Muon Particle Physics

Future of cLFV experiments

Satoshi Mihara
KEK/J-PARC/Sokendai

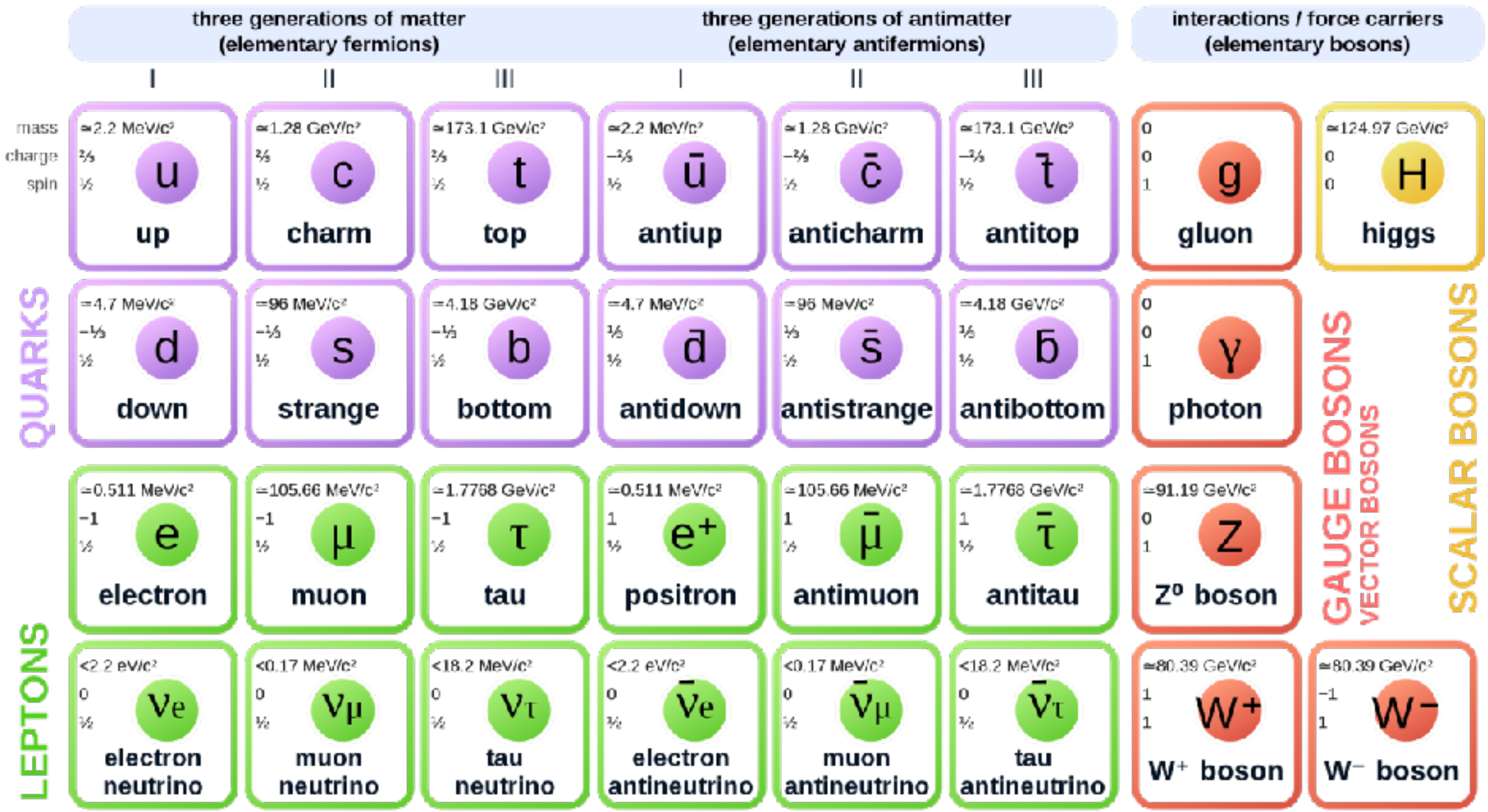
Outline

- Introduction
- CLFV physics with DC muon beam
- CLFV physics with pulsed muon beam
- CLFV physics with tau leptons
- CLFV physics at collider experiments
- Muon g-2/EDM
- Prospects and summary

Introduction

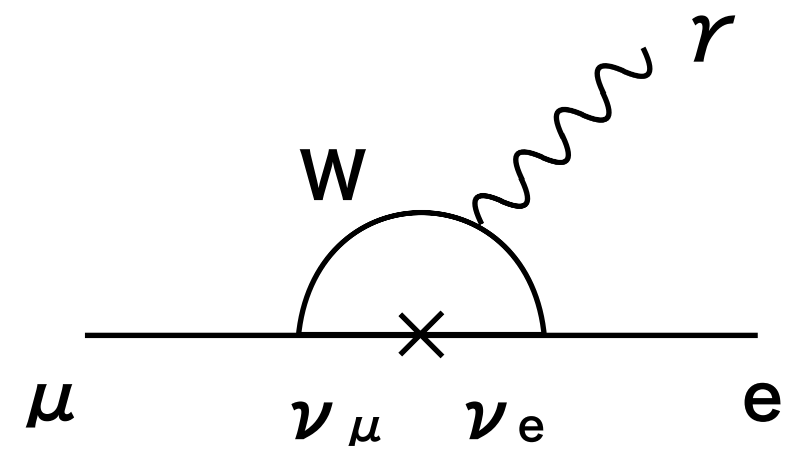
Charged Lepton Flavor Violation

Standard Model of Elementary Particles

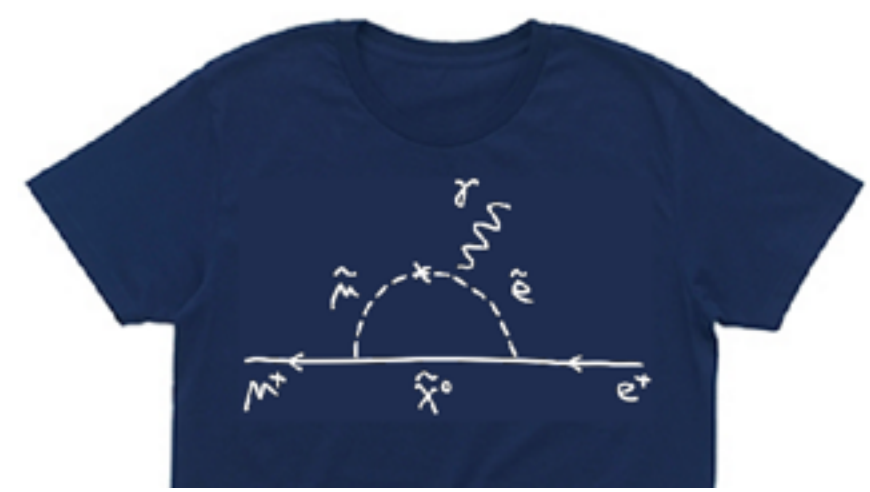


Wiki

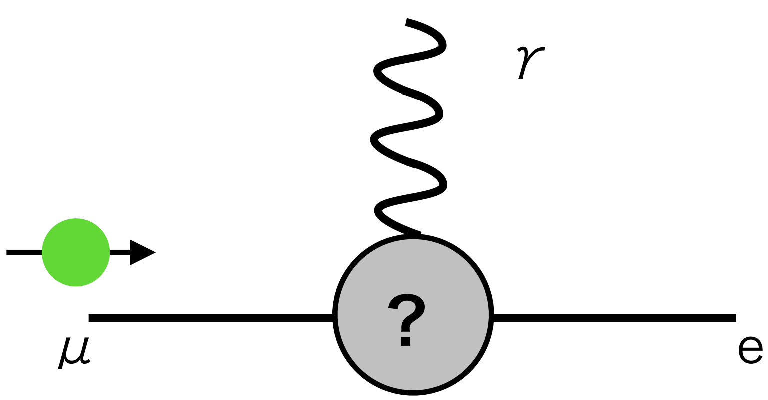
Charged Lepton Flavor Violation



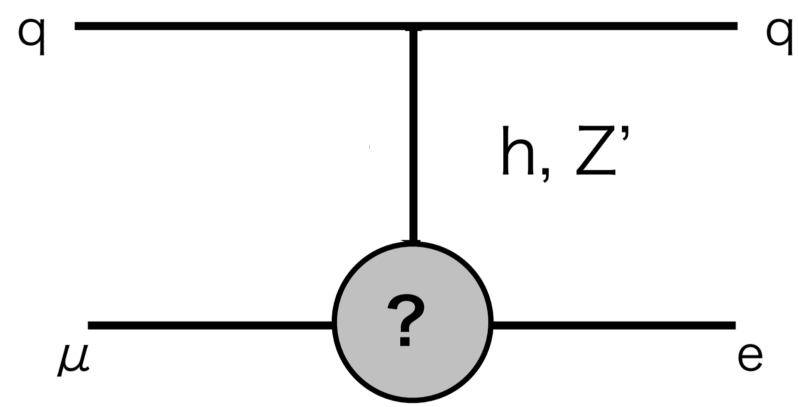
- cLFV rate in the Standard Model with non-zero neutrino mass is too small to be observed in experiments; O(BR) < 10^{-50}
  - No SM Physics Background
  - Observation = clear evidence of NP
- Motivated by many kinds of new physics models BSM
- Origin of neutrino mass



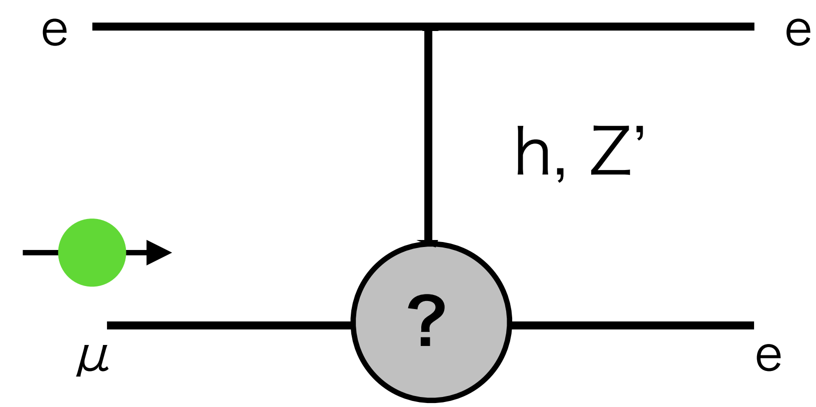
$\mu \to e\gamma$



μ-e conv.

