Physics at MEGII

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New Frontiers in Lepton Flavor

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[Link to the contribution on Indico]

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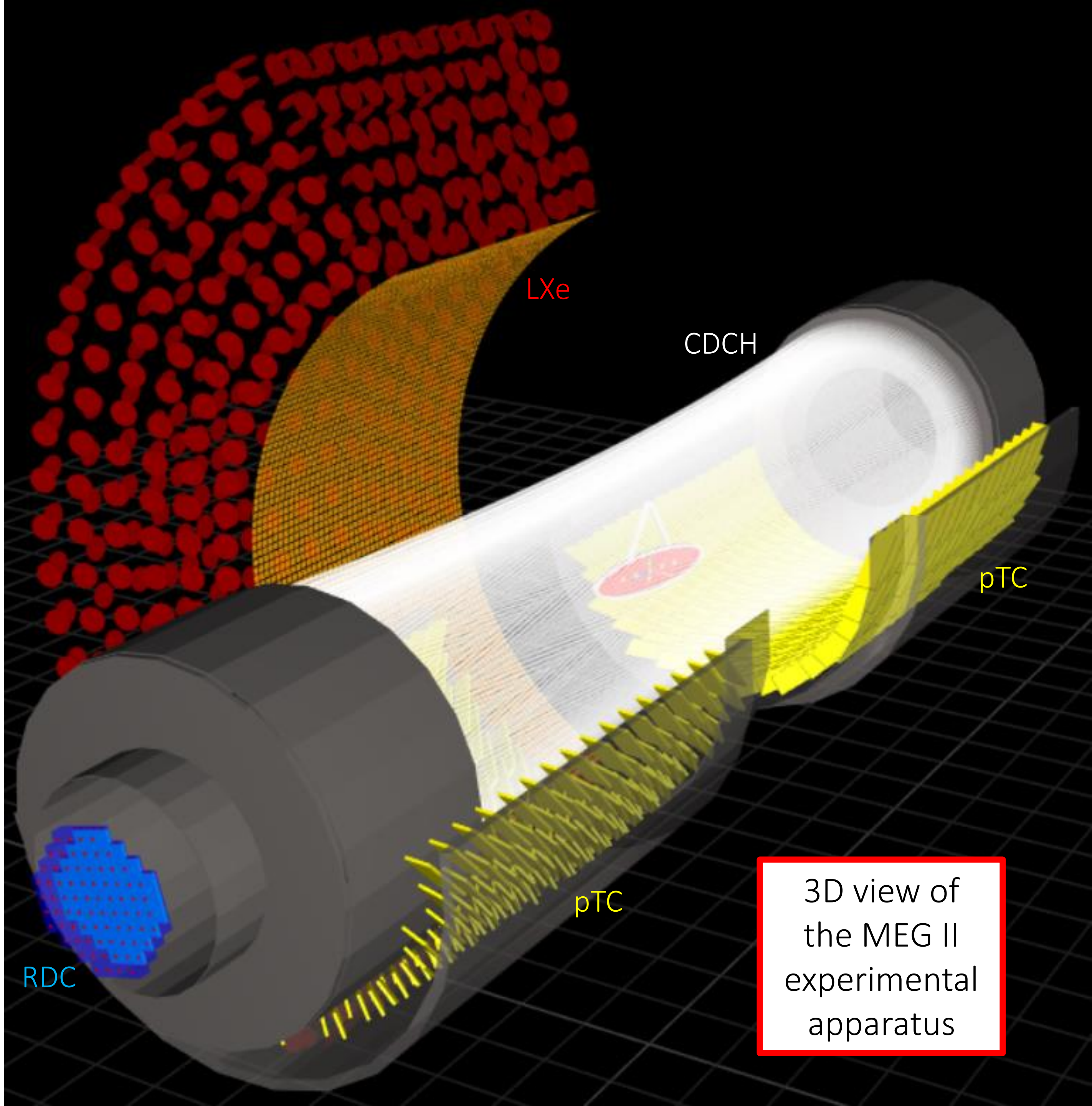
MEG II

Outline

- Introduction to the MEG II experiment
- MEGII experimental apparatus
  - Beam and target
  - pixelated Timing Counter (pTC)
  - Cylindrical Drift CHamber (CDCH)
  - Liquid Xenon detector (LXe)
  - Radiative Decay Counter (RDC)
  - Trigger and DAQ (TDAQ)
- Main problems and solutions
- Physics data taking and current performances
- Conclusions and prospects



3D view of the MEG II experimental apparatus

Introduction to the MEG II experiment

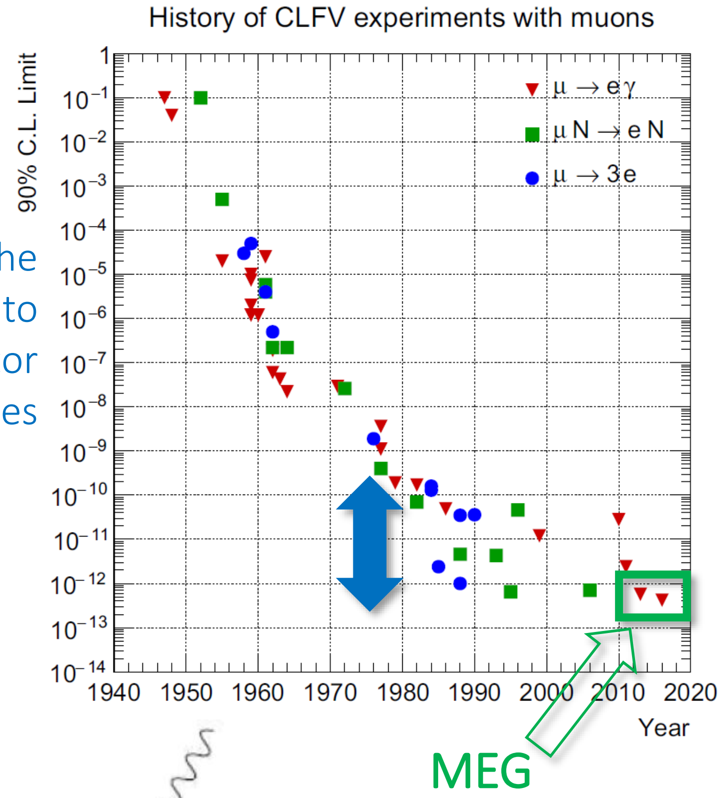
Physics context: CLFV

- Lepton Flavour Violation (LFV) processes experimentally observed for neutral leptons
- Neutrino oscillations $\nu_l \rightarrow \nu_{l'}$

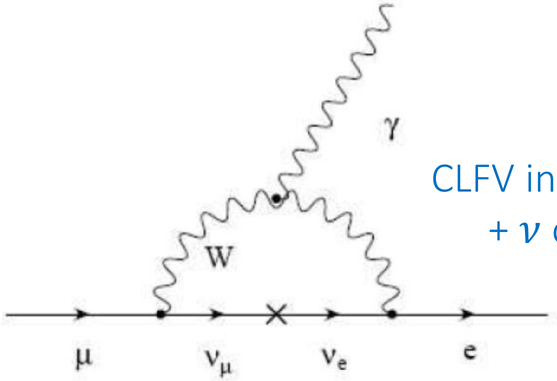
↓

- LFV for charged leptons (CLFV): $l \rightarrow l'$???
- If found ➜ definitive evidence of New Physics (NP)

3 orders of magnitude in the last 35 years mainly due to improvements in detector and beam technologies

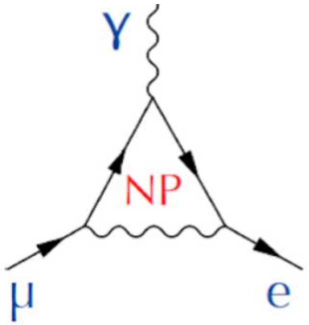


- SM extension + ν oscillations ➜ $l \rightarrow l'$ ✓
  - **But not experimentally observable**: m_ν small ➜ $\mathrm{BR} < 10^{-50}$
- Beyond SM theories (SUSY-GUT) predict **additional particles and interactions**
  - CLFV rare but enhancement up to an observable level $\left(\mathrm{BR} \approx 10^{-(14\div15)}\right)$
- In this context the MEG experiment represents the state of the art in the search for the CLFV $\mu^+ \rightarrow e^+\gamma$ decay
  - **Final results** exploiting the **full statistics** collected during the **2009-2013** data taking period at **Paul Scherrer Institut** (PSI)
  - $BR(\mu^+ \rightarrow e^+\gamma) < 4.2 \times 10^{-13}$ (90% C.L.) **world best upper limit**



CLFV in SM extension + ν oscillations

European Physics Journal C (2016) 76:434

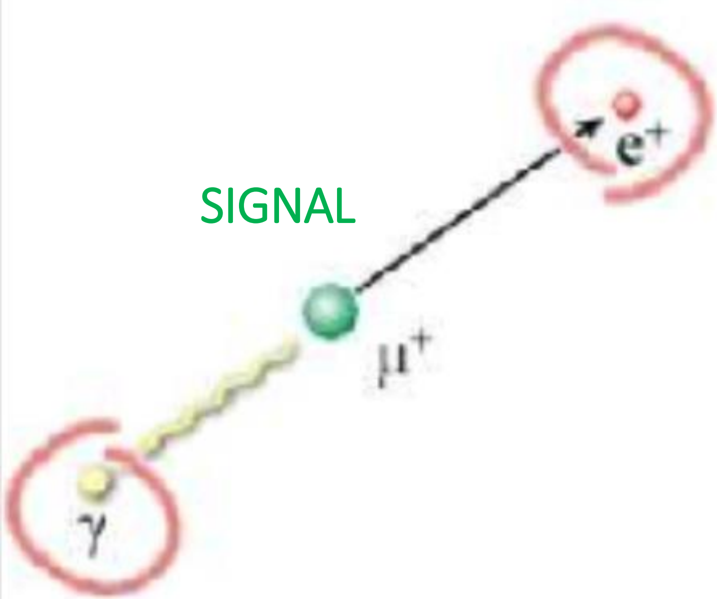


$\mu^+ \to e^+\gamma$ decay

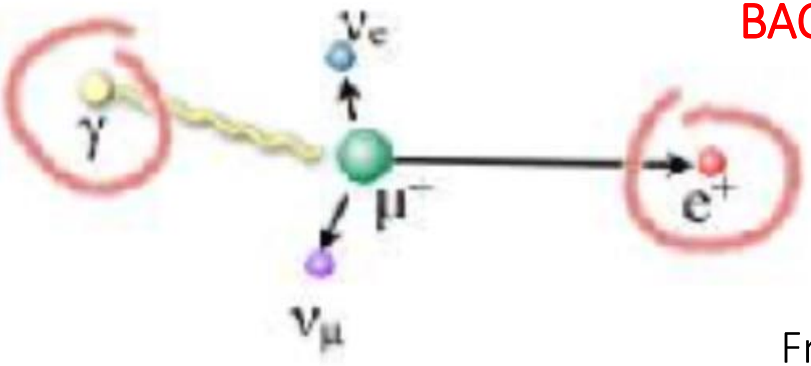
Kinematic variables

$E_e, E_\gamma, t_{e\gamma}, \theta_{e\gamma}$

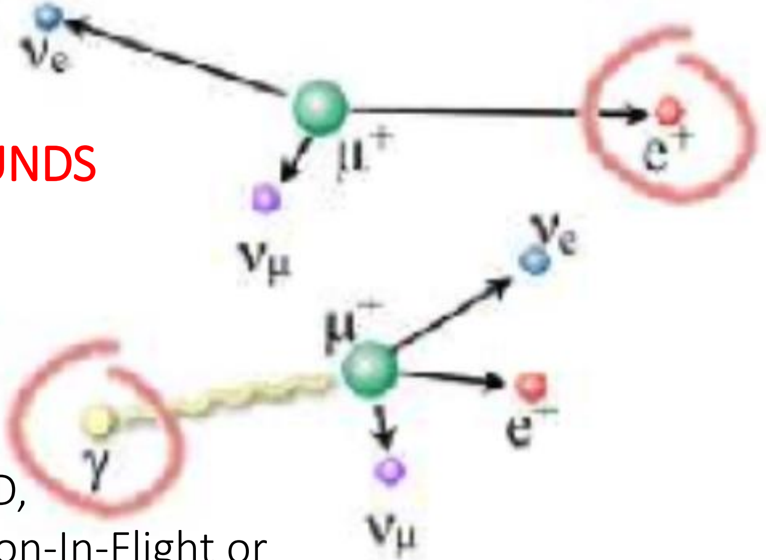
SIGNAL



BACKGROUNDS



Radiative Muon Decay (RMD)



From RMD, Annihilation-In-Flight or bremsstrahlung

Accidental

- $28\ \mathrm{MeV/c}\ \mu^+$ continuous beam stopped in a thin target ($15°$ slant angle)
- Most intense DC muon beam in the world at PSI: $R_\mu \approx 10^8\ \mathrm{Hz}$
- μ^+ decay at rest: 2-body kinematics
- $E_\gamma = E_e = 52.8\ \mathrm{MeV}$
- $\theta_{e\gamma} = 180°$
- $t_{e\gamma} = 0\ \mathrm{s}$

Radiative Muon Decay (RMD):

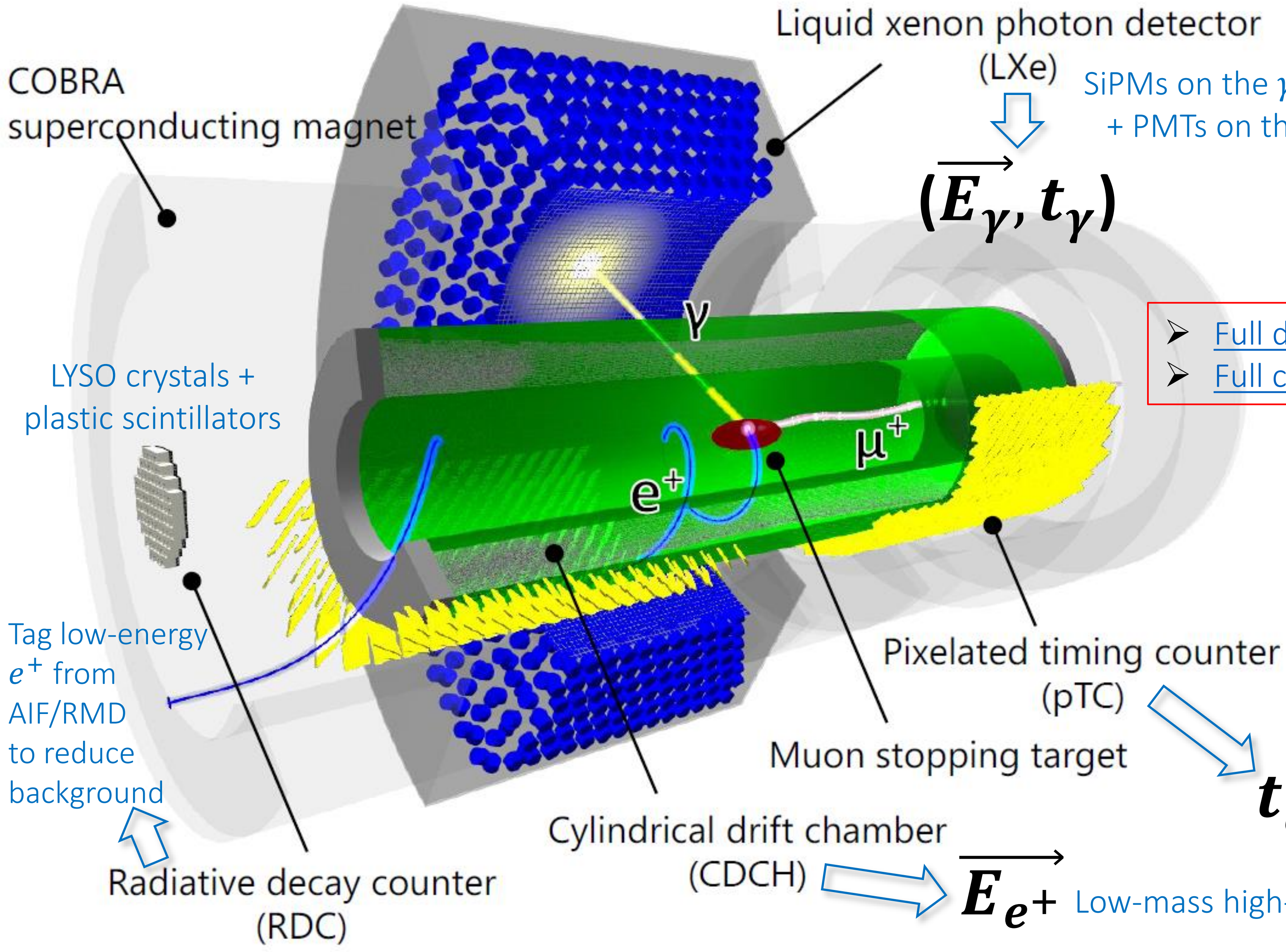
- $E_\gamma < 52.8\ \mathrm{MeV}$
- $E_e < 52.8\ \mathrm{MeV}$
- $\theta_{e\gamma} < 180°$
- $t_{e\gamma} = 0\ \mathrm{s}$

Accidental:

- $E_\gamma < 52.8\ \mathrm{MeV}$
- $E_e < 52.8\ \mathrm{MeV}$
- $\theta_{e\gamma} < 180°$
- $t_{e\gamma} = \mathrm{flat}$

- $BKG_{ACC} \propto R_\mu \Delta E_e \Delta t_{e\gamma} \Delta E_\gamma^2 \Delta\theta_{e\gamma}^2$ ➜ DOMINANT in high rate environments
- $BKG_{RMD} \approx 10\% \times BKG_{ACC}$

The MEG II experiment



SiPMs on the γ entrance face
+ PMTs on the other faces

$(\overrightarrow{E_\gamma}, t_\gamma)$

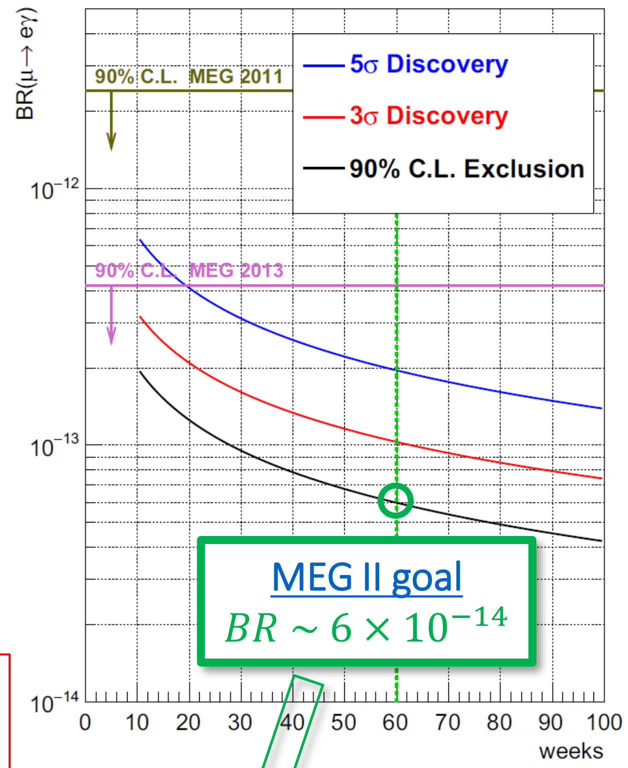
LYSO crystals +
plastic scintillators

Tag low-energy e^+ from AIF/RMD to reduce background

t_{e^+} Plastic scintillator tiles read out by SiPMs

$\overrightarrow{E_{e^+}}$ Low-mass high-granularity single volume detector

- Full design paper
- Full commissioning paper



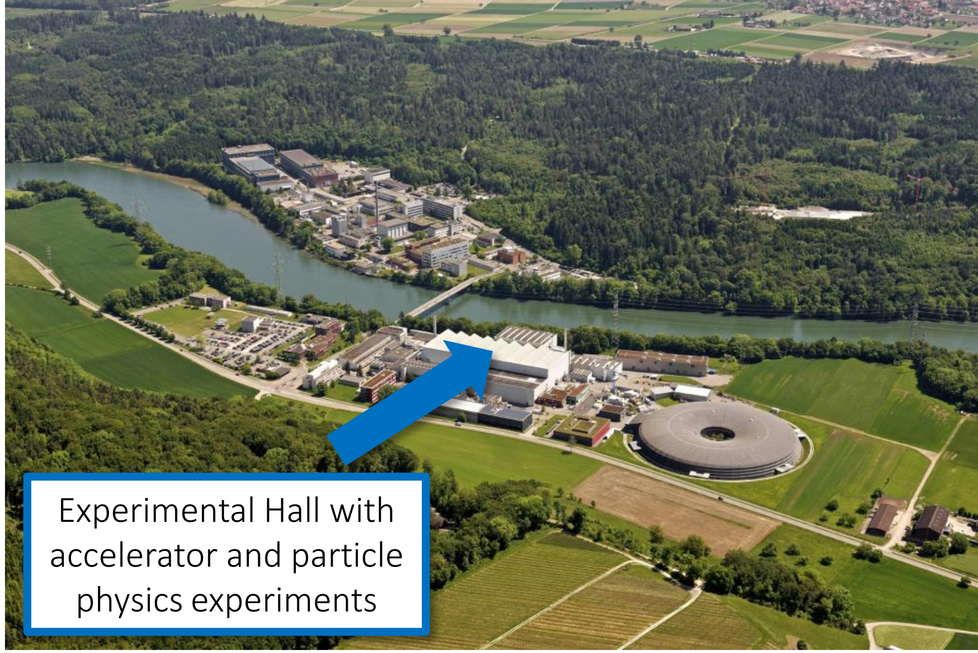
MEG II goal
$BR \sim 6 \times 10^{-14}$

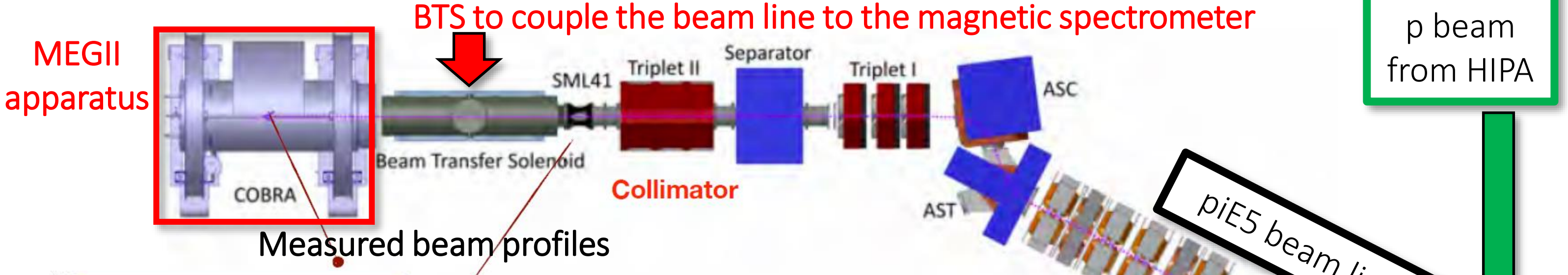
- Increasing the μ^+ stopping rate
- Improving the detectors figures of merit
  - $\times$ 2 factor than MEG

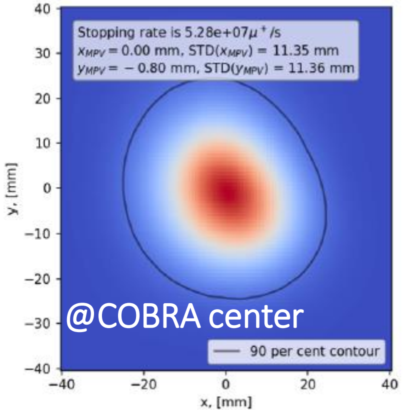
MEGII experimental apparatus

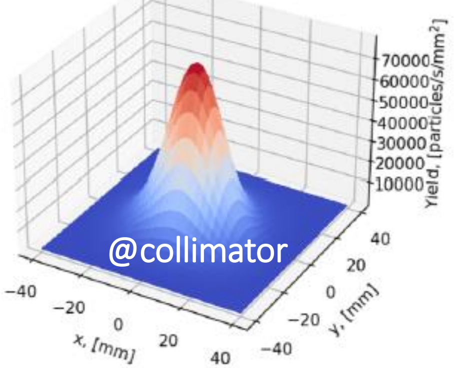
Beam and target: why PSI?

