

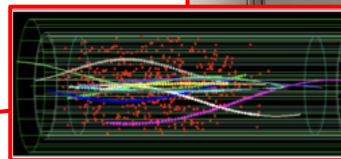
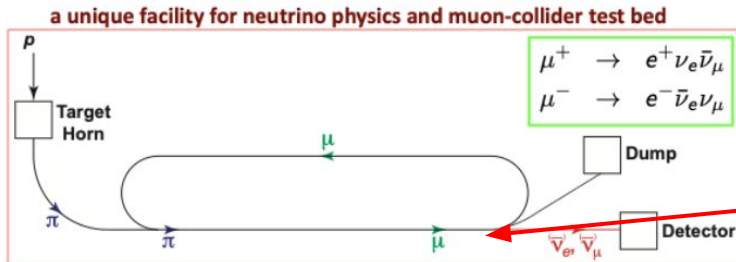
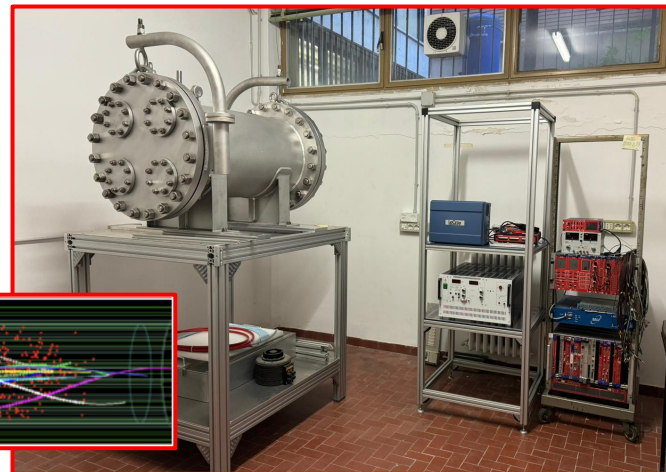
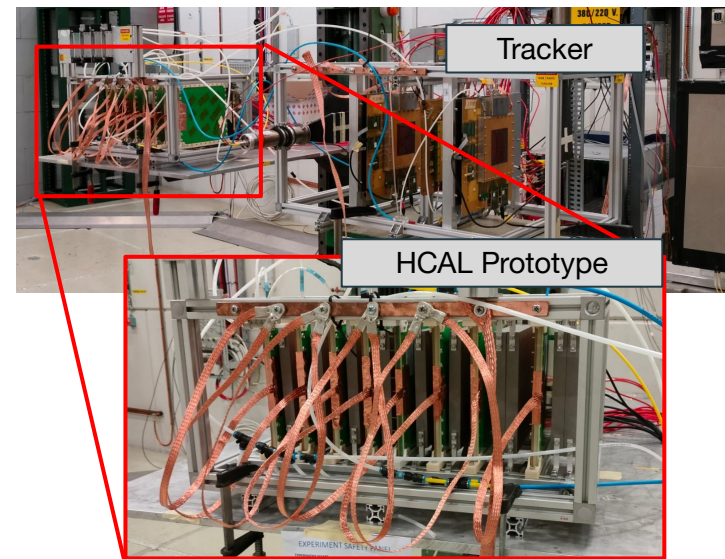
RD_MuColl – INFN Bari

Anagrafica e Richieste servizi di sezione

L. Longo

Meeting CSN1 Bari - 25 Giugno 2025

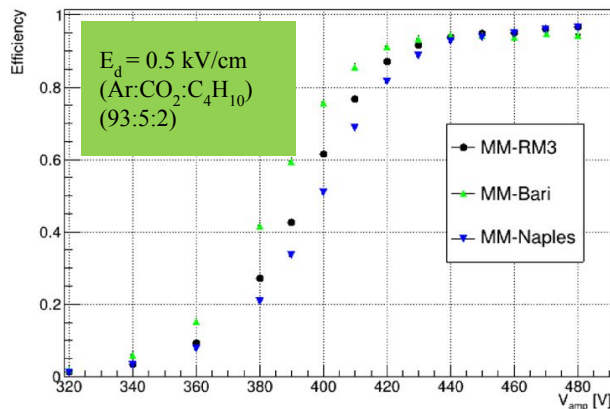
- Sviluppo di un prototipo di calorimetro adronico a sampling basato su Micro Pattern Gaseous Detector, MPGD-HCAL (DRD1-WP5/DRD6-WP1):
 - Bari DRD6 contact: L. Longo
 - DRD6-WP1 MPGD-HCAL contact: L. Longo
- Sviluppo di un prototipo di TPC con readout ottico da utilizzare per beam monitoring al dimostratore del muon collider → sinergico con lo sviluppo di una TPC come mezzo attivo (DRD1-WP4/WP8)
 - DRD1-WP4/WP8 TPC contact: E. Radicioni



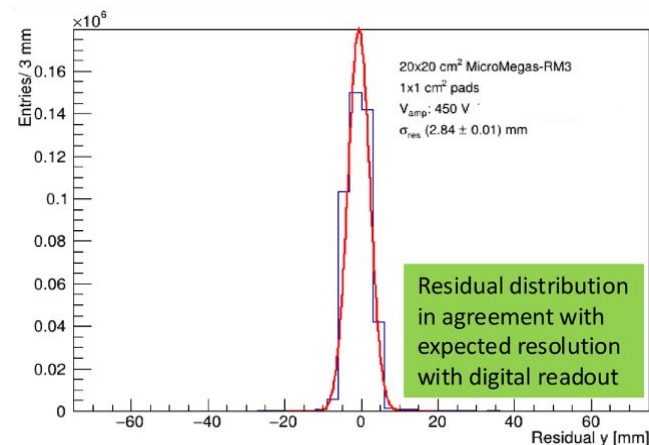
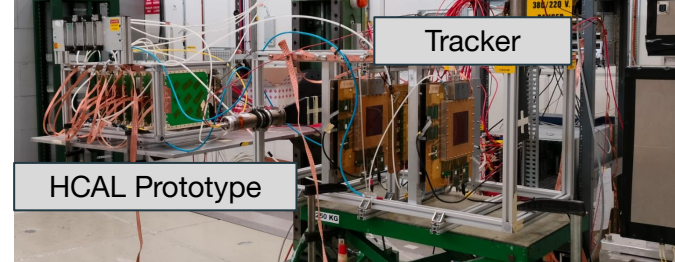
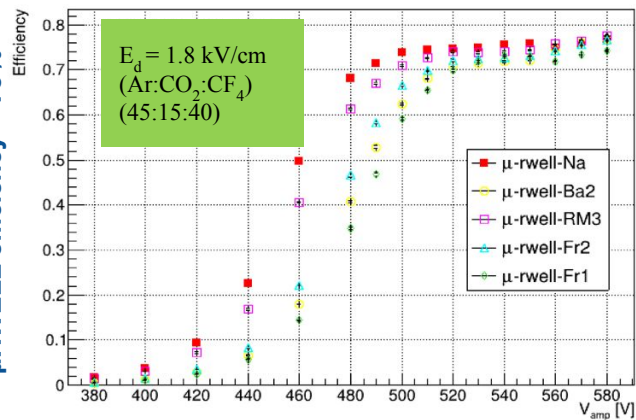
- **Sviluppo di un prototipo di calorimetro adronico a sampling basato su Micro Pattern Gaseous Detector, MPGD-HCAL (DRD1-WP5/DRD6-WP1):**
 - Testbeam 2024: SPS testbeam per caratterizzazione delle camere (Giugno 26-Luglio 10 2024, Settembre 18-Ottobre 2 2024), PS per la caratterizzazione del prototipo di cella calorimetrica a 8 layer (Luglio 10-24 2024)
 - progettazione e realizzazione di 2 camere Micromegas e 2 μ RWELL 50x50cm²:
 - rimessa in funzione del vecchio cosmic teststand del GDD lab al CERN per la caratterizzazione delle 4 camere in previsione del testbeam di ottobre; un summer student ed un borsista infn per la caratterizzazione
 - progettazione e realizzazione della struttura meccanica della cella calorimetrica, contenente 8 camere da 20x20 cm² e 4 camere 50x50cm²
 - Testbeam 2025: PS per la caratterizzazione del nuovo prototipo a 12 layer, 8 20x20cm² + 4 50x50cm² (Ottobre 15-29 2025)
 - studio della possibile elettronica alternativa → al momento si stanno utilizzando gli APV:
 - VMM3a → una camere μ RWELL testata durante il secondo SPS testbeam del 2024
 - FATIC3 → goal: testarli entro la fine dell'anno
 - Simulation:
 - impatto di una calibrazione basata sul BDT sia per una simulazione standalone in Geant4 che per quella sviluppata all'interno del muon collider framework:
 - Impatto sulle performance di MPGD-HCAL della geometria a 10 TeV di muon collider
 - Conferenze/workshop: [ICHEP2024](#), [MPGD2024](#), [VCI2025](#), [IFAE2025](#), [13thBTTB](#), [CEPC2025](#), [EPS2025](#)

MPGDHCAL: testbeam

Micromegas efficiency ~ 95%



μ RWELL efficiency ~ 75%



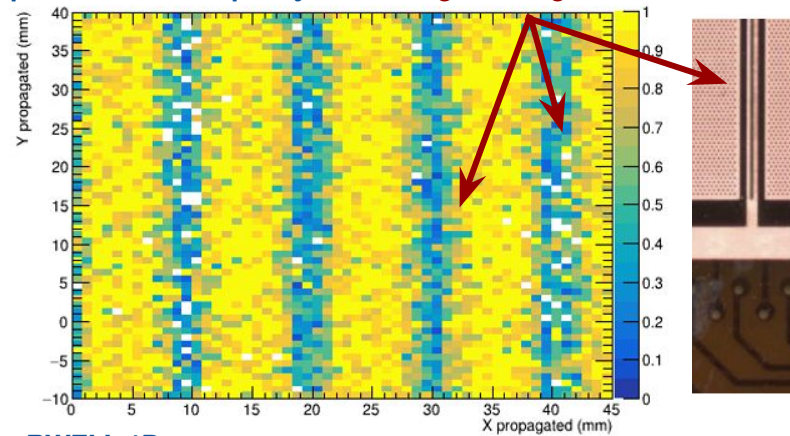
Similar spacial resolution (~3mm) for both technologies