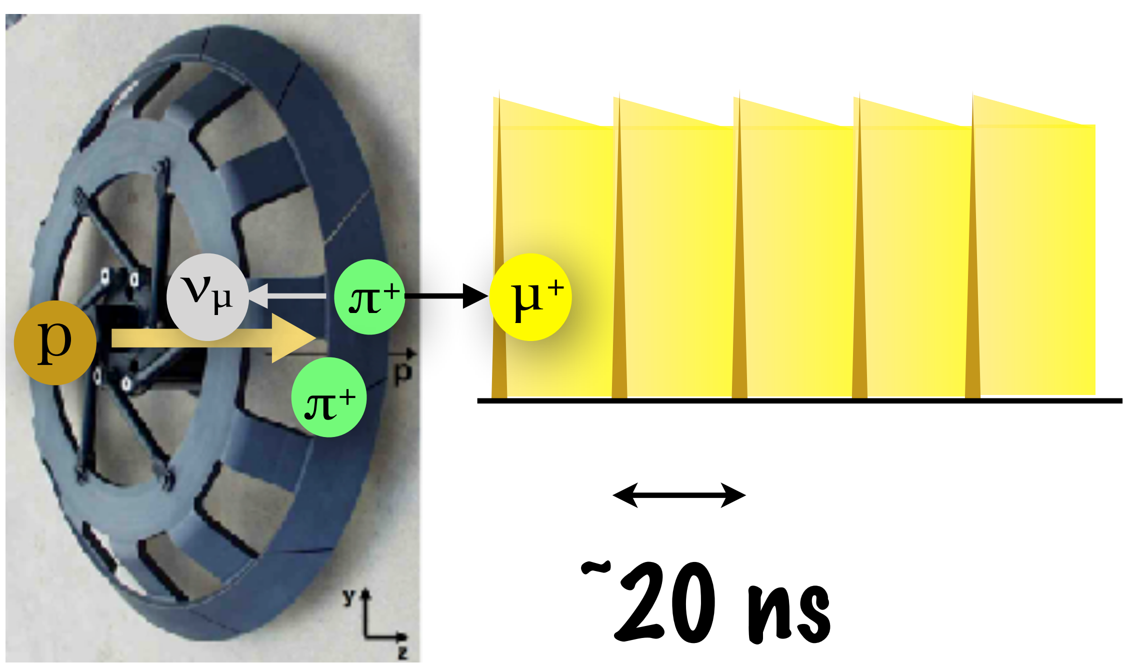


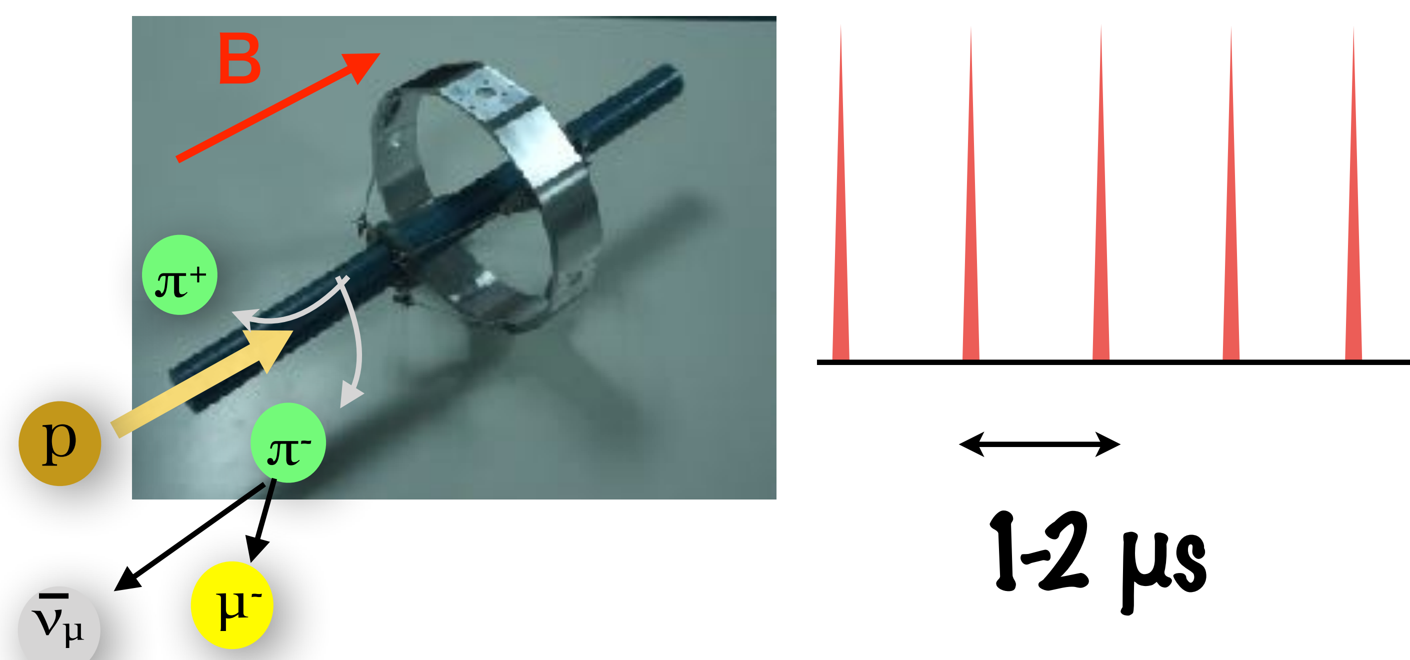
$\mu \to eee$

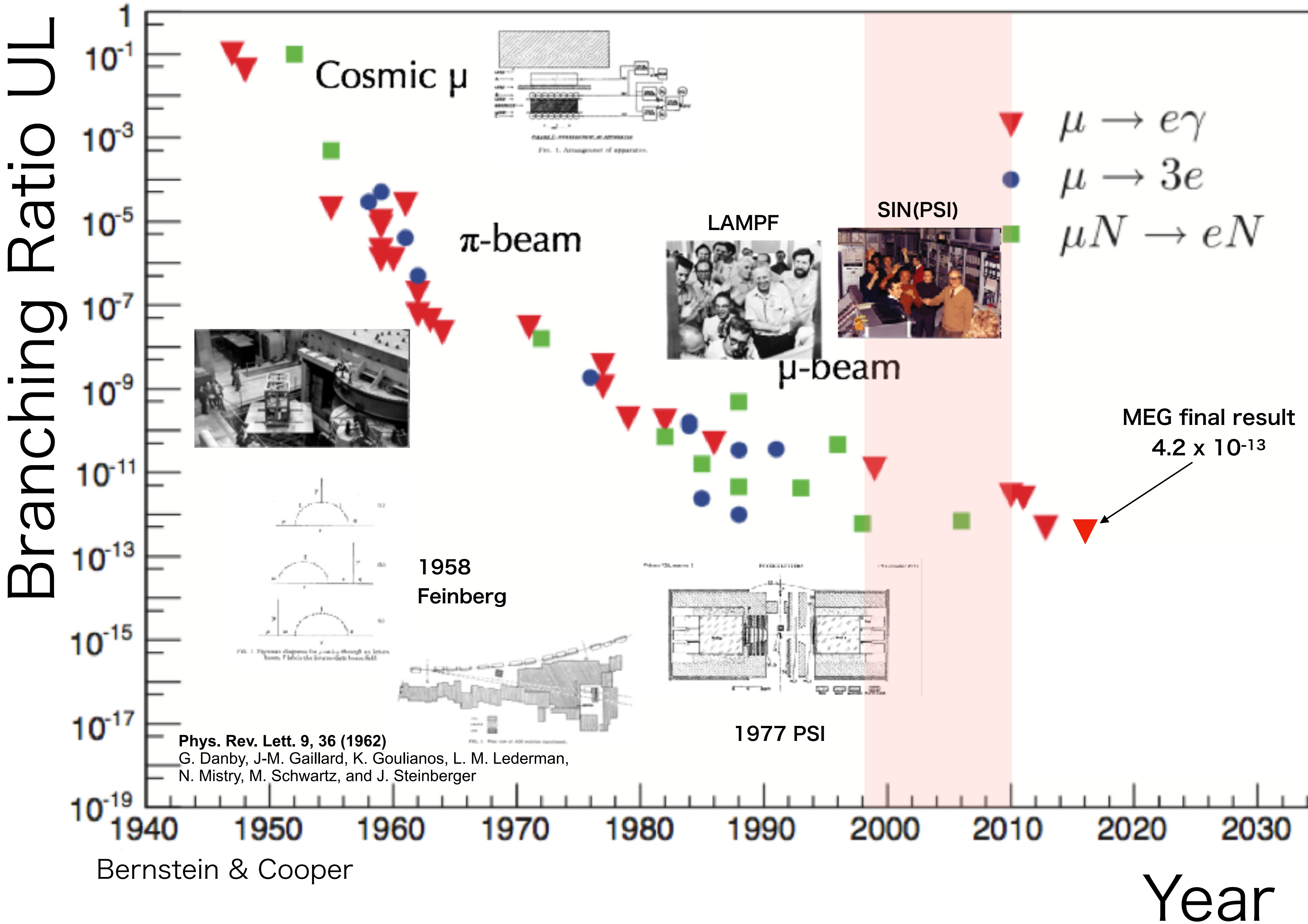


DC Beam and Pulsed Beam

- DC beam for coincidence experiments
  - Decay of pions stopping on the material surface. Muons are polarized
  - μ→eγ, μ→e e e
- Pulse beam for non-coincidence experiments
  - Pion decay in flight
  - μ-e conversion

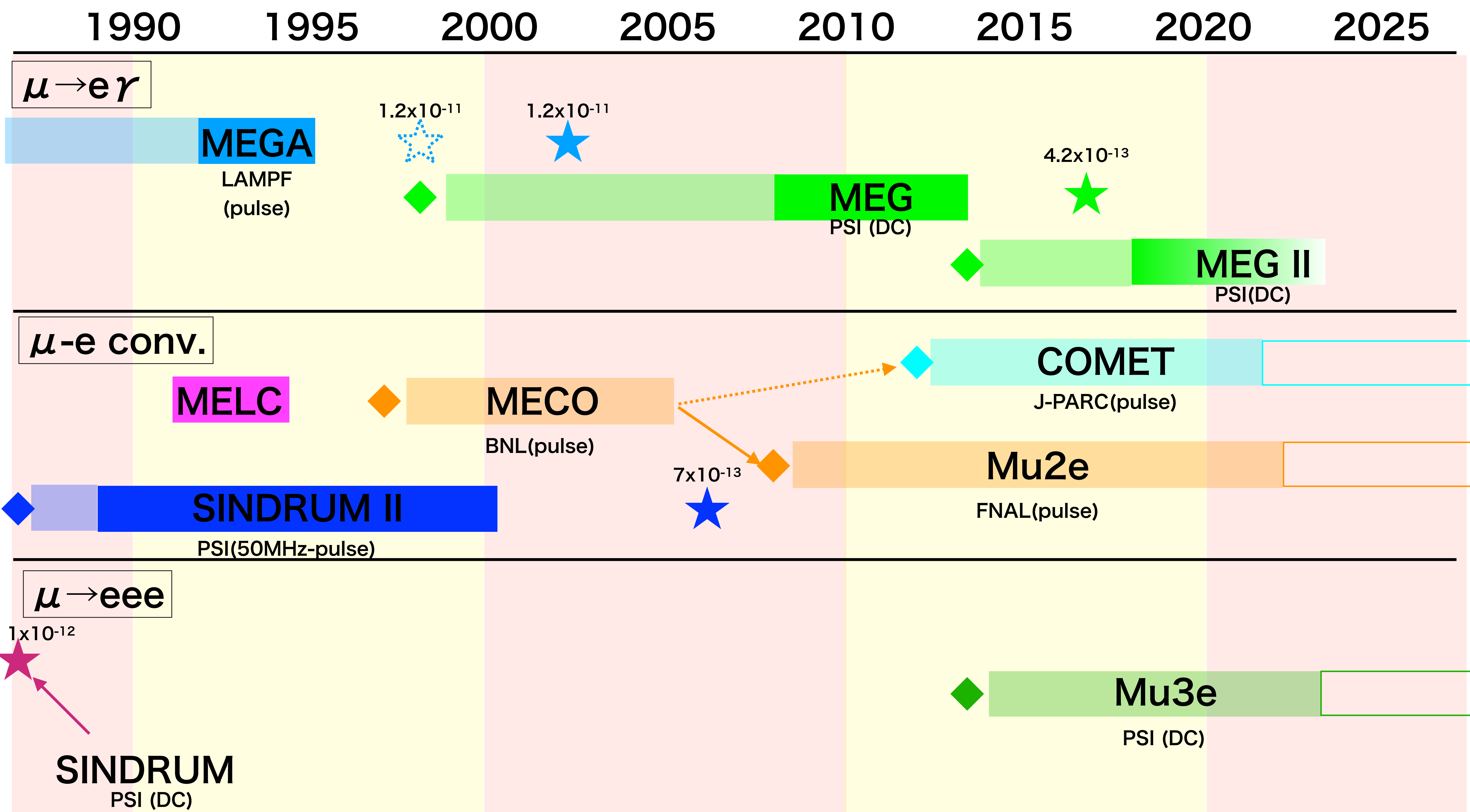






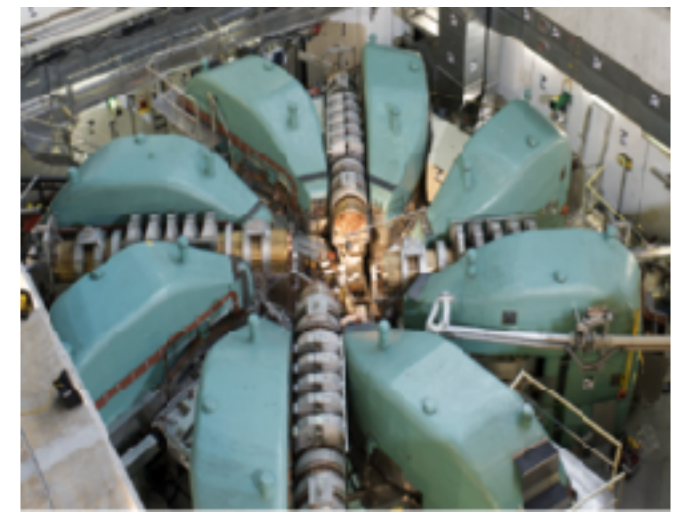
Branching Ratio UL
Cosmic μ
π-beam
LAMPF
SIN(PSI)
μ-beam
$\mu \to e\gamma$
$\mu \to 3e$
$\mu N \to eN$
MEG final result
4.2 x 10-13
1958
Feinberg
1977 PSI
Phys. Rev. Lett. 9, 36 (1962)
G. Danby, J-M. Gaillard, K. Goulianos, L. M. Lederman,
N. Mistry, M. Schwartz, and J. Steinberger
Bernstein & Cooper
Year

Muon cLFV experiments



Current Status of Charged Lepton Flavor Violation Search

- $\mu \to e\gamma$
  - MEG $Br(\mu \to e\gamma) < 4.2 \times 10^{-13}$ → **MEG II**
- $\mu \to eee$
  - SINDRUM $BR(\mu \to eee) < 1.0 \times 10^{-12}$ → **Mu3e**
- μ-e conversion
  - SINDRUM II $R(\mu\text{-}e: Au) < 7 \times 10^{-13}$ → **COMET/Mu2e**



PSI Ring Cyclotron
590MeV, 1.4MW

FNAL
8GeV, 8kW

J-PARC
8GeV, 3.2-56kW

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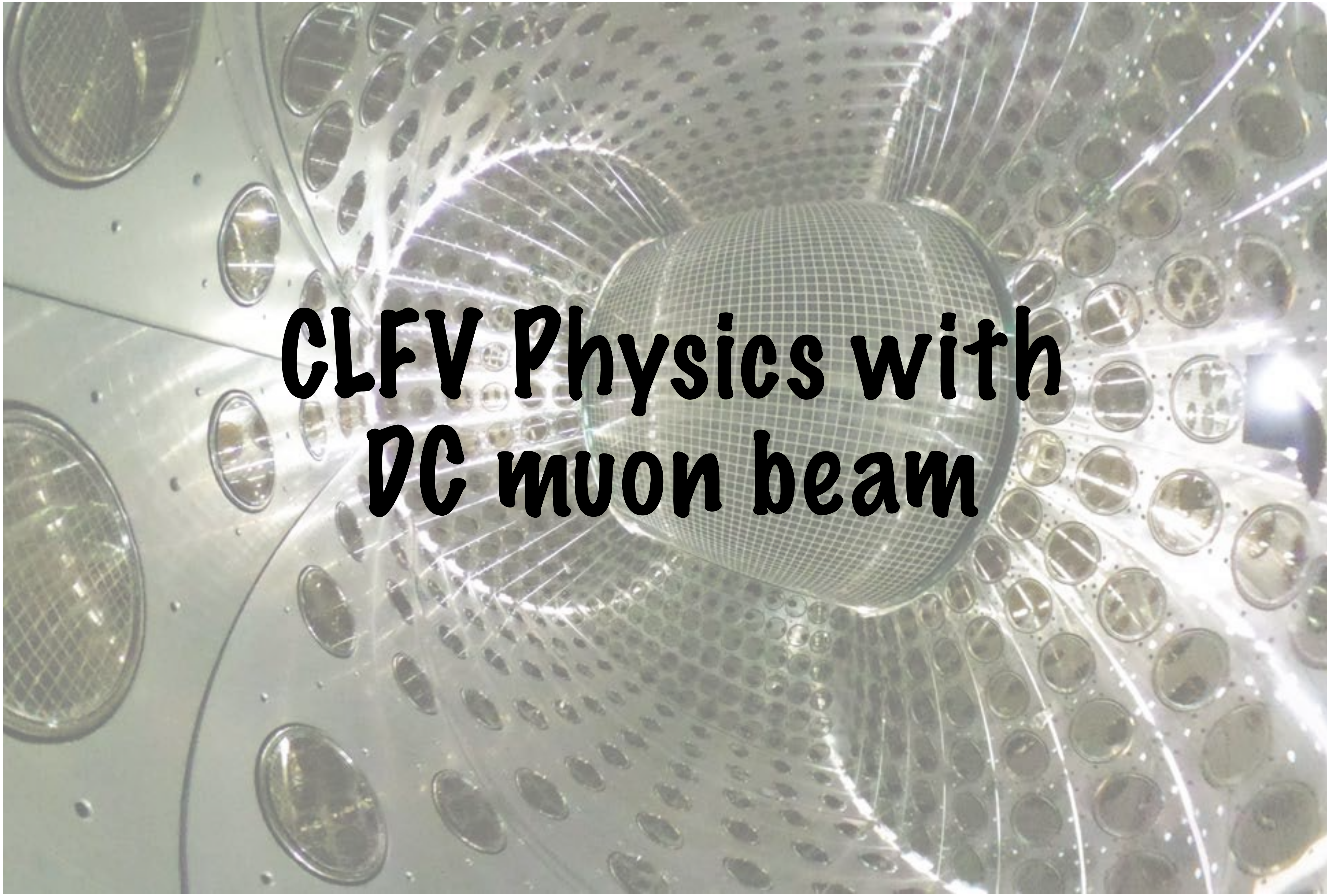
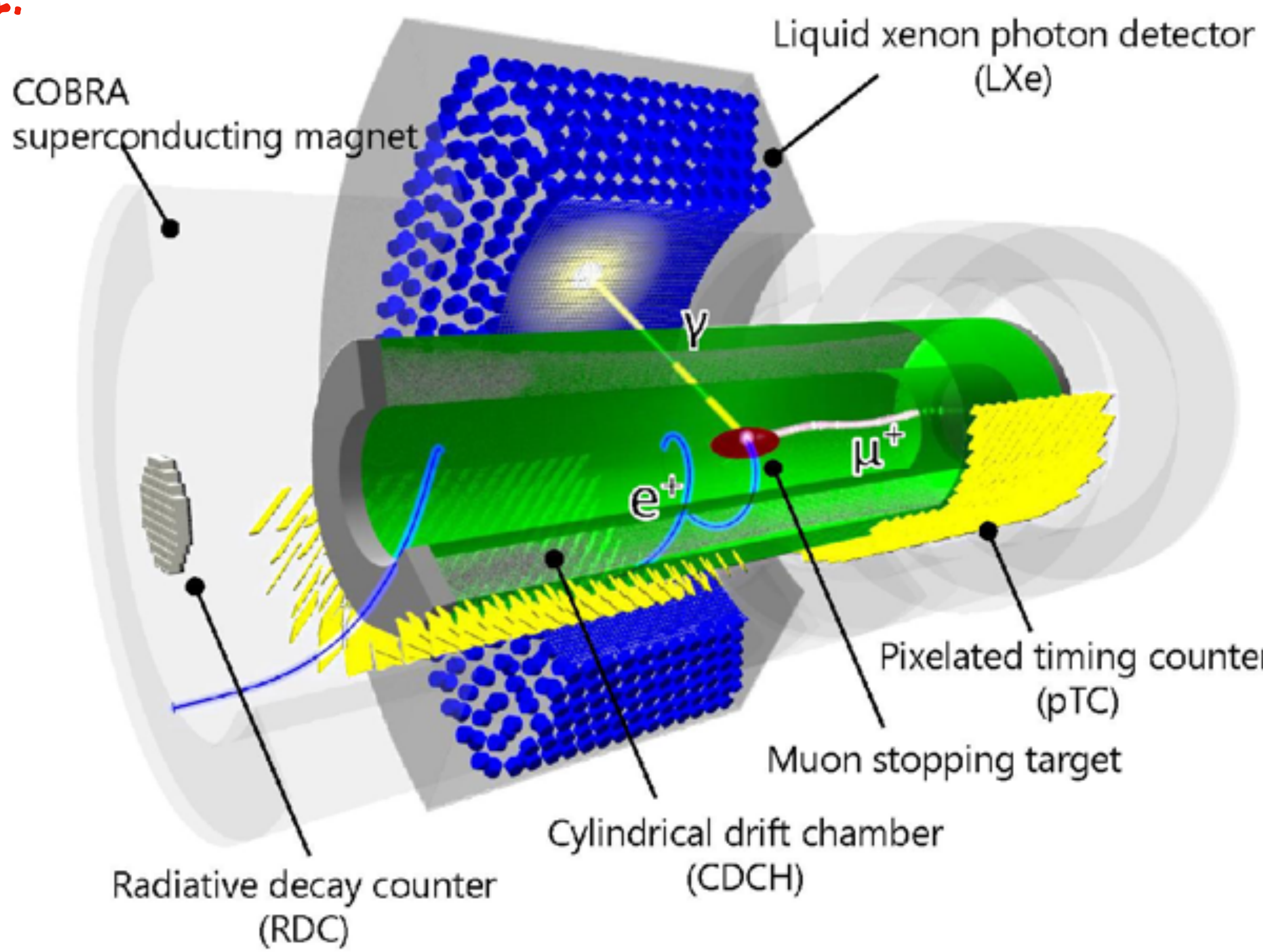
J-PARC