- The Paul Scherrer Institute (PSI) is **the largest research institute for natural and engineering sciences within Switzerland**
- World-class research in 3 main subject areas: matter and material; energy and environment; human health
- **World's most powerful High Intensity Proton Accelerator** (HIPA)
- $590\ \mathrm{MeV}/1.4\ \mathrm{MW}\ p$ beam drives several user facilities including
  - **Swiss Muon Source** (SμS): **the world's most intense continuous muon source**
  - **Up to $10^8\ \mu/s$** ($10^{10}\ \mu/s$ with the High Intensity Muon Beam - HIMB - upgrade)
  - 6 beamlines available for experiments using muons

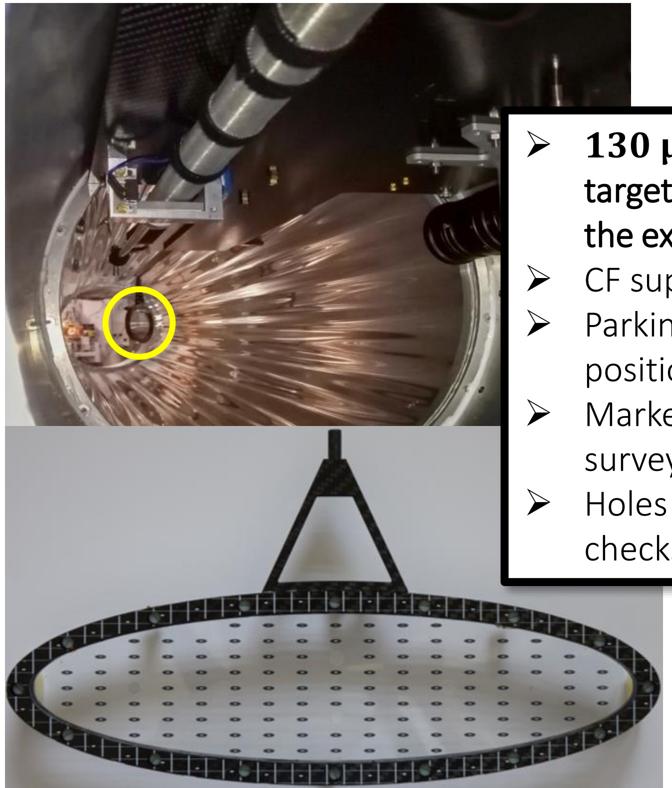








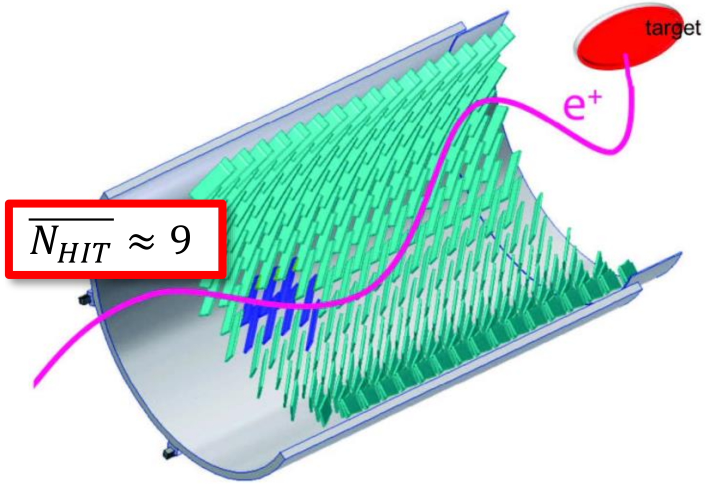
- Up to $10^8\ \mu^+/s$
- 28 MeV/c surface muons
- Possibility to switch to pions for calibrations



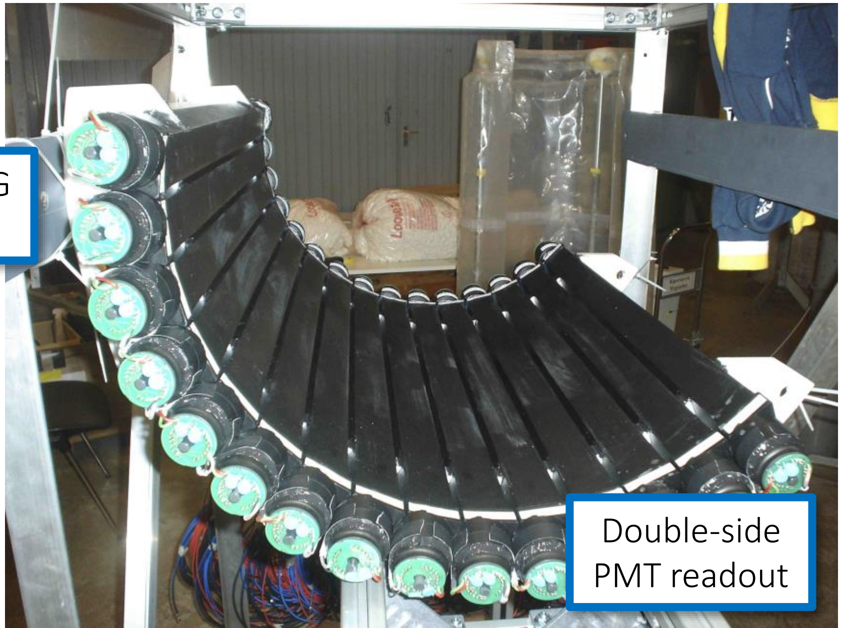
- **130 μm-thick PVT target at the center of the experiment**
- CF support structure
- Parking/measuring positions
- Markers for optical surveys (deformation)
- Holes for tracking checks

pixelated Timing Counter (pTC)

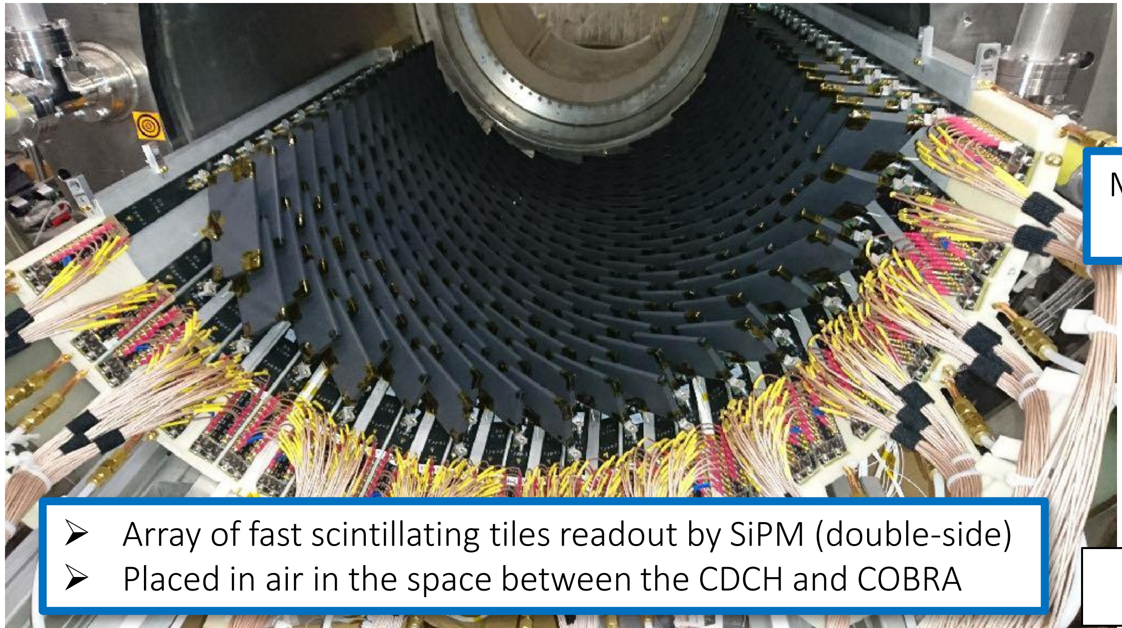
- Precise measurement of the $e^+\gamma$ time coincidence is one of the MEGII key features to suppress the dominant accidental background
- To meet MEG II requirements the pTC needs to measure the time of arrival of $\approx 50\ MeV\ e^+$ with $\sigma_t \sim 30\ ps$ @ high rate (few MHz)
- The **MEGII pTC is based on a new concept** to overcome the MEG TC limitations
  - Fast plastic scintillators
    - Good σ_t of a single counter due to its small dimensions
    - Pile-up hit rate kept under control
  - High segmentation: 256 scintillating tiles $\times$ 2 modules (US-DS) instead of 15×2 bars
    - Each e^+ time is measured with many counters to significantly improve the total σ_t
    - Flexible detector layout to maximize the e^+ detection efficiency and hit multiplicity



MEG TC



Double-side PMT readout

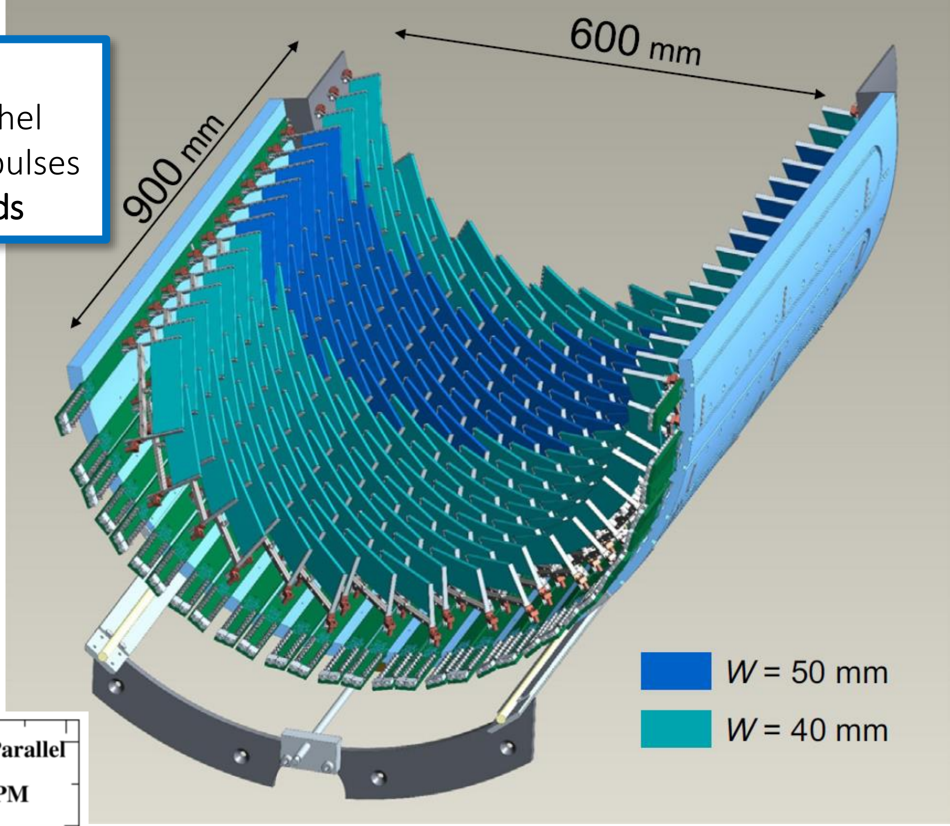


MEG II pTC

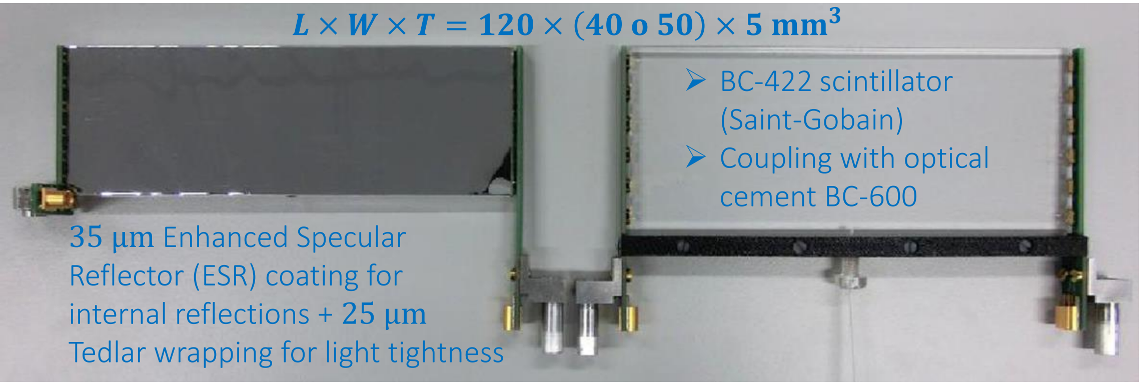
- Array of fast scintillating tiles readout by SiPM (double-side)
- Placed in air in the space between the CDCH and COBRA

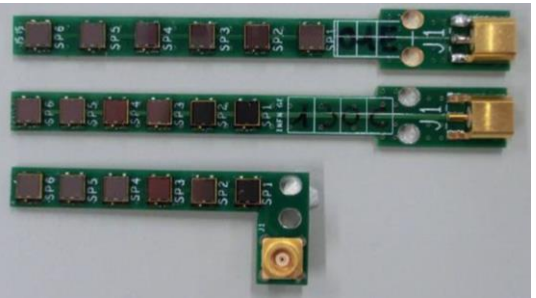
Design

- One of the 2 pTC modules with 256 counters
- **Inter-pixel time calibration with track-** (high-momentum Michel e^+ crossing several counters) **and laser-** (synchronous light pulses distributed to counters through optical fibers) **based methods**

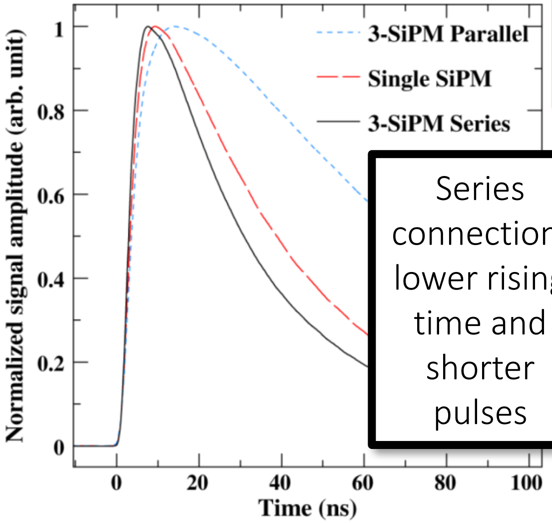


- 2 semi-cylindrical super-modules mirror symmetric to each other and placed Up-Stream (US) and Down-Stream (DS) with respect to the μ^+ stopping target inside the COBRA spectrometer
  - Full e^+ angular acceptance coverage when γ points to LXe calorimeter
  - $23 < |z| < 116.7\ cm, -165.8° < \phi < +5.2°$
- 256 counters per super-module
  - 16 counters @ $5.5\ cm$ interval in z and 16 counters @ $10.3°$ interval in ϕ
  - $45°$ tilt angle to be $\approx$ perpendicular to e^+ trajectories



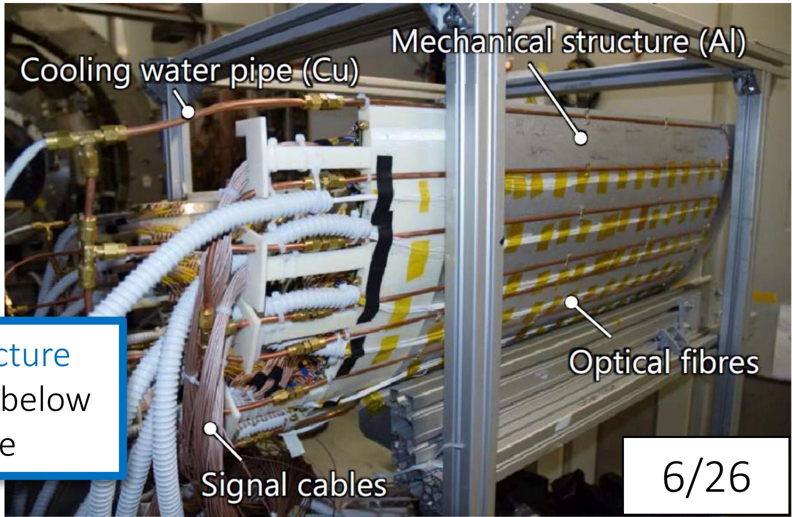


- PCB with 6 AdvanSiD SiPMs per side with series connection
  - Lower total capacitance
  - **Power supply/readout directly via the DAQ board**

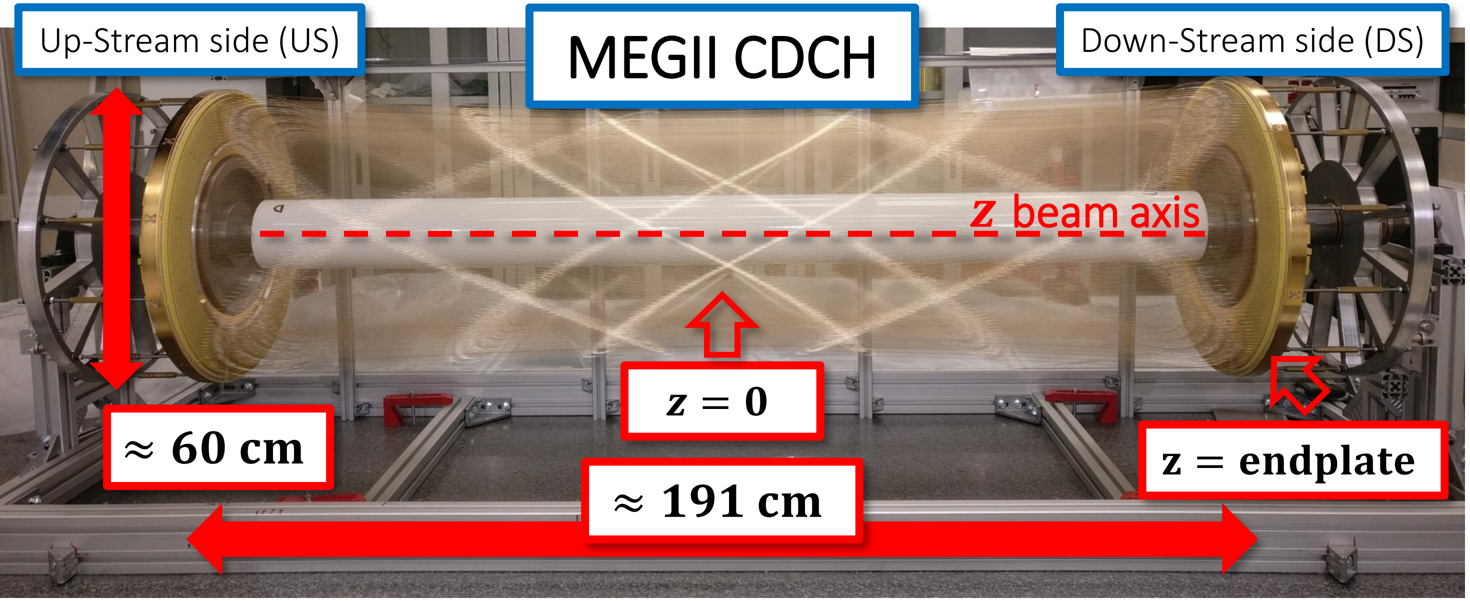


Series connection: lower rising time and shorter pulses

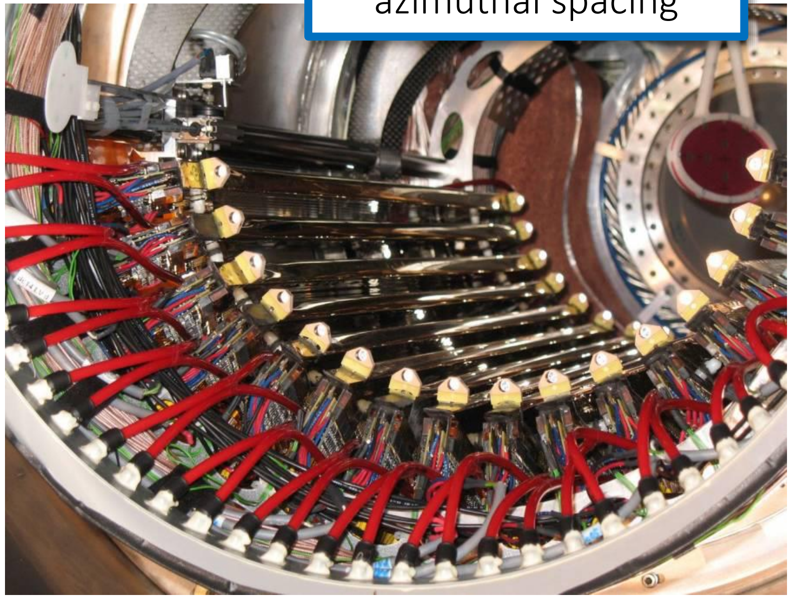
- 18 mm-thick aluminum mechanical structure
- Cooling system to kept the temperature below 20°C and optimize the SiPM performance



