The MEG II Experiment: status and perspective

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ZOOM 29-04-2021
(on behalf of the MEG collaboration)

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Outlook

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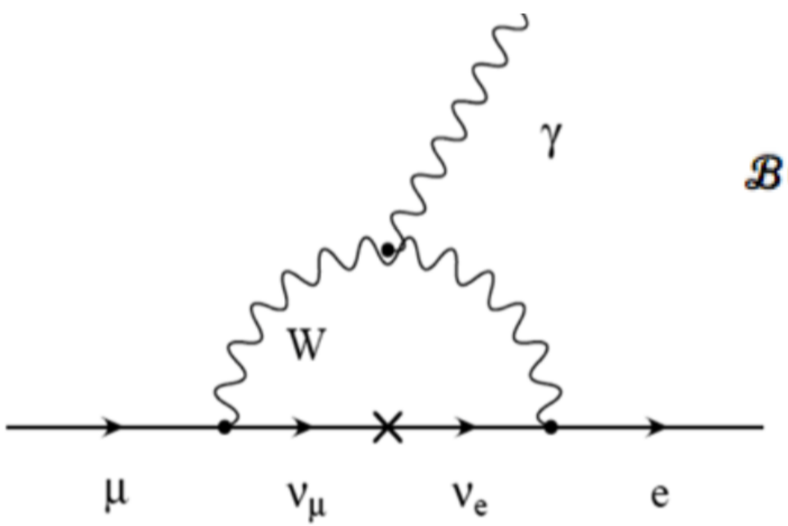
- **Quick** overview of **cLFV** (with muons)
  - ***highly sensitive*** *to physics* ***beyond*** *the* ***standard model***
  - ***comparison*** *between* ***different channels***
- **MEG II** experiment
  - ***overview***
  - ***status***
- Conclusions

cLFV = physics beyond SM

- l → l' + X (X = γ, " " , ee, μμ, others…)



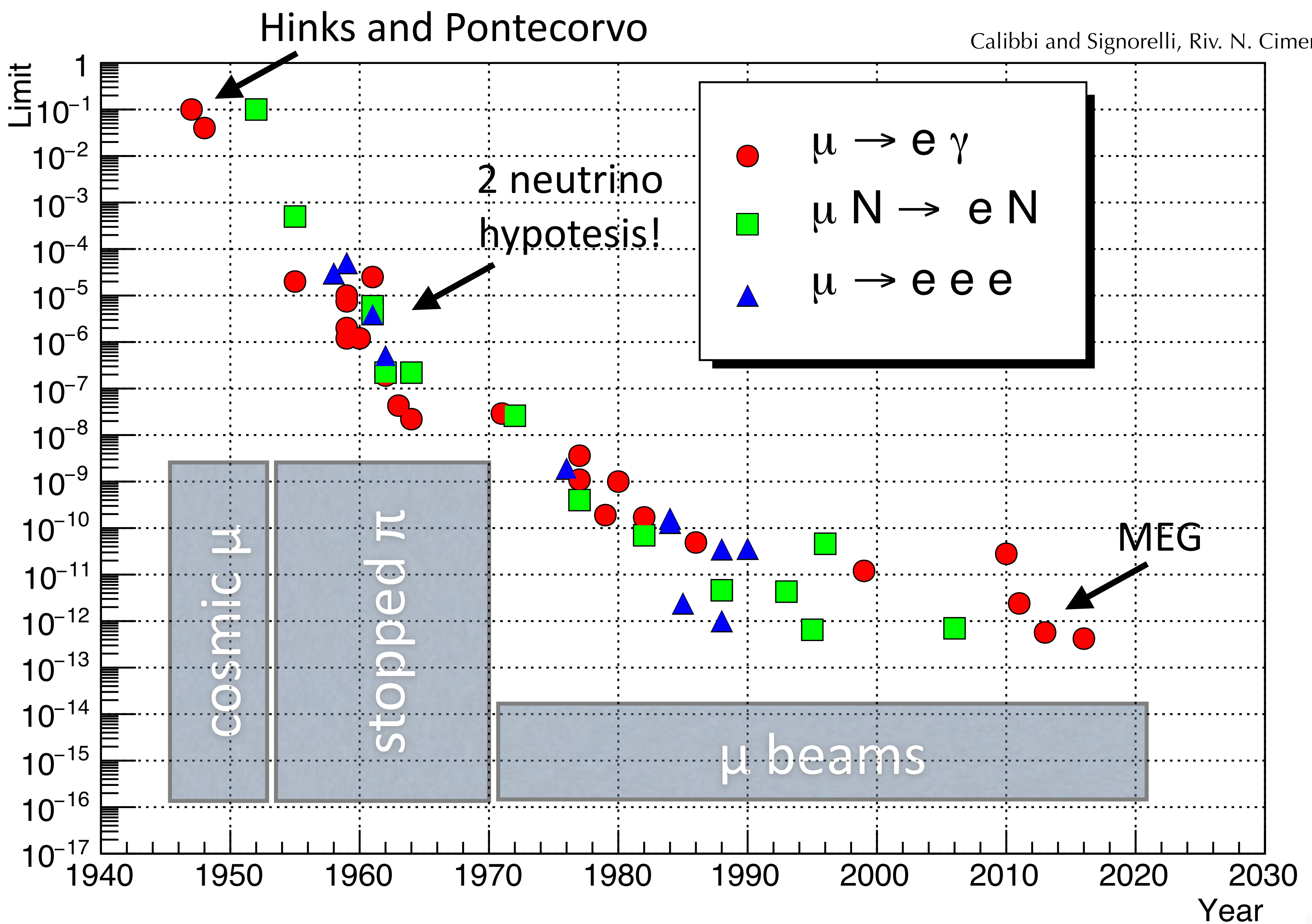
$$\mathcal{B}(\mu \to e\gamma) = \frac{3\alpha}{32\pi}\left|\sum_{i=2,3} U^*_{\mu i} U_{ei} \frac{\Delta m^2_{i1}}{M_W^2}\right|^2 \simeq 10^{-54}$$

too small to be experimentally accessible → portal to New Physics

extensively exploited in intensity frontier searched

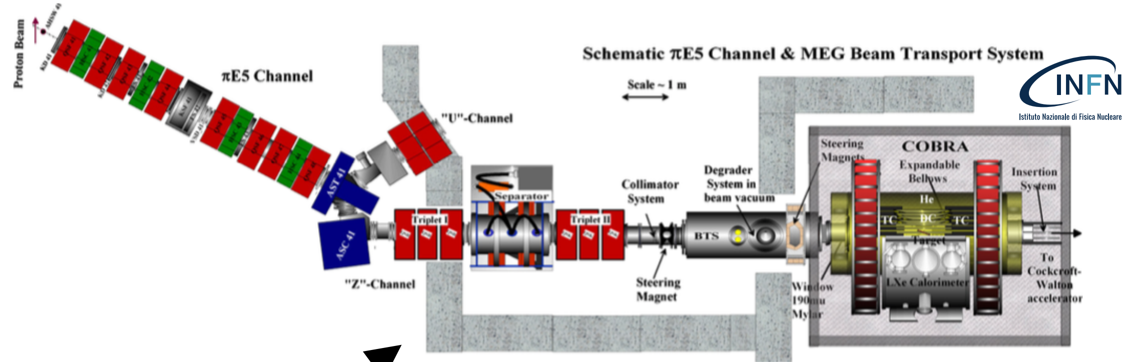
SM background free searches!

70 years of searches

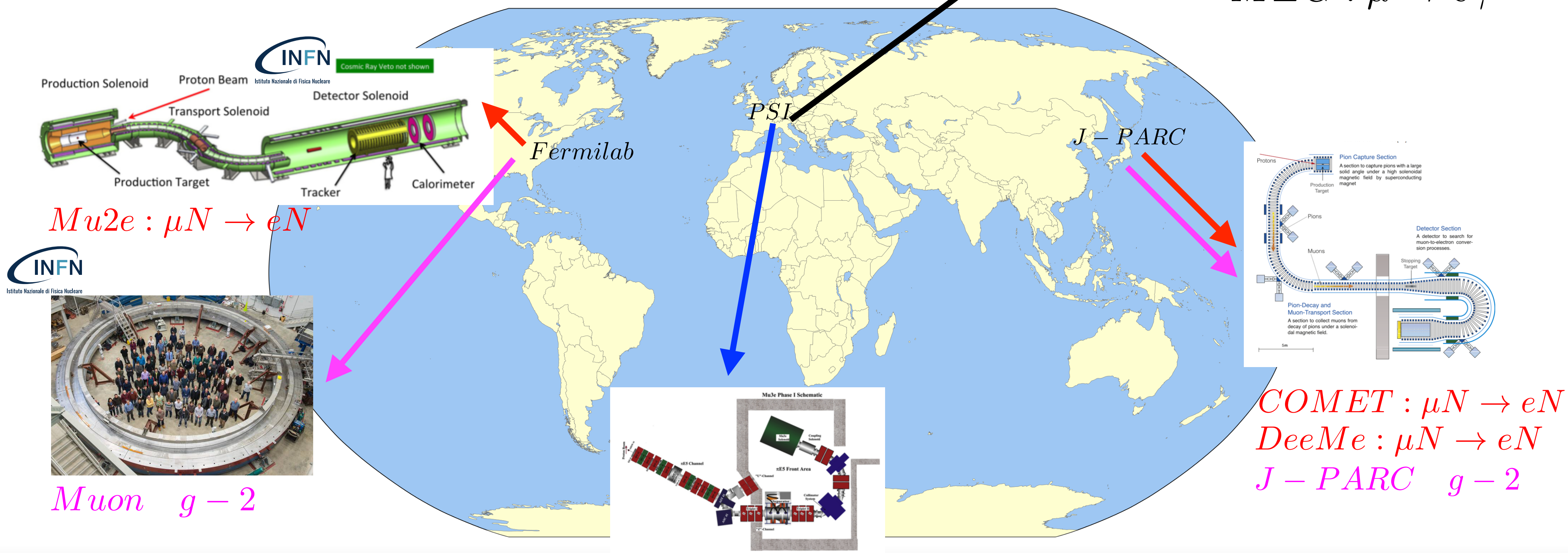


μ as a golden channel

- **High intensity** and **low energy** μ **beams**
  - ***large statistics*** *possible*
- **long decay time**
  - *beam* ***transport*** *to a* ***target***
- **simple kinematics**
  - ***precise*** *measurements in a* ***high rate*** *background*



$MEG : \mu \rightarrow e\gamma$



$Mu2e : \mu N \rightarrow eN$

$Muon \quad g-2$

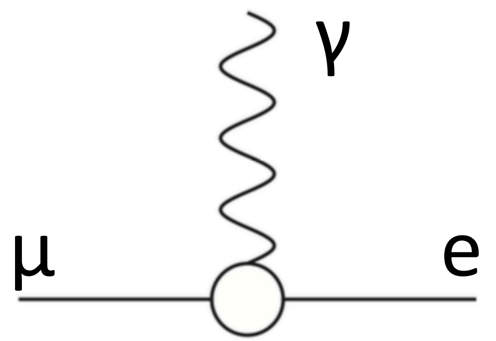
$Mu3e : \mu \rightarrow eee$

$COMET : \mu N \rightarrow eN$

$DeeMe : \mu N \rightarrow eN$

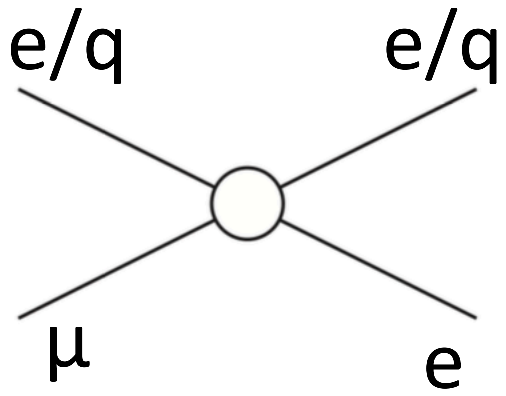
$J-PARC \quad g-2$

New physics* couplings



dipole transition

μ→eγ favoured



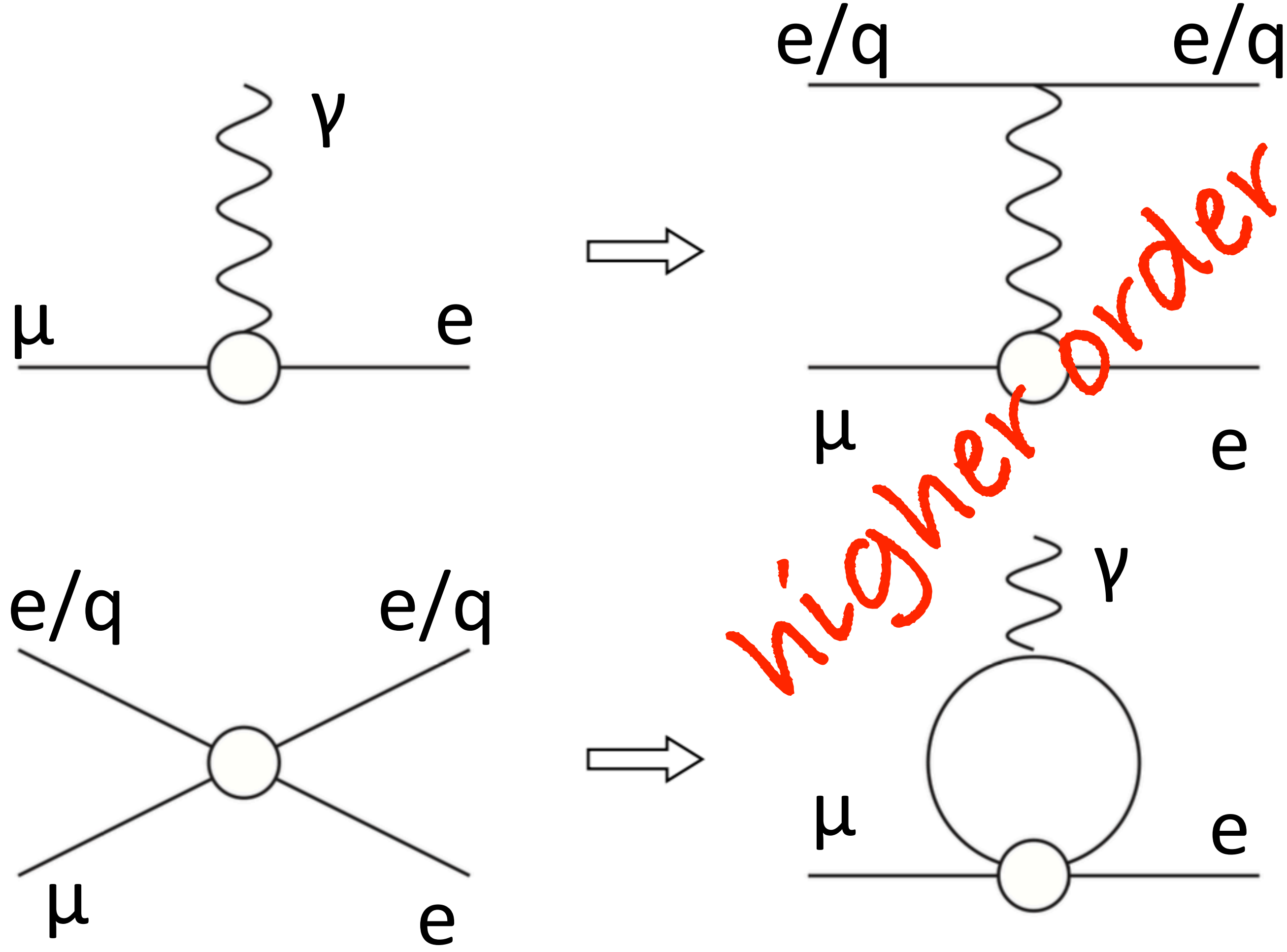
four particle interaction

μN→eN, μ→eee favoured

*Model independent approach

Calibbi and Signorelli, Riv. N. Cimento, 2017

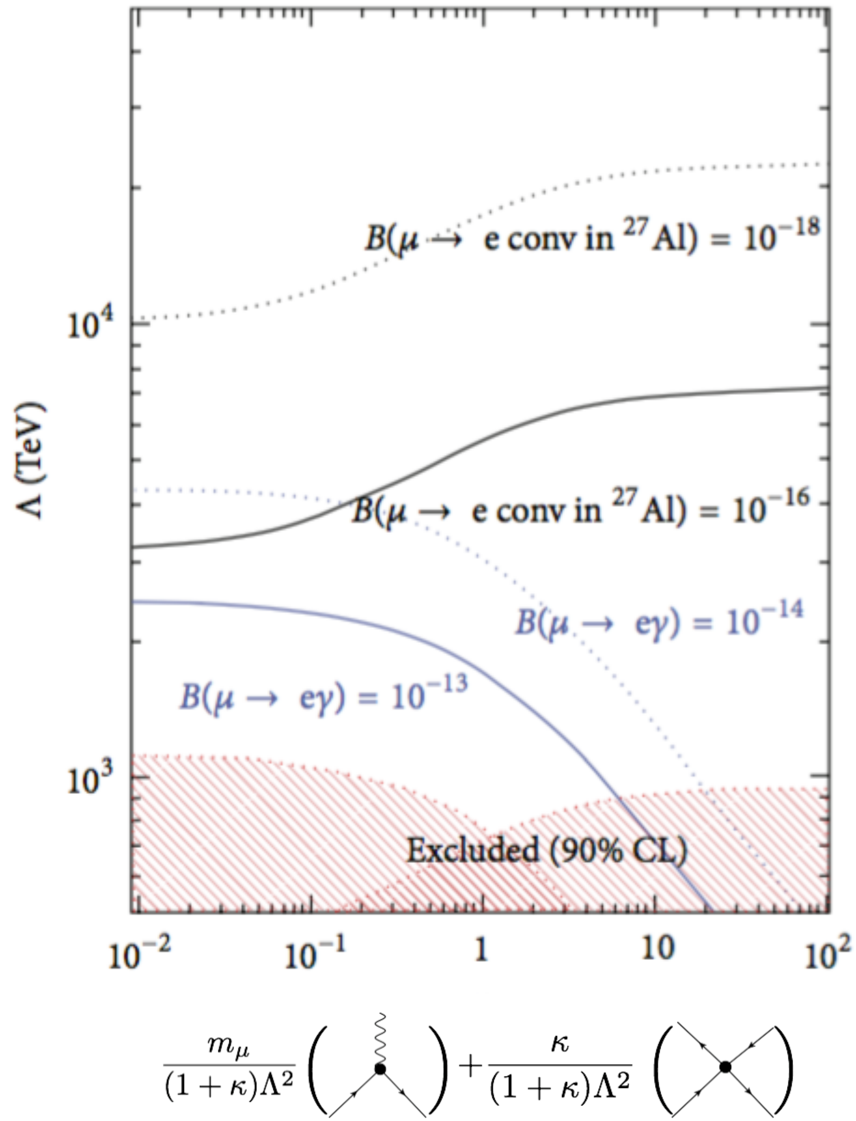
New physics* couplings



*Model independent approach

Calibbi and Signorelli, Riv. N. Cimento, 2017

Effective parametrisation



de Gouvea and Vogel, Prog. Part. Nucl. Phys. 2013

- **effective Lagrangian**
  - *function of the* ***NP scale Λ*** *and* ***NP nature*** *through* ***κ***
    - **dipole transition**
      - *BR(μ -> eγ)/BR(μN->eN)≈10^{-2}*
    - **four fermion** interaction
      - *μN->eN favoured*
- From **current** and **future experiments 10^3 TeV** new physics scale **sensitivity**

	current limit	future limit
μ->eγ	4.2×10^{-13}	6×10^{-14}
μN->eN	10^{-12} - 10^{-13}	6×10^{-17}
μ->eee	10^{-12}	10^{-15} - 10^{-16}

OLD slide

Comparison* with g-2 experiment

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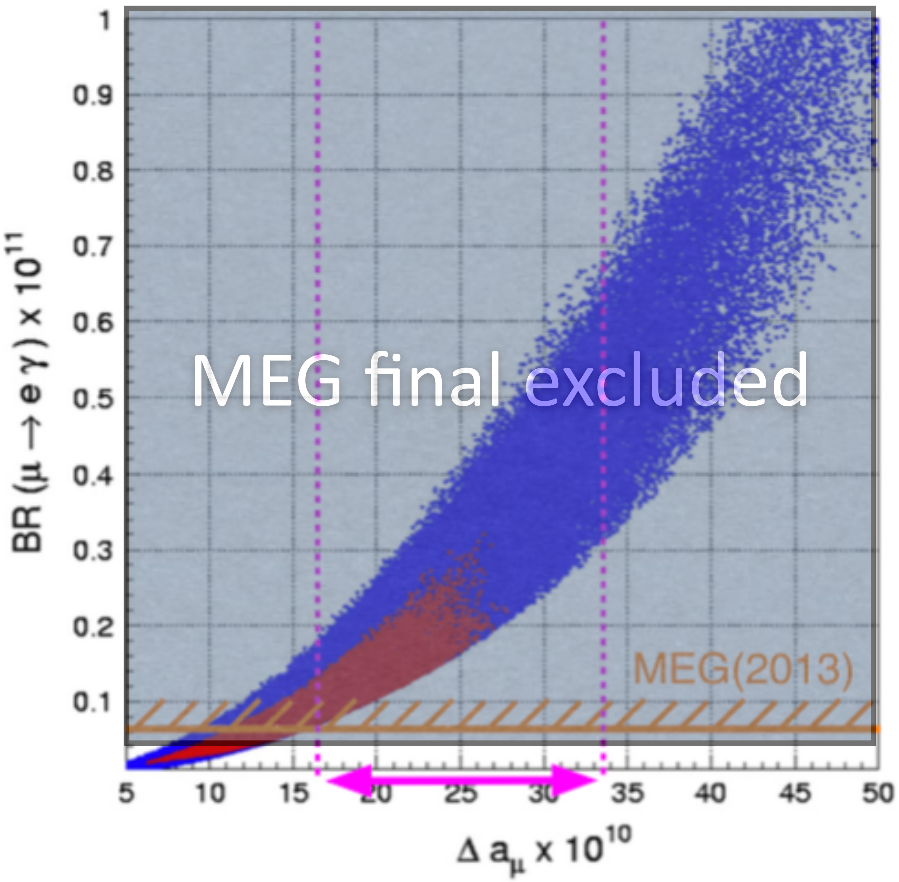
- **3.4 σ discrepancy** w.r.t. Standard Model prediction
  - *possible **hint** of **new physics***
  - *this **would enhance** to **μ->eγ** for example in a **supersymmetric** model*
    - **cLFV coupling** $|\delta_{LL}^{12}|^2 \approx 10^{-4}$ **almost excluded**
- resolution **improvements** by a **factor 4** from future experiments at **Fermilab** and **J-PARC**
  - *together with **new generation** cLFV **experiments** will be **sensitive** to $|\delta_{LL}^{12}|^2 \approx 10^{-5}$*

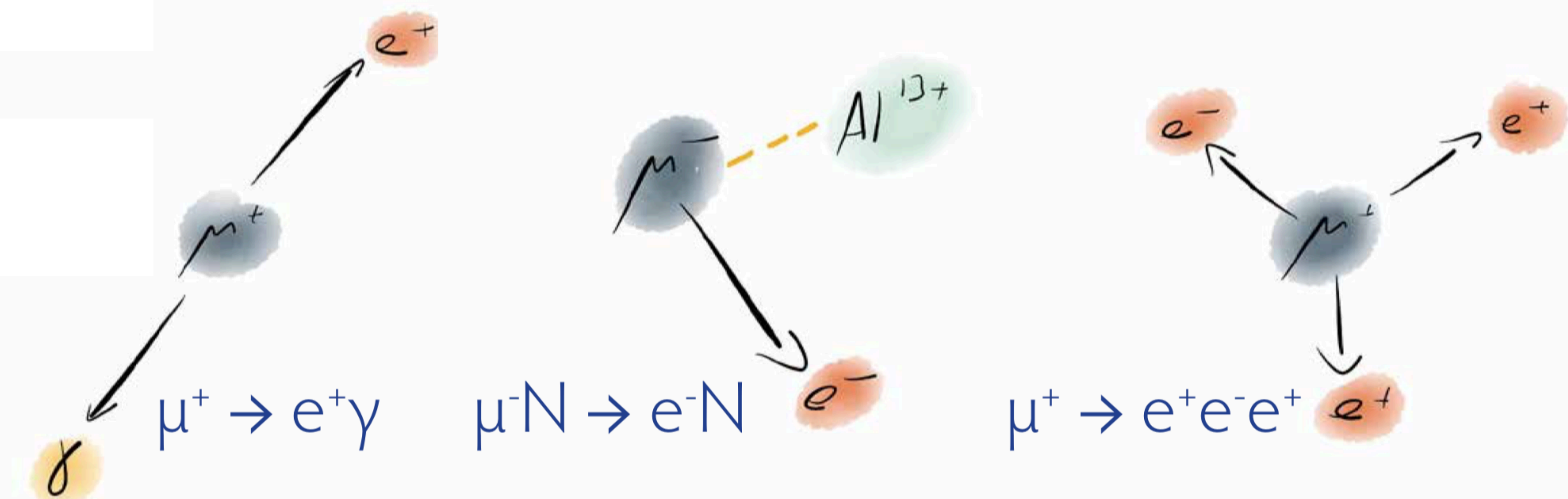


$$\mathcal{B}(\mu \to e\gamma) \approx 10^{-4} \left(\frac{\Delta a_\mu}{200 \times 10^{-11}} \right)^2 |\delta_{LL}^{12}|^2$$

G. Isidori et al., PRD, 2007

*Model dependent

Muon cLFV: kinematics



$\mu^+ \rightarrow e^+\gamma$ | $\mu^-N \rightarrow e^-N$ | $\mu^+ \rightarrow e^+e^-e^+$