CLFV Physics with DC muon beam

MEG II: $\mu^+ \rightarrow e^+\gamma$ search

- MEG achieved 4.2×10^{-13} @ 90% C.L.
    - Background was dominated by Accidental event overlaps
- MEG II aims at twice better resolutions than MEG in all components
- Double the muon beam rate
    - 7×10^{7} muon stops/s
- New detector to tag the radiative muon decay event
- New calibration method

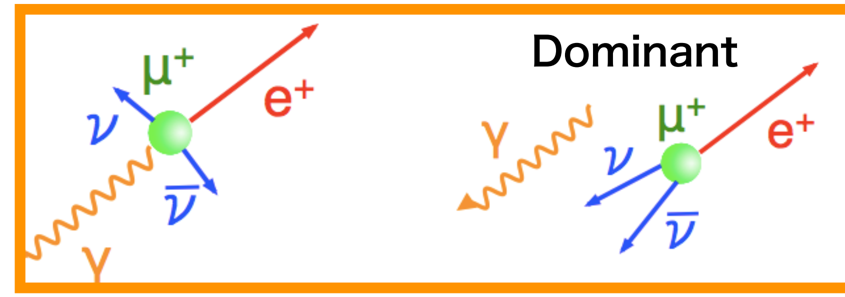


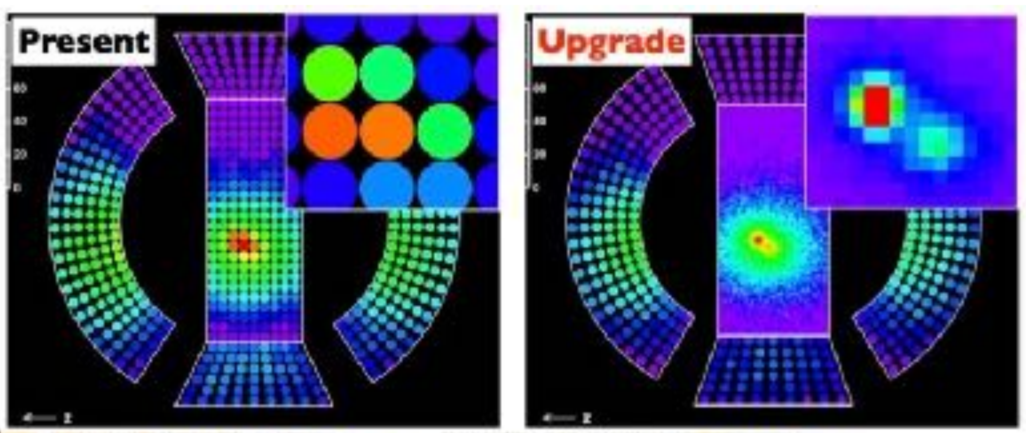
Target Sensitivity : 6×10^{-14} in 3 years running

Highlight of MEG II Detector Upgrade

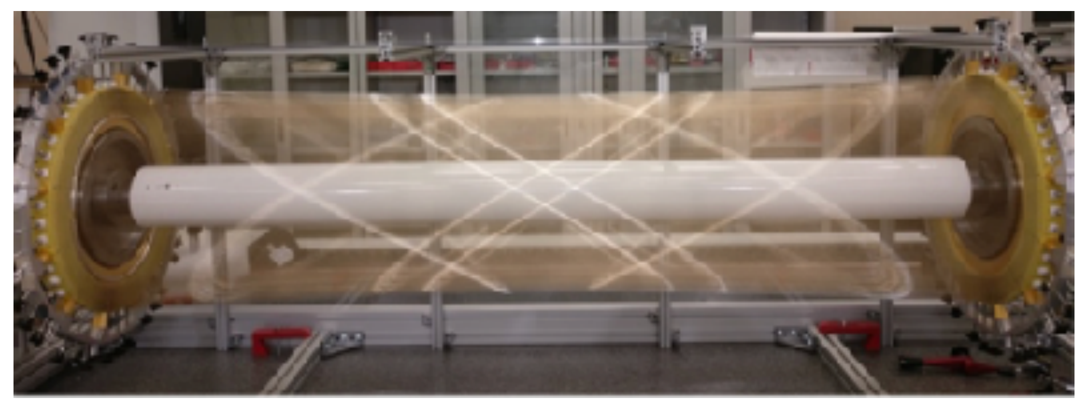
- Based on experience in MEG I
  - Liquid Xe PD, Positron DC, Timing Counter

Background

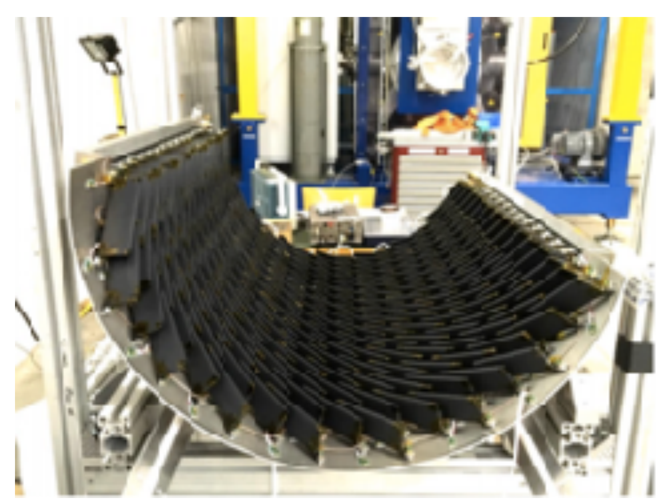


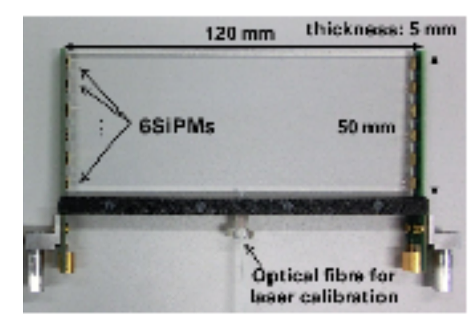


LXe
2inch PMT →VUV SiPM



Single Volume
Low mass
Stereo-wire DC

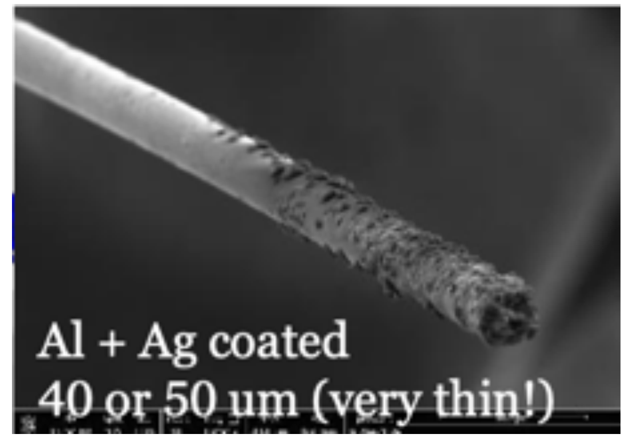




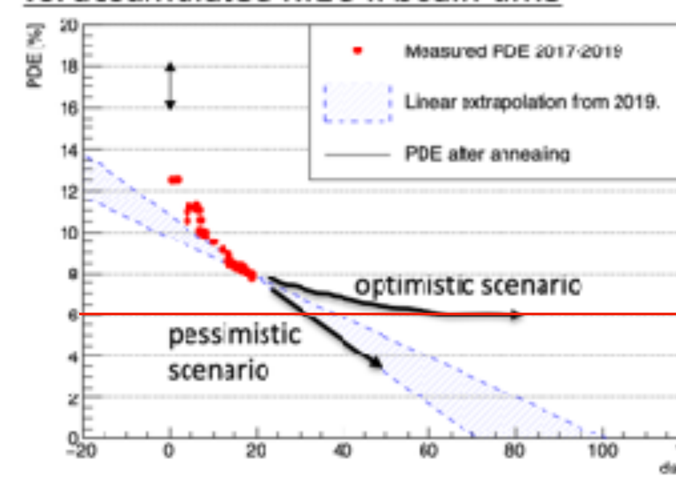
Pixelated TC
with SiPM readout
σ_t~35psec

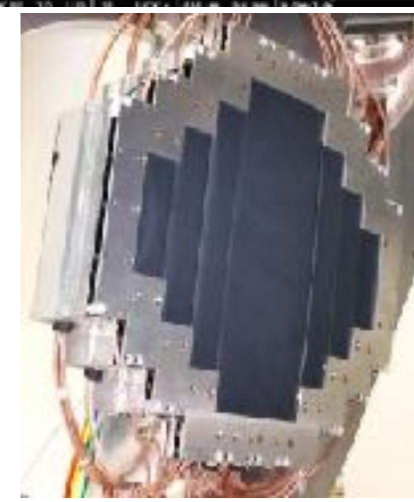
MEG II Status in 2020

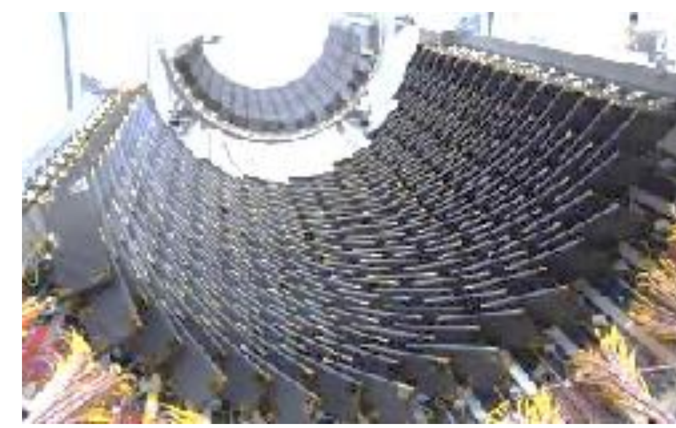
- All sub-detector components are ready & engineering run is in progress though there are some problems;
  - e^+ drift chamber: wire breaking problem and Corona discharge → fixed by removing weak wires and adding small amount of CO_2/H_2O
  - LXe MPPC Photon Detection Efficiency degradation due to (probably) VUV effect → can be recovered fully by annealing
  - TC & RDC are both in good shape

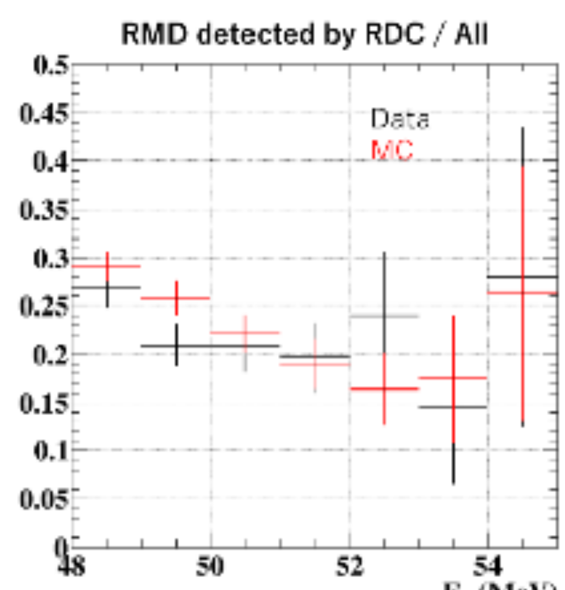


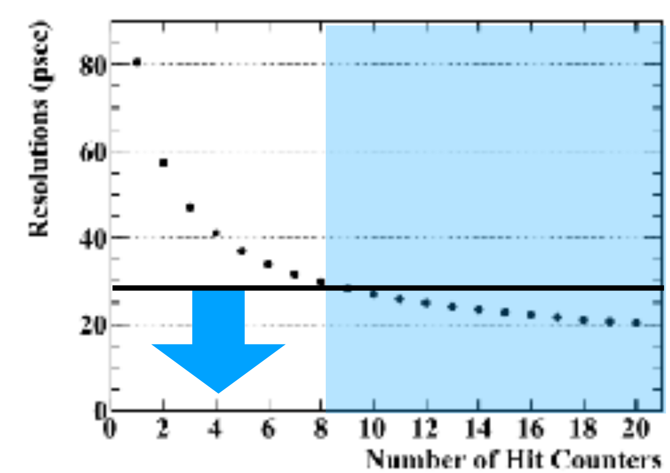
VUV PDE of MPPC
vs. accumulated MEG II beam time









