Gruppo 1 Padova

Stato Esperimenti, Anagrafica e Preventivi

CdS

7/7/2021

Stefano Lacaprara

INFN Padova

Slides by Roberto, Martino, Gabriele, Enrico, Donatella, Patrizia, Mauro

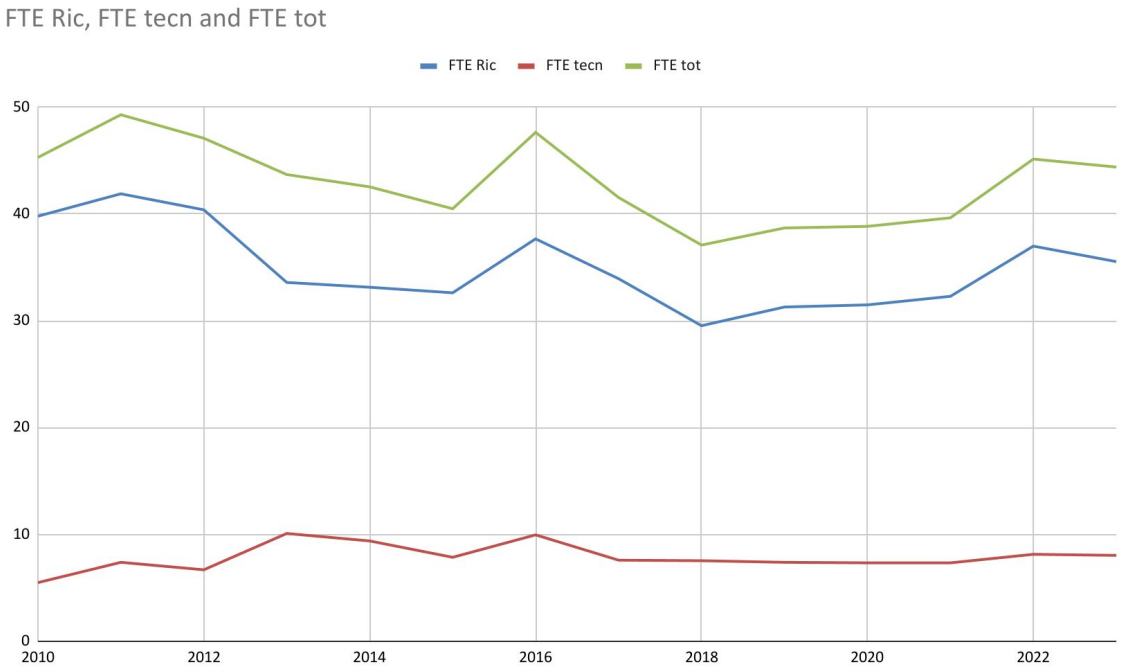
Outline

- General Summary
- Belle II
- CMS / Fase2_CMS
- LHCb
- LUXE presentazione dedicata di Mauro
- FCC
- MuonE
- MuColl

Sigle in ordine alfabetico

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

Anagrafica Gruppo1 ultimi 10 anni

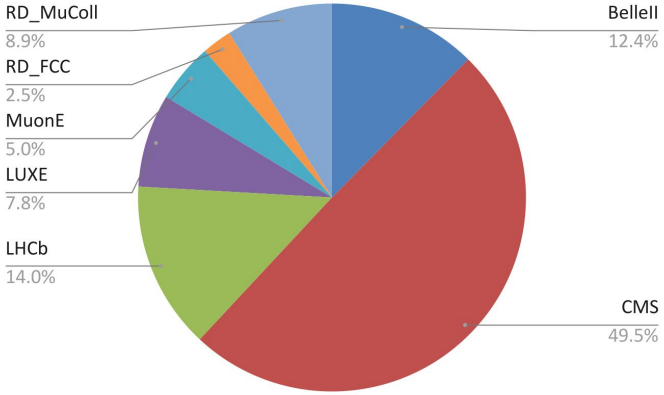


FTE preliminari!!!

FTE e persone per sigla

Da aggiornare

	Belle II		CMS		FASE2_CMS		LHCb		MuonE		RD_MuColl		RD_FCC_DTz		LUXE#	
	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	1.35	5	3.4	15	0.9	6	3.7	7
2023	5.5	10	FTE: 23.5		Px: 32		6.2	10	2.2	6	3.6	13	1.1	9	3.45	8
Δ	+1.0	+1	-2.8*		-5*		+0.7	+1	+0.85	1	+0.2	-2	+0.2	+3	-0.25	+1



*AdR+PhD ended

Totale: **Ricercatori+Tecnologi: 45.7 FTE**
2022 45.2 FTE

NB anagrafiche da confermare

Belle II

RL: R.Stroili

SuperKEKB/Belle II in 2022ab

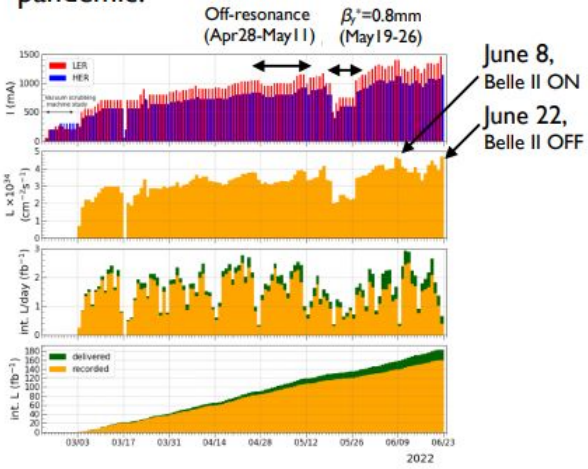
The MR operation (in 2022a) started on February 21, and ended on June 22 due to the unfortunate rise in electricity rates (originally scheduled until morning on July 1).

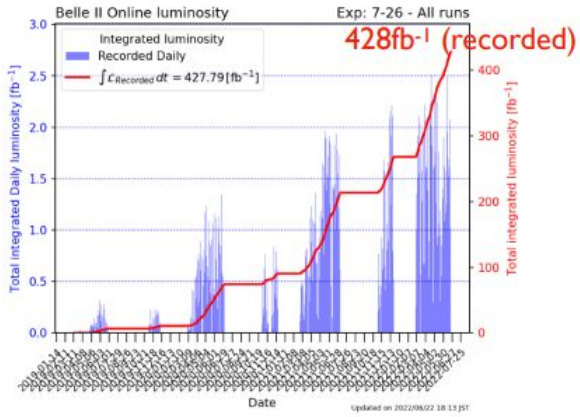
Major achievements;

- ~4.7x10³⁴/cm²/s, the new world record luminosity more than twice of KEKB.
- Integrated luminosity: 428/fb
  - Recorded about half of the BaBar data set in one year
- We could continue operations despite pandemic.

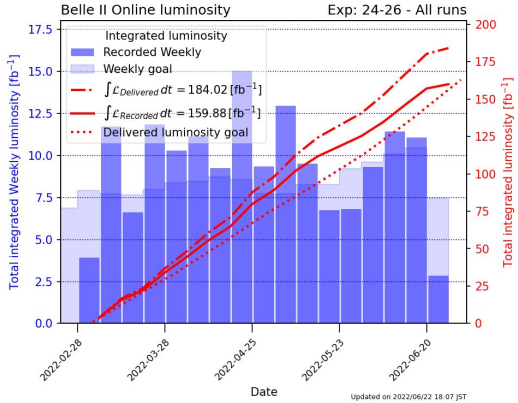
I [mA]: 1321(LER)/1099(HER)
n_b = 2249

Integrated luminosity	Recorded	Date	Delivered	Date
Shift (pb^{-1})	958.1	April 24, swing, 2022	1035.9	April 22, swing, 2022
1 days (fb^{-1})	2.503	April 22, 2022	2.912	June 11, 2022
7 days (fb^{-1})	15.001	April 18 - April 24, 2022	16.599	April 18 - April 24, 2022





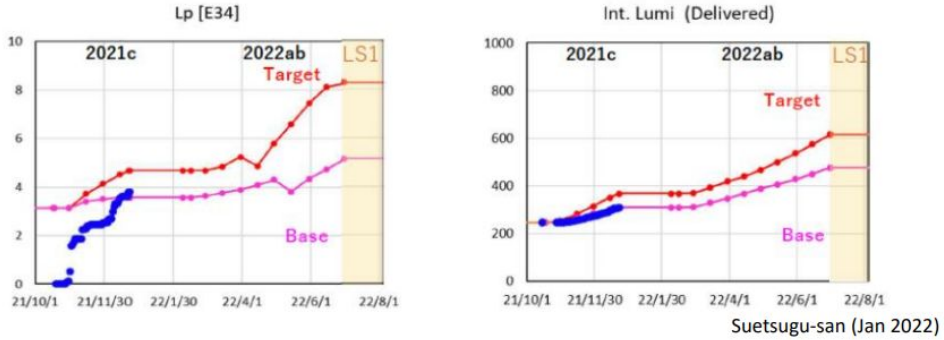
2022ab data taking



4S: 360 /fb
4S offres: 40 /fb
5S scan: 20 /fb

Objectives in 2022ab

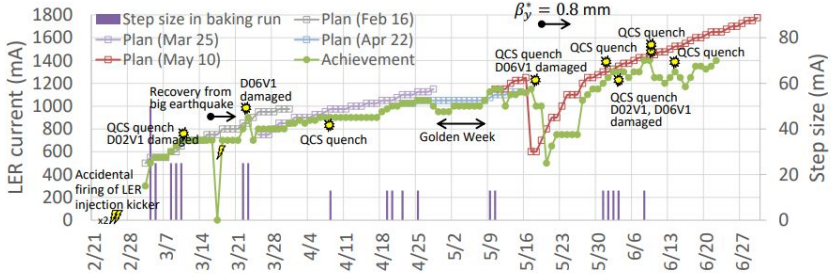
- Get on track to the "Target" luminosity profile.
  - $\mathcal{L}_{peak}$ = 3.81 × 10^{34} /cm²/s (2021c) → 5^{base} ~ 8^{target} × 10^{34} /cm²/s (2022b)
  - $\int \mathcal{L}_{delivered}$ = 307 fb^{-1} (2021c) → 480^{base} ~ 620^{target} fb^{-1} (2022b)



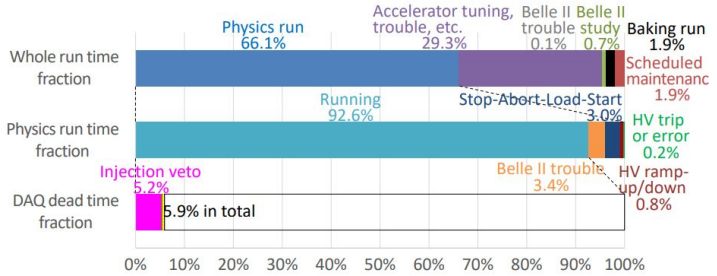
Suetsugu-san (Jan 2022)

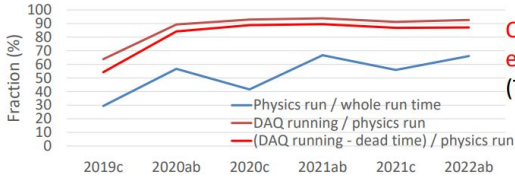
- Studies to understand the machine performance
  → Consider effective ideas to realize ~5-6 x 10^{35} /cm²/s. (ITF charge)
- 90% of Belle II data taking efficiency

Major issues for stable operation



Data taking efficiency in 2022ab

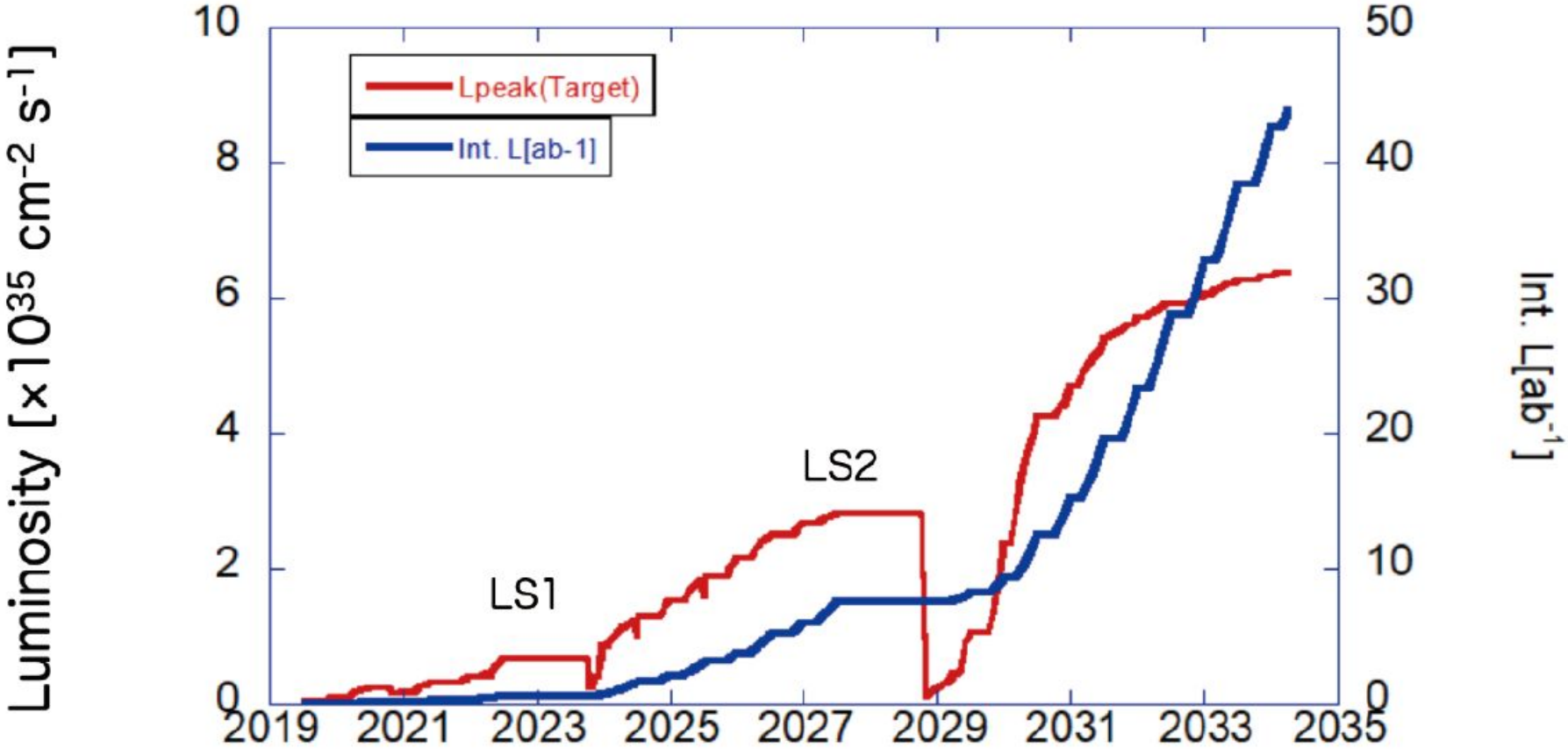




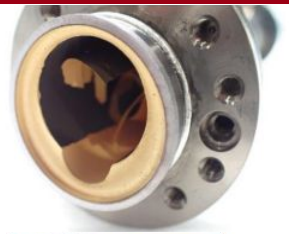
Overall data taking efficiency = 87.1%
(Target 90%)

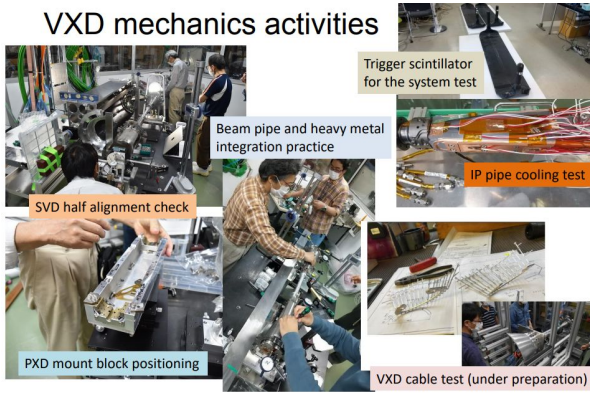
Getting worse with the beam background.

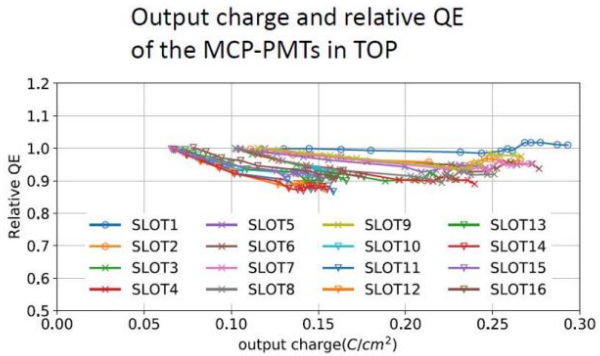
Updated luminosity profile

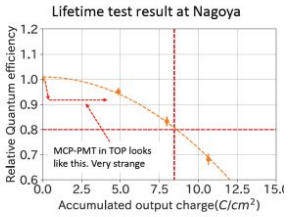


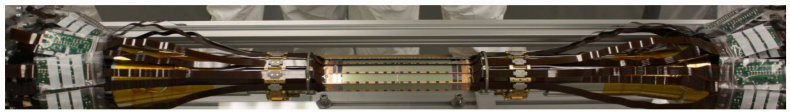
- Long Shutdown tra 2022 e 2023
  - Remedy of the IR beam pipe
  - PXD2 readiness
  - VXD assembly and installation
  - More background reinforcement
  - TOP MCP-PMT replacement (under discussion)
  - DAQ/TRIG upgrade
  - KLM BB2 issue

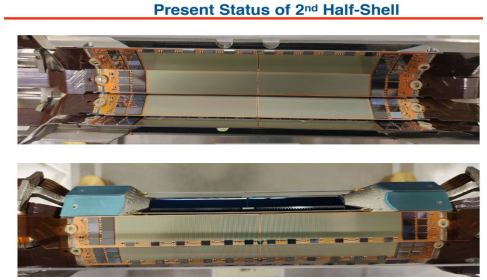


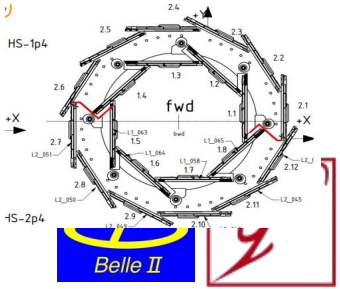












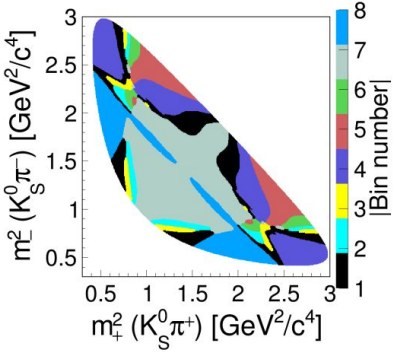
pubblicazioni di Fisica:

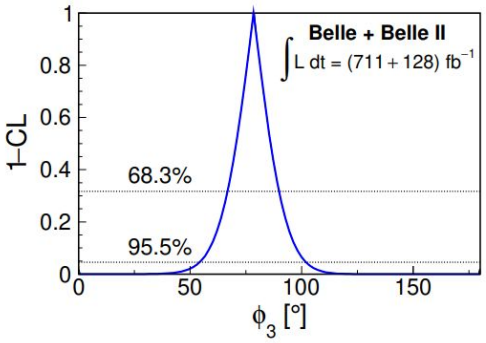
- Combined analysis of Belle and Belle II data to determine the CKM angle ϕ_3 using B+ →D(K_S→h−h+)h+ decays

  JHEP 02 (2022) 063

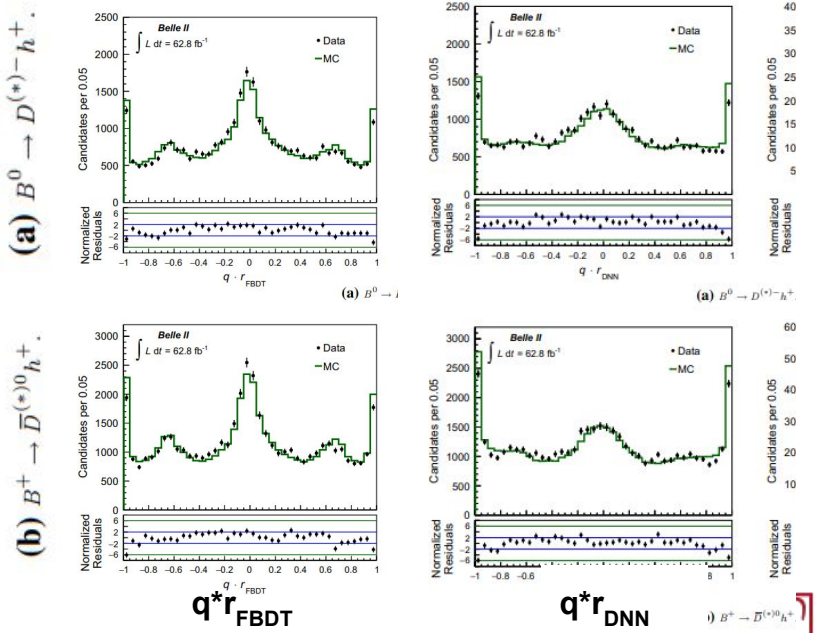
- B-flavor tagging at Belle II

  Eur.Phys.J.C 82 (2022) 4, 283





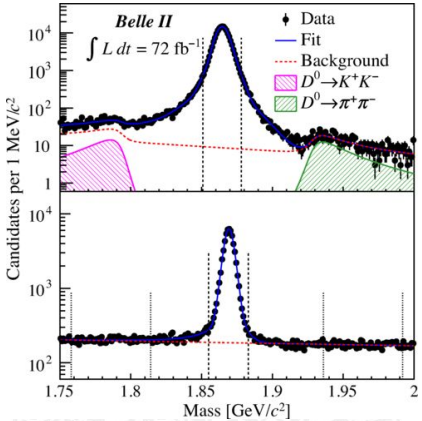
We measure $\phi_3 = (78.4 \pm 11.4 \pm 0.5 \pm 1.0)^\circ$

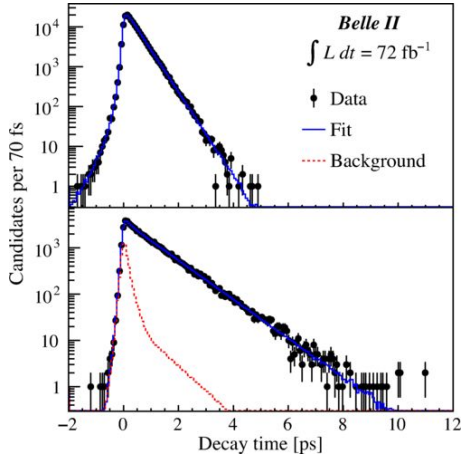


$\varepsilon_{\text{eff}} = (30.0 \pm 1.2(\text{stat}) \pm 0.4(\text{syst}))\%,$

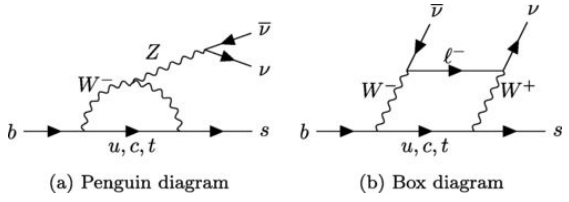
pubblicazioni di Fisica:

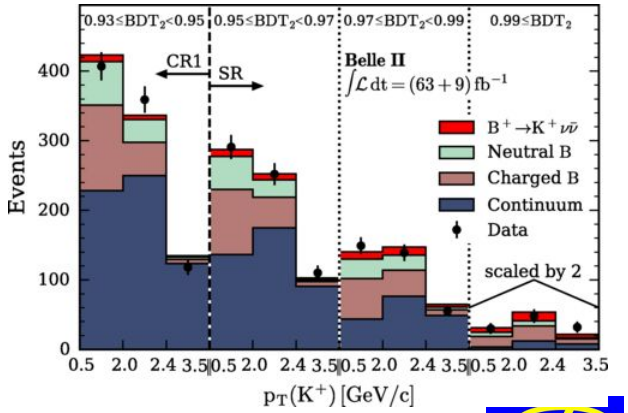
- Probing charged lepton flavor violation with axion-like particles at Belle II — JHEP 11 (2021) 218
- Precise measurement of the D^0 and D+ lifetimes at Belle II — Phys.Rev.Lett. 127 (2021) 21, 211801
- Search for $B^+ \to K^+ \nu\bar{\nu}$ Decays Using an Inclusive Tagging Method at Belle II — Phys.Rev.Lett. 127 (2021) 18





$\tau(D^0) = 410.5 \pm 1.1(\text{stat}) \pm 0.8(\text{syst})$ fs and $\tau(D^+) = 1030.4 \pm 4.7(\text{stat}) \pm 3.1(\text{syst})$ fs, are the most precise to date and are consistent with previous determinations.