Kinematics

- 2-body decay
- Monoenergetic e^+, γ
- Back-to-back

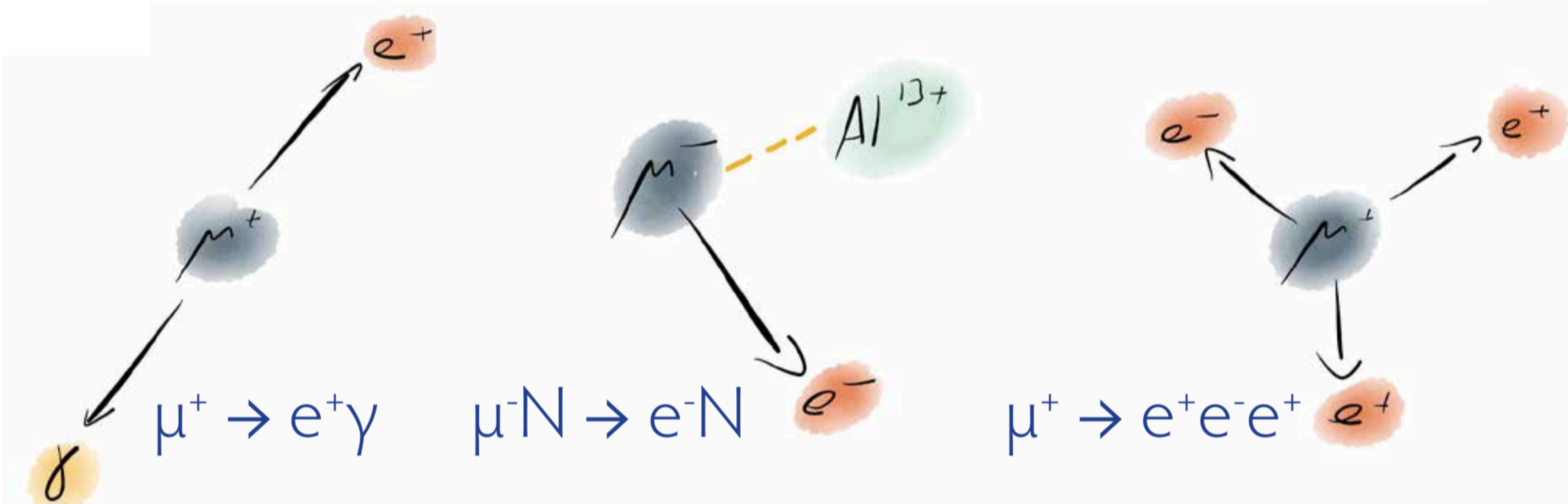
Kinematics

- Quasi 2-body decay
- Monoenergetic e^-
- Single particle detected

Kinematics

- 3-body decay
- Invariant mass constraint
- $\Sigma\, p_i = 0$

Muon cLFV: background



Kinematics

- 2-body decay
- Monoenergetic e^+, γ
- Back-to-back

Background

- Accidental background

Kinematics

- Quasi 2-body decay
- Monoenergetic e^-
- Single particle detected

Background

- Decay in orbit
- Antiprotons, pions

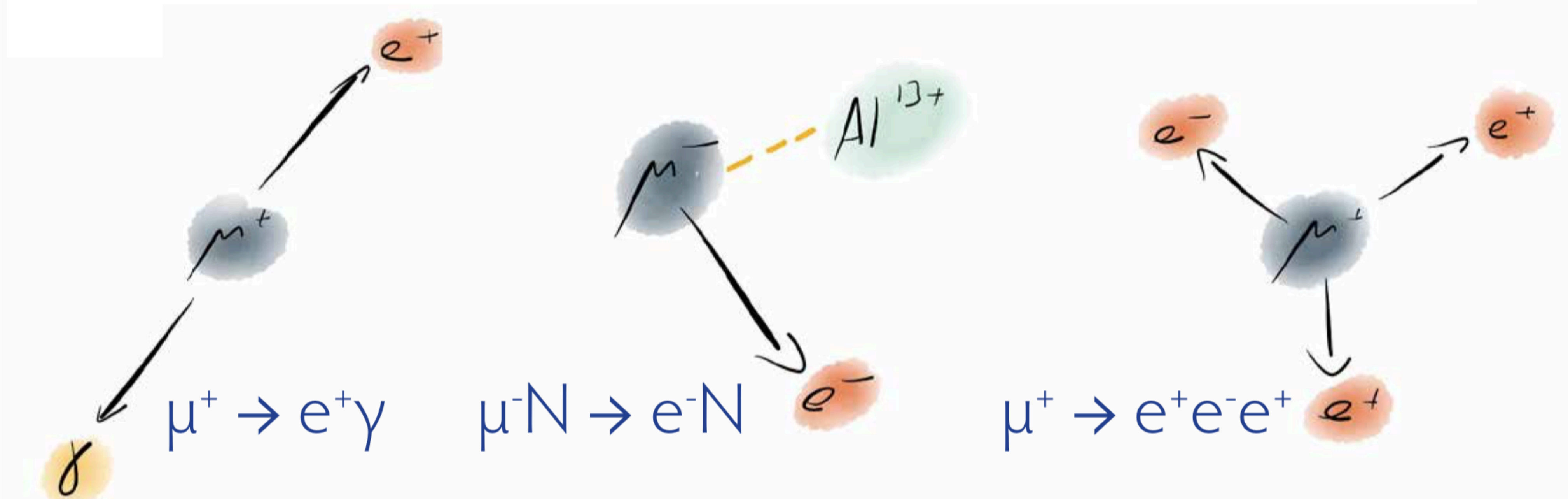
Kinematics

- 3-body decay
- Invariant mass constraint
- $\Sigma p_i = 0$

Background

- Radiative decay
- Accidental background

Muon cLFV: beam line



Kinematics

- 2-body decay
- Monoenerge…
- Back-to-b…

Backgro…

- A… …al background

Continuous Beam

Kinematics

- Quasi 2-body d…
- Monoenerge…
- Single pa… …etected

Backgro…

- D… … orbit
- An… protons, pions

Pulsed Beam

Kinematics

- 3-body decay
- Invariant mas… …aint
- $\Sigma p_i = 0$

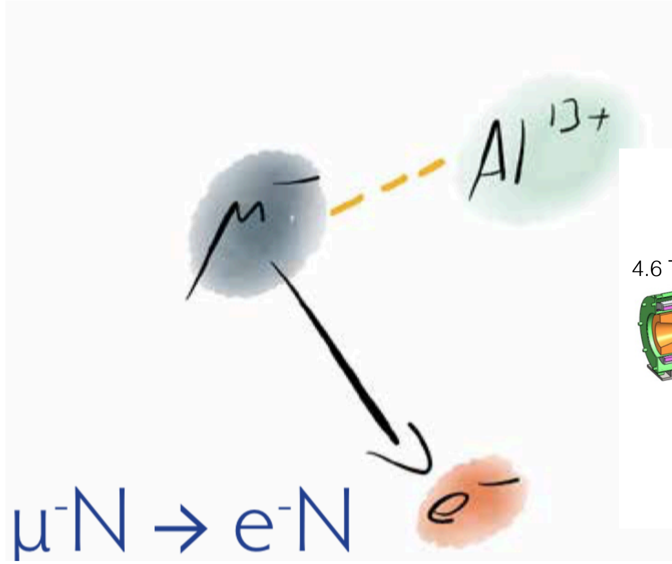
Backgro…

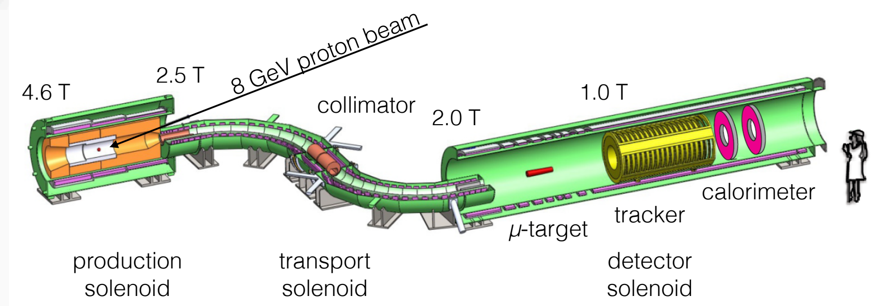
- R… … decay
- Ac… …dental background

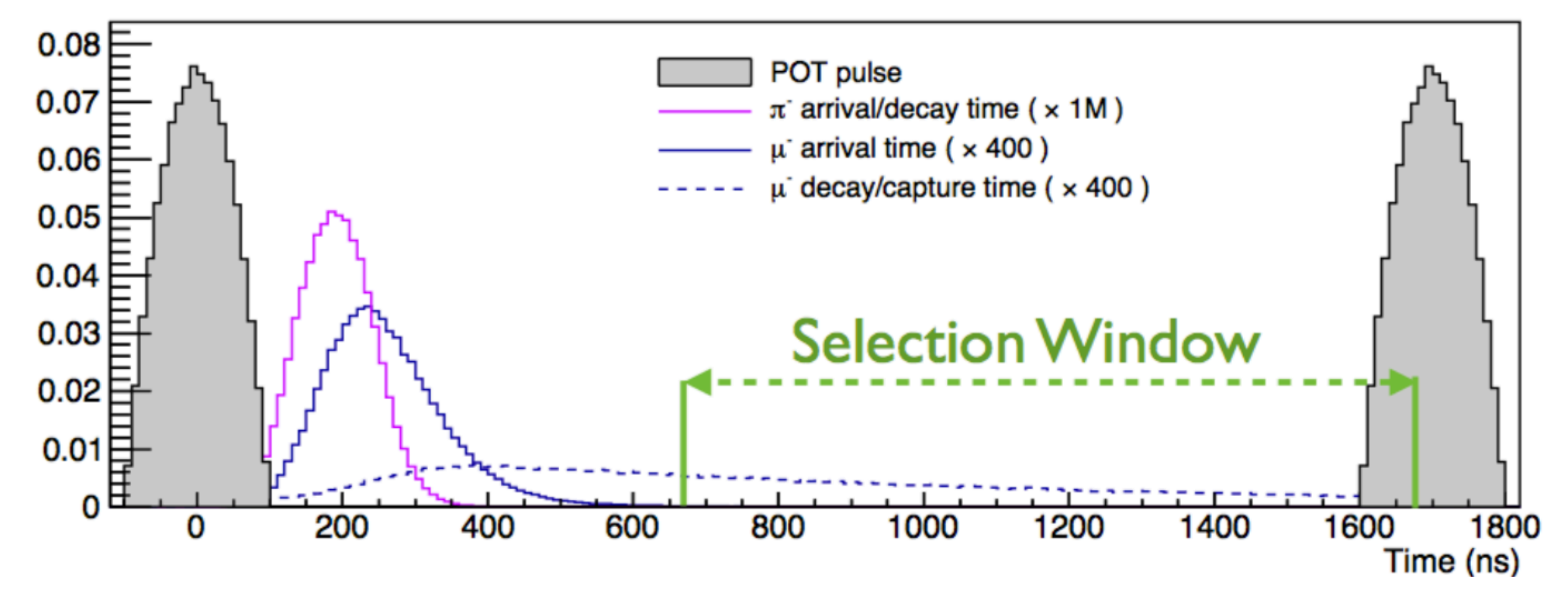
Continuous Beam

Muon cLFV: beam line

Mu2e @FNAL

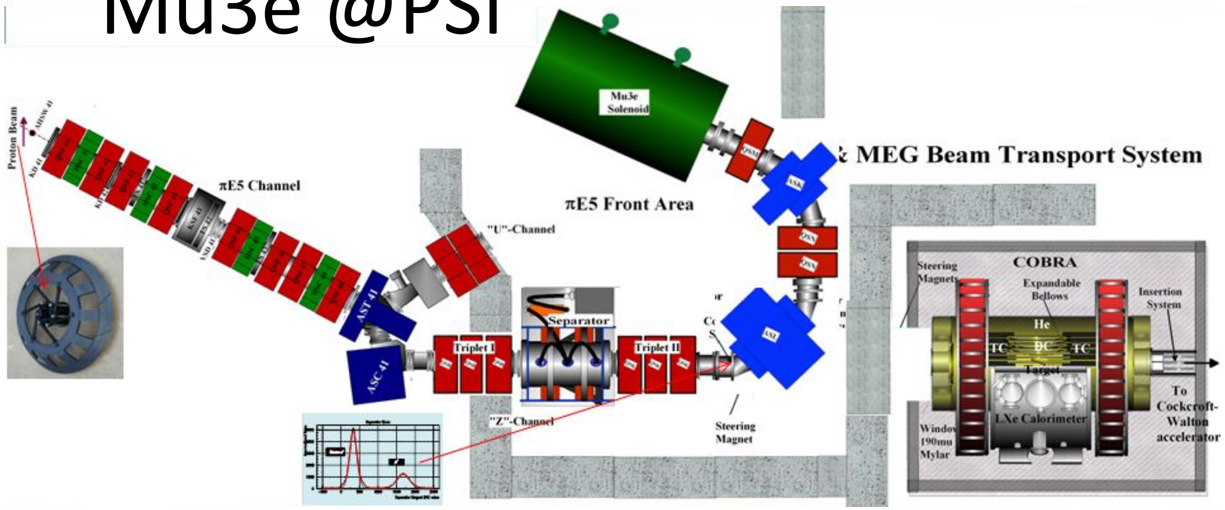


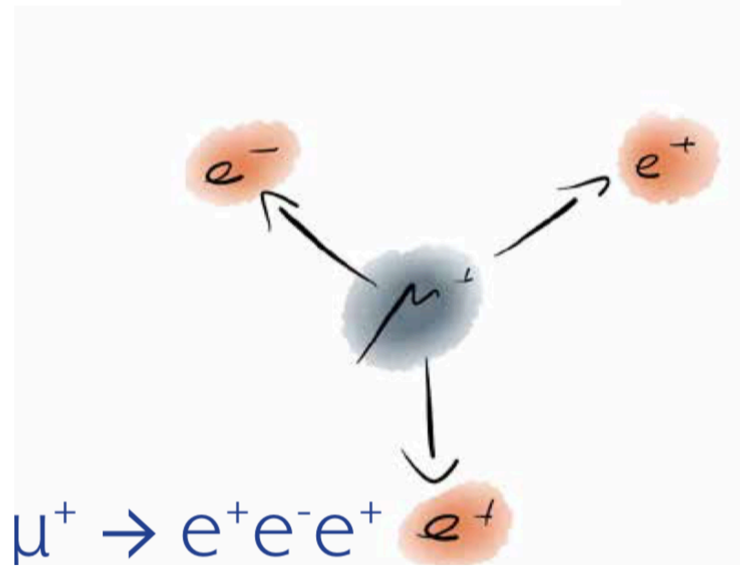


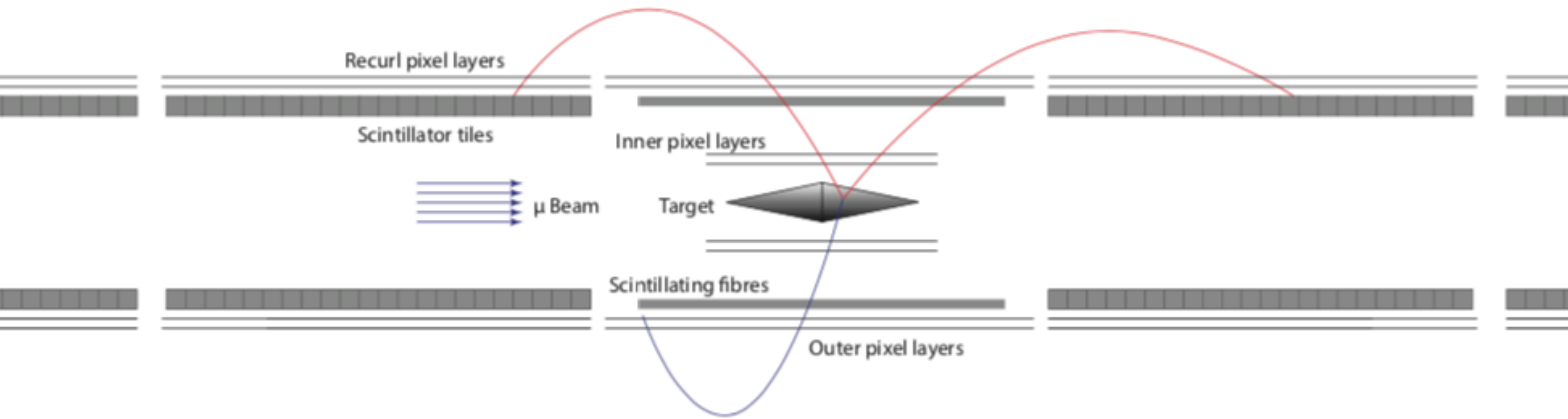


Muon cLFV: beam line

Mu3e @PSI







Searching for $\mu \rightarrow e\gamma$

The MEG II experiment @PSI

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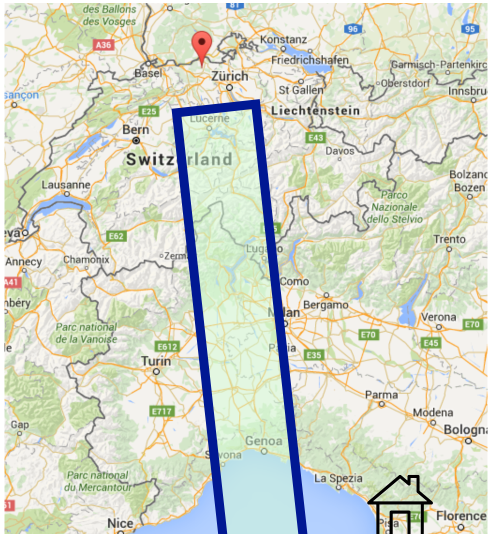
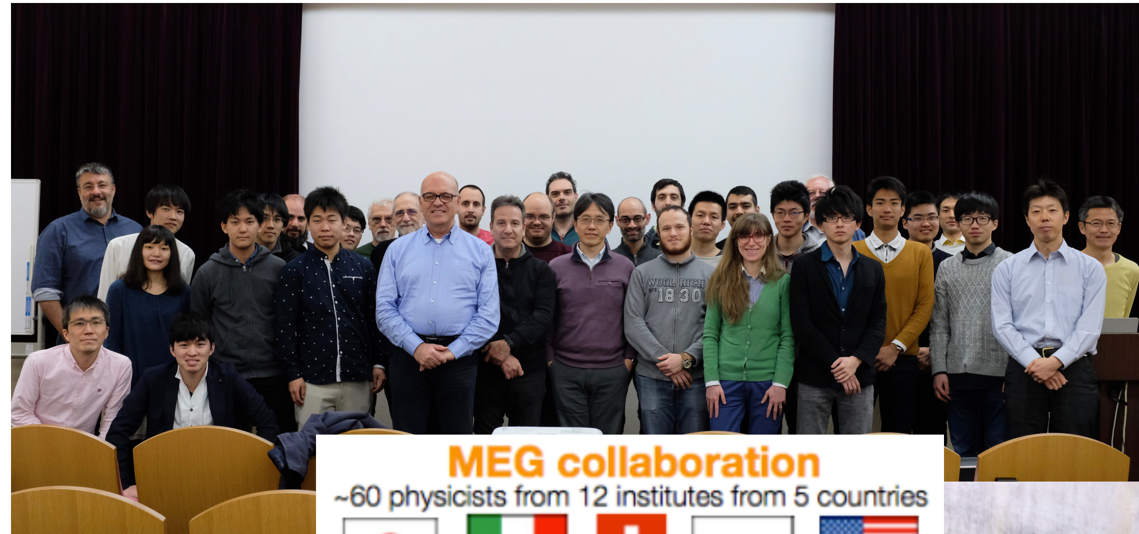
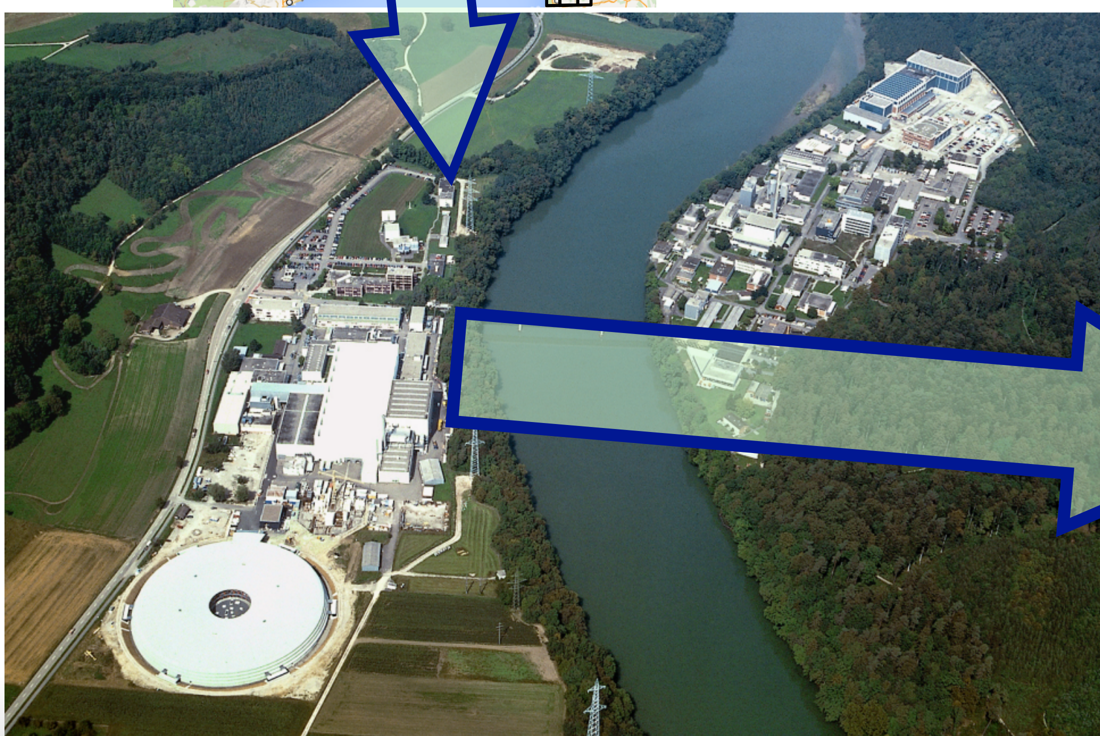




MEG collaboration

~60 physicists from 12 institutes from 5 countries



MEG II experiment

- **Continuation** of **MEG**
- **Reuse** as many as possible **knowhow** and **infrastructures**
  - ***magnet***
  - *gamma-ray detector* ***cryostat****,* ***LXe*** *and* ***PMTs***
  - *calibration tools*
- Goal: **increase** the sensitivity by about **1 order of magnitude** by pushing the experiment at its **limit**

Signal and background

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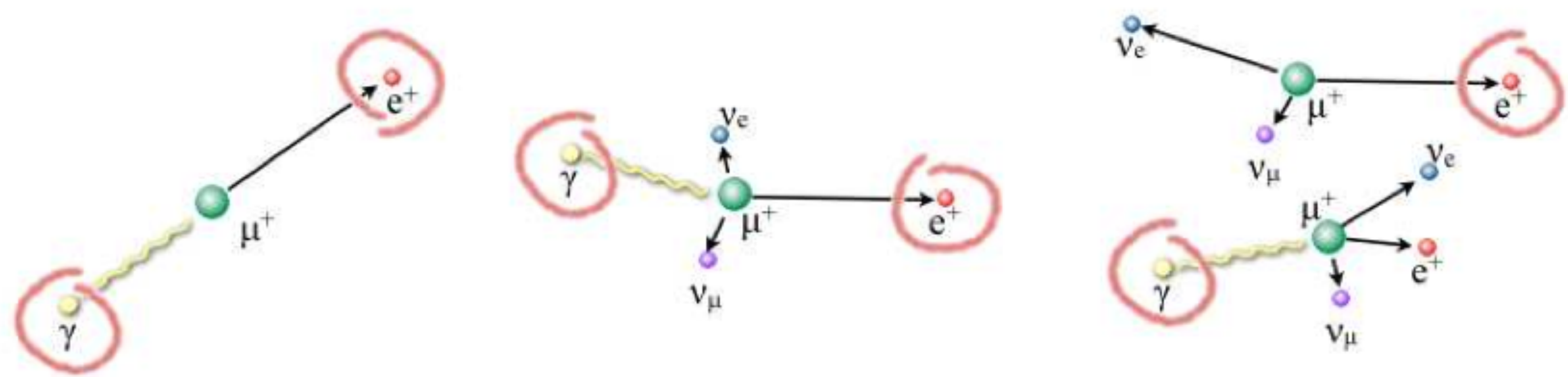


$E_\gamma = 52.8$ MeV	$E_\gamma < 52.8$ MeV	$E_\gamma < 52.8$ MeV
$E_{e^+} = 52.8$ MeV	$E_{e^+} < 52.8$ MeV	$E_{e^+} < 52.8$ MeV
$\Theta_{e\gamma} = 180^\circ$	$\Theta_{e\gamma} < 180^\circ$ [1]	$\Theta_{e\gamma} < 180^\circ$
$T_{e\gamma} = 0$ s	$T_{e\gamma} = 0$ s	$T_{e\gamma} \Rightarrow$ flat

Accidental background is **dominant** and determined by **beam rate** and **resolutions**

$$B_{acc} \propto R_\mu \Delta E_e \Delta E_\gamma^2 \Delta\Theta_{e\gamma}^2 \Delta t_{e\gamma}$$

$$B_{RMD} \approx 0.1 \cdot B_{acc}$$

Keywords

(1) **thin**: "low" energy

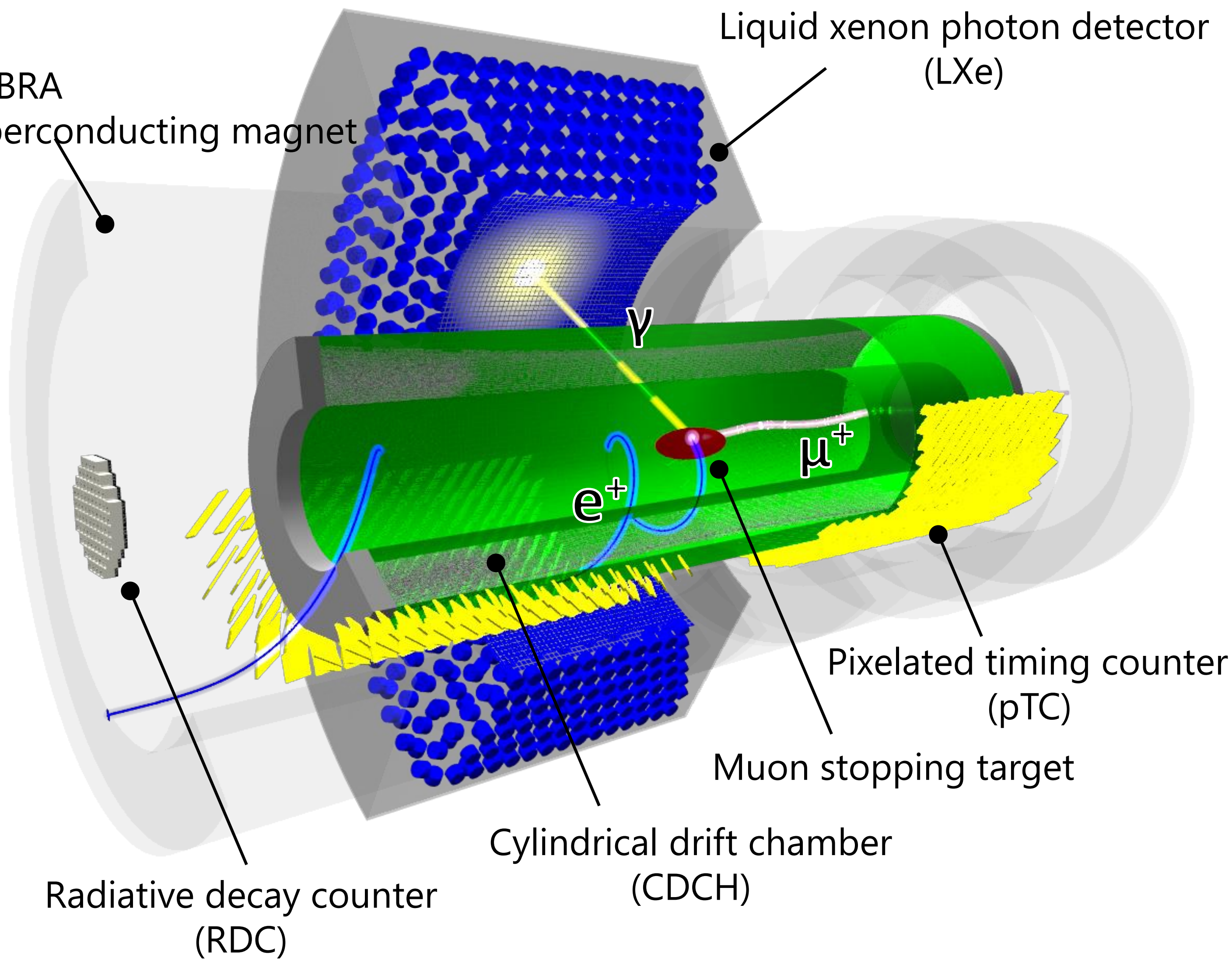
(2) **fast**: high rate $\Longleftrightarrow$ high intensity frontier

