Gruppo 1 Padova

Stato Esperimenti, Anagrafica e Preventivi

CdS

5/7/2023

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Slides by Martino, Ale, Ezio, Donatella, Patrizia, Lorenzo, Enrico, Gabriele e tanti altri …

Outline

- General Summary
- Belle II
- CMS / Fase2_CMS
- LHCb
- LUXE
- MuonE
- RD FCC
- RD MuColl
- TwoCrys

Sigle in ordine ~alfabetico

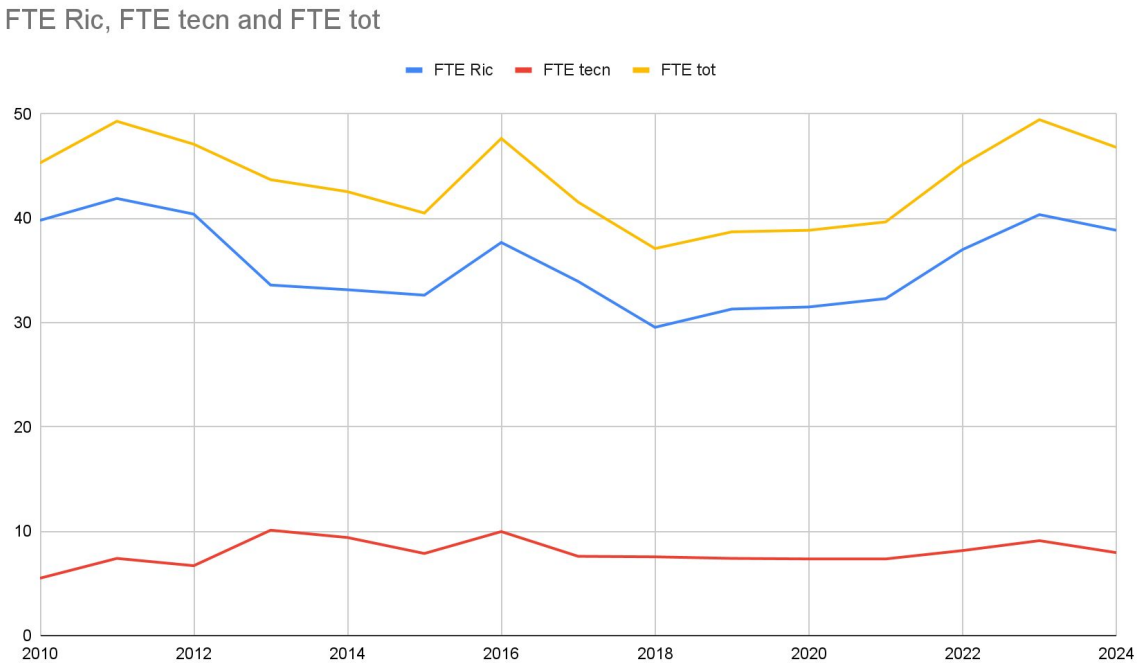
NB: verosimilmente le sigle di CSN2 di neutrini agli acceleratori passeranno in CSN1 gia' dal bilancio di Settembre

- Dune
- T2K (dal 2025)

Presentazione ancora su CSN2 (Andrea) domani.

L'anagrafica potrebbe essere soggetta a piccole variazioni come al solito

Anagrafica Gruppo1 ultimi 10 anni

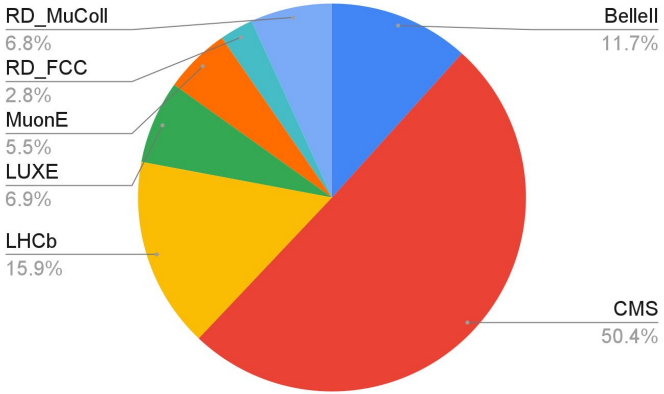


FTE preliminari!!!

FTE e persone per sigla

Da aggiornare

	Belle II		CMS		FASE2_CMS		LHCb		LUXE#		MuonE		RD_MuColl		RD_FCC_DTz	
	FTE	Px	FTE	Px	FTE	Px	FTE	Px	FTE	Px	FTE	Px	FTE	Px	FTE	Px
2021	5.15	11	19.55	24	9.3	22	4.8	10			3.25	9	3.95	15	0.3	2
2022	4.5	9	FTE: 26.3		Px: 37		5.5	9	3.7	7	1.35	5	3.4	15	0.9	6
2023	5.5	10	FTE: 23.5		Px: 32		6.2	10	3.45	8	2.75	9	3.6	13	1.1	9
2024	5.4	9	FTE: 23.3		Px: 35		7.35	12	3.2	9	2.45	0	3.6	13	1.3	10
Δ	-0.1	-1	-0.2		+3		+1.15	+2	-0.25	+1	-0.3	-	-	-	+0.2	+1



Totale: **Ricercatori+Tecnologi: 49.45 FTE**
2023 46.8 FTE

NB anagrafiche da confermare

Belle II

RL: Stefano L.

Belle II - status and future

- Collected ~430 /fb, 362 at Y(4S)
  - Lmax: ~4.7E34 cm-2s-1
- Now in LS1
  - Lot of works in progress for accelerator
  - And detector (next slide)

SuperKEKB: LINAC and Main Ring

LS1 (many upgrade works at SuperKEKB)

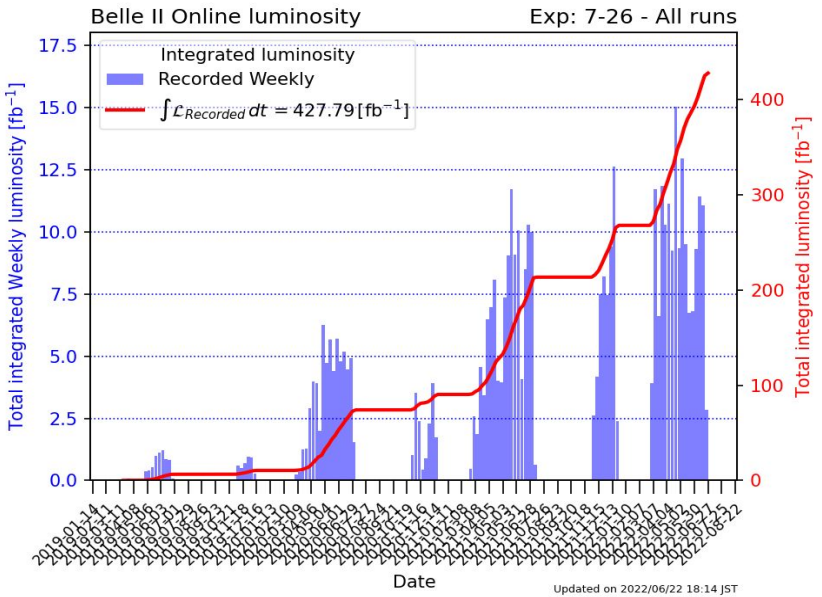
LINAC

- e- beam
  - Laser system has worked fine without any significant trouble.
  - DOE was installed also at 2nd laser line in the last summer maintenance, and it has worked fine.
  - In the run 2022a/b, bunch charge of 2 nC can be kept with bunch charge feedback.
  - 5 nC from gun was demonstrated. Further beam study is on-going during LS1.
  - New DOE with large area improve energy spread and emittance until HER injection.
  - BTe-ECS is planned to install at FY2024
- e+ beam
  - The new FC is working fine.
  - Reached bunch charge of 3.5 nC at BT end (final design 4 nC).
- Upgrade work during LS1
  - Pulsed Quads (x8) at J-ARC for the simultaneous dedicated matching of HER/LER injection beam
  - Pulsed Quads (x4) at Sector1, 2 for low beta optics of HER injection beam
  - New accelerating structure
  - Replacement of air conditioners at SectorA, B (in the accelerator tunnel)
  - Fast kicker for 2nd bunch orbit correction
- Issues
  - Emittance growth at end of BT2 for both of e- and e+ beam (BT report, Injection report)
  - Low e- injection efficiency of 2nd bunch
  - Increase the e- bunch charge while keeping small emittance

MR

- Many upgrade & maintenance works are progressed during LS1.
  - LS1 started in July 2022 and will end in November 2023.
  - Next beam operation is scheduled to restart in December 2023.
- Progress of "IR works" & "NLC construction" were reported.
  - And also, damaged collimator heads were replaced with new ones.
  - Most planed works will be completed by October 2023.
  - Beam operation will resumed from December 2023.
- Sudden Beam Loss (SBL) is one of the concerned issues to be solved.
  - Frequently, the beam suddenly disappears within few turns just before the abort.
  - The cause of SBL is still unknown. (Several candidates for the cause are considered.)
  - Continuation of investigation or study of SBL is needed to avoid it.

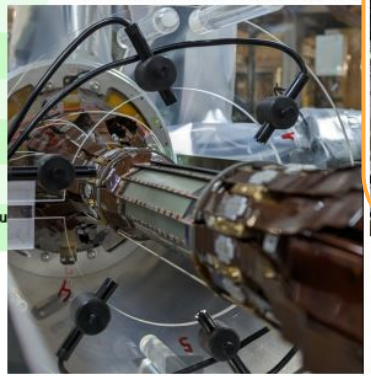
is this sufficient to solve our main issues during run 1 ?



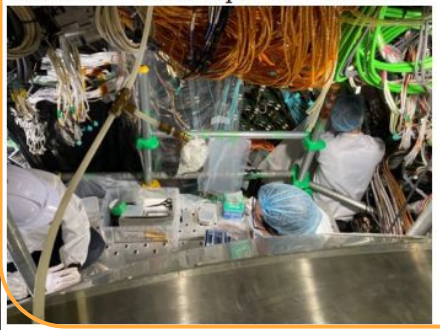
Detector upgrade and maintenance

PXD/SVD	PXD commissioning plan in KEK, and VXD reinstallation. SVD 3/6-mixed mode.
CDC	Improvement in gas circulation and monitoring
TOP	TOP MCP-PMT replacement
ECL	Improvement in pedestal correction Gain adjustment on ShaperDSP
KLM	BB2 efficiency recovery Reinforcement of monitoring system
TRG	Optimization of trigger veto. TOPTRG
DAQ	PCIe40 long-term stability test with realistic high-occupancy data
Background	Additional neutron shields
MDI	Installation of additional loss monitors and speed-u abort signal

PXD2 at KEK since March



TOP MCP−PMT replacement work

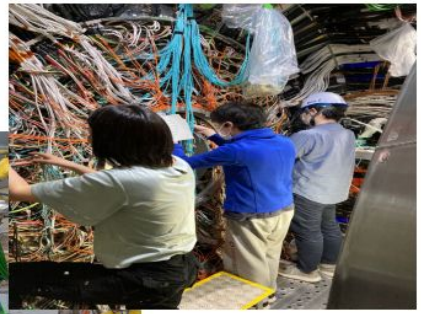


Padova involved

VXD extraction in May

SVD standalone commissioning

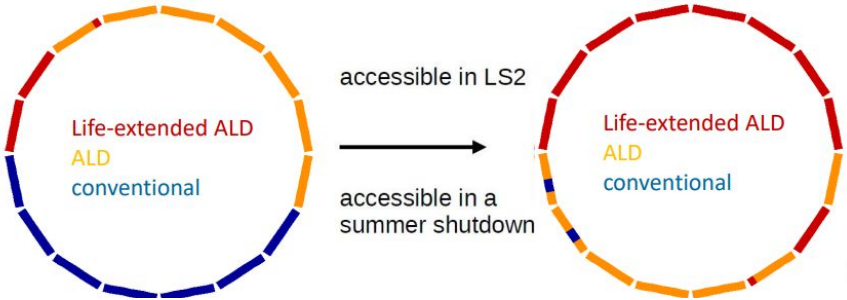
CDC FE reinstallation work

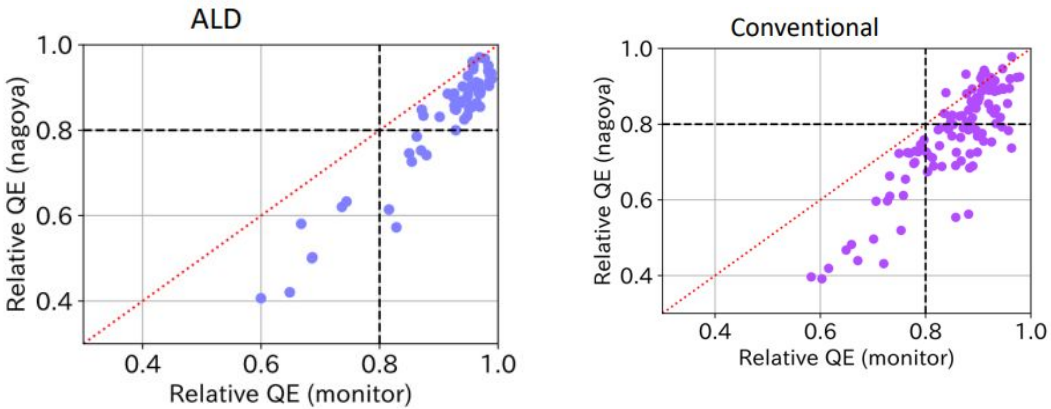


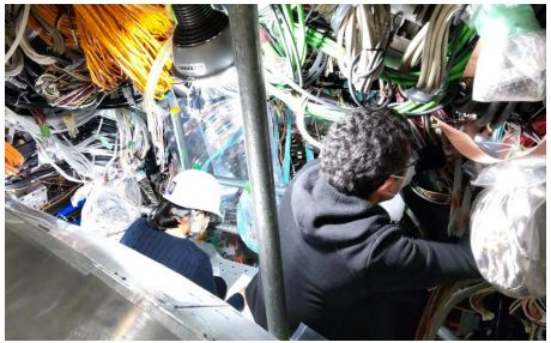
but also DAQ upgrade, KLM work, ...

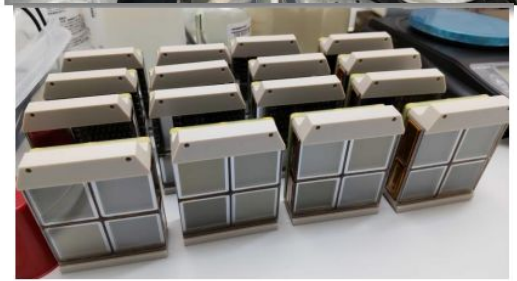
TOP PMT replacement

- Replace bad electronics
- Started from upper half to move ALD PMTs to lower half









Operation schedule and constraints for JFY2024

Rough idea of the near-term run periods

https://confluence.desy.de/display/BI/Run+Plan

Fiscal year	4	5	6	7	8	9	10	11	12	1	2	3
2021	2021b							2021c				2022a
2022	2022b			LS1								
2023									2023c	①	2024a	
2024	2024b			③			2024c			②		2025a
2025	2025b							2025c		①	2026a	
2026	2026b							2026c		①	2027a	

Assumption: 7 months operation per fiscal year with sufficient budget

① Pause of operation for new year holidays instead of a usual winter shutdown
(decided to try it first in FY2023; to be discussed for FY2025 and beyond)

② Power restriction due to renewal of the central electric power substation
(already decided)

③ Renovation work of the roof of Tsukuba Hall in parallel to the operation
(under discussion → We are asked to give the green light by Jun 9.)

What are our goals for 2024 ?

(please a clear and sound message)

Run stably at $10^{35}/cm^2/s$

Reach 150 fb^{-1} per month

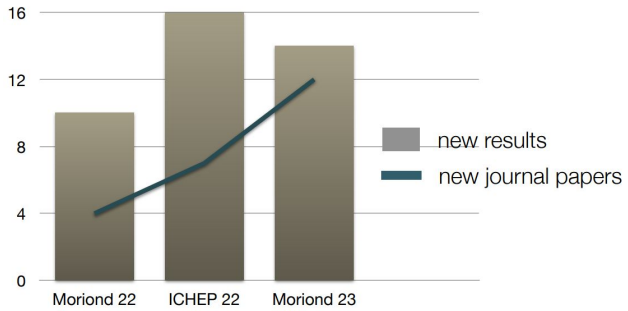
Exceed 1 ab^{-1}

(setting the pace for run 2)
(while doing good physics and working for the upgrade)

Belle II - Physics

Journal-paper results approved in past 16 months

Measurement of the Ds lifetime — world leading, arXiv: 2306.00365
Energy-dependence of $B^{(*)}B^{(*)}$bar cross section — unique
Observation of $ee \to \omega\chi b$ at 10.75 GeV — unique, PRL. **130**, 091902 (2023)
Test of light-lepton universality in $B \to D^* \ell\, \nu$ decays — unique
Test of light lepton universality in inclusive $B \to [Xc]\ell\nu$ decays — unique, arXiv: 2301.08266. Accepted
Measurement of CKM angle γ using GLW — Belle + Belle II sample
Measurement of CKM angle γ using GLS — Belle + Belle II sample, arXiv: 2306.02940
Search for long-lived spin-0 mediator in b → s transitions— world leading, arXiv: 2306.02830
Measurement of of the τ mass — world leading, arXiv: 2305.19116
BF and ACP in $B^0 \to h^+h^{\sigma-}$ decays and isospin sum rule — world leading
BF and ACP of $B^0 \to \pi^0\pi^0$ decays — competitive, arXiv: 2303.08354. Accepted
ACP in $B^0 \to K^0_S K^0_S K^0_S$
|Vcb| using untagged $B \to D^* \ell\, \nu$ decays — competitive
CPV in $B^0 \to K^0\pi^0$ decays — competitive, arXiv: 2305.07555
CPV in $B^0 \to \phi K^0_S$
Novel method for charm flavor tagging — unique, arXiv: 2304.02042. Accepted
B^0 lifetime and oscillations in $B^0 \to D^{(*)}h$ decays PRD **107**, L091102 (2023)
Search for a dark-sector ττ resonance in ee → mumu ττ decays — world leading
Search for a dark-sector Z' to invisible — world leading, PRL **130**, 231801 (2023)
Search for τ → ℓ α — world leading PRL **130**, 181803 (2023)
Search for a dark γ and invisible darkHiggs in μμ+MET— world leading, PRL **130**, 071804 (2023)
Measurement of the Ω^0_c lifetime — PRD **107**, L031103 (2023)

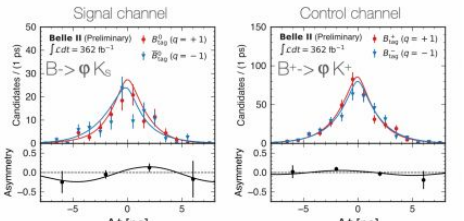


Physics Highlight

B-> φ K_S NEW FOR MORIOND

- Simultaneous Δt fit to extract the CP asymmetries
  - B->K+K-K_S fixed from HFLAV
  - Validated on the B+ control sample (null asymmetry)
- Mostly unique to Belle II
  - On par with most precise determinations of A_{CP}
  - 10-20% improvement on S_{CP} for the same signal yield wrt Belle/BaBar determinations

(background subtracted)



$A_{CP} = 0.31 \pm 0.20^{+0.05}_{-0.06}$
$S_{CP} = 0.54 \pm 0.26^{+0.06}_{-0.08}$

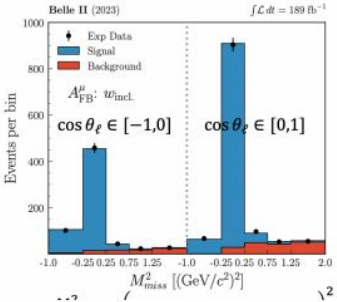
$A_{CP} = 0.12 \pm 0.10$ (stat.)
$S_{CP} = -0.09 \pm 0.12$ (stat.)

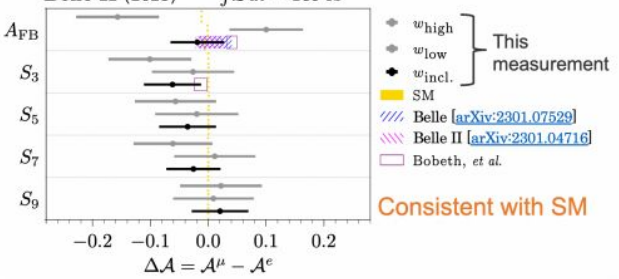
HFLAV: S = 0.74$^{+0.11}_{-0.13}$, A = -0.01±0.14

Light-Lepton Universality Test: Angular Asymmetry

New for Moriond

We tested lepton universality by comparing five angular asymmetries of e and μ, $\Delta\mathcal{A}_x(w) = \mathcal{A}_x^{\mu}(w) - \mathcal{A}_x^{e}(w)$, using exclusive $\bar{B}^0 \to D^{*+}\ell^-\bar{\nu}_\ell$ decays.





Consistent with SM

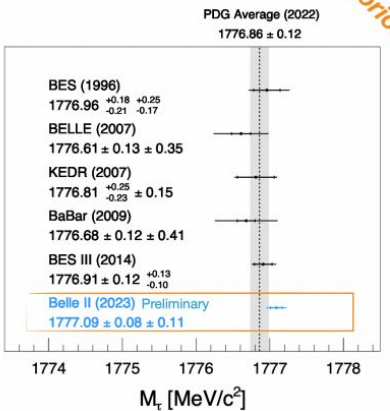
First e-μ universality test of differential angular observables in w

No evidence of lepton universality violation with at least p-values of 0.12

World-best τ mass

New for Moriond!

12



Isospin sum-rule and $K_S\pi^0$

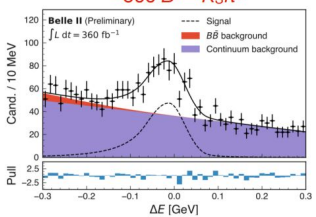
Two analyses for $B^0 \to K_S\pi^0$, one decay-time integrated and the other decay-time dependent [arXiv:2305.07555], combined to enhance sensitivity:

$\mathcal{B} = (10.50 \pm 0.62 \pm 0.67) \times 10^{-6}$

$A_{CP} = -0.01 \pm 0.12 \pm 0.05$

$S_{CP} = 0.75^{+0.20}_{-0.23} \pm 0.04$

~500 $B^0 \to K_S\pi^0$

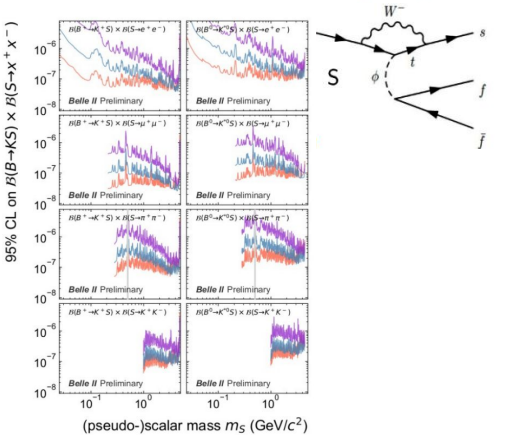


Putting all $K\pi$ results together, *the Belle II isospin sum-rule gives*

$I_{K\pi} = (-3 \pm 13 \pm 5)\,\%$

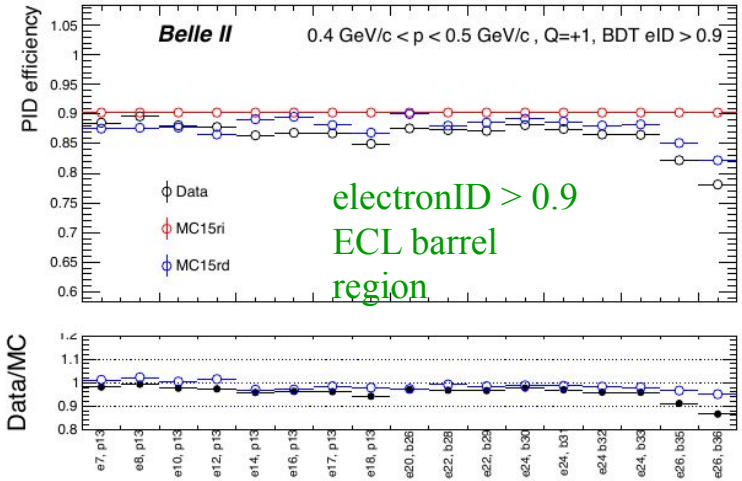
Agrees with SM. Competitive with world average of $(-13 \pm 11)\,\%$

First Belle II long-lived particle (LLP) search

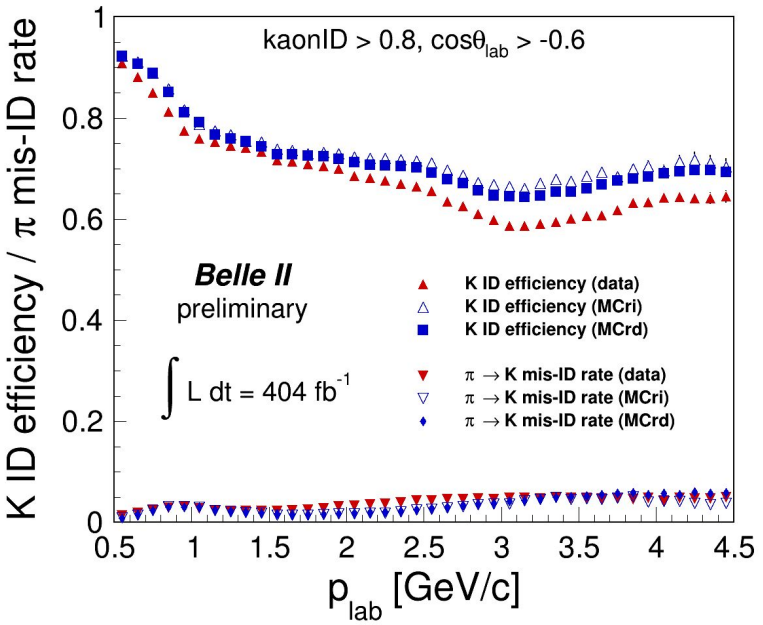


PID performance monitoring

- Mandate of the group: measure the PID performance of the detector and provide efficiency corrections / systematic uncertainties to be used in analysis:

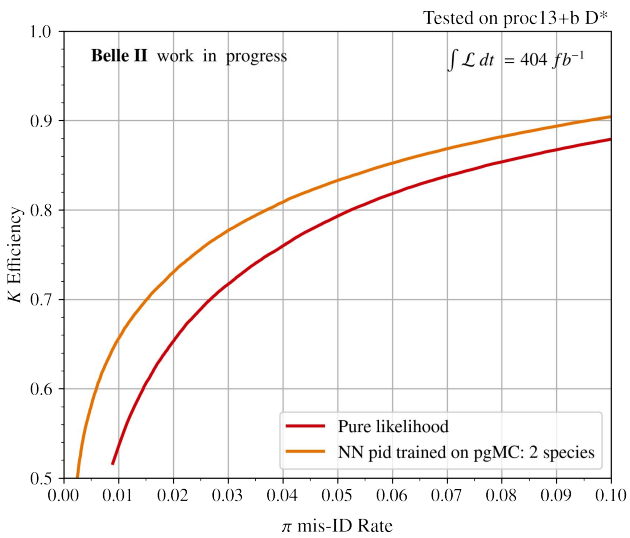


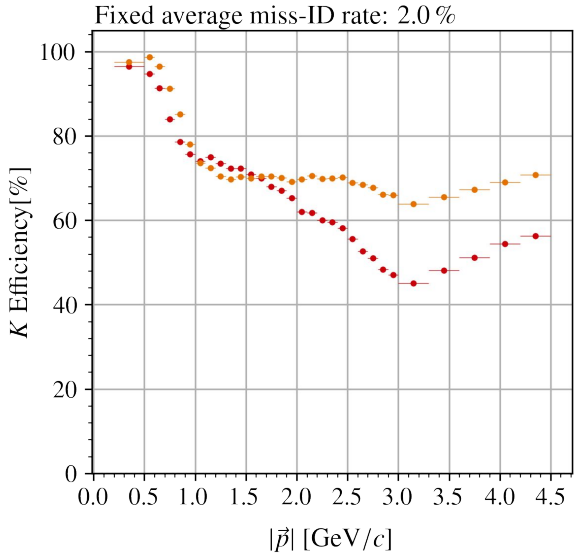
Effects of beam background are well reproduced in the run dependent Monte Carlo

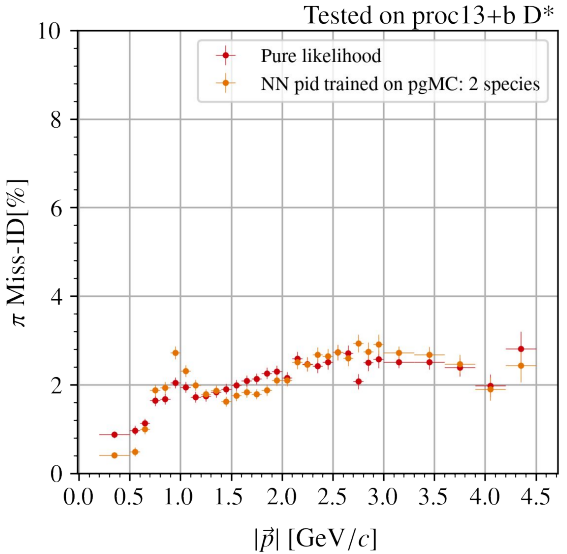


Developments in PID

- Pushing beyond the default Belle II approach, based on likelihood ratios from all the subdetectors contributing to PID;
- Feeding high level info to a Neural Network to discriminate between pions and kaons:



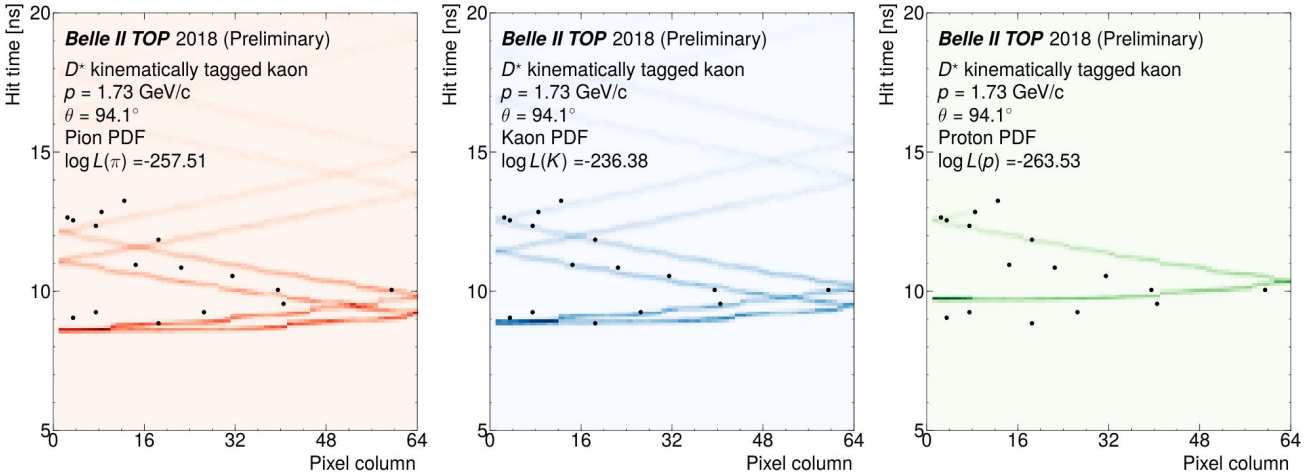




The NN outperforms the likelihood based discriminator, especially at high momentum

TOP with machine learning

- The TOP PID relies on pattern matching between the measured position and time of arrival of the Cherenkov photons, and the pdf's, which depend on the particle hypothesis and track parameters;
- Right now, the pdf computation is done analytically;
- Significant drawbacks, as this requires a ~perfect MC modeling of the detector;

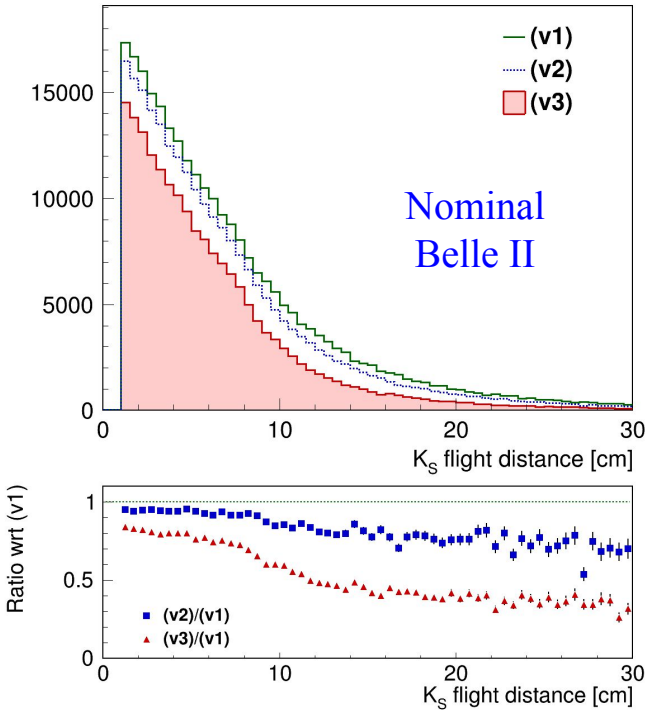


- We started developing a new approach, in which the pattern recognition is performed by a more sophisticated tool, based on machine learning.