Competitivo con risultati Belle con 1/10 della statistica

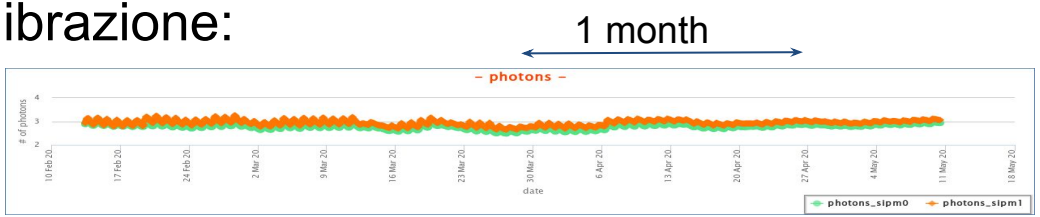
conference papers (2021)

- Measurement of the inclusive semileptonic B meson branching fraction in 62.8/fb of Belle II data [BELLE2-CONF-PH-2021-012]
- Measurements of the branching fractions for $B \to K^{*}\gamma$ decays at Belle II [BELLE2-CONF-PH-2021-004]
- Measurement of the $B^{-} \to D^{0}\, l\, \nu_{l}$ Branching Fraction in 62.8 fb^{-1} of Belle II data [BELLE2-CONF-PH-2021-011]
- Exclusive $B \to X_{u}\, l\, \nu_{l}$ Decays with Hadronic Full-event-interpretation Tagging in 62.8 fb^{-1} of Belle II Data [BELLE2-CONF-PH-2021-013]
- Measurement of the branching fraction for $B^{0} \to \pi^{0}\, \pi^{0}$ decays reconstructed in 2019–2020 Belle II data [BELLE2-CONF-PH-2021-003]
- Rediscovery of $B^{0} \to J/\psi\, K_{L}^{0}$ at Belle II [BELLE2-CONF-PH-2021-002]
- Measurement of the branching fractions of $B \to \eta' K$ decays using 2019/2020 Belle II data [BELLE2-CONF-PH-2021-007]
- Measurement of the time-integrated mixing probability χ_{d} with a semileptonic double-tagging strategy and 34.6 fb^{-1} of Belle II collision data [BELLE2-CONF-PH-2021-004]
- Muon and electron identification efficiencies and hadron-lepton mis-identification rates at Belle II for Moriond 2021 [BELLE2-CONF-PH-2021-002]
- Study of $B \to D^{(*)}h$ decays using 62.8 fb^{-1} of Belle II data [BELLE2-CONF-PH-2021-008, arXiv:2104.05628]

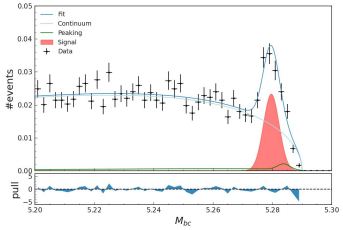
Plus many more for Moriond 2022

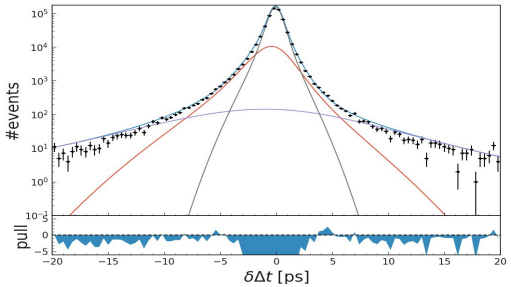
attività a Padova

- sistema di monitor del laser di calibrazione:
  - spedito durante il lockdown
  - installato a Marzo 2021
  - in funzione

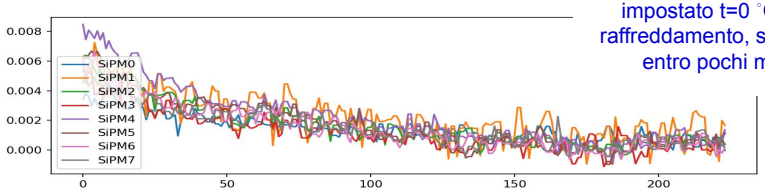


- analisi: CPV nel canale B→η'K
  - BR measurement done
  - goal is full TDCPV for Winter conferences
    - analysis based on full BelleII dataset





- studio sulla sostituzione dei fotomoltiplicatori in LS2 (2027):
  - definito il sistema di controllo e raffreddamento dei SiPM
  - in fase di commissioning



impostato t=0 °C, in raffreddamento, stabilità entro pochi mK

responsabilità

	2022	2023
Alessandro Gaz	Responsabile allineamento della calibrazione del TOP TOP liaison tracking	Membro Exec Board Convener del gruppo di performance Charged PID
Stefano Lacaprara	Contact person Fisica PD Production Manager Convener Physics Group TDCP	Data Production Manager Contact person Fisica PD PI (tbc)
Roberto Stroili	PI Contact person computing PD	Contact person computing PD
Ezio Torassa	Membro Executive Board TOP liaison upgrade Deputy coordinator TOP photomultipliers	TOP liaison upgrade Deputy coordinator TOP photomultipliers

anagrafica

2022		2023	
Alessandro Gaz	100 %	Alessandro Gaz	100 %
Stefano Lacaprara	100 %	Stefano Lacaprara	100 %
Paolo Sartori	0 %	Paolo Sartori	0 %
Franco Simonetto	10 %	Franco Simonetto	10 %
Roberto Stroili	100 %	Roberto Stroili	100 %
Ezio Torassa	90 %	Ezio Torassa	90 %
Jakub Kandra	100 % (da Ottobre)	Jakub Kandra	100 %
totale ricercatori (FTE)	**4.00 (+ 1)**		**5.00**
Massimo Benettoni	10 %	Massimo Benettoni	10 %
Flavio Dal Corso	20 %	Flavio Dal Corso	20 %
Fabio Montecassiano	20 %	Fabio Montecassiano	20 %
totale (FTE)	**4.50 (+1)**		**5.50**

richieste 2023

richieste alla sezione

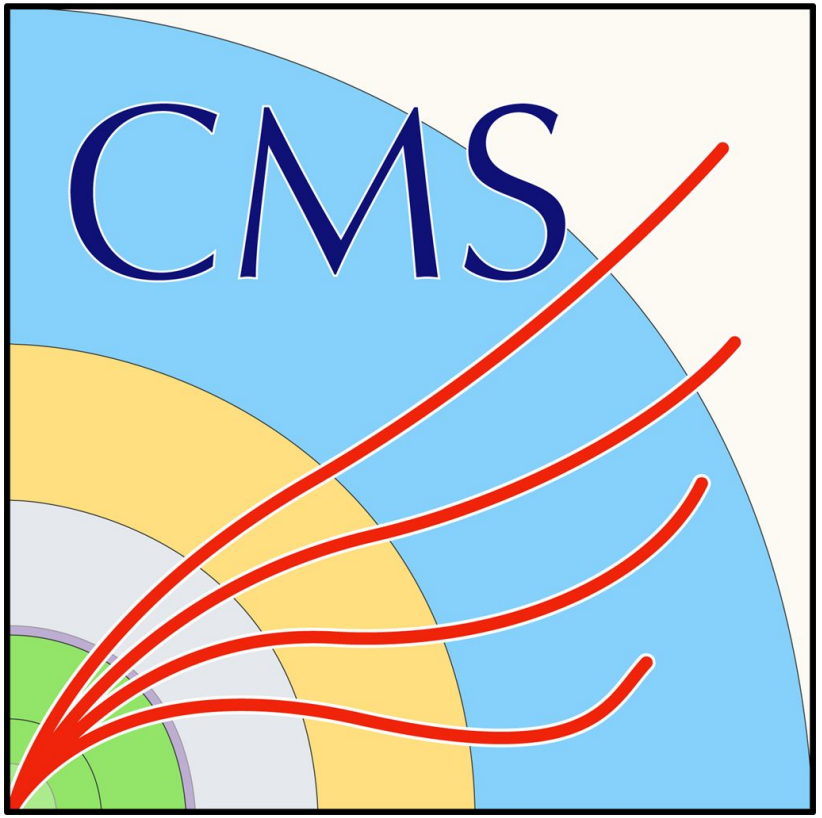
Servizio progettazione ed officina Elettronica	1+1 m. u.
Servizio officina Meccanica	1 m. u.
Servizio progettazione Meccanica (simulazione termica TOP)	3 m. u.
Servizio calcolo	0 m. u.

richieste all'INFN

sede	capitolo	descrizione	richiesta (k€)	S. J. (k€)
PD	consumo	Metabolismo (1.5 k€ * FTE)	8.0	0
PD	missioni	Metabolismo [(6.0 k€ + 1.0 k€) * FTE]	38.5	0
PD	missioni	Membro Executive Board	5.0	0
PD	missioni	Data Processing Manager	5.0	0
PD	missioni	sostituzione PMT TOP	6.0	0
PD	inventariabile	stage motorizzato xy	6.0	0

CMS

RL: M.Margoni



Sommario

- Highlights da CMS
- Fisica padovana in CMS
  - Analisi & Preparazione Run3
  - Outreach
  - Detector
- Anagrafica 2022 → 2023
- Responsabilita’
- Richieste 2023

Fisica padovana in CMS: Analisi

CMS highlights

- Top physics: Most precise top mass measurement using lepton+jets m_t=171.11±0.38 GeV, m(t) from jet mass, differential $t\bar{t}$ & tW xsecs, $t\bar{t}W$ xsec, charge asymmetry
- Higgs physics: search for pp → VH, H → $c\bar{c}$, search for di-Higgs production, measurement of H → WW xsec
- Observation of triple J/ψ production
- Vector Boson Scattering: Observation of opposite-sign WW scattering, EWK production of Wγjj
- Precision Drell-Yan production: Mass dependence of dilepton P_T, Z+ jets differential distributions
- Heavy Ions Physics: Observation of Y(3S) in PbPb collisions

- Padova Group (analisi appena sottomesse per la pubblicazione): Search for composite Majorana neutrino, Produzione associata VH, H → cc (vedi slides)

Summary Analisi

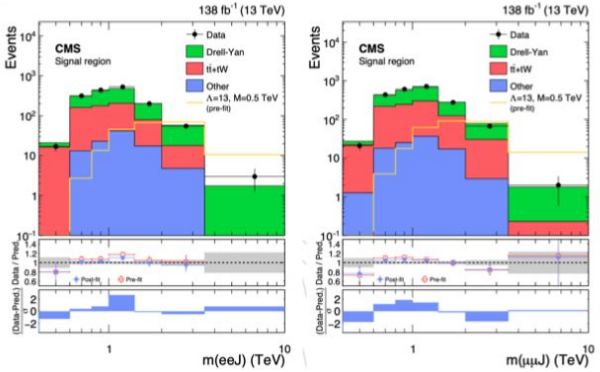
- Ricerca di neutrino di Majorana in modelli composti con due leptoni e due jet nello stato finale. *Tesi di Dottorato di Matteo Presilla, ora assegnista a Perugia. Appena sottomessa per la pubblicazione* (P. Azzi, M. Presilla)
- Produzione associata di Higgs e Bosone vettore VH, H → cc. *Appena sottomessa per la pubblicazione* (P. Bortignon)
- Ricerca di Vector Boson Scattering nel canale semileptonico Zvjj (P. Azzi, M. Presilla)
- Misura della violazione della simmetria CP nel canale $B_s \to J/\psi\Phi$. *Pubblicata nel 2021, si sta lavorando a un tagging di flavor innovativo che raddoppiera` la precisione. Tesi di Dottorato di Enrico Lusiani* (A. Bragagnolo, E. Lusiani, M. Margoni, P. Ronchese, F. Simonetto)
- Ricerca del decadimento raro $B_s \to \tau\tau$ mediante analisi multivariata. *Tesi di Dottorato di H. Yarar* (T. Dorigo, H. Yarar)
- Sviluppo di DNN per hh → bb$\tau\tau$ risonante e non risonante (T. Dorigo, G. Strong)
- Ricerca di decadimenti rari Z, H → J/$\psi\gamma$. (R. Ardino, U. Gasparini, A. Zucchetta)

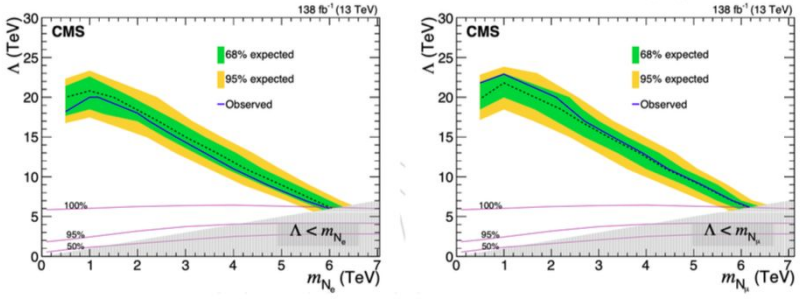
Ricerca di Heavy Composite Neutrino

- 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).

- Strategy: simultaneous fit of the binned M(llJ) (i.e. dilepton+leading fat jet) of SR, DY-CR and TOP-CR:
  - electron channel: simultaneous fit M(eeJ) in SR, M(eeJ) in DY cr, M(eμJ) in TOP cr
  - muon channel: simultaneous fit M(μμJ) in SR, M(μμJ) in DY cr, M(eμJ) in TOP cr

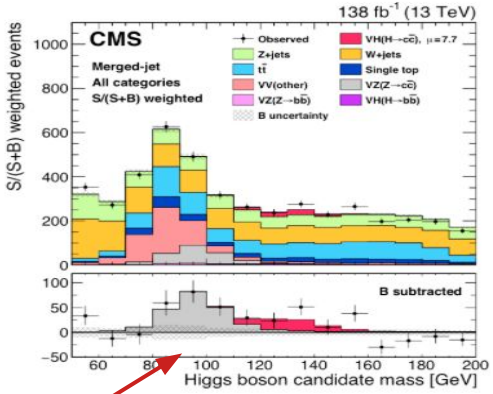
No excess, setting limit
Paper to be submitted to PLB

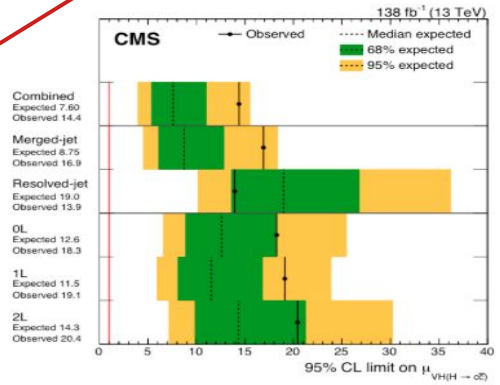




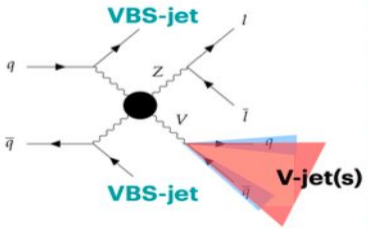
VH, H->cc

- Exploits associated production with a vector boson. Their leptonic decays provide an efficient trigger strategy
- Cutting Edge machine learning algorithms (ParticleNet) are used for flavour tagging and mass regression
- Di-jet and Fat-jet analyses combined to cover low-pt and high-pt phase space
- First evidence of VZ(cc) at a hadron collider
- Expected limits on VHcc better than expectation thanks to many analysis technique improvements
- Paper submitted to PRL

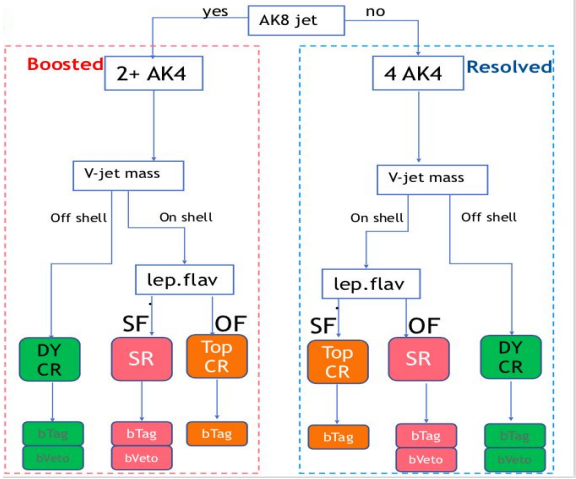


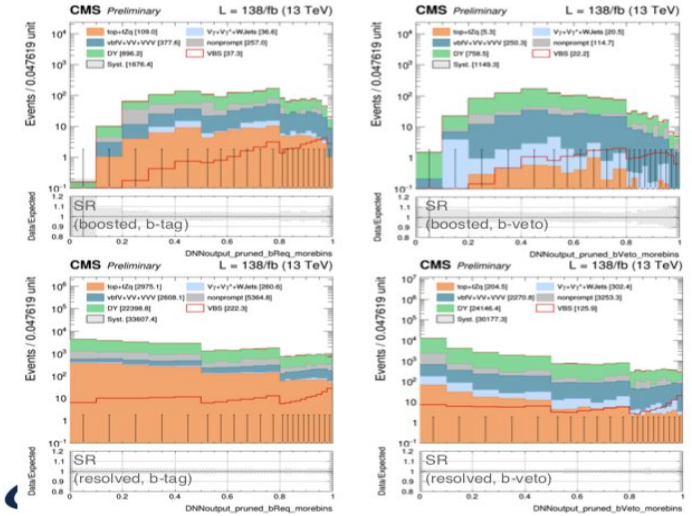


VBS in ZVJJ Semileptonico



Goal: Measurement of electroweak and anomalous (dim8) production of VZ+2jets in Run2 data





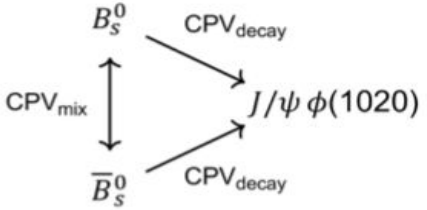
Simultaneous fit in SRs+ DYcr + TOPcr
a-priori expected significance from Asimov dataset,
with Full Run2 (EWK VBS zvjj):

	BOOSTED	RESOLVED	Combination	Year
combined	0.60	0.87	0.99	2016
combined	0.66	0.93	1.03	2017
combined	0.77	0.96	1.16	2018
combined	1.21	1.70	2.00	Run2

Work in progress for combination with WV (already published) for paper

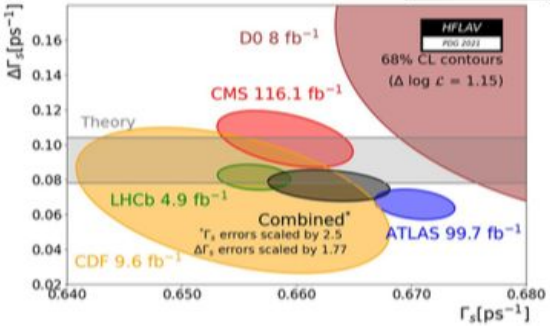
Precision measurement of CP-Violation in Bs → J/ψΦ

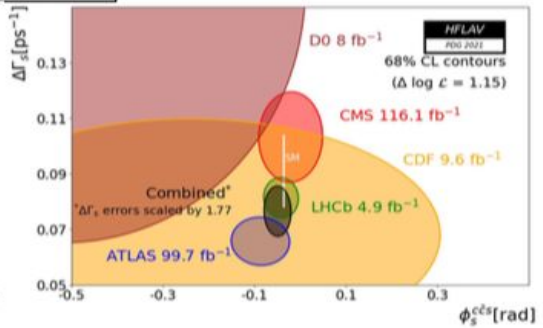
- Precise characterization of the $B_s^0 - \overline{B}_s^0$ system
  - Highly complex **time-** and **flavour**-dependent **angular** analysis
  - Several physics parameters measured with a single analysis
    - $|\lambda|$, ϕ_s: CP-violating in the decay and decay/mixing interference
    - Γ_s: average decay width
    - $\Delta\Gamma_s$, Δm_s: decay width and mass difference between eigenstates
- Comprehensive test of the physics of CPV and flavour mixing, with room for **New Physics**
- High-priority measurement for both the experimental and theoretical community
- Heavily statistically limited
  - ↪ Long-term commitment (Run-3, HL-LHC [CERN Yellow Report])
- **Outlook**: one of the most precise single measurement of ϕ_s and $\Delta\Gamma_s$ due to several key improvements



$$\Gamma\left(B_{s\,(\nrightarrow \overline{B}_s^0)}^0 \to f\right)(t) \overset{?}{\neq} \Gamma\left(\overline{B}_{s\,(\nrightarrow B_s^0)}^0 \to f\right)(t)$$

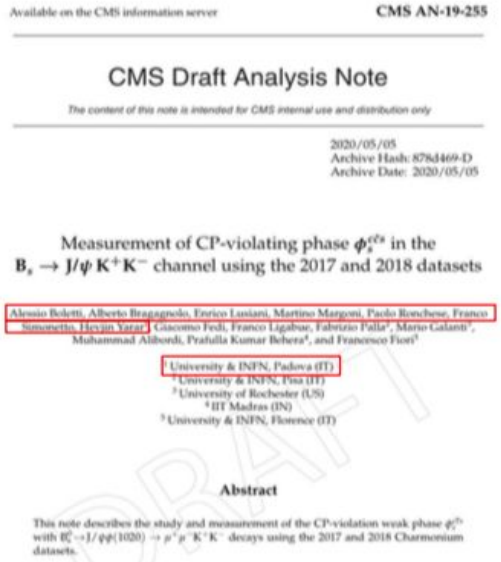
STATE-OF-THE-ART





CPV in Bs → J/ψΦ: Padova involement and status

- **The CMS Padova group has a long-standing experience and commitment** in high-profile B-Physics results
  - Huge expertise in final-state reconstruction, angular analysis and flavour tagging
  - Involvement in world-averages computation (HFLAV 2021)
- **Leading role** in previous CMS results [PLB816(2021)136188, PLB757(2016)97]
  - Two PhD thesis [A. Bragagnolo (2021), J. Pazzini (2015)]
    - ↪ plus one in the making [E. Lusiani (2023)]
- **Current personpower:** A. Bragagnolo (post-doc), E. Lusiani (PhD student and INFN/CERN *simil*fellow), M. Margoni, P. Ronchese, F. Simonetto
  - Other institutions involved: Sofia University (BU)
- **Timescale**: analysis expected to converge in Fall 2022 (due to PhD deadline)
- **Key improvements w.r.t. the previous CMS work**
  - Extremely powerful flavour tagging framework based on deep neural network which is expected to **improve the statistical power of the measurement by more than a factor of 3**
    - This is being achieved through several *first-of-a-kind* tools which are expected to mark a paradigm shift in flavour tagging in hadron colliders
  - Improved description of description of efficiencies, time resolution and amplitude interference to reduce the largest sources of systematic uncertainty identified in the previous works


Available on the CMS information server CMS AN-19-255

CMS Draft Analysis Note

The content of this note is intended for CMS internal use and distribution only

2020/05/05
Archive Hash: 87fd469-D
Archive Date: 2020/05/05

Measurement of CP-violating phase $\phi_s^{c\bar{c}s}$ in the $B_s \to J/\psi K^+K^-$ channel using the 2017 and 2018 datasets

Alessio Boletti, Alberto Bragagnolo, Enrico Lusiani, Martino Margoni, Paolo Ronchese, Franco Simonetto, Heyjin Yarar, Giacomo Fedi, Franco Ligabue, Fabrizio Palla[2], Mario Galanti[3], Muhammad Alibordi, Prafulla Kumar Behera[4], and Francesco Fiori[5]

[1] University & INFN, Padova (IT)
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[3] University of Rochester (US)
[4] IIT Madras (IN)
[5] University & INFN, Florence (IT)

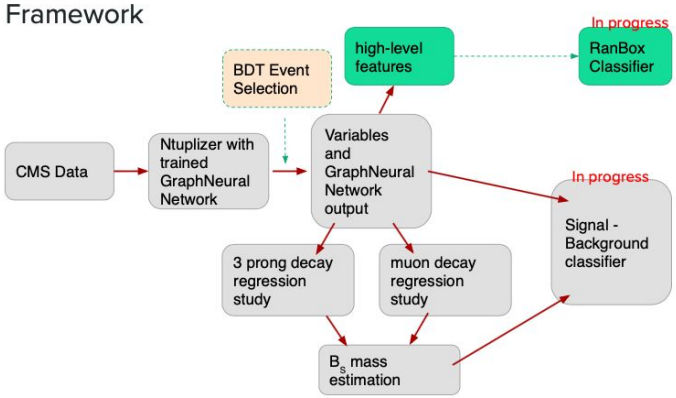
DRAFT

Abstract

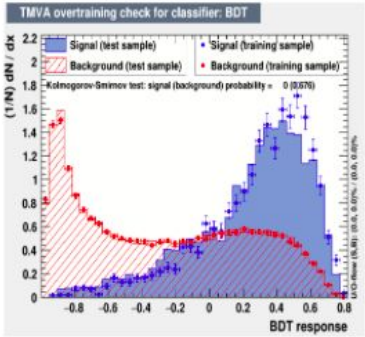
This note describes the study and measurement of the CP-violation weak phase $\phi_s^{c\bar{c}s}$ with $B_s^0 \to J/\psi\phi(1020) \to \mu^+\mu^- K^+K^-$ decays using the 2017 and 2018 Charmonium datasets.