Cylindrical Drift CHamber (CDCH)



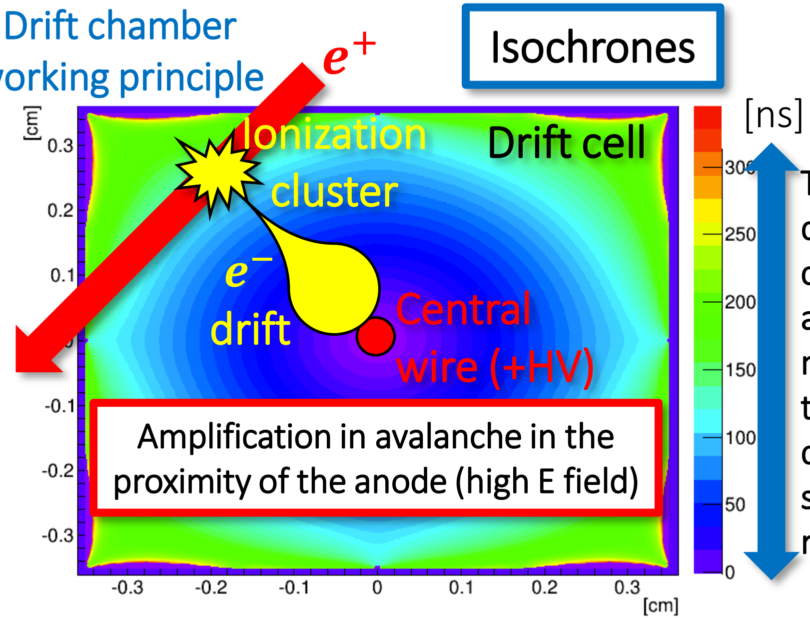
MEG DCH
16 trapezoidal modules with 10.6° azimuthal spacing



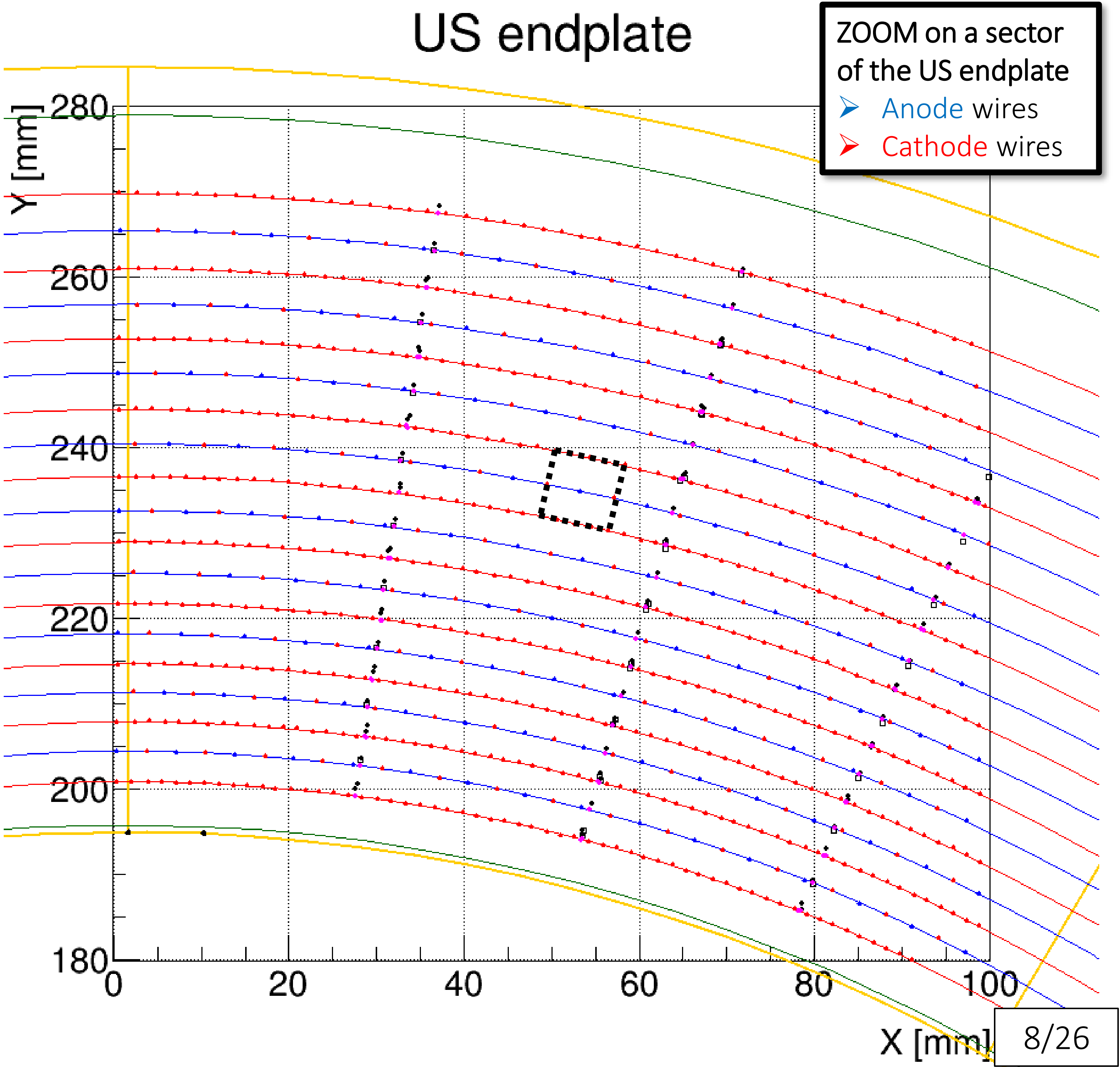
- Low-mass single volume detector with high granularity filled with He:iC_4H_{10} 90:10 gas mixture
  - \+ additives to improve the operational stability: 1.5% isopropyl alcohol + 0.5% Oxygen
  - 9 concentric layers of 192 drift cells defined by 11904 wires: ΔR ≈ 8 cm active region
  - Small drift cells few mm wide: occupancy of ≈1.5 MHz/cell (center) near the stopping target
  - High density of sensitive elements: ×4 hits more than the MEG drift chamber (DCH)
- Total radiation length $1.6 \times 10^{-3}\ X_0$: less than $2 \times 10^{-3}\ X_0$ of MEG DCH or ≈150 μm of Silicon
  - MCS minimization and γ background reduction (bremsstrahlung and Annihilation-In-Flight)
- **Extremely high wires density** (12 wires/cm^2) → the classical technique with wires anchored to endplates with feedthroughs is hard to implement
  - CDCH is the first drift chamber ever designed and built in a modular way

High wire density

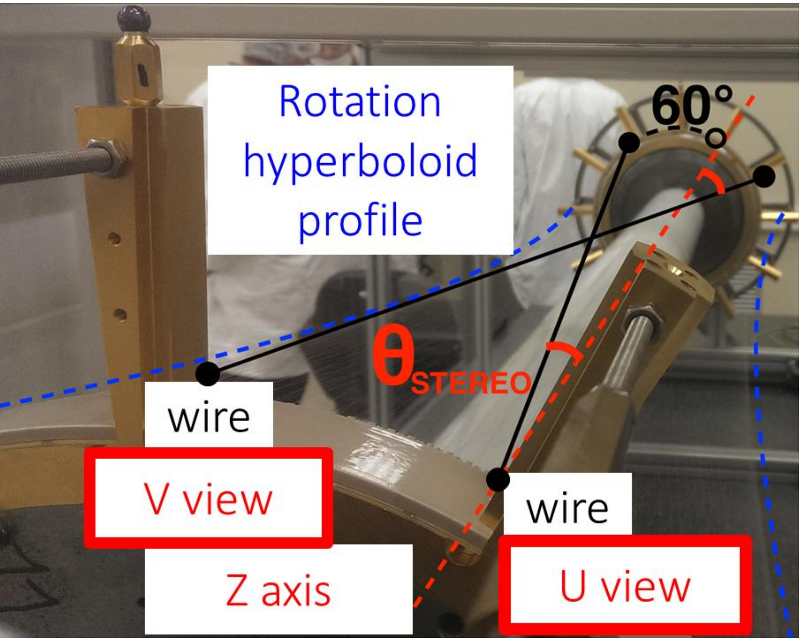
Drift chamber working principle



The measured drift time is converted into a position measurement through dedicated space-time relations



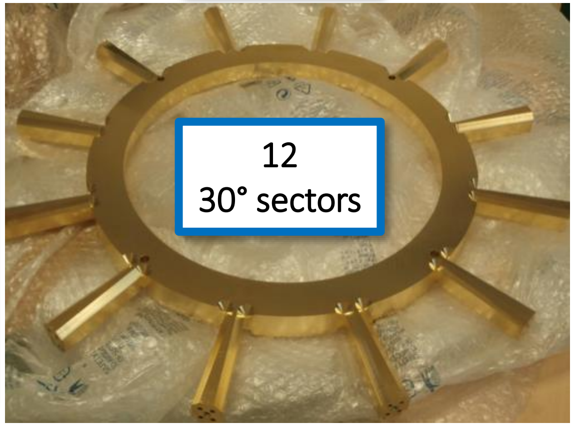
Design and wiring

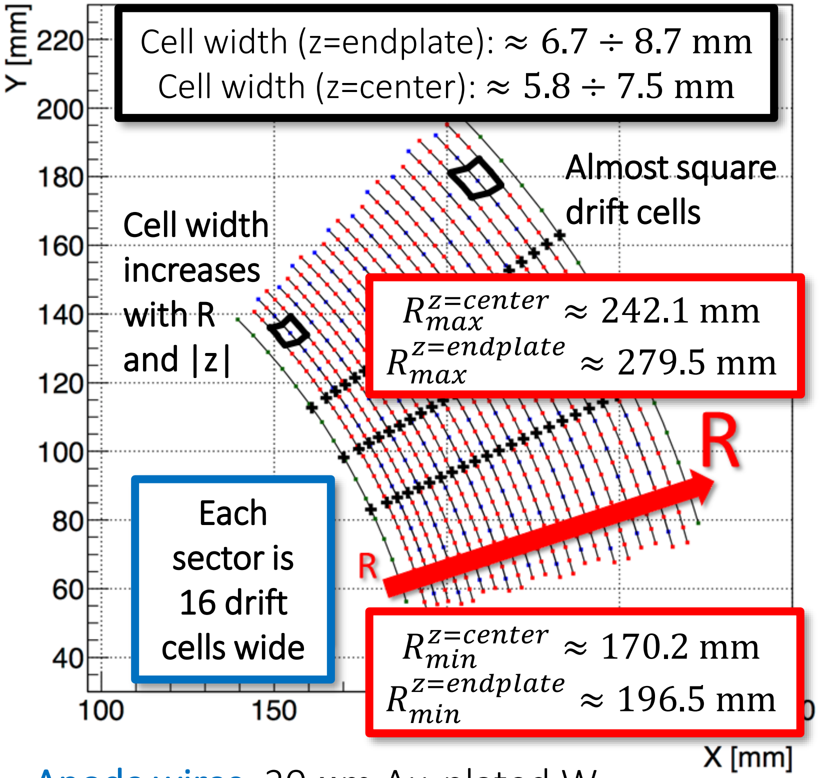


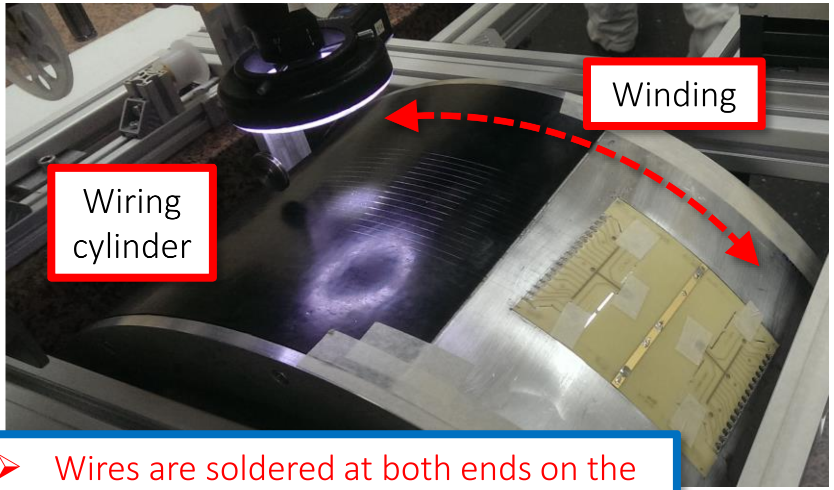
Stereo wire geometry for longitudinal hit localization

- $\theta_{stereo} \approx 6° \div 8.5°$ as R increases

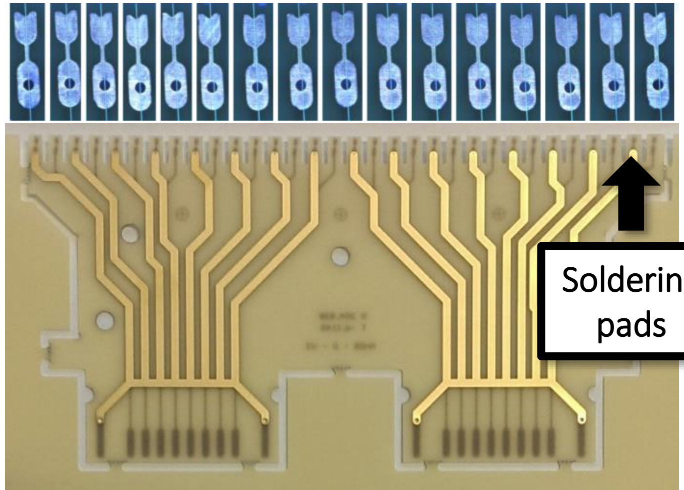
Endplate



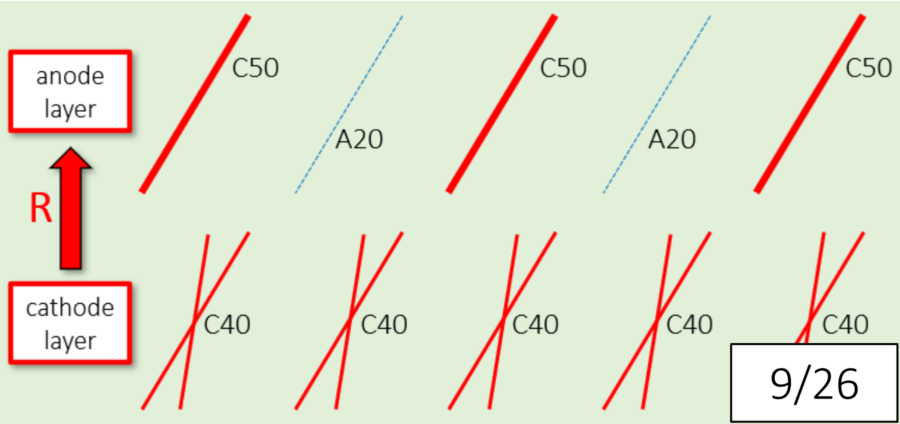




- Anode wires: 20 μm Au-plated W
- Cathode wires: 40/50 μm Ag-plated Al
  - **40 μm ground mesh between layers**
- Guard wires: 50 μm Ag-plated Al
- Field-to-Sense wire ratio 5:1

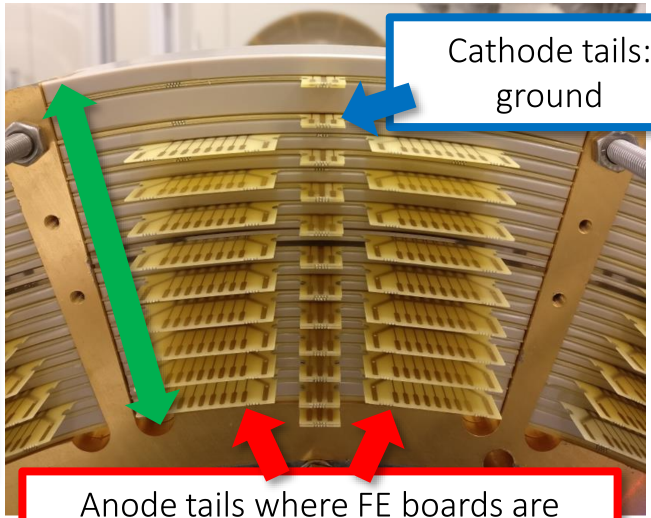


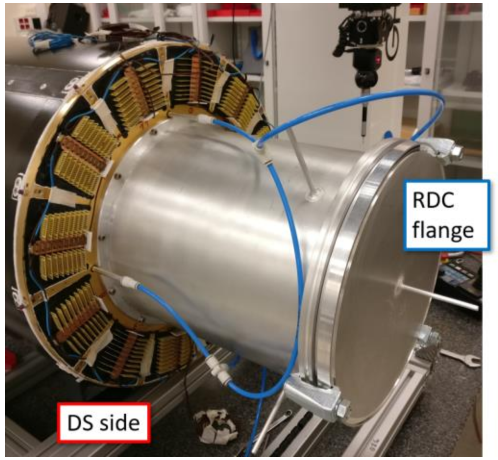
- Wires are soldered at both ends on the pads of 2 PCBs (wire-PCBs) which are then mounted on the CDCH endplates
- Wiring inside a cleanroom

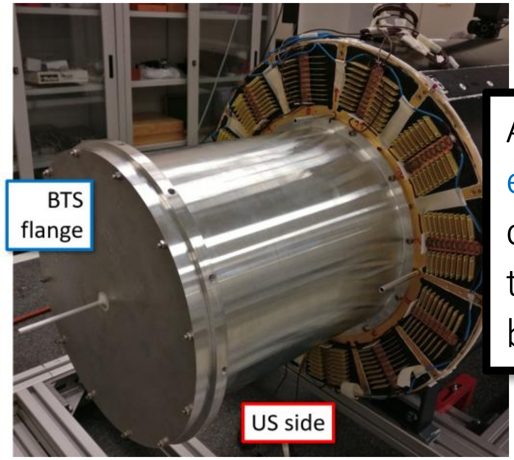


Mechanical structure

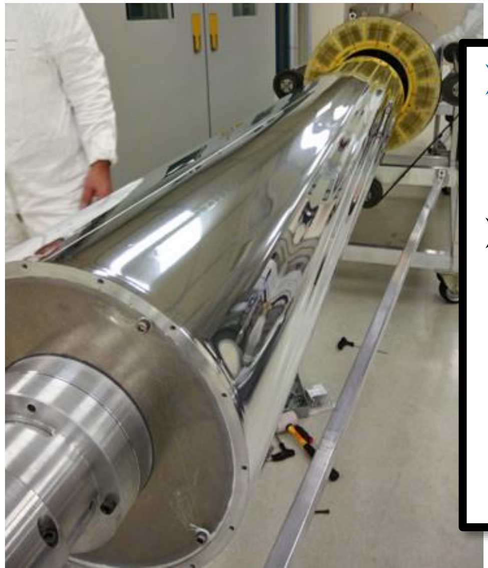
- Modular assembly inside a cleanroom
- Final stack of wire-PCBs in one sector
- PEEK spacers adjustment after CMM geometry measurements