Lower efficiency for μ RWELL → understood that the effect is due to the DLC ground lines

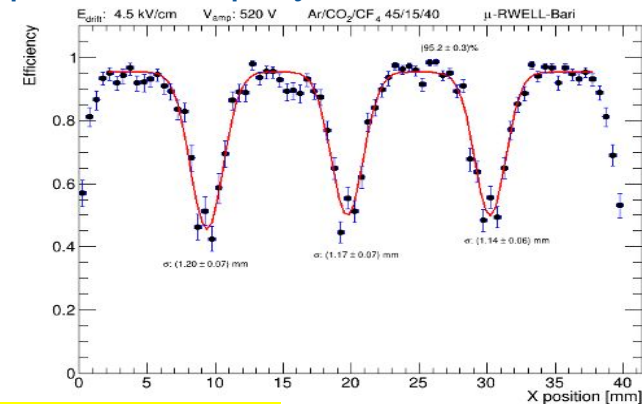


MPGDHCAL: testbeam

μ RWELL 2D occupancy

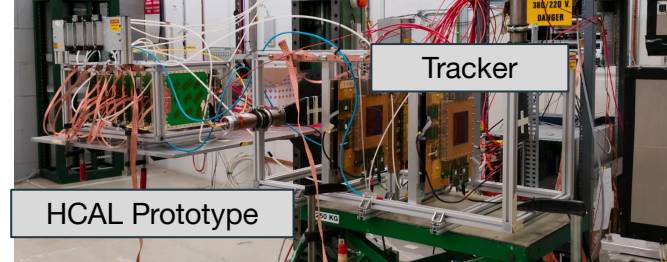


μ RWELL 1D occupancy

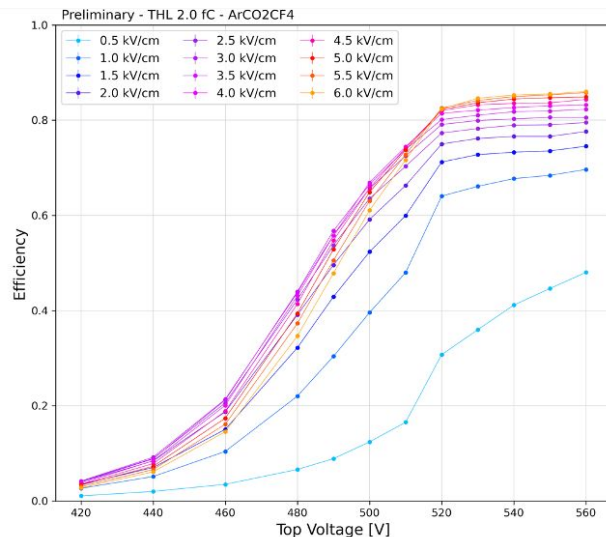


Credits to A. Stamerra

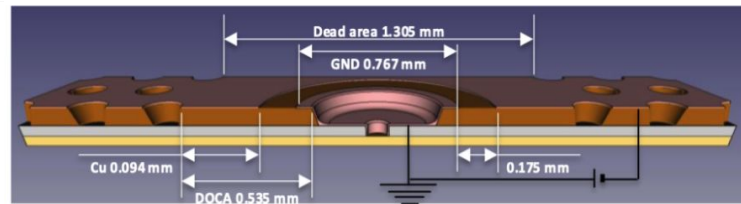
Decided to produce the new 50x50cm² with a different grounding: Dot-grounds



Credits to L. Generoso



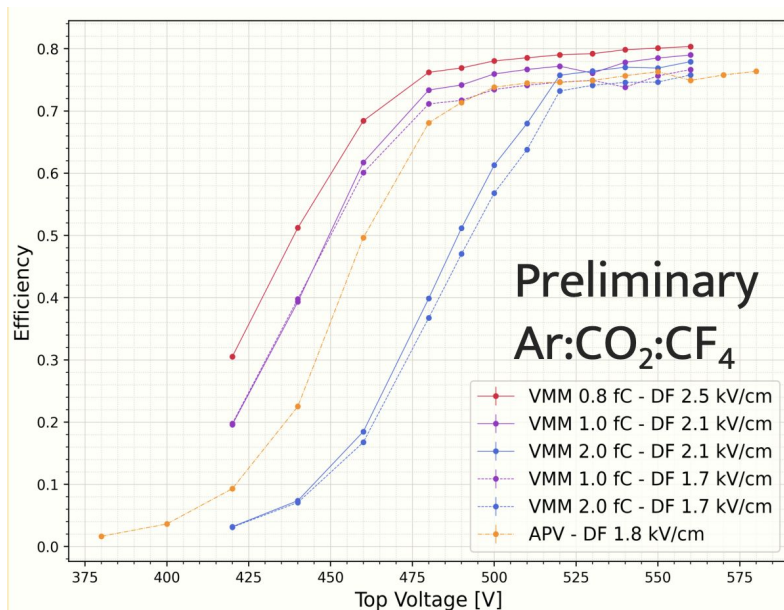
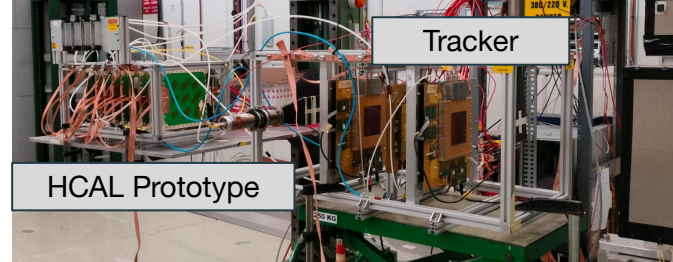
- **Locally very high efficiency ~ 95%**
- Ground lines introduce regions of ~ 1 mm with ~50% efficiency drop
- **Inefficiency regions can be partially recovered increasing drift field**



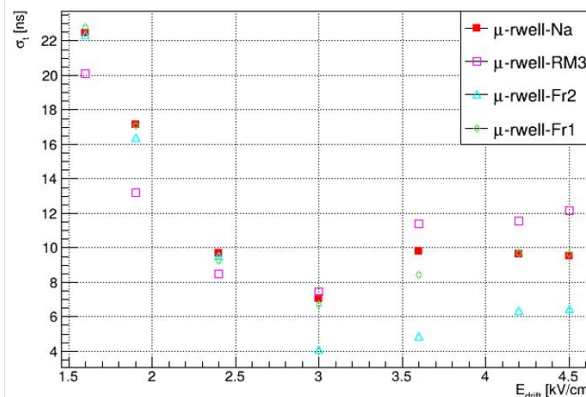
MPGDHCAL: testbeam

μ RWELL tested with different electronics (APV vs VMM):

- Results well in agreement
- timing w/ $\text{Ar}:\text{CO}_2:\text{CF}_4 \rightarrow$ few ns ($\sim 6\text{ns}$) with Drift field of 3 kV/cm; similar results with different electronics



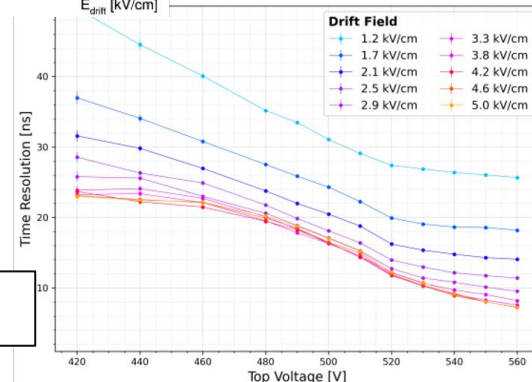
Credits to L. Generoso



APV electronics

Credits to A. Stamerra

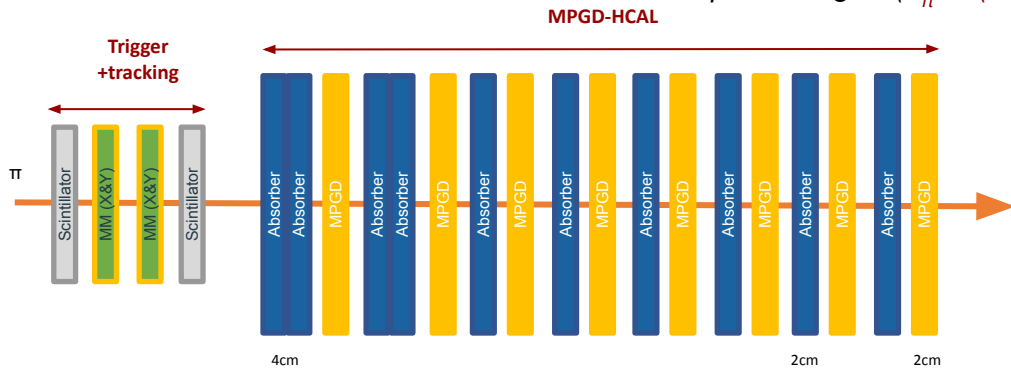
Electronics VMM



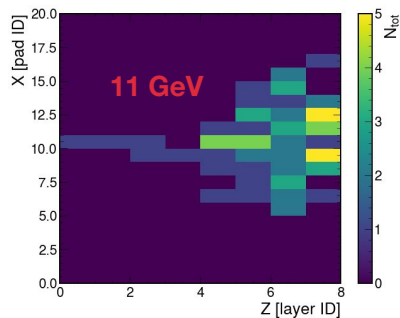
INFN MPGDHCAL: testbeam

HCAL prototype: PS testbeam data under study

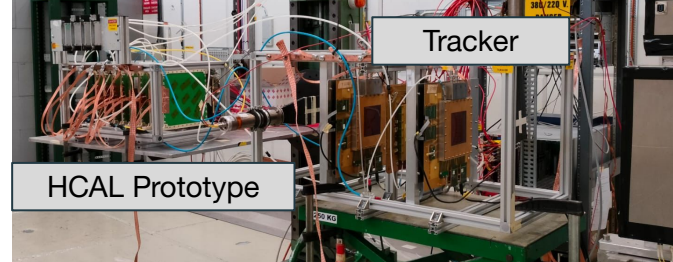
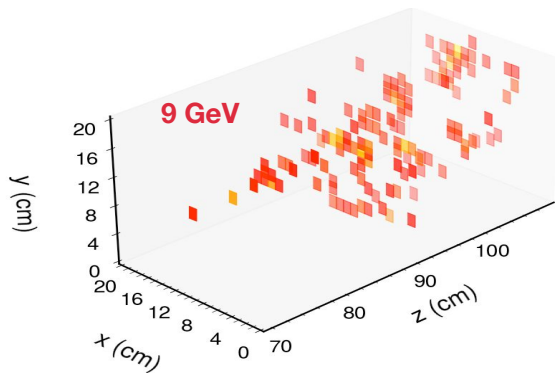
Number of hits distributions for MC and data at different pion energies ($E_\pi = f^{-1}(\langle N_{hit} \rangle)$)



