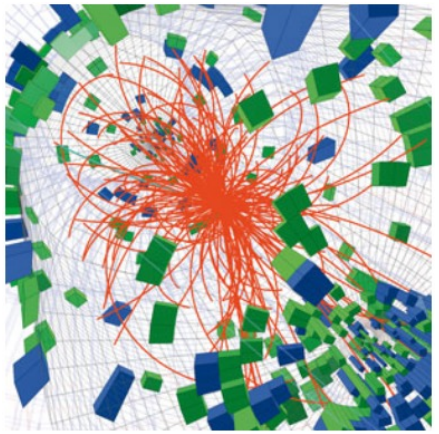
Attività CSN1

P. de Simone

Consiglio di Laboratorio – Preventivi 2025

09/07/2024

CSN1, **fisica delle particelle con acceleratori**



riorganizzazione degli R&D
nell'implementazione della Roadmap ECFA: DRD

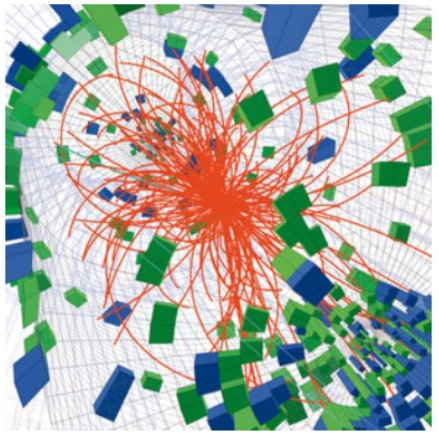
la Giunta Esecutiva intende supportare i DRD attraverso co-finanziamento ➔ **finanziamenti ai DRD referati e approvati dalle commissioni scientifiche**, ne seguono una serie di problemi di gestione **non banali:**

✓ in CSN1 abbiamo RDfcc, RDmucol, RDflavour
✓ come gestire la sovrapposizione tra le diverse CSN

proposta CSN1:

- la mappatura su esperimento/progetto sembra piu` naturale per la CSN1
- estendere e/o duplicare l'esperienza RDflavour per nuovi R&D
- missioni restano legate e referate sulla sigla principale su cui si fa l' R&D, mentre per la partecipazione alle attivita` definite nei WP dei DRD ➔ gettone al coordinatore su dotazioni
- un rappresentante nazionale inter-CSN per ogni DRD
- collegio referale inter-CSN:
    1. si occupa della coerenza e non duplicazione delle attivita` su piu` commissioni
    2. i finanziamenti specifici di CSN1 rimangono nelle mani dei referee di sigla

CSN1, **fisica delle particelle con acceleratori**



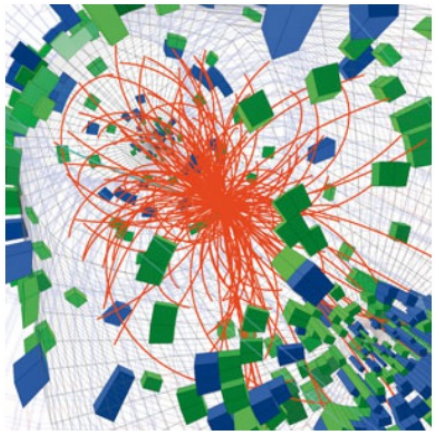
riorganizzazione degli R&D
nell'implementazione della Roadmap ECFA: DRD

in questa fase di strutturazione dei programmi delle collaborazioni internazionali DRD(*) e' importante che le attività di R&D siano identificate per proseguire ed essere riconosciute come un contributo INFN:

"invitiamo quindi tutti a sottomettere le richieste nei preventivi, rispettando la pertinenza delle linee scientifica di ricerca interessate nelle commissioni scientifiche CSN, in particolare si chiede di specificare nella richiesta esplicita il DRD dove l'attività viene considerata oggetto di una milestone/deliverable di un WP"

(*)
DRD1 gas detectors
DRD2 liquid
DRD3 solid state
DRD4 photon & PID
DRD5 quantum & emerging technologies
DRD6 calorimetry
DRD7 electronics

CSN1, **fisica delle particelle con acceleratori**

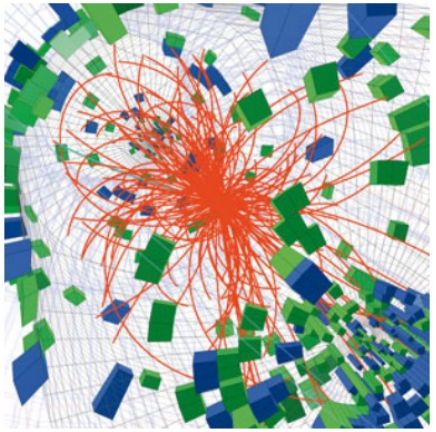


- **borse di studio finanziate dalla CSN1**

➔ ai Laboratori Nazionali di Frascati sono arrivate **due ragazze** con **borse** di un mese per studenti triennali
ma, nessuna ragazza/o con borse trimestrale per studenti magistrali o neo-laureati

- prossime riunioni di CSN1 :
  - ✓ 15-16-17 **Luglio** **Roma 3**
    https://agenda.infn.it/event/42176/
  - ✓ 9/12 **Settembre** **La Biodola**
    https://agenda.infn.it/event/42177/

CSN1, **riepilogo bilancio** 2024 **in** K€



***bilancio annuale della** CSN1 **circa** 25000 K€*

© la giunta ha recentemente approvato il passaggio CSN2➔CSN1 di Hyper-K

per area tematica

Settembre 2023

FISICA AI COLLIDER ADRONICI (LHC)			FISICA DEI NEUTRINI			FISICA DEL SAPORE			FISICA DEI LEPTONI CARICHI			STRUTTURA PROTONE			NUOVI ACCELERATORI			DARK SECTOR		
ESPERIM.	RICH.	PROP.	ESPERIM.	RICH.	PROP.	ESPERIM.	RICH.	PROP.	ESPERIM.	RICH.	PROP.	ESPERIM.	RICH.	PROP.	ESPERIM.	RICH.	PROP.	ESPERIM.	RICH.	PROP.
ATLAS	6.166,5	3.385	DUNE✶	5.058,5	1.923,5	BELLE2	1.411	958,5	GMINUS2	224,5	133,5	AMBER	675,5	537	RD_FCC	572,5	359,5	PADME	92	75
CMS	8.557,5	4.614	ICAR_US✶	263	333	BESIII	853	670	MEG	499,5	332				RD_MUCOL	545	299			
FASE2_ATLAS	4.159,5	778	SNDLHC	527,5	496,5	IGNITE	300	435	MUEDM✶	56,5					SELDOM_2CRYST✶	57				
FASE2_CMS	3.976	2.130				KLOE	65,5		MUONE	791	779									
LHC-f	74,5	62				LHC-b	2.204,5	1.729	PMU2E	733,5	711									
						NA62	875	710,5												
						RD_FLAVOUR		403												
TOTALE	**22.934**	**10.969**	**TOTALE**	**5.849**	**2.753**	**TOTALE**	**5.709**	**4.906**	**TOTALE**	**2.305**	**1.955,5**	**TOTALE**	**675,5**	**537**	**TOTALE**	**1.174,5**	**658,5**	**TOTALE**	**92**	**75**

RIEPILOGO	DESCRIZIONE	RICHIESTE	PROPOSTE	DIFFERENZA
	Esperimenti che continuano	33.361,0	19.597,5	-13.763,5
	Esperimenti nuovi ✶	5.378,0	2.256,5	-3.121,5
	Dotazioni Strutture	1.543,5	1.906,0	362,5
	Esperim. finanziati su Dotazioni	739,5	634,0	-105,5
	CALC1_TIER1	1.458,5	0,0	-1.458,5
	Fondo Indiviso		606	606,0
	TOTALE	**42.480,5**	**25.000,0**	**-17.480,5**

*ESPERIMENTI NUOVI

CSN1, **riepilogo bilancio** 2024 **in** K€ - LNF

bilancio annuale *1969 – 56 (SHADOW) – 33 (Hike) = 1880 K€*

124,5 K€ per dotazioni & 61K€ per le sigle con meno di 2FTE

Esperimento	Strutt.	MISSIONI		CONSUMO		ALTRI CONS.		SEM		TRASPORTI		PUB	LICENZE SW		MAN.		INVENTARIO		APPARATI		ALTRI SERV.		TOT. PARZIALI		GENERALE
		Assegn.	Sub-Jud	Assegn.	Sub-Jud	Assegn.	Sub-Jud	Ass.	S.J.	Assegn.	S.J.	Ass.	Assegn.	S.J.	Ass.	S.J.	Assegn.	Sub-Jud	Assegn.	Sub-Jud	Assegn.	Sub-Jud	Assegn.	Sub-Jud	
ATLAS	LNF	58		20,5																			78,5		78,5
BELLE2	LNF	22	1	3,5																			25,5	1	26,5
BESIII	LNF	21	8	3																			24	8	32
CMS	LNF	29		12																			41		41
DUNE	LNF	7			150														190		45	80	242	230	472
FASE2_ATLAS	LNF			17,5	15														30				47,5	15	62,5
GMINUS2-DTZ	LNF	1		0,5																			1,5		1,5
IGNITE-DTZ	LNF				10																			10	10
KLOE-DTZ	LNF	1		17,5											26					5			44,5	5	49,5
LHC-b	LNF	66,5		18																	43	43	127,5	43	170,5
NA62	LNF	83	7	10,5						2											182		277,5	7	284,5
PADME	LNF	15	5	7,5	15																		22,5	20	42,5
PMU2E	LNF	127,5	26	11,5	18,5		11			5									162				306	55,5	361,5
RD_FCC	LNF	26	5																				26	5	31
RD_FLAVOUR	LNF			30	66					2													32	66	98
RD_MUCOL	LNF	13	6	8																			21	6	27
SHADOWS-DTZ	LNF		24		32																			56	56
Z-DOTAZIONI	LNF	53,5		28				2				3					38						124,5		124,5
Totale Struttura		523,5	82	188	306,5		11	2		9		3			26		38		382	5	270	123	1441,5	527,5	1969

CSN1, **rassegna di attività** - LNF

Fisica del sapore
Fisica dei leptoni carichi
Fisica dei neutrini
Dark sector
Frontiere dell'energia & nuovi acceleratori

- ATLAS M. Antonelli
- Belle II G. Finocchiaro
- BESIII M. Bertani
- CMS L. Benussi
- DUNE D. Domenici presentazione dedicata
- GMINUS2 S. Dabagov sigla in chiusura nel 2025 con l'ultimo update della misura
- IGNITE P. Ciambrone **sigla sinergica con esperimenti di** CSN1
- KLOE E. De Lucia
- LHCb B. Sciascia
- NA62 M. Moulson
- PADME T. Spadaro
- PMU2E I. Sarra
- RD_FCC M. Boscolo
- RD_FLAVOUR **tasca per** R&D **esp. di fisica del sapore ad alta luminosità**
- RD_MUCOL I. Sarra
- UA9 A. Girobono

Calcolo Scientifico a LNF: il Tier2

Infrastruttura di calcolo dell'INFN ➔ Grid, INFN-Cloud

- Grazie al PNRR tutti i 9 Tier2 dell'INFN vengono potenziati in termini di impianti, rete e risorse. In questo ambito l'attuale infrastruttura INFN-Cloud si estende a tutti i Tier2
- Per LNF viene realizzato **anche** un nuovo Data Center che sarà in grado di ospitare anche sistemi di calcolo ad alta densitià/HPC

Calcolo a LNF stato e richieste

Tier 2 in Grid per esperimenti con risorse pledged:

- 2024 ATLAS: ~ 3.9 PBn disco, ~60 kHS06
  - ✓ **richieste 2025**: (obsolescenza + delta) CPU 2877 HS06 , disco 428 TBn: 28770 € per la CPU e 42800 € per il disco, 8876 € OH (rete+server), TOT 80446 €
- 2024 PADME: ~ 670 TBn disco, ~10 kHS06
  - ✓ **richieste 2025**: (obsolescenza + delta) CPU 6 kHS06 obsolescenza , disco 0 TBn obsolescenza: 60 k€ per la CPU

Nel 2024 le richieste degli esperimenti sono state coperte con fondi PNRR, per il 2025 non è ancora stato stabilito

Utilizzo opportunistico del Tier2 anche da parte di altri esperimenti: Belle-II, LHCb, …

IGNITE è un progetto, supportato dalla GE, che intende promuovere e coordinare le attività di ricerca e sviluppo nel campo della microelettronica per la realizzazione di un sistema rad-hard integrato per il read-out di rivelatori a pixel 4D, in grado di soddisfare le richieste dei rivelatori di vertice della prossima generazione

(σ_t <30 ps, $\sigma_s \approx$ 10 μm, Φ $10^{16} \div 10^{17}$ 1-MeV neutroni equ. per cm^2)

- vede coinvolte 14 sezioni INFN e 69 ricercatori/tecnologi (~20 FTE) - dati 2024
- basato sullo sviluppo di ASIC con tecnologia CMOS – 28nm

Anagrafica 2025

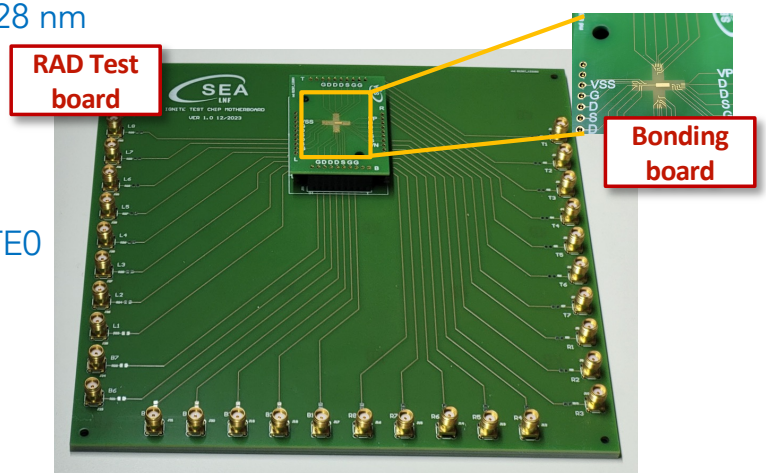
Progetto "sinergico" con gli esperimenti di LHC

- ✓ P. Albicocco 10% sinergico con LHCb
- ✓ M. Beretta 10% sinergico con FASE2_ATLAS
- ✓ P. Ciambrone 20% sinergico con LHCb (Resp. Loc.)
- ✓ G. Tinti 10% sinergico con NA62

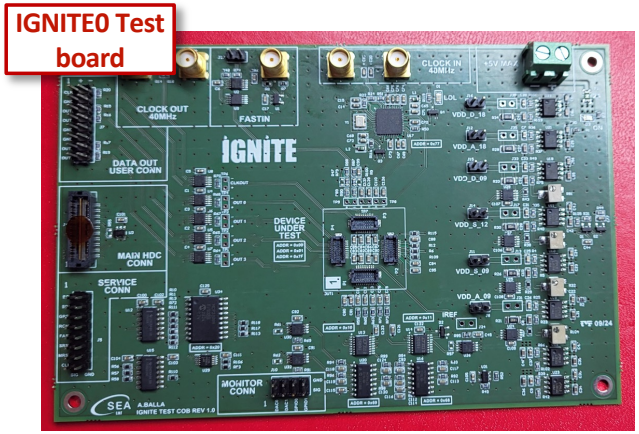
IGNITEd
INFN Ground-up iNITiative for µElectronics developments

Attività 2023 - 2024

- Sviluppo schede di test per la caratterizzazione sotto radiazione della tecnologia a 28 nm
  - ✓ 30 canali di lettura
  - ✓ Sistema modulare per il bonding del chip con differenti layout



- Sviluppo schede di test per la caratterizzazione del primo prototipo del chip IGNITE0
  - Sistema di alimentazione a bassa tensione (8 tensioni)
  - Sistema di generazione del clock a bassissimo jitter
  - DAC/ADC a 16 bit per settings e monitor
  - Trasmissione segnali ad alta velocità (1,28 Gbit/s DDR)



Attività 2024 - 2025

- Sviluppo scheda di test per il secondo prototipo del chip a 64x64 canali da utilizzare anche per la caratterizzazione sotto radiazione
- Sviluppo del sistema di test basato su FPGA

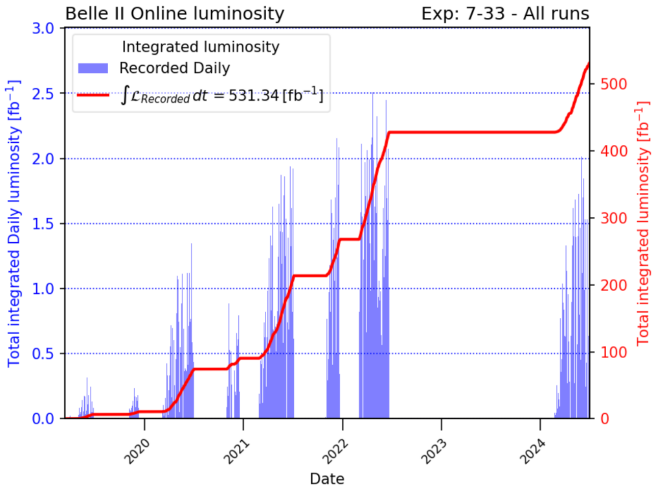
Richieste 2024 - 2025

- ~ 6 ÷ 8 M.U. **Servizio Elettronica e Automazione**
- ~ 10 k€ **su consumo per lo sviluppo di schede elettroniche**

Fisica del sapore

Belle II

- SuperKEKB and Belle II restarted operation in Jan '24 (first Run2 collisions on Feb 20th) after a long shutdown period (LS1)
- Detector is performing well, data-taking efficiency ≳ 90%. About 100 fb^{-1} collected so far (Run2 2024), total Belle II recorded lumi: 530 fb^{-1}
- During LS1 several interventions on SuperKEKB to reduce backgrounds and increase luminosity, and on Belle II to install the new pixel detector and general detector maintenance, including interventions on RPC readout FEE, responsibility of RM3 and LNF



Belle II @ LNF

A. Calcaterra	1 Ric.	60%	
R. de Sangro	1 Ric.	90%	
G. Finocchiaro	1 Ric.	90%	Resp. Loc.
I. Peruzzi	Ass. Senior		
M. Piccolo	Ass. Senior		
Totale FTE		2.4	