(3) **stable**: precision measurement $\Longleftrightarrow$ background rejection

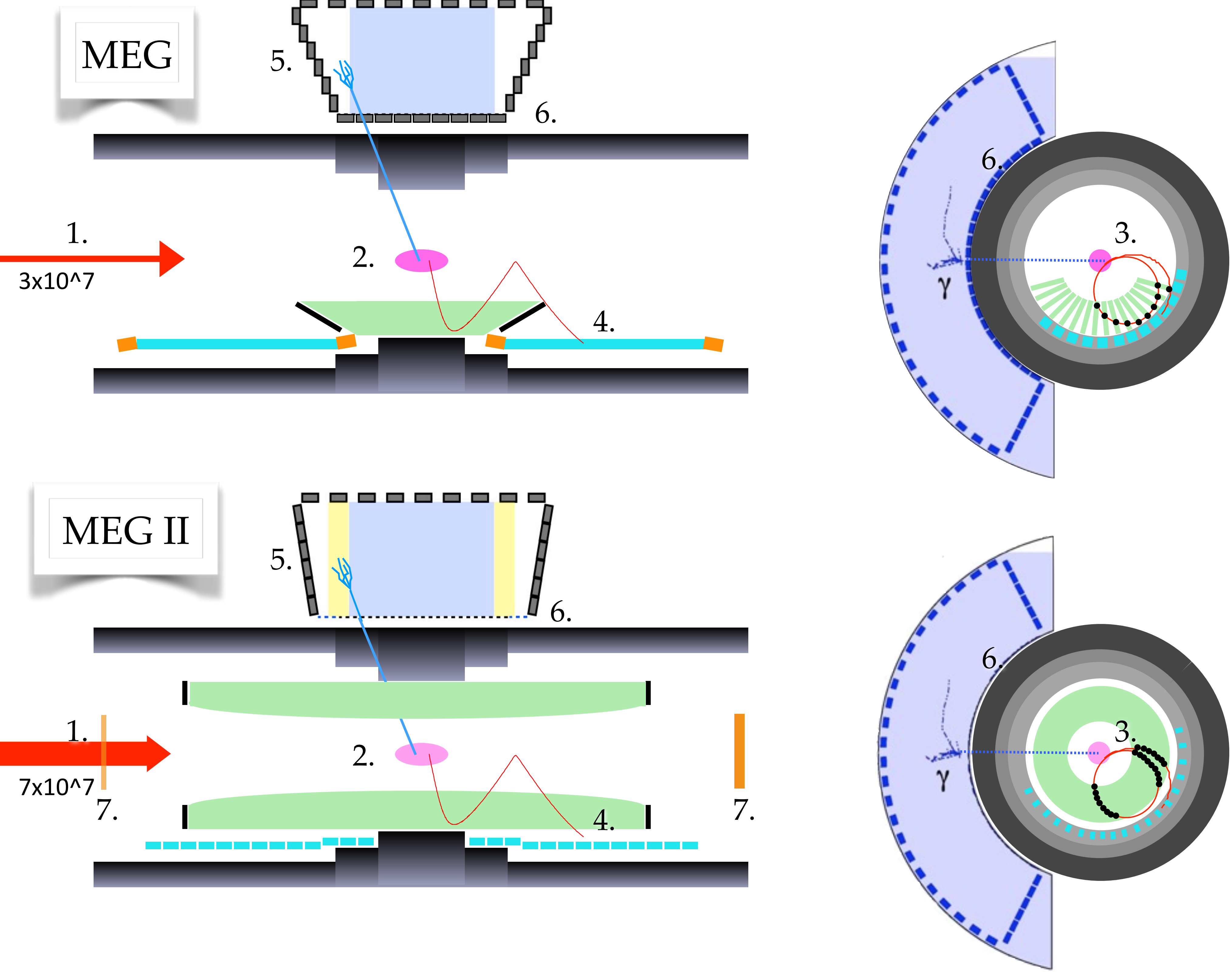
<u>MEG solutions</u>

. **μ beam stopped** on a 205μm polyethylene target (1)
. **non uniform** solenoidal **magnetic** field (2)
. tracking with **ultra-thin DC** (1) and timing with **plastic scintillators** (2)
. γ detection with **LXe scintillator** (1+2)
. **complete** and **redundant calibration** techniques (3)

Experimental approach



A. M. Baldini et al, The design of the MEG II experiment EPJC, 2018


MEG
5.
6.
1.
3x10^7
2.
4.
6.
3.
γ
MEG II
5.
6.
1.
7x10^7
7.
2.
4.
7.
6.
3.
γ

Sensitivity to the limit

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μ

1. **Increasing μ-stop** on target
2. **Reducing** target **thickness** to minimise e+ MS & bremsstrahlung and use a more **robust** one

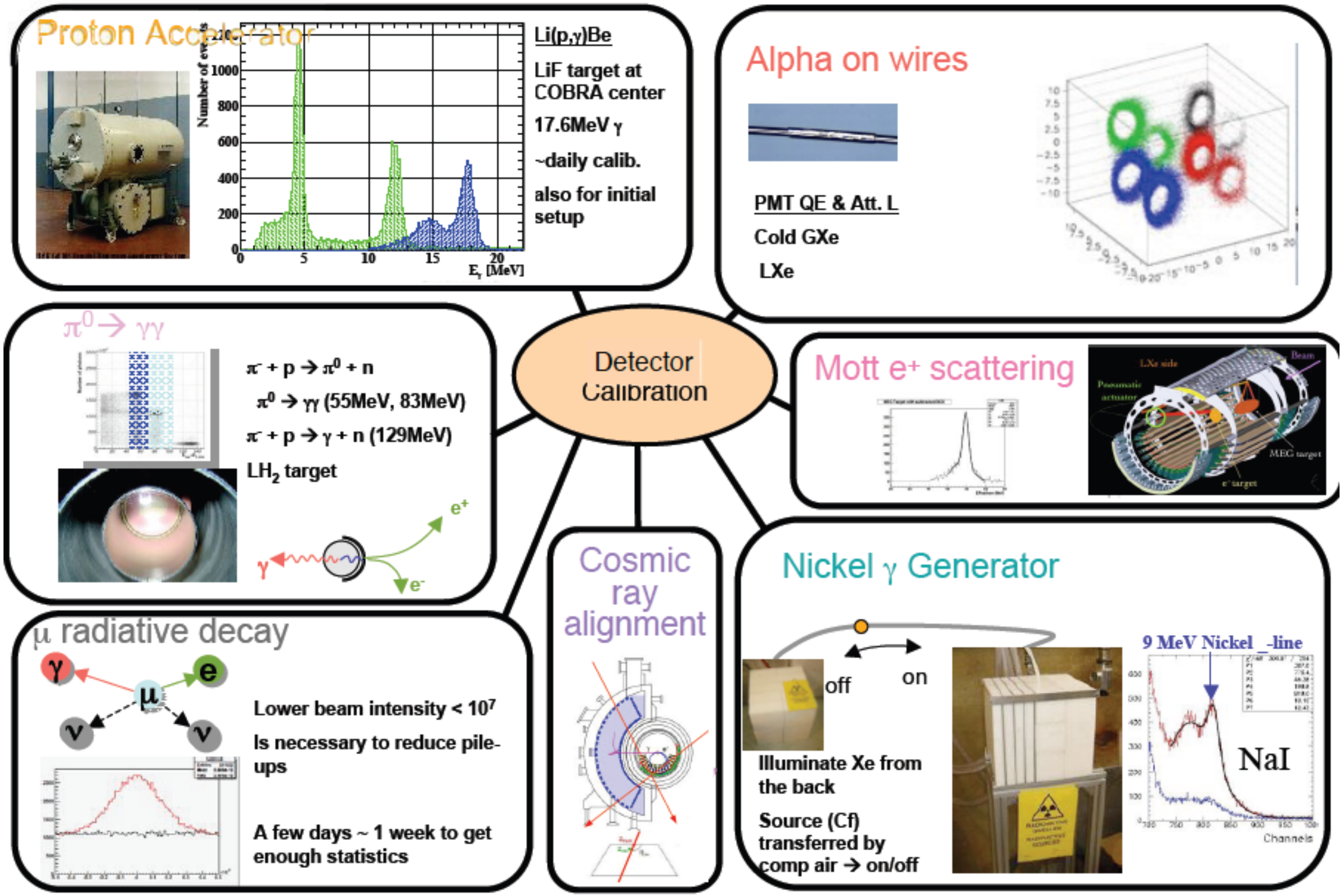
e

3. **Replacing** the **e+ tracker** reducing its radiation length and **improving** its **granularity** and **resolution**
4. **Improving** the **timing counter granularity** for **better timing** and **reconstruction**
5. **Improving** the **e+ tracking-timing integration** by measuring the e+ trajectory up to the TC interface

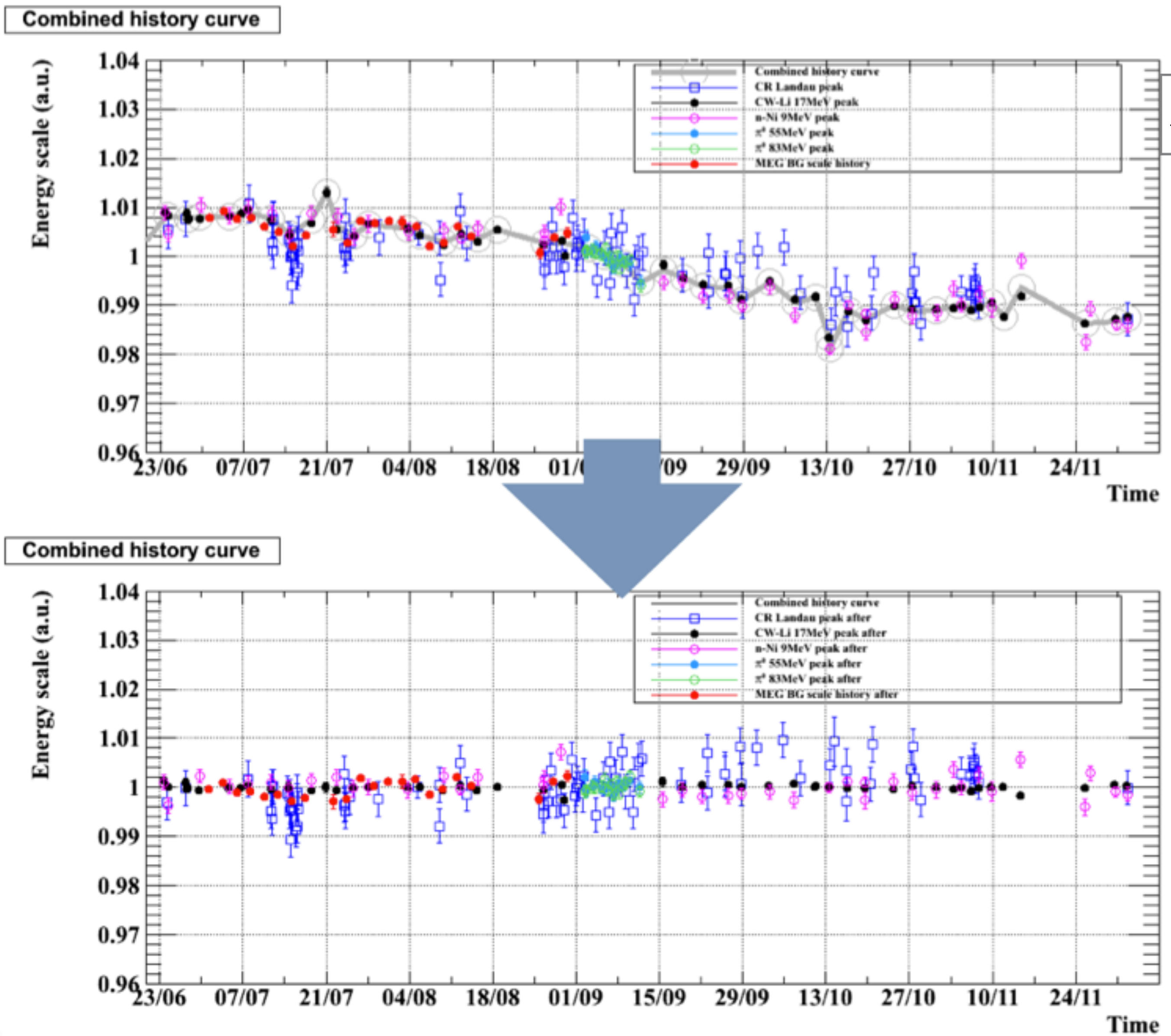
γ

6. **Extending γ-ray** detector **acceptance**
7. **Improving** the **γ-ray energy** and **position resolution** for **shallow** events
8. **Integrating splitter, trigger and DAQ** maintaining high bandwidth

Calibration systems (a subset…)



Relevant example



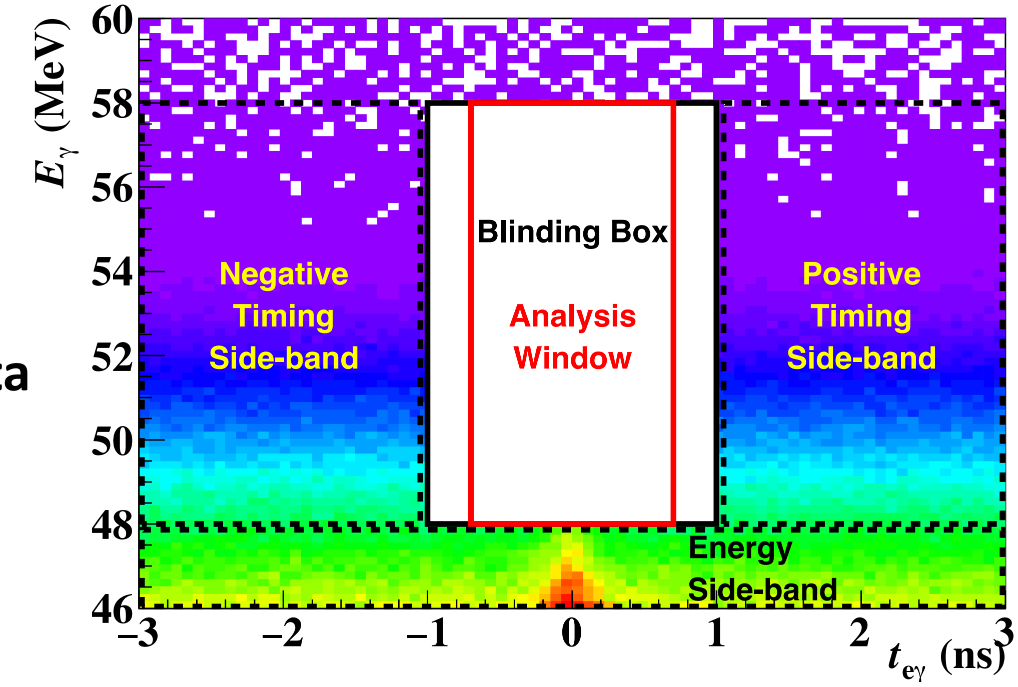
$$B_{acc} \propto R_{\mu} \Delta E_e \Delta E_{\gamma}^2 \Delta \Theta_{e\gamma}^2 \Delta t_{e\gamma}$$

γ energy scale **before** and **after** calibration

uncertainty less than 0.5%

Data analysis

- Decided to extract **CL to B(μ→eγ)** from a **likelihood analysis** in a **wide signal box**
- Each **event** is described in terms of **5 kinematic variables**
  - *$x_i = (E_\gamma, E_e, t_{e\gamma}, \varphi_{e\gamma}, \vartheta_{e\gamma})$*
- **resolutions** and **PDFs** evaluated **on data outside the signal box**
  - *signal box **closed** until **analysis is fixed***
- Use of **sidebands**
  - ***accidental background** from **Left and Right sidebands***
  - ***Radiative Muon Decay** (RMD) studied in the **E_γ sideband***



MEG result: milestone for MEG II

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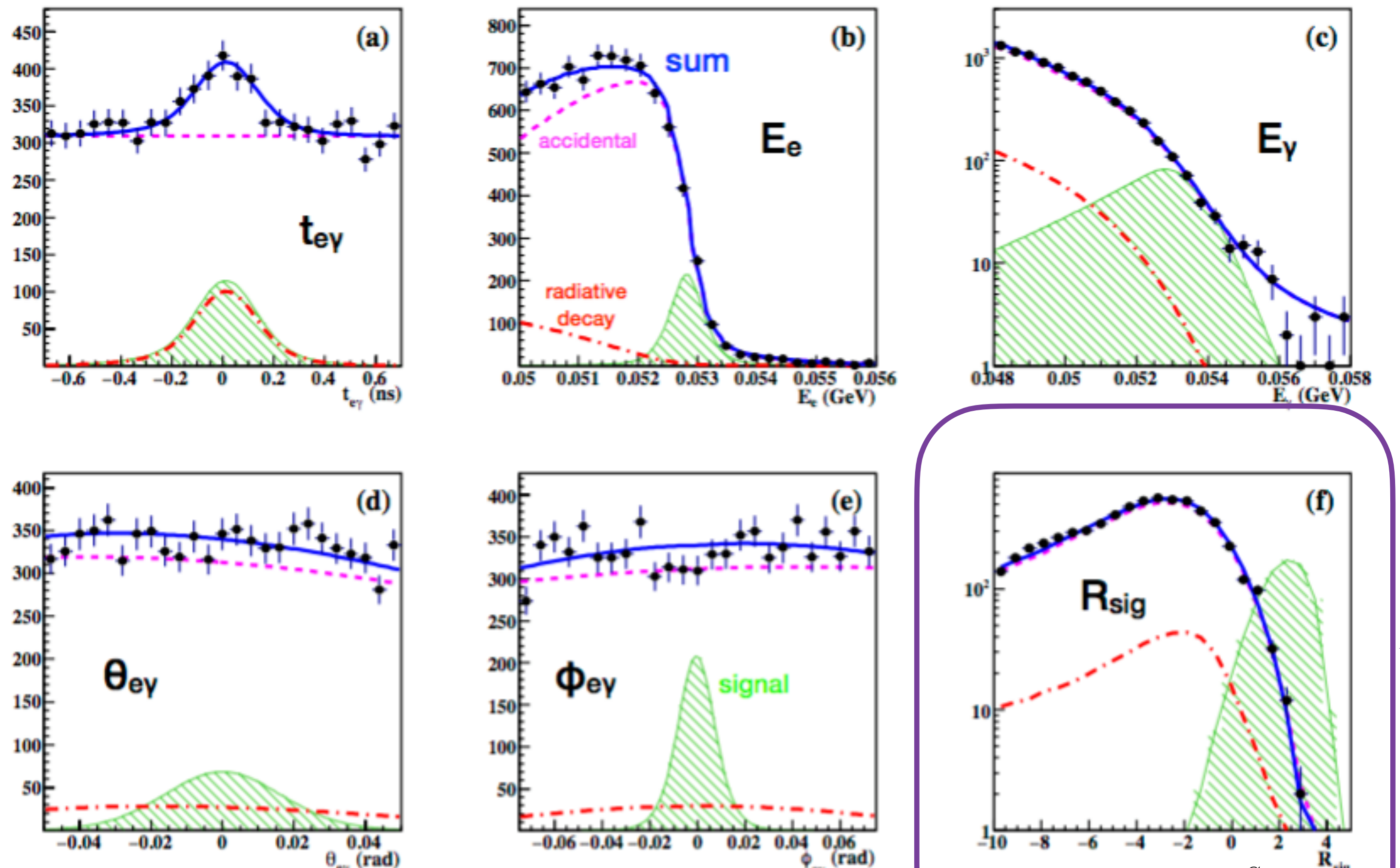

$$R_{Sig} = Log_{10}\left(\frac{S}{0.1R + 0.9B}\right)$$

← only as a check

Dataset	2009-2011	2012-2013	All
Best Fit	-1.3	-5.5	-2.2
UL 90% CL	6.1 10^-13	7.9 10^-13	**4.2 10^-13**
Sensitivity	8.0 10^-13	8.2 10^-13	5.3 10^-13

BR(μ→eγ)<4.2 10^-13 @90% CL

A. M. Baldini et al, EPJC, 2016

Other results from MEG

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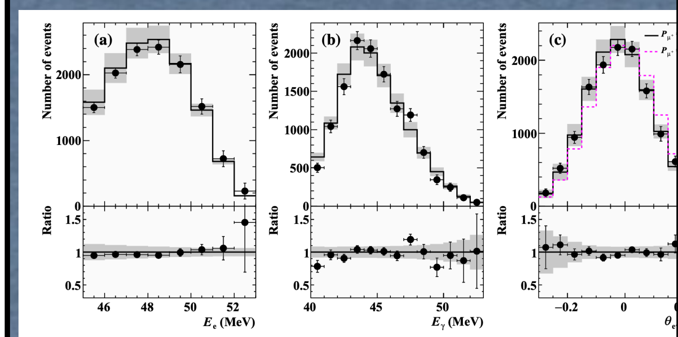
Eur. Phys. J. C (2016) 76:108
DOI 10.1140/epjc/s10052-016-3947-6
THE EUROPEAN PHYSICAL JOURNAL C
CrossMark
Regular Article - Experimental Physics

Measurement of the radiative decay of polarized muons in the MEG experiment

The MEG Collaboration

A. M. Baldini[1a], Y. Bao[3], E. Baracchini[5,16], C. Bemporad[1a,1b], F. Berg[3,4], M. Biasotti[6a,6b], G. Boca[7a,7b], P. W. Cattaneo[7a], G. Cavoto[9a], F. Cei[1a,1b], G. Chiarello[8a,8b], C. Chiri[8a,8b], A. de Bari[7a,7b], M. De Gerone[6a], A. D'Onofrio[1a,1b], S. Dussoni[1a], Y. Fujii[5], L. Galli[1a], F. Gatti[6a,6b], F. Grancagnolo[8a], M. Grassi[1a], A. Graziosi[9a,9b], D. N. Grigoriev[10,11,12], T. Haruyama[13], M. Hildebrandt[3], Z. Hodge[3,4], K. Ieki[3,5], F. Ignatov[10,12], T. Iwamoto[5], D. Kaneko[5], Tae Im Kang[14], P.-R. Kettle[3], B. I. Khazin[10,12], N. Khomutov[15], A. Korenchenko[15], N. Kravchuk[15], G. M. A. Lim[14], S. Mihara[13], W. Molzon[14], Toshinori Mori[5], A. Mtchedlishvili[3], S. Nakaura[5], D. Nicolò[1a,1b],



Eur. Phys. J. C (2016) 76:223
DOI 10.1140/epjc/s10052-016-4047-3
THE EUROPEAN PHYSICAL JOURNAL C
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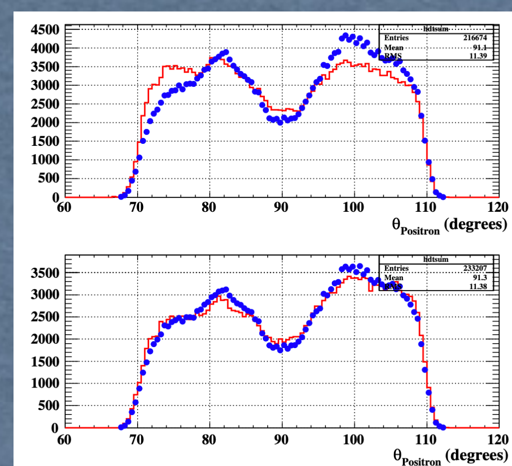
Regular Article - Experimental Physics

Muon polarization in the MEG experiment: predictions and measurements

The MEG Collaboration

A. M. Baldini[4a], Y. Bao[1], E. Baracchini[3,15], C. Bemporad[4a,4b], F. Berg[1,2], M. Biasotti[8a,8b], G. Boca[6a,6b], P. W. Cattaneo[6a], G. Cavoto[7a], F. Cei[4a,4b,a], G. Chiarello[12a,12b], C. Chiri[12a], A. De Bari[6a,6b], M. De Gerone[8a], A. D'Onofrio[4a,4b], S. Dussoni[4a], Y. Fujii[3], L. Galli[4a], F. Gatti[8a,8b], F. Grancagnolo[12a], M. Grassi[4a], A. Graziosi[7a,7b], D. N. Grigoriev[9,13,14], T. Haruyama[10], M. Hildebrandt[1], Z. Hodge[1,2], K. Ieki[1,3], F. Ignatov[9,14], T. Iwamoto[3], D. Kaneko[3], T. I. Kang[5], P.-R. Kettle[1], B. I. Khazin[9,14], N. Khomutov[11], A. Korenchenko[11], N. Kravchuk[11], G. M. A. Lim[5], S. Mihara[10], W. Molzon[5], Toshinori Mori[3], A. Mtchedlishvili[1], S. Nakaura[3], D. Nicolò[4a,4b],

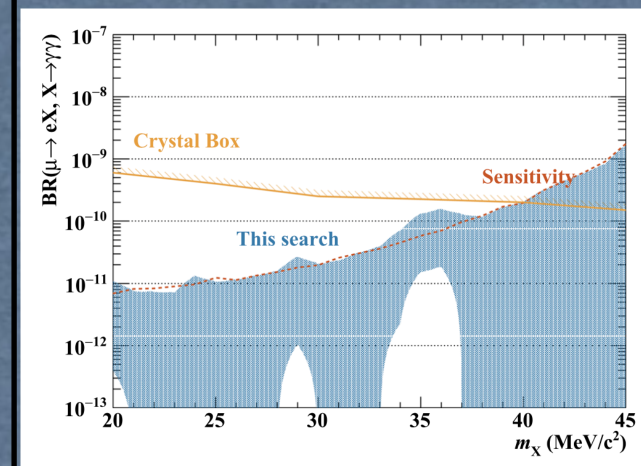


Eur. Phys. J. C (2020) 80:858
https://doi.org/10.1140/epjc/s10052-020-8364-1
THE EUROPEAN PHYSICAL JOURNAL C
Regular Article - Experimental Physics