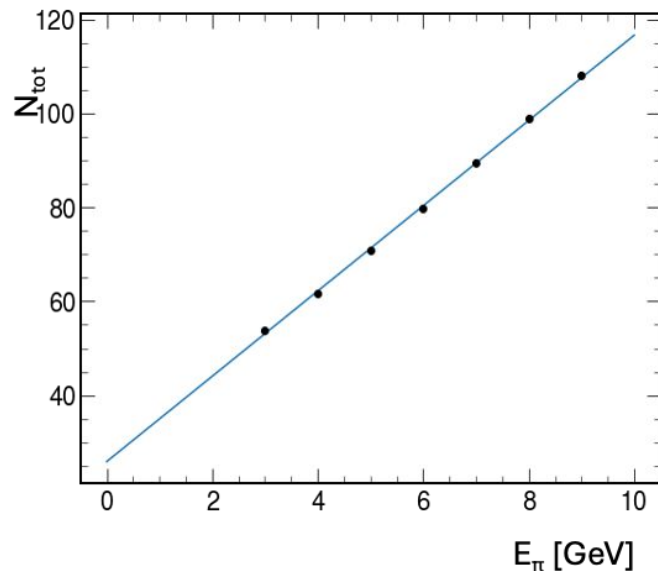
Credits to A. Pellecchia



Idea to include a RPC layer as timing layer



Credits to A. Stamerra



Good linearity between total number of hits and impinging pion energy

MPGDHCAL: new prototype fully constructed in Bari

• Triple-GEM tracker

- Moveable to scan entire surface

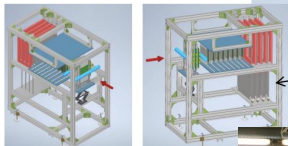
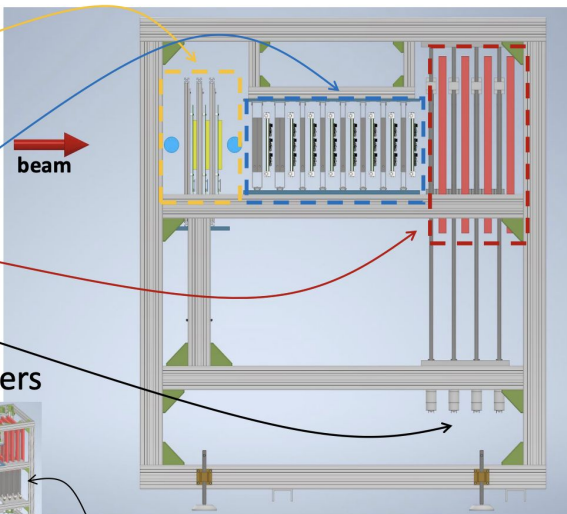
• 1λ with $20 \times 20 \text{ cm}^2$

- 8 dets, $8 \times 2 \text{ cm}$ steel

• 1λ with $50 \times 50 \text{ cm}^2$

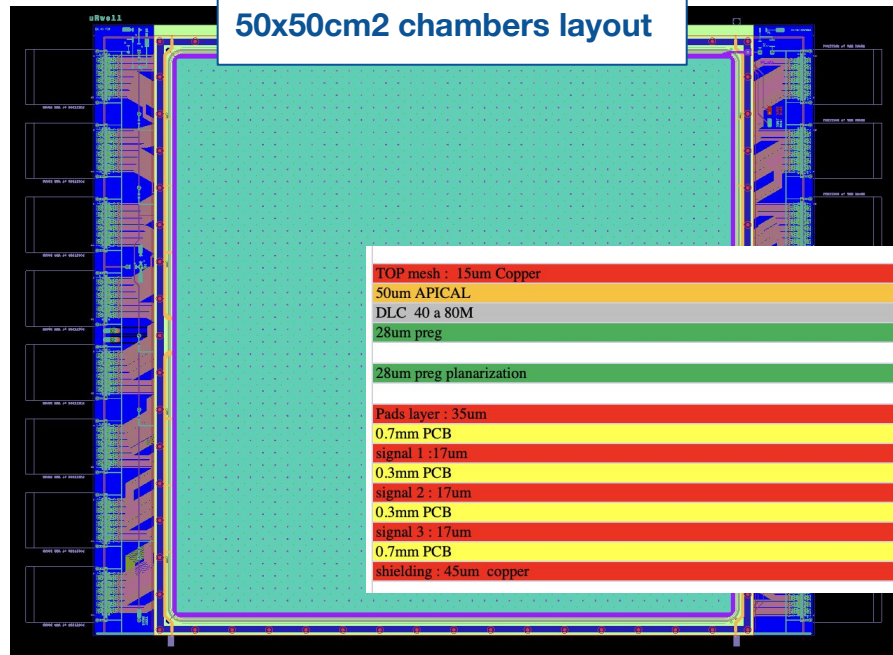
- 4 dets, $4 \times 4 \text{ cm}$ steel

- Allows to insert / extract steel absorbers



Un grazie agli attori coinvolti per la progettazione, la realizzazione in officina e la parte di elettronica per la movimentazione sicura delle lastre

50x50cm² chambers layout

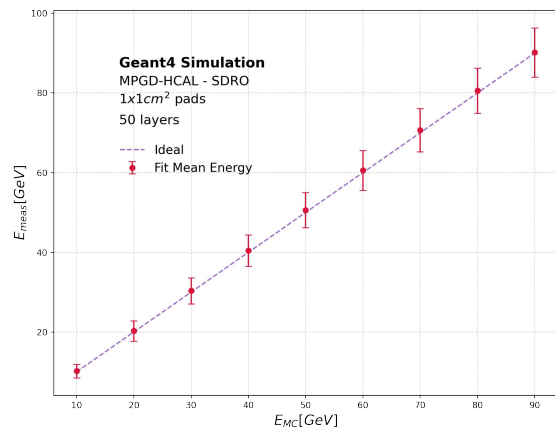
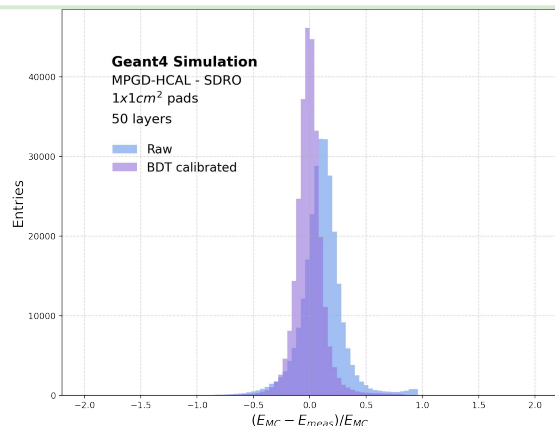


- Improved the gas distribution with a dedicated manifold within the drift support frame
- Reduced the cross-talk increasing the distance between pads layer and first signal layer to 0.7mm and between signal lines
- Production expected by August

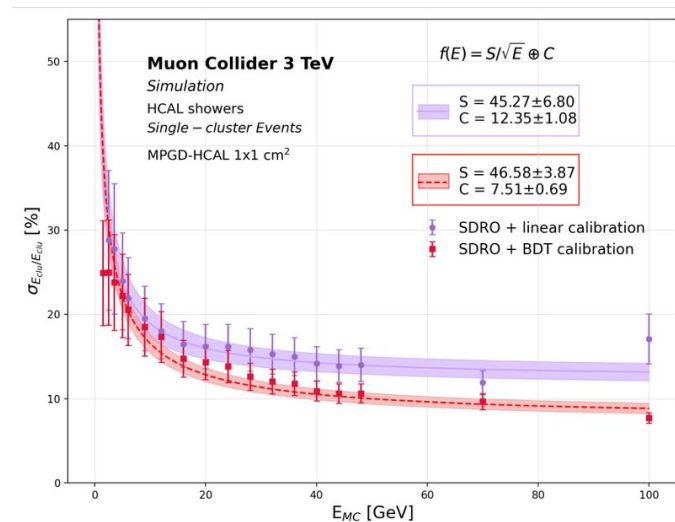
MPGDHCAL: Simulation - Energy BDT calibration

Calibrated energy = **BDT output coefficient** x Raw cluster energy, estimated with semi-digital readout