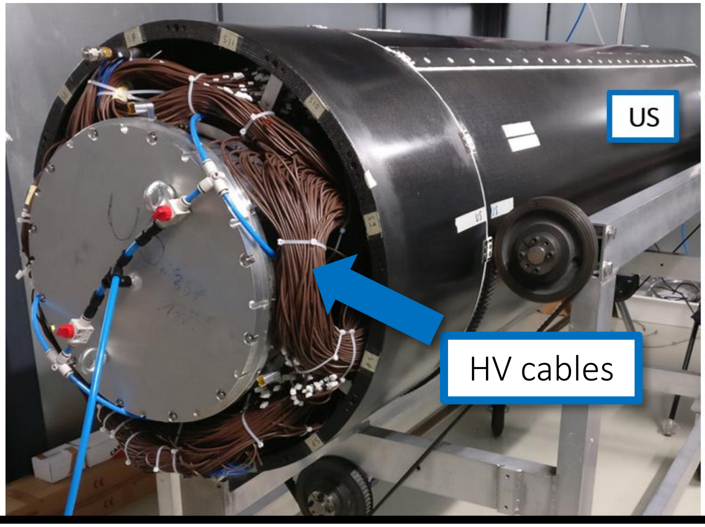


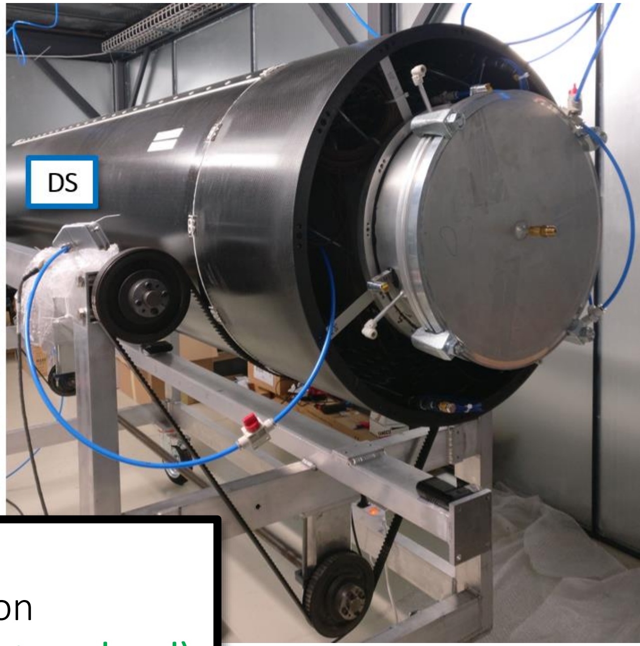


Aluminum inner extensions to connect CDCH to the MEG II beam line



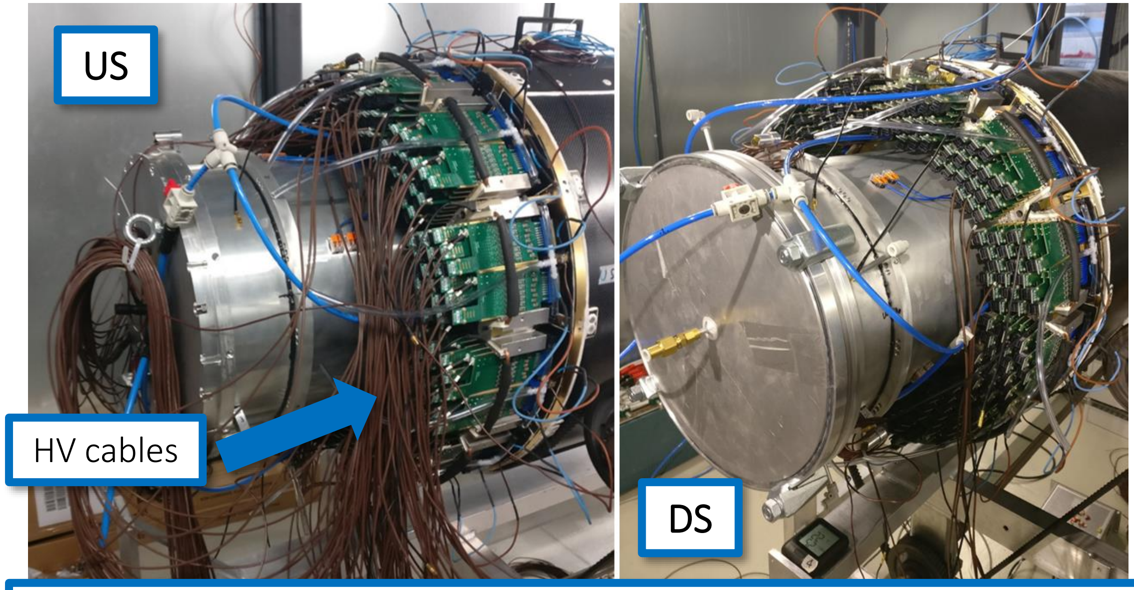
- 20 μm-thick one-side aluminized Mylar foil at inner radius
- To separate the inner beam + target volume filled with pure He from the wire volume filled with He:IsoB 90:10 mixture



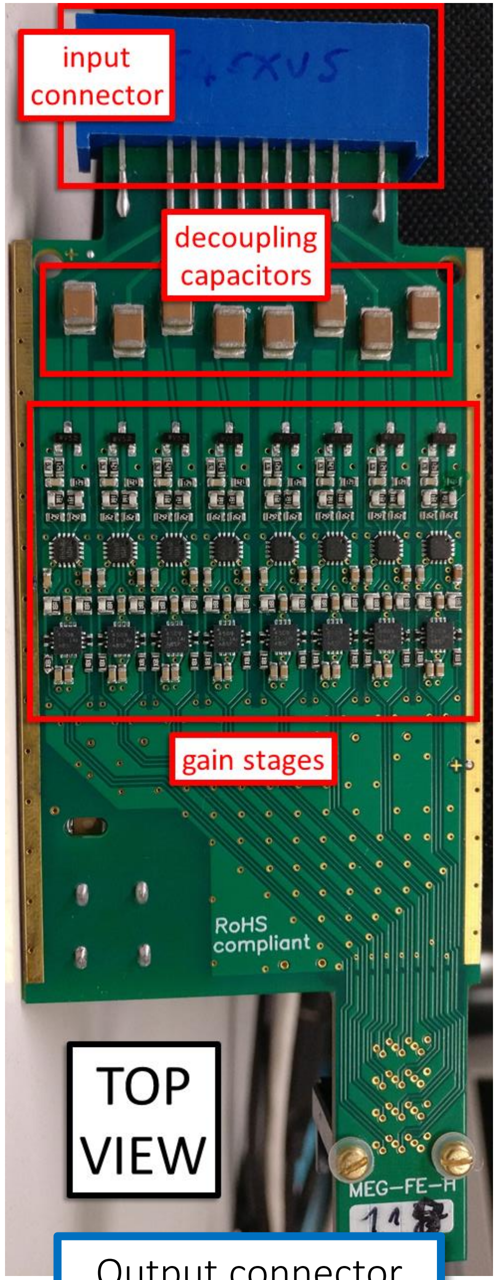


- External CF structure
  - Structural + gas tightness function
- CDCH mechanics proved to be stable (at μm level) and adequate to sustain a full MEG II run

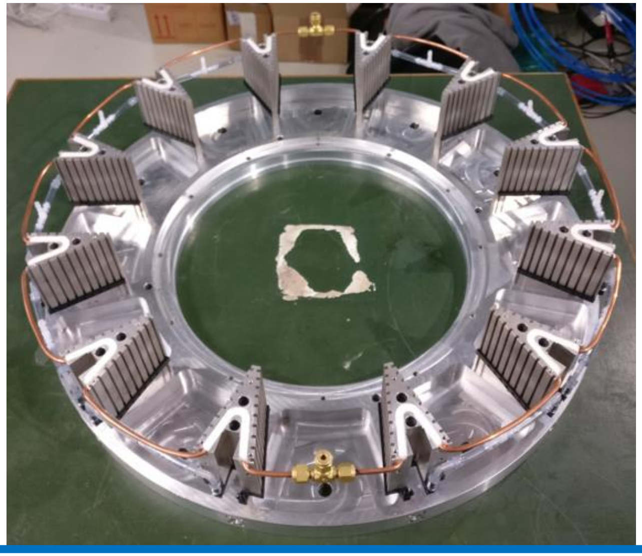
FE electronics



- 216 FE boards per side
  - 8 differential channels to read out signal from 8 cells
  - Double amplification stage with low noise and distortion
  - High bandwidth of nearly 400 MHz
    - To be sensitive to the single ionization cluster and improve the drift distance measurement (cluster timing technique)
- Signal read out from both CDCH sides
- HV supplied from the US side



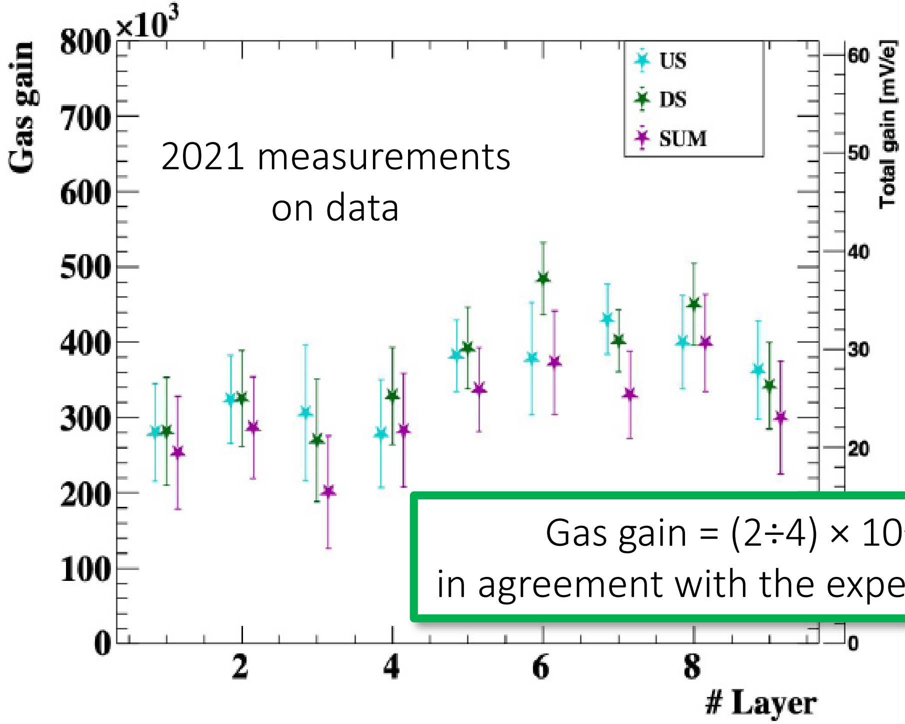
Output connector and HV stage on the bottom side



- FE electronics cooling system embedded in the board holders
  - Power consumption for each channel: 40 mA at 2.2 V
  - Heat dissipation capacity granted by a **1 kW chiller system**: 300 W/endplate
- Dry air flushing inside the endcaps to avoid water condensation on electronics and dangerous temperature gradients

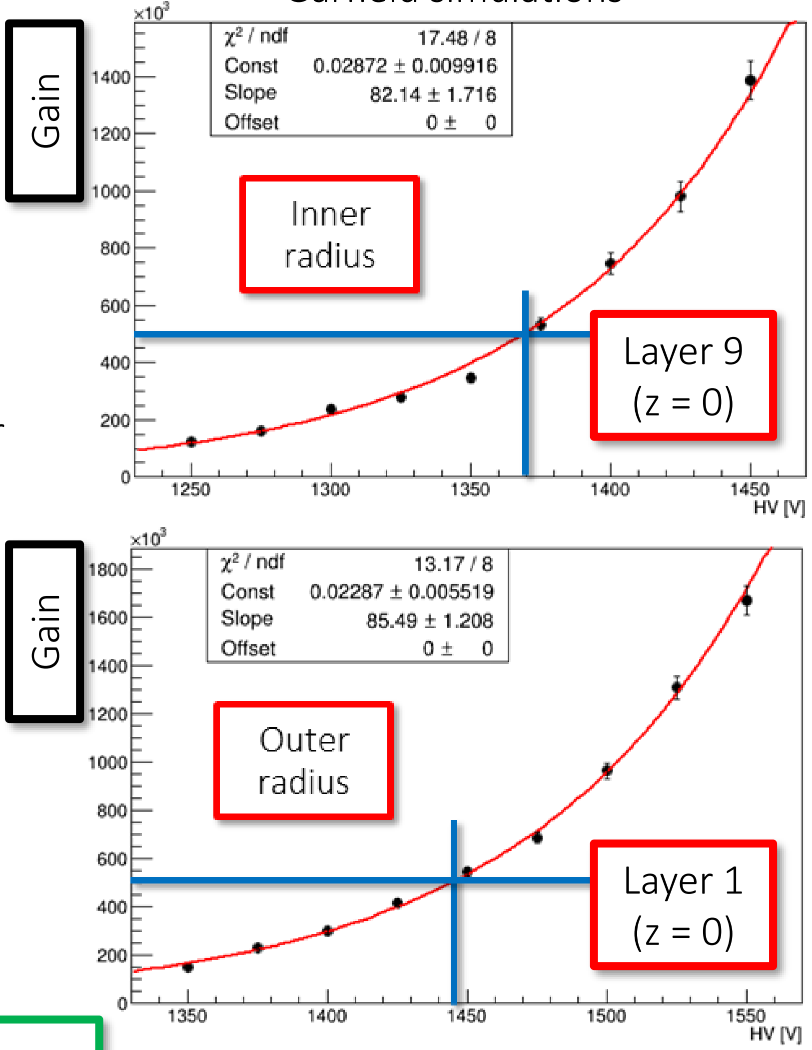
Working point

- **Garfield simulations on single electron gain**
  - Gas mixture He:Isobutane 90:10 and P = 970 mbar (typical at PSI)
- Working point → HV for gas gain $G = 5 \times 10^5$
  - To be sensitive to the single ionization cluster

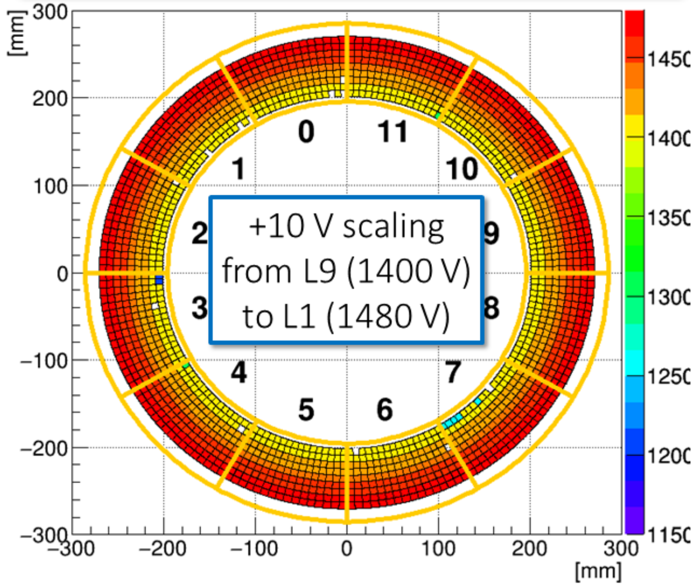


Gas gain = (2÷4) × 10^5
in agreement with the expectation

Garfield simulations

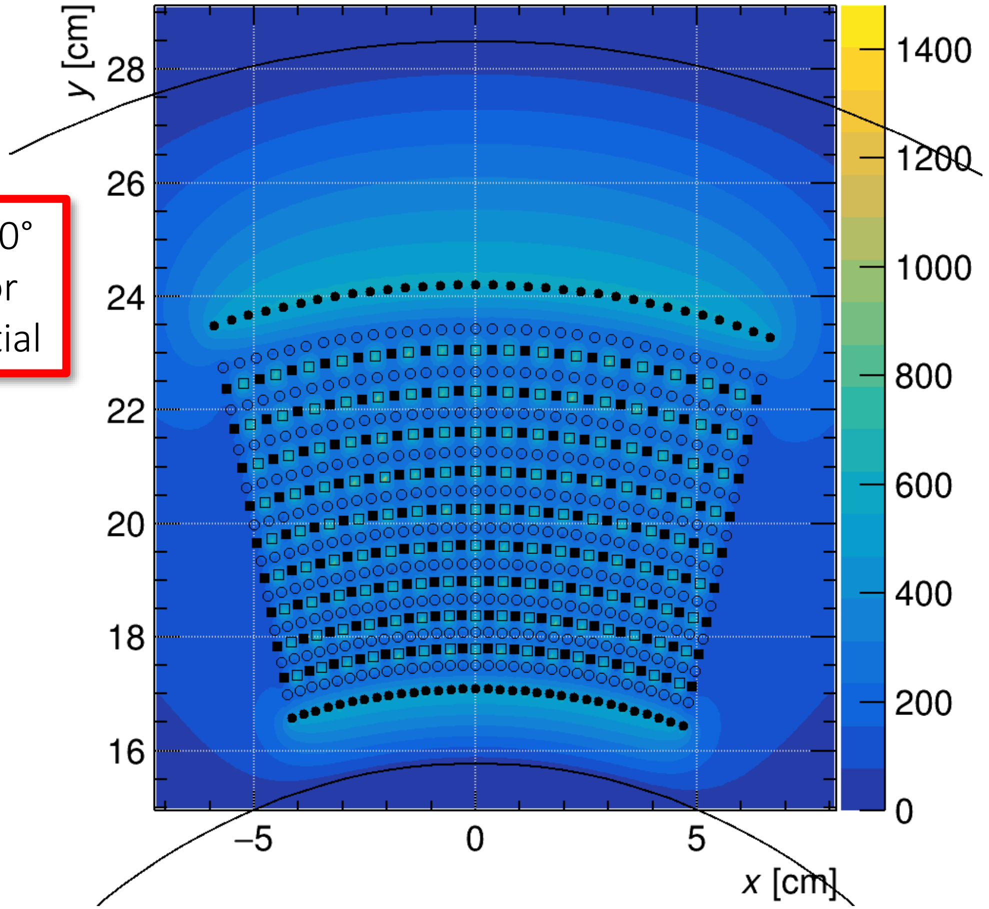


- **HV map of the Working Point** (WP) **as a function of the layer**
- Average HV value per layer + tuning by 10 V/layer to compensate for the variable cell dimensions with radius and z

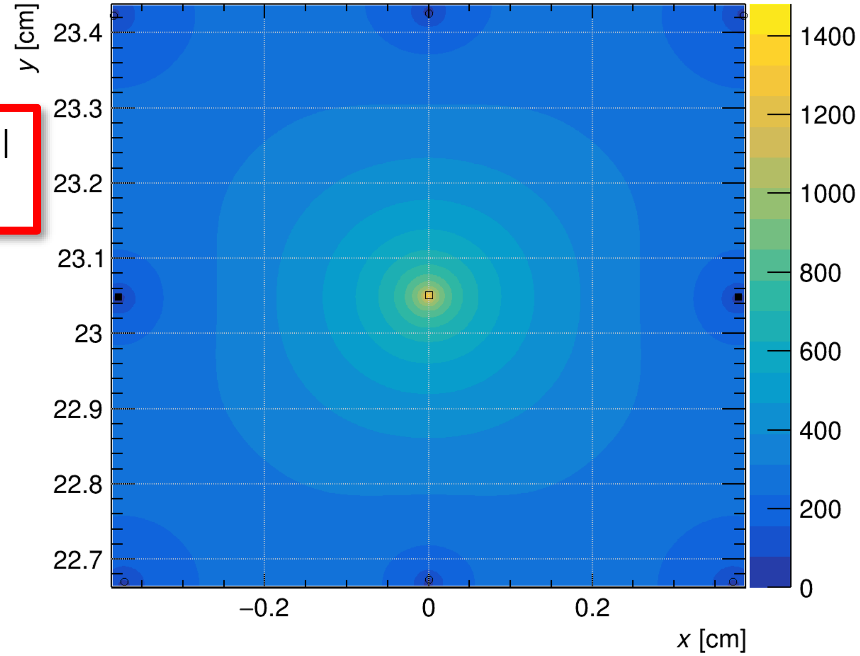


- Final CDCH length experimentally found through systematic HV tests at different lengths/wires elongations
- Final length set to +5.2 mm of wires elongation
  - **65% of the elastic limit**

One 30° sector potential

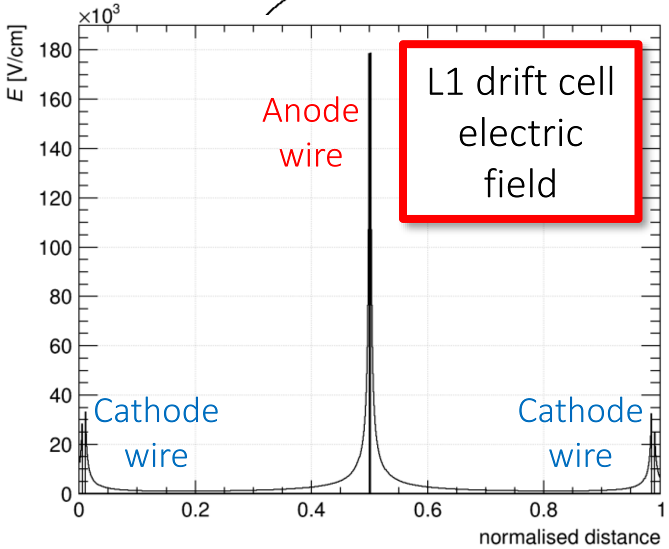


L1 drift cell potential

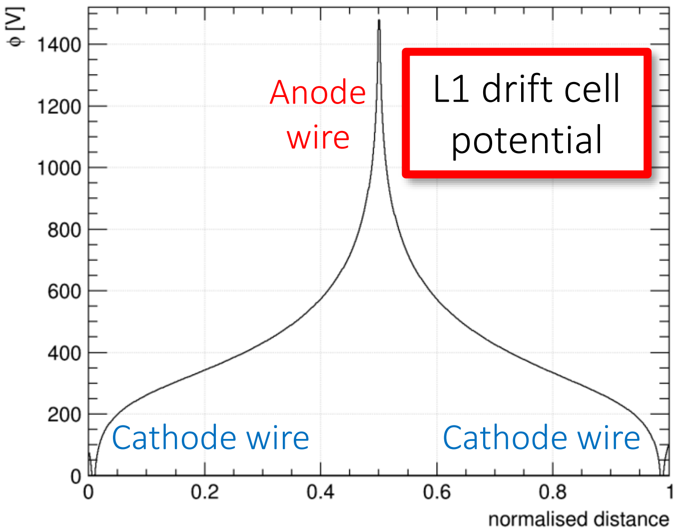


Garfield++ with HV WP and He:isoB 90:10

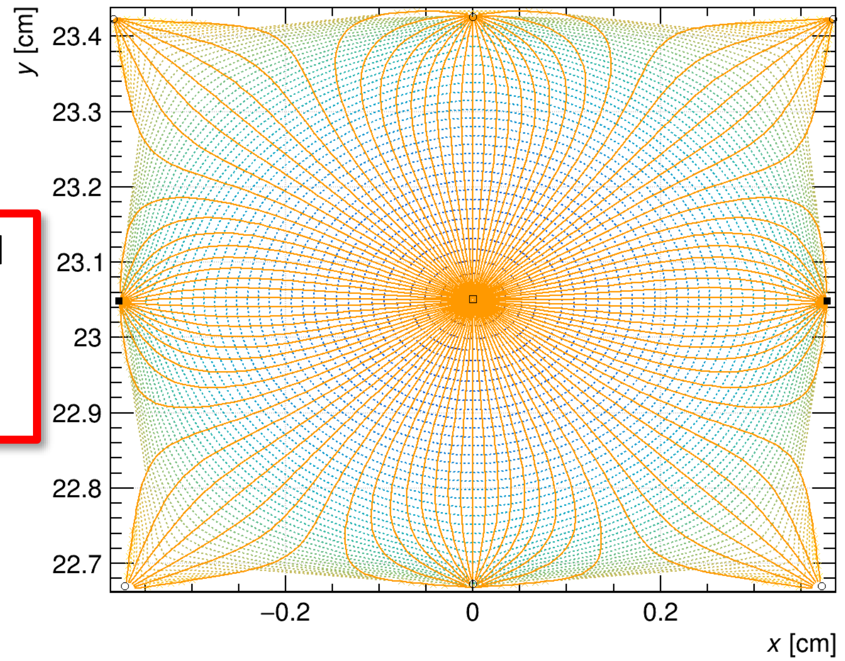
L1 drift cell electric field



L1 drift cell potential



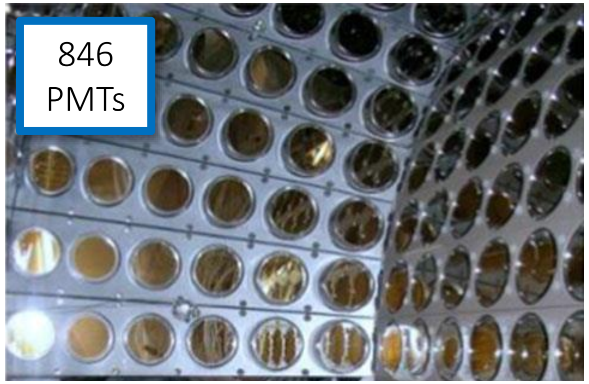
L1 drift cell drift lines and isochrones