Tech support: A. Russo

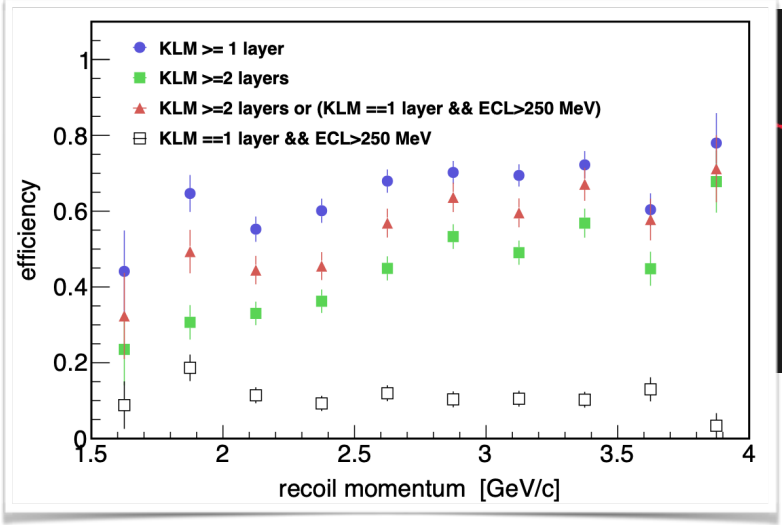
✸ *un assegno di ricerca e' stato recentemente bandito*

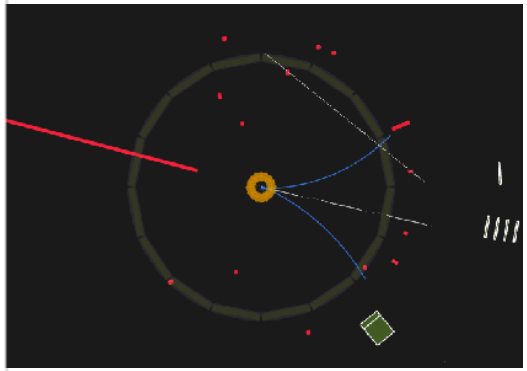
Responsibilities:

- ✓ K_L identification in Belle II (G. Finocchiaro)
- ✓ Chair of KLM PI board (G. Finocchiaro)
- ✓ Belle II shift manager (A. Calcaterra)

Belle II @ LNF: detector performance, analysis and shift management

K_L detection and identification efficiency using the control sample $e^+e^- \to \phi(K_S K_L)\,\gamma$





$B^0 \to J/\psi\, K_L$, $B^0 \to \eta'\, K_L$

Respectively, SM reference and probe for penguin-dominated decays sensitive to NP effects

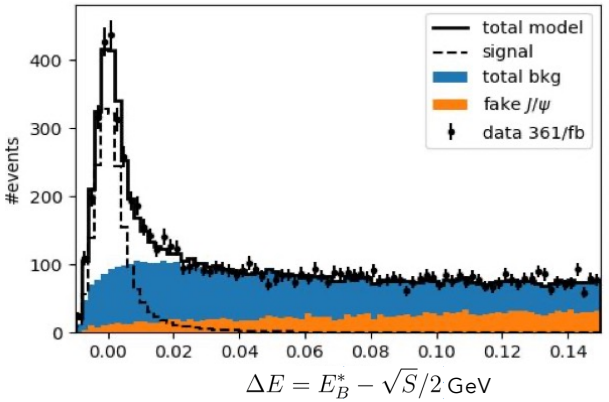
Experimentally challenging for the K_L reconstruction and the relatively large backgrounds, in part also *CP*-violating

The Belle II shift system

- 20 parallel shift streams (central data taking, 8 sub-detectors, DAQ, Data Production, SW Quality…)
- Timely and orderly fill 3 (or 6) daily shifts for each stream
- …for over 1000 collaborators from 125 institutions

Since 2018 (and up to the first 2024 data taking period just finished) the Belle II shift system was based on the system setup by A. De Santis for KLOE and then used by PADME, based on PHP pages and SQL.
New needs in the Belle II shift management required further developments, and the most complex parts of the system have been ported to python, which is widely used in Belle II. The serving web system was also entirely rewritten in python, extensively tested and from Summer 2024 will replace the current system.

$B^0 \to J/\psi\, K_L$



Belle II @ LNF: detector performance and R&D

- ~ 50 physics papers with Run1 data
- Paper on KLM readout electronics submitted to NIM
- General Belle II and KLM detector papers in the works
- Huge effort for the Belle II detector upgrades CDR, just published on arXiv

Design and Commissioning of Readout Electronics for a Hybrid K_L^0 and μ Detector at the Belle II Experiment

Chris Ketter[a], Rama Adak[b], Matt Andrew[a], Tagir Aushev[c], Swagato Banerjee[d], Eric Becker[e], Matteo Beretta[f], Enrico Bernieri[g], Diptaparna Biswas[d], Denis Bodrov[h], Paolo Branchini[f], Antonio Budano[g], Chunhui Chen[i], Yu-Tan Chen[j], Seema Choudhury[i], James Cochran[i], Riccardo de Sangro[f], Giuseppe Finocchiaro[f], Enrico Graziani[g], William Jacobs[k], Shuaiyan Kang[i], Taylor Kimmel[l], Haruki Kindo[l], Brian Kirby[m], Brandon Kunkler*[k], Tommy Lam[l], Dmitri Liventsev[n], Cristina Martellini[g], Alberto Martini[o], Jincheng Mei[b], Frank Meier[p], Sayan Mitra[i], Roman Mizuk[q], Isar Mostafanezhad[r], Mikihiko Nakao[s], Kurtis Nishimura[a], Benjamin Oberhof[f], Pavel Oskin[q], Pavel Pakhlov[c], Galina Pakhlova[c], Katherine Parham[p], Antonio Passeri[g], Atanu Pathak[d], Sourav Patra[d], Ida Peruzzi[f], Richard Peschke[a], Marcello Piccolo[f], Leo Piilonen[t], Vitaliy Popov[q], Soeren Prell[i], Harsh Purwar[a], Alessandro Russo[f], Debashis Sahoo[i], Simon Schneider[p], Vasily Shebalin[a], Xiaowen Shi[a], Elena Solovieva[u], Zachary Stottler[l], Kazutaka Sumisawa[s], Diego Tagnani[g], Timofey Uglov[c], Gary Varner*[a], Michele Veronesi[i], Gerard Visser[k], Anselm Vossen[p], Ting Wang[b], Xiaolong Wang[b], Lynn Wood[e], Xinping Xu[h], Yunxiao Zhai[i], Keisuke Yoshihara[a], Valentina Zhukova[v]

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[d] *University of Louisville, Louisville, Kentucky, 40292, U.S.A.*
[e] *Pacific Northwest National Laboratory, Richland, Washington, 99352, U.S.A.*
[f] *INFN National Laboratory of Frascati, Frascati, Rome, 00044, Italy*
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[j] *National Taiwan University, Taipei, 10617, Taiwan*
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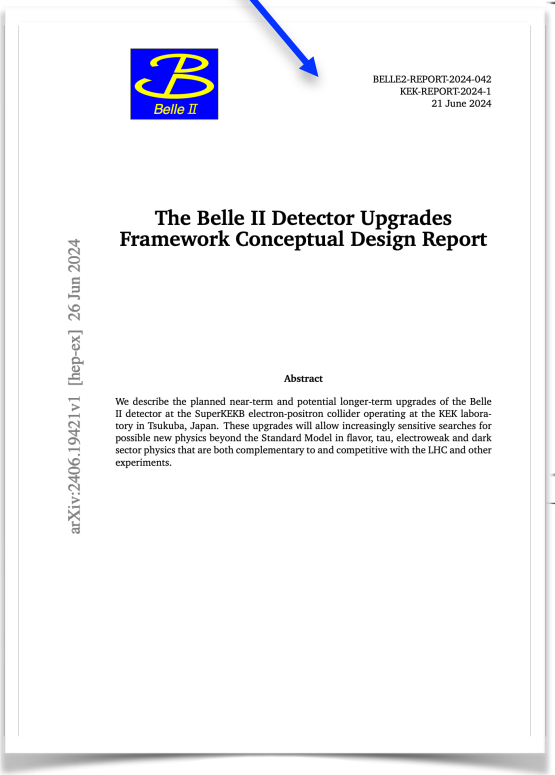
[m] *Brookhaven National Laboratory, Upton, New York, 11973, U.S.A.*
[n] *Wayne State University, Detroit, Michigan, 48202, U.S.A.*
[o] *German Electron Synchrotron (DESY), Hamburg, 22607, Germany*
[p] *Duke University, Durham, North Carolina, 27708, U.S.A.*
[q] *IJCLab, Université Paris-Saclay, Orsay, 91405, France*
[r] *Nalu Scientific, Honolulu, Hawai'i, 96822, U.S.A.*

Preprint submitted to NIM-A *June 2, 2024*



BELLE2-REPORT-2024-042
KEK-REPORT-2024-1
21 June 2024

The Belle II Detector Upgrades Framework Conceptual Design Report

Abstract

We describe the planned near-term and potential longer-term upgrades of the Belle II detector at the SuperKEKB electron-positron collider operating at the KEK laboratory in Tsukuba, Japan. These upgrades will allow increasingly sensitive searches for possible new physics beyond the Standard Model in flavor, tau, electroweak and dark sector physics that are both complementary to and competitive with the LHC and other experiments.

- The KLM barrel glass RPCs are currently operated in *streamer mode*
- A possible option for the KLM upgrade is to operate them in ***avalanche mode*** to reduce the dead time and sensitivity to high neutron fluxes
- We are going to make a proposal in CSN1 to start an R&D effort using a small RPC chamber. FEE to be designed by the RM3 group, while tests on a CR stand will be carried over at LNF

<u>Richieste alla CSN1 (da finalizzare):</u>

- 36 k€ (in parte SJ) per missioni per turni e maintenance KLM
- 4 k€ consumo per bombole gas e allestimento setup di test
- 2 k€ inventario per regolatori di flusso

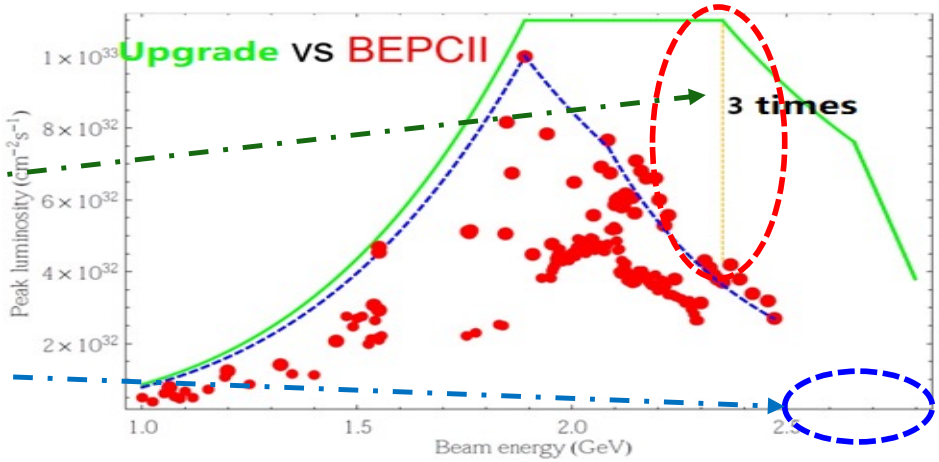
<u>Richieste risorse a LNF (da presentare al CIF di dicembre '24)</u>

- 2 m.p. per assistenza allestimento e operazione test setup
- Spazio per test setup con sistema di gas— potrebbe essere il laboratorio di Belle II

- **Run 2023/24, sette mesi di presa dati come programmato:**
- ✓ 4.0 fb^{-1} proseguimento presa dati al picco (20 fb^{-1} tot) di $\psi(3770)$ per lo studio dei decadimenti D^0/ $D^{+,-}$
- ✓ scan a 31 diversi punti di energia, intorno a ψ (3770) e @1800-2000 MeV per studi R-QCD
- ✓ I rivelatori di BESIII stanno funzionando senza problemi

Stato di BEPCII , e^+e^- collider @ Eb = 1.0 – 2.45 GeV

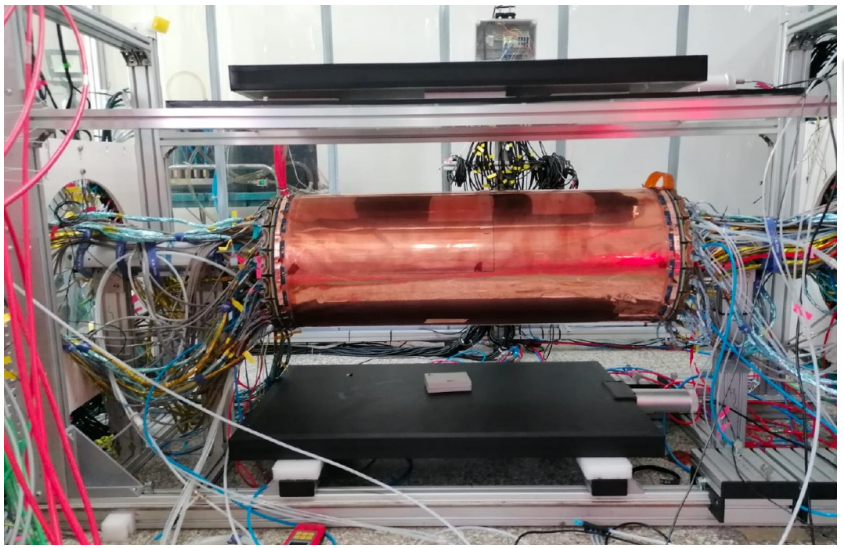
- ✓ luminosità $1.0 \times 10^{33} cm^{-2}s^{-1}$ @ Ecm = 1.885 GeV, I_b=920mA*920mA e 118 bunch
- ✓ shutdown luglio-dicembre 2024 UPgrade aumento luminosità fattore x 3 @E_b=2.35 GeV) e installazione CGEM-IT
- ✓ nel 2028 UPgrade in energia: E_b=2.45 GeV-->2.8GeV



CGEM-IT @IHEP

- ✓ completato e funzionate
- ✓ in fase di commissioning con i cosmici

➔ ha appena ricevuto luce verde dal review committee e IHEP Director per installare durante questo shut-down (7-12/2024) ***fatto salvo che i colleghi di IHEP garantiscano la sicurezza dell'operazione di rimozione della IDC***



test installazione con MocUp @IHEP, contributo R.Tesauro

M.Bertani (LNF) & I.Garzia (FE) convener del Comitato Italiano di Fisica

Relative Phase of Charmonia:

- Measurement of the phase between Strong and Electromagnetic $J/\psi \to p\bar{p}$ decay amplitudes (internal review committee)
- Measurement of the Branching Ratio of J/psi -> K+K- via psi(2S) -> pi+pi- J/psi (internal review committee)
- Measurement of the relative phase between strong and electromagnetic decay amplitude of psi(2S) by means of e+e- → pi pi J/psi final state
- Measurement of the BR(J/psi → $\omega\pi^0$)

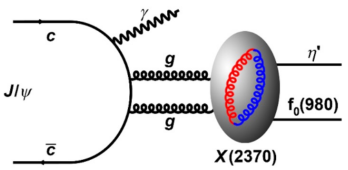
Started collaboration with IHEP and USTC groups (China) to expand analyses to other final states ($\Sigma^0\Sigma^0$, $\Sigma^+\Sigma^-$, $\Lambda\Lambda$)

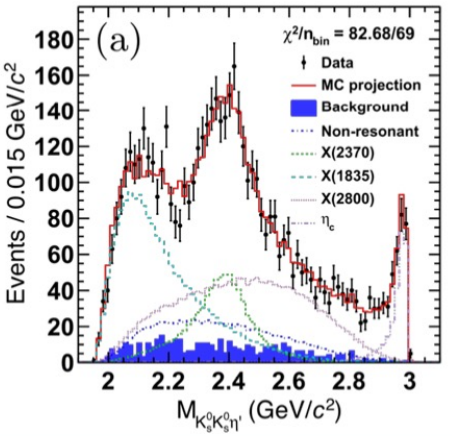
Chamonium spectroscopy and decay

- Inclusive Measurements of the hc(1 1P1) in the psi(2S) Decay (submitted to PRD)
- Lepton Flavour Universality Violation test with psi(2S) → tau tau
- $\psi(2S) \to \pi\pi J/\psi$, $J/\psi \to KK$
- $J/\psi \to \omega\pi^0$: measurement of possible G-parity contribution (phase measurement under study)

Exotics:

- Search for $Z_c(4430)$ tetraquark in $e^+e^- \to \pi\pi\psi(2S)$ invariant mass
- Search for hidden-strangeness pentaquark





Highlights

The BESIII Collaboration Discovered a Glueball-like Particle – X(2370)

17-05-2024 PRL 132 (2024) 181901

The Beijing Electron Positron Collider II (BEPCII) has recently made a significant achievement. The BESIII experiment at BEPCII performed the first measurements of the quantum numbers of the X(2370) particle, along with its mass, production, and decay properties, and found that they are consistent with the features of a glueball, which has long been the subject of intensive experimental searches. This important result was published in the journal of Physical Review Letters on May 2nd as an Editor's Suggestion.