Credits to L. Generoso



Muon Collider framework



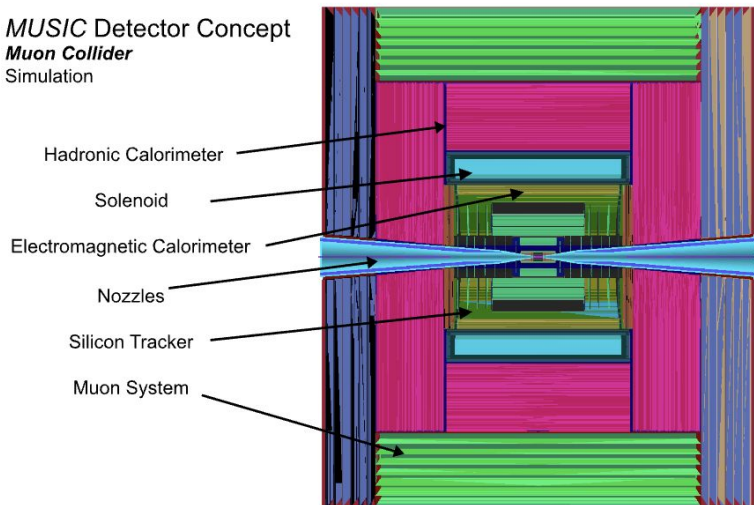
- **GEANT4:**
 - **Energy response improved** in the BDT calibrated shower energy: tighter peak, symmetrically centered in 0
 - **Good linearity** of the **reconstructed energy** with respect to the **MC true energy**
- **MuColl:**
 - compatible stochastic term $S \sim 45\%$
 - **Significant reduction of the constant term C: $12\% \rightarrow 7\%$**

MPGDHCAL: Simulation - 10 TeV

Evaluated the impact of the MUSIC detecto concept (for a MuCol at 10 Tev) on a MPGDHCAL

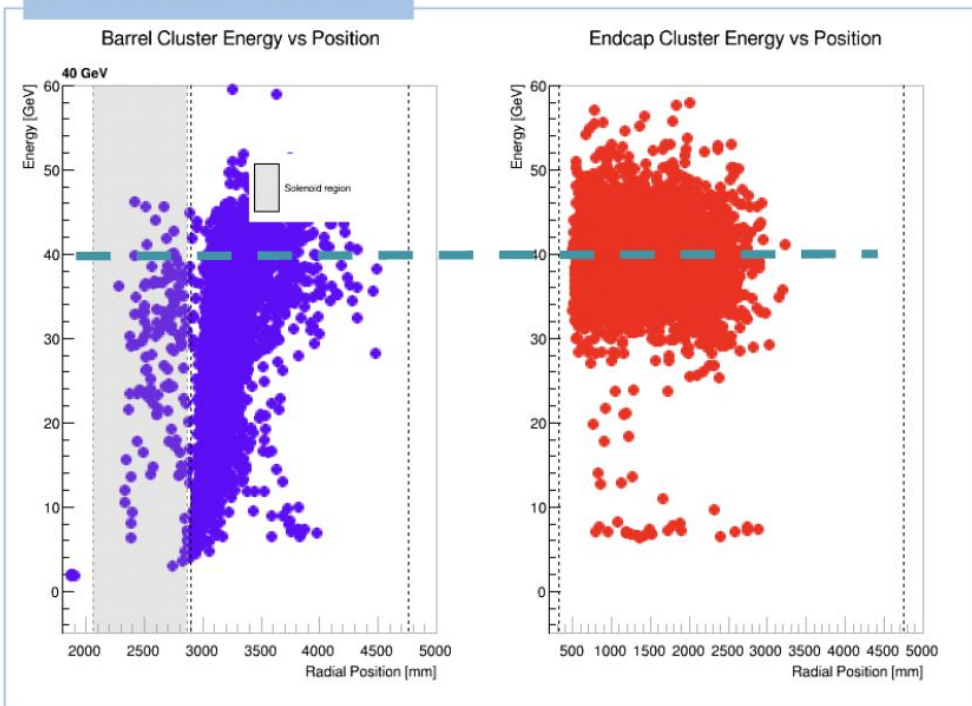
- **Solenoid between ECal and HCAL**

MUSIC Detector Concept
Muon Collider
Simulation



True Energy = 40 GeV

Credits to M. Maniscalco



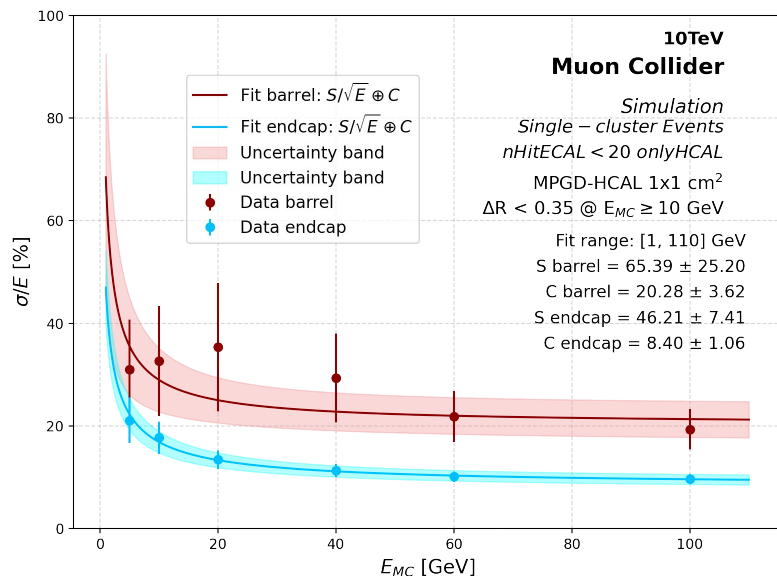
Depending of the hadrons energy, the **shower can initiate in the solenoid**:

- part of the shower is lost
- **Barycenter of the cluster** falls in the **solenoid region** or close to the **boundary** between **HCAL** and **solenoid**
- **Reconstructed energy** shifts towards **lower values**

MPGDHCAL: Simulation - 10 TeV

Credits to M. Maniscalco

Impact of the solenoid on HCAL - pions gun

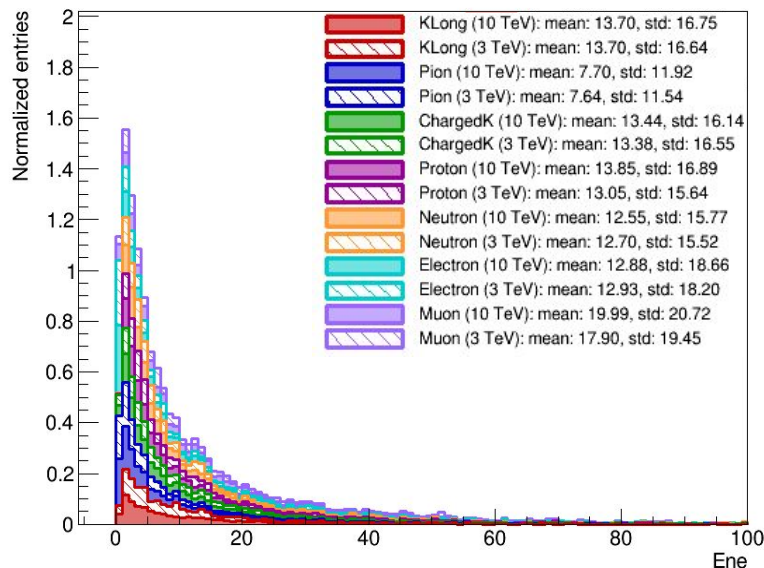


- **End-cap resolution compatible with 3 TeV, even with better constant term:**
 - Improvement thanks to the 10 extra layers
- **Worsening of barrel resolution:**
 - Further development needed to recover the hadrons showering in the solenoid

Effect of the solenoid on MPGD-HCAL cannot be disregarded:

- $H \rightarrow b\bar{b}$ @ 10 TeV generated to assess jet composition and energy spectra of the jet constituents:
 - **Similar energy spectra between 3 and 10 TeV**
 - **Higher constituents multiplicity**

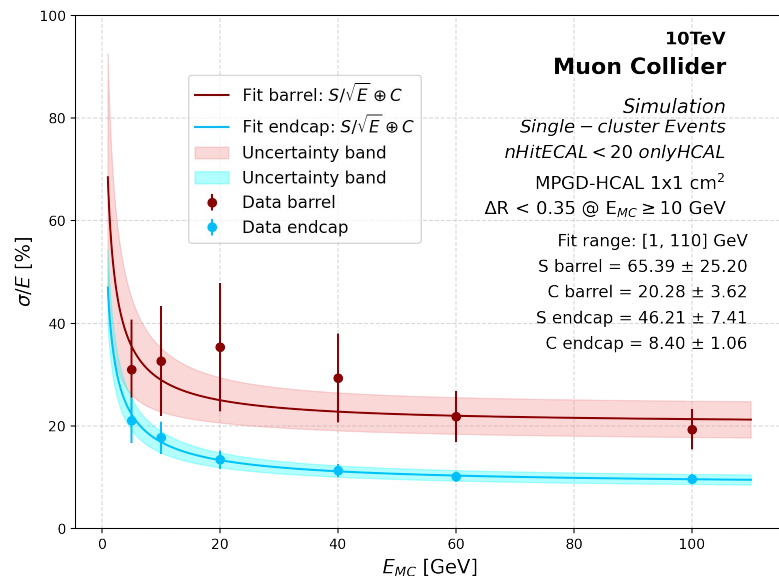
Ene Stacked (10 vs 3 TeV)



MPGDHCAL: Simulation - 10 TeV

Credits to M. Maniscalco

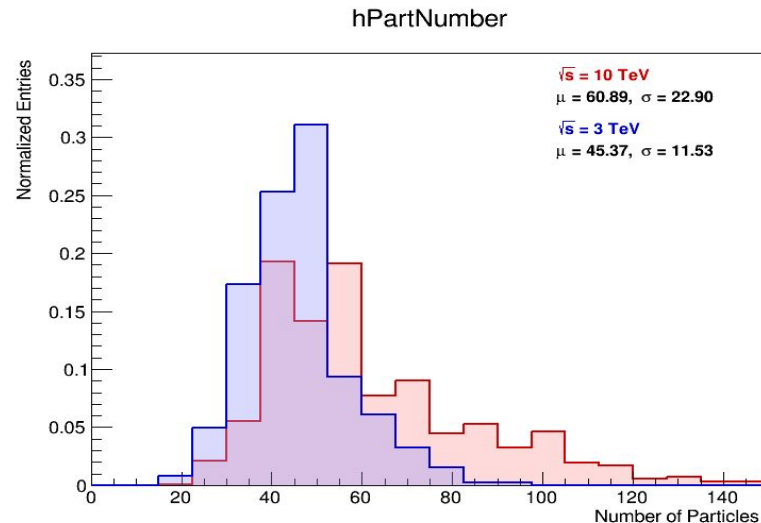
Impact of the solenoid on HCAL - pions gun