Search for lepton flavour violating muon decay mediated by a new light particle in the MEG experiment

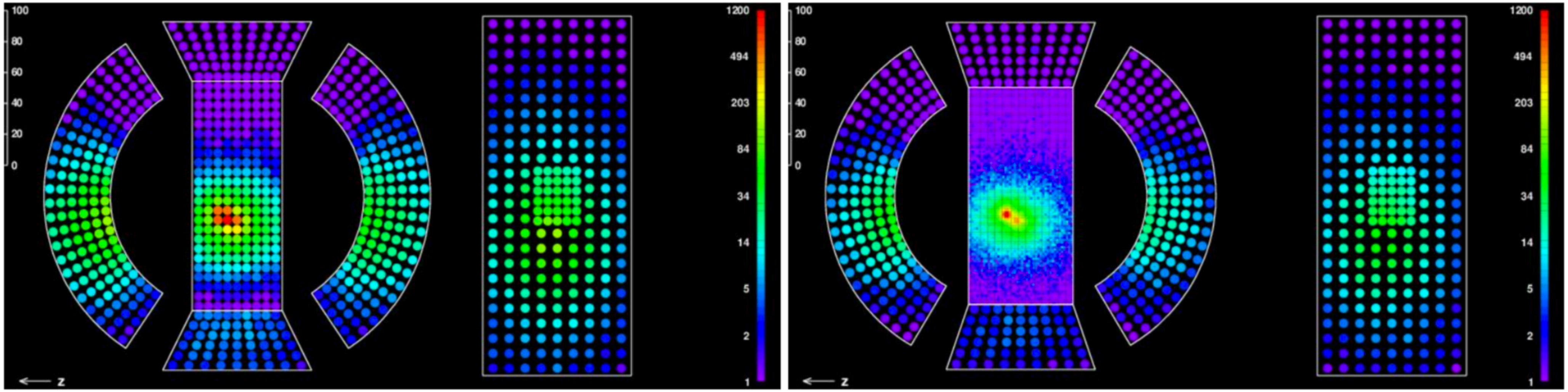
The MEG Collaboration

A. M. Baldini[1a], F. Berg[2,3], M. Biasotti[4a,4b], G. Boca[5a,5b], P. W. Cattaneo[5a], G. Cavoto[6a,6b], F. Cei[1a,1b], M. Chiappini[1a,1b], G. Chiarello[6a,6b], C. Chiri[7a,7b], A. Corvaglia[7a,7b], A. de Bari[5a,5b], M. De Gerone[4a], M. Francesconi[1a], L. Galli[1a], F. Gatti[4a,4b], F. Grancagnolo[7a], M. Grassi[1a], D. N. Grigoriev[8,9,10], M. Hildebrandt[2], Z. Hodge[2,3], K. Ieki[11], F. Ignatov[8,10], R. Iwai[11], T. Iwamoto[11], S. Kobayashi[11], P.-R. Kettle[2], W. Kyle[12], Khomutov[13], A. Kolesnikov[13], N. Kravchuk[13], N. Kuchinskiy[13], T. Libeiro[12], G. M. A. Lim[12], V. Malyshev[13],

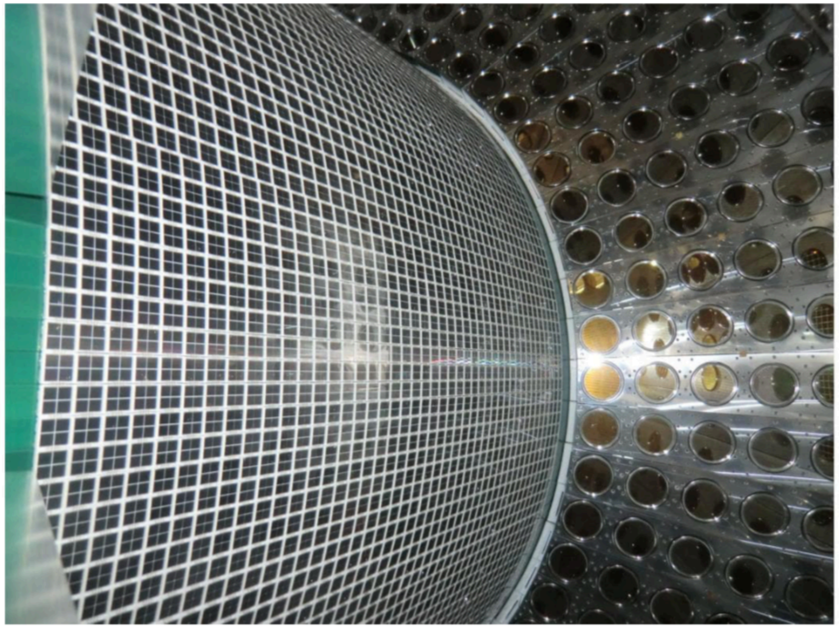


MEG II commissioning

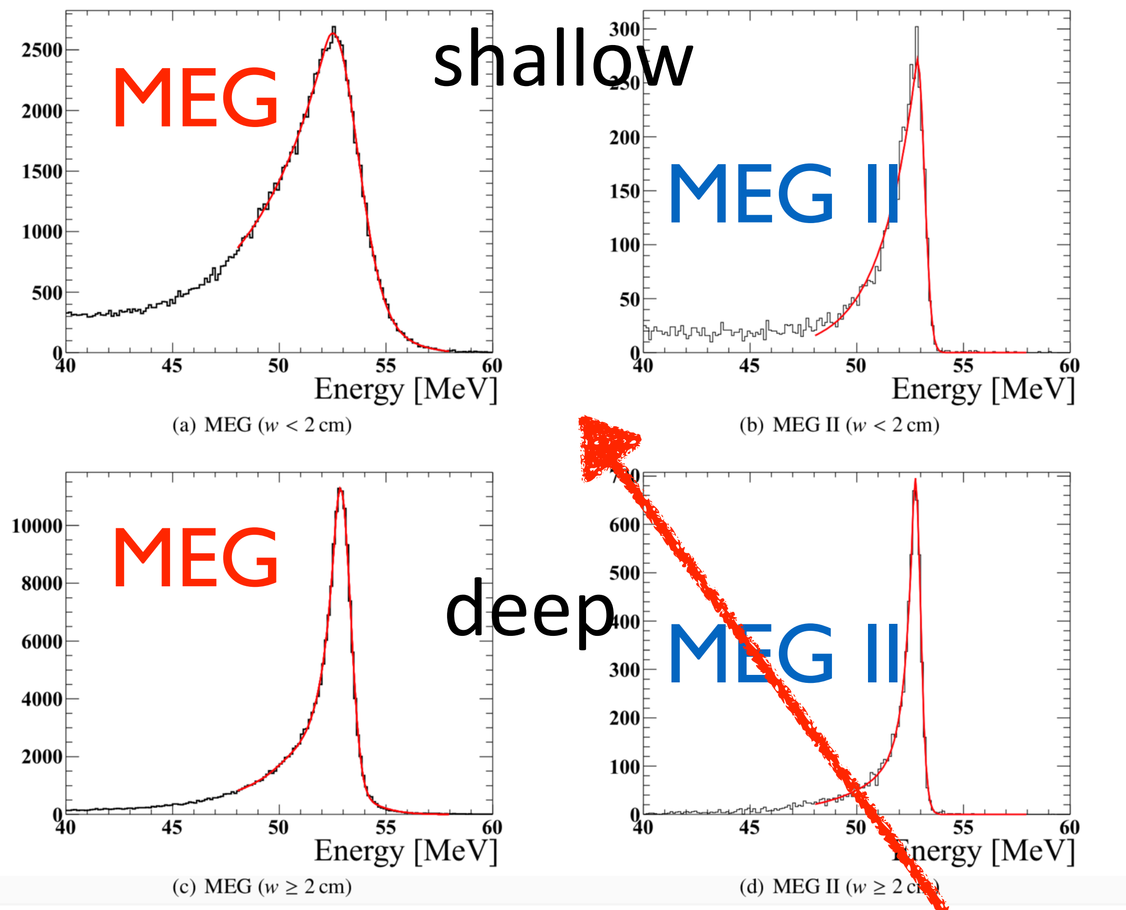
LXe detector

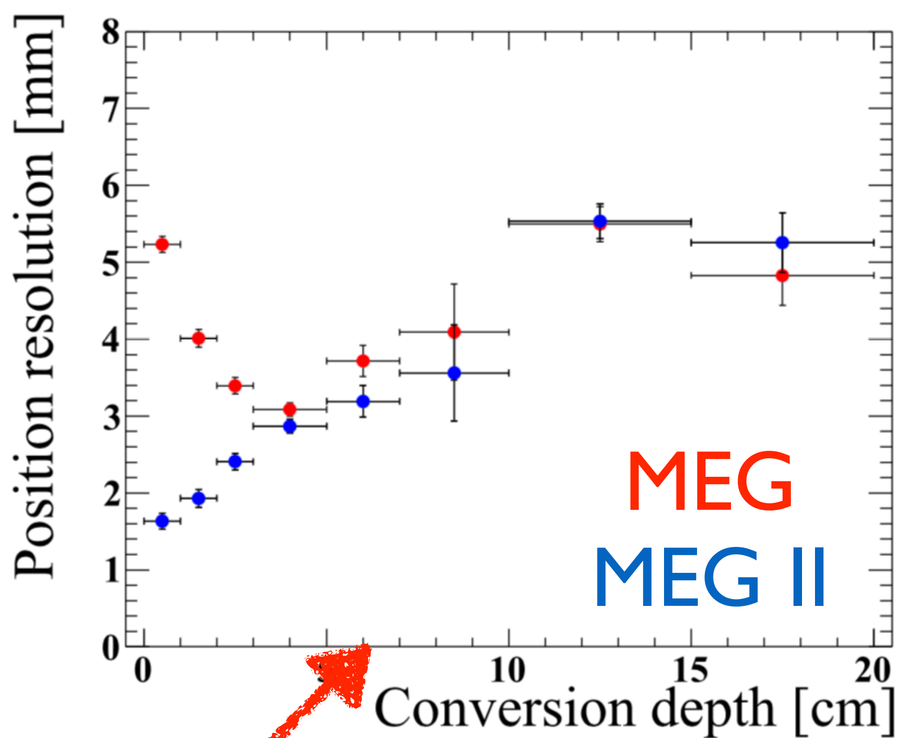


- Same detector as MEG
- homogenous
  - *LXe as scintillator*
    - bright: 40 photons/keV
    - fast: 4/22/40 ns
  - *VUV MPPC replacing PMTs in the inners face*
    - 4192 channels instead of 216!!
    - uniform response in particular for shallow events



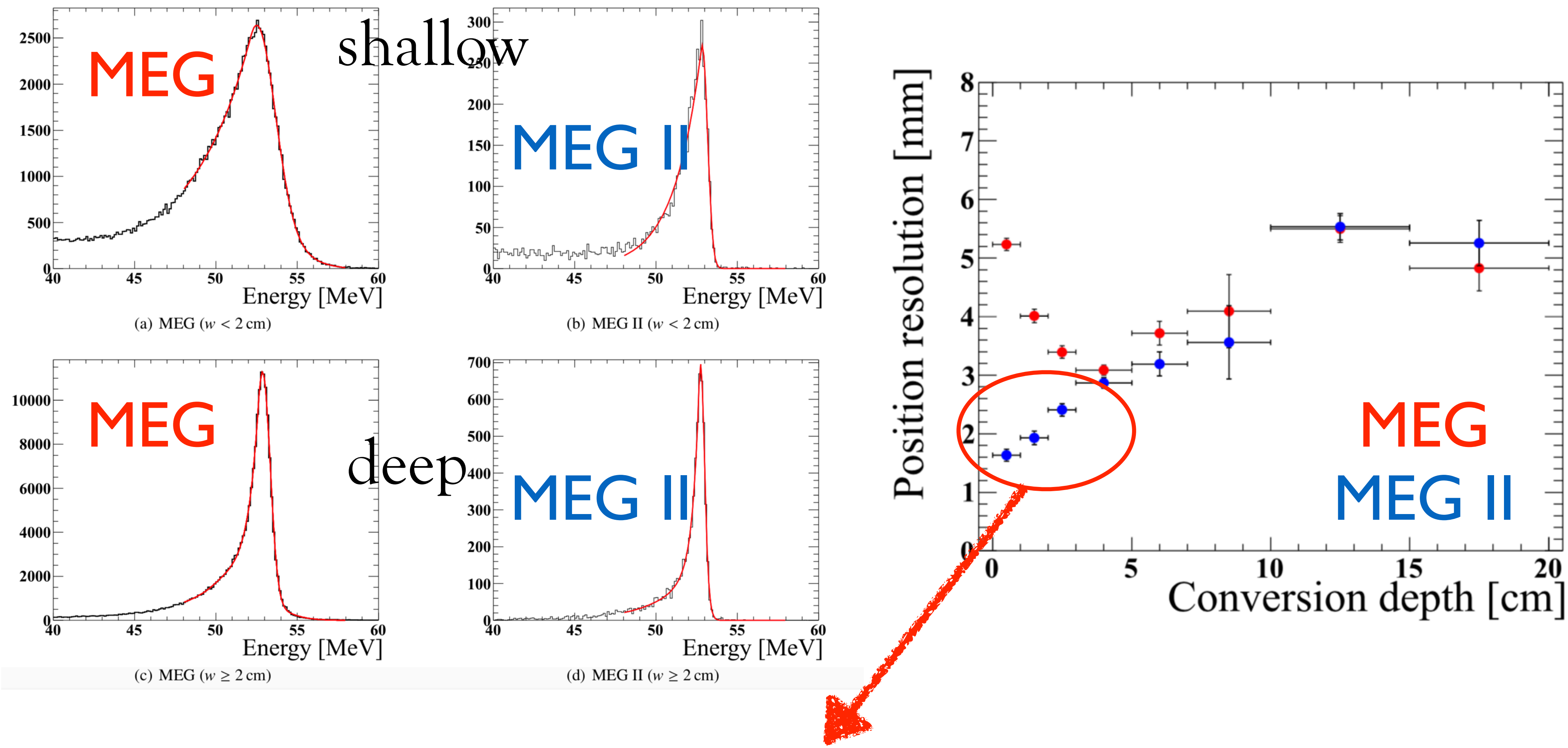
Performance improvement





$$B_{acc} \propto R_\mu \Delta E_e \Delta E_\gamma^2 \Delta \Theta_{e\gamma}^2 \Delta t_{e\gamma}$$

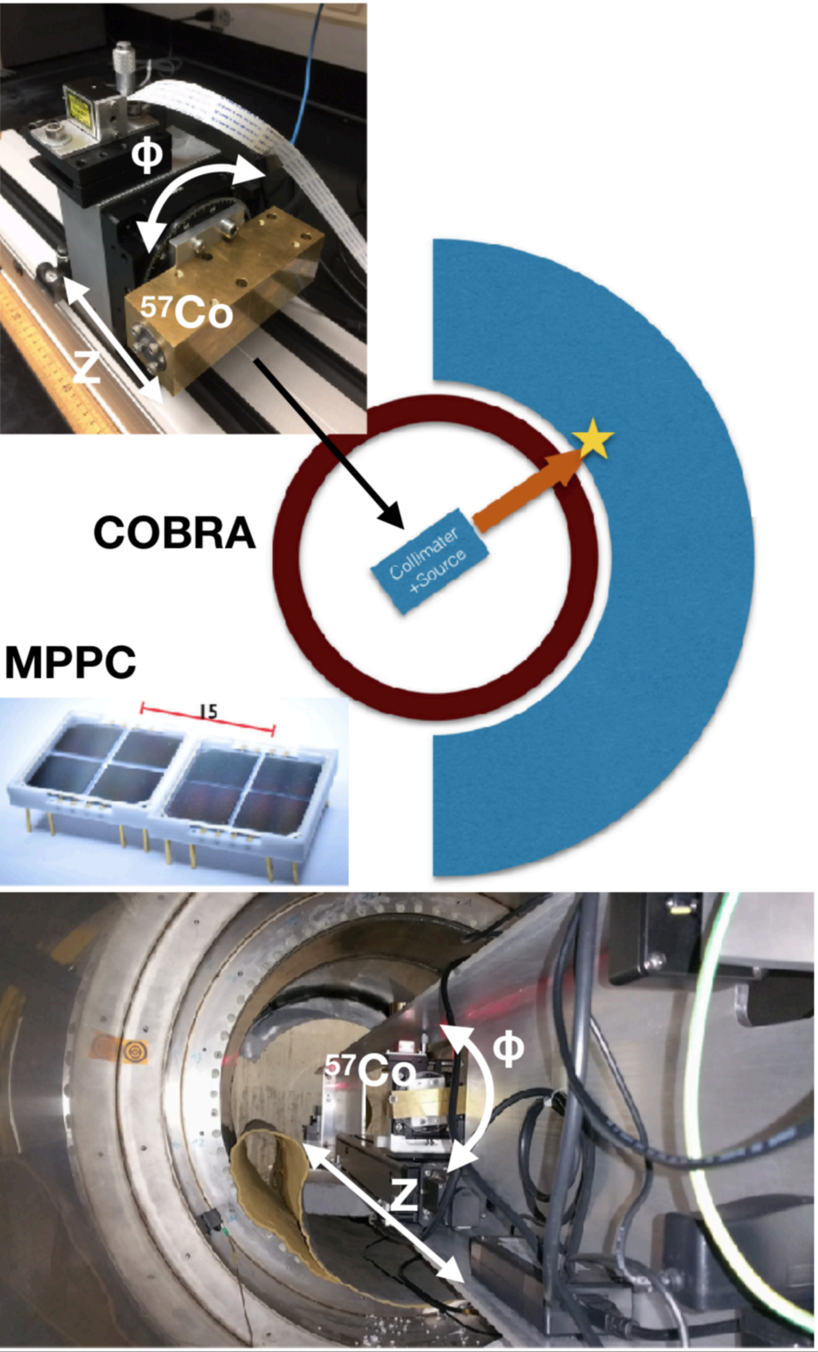
Performance improvement

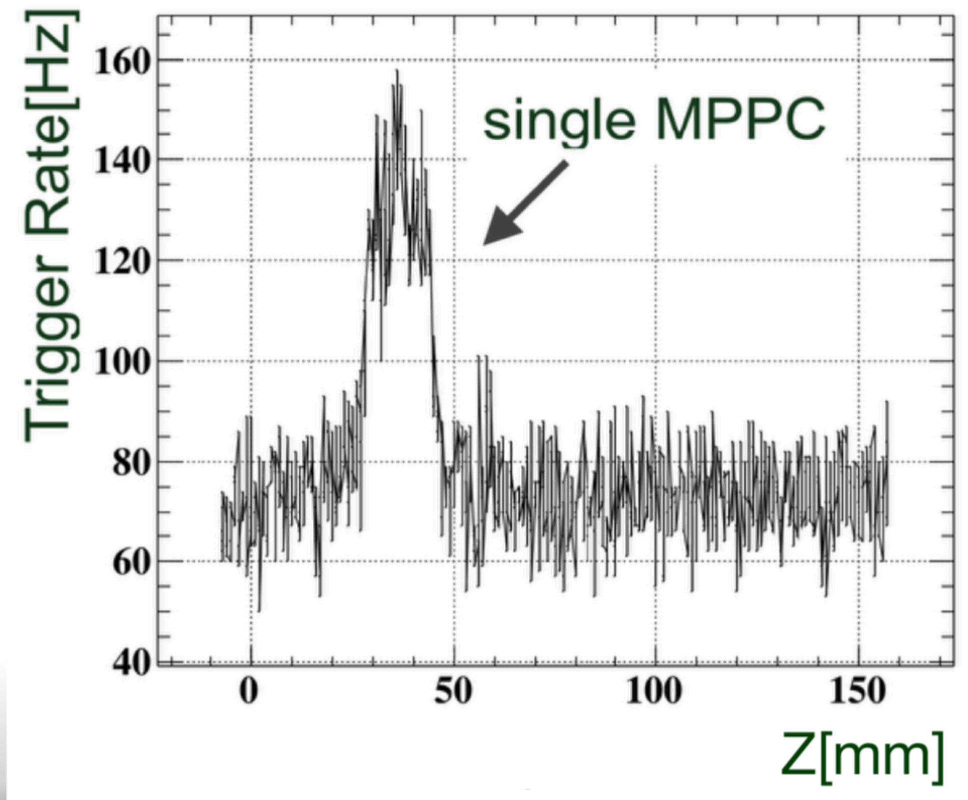


Precise MPPC position needed…
at LXe temperature!

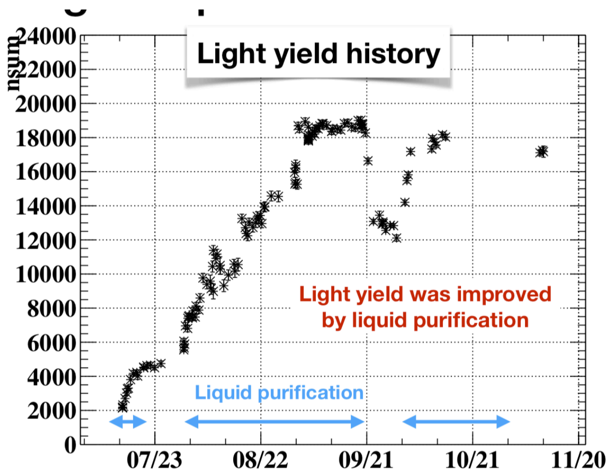
X-ray alignment

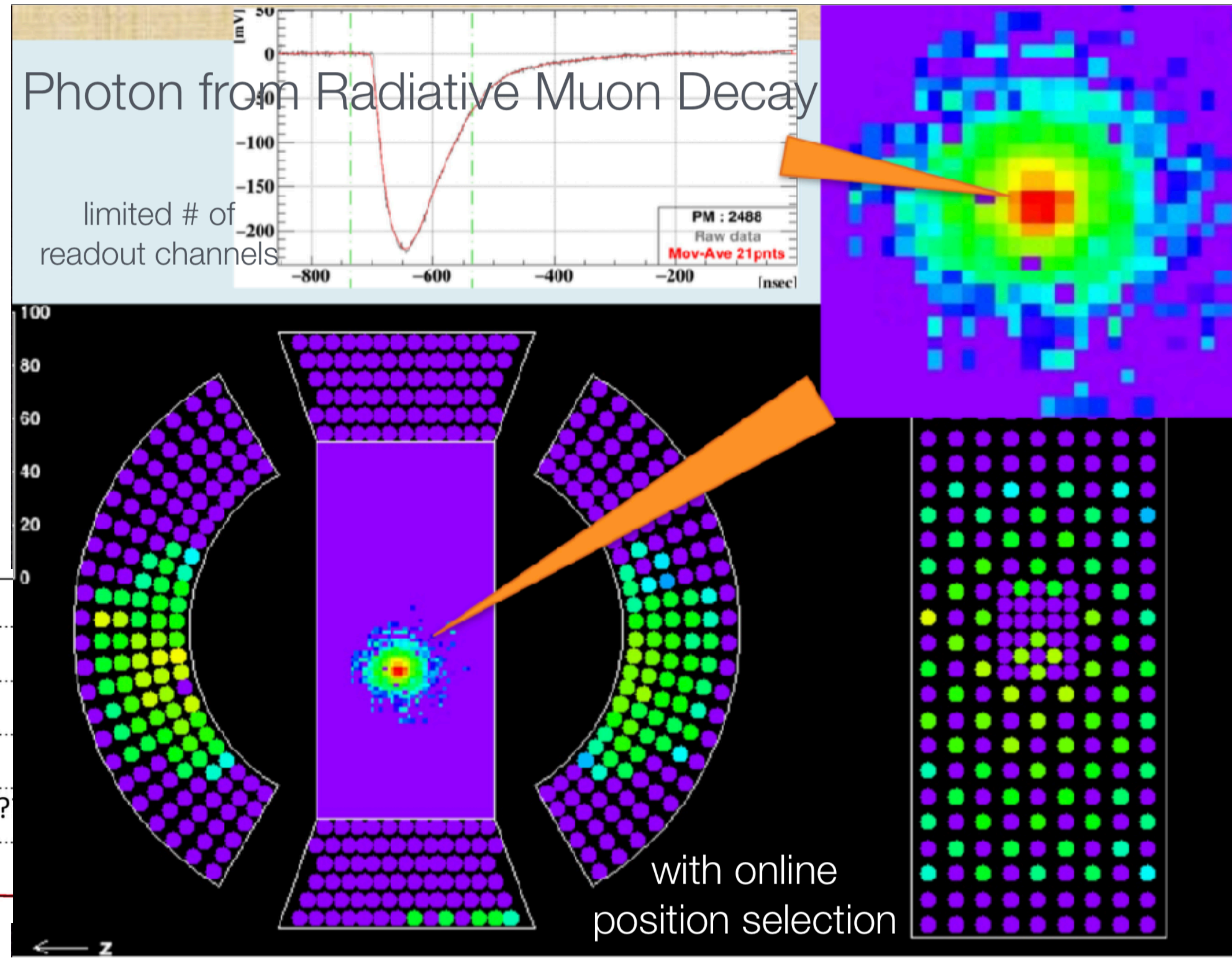
- **LXe** inner face **radiography**
  - ***direct** measurement of **MPPC position***
- **collimated ^{57}Co** source on **movable** support (124 and 136 keV)
  - ***1.2x4 mm^2 beam***
  - *scan by **1mm (half** of **MMPC**)*