We obtained a dedicated PhD scholarship on PNRR funds to work on this

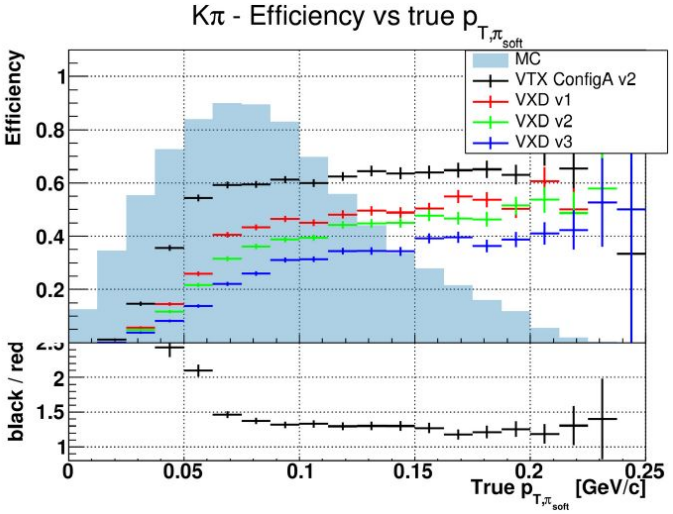
Belle II Upgrade

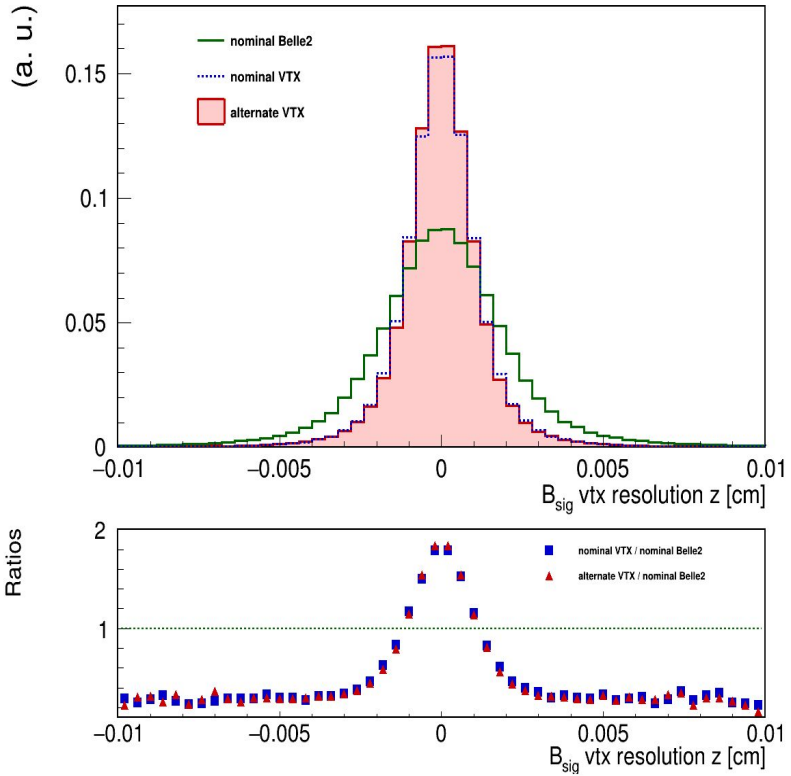
- We are exploring the options for an upgrade of Belle II, to happen around the year 2028 (LS2);
- Main motivation: recover the performance that is lost due to the higher than anticipated machine-related backgrounds;
- Two projects currently on the table:
  - VTX: 5 layer pixelated silicon detector, to replace PXD and SVD;
  - instrumenting the KLM barrel with scintillators (replacing the RPC's), and adding TOF capabilities;
- We aim at producing a CDR for the coming Fall.



Impact on K_S reconstruction efficiency in different background scenarios (optimistic, realistic, pessimistic)

Belle II Upgrade – VTX





Very significant improvement of VTX over the currently installed VXD (PXD+SVD) in terms of soft p reconstruction efficiency and vertexing resolution.

AIDAinnova task 8.4.2 sinergica a Belle II

SiPM development for the TOP detector upgrade of the Belle II experiment

AIDAinnova Padova members

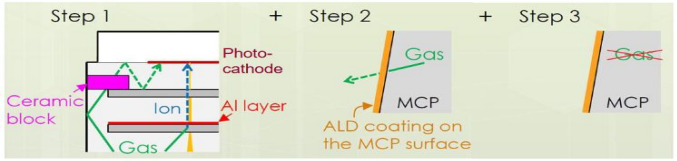
	Flavio Dal Corso	Jakub Kandra[(a)]	Roberto Stroili	Ezio Torassa
2023	AIDAinnova 10%	0%	0%	10%
	Belle II 30%	100%	100%	90%
2024	AIDAinnova 0% ?	100%	0%	10%
	Belle II 40% ?	0%	100%	90%

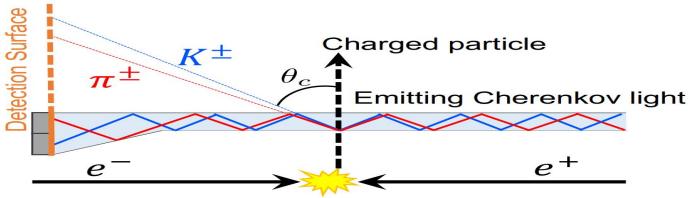
Three types of MCT-PMTs
have been installed in the TOP detector

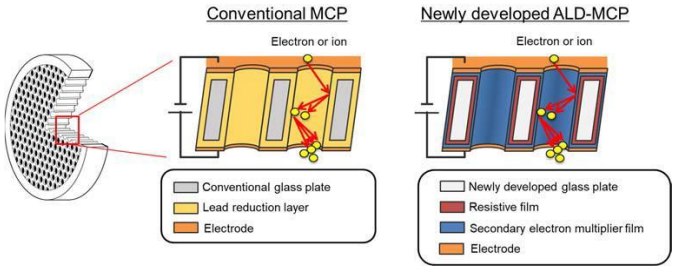
Step 1: Conventional

Step 2: Atomic layer deposition (ALD)

Step 3: Lifetime extended ALD







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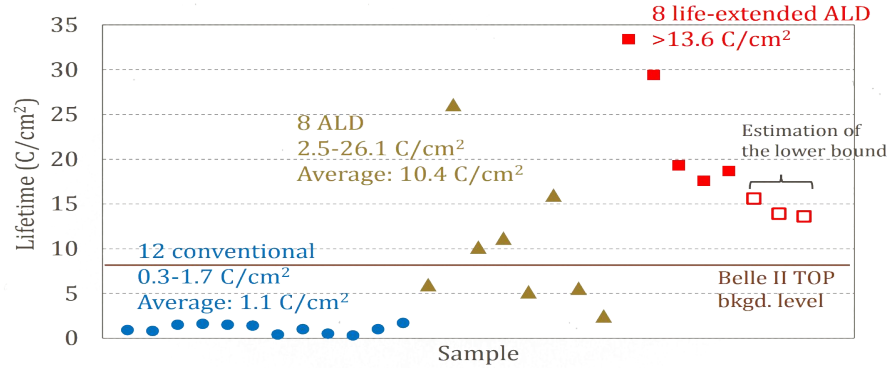
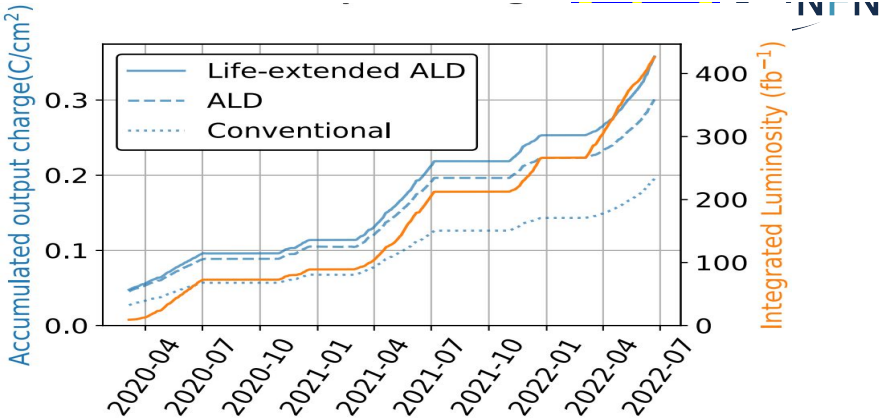
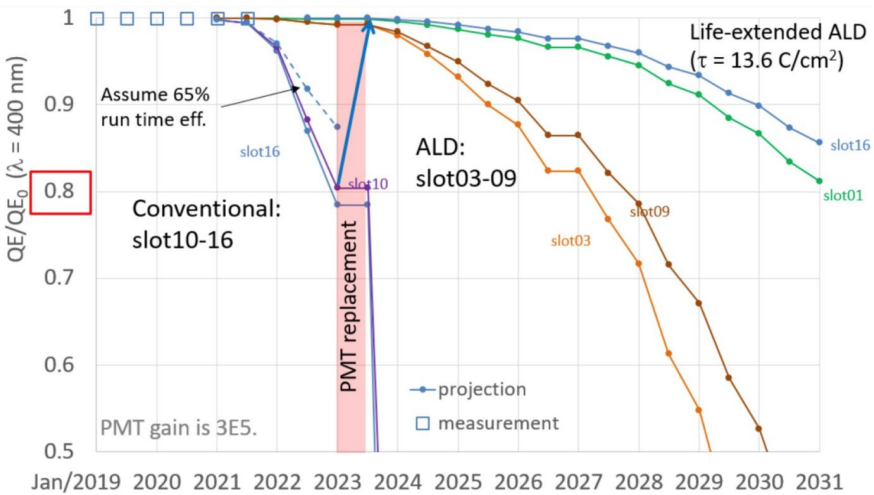
Lifetime: charge (C/cm^2) reducing QE to 80% measured in 2017 with led source



Accumulate charge up to long shutdown



Expected QE degradation with expected $\mathcal{L}$ increase



During the current long shutdown we replaced ~250 conventional MCP-PMT.

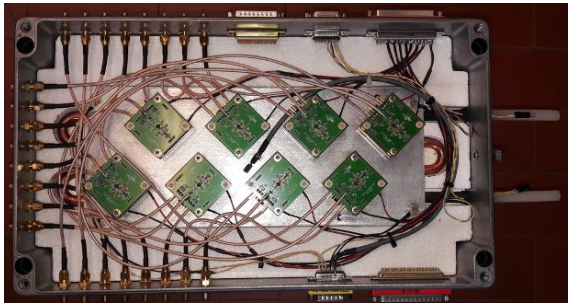
How many years life-extended ALD can survive @ $\mathcal{L} = 6 \times 10^{35}$ cms^{-2} s^{-1} ?

If the accelerator can reach even higher luminosities we do not have a working solution.

New MCP-PMT developments and radiation hardness SiPMs must be investigated.

Tests are ongoing in Padova measuring the characteristics of SiPMs in the market for different temperatures, before and after irradiation. AIDA funds available at FBK to produce new prototypes

Dark box with SiPM blocks over cooling plate



SiPMs illuminated with picosecond laser
T from +20 °C to -50 °C

Available SiPMs tested / to be tested

PRODUCER	cell size	dimensions
OnSemi	35μm	1x1 - 3x3 mm^2
Hamamatsu	15-25-50 μm	1.3x1.3 - 3x3 mm^2
FBK	15μm	1x1 - 3x3 mm^2
Ketek	15-35 μm	3x3 mm^2

Preliminary results of SiPM irradiated in Nov. 2022, next irradiation in July 2023

5.07 x 10^{11} neutrons/cm^2

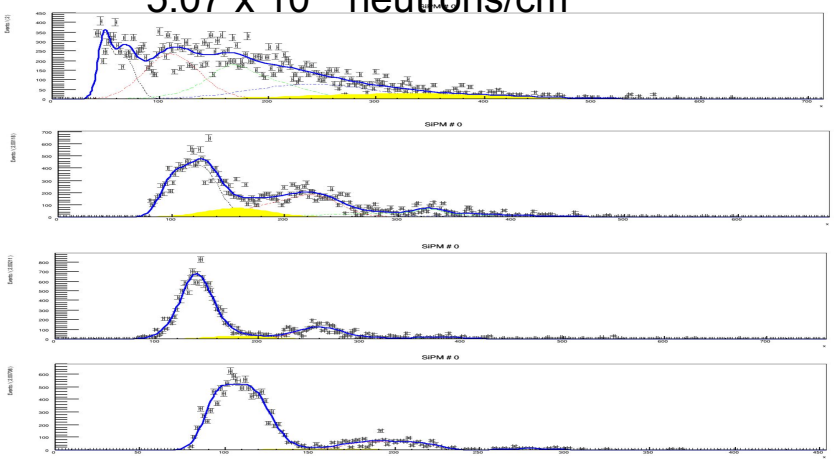
5.07 x 10^{10} neutrons/cm^2

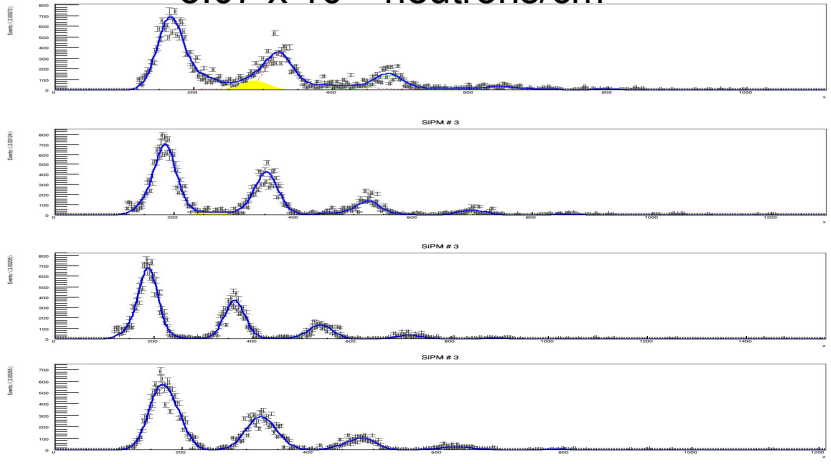
20 °C

0 °C

- 20 °C

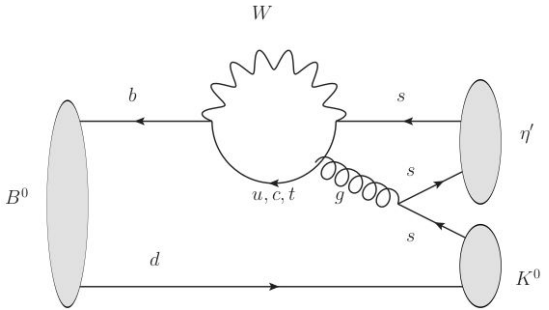
- 40 °C





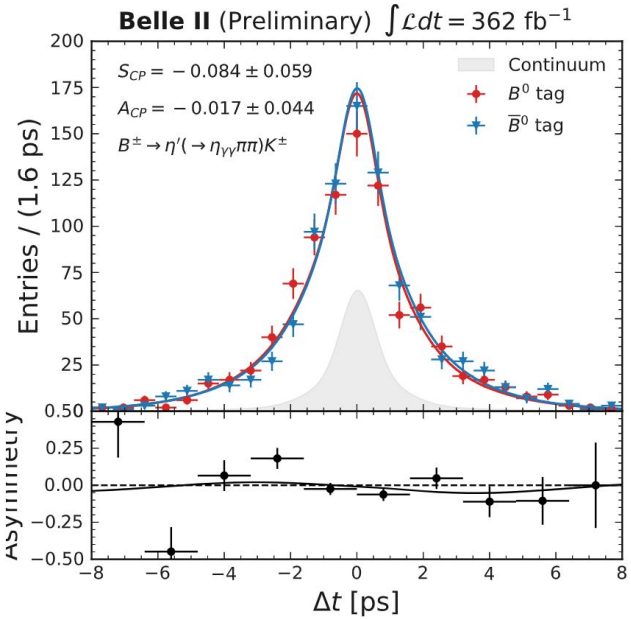
TDCPV B→ η' K_s analysis: Motivation

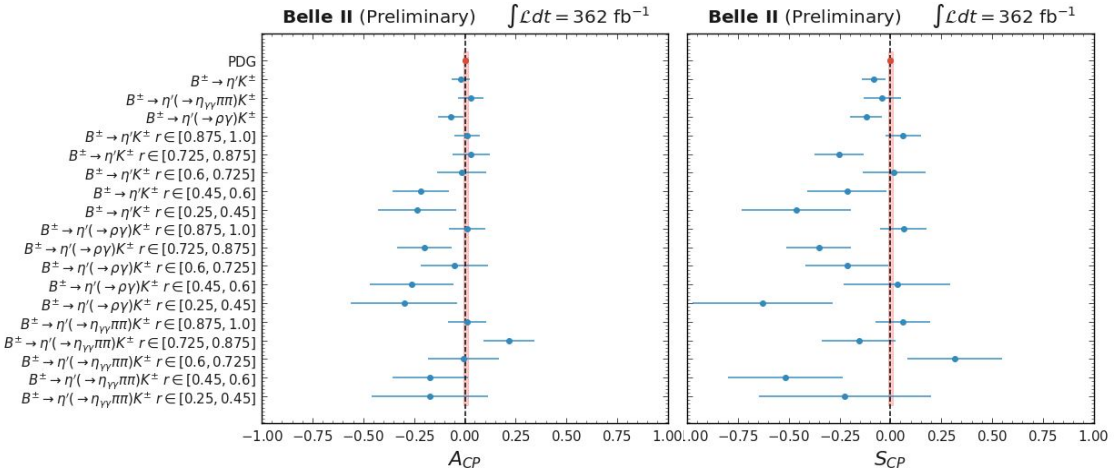
- b→ qqs charmless decay hadronic penguins
- Highest BR for b→qqs decays
  - significantly lower than golden channel B → J/ψK_S
- TDCPV measurement interesting for comparison with b→ccs transition
  - Very little tree pollution, theoretically very clean
    - $S_{\eta'K} = \sin 2\varphi_{eff}$, $\Delta S_{\eta'K} \approx \pm 0.01$
  - **Most sensitive channel for the detection of NP**
- **Analysis closed to publication (not yet)**



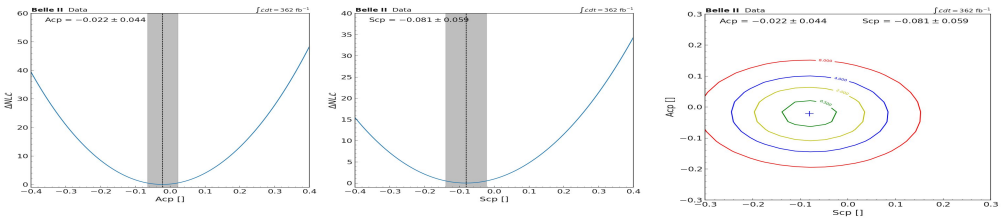
η′K^0	BaBar N(BB)=467M	0.57 ± 0.08 ± 0.02	−0.08 ± 0.06 ± 0.02
	Belle N(BB)=772M	0.68 ± 0.07 ± 0.03	−0.03 ± 0.05 ± 0.03
	Average	**0.63 ± 0.06**	**−0.05 ± 0.04**

ACP and SCP fit in control channels





	C_{CP}	S_{CP}
$B^\pm \to \eta'(\to \eta_{\gamma\gamma}\pi^+\pi^-)K^\pm$	-0.027 ± 0.063	-0.042 ± 0.091
$B^\pm \to \eta'(\to \rho\gamma)K^\pm$	0.069 ± 0.061	-0.110 ± 0.078
simultaneous fit	0.018 ± 0.044	-0.083 ± 0.059



TD B->eta' Ks analysis

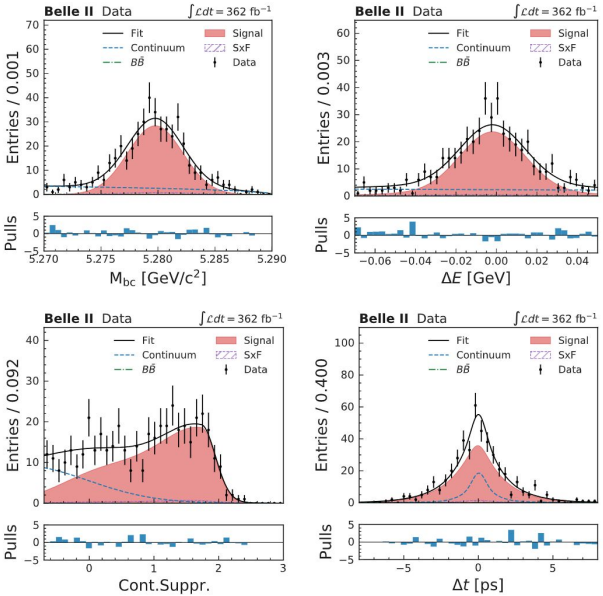
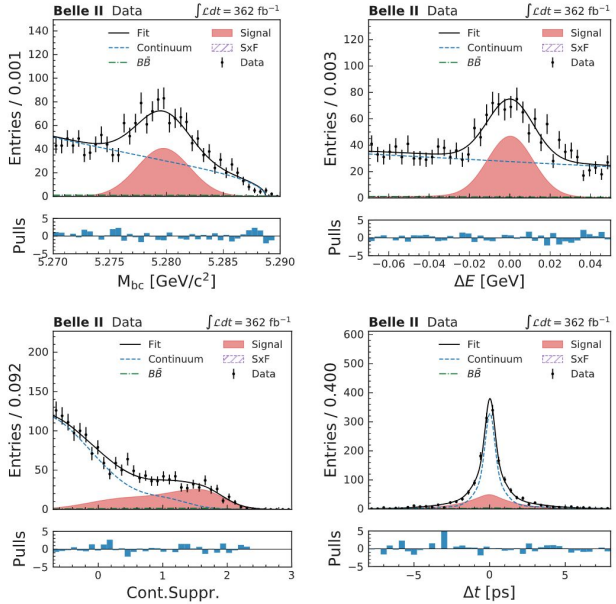
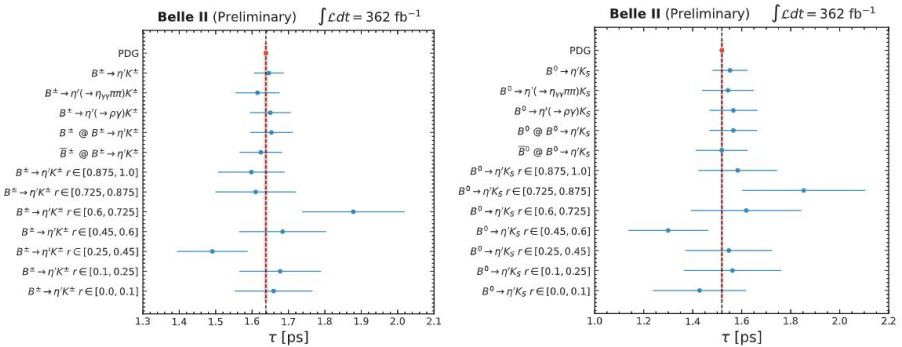


TABLE 20. Lifetime fit results on Data

channel	τ_B [ps]
$B^{\pm} \to \eta' K^{\pm}$	$1.643^{+0.042}_{-0.041}$
PDG	1.638 ± 0.004
$B^0 \to \eta' K^0_S$	$1.565^{+0.076}_{-0.071}$
PDG	1.519 ± 0.004





TD B->eta' Ks analysis

- Analysis fully done in PD
  - Flagship analysis in Belle II
- In later phase of internal review
  - Expecting the permission to unblind data for signal channels very soon
    - Maybe even today

Parameter	Result	Analysis	$nB\overline{B}$ ($\times 10^6$)
	.. $\pm$ 0.08 $\pm$ 0.026	this analysis	387
C_{CP}	-0.05 ± 0.04	World average [5]	
	$-0.03 \pm 0.05 \pm 0.03$	Belle [3]	772
	$-0.08 \pm 0.06 \pm 0.02$	BaBar [4]	467
	.. $\pm$ 0.10 $\pm$ 0.036	this analysis	387
S_{CP}	0.63 ± 0.06	World average [5]	
	$0.68 \pm 0.07 \pm 0.03$	Belle [3]	772
	$0.57 \pm 0.08 \pm 0.02$	BaBar [4]	467

- Results competitive with Belle/BaBar
  - Still limited by statistics
- Future plan:
  - BR measurement (can be world leading)
  - Use new GNN flavour tagger (30->40% effective tagging power on data!)
  - include more final states
    - possibly KL

Anagrafica e Richieste

- Benettoni 10 → 10%
- Dal Corso 30 → 40% ?
- Gaz 100 → 100%
  - EB member, HadronID conv. (L2)
- Lacaprara 100 → 100%
  - Data Production manager (L1), EB/IB member
- Kandra 100 → 100%
- Sartori 0 → 0%
- Simonetto 10 → 0%
- Stroili 100 → 100%
- Torassa 90 → 90%
  - **Totale 5.4 5.3**
  -

Richieste servizi:

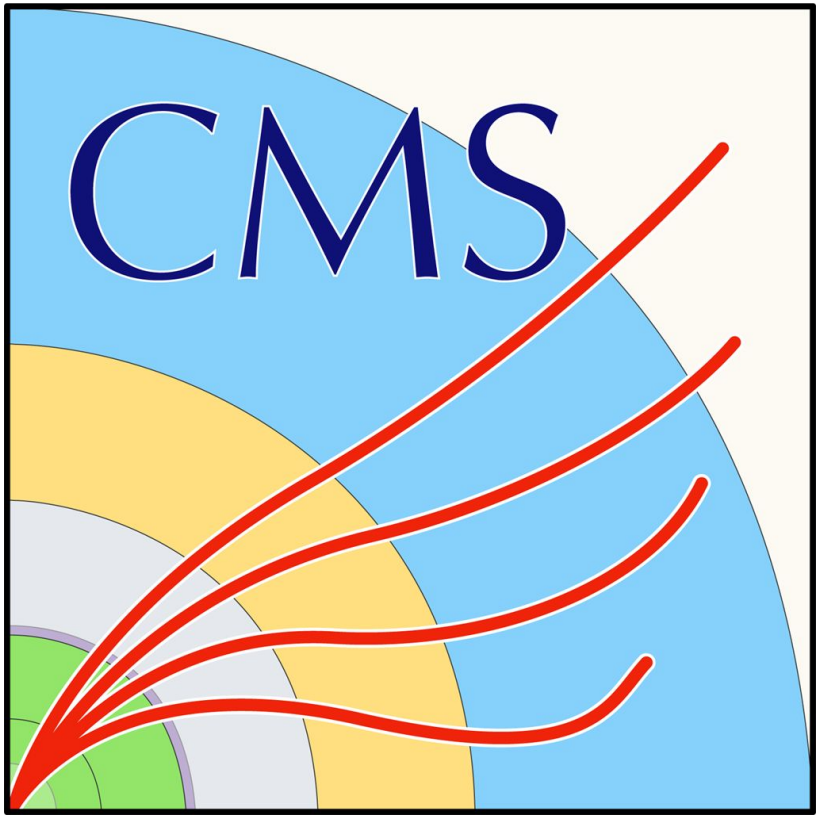
- Servizio progettazione Meccanica (progettazione prototipo cooling SiPM)
  - **1 m. u.**
- Servizio progettazione ed officina Elettronica
  - SiPM e MCP-PMT
  - **1+1 m. u.**

Richieste in CSN1

- In discussione

CMS

RL: M.Margoni



Sommario

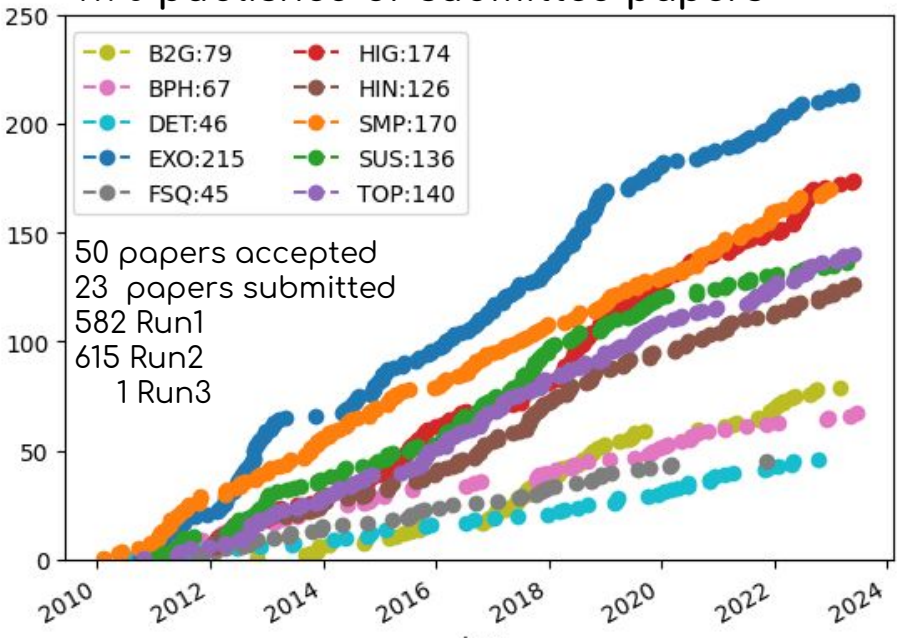
- Highlights da CMS
- Fisica padovana in CMS
  - Analisi & Preparazione Run3
  - Outreach
  - Detector
- Anagrafica 2023 → 2024
- Responsabilità
- Richieste 2024

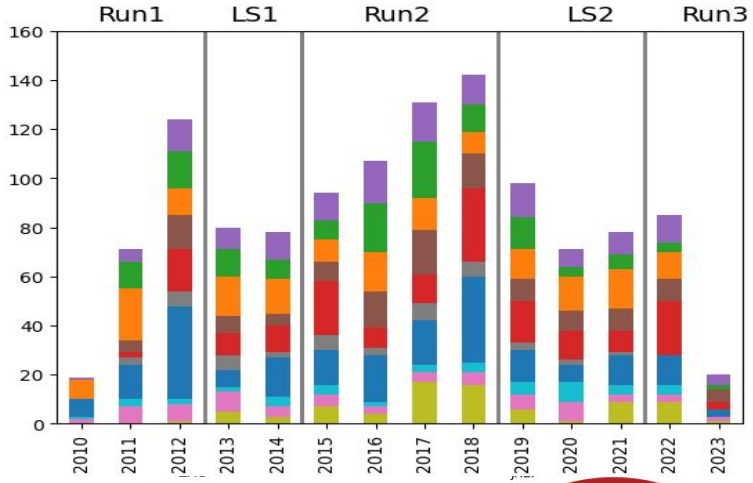
CMS e` arrivato a 1200 pubblicazioni con dati LHC

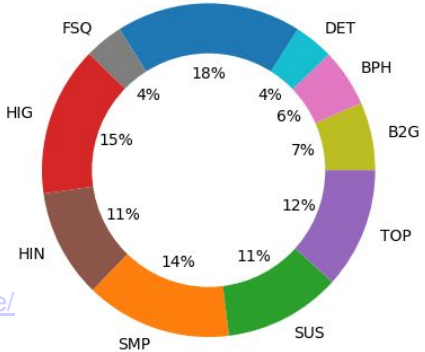
Show all | Total | Exotica | Standard Model | Supersymmetry | Higgs | Top | Heavy Ions

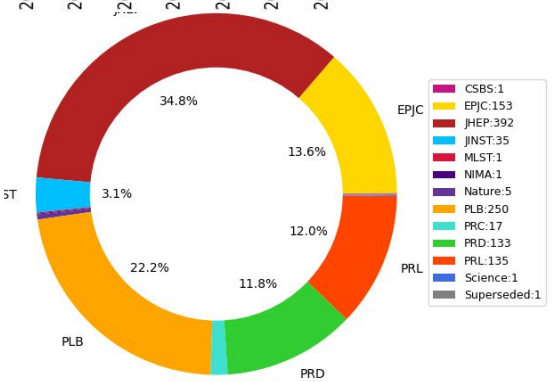
B and Quarkonia | Forward and Soft QCD | Beyond 2 Generations | Detector Performance

1198 published or submitted papers









http://cms-results.web.cern.ch/cms-results/public-results/publications-vs-time/
https://mia-tosi.web.cern.ch/CMS_publications/plots/

CMS e` arrivato a 1200 pubblicazioni con dati LHC

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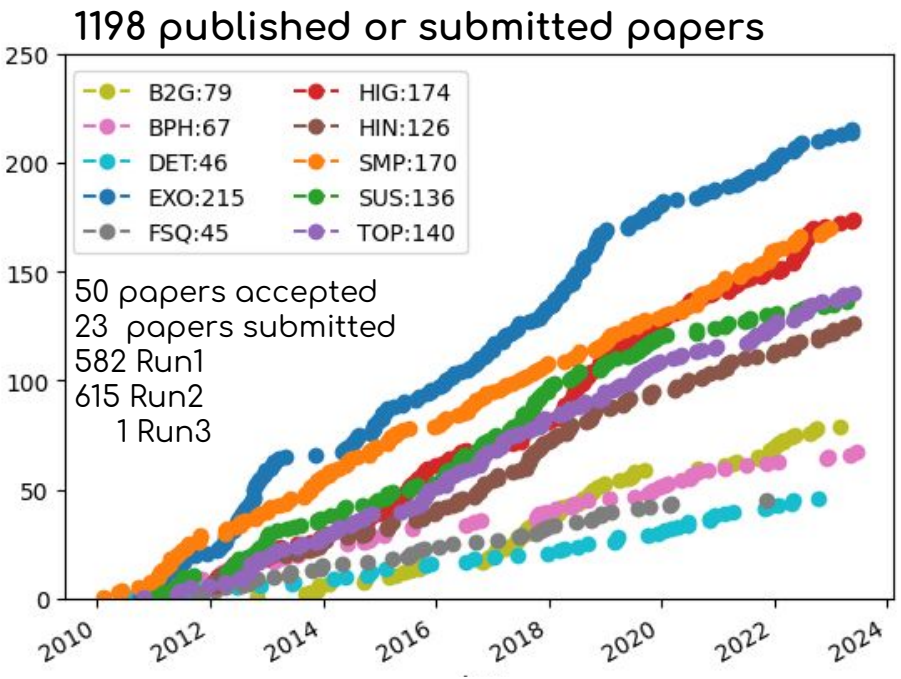
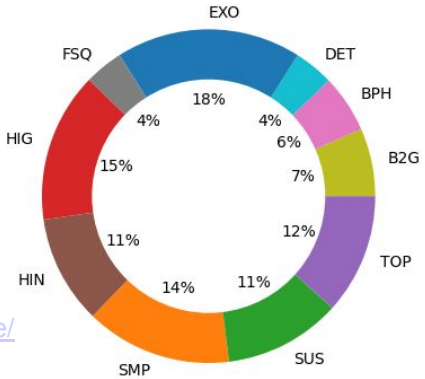
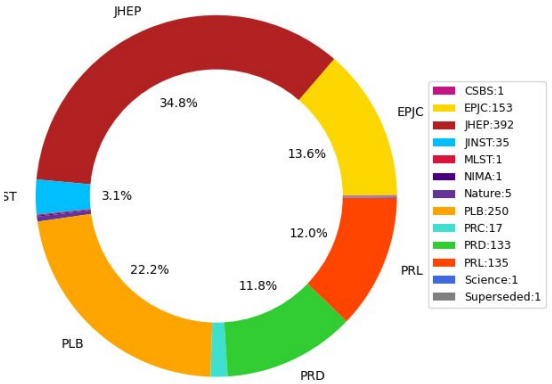


http://cms-results.web.cern.ch/cms-results/public-results/publications-vs-time/
https://mia-tosi.web.cern.ch/CMS_publications/plots/