Bs → ττ

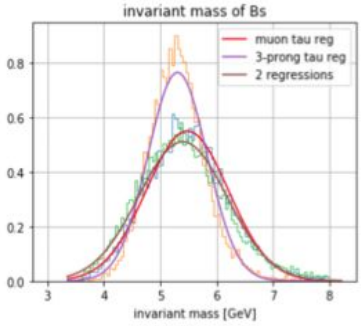
Framework



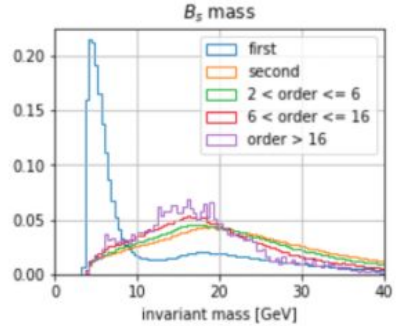
Preliminary Results



Response curve of the BDT for event selection after a planing approach



Bs mass estimated using the attributes predicted by the regressors on both tau candidates (yellow, blue and green lines). Red curve represents the gaussian fit to the distribution where we regress to the muon-decaying tau attributes and use the gen attributes of the 3-prong tau to estimate the Bs mass. Purple curve represents the opposite case, whereas the brown curve represents the gaussian fit to estimations computed with regressed attributes for both taus.

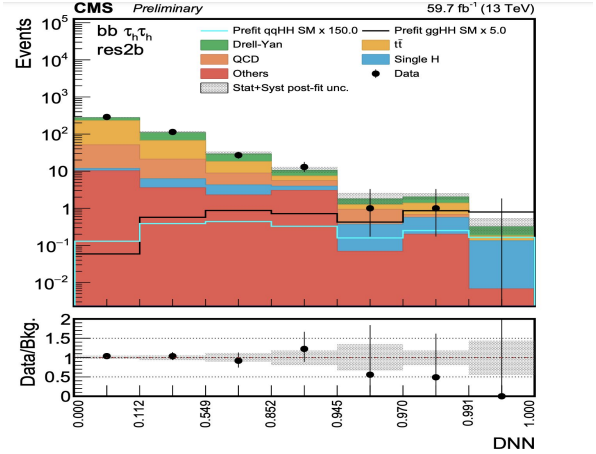


Bs mass estimated using the attributes predicted by the regressions on B-Parked data sample. In each event there are multiple tau candidates for the 3-prong decaying tau and are ordered by pT. Blue curve shows the study with the first most energetic tau candidate, while the other curves represent the rest of the candidates in pT order

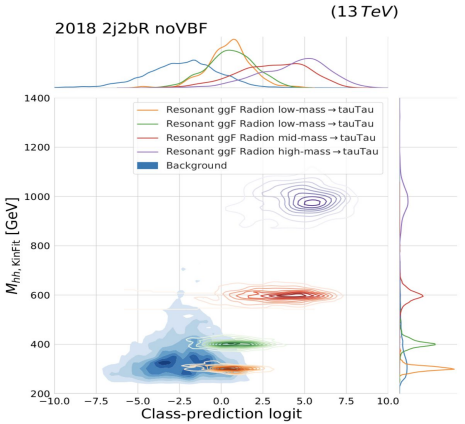
hh → bbττ Searches: Non-resonant/resonant

- Run-II search for **non-resonant** *hh→bbττ* (ggF+VBF)
  - Published in PAS-HIG-20-010
    - PLB in preparation
    - Combination with the channels submitted to Nature
  - Most stringent limit on non-res di-Higgs @ CMS Run-II
    - Obs: 3.3xSM c.f. *bbγγ* 7.7xSM
- Run-II search for **resonant** *hh→bbττ* (ggF+VBF)
  - Generic search for heavy Higgs in the forms of neutral spin-0 and spin-2 particles
- Giles Strong contributions:
  - DNN for final summary stat in all inference categories
  - *bb* and $\tau\tau$ mass-cut optimisation
  - Documented in AN-2019/188

Expected limit	2016	2017	2018	Run 2
$\sigma_{\mathrm{ggF+VBF}}(\mathrm{pp}\to\mathrm{HH}\to\mathrm{bb}\tau\tau)/\sigma^{SM}_{\mathrm{ggF+VBF}}$	10.6	11.7	8.2	5.2
$\sigma_{\mathrm{ggF+VBF}}(\mathrm{pp}\to\mathrm{HH}\to\mathrm{bb}\tau\tau)$ [fb]	23.6	26.0	18.2	11.6
$\sigma_{\mathrm{ggF+VBF}}(\mathrm{pp}\to\mathrm{HH})$ [fb]	324	356	249	159
Observed limit	**2016**	**2017**	**2018**	**Run 2**
$\sigma_{\mathrm{ggF+VBF}}(\mathrm{pp}\to\mathrm{HH}\to\mathrm{bb}\tau\tau)/\sigma^{SM}_{\mathrm{ggF+VBF}}$	8.9	9.5	5.5	3.3
$\sigma_{\mathrm{ggF+VBF}}(\mathrm{pp}\to\mathrm{HH}\to\mathrm{bb}\tau\tau)$ [fb]	19.6	21.2	12.4	7.5
$\sigma_{\mathrm{ggF+VBF}}(\mathrm{pp}\to\mathrm{HH})$ [fb]	272	291	169	102



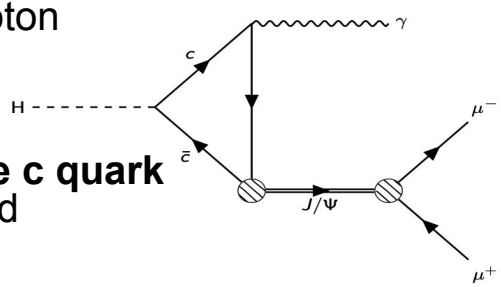
DNN distribution in most sensitive category: 2018 τ_h τ_h resolved b-jets

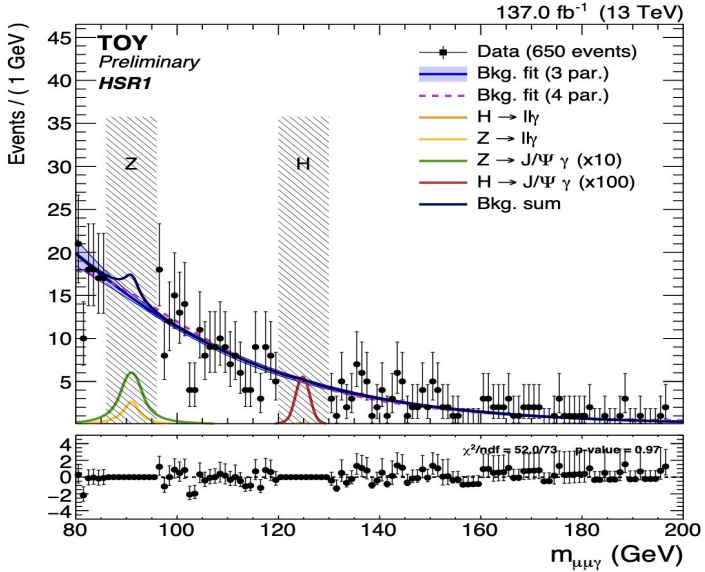


(c) $\tau_h\,\tau_h\,b\,b$ channel

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:
  - $B(Z \to J/\Psi\,\gamma) = 9 \times 10^{-8}$
  - $B(H \to J/\Psi\,\gamma) = 3 \times 10^{-6}$
- 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 $H \to \gamma\gamma$)
  - 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)

Toward Run3 - CMS Italia

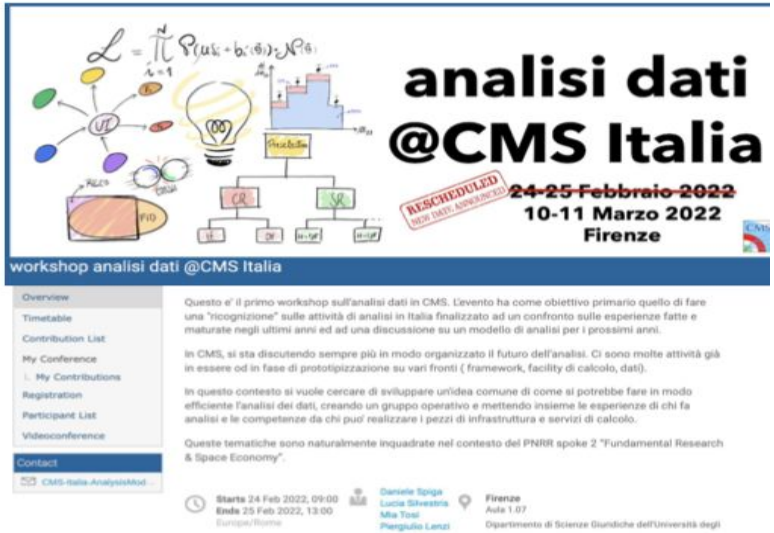
analysis activities and preparation for Run3 on multiple fronts:

large datasets are hard to handle
(evolving conditions, different reference MC, different LHC energy)

→ analisi dati @CMS Italia [10-11/03, Firenze (!) + zoom]

⇒ INFN analysis facility prototype presented
→ efficient data analysis in Run3 and beyond
exploiting INFN computing resources

⇒ review common analysis practices across CMS Italia groups
→ there is –of course– a wide variety of use cases,
but some already make use of Dask and traditional HTcondor
and are already geared towards the newer tools like RDataFrame



physics analyses mini-workshop series

→ HIG @CMS Italia [11-12/05, zoom w/ CERN as hub]

→ BPH @CMS Italia [24-26/05, zoom w/ CERN as hub]

→ SMP @CMS Italia [19-20/07, zoom w/ CERN as hub]

→ searches @CMS Italia [work in progress]

GOALS :

- discuss Run2 results
- review Run3 plans and new strategies/ideas
  → trigger strategy and new tools
- check person power availability

2

Outreach

happy birthday Higgs boson ! (10 years from the discovery)

many outreach activities on going

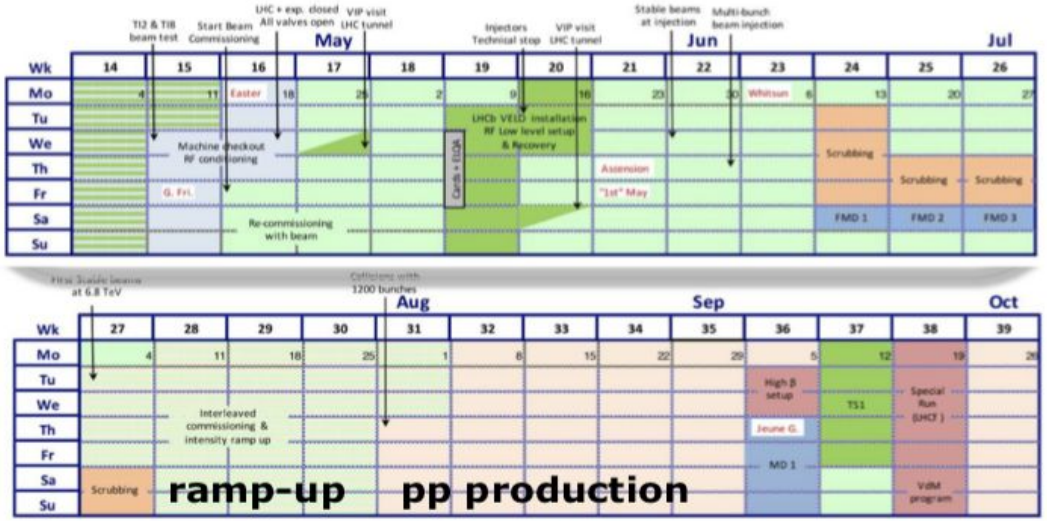
- INFN : video clip w/ short speech from different Divisions
  thanks to Marina for her precious help
- ATLAS&CMS Italia : competition targeting bachelor students
  w/ award ceremony during LHCP in Bologna
  thanks to Luisa and Sabine for the invaluable support
  and to the director for advancing the money ;)
- CMS Italia : public event during CMS Italia in Florence
  w/ CMS italian (ex-)spokespersons
- CMS Padova : coordinating the *HEPscape room*
  during the European Researchers' Night
  thanks to Sabine for the precious support
  + DFA bookmark

Fisica padovana in CMS: Rivelatore

Preparazione Run3

Toward Run3 - the LHC plan

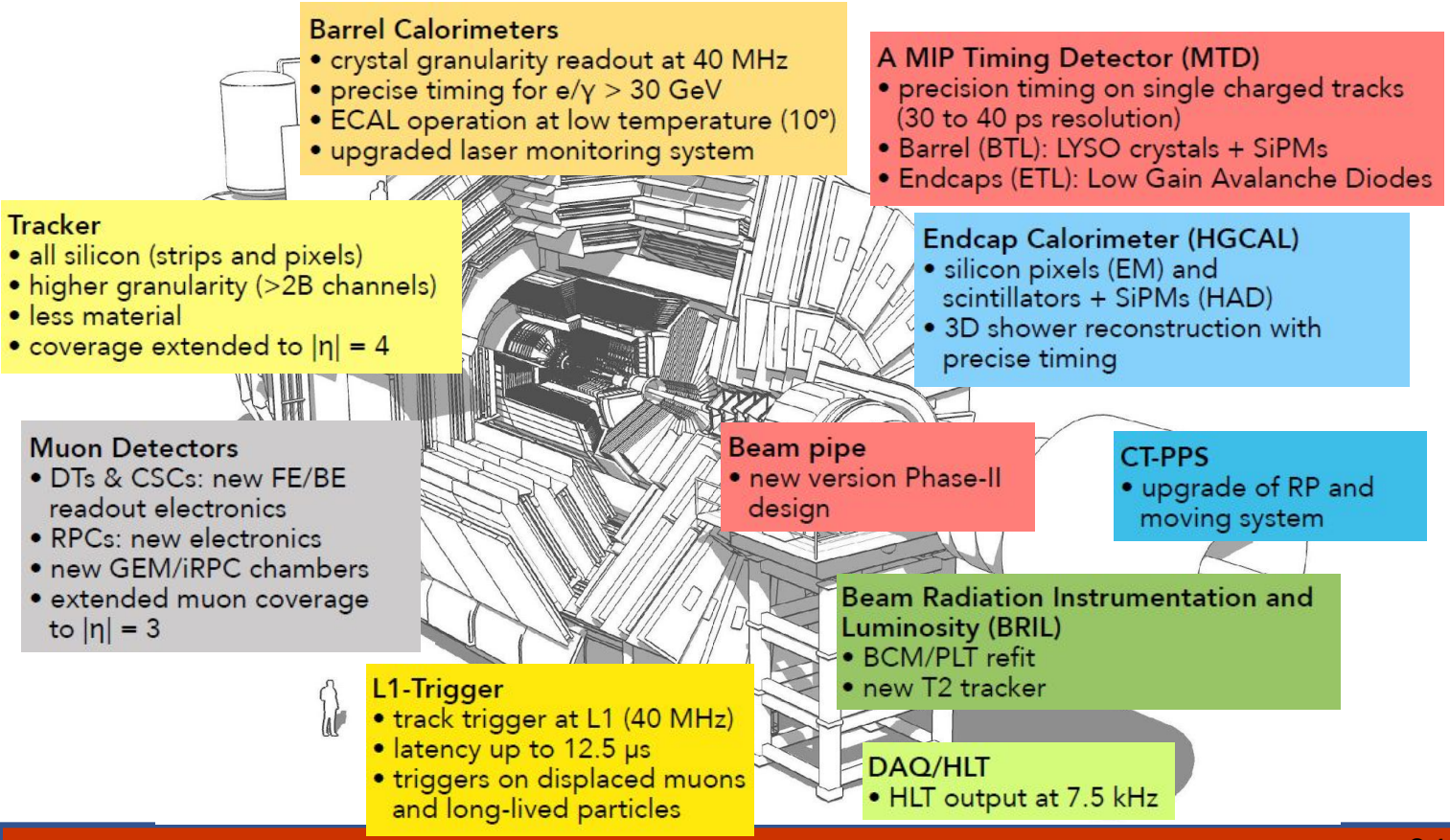
- June 2nd:
  1st stable 900 GeV collisions
- July 5th
  stable beams at 13.6 TeV
- Aug 4th
  start of 13.6 TeV collisions
  w/ 1200 bunches



⇒ during the 4.5 weeks of ramp-up O(200) pb-1 collectable by CMS

⇒ ~4M (0.4M) W (Z) bosons

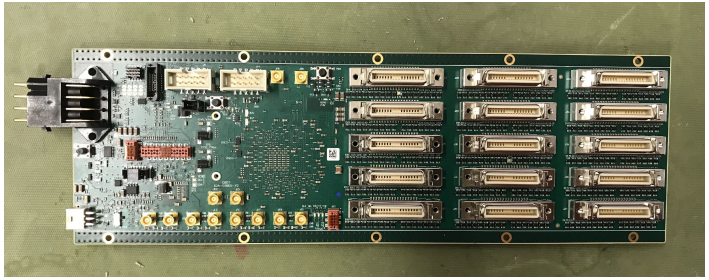
Preparazione al Run 3 e HL-LHC

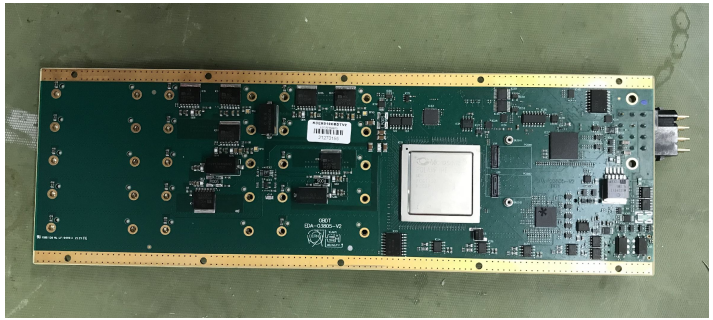


- Il lungo shutdown 2 si e` concluso
- Molti lavori di manutenzione e improvements sono stati eseguiti con contributo padovano nei DT e nei Pixels

Phase II front-end electronics developments: OBDT

- The On-Board electronics for Drift Tubes is a board based on a FPGA (PolarFire) that implements TDC functionalities
- The OBDT has also control capabilities:
  - FE access, monitoring, test pulse, RPC connection
- It is radiation tolerant (up to 20 krad)
- OBDT Phi v2:
  - Phi Superlayers
  - Total boards = 900 units;
  - New 3M MDR connectors;
  - 240 channels;
  - Includes safety features;
  - Revised clock distribution;
  - LpGBT chip for timing and S.C.
  - LpGBT 10GFEC5 for data-readout;
  - 2 VTRX+ as optical transceivers.

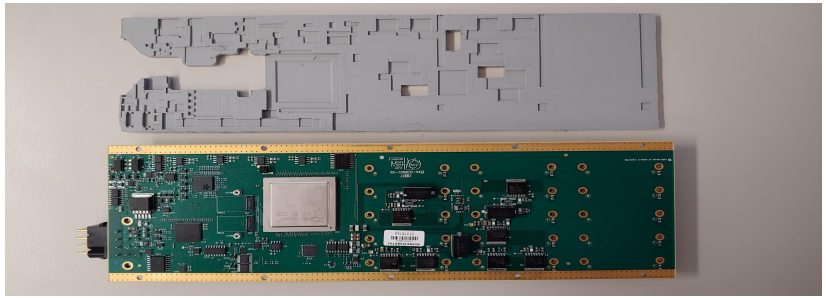




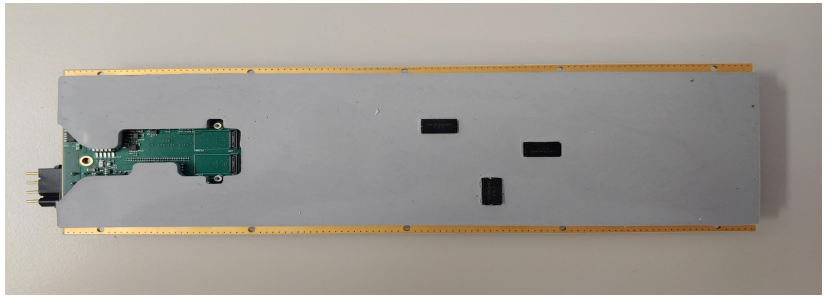
A. Bergnoli, A. Triossi
M. Bellato, S. Ventura,
F. Gonella, SPE, Officina meccanica.

OBDT: Thermal GAP experiments

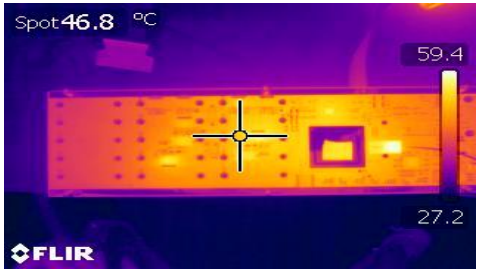
Customized thermal pad, obtained polymerizing a liquid solution on a mould: Removable



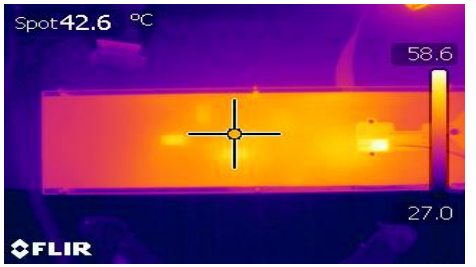
Smooth out hotspots and insures heat removal over 100% of the surface



Without thermal gap



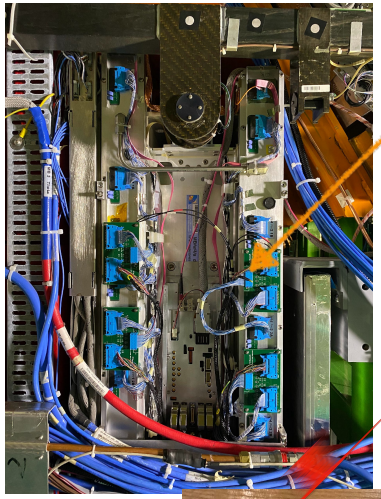
With thermal gap

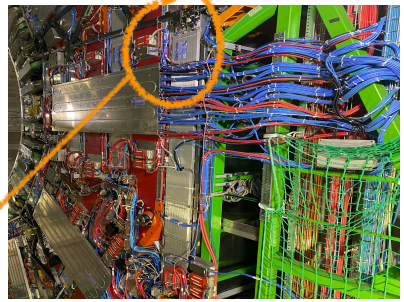


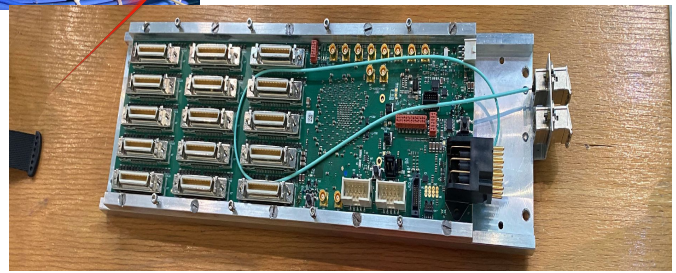
- Power consumption ~10W measured at almost the final operating conditions (240 TDC Ch. and two 10Gbit/s links up)

OBDT: Test installation and Installation Plan

- 4 FE splitter boards and 4 new FE cables installed in the top part of YB+2S1MB4
- Mechanics for supporting the OBDTv2
- Fibers from OBDT to X2
- LV cables to one A3009 with spare channels in X4J2



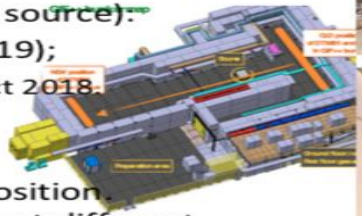




- Review dell'elettronica di Fase 2 andata bene e fondi sbloccati
- Test per l'installazione in corso a Legnaro:
  - Validazione di firmware: OK
  - Validazione di hardware: OK
  - Validazione del sistema di Slow Control: in corso.
- **Programma: effettuare una nuova installazione delle OBDT v2 in una pausa della presa dati, probabilmente a fine anno.**
  - Preproduzione di 15 schede a breve
  - Per la fine dell'anno si prevede di avere due settori equipaggiati con OBDT: uno con v1 e uno con v2

DT chambers: Longevity studies .