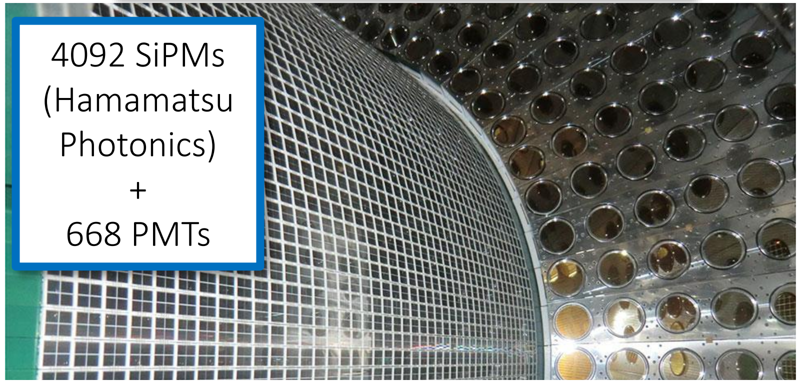


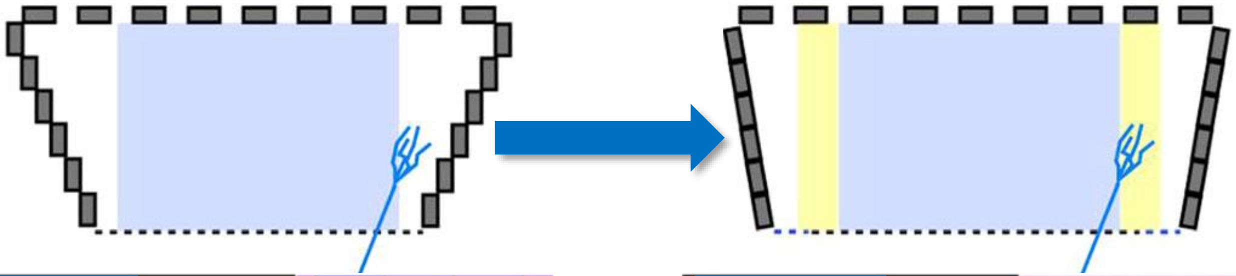
Liquid Xenon detector (LXe)

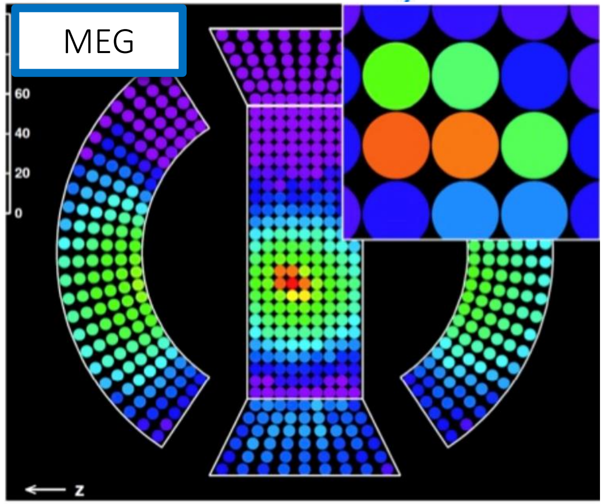
Power supply/readout of the SiPMs directly via the DAQ board

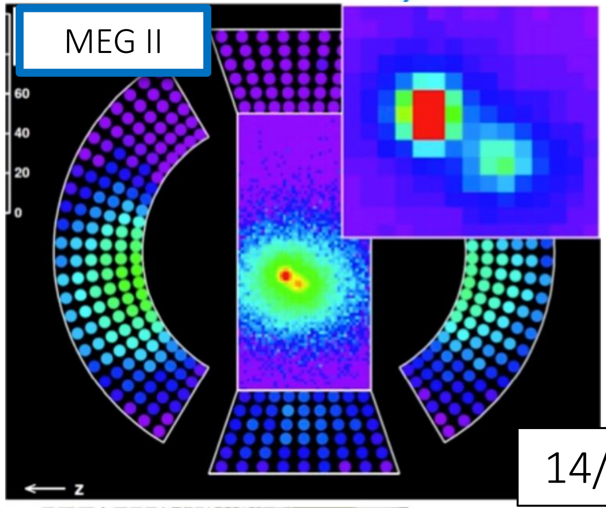
- Biggest liquid Xenon detector in the world with 900 liters
  - Same **C-shape cryostat** (liquid phase at 165 K) of MEG
- Goal: measurement of the γ energy, time and position with an improvement of a factor $\times 2$ with respect to MEG to suppress the background events in MEGII
- Keys of the upgrade
  - Replacement of 216 2" PMTs in the γ **entrance face with 4092 SiPMs** (active area $12 \times 12\ \mathrm{mm}^2$)
    - Improvement of the spatial ($\sim \mathrm{mm}$) and energy ($\sim 1\%$) resolutions thanks to the light collection uniformity
    - Lower material budget: 9% higher Photon Detection Efficiency/Quantum Efficiency (PDE/QE)
  - **10% z-acceptance improvement per side** thanks to the new PMT layout on the lateral faces





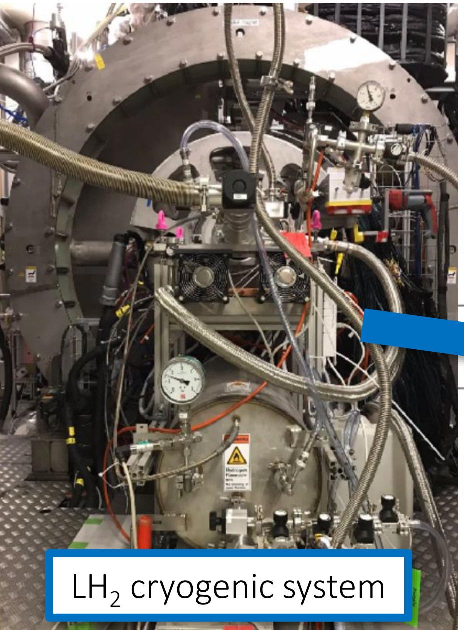


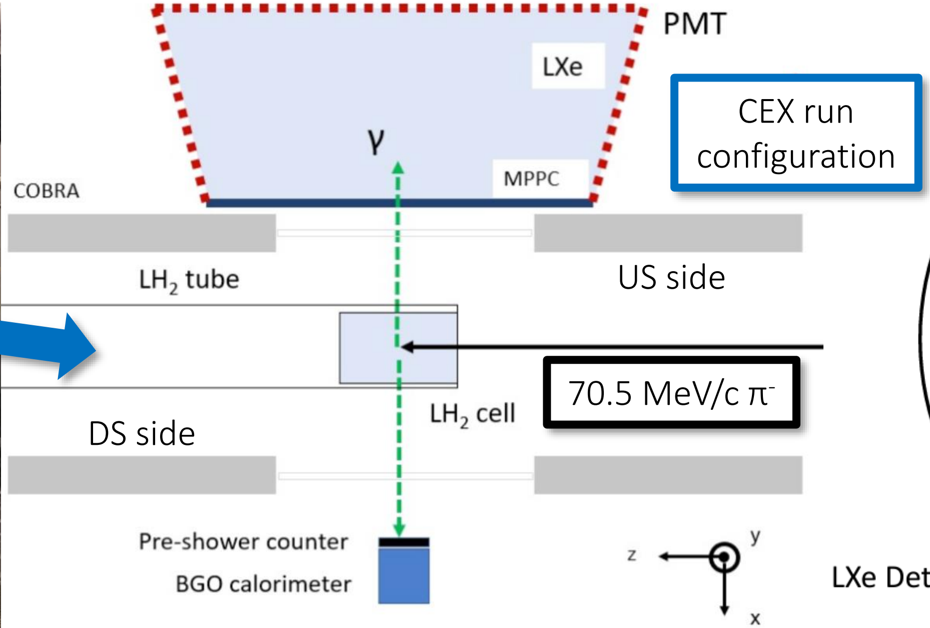


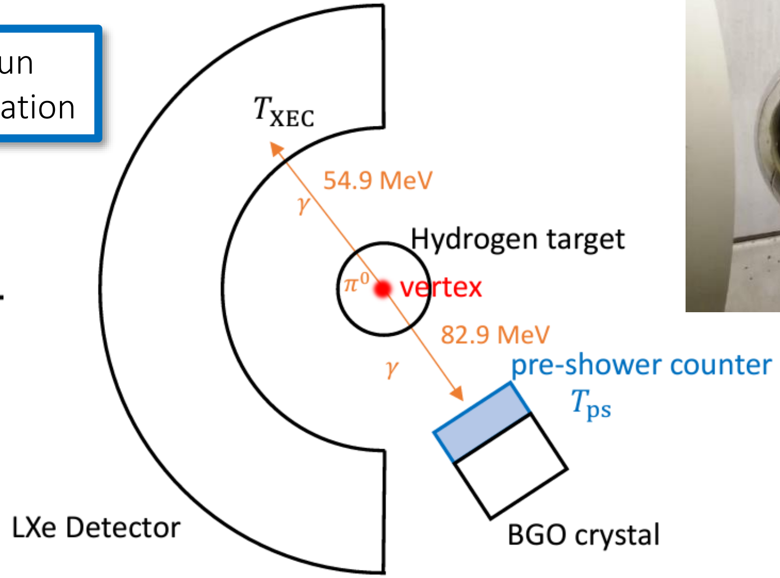


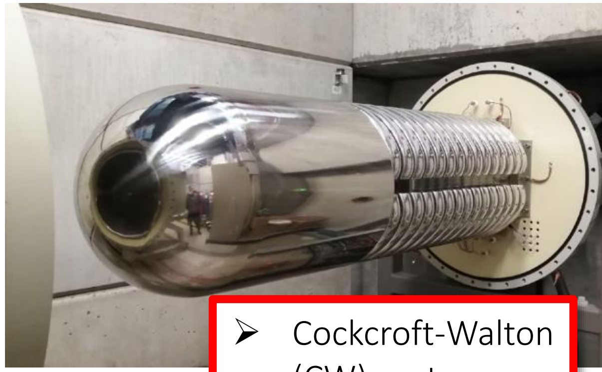
LXe calibrations

Type	Process	Energy	Purpose	Frequency
LED	Blue light	460 nm	Gain calibration	Daily
Radioactive source	^{241}Am(α,γ)^{237}Np	5.5 MeV (α); 56 keV (γ)	PDE calibration	Daily
Cosmic ray	μ from atmospheric showers	Wide spectrum O(hundred MeV, GeV)	Light yield monitor	3/week
CW proton	^{7}Li(p,γ)^{8}Be, ^{11}B(p,γ)^{12}C	14.8 MeV, 17.6 MeV (Li); 4.4 MeV, 11.6 MeV, 16.1 MeV (B)	Light yield monitor	3/week
Thermal neutron capture	^{58}Ni(n,γ)^{59}Ni	9 MeV	Light yield monitor	3/week
CEX	$\pi^-(p,n)\pi^0$, $\pi^0 \rightarrow \gamma\gamma$	55 MeV, 83 MeV	Energy scale/resolution	Dedicated run



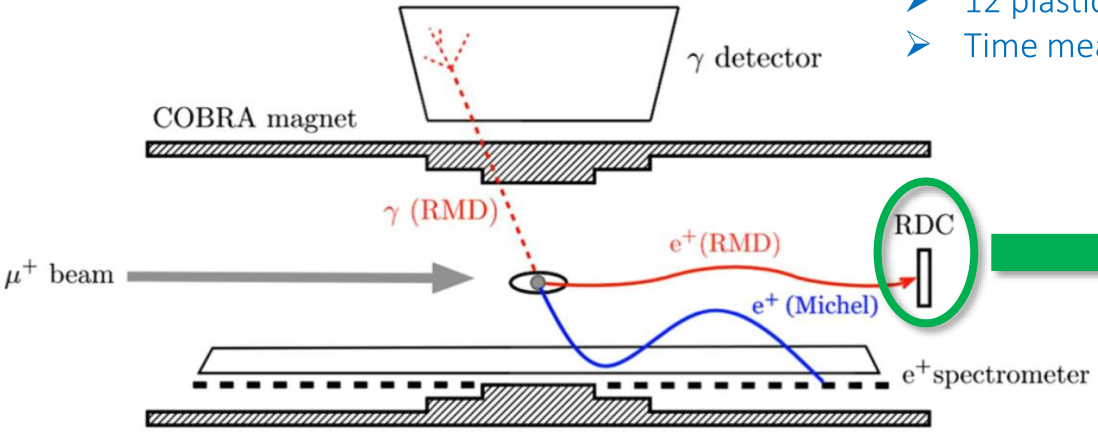




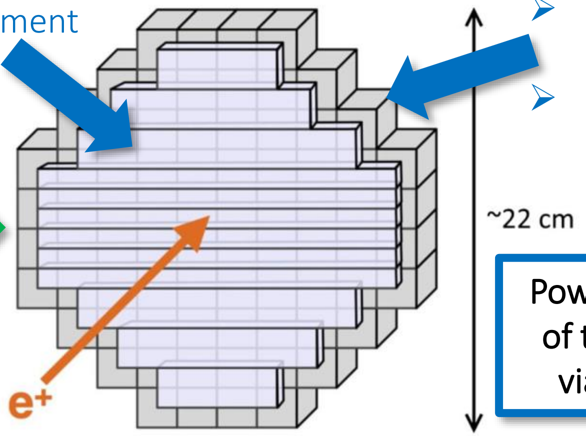


- Cockcroft-Walton (CW) proton accelerator
- Dedicated DS beam line

Radiative Decay Counter (RDC)

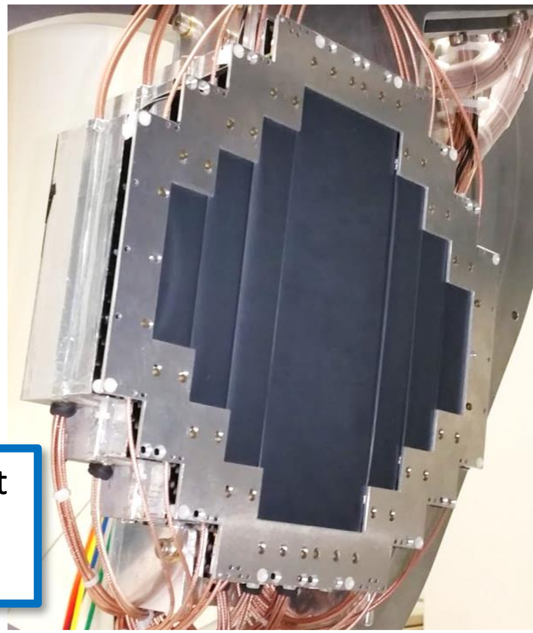


- 12 plastic scintillators BC-418 (Saint Gobain)
- Time measurement



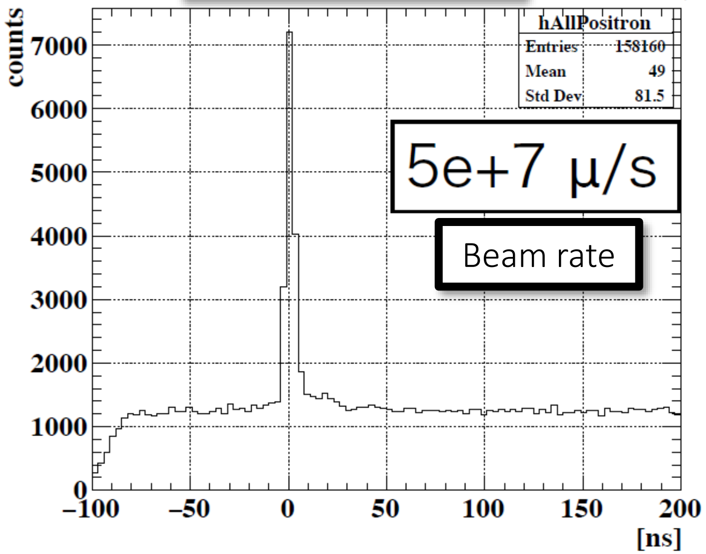
- 76 LYSO crystals
- Energy measurement

Power supply/readout of the SiPMs directly via the DAQ board



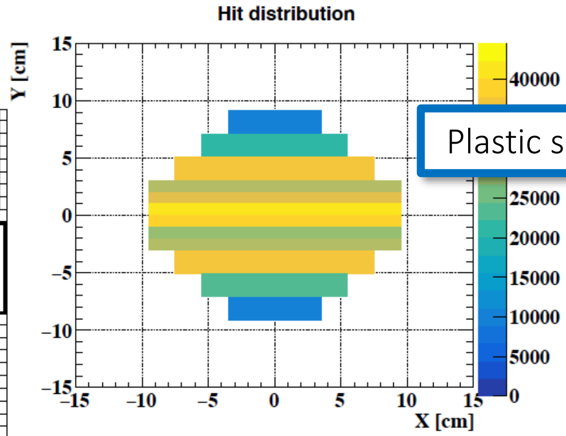
- VETO detector to tag low-energy e^+ (1-5 MeV) from AIF/RMD in time coincidence with high-energy γ (> 48 MeV) to remove these events from the $\mu^+ \rightarrow e^+\gamma$ candidate sample
- Expected performances
  - $\sigma_t \approx 100$ ps, $\sigma_E \approx 8\%$
- Background reduction and improvement in the MEG II sensitivity up to 15%

$t_e^{RDC} - t_\gamma^{LXe}$[ns]