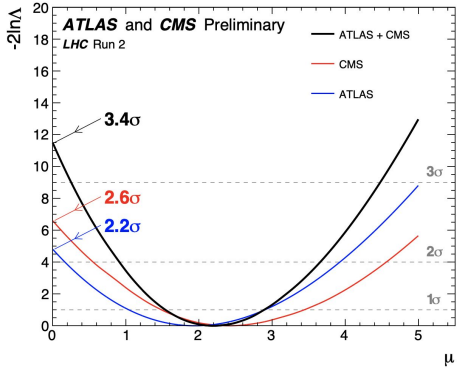
- Padova Group:
strongly involved in B physics, Standard Model, Higgs and Exotic searches

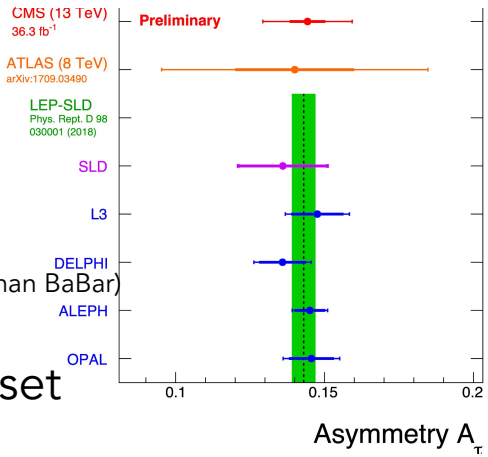




CMS highlights

- Top physics:
  - x-section ttbar at $\sqrt{s}$ = 13.6 TeV (Run3 result)
  - observation of four top quark production
- Higgs physics:
  - evidence of rare H→Zγ (ATLAS + CMS)
  - di-higgs combination : ~3x SM sensitivity
  - Higgs width measurement : Γ_H = 3.2 +2.4 -1.7 MeV
- standard model physics:
  - measurement of the **τ**-polarization in Z decays
  - **exclusive γγ→WW and γγ→ZZ**
- heavy flavour physics:
  - BR(**τ→μμμ**) < 2.9 (2.4)x10-8 at 90% CL (best LHC limit, even better than BaBar)
  - Bs→**μμ** measurement (most precise BR & lifetime)
  - observation of rare decay **η→μμμμ** using scouting dataset





Fisica padovana in CMS: Analisi

Summary Analisi

- Ricerca di neutrino di Majorana in modelli composti con due leptoni e due jet nello stato finale. Tesi di Dottorato di Matteo Presilla, ora assegnista a Perugia. **Pubblicata recentemente** (P. Azzi, M. Presilla)
- Produzione associata di Higgs e Bosone vettore VH, H → cc. **Accettata dalla rivista** (P. Bortignon)
- Ricerca di Vector Boson Scattering nei canali semileptonici WVjj e ZVjj (P. Azzi, M. Presilla)
- Misura della violazione della simmetria CP nel canale $B_s \rightarrow J/\psi\Phi$. Pubblicata nel 2021, si sta lavorando a un tagging di flavor innovativo che raddoppierà la precisione. Tesi di Dottorato di Enrico Lusiani (A. Bragagnolo, E. Lusiani, M. Margoni, P. Ronchese, F. Simonetto)
- Ricerca di decadimenti rari Z, H → J/ψγ. (R. Ardino, U. Gasparini, A. Zucchetta)
- Ricerca di accoppiamenti di Gauge anomali (U. Gasparini)
- Produzione elettrodebole di W+2jets (A. Bulla, P. Bortignon, M. Tosi)
- Sezione d'urto differenziale tt canale dileptonico (G. Celotto, T. Dorigo)
- Ricerca del decadimento hh → 4b (J. M. Villa Damigo, T. Dorigo)

EXO Search for HNL

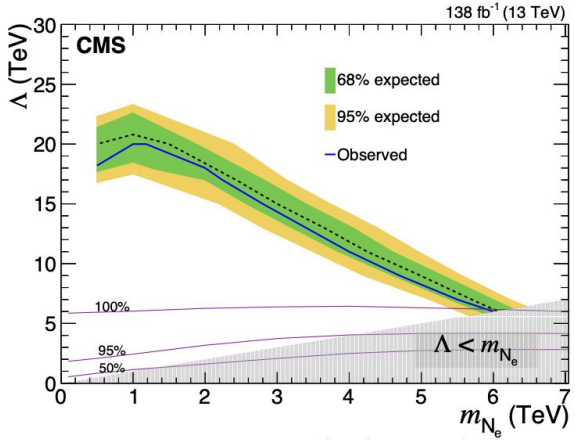
EXO-20-011 “Search for Heavy Composite Majorana Neutrinos”:

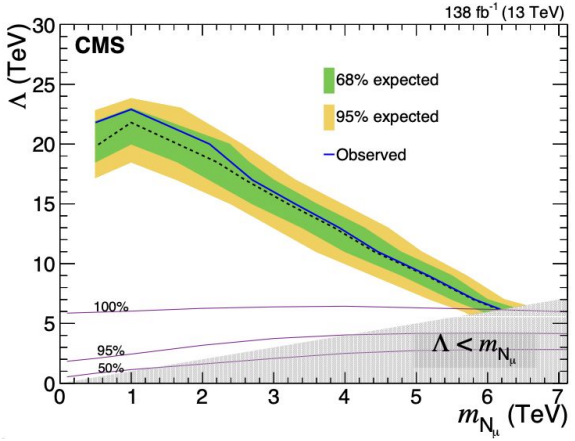
- Paper being published by PLB (proof received)
- Search for heavy composite majorana neutrinos in two independent final states eeqq, μμqq with two SF high-pt isolated leptons and one fat jet capturing the two quarks (more efficient given the specific theoretical model studied). Full Run2 statistics.

EXO-23-006: Review of VLQ+VLL+HNL searches at CMS in Run2

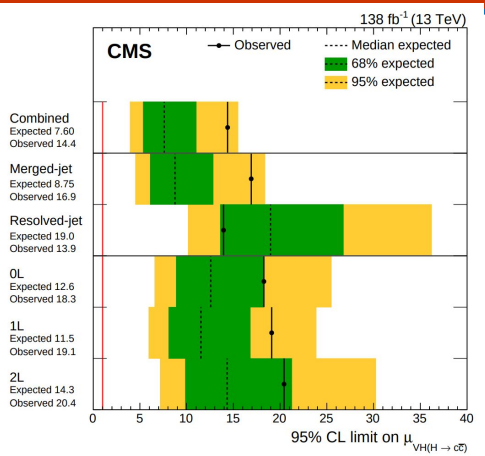
Editor role for the HNL overall combination and future prospects at HL-LHC

Planned for Fall 2023





Produzione associata Higgs e Bosone Vettore, H → cc

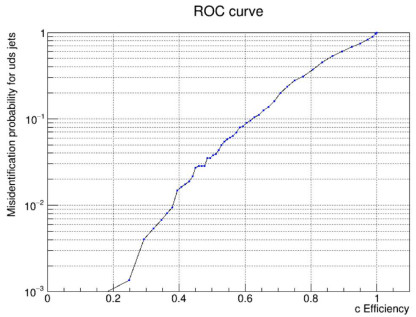


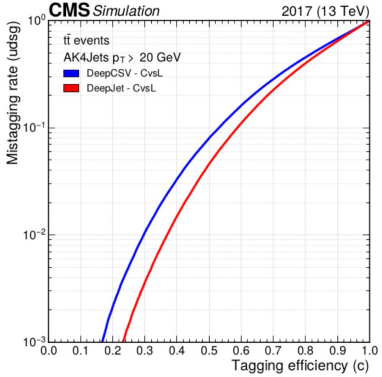
- **VH**cc with full RunII
  - **accepted** for publication on PRL.
  - Proof received this month.

- **VBF** Hcc (with **Uni Bari**)
  - L1 and HLT Trigger studies for Run3 to increase signal efficiency
  - New L1 seed (L1_DoubleJet_110_35_DoubleJet35_Mass_Min620) and HLT path (HLT_QuadPFJet100_*_ParticleNetTagCvsL0p6CvsB0p6_VBF2) using ParticleNet@HLT integrated in the trigger menus

- H To **Muons**
  - Started recently checking MC availability and coordination with other groups involved

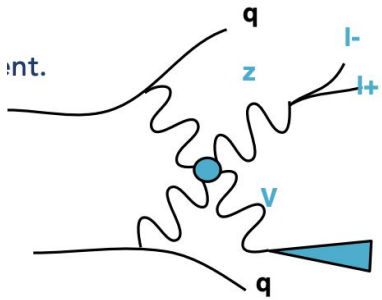
Particle Net at HL



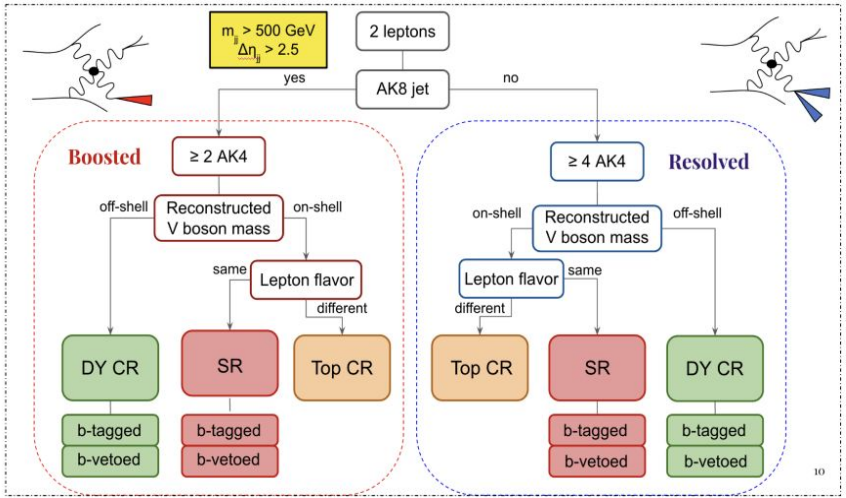


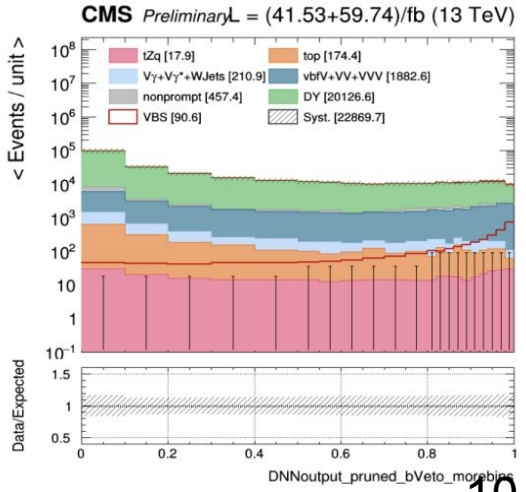
SMP VBS - VBS ZVjj

- **VBS ZV analysis SMP-22-011** (**P. Azzi(PD)**, Presilla(PG)+ et al.)
  - Analysis still blind, under ARC review.
- Categorized on V-hadronic decay topology and b-jets in the event
- Major background Z+jets modelled with semi-data driven technique
  - simultaneous fit of DY CRs and SRs
  - Top CR also included in the fit to control top normalisation.
- DNN trained on signal vs all backgrounds
  - 8 different models for the various topologies and years of data
  - Taking Asimov a-priori statistical significance ~1.8.



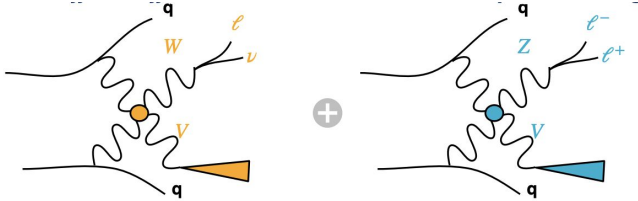
EWK ZV VBS sensitivity **never measured before**.

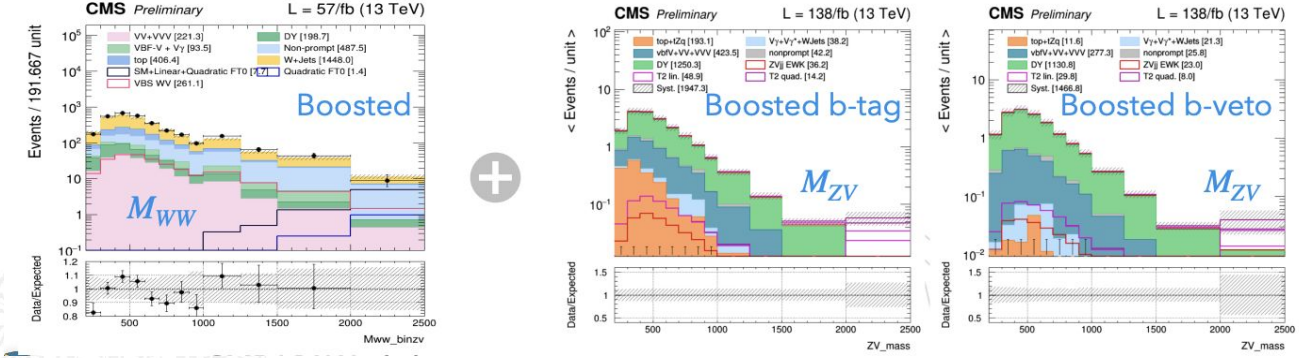




SMP VBS - EFT interpretation

- **aQGC from EFT dim-8 with the WVjj + ZVjj semi-leptonic channels**
- Analysis aims to fully maximise VBS semi-leptonic final state, with limit setting on EFT WVjj
- Same selections, n-tuples and objects as in the EWK WVjj analysis SMP-20-013. Goal: Combination.

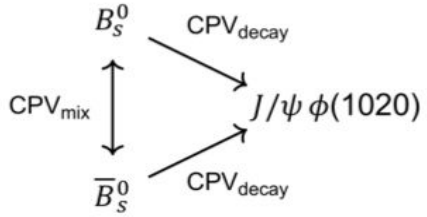




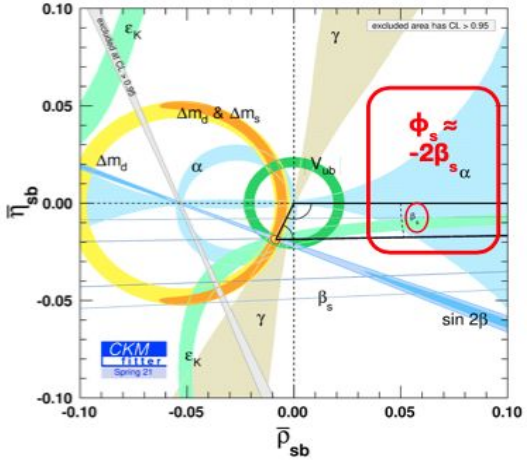
- **VBS ssWW analysis needs to be redone with modern tools to enter the full Run2 VBS combination for the EFT interpretation with dim8 operators.**
- Performed study of the ZZ background characterization for this channel (Master Project)
- Small background but could contain a contribution from anomalous couplings as well.

Precision measurement of CP-violation in $B_s \rightarrow J/\psi\phi(1020)$

- Precise characterization of the B_s meson system with a **time-** and **flavour**-dependent **angular** analysis of the final state
- Several physics parameters extracted with a single measurement
  - $\boldsymbol{\phi_s}$: CPV in the decay/mixing interference
  - $\boldsymbol{|\lambda|}$: CPV in the decay
  - $\boldsymbol{\Gamma_s}$: average decay width
  - $\boldsymbol{\Delta\Gamma_s}$: decay width difference between eigenstates
  - $\boldsymbol{\Delta m_s}$: mass difference between eigenstates
  - 6 polarization parameters
- Comprehensive test of the physics of CPV and flavour mixing, with room for **New Physics**
- Flagship CMS flavour physics analysis
- Heavily statistically limited
  - Long-term commitment (LHC Run-3, HL-LHC)

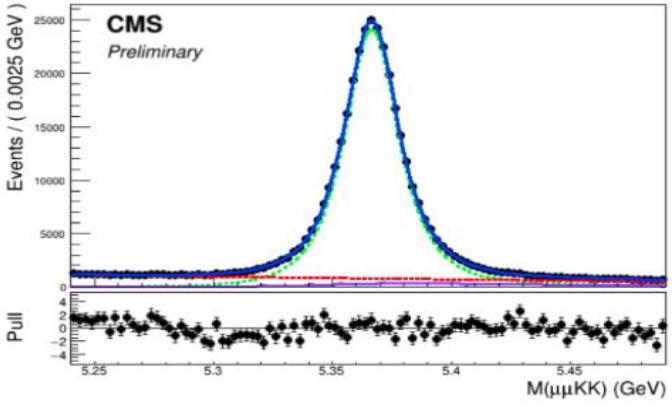


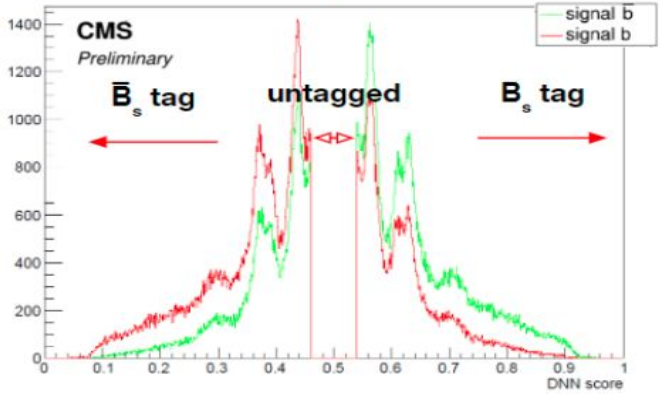
$$\Gamma\left(B_{s\,(\rightsquigarrow \overline{B}_s^0)}^0 \rightarrow f\right)(t) \stackrel{?}{\neq} \Gamma\left(\overline{B}_{s\,(\rightsquigarrow B_s^0)}^0 \rightarrow f\right)(t)$$



CPV in Bs ➜ J/ψ ϕ(1020): status and outlook

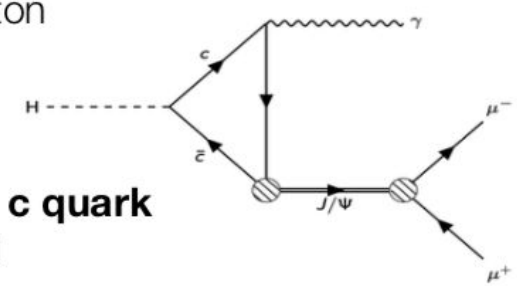
- The Padova group led the analysis team
- Developed an innovative flavour-tagging framework that enhances performance by 300%
- Preliminary results look very competitive
  - Several methodology improvements
  - Factor ~2 improvement on CPV sensitivity with respect to previous results
  - Projected to be among the most precise single ϕ_s measurements to date
- Expected to start the internal CMS review soon
  - Aiming to Fall23 conferences
- This work produced two PhD thesis at UNIPD: Bragagnolo (2021), Lusiani (2023)

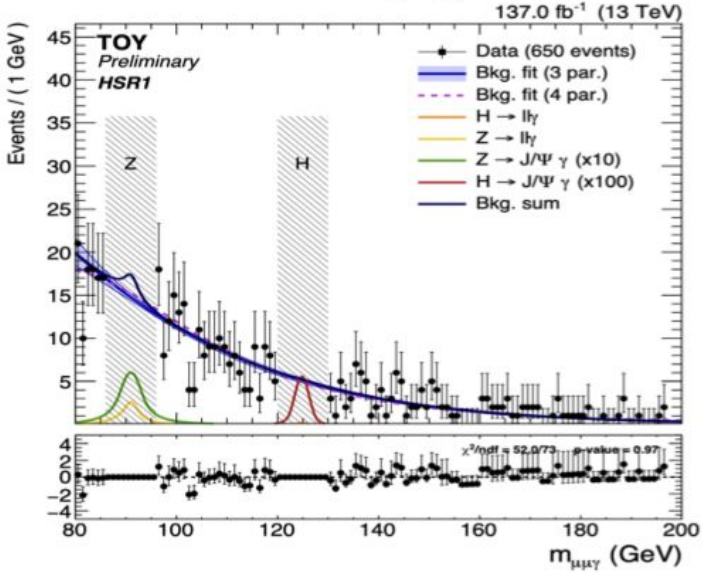




Rare SM Higgs and Z decays

- The Higgs and Z bosons are expected to decay to a J/Ψ meson and a photon
- Never observed before, because branching ratios are small:
  - B(Z→J/Ψ γ) = 9 x 10^{-8}
  - B(H→J/Ψ γ) = 3 x 10^{-6}
- The observation would allow a measurement of the **Higgs coupling to the c quark**
- With the J/Ψ decaying to $\mu\mu$, the final state is clean and the bkg very limited

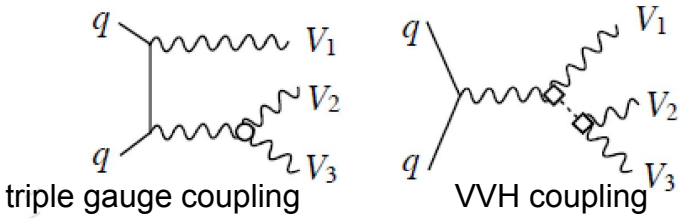




- The strategy is to model the QCD (dominant) background with analytic functions (à la H→$\gamma\gamma$)
  - Minor resonant backgrounds controlled in a dedicated control region
- Analysis is under scrutiny of the CMS Collaboration
  - [**Z**]: expected small excess (0.5σ), or to exclude 7 times the SM
  - [**H**]: expected exclusion approximately 50 times the SM, becomes candidate for end of HL-LHC
- Lot of room for improvements:
  - Design a new, dedicated trigger algorithm for the upcoming LHC run (now the bottleneck of the analysis)

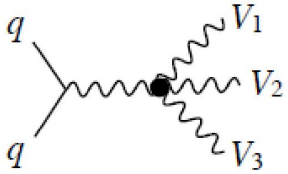
WWZ production for triple and quartic gauge coupling study

Three bosons production is an interesting process, sensitive to triple and quartic gauge couplings(and VVH coupling):

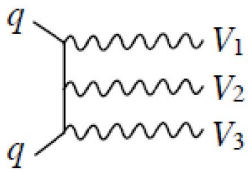


triple gauge coupling

VVH coupling



quartic gauge coupling



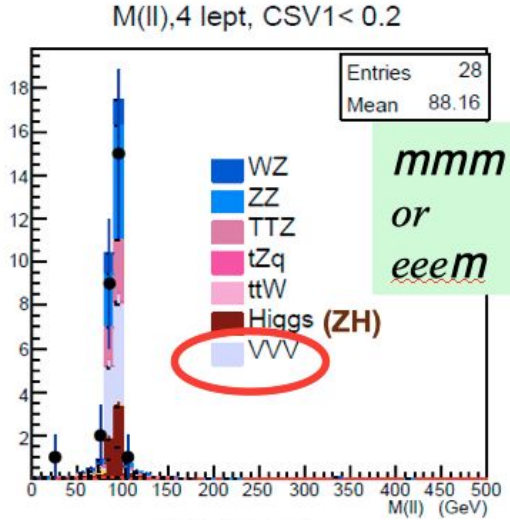
t-channel

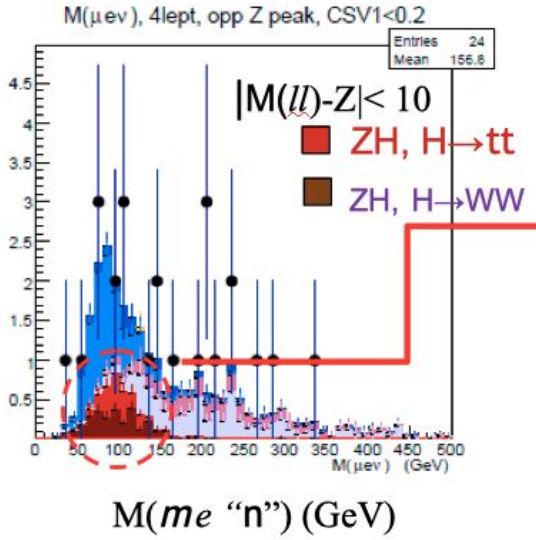
Preliminary results published by CMS on Run2 data, inclusively using SS dileptons/ 3-leptons/ 4-5-6 leptons topologies (with poor separation from Higgs mediated (VVH) process)

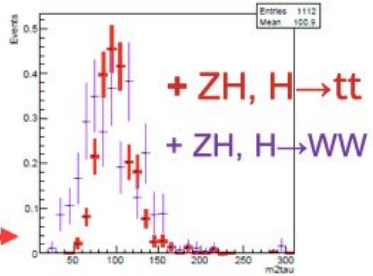
WWZ production for triple and quartic gauge coupling study

Dedicated analysis using $\mu\mu\mu e$ + $eee\mu$ topology: very clean
(after anti b-tag, to suppress *ttZ*, *tZq* background processes)

Reconstruct $\mu e\nu$ system recoiling against Z→*ll* decay
to separate ZWW from backgr. ZZ & ZH processes



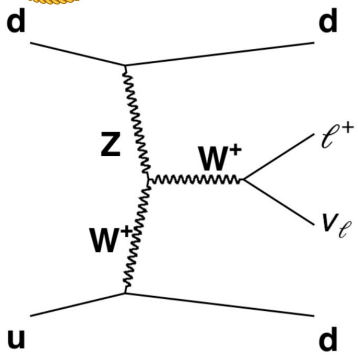




reasonably good
MH (and MZ→tt) reconstruction

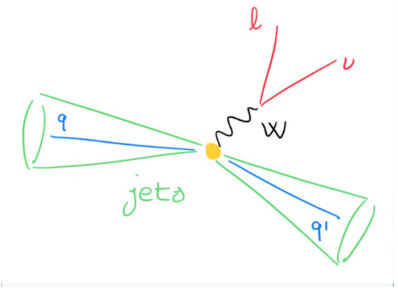
good separation
between VVV
and ZZ/ZH processes

VBF-W w/ full RunII



Motivation:

- Test of the SM gauge sector, **complementary** to Higgs boson measurements
- Sensitive to new (BSM) physics: a**TGC, EFT**

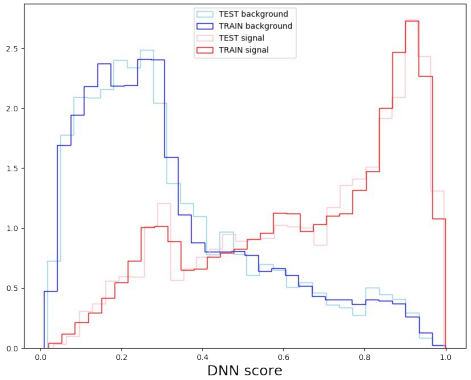


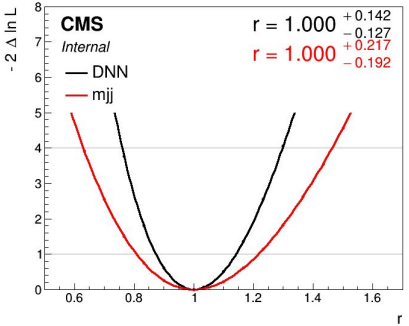
Signature:

- 2 highly energetic jets ("tagging" jets) :
  - Large gap in **η** (**|Δηjj|**)
  - high jet invariant mass (**mjj**)
- 1 charged lepton and neutrino pTmiss
  - Central with respect to the VBF jets

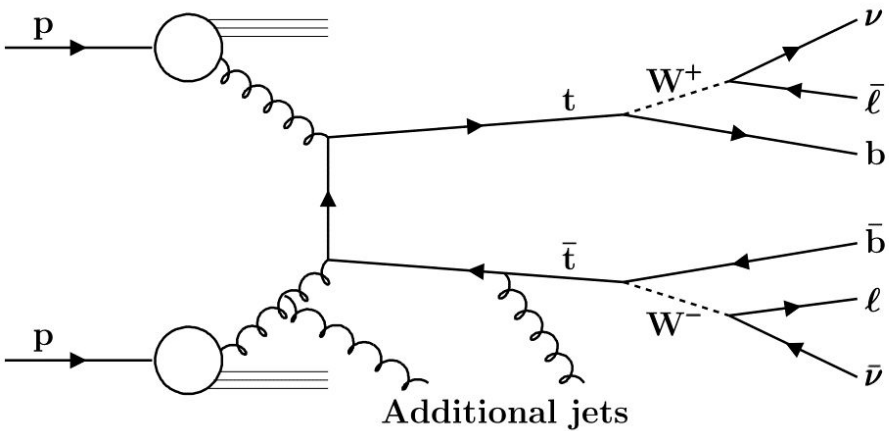
Signal Extraction:

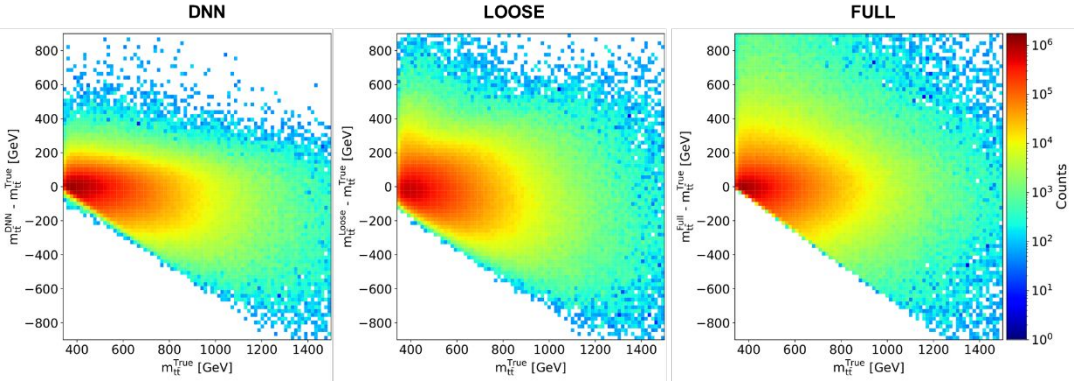
- **Control regions** used to constrain the normalizations of the main backgrounds. **Signal region** used to perform the fit.
- Combined binned maximum likelihood fit of the **DNN output** distribution with signal and background templates
- DNN trained with **10** physical variables and 3 hidden-layer with 64 neurons each
- Fit performed separately for both lepton flavors
- Systematic uncertainties treated as **nuisances**
- Expected 10% precision on cross-section measurement for both channels (only with 2018 data)





$m_{t\bar{t}}$ regression using DNN in the eμ final state

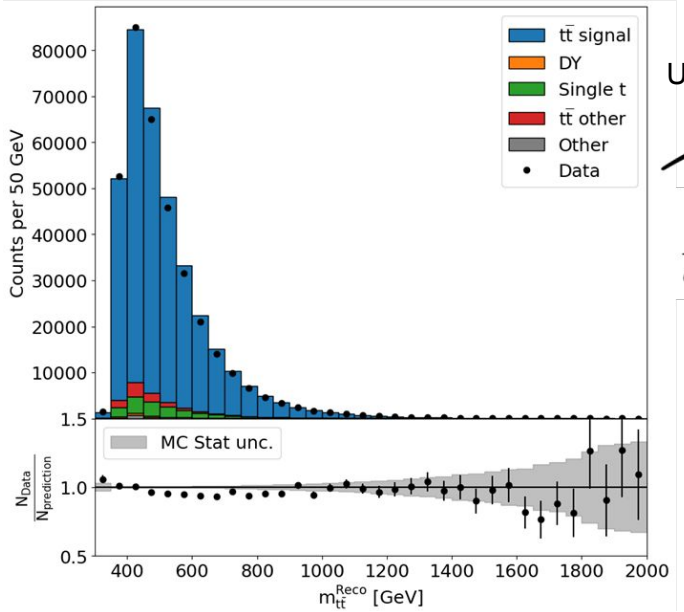




The Process

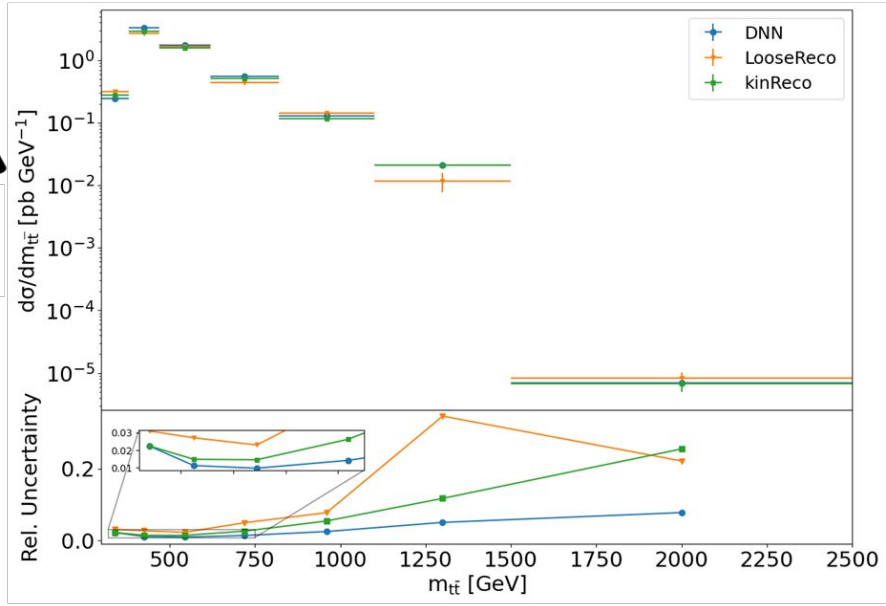
- Differential cross section measurements of the production of top quark pairs represent **precision tests** of the SM
- Relatively **clean** decay channel with small SM background (Drell-Yan and tW+jets)
- **Challenging** top quark pairs kinematic **reconstruction** due to the presence of two final state neutrinos
- Analytical approaches (Loose and Fulll kinematic reconstructions) are compared to DNN-based approach

$m_{t\bar{t}}$ regression using DNN in the eμ final state



Unfolding the distribution

$$\frac{d\vec{\sigma}}{dm_{t\bar{t}}} = \frac{A^{-1}\left(\vec{m}_{t\bar{t}}^{\,\mathrm{Reco}} - \vec{b}\right)}{\Delta_m \; \mathcal{L} \; \mathrm{BR} \; \mathrm{Acc}}$$

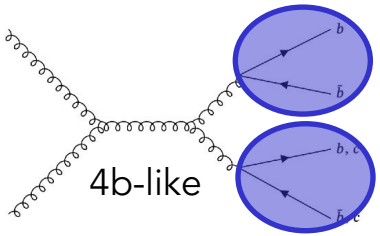


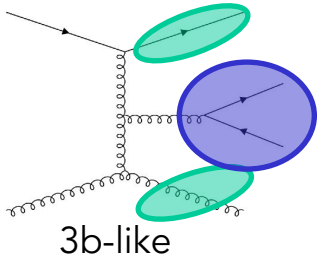
- Improvement in the **efficiency** of the kinematic reconstruction
- Significant improvement in the **resolution** of $m_{t\bar{t}}$ using DNN regression vs analytical approaches
- Improvement in the **statistical uncertainty** in the unfolded distribution