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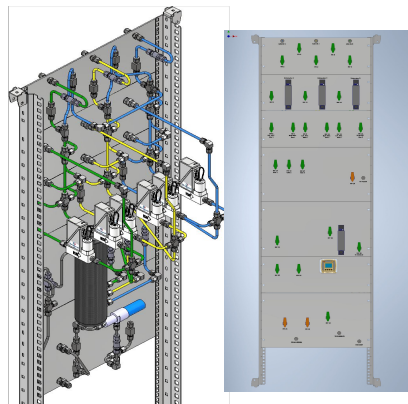
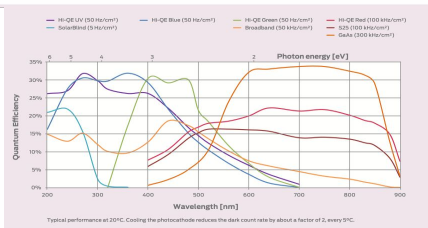
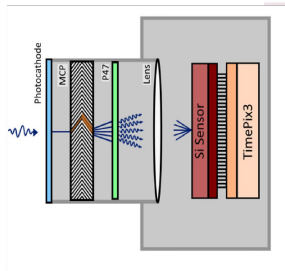
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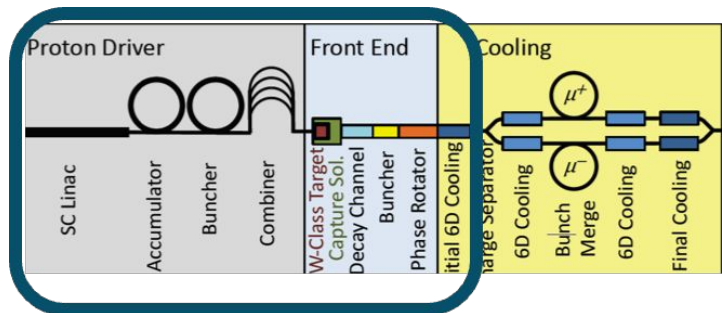
TPC: Attività 2025 → 2026

- Sviluppo di un prototipo di TPC con readout ottico da utilizzare per beam monitoring al dimostratore del muon collider → sinergico con lo sviluppo di una TPC come mezzo attivo (DRD1-WP4/WP8)
 - Vessel:
 - posizionato sul suo tavolo
 - modifica della flangia per permettere l'utilizzo del vessel tra i 100-200mbar ai 10 bar → il basso range in pressione puo' essere sfruttato per un muon monitor leggero al dimostratore
 - HV/LV elettronica: acquistata
 - Gas system:
 - Design finalizzato ed acquisti effettuati
 - Realizzazione entro l'estate del 2025
 - Acquisto di un image intensifier sensibile al rosso/infrarosso
 - Field cage: design cominciato
 - Thick GEMs: design pronto, acquisto da finalizzare

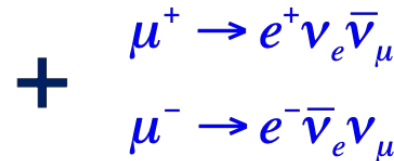
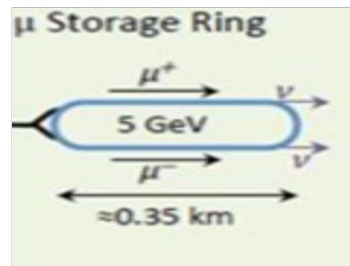


Per la realizzazione del readout ottico sono necessari Obiettivo Fotografico e ThickGEM, rimandati al finanziamento DRD mai (o per lo meno non ancora) avvenuto

INFN A Low energy Neutrino beam as first stage for MuColl



First intense ν_e and $\bar{\nu}_e$ Beam in the world !!



- neutrino beams via muon decay in the straight section of a storage ring.
- Key advantages of generating neutrino beams from muon decays rather than meson decays are:
 - The absolute neutrino flux can be accurately determined, provided the stored muon current, momentum, and polarization are carefully measured.
 - The beam contains only one type of neutrino and one type of antineutrino, with their identities controllable by selecting the charge of the stored muons.
 - This enables precise measurements of ν_e , $\bar{\nu}_e$, ν_μ , and $\bar{\nu}_\mu$.

Physics Motivation:

- Neutrino X-sections measurements in this range are very few, old and show large discrepancies
- The lack of those information can bias or reduce the sensibility of the future generation Neutrino Oscillation experiments

Contribution for the European Strategy, paper under preparation

Credits to G. Catanesi, E. Radicioni



RD_MuColl: richieste

Per il calorimetro, si è applicato alla call di gr5 con il progetto INCANTO (InNovative CALorimeters for New Topologies and Operation)
 RL: R. Venditti, WP4 HCAL coordinator: L.Longo. Le richieste finanziarie incluse nella call sono evidenziate nei commenti ma verranno richieste a rd_mucol se il progetto non passasse.

MPGDHCAL: richieste

Capitolo	Descrizione	Costi (K-EUR)	Commenti
consumo	Gas: Fornitura di gas tecnici per operazioni di test su MPGD e rivelatori associati [DRD1-WP5, DRD6-WP1]	5.00	INCANTO
consumo	Produzione di 2 prototipi di catodo con drift gap sottile da utilizzare nei layer attivi di HCAL [DRD1-WP5, DRD6-WP1]	5.00	INCANTO
consumo	Testboard per il chip di lettura CALOROC (o chip analogo) ai fini della valutazione delle prestazioni di questo ASIC accoppiato con i rivelatori Micromegas e micro-rwell utilizzati nel prototipo di MPGDHCAL, in vista della scelta dell'elettronica di lettura finale. La stima e' fatta basandosi sui costi della serie di chip ROC prodotti dalla WeeROC (https://www.weeroc.com/read-out-chips/). [DRD1-WP5, DRD6-WP1]	3.50	INCANTO
consumo	Frontend board con chip di lettura PSIROC A5205/DT5205 (con picotdc) distribuito dalla CAEN. La quotazione non e' attualmente disponibile (la board non è sul catalogo 2025 ma sara' inclusa nel catalogo 2026) ma il prezzo dovrebbe essere simile al frontend board FERS-5200 [DRD1-WP5, DRD6-WP1].	8.50	INCANTO
consumo	Produzione di adattatori da connettori HRS a connettori per modulo FERS o testboard da impiegare sia su camere 50x50cm2 che su camere 20x20cm2 ai fini della valutazione delle prestazioni di questo ASIC accoppiato con i rivelatori Micromegas e µrwell utilizzati in MPGDHCAL, in vista della scelta dell'elettronica di lettura finale [DRD1-WP5, DRD6-WP1].	0.50	INCANTO
consumo	Elettronica VMM per equipaggiare un rivelatore MPGD 50x50 cm^2 per studi di caratterizzazione (efficienza e risoluzione temporale) al variare della gap di drift e della miscela di gas. Il sistema VMM comprende le seguenti voci: 1) 16 ibridi VMM (12.2 ke) 2) 2 schede DVMM (3.8 ke) 3) 2 schede FEC (3.7 ke) 4) 1 crate SRS (1.5 ke) 5) 2 power box per gli ibridi complete di cavi di distribuzione (1k). Le quotazioni si riferiscono ai costi indicati sul mercato del CERN. [DRD1-WP5, DRD6-WP1].	22.50	INCANTO
trasporti	Material transportation: Spedizione di moduli e componenti per HCAL verso siti di test	2.00	INCANTO

RD_MuColl: richieste

Per il calorimetro, si è applicato alla call di Common Project di DRD1 con il progetto *Industrialisation of Resistive Bulk Micromegas*, con contatto locale L. Longo

MPGDHCAL: richieste

Capitolo	Descrizione	Costi (K-EUR)	Commenti
consumo	CommonProject request for Industrialization of Resistive Bulk Micromegas; acquisto di materiale per la realizzazione di prototipi di test at ELTOS [DRD1-WP5]	5.00	COMMON PROJECT
consumo	Acquisto di materiale per la modifica della struttura meccanica per renderla un cosmic stand (o realizzazione di un piccolo setup) da sfruttare per la caratterizzazione delle camere con drift gap sottili e nuove miscele [DRD6-WP1]	5.00	
consumo	Materiale per testbeam	2.5	
consumo	Realizzazione di due prototipi RPC a timing spinto, da impiegare all'interno della struttura calorimetrica come reference temporale [DRD1-WP7]	7.00	
consumo	Mass Flow Meter per studi di miscele di gas [DRD1-WP1]	5.00	
consumo	Spese manutenzione laboratorio MPGD	1.00	
missioni	Missioni per test alla GIF++ per studi su ecomiscele	3.00	
missioni	Missione per testbeam calorimetro	15.00	
missioni	Missioni per caratterizzazione RPC	7.00	

Per la TPC, potrebbero essere incluse altre voci di missione legate all'attività del dimostratore

TPC: richieste

Capitolo	Descrizione	Costi (K-EUR)	Commenti
consumo	TimePix4 per la realizzazione della lettura ottica della TPC [DRD1-WP4/WP8]	40	
consumo	Obiettivo fotografico [DRD1-WP4/WP8]	5	
consumo	2 thichGEM [DRD1-WP4/WP8]	4	
consumo	Field cage [DRD1-WP4/WP8]	5	
consumo	HV cables and connectors [DRD1-WP4/WP8]	2	
consumo	Gas + mechanical supports [DRD1-WP4/WP8]	3	