CMS - DT chambers Longevity studies
(activities and Results)



Summary of activities

- Irradiation at GIF++ (Gamma rays Facilities of 14 TBq ^{137}Cs source).

MB1 all layer (2015).; MB2 (2 layers ,2017-2018 and 2018-2019);
MB2(8 New wires 2018-2019, one layer). Test Beam Oct 2017; oct 2018.
-> Public Results CMSPublic/DTLongevitynewHGCal ,

- Work GIF++ 2021:2022:
- Displacement of chamber , electronics and DAQ in new position. Chamber performances verified with cosmics. Source rates at different source attenuation measured in new position with the currents on not aged layers. Test Beam (July 21, September 21, October 21 , April 22)) New Irradiation in the **new position** in GIF++ area with almost same equivalent integrated dose (3000 fb-1 in th external wheels). .
- At LNL: realisation of specific detectors for monitor at GIF and for easy investigation of material; tests on aged and not aged wires; inspection (material deposit) with EDS
- At DFA, Unipd: aged and not aged wires inspection SIMS and FTR (material deposit)
- At Chemistry Department, Unipd (material deposit) investigation

-> Public Results (LNL 2021 Report,) Studies on a case of aging in a gaseous particle detector

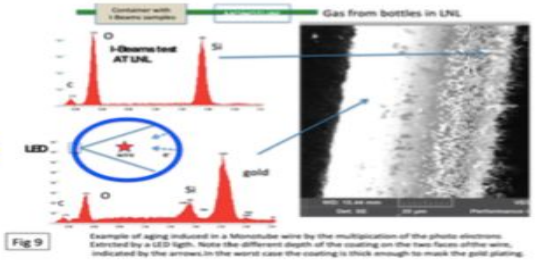


Fig 9

A.M. A.Meneguzzo INFN Sezione di Padova

Sviluppo di algoritmi di trigger locale basati su reti neurali

40 MHz Scouting: Attività di upgrade di Fase-2 dell'esperimento CMS

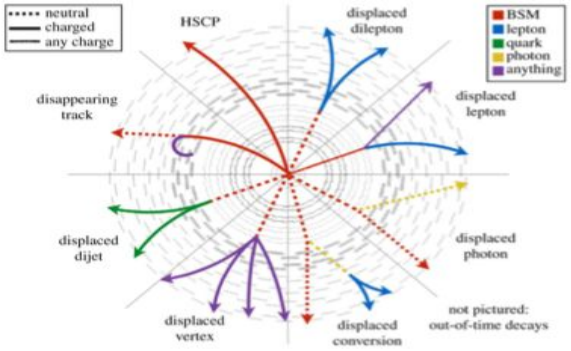
⇒ Acquisire e processare i dati prodotti da CMS ogni bunch crossing
⇒ Studio di processi rari e segnature difficili da triggerare a L1

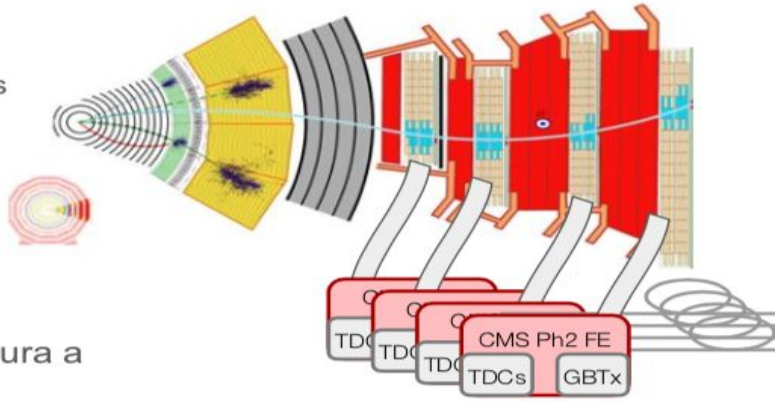
Le DT di CMS offrono la possibilità di fare scouting a livello del front-end, prima di qualsiasi ricostruzione/trigger

- Lettura dalle board di Fase 2 Upgrade di CMS → **OBDT**
- Analisi e monitoring del 100% dei dati del detector (unbiased)
- Possibilita' di esplorare segnature non-standard, e.g.
  - Displaced muons
  - Jets prodotti nello spettrometro per muoni da Long Lived Particles

- Un settore di CMS (circa 3100 canali) è stato equipaggiato con le nuove boards di Front-end (OBDTv1)
  - E' pianificato di instrumentare un secondo settore con la nuova versione (OBDTv2) a fine 2022

- Sistema funzionalmente simile a quello usato a LNL per la lettura a 40MHz delle miniDT prodotte per Lemma.





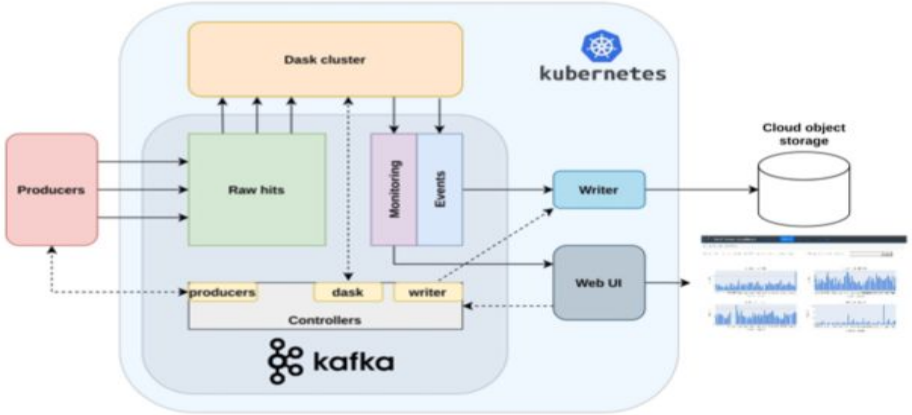
Sviluppo di algoritmi di trigger locale basati su reti neurali

Sviluppo di sistemi per acquisizione e processing per lettura trigger-less dei detectors

- Utilizzo di Neural Networks su FPGA per ricostruzioni veloci (O(100) ns) in hardware
- Readout via DMA da evaluation board montate su server commerciali

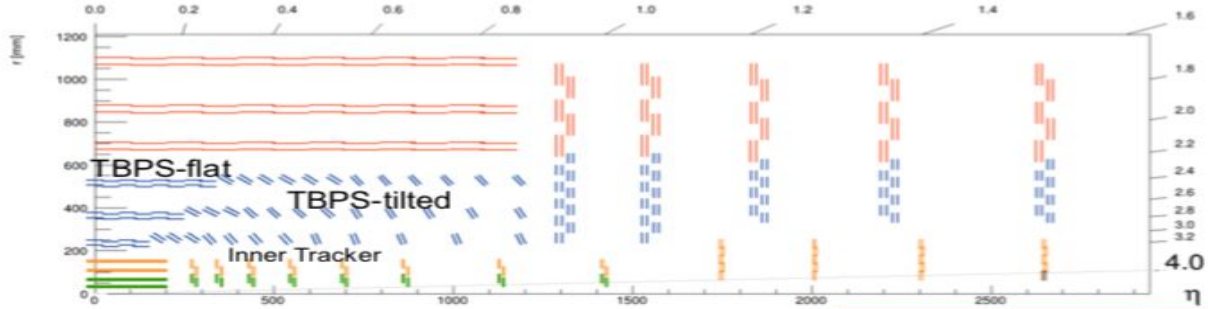
- Utilizzo di strumenti derivanti dal mondo dei Big Data per il processing dei dati
- Sviluppo di architetture per il processing scalabili e facilmente portabili ad altri use-cases
  - Utilizzo in test beams ed esperimenti locali
- Sistema di processing sviluppato e testato tra LNL e CloudVeneto
  - Processing online svolto "off-site" su risorse cloud
  - In corso deployment ed integrazione a CMS

https://arxiv.org/pdf/2105.04428.pdf



https://www.sciencedirect.com/science/article/abs/pii/S0168900222003412#!

Phase II Tracker Upgrade: MaPSA testing in Padova



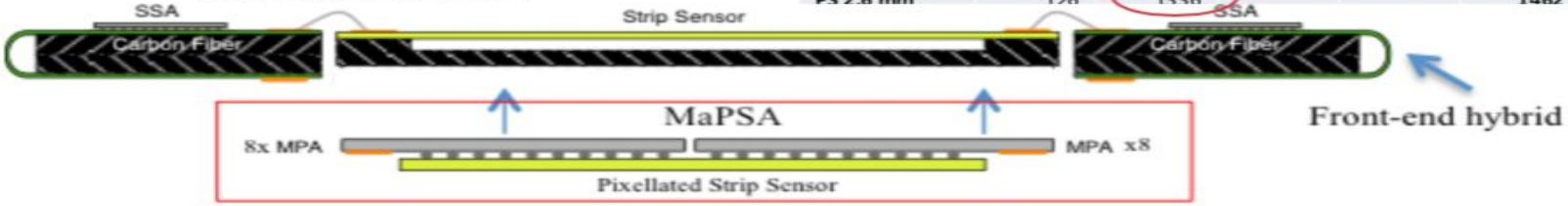
Tracker layout (OT616_IT616). In blue the PS modules location.

- 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

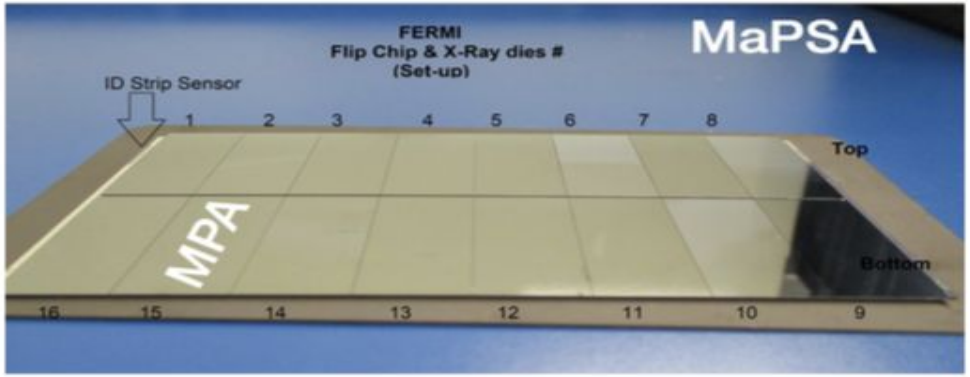
PS module cross-section.



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 over the summer
- Testing procedures in the process of being finalized
- Grading criteria also closed to final.
- We will exercise both the testing procedures and grading during round#3 prototypes
- Final MaPSA testing will be split between Fermilab, Purdue and Brown for final production
- 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.



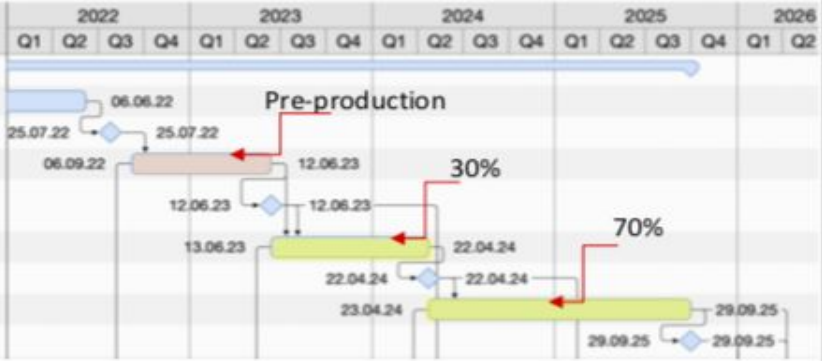
A MaPSA assembly from round#3 prototypes

8" probe station setup in Padova for MaPSA testing

Phase II Tracker Upgrade: MaPSA testing in Padova

- Pre-production of 300 MaPSA planned for 1st half of 2023
- 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 2023 until summer of 2025
- 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
56	**OT MaPSA**	**23 Aug 2019**		**29 Sep 2025**
57	MaPSA prototyping with candidate vendors	23 Aug 2019	141 weeks	6 Jun 2022
58	MaPSA contract (LHCC)	25 Jul 2022		25 Jul 2022
59	Test of pre-production MaPSAs	6 Sep 2022	40 weeks	12 Jun 2023
60	MaPSA pre-production completed (5% of MaPSAs) (LHCC)	12 Jun 2023		12 Jun 2023
61	Test of production MaPSAs - part I	13 Jun 2023	45 weeks	22 Apr 2024
62	30% of MaPSAs received (LHCC)	22 Apr 2024		22 Apr 2024
63	Test of production MaPSAs - part II	23 Apr 2024	75 weeks	29 Sep 2025
64	All MaPSAs received (LHCC)	29 Sep 2025		29 Sep 2025



Phase II Tracker Upgrade: MaPSA testing in Padova

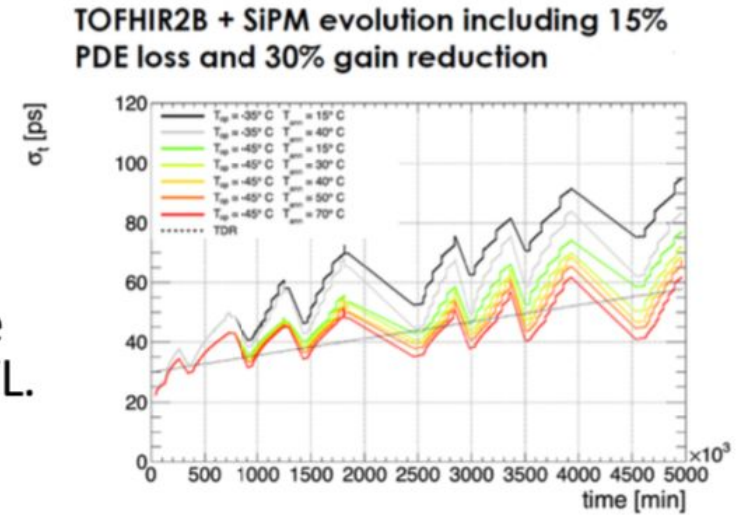
- Test setup in Padova essentially ready
- We completed the test of the first MaPSA from an old batch of prototypes with the MPA1 chip
- Fermilab personnel responsible for the MaPSA testing visited Padova on May 9th and 10th.
- Test system is fully operational and results from Fermilab were reproduced (albeit a slightly higher noise which is under investigation)

Testing MaPSA in Padova, May 2022

Probe-card alignment on MaPSA pads

Barrel Timing Layer

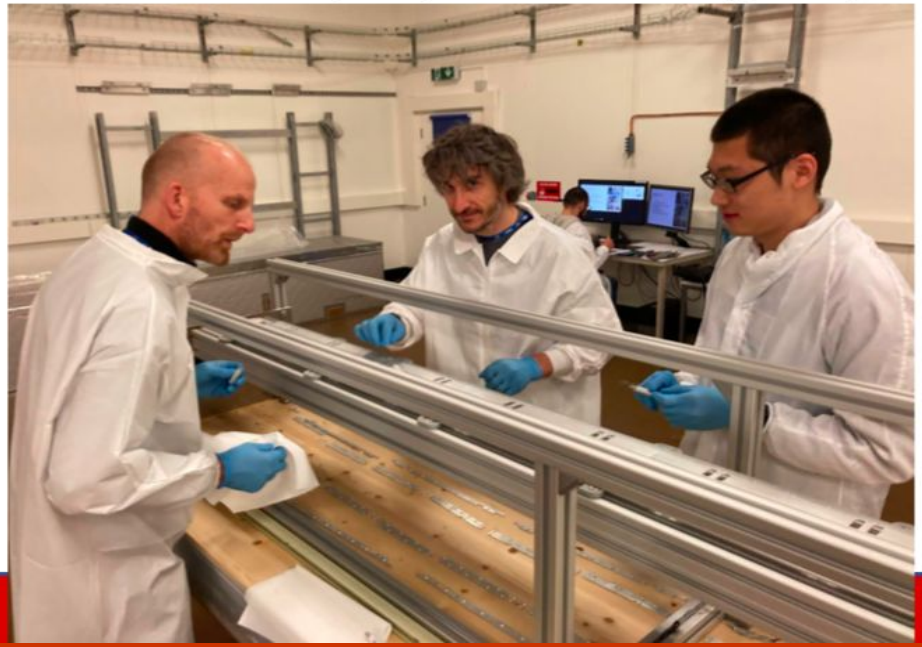
- Il timing detector di CMS fornira' informazione temporale sul passaggio di particelle cariche con una risoluzione temporale di 30-40 ps. L'elettronica di lettura dovra' restare a basse temperature (approx. -40 °C).
- Padova responsabile del disegno e la produzione dei trays per il raffreddamento dei moduli del BTL.
- Thermo Electric Coolers verranno installati per raggiungere $T_{op} = -45\ ^{o}C$ e $T_{ann} = 70\ ^{o}C$
- Padova responsabile dei test dei TECs
  - misure di efficienza in funzione della T di esercizio
- Padova responsabile dei test dei prototipi degli alimentatori dei TECs.



M. Benettoni, E. Borsato, R. Carlin, P. Checchia, M. Giorato, R. Isocrate, M. Tosi, R. Rossin, L. Silvestrin, S. Ventura, S. Mancin (DTG)

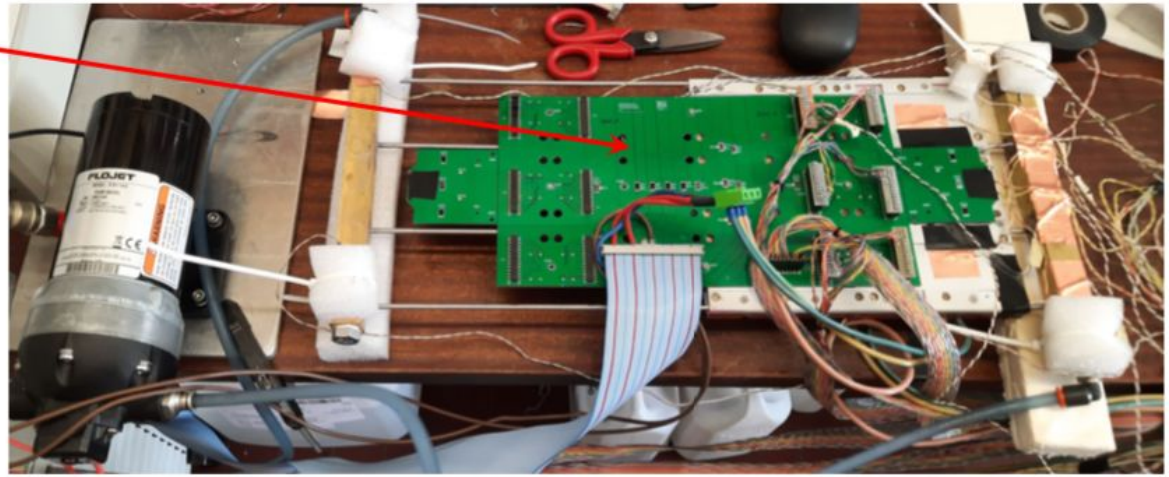
Barrel Timing Layer

- Nuovo disegno dei cold plates (con lamine di ritenzione per migliorare l'accoppiamento termico tubi-piastre) finalizzato e prototipi consegnati al CERN per costruzione del tray di prova con CO_2 evaporativa alla TIF

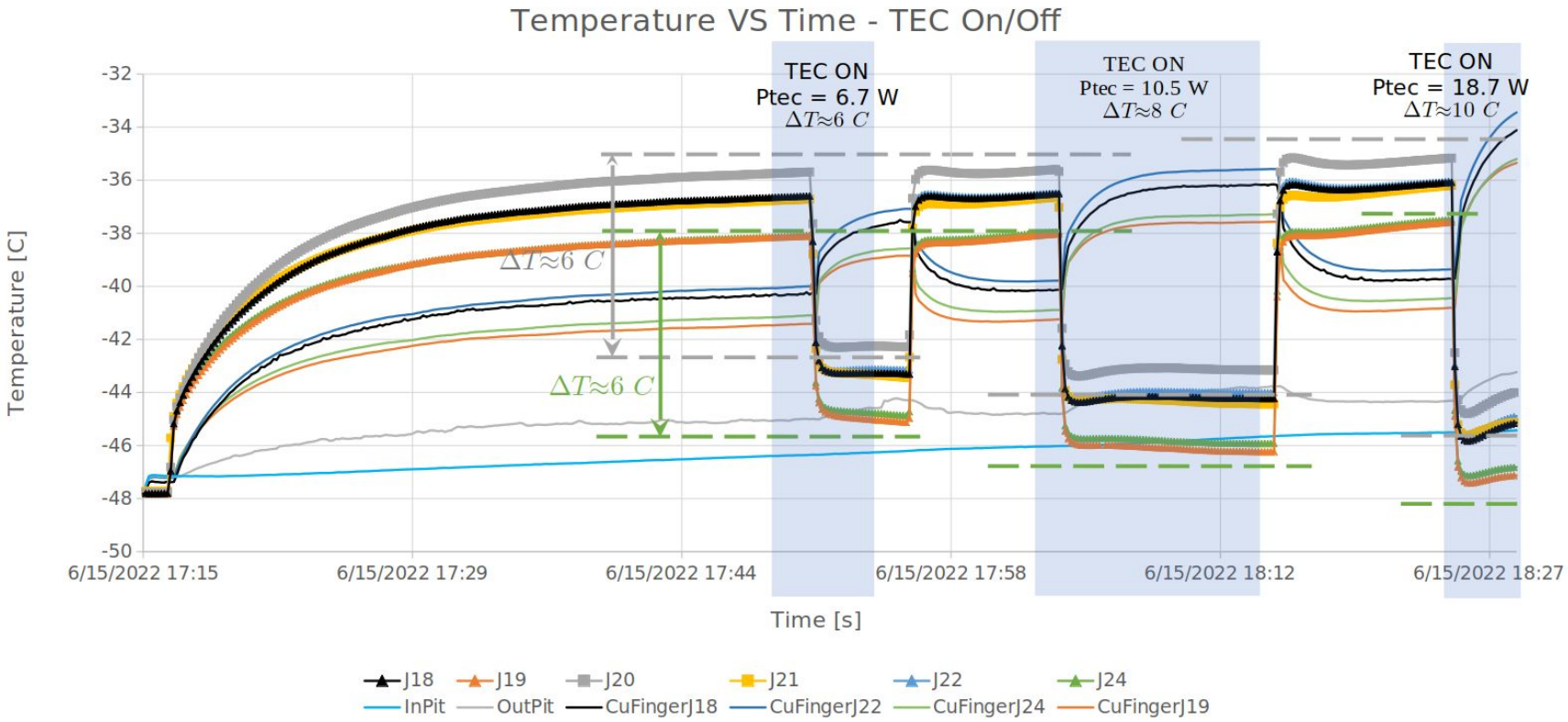


Barrel Timing Layer

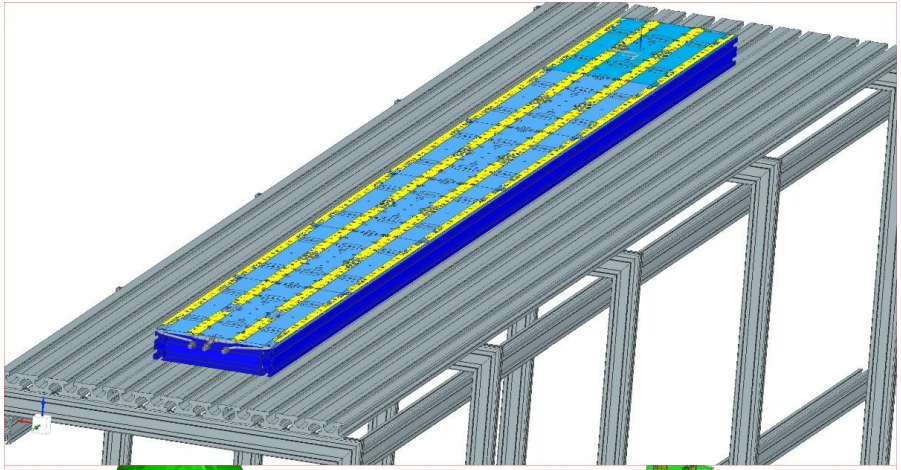
- Prototipo delle nuove cold plate anche a PD per test a temperatura ambiente e di esercizio (frigo a -45 °C)
  - Circuito di raffreddamento realizzato ad hoc dalla officina meccanica
- Popolata ½ cold plate con cristalli in LYSO, SiPM, e TEC. Emulazione della potenza dissipata dal resto dell'elettronica (non ancora disponibile) mediante una mockup board.
- Primi test su questo sistema
  - Test eseguiti nel Lab Gr1
  - Misure di temperatura con Pt1000 e termocoppie