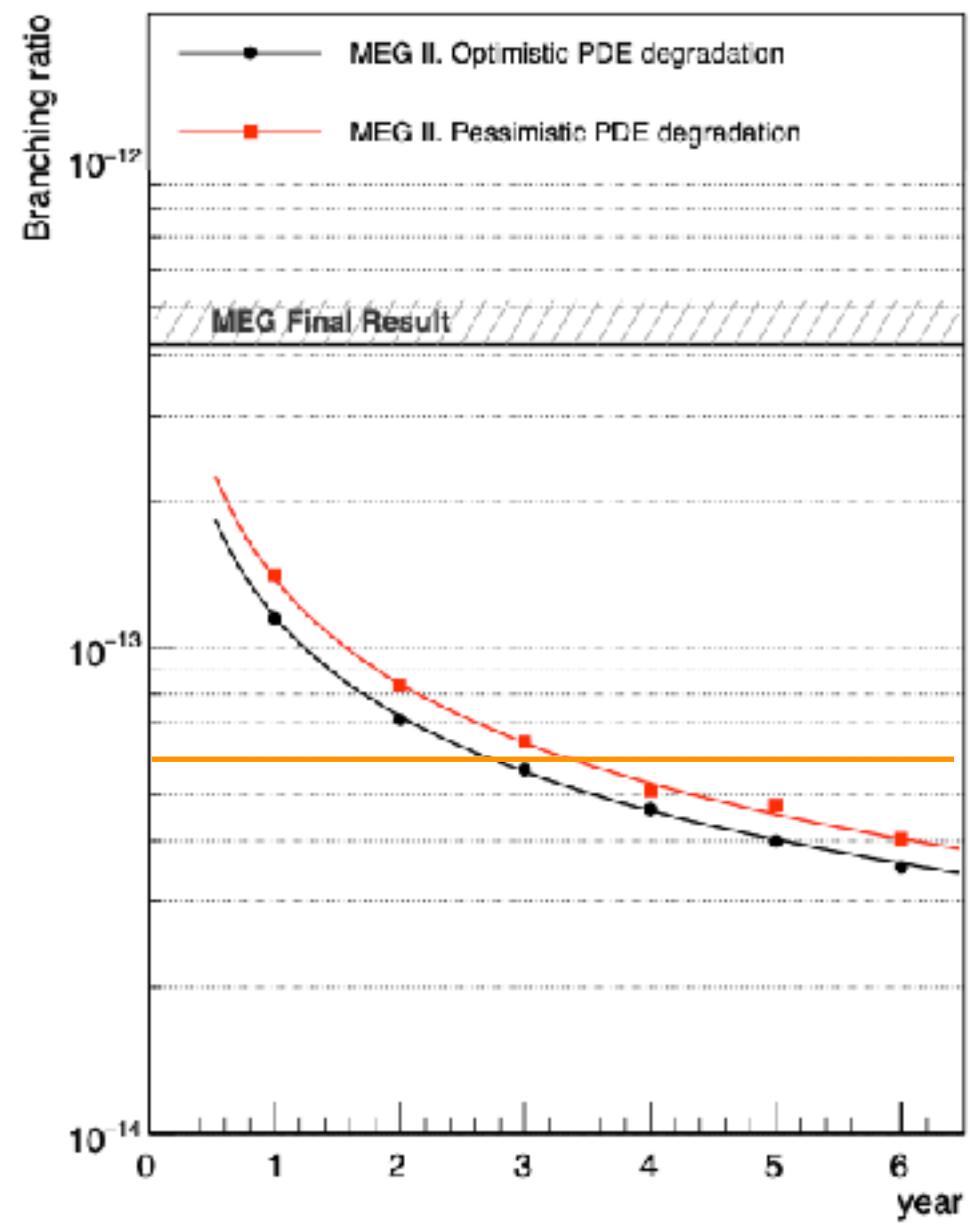


Update of Expected MEG II Sensitivity

- If no continuous MPPC PDE degradation below 6%,
  - Br < 5.6x10^{-14} (90% C.L.)
- If PDE decreases below 2% after 60 days MEG II beam, we need MPPC annealing each year and;
  - Br < 9.7x10^{-14} (90% C.L.)
  - Br < 6.4x10^{-14} (90% C.L.) with reduced beam intensity & 120 days running each year

MEG II sensitivity vs. DAQ year

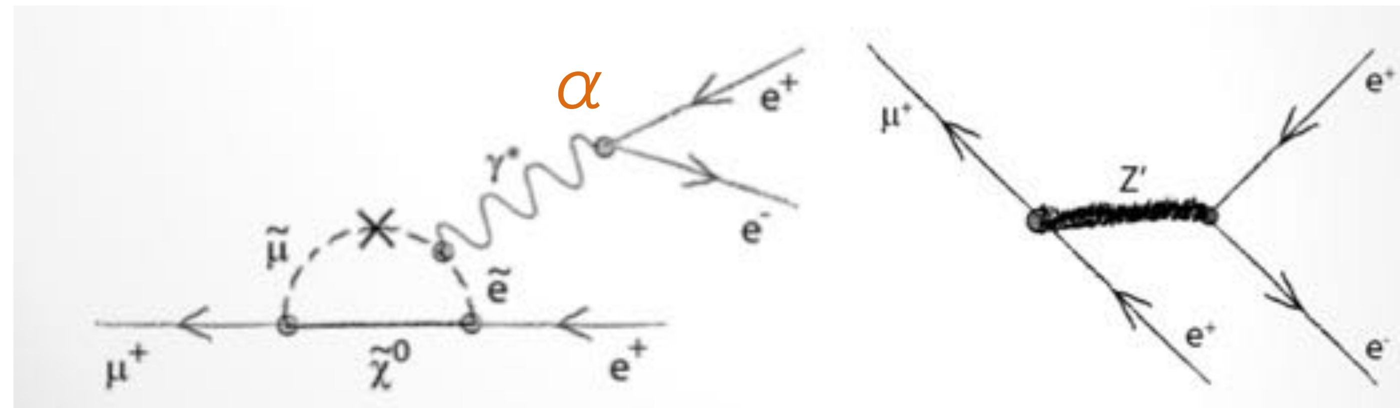
with measured LXe detector performance & PDE degradation

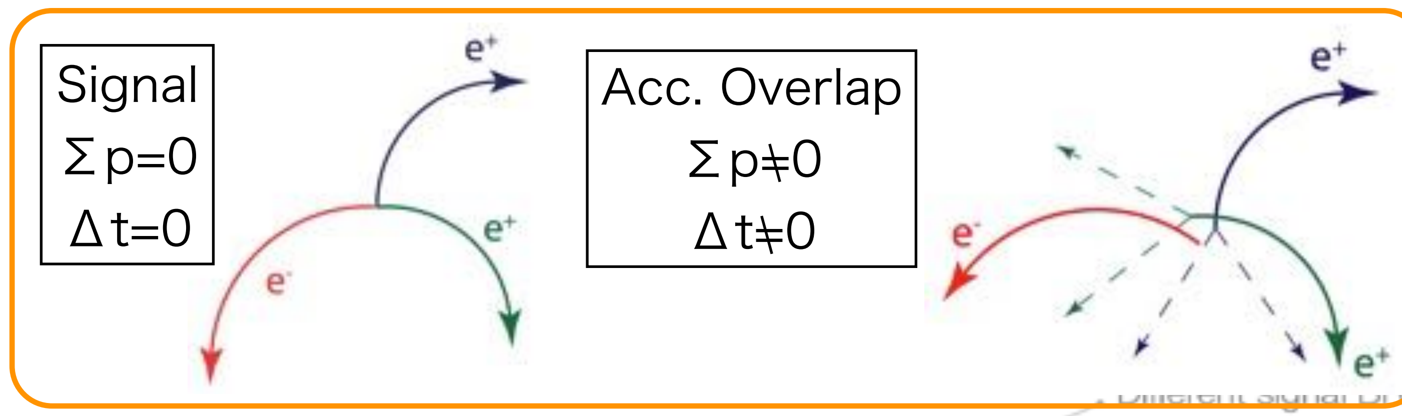


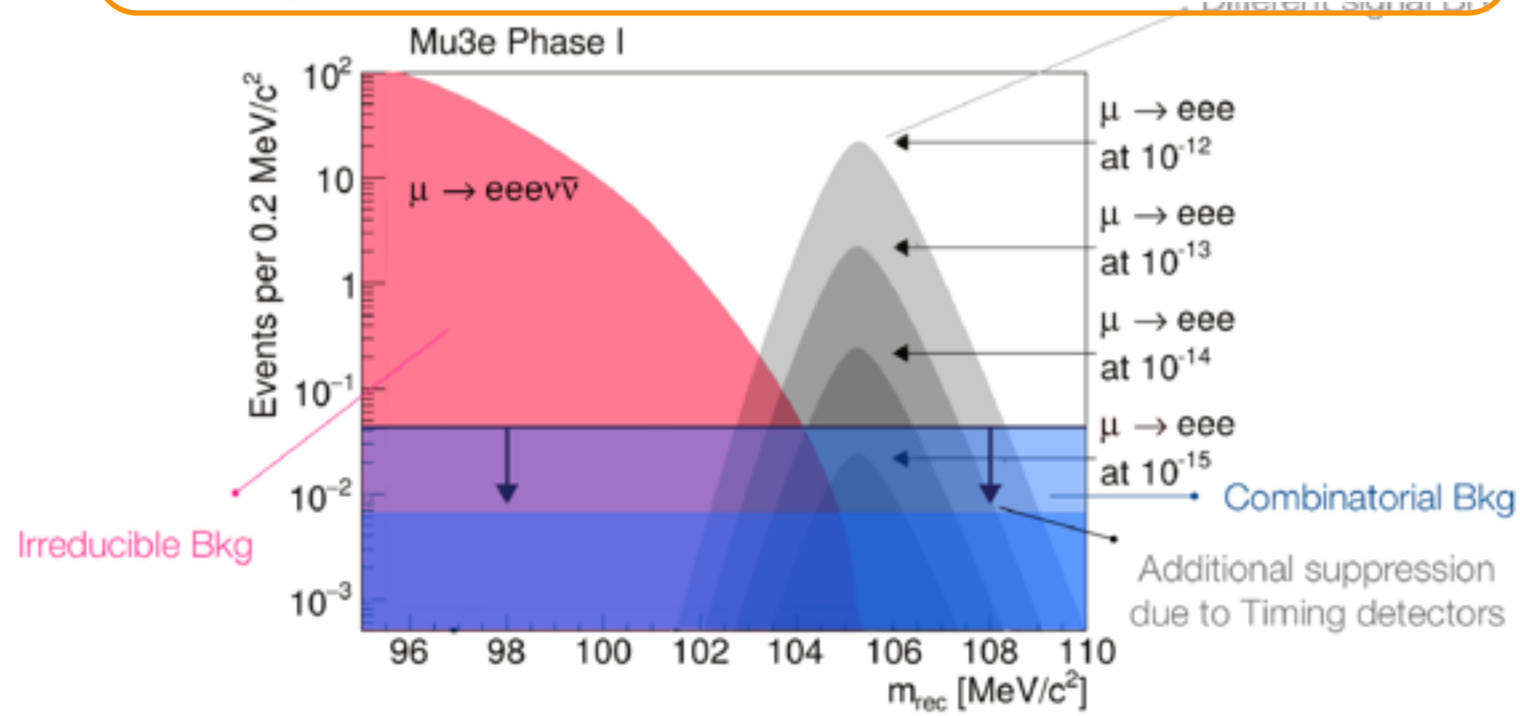
S. Ogawa JPS Meeting Sep. 2020

Mu3e: μ→eee Search

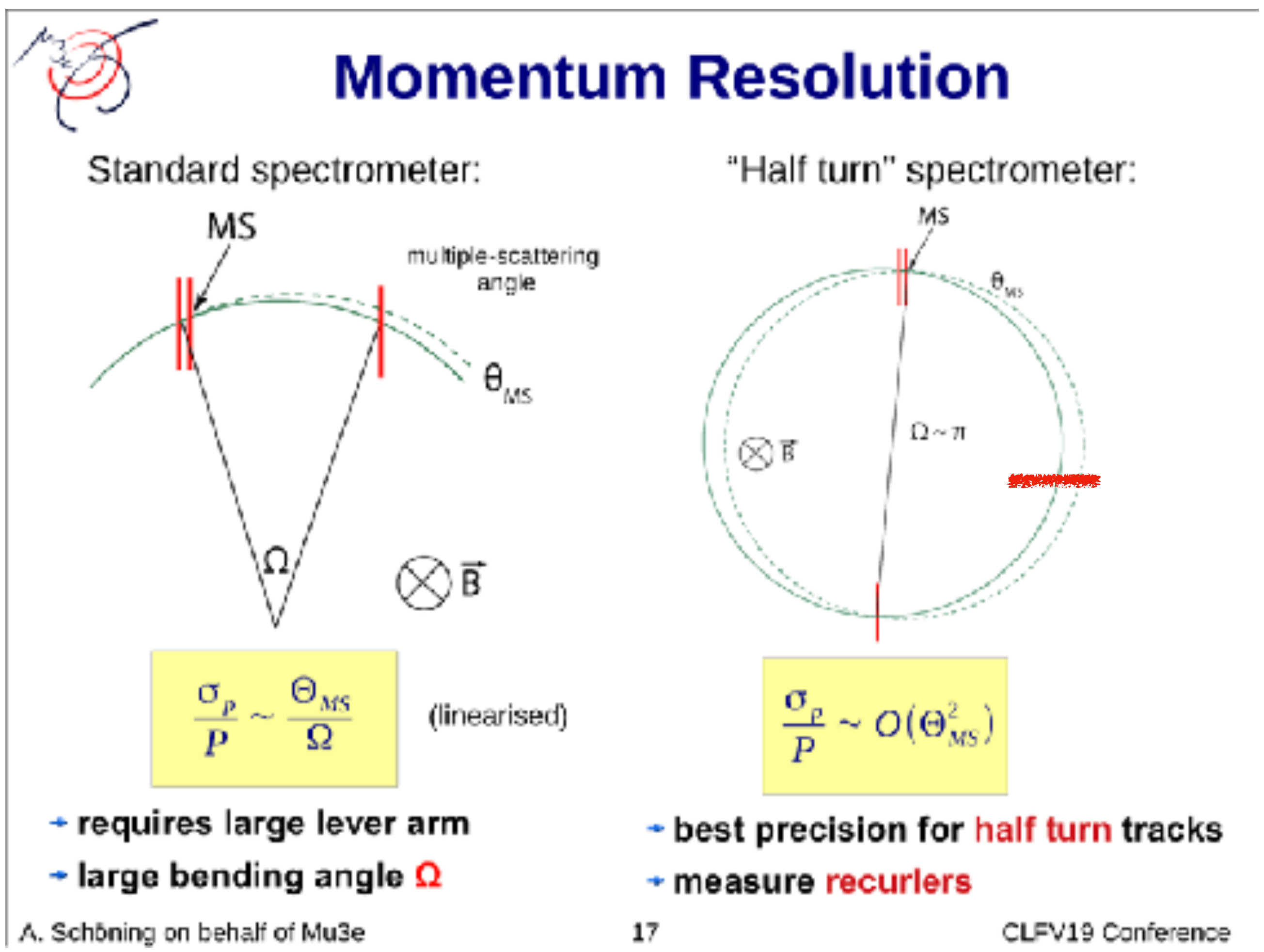
- Another channel sensitive to cLFV with DC muon beam
  - 1.0×10^{-12} (90% C.L.) by SINDRUM
  - Goal : 10^{-16} in 2 steps
- Measure all electron tracks with extreme precision
- Background source
  - $\mu^+ \to e^+e^+e^-\nu\overline{\nu}$
  - Accidental overlap
- Beamline is shared with MEG II