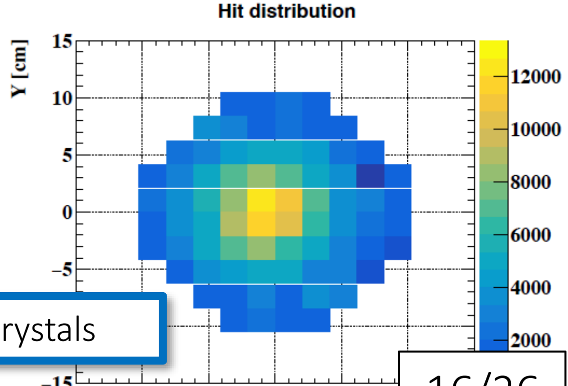


5e+7 μ/s

Beam rate



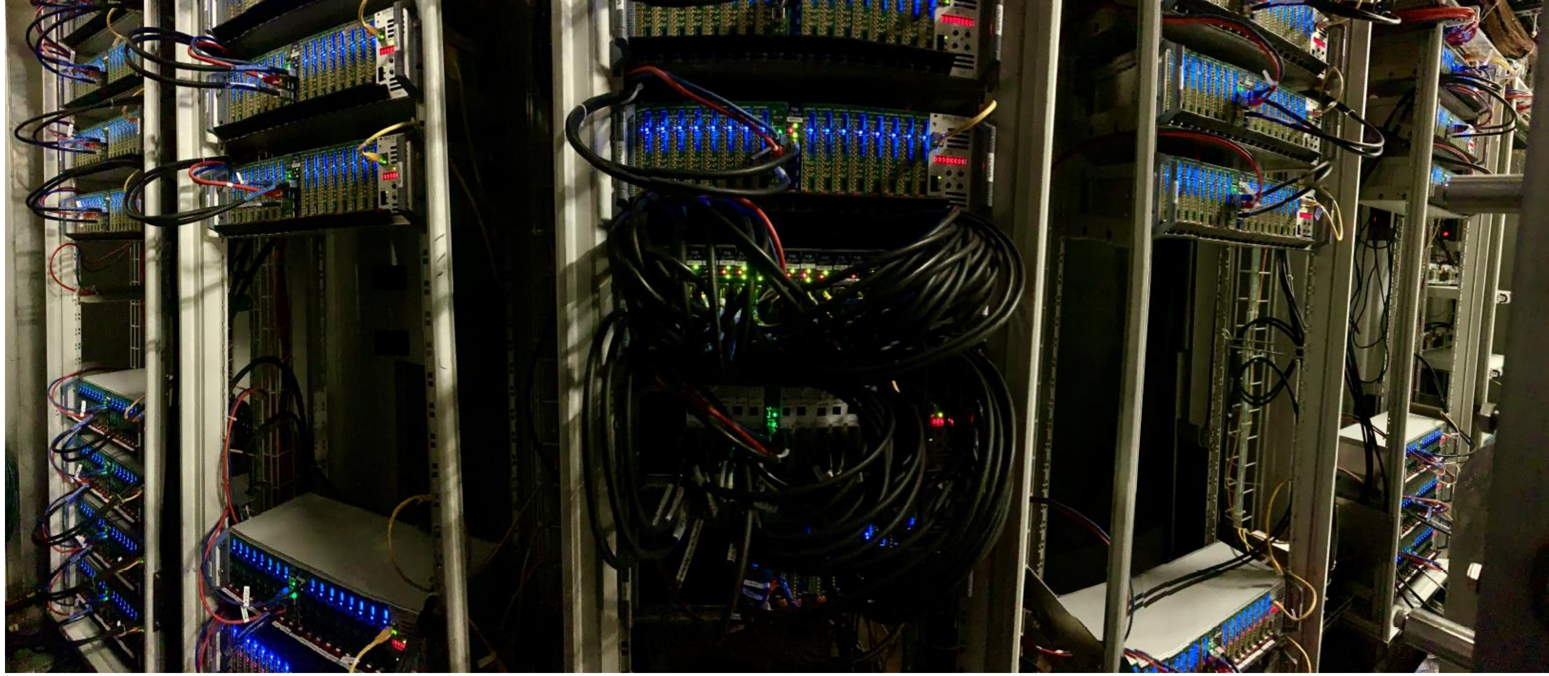
Plastic scintillators



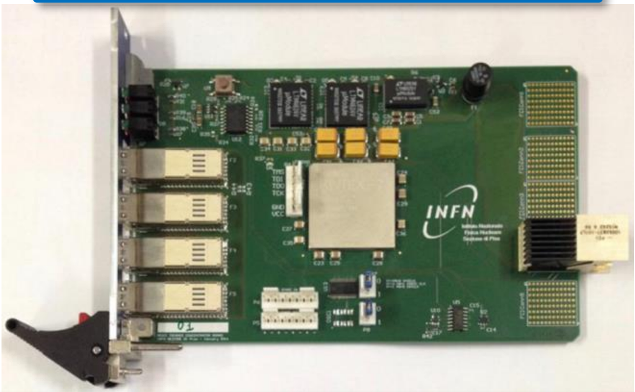
LYSO crystals

Trigger and DAQ (TDAQ)

- Re-design of the MEGII detectors leads to an increase of a factor $\times$ 3 in the number of readout channels
  - ≈9000 in total
- Integration of Trigger and DAQ operations in a single system: WaveDAQ
  - 37 crates each housing 16 WDBs (256 channels each)
  - + 1 Trigger Concentrator Board (TCB) for online data processing + clock and trigger signals distribution
  - + 1 Data Concentrator Board (DCB) for data handling/formatting
- Acquisition of the whole waveform (as in MEG) for the offline background suppression
  - Sampling at $\mathbf{1.4\ GSPS}$
  - Digitization with 80 MHz ADCs to execute complex trigger algorithms with the integrated FPGA
    - Estimate of the γ energy (E_γ) + $e^+\gamma$ time coincidence ($t_{e\gamma}$)
  - Online resolution
    - $\Delta E_\gamma \sim 2.5\%$ (improvement factor $\times$ 1.5)
    - $\Delta t_{e\gamma} \sim 2$ ns (improvement factor $\times$ 1.5)
  - Final trigger rate 10-30 Hz with selection efficiency ~ 1



Trigger Concentrator Board (TCB)

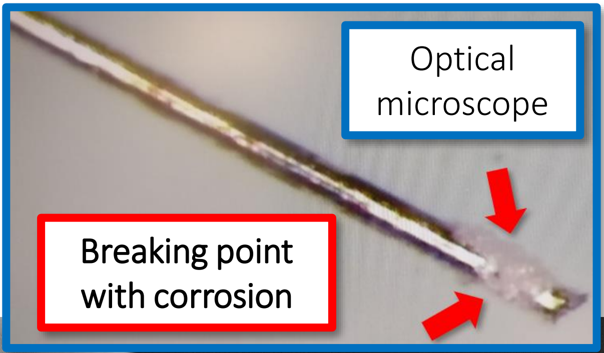


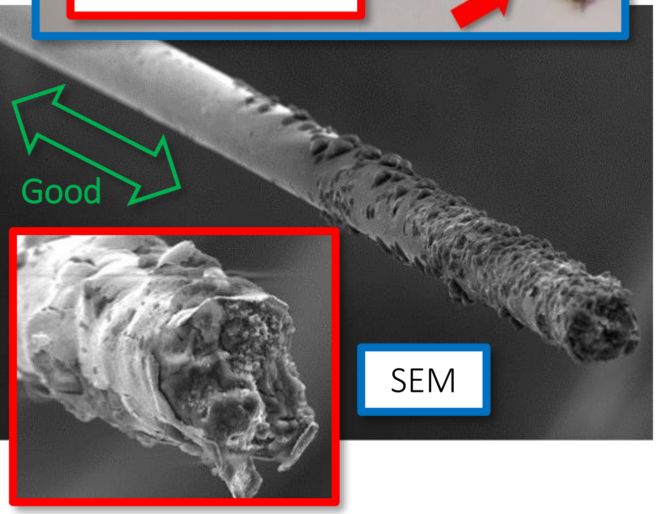
WaveDREAM Board (WDB)

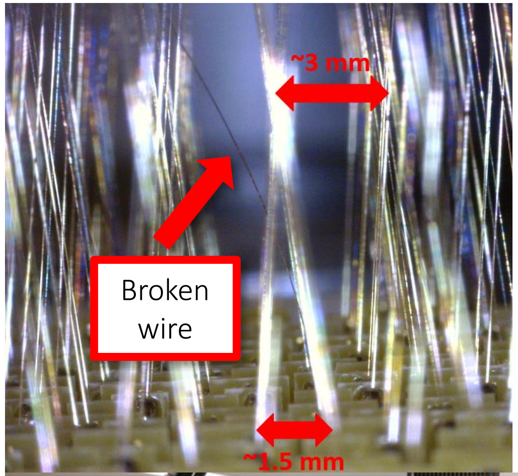
WaveDREAM Board (WDB)
- 16 channels with programmable gain ($0.5 \div 100$) and shaper + SiPMs power supply
- Comparators for timing measurements
- Waveform analog sampling at $\mathbf{1 \div 5\ GSPS}$ via the DRS4 (Domino Ring Sampler 4) chip

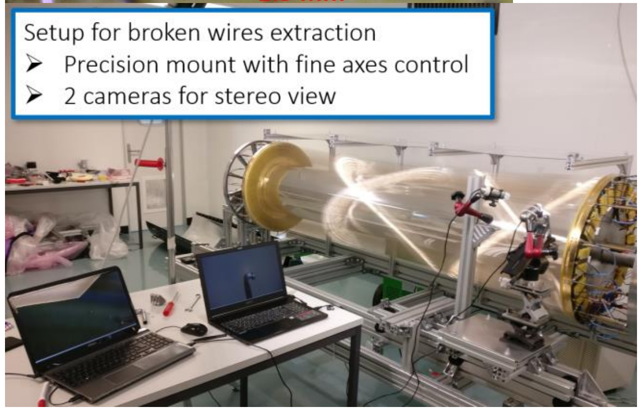
Main problems and solutions

CDCH history

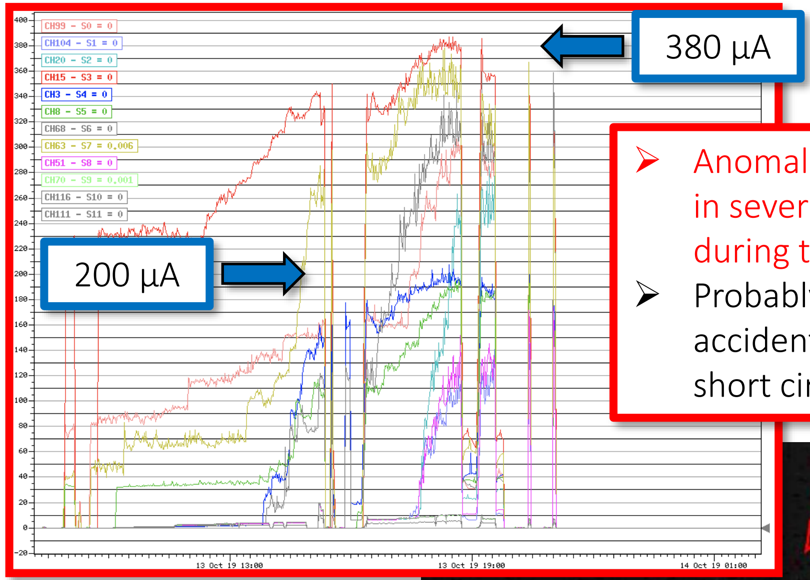




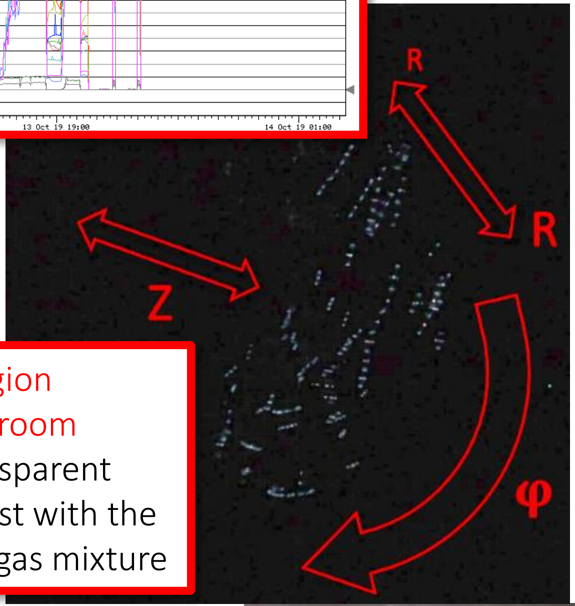




- Breaking of 107 Al wires (90% 40 µm) in presence of humidity
- All broken wires successfully removed and eliminated other possible damaged wires by extra stretching CDCH (then again CDCH at the working length)
- No more broken wires due to corrosion since CDCH kept in inert atmosphere (flushed with Nitrogen or Helium once sealed)



- Anomalously high currents in several sectors/layers during the first data taking
- Probably triggered by an accidental anode-cathode short circuit

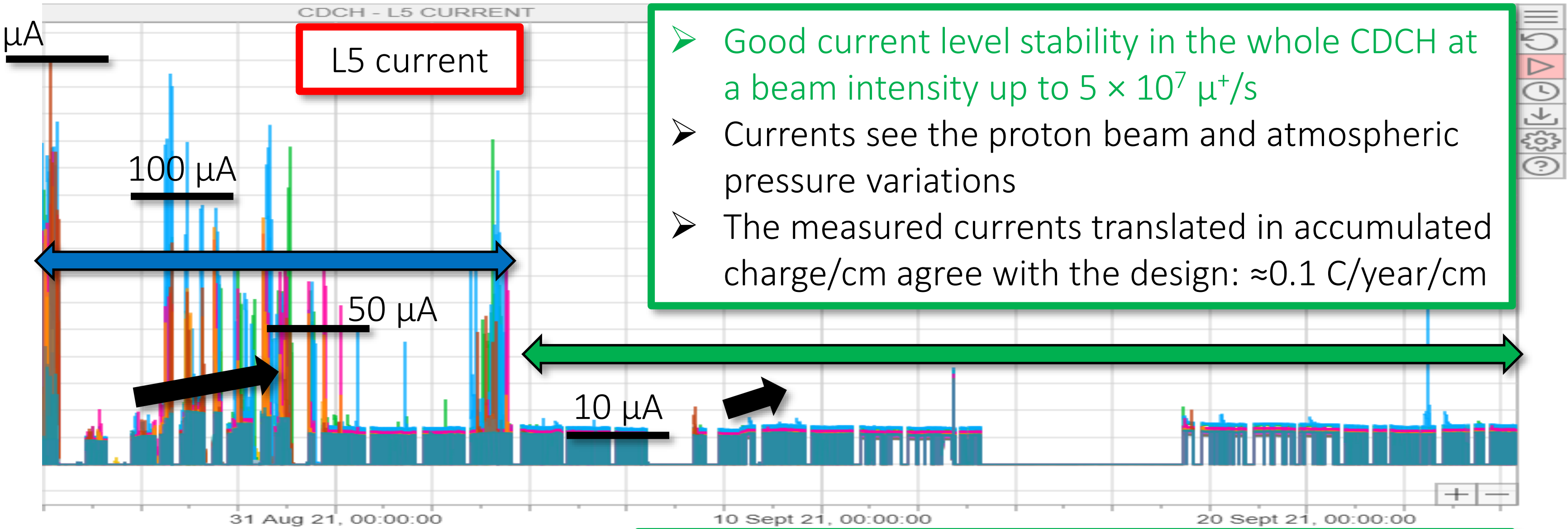


- One of the discharge region photographed in a dark room
- CDCH closed with a transparent plexiglas shell and HV test with the standard He:IsoB 90:10 gas mixture

- Corona-like discharges in correspondence of 6 whitish regions
- Problem cured with additives in the gas mixture
- Oxygen proved to be effective in reducing high currents (plasma cleaning?)
- Isopropyl alcohol crucial to keep stable the current level

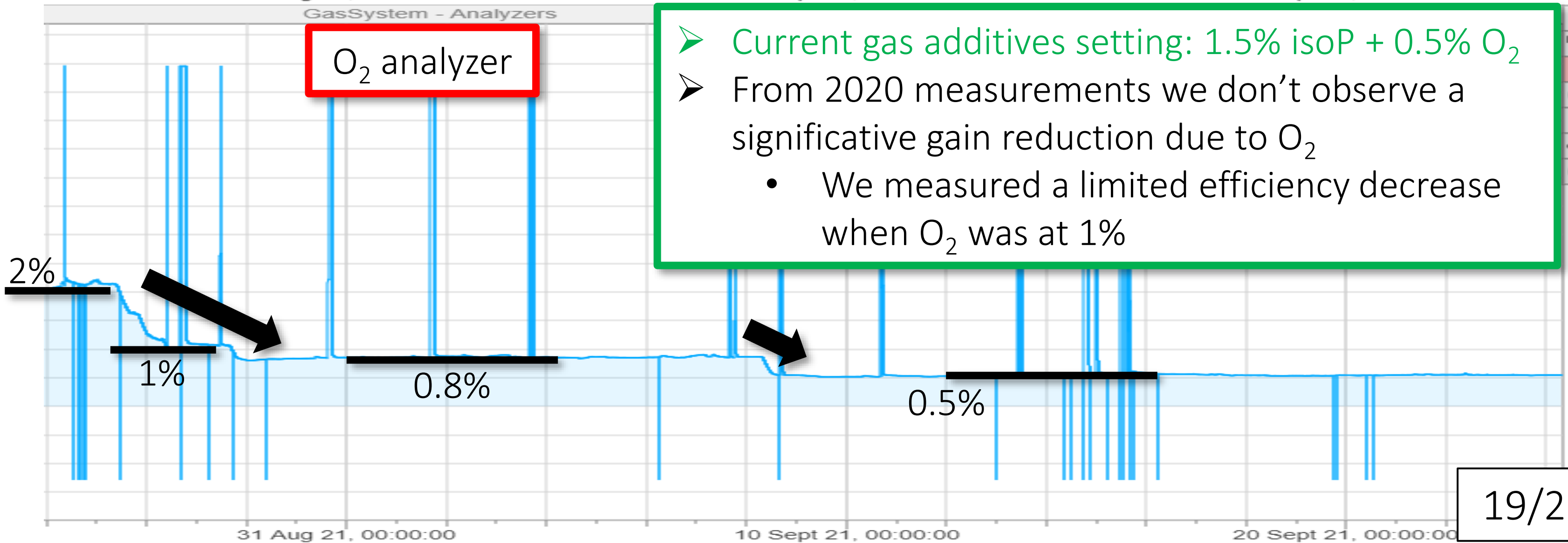
CDCH conditioning and stable operations

- Example of conditioning period with current discharges in presence of the μ^+ beam
- HV up to WP+40V and Oxygen concentration up to 2% to speed up the O_2 cleaning



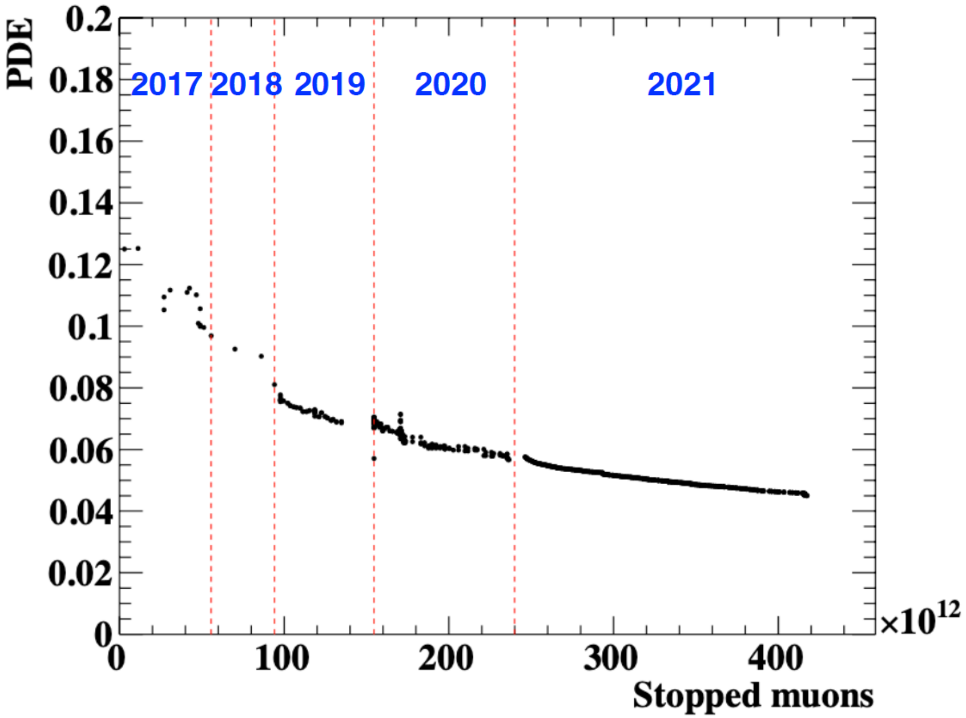
- Good current level stability in the whole CDCH at a beam intensity up to 5×10^7 μ^+/s
- Currents see the proton beam and atmospheric pressure variations
- The measured currents translated in accumulated charge/cm agree with the design: ≈0.1 C/year/cm

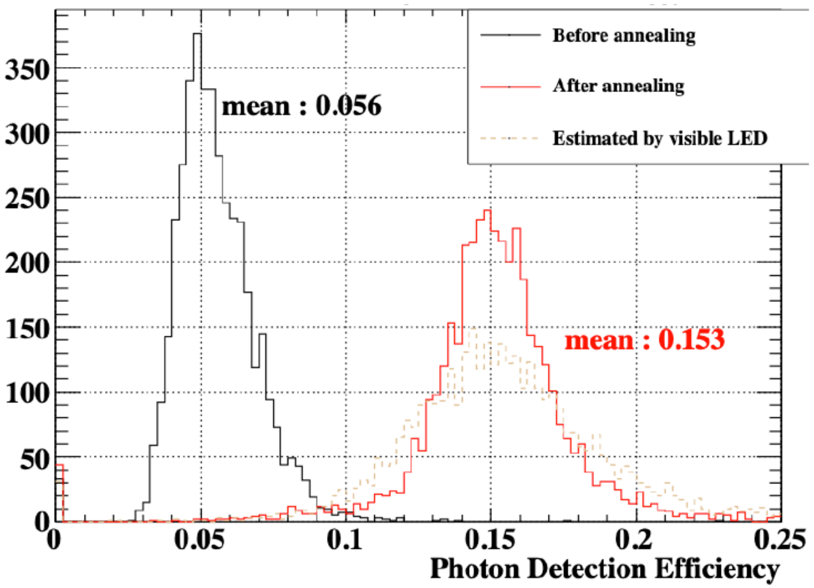
- We are very sensitive to the isopropyl alcohol concentration
- We experienced that 1-1.5% isoP concentration is crucial to keep the stability

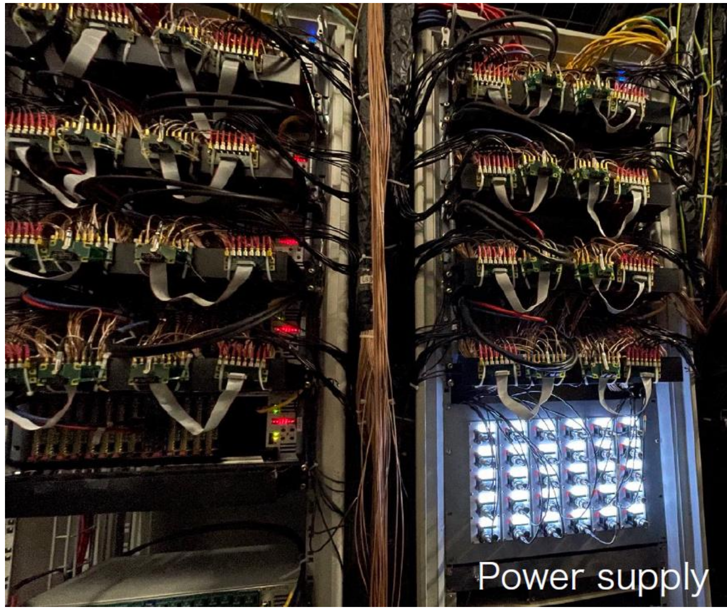


- Current gas additives setting: 1.5% isoP + 0.5% O_2
- From 2020 measurements we don't observe a significative gain reduction due to O_2
  - We measured a limited efficiency decrease when O_2 was at 1%