Anagrafica

Preliminare

PERSONA		RD_MUCOL
Nome	Cognome	%FTE
Ali	Muhammad	100
Catanesi	Maria Gabriella	
Colaleo	Anna	20
Creanza	Donato Maria	20
Fiore	Luigi	
Generoso	Lisa	20
Iaselli	Giuseppe	50
Longo	Luigi	30
Maggi	Marcello	30
Pellecchia	Antonello	30
Pugliese	Gabriella	10
Radicioni	Emilio	30
Radogna	Raffaella	10
Ramos	Dayron	10
Simone	Federica	20
Smy	Salvatore	10
Spina	Roberto	30
Stamerra	Anna	30
Venditti	Rosamaria	30
Verwilligen	Piet Omer J	10
Zaza	Angela	30

- **TotFTE: 5.2, in crescita rispetto allo scorso anno**

Richieste di servizi di sezione

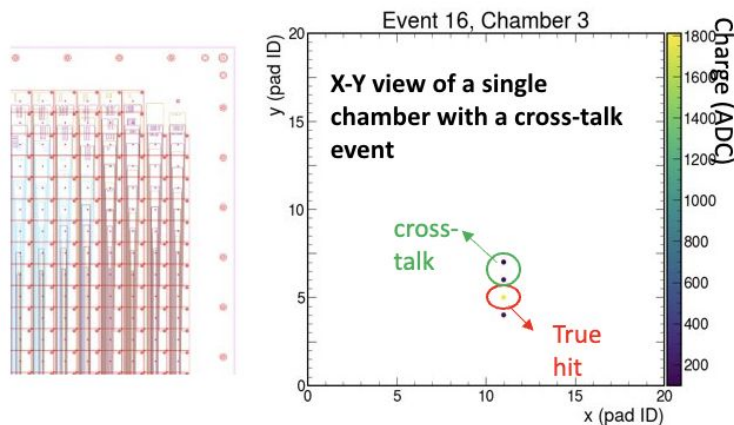
Servizio	MP	Motivazione	Stato
Progettazione Meccanica	0.5	• Possibile update della struttura meccanica contenute per renderla un cosmic stand o realizzazione di un cosmic setup da sfruttare per la caratterizzazione delle camere	Richiesta da sottomettere
Officina meccanica	1.5	• Implementazione delle modifiche alla struttura meccanica o realizzazione di un cosmic setup per le camere del calorimetro	Richiesta da sottomettere
Servizio elettronico	1	• Supporto per la lettura dei layer attivi (basati su tecnologia MPGD) del prototipo di un calorimetro adronico per un futuro esperimento al Muon Collider con FATIC3 • Produzione di adattatori da connettori HRS a connettori per modulo FERS o testboard	Richiesta da sottomettere



Backup

Cluster reconstruction

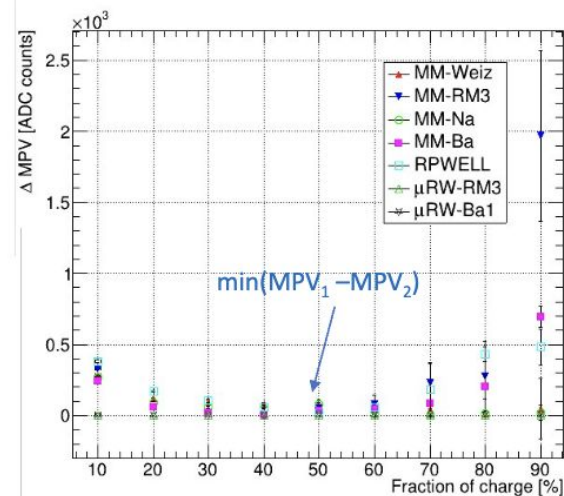
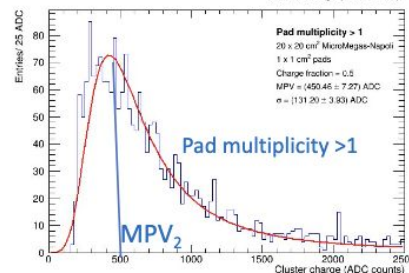
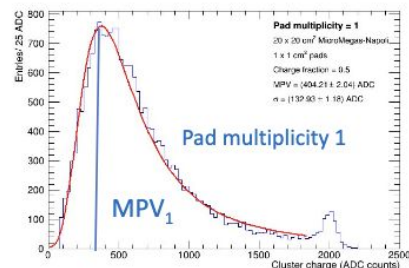
Preliminary



High probability of cross-talk effect observed among adjacent pads due to routing of the vias connecting pads to the connectors

Developed ad-hoc clustering algorithm based on charge sharing criterium

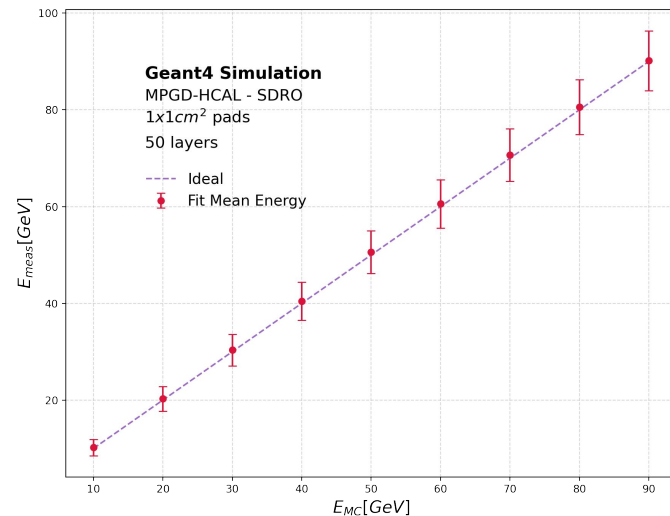
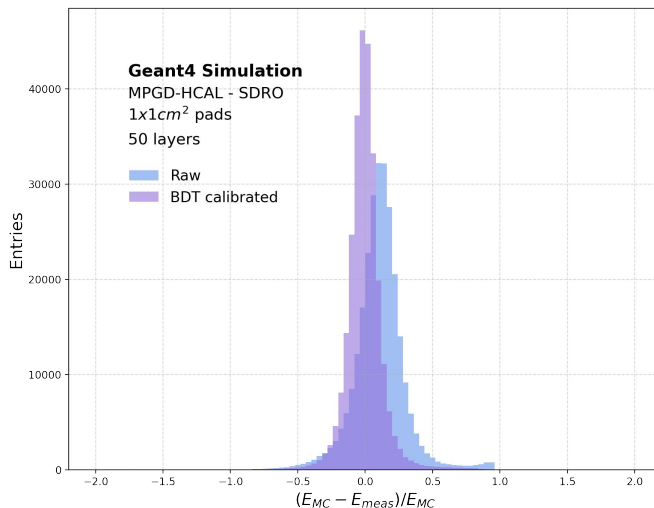
- Selected pad with highest charge $Q_{\max}$
- Add a second pad if $Q = 50\% Q_{\max}$



Simulation: BDT for energy calibration

Purpose: improve the energy calibration, linearity and resolution of monochromatic $\pi^\pm$ guns in the GEANT4 Simulation

- only 50 layers considered
- energy range: [10,90] GeV
- calibrated energy = **BDT coefficient** X Semi-digital energy estimate
- **Input Features :**
 - Number of hits in the whole HCAL
 - Shower energy reconstructed with 3-level semi-digital read-out
 - Number of hits in the 3 energy ranges
 - Number of hits per layer
 - Energy Fraction per layer
 - X, Y, and Z centroid (weighted by the hit energy)
 - Standard dev of hit coordinate X & Y per layer



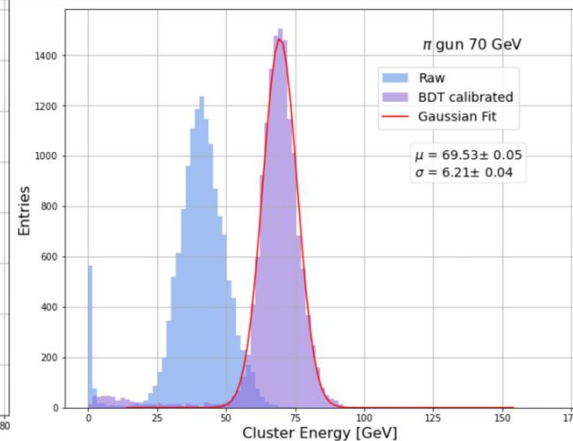
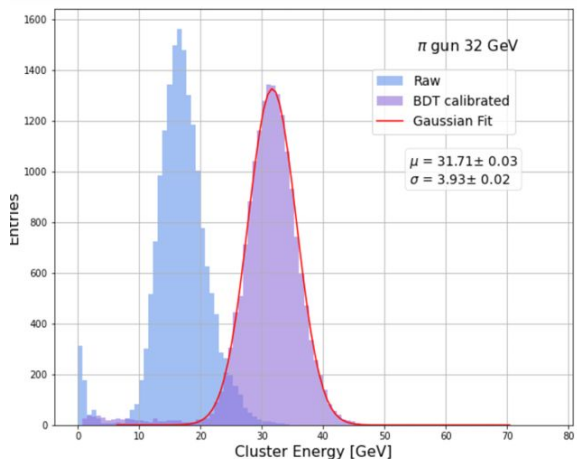
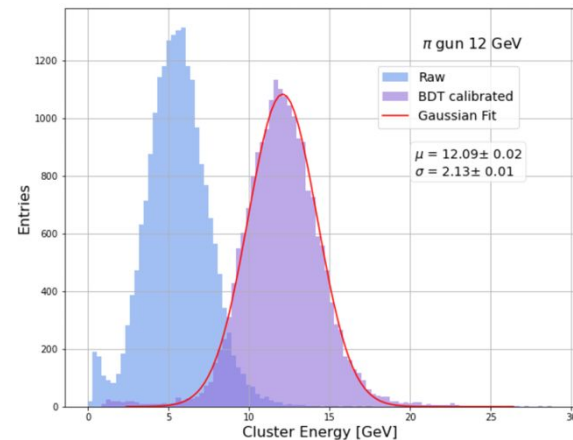
- **Energy response improved** in the BDT calibrated shower energy:
 - Tighter peak, symmetrically centered in 0
- **Good linearity** of the **reconstructed energy** with respect to the **MC true energy**