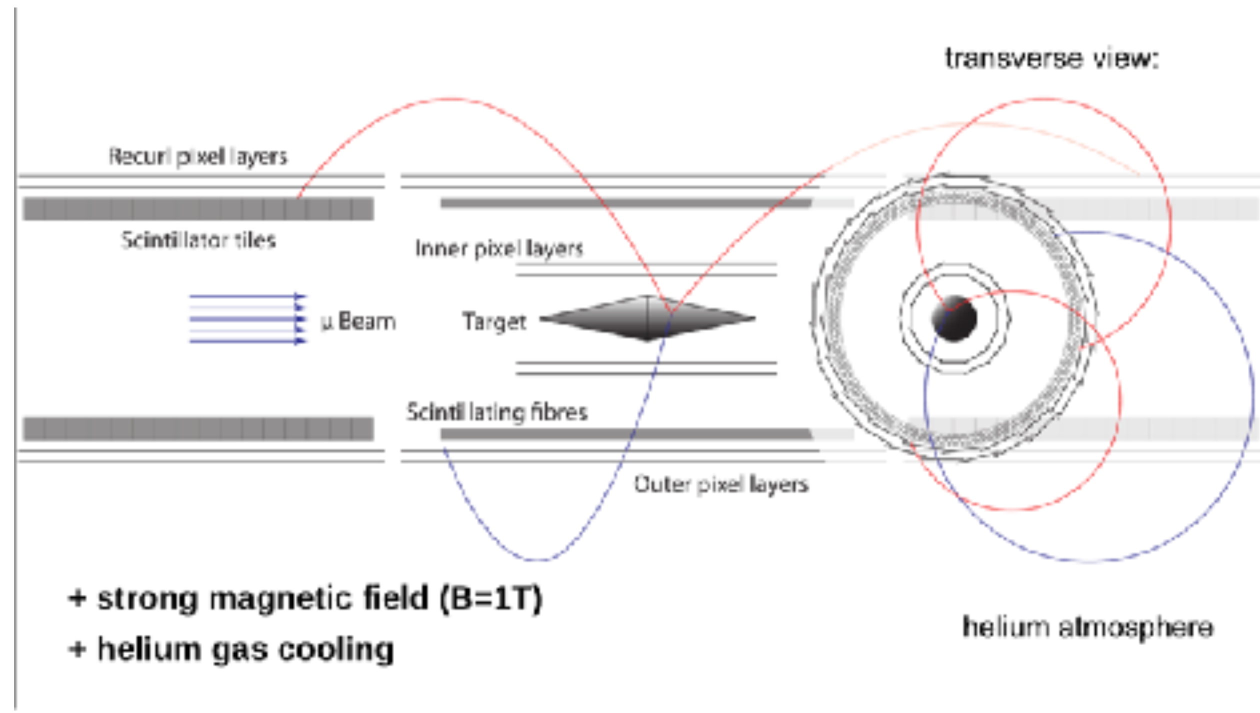






Momentum Resolution

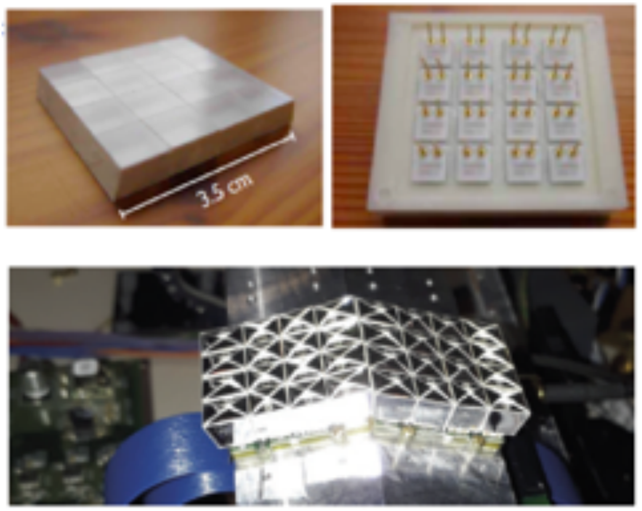




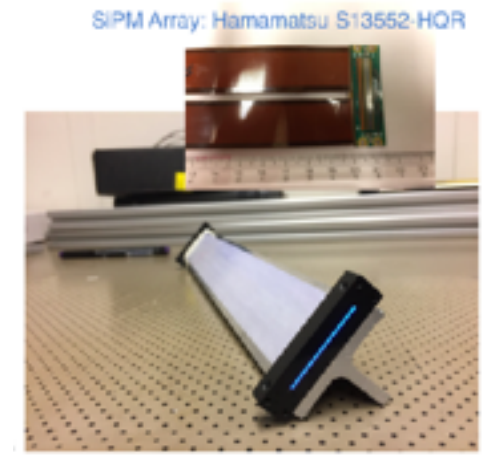
Ultra-thin silicon pixel detector 1 per mil radiation length/layer

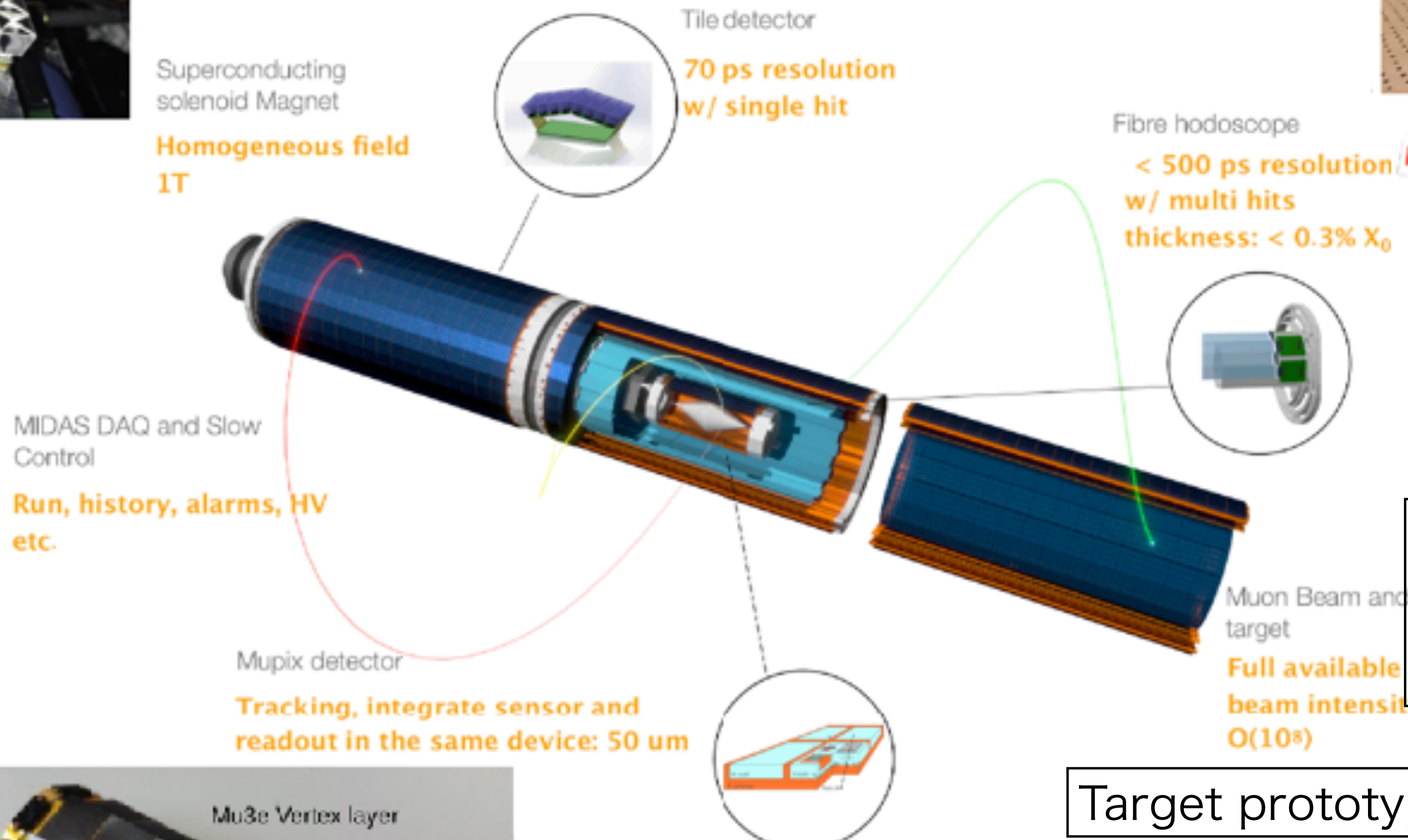
A. Schöning, CLFV19

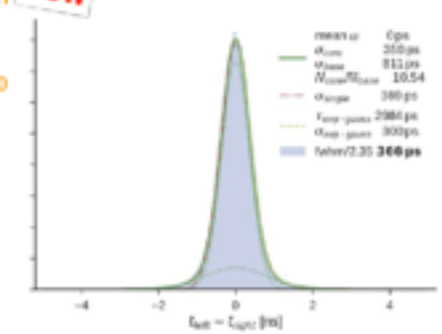
Detector Preparation



Tile detector prototype
Good enough σ_t



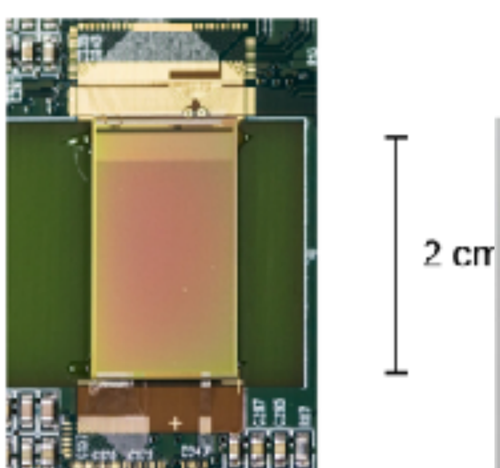




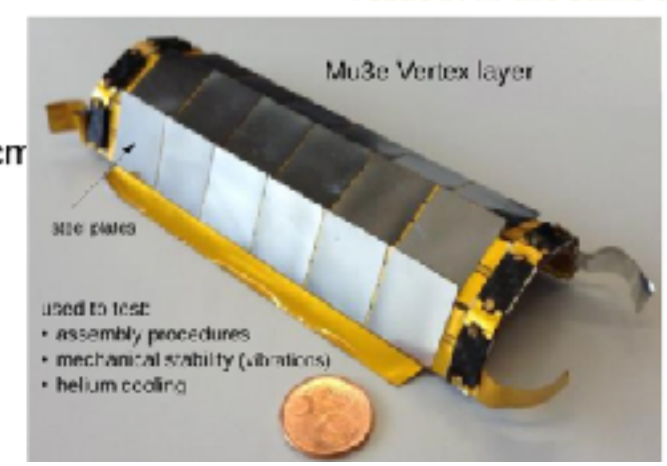
Fiber hodoscope prototype
Good enough σ_t

Target prototype

MuPix8 prototype (2018)