X(2370) measurements:

$J^{PC} = 0^{-+}$ with significance >9.8σ

$M = 2395 \pm 11^{+26}_{-94}$ MeV

$\Gamma = 188^{+18}_{-17}{}^{+124}_{-33}$ MeV

$B(J/\psi \to \gamma X(2370))B(X(2370) \to f_0(980)\eta')B(f_0(980) \to K^0_S K^0_S) = 1.31 \pm 0.22^{+2.85}_{-0.84} \times 10^{-5}$

- schedule: smontaggio Inner Drift Chamber e installazione CGEM-IT

No.	tasks	Duration（day）	Start time and stop time
1	Removal of equipment of machine		July 1- Aug. 6
2	Pull-out of EEMC		
3	Removal of inner chamber （Operate simultaneously on both sides ）	51	Aug. 7- Sep.7 Sep.8- Sep. 28
4	Installation of CGEM	44 (47 days are required from gg., including 4 rest days)	Sep.29- Nov. 11
5	Recover EEMC		Nov. 12-Dec.30
6	Recover equipment of machine		
total		180 days	July 1- Dec.30

Contributo LNF:

- ✓ CGEM-IT test installazione & commissioning (M.Bertani, R.Tesauro)
- ✓ CGEM-IT sistema LV/HV consulenza (G.Felici, M.Gatta)
- ✓ Comitato Italiano di Fisica (M.Bertani convener)
- ✓ partecipazione a numerosi comitati di revisione interna pre-pubblicazione lavori di fisica (M.Bertani, A. Calcaterra, P. Patteri)

Richieste e attività per il 2024

Composizione del gruppo BESIII LNF (tot 2.15 FTE)

M. Bertani	95% (0.5%AidaInnova)
A. Calcaterra	40%
G. Felici (ass.)	50%
A. Sansoni	30%
P. Patteri (ass.)	0%

Preventivi di spesa preliminari (K€) (possibili aggiustamenti al ~10%):

Missioni	Consumo/altri consumi
30	10

missioni a IHEP coperte al 40% da **MSCA RISE FEST (2020-2024-->26)**

CGEM IT: installazione fine settembre-fine dicembre 2024

per il 2024 supporto tecnico R.Tesauro per installazione (sett.-dic.)

per il 2025 supporto tecnico/elettronica (R.Tesauro/M.Gatta) post installazione+commissioning

KLOE-2 **achievements** 2024

D. Babusci, C. Bloise, F. Bossi, G. Capon, E. De Lucia (Resp. Loc.), A. De Santis, S. Giovannella, M.Martini, S.Miscetti, and F. Fortugno

- Root Output for Data Preservation – KLOE-2 Data and MC completed, and KLOE Data started. Next KLOE MC
- New analysis of the hadronic cross section started with the Initial State Radiation method (e+e- --> pi+ pi- gamma) with the 1.7 fb^{-1} sample of 2004-2005 data – Liverpool University group joined in 2023 (G.Venanzoni et al.)
- Main physics results:

$\phi \to K_S K_L \to \pi^+\pi^-\,\pi^\pm e^\mp \nu$ and $\phi \to K_S K_L \to \pi^\pm e^\mp \nu\, 3\pi^0$

Contents lists available at ScienceDirect

Physics Letters B

journal homepage: www.elsevier.com/locate/physletb

Physics Letters B 845 (2023) 138164

Direct tests of T, CP, CPT symmetries in transitions of neutral K mesons with the KLOE experiment

The KLOE-2 Collaboration

D. Babusci [c], M. Berłowski [r], C. Bloise [c], F. Bossi [c], P. Branchini [n], B. Cao [o], F. Ceradini [m,n], P. Ciambrone [c], F. Curciarello [h,i], E. Czerwiński [b,*], G. D'Agostini [k,l], R. D'Amico [k,l], E. Danè [c], V. De Leo [k,l], E. De Lucia [c], A. De Santis [c], P. De Simone [c], A. Di Domenico [k,l], E. Diociaiuti [c], D. Domenici [c], A. D'Uffizi [c], G. Fantini [k,l], A. Gajos [b], S. Gamrat [b], P. Gauzzi [k,l], S. Giovannella [c], E. Graziani [n], X. Kang [q], A. Kupść [o,r], G. Mandaglio [e,a], M. Martini [c,j], S. Miscetti [c], P. Moskal [b], A. Passeri [n], E. Pérez del Río [b], M. Schioppa [h,i], A. Selce [m,n], M. Silarski [b], F. Sirghi [c,d], E.P. Solodov [f,g], W. Wiślicki [r], M. Wolke [o], J. Bernabéu [p]

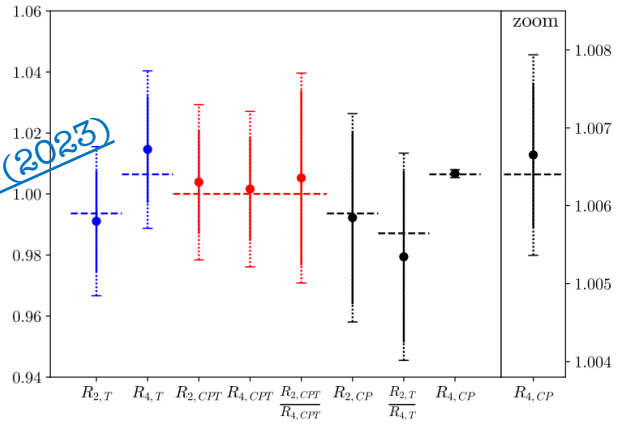


Fig. 10. Comparison of the measured symmetry-violation-sensitive single and double ratios and their expected values (horizontal dashed lines) assuming CPT invariance, the validity of the $\Delta S = \Delta Q$ rule and T violation extrapolated from observed CP violation in the mixing [28]. Solid error bars denote statistical uncertainties and dotted error bars represent total uncertainties (including error on the D factor in case of single T and CPT-violation sensitive ratios). The right-hand-side panel magnifies the region of the CP-violation-sensitive ratio $R_{4,CP}$.

KLOE-2 **achievements** 2024

- Finalizing $\gamma\gamma \to \pi^0$ analysis with High Energy Tagger (HET). Test beam at BTF in 2023 on HET response to evaluate efficiency & acceptance: **simulation of Bhabha scattering events at very low angles validated**

- "From future to past effect" in $\phi \to K_S K_L \to \pi^+\pi^- \pi^+\pi^-$ *[PRD 105 (11) 2022)]*

Peculiar time correlation between entangled neutral kaons produced at a ϕ-factory: the past state of the first decayed kaon, when it was still entangled before its decay, is post-tagged by the result and the time of the future observation on the other kaon decay.

First evidence of the dependence of the t_1 distribution from the future time t_2, their difference confirming the post-tagging effect

Observation of the post-tagging effect for entangled K mesons at KLOE

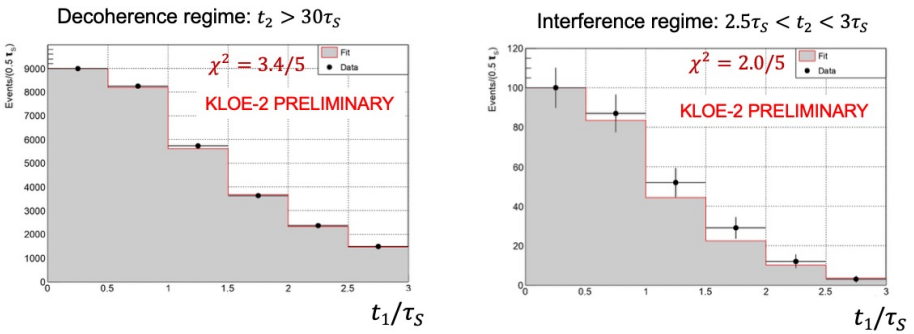


Figure 2: The measured t_1 distribution for $\phi \to K_S K_L \to \pi^+\pi^- \pi^+\pi^-$ events (black dots), in the case of the decoherence regime with $t_2 > 30\ \tau_S$ (left), and the interference regime with $2.5 < t_2 < 3\ \tau_S$ (right). The result of the fit with the prediction of quantum mechanics based on eq.(6) taking into account the experimental resolution effects on t_1 and t_2 times with a smearing matrix obtained from a Monte Carlo simulation (histogram) is superimposed.

PoS(EPS-HEP2023)371

KLOE-2 **anagrafica & richieste**

Preventivi di spesa preliminari (Keuro) (possibili aggiustamenti al ~10%):

Sigla	Ric	Tec	FTE	<FTE>	MISS	CON	APP	ALTRO CAP
KLOE-2	8	0	1.5	0.2	1.0	2.5	5	26 MAN

D. Babusci (20%), C. Bloise (20%), F. Bossi (20%), G. Capon, E. De Lucia (20%), A. De Santis (10%), S. Giovannella (20%), M.Martini (20%) and S.Miscetti (20%)

Personale tecnico		
	Computing (Fortugno 50%)	

LHCb **achivements** 2024

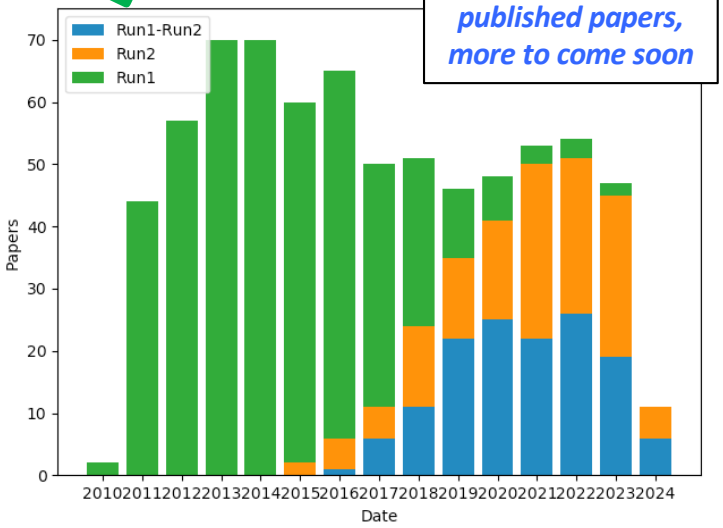
LNF activities

Physics results: analysis of Run 1+2 data + attaching also Run 3 data
- **Ongoing analyses of Semileptonic, Rare B-decays, Fixed Target**

U1: **Major upgrade of all SDs completed on-budget,**
$\mathcal{L}$= 2×10^{33} cm^{-2}s^{-1} **(5×Run 2)**
- **2024 data taking**: LHCb followed the LHC intensity ramp up and took data until TS1 (14 June) with all SD in global but UT; after TS1, taking data with all SDs with a good DAQ efficiency (>90%). Now focussing on HLT optimization.

- MUON: **focussing on** DAQ, MuonID **performance and** data/MC **studies**
- SMOG2: **Commissioning + Heavy Ion data taking**
- **Strong involvement in** LHCb **organization**

More than 700 published papers, more to come soon



[For details on all results, see: http://lhcbproject.web.cern.ch/lhcbproject/Publications/LHCbProjectPublic/Summary_all.html]

U2*: U1 will not saturate precision in many key observables; U2 will fully realise the flavour-physics potential of the HL-LHC. U2 is a major change of the detector during LS4: to sustain $\mathcal{L}_{peak}$ up to 1.5×10^{34} cm^{-2}s^{-1} **aiming at ~300/fb in Run5 and Run6 of LHC.**

- MUON: **goal maintain current performance. Solutions proposed ***, currently under scrutiny**:
  → R1-R2 (rates up to 1 MHz/cm^2): μ-Rwell detectors with small pads
  → R3-R4 (rates $\lesssim$ 50 kHz/cm^2): keep most of the present MWPC and read them at their full granularity
- SMOG3: **polarised target**

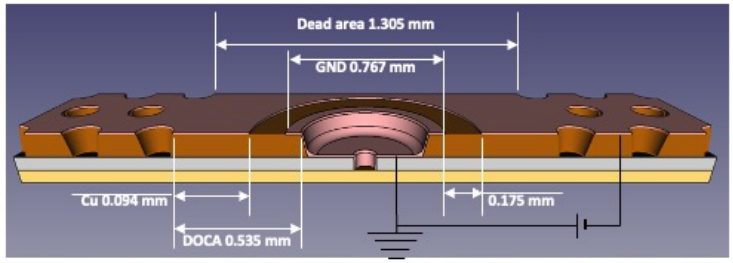
* **U2 Frame TDR**: https://cds.cern.ch/record/2776420/

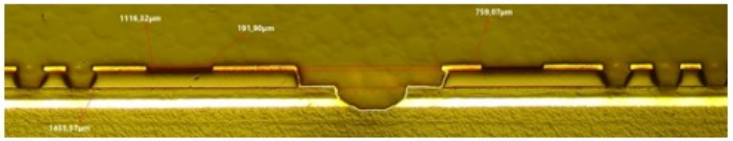
LHCb: μ-Rwell status 2024 and plans 2025

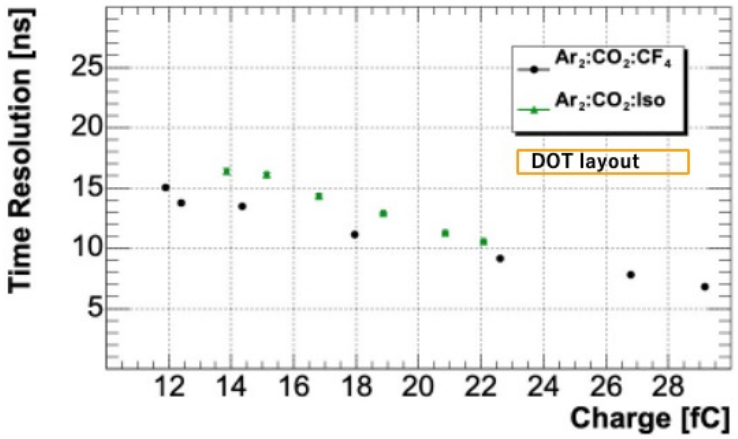
The CID (CERN-INFN-DLC) sputtering machine, a **joint project between CERN and INFN**, is used for preparing the **base material of the detector**. LNF involved on the tuning of the machine: in the 2024 focus on the sputtering of large foils.

PEP-Dot layout:

- DLC grounding through conductive dots connecting the DLC with a conductive grid on the readout PCB [Pad R/O = 9x9mm2; Grounding: Dot pitch = 9mm, dot rim = 1.3 mm] → 97% geometric acceptance
- Results from 2023 Test Beam (H8C) with a preliminary version of the FATIC chip (Bari)
- New Test Beam (Nov 2024) with an updated version of the FATIC aiming at reduce the FEE thr down to 3-3.5 fC.

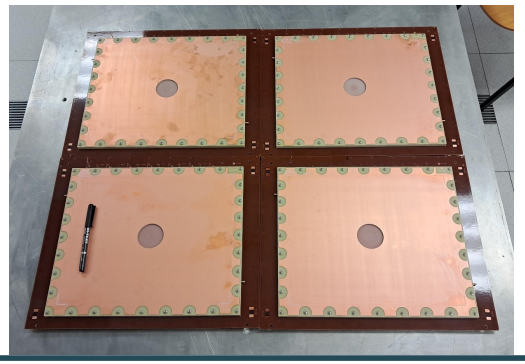






Prototypes and tests:

- **M2R1** (4): funded 2023, delivered Jun 2024: X-ray characterization (Jul 24) then Test Beam with FATIC3 (Nov 24)
- **M2R2** (2): funded in 2024, tentative delivery Apr 25; high rate test (PSI) with FATIC4 in Autum 25
- **M5R2** (2): required for 2025



LHCb: anagrafica, coordinamento, richieste

Gruppo cresciuto rispetto allo scorso anno: 24 persone
- **20 Ricercatori [10.5 FTE → 14.3 FTE** (di cui 2.0 sinergici)**]**
  Ingresso di 6 colleghi/e «da NA62» (stop di Hike/Shadows)
- **4 Tecnologi [2.5 FTE → 2.5 FTE** (di cui 0.4 sinergici)]

Pietro Albicocco 60% + 10% IGNITE sinergico = 70%
Antonella Antonelli 10%
Giovanni Bencivenni 60% + 10% AIDAINNOVA sinergico = 70%
Pierluigi Campana 50%
Vladimir Chulikov 100%
Paolo Ciambrone 60% + 20% IGNITE sinergico = 80%
Erika De Lucia 60% + 10% AIDAINNOVA sinergico = 70%
Patrizia de Simone 95% + 5% PRIN_2022N4W8WR sinergico = 100%
Pasquale Di Nezza 80% + 20% PNRR_ROMETECHS5 sinergico = 100%
Giulietto Felici 30%
Matteo Giovannetti 100%
Gaia Lanfranchi 70%
Silvia Martellotti 20%
Elisa Minucci 100% su PRIN_2022N4W8WR sinergico = 100%
Gianfranco Morello 70% + 10% AIDAINNOVA sinergico = 80%
Mattew Moulson 10% + 20% AIDAINNOVA sinergico = 30%
Matteo Palutan 100%
Monica Pepe Altarelli 100%
Marco Poli Lener 60% + 10% AIDAINNOVA sinergico = 70%
Marcello Rotondo 80% + 10% PRIN_2022N4W8WR sinergico = 90%
Marco Santimaria 100%
Barbara Sciascia 95% + 5% PRIN_2022N4W8WR sinergico = 100%
Tommaso Spadaro 20%
Gemma Tinti 10% + 10% IGNITE sinergico = 20%

Ruoli di coordinamento in LHCb attivi:
- E. De Lucia: **WP-D Simulation Coordinator L2b**
- E. De Lucia: **Muon@U2 TB data analysis L2b**
- P. de Simone: **Muon Software Coordinator L2b**
- P. Di Nezza**: SMOG2 Project Leader L2a**
- M. Palutan: **U2 Planning Group Chair L1**
- M. Pepe Altarelli: **Chair of Membership Committee L1**
- M. Poli Lener: **Muon@U2 detector L2b**
- B. Sciascia: **Muon Project Leader L1**
- B. Sciascia: **Membership Committee Member L2b**

Ric	Tec	FTE	<FTE>	MISS	CON	ALTRO
20	4	16.8	0.70	238.5	74.0	86

Richieste 2025

Missioni: **247.5 kE**
Estere: FTE*2MU*3.7kE/FTE = **124.5 kE**
Interne: FTE*1kE/FTE = **17.0 kE**
Muon YETS e piquet 3MU*3.7kE: = **11.0 kE**
Missioni DLC machine: = **12.0 kE**
Test beam: [PSI, muRwell, MWPC Muon@U2] = **6 kE**
Trasferimento Tecnologico alla ELTOS = **3 kE**
Responsabilità: 5MU*3.7kE [SMOG2 PL] +3*1MU*3.7kE[Sim+Muon software+Detecor@U2] +5MU*3.7kE [U2 chair]+5MU*3.7kE [MemCo chair] +5MU*3.7kE [MUON PL] = **20MU***3.7kE = **74.0 kE**

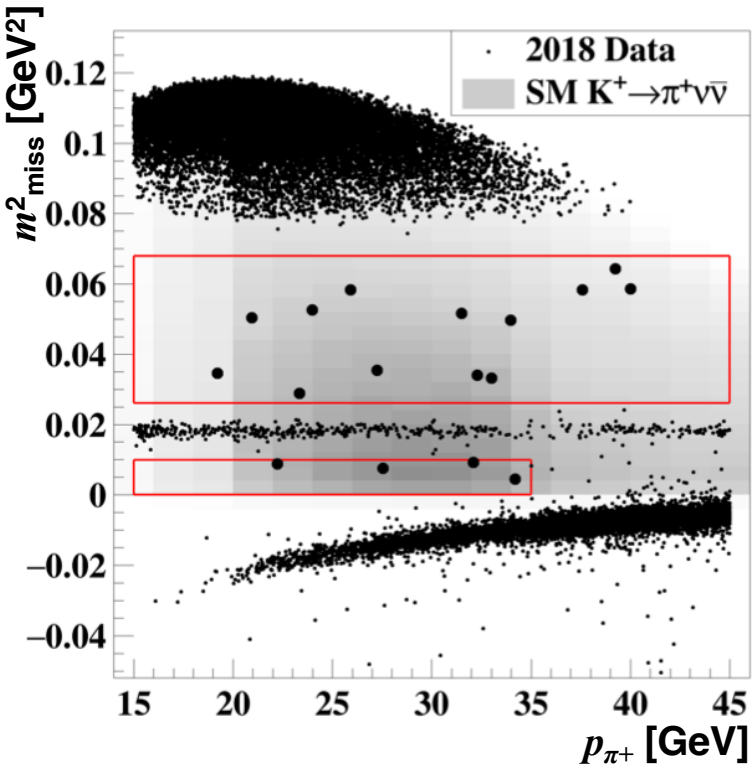
Consumo: **74.0 kE**
Metabolismo: FTE*1.5 kE = **25.0 kE**
SMOG2: Gas for 2025 data taking = **4 kE**
Muon@U2 [muRwell]: prototipi = **45 kE**