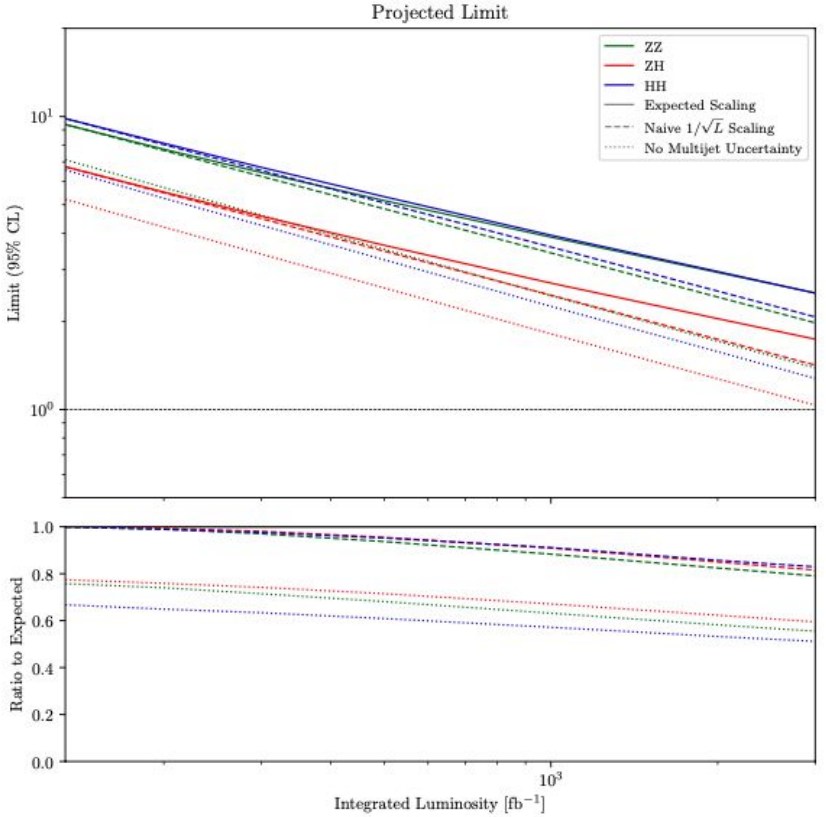
Metric space in hh→bbbb events

Run-II search for non-resonant hh→ bbbb (ggF+VBF)

- Observed cross section ~3.9xSM [Phys. Rev. Lett. 129 (2022) 081802]
- Data driven background techniques: background modeled from 3b events
- Machine learning techniques for 4b/3b discrimination
- Kinematic reweighting is employed for modeling background in the signal region



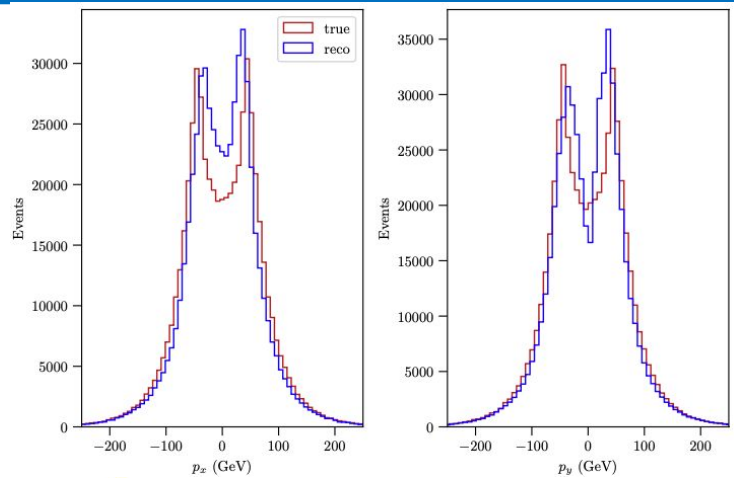


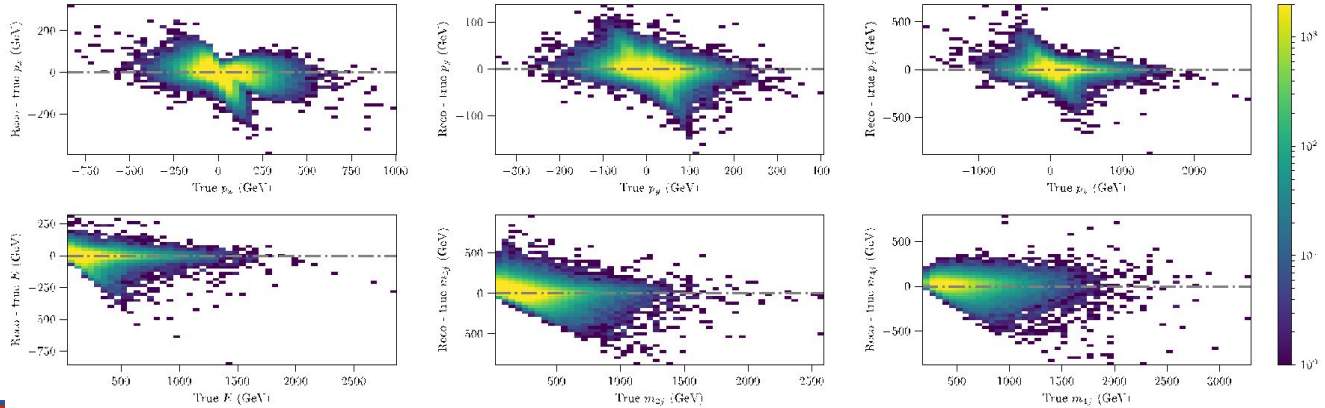


Metric space in hh→bbbb events

Use of an autoencoder (AE) for the background modeling

- Embedding in a dimension-reduced space may show interesting metrics between events
- Previous works based on optimal transport and Wasserstein distance between events show interesting results
- Classifier to distinguish real/reconstructed events





- With a 50% dimension reduction, the AE still reconstructs m2j and m4j
- Px and Py suffer from the AE phi-invariance→need to reconstruct higher level features?
- Still in progress

Run3

because of the energy crisis,
only 13.5 weeks of proton collisions at 13.6 TeV
→ expected ~70 fb-1 w/ <PU>≳50

- first beam : March 28th

splashes : end of March

- first Stable Beams at 900 GeV : April 6th
- first Stable Beams at 13.6 TeV : April 21st

"intensity ramp up" [low number of bunches and beam intensity]
→ detectors calibration

- start of physics run : May 15th → May 1st (!)

2400 bunches on May 11th (!),
but still limited intensity 1.6e11 ppb (wrt 1.8e11 ppb)

- end of pp physics : Sep 13th

then, 4(+1) weeks of PbPb(pp ref)

CMS status –so far

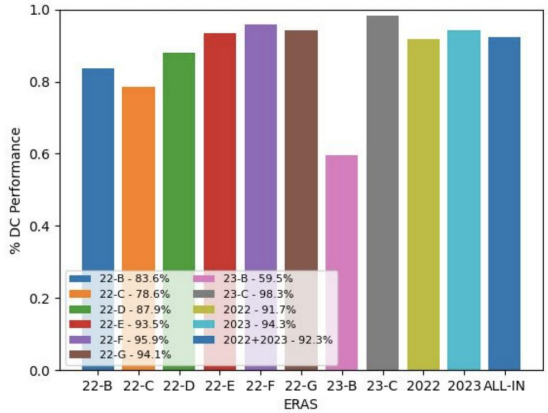
CMS is working fine after YETS activities

2023 : pp collisions

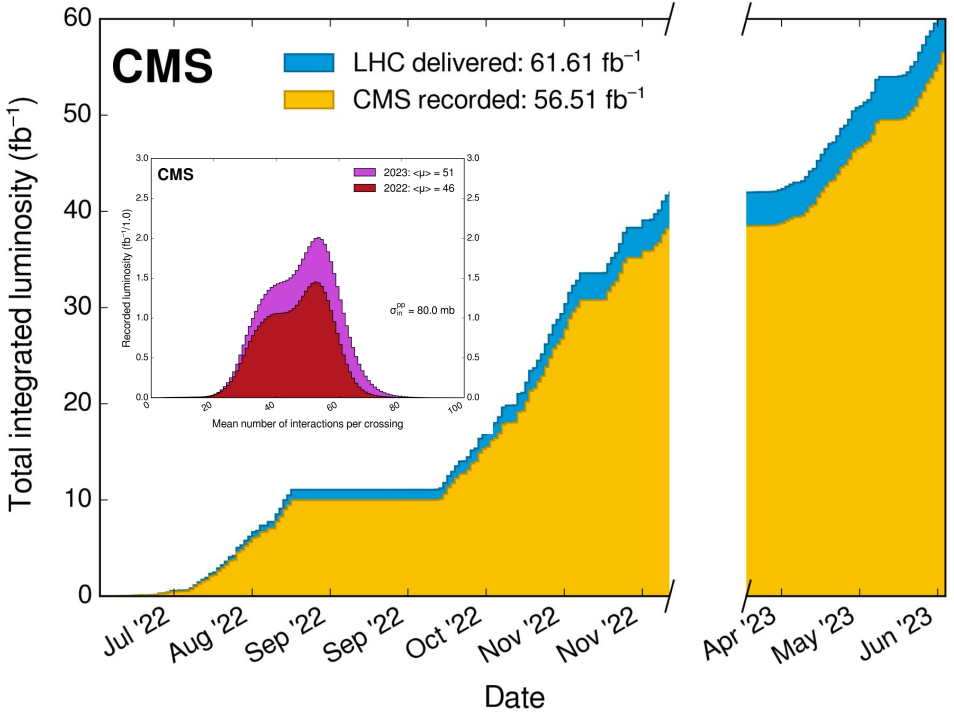
LHC delivered luminosity : ~20 fb-1, so far

recording efficiency : ~92%

good data quality : >98%



https://twiki.cern.ch/twiki/bin/view/CMSPublic/LumiPublicResults



as usual, LHC luminosity ramp up data largely used to synchronize and calibrate different subsystems

Run 3 trigger strategy

Run3 provides new c.o.m energy ⇒ cross section measurements at new energy

→ ttbar x-sec at 13.6 TeV already made public in September 2022

Run3 is an opportunity to be less dependent on new physics biases

⇒ follow up some local 3-sigma excesses

Run3 is an opportunity to do something new

→ new ideas about **direct searches for new physics**

→ new ideas for **measurements**

→ new approaches for **shrinking uncertainties**

⇒ more accurate background modelling

⇒ more accurate calibrations

in order to accommodate the wide CMS physics interest, we need to

→ exploit the CMS resources adjusting both L1 and HLT menu

→ improve the trigger efficiency (at least for specific physics case)

→ add new trigger strategies

→ push the purity of collected events

	2022	2023
lumi-leveling duration [h]	6 (~50%)	10 (>80%)
lumi-leveling PU	54	60 or 65 (15 or 21% gain in int. lumi.)
L1 max rate [kHz]	100	110*
HLT max rate [kHz]	2.5 +3	2 +3.5

*but contingency needs to be considered (!)

Parking strategy in 2023

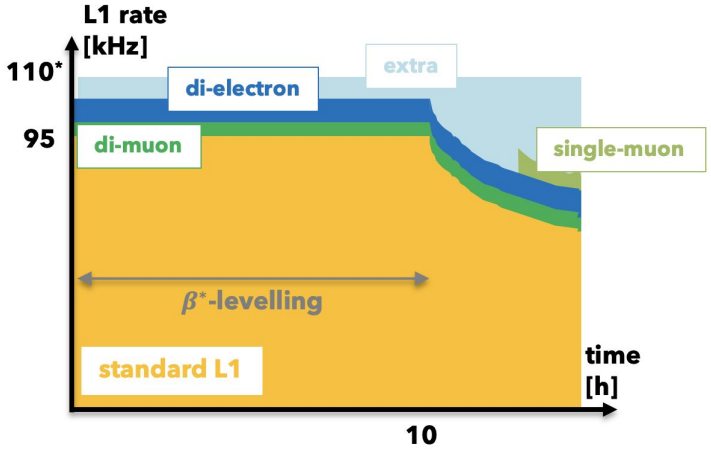
Parking approach was exploited since Run1
typically in the last year before the Long Shutdown
exploiting the computing resources which are much more free
[part of the bandwidth promptly reconstructed for monitoring]
in 2022, the operation conditions and computing resources
allowed to have the parking since the beginning
→ CMS would continue to pursue in Run3

could we rearrange the ~3 kHz Parking budget ?

- di-muon : ~1400 Hz @HLT
- ✓ di-electron : ~20 Hz @HLT
- ✓ single-muon : 0 Hz [we will not almost reach 1.7e34 Hz cm-2]

"spare" quota used for new approaches :

- VBF : ~1000 Hz @HLT
- hh→4b : 200 Hz @HLT
- LLP ~150 Hz @HLT



NB: thanks to the lower integrated luminosity than originally expected,
Parking dataset was promptly processed (!)
..it will probably be the case in 2023 as well

Outreach

HEPscape! @Padova (synergy between DFA and INFN-Sezione di Padova)

the first High Energy Physics escape room,

a project designed by INFN Rome researchers in 2021

NB:

- this idea started the Padova initiative of performing only escape rooms for the ERN2022
- the performance at ERN2022 involved people from other experiments as well ;)

[thanks to Federica Borgato, Alessandro Gaz, Andrea Rossi, Lorenzo Sestini]

→ Science4All 2022 — sinergy w/ DFA and other Gr1 groups

(Padova): 100 visitatori

→ Quantum Festival 2022 — invited and sinergy w/ MiB

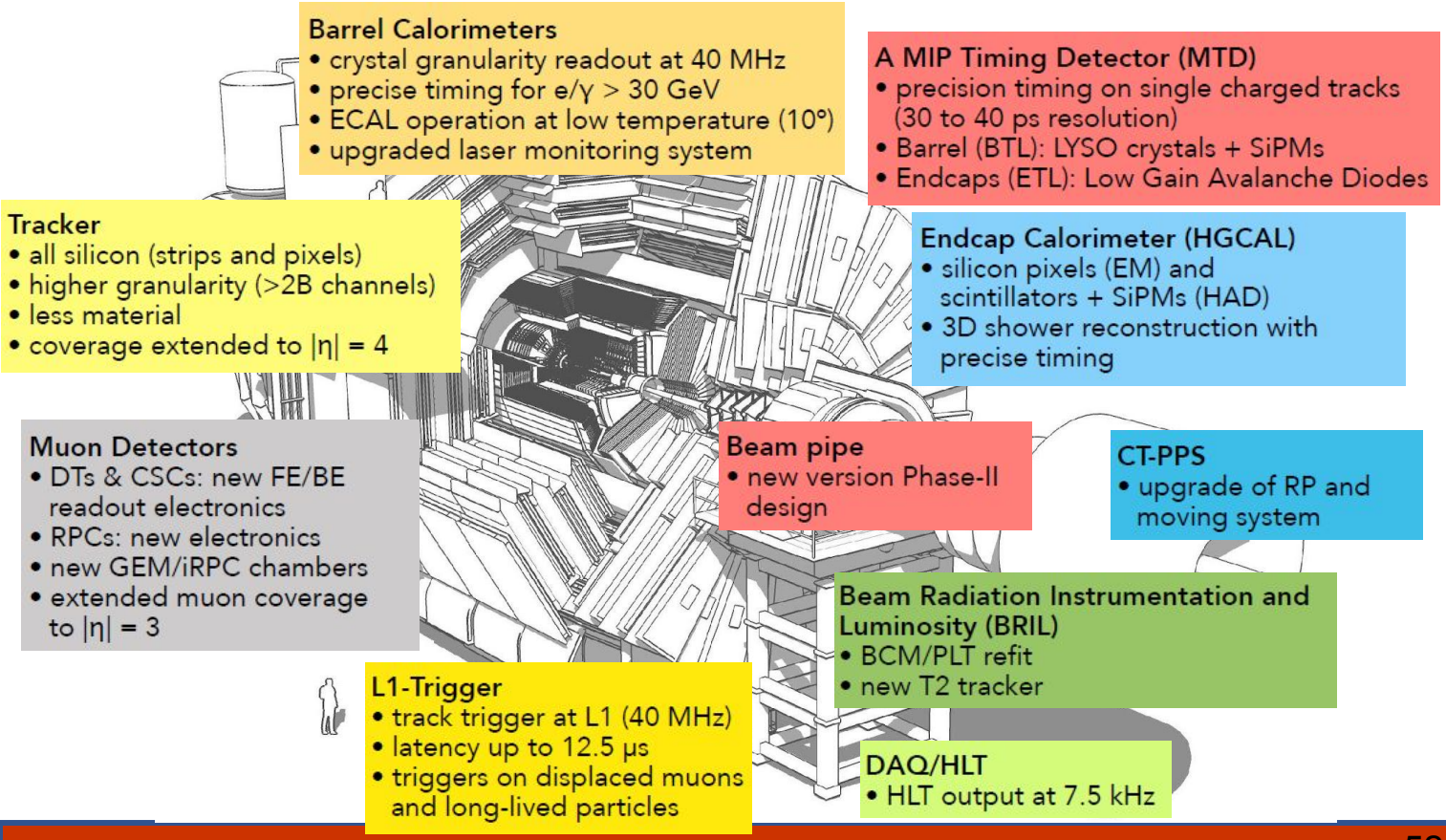
(Gardone Val Trompia, BS): 400 visitatori

→ Play 2023 (Modena): 120 visitatori — invited and sinergy w/ BO

→ Science4All 2023 (Padova)

Fisica padovana in CMS: Rivelatore

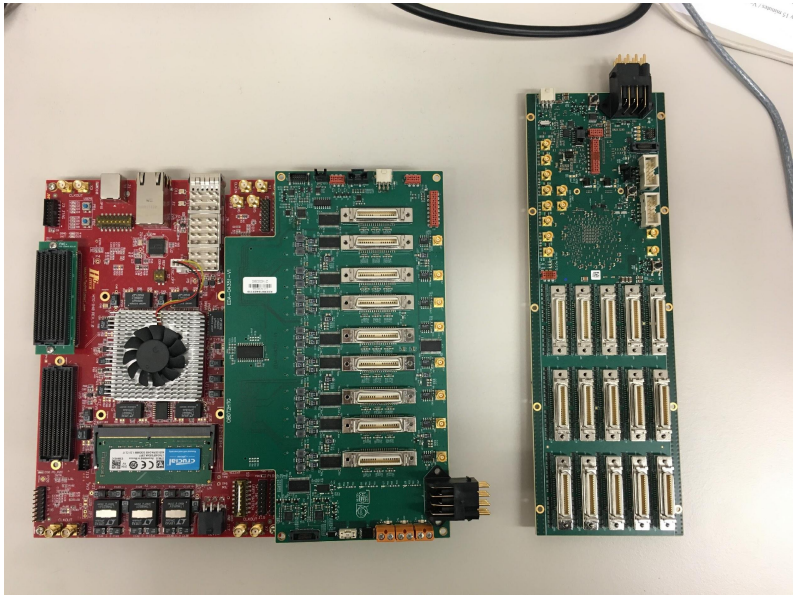
Run3 e preparazione a HL-LHC



- Molti lavori di manutenzione e improvements sono stati eseguiti con contributo padovano nei DT e nei Pixels

DT Phase 2

- OBDT pronta per la produzione
  - test finale di immunita’ alla radiazione in Luglio 2023
  - gare in corso per PCB, assemblaggio, componenti, cavi
  - produzione di 900 unita’ a partire da gennaio 2024
  - qualifica di 900 schede OBDT a Legnaro - 2024
  - sistema di test in fase di allestimento
- Sistema di timing & slow control
  - prototipo funzionante su hardware commerciale
  - hardware per la produzione : non identificato
- Sviluppo firmware: 2 tecnologi coinvolti, 1.5 FTE



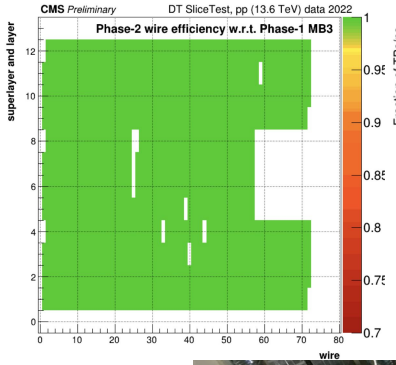
DT Phase 2: Demonstrators

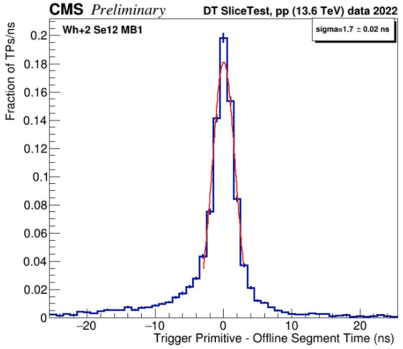
Slice Test in Sector 12

- To test the Phase2 on-board electronics (OBDT) prototypes, the Front-end signals from YB+2S12 were split between legacy and new electronics. Both were operated in parallel during the first year of Run3 (2022)

- Also a new trigger primitive generation algorithm was implemented on Phase1 backend boards (Analytical Method)

- The S12 slice test was very well integrated in CMS, operations and monitoring were satisfactory and good quality data were collected during pp collisions (overall about 1.9 fb-1 collected in 2022)





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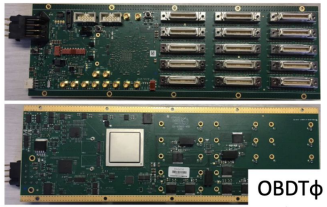
DT Phase 2: Demonstrators

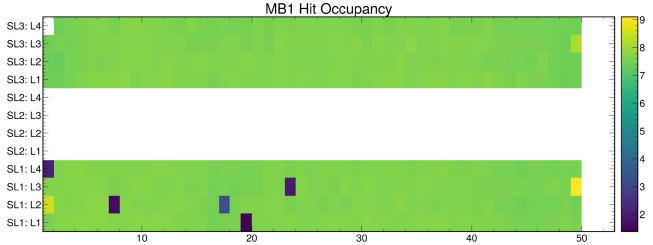
New Slice Test in Sector 1

- The demonstrator is extended to test the final version of OBDT, the DSS system (MONSA) and the new Timing/Slow Control backend boards, with new installations in Sector 1

- Both the mechanics (cables, low voltage distribution boxes, board supports, fibers, DSS cables, cooling) and the new boards (2 OBDT Theta and 6 OBDT Phi, of which one in the final version) were installed. The system was finalised Feb, 10th.

  - The legacy system was retested and no problems were observed. The commissioning of the new electronics just started, a first look to occupancy and noise show excellent status





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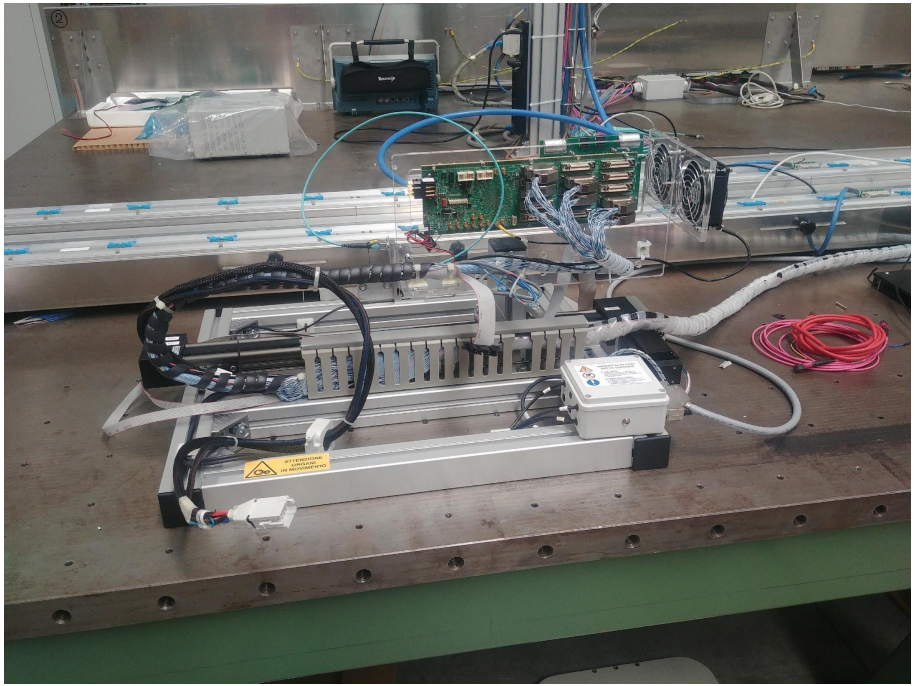
DT Phase 2

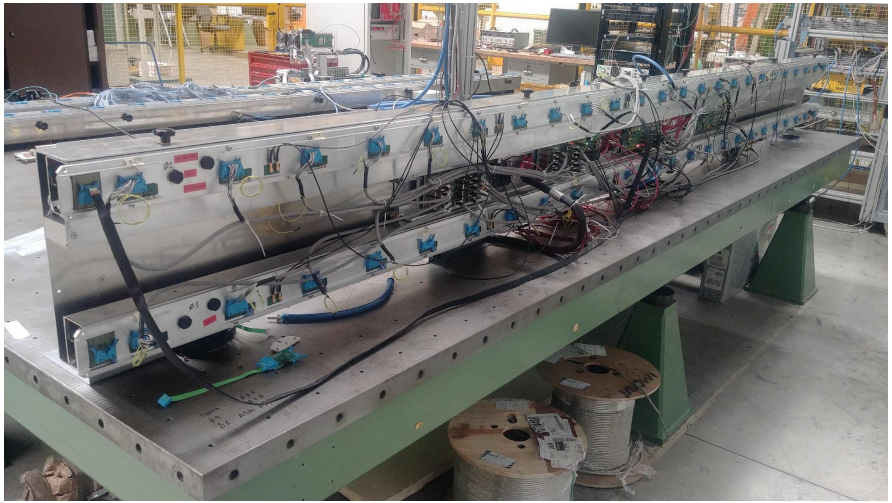
- Test di immunita’ alla radiazione di due schede
  - OBDT + Splitter board
  - irraggiamento con fascio di protoni presso

  Centro Protonterapia APSS Trento
  - Turno a Luglio 2023



DT Phase 2

- Produzione minicrate
  - Padova deve allestire e qualificare 60 minicrate tipo MB3
  - Sito di produzione pronto a LNL
- Padova fornisce il sistema di test dei minicrate a tutta la collaborazione DT
- Padova fornisce il Mockup di qualifica pre-installazione dei minicrate al CERN
- Padova fornisce il sistema di qualifica post installazione a tutta la collaborazione



DT chambers: Longevity studies

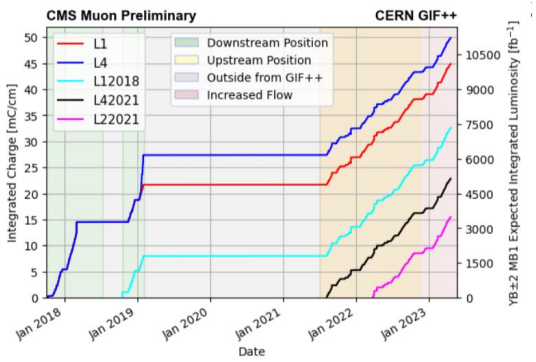
GIF++ 2021-2023: chamber MB2 in new position in the GIF++ area:

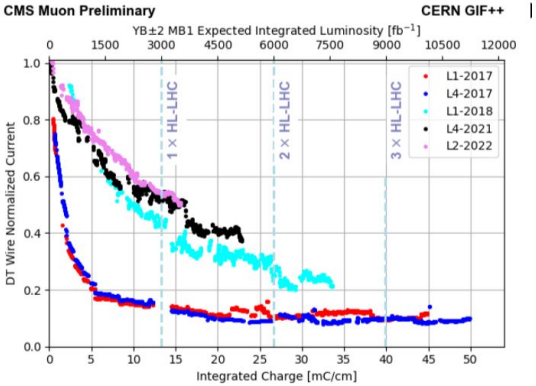
- Displacement of chamber, electronics and DAQ in new position. Irradiation with acceleration factor 10.

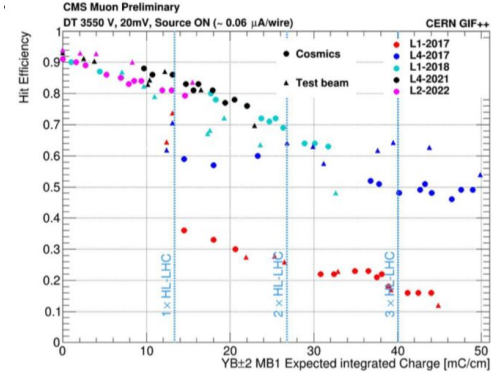
Integrated dose evaluated from currents measured on not irradiated layers (left plot). 8 New wires (L4_2021).

In Spring 2022: start of irradiation of a Full Layer (L2_2022) .

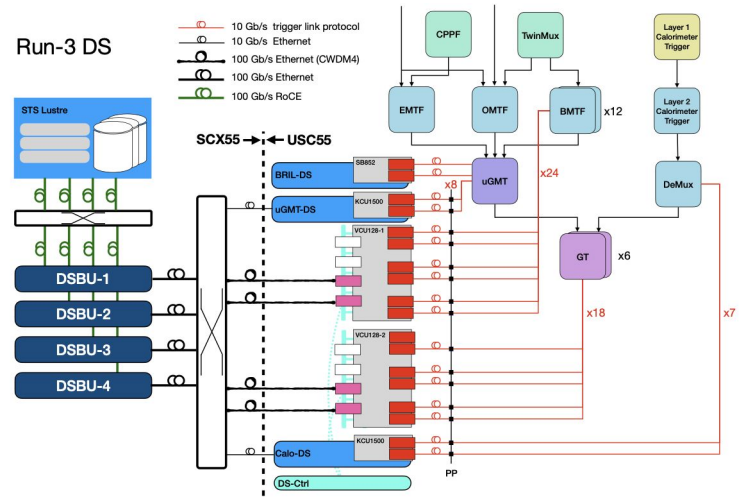
- Performances along irradiation evaluated from currents and from hit rates at different source attenuation (center plot). Reconstructed tracks of cosmic ray and muon of test beam with hits of not irradiated layers allowed measurements of efficiency at different integrated charge (right plot) and at different background rates of the irradiated wires.
- All the wires irradiated since 2018 present the same behaviour. The decrease of the efficiency was evaluated not to affect significantly the muon track reconstruction also in the most exposed stations (MB1 external wheels). The bad behaviour of 2017 irradiated layers has not been confirmed. The expected behaviour is assumed the one of the others irradiated wires.





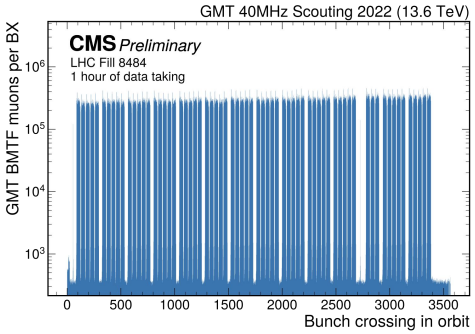


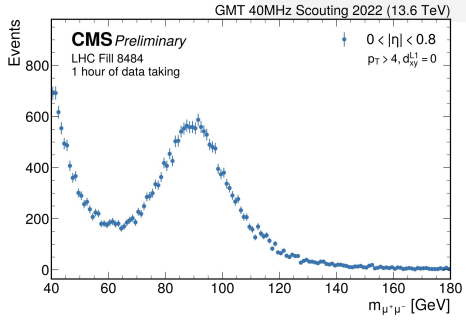
40 Mhz Level-1 Scouting



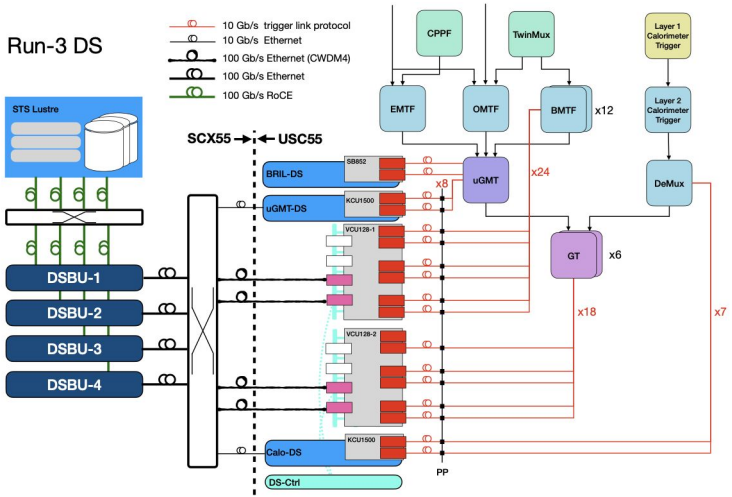
Level-1 Scouting

- Intercept (“spy”) the stream produced by trigger boards to extract data at 40MHz
- Acquisition of L1 trigger primitives at the full BX rate
  - 8 μ from Global Muon Trigger
  - 12 e/γ, jets, τ and missing ET from Calo
  - *Local μ trigger primitives in the CMS barrel*
  - *BITs from Global Trigger*
- Data are extracted and zero-suppressed via FPGA and delivered to computing resources for online processing
- A complete demonstrator of L1 Scouting system is in place and currently collecting data during Run-3

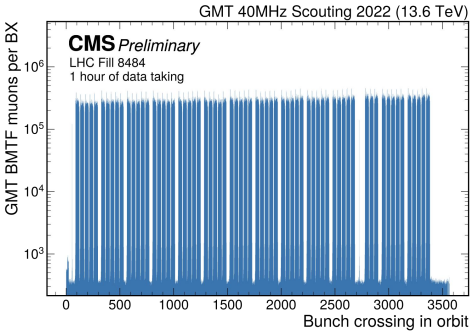


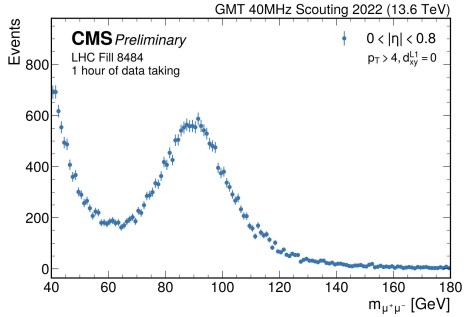


40 Mhz Level-1 Scouting



- ML-based calibrations applied on-the-fly to correct the μ spectra
- Anomaly-detection algorithm (NPLM) deployed to the trigger-less data stream as Data Quality Monitoring tool
- Characterization of data collected in Run3:
  - Ongoing studies of GMT muons
  - First studies with Calo objects
- Developments toward full integration of DAQ & CMS-SW
  - Aggregation of data based on the LHC Orbit
- Phase-2 simulations (W →3π rare decay)





40 Mhz Level-1 Scouting: Overview of the activities

40MHz Level-1 Scouting

- Firmware and software development: R. Ardino (PhD student)
- Analysis and ML application: R. Ardino (PhD student), S. Giorgetti (PhD student), M. Migliorini (PhD student)
- CMSSW Orbit merger*:* M. Migliorini (PhD student)
- Phase-2 simulations (W →3π): P.Cappelli (master student)
- R. Ardino (PhD student), S. Giorgetti (PhD student), M. Migliorini (PhD student), J. Pazzini, M. Zanetti

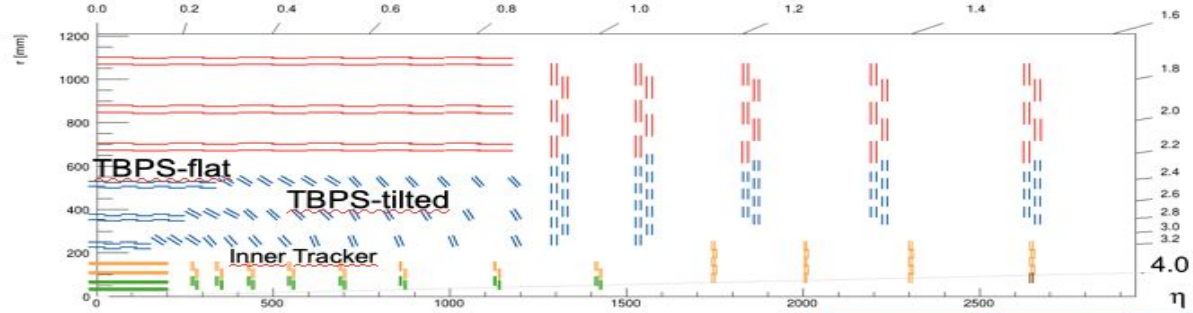
40MHz Phase-2 CMS drift tubes muon (DT) detector Scouting

- First implementation of the 40MHz raw-data scouting at detector level
- Readout from Phase-2 upgrade On-Board DT readout boards (*OBDT*)
- Implementation also carried out with a test setup at LNL with miniDTs
- M. Migliorini (PhD student), J. Pazzini, A. Triossi, M. Zanetti

New Physics Learning Machine (NPLM) and Anomaly detection

- Trigger-less data suited for anomaly detection application
- New Physics Learning Machine (NPLM) technique to spot anomalies
- *"Triggerless data acquisition pipeline for Machine Learning based statistical anomaly detection"* talk at CHEP2023
- G. Grosso, N. Lai (master student), M. Migliorini (PhD student), J. Pazzini, A. Triossi, M. Zanetti, A. Zucchetta

Phase II Tracker Upgrade: MaPSA testing in Padova



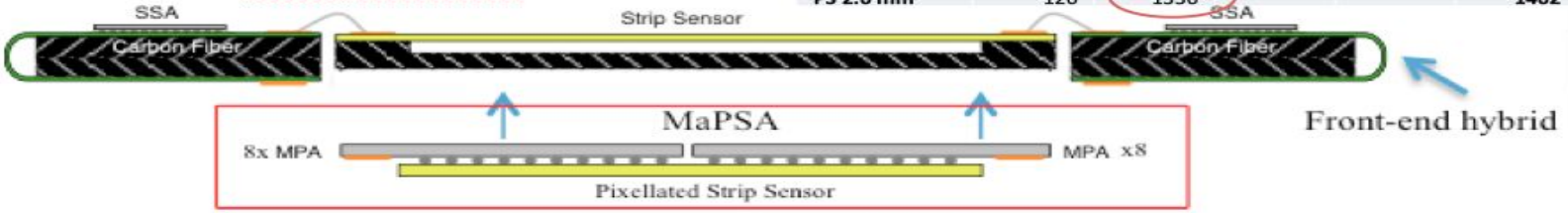
Tracker layout (OT616_IT616). In blue the PS modules location.