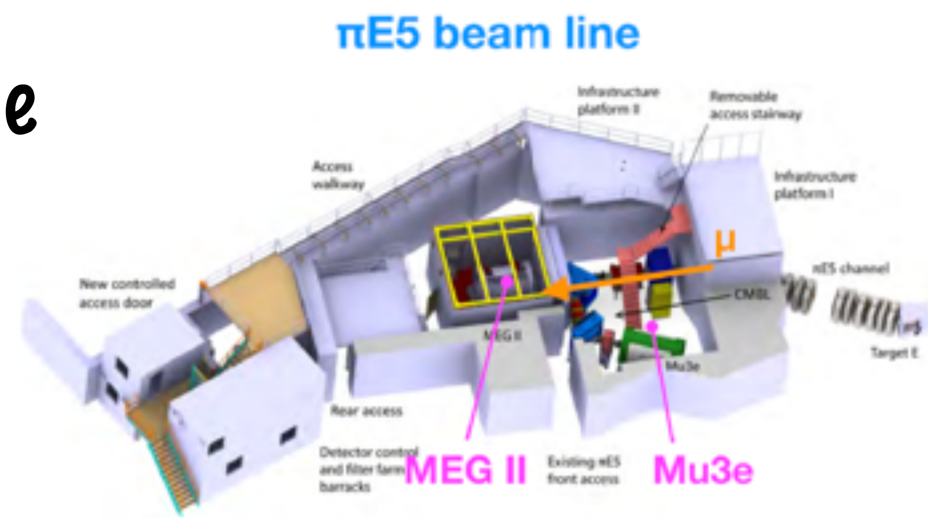
pixel size 80 x 80 μm²

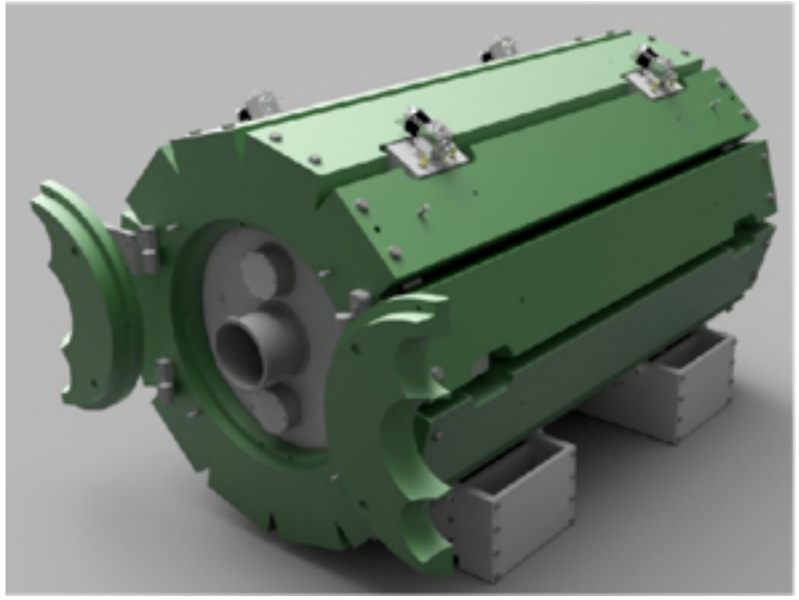


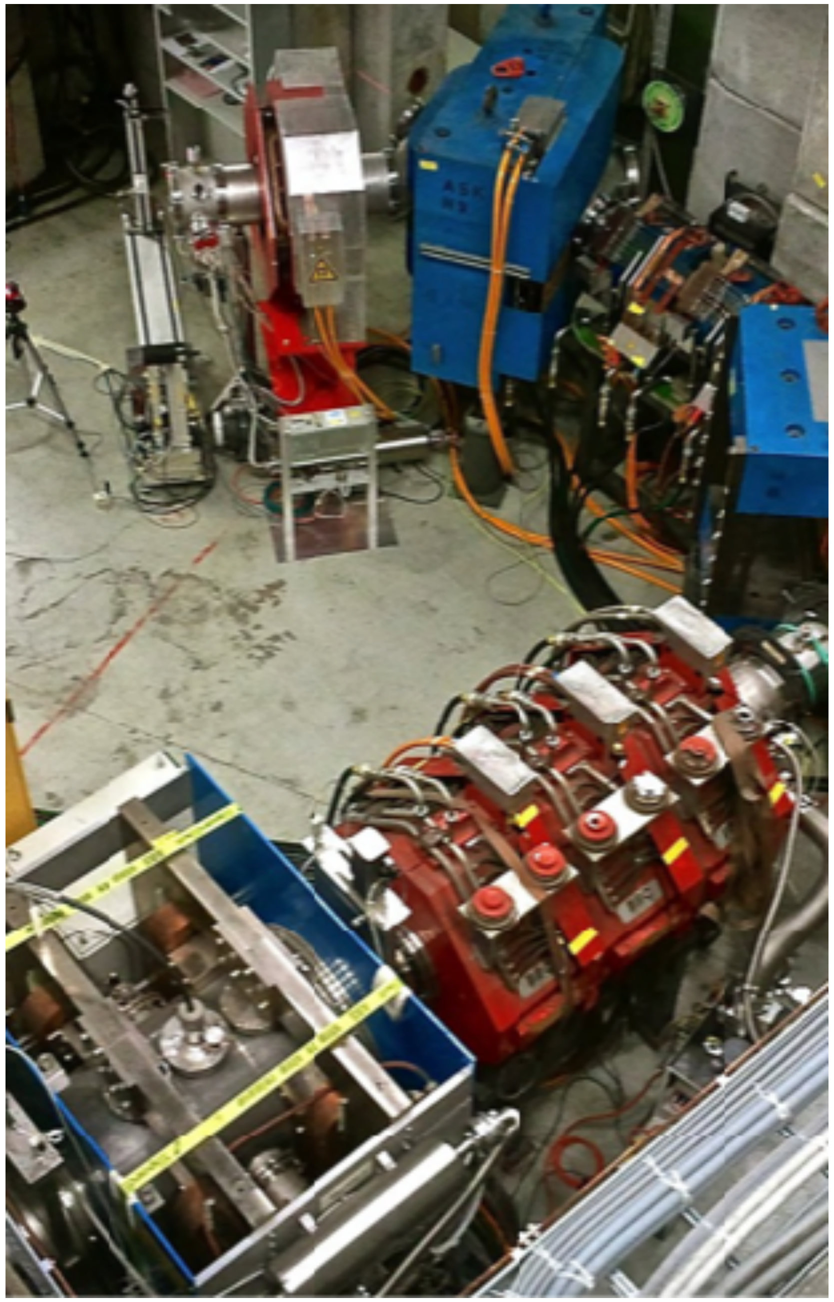
1st large-area prototype
MuPix8 is being tested
MuPix9 & MuPix10 follow

Mu3e Status

- Moving from R&D phase to construction phase
  - Production in 2019
  - Detector construction in 2020
- Commissioning start in 2021







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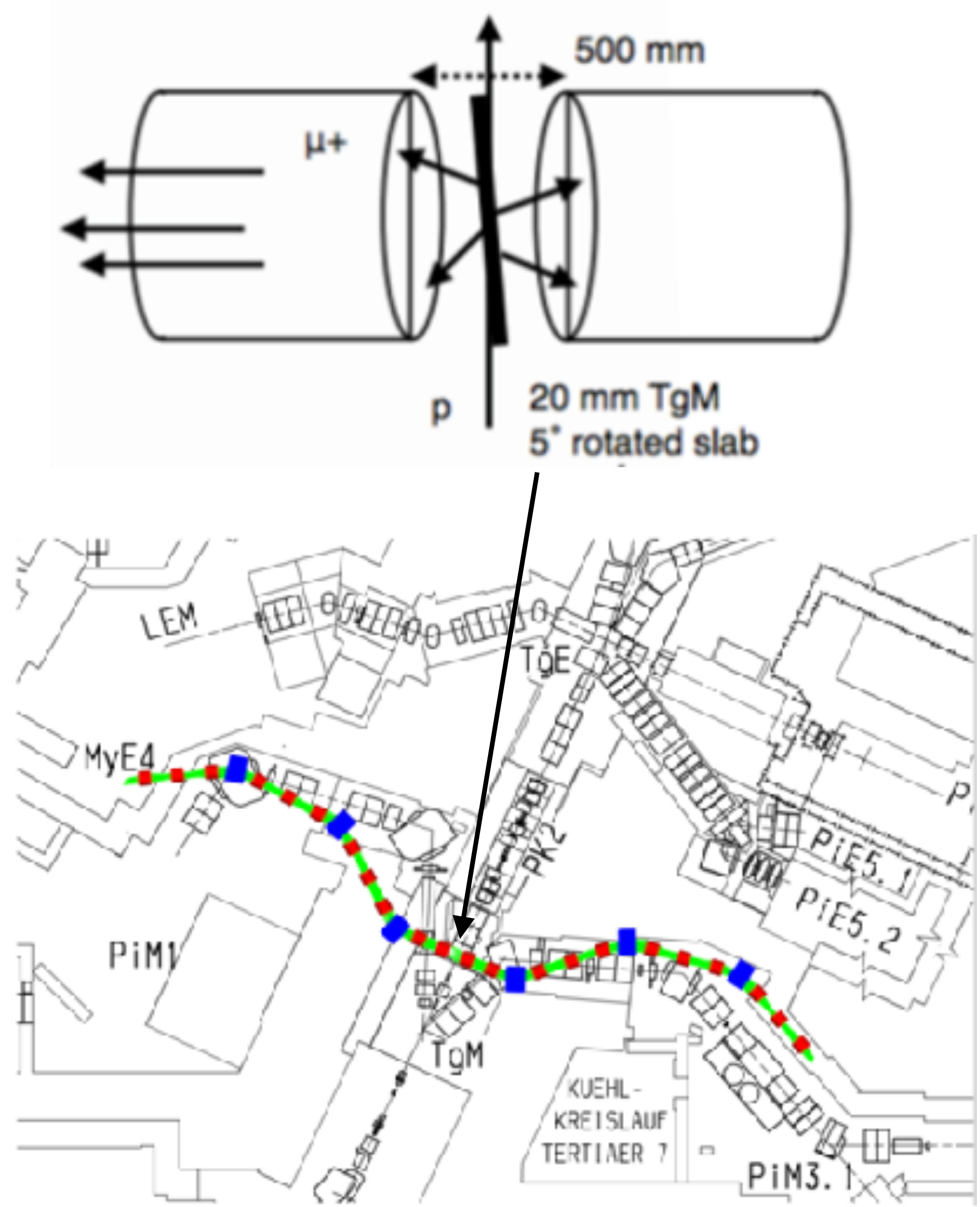
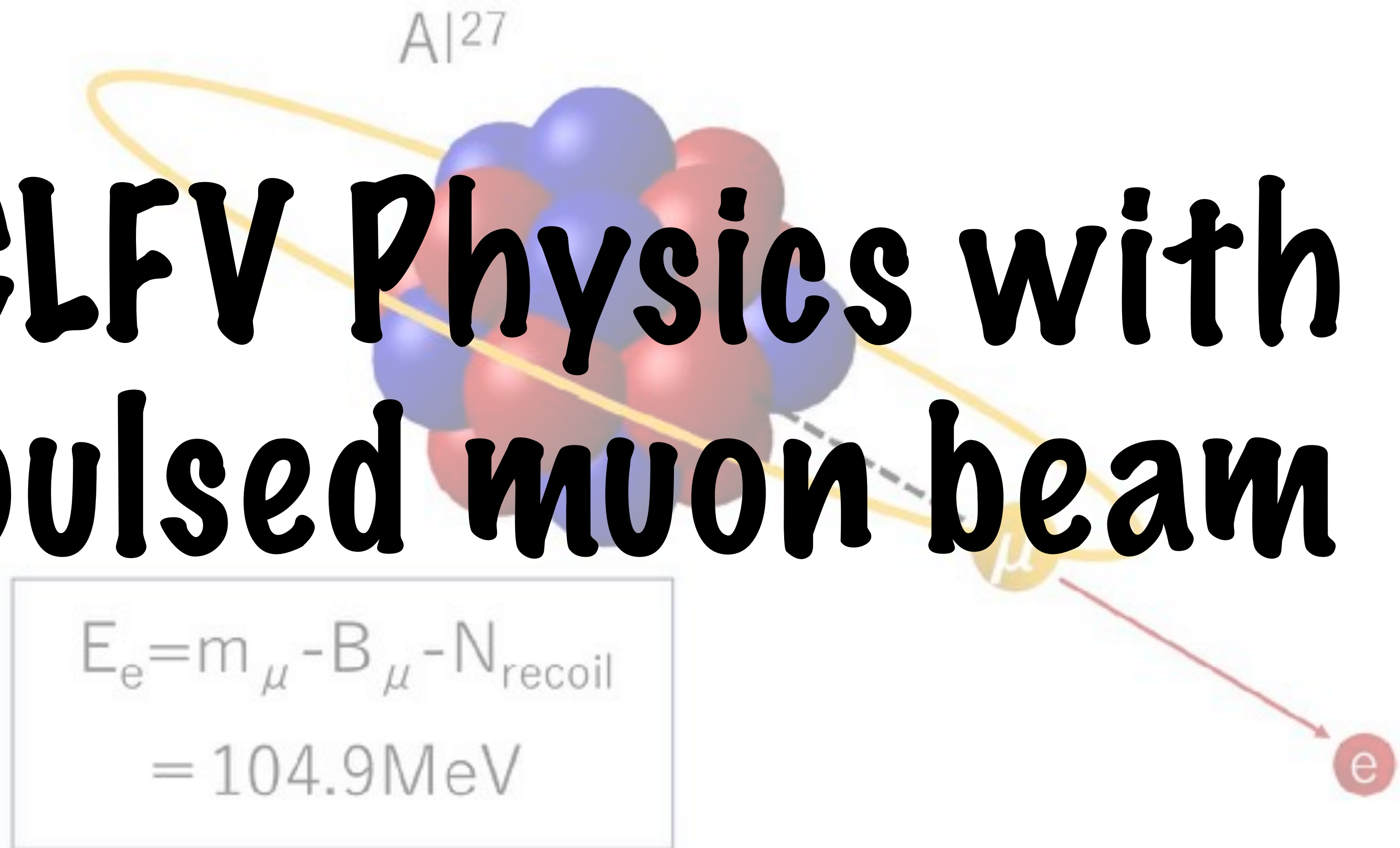
Future prospects of High-intensity DC muon beam

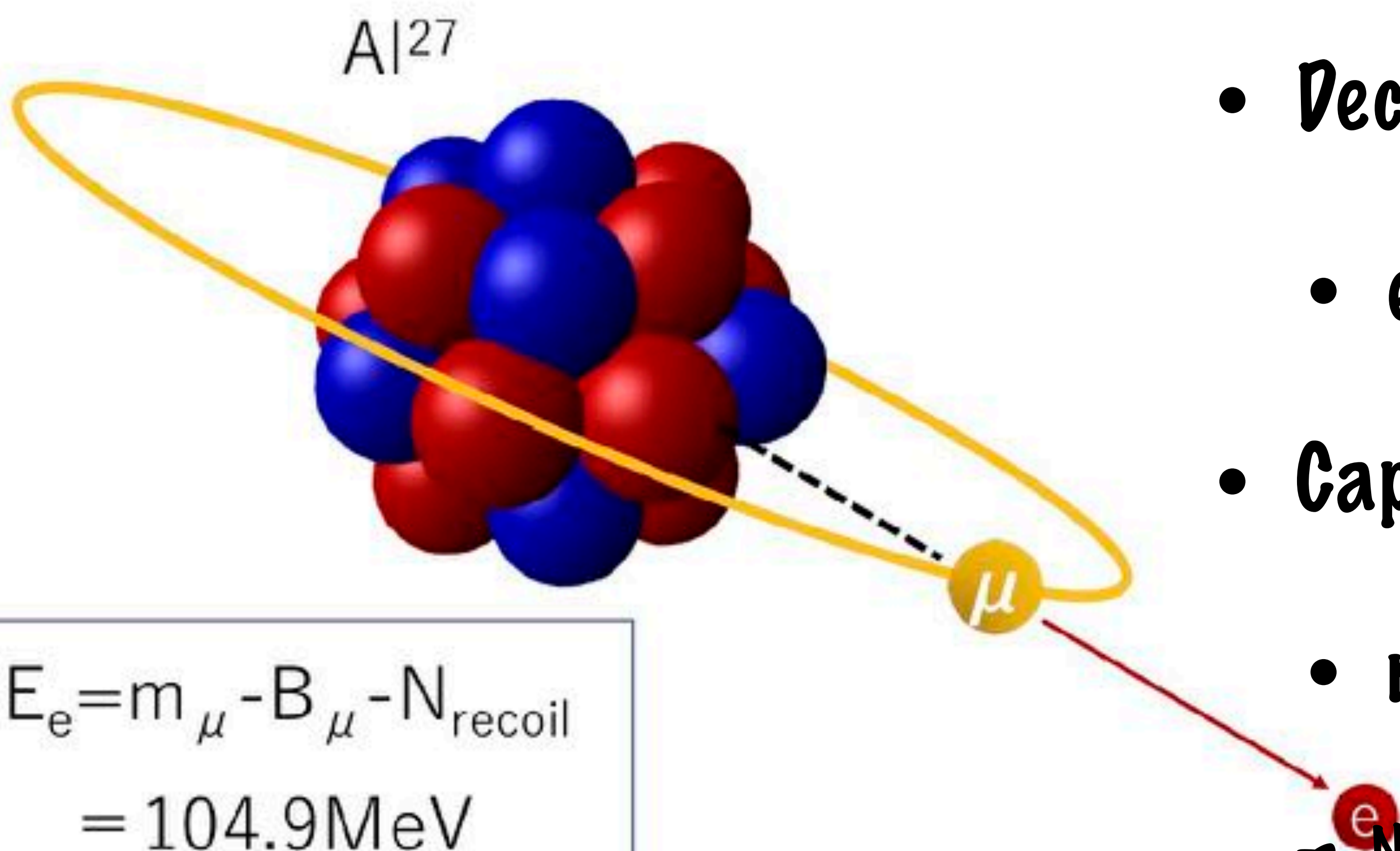
- PSI HiMB project
    - Development of high-intensity beam by modification of existing target (TgM) and beam lines → goal of 10^{10} surface-μ^+/s
- New Target M Station (TgM) with 20mm thick graphite slab at 5°
- Split capture solenoid channel close to target
    - One side: particle physics (high-intensity)
    - Other side: materials science (high-intensity, high-polarization)
- Normal conducting solenoids Front-end: radiation hard Copy of existing μE4 solenoids
- First (simple) beam optics shows that $O(10^{10})$ μ^+/s can be transported