LXe PDE decrease and recovery by annealing

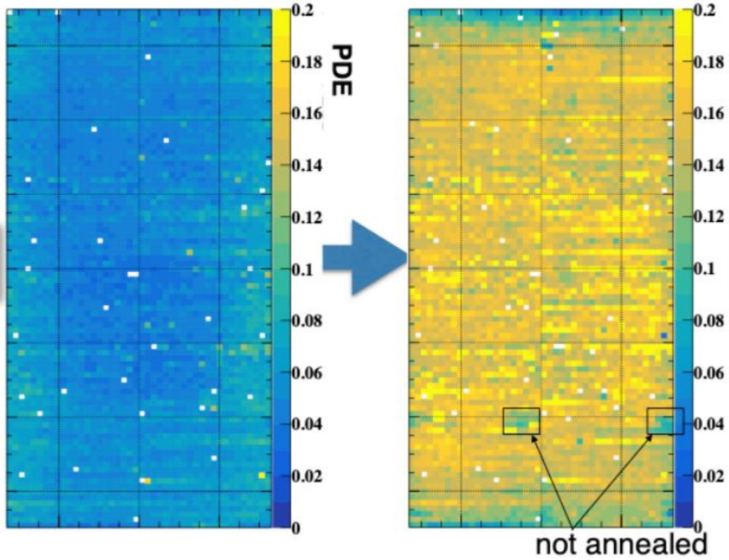






PDE before/after annealing

Before

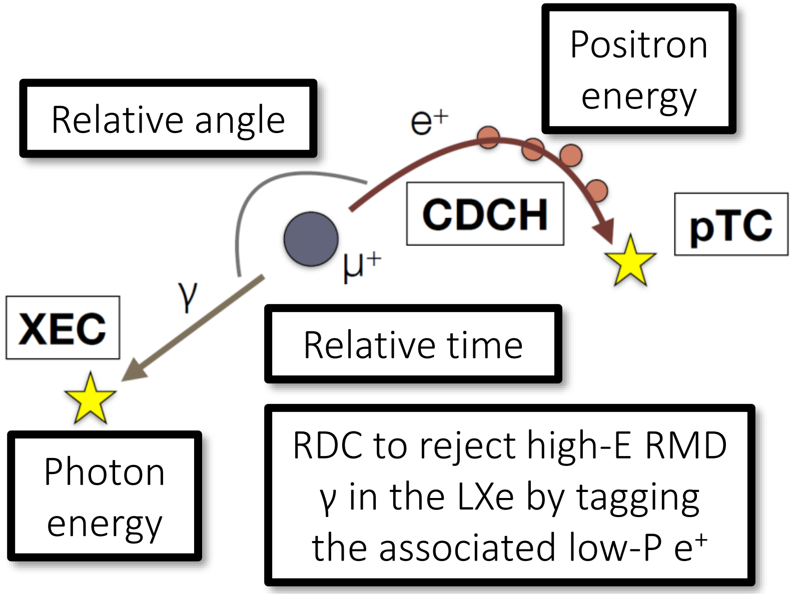


After

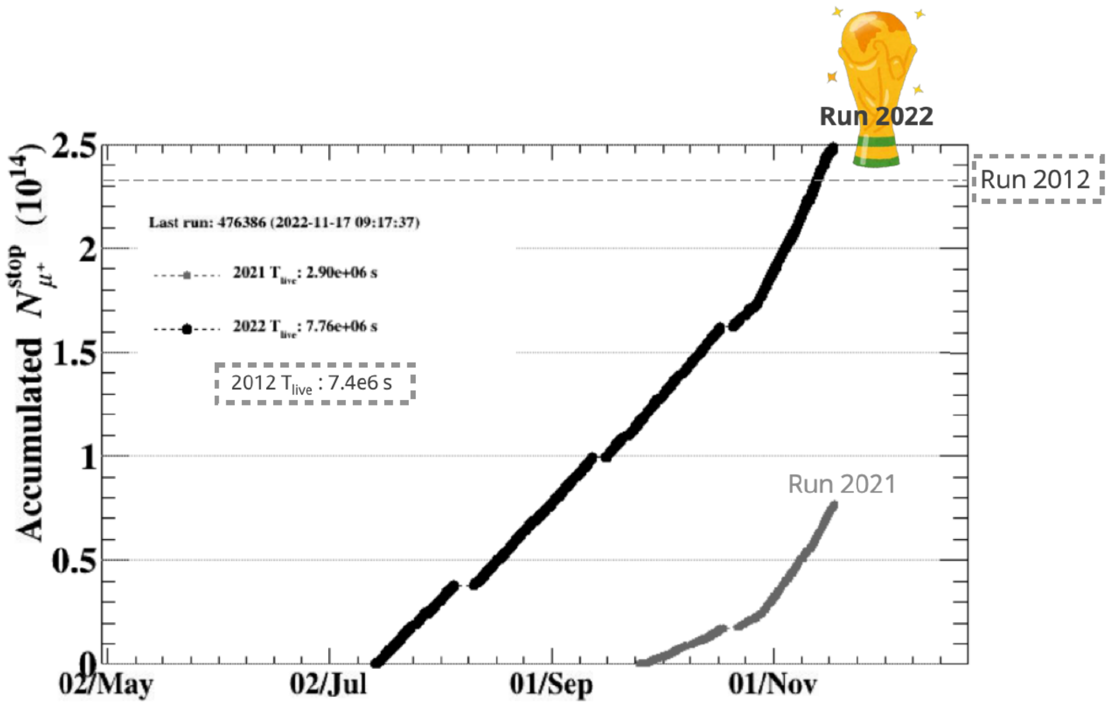
- Experienced a Photon Detection Efficiency/Quantum efficiency (PDE/QE) decrease with beam time
- Caused by the **SiPM surface damage by radiation**
- Solution by performing the SiPM heating
  - **Annealing every year** during the accelerator shutdown period
  - **Joule heat method**: reverse bias with a dedicated power supply
  - **About two months** to complete the annealing of all the sensors
- 15% PDE allows to operate the LXe at a beam rate of 5×10^7 μ^+/s for 120 days

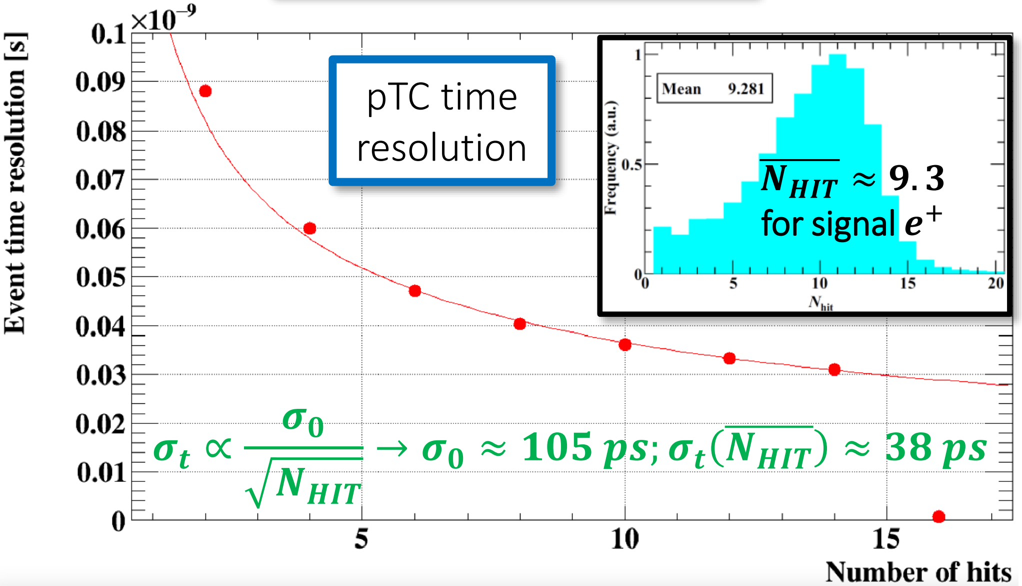
Physics data taking and current performances

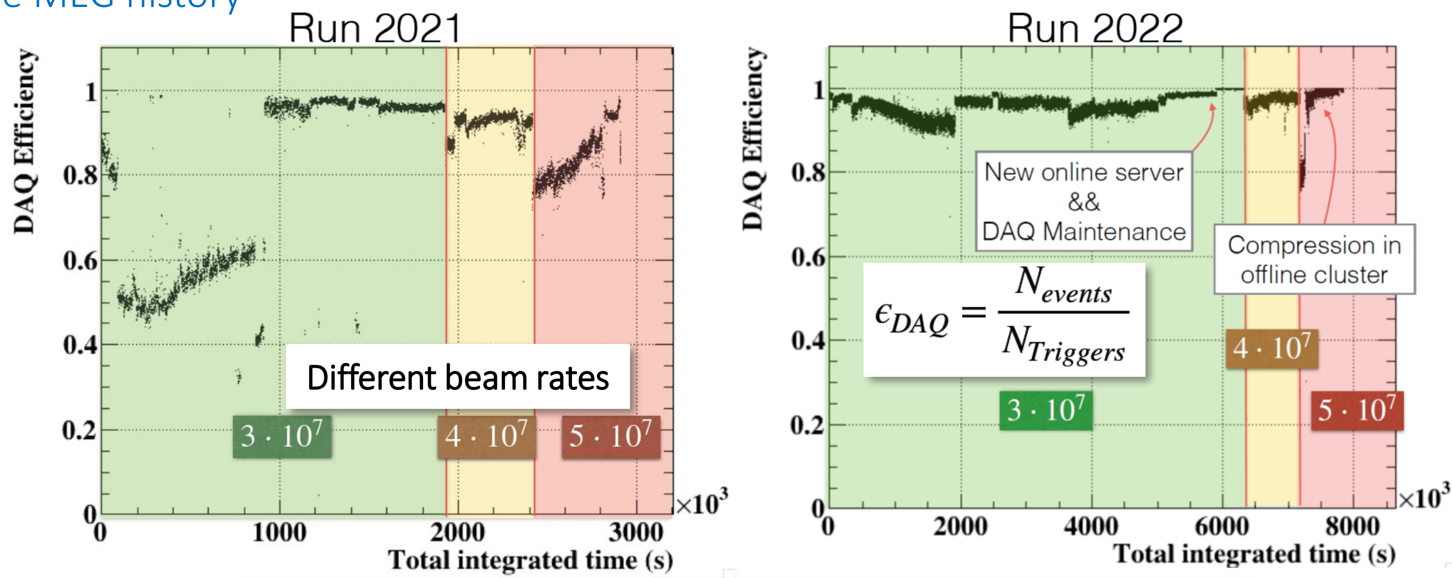
TDAQ and pTC



- Physics data taking since 2021 (full DAQ electronics available) after 3 years of engineering runs (10% of DAQ electronics) and commissioning (despite the pandemic) with continuous improvements
- Run 2022 is the longest ever achieved in the MEG history



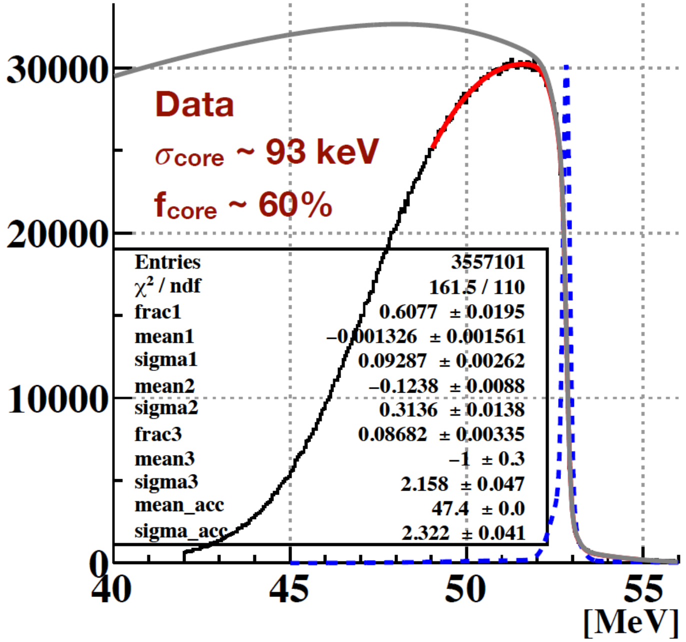


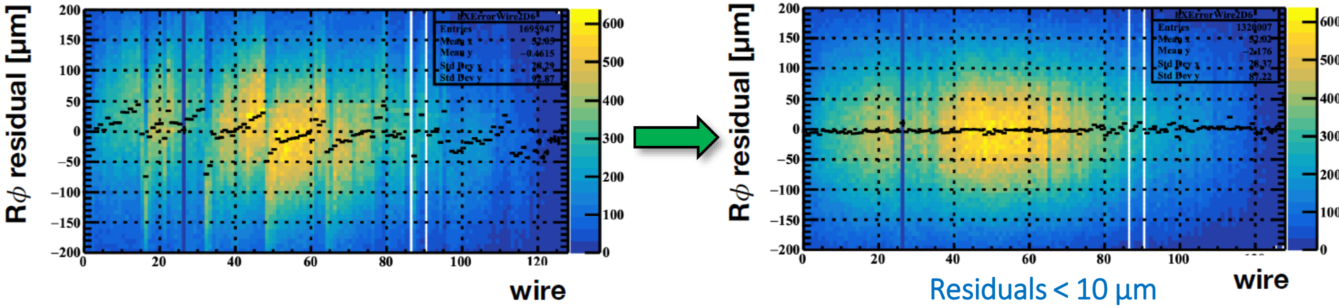


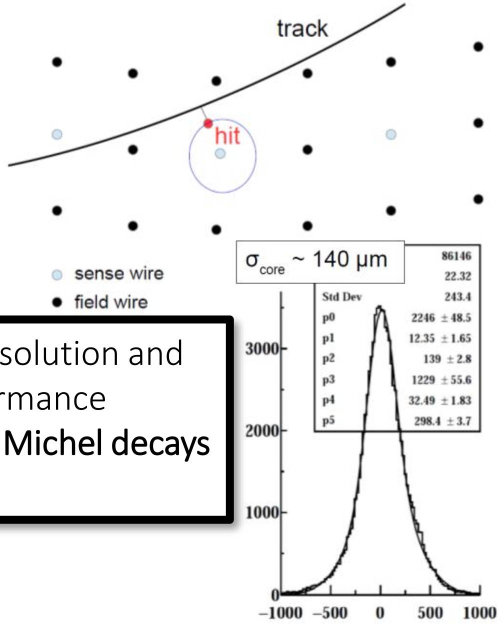
Significant improvement in the DAQ efficiency and stable operation up to 30 Hz trigger rate (× 3 the design)

CDCH

HW alignment only (surveys)
- ± 100 µm range

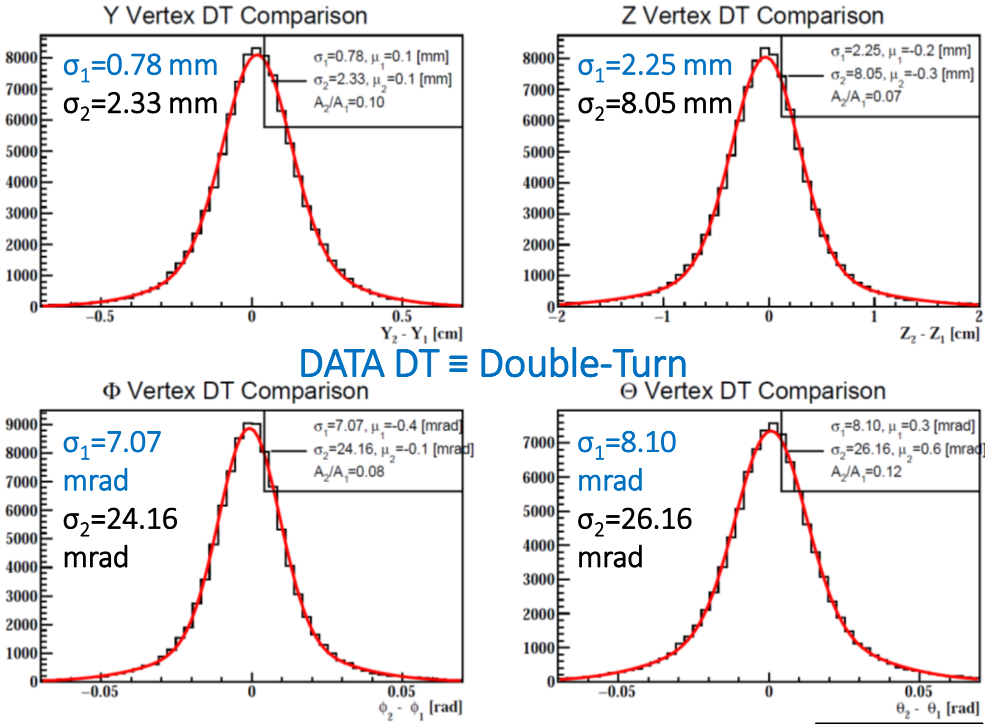




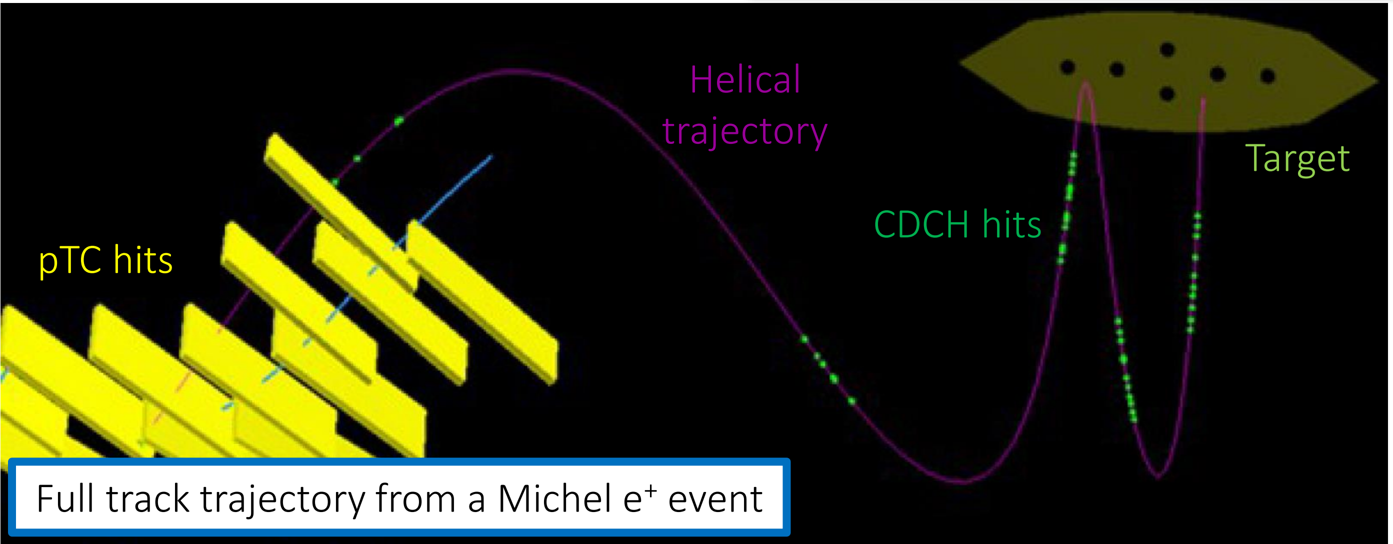


- **Hit-track residuals** give a measurement of how misalignments, single-hit resolution and other systematics (B field) combine to determine the reconstruction performance
- **Iterative wire alignment based on hit-track residuals of positron tracks from Michel decays**
  - Alternative method with a global fit using cosmic rays is on going

Diagnostic tools
- Momentum spectrum of positrons from Michel decays → σ_p/bias
  - PDF(p) = [PDF_{THEORY}(p) × Acceptance(p)] ⊗ $Resolution_{TRIPLE-GAUSSIAN}$(Δp)
- Comparison of multiple turns made by the same track → kinematical resolutions/bias



$$\sigma_\theta = \sigma_{\theta_1-\theta_2}/\sqrt{2} \text{ x MC-based correction}$$