- PS modules are a sandwich of Strips/Pixel sensors separated by 1.6, 2.6 or 4.0 mm.
- A total of 5592 PS modules needs to be built
- MaPSA is the sensor (Pixel)/ Readout-chip (MPA) assembly (flip-chip bump bonded).

Number of MaPSA for the INFN production

Module types	Flat TBPS	Tilted TBPS	TB2S	TEDD	Total
2S 1.8 mm			4416	2768	7184
2S 4.0 mm				424	424
PS 1.6 mm	826				826
PS 2.6 mm	126	1336			1462

PS module cross-section.

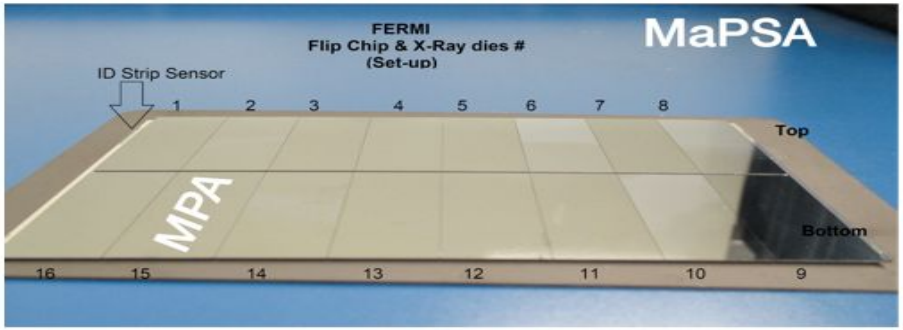


MaPSA assembly in RED box

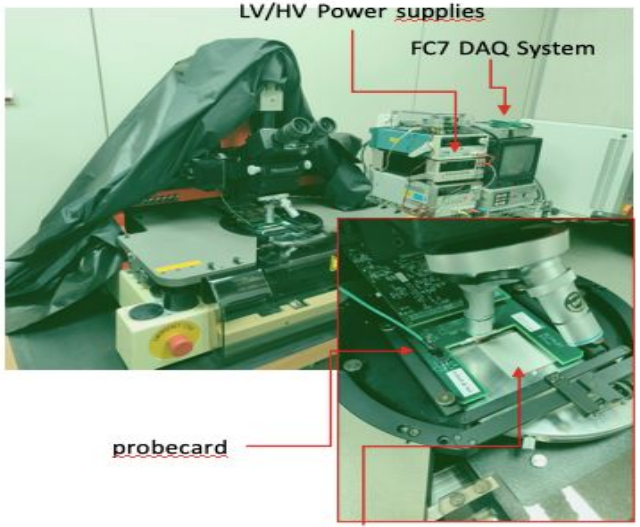
Phase II Tracker Upgrade: MaPSA testing in Padova

- Last round of prototypes (#3) with final MPA2 chips available for testing since early spring 2023.
- Soon we will have pre-production parts
- MaPSA intended for the module production in Italy will be sample tested in Padova

- Not decided yet on the logistic for MaPSA distribution (Padova will receive them all from the US and then re-distribute them to Perugia and Bari or instead we'll receive only those for sample testing)
- Problematic MaPSA trouble-shooting and in-depth characterization also a responsibility of Padova.



A MaPSA assembly from round#3 prototypes in Padova

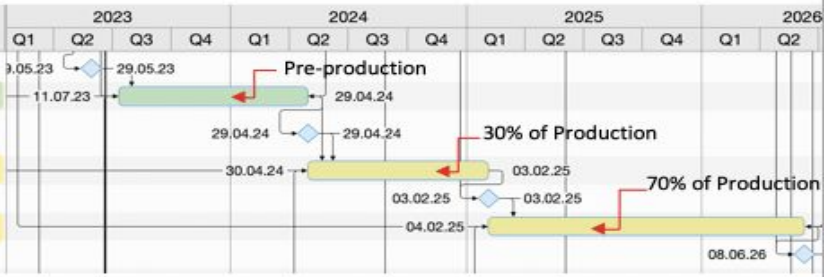


MaPSA under test

Phase II Tracker Upgrade: MaPSA testing in Padova

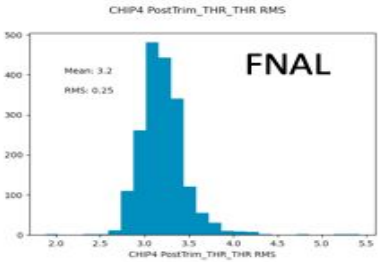
- Pre-production of 300 MaPSA planned for 2nd half of 2023 into spring 2024
- We will try to test as much as possible of the pre-production in order to gain experience
- Production will span from the 2nd half of 2024 until summer of 2026
- Production is split into 10 batches (about 200 MaPSA per batch in Italy) with the goal of testing about 10% in Padova.

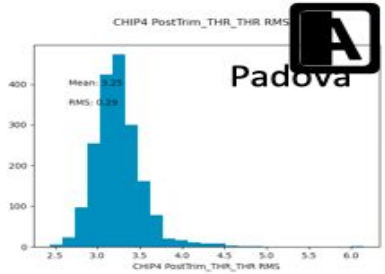
Title	Planned Start	Given Duration	Planned End
MaPSA contract (LHCC)	29 May 2023		29 May 2023
Test of pre-production MaPSAs	11 Jul 2023	42 weeks	29 Apr 2024
MaPSA pre-production completed (5% of MaPSAs) (LHCC)	29 Apr 2024		29 Apr 2024
Test of production MaPSAs - part I	30 Apr 2024	40 weeks	3 Feb 2025
30% of MaPSAs received (LHCC)	3 Feb 2025		3 Feb 2025
Test of production MaPSAs - part II	4 Feb 2025	70 weeks	8 Jun 2026
All MaPSAs received (LHCC)	8 Jun 2026		8 Jun 2026

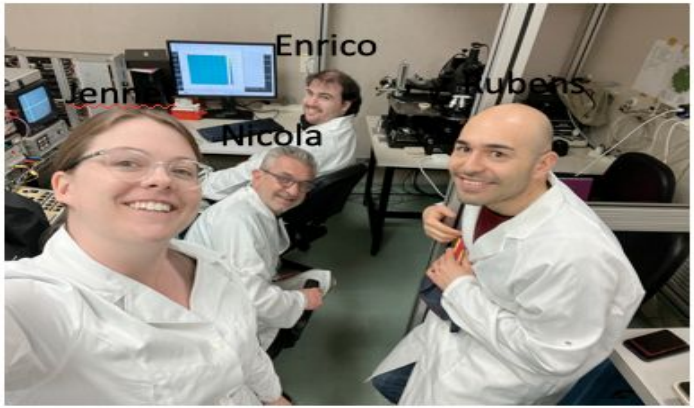


Phase II Tracker Upgrade: MaPSA testing in Padova

- Test setup in Padova essentially ready.
  - Now with an additional shield encasing the probe station in order to minimize EM interference
  - Some issue with clean power distribution when using the plasma etcher in the adjacent room we need to cope with.
- Successful test of a full MaPSA #3 prototype with final MPA2 chips
  - We could reproduce the Fermilab results
  - Some issue with instability of test results is under investigation
  - More MaPSA from Bari to be tested soon
- Now Enrico Lusiani is joining the group and Rubens Raffagnato is giving us support from the officina elettronica.



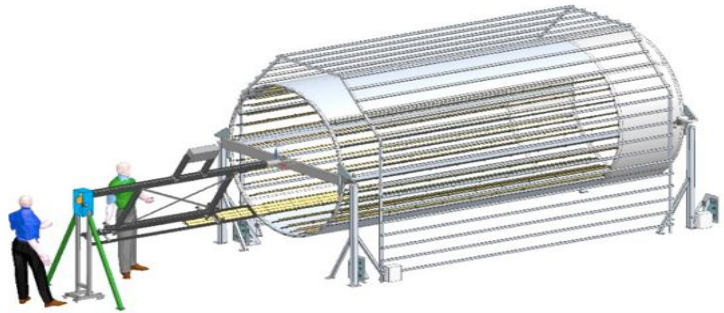


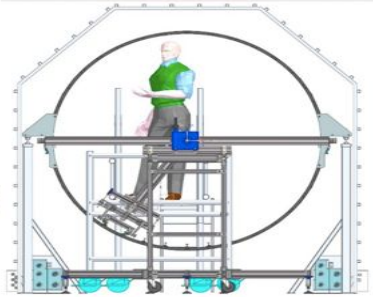


Barrel Timing Layer

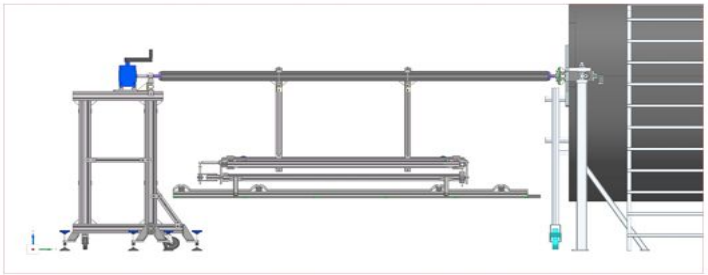
Tray installation jig assembly in progress

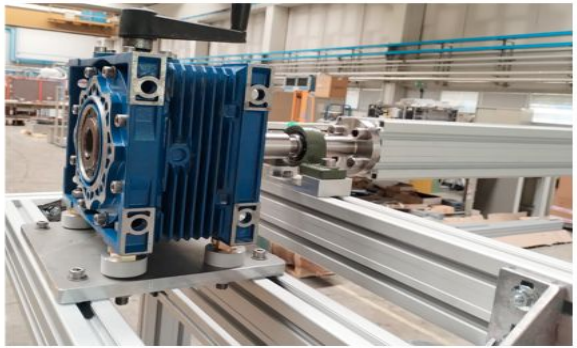
Tower and rotating beam assembled, under test with applied load to simulate tray and suspended part of jig loads





Test in progress to qualify the jig with 50 daN dummy gravity load , torque on worm gear unit up to 500 Nm

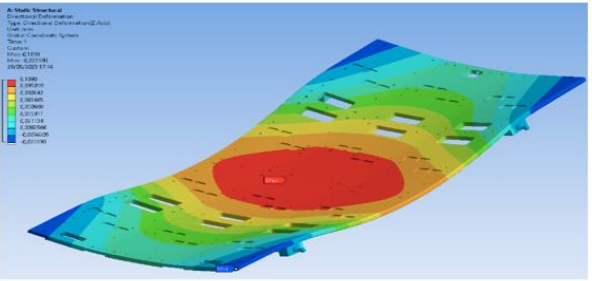
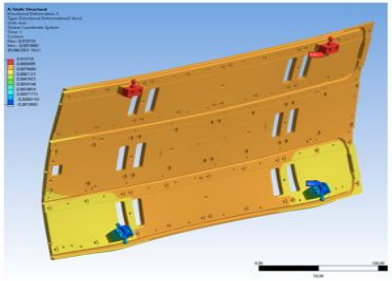




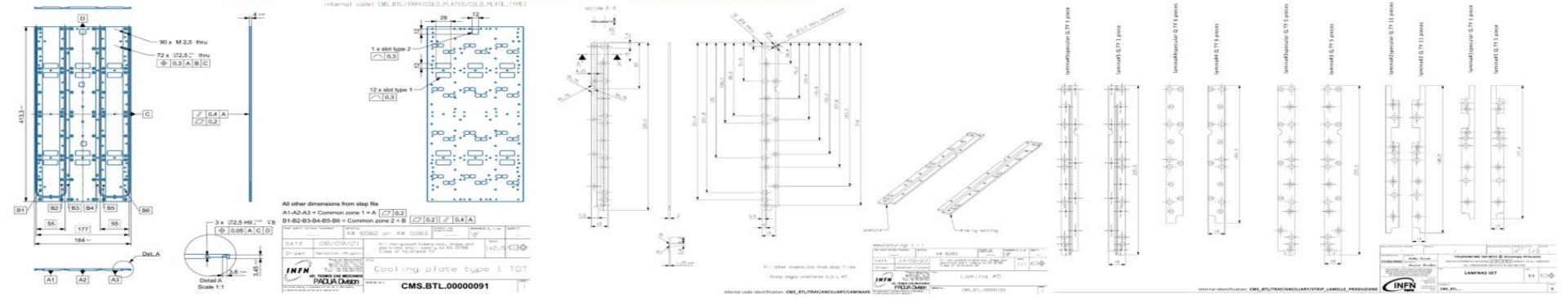
Barrel Timing Layer

Design qualification: dummy CP deformation and esteem of BTL tray deflection

Comparison of FEA analysis w.r.t. load test on dummy plate, test in progress to identify and reduce localized deformations

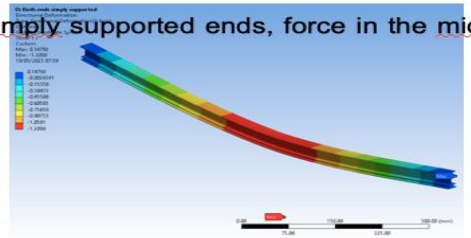
Production of tray final drawings and request of offers ongoing

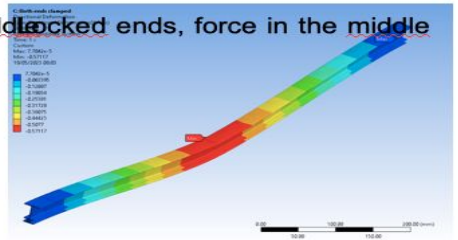


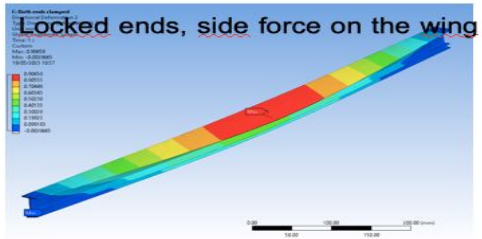
Barrel Timing Layer

Design qualification: GF I-beam elastic properties and I-beams+feet deformation esteem

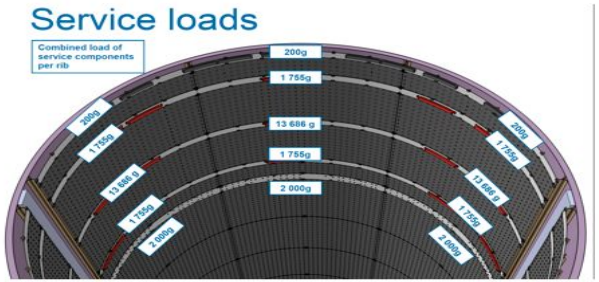
Esteem of glass fiber elastic properties, assumed as unidirectional orthotropic:
Ez ~ 40 GPa, Ex, y ~ 4 Gpa (corresponding to ~ 60% of GF ? … depending on fibers modulus)

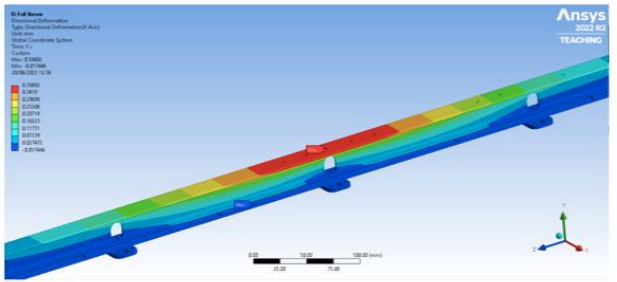






Measurement of I-beam on feet sample deformation and esteem of rail deformation in the BTST





Barrel Timing Layer

Articolo sottomesso a JINST il 5 giugno 2023

Prepared for submission to JINST

Integration of thermo-electric coolers on the CMS MTD SiPM arrays for operation under high neutron fluence

A. Bornheim,[1] W. Lustermann,[2] K. Stachon,[2] G. Reales Gutiérrez,[3] A. Benaglia,[4]
F. De Guio,[4,8] A. Ghezzi,[4,8] M. T. Lucchini,[4,8,†] M. Malberti,[4] S. Palluotto,[4,8]
T. Tabarelli de Fatis,[4,8] M. Benettoni,[5] R. Carlin,[5,9] M. Tosi,[5,9] R. Rossin,[5,9] P. Meridiani,[6]
R. Paramatti,[6,12] F. Santanastasio,[6,12] J. C. Silva,[7] J. Varela,[7] A. Heering,[10,†]
A. Karneyeu,[10,14] Y. Musienko,[10,14] M. Wayne,[10] T. Anderson,[11] B. Cox,[11] C. P. Lara,[11]
A. Ledovskoy,[11] S. White,[11] I. Schmidt[12]

Tesi di laurea triennale in Ingegneria Meccanica

UNIVERSITÀ DEGLI STUDI DI PADOVA

Scuola di ingegneria

Corso di Laurea triennale in Ingegneria meccanica

Ideazione e progettazione di dime per il controllo dimensionale di particolari meccanici per il rivelatore BTL dell'esperimento CMS al HL-LHC del CERN

Anagrafica 2024

- Out:
  - Grosso (Dottoranda)
  - Strong (Assegno)
  - Govi (Assegno INFN)

- In:
  - Bortolato (Dottorando)
  - Bulla (Dottorando Cagliari)
  - Giorgetti (Dottoranda)

- Strutturati :

(cambiamento FTE%)
Ronchese 80 → 70
Lusiani 100 → 70

Ruolo	Persone	FTE
Ricercatori & Dottorandi	24	18.0
Tecnologi	11	5.3
Totale	35	23.3

Responsabilità CMS 2024

Area			Livello	Ruolo	data inizio	data fine
DT	Bellato	Marco	L3	TM7 HW Coordinator		
FIS	Bortignon	Pierluigi	L3	Higgs to muon working group convener		
FIS	Bragagnolo	Alberto	L3	BPH VFS Convener	9/2022	9/2024
FIS	Bragagnolo	Alberto		BPH Release validator	9/2018	9/2024
FIS	Bragagnolo	Alberto		BPH HLT validator	9/2019	9/2024
TK	Bulla	Andrea		TRK Release Validator (DATA)	1/2023	2024
FIS	Dorigo	Tommaso	L3	Statistics Committee member		
TK	Lusiani	Enrico		TRK Release Validator		
TK	Lusiani	Enrico	L3	TRK @ HLT Convener	4/2023	
PH	Margoni	Martino		Membro PubComm top/b	2021	
CMS Italia	Margoni	Martino		LR Padova	1/1/2022	1/1/2025
CMS Italia	Tosi	Mia	L2	Coordinatore Italiano della Fisica	1/2022	12/2024
PH	Tosi	Mia	L1.5	Trigger Officer	6/2022	1/8/2024
PH	Tosi	Mia	L3	BPH Software & Framework Coordinator	9/2021	8/2024
TK	Tosi	Mia	L2	Tracker Conference Committee Chair	9/2022	
DT	Ventura	Sandro	L2	Electronics Coordinator	9/2021	9/2023
MUON	Ventura	Sandro	L2	Electronics Coordinator	9/2021	9/2023
DT	Ventura	Sandro	L3	Online Software Coordinator	2005	9/2023
FIS	Zucchetta	Alberto		Jornal submission editor (JSE)		

Responsabilità CMS/Fase 2 2024

Area			Livello	Ruolo	Data inizio	Data fine
TK	Bacchetta	Nicola	L2	Tracker Upgrade Technical Coordinator		
TK	Bacchetta	Nicola	L2	TBPS Coordinator		
TK	Bacchetta	Nicola	L3	Integration, Cooling&Services Coordinator		
DT	Bellato	Marco	L3	OBDTφ, Slow Contol & Timing Backend		
DT	Bergnoli	Antonio	L3	OBDTφ, Slow Contol & Timing Backend		12/2024
DT	Triossi	Andrea	L2	Deputy Upgrade Coordinator		12/2023
DT	Triossi	Andrea	L3	OBDTφ, Slow Contol & Timing Backend		
CMS Italia	Ventura	Sandro	L2	Upgrade Coordinator	1/2022	12/2024

Richieste CSN1

Missioni

- Metabolismo+shifts/services 200.5 keu
- Responsabilità: 110.0 keu

Consumi

- Metabolismo+camera pulita: 39.5 keu

CORE (previo accordo con gli RA)

- BTL: Meccanica ?

Richieste in Sezione

Officina elettronica		Mesi uomo
Tracker	Test in camera pulita	6
Totale		6

SPE		Mesi uomo
DT	Manutenzione camere al CERN	2
	Slice test fase 2	4
	Irraggiamento preproduzione fase 2	6
	Produzione elettronica Fase 2	16
Totale		28

Ufficio tecnico		Mesi uomo
BTL	Definizione/produzione esecutivi per produzione tray	4
	Benettoni	2
Totale		6

Officina Meccanica		Mesi uomo
BTL	Assemblaggio jigs, verifiche e QC/QA	6
Totale		6

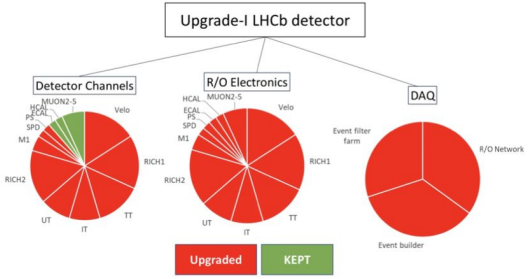
Calcolo		Mesi uomo
	Supporto cluster locale, cloud	3
	Supporto produzione locale dati	3
	Connessione, operazione, mant. TIER2 PD-LNL	18
Tracker	Supporto Computing & Networking	1
Totale		25

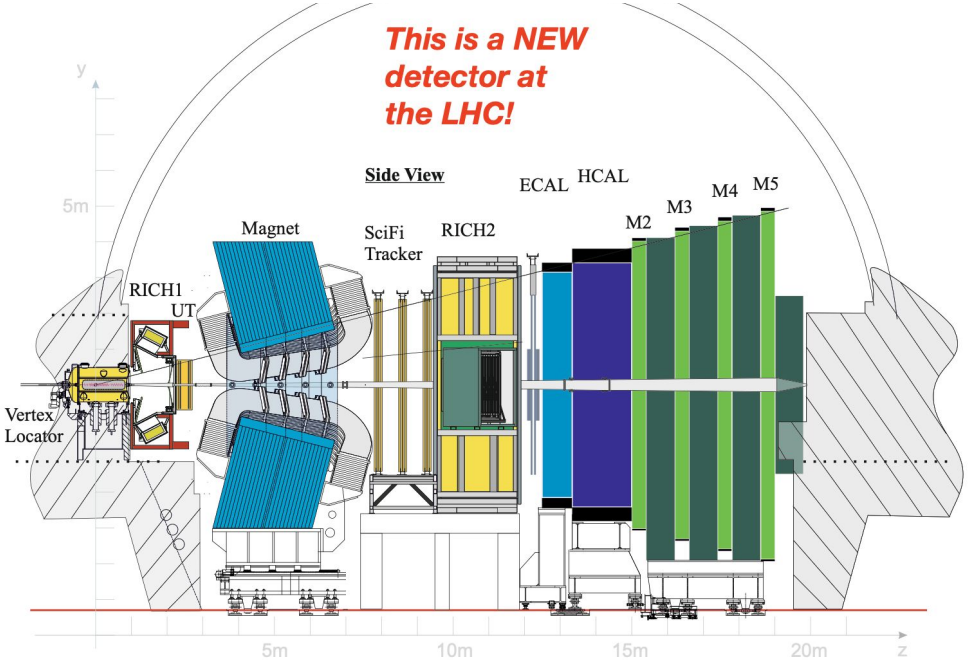
LHCb status update
Riunione preventivi 2024

Lorenzo Sestini
per il gruppo LHCb-Padova
5 luglio 2023

Stato LHCb: Upgrade 1

- Installazione completata recentemente con l'Upstream Tracker (UT)
- Quasi tutti i rivelatori sono stati sostituiti: **detector praticamente nuovo!**
- Nel 2022 sono stati raccolti dati per commissioning e calibrazioni, e circa 35 pb-1 utili per Early Measurements (senza UT)
- Il 10 gennaio, un incidente nel vacuum di LHC ha causato una deformazione del RF foil del VELO (no danni ai sensori)
- Riparazione possibile nel prossimo YETS, nel 2023 il VELO non potrà essere chiuso completamente
- Programma di fisica del 2023 verrà condizionato da questo, ma impatto limitato dal fatto che il detector è nuovo e siamo in fase di apprendimento

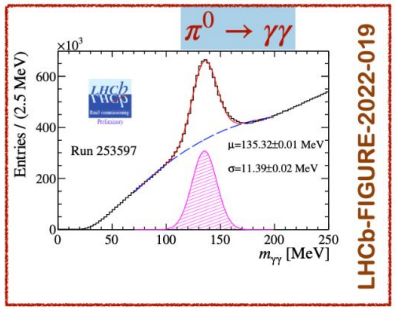


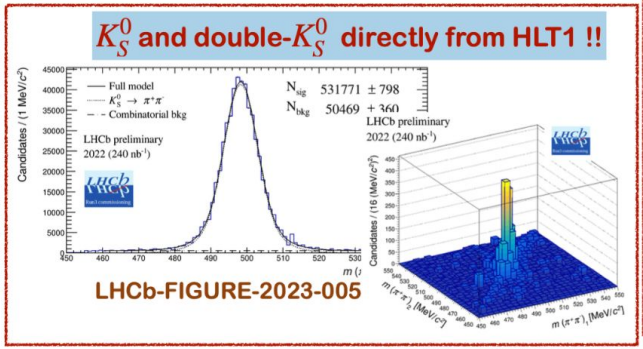


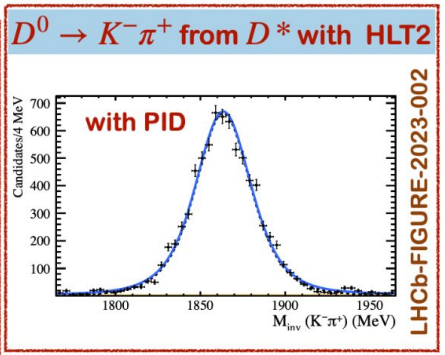
LHCb Upgrade 1: primi plots

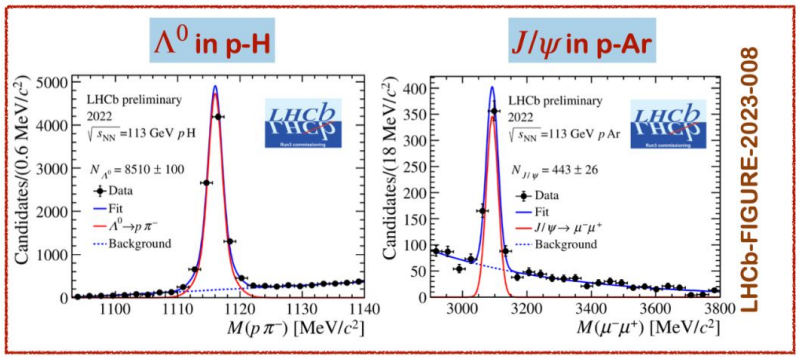
Da presentazione C. de Mello ad LHCP 2023

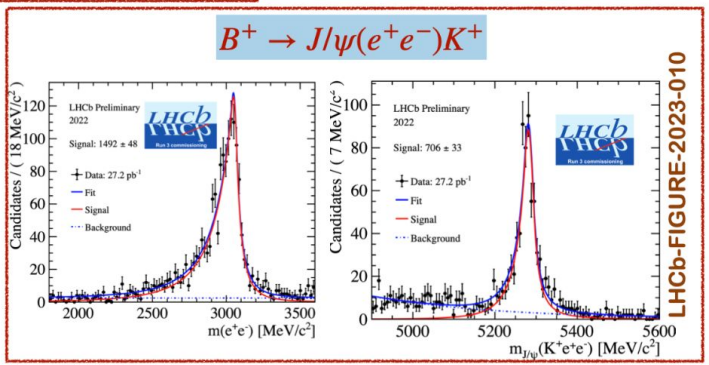
first plots!











Upgrade 1 a Padova: RICH

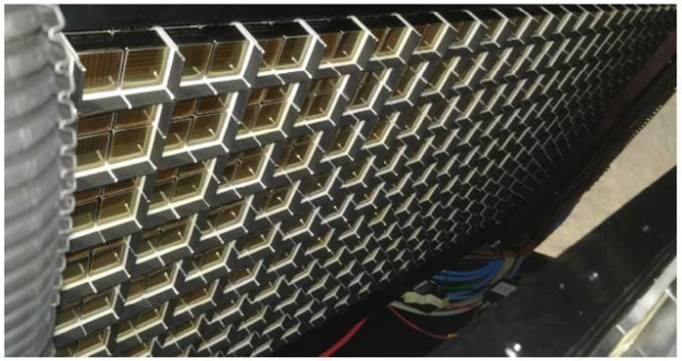
M. Benettoni, F. Borgato, A. Lupato, G. Simi

- RICH PID tratto distintivo di LHCb, fondamentale per il programma di fisica di LHCb
- Padova coinvolta nel design e nella costruzione
- Responsabilità nella
  - caratterizzazione dei PMT [Lupato, Simi]
  - meccanica [Benettoni]
  - calibrazione del rivelatore [Simi]
  - commissioning
  - installazione

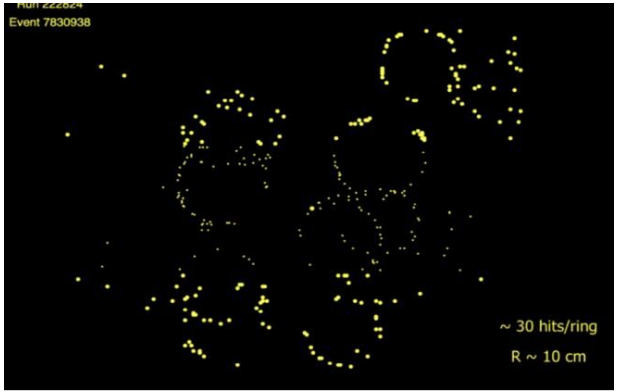
2022

- Installati nuovi fotorivelatori e elettronica @ 40MHz
- Ridisegnata l'ottica del RICH1
- Installazione completata febbraio 2022
- Detector commissioned and now in data taking

RICH1: MaPMTs installed upper side

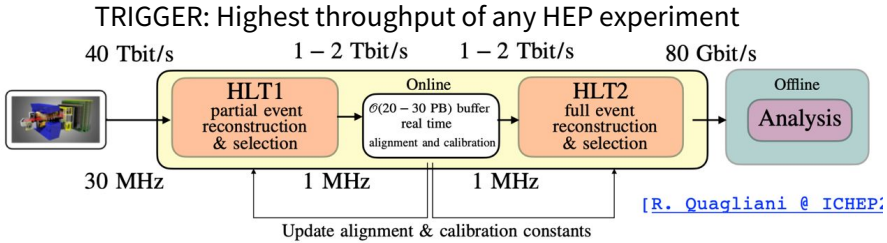


RICH2: first rings, LHC October '21 test



Upgrade 1 a Padova: Trigger & Sprucing

A. Bertolin



- **Full software trigger: 30 MHz processing rate**

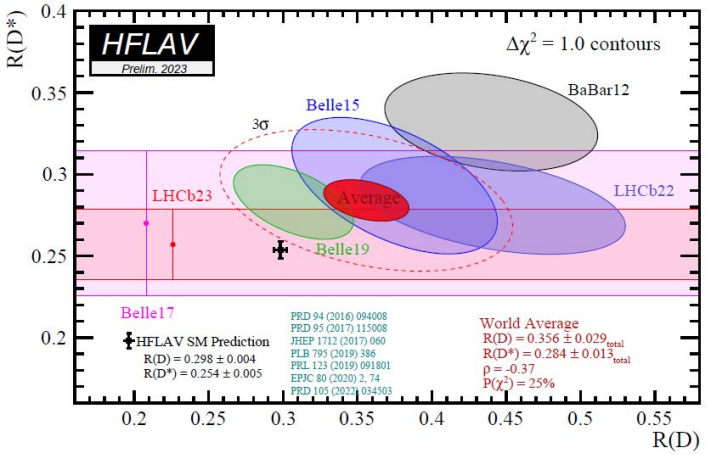
- Due livelli: **Hlt1**, ricostruzione, e **Hlt2**, selezione. Tra l'Hlt2 e l'analisi finale livello intermedio di selezione: **Sprucing**.
- Padova (A. Bertolin) e la Peking University (S. Zhang) sono responsabili:
  - di tutte le linee Hlt2 del gruppo di fisica 'B To Open Charm' (231 linee per ora)
  - di tutte le linee Sprucing del gruppo di fisica 'B To Open Charm' (170 linee per ora)
  - della gestione di tutte le linee di Sprucing di LHCb (444 linee per ora)
- Le linee Hlt2 del 'B To Open Charm' sono state usate nel 2022 e sono sostanzialmente pronte per il 2023.
- Lo Sprucing verrà usato per la prima volta in tempo reale nel 2023. Verranno ri-processati anche i dati acquisiti nel 2022. Next step: validazione dello Sprucing usando i dati acquisiti.