Altri servizi diversi: **86 kE**
MoF-B LHCb MUON (70% of 120 kCHF → 84 kCHF →) **86 kE** [TBC]

NA62: status of $K^+ \to \pi^+ \nu\nu$ measurement

Summary of $K^+ \to \pi^+ \nu\nu$ result from NA62 Run1 (2016-2018)

- expected signal (SM): 10 evts
- expected background: 7 evts
- total observed: 20 evts
- **3.4σ signal significance**
- most precise measurement to date



BR($K^+ \to \pi^+ \nu\nu$) = (10.6 $^{+4.0}_{-3.4\ stat}$ ± 0.9_{syst}) × 10^{-11}

JHEP 06 (2021) 093

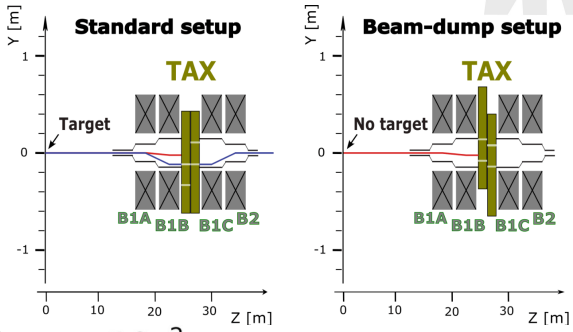
Analysis improvements for Run2 :

- signal acceptance increased by 20%
- improved evaluation of trigger and random-veto efficiencies
- signal yield improved by 50%
- single-event sensitivity (SES) from 2022 data alone similar to all of Run1
- studies ongoing to understand scaling of background from Run1

Expected values, work in progress!
CERN-SPSC-2024-012

✓ **about 10 signal evts per year**
✓ expected 50 – 60 signal evts by 2025 – 2026
✓ to reach BR($K^+ \to \pi^+ \nu\nu$) to 20%

NA62: hidden-sector physics in beam-dump mode



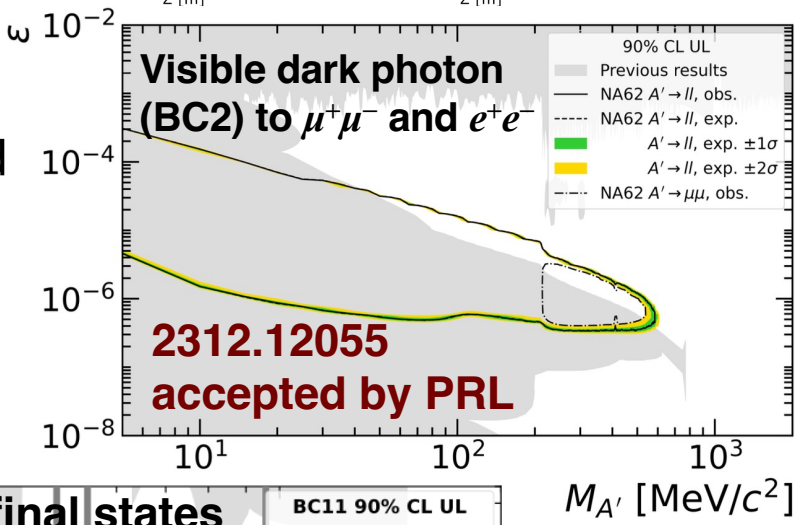
- ✓ target removed
- ✓ collimator closed
- ✓ beam intensity increased 1.5x

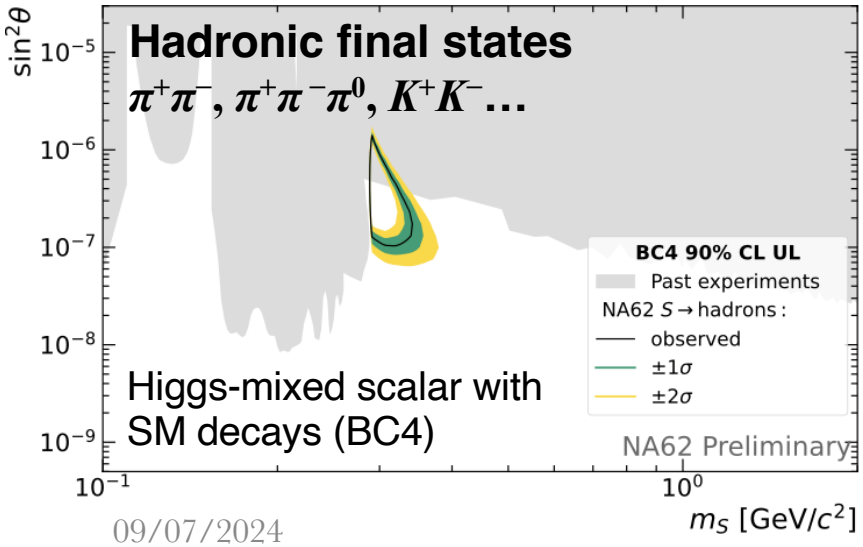
dedicated data taking in dump mode for short periods during $K^+ \to \pi^+ \nu\nu$ running

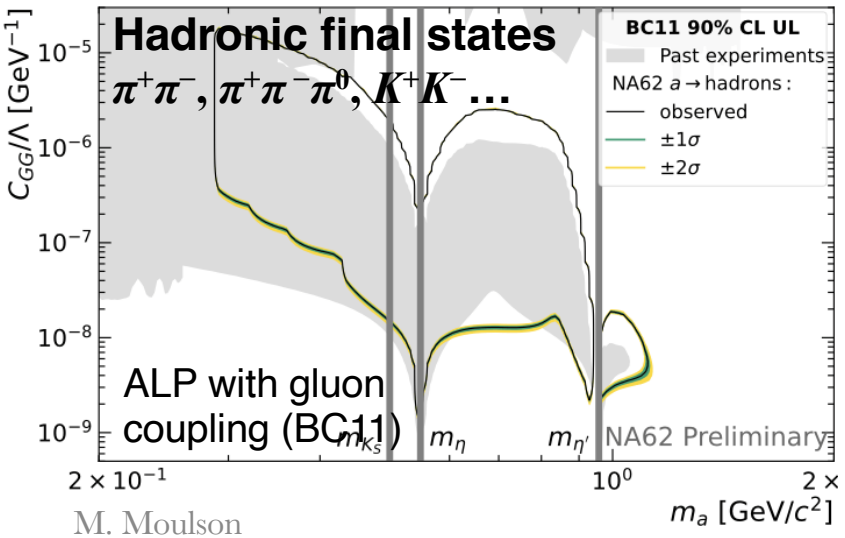
1.4×10^{17} protons on target (pot) collected in dump mode in 2021 (few days)

- major role by LNF group in 2021 data taking and coordination of data analysis
- 3 **new publications** from 2021 data

10^{18} pot (few weeks) to be collected by LS3







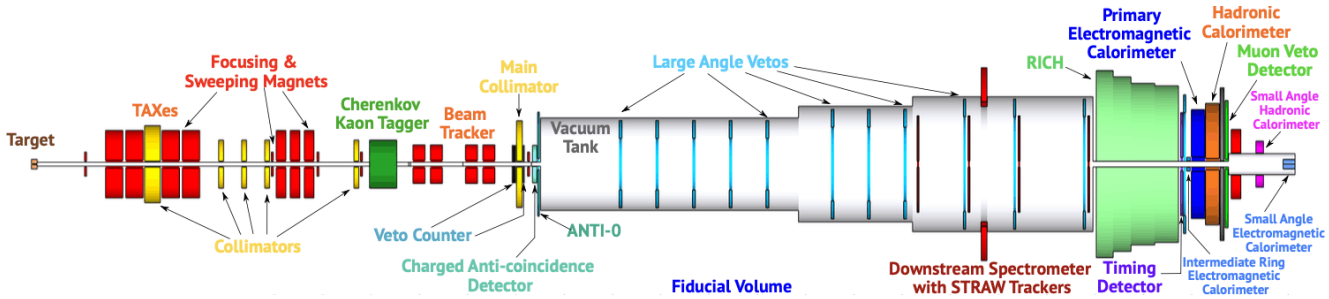
from NA62 to HIKE

HIKE was a multi-phase, general purpose kaon experiment proposed to extend the NA62 physics program into the HL-LHC era and beyond

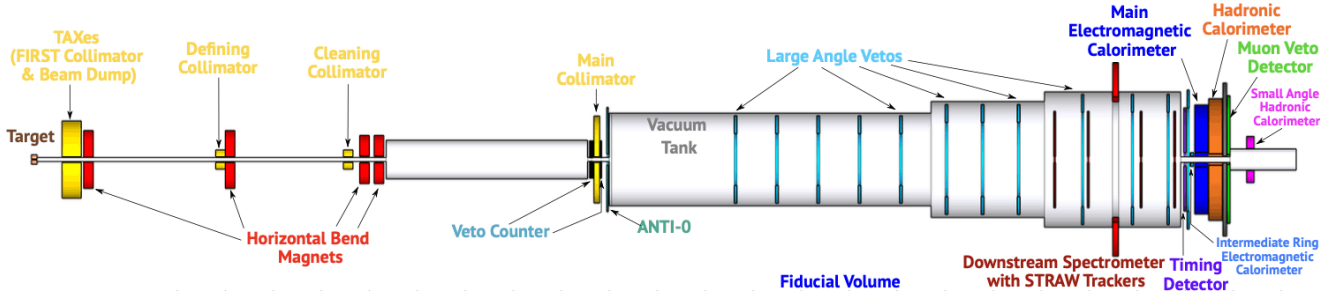
15-year program in ECN3 area with start of data taking around 2030

HIKE
High Intensity Kaon Experiments

Phase 1: $K^+ \to \pi^+ \nu\nu$ to 5%, LFV/LNV & other rare decays, precision mmts



Phase 2: $K_L \to \pi^0 \ell\ell$ to 12-18%, LFV/LNV & rare decays, precision mmts



Plus FIP searches with kaon beams and in periodic dump-mode runs

Proposal SPSC-P-368 (2311.02831) made public October 2023

CERN Directorate at Research Board, 6 Mar 24:

SHiP experiment approved to run in ECN3 after LS3

HIKE physics case judged excellent, but decision made on "strategic" grounds

NA62 experiment will decommission in LS3

Effectively ends kaon physics at CERN … 😟

NA62: anagrafica, coordinamento, richieste

Personale:

1. A. Antonelli (Ric. I): 90%
2. V. Kozhuharov (Prof. Ord. Assoc.): 50%
3. G. Lanfranchi (Ric. II): 30%
4. S. Martellotti (Ric. III): 80%
5. M. Moulson, RL (Ric. II): 70%
6. L. Plini (Dott.): 100%
7. M. Soldani (Ass. Ric.): 50% + 50% AIDAinnova syn
8. T. Spadaro (Ric.II): 40%
9. J. Swallow (Bors. Str.): 100%
10. G. Tinti (Ric. III): 80%

Total: 690% + 50% in sinergia

Ruoli di coordinamento in NA62 nel 2024:

- ✓ A. Antonelli: Responsabile Nazionale NA62
- ✓ S. Martellotti: Co-convener, Photon Veto WG
- ✓ M. Moulson: Co-convener for detector R&D, Future Experiments WG
- ✓ T. Spadaro: Co-convener, Exotics Analysis WG
- ✓ J. Swallow: Co-convener, PNN WG
- ✓ G. Tinti: Co-convener, Photon Veto WG

Richieste in k€ (preliminari!)

- **Consumo: 14** (metabolismo)
- **Missioni: 96** (25 settimane run + resp.)
- **Servizi: 22** (consumi CERN NA62 Italia + LNF)
- MOF NA62 **Italia: 170**

Ringraziamo sentitamente!

- RSCR: **E. Paoletti, D. Pierluigi, A. Russo, R. Tesauro**
- SEA: **M. Gatta, S. Ceravolo**

per la costruzione di prototipi e attrezzature di beam test e relativa elettronica per HIKE e AIDAinnova

Fisica dei leptoni carichi

Mu2e: progress on calorimeter construction

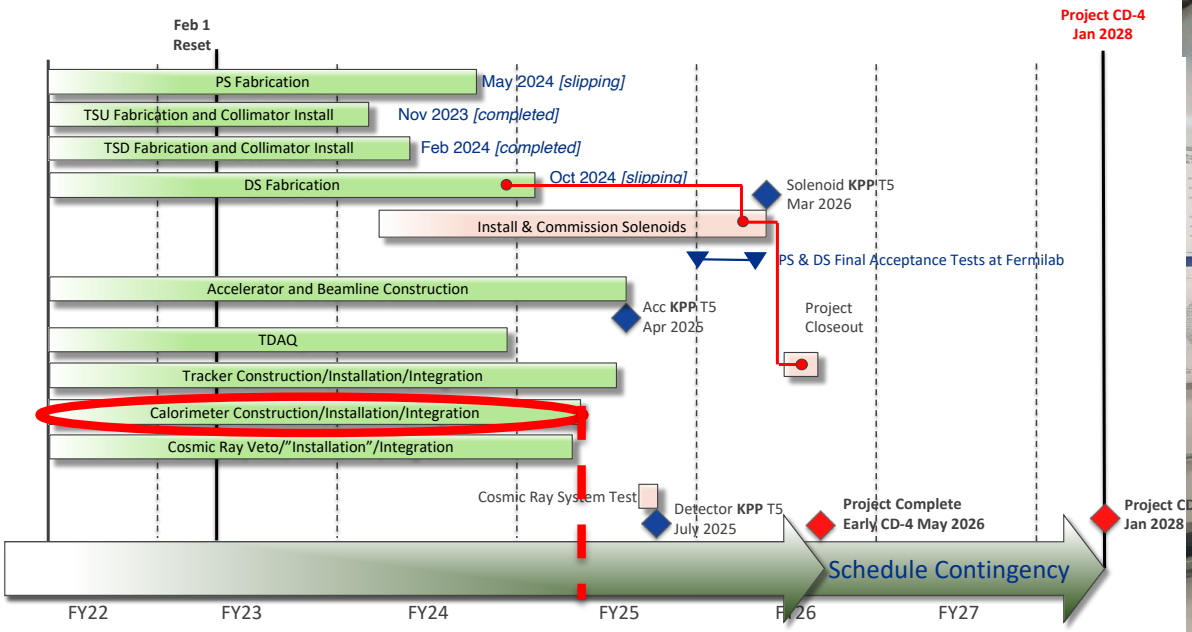
For both calorimeter disks, the assembly of mechanics, analog electronics, and power distribution is completed. Cable routing from FEE to Digital boards is completed for Disk-1 and 2/3 for Disk-0

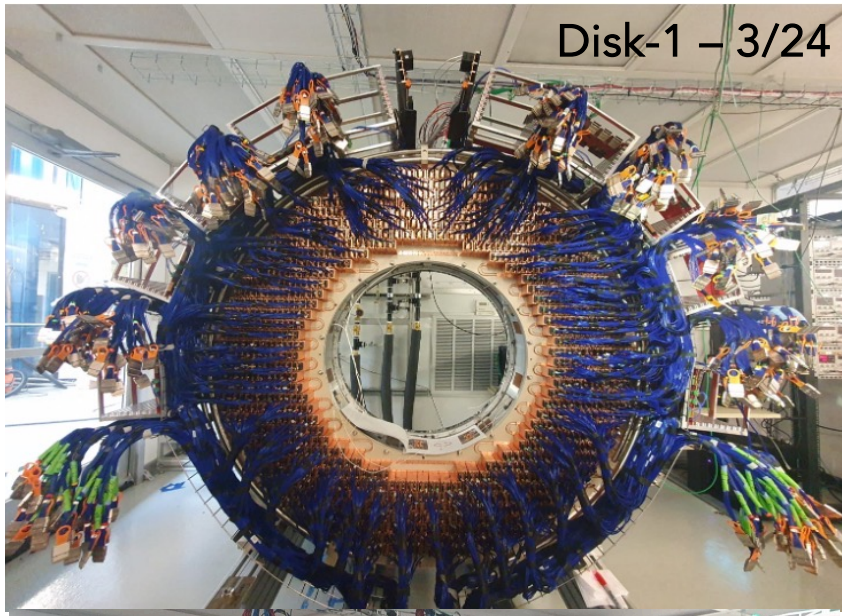
Disk-0 will be completed in September

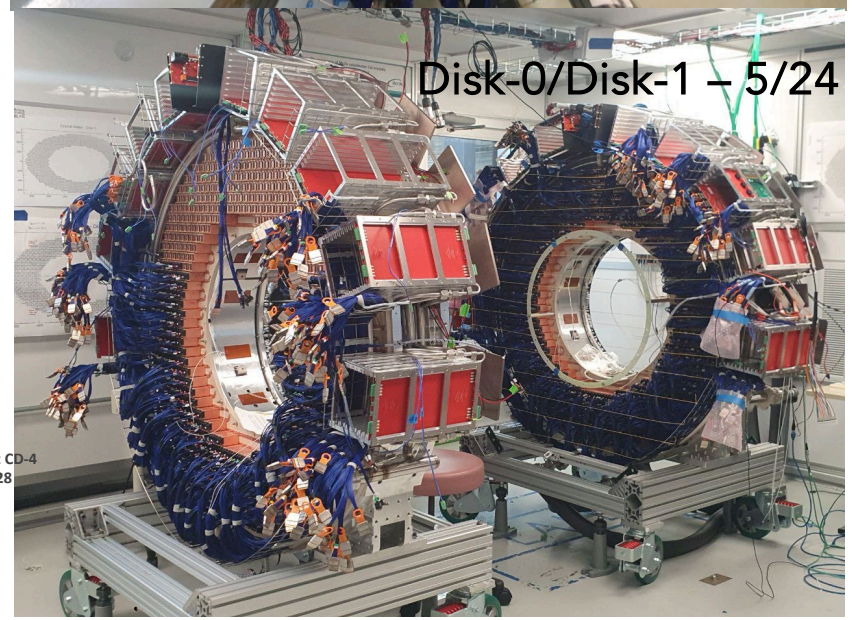
at Mu2e Hall:

✓ LV/HV power supplies are installed

✓ Service cables in the south/north side are routed

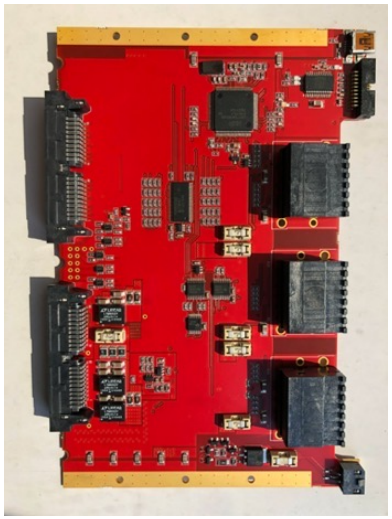




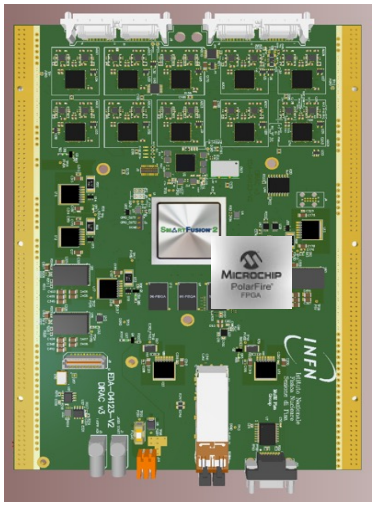


Mu2e: progress on calorimeter installation

MZB Board

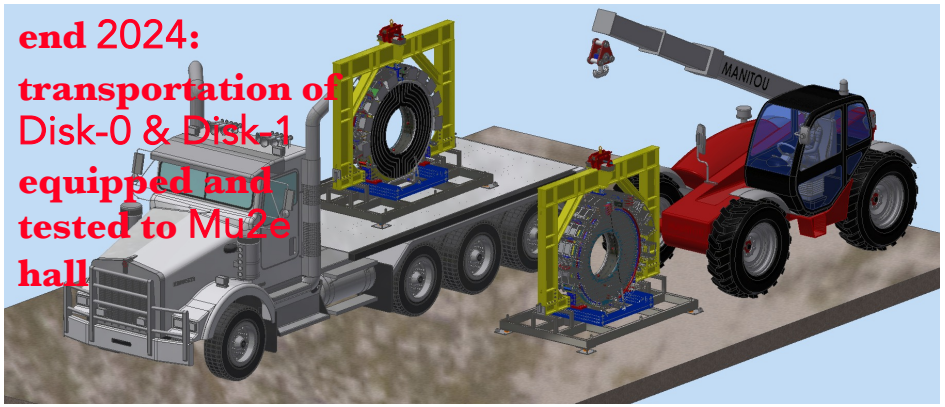


DIRAC Board



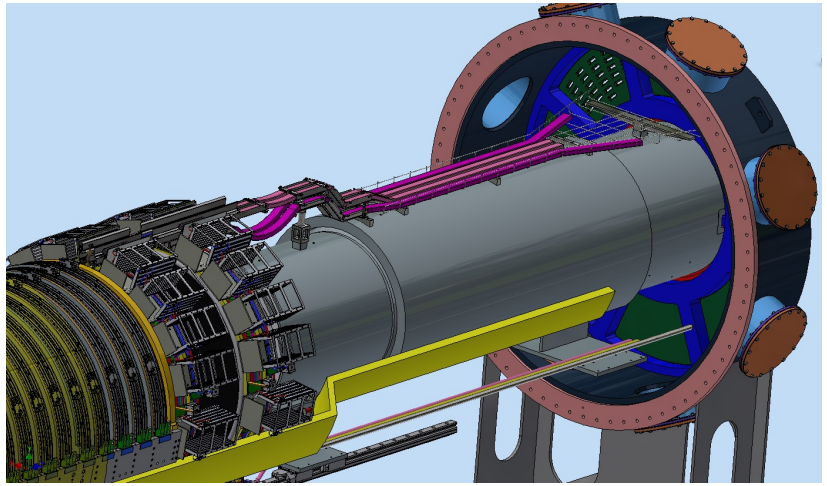
MZB production (170 units) completed
Burn-IN + QC tested
First 85 @ FNAL already

DIRAC production (170 units) completed
Burn-IN + QC test in progress
Ship to Fermilab in June



end 2024: transportation of Disk-0 & Disk-1 equipped and tested to Mu2e hall

- cables trays layout completed
- building will start at LNF after summer
- ready to install beginning 2025



Design of IFB calorimeter flanges and related calculation completed

✓ verification with Integration team ongoing for final production
✓ verification with Tracker team ongoing for interface of radial flanges

Modification of Sidet Vacuum Vessel door for hosting the IFB flanges under way to qualify vacuum tightness (INFN-in-kind)

✓ all Feed-throughs apart TDAQ fibers already in our hands & tested
✓ procurement of flanges and transition box on IFB support

Complete Interlock and PLC control: cooling, power, vacuum, Inner Ring

Mu2e calorimeter: anagrafica & richieste

Ricercatori/Tecnologi LNF

1. S. Bini Ric, 40%
2. C. Bloise Dir Ric, 80%
3. S. Carsi Associato, 100%
4. F. Colao Associato Enea, 50%
5. E. Diociaiuti Tecn, 20%, L3
6. S. Giovannella I Ric, 70%, L2 + L3
7. D. Hampai I Tecn, 20%
8. F. Happacher I Ric, 70%, L2 + L3
9. M. Martini Ass. UniMarconi, 40%
10. S. Miscetti Dir Ric, 70%, Spoke P. + L2
11. L. Montalto Associato, 100%
12. D. Rinaldi Associato, 100%
13. I. Sarra Tecn, 30%, Resp. locale + L3

Totale ➔ 7,7 FTE/13

Richieste 2025

apparati	k€	k€ (sj)
impalcatura + tenda	10	5
CALO DISK JACKS	5	
terminal block sull'IFB	7.5	
Flange dell'IFB e connettorizzazione	20	10
Dal 2024: laser		12
trasporti		
Trasporto Flange + terminal block	10	
consumi		
Metabolismo	12	
Mu2e-II: scheda di interfaccia ed utilizzo dell'asic TOPHIR2		15
missioni		
gettone SpokesPerson 6 M.U.	33	
4M * L2 + 2 M * 5 L3 = 14 M a 5.5 kEuro/mese	77	
MEstere altri =5 (FTE) * 1.5 MU * 5.5 kE/mese	42	
Tecnici x assemblaggio e installazione 6 MU	33	
test beam Mainz		15
Missioni Interne metabolismo 0.7 kE x FTE	6	

Dark sector

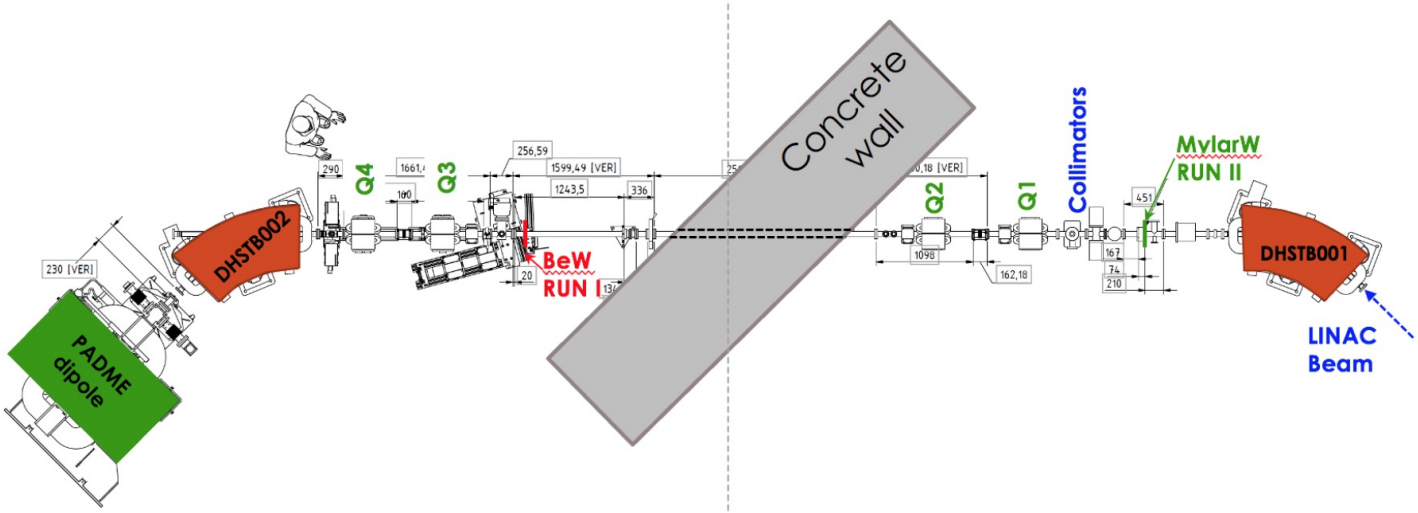
PADME status in a glance

Positrons from the DAFNE LINAC up to 550 MeV, O(0.5%) energy spread

Repetition rate up to 49 Hz, macro bunches of up to 300 ns duration

Intensity must be limited below ~ 3 × 10^4 POT / spill against pile-up

Emittance ~ 1 mm x 1.5 mrad @ PADME



Past operations:

Run I e^- primary, target, e^+ selection, 250 μm Be vacuum separation [2019]

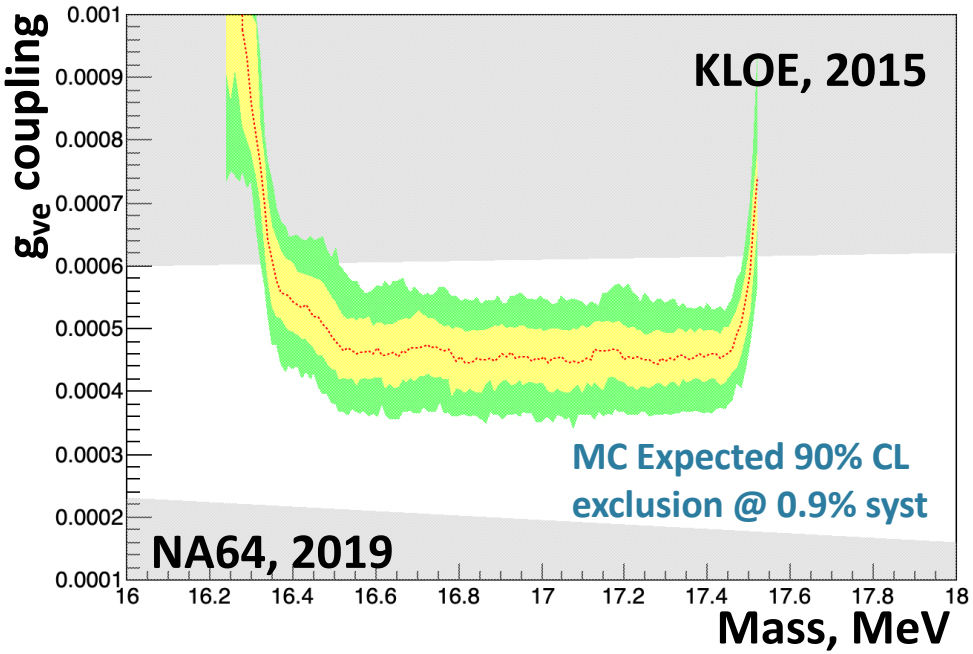
Run II e^+ primary beam, 125 μm Mylar™ vacuum separation, 28000 e^+/bunch [2019-20]

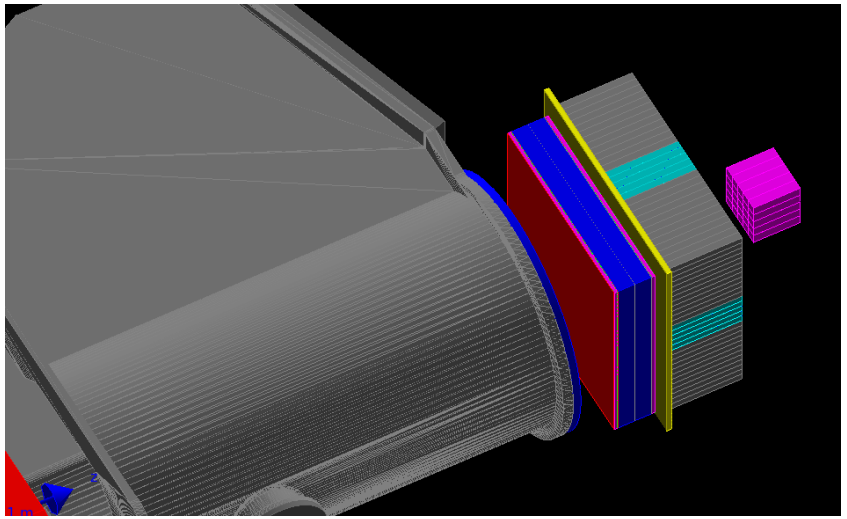
Run III dipole magnet off, ~3000 e^+/bunch, 47 scan points $s^{1/2}$ ~ 17 MeV [2022]

Data quality and goals for Run-III: X17

Search for X17 via resonant production at PADME Run-III

5×10^{11} e^+ scan around E(e^+) ~ 283 MeV: signal on top of Bhabha s+t-channel bkg, X17 width smeared by e^- motion *[Nardi, Darmé, et al., PRD 106 115036, PRL 132 (2024) 26, 261801]*





Building a new micromega TPC tagger to provide a better vertex reconstruction, improve the e/γ rejection and allow normalization to γγ

- Run III **signal box still closed ➔ opening is imminent**
- Run IV **proposed for 2025: stat ~ twice that of 2022 (~6 months) to close gap with** NA64

https://agenda.infn.it/event/39815/contributions/224282/attachments/116799/168457/CSN1_Feb2024.pdf

Preliminary 2025 PADME FTE

New-tracker related additions in terms of man-power: researchers, tecnological personnel

Fundamental contribution of expert technicians: E. Capitolo, R. Pileggi, B. Ponzio

New tracker construction to be completed by autumn, in time for the 2025 proposed run

LNF	
F. Bisconti	20
S. Bertelli	5
F. Bossi	40
C. Di Giulio	20
E. Di Meco	100
D. Domenici	10+10syn
G. Finocchiaro	10
P. Gianotti	30
V. Kozhuharov	50
M. Mancini	100
I. Sarra	10
T. Spadaro	40
E. Spiriti	10
E. Vilucchi	10
M. Antonelli, G. Mancini, C. Arcangeletti	10, 25, 15
	515

RM1	
F. Ferrarotto	40
F. Anulli	10
E. Leonardi	80
G. Organtini	20
M. Raggi	50
P. Valente	70
A. Variola	20
	290

NA_DTZ	
P. Massarotti	5
G. Sekhniadze	10
P. Iengo	10
	25

2025 LNF responsibles:

- V. Kozhuharov: spokeperson
- F. Bossi: pub. board
- T. Spadaro: phys. coord., LR, NR

2025 LNF budget requests:

- Chamber construction (~ 20 k€)
- Run costs 20 k€ (gas, other items)
- Metabolism consumables 7.5 k€

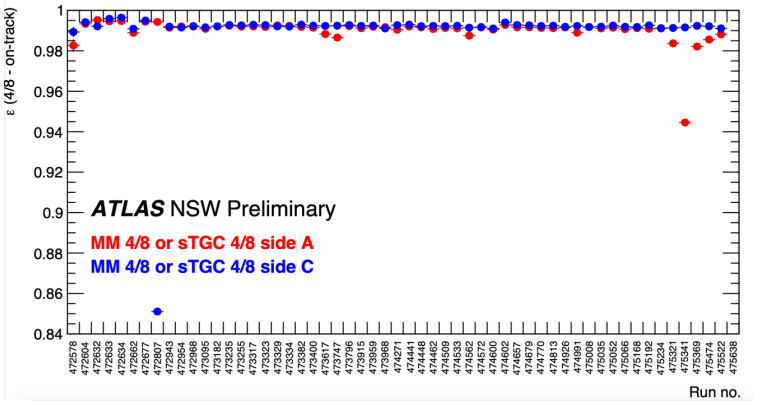
Frontiere dell'energia e nuovi acceleratori

ATLAS: LNF main projects

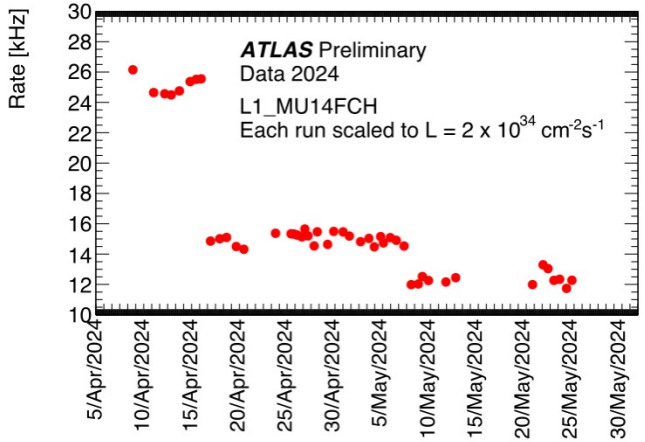
New Small Wheel operation

LNF still involved in operation and maintenance activity. Several responsibilities covered during the construction and installation phases

track reconstruction is >99% in 2024



NSW in Level-1 Trigger chain included lead to a fakes rate rejection ~11 kHz, keeping the trigger efficiency up to 98%



Inner Tracker (ITk) - Upgrade

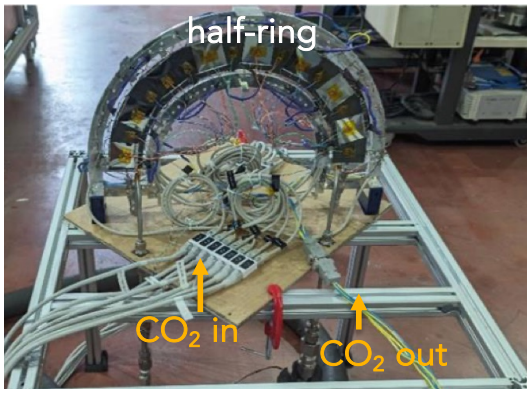
full silicon tracker: strip + pixel

✓ Italy is building one outer pixel endcap

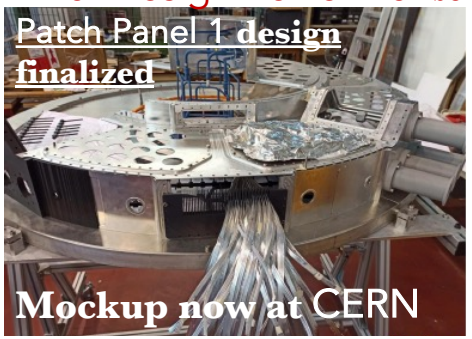
✓ LNF is responsible for the assembling and commissioning

activities on going:

1. system tests on prototypes: DAQ, DCS, CO_2 cooling
2. mechanical prototypes of carbon fiber structures, tooling optimization
3. infrastructure finalization: clean room, CO_2 pipes