CLFV Physics with pulsed muon beam



Mu-e conversion

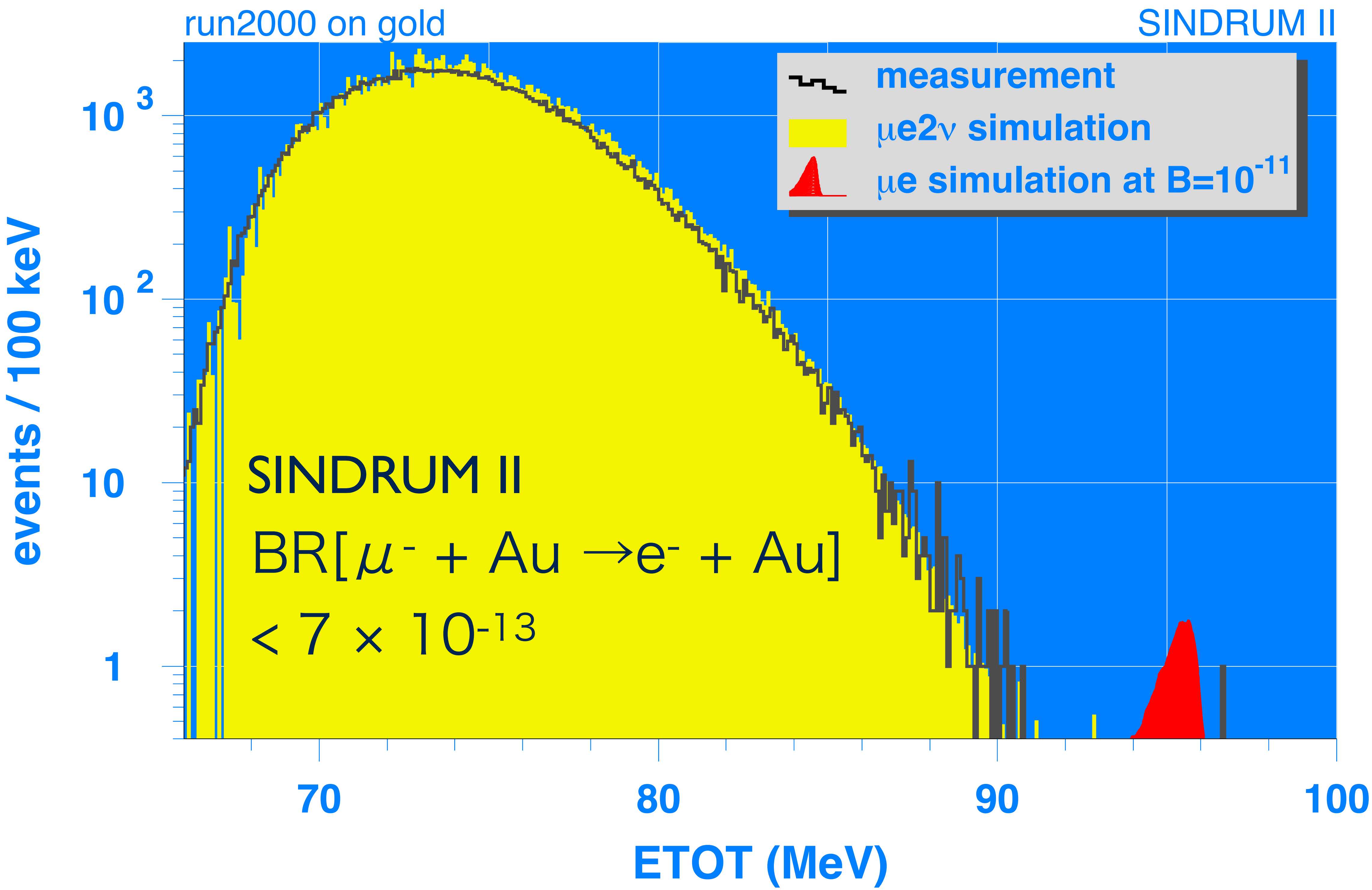


$E_e = m_\mu - B_\mu - N_{recoil}$
$= 104.9\,MeV$

- Atomic capture of μ^-
  - Decay in orbit (DIO) — $\mu^- \rightarrow e^- \bar{\nu}_e \nu_\mu$
    - electron gets recoil energy
  - Capture by nucleus — $\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1)$
    - resultant nucleus is different
  - $\tau_\mu^N < \tau_\mu^{free}$ (τ_μ^{Al} = 860 nsec)
  - μ-e conversion — $\mu^- + (A,Z) \rightarrow e^- + (A,Z)$

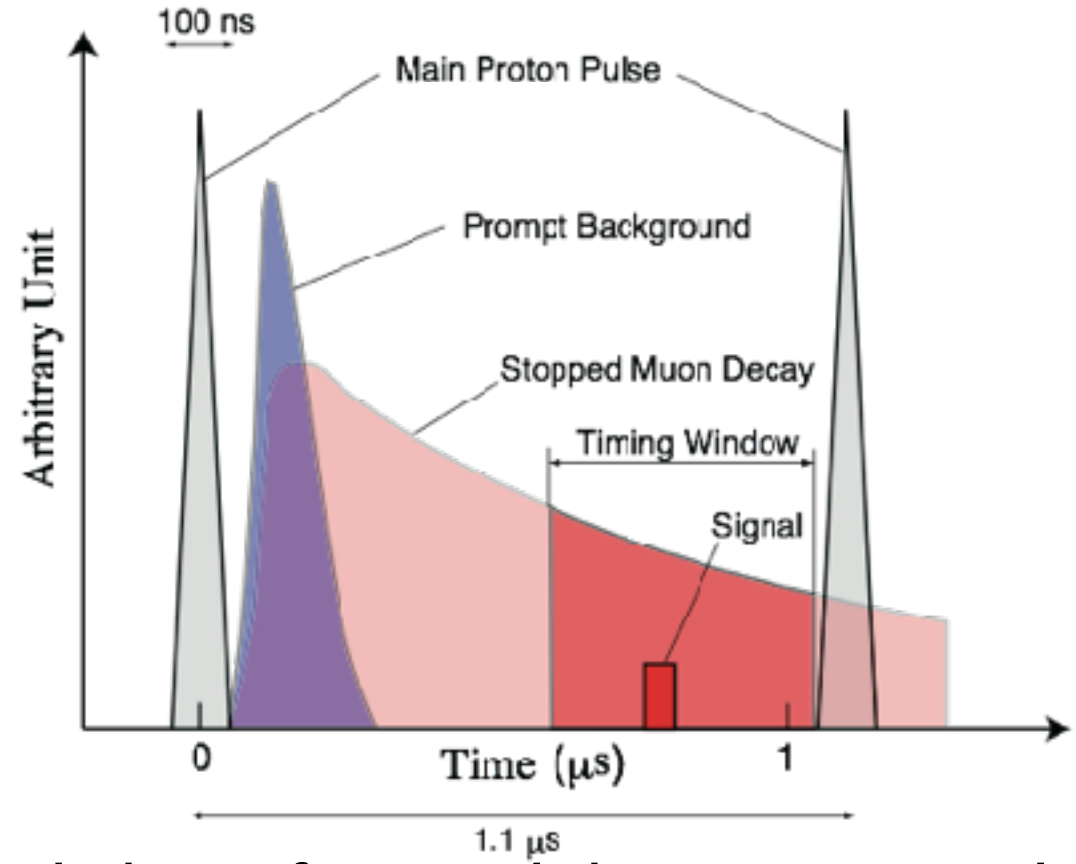
- $E_{\mu e}(Al) \sim m_\mu - B_\mu - E_{rec} = 104.97\,MeV$
  - B_μ: binding energy of the 1s muonic atom

Electron Energy Spectrum



μ-e Conversion
Signal and Background

- Signal
  - Electron from the muon stopping target with a characteristic energy with a delayed timing
- Background
  - Decay in Orbit Electron
  - Radiative muon capture
  - Cosmic-ray
  - Anti-protons
  - and others



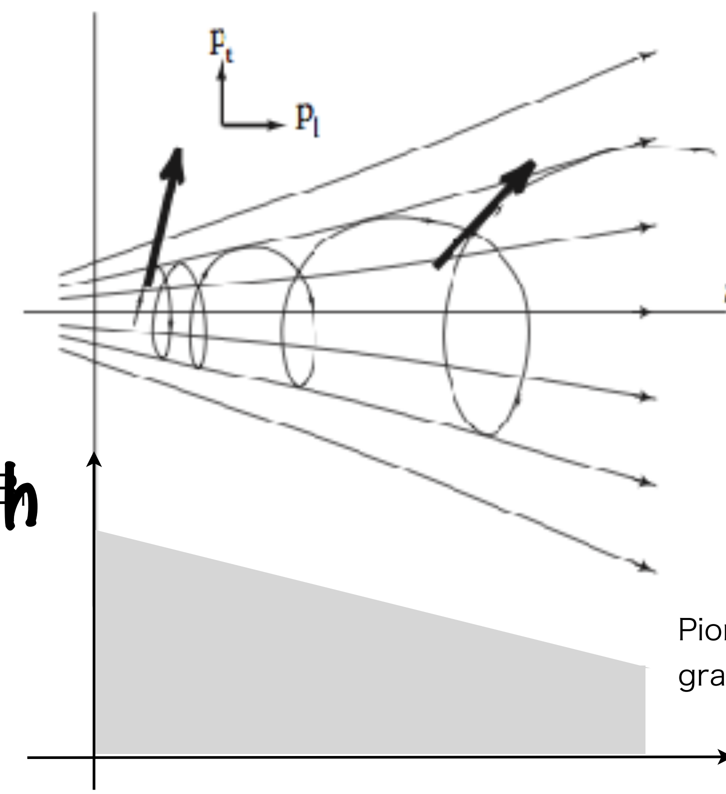
Tiny leakage of protons in between consecutive pulses can cause a background through Beam Pion Capture process:

- $\pi^- + (A,Z) \rightarrow (A,Z-1)^* \rightarrow \gamma + (A,Z-1)$
  $\gamma \rightarrow e^+ e^-$

$$R_{ext} = \frac{\text{Number of protons between pulses}}{\text{Number of protons in a pulse}}$$

MELC Proposal

- Pion production in magnetic field
- Pion/muon collection using gradient magnetic field
- Beam transport & momentum selection with curved solenoid magnets



Pion/muon collection using gradient magnetic field

ISSN 1063-7788, Physics of Atomic Nuclei, 2010, Vol. 73, No. 12, pp. 2012-2016. © Pleiades Publishing, Ltd., 2010.
Original Russian Text © R.M. Djilkibaev, V.M. Lobashev, 2010, published in Yadernaya Fizika, 2010, Vol. 73, No. 12, pp. 2067-2071.

ELEMENTARY PARTICLES AND FIELDS
Experiment

Search for Lepton-Flavor-Violating Rare Muon Processes

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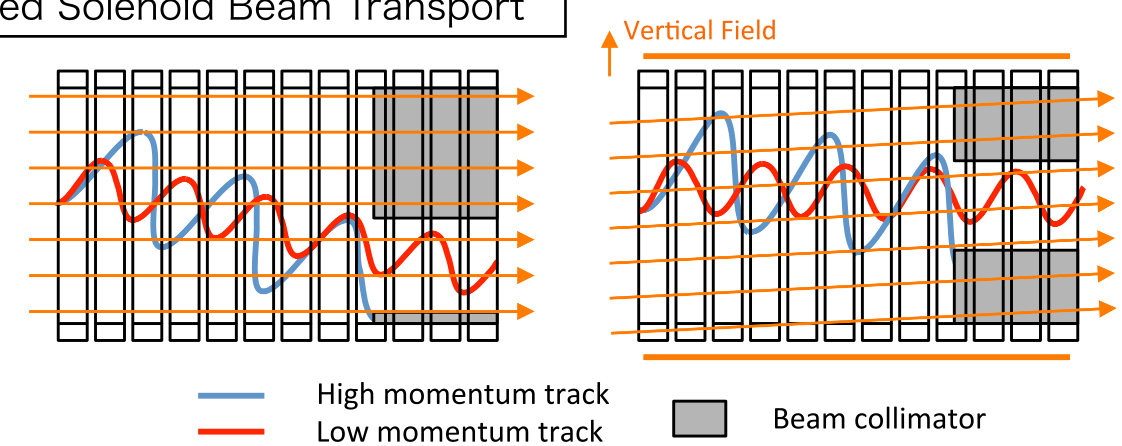
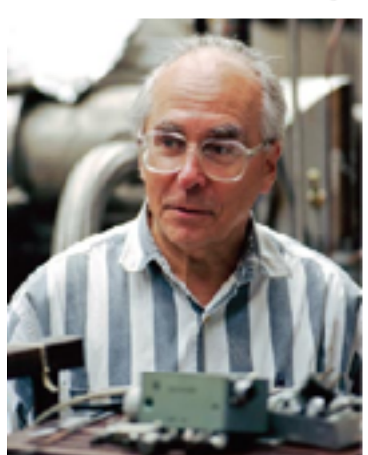
Received March 26, 2010; in final form, July 12, 2010

Curved Solenoid Beam Transport





Vladimir Lobashev 1934-2011
CERN Courier Vol 51, No 8

- Momentum and charge separation
- Same scheme used in COMET Phase-II electron spectrometer