Alcuni recenti highlights di Fisica

Nuova misura di R(D*) arXiv:2305.01463

$$\mathcal{R}(D^{*-}) \equiv \mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$$

con decadimenti adronici del tau



Confermata tensione di 3.1σ tra media delle misure e SM prediction

Nuova misura di sin(2β) con il full Run 2

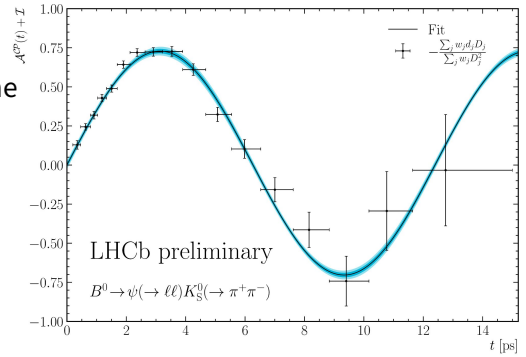
sin(2β) obtained by the "golden mode" $B^0 \to J/\psi K^0_S$ ⇒ CP violation induced by mixing

need to know the flavour of the B at production: "flavour tagging"

$$\mathcal{A}^{CP}(t) = \frac{\Gamma(\overline{B}^0(t)\to f) - \Gamma(B^0(t)\to f)}{\Gamma(\overline{B}^0(t)\to f) + \Gamma(B^0(t)\to f)} = \frac{S\sin(\Delta m_d t) - C\cos(\Delta m_d t)}{\cosh\left(\frac{1}{2}\Delta\Gamma_d t\right) + \mathcal{A}_{\Delta\Gamma}\sinh\left(\frac{1}{2}\Delta\Gamma_d t\right)}$$

$\Delta\Gamma_d \approx 0 \Rightarrow$ $A_{CP}(t) = \sin(2\beta)\sin(\Delta m_d t)$

Da presentazione C. de Mello ad LHCP 2023



S/sin(2β)=0.716±0.013 (stat) ±0.008 (syst)

Misura più precisa della world average

Analisi a Padova: universalità leptonica

F. Borgato, A. Lupato, G. Simi

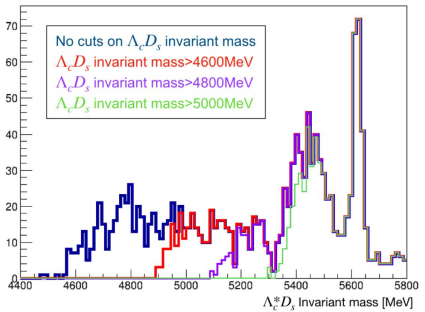
- Per la misura dell'universalità leptonica nei b-barioni Λ_b con i dati del Run 2 è necessario ridurre l'errore sistematico (A. Lupato, G. Simi LCHB-ANA-2018-026) dominato da
  - Fattori di forma del decadimento $\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu$
  - Fondo da $\Lambda_b^0 \to \Lambda_c^* D_s^{(*)}$

$$R(\Lambda_c^*) = \frac{B(\Lambda_b^0 \to \Lambda_c^* \tau^- \bar{\nu}_\tau)}{B(\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu)}$$

- **Analisi: Fattori di Forma**
  - Prima misura in questo decadimento
  - Analisi completata, in review
  - Timescale: conferenze invernali
  - Persone coinvolte: **A. Lupato, G. Simi**

- **Analisi: Branching Ratio Ratios**
  - B_1=B($\Lambda_b \to \Lambda_c(2565)\mu\nu$)·B($\Lambda_c(2595) \to \Lambda_c\pi^+\pi^-$)
  - B_2=B($\Lambda_b \to \Lambda_c(2625)\mu\nu$)·B($\Lambda_c(2625) \to \Lambda_c\pi^+\pi^-$)
  - Persone coinvolte**:** **A. Lupato, G. Simi**

- **Analisi: Osservazione e Misura del** $BF(\Lambda_b^0 \to \Lambda_c^* D_s^{(*)})$
  - Prima osservazione del decadimento
  - Principale fondo per R(Λ_c*)
  - Analisi preliminare in aggiornamento
  - Persone Coinvolte: **F. Borgato, A. Lupato, G. Simi**



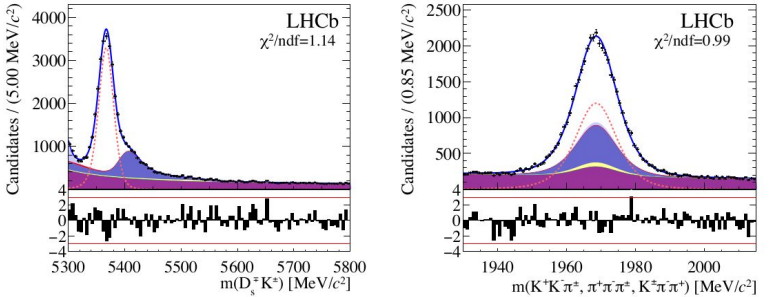
Selection optimization

Analisi a Padova: B to Open Charm

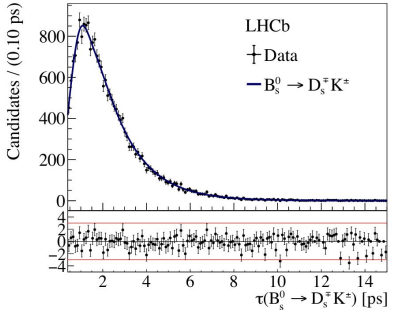
A. Lupato, A. Bertolin

- CKM γ angle determinations are among the LHCb flagship measurements
- **Golden channel for time dependent measurements of th CKM γ angle at LHCb:** $B_s \to D_s K$

Fit to full Run2 data



- the analysis on Run 2 data is being reviewed by LHCb and is targeting the CKM conference
- expected sensitivity on γ is about 10°

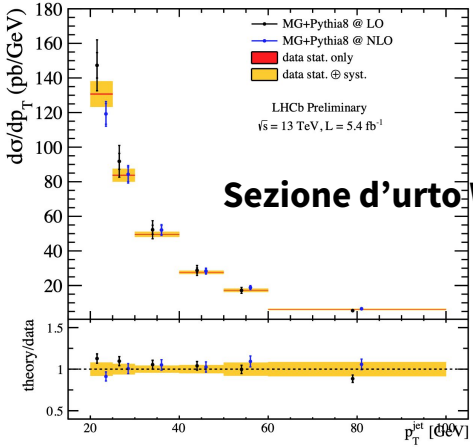


- **Similar ongoing analyses**:
  - CP asymmetry from B->Dpi (**A. Lupato** et al)
  - CP asymmetry from Bs->Ds*K (**A. Bertolin** et al)

Analisi a Padova: Fisica Elettrodebole

L. Buonincontri, L. Giambastiani, A. Gianelle, D. Lucchesi, L. Sestini, D. Zuliani

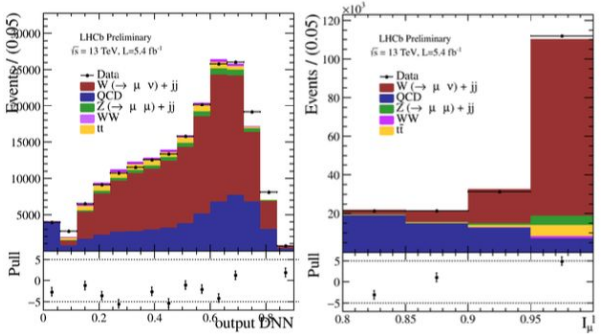
- **Determinazione delle sezioni d'urto W+jets e Z+jets**
  - sensibili alle Parton Distribution Functions in una regione complementare rispetto ad ATLAS e CMS
  - prime misure a 13 TeV nella forward region
  - Bosoni W e Z ricostruiti nei decadimenti muonici
  - sono considerati stati finali con 1 e 2 jets
  - sezioni d'urto misurate in modo differenziale in funzione della cinematica



Sezione d'urto W+jets

- **Produzione di dibosoni (WW, WZ, ZZ) nella regione in avanti**
  - Importante verifica del SM nella regione in avanti
  - per aumentare la statistica, un bosone viene ricostruito nel decadimento adronico in 2 jets
  - Deep Neural Network per separare WW from W+jets (main background)
  - prima misura di questi processi ad LHCb, dominata dalla statistica nel Run 2
  - Tesi PhD di **D. Zuliani** (W+jets, WW) e **L. Giambastiani** (Z+jets, ZZ)

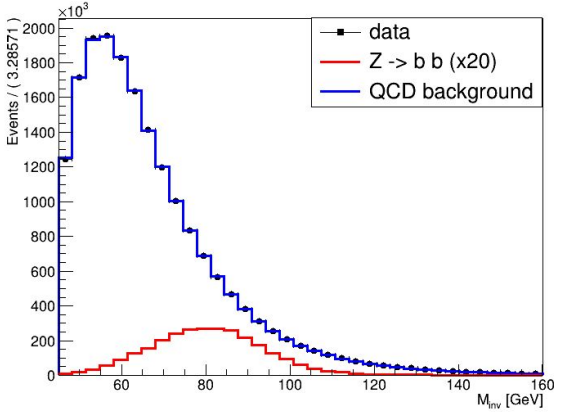
Fit estrazione WW



Analisi a Padova: b-jets e c-jets

L. Buonincontri, L. Giambastiani, A. Gianelle, D. Lucchesi, L. Sestini, D. Zuliani

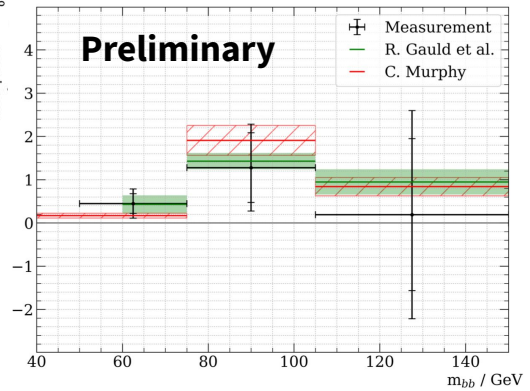
- **Ricerca H → cc (e H→bb) nella regione in avanti**
  - grazie all'eccellente sistema di tagging LHCb può contribuire alla ricerca dell'H→cc
  - Deep Neural Network per separare i flavour dei jets
  - Metodo data-driven per determinazione fondo QCD
  - Determinazione upper limits con il full Run 2 in corso
  - Misura simultanea di Z → cc e Z→bb come validazione
  - Tesi PhD di **L. Buonincontri**



- **Asimmetria angolare di carica nei b-dijets**
  - sensibile a contributi di nuova fisica
  - cruciale la separazione tra b-jets e b-bar-jets
  - prima misura di questa quantità a 13 TeV
  - collaborazione Padova-Edimburgo

$$A^{b\bar{b}} \equiv \frac{N(\Delta\eta > 0) - N(\Delta\eta < 0)}{N(\Delta\eta > 0) + N(\Delta\eta < 0)}$$

$$\Delta\eta = \eta_b - \eta_{\bar{b}}$$

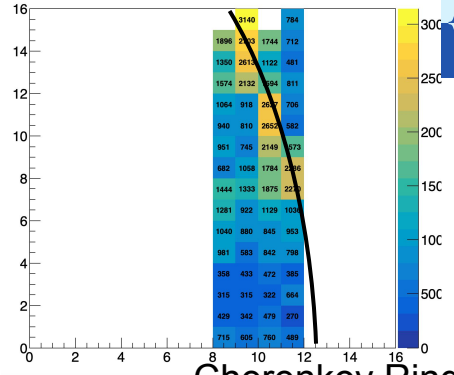


Upgrade futuri

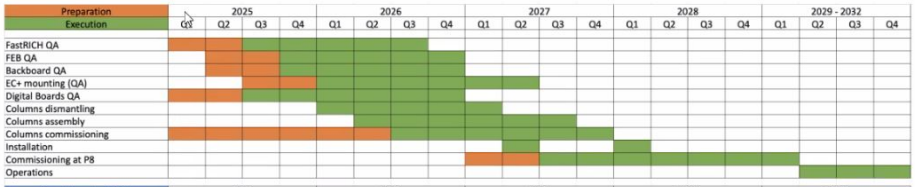
Upgrade 1b (Run 4): RICH

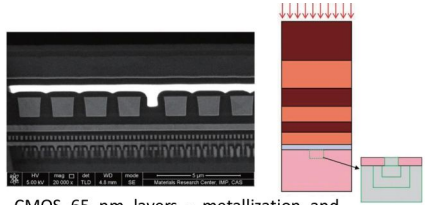
F. Borgato, A. Lupato, G. Simi

- Upgrade 1b goal: nuova elettronica di front-end, nuova meccanica adatta per estrazione del calore
- Upgrade 1b responsabilità Padovane:
  - Test sotto fascio di prototipi elettronica + rivelatori
  - Caratterizzazione resistenza alla radiazione dell'elettronica
  - Assemblaggio e Commissioning at CERN

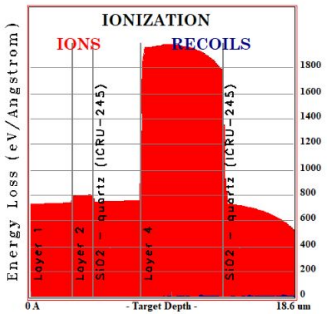


Cherenkov Ring with test beam prototype





CMOS 65 nm layers - metallization and passivation layers are on top of Poly-Si gates and critic Silicon dioxide layers (taken from Chin. Phys. B Vol. 26, No. 8 (2017) 088501) , modeled with staked layers.



Upgrade 2 (Run 5): RICH

F. Borgato, A. Lupato, G. Simi

- Upgrade 2 goal: Time resolved RICH
- Attività Padovane: sviluppo in collab. con FBK e altri gruppi italiani di nuovi sensori per HL-LHC
  - Design of the sensors, qualification of rad tolerance
  - Use existing devices to test characteristics useful for the design of the new Back Side Illuminated SiPM

Requirements on the new RICH

- Single photon sensitivity, with large QE
- Single-photon Cherenkov angle uncertainty 0.4/0.2 mrad (RICH1/RICH2), a factor 2 better than expected for Run3
- Number of detected photons per saturated track: ~40/30 (RICH1/RICH2)
- Able to sustain very high photon rates within a LHC bunch crossing (25 ns)
  - In the current RICH detector we expect a maximum channel occupancy of ~25% with ~9 mm² pixel area (~1 MHz/mm²)
  - For Upgrade II we expect a photon hit density of ~10 MHz/mm² (assuming current geometry/optics)
- High granularity (hence electronics channel density) to keep maximum channel occupancy below ~25%
  - Translates in a pixel size of ~1 × 1 mm² assuming current geometry/optics (might be relaxed if geometry/optics is optimized)

Excellent time resolution within a 25 ns bunch

- Ideally <100 ps r.m.s. for single photon (the smaller the better)

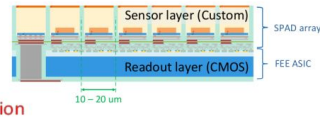
Signal/noise ratio: average Dark Count Rate occupancy <0.001

Radiation hardness

- Extrapolating from Upgrade I (using a factor ×10): ~2 Mrad TID, ~3 × 10¹³ 1 MeV n_{eq}/cm^2, ~1 × 10¹³ HEH/cm²

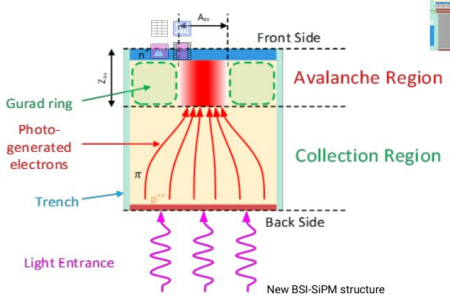
The next-generation of developments, currently being investigated at FBK, is building a *backside-illuminated, NUV-sensitive SiPM*. Several technological challenges should be overcome.

Clear *separation between charge collection and multiplication regions*.



Potential Advantages:

- Up to 100% FF even with small cell pitch
- Ultimate Interconnection density: < 15 um
- High speed and dynamic range
- Low gain and external crosstalk
- (Uniform) entrance window on the backside, ideal for enhanced optical stack (VUV sensitivity, nanophotonics)
- Local electronics: ultra fast and possibly low-power.



Development Risks:

- Charge collection time jitter
- Low Gain → SPTR?
- Effectiveness of the new entrance window

Radiation hardness:

- The SiPM area sensitive to radiation damage, is much smaller than the light sensitive area
- **Assumption**: the main source of DCR is field-enhanced generation (or tunneling).

Attività RICH Upgrade

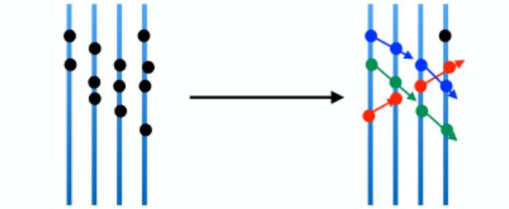
Richieste finanziarie e risorse

- Upgrade Ib
  - Electronics consumables for irradiation tests
    - (FPGA for programming/controlling the FastRICH electronics) or (custom test board with signal generator)
  - Travel funds
- Upgrade II
  - SiPM R&D
    - Cooling system for -50 C
      - Peltier cells
      - Mechanics (Servizio Progettazione ~1MU)
    - Cooling system for liquid nitrogen temperature
      - 10L Dewar
      - Mechanics (Servizio progettazione ~1MU)
    - Laser refurbishment
      - Optical fibers, lenses
  - Metamaterials
    - TBD in GRV

TimeSPOT : Time and SPace real-time Operating Tracker

F. Borgato, G. Simi

GR5 project: development of a **complete tracking demonstrator** capable of copying with extremely **high instantaneous luminosities**. **Now included in R&D for LHCb Velo Upgrade II**

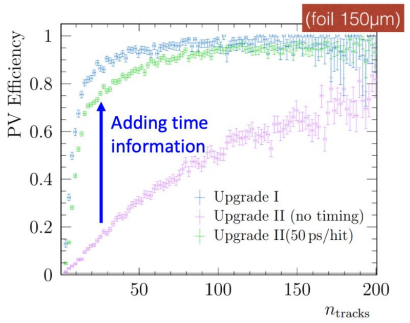


Hits no time info Hits with time info

With high luminosities the **tracking detectors** will become inefficient!
How to **correctly reconstruct** the **traces**?

TIME INFORMATION

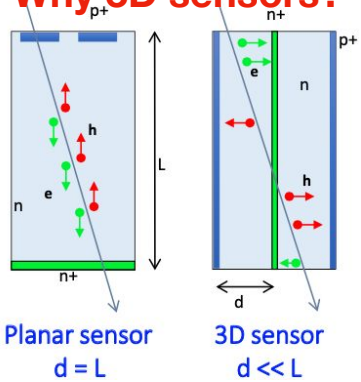
LHCb Upgrade-2 (Long shutdown 4) requirements:



- Fluence 1 MeV
- ps per hit

TimeSPOT 3D sensors satisfy all the requirements!
Viable option for the VELO Upgrade-2

Why 3D sensors?



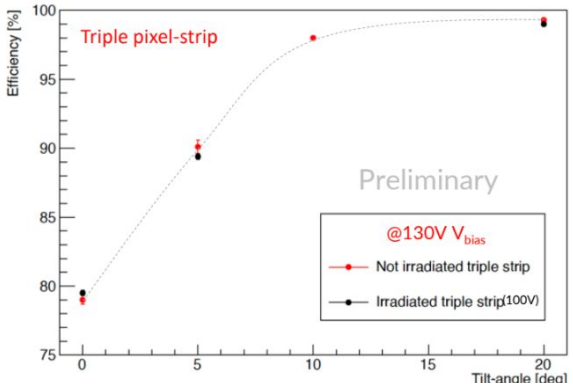
TimeSPOT : Time and SPace real-time Operating Tracker

F. Borgato, G. Simi

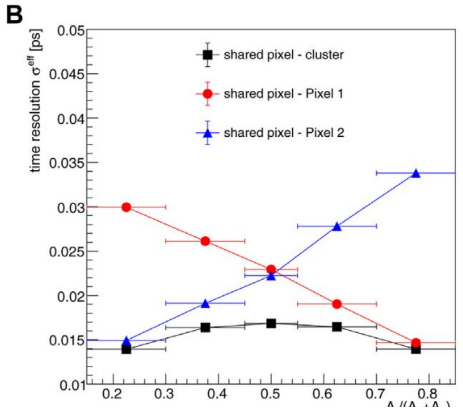
Test beam @CERN, SPS: published in Frontiers in Physics

Efficiency studies:

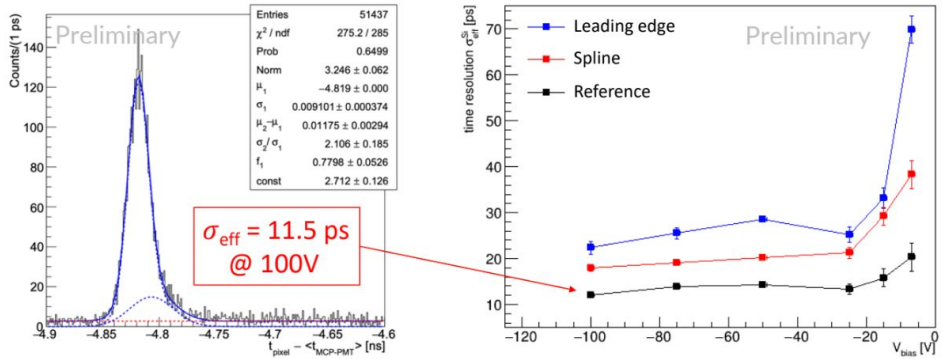
99.10.6% @20°

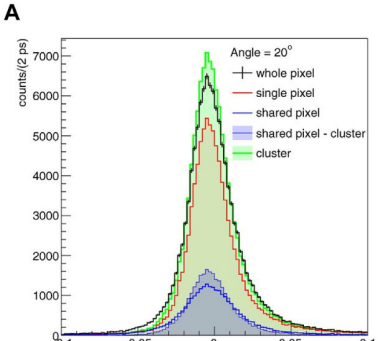


Individual Pixel Charge Sharing:



Single Pixel Time resolution:



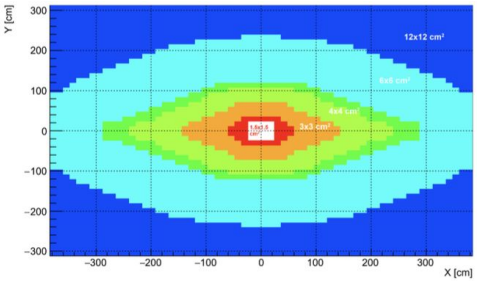


Upgrade 1b/2: ECAL

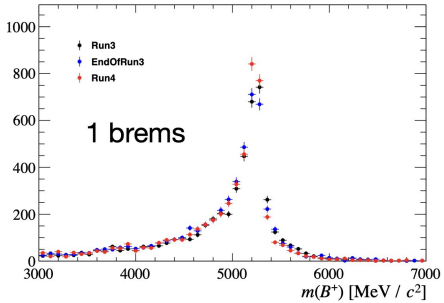
P. Andreetto, L. Arnone, A.Gianelle, L. Sestini, D. Zuliani, D. Lucchesi

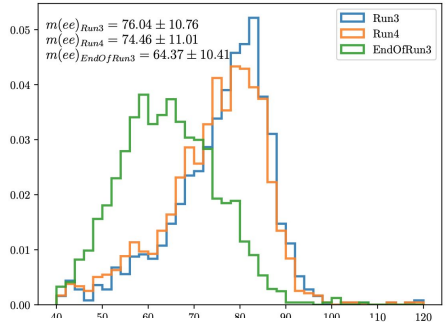
Attività di simulazione degli upgrade futuri di ECAL

Attività sinergica con RD_Mucol

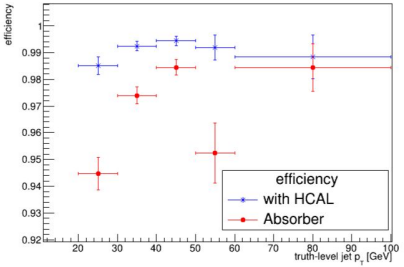


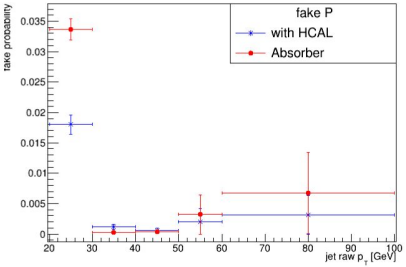
- Performance di ricostruzione degli elettroni
  - studi a basso (B→Kee) e alto (Z→ee) regime di energia
  - si tiene in considerazione anche la bremsstrahlung recovery e la saturazione dell'ADC (tuning del range dinamico)





- Performance ricostruzione dei jets in diverse configurazioni del calorimetro:
  - con HCAL o con assorbitore



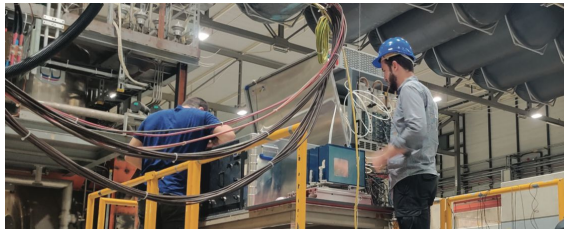


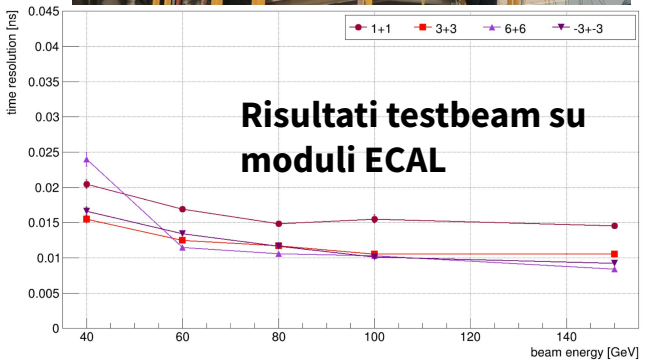
TDR per LS3 (Upgrade 1b) in preparazione!

Upgrade 1b/2: ECAL

P. Andreetto, L. Arnone, A.Gianelle, L. Sestini, D. Zuliani, D. Lucchesi

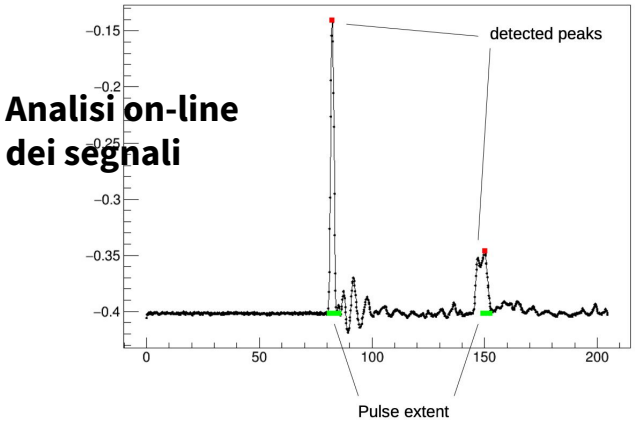
Sinergico con i tests beam per RD_Mucol





- **Contributi alle campagne di test-beam a DESY ed SPS**
  - analisi dati (time and energy resolution)
  - montaggio prototipi
  - shifts per data taking

- **Ricostruzione on-line su FPGA**
  - determinazione dell'altezza dei segnali
  - clustering real-time, utilizzando tecniche innovative (es. basate su machine learning)
  - per questa attività necessario il supporto del servizio di Progettazione elettronica

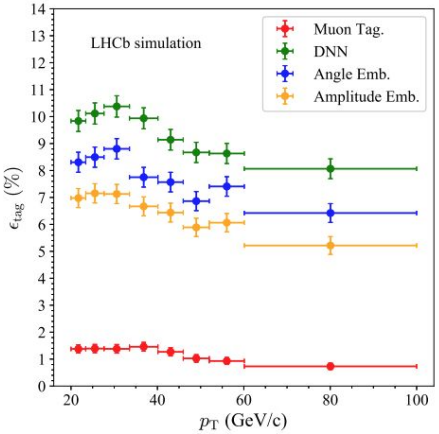


Quantum Computing ad LHCb

A. Gianelle, S.Monaco, L. Sestini, D. Zuliani, D. Lucchesi

Applicazione del Quantum Machine Learning all'analisi dati di LHCb

- Classificazione dei b-jets usando il QML
  - Studi iniziali su simulazione computer quantistico
  - Stiamo lavorando all'applicazione su hardware
- Interpretabilità degli algoritmi di QML tramite la misura dell'entropia di entanglement
  - Tesi di **S. Monaco**



Simulazione con algoritmi quantistici

- Simulazione di distribuzioni di eventi tramite Quantum Born Machines
- Simulazione risposta detector (ECAL) con Quantum Generative Adversarial Network

Attività inquadrata nella sigla PNRR_ICSCS10 (0.05 FTE L. Sestini)

Possibile sinergia con AI_INFN, la nuova sigla gruppo V

LHCb-Padova: responsabilità

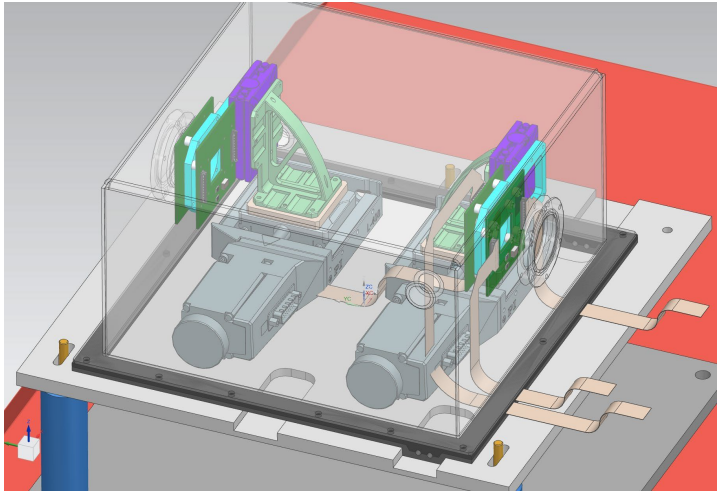
Nome	Responsabilità
A. Bertolin	Sprucing manager
L. Giambastiani	Simulation Liaison for the “QCD, Electroweak and Exotica” group
D. Lucchesi	Coordinator of the “Innovative Analysis Techniques” (WP4 of Data Processing and Analysis project) (2b)
A. Lupato	Convener of the “Semileptonic decays Physics WG” (2a)
L. Sestini	Member of the Collaboration Board
D. Zuliani	Convener of “Trigger, Online data processing and jets” for the “QCD, Electroweak and Exotica” group (2b)

LHCb-Padova: anagrafica e richieste

Nome	Profilo	FTE
P. Andreetto	Tecnologo	0.25
M. Benettoni	Primo Tec.	0.20
A. Bertolin	Ricercatore	0.70
F. Borgato	PhD	0.80
L. Buonincontri	PhD	0.70
A. Gianelle	Tecnologo	0.50
L. Giambastiani	PhD	0.70
D. Lucchesi	Prof. Ord.	0.70
A. Lupato	RTDA	0.70
G. Simi	Prof. Ass.	0.70
L. Sestini	Ricercatore	0.65 + 0.05 PNRR_ICSCS10 (sinergico)
D. Zuliani	Assegnista	0.70
Totale		**7.35**

- **7.35 FTE in totale**
  - 6.2 FTE nel 2022
  - 3 tecnologi INFN: P. Andreetto (25%), M. Benettoni (20%), A. Gianelle (50%)
- **Richieste finanziarie**
  - Missioni secondo formule standard
  - Materiale per test RICH upgrade (in fase di definizione)
- **Richieste servizi Sezione di Padova**
  - **Progettazione elettronica 1 m.u.** → Supporto per elettronica usata nei test irraggiamento RICH
  - **Progettazione elettronica 1 m.u.** → Supporto per programmazione FPGA usate nella ricostruzione on-line di ECAL

LUXE @ PD



M. Morandin
INFN- PD

CdS - 5 luglio 2023

Istituto Nazionale di Fisica Nucleare
Sezione di Padova

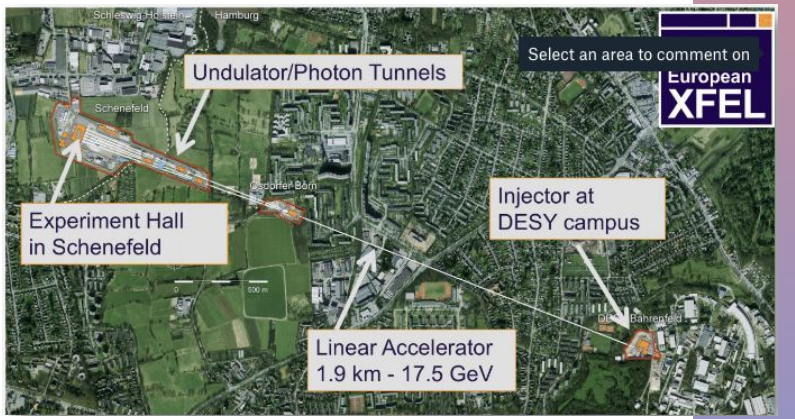
Sommario

- Introduzione
- Stato di LUXE
- Stato del Gamma Beam Profiler (GBP)
- Prospettive e richieste per il 2024