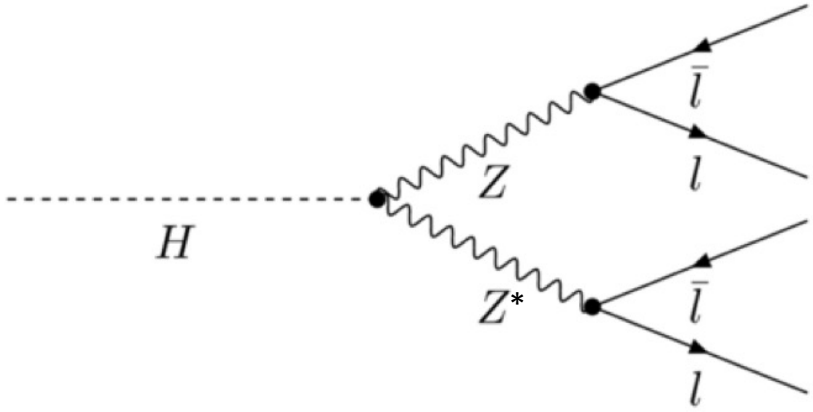


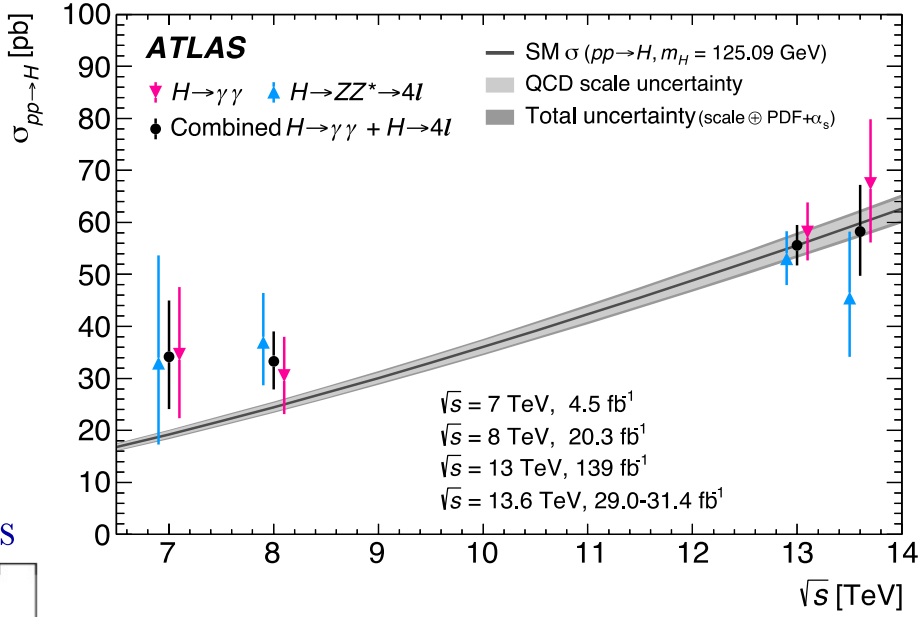
Final Design Review for services and integration in May



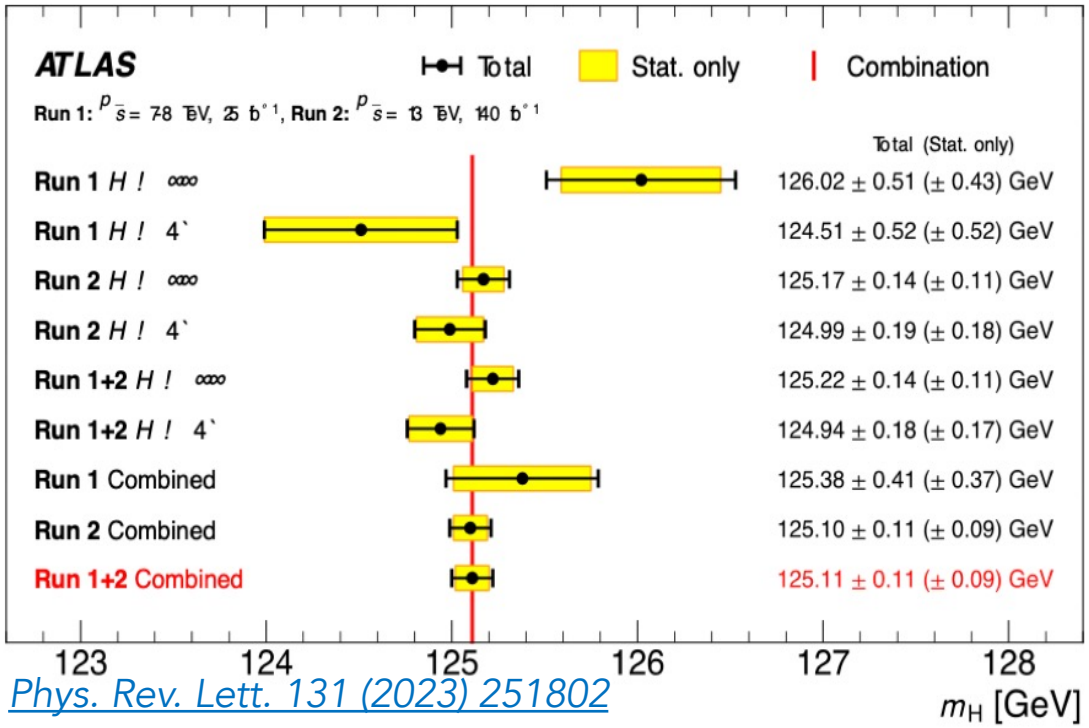
in the PP1 the services from all sub-detectors (inner and outer pixel system, strips) are routed to the off-detector electronics

ATLAS: LNF activity on H→ZZ*→ 4l channel





most precise measurement of the Higgs boson mass



Phys. Rev. Lett. 131 (2023) 251802

LNF **contribution**

HZZ group convenorship: *C. Arcangeletti*

- focusing on performing measurements of the Higgs boson properties in the H→ZZ* and H→μμ decay channels at 13.6 TeV
  - ✓ setup a baseline for future analysis with full Run3 statistics
- Higgs coupling measurements and test for possible BSM effects in different frameworks
  - ✓ working on alternative interpretations in collaboration with theorists

ATLAS: LNF anagrafica & richieste

Abritta, Costa, Albicocco, Antonelli, Arcangeletti, Battisti, Beretta, Behtouei, Bisconti, Buadze, Capitolo, Cesarini, Chiarella, Chubinidze, Croce, Dane`, Gardini, Gongadze, Ligi, Li Voti, Mancini, Paraskevopoulos, Pileggi, Ponzio, Pudzha, Rosatelli, Sansoni, Vilucchi, Vannoli, Testa

per un totale di circa 16 FTE

Ruoli di coordinamento :

Dane`	ITK PP1 integration responsible
Mancini	NSW MM coordinator
Paraskevopoulos	DCS Muon coordinator
Testa	system test coordinator
Arcangeletti	HZZ convener

Richieste finanziarie :

✓ 100 k€ missioni

✓ 1 M€ consumi, apparati, …

Richieste servizi per il 2025:

simili alle richieste fatte per il secondo semestre 2024 al CIF ➔

SEM 2.5 FTE, SEA 1.5 FTE , DA (Criogenia, Vuoto) 0.5 FTE, DR (Reparto Supporto Attività Sperimentali) 1.5 FTE

CMS: LNF **status and plans**

CMS – LNF **ha la responsabilità del sistema** GGM (Gas Gain Monitor) **degli** RPC

- il GGM dopo circa 15 anni di operazione ha richiesto una **completa ristrutturazione del sistema DAQ e del sistema di monitoring dei parametri ambientali** ➔ **operativo**

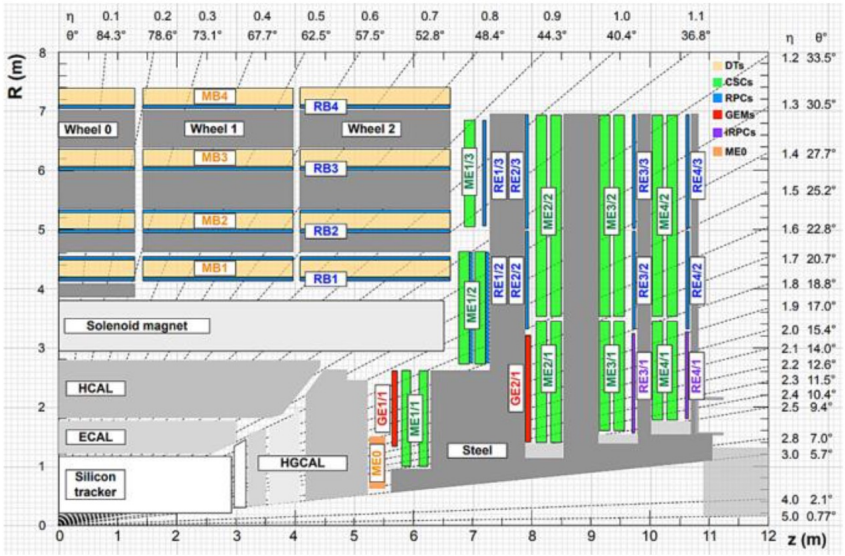


Figure 3.20: A quadrant of the CMS Muon Spectrometer, showing DT chambers (yellow), RPC (light blue), and CSC (green). The locations of new forward muon detectors for HL-LHC phase are contained within the dashed box and indicated in red for GEM stations (ME0, GE1/1, and GE2/1) and violet for improved RPC stations (RE3/1 and RE4/1) [34].

CMS – Upgrade

L.Benussi: responsabile della produzione delle camere GEM

- tutte le camere GEM delle regioni GE2/1 di competenza di Frascati **sono state completate e spedite al** CERN

per il 2025 @ CERN: partecipazione alla fase finale dell'assemblaggio dei moduli finali, ME0, prima dell'installazione in CMS

S. Meola: responsabile FEE iRPC

- **svolti** tests di irraggiamento del prototipo delle FEB per gli iRPC, per finalizzare il design della versione finale della FEB
- **svolti** longevity tests alla GIF++ con γ da ^{60}Co e tests beam, sia su RPC che iRPC per studiare i parametri di benchmark e le prestazioni degli iRPC

per il 2025: finalizzare l'elettronica di FEE per gli iRPC e pianificare la loro installazione su CMS

D. Piccolo: responsabile

sinergia con AIDAINNOVA per studiare ECO-Gas (4 anni, il terzo dei quali è iniziato a Marzo 2023): misure di aging con le miscele ecologiche studiate sotto irraggiamento alla GIF++.
In programma studi di compatibilità a lunghissimo termine con i materiali usati nei rivelatori.
Il programma chiuderà in Aprile 2025 e verrà preparato lo status report finale.

CMS BRIL

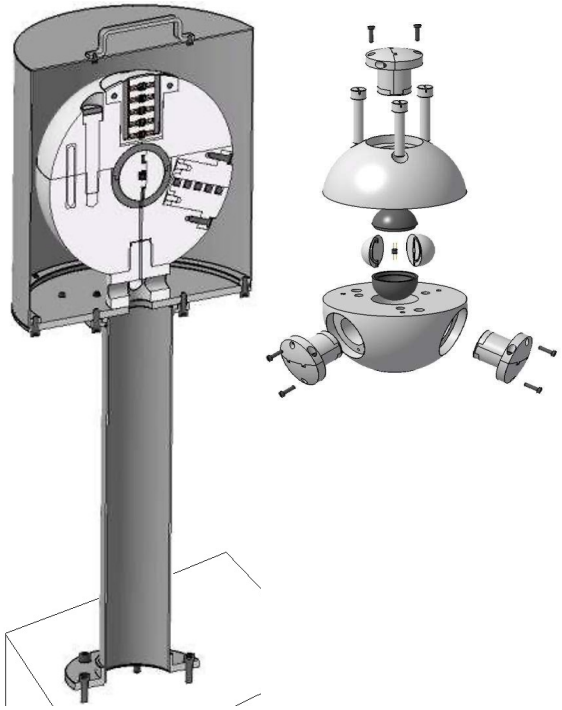
Tetra-Ball ➔ Providing CMS BRIL (Beam Radiation, Instrumentation, and Luminosity) with a neutron spectrometer eV-to-GeV for monitoring the neutron background in cavern and benchmarking the FLUKA-simulated CMS environment

history: CMS-BRIL neutron background monitoring was a russian task, initially started with Bonner spheres. The search for replacement proposals identified the single-moderator-neutron spectrometer SP^2 (***Bedogni*** and co-w.) as suitable candidate: the **Tetra-Ball**. After testing (2024-2025), CMS-BRIL may decide to « order » 5-6 T-Balls to INFN. INFN will operate and maintain the device/s.

Work done in 2024:

Conceptual design

- T-Ball = a sphere with diam. 29 cm embedding 21 pairs of Silicon-carbide sensors.
- One pair has: 1 SiC coated with 6LiF (sensitive to thermal neutrons + parasitic particles) + one bare SiC (sees only parasitic components)
- 21 pairs are distributed along the axes of a tetrahedron to isotopically "see" the space
- Simulations confirmed that the spectrometric capability are preserved in 4π
- Mechanics was designed
- Electronics was designed



Testing

- SiC sensors characterised
- Single-sensor electronics (analog + μP board) validated
- Rad-hardness tests done
- SiC pair validated in CMS cavern in June 24 with great success (coated / uncoated > 150)
- SiC closely follows CMS luminosity monitor !!

per il 2025: **costruzione del primo prototipo**, calibrazione con sorgenti di neutroni del primo prototipo, installazione e commissioning al CERN

CMS: LNF **anagrafica & richieste**

Luigi Benussi	LVL3	Ricercatore	70%
Stefano Bianco		Ricercatore	75%
Michele Arturo Caponero		Ricercatore	80%
Sabino Meola	LVL2	Ricercatore	100%
Davide Piccolo		Ricercatore	70%
Giovanna Saviano		Ricercatore	80%
Cristian Vendittozzi		Ricercatore	100%
Roberto Campagnola		Assegnista	100%
Roberto Bedogni		Ricercatore	30%
Miguel Angel Caballero Pacheco		Assegnista	20%
Antonino Pietro Paolo		Ricercatore	20%
Claudio Cantone		Tecnologo	20%
Tommaso Napolitano		Tecnologo	15%
Abner Ivan Castro Campoy		Assegnista	30%
Assegnista di Ricerca (*)		Assegnista	100%
Marco Parvis		Prof. Associato	30%

TOT: FTE 9.4/16

Alessandro Russo	Tecnico	0.5
Daniele Pierluigi	Tecnico	0.5
Roberto Tesauro	Tecnico	0.3
Emiliano Paoletti	Tecnico	0.2

Richieste finanziarie :

✓ 60 k€ missioni

✓ 25 k€ consumi

✓ 0 k€ apparati

Roberto Campagnola AdR on leave Novembre 2024

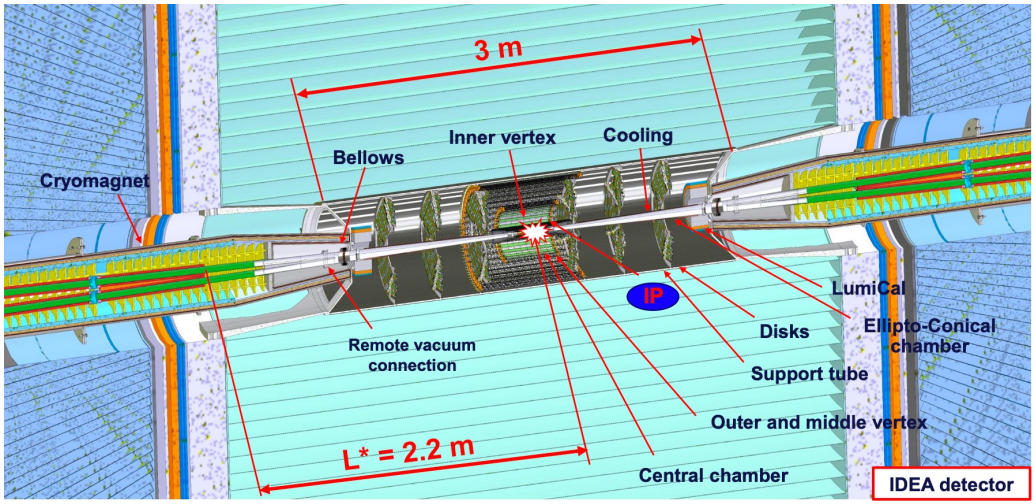
(*) 1 AdR to be assigned on July 11 2024

Associate prof. Stefano Colafranceschi EM Univ., Harrisonburg (VA) USA

RD_FCC WP2: acceleratore

Disegno della regione di interazione di FCC-ee

- Progettazione meccanica regione di interazione



mechanical design of the beam pipe with its cooling system along with

- ✓ **luminosity calorimeter**
- ✓ **IR bellows**
- ✓ **IDEA silicon tracker detector**

Central Support Tube concept introduced for the first time ➔ it will be a lightweight carbon-fibre tube attached to the IDEA tracker detector

Progress on the central and conical chamber design and vacuum chambers material budget optimization finalize:

- ✓ IR bellows design
- ✓ remote vacuum connection
- ✓ Services
- ✓ supports

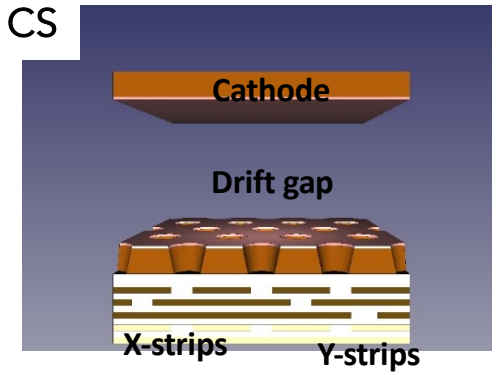
solo un esempio tra le tante attivita' in corso

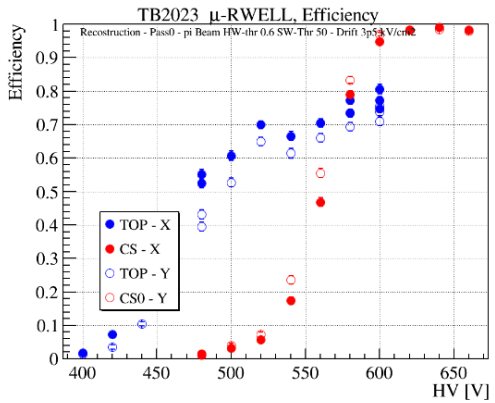
- Mock-up regione di interazione **in via di realizzazione a LNF** (progetto separato e sinergico)
- Studio dei fondi macchina nel rivelatore
- Studio beam losses & collimation
- Ottica del Final Focus optics e schema di compensazione del campo solenoidale
- Beamstrahlung radiation and handling

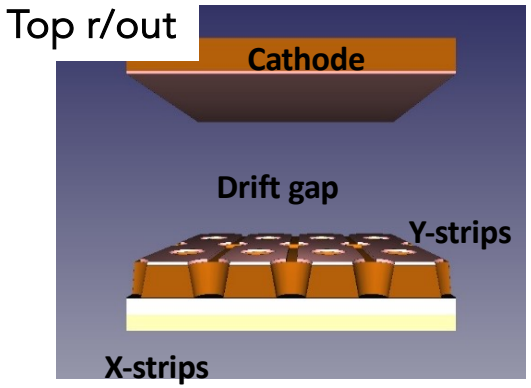
RD_FCC WP5: MPGD **attività** 2024 - 2025