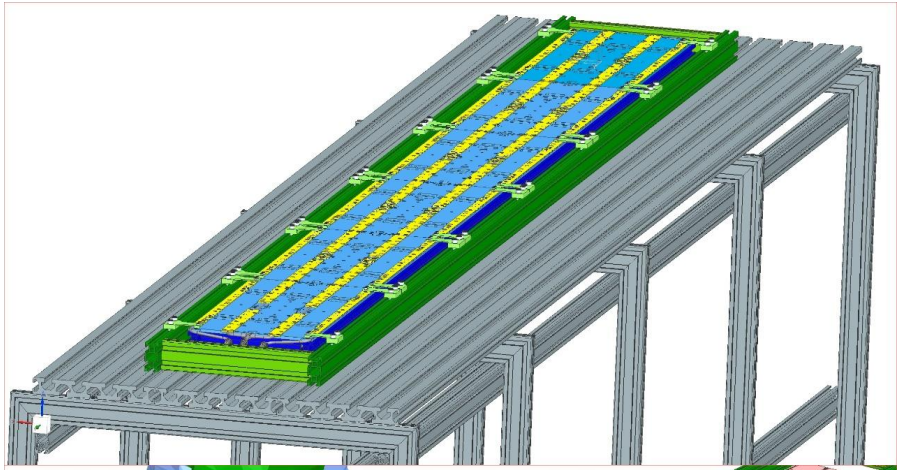


TEC tests: guadagno in T sui SiPM con i TEC

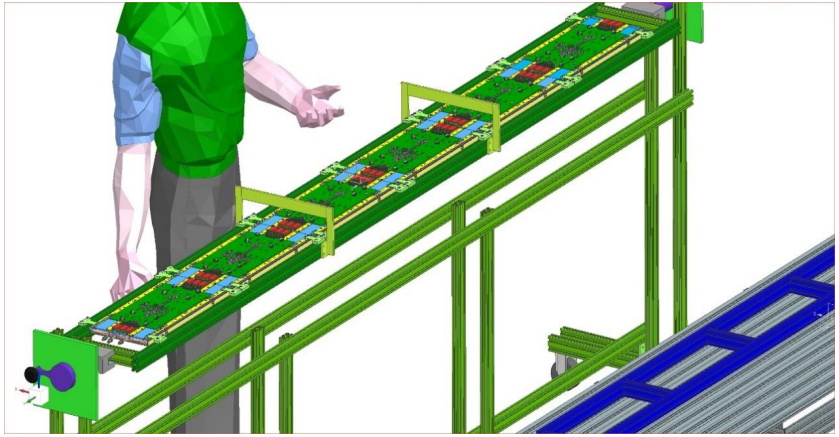


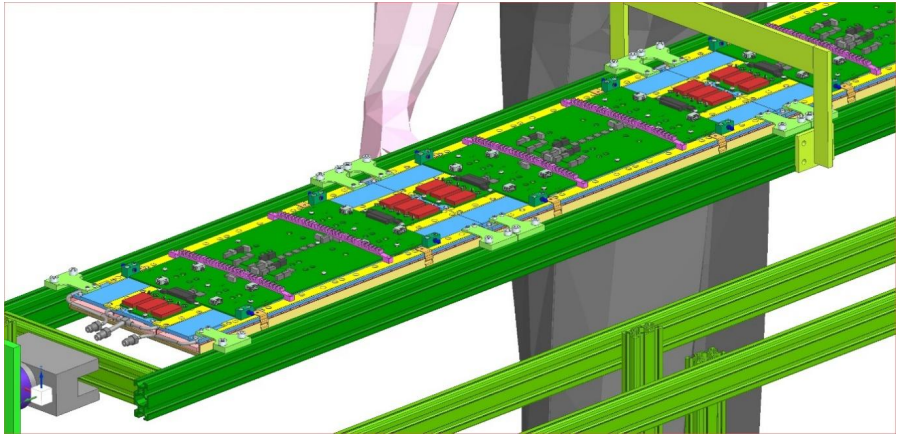
Ufficio Tecnico: Tray assembly tools and sequence

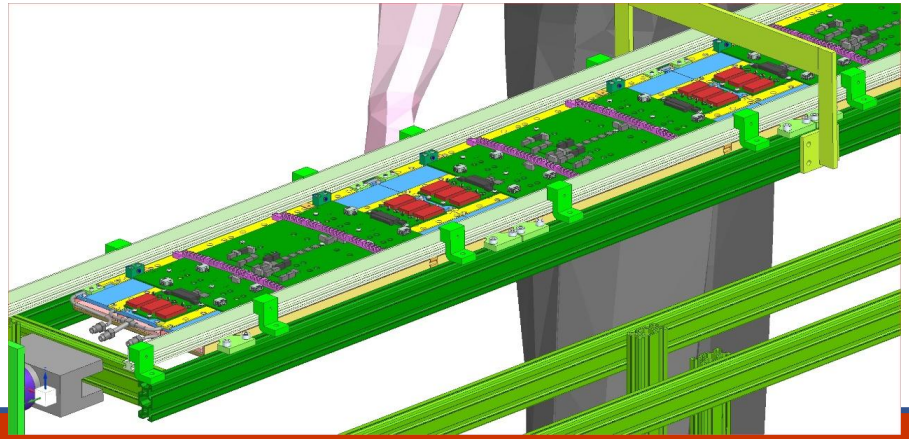


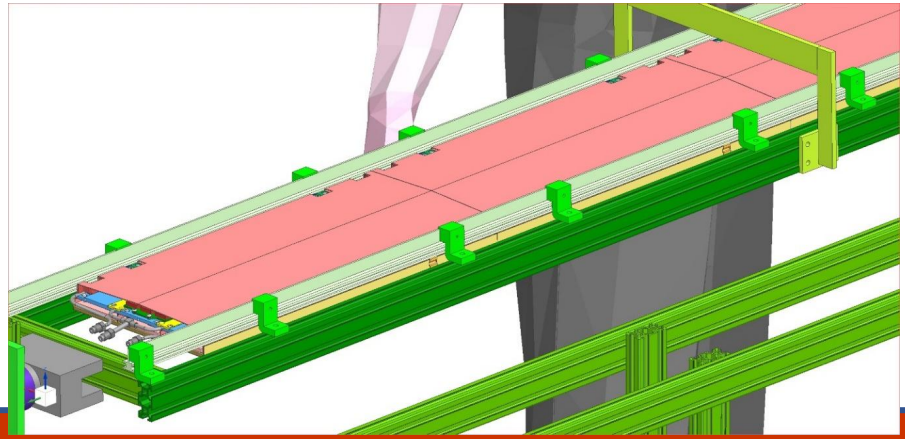


Ufficio Tecnico: Tray assembly tools and sequence









Trigger: Run3

Toward Run3 - trigger

several new L1 seeds requested (most likely not all of them may fit into the bandwidth)
⇒ we are discussing w/ LHC the possibility to keep the beam for longer reaching lower instantaneous luminosities

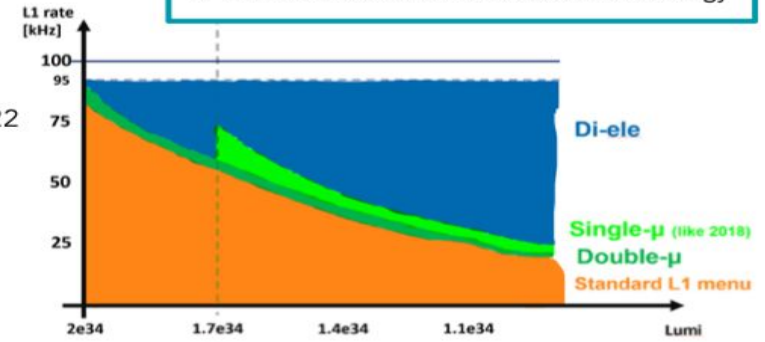
- LLP (thanks also to L1 BMTF) entered the menu w/ high-priority
- BPH triggers (new phase spaces)
  - → most of the bandwidth to di-Electron : R(K/K*) analysis (parking)
    L1 seed is very challenging → ~some O(100) of B→Kee events expected in 2022
  - → single-muon parking (2018 strategy) lower priority
    [already billions of event collected in 2018]
  - → di-muon triggers –mainly– for Bs→$\mu\mu$ (prompt reco)
- new Scouting ~30 kHz (30% of the input rate of the HLT!)
  - → timing 180 ms/event w/ GPU (290 ms/event w/o GPU !)
  - → includes tracks, vertex, egamma, muon, MET event size : 7.7 kB
  - → Particle Flow candidate based on pixel tracks
- exploit ramp-up period (4.5 weeks O(200) pb-1)

several improvement deployed at HLT
- GPU pixel-tracking and calorimeter local reconstruction
- new DNN based E/Gamma regression
- new Deep taggers : deepTau, deepJet, ParticleNet

HLT farm w/ > 200 nodes installed @ P5 2 AMD EPYC "Milan" 7763 (64 core, 128 threads) + 2 GPU NVidia T4

Run3 priorities for Physics

- improve LLP acceptance
- shed light on LFUV anomalies
- investigate our own Run2 excesses
- open new phase space w/ new triggers
- cross section measurements at new energy



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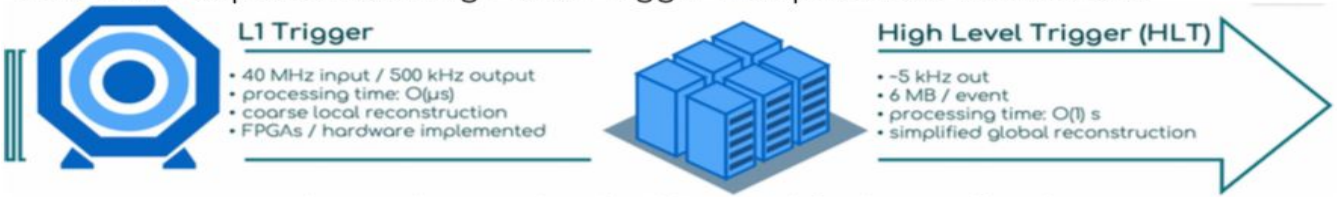
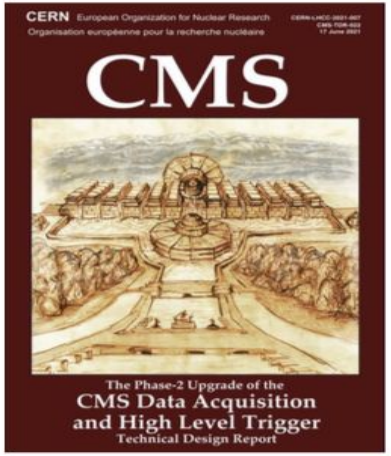
Trigger: LHC-HL

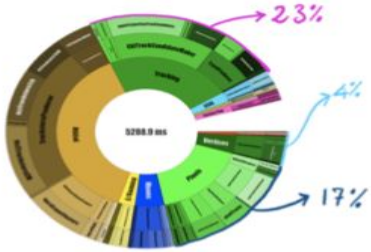
Phase2 developments

CMS Data Acquisition and High Level Trigger TDR published in June 2021



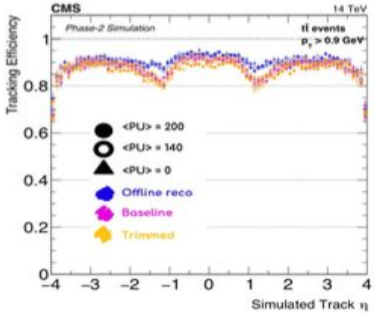


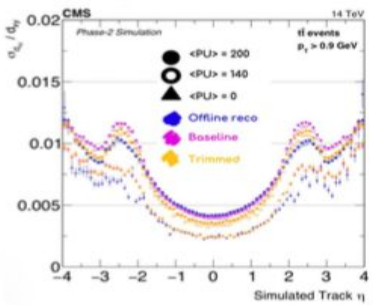
- reconstruction advanced enough to build a simplified menu for Phase2
  → basic single-object paths w/ performance very close to Phase1
  → rates and timing under control [large pT threshold increases not needed]



but in order to meet the overall constraints for the HLT farm, we need to improve the overall timing by a factor x1.5-2
⇒ heterogeneous HLT under development

one of the main contributors as well as a key ingredient for many different algorithms is tracking





NB: we are working on the integration of the MTD as well

5

Anagrafica 2023

- Out:
  - Ghosh (Assegno)
  - Rigoni (Assegno Tecn.)
  - Checchia (dal 1.6.2022 per pensionamento)
  - Yarar (Dottoranda)
  - Layer (Dottorando)
- In:
  - Nessuno
- Strutturati (cambiamento FTE)
  - Carlin 100 → 90
  - Margoni 100 → 90

Ruolo	Persone	FTE
Ricercatori e studenti	23	18.6
Tecnologi	10	5.2

Responsabilita’ 2023

Area			Livello	Ruolo
TK	Bacchetta	Nicola	L2	Tracker Upgrade Technical Coordinator
TK	Bacchetta	Nicola	L2	TBPS Coordinator
TK	Bacchetta	Nicola	L2	Integration, Cooling&Services Coordinator
DT	Bellato	Marco	L3	TM7 HW Coordinator
DT	Bellato	Marco	L3	OBDTϕ, Slow Contol & Timing Backend
DT	Bergnoli	Antonio	L3	OBDTφ, Slow Contol & Timing Backend
FIS	Dorigo	Tommaso	L3	Thesis Awards Committee co-chair
FIS	Dorigo	Tommaso	L3	Statistics Committee member
TK	Lusiani	Enrico		TRK Release Validator
CMS Italia	Margoni	Martino		LR Padova
FIS	Margoni	Martino		BPH Conference Contact
DT	Meneguzzo	Anna	L3	Longevity TaskForce coordinator
DT	Meneguzzo	Anna	L3	DPG Chamber Performance Coordinator
CMS Italia	Tosi	Mia	L2	Coordinatore Italiano della Fisica
FIS	Tosi	Mia	L1.5	Trigger Officer
FIS	Tosi	Mia	L3	BPH Software & Framework Coordinator
DT	Triossi	Andrea	L2	Deputy Upgrade Coordinator
MUON	Ventura	Sandro	L2	Electronics Coordinator
DT	Ventura	Sandro	L2	Electronics Coordinator
DT	Ventura	Sandro	L3	Online Software Coordinator
CMS Italia	Ventura	Sandro	L2	Upgrade Coordinator

Richieste CSN1

- **Missioni**
  - Metabolismo+shifts/services: 205.0 keu
  - Responsabilita': 87.5 keu
  - Preparazione Fase 2:

    DT: slice test operations 38 keu + Irraggiamento preprod OBDTv2 11.5keu. Tot. 49.5 keu

    BTL: commissioning 11.5 keu

  - Run 3 Operation: DT: Manutenzione HW Fase1 e Longevity 8 keu
- **Consumi**:
  - Metabolismo: 40.0 keu
- **CORE**
  - DT:
    - 2.2.1: contributo INFN per Mic2 preproduction: 15keu
    - 2.2.2: contributo INFN per prod ATCA Clock & Slow Control: 15 keu
  - BTL: Nessuna nuova richiesta (174 keur gia` approvati per il 2022 per Meccanica per prod. tray)
  - Tracker: Nessuna nuova richiesta (11.8 keu già approvati per il 2021 da spostare)

Richieste in Sezione

Officina elettronica		Mesi uomo
Tracker	Setup test in camera pulita	3
Totale		3

SPE		Mesi uomo
DT	Manutenzione camere al CERN	2
	Studio ageing a GIF++	1
	Slice test fase 2	6
	Irraggiamento preproduzione fase 2	6
	Sviluppo elettronica Fase 2	16
BTL	Setup sistema test prototipo PS dei TEC	1
Totale		32

ALTRO	
Tracker	Richiesta spazio per lo stoccaggio dei moduli (1 o 2 dry cabinets)

Ufficio tecnico		Mesi uomo
BTL	Progettazione tool di installazione	4
	Benettoni	2
Totale		6

Officina Meccanica		Mesi uomo
BTL	Supporto test cold plates	3
	Prototipi Tray e attrezzature	3
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 Update - preventivi INFN 2022

G. Simi - Universita' di Padova
per il gruppo LHCb Padova
Riunione del Consiglio di Sezione di Padova

Overview

Stato dell’esperimento

Highlights di fisica

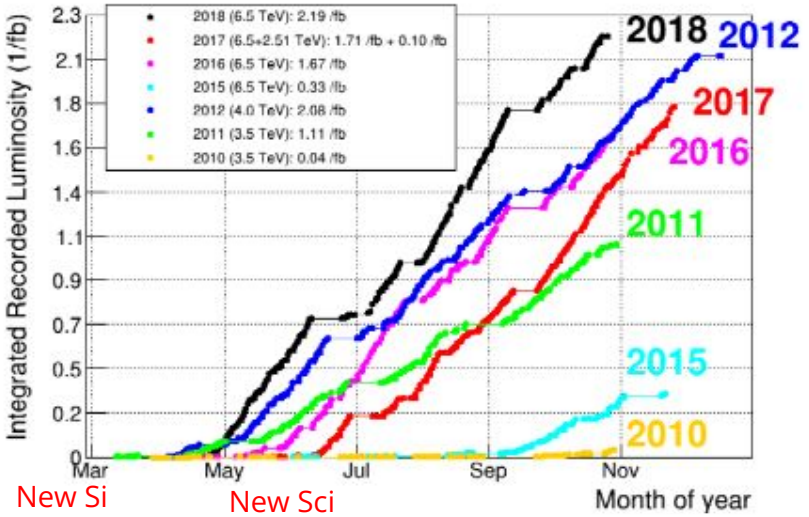
Attivita’ Padovane

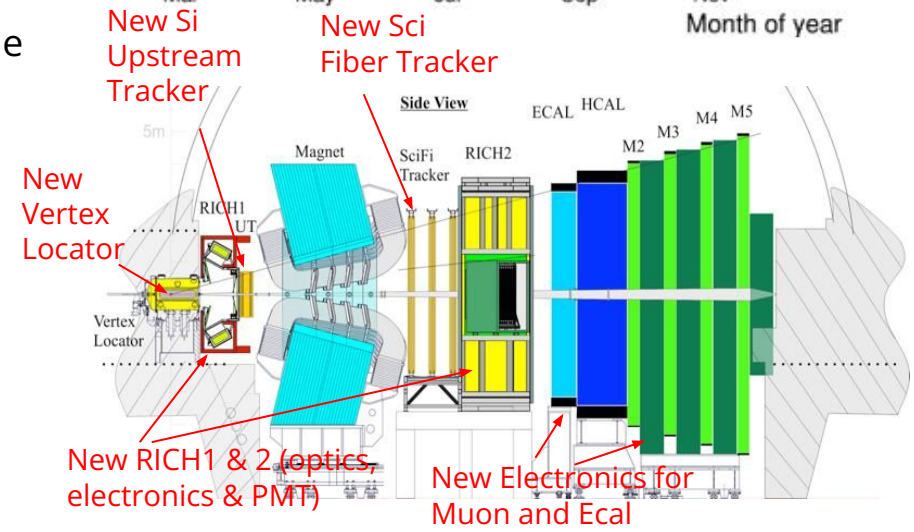
- Electroweak Analyses
- Flavour Physics Analyses
- Innovative Analysis Techniques
- Quantum Computing at LHCb
- ECAL For Upgrade 2
- RICH Upgrade II
- VELO Upgrade

Major Upgrade I

LHCb Upgrade I

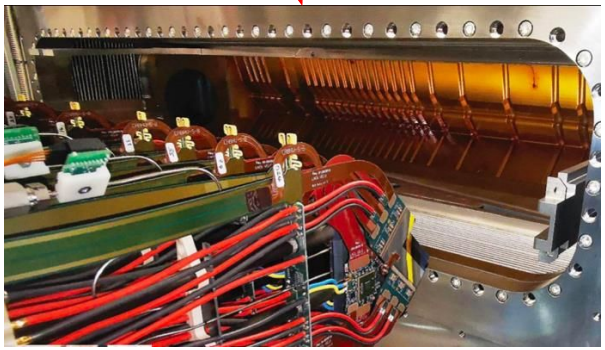
- Major Upgrade del rivelatore durante il Long Shutdown II
  - Trigger a 40MHz, Real Time Reconstruction
  - Nuovo VELO con Si μchannel cooling @ 5mm from the beam pipe
  - Aumento Granularità nei tracciatori (UT) e nel PID (RICH)
  - Nuova elettronica per MUON e ECAL
  - PLUME & SMOG2 gas target upgrade
- Padova coinvolta nell'upgrade del RICH1&2 [Simi, Benettoni]



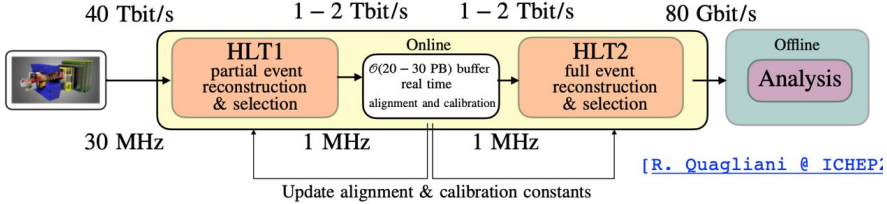


LHCb Upgrade I

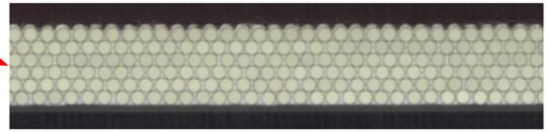
VELO: Installation completed May 2022, now commissioning



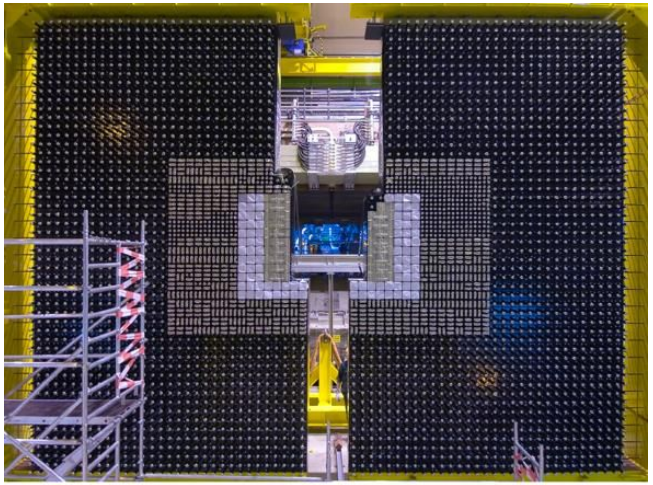
TRIGGER: Highest throughput of any HEP experiment



SciFi: Installation completed March'22, now commissioning



Calo and Muon: Detectors in Global data taking



UT: Aim to be ready for detector installation later in year, not essential for early physics operation