Semi-digital readout with BDT calibration

Calibrated energy = BDT output coefficient x Raw cluster energy

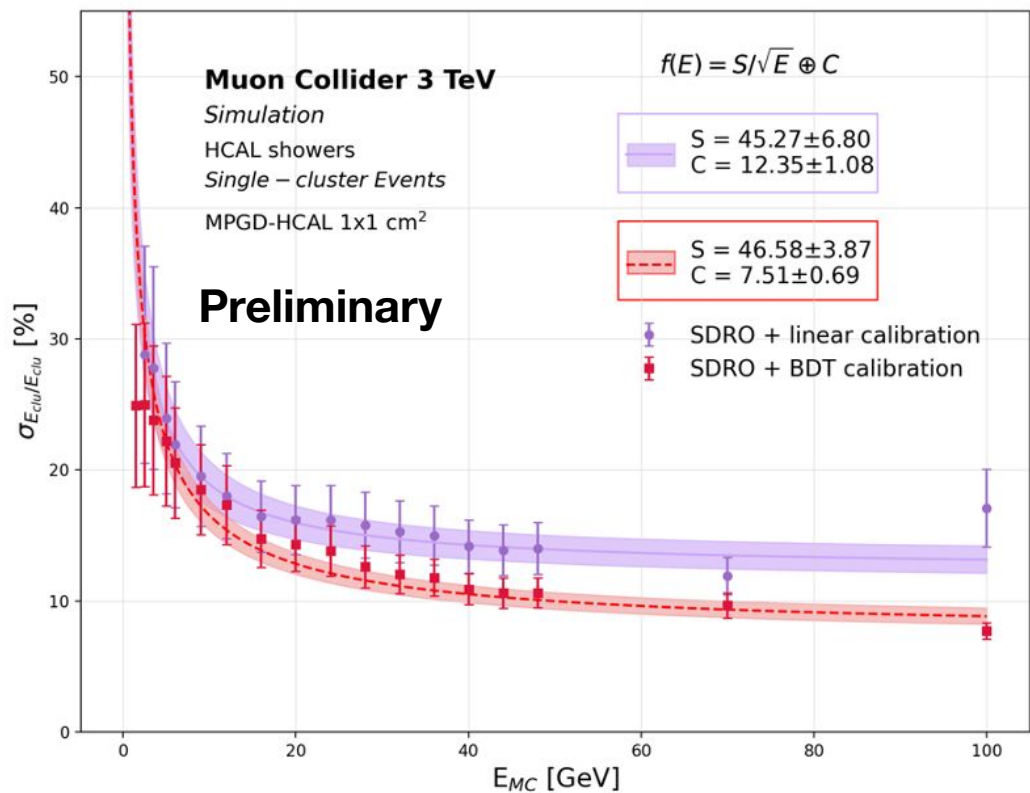
BDT implementation details

- **XGBoost** squared-error regression
- **Features dataset from pandora:**
 - Cluster energy and 3D centroid position
 - (Cluster size) / ln (cluster energy + 1)
 - Number of hits in ECAL and in HCAL
 - Number of HCAL hits below and above the 2nd threshold of the semi-digital RO
 - Total energy in ECAL and in HCAL
 - Total fraction of hits/energy in ECAL and in HCAL
 - Number of hits for each layer of ECAL and HCAL
 - Energy Fraction for each layer of ECAL and HCAL



Semi-digital readout with BDT calibration

Calibrated energy = **BDT output coefficient** x Raw cluster energy



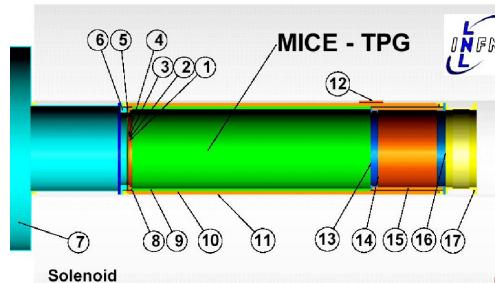
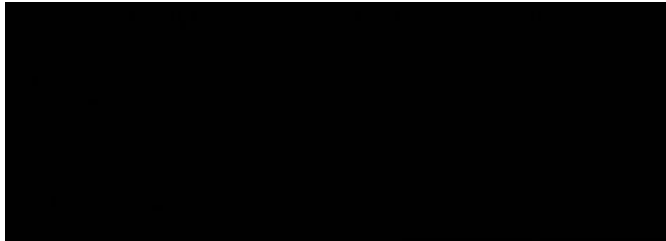
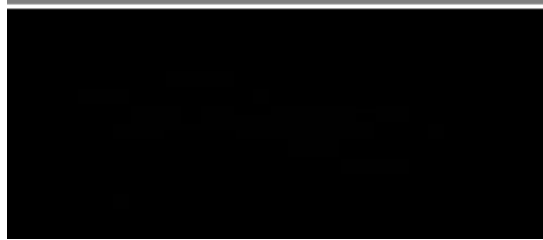
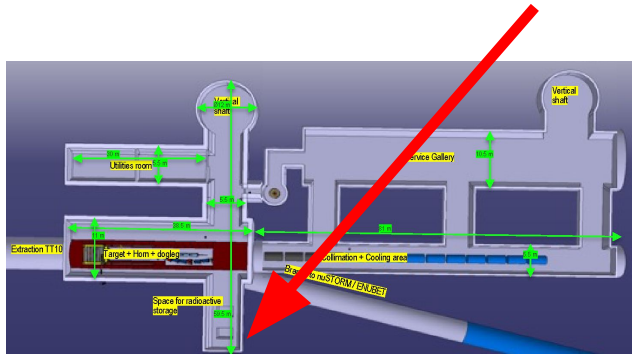
- **only pions not showering in ECAL;**
- fit function $f(E) = S/\sqrt{E} \oplus C$;
- **Better energy resolution for $E_{MC} > 10$ GeV**
- compatible stochastic term $S \sim 45\%$
- **Significant reduction of the constant term C:**
12% $\rightarrow$ 7%

R&D per una TPC di nuova generazione con readout ottico

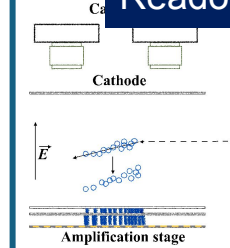
Un passo importante nell'R&D verso la realizzazione del muon collider riguarda il dimostratore del canale di raffreddamento dei muoni che si realizzerà al CERN nei prossimi anni. Il dimostratore (che probabilmente verrà installato in uno dei vecchi tunnel neutrino del CERN) produrrà una grande quantità di muoni e neutrini (circa 200 MeV/c).

La misura di precisione dell'emittanza del fascio dei muoni (x, y, z, P_x, P_y, P_z) ottenuta particella per particella, sarà un elemento fondamentale per la validazione delle performances del canale di raffreddamento dei muoni.

Una TPC di nuova generazione attrezzata con un readout ottico rappresenta un **tracciatore ideale** per questo scopo.



Why an Optical Readout



cameras do not allow to access the longitudinal coordinate due to their slow readout speed

The goal is to combine optical and charge readout ☐ Full 3D fast tracking

Supported by AIDAInnova – EU Grant & INFN/DRD1/WP4/WP8 (INFN R&D for gas detectors)

Why a TPC as a muon monitor in the cooling sector

- Full particle parameters (x , p) reconstructed in 3D
- Very low material budget, excellent track resolution
- It was already in the MICE proposal, but it can now be made much better with an optical readout
- It still requires studies to design and test the readout, and find the optimal gas mixture in optical mode

In 2023 the Bari group proposed to realize a large prototype of a TPC (30 cm diameter, 50 cm drift) with optical readout (TimePix4 or similar) tailored to precise, particle-by-particle muon emittance measurement during beam setup phases

- A field-cage suitable for atmospheric-pressure operation is already available.
- The readout part can be easily replaced with an optical one.
- Once ready, the size allows to insert it in a solenoid (we know of one available at CERN) and test it in a muon beam.
- MPGD TPCs were already studied for beam monitoring, e.g. <https://web2.infn.it/GEMINI/index.php>
- The optical readout has in this case the advantage to allow lighter structures and higher rate w.r.t. a traditional pad plane
- The development of this device may be synergic with the development of a TPC as an active target and both fit very well the **DRD1, W8/W4 Program**
- This application requires non-pressurized operation

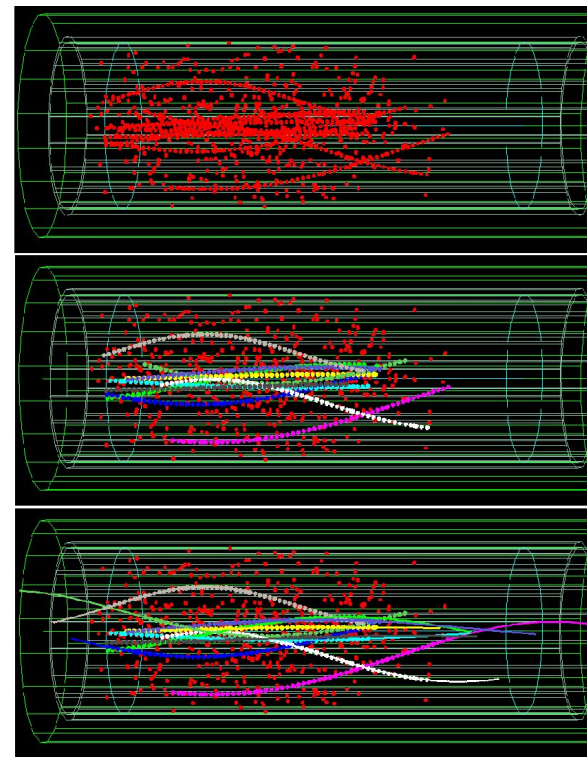
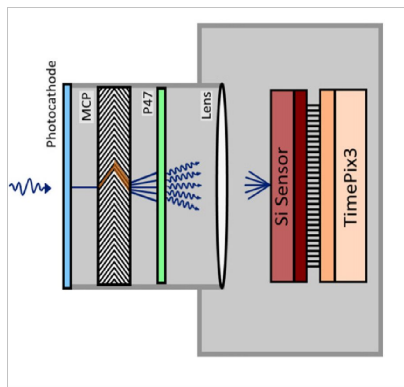