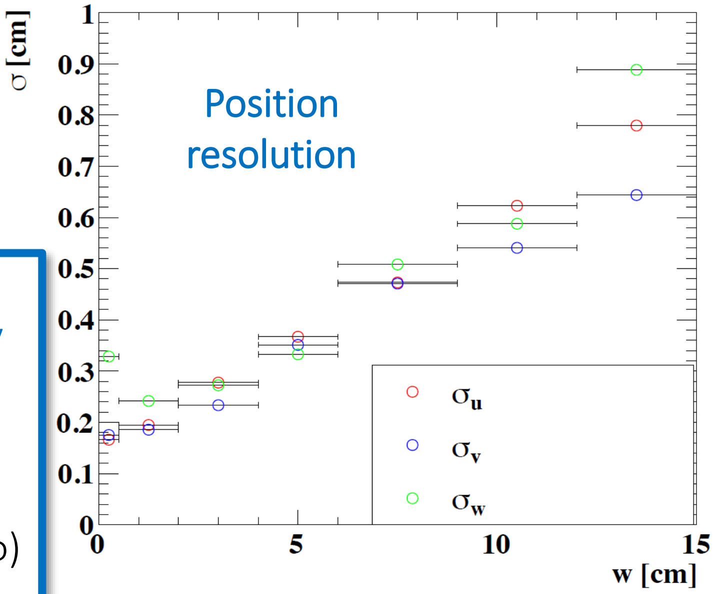


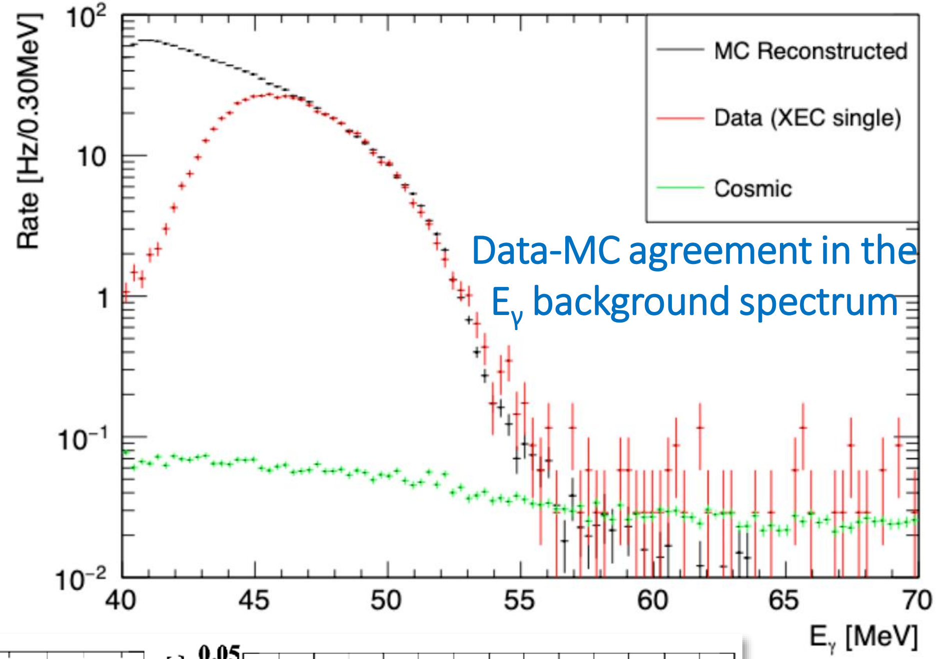
Full track trajectory from a Michel e⁺ event

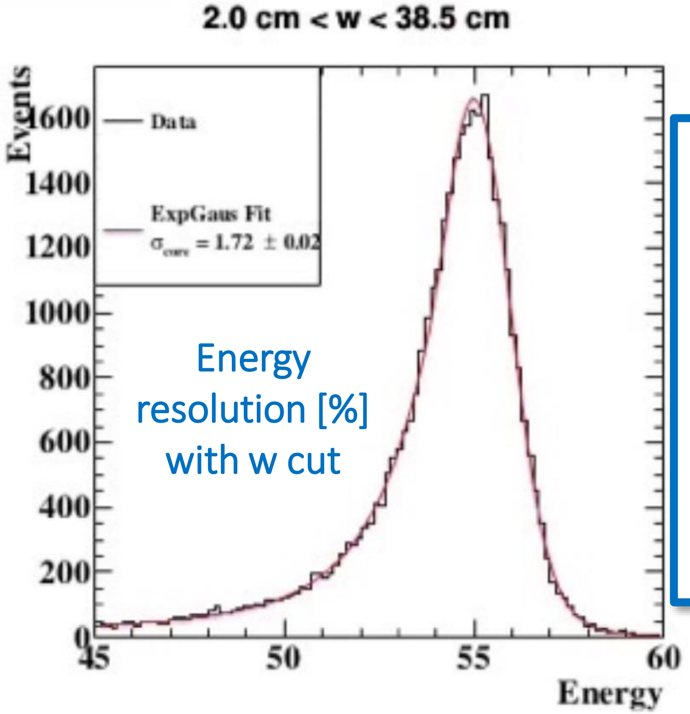
LXe

Position resolution measured in 2018 with CW(Li) 17.6 MeV events + collimators

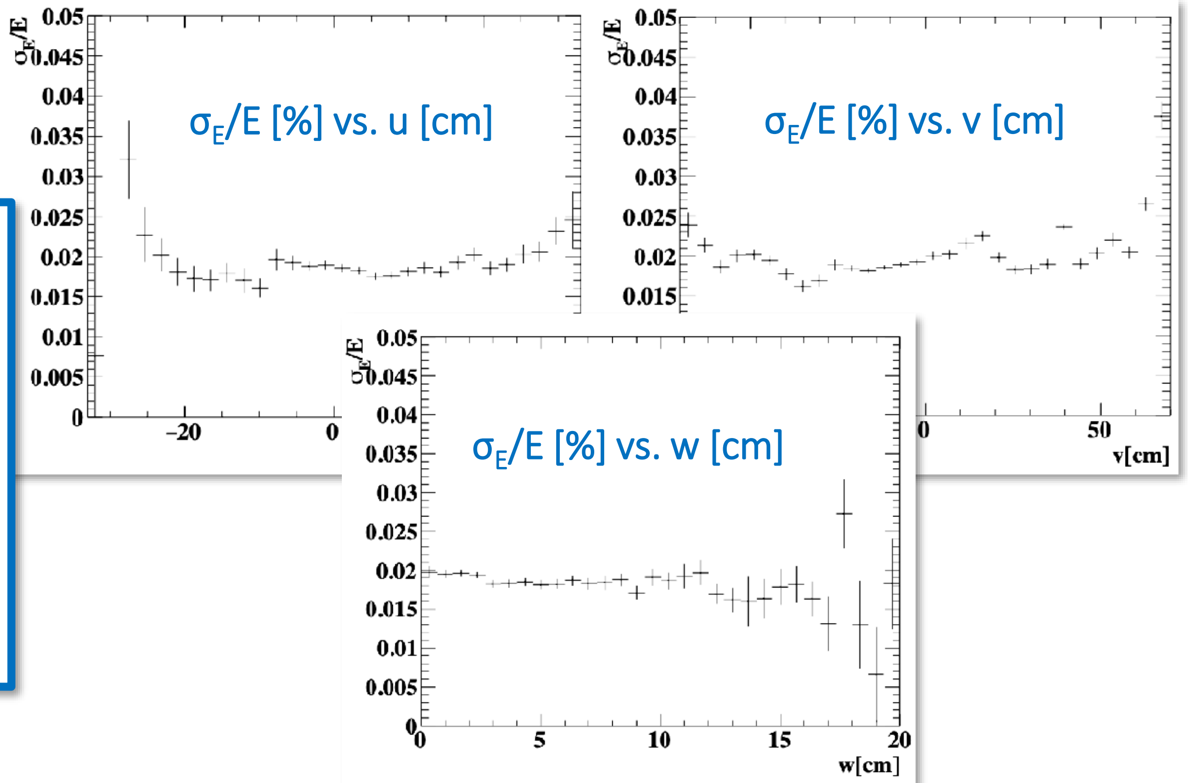
- (u, v) coordinates → LXe entrance face (x, y) coordinates → MEG (z, Rϕ) coordinates
- w ≡ radial depth







- Energy resolution for deep events from CEX run (1.7%) is worst than the MC one (1.1%)
- **Uniformity response** vs. (u, v) under study
- σ_E/E is worst for shallow events (2%) with respect to deep events



MEGII performance overview

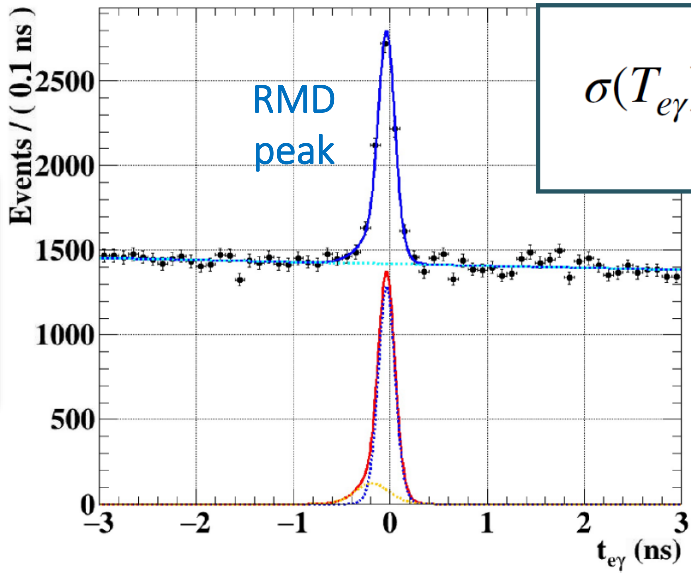
Variable	Obtained (MEG)	MEGII proposal	Currently measured on data (MEG II)
ΔE_e [keV]	380	130	90
$\Delta\theta_e, \Delta\varphi_e$ [mrad]	9, 9	7.0, 5.5	8, 7
Efficiency_e [%]	40	70	65
ΔE_γ [%] (deep/shallow)	1.7/2.4	1.0/1.1	1.7/2.0
$\Delta\text{Position}_\gamma$ [mm]	5	2.4	2.5
Efficiency_γ [%]	60	70	60
$\Delta t_{e\gamma}$ [ps]	120	85	80

Positron variables

Photon variables

Combined

- $e^+ - \gamma$ relative timing resolution with the contributions of the LXe and pTC detectors from RMD events
- Agreement between the RMD and CEX analyses
  - σ_t(CEX) = 65 ± 8 ps



$$\sigma(T_{e\gamma}) = (69 \pm 5) \oplus \frac{105}{\sqrt{n_{TC}}}$$

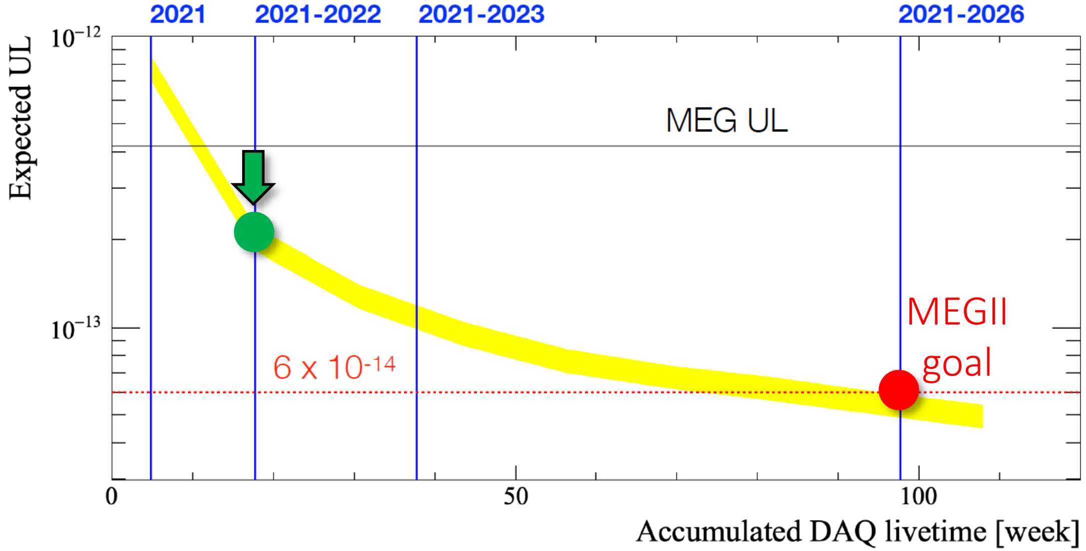
photon

positron

Conclusions and prospects

- In the world of the Intensity Frontier and CLFV the MEG experiment with the first phase (current best Upper Limit) and now its upgrade MEGII play a starring role in the search for the $\mu^+ \rightarrow e^+\gamma$ decay
- The MEGII experiment is currently in the physics data taking phase after a big effort on the hardware side for the commissioning with continuous improvements
- Solid performances (tested on real data) are found with continuous improvements thanks to the analysis group
- **Close to publish the first physics results**
- $\mathrm{BR}(\mu^+ \rightarrow e^+\gamma) \sim 6 \times 10^{-14}$ goal is achievable in 4-5 years
- MEGII is competitive with the new generation of CLFV experiments (Mu2e, COMET, DeeMe, Mu3e in the muon sector) and its **search is complementary to the others**

Assuming full beam time assignment to MEG (20 weeks livetime/year at 5 x 10^7 μ/s)

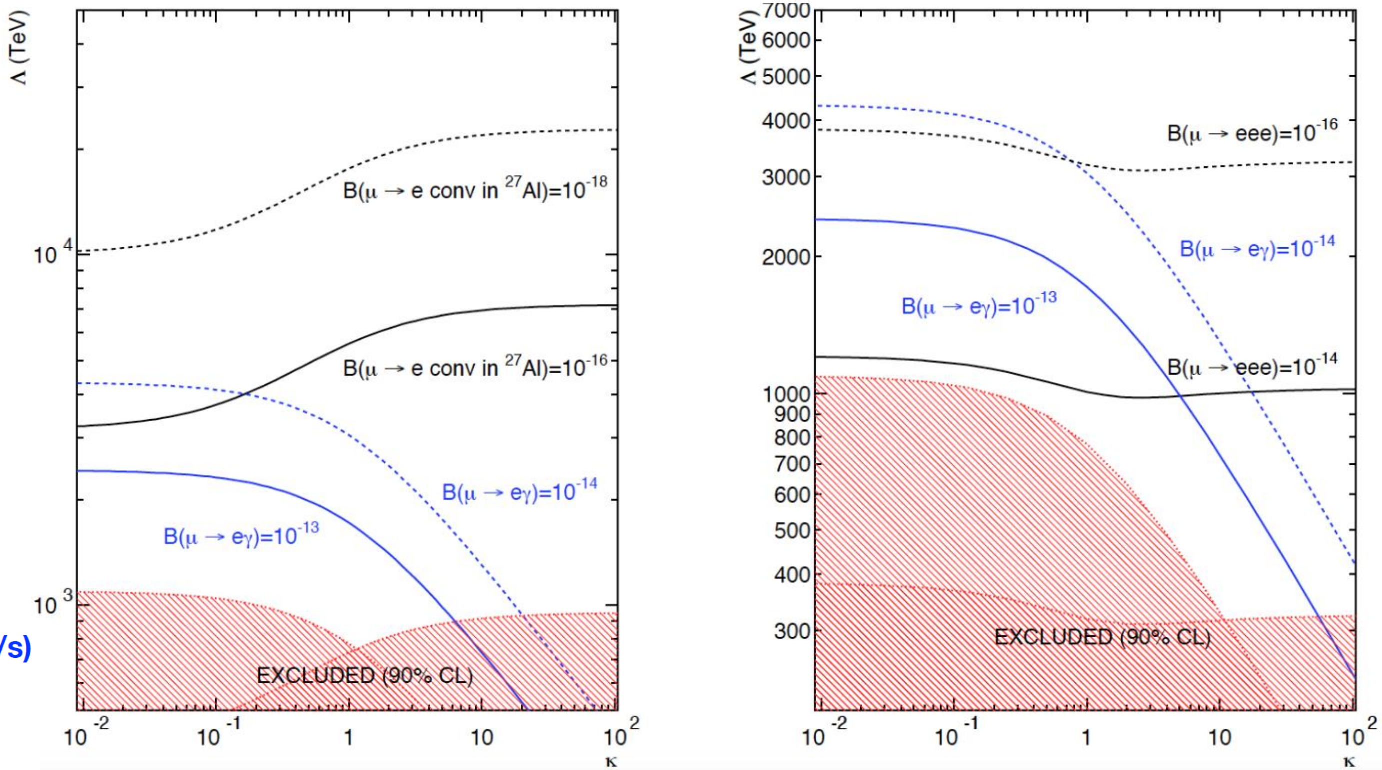


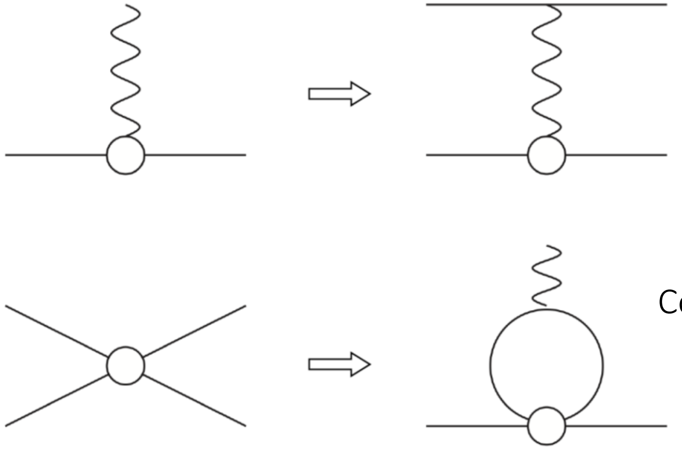
Effective Lagrangian

Dipole term

4-fermion term

$$\mathcal{L}_{CLFV} = \frac{m_\mu}{(k+1)\Lambda^2}\bar{\mu}_R\sigma_{\mu\nu}e_L F^{\mu\nu} + \frac{k}{(k+1)\Lambda^2}\bar{\mu}_L\gamma_\mu e_L(\bar{e}\gamma^\mu e) + h.c.$$





Contribution of the dipole operator to the 4-fermion dominating processes

Contribution of the 4-fermion operator to the dipole dominating processes

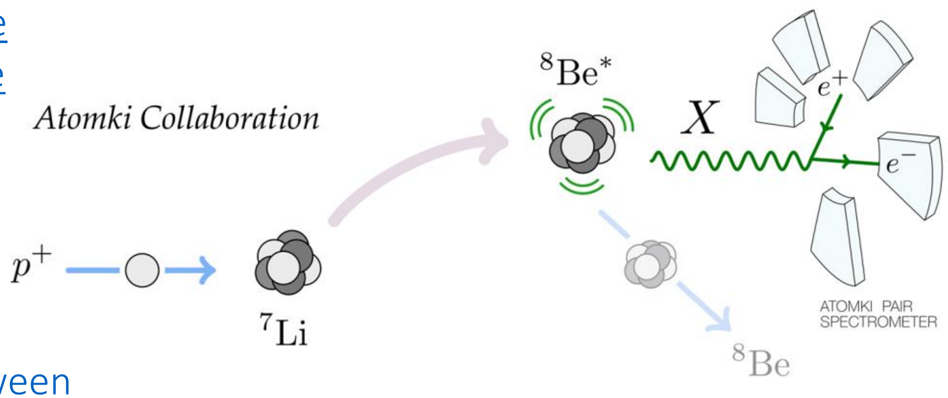
Beyond $\mu^+ \to e^+\gamma$: the X(17) boson search

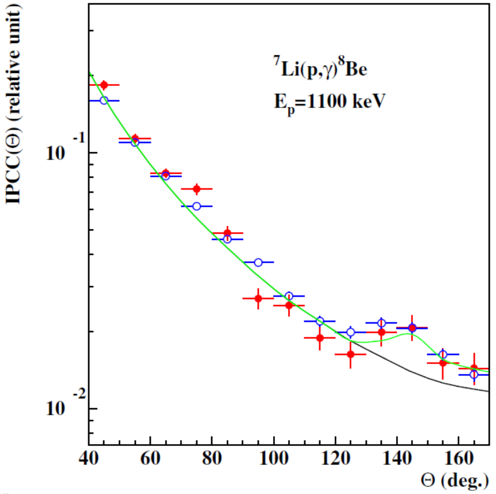
- In 2016 the Atomki collaboration measured an excess in the angular distribution of the Internal Pair Creation (IPC) in the ^{7}Li(p, e^+e^-)^{8}Be nuclear reaction
- This anomaly was confirmed by further measurements
  - ^{3}H(p, e^+e^-)^{4}He reaction
- Possible interpretation
  - Production of a new physics boson mediator of a fifth fundamental force that describes the interaction between dark and ordinary matter

$$p\ N \to N'^* \to N'\ (X \to)\ e^+e^-$$

  - Its mass is expected to be 17 MeV → X(17)
- An independent experiment could confirm or not this results
  - Artifact of the detector geometry???

- MEG II has all the ingredients to repeat the Atomki measurement
  - CW proton accelerator (used for LXe detector calibrations)
  - CDCH for e^+e^- measurement
  - pTC as trigger
  - B field → e^+e^- invariant mass with CDCH + COBRA magnet

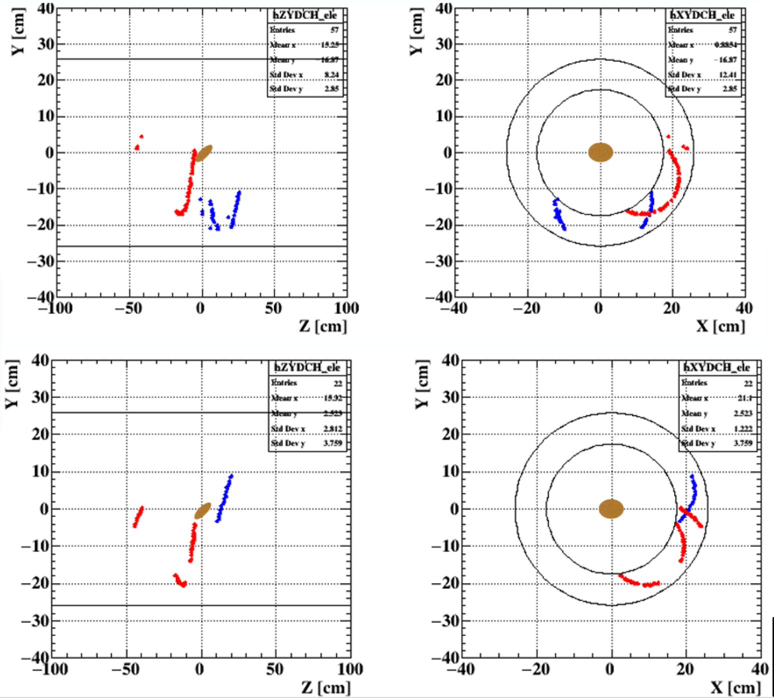




MEGII
- First DAQ done
- Analysis ongoing

p+ = 6.7 MeV
p- = 8.3 MeV
angle = 141°

p+ = 6.7 MeV
p- = 6.9 MeV
angle = 101°



- e+ hit
- e- hit
- target

THANKS
FOR YOUR ATTENTION