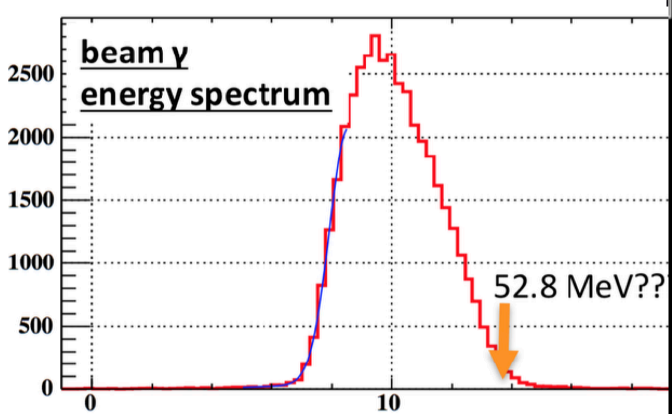




First gamma-rays in 2017



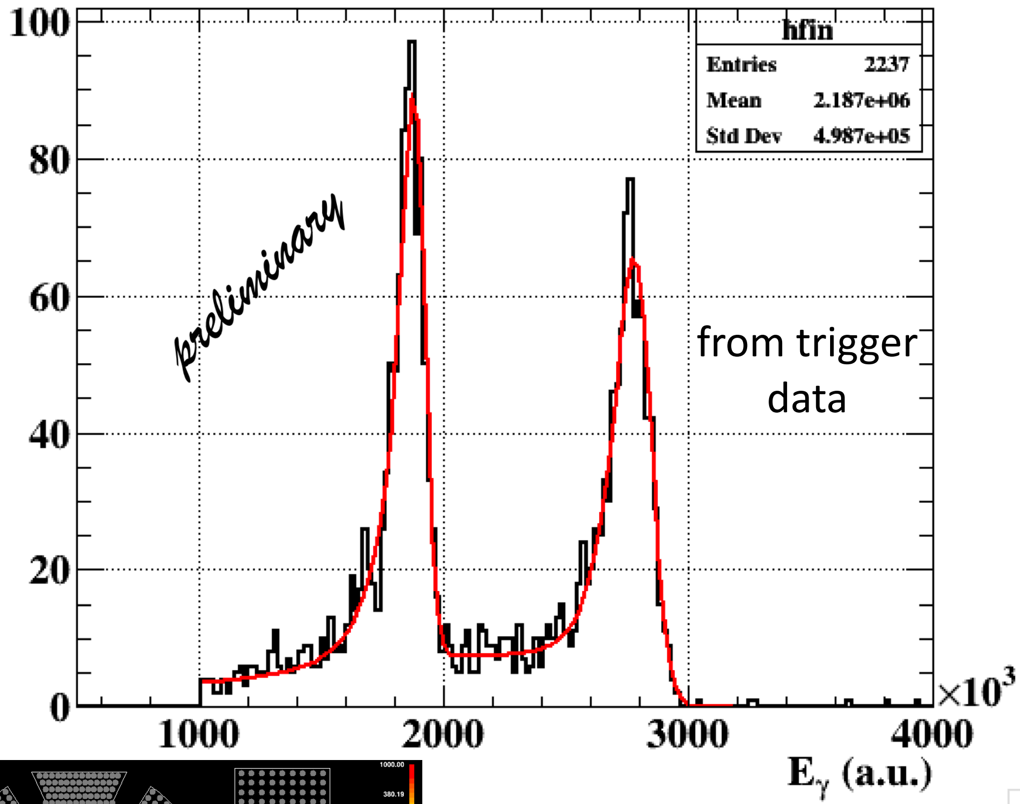


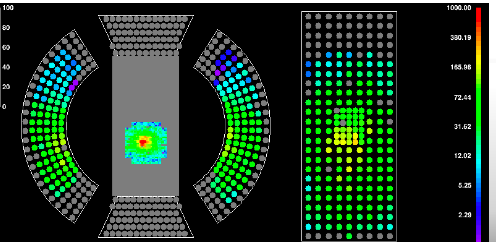


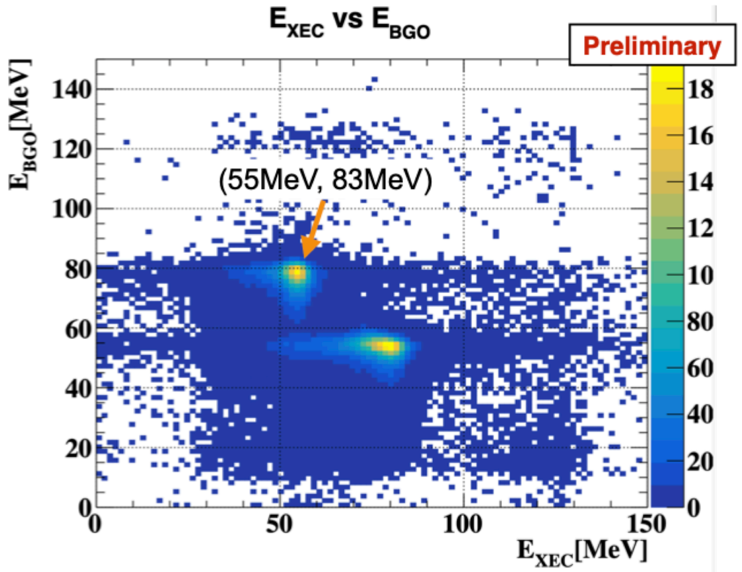
estimated from 4.4 MeV by AmBe
and 9 MeV from n capture on Nickel

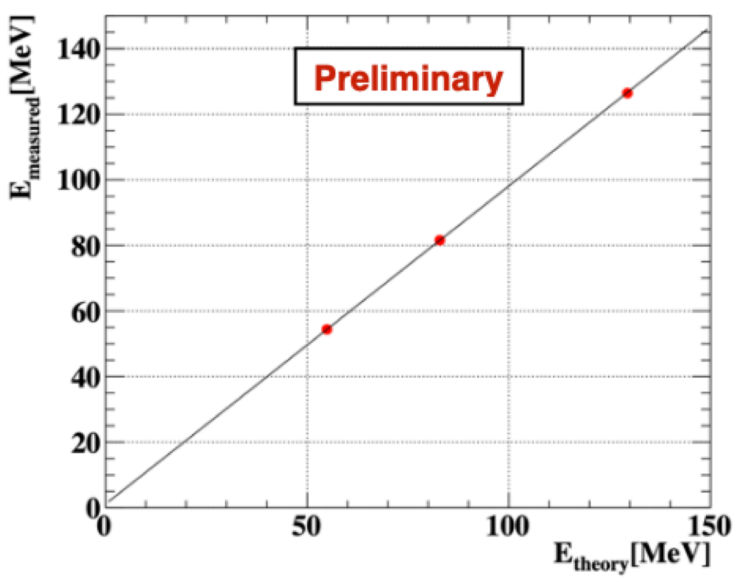
CEX run in November 2020

$\pi^0 \rightarrow \gamma\gamma$ events
10% of readout chan
dedicated LH2 and use of π^- instead of μ
huge man power needed!





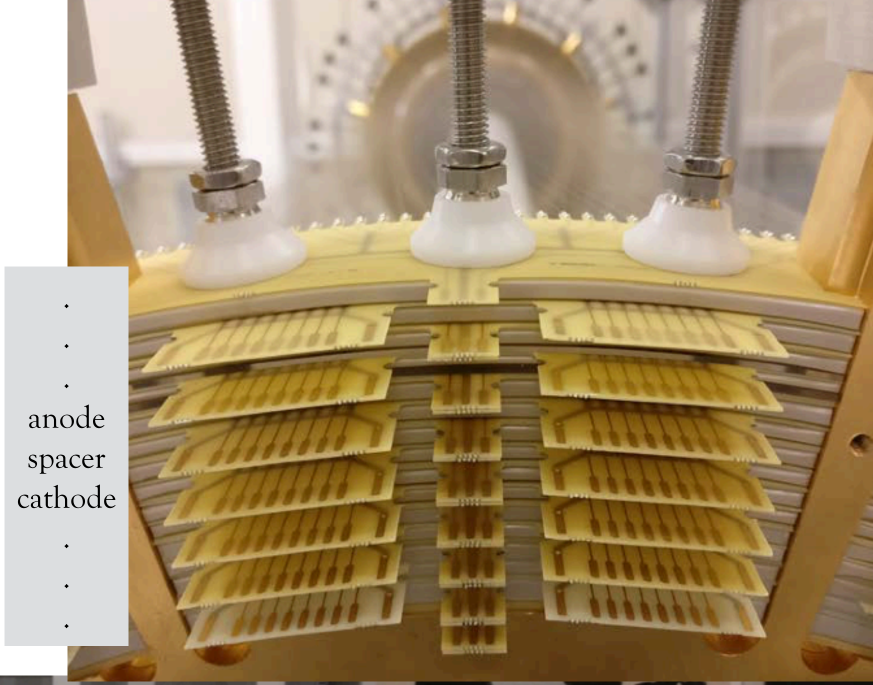


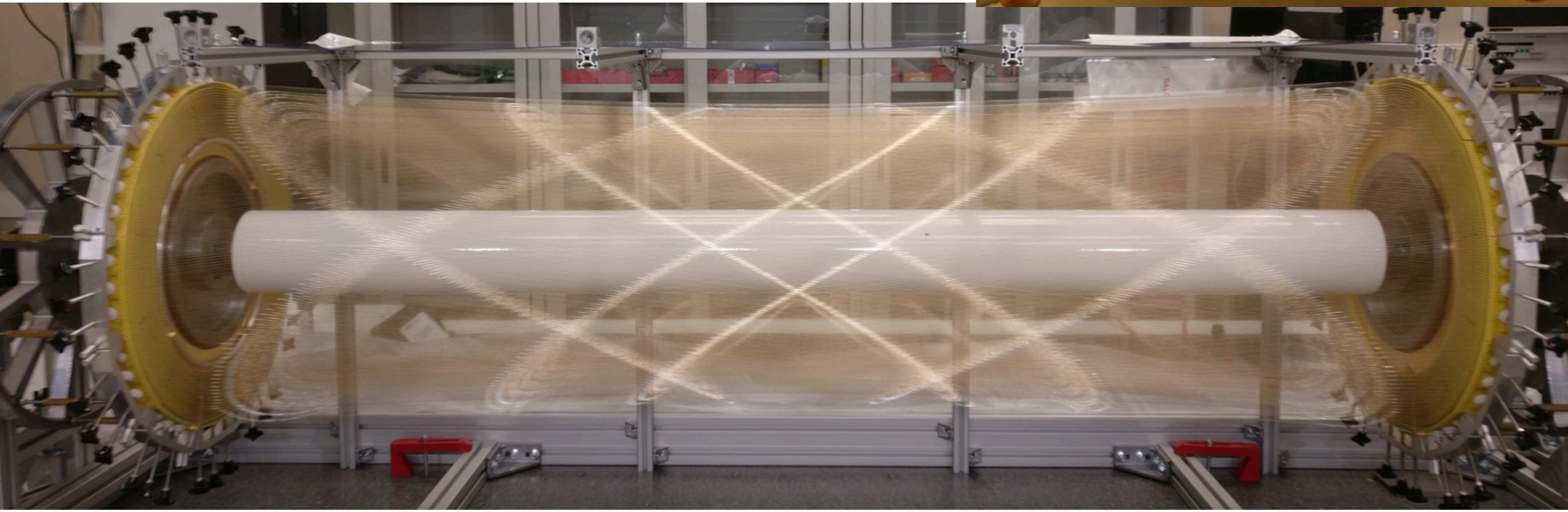


L. Galli, INFN Pisa

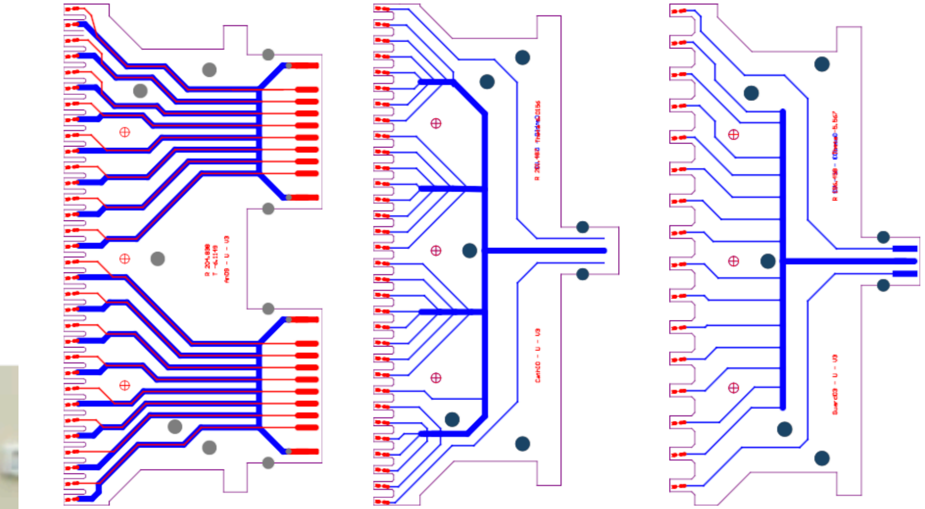
Drift chamber

- **single** volume DC
- **He-Isobuthane** (90-10) **low mass** gas mixture *(+ addition 1* isopropilic alcohol and ~0.5% oxygen or less)*
    - ***2 x 10^{-3} radiation length** per **track***
- **1728 anode** wires + **~10000 cathodes**
    - ***anode**: **20μm** W/Au, **cathode**: **40/50 μm** Al/Ag*



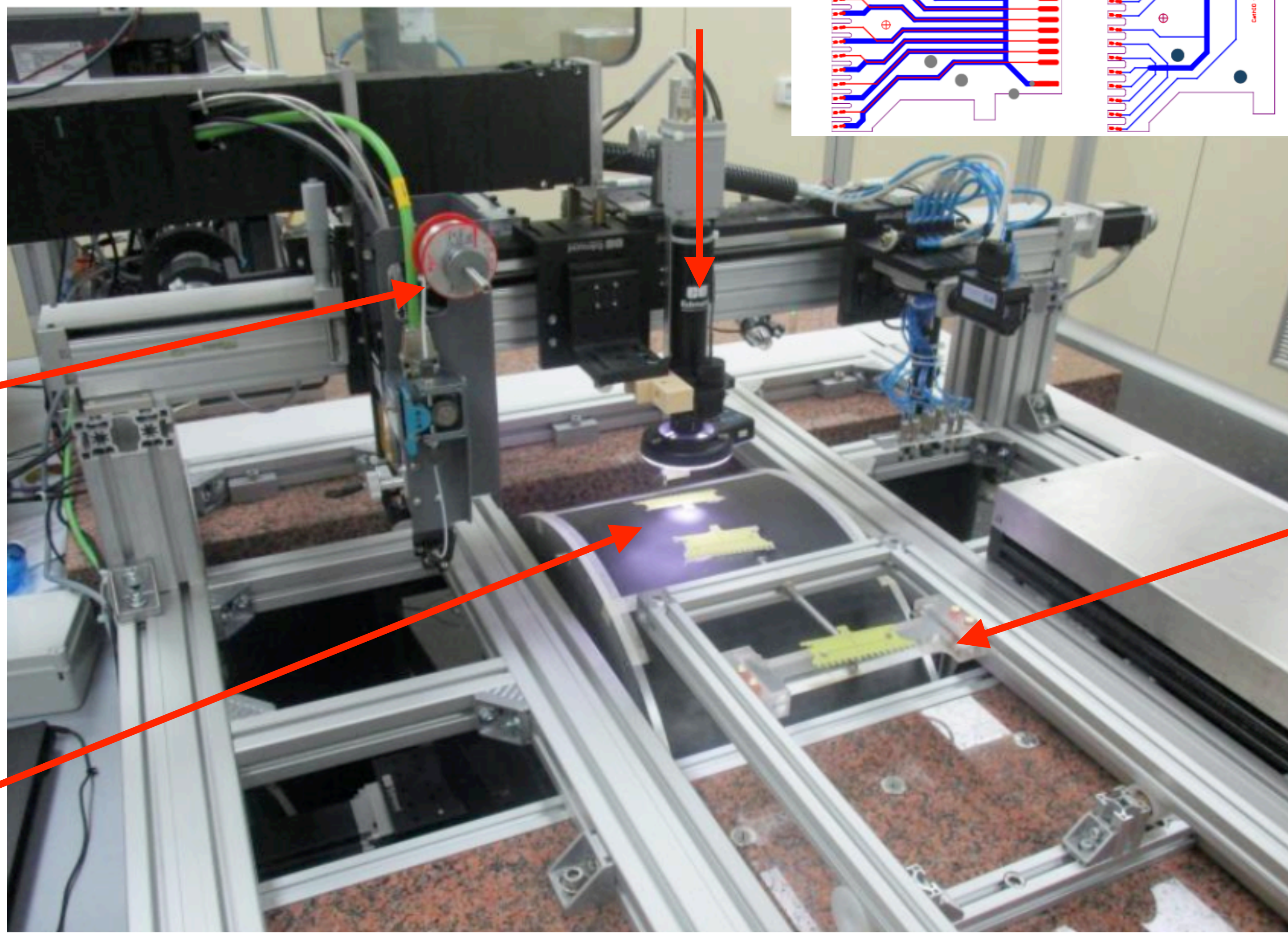


Wiring



wire spool
tension controlled unwinding

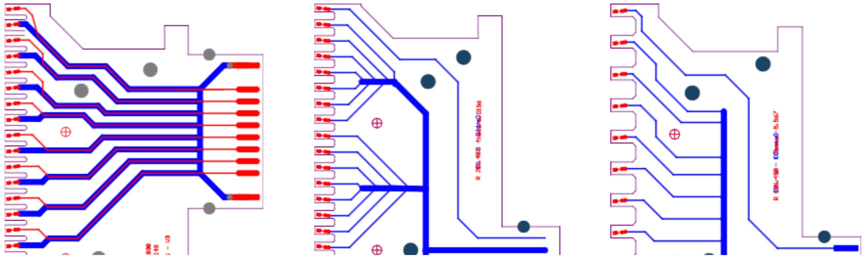
soldering wire

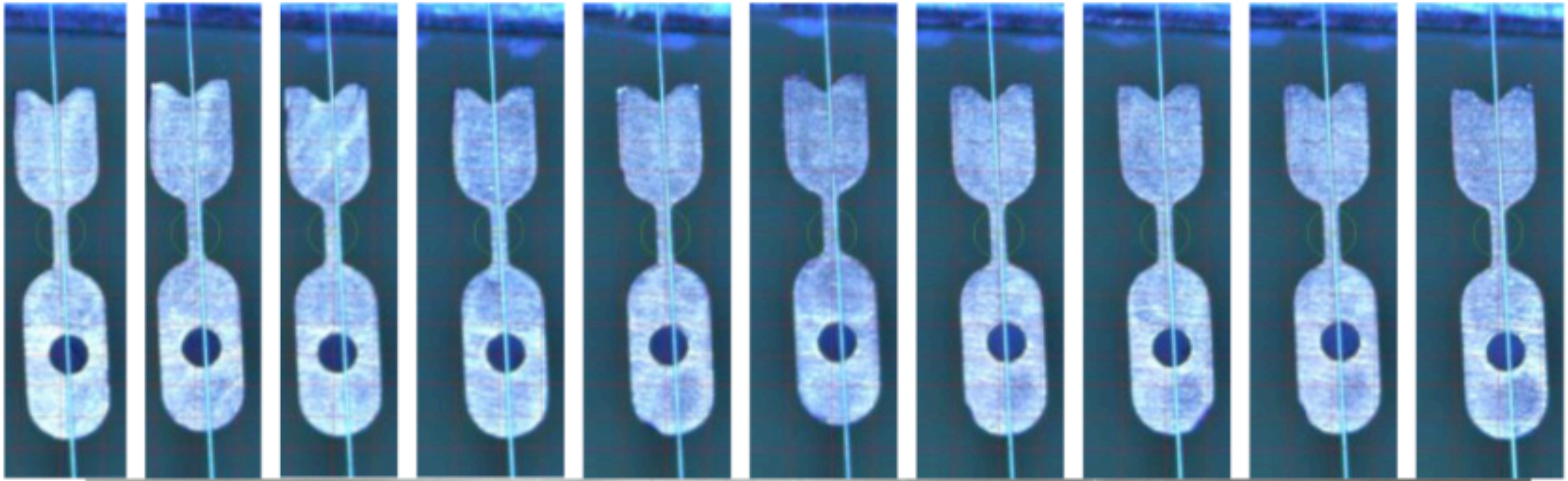


extracted PCBs

wiring PCBs on cylinder

Wiring

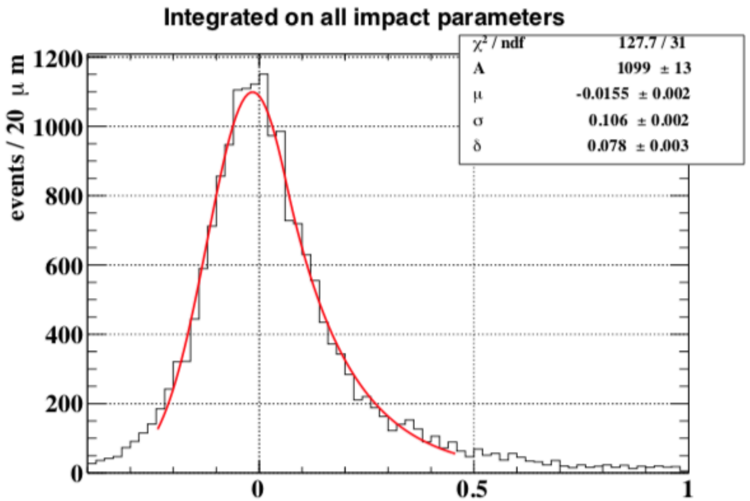




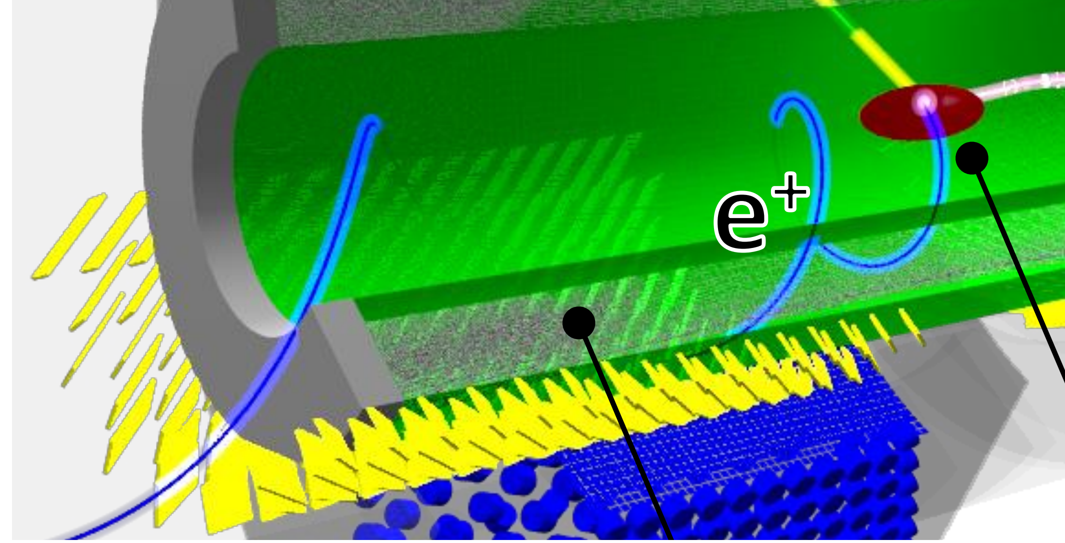
cylinder

Performance

Single hit resolution
measured in dedicated facility

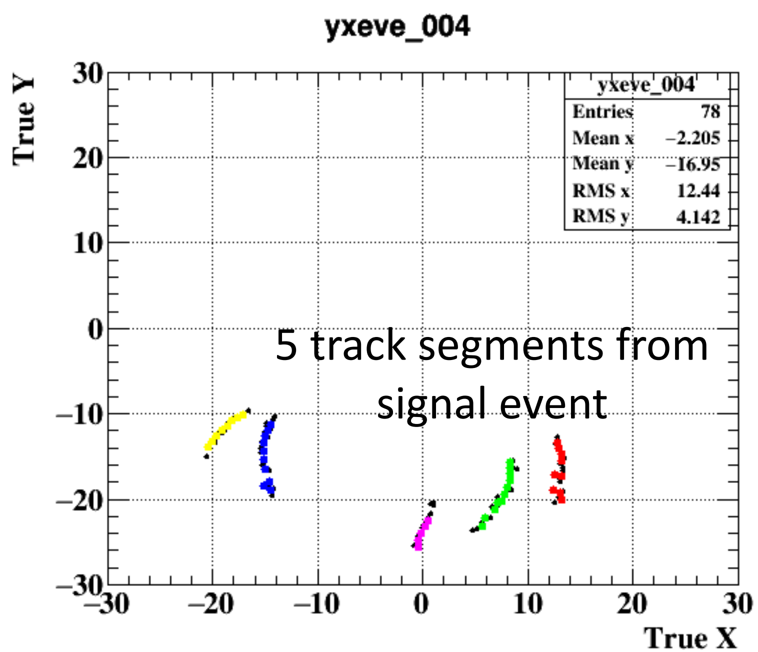


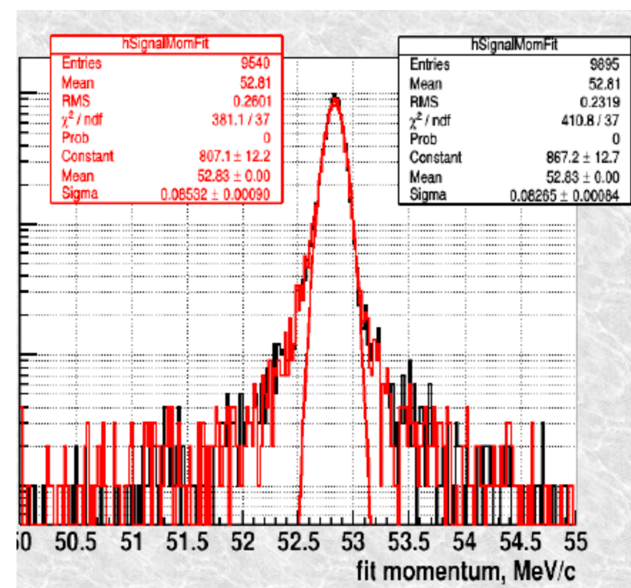
A. M. Baldini et al., JINST, 2016
L. Galli et al., TNS, 2015