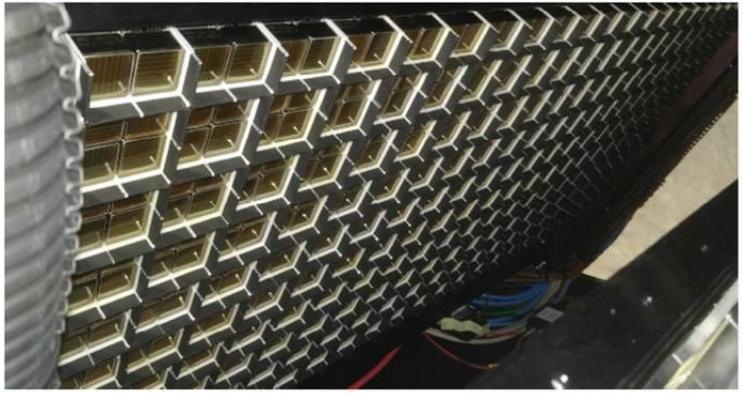
LHCb Upgrade I: RICH

- RICH PID tratto distintivo di LHCb, fondamentale per il programma di fisica di LHCb
- Padova coinvolta nel design e nella costruzione
- Responsabilita' nella
  - caratterizzazione dei PMT [Simi]
  - meccanica [Benettoni]
  - calibrazione del rivelatore [Simi]
  - commissioning
  - installazione
- Installati nuovi fotorivelatori e elettronica @ 40MHz
- Ridisegnata l'ottica del RICH1
- Installazione completata febbraio 2022
- Detector commissioned and now in data taking

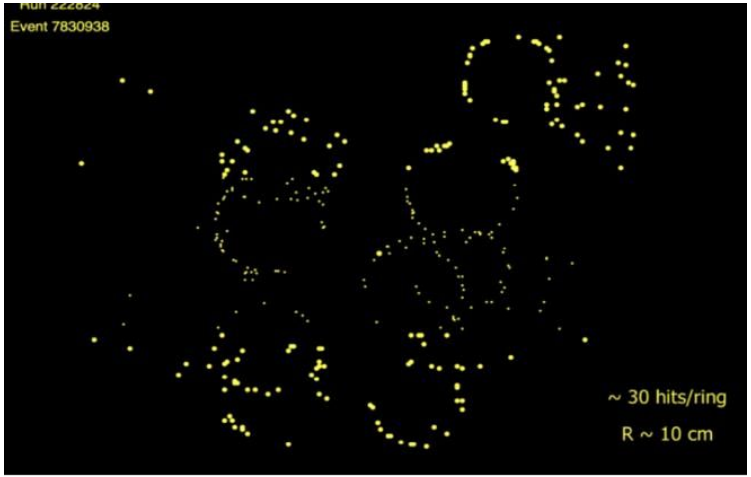
Upstream Tracker to be installed in September

Upgrade Ib: only electronics, Padova involved in test beams

RICH1: MaPMTs installed upper side



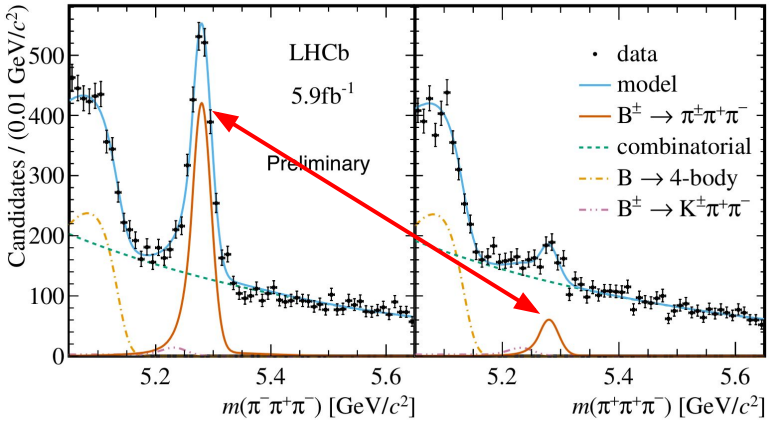
RICH2: first rings, LHC October '21 test



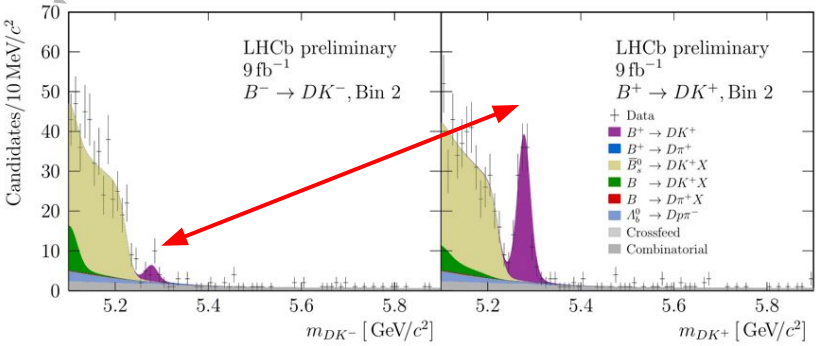
LHCb Analysis highlights

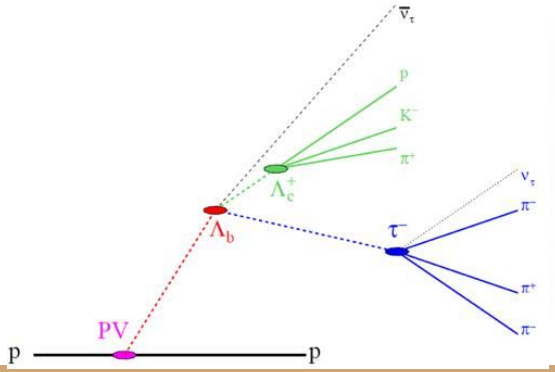
- CP Violation in $B^{\pm}\to K^{\pm}K^{+}K^{-}$, $B^{\pm}\to\pi^{\pm}\pi^{+}\pi^{-}$, $B^{\pm}\to\pi^{\pm}K^{+}K^{-}$: 75% CPV
- $B^{\pm}\to DK^{\pm}$ with $D\to K^{\mp}\pi^{\pm}\pi^{\pm}\pi^{\mp}$
  - 85% largest CPV ever measured
  - γ measurement
- LFU in b-> c$l\nu$
  - $R(\Lambda_c) = 0.242 \pm 0.026\ stat \pm 0.040\ syst \pm 0.059\ ext$

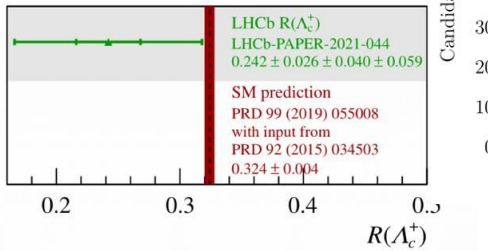
LHCb-PAPER-2021-049 LHCb-PAPER-2021-050



LHCb-PAPER-2022-017





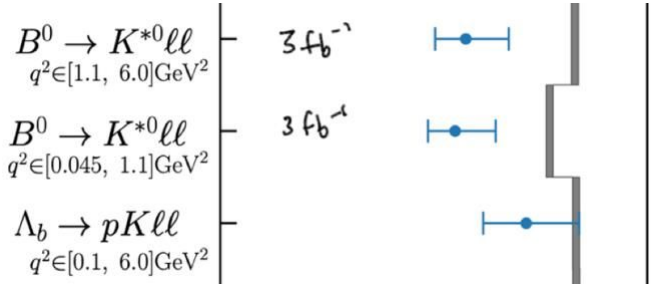


LHCb Analysis highlights

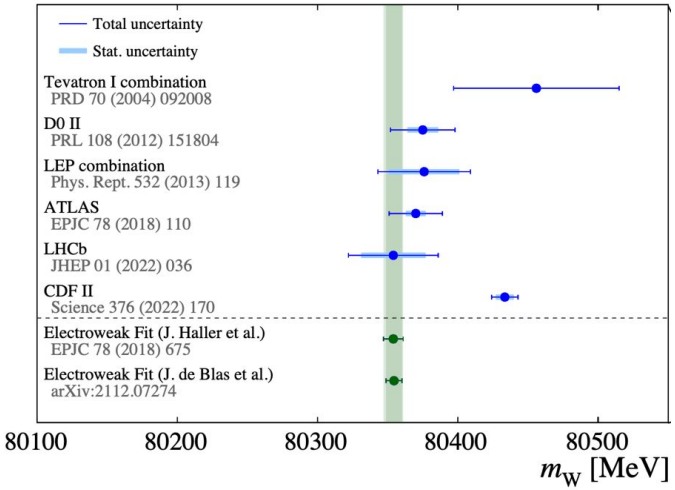
$R_K = \frac{\mathcal{B}(B^+ \to K^+ \mu^+ \mu^-)}{\mathcal{B}(B^+ \to K^+ e^+ e^-)}$ 3.1σ **below SM**

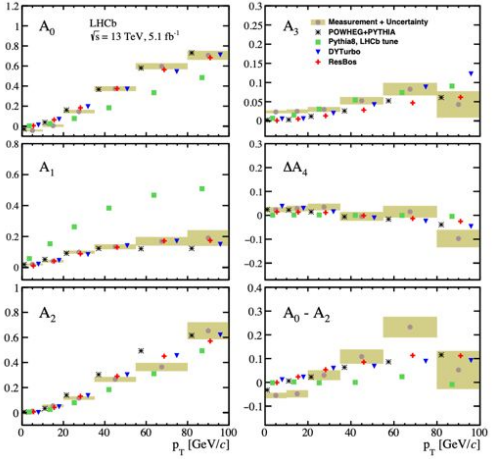
Nat. Phys 18 (2022) 277

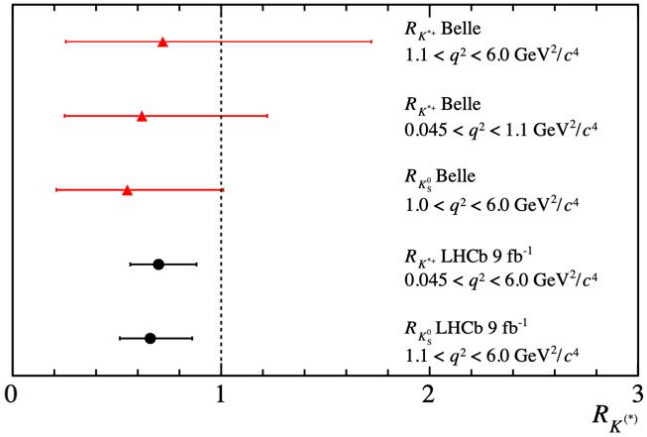
Update with full Run 2 ongoing



W mass – hot topic with recent CDF result: JHEP 01 (2022) 36





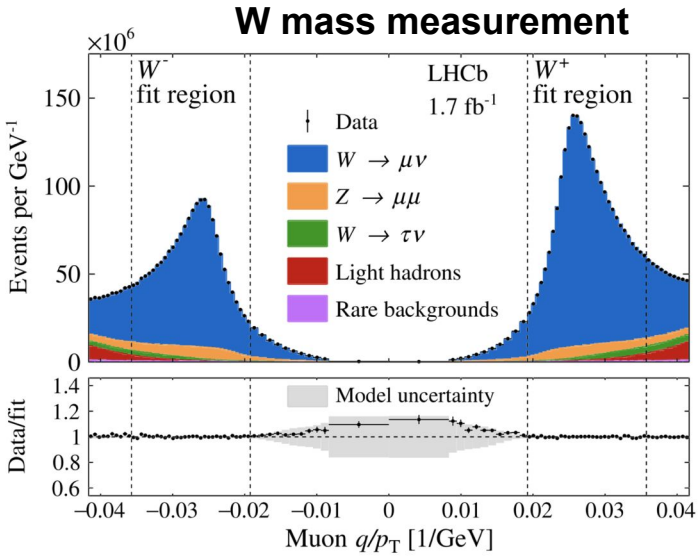


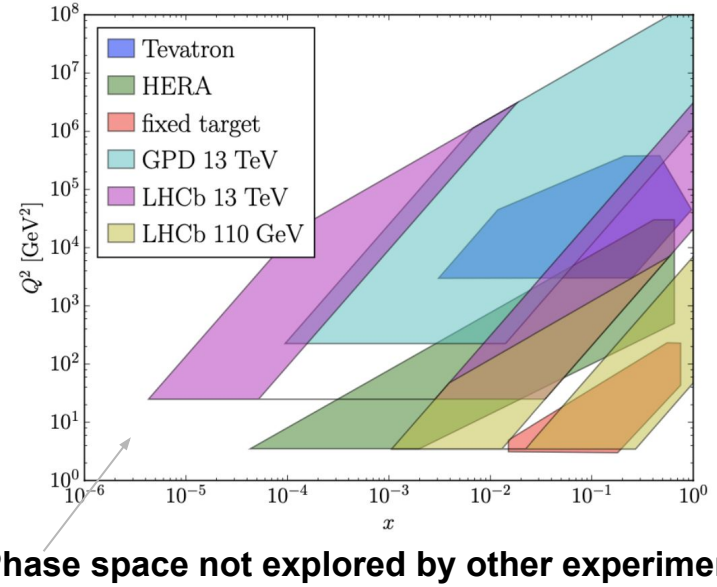
First measurement of the $Z \to \mu + \mu$ angular coefficients and differential cross section in the forward region

Attivita` Padovane

QCD, Electroweak and Exotica (QEE) Physics at LHCb

- LHCb can be considered as a General Purpose Forward detector
- QCD and Electroweak measurements in a phase-space region complementary to ATLAS/CMS
- Direct searches with low momentum threshold trigger and excellent particle identification capabilities

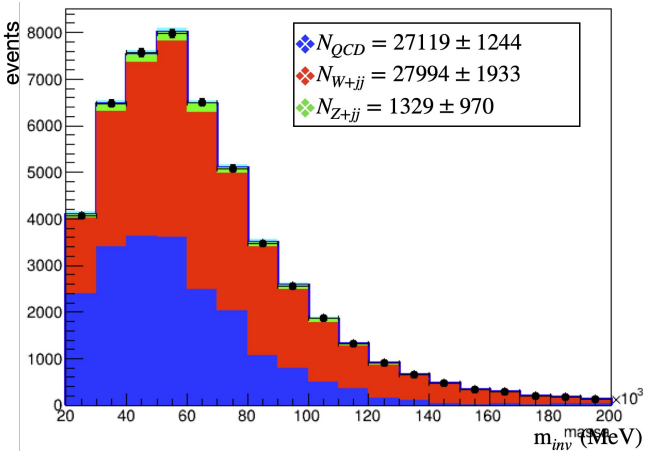




Phase space not explored by other experiments

QCD, Electroweak and Exotica (QEE) Physics at LHCb

- LHCb-Padova has crucial roles in the QEE Working Group:
  - Convener: Lorenzo Sestini
  - Simulation liaison: Luca Giambastiani
  - Statistics and Machine learning liaison: Davide Zuliani
- We are the main proponents of several on-going analyses:
  - WW production in lepton+jets final state (PhD project of Davide Zuliani)
  - ZZ production in lepton+jets final state (PhD project of Luca Giambastiani)
  - H->cc search (PhD project of Laura Buonincontri)
- We are also involved in the Run 3 preparation:
  - QEE Run 3 migration task force
  - Early measurement of Z+jet production at 13.6 TeV



Analisi dati Run 2 (A. Bertolin)

ARTICLES
https://doi.org/10.1038/s41567-021-01394-x
nature physics

Check for updates

OPEN

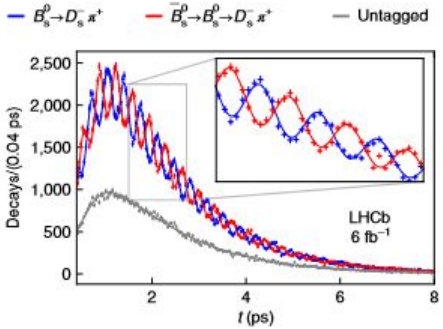
Precise determination of the B_s^0–$\overline{B}_s^0$ oscillation frequency

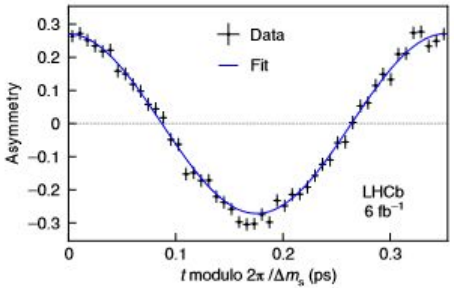
LHCb collaboration*

Mesons comprising a beauty quark and strange quark can oscillate between particle (B_s^0) and antiparticle ($\overline{B}_s^0$) flavour eigenstates, with a frequency given by the mass difference between heavy and light mass eigenstates, Δm_s. Here we present a measurement of Δm_s using $B_s^0 \to D_s^- \pi^+$ decays produced in proton–proton collisions collected with the LHCb detector at the Large Hadron Collider. The oscillation frequency is found to be $\Delta m_s = 17.7683 \pm 0.0051 \pm 0.0032\,\text{ps}^{-1}$, where the first uncertainty is statistical and the second is systematic. This measurement improves on the current Δm_s precision by a factor of two. We combine this result with previous LHCb measurements to determine $\Delta m_s = 17.7656 \pm 0.0057\,\text{ps}^{-1}$, which is the legacy measurement of the original LHCb detector.

as corresponding author of the paper and coordinator of the analysis

next step: CKM γ using this Δm_s as input, internal LHCb review just started, may be as conference result by the end of 2022 …





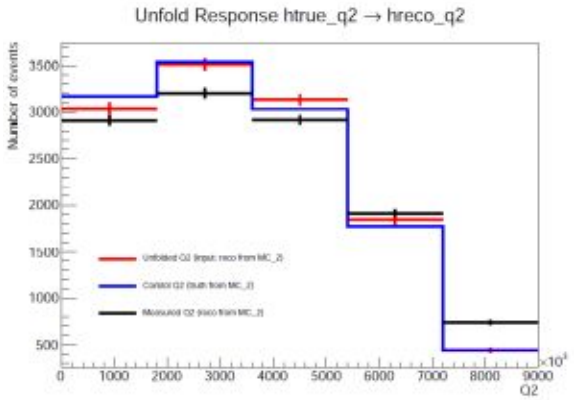
Universalità Leptonica $R(\Lambda_c^*) = \frac{B(\Lambda_b^0 \to \Lambda_c^* \tau^- \bar{\nu}_\tau)}{B(\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu)}$

Per la misura dell'universalità leptonica nei b-barioni Λ_b con i dati del run2 è necessario ridurre l'errore sistematico (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 $\Lambda_b^0 \to \Lambda_c^* D_s^{(*)}$

Fattori di Forma $\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu$

- Prima misura in questo decadimento
- Analisi completata, in review
- Timescale: conferenze invernali
- Persone coinvolte: G. Simi



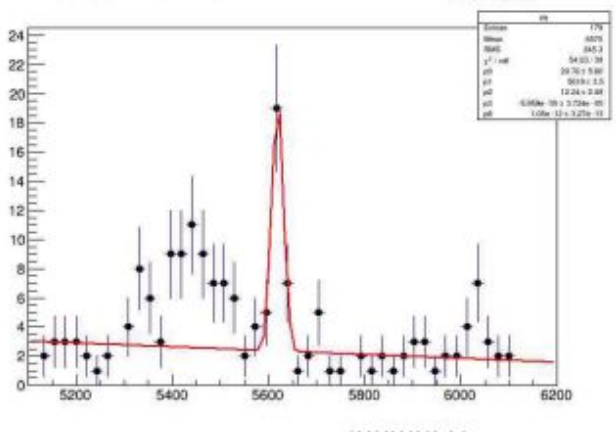
Universalità Leptonica $R(\Lambda_c^*) = \frac{B(\Lambda_b^0 \to \Lambda_c^* \tau^- \bar{\nu}_\tau)}{B(\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu)}$

Per la misura dell'universalità leptonica nei b-barioni Λ_b con i dati del run2 è necessario ridurre l'errore sistematico (G. Simi LCHB-ANA-2018-026) dominato da

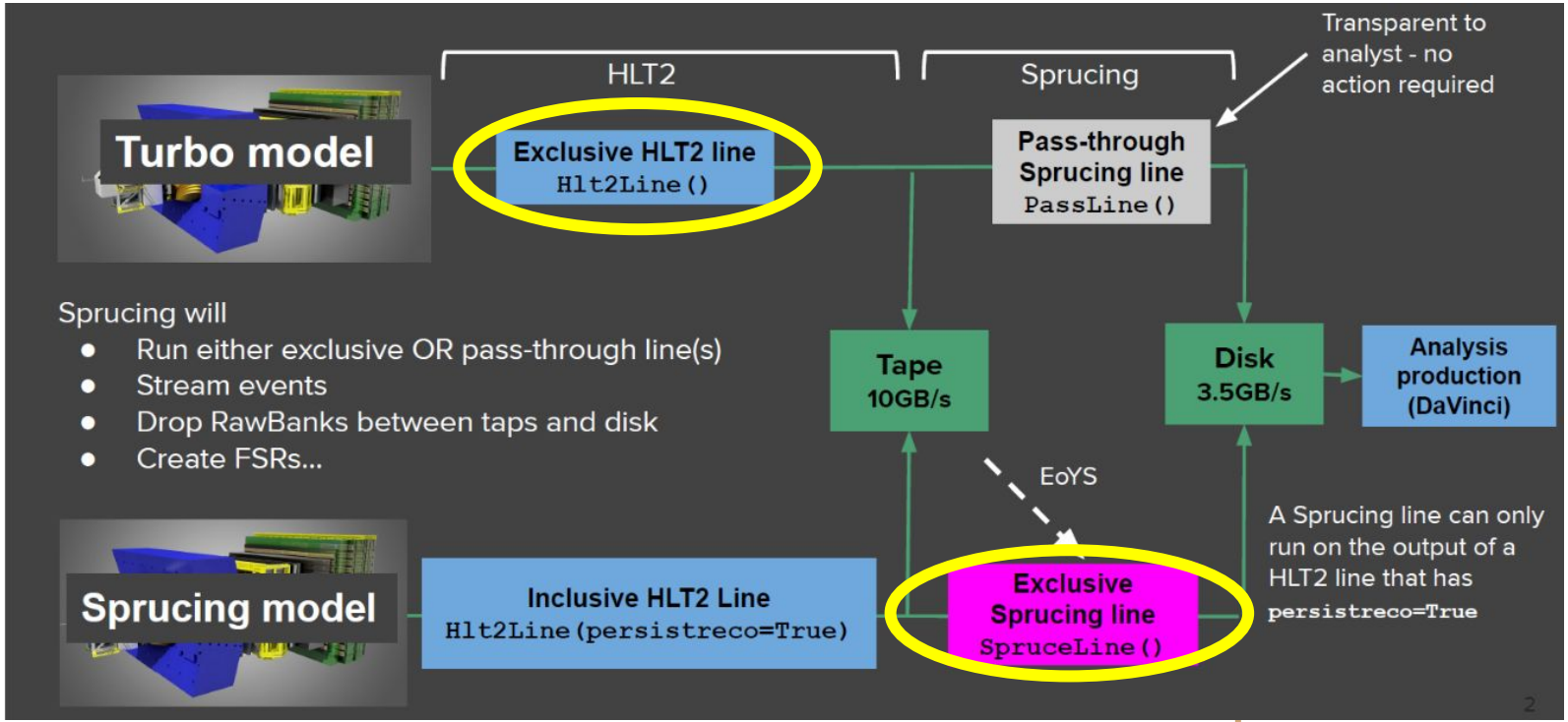
- Fattori di forma del decadimento $\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu$
- Fondo da $\Lambda_b^0 \to \Lambda_c^* D_s^{(*)}$

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: G. Simi, F. Borgato



Presa dati 2022 (A. Bertolin)



- ❑ gestione delle Exclusive HLT2 ed Exclusive Sprucing lines per il gruppo di fisica B2OC
- ❑ coordinamento delle Exclusive Sprucing lines per tutto LHCb

Innovative Analysis Techniques group at LHCb

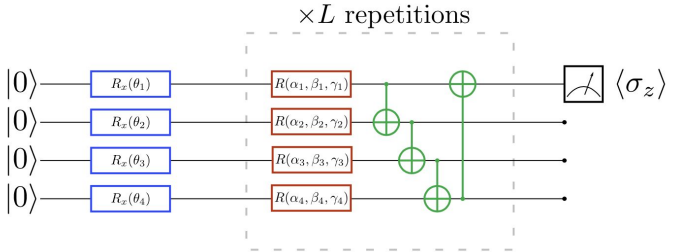
- The “Innovative Analysis technique” group is part of the Data Analysis Project (DPA) at LHCb:
  - new software and hardware technologies
  - quantum computing
  - usage of GPU for analyses
  - analysis facilities
- LHCb-Padova gives a fundamental contribution:
  - Coordinator: Donatella Lucchesi
- Preparation of an Analysis Facility at LHCb:
  - Computing scientists from INFN-Padova are involved: Alessio Gianelle, Paolo Andreetto, Federica Fanzago