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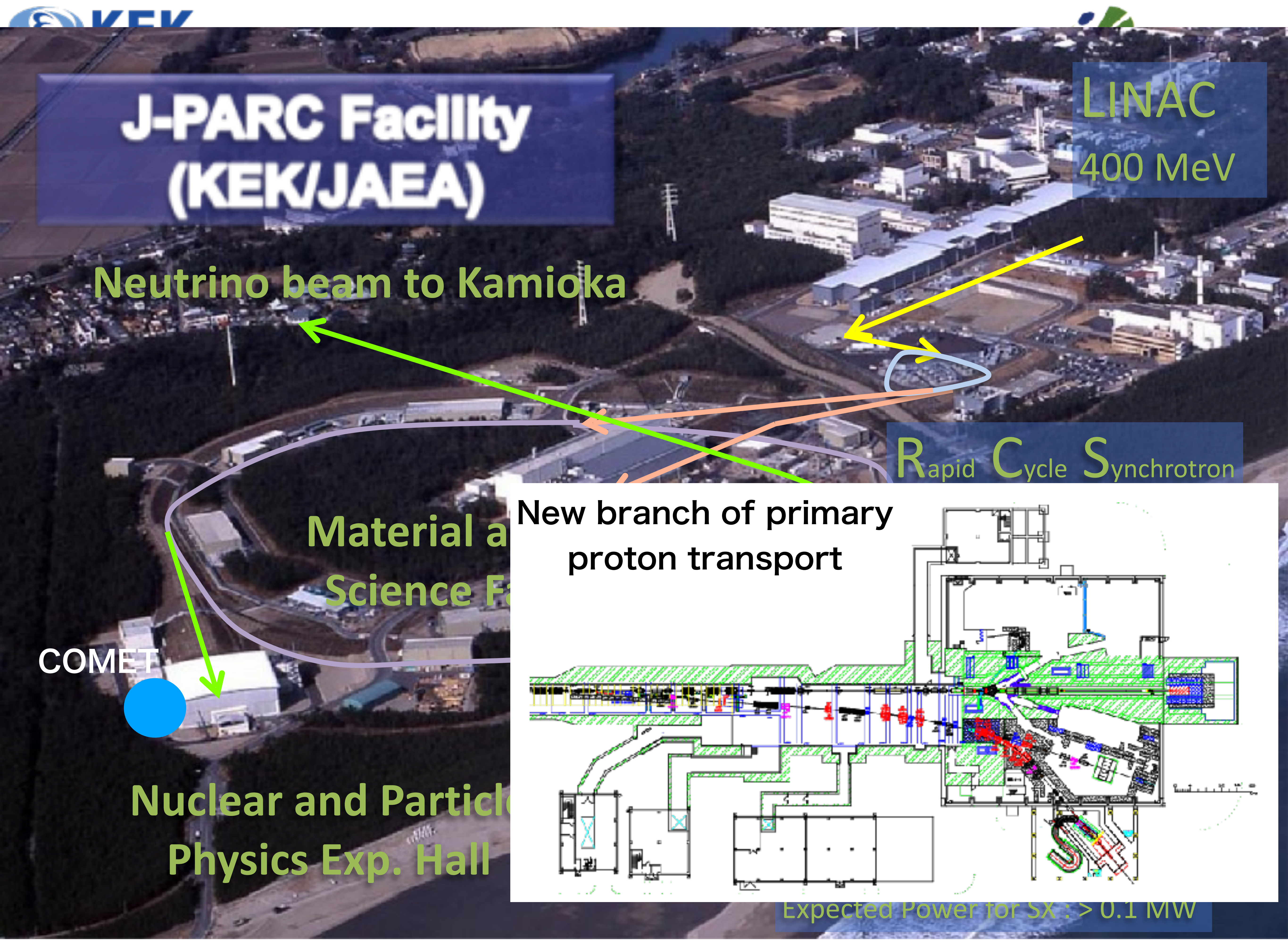
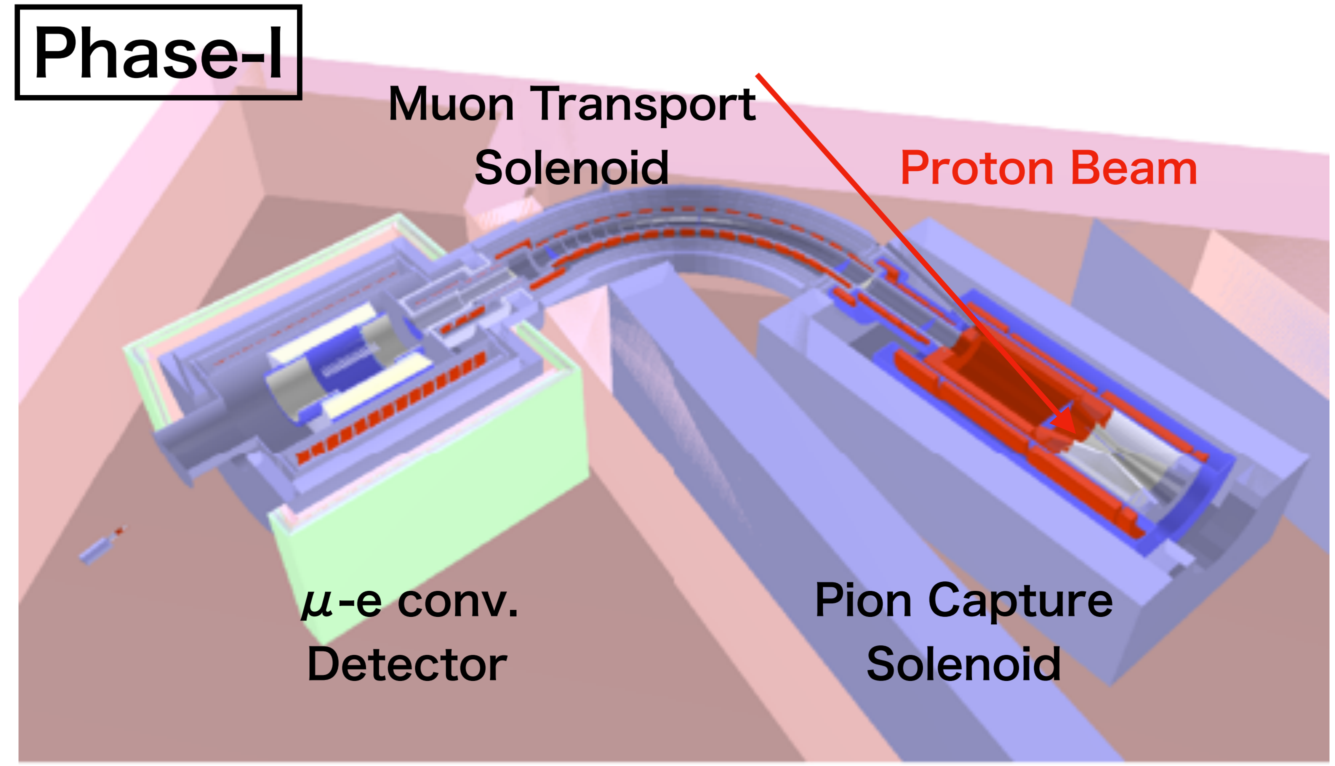
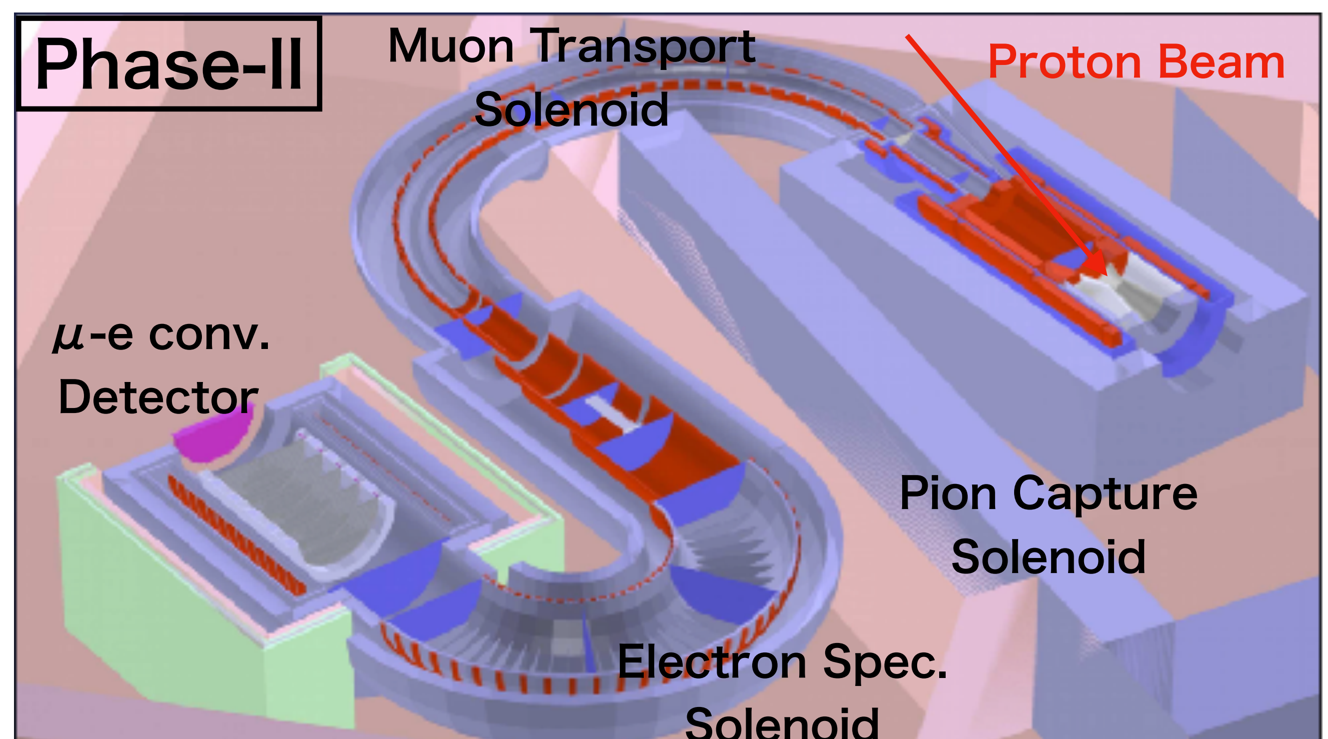
COMET at J-PARC


J-PARC Facility
(KEK/JAEA)
LINAC
400 MeV
Neutrino beam to Kamioka
Rapid Cycle Synchrotron
Material a
Science Fa
COMET
Nuclear and Particle
Physics Exp. Hall
New branch of primary
proton transport
Expected Power for SX : > 0.1 MW

COMET

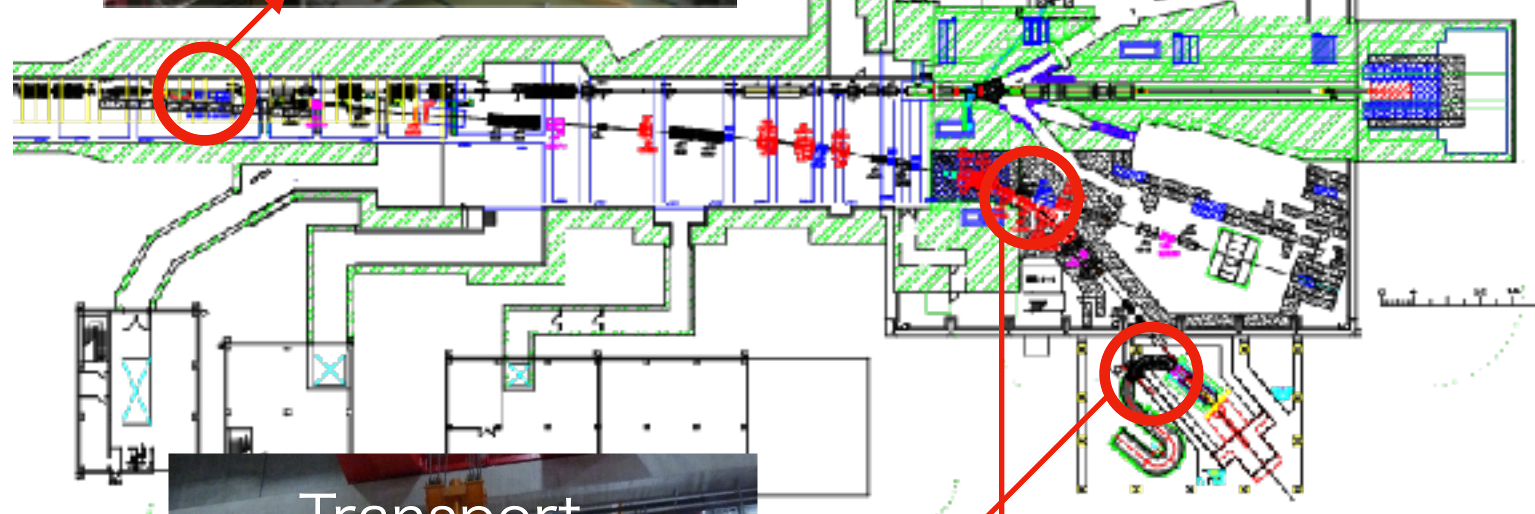
- Target S.E.S. 2.6×10^{-17}
- 8GeV Pulsed proton beam at J-PARC
  - Insert empty buckets for necessary pulse-pulse width
  - bunched-slow extraction
- pion production target in a solenoid magnet
- Muon transport & electron momentum analysis using C-shape solenoids
  - smaller detector hit rate
  - need compensating vertical field
- Tracker and calorimeter to measure electrons
- COMET decided to take a staging approach to realize this. The collaboration is making an effort to start physics DAQ as early as possible under this.
  - Phase-I 8GeV-3.2kW, < 10^{-14}
  - Phase-II 8GeV-56kW, < 10^{-16}



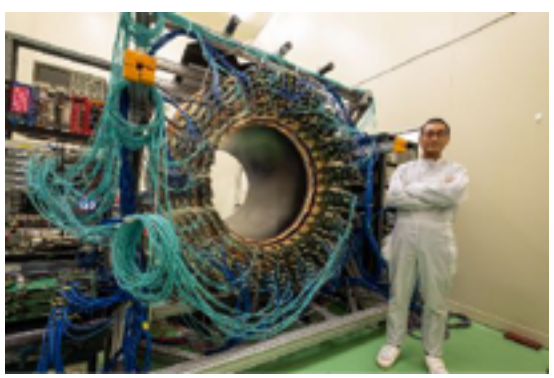


Status of COMET Phase I

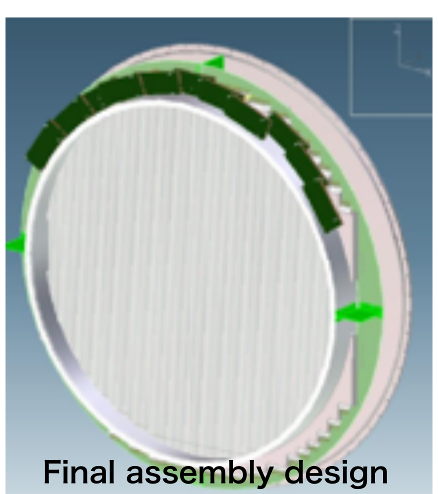
- Facility
  - Proton beam line & SC magnet system
- Detectors
  - Phase-I Physics Detector (CDC & TC)
  - Phase-I Beam measurement Detector (Straw tracker and LYSO Ecal)

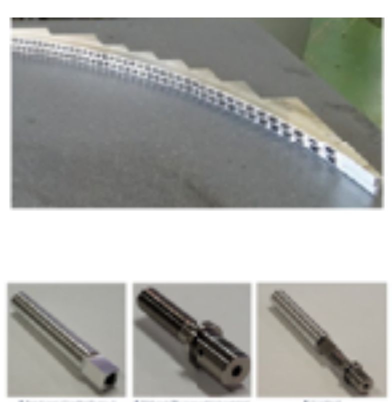


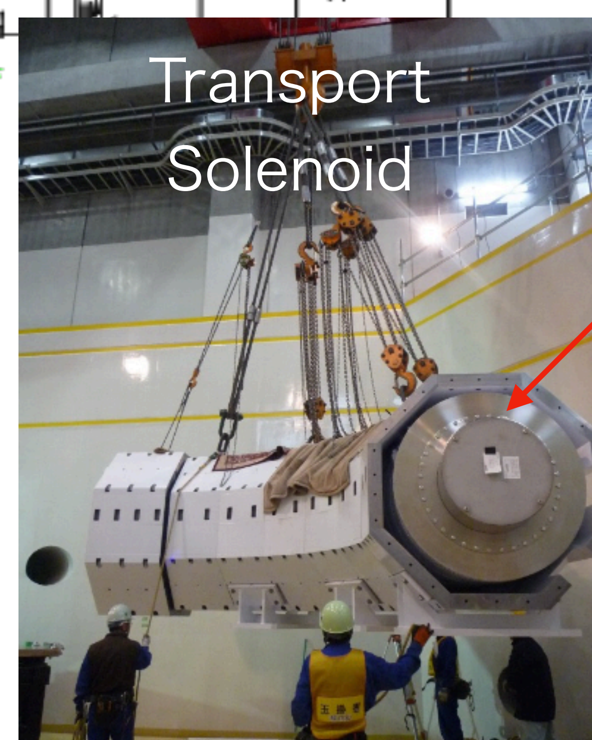
CDC CR test at KEK



Straw tracker & Ecal Prototype