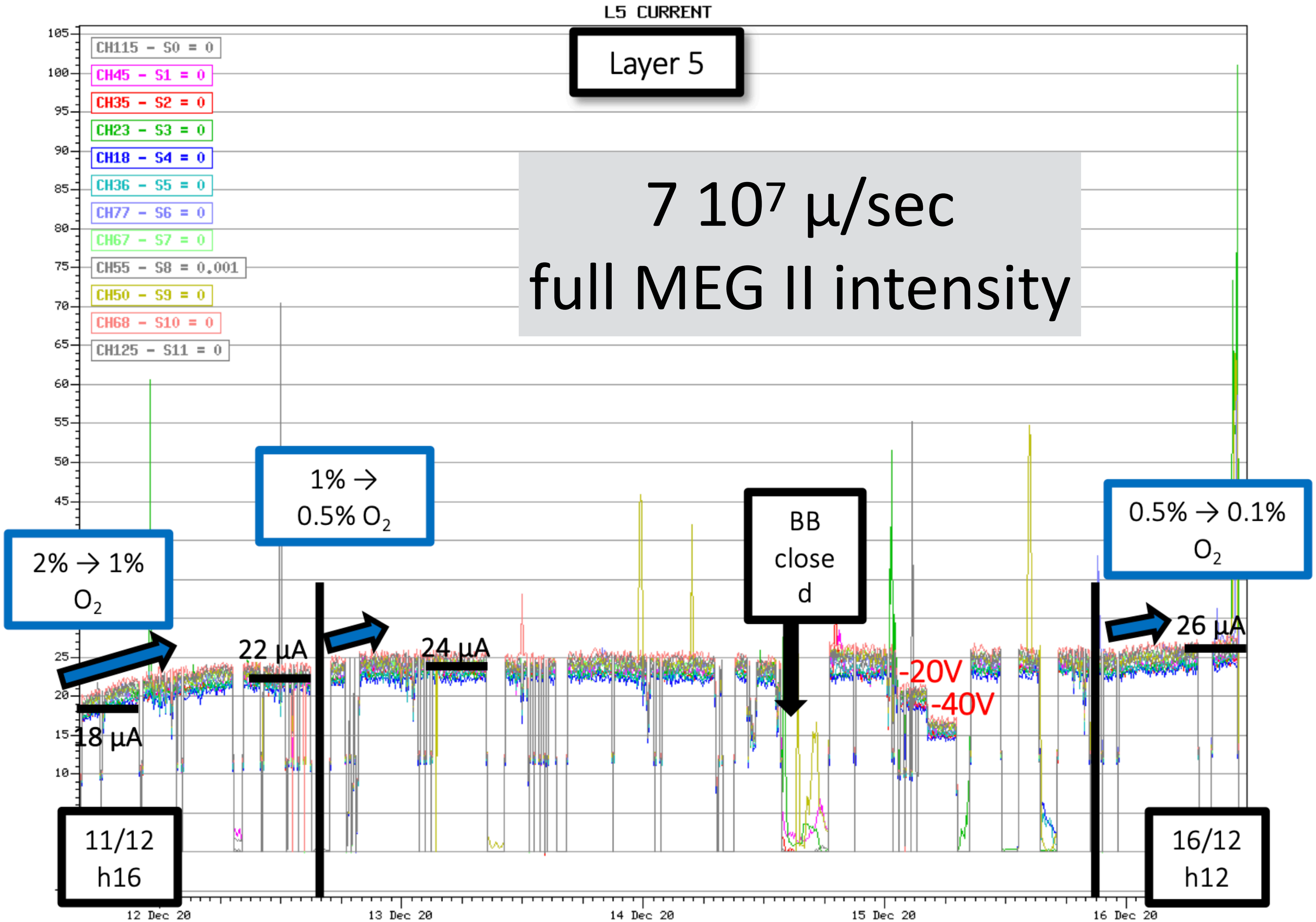
- x4 hits more than MEG
  →better momentum resolution
- tracks down to TC
  - larger tracking efficiency

From MC simulations the DC performances are in agreements with experimental requirements



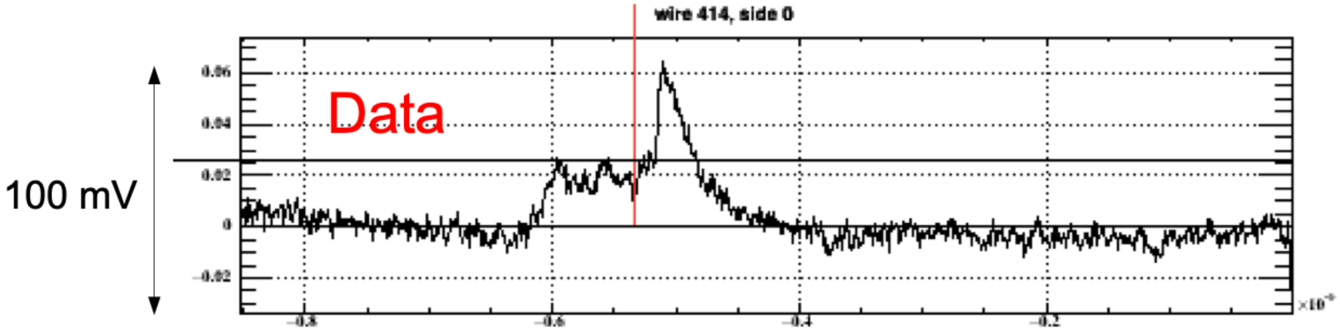


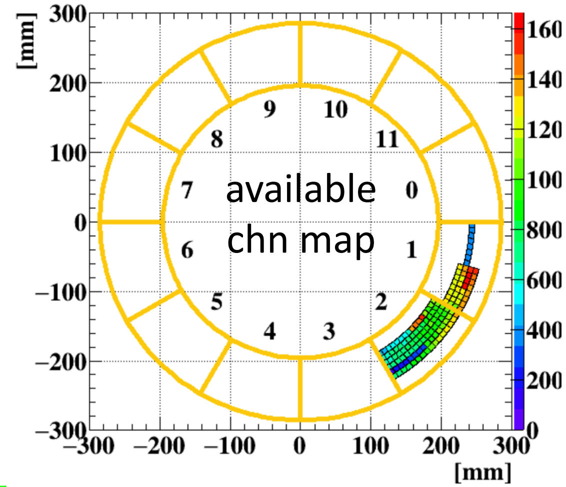
Commissioning in 2020



Stability with different gas admixtures (O_2 concentration)

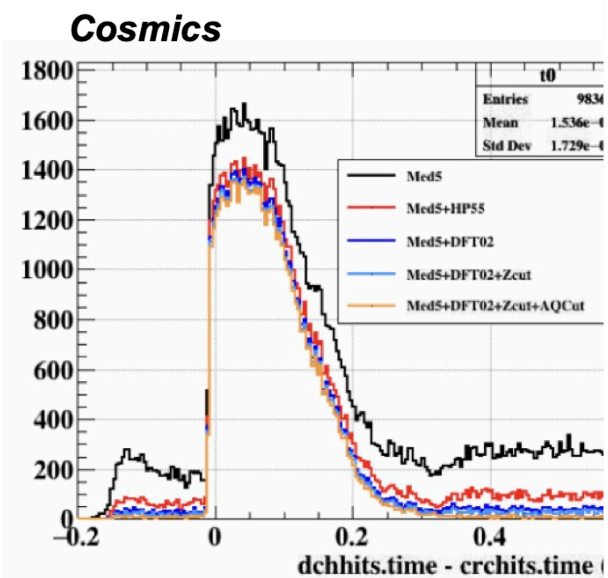
Commissioning in 2020

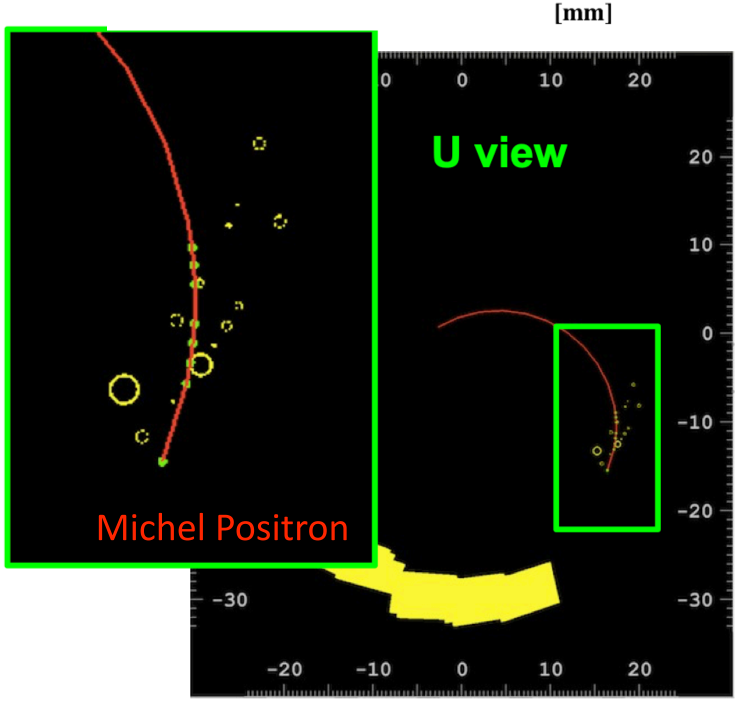




Only **10% of readout channels** available from WDB **preproduction**:

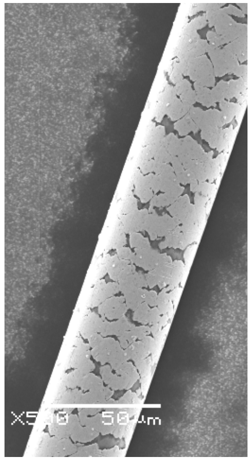
- **noise studies**
- **hit reconstruction**
- **gain measurements** (front end and gas)
  - **FE gain optimised** (x4 w.r.t. design)
- fit of **very first tracks**

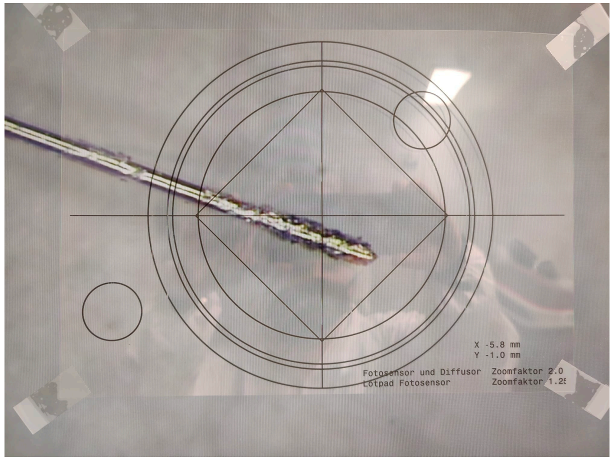




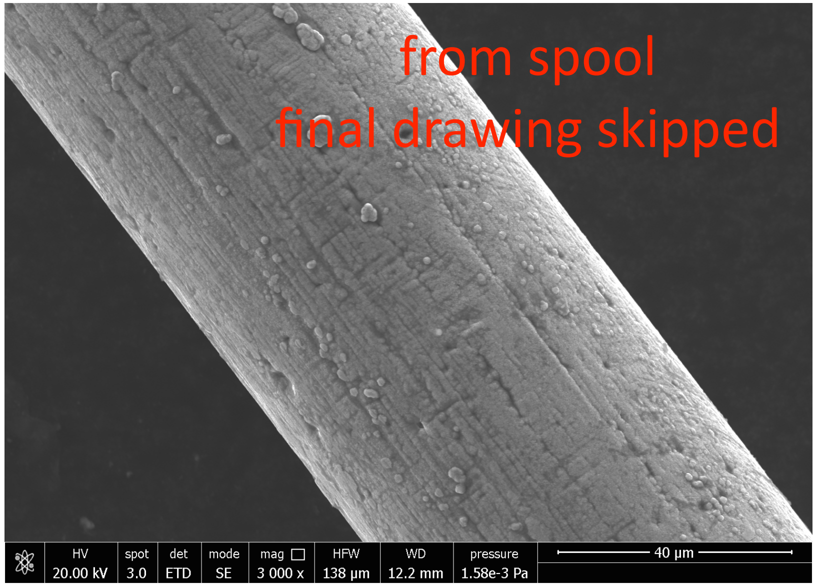
New CDCH wiring

- **Disclaimer**: the first CDCH is being integrated in the experiment and we believe it can cope with MEGII requirements; if proven to be stable on the long term (test in July this year)
  - *nonetheless we want to insure the collaboration by building a back up chamber*

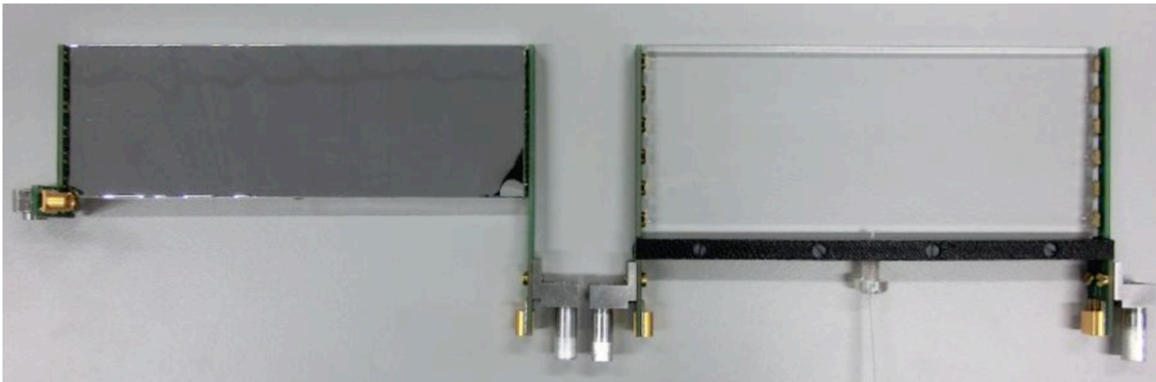


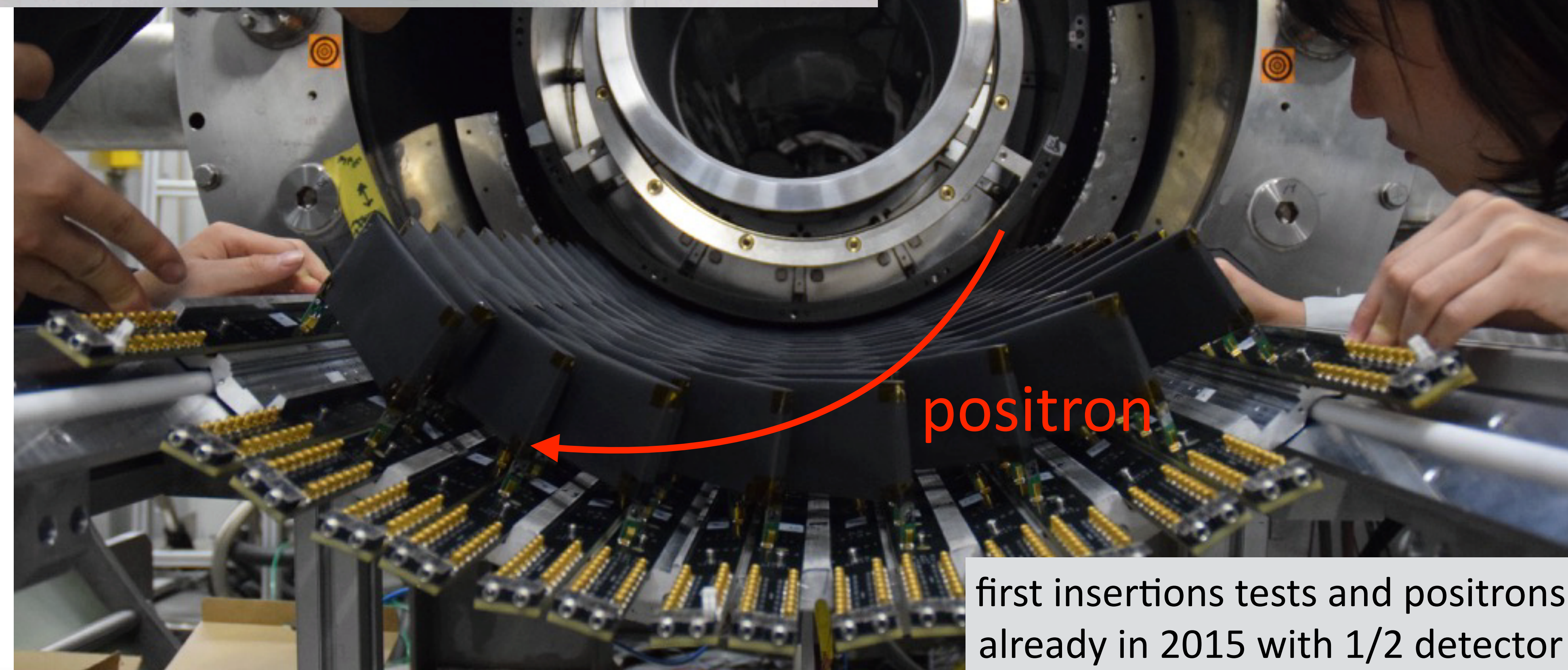


- Cathode wire weakness understood
  - *insufficient Ag plating due to last wire drawing during production*
    - this induces corrosion if moisture is present also at small Relative Humidity values (~10%)
    - checked with the company the possibility to skip last drawing and the reliability of the method
    - only 50 µm wires, 40µm wires must be drawn after plating
- Material procurement on going
  - *ready to start wiring within the end of the year*
  - *will take ~1 year*



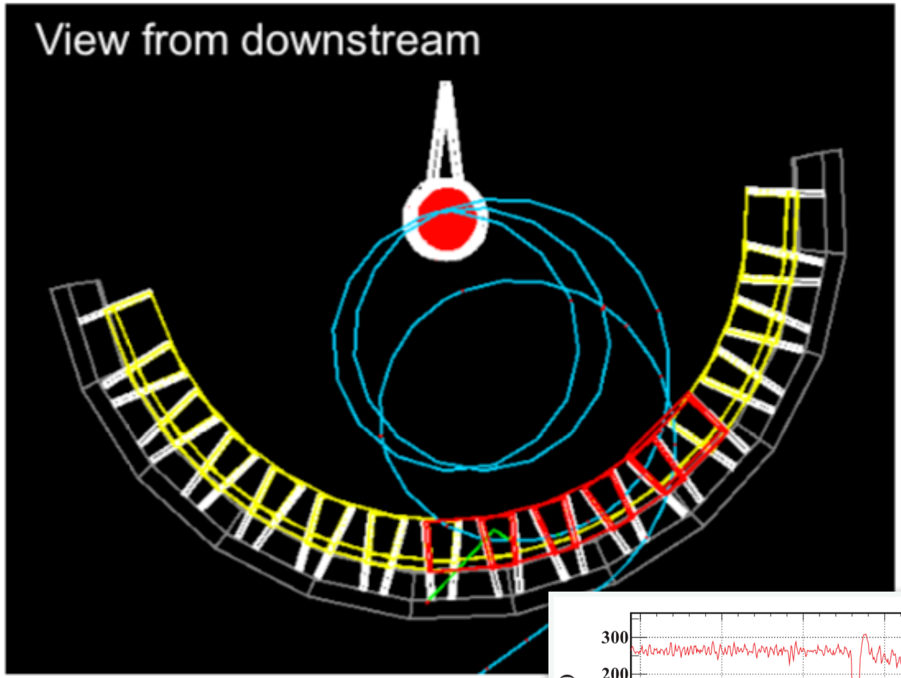
Timing Counter

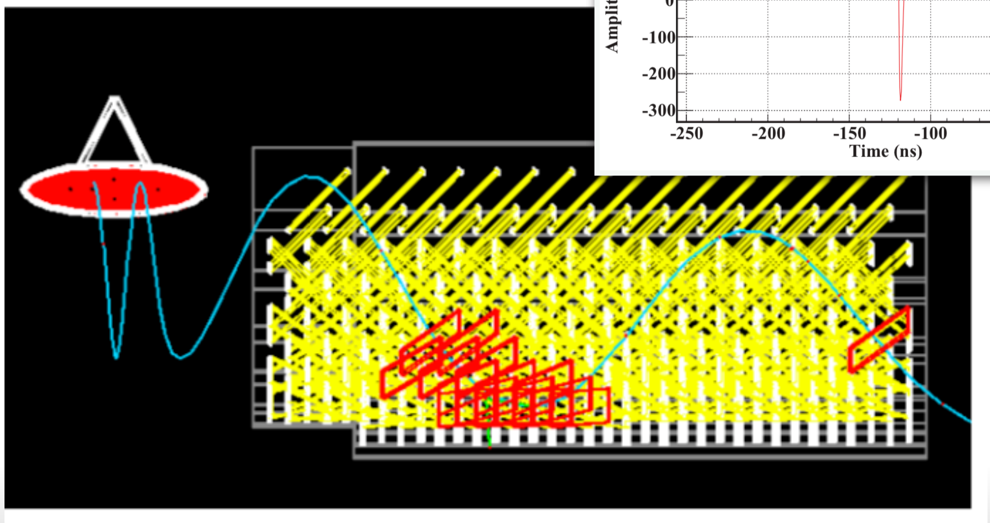


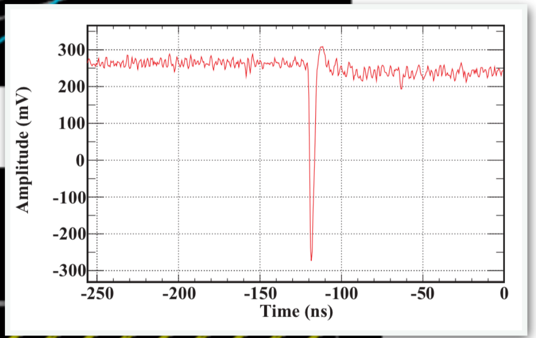


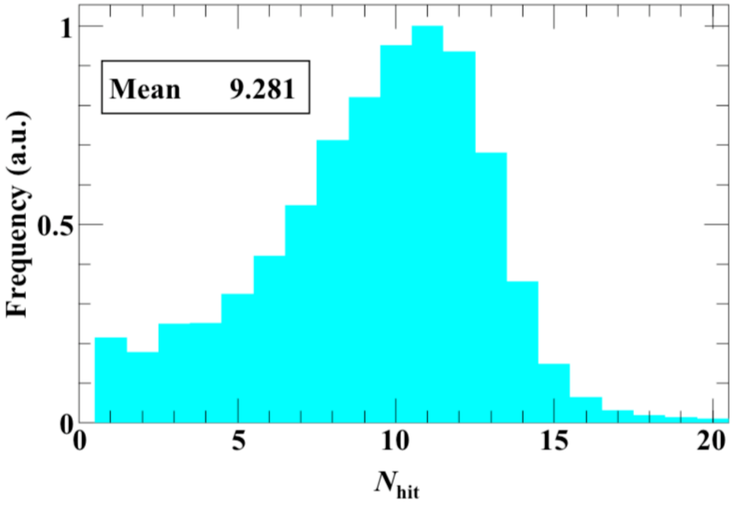
first insertions tests and positrons already in 2015 with 1/2 detector