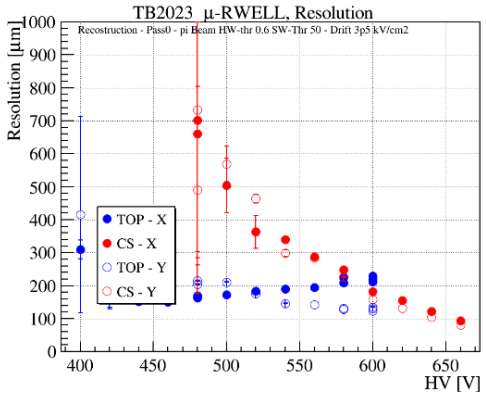
I risultati del TB-2023**, in cui sono stati confrontati i due layout** 2D (CS e Top r/out)**, hanno fornito i seguenti risultati:**

- ✓ CS, **risoluzione spaziale <200um (con pitch 1.2 mm), punto di lavoro molto alto, ≥ 600V, efficienza ~98%**
- ✓ Top r/out, **risoluzione spaziale ~200um (pitch 0.8 mm), punto di lavoro basso ~500V, efficienza ~70% (dead-zone)**



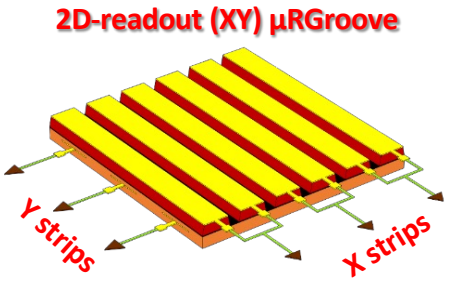


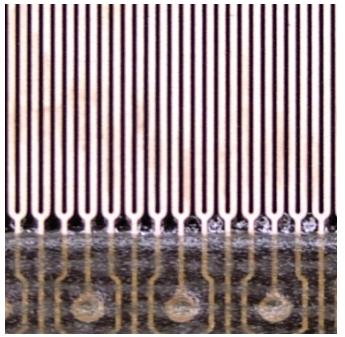




Soluzioni allo studio e **programma 2025**:

- Hybrid CS → CS + stadio di pre-amplificazione a GEM, per abbassare il punto di lavoro, migliorando notevolmente la stabilità della RWELL e mantenendo elevate prestazioni spaziali con pitch millimetrici
- micro-Rgroove → nuovo layout in cui lo stadio di amplificazione non è basato su **«well»** ma **«groove»,** questo **facilita la realizzazione del readout a strip sul top**, senza introdurre dead-zone (introdotto da Z. Yi in RD51)





RD_FCC : anagrafica & richieste

RD_FCC LNF incluse attivita' sinergiche: **TOT: FTE 6.9/15**

ANAGRAFICA	WP	FTE	sinergica	FTE totale
Boscolo Manuela	Accel	0.6	0.4 FCCIS	1
Broggi Giacomo	Accel	1		1
Ciarma Andrea	Accel		1 FCCIS	1
De Pasquale Enrico	Accel	0.3	0.1 FCCIS	0.4
Fransesini Francesco	Accel	1		1
Lauciani Stefano	Accel	0.3		0.3
Giulia Nigrelli	Accel	1		1
Mikhail Zobov	Accel	0.2		0.2
Gianni Bencivenni	MPGD	0.2		0.2
Marco Poli Lener	MPGD	0.25		0.25
Gianfranco Morello	MPGD	0.15		0.15
Danilo Domenici	MPGD	0.1		0.1
Erika De Lucia	MPGD	0.1		0.1
Monica Bertani	MPGD	0.1		0.1
Marcello Rotondo	Fisica	0.1		0.1

Accel FTE 5.9

MPGD FTE 0.9

Fisica del B FTE 0.1

WP Acceleratore

Nuova attività sperimentale R&D MOCKUP IR: progetto finanziato dalla GE e dal CERN (nessuna richiesta su RD_FCC)

Richiesta: 2 tecnici meccanici 1 mese (0.1 FTE per il 2025) per assemblaggio component mockup IR

WP MPGD

Produzione di N.2 fogli 50x50 cm² di GEM **4 k€ Consumo**

Produzione di N.2 frame per le GEM in peek **2.5 k€ Consumo**

Test Beam 2025 (SJ) **5 k€ Missioni**

Responsabilità ai LNF:

Convener WP2 RD_FCC (M. Boscolo),
Convener WP5 RD_FCC (M. Poli Lerner),
Convener WG MDI FCC Feasibility Study (M. Boscolo)
M. Boscolo, **membro Executive Board FCC**
Rappresentante INFN nel **ICB** (M. Boscolo)
Componente **PED** coordination (M. Boscolo)
Componente technical coordination **TCG** (M. Boscolo)

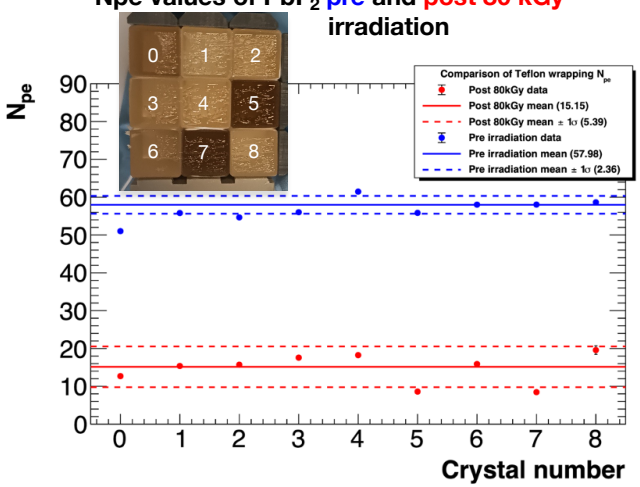
RD_MUCOL: CRystal calorImeter with Longitudinal InformatioN (CRILIN)

- ✓ High granularity, longitudinal segmentation, excellent timing
- ✓ Modular and flexible architecture with stackable sub-modules allows for design optimization
- ✓ 1x1x4 cm^3 PbF_2 Cherenkov crystals + dual, UV-extended 10μm SiPM readout

2024: Beam teast of Proto-1 @ BTF pre and after irradiation @ Casaccia

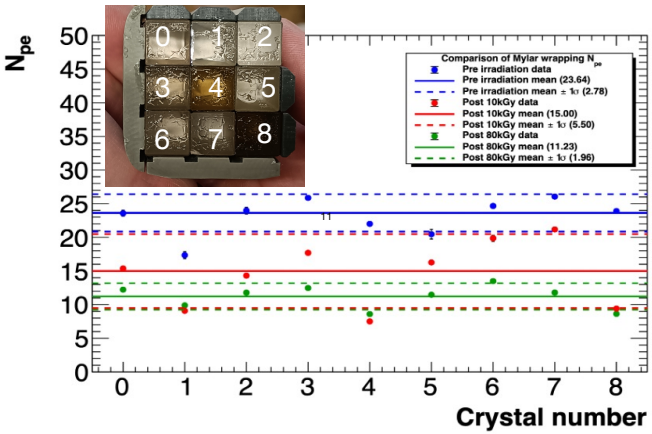
Telfon wrapping

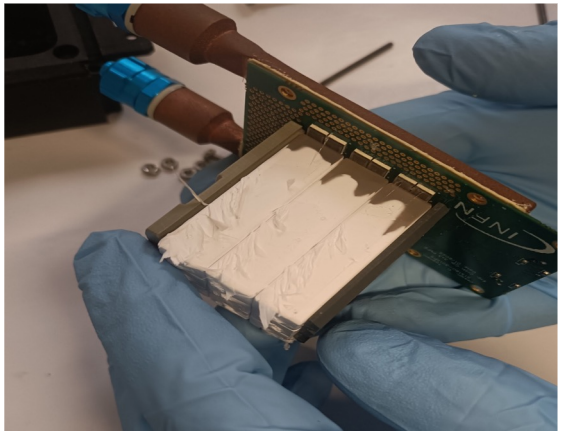
Npe values of PbF_2 pre and post 80 kGy irradiation

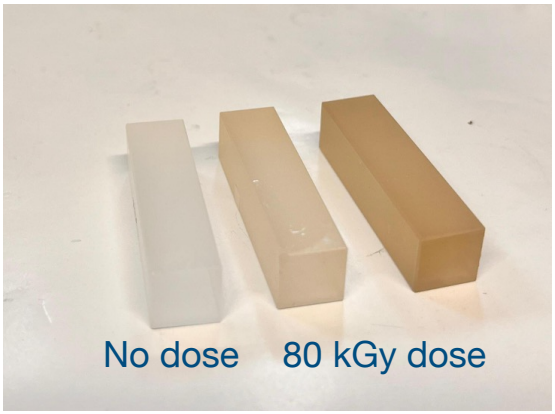


Mylar wrapping

Npe values of PbF_2 pre, after 10 kGy and after 80 kGy irradiation







- Two different wrappings tested, Teflon and Mylar
- Teflon was damaged and brittle
- Light Yield loss evaluated through variation in charge and number of photo-e^-
- Considerable variability in the crystals response to radiation, despite SICCAS claiming the use of high-purity (>99.9%) PbF_2 powder for crystal growth
- Crystals evident loss of transparency
- Transparency loss was uniform length-wise in the crystals
- SiPM pedestal increases significantly with the absorbed dose

- New test planned to evaluate SiPMs PDE loss and optical grease degradation

RD_MUCOL: CRystal calorImeter with Longitudinal InformatioN (CRILIN)

recap test beams 2023/24:

- ✓ σ_t < 40 ps for single crystals, for E_{dep} > 1 GeV
- ✓ **radiation resistance** ➔ huge disuniformity post-irradiation has been observed

solution could be ➔ PbWO-UF or LYSO in the first calorimeter layer

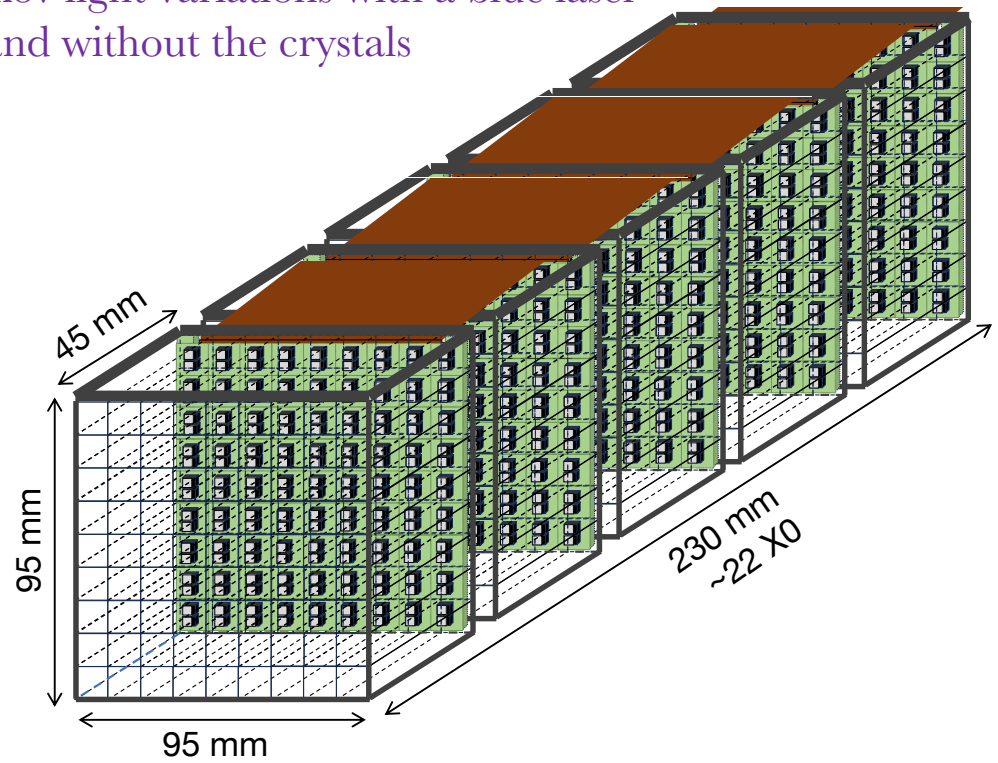
still we need to scrutinize the aging of the crystals and SiPMs:

- new irradiation tests monitoring the Cherenkov light variations with a blue laser
- with a simultaneous test of the SiPMs with and without the crystals

remind:

We submitted and won an Italian grant for the project CALORHINO: *An innovative radiation-hard calorimeter proposal for a future Muon Collider Experiment*

the grant is funding the development of a 5x5x4(layers) Crilin prototype: 1 M_R – 16.8 X_0



from DRD6-WP3

- ✓ funds to expand the PRIN prototype to a 9x9x5 (layers) configuration, with a target of 2 M_R – 22 X_0

RD_MUCOL: LNF **group & financial requests**

cognome	nome	note	profilo	perc
Cantone	Claudio		Tecnologo	20%
Cemmi	Alessia		Scientifica Dipendenti altri enti	25%
Colao	Francesco		Scientifica Dipendenti altri enti	20%
Di Sarcina	Ilaria		Scientifica Dipendenti altri enti	25%
Happacher	Fabio	+ 10% su PRIN_20229TBY8B in sinergia con RD_MUCOL	Primo Ricercatore	10%
Li Voti	Roberto		Scientifica Università	30%
Sarra	Ivano	+ 20% su PRIN_20229TBY8B in sinergia con RD_MUCOL	Tecnologo	20%
Scifo	Jessica		Scientifica Dipendenti altri enti	25%
Soleti	Stefano Roberto		Scientifica Enti stranieri	50%
Verna	Adriano		Scientifica Dipendenti altri enti	25%

TOT: FTE 2.5/10

RICHIESTE 2025		keuro	SJ
Consumi	Test irraggiamento con laser blu cristallo+SiPM e SiPM da solo a Casaccia fino a 80kGy	3.5	
	Scheda interfaccia mezzanine con board con asic TOPHIR2	5	
	Cavi interfaccia tra connettori sul kapton e mezzanine (x125 canali)	3	
Inventariabile	Modulo caen A5818 controllo digitizer		4.5
Missioni	Metabolismo 3.9 FTE	20	
	Test beam CRILIN al CERN ed attività correlate di integrazione		10
	Conferenze e riunioni in preparazione prossima Strategy	5	

DRD6 Crilin

Institute 1 : INFN-LNF, Frascati (Italy)

Institute 2 : INFN-Padova, Padova (Italy)

Institute 3 : INFN-Torino, Torino (Italy)

Institute 4 : INFN-Trieste, Trieste (Italy)

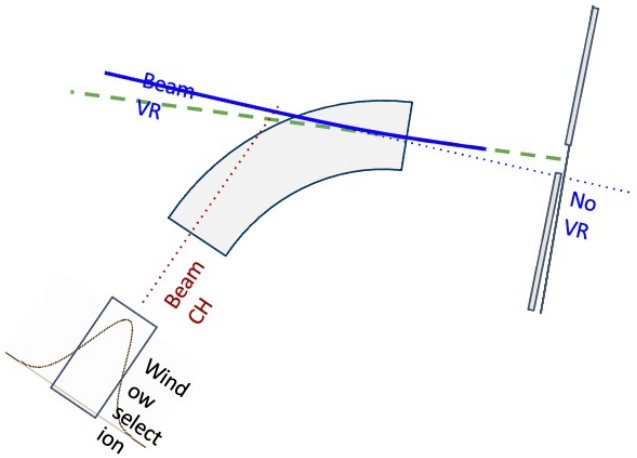
Institute 5 : HZDR, Dresden (Germany)

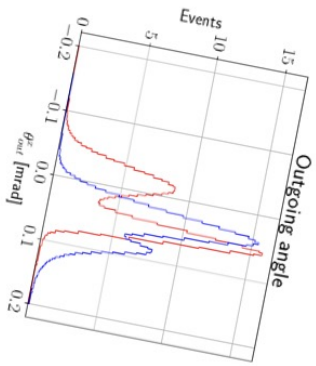
Institute 6 : DIPC, San Sebastián (Spain)

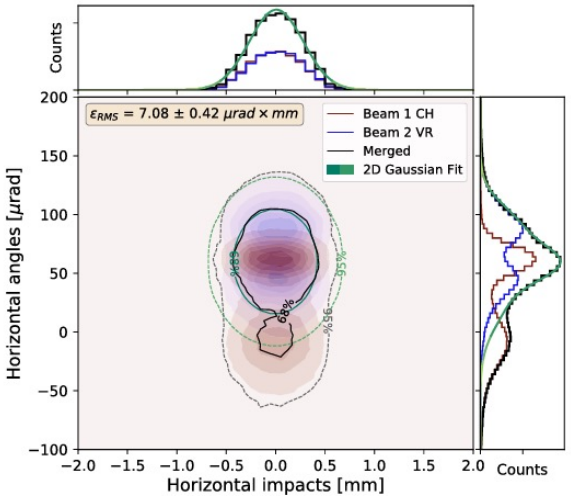
RICHIESTE DRD6 Crilin		keuro
Consumi	Mezzanine boards	40
Inventariabile	Moduli CAEN V2745 64ch x 4 board	80

UA9: beam merging crystal assisted

- ✓ Increase the bunch population without increasing the emittance gives a net increase of the Luminosity
- ✓ To merge two bunches in phase space ➔ a deflecting force must be applied to **only one bunch**
- ✓ Thanks to the coherent and not coherent motions, curved crystals can act as an angular filter ➔ Volume Reflection (VR), also if not perfectly efficient







Phase–space distribution density of the merged beam at the crystal exit face. The level contours highlight the 68% and the 95% fractions of the merged population (black dashed).