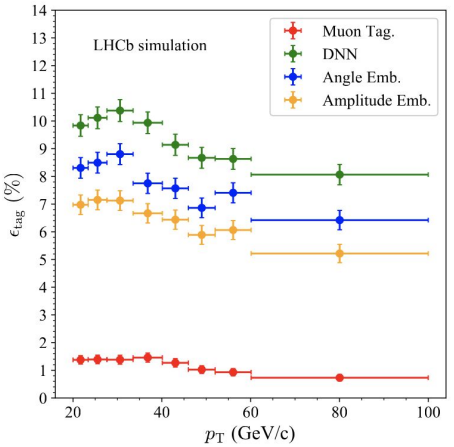
Work package	Coordinator(s)
Overall coordination	Eduardo Rodrigues
WP1 - Sprucing	Nicole Skidmore
WP2 - Analysis Productions	Chris Burr
WP3 - Offline Analysis Tools	Patrick Koppenburg
WP4 - Innovative Analysis Techniques	Donatella Lucchesi
WP5 - Legacy Software & Data	Federico Leo Redi
WP6 - Analysis Preservation & Open Data	Sebastian Neubert

Quantum Computing at LHCb

- Quantum Machine Learning (QML) applied to jet identification:
  - b vs b-bar jets identification
  - **paper accepted by JHEP, main authors from Padova** (Davide Zuliani, Donatella Lucchesi, Alessio Gianelle, Lorenzo Sestini)
  - reference: https://arxiv.org/abs/2202.13943
- On-going studies and future plans:
  - study b- vs c-jet separation with QML
  - exploit different quantum simulators and hardware
  - apply Quantum Computing algorithms to other tasks, like track or jet reconstruction

Angle embedding QML circuit



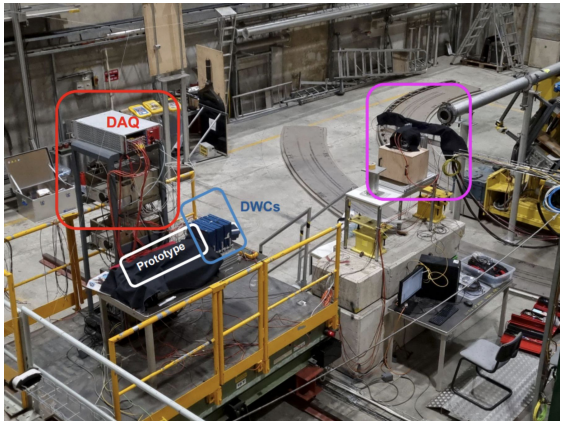


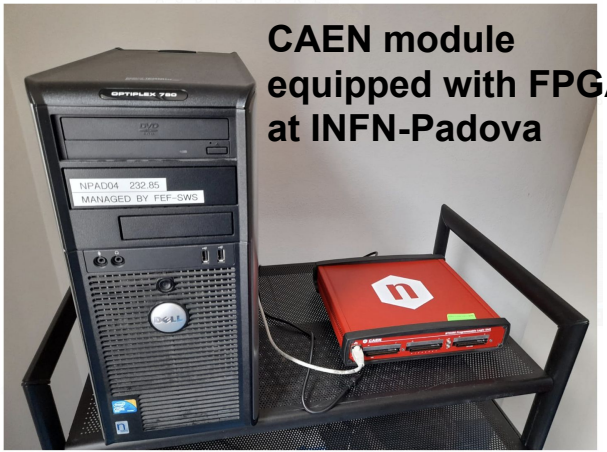
Performance comparison with classical methods (e.g. DNN)

ECAL for LHCb Upgrade 2

- ECAL for the HL-LHC phase:
  - Fundamental for high momentum and electroweak physics
- Participation to test beams with ECAL cell prototypes:
  - Innovative technologies and materials (e.g Spaghetti Calorimeter with GAGG fibers)
  - Davide Zuliani is at CERN as simil-fellow to join the ECAL group and for commissioning of current ECAL
- Simulation studies with the new ECAL technology and configuration
- R&D over new ECAL reconstruction algorithms to be run online on FPGA:
  - **CAEN module bought at the end of last year**
  - Paolo Andreetto is taking care of the firmware preparation
  - **We would like to ask some advice and help from the Electronics service of INFN-Padova**

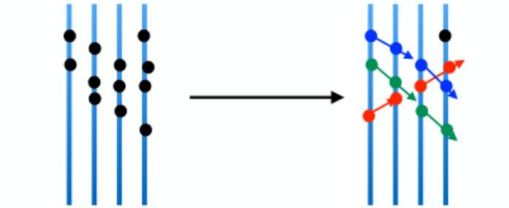
Testbeam at SPS





TimeSPOT : Time and SPace real-time Operating Tracker

GOAL: development of a **complete tracking demonstrator** capable of copying with extremely **high instantaneous luminosities** foreseen at HL-LHC (High Luminosity LHC)

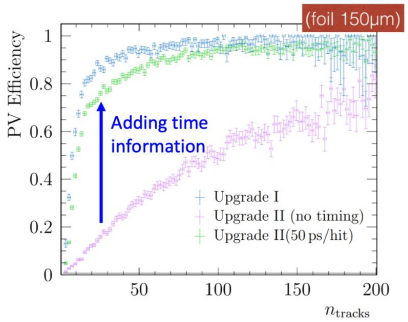


Hits no time info Hits with time info

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

TIME INFORMATION

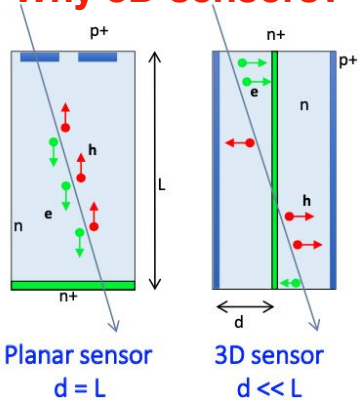
LHCb Upgrade-2 (Long shutdown 4) requirements:



- Fluence 1 MeV
- ps per hit

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

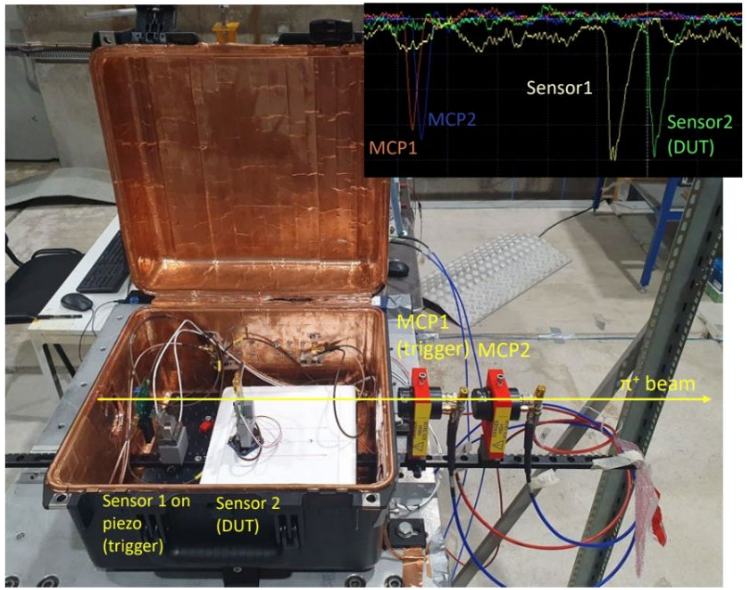
Why 3D sensors?



TimeSPOT : Time and SPace real-time Operating Tracker

Test beam @CERN, SPS:

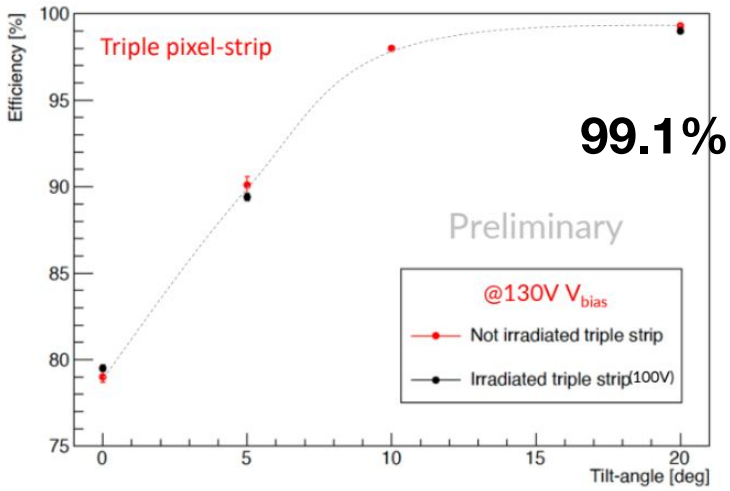
- 180 GeV pion beam
- 2 MCP-PMTs on the beam line to time-stamp
- Piezo-electric stages to precisely align the 3D structures
- Readout with 8GHz bandwidth 20GSa/s
- Possibility of operating the fixed sensor down to -40° using dry ice to test irradiated sensors



TimeSPOT : Time and SPace real-time Operating Tracker

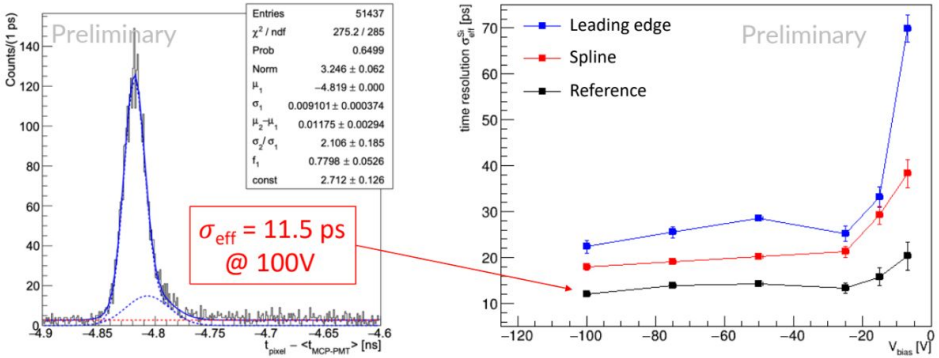
Test beam @CERN, SPS: results

Efficiency studies:



99.1% @20°

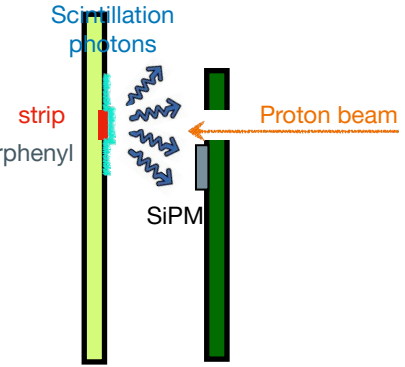
Time resolution:

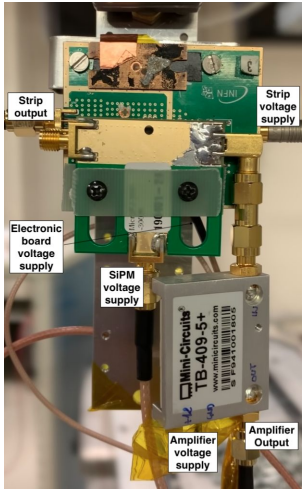


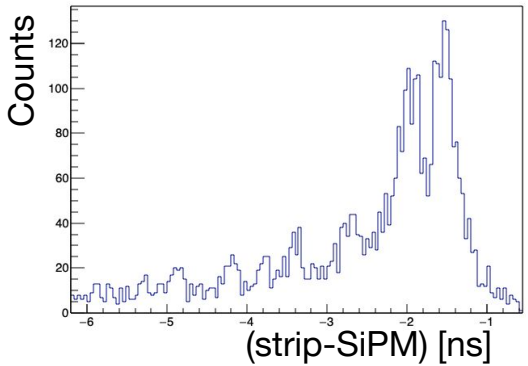
TimeSPOT : Time and SPace real-time Operating Tracker

Test beam @LNL: AN2000

- TimeSPOT 3D pixel strip tested with 2 MeV protons by means of the microbeam facility (2m spatial resolution).
- The P-terphenyl organic scintillator was deposited above the strip, with a SiPM facing it as a time-tag.







The time distribution has a peaked structure, to be investigated.
The very first peak has _ps_, a promising result for this innovative time-tag technique

To improve the SiPM time resolution:

- More photons (bigger SiPM and optimized setup)
- SiPM with high efficiency in the P-terphenyl scintillation light spectrum
- Customized FE optimized for fast signals

Anagrafica e Richieste

- Percentuali (5.6FTE)
  a. A. Bertolin 70%
  b. D.Lucchesi 70% (TBC)
  c. L. Sestini 70%
  d. G. Simi 70%
  e. D. Zuliani 70%
  f. L. Giambastiani 70%
  g. L. Buonincontri 70%
  h. F. Borgato 70%

- Percentuali tecnologi(0.6FTE)
  a. Benettoni 20%
  b. Gianelle 40%
- Richieste finanziarie
  a. Missioni, consumo secondo le formule standard
- **Servizi**
  a. **Progettazione elettronica 1m.u.** per Customized FE optimized for fast signals readout for 3D sensors
  b. **Progettazione elettronica 1 m.u.** per aiuto con FPGA firmare per ECAL Upgrade

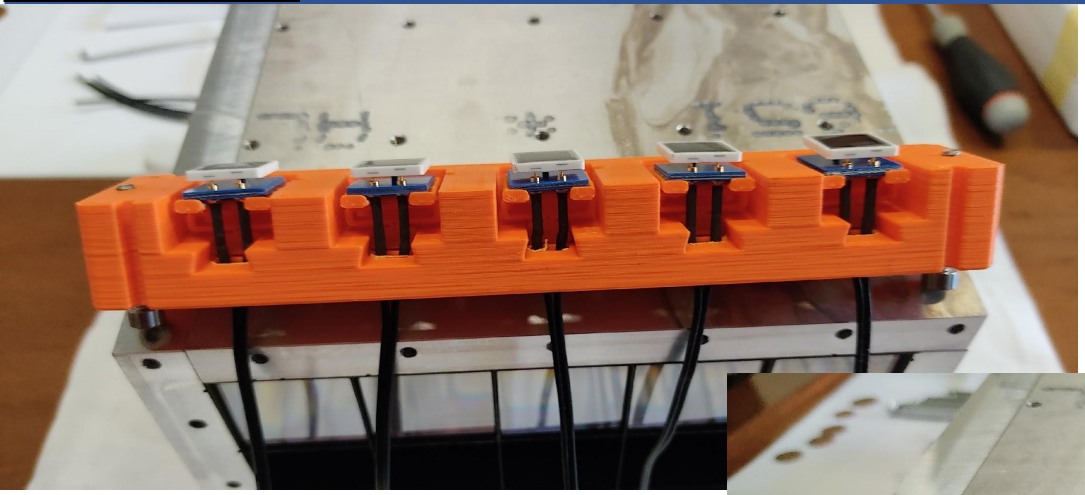
MUonE

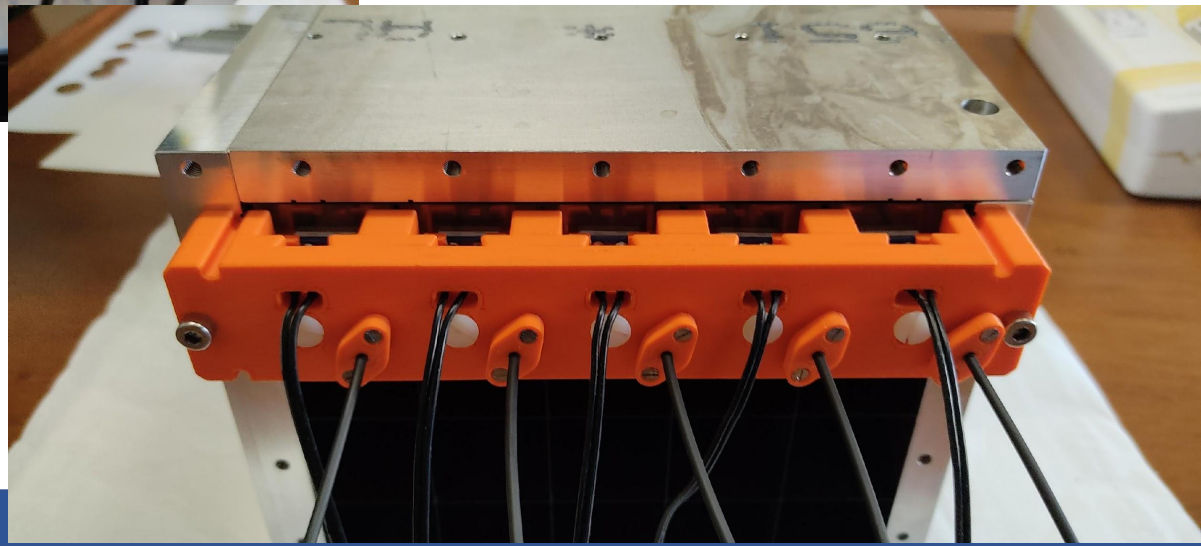
E. Conti, CdS 30/6/2022

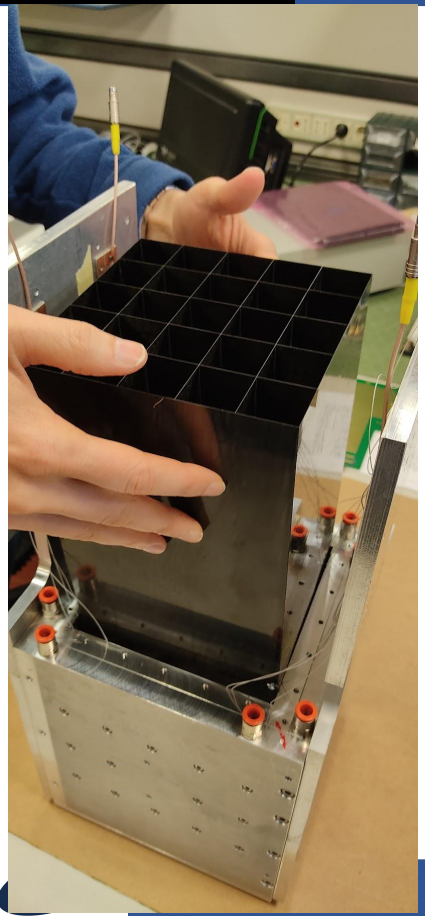
Attività 2021-2

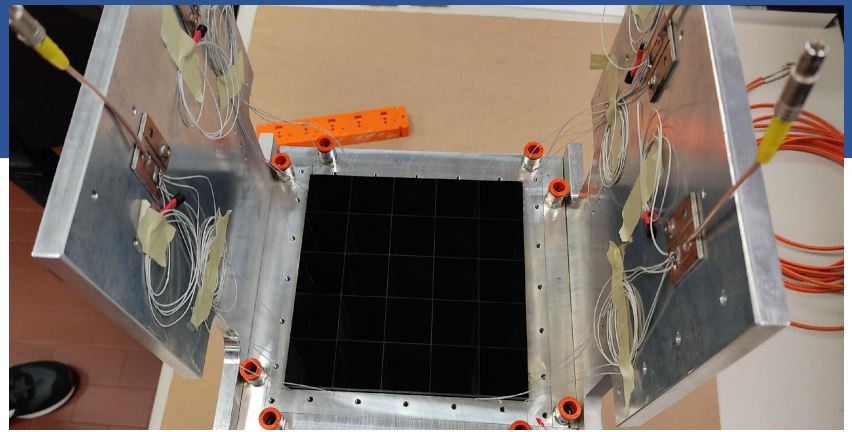
- Alla fine del 2021:
  - primo test beam @CERN con fascio μ di un modulo S2 (strip Silicio) congiunto CMS-MUonE, in *parasitic mode*
    - (test tecnico)
- Nel 2022:
  - costruzione della prima stazione (3 piani x-y)
  - terminata la realizzazione del modulo ECAL, con FE electronics, + laser pulse system (sistema di impulsamento di luce laser via fibre ottiche su ogni cristallo PWO)
  - sviluppo (ancora in corso) del DAQ per ECAL
  - Primo Test beam @CERN per ECAL, in luglio, con fascio elettroni
  - Test beam @CERN combinato 1 (o 2) stazioni + ECAL, Ott-Nov, con fascio μ