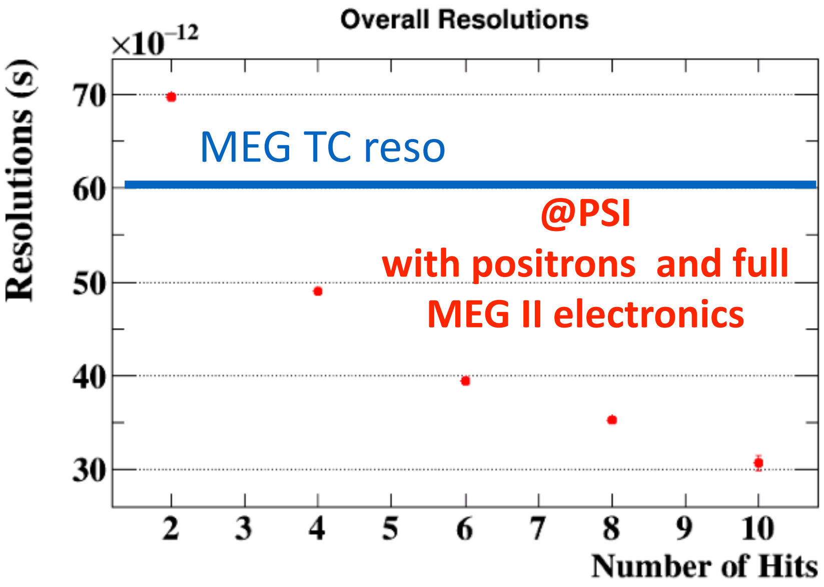
Ready for MEG II





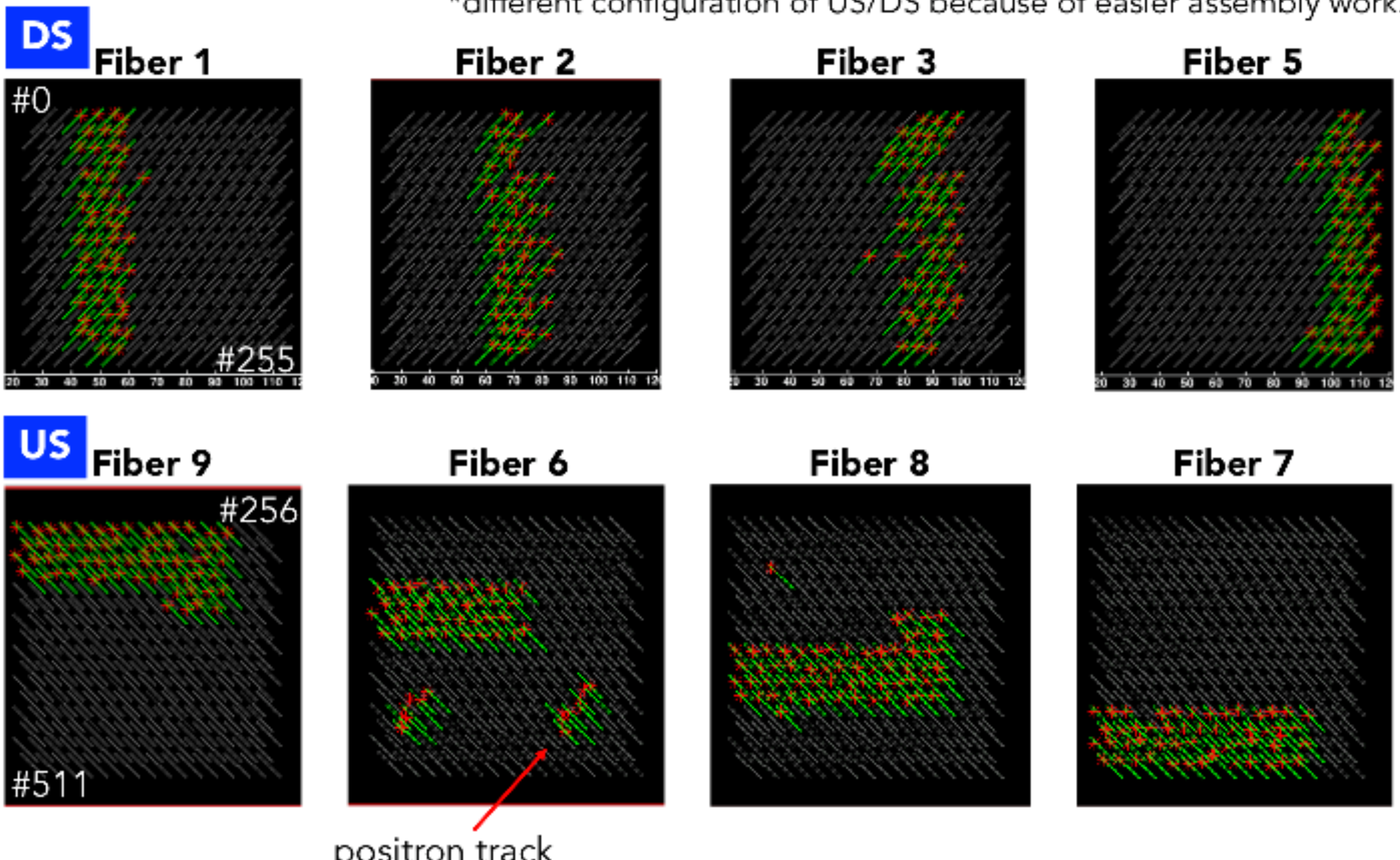






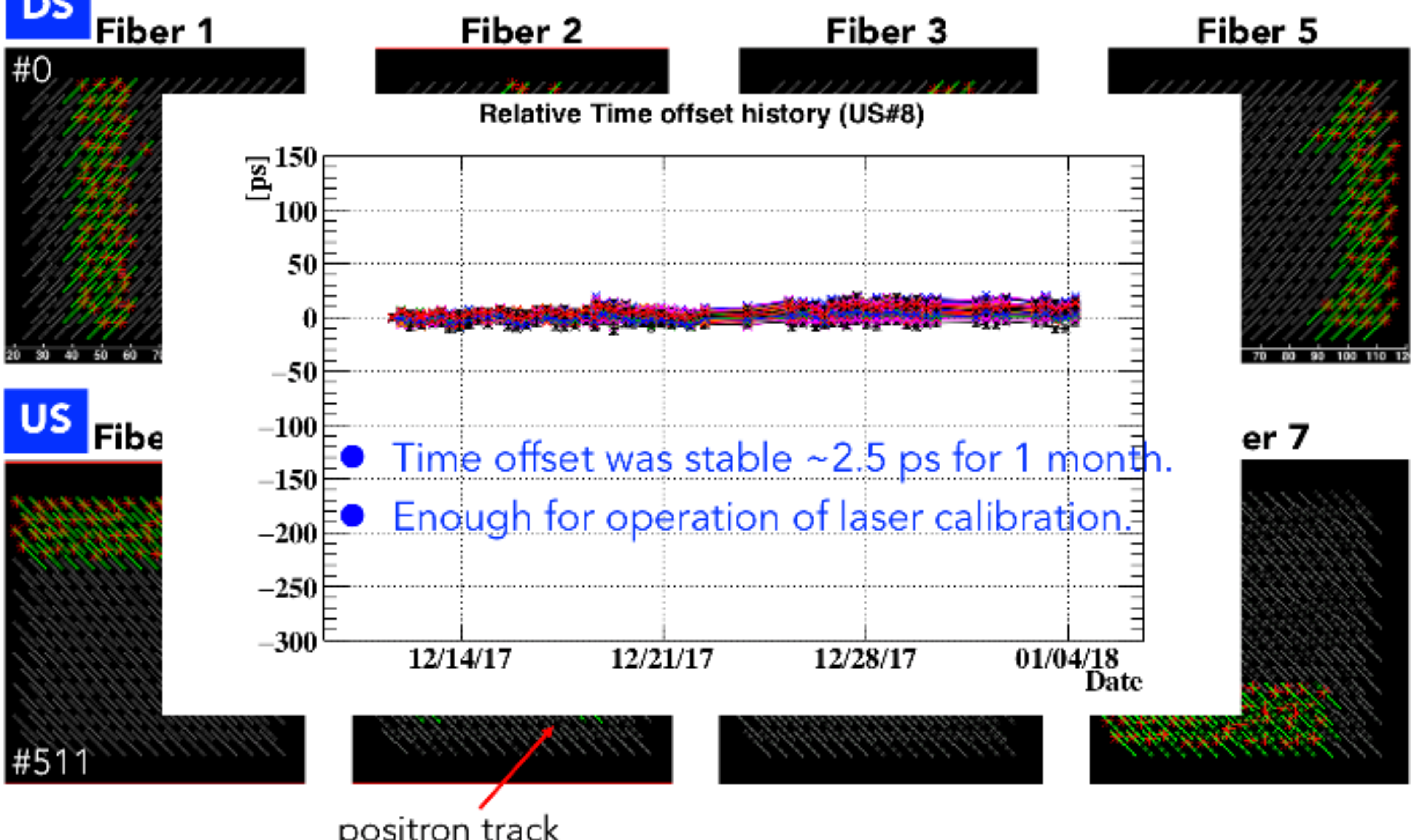
Calibration with laser

*different configuration of US/DS because of easier assembly work.



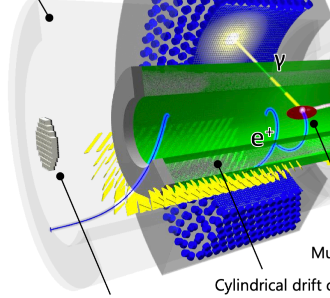
Calibration with laser

*different configuration of US/DS because of easier assembly work.



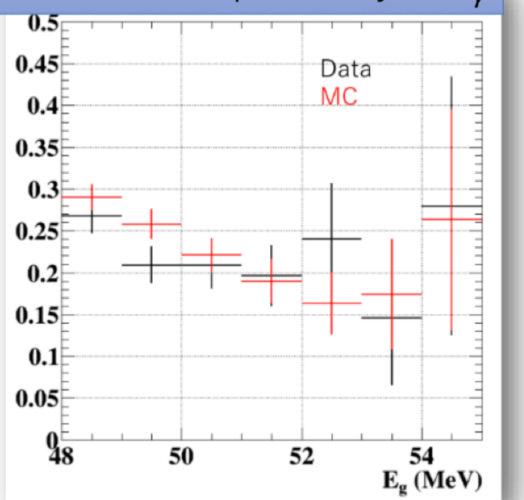
- Time offset was stable ~2.5 ps for 1 month.
- Enough for operation of laser calibration.

Radiative decay counter

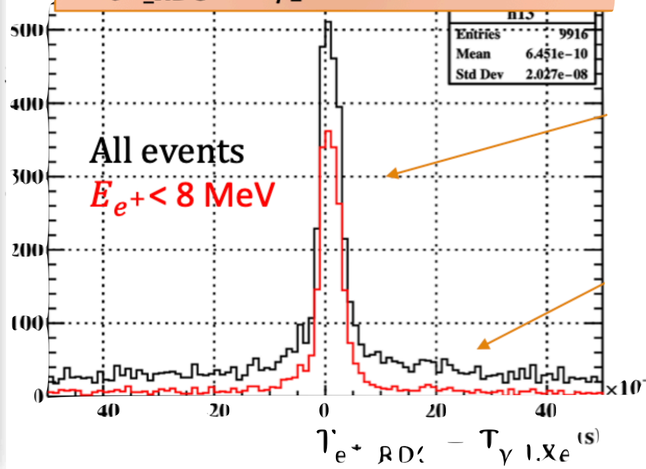


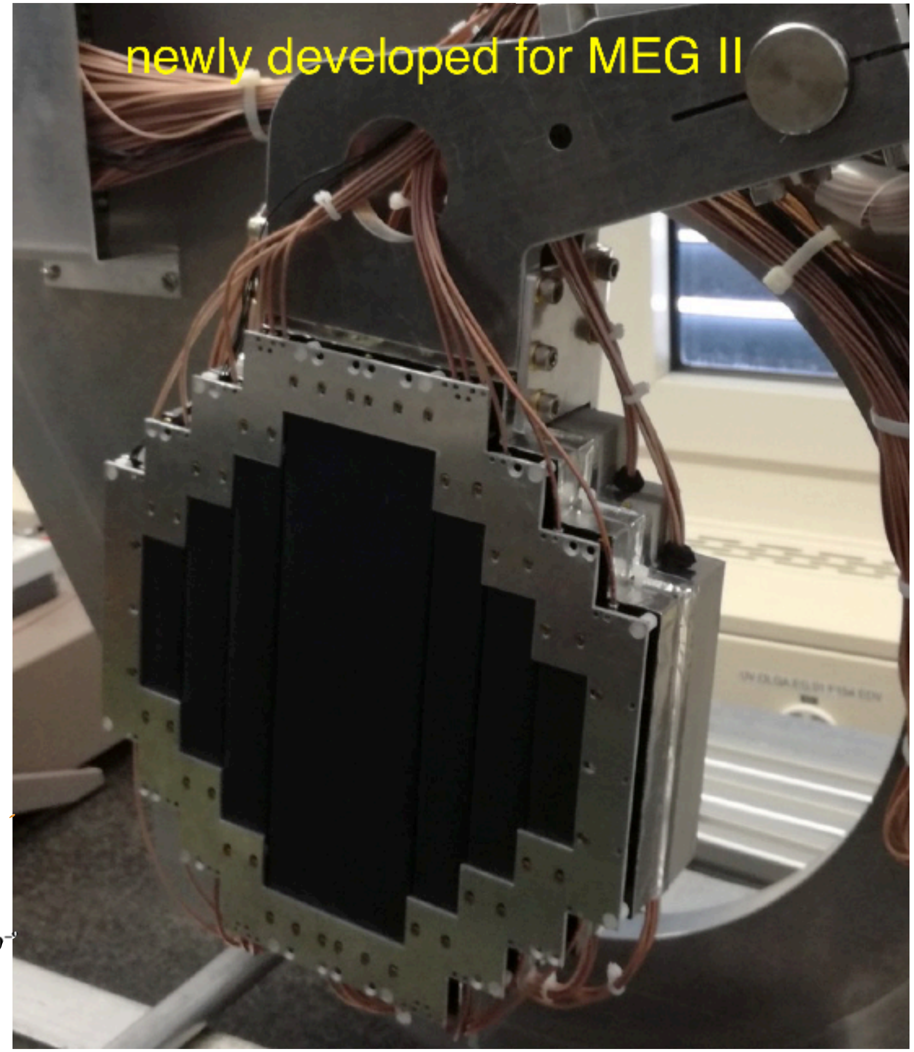
- Tags BG gamma rays from radiative decays by measuring low energy positrons
- Improves sensitivity by 15%

RMD detection probability vs. E_γ



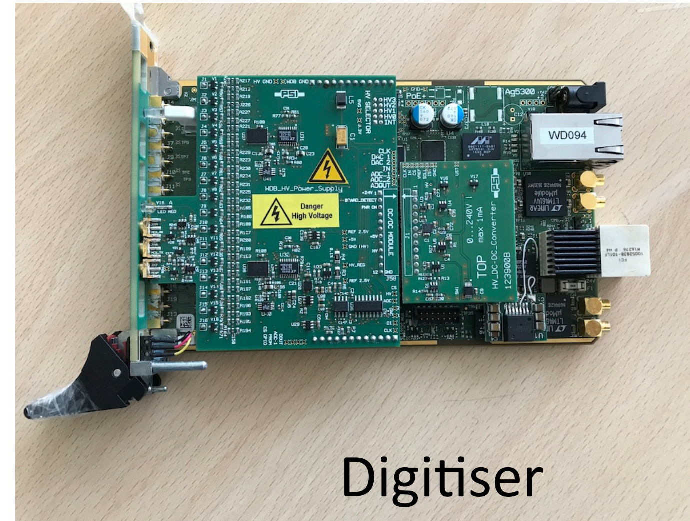
$T_{e^+\_RDC} - T_{\gamma\_LXe}$ (μ beam 2017)

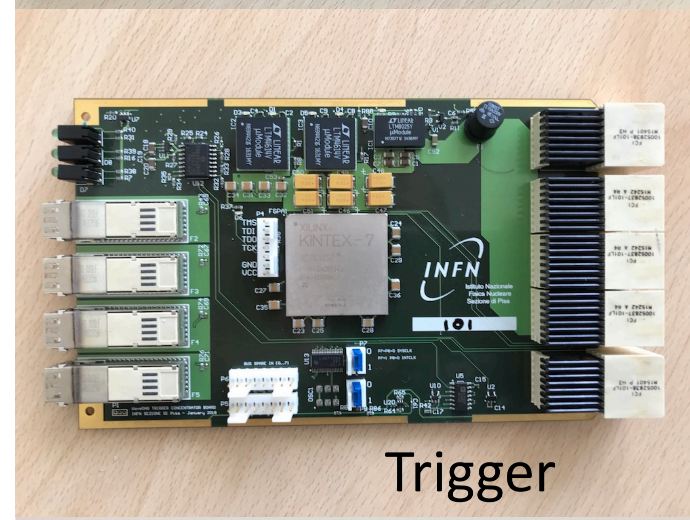


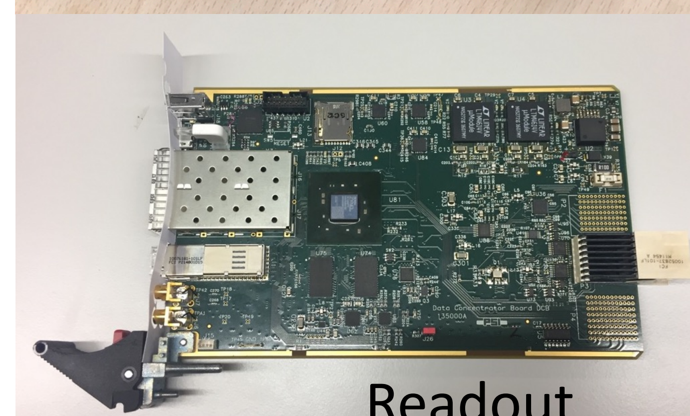


TDAQ electronics

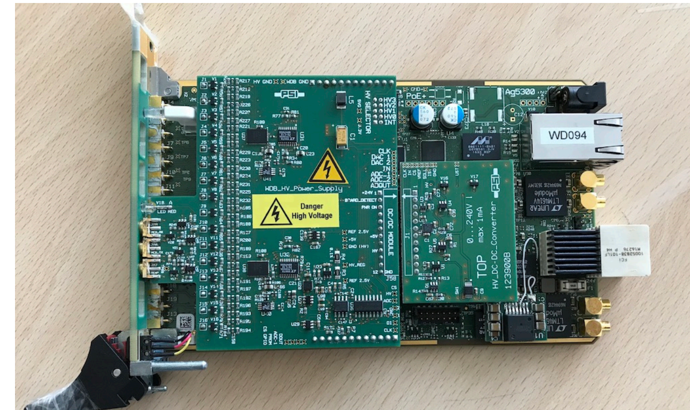
- Fully custom
- Trigger and DAQ integrated
    - *wfm digitiser @2GSPS with DRS chip*
        - SiPM power supply and amplification included
    - *Complex FPGA based trigger with latency <450ps*
    - *up t0 10 Gb/s DAQ throughput*

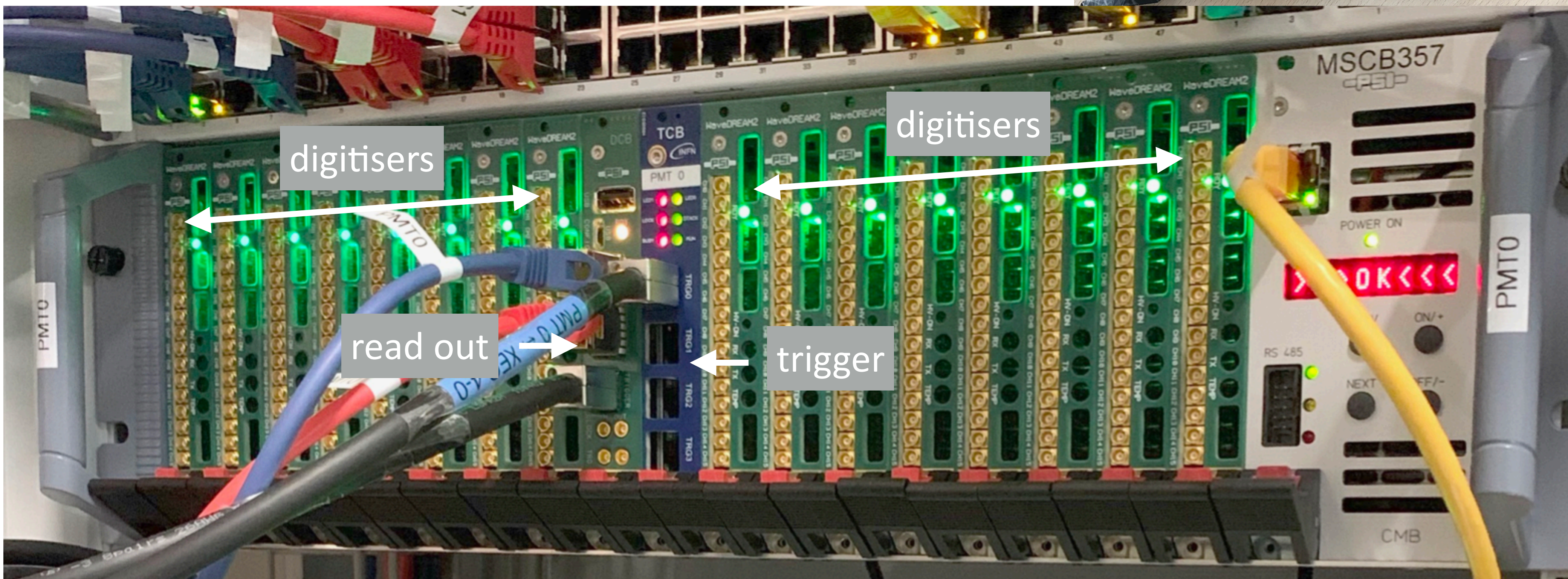




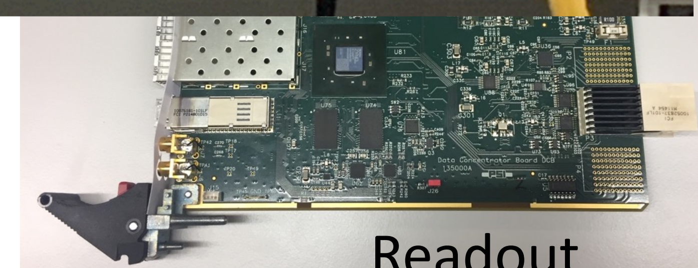


TDAQ electronics



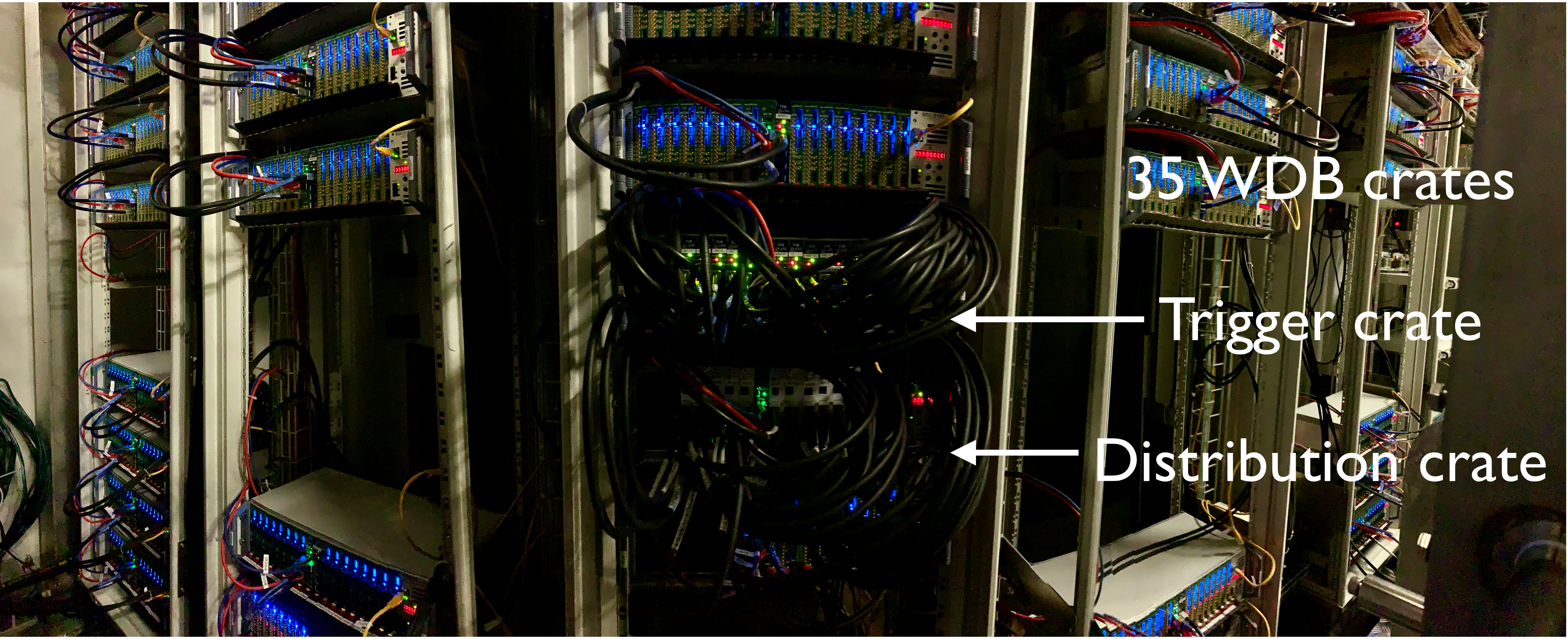


- *up t0 10 Gb/s DAQ throughput*



Installation completed

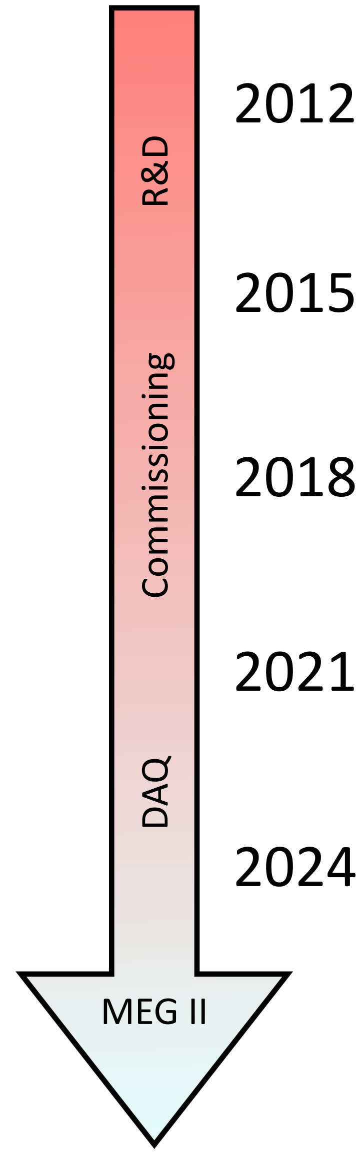
Istituto Nazionale di Fisica Nucleare



DAQ commissioning ongoing followed by the trigger

Construction status

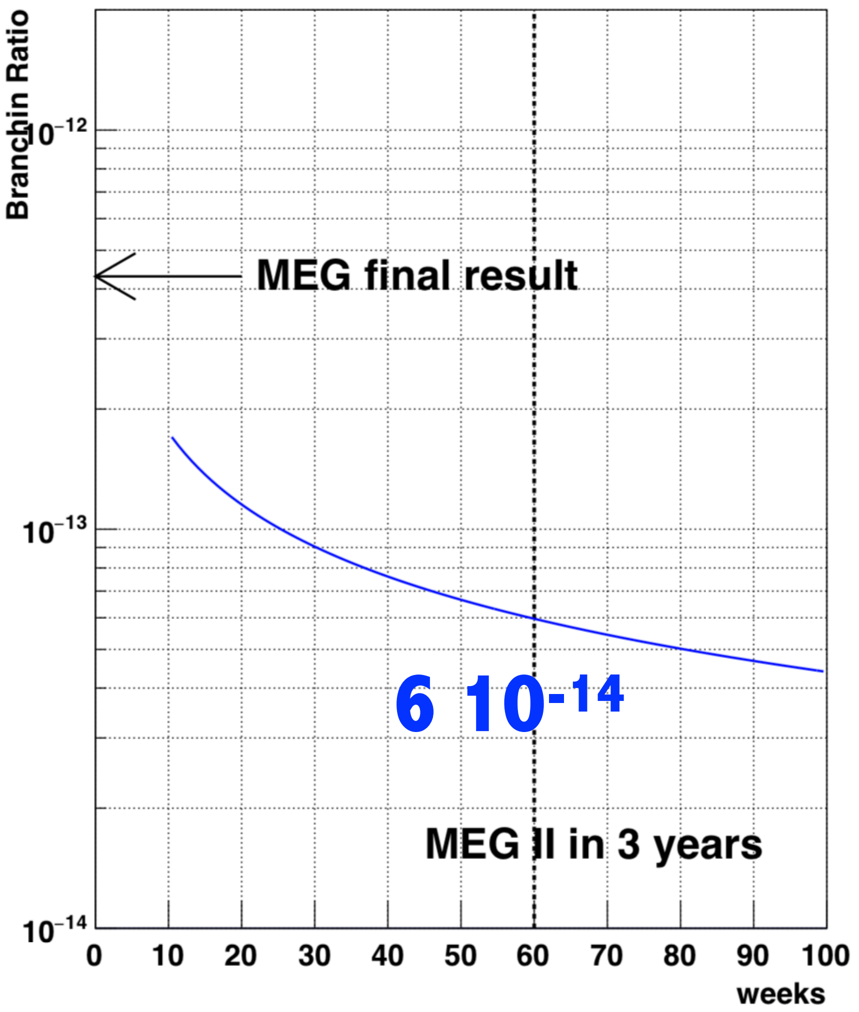
- LXe: commissioned with ~10% of the channels with muon beam and CEX data
- DC: commission ongoing
  - *in 2020 we reached the detector stability at full intensity beam*
- TC: 100% tested and ready for physics runs
- RDC: tested under beam and ready for physics runs
- TDAQ: installation completed in March 2021
  - *DAQ commissioning at advanced stage*
  - *basic trigger algorithms commissioned*
    - first version of MEG trigger expected for the end of this year
- 2021 beam time from July until the end of the year
  - *first physics-like data expected before the end of the year*