LUXE (Laser Und XFEL) a DESY

- Nuovo esperimento HEP proposto a DESY e Eu.XFEL
  - l'Italia è partner di European XFEL, rappr. INFN e CNR nel Council
  - paesi membri XFEL Gmbh: Denmark, **France**, **Germany**, Hungary, **Italy**, **Poland**, Russia, Slovakia, **Spain**, **Sweden**, Switzerland, and the **United Kingdom** **[also in LUXE collab. that also include Israel and Romania]**
- Collisioni inizialmente di fascio di elettroni **XFEL e Laser ad alta potenza**
  - in una seconda fase di fascio gamma con Laser

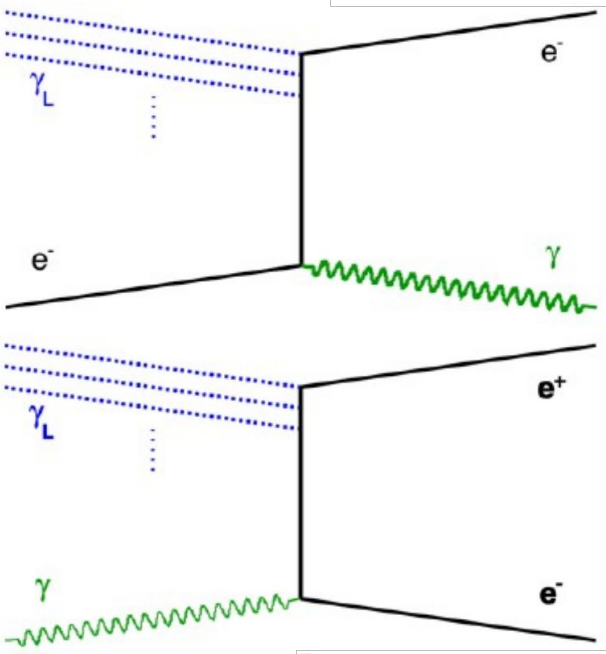
- Primi passi:
  - Summer 2017: Started to develop LUXE
  - Feb. 2021: CDR produced
  - Oct. 2021: DESY directorate decided for CD0 based on CDR
  - Nov. 2021: EU.XFEL directorate expressed intention to build beam extraction
- Collaborazione internazionale
  - ~90 membri (17 istituzioni a Sep. 2022)
- Gruppi INFN coinvolti: Bologna, Padova
- Documentazione
  - Sito WEB LUXE : https://luxe.desy.de/documents

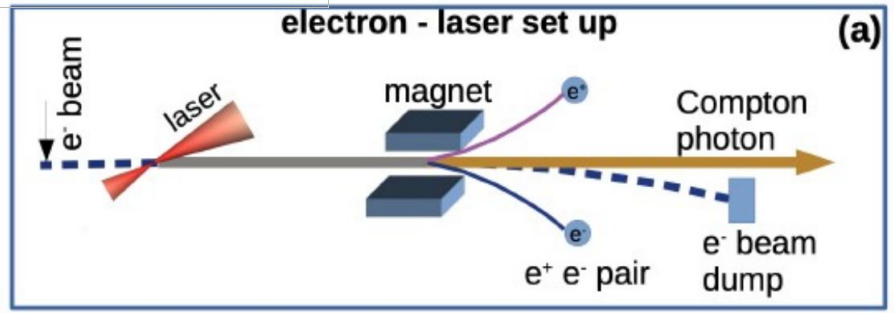


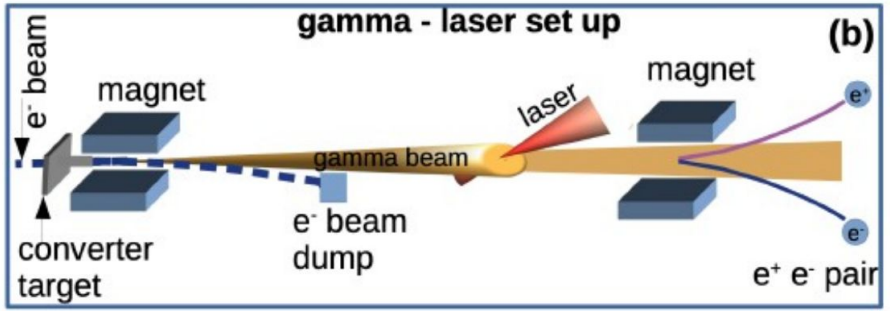
Obiettivi di LUXE

- esplorare le interazioni di fotoni reali con elettroni e positroni in un regime di intensità del campo e.m. dove gli accoppiamenti con le cariche diventano non-perturbativi
- effettuare misure di precisione di tali interazioni nella regione di transizione fra il regime perturb. e non perturb. della QED
- utilizzare i processi di strong-field QED per effettuare una ricerca di nuove particelle BSM

LUXE in una slide

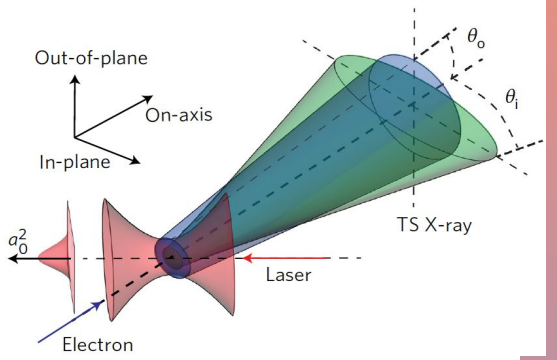


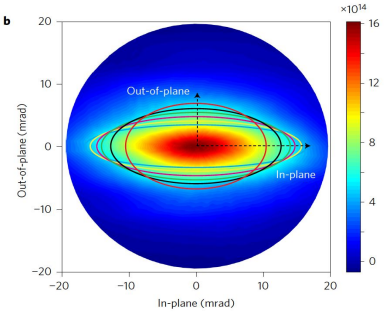




Compton-scattered gamma beam

- La distribuzione angolare del gamma, dipende dalla intensità del fascio laser polarizzato
- in particolare il rapporto fra larghezza sul piano della polarizzazione, rispetto a quello ortogonale



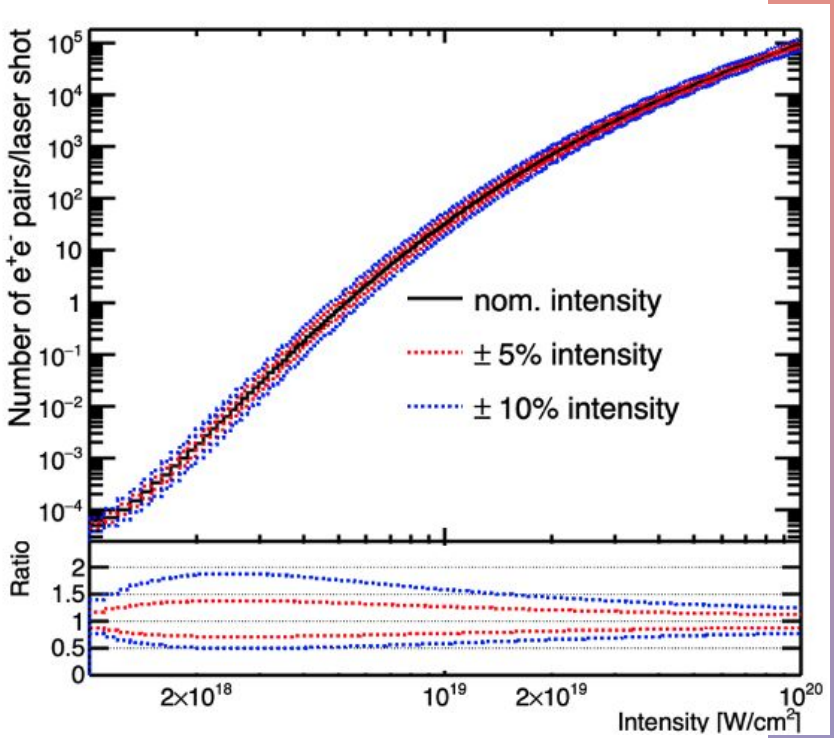


Perchè un Gamma Beam Profiler

- Le variazioni di intensità di laser sono in relazione con variazioni sul valore di ξ
- I processi di fisica dipendono fortemente da ξ

$$\xi \propto \sqrt{I_{Laser}}$$

  - Piccole variazioni di ξ comportano grandi variazioni sui rate di produzione
  - Una incertezza del 5% sulla intensità assoluta risulta in una variazione oltre un fattore 2 sui rate previsti
- Due metodi di misura diretta di ξ
  - Diagnostica laser 3D (energia, durata e larghezza impulso) -> qualche % errore sull'intensità dell'impulso laser all'origine
  - Gamma Beam Profiler (GBP) che misura l'intensità nella zona di interazione come rilevata dal fascio di elettroni



Stato di LUXE

In generale

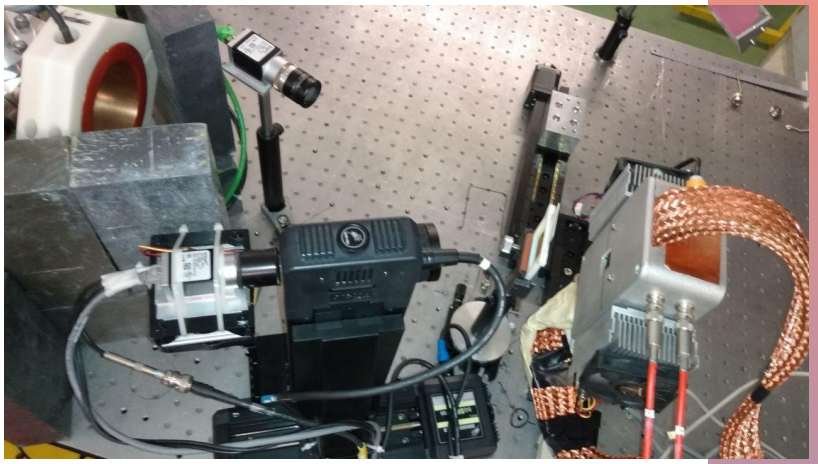
- A fine 2022 LUXE ha avuto l'approvazione CD1
- tuttavia la situazione venutasi a creare a EU.XFEL a seguito della guerra in Ucraina ha condizionato i passi successivi
- la linea di fascio di LUXE è stata messa in seconda priorità ed è venuto quindi a mancare il contributo di alcuni M€ destinato a tal fine
- la collaborazione ha cercato quindi di ottenere nuovi fondi sia da DESY, sia attraverso la partecipazione a due progetti Europei
    - ERC Synergy
    - HORIZON-INFRA-2023-DEV-01
  - come Padova abbiamo partecipato in particolare al secondo in cui abbiamo una responsabilità nella progettazione e produzione dei beam-dump, i cui tempi di realizzazione sono critici in quanto si tratta degli elementi che devono essere posizionati per primi sulla linea del fascio
- l'esito di questi tentativi sarà chiaro prima di fine anno
- rispetto all'anno scorso si è accumulato un ritardo di circa un anno ed è prevedibile che non si riesca a completare l'installazione di beam-line e detector nel 2025
- nel frattempo è stato scritto il TDR di LUXE che dovrebbe essere pubblicato a breve

Stato del Gamma Beam Profiler

Istituto Nazionale
di Fisica Nucleare
Sezione di Padova

Stato del GBP (I)

- **Sensori prodotti a Tomsk**
  - i sensori sono arrivati in qualche stati bondati a settembre ´22 e dovevano essere provati a CLEAR (CERN) in dicembre 2022, ma il run è saltato a causa della chiusura anticipata delle macchine del CERN
  - abbiamo quindi fatto un test al CERN a marzo 2023, con misure precise della carica e della posizione del fascio, bunch per Bunch
  - l'analisi dati è risultata particolarmente complicata per difficoltà dovute al fatto che vari stream di dati non erano sincronizzati con la precisione necessaria.
  - un risultato evidente è stato però la scoperta di una resistività delle strip molto più elevata del previsto (resistenza dell'ordine del MOhm)
    - i colleghi russi avevano fatto una metalizzazione molto sottile ed è probabile che lo strato di cromo si sia ossidato



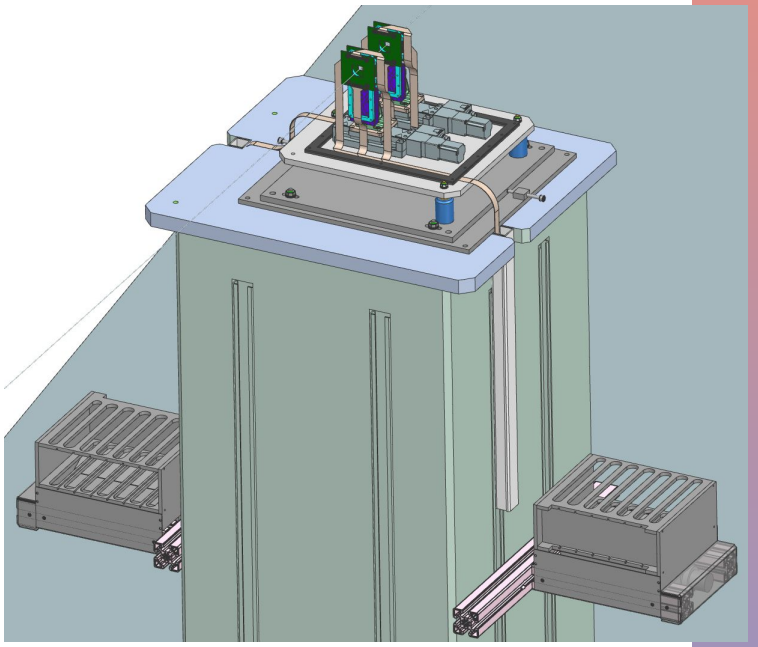
- **Sensori prodotti da FBK**
  - hanno richiesto molto più tempo e lavoro del previsto: sono emersi vari problemi e ciascuno ha richiesto poi di prove e affinamento della procedura di produzione
    - difficoltà di adesione dell'alluminio
    - bolle del photo-resist che portavano ad avere difetti delle metalizzazioni; all'inizio di pensava la causa fosse la modalità di deposizione del resist, ma alla fine si sono accorti che si trattava di un effetto di particelle di polvere che rimanevano sulla superficie dello zaffiro.

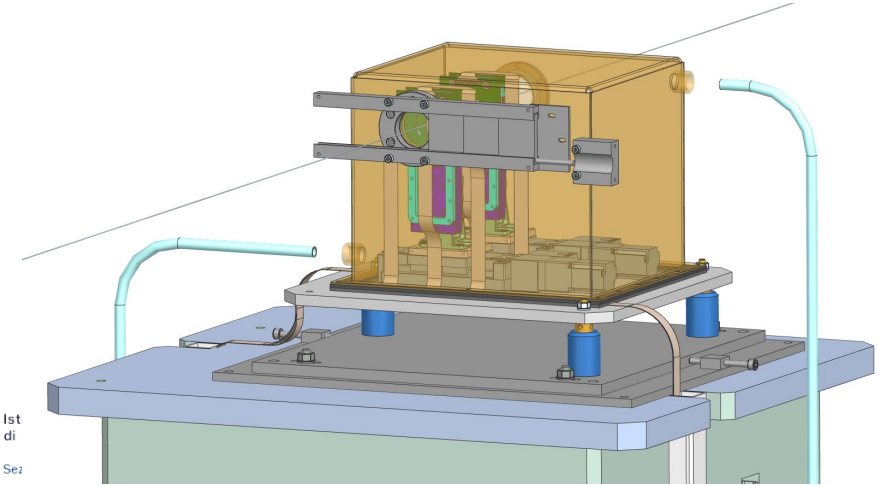
Stato del GBP (II)

- **Situazione a CLEAR**
  - abbiamo adesso a CLEAR una postazione fissa su una deviazione del fascio che viene usata solo una volta al giorno per misure di energia del fascio
  - siamo in grado di acquisire i dati da remoto, senza dovere essere presenti al CERN
  - possiamo prendere dati, grazie alla disponibilità dei colleghi di CLEAR, anche senza avere tempo dedicato
  - dovrebbe essere quindi possibile nei prossimi mesi eseguire test finale con i rivelatori FBK
- **Sviluppo collaterale importante**
  - nelle misure di marzo abbiamo utilizzato uno scintillator screen + camera come monitor del fascio che ha dato degli ottimi risultati
  - il limite di questo approccio è legato alla quantità di segnale che si riesce a generare
  - stiamo valutando fino a dove possiamo spingerci inserendo assorbitori di spessore opportuno sul fascio gamma, prima dello scintillatore

Altre attività: meccanica

- Ordinati i componenti della meccanica per una stazione
- Tempi di consegna "biblici": 11 mesi per il pezzo più importante
- Speriamo di riuscire ad assemblare tutto entro fine anno





Attività nel software a PD

- supporto per il sistema di data acquisition a CLEAR
- sincronizzazione e analisi dei dati di CLEAR
- aggiornamento della simulazione GEANT del GBP e produzione di dati per la Technical note, il TDR e i test beam (stima prestazioni e dosi accumulate)
- attività parallela su Allpix2 , strumento utilizzato per simulare la risposta dei rivelatori al silicio, per adattare tale struttura di simulazione allo zaffiro
  - la prima implementazione di un software Allpix2 modificato è stata convalidata con i dati presenti in letteratura
  - i risultati principali sono stati presentati al 4° Allpix Squared User Workshop presso il DESY

E-320 @ FACET-II (SLAC)

- L' anno scorso avevamo ricevuto l'invito a partecipare all'esperimento alla presa dati del progetto E320 a FACET-II (SLAC) che ha un programma di fisica simile, anche se meno ambizioso al momento, rispetto a quello di LUXE
- Purtroppo il 27/12/22 c'e' stato un incidente a SLAC in cui un elettricista è stato investito da un arco elettrico ed è finito in ospedale.
  - l'incidente ricorda un altro noto incidente elettrico avvenuto nel 2004, ai tempi di BaBar, in cui un elettricista subì gravi ustioni
- Facet-II sta ripartendo adesso e si pensa che E-320 possa avere fascio nel 2024

Department of Energy
Washington, DC 20585

February 24, 2023

Dr. Stephen K. Streiffer
Interim Laboratory Director
SLAC National Accelerator Laboratory
Stanford University
Office of the President
2575 Sand Hill Road
Menlo Park, California 94025

Dear Dr. Streiffer:

This letter serves as notification of the Office of Enterprise Assessments, Office of Enforcement's decision to conduct an investigation into the facts and circumstances associated with an arc flash injury event that occurred on December 27, 2022, in building 626 at the SLAC National Accelerator Laboratory. SLAC reported this event into the Department of Energy's (DOE) Occurrence Reporting and Processing System under SC-SSO-SU-SLAC-2022-0019, dated December 30, 2022.

Prospettive e richieste per il 2024

Il 2024

- con la realizzazione e il test del prototipo di sensore prodotto da FBK riteniamo di concludere il programma di R&D sul rivelatore a zaffiro entro il 2023, con la scelta della tecnologia da usare
  - microstrip zaffiro o scintillator screen
- il residuo di inventariabile verrà quindi usato per acquistare altre due schede FERS per portare a 128 i canali letti per sensore oppure per acquistare un sistema di camera e scintillatore in modo da poter partecipare alla eventuale presa dati a E320:
- l'ottimizzazione delle caratteristiche del rivelatore e la FDR sono rimandate al 2024 (6/'24)
- stante l'incertezza e lo slittamento dei tempi, sottoporremo quindi la richiesta di finanziamento per la costruzione del rivelatore nel corso del 2024, dopo l'approvazione CD2
- inizierà, se, come speriamo verrà approvato il progetto Europeo (esito atteso per agosto '23), il lavoro di progettazione dei beam dump di LUXE che si protrarrà per tutto il 2024

Personale coinvolto nel 2024

- **PADOVA (alcune t.b.c.)**
  - **Personale a tempo indet.** (tot.: 1.25 FTE)
    - M. Morandin - 0.75 FTE
    - G. Simi - 0.15 FTE
    - M. Benettoni - 0.10 FTE
    - A. Paccagnella (DEI) - 0.15 FTE
    - D. Pantano (Assoc. Tec.) - 0.10 FTE
  - **Personale a tempo det.** (tot. 2.20 FTE)
    - S. Mattiazzo (RTD-B) - 0.05 FTE
    - S. Vasyukov (AdR INFN) - 1 FTE
    - P. Grutta (Dottorando) - 1 FTE
    - S. Bonaldo (post-doc DEI) - 0.15 FTE
  - **Altri collaboratori**
    - Umberto Dosselli
    - F. Dal Corso

Servizi di Sezione

- Impegno sui beam dump (progetto Europeo)

Nome	Inquadramento	Servizio	PM	Da rendicontare	Periodo
M. Morandin	Dir. Ric.		1	SI	2024-2026
M. Benettoni	I Tecn.	Prog. Mecc.	4	SI	2024-2027
Disegnatori	IV liv.	Prog. Mecc.	10	SI	2024-2025

- Montaggio movimentazione meccanica I stazione
  - 1 m.u. O.M.

Servizio	Attività	Durata	Periodo
Calcolo e reti			
Elettronica			
Meccanica	La produzione dei pezzi meccanici si prevede venga eseguita da ditte esterne. Possibili attività da svolgere presso l'OM riguardano l'assistenza nei test di assemblaggio e di contatto termico fra il core di alluminio e ls shell in rame,	2 mesi-uomo	2025-2026
Servizio Progattazione Meccanica	Progettazione dei due beam dump, preparazione e gestione tecnica delle gare, effettuazione controlli e misure di validazione, spedizione a DESY e collaborazione per l'installazione finale.	14 mesi-uomo	2024-2027

Richieste PD 2023

Missioni			
	Missioni interne ed estere metabolismo	1 m.u. per FTE	12,0	
	TOTALE		**12,0**	**0,0**
Consumo			
	Metabolismo consumo		5,0	
	Materiali e componenti per struttura meccanica II stazione		0,0	13,0
	TOTALE		**5,0**	**13,0**
Trasporti			
	Spedizioni meccanica		1,0	
	TOTALE		**1,0**	**0,0**
Inventario			
	Alimentatori, sensori per II stazione		1,0	
	TOTALE		**1,0**	**0,0**
Costruzione apparati			
	Guide lineari e controller alta precisione per II stazione		0,0	11,0
	TOTALE		**0,0**	**11,0**
GRAN TOTALE			**19,0**	**24,0**

MUONE Padova 2024

E. Conti

Activity 2023

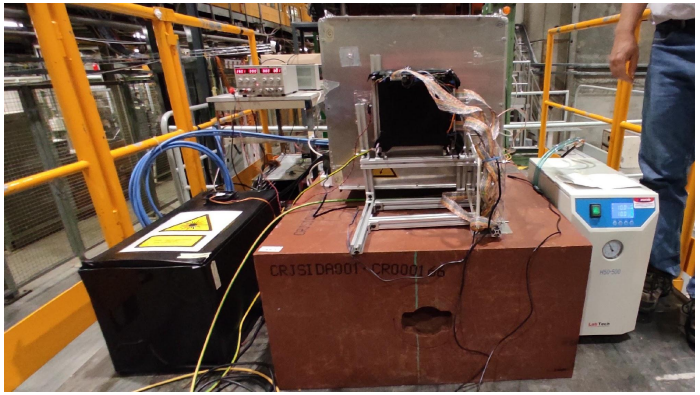
- The main goal of the year is the physics data taking in Aug-Sept 2023 at the M2 muon beam line at CERN (2 weeks as main user + 1 week in parasitic mode) with a prototype of the full apparatus:
  - 2 tracker modules (1 for beam direction, 1 with target)
  - ECAL
- It is not simply a technical test of the apparatus and of the triggerless DAQ system, but a data collection for physics, to measure the running of α_{em} with O(10%) precision.

  It is a fundamental preliminary for the proposal of the experiment, to be written in 2024.

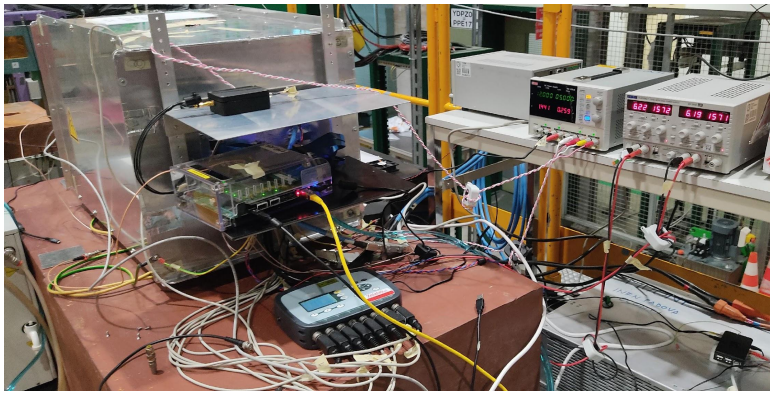
ECAL Calibration

- The ECAL module, developed and build by Padova, with contributions (FEBs) of Imperial College, has to be calibrated in the full energy range of the experiment, i.e. 1 to 150 GeV
- 2 calibration runs at CERN in June:
  - high energy, 20-150 GeV , in H2 beamline, 10 days
  - low energy, 1-10 GeV, in T09 beamline, 7 day
- There, also first test of the new FW for the triggerless DAQ (Montecassiano)

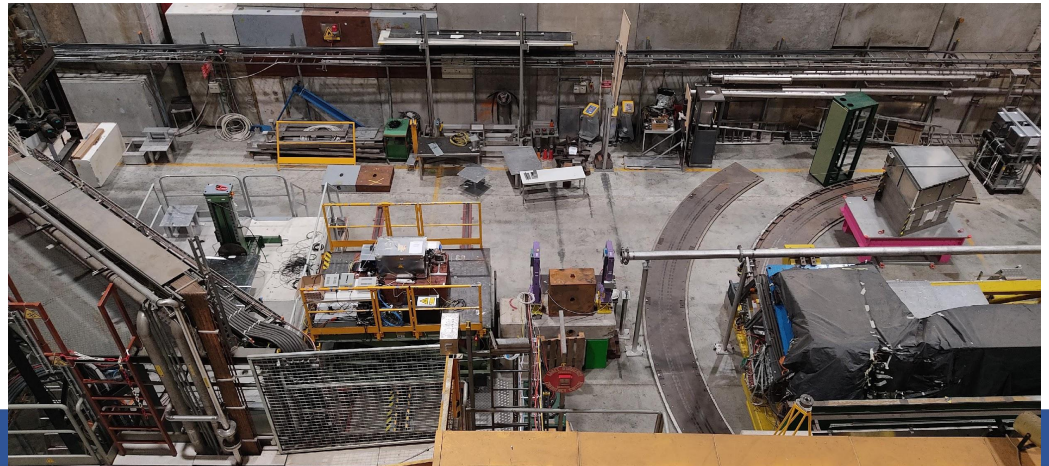
2023 test beam in H2



front

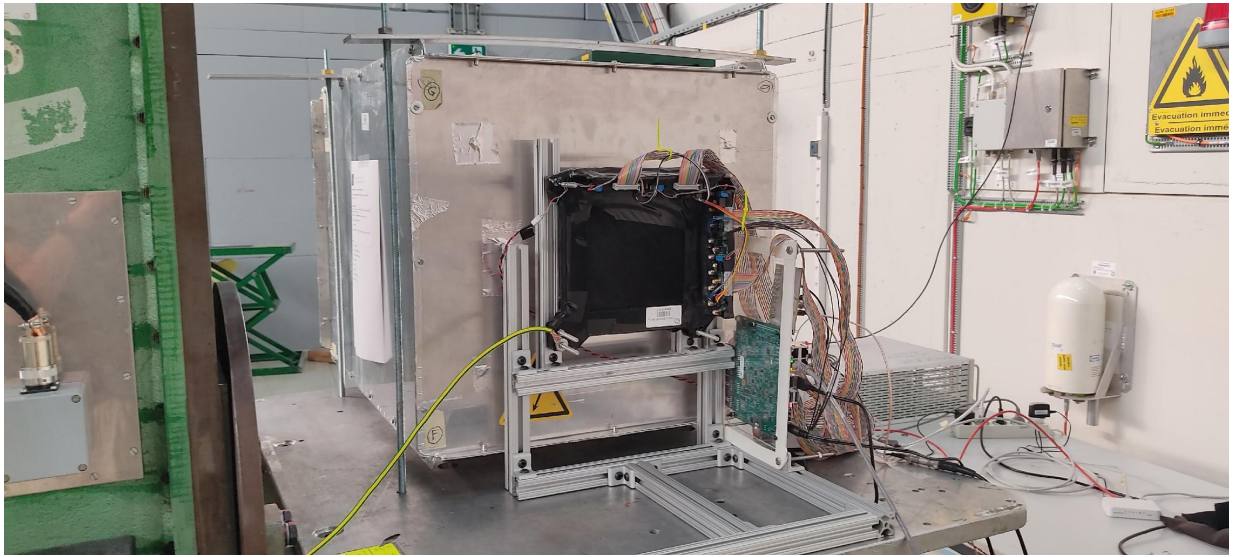


rear



panoramic view

2023 test beam in T09



Activity 2024

- writing of proposal
- study of PID
- study of systematics due to geometry and misalignment
- verify possible use of 1S trackers (instead of 2S)
- .....

Anagrafica 2024

(in progress)

Name	% 2023	% 2024
Benettoni	10	10
Bragagnolo	20	--
Conti	85	95
Ghosh	80	--
Mastrolia	10	10
Montecassiano	20	20
Passera	10	10
Ronchese	20	30
Simonetto	20	30
Lusiani	--	30
Rossin	--	10
TOTALE FTE	2.75	**2.45**

richieste finanziarie 2024

(in progress)

- Missioni: 10 K
- consumo : 7k (meccanica, cavi, elettronica)

- SERVIZI DI SEZIONE:
  - 0.5 mesi/uomo uff.tecnico
  - 1 mese/uomo off.meccanica (update meccanica ECAL)
  - 1 mese/uomo off.elettronica (cavi LV, scheda laser trigger)

RD FCC

FUTURE
CIRCULAR
COLLIDER

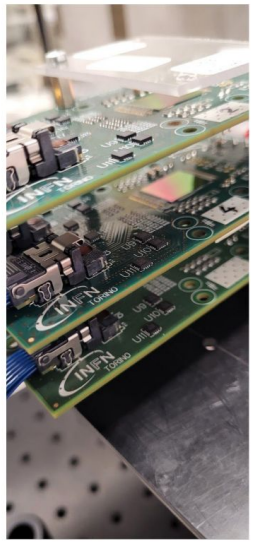
P.Azzi

RD-FCC - R&D on MAPS

- The ARCADIA collaboration (2019-2022) has developed a full-chip prototype targeting requirements for different applications (future colliders, space, medical)
  - Low power→ O(20 mW cm^{-2}) in high rate mode
    - Scale down to O(10 mW cm^{-2}) in Low Rate mode for space applications
  - Small pixel pitch → 25 × 25 µm^2
  - Thin sensors → 100 µm
  - Scalability to large area → up to 4 × 4 cm^2
  - High particle rate→ up to 100 MHz cm^{-2}
  - Timing resolution → O(1 µs)
    - Investigating more advanced solutions for O(10 ns) timing

RD-FCC - R&D on MAPS

- The latest prototype has been delivered in Spring 2023 and an experimental campaign has just started
- Goals:
  - Measurement of the system stability;
  - Measurement of the spatial resolution;
  - Measurement of the efficiency.
- Source: cosmic rays

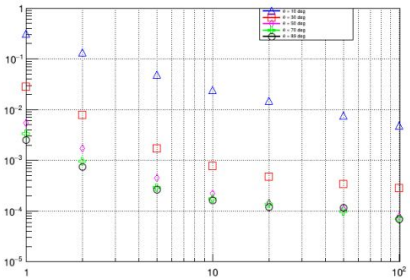


Financial requests

Item	Cost
Power supply (4 Channel 500 V/3 mA Desktop HV, DT5519EM CAEN)	4.5 k€
Produzione di PCB per strutture di test	1.5 k€
Cavi, componenti, etc	1 k€
TOTALE	7 k€

SIGLA RD-FCC - Attivita' Software & Fisica & responsabilità'

- Responsabilita':
  - P. Azzi Coordinatore RD-FCC WG1 "Software e Fisica"
  - P. Azzi Coordinatore "Physics Performance WP" di "FCC Physics Experiment and Detector" (CERN)
  - P. Azzi Convener del ECFA-WG2 per attività Higgs/EWK/Top Factories
- Attività in corso e future:
  - Ricostruzione di tracce con il rivelatore IDEA. Studi di tracking performance.
  - **Attivita' sinergica con AIDAInnova task 12.5.2** "Particle Flow per DR calorimeter with Pandora"
  - Sviluppo computing tools e user support per produzione MC e analisi dati al CNAF
  - Studi di fisica per ricerca di LLP, utilizzo di timing per BSM
- No Richieste di calcolo locali, solamente richieste al CNAF



Risoluzione in p degli elettroni nella DCH. Ottenuta con Geant al CNAF con il nuovo software key4HEP
Plot semplice—> preparare tutta la catena molto complicato

Anagrafica	%
Azzi Patrizia	20% RD-FCC+ 10% AIDA sinergico
Bacchetta-Nicola	10
Roberto Carlin	10
Federica Fanzago	10
Martino Margoni	10
Serena Mattiazzo	10+*10 PHALAFEL sinergico?*
Federico Nardi	10
Roberto Rossin	10
Mia Tosi	20
Totale	130/140

Development of particle flow algorithms based on Neural Network techniques for the IDEA calorimeter at future colliders

Adelina D'Onofrio[1], Michela Biglietti[1], Biagio Di Micco[2], Iacopo Vivarelli[3], Patrizia Azzi[4], Sofia Vallecorsa[5]

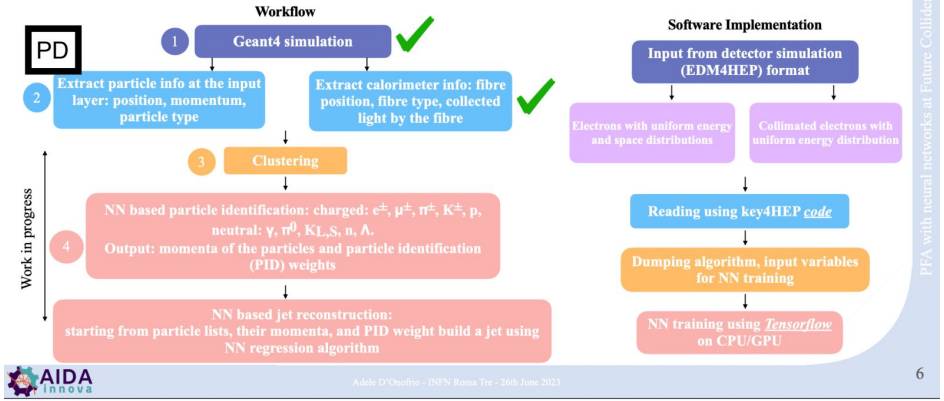
[1]INFN - Roma Tre
[2]Roma Tre University
[3]University of Sussex
[4]INFN - Padova
[5]CERN

26th June 2023

AIDA Innova Task 12.5.2

Overview of the Particle Flow Project

- The aim of the project is to build a Neural Network based algorithm that, from a given collection of energy deposits in the calorimeter, is able to completely reconstruct a jet in the detector and maximise the energy resolution of the dual read-out calorimeter

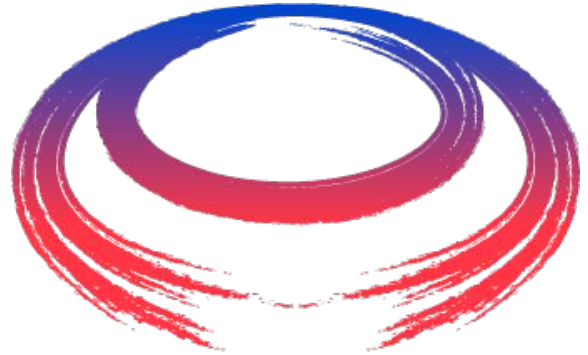


PD Contribution #2: studio dell'input prodotto con la simulazione in GEANT e convertito in EDM4HEP output. Validazione della conversione. Studi di tracking con singola particella, come input per i prossimi step di ricostruzione/PFlow.