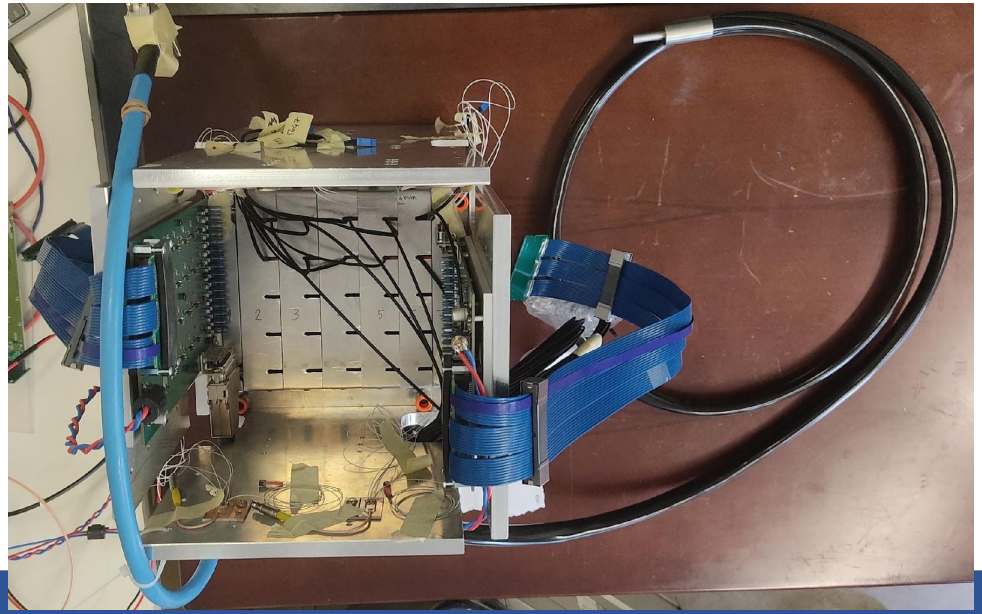
Montaggio APD e fibre ottiche

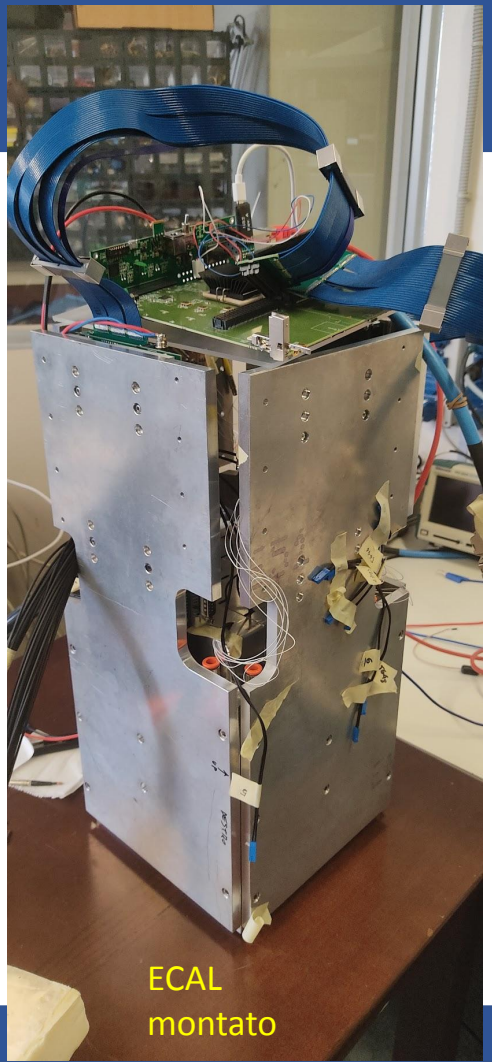






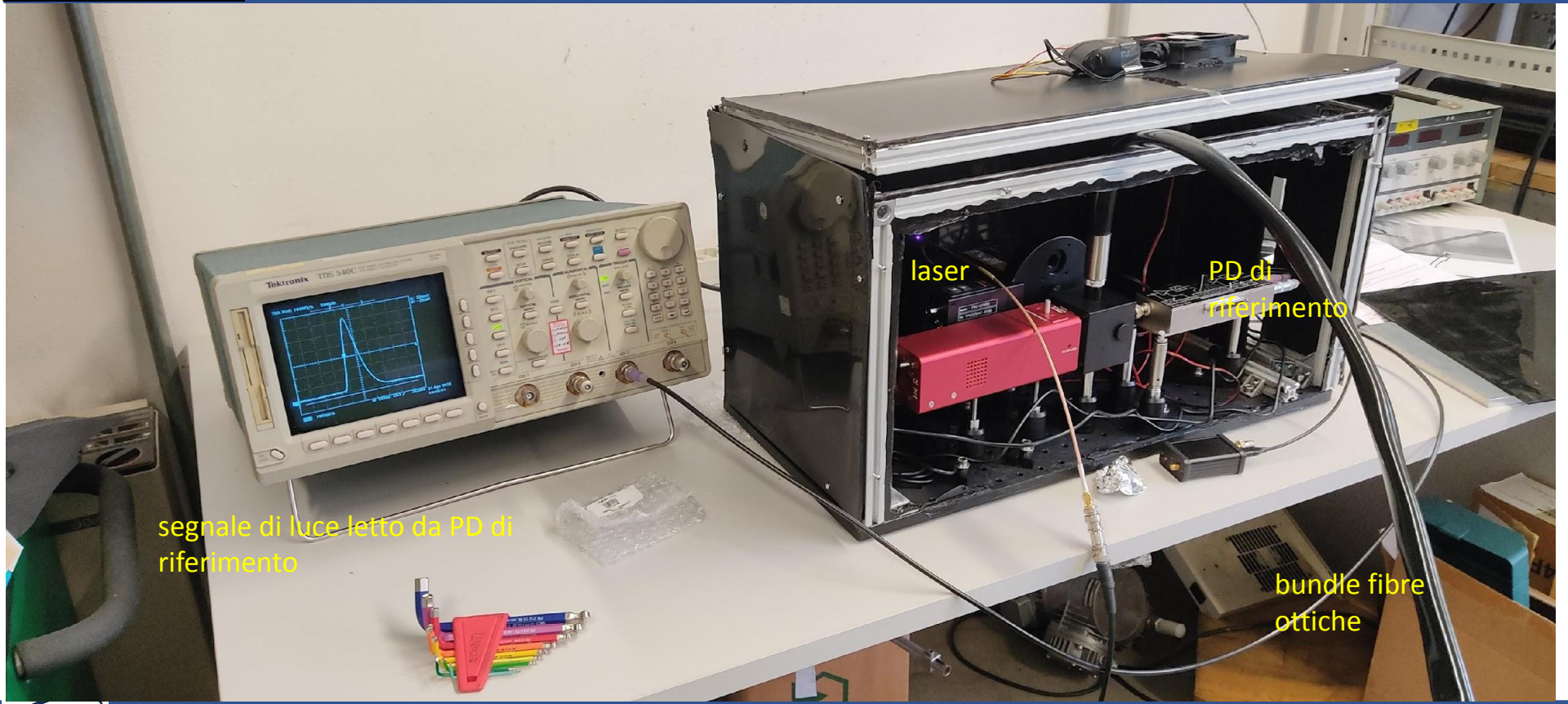




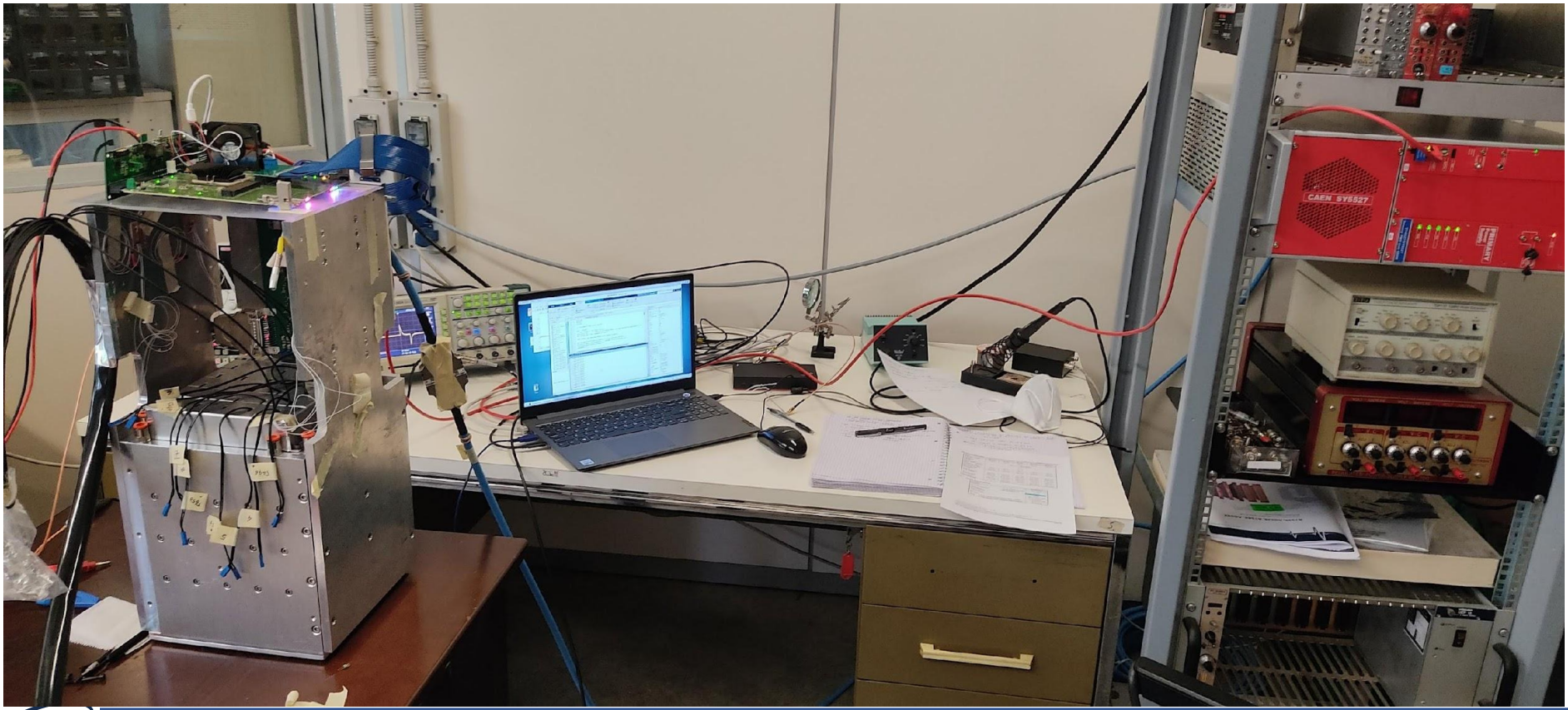


ECAL
montato

Laser pulse system



μONe lab in LNL



Attività 2023

- Per ECAL
  - non si prevede nessun sviluppo hardware;
  - attività finalizzata al passaggio da rame a segnali optoelettronici e integrazione nella DAQ dell'esperimento
- scrittura del Proposal Esperimento
- test beam fine 2023, con molte stazioni, da definire meglio

Anagrafica

[provvisoria, da confermare] più o meno la stessa del 2021:

Benettoni	10%
Conti	70%
Ghosh	80%
Mastrolia	10%
Passera	10%
Rossin	?%
Ronchese	20%
Simonetto	20%
Bragagnolo	?%

- Totale FTE: ~ 2.2
- 2021 era 1.35

Richieste finanziarie

[da definire]

essenzialmente richiesta di missioni per il test beam 2023

Richieste di Servizi di sezione

Dobbiamo sviluppare il firmware per la gestione e l'acquisizione dei segnali elettro-ottici e l'integrazione della scheda FC7 nella DAQ dell'esperimento, tramite scheda Serenity Board

In collaborazione con Bologna e CERN

Chiediamo supporto al **Servizio Progettazione Elettronica**

RD MuColl

D. Lucchesi

RD_Mucol Progress

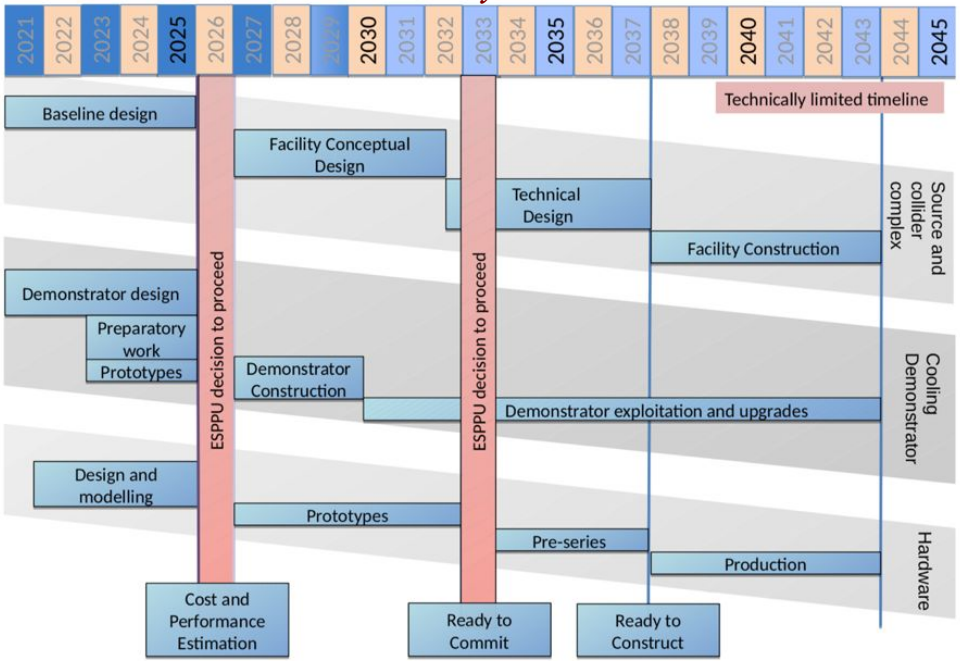
Accelerator R&D roadmap, established by Laboratory Directors Group (LDG) to define a route towards implementation of the goals of the 2020 ESPPU, was formed by several panels among which Bright Muon Beams and Muon Colliders:

Panel members: **D. Schulte**,(Chair), M. Palmer (Co-Chair), T. Arndt, A. Chancé, J. P. Delahaye, A.Faus-Golfe, S.Gilardoni, P.Lebrun, K.Long, E.Métral, N.Pastrone, L.Quettier, T.Raubenheimer, C.Rogers, M.Seidel, D.Stratakis, A.Yamamoto
Associated members: A. Grudiev, R. Losito, D. Lucchesi

Intense preparation and review activities in 2021: 3 Community Meetings + dedicated Physics and Detector Workshop

Results

Technically limited timeline



presented to CERN Council in December and published:

Yellow Report under implementation

A 3 TeV muon collider could be ready by 2045 as reviewed by the Roadmap committee

Plan

The panel has identified a development path that can address the major challenges and deliver a 3 TeV muon collider by 2045

Strong INFN involvement on accelerator design

Two Scenarios

Aspirational		Minimal	
[FTEy]	[kCHF]	[FTEy]	[kCHF]
445.9	11875	193	2445

~70 Meu/5 years

Label	Begin	End	Description	Aspirational		Minimal	
				[FTEy]	[kCHF]	[FTEy]	[kCHF]
MC.SITE	2021	2025	Site and layout	15.5	300	13.5	300
MC.NF	2022	2026	Neutrino flux mitigation system	22.5	250	0	0
MC.MDI	2021	2025	Machine-detector interface	15	0	15	0
MC.ACC.CR	2022	2025	Collider ring	10	0	10	0
MC.ACC.HE	2022	2025	High-energy complex	11	0	7.5	0
MC.ACC.MC	2021	2025	Muon cooling systems	47	0	22	0
MC.ACC.P	2022	2026	Proton complex	26	0	3.5	0
MC.ACC.COLL	2022	2025	Collective effects across complex	18.2	0	18.2	0
MC.ACC.ALT	2022	2025	High-energy alternatives	11.7	0	0	0
MC.HFM.HE	2022	2025	High-field magnets	6.5	0	6.5	0
MC.HFM.SOL	2022	2026	High-field solenoids	76	2700	29	0
MC.FR	2021	2026	Fast-ramping magnet system	27.5	1020	22.5	520
MC.RF.HE	2021	2026	High Energy complex RF	10.6	0	7.6	0
MC.RF.MC	2022	2026	Muon cooling RF	13.6	0	7	0
MC.RF.TS	2024	2026	RF test stand + test cavities	10	3300	0	0
MC.MOD	2022	2026	Muon cooling test module	17.7	400	4.9	100
MC.DEM	2022	2026	Cooling demonstrator design	34.1	1250	3.8	250
MC.TAR	2022	2026	Target system	60	1405	9	25
MC.INT	2022	2026	Coordination and integration	13	1250	13	1250
			Sum	445.9	11875	193	2445

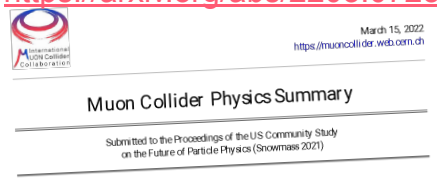
Latest International Collaboration Activities

Project submitted in response to HORIZON-INFRA-2022-DEV-01-01: Research infrastructure concept development, Total EU budget 3 MEu

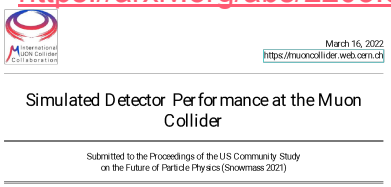
- Participants: EU, China, Japan, US
- WP 2: Physics and Detector Requirements Leader D. Lucchesi Univ. PD + strong contribution of local and national

- Strong contribution to Snowmass process:
  - **thanks to the INFN computing resources, in particular CloudVeneto**

https://arxiv.org/abs/2203.07256

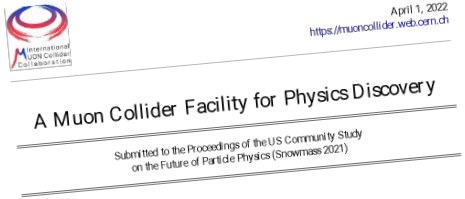


https://arxiv.org/abs/2203.07964

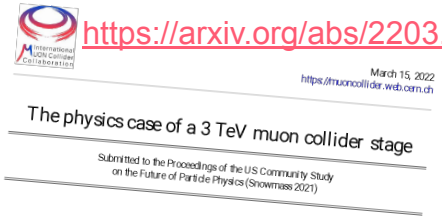


https://arxiv.org/abs/2203.07224

https://arxiv.org/abs/2203.08033

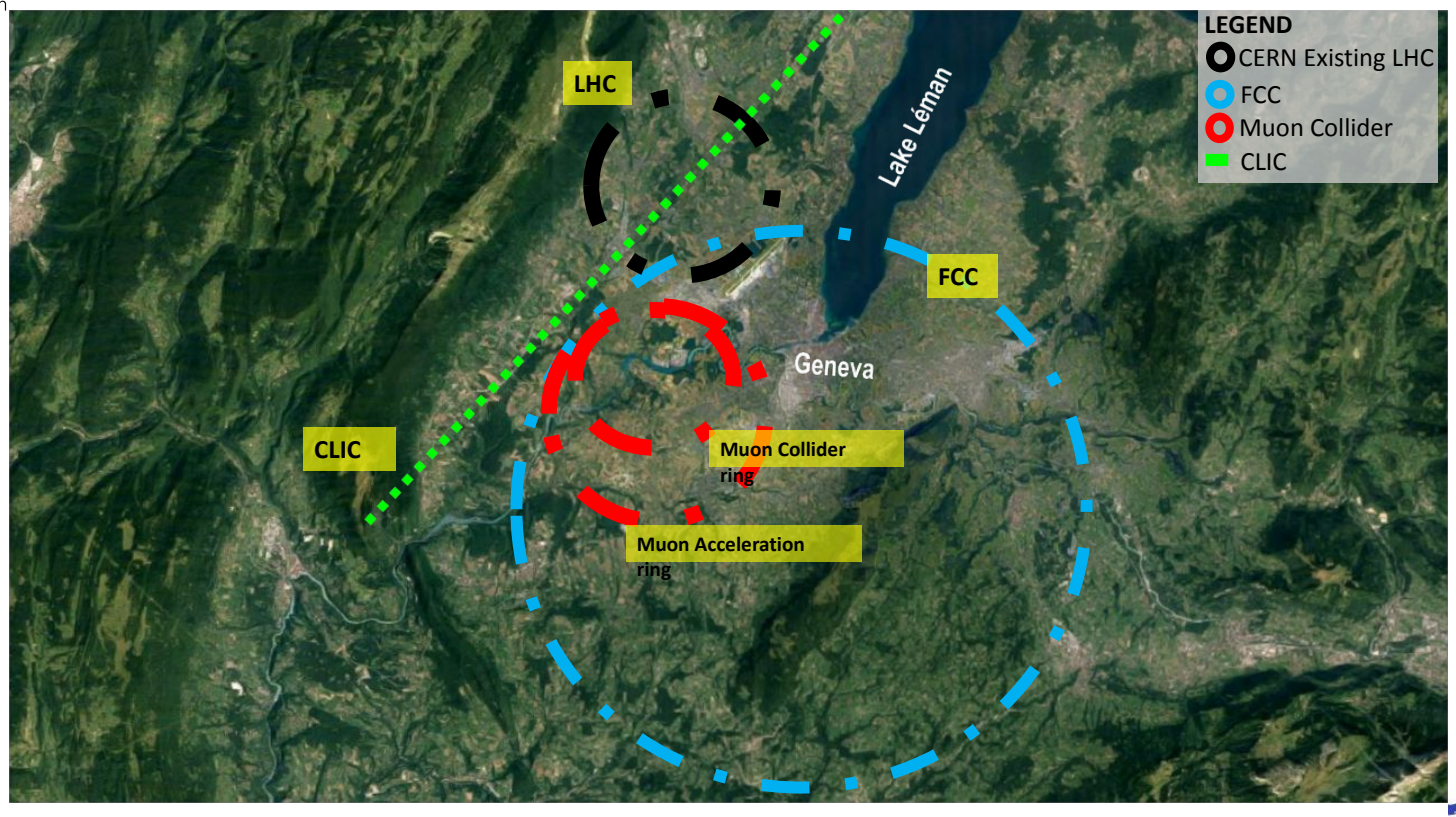


https://arxiv.org/abs/2203.07261



International MUON Collider Collaboration

As part of the EU project, produced a footprint of the Muon Collider



RD_Mucol Padova

Anagrafica

Ricercatori		FTE
1	Bertolin Alessandro	30
2	Buonincontri Laura	30
3	Collazuol Gianmaria	0
4	Dorigo Tommaso	20
5	Dosselli Umberto	15
6	Giambastiani Luca	30
7	Lucchesi Donatella	30
8	Nardi Federico	80
9	Sestini Lorenzo	20
10	Strong Giles	10
11	Zanetti Marco	
12	Zuliani Davide	30
12		2.95
Tecnologi		
1	Andreetto Paolo	15
2	Gianelle Alessio	40
3	Gonella Franco	10
3		0.65

Richieste di missioni: seguiremo gli algoritmi INFN

Richieste Calcolo: 50 kE da definire per dove farle in base alle nuove regole del calcolo INFN

Richieste Test Beam da definire

Will continue to use local cloud
Alessio will continue to provide support (and work)

RD FCC

FUTURE
CIRCULAR
COLLIDER

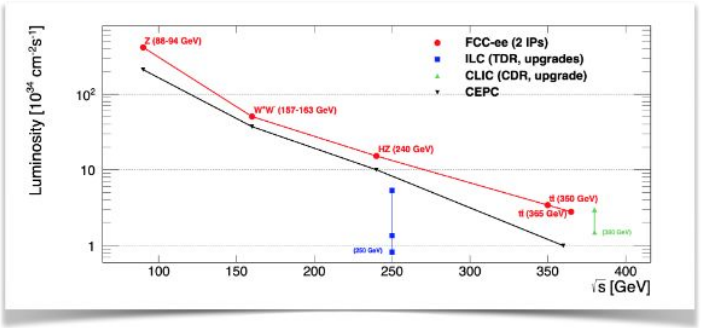
P.Azzi

THE FCC INTEGRATED PROGRAM:
INSPIRED BY SUCCESSFUL LEP – LHC PROGRAMS AT CERN

comprehensive long-term program maximizing physics opportunities

- **stage 1: FCC-ee (Z, W, H, $t\bar{t}$) as Higgs factory, electroweak & top factory at highest luminosities**
- **stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, with ion and eh options**
- complementary physics: intensity & energy frontier
- common civil engineering and technical infrastructures

FCC feasibility study ongoing (2021-2025)



FCC-ee 2045-2060

FCC-hh 2070 - 2090++

- Ultra-Precision EWK(Z,W,t) for indirect sensitivity to BSM
- Ultra-Precision measurements of Higgs properties
- Vast and Competitive Flavour Physics program with 10^{12}Z
- Extended sensitivity for direct discovery of feebly interacting particles with 10^{12}Z

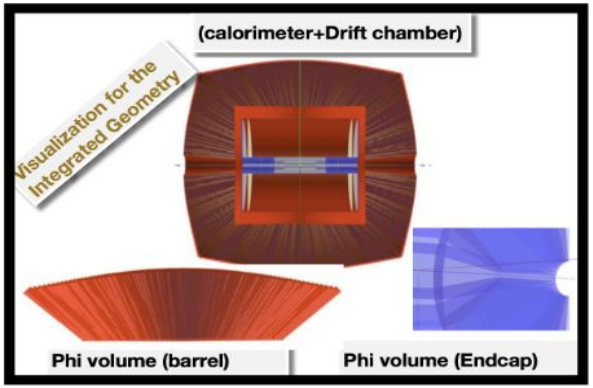
patrizia.azzi@cern.ch

SIGLA RD-FCC (Resp. Locale: P. Azzi)

FUTURE CIRCULAR COLLIDER

- Principali attività già in corso:
  - **Coordinazione del lavoro di Simulazione e di Fisica, WP1 per RD-FCC** (P. Azzi(PD)+N. De Filippis(BA))
    - P. Azzi convener del "Physics Performance WP" del "FCC Physics Experiment and Detector" Project
    - P. Azzi convener del Gruppo ECFA "Physics Tools" per il Workshop su Higgs/EWK/Top Factories
  - Lavoro sulla simulazione e ricostruzione di tracce di IDEA e generazione eventi con FullSimulation.
  - Lavoro sulla regione di interazione, MDI
- Per il 2023 focus sullo studio per l'**utilizzo di un timing layer (tipo MTD) all'interno del rivelatore IDEA:** studi di simulazione del rivelatore e di ottimizzazione con ML (per PID in eventi di fisica del B o strange tagging,)
- **Attività sinergica con AIDAInnova** per "Sviluppo di Particle Flow in DR calorimeter" (Task 12.5.2, capofila Roma3):
  - Sviluppo e validazione tracking in key4hep come input all'algoritmo nel framework di Pandora
- **Fondi esterni:**
  - Un PRIN sottomesso ("giovani"): StrangeMode (Machine-learning Optimized DEsign for strange tagging)

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



1

Richieste RD_FCC

- RD_FCC restera’ sotto dotazioni
- Richieste CSN1: missioni metaboliche da algoritmo
- Richieste servizi sezione: nessuno

Conclusioni

- **Belle II**
  - Long Shutdown 1 iniziato: raccolta statistica ~BaBar
  - fisica continua a crescere
  - Prospettive per upgrade
- **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** upgrade I un successo
  - Attivita' per Upgrade II
  - Diversi fronti di analisi con grande coinvolgimento padovano
- **LUXE**
  - Vedi presentazione Mauro
- **MUonE**:
  - ECAL module pronto, test-beam a luglio 2022
  - person-power issue un po' meglio
- **MuColl**:
  - PD ben rappresentata e attiva
  - Plan for 2045 MuColl
- **FCC**
  - Continua lavoro su simulazione e MDI
  - Focus 2023 su timing layer (sinergia con CMS)

Backup