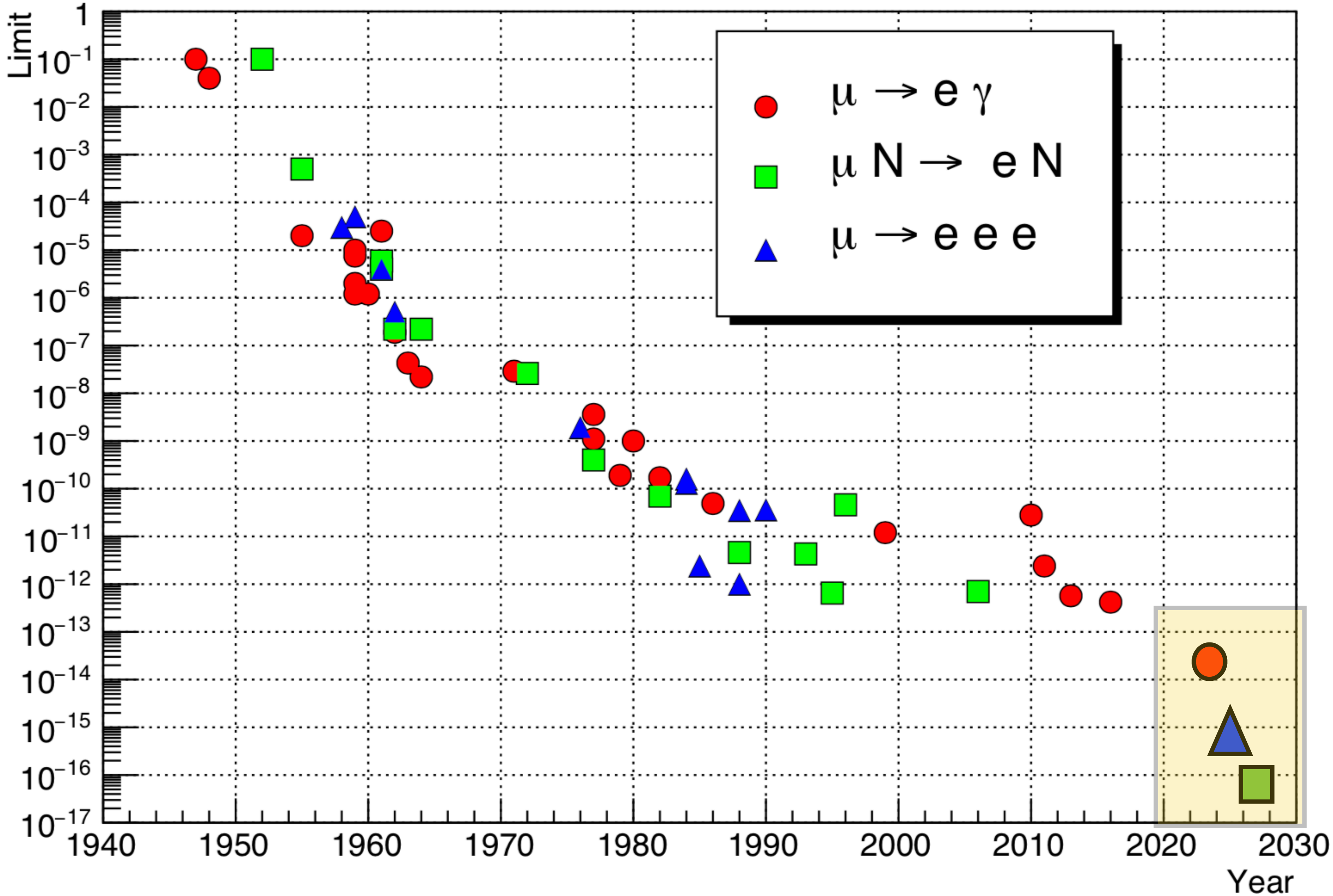
MEG II vs MEG

PDF parameters	MEG	MEG II
E_{e^+} (keV)	380	130
θ_{e^+} (mrad)	9.4	5.3
ϕ_{e^+} (mrad)	8.7	3.7
z_{e^+}/y_{e^+} (mm) core	2.4/1.2	1.6/0.7
E_γ(%) (w>2 cm)/(w<2 cm)	2.4/1.7	1.1/1.0
$u_\gamma, v_\gamma, w_\gamma$ (mm)	5/5/6	2.6/2.2/5
$t_{e^+\gamma}$ (ps)	122	84
Efficiency (%)		
Trigger	≈ 99	≈ 99
Photon	63	69
e^+(tracking × matching)	30	70

$$B_{acc} \propto R_\mu \Delta E_e \Delta E_\gamma^2 \Delta\Theta_{e\gamma}^2 \Delta t_{e\gamma}$$

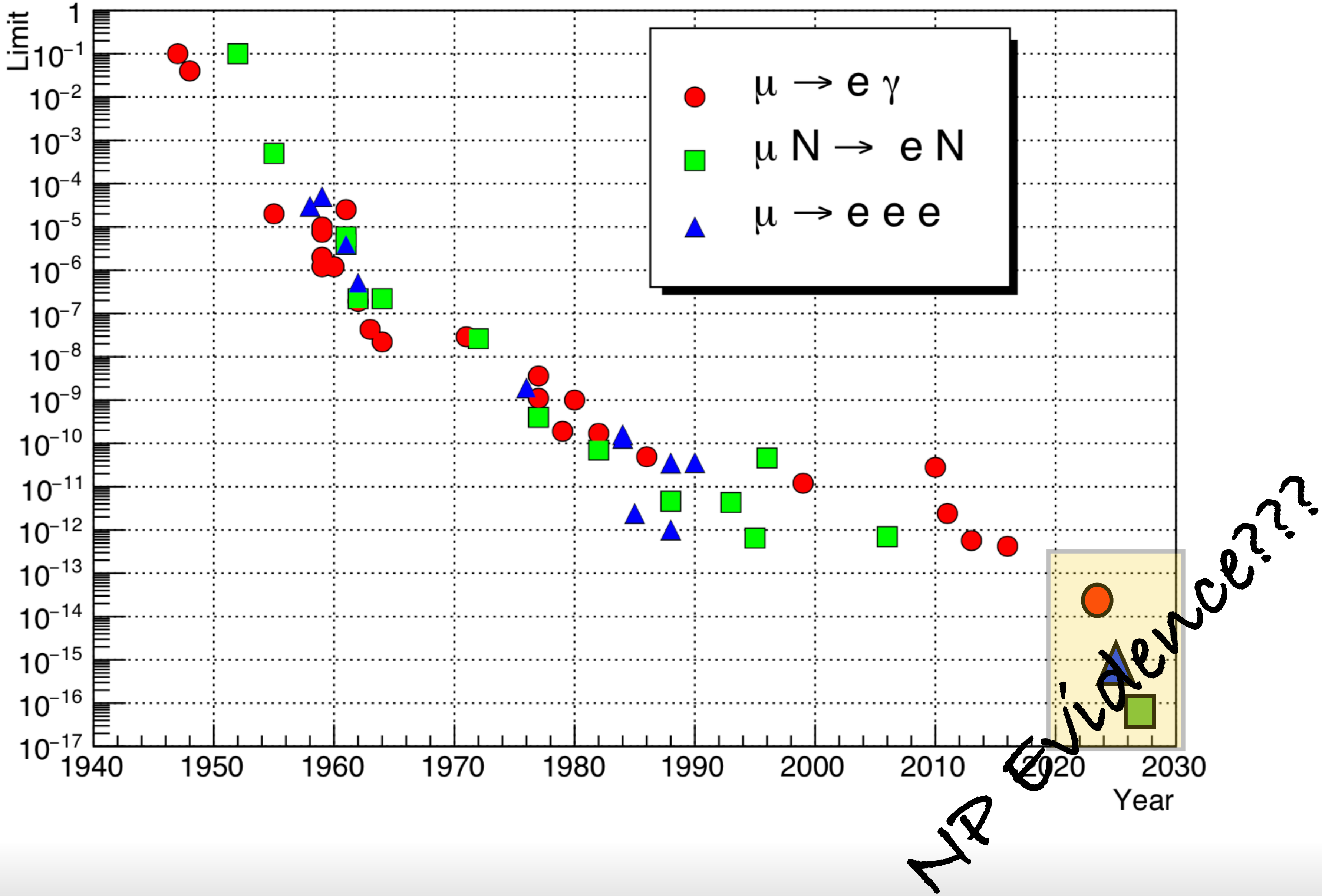


cLFV in 10 years



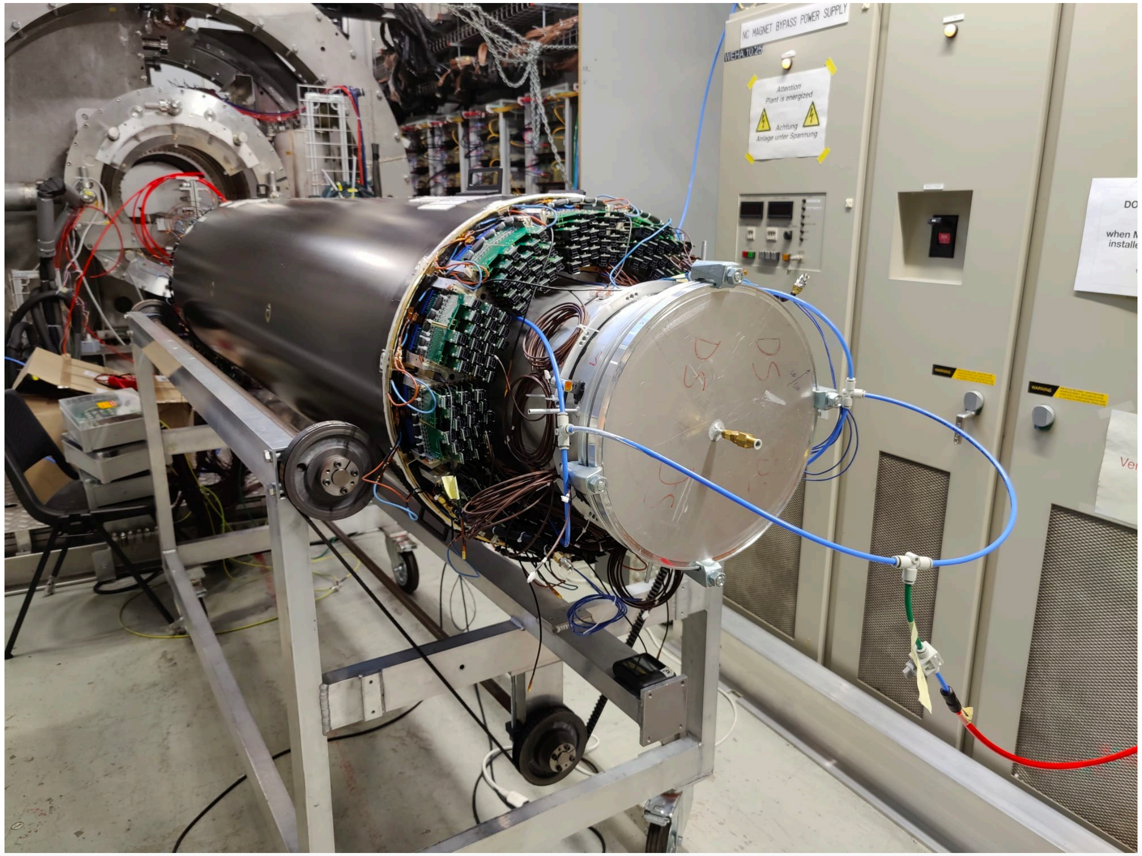
cLFV in 10 years

Calibbi and Signorelli, Riv. N. Cimento, 2017



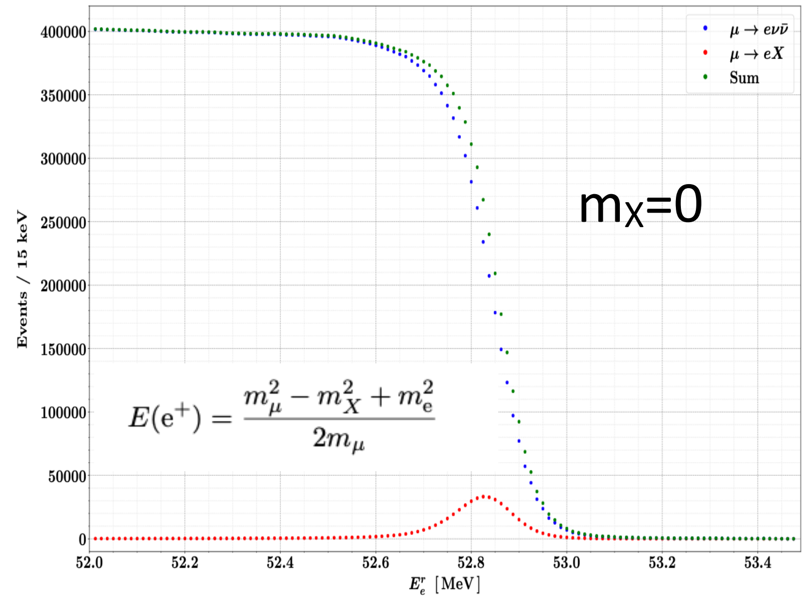
Ready to go!

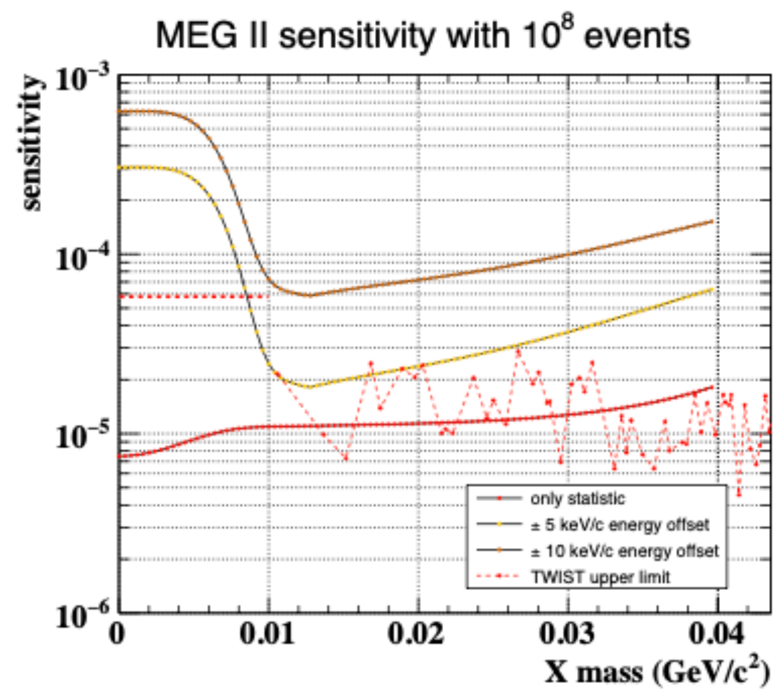
- Despite the pandemic we plan to have a full MEG II run
  - *beam from August; installation ongoing*



Additional channel: μ→eX

- Search for invisible, light and neutral scalar boson X
  - **final state** with a **positron** of a **fixed momentum**
    - **MEG II competitive** with **TWIST** from **pure statistical** point of view
    - <u>**systematics**</u> on **positron energy scale dominant** for **small X mass** (<~10MeV)
    - **working group** established





<u>Master Thesis</u>: A. Gurgone @Univ. Pisa
E. Ripiccini @Univ Roma 1
<u>PhD Thesis</u>: M. Francesconi @Univ. Pisa

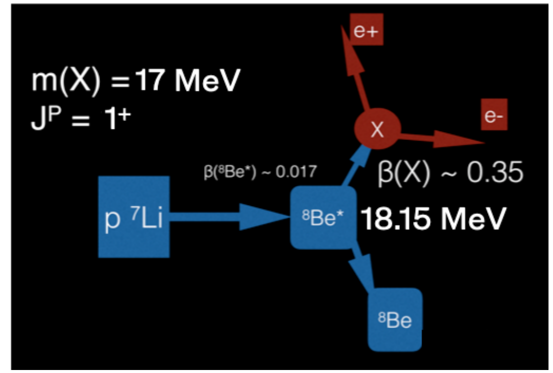
Other physics: X(17 MeV) Boson

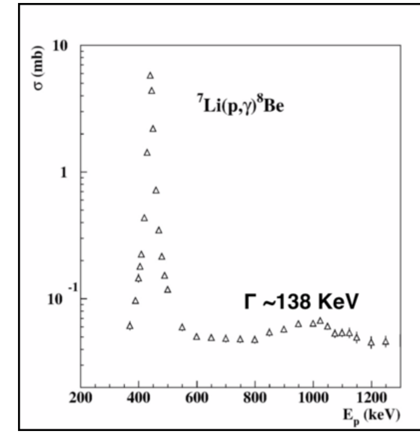
Anomaly in the process (p,7Li)8Be* measured by Atomki experiment

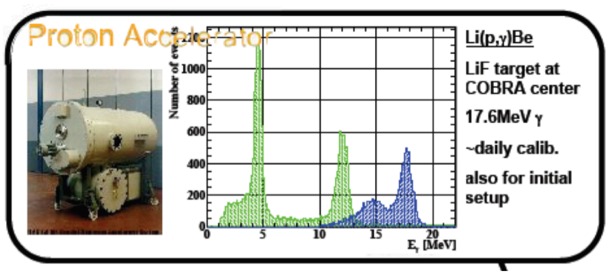
- *can be **replicated** by **MEG II***
  - **CW accelerator** used to LXe calibration
  - **tracking of e^+e^-** with **drift chamber** at **reduced magnetic field**
    - **similar** angular resolution
    - **improved** invariant mass resolution ~500keV instead of 1MeV

Thinner CW Li target in production

- **first tests** within the **end of this year** for method assessment
  - finalluy **O(1 WEEK)** DAQ time will be sufficient







from slide 26...

<u>PhD Thesis</u>: P. Schwendiman @PSI
M. Meucci @Univ Roma 1

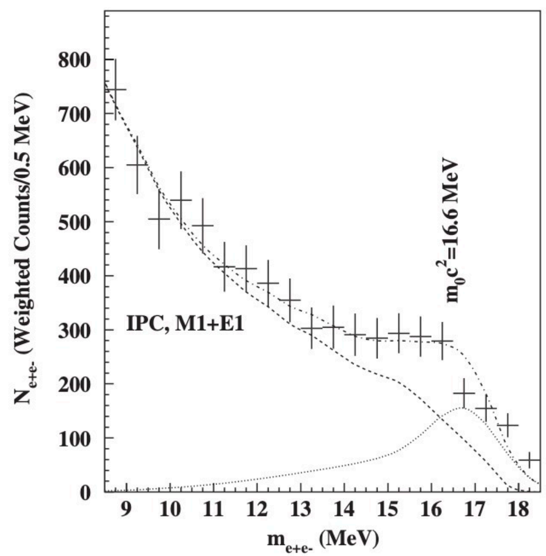
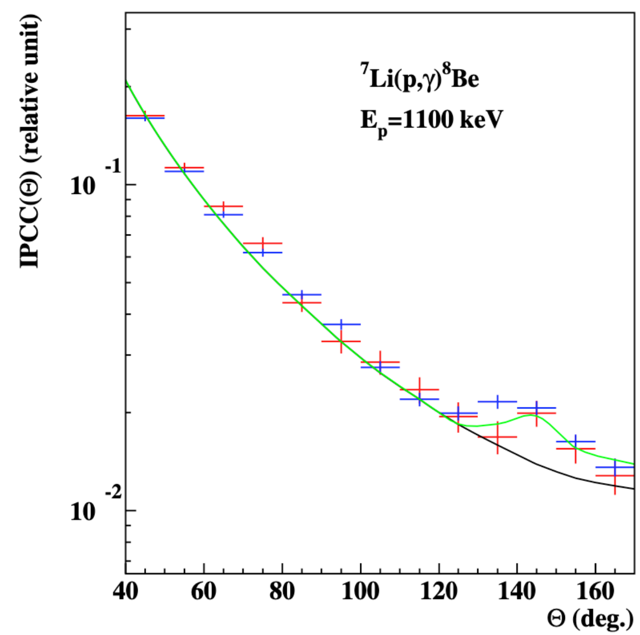


FIG. 5. Invariant mass distribution derived for the 18.15 transition in ^{8}Be.



Conclusions

- cLFV with muons features a unique opportunity to discover physics beyond the standard model
  - *muon sector is the most promising from:*
    - $\mu \rightarrow e\gamma$, $\mu N \rightarrow eN$ and $\mu \rightarrow eee$
      - *complementary searches: sensitive to different new physics dynamics*
- MEG II is ramping up @PSI
  - *goal: 6×10^{-14}*
  - *construction completed*
  - *full engineering run in 2021 with first MEG trigger data towards the end of the beam time*
    - a full physics program looks just behind the corner!

Thanks for your attention!

Many channels

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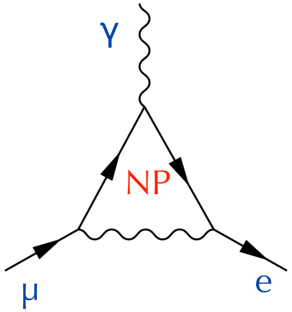
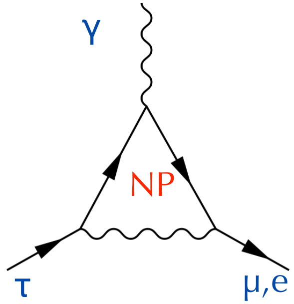
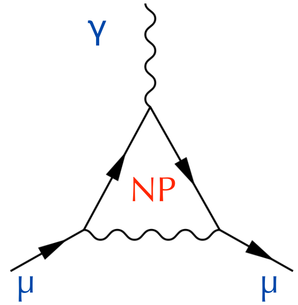


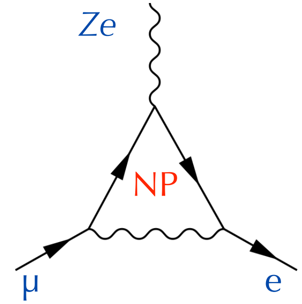
$\mu \to e\gamma$



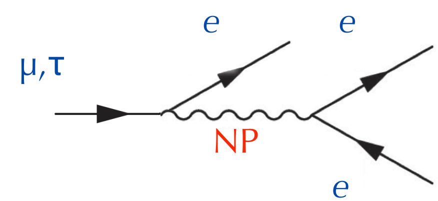
$\tau \to \mu\gamma$
$\tau \to e\gamma$



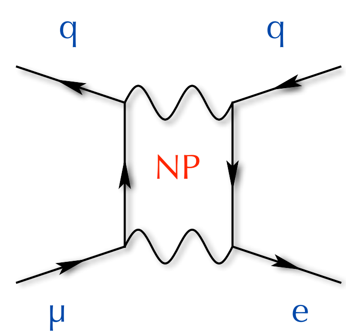
$(g-2)_\mu$

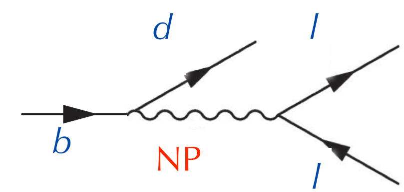


$\mu^- \mathcal{N} \to e^- \mathcal{N}$



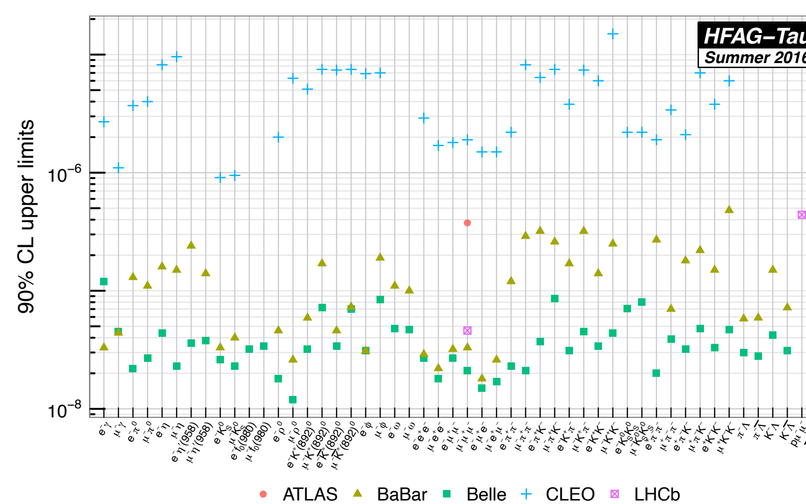
$\mu \to eee$





$B \to \ell\bar{\ell}'$
$B \to \ell\bar{\ell}' X_s$

- A **wide field** of research
  - ***LFV decays of leptons***
  - ***Anomalous magnetic moment for the μ***
  - ***Muon-to-electron conversion***
  - ***LFV in meson decays***



μ as a golden channel

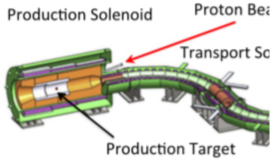
- High inten
  - *large s*
- long decay
  - *beam t*
- simple kin
  - *precise*

Table 8

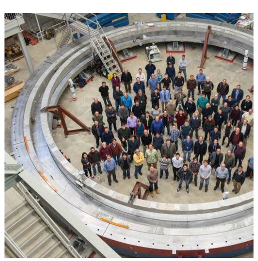
"DNA" of flavour physics effects for the most interesting observables in a selection of SUSY and non-SUSY models ★★★ signals large effects, ★★ visible but small effects and ★ implies that the given model does not predict sizable effects in that observable.

	AC	RVV2	AKM	δLL	FBMSSM	LHT	RS
$D^0-\bar{D}^0$	★★★	★	★	★	★	★★★	?
ϵ_K	★	★★★	★★★	★	★	★★	★★★
$S_{\psi\phi}$	★★★	★★★	★★★	★	★	★★★	★★★
$S_{\phi K_S}$	★★★	★★	★	★★★	★★★	★	?
$A_{CP}(B\to X_s\gamma)$	★	★	★	★★★	★★★	★	?
$A_{7,8}(B\to K^*\mu^+\mu^-)$	★	★	★	★★★	★★★	★★	?
$A_9(B\to K^*\mu^+\mu^-)$	★	★	★	★	★	★	?
$B\to K^{(*)}\nu\bar{\nu}$	★	★	★	★	★	★	★
$B_s\to\mu^+\mu^-$	★★★	★★★	★★★	★★★	★★★	★	★
$K^+\to\pi^+\nu\bar{\nu}$	★	★	★	★	★	★★★	★★★
$K_L\to\pi^0\nu\bar{\nu}$	★	★	★	★	★	★★★	★★★
$\mu\to e\gamma$	★★★	★★★	★★★	★★★	★★★	★★★	★★★
$\tau\to\mu\gamma$	★★★	★★★	★	★★★	★★★	★★★	★★★
$\mu+N\to e+N$	★★★	★★★	★★★	★★★	★★★	★★★	★★★
d_n	★★★	★★★	★★★	★★	★★★	★	★★★
d_e	★★★	★★★	★★	★	★★★	★	★★★
$(g-2)_\mu$	★★★	★★★	★★	★★★	★★★	★	?

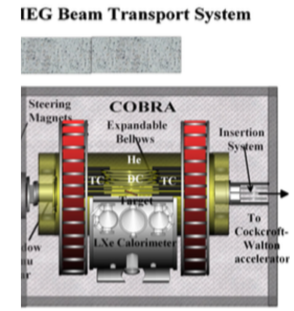
Altmannhofer et al, Nuclear physics B, 2010



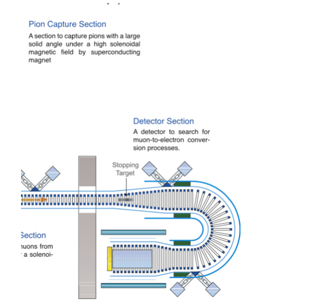
$Mu2e : \mu N$ –



$Muon \quad g$ –



: $\mu \to e\gamma$



$ET : \mu N \to eN$

$e : \mu N \to eN$

$ARC \quad g-2$

Complementarity μ→eγ ⇔ eee

Crivellin, Davidson et al, arXiv:1611.03409, 2016