6

RD MuColl

D. Lucchesi



International
MUON Collider
Collaboration

RD_Mucol Progress Summary

The 2022 has been a very important year:

- Snowmass meeting in Seattle: muon collider received a lot of support from the young researchers, post-docs and students.

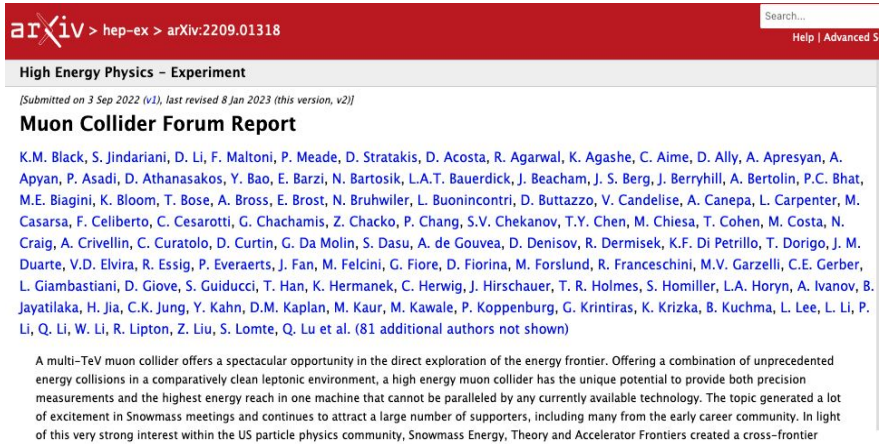
- The Snowmass report requested important fundings for muon collider, including the possibility to host the demonstrator and then the machine.

- The P5 (Particle Physics Projects Prioritization Panel) deliberation on budget is expected by the end of the summer.

- The project MuCol, A Design Study for a Muon Collider complex at 10 TeV center of mass funded by EU.

US activities

Snowmass white papers and the muon collider community forum report are based on the work done within the collaboration. In addition, an Implementation Task Force to evaluate the sustainability was formed.



arXiv > hep-ex > arXiv:2209.01318

Search... Help | Advanced S

High Energy Physics – Experiment

[Submitted on 3 Sep 2022 (v1), last revised 8 Jan 2023 (this version, v2)]

Muon Collider Forum Report

K.M. Black, S. Jindariani, D. Li, F. Maltoni, P. Meade, D. Stratakis, D. Acosta, R. Agarwal, K. Agashe, C. Aime, D. Ally, A. Apresyan, A. Apyan, P. Asadi, D. Athanasakos, Y. Bao, E. Barzi, N. Bartosik, L.A.T. Bauerdick, J. Beacham, J. S. Berg, J. Berryhill, A. Bertolin, P.C. Bhat, M.E. Biagini, K. Bloom, T. Bose, A. Bross, E. Brost, N. Bruhwiler, L. Buonincontri, D. Buttazzo, V. Candelise, A. Canepa, L. Carpenter, M. Casarsa, F. Celiberto, C. Cesarotti, G. Chachamis, Z. Chacko, P. Chang, S.V. Chekanov, T.Y. Chen, M. Chiesa, T. Cohen, M. Costa, N. Craig, A. Crivellin, C. Curatolo, D. Curtin, G. Da Molin, S. Dasu, A. de Gouvea, D. Denisov, R. Dermisek, K.F. Di Petrillo, T. Dorigo, J. M. Duarte, V.D. Elvira, R. Essig, P. Everaerts, J. Fan, M. Felcini, G. Fiore, D. Fiorina, M. Forslund, R. Franceschini, M.V. Garzelli, C.E. Gerber, L. Giambastiani, D. Giove, S. Guiducci, T. Han, K. Hermanek, C. Herwig, J. Hirschauer, T. R. Holmes, S. Homiller, L.A. Horyn, A. Ivanov, B. Jayatilaka, H. Jia, C.K. Jung, Y. Kahn, D.M. Kaplan, M. Kaur, M. Kawale, P. Koppenburg, G. Krintiras, K. Krizka, B. Kuchma, L. Lee, L. Li, P. Li, Q. Li, W. Li, R. Lipton, Z. Liu, S. Lomte, Q. Lu et al. (81 additional authors not shown)

A multi-TeV muon collider offers a spectacular opportunity in the direct exploration of the energy frontier. Offering a combination of unprecedented energy collisions in a comparatively clean leptonic environment, a high energy muon collider has the unique potential to provide both precision measurements and the highest energy reach in one machine that cannot be paralleled by any currently available technology. The topic generated a lot of excitement in Snowmass meetings and continues to attract a large number of supporters, including many from the early career community. In light of this very strong interest within the US particle physics community, Snowmass Energy, Theory and Accelerator Frontiers created a cross-frontier Muon Collider Forum in November of 2020. The Forum has been meeting on a monthly basis and organized several topical workshops dedicated to physics, accelerator technology, and detector R&D. Findings of the Forum are summarized in this report.

Snowmass 2021

ITF's Look Beyond Higgs Factories

	CME (TeV)	Lumi per IP (10^34)	Years, pre-project R&D	Years to 1st Physics	Cost Range (2021 B$)	Electric Power (MW)
FCCee 0.24	0.24	8.5	0-2	13-18	12-18	290
ILC 0.25	0.25	2.7	0-2	<12	7-12	140
CLIC 0.38	0.38	2.3	0-2	13-18	7-12	110
HELEN 0.25	0.25	1.4	5-10	13-18	7-12	110
CCC 0.25	0.25	1.3	3-5	13-18	7-12	150
CERC(ERL)	0.24	78	5-10	19-24	12-30	90
CLIC 3	3	5.9	3-5	19-24	18-30	~550
ILC 3	3	6.1	5-10	19-24	18-30	~400
MC 3	3	2.3	>10	19-24	7-12	~230
MC 10-IMCC	10-14	20	>10	>25	12-18	O(300)
FCChh 100	100	30	>10	>25	30-50	~560
Collider in Sea	500	50	>10	>25	>80	»1000

ITF Report – T. Roser, et al. arXiv:2208.06030

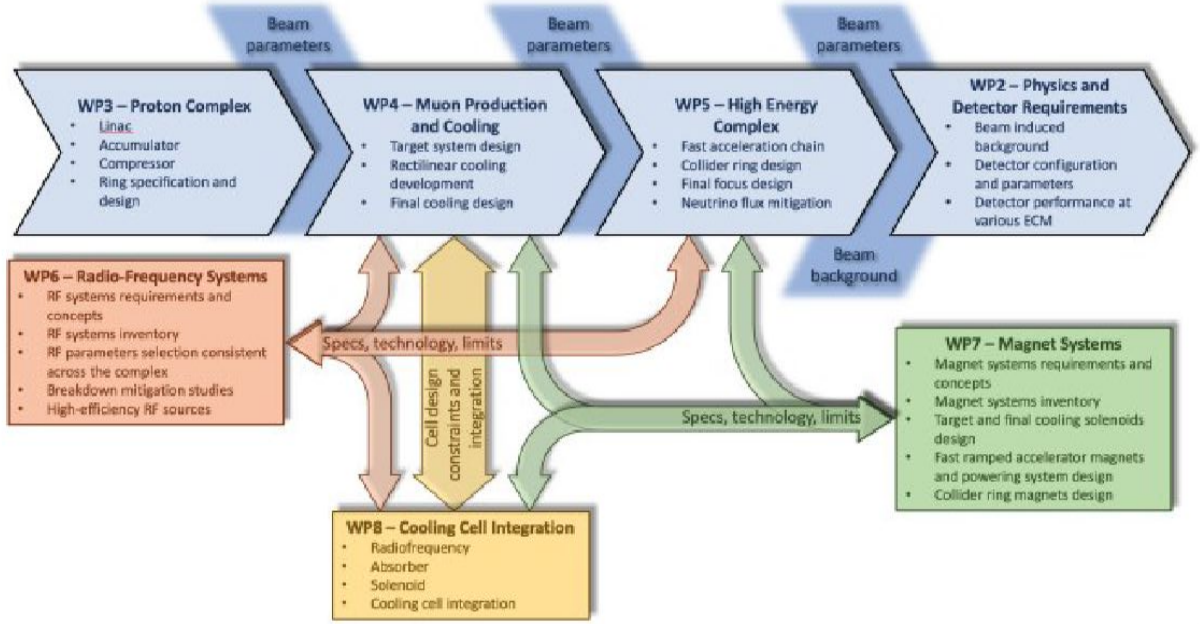
One of the conclusions:
Muon Collider is a viable option for the HEP future

EU Design Study Work Program

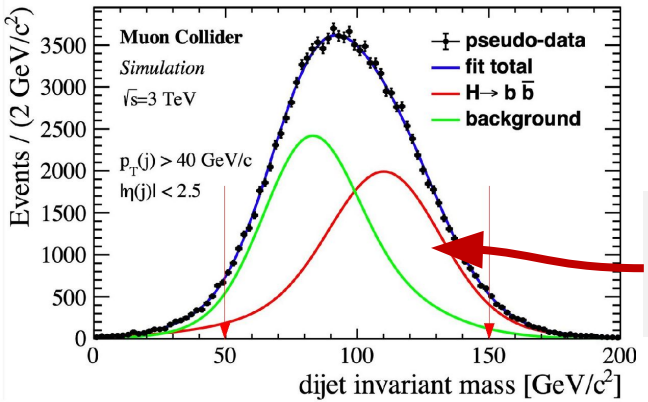
MuCol will develop the collider concept and assess the physics performance based on realistic performance goals for the collider components. The identification of the cost and power consumption drivers will enable determination of the cost and power consumption scale. This will allow the next European Strategy for Particle Physics Update process to make informed choices for the selection of the next large collider to be built in Europe.

Workpackage leaders:
WP 1: R. Losito (CERN)
WP 2: D. Lucchesi (UniPd)
WP 3: N. Milas (ESS)
WP 4: Ch. Rogers (RAL)
WP 5: A. Choince (CEA)
WP 6: C. Marchand (CEA)
WP 7: L. Bottura (CERN)
WP 8: L. Rossi (U. Milano)

Study Leader: D. Schulte
Technical Coordinator: R. Losito
Gender Advisor: E.J. Bahng (ISU)



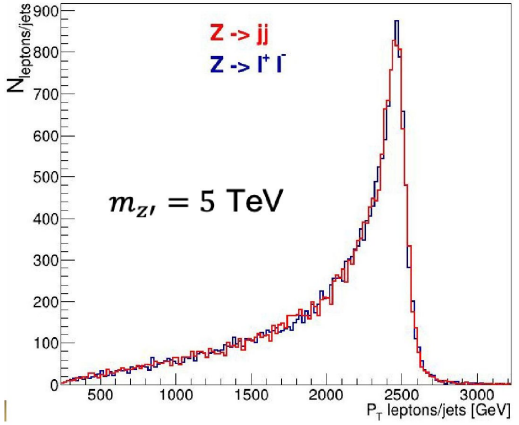
Activities in Padova - 1



Determine detector & physics performance at $\sqrt{s}$ =3 TeV

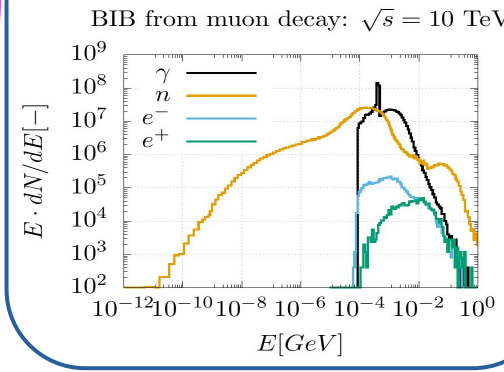
Tracking+jets+b-tag
Meet requirements for precision SM measurements

Study requirement for a $\sqrt{s}$ =10 TeV detector

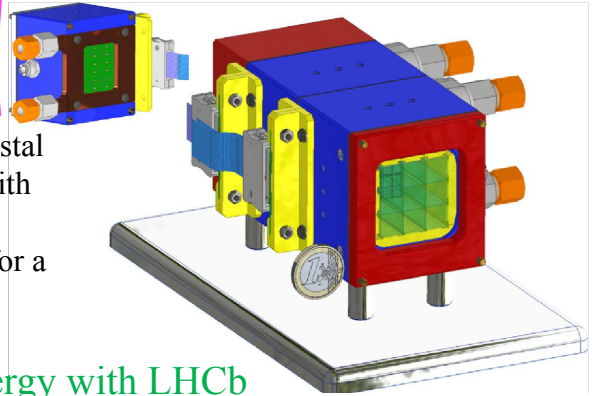


Collaborate on machine detector interface studies

Evaluate BIB with different lattice and nozzle configurations



Participate to calorimeter design & tests beam



CRILIN: CRystal calorImeter with Longitudinal InformatioN for a future Muon Collider

Sinergy with LHCb

Activities in Padova - 2

Support code, migrate to new tools, manage the resources

The new release: basic concepts

Muon Collider Software v.2.8, delivered in April 2023

The reference Linux distribution is Alma Linux 9
CentOS 8 and CentOS 8 Stream are deprecated and not supported anymore

Main external dependencies updated to the latest versions

Updated all the components in common with ILC Software

Package	Version
ROOT	6.28
GEANT4	11.1
DD4hep	1.25
PandoraPFA	4.2
ACTS(*)	13.0

* Used older version for back compatibility

Software development: ongoing tasks

Migration to key4hep:
- Software management based on spack
- EDM4hep model for Muon Collider workflow
- Analysis of Gaudi framework (multithreading support)

Definition of a release validation workflow

For a thorough description of the tasks see the next presentation

Paolo Andreetto
Alessio Gianelle

Orsay, 20/06/23 IMCC 2023 - Muon Collider Detector and Physics Group

Resources

CloudVeneto Openstack based cloud infrastructure operated by INFN-Padova	
Computing	200 VCPU, 740 GB RAM, 100 Virtual machines
Storage	90 Tb on volumes, 75 Tb on object storage (Ceph)
Platforms	Docker, Kubernetes, batch clusters on demand
Access	INFN Identity Provider (INFN-AAI)

INFN-CNAF Tier-1 Grid resources managed by INFN-CNAF	
Computing	6 Computing Elements HT-Condor based
Storage	150 Tb on Storage element (StoRM)
Access	VO muoncoll.infn.it + IAM, CE only for INFN people

CERN site	
Computing	Computing Element HT-Condor based
Storage	100 Tb on EOS, 300Gb on CVMFS
Access	CERN SSO

INFN-Cloud PaaS solution operated by INFN	
Computing	Not yet assigned
Storage	300 Tb required
Access	INFN IAM (under testing)

RD_Mucol Padova

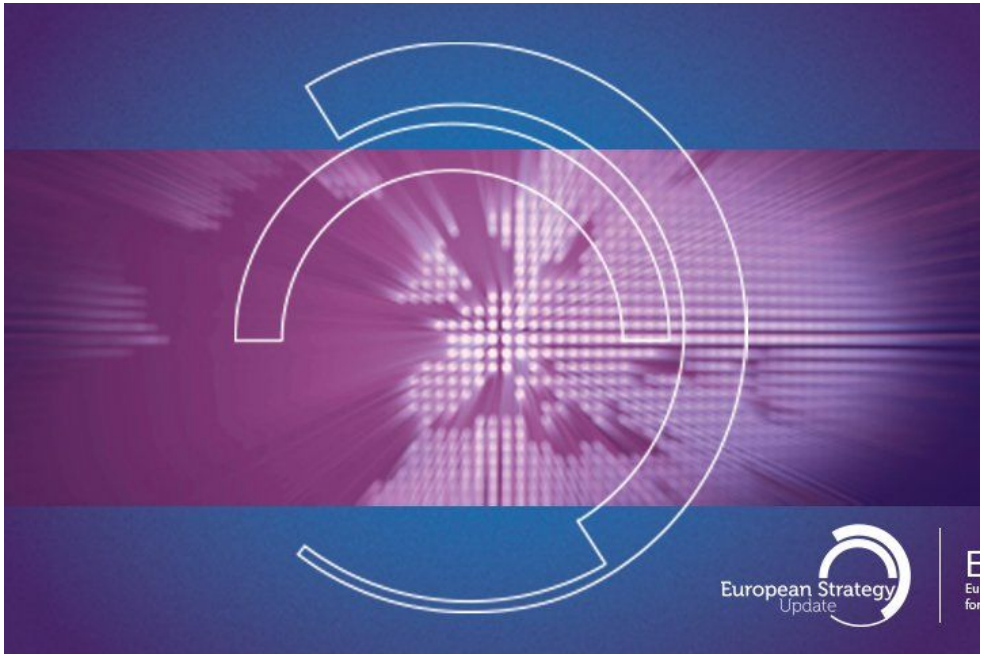
Anagrafica

Ricercatori		FTE
1	Bertolin Alessandro	30
2	Buonincontri Laura	30
3	Collazuol Gianmaria	0
4	Dorigo Tommaso	10
5	Giambastiani Luca	30
6	Lucchesi Donatella	30
7	Lupato Anna	30
8	Nardi Federico	80
9	Sestini Lorenzo	20
10	Strong Giles	10
11	Zuliani Davide	30
		3
Tecnologi		
1	Andreetto Paolo	15
2	Gianelle Alessio	45
		0.6

Totale 3.6 FTE (alcune % da confermare)

Richieste Calcolo PD
Nessuna richiesta di fondi aggiuntivi
Uso della cloud, supporto come utenti

ECFA Detector R&D Roadmap



Detector R&D Collaborations in the context of the ECFA Roadmap

- The Roadmap has identified **detector technologies**[1)] that need to be developed for the next generations of particle physics experiments.
- To address those needs in a coordinated and efficient way, **Detector R&D Collaborations** are being formed.
- Some similarity to the CERN R&D collaborations before the construction of LHC (still alive **RD50, RD51…**)
- Collaborations shall form, define their work programme, define and organise their funding, define their management, **report once per year to a DRD Committee at CERN**.
- Joint R&D should increase efficiency (avoid duplication, form partnerships) and lead to synergies (share equipment, samples, know-how).
- The label ECFA Roadmap should enhance chances for extra funding from Funding Agencies. **The participating groups (nationally clustered?) request funds from their FAs.**

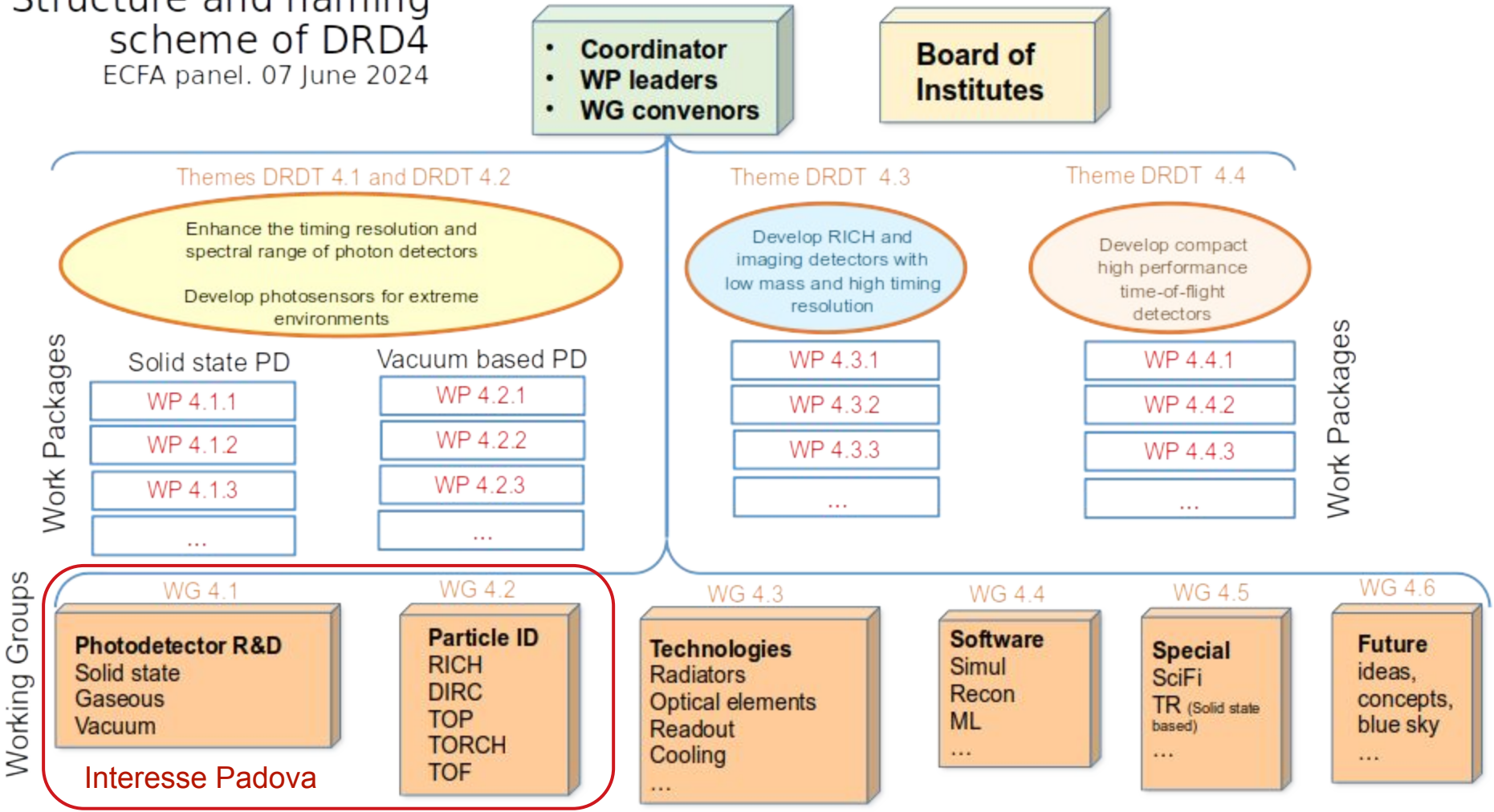
[1)] IMPORTANT: we are talking about technological (strategic) detector R&D in the fields photodetectors and Particle ID. This is different from experiment-specific developments and optimisations (adaptation of geometry, full-size prototype, industrialisation of production process, …). The latter R&D shall remain fully under the responsibility of the experiments.

Status of the DRD4 collaboration

- A preparation team (volunteers) has been formed (see next slide)
- A collaboration structure has been defined and agreed on
- Program broken down in Working Groups and Work Packages (themes)
- DRDC chair nominated by CERN Director of Research: Thomas Bergauer
- Common Funds: a small O(0.5kE) will be requested to run the collaboration, detailed definition suspended until collaboration is approved and management elected (early 2024).
- Padova involvement: **Belle II and LHCb**

Structure and naming scheme of DRD4

ECFA panel. 07 June 2024



Padova involvement

Working groups:

- 4.1 Photon Detectors: SiPM radiation hardness test, MCP-PMT lifetime measurements, development of BSI SiPM
- 4.2 PID techniques: metamaterials, design of time resolved RICH, PID upgrade

Belle II

- THEME 4.1 Solid State Photodetectors (SSPD)
  - 4.1.2 Fast radiation hard SiPMs
  - Which resources do you foresee to make available for this WP ?
  - - personnel: 0.2 F, 0.2 E, 0.7 P:
  - - financial resources: 5 kEUR
  - - already available: 100%
- THEME 4.2 Vacuum based PD
  - 4.2.1 VPD: New material, new coatings, longevity and rate capability study.
  - Which resources do you foresee to make available for this WP ?
    - personnel: 0.1 F, 0.2 P
    - financial resources: 25 kEUR
    - already available: 0%
- THEME 4.3 RICH and Imaging Detectors
  - 4.3.2: Next RICH detectors (less than ten years)
  - Which resources do you foresee to make available for this WP ?
    - personnel: 0.1 F, 0.1 E, 0.1 P
    - financial resources: 10 kEUR
    - already available: 0%

LHCb

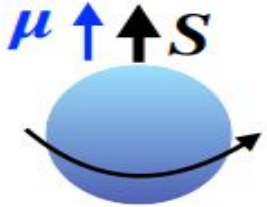
- THEME 4.1 Solid State Photodetectors (SSPD)
  - WP 4.1.2: Fast radiation hard SiPMs
  - WP 4.1.4: Timing of SSPD timing – including the appropriate readout electronics
  - FTE 0.4
  - ~5kE annual available from FA (INFN, GRI)
  - Additional 5kE to be requested to FA (INFN, GR?)
  - 1 post doc to be requested to FA (Ass. Ric. INFN + Univ. Padova)
- THEME 4.3 RICH and Imaging Detectors
  - WP 4.3.1: New Materials, Radiators and Components for RICH detectors
    - FTE 0.1
    - 2-3kE available from FA (Univ. Padova)
    - Additional 5kE to be requested to FA (INFN GR?)
    - 50% post doc requested to FA
  - WP 4.3.2: Next RICH detectors (less than ten years)
    - FTE: 0.2
    - ~5kE annual available from FA (INFN, GRI)

Prova di principio dell’estrazione di fascio da LHC con due cristalli curvi

Introduction

- Quantum system

$$\boldsymbol{\delta} = d\frac{q\hbar}{2m}\frac{\boldsymbol{S}}{\hbar} \qquad \boldsymbol{\mu} = g\frac{q\hbar}{2m}\frac{\boldsymbol{S}}{\hbar}$$



$\boldsymbol{\delta}$= electric dipole moment (EDM)
$\boldsymbol{\mu}$= magnetic dipole moment (MDM)

Hamiltonian

$$H = -\boldsymbol{\mu} \cdot \boldsymbol{B} - \boldsymbol{\delta} \cdot \boldsymbol{E}$$

Time reversal, Parity:

$$d\mu_N \boldsymbol{S} \cdot \boldsymbol{E} \xrightarrow{T,P} -d\mu_N \boldsymbol{S} \cdot \boldsymbol{E}$$

The EDM violates *T* and *P* and, via *CPT* theorem, violates *CP*

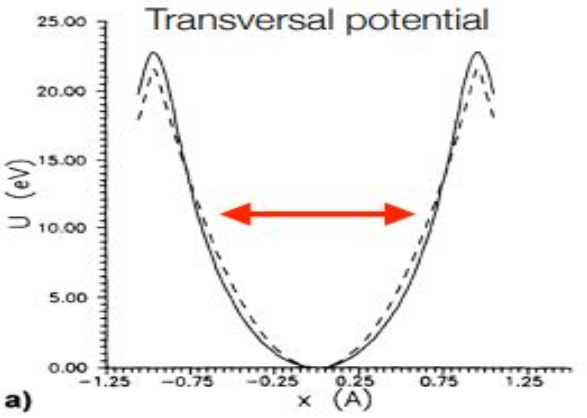
	C	P	T
$\boldsymbol{\mu}$	−	+	−
$\boldsymbol{\delta}$	−	+	−
$\boldsymbol{E}$	−	−	+
$\boldsymbol{B}$	−	+	−
$\boldsymbol{S}$	+	+	−

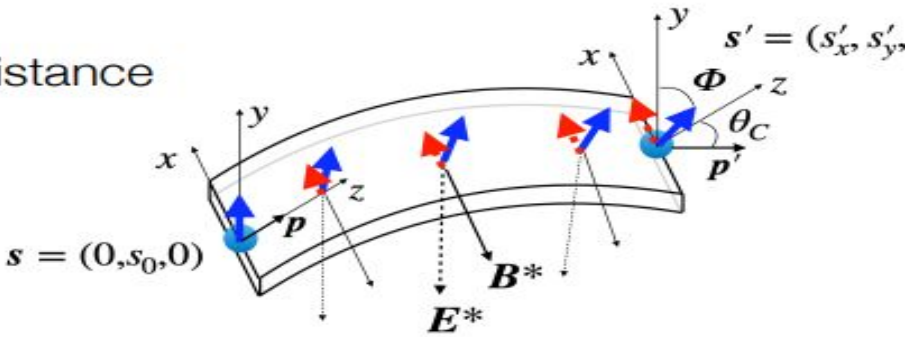
Channeling in bent crystals

- Positively charged particles with momentum parallel to crystal plane (within few μrad) can be trapped
  - Electric field $E \approx 1$ GV/cm
  - Effective magnetic field B≈500 T
- **Steer** charged particles trajectories at a given angle
- Induces **spin precession** in short distance

$$\Phi \approx \frac{g-2}{2}\gamma\theta_C$$

$$s'_x \approx s_0 \frac{d}{g-2}[\cos(\Phi) - 1]$$

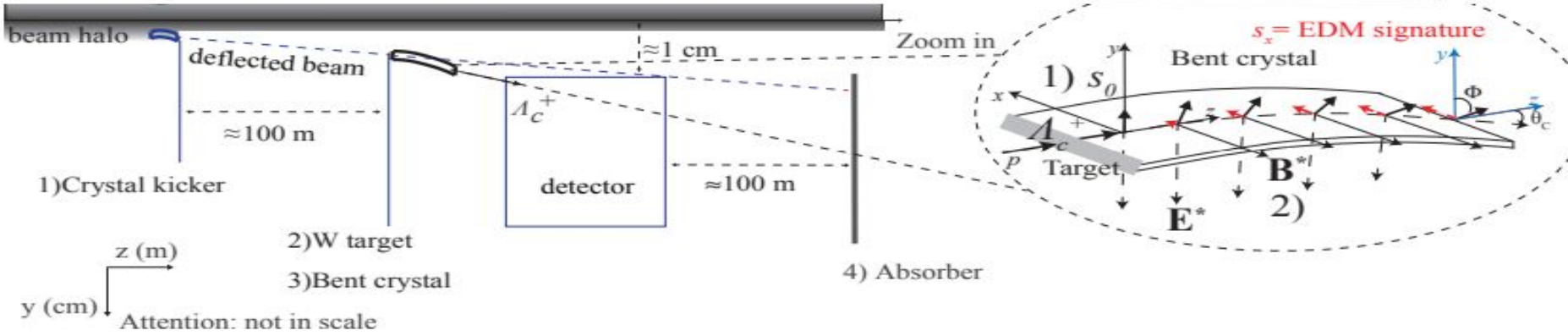




Double crystal fixed-target setup

CERN-PBC-REPORT-2019-001 D. Mirarchi et al., EPJC 80 (2020) 929

- EDM/MDM from spin precession of channeled baryons in **bent crystals**



p extraction | Λ_c^+ polarised production | channeling | spin precession | event reconstruction

PoP at IR3 and next steps

- LHCb expressed strong interest in the MDM/EDM charm baryon experiment
  - in light of Upgrade I installation/commissioning and given the complexity of the 2 crystal proposal encourages to make a PoP test at IR3
- PoP test at IR3 ➜ Phase 0 (Run3)
  - MoU between CERN/INFN signed in Dec 2022. Also France (IJCLab), Spain (Valencia) signed MoU with CERN
- If successful
  - ➜ Phase 1 (Run4): setup to perform first physics measurements (Λ_c^+, Ξ_c^+ MDM/EDM, forward charm physics, $\mathcal{O}(10^{13})$ PoT)
  - ➜ Phase 2: setup to perform ultimate precision physics measurements (Λ_c^+,Ξ_c^+ MDM/EDM)

Attività in sezione

- Sigla
  - Non viene aperta una sigla, richieste minime di circa 10kE per viaggi e consumo (elettronica) su dotazioni, non si mettono FTE
- Tracciatore
    - Design/costruzione del substrato per raffreddamento semplificato diverso da quello del velo di lhcb (CO_2): water, vortex
    - Incollaggio su substrato
    - Test funzionali al CERN
      - **0.5m.u. di un tecnico officina elettronica** parzialmente al cern
    - Disegno per integrazione modulo velo nelle roman pot
      - **0.5m.u. progettazione meccanico**
- DAQ
  - Possibile sinergia con sviluppi dell'elettronica digitale per il readout ad alta frequenza in CMS (40 MHz scouting)
  - Responsabilita' in mano a sezioni di Pisa e Milano, contributo allo sviluppo del firmware e dell'infrastruttura di online processing
- Prospettive
  - Presentazione in CSN1 a luglio (settimana prox)
  - Primo passo verso la proposta di un esperimento a targhetta fissa

Conclusioni

- **Belle II**
  - LS1 in chiusura: ripresa fasci fine 23, collisioni 24
  - Attivita' per upgrade (HW e non), fisica e performances
- **CMS:** Attivita' Padova continua: analisi, fase2, e HL:
  - Impegno su molti fronti su analisi, grande impatto in B-physics Molta attivita' per DT, Tracker, e BTL
- **LHCb**
  - Ripresa con esperimento quasi nuovo
  - Diversi fronti di analisi con grande coinvolgimento padovano
- **LUXE**
  - Verso finalizzazione GBP
  - Tempi incerti a DESY
- **MUonE**:
  - 2023 physics data taking: 2 tracker + ECAL. Measure α_{em} with O(10%) precision
  - 2024 proposal esperimento
- **FCC**
  - Attivita' Arcadia e Aida per particle flow
- **MuColl**:
  - PD ben rappresentata e attiva: snowmass process positivo per il progetto
- **Twocryst:**
  - Proof of principle per misura EDM con cristalli su fascio a LHCb