Figure 8.7: top: simulated track and noise hits in the TPG; middle: highlighted hits are those assigned by the pattern recognition to belong to the same track; bottom: tracks fitted on the clustered hits

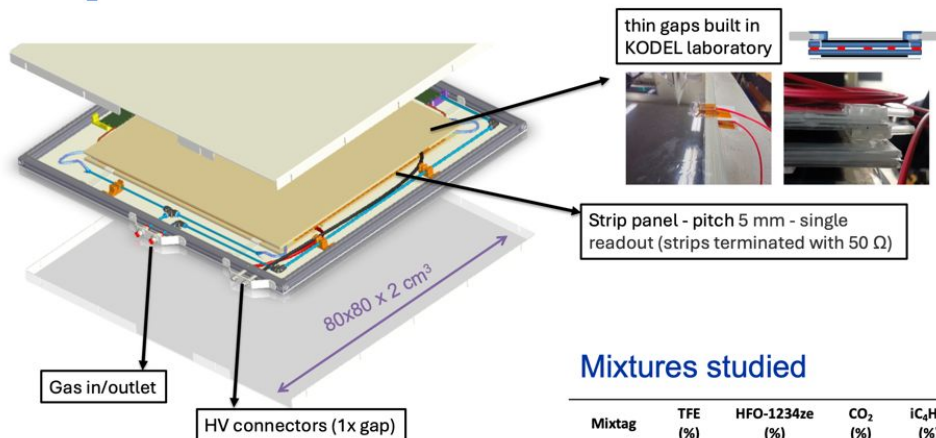
Status & Prospect

- A **Settembre 2023** , l'R&D riguardante lo sviluppo di una TPC con read-out ottico nell'ambito di **RD_MUCOL** e' stato approvato dalla **CSN1**.
- Sono stati finanziati (o sono in fase di finanziamento) solo items riguardanti la versione non-pressurizzata del detector.
- Le restanti richieste (benche' approvate scientificamente) sono stato rimandate alla discussione riguardante i finanziamenti specifici dei DRD .
- Nel **2024** e' stato finanziato il sistema della alte tensioni da 100KV per **21Keuro**.
- Nel **2025** e' stato finanziato *l'Image Intensifier (28Keuro)* ma non *i* 2 piani di thick gem (30 cm di diametro) e l'obiettivo fotografico che fanno parte del sistema di intensificazione del segnale ottico.
- I due items sono stati rimandati al finanziamento dei DRD (mai avvenuto), ma sono essenziali per mettere in funzione il readout.
- Nel **2026 contiamo di richiedere un TimePIX4 , gli elementi mancanti della catena di readout e cavi e connettori HV**



YEAR	Item	Cost (Keuro)	Total/Year (investment)	Possible connection & synergy with DRD1
2024	HV (100KV)	21	21	WP4 ,WP8
2025	Image Intensifier	28	28	WP4, WP8
	Obiettivo fotografico	5		
	2 piani di Thick GEM (30 cm)	4	5+4 in DRD1	
2026	TimePiX4	50	50	WP8, WP4

Cosmic tests on thin-RPC

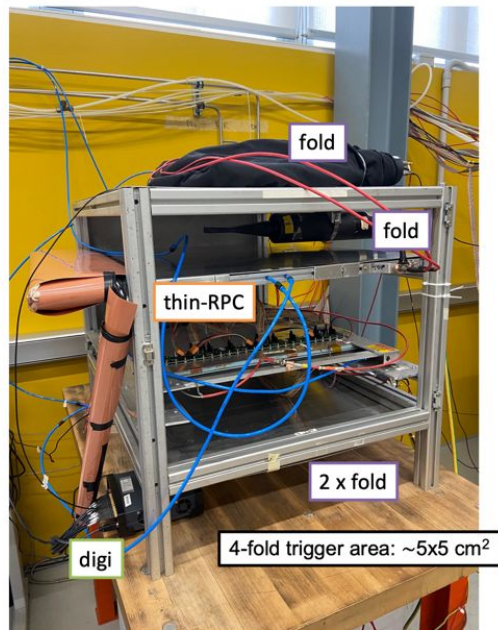


- **Double gap** with strip readout panel in between
 - Soda-lime glass electrodes: 1.1 mm thickness
 - Gas gap: 500 μm thickness
- Signal readout: [CAEN Digitizer DT5742](#) for signal detector study

Mixtures studied

Mixtag	TFE (%)	HFO-1234ze (%)	CO ₂ (%)	iC ₄ H ₁₀ (%)	SF6 (%)
STD	95.2	-	-	4.5	0.3
STD2ISO	97.7	-	-	2	0.3
STD0ISO	99.7	-	-	-	0.3
STD30CO2	65	-	30	4	1
ECO65	-	65	30	4	1
TFEISO	95	-	-	5	-
TFE	100	-	-	-	-
Density (g/l)	4.68	5.26	1.98	2.69	6.61
GWP	1430	7	1	3	22800

Setup

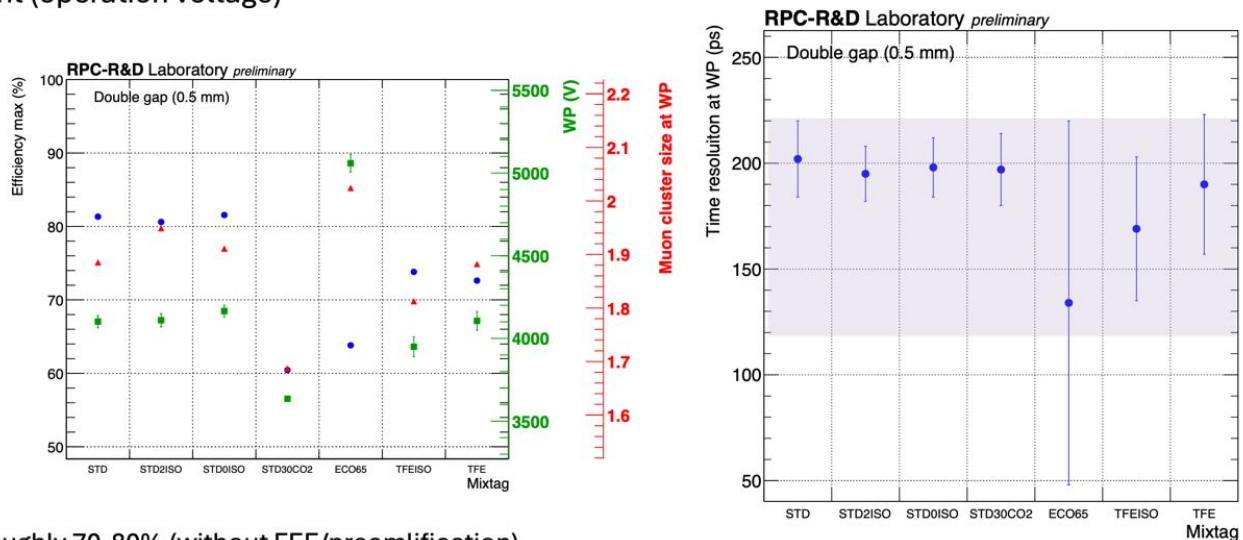


Summary: preliminary results

Efficiency and Working Point (operation voltage)

$$\varepsilon(HV) = \frac{\varepsilon_{max}}{1 + e^{-\beta(HV-HV_{50})}}$$

$$WP = \frac{\log 19}{\beta} + HV_{50} + 150 \text{ V}$$

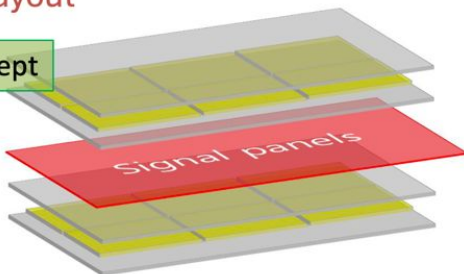


- Low efficiency at WP, roughly 70-80% (without FEE/preamplification)
- WP ~ 4 kV, around +1kV for ECO65
- Cluster size lower than 2 strips (strip pitch 5 mm)
- Chamber time resolution ~ 200 ps for all mixtures

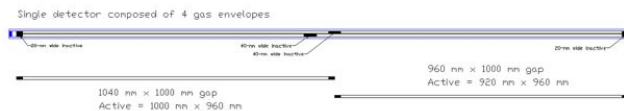
Foreseen steps

- New layout

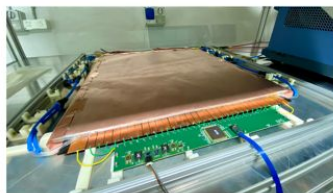
Bi-gap concept



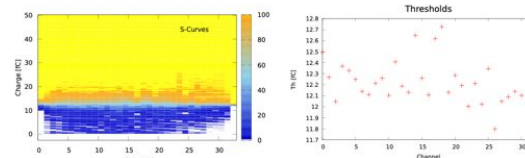
- 1 mm **RPC segmented** by a thin layer of a floating dielectric electrode, in two 0.5 mm sub-gaps
- Expected: 100-200 ps time resolution spatial resolution better than 1 mm with 3 mm wide pick-up strips



- FEE – low charge operation
Tests with FATIC3-RPC version



Pre: FATIC2 on double gap glass RPC



- Improve granularity and charge centroid algorithm
DRD1 test beams (July and November)
- Sustainability test: Low flux RPC operation