LNF contribution:

Beam dynamics and design studies of the beamline to carry the beam from the crystal exit up to the experimental area

[Scandale, W. et al. - Beam merging assisted by a bent crystal, Eur. Phys. J. Plus, Vol. 138 n. 11]

Anagrafica @ LNF:

1) ***A. Giribono .2 Resp. Locale***
2) ***S. Pioli .2***
3) ***C. Vaccarezza .1***

Gestione delle missioni centralizzate **nessuna richiesta** LNF **nel** 2025

CSN1, **conclusioni** - LNF

Fisica del sapore
Fisica dei leptoni carichi
Fisica dei neutrini
Dark sector
Frontiere dell'energia & nuovi acceleratori

- ATLAS
- BELLE II
- BESIII
- CMS
- DUNE
- GMINUS2
- IGNITE
- KLOE
- LHCb
- NA62
- PADME
- PMU2E
- RD_FCC
- RD_FLAVOUR
- RD_MUCOL
- UA9

✓ *L' attività scientifica* @ LNF *copre quasi tutte e aree tematiche della* CSN1

✓ *dando spesso contributi determinanti in tutte le fasi della vita di un esperimento: progettazione, costruzione, analisi dei dati*

✓ *molte richieste di supporto :*

- *upgrade in corso di ATLAS e CMS*
- *imminente installazione del calorimetro di PMU2E e probabilmente della CGEM IT di BESIII*
- *upgrade di PADME*
- *numerosi R&D in corso, LHCb, RD_FCC, RD_MUCOL*
- *imminente un nuovo R&D di Belle II*
- *DUNE spazi, servizi di supporto per la criogenia e per il magnete (presentazione dedicata)*

✓ *fondamentale mantenere e potenziare l'expertise dei nostri tecnici e le infrastrutture presenti nei nostri laboratori*

spares

Calcolo Scientifico a LNF: i DC del centro nazionale ICSC

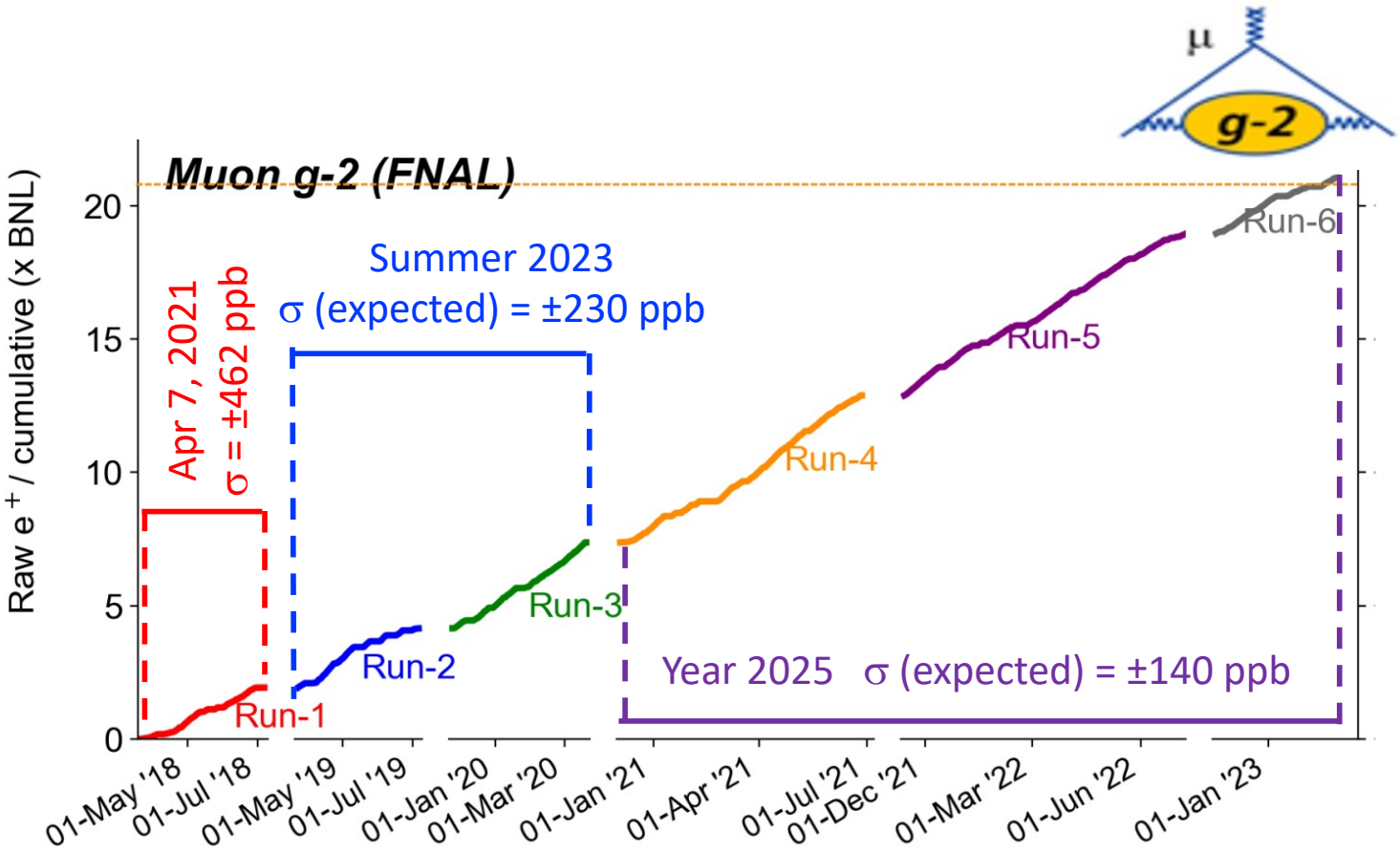
- ICSC - Spoke 0 – Consolidamento infrastruttura Tier2
  - 300k€ infrastruttura sala T2 (realizzazione isola corridoio freddo, impianto elettrico, condizionamento di backup, nuovi armadi)
- Con fondi PNRR 2023 sono state acquisite CPU e disco con gare nazionali per esperimenti e per I progetti del centro nazionale ICSC (WP3 DataCloud):
  - 2023/4 ~0.5M€ per il Tier2: CPU 50 kHS06, disco 2.4 PBr,
  - 2024/5:
    - DC Tier2: ~300 k€ CPU
    - DC HPC: ~ 200 k€ rete, ~ 1 M€ CPU, GPU, storage
    - LNF: ~70 k€ per sistema virt. in comune con il serv. calcolo
- ICSC – Spoke 0 – Realizzazione DC Space Economy
- 5.7 M€ per la realizzazione nel nuovo edificio acquisito di un DC di ~ 400 mq, cabina elettrica per supportare fino a 1.2 MW di carico IT, raffreddamento misto ad aria e DLC (~400 kW per sistemi a media densità, ~800kW per sistemi ad alta densità con raffreddamento DLC), possibilità di espansione se necessario.
- Personale: 3 persone assunte TD 2y: 2 T3 e un C6, un ulteriore T3per 1y concorso in atto

g-2 at LNF

The experiment reached the TDR statistical goal in March 2023

Since then, data taking is focused on systematic studies (detailed beam structure, magnet calibration, etc.)

Termine della presa dati per l'esperimento g-2: 8 luglio 2023



INFN ha la leadership di una delle misure della frequenza di precessione dello spin dei mu (w_a): waEuropa con Italia+UK

Attivita' g-2 @ LNF nel 2024

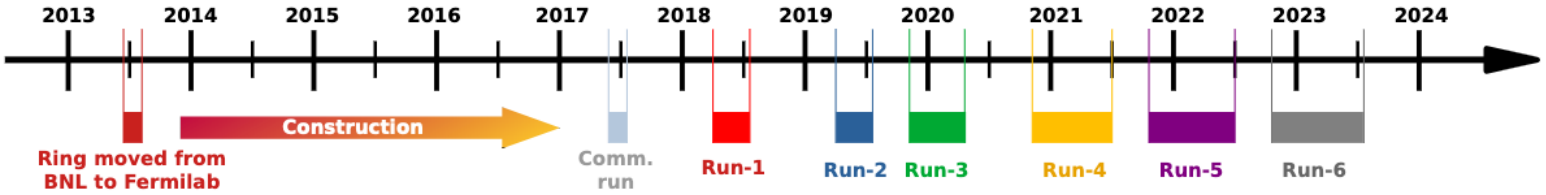
- analisi dei run 4/5/6
- advanced beam dynamics calculations within the scope of g-2 for future concepts ***[PLB 839 (2023) 137789]***

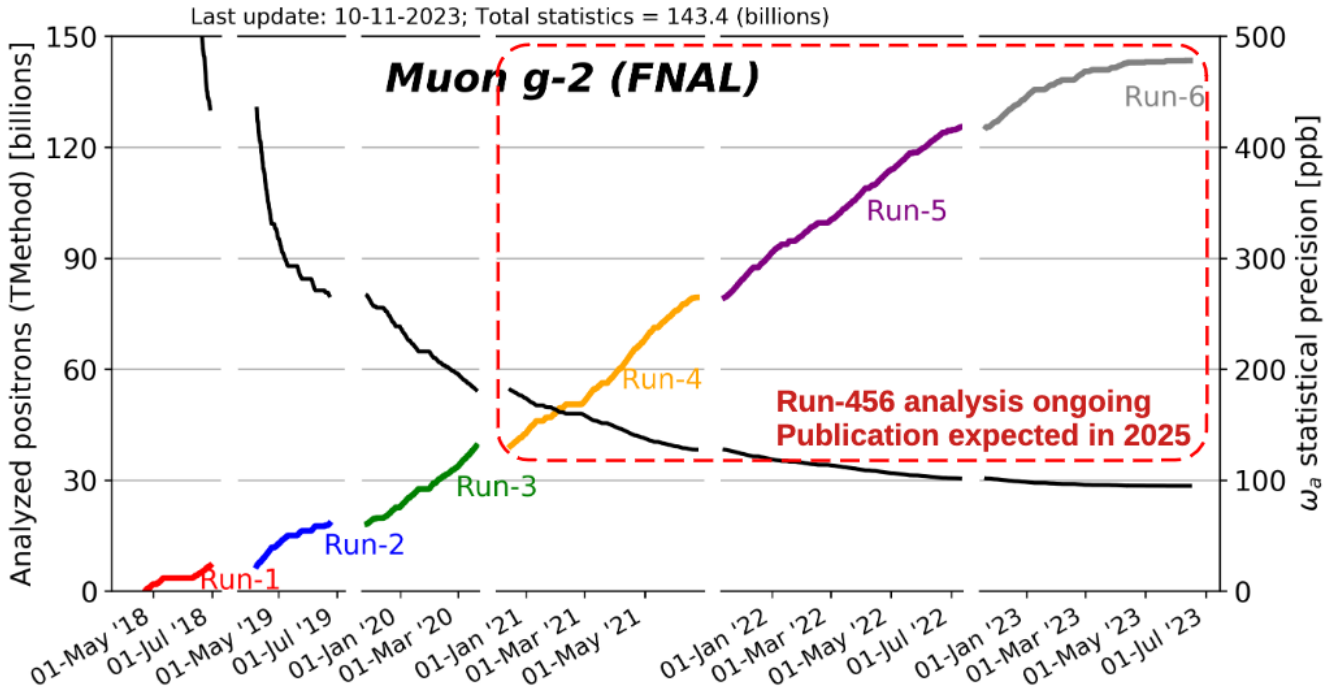
@ Personale FTE (effective)

S. Dabagov – 35%

D. Hampai – 10%

What's next

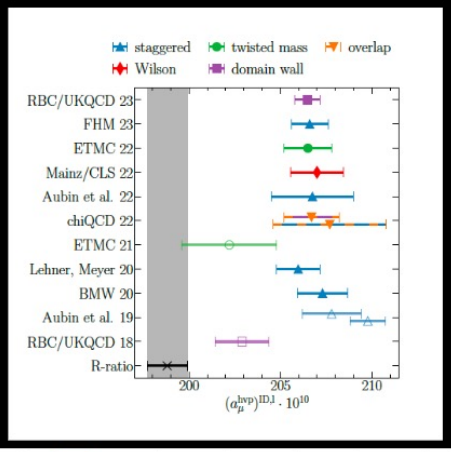

2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Construction
Ring moved from BNL to Fermilab
Comm. run
Run-1
Run-2
Run-3
Run-4
Run-5
Run-6


Last update: 10-11-2023; Total statistics = 143.4 (billions)
Muon g-2 (FNAL)
Analyzed positrons (TMethod) [billions]
ω_a statistical precision [ppb]
Run-1
Run-2
Run-3
Run-4
Run-5
Run-6
Run-456 analysis ongoing
Publication expected in 2025
01-May '18
01-Jul '18
01-May '19
01-Jul '19
01-Jan '20
01-Mar '20
01-Jan '21
01-Mar '21
01-May '21
01-Jan '22
01-Mar '22
01-May '22
01-Jul '22
01-Jan '23
01-Mar '23
01-May '23
01-Jul '23

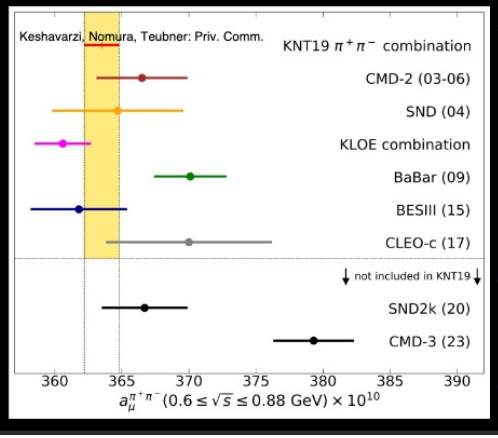
KLOE-2

- New analysis of the hadronic cross section started with the Initial State Radiation method (e+e- --> pi+ pi- gamma) with the 1.7 fb^{-1} sample of 2004-2005 data – Liverpool University group joined in 2023 (G.Venanzoni et al.) – renewed interest after results from CMD-3 hadronic cross-section with energy scan

Comparison with SM prediction (2023)



HVP from **lattice** (intermediate region~ 1/3 a_μ^{HLO})



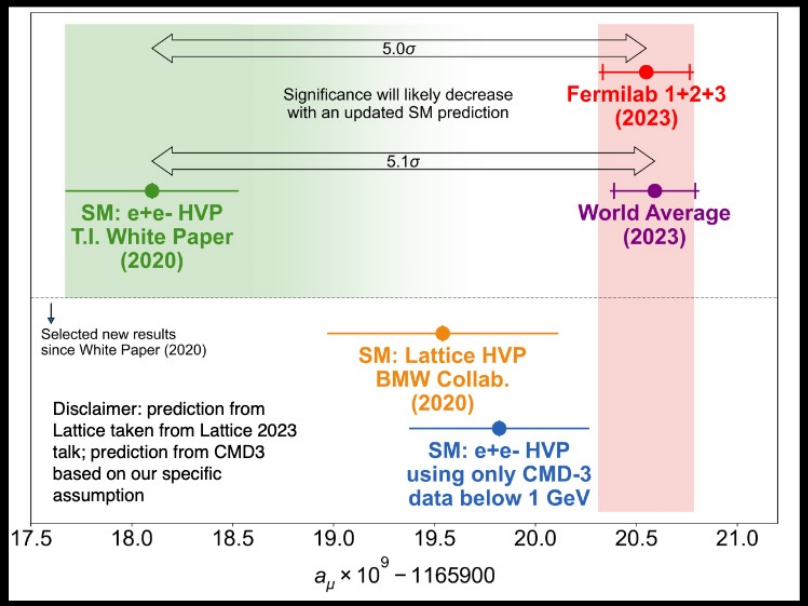
inc. in wp20

HVP from **data** (2π dominant channel)

NOT inc. in wp20

Comparison with wp20

New results after 2020



- Comparison of FNAL Run1-3 result with the Theory Initiative's calculation **wp20** is at **5 sigma**
- Waiting for a clarification of the theory (see (https://muon-gm2-theory.illinois.edu/)

65

LHCb

- restarted data taking at $\mathcal{L}$ up to 2×10^{33} cm^{-2}s^{-1} (x5 $\mathcal{L}$ Run 2)
- upgrade detector qualified to accumulate 50 fb^{-1} ➔

upgrade all sub-detector electronics to 40 MHz readout
make all trigger decision in software and some new detectors

VELO from microstrip sensors (R,ϕ) to 55×55 μm^2 pixel sensors closer to the beam, from 5.5 mm to 3.5 mm

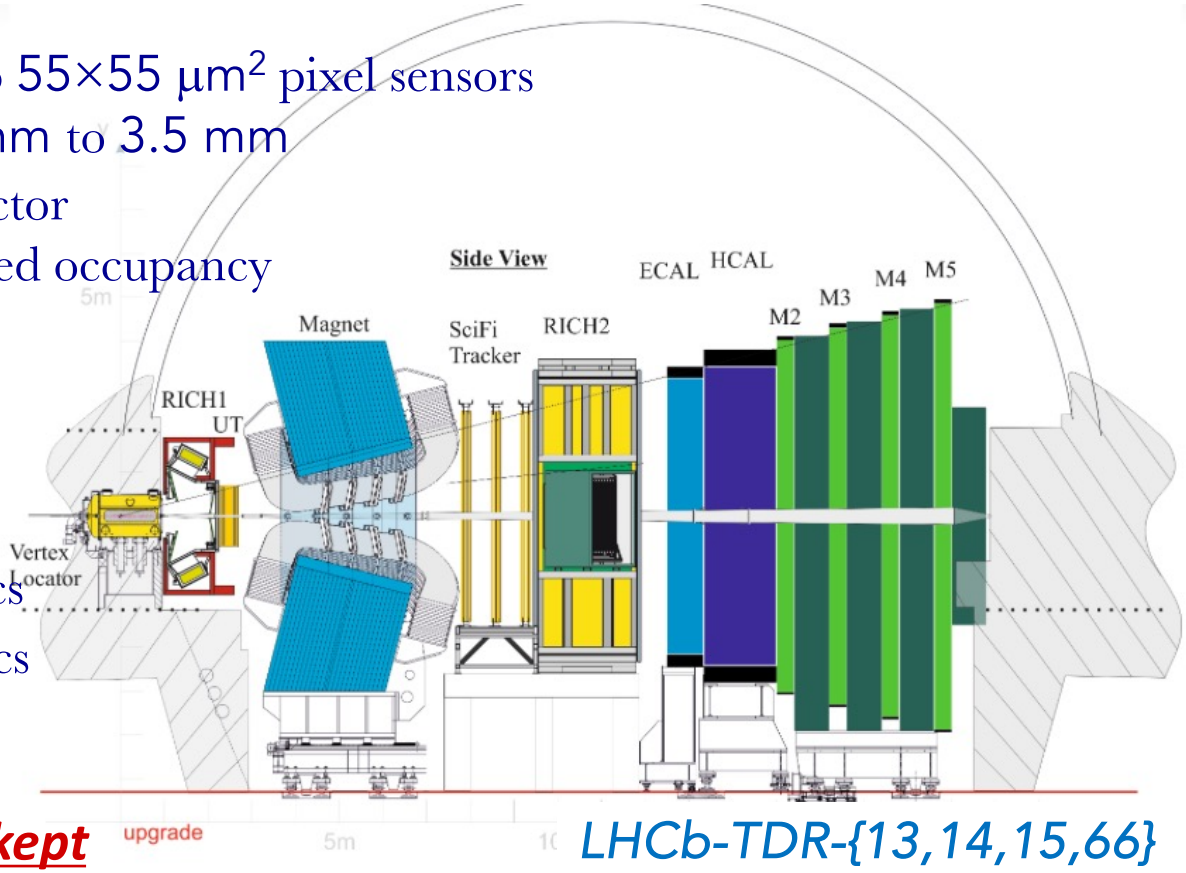
Upstream Tracker silicon strip detector adapt segmentation to increased occupancy

SciFi Tracker 3 stations of X-U-V-X scintillating fibre planes

PID new photodetectors for RICH1 and RICH2

Calorimetry new readout electronics

Muon System new readout electronics



➔ ***less than 10% of all channels kept***

LHCb-TDR-{13,14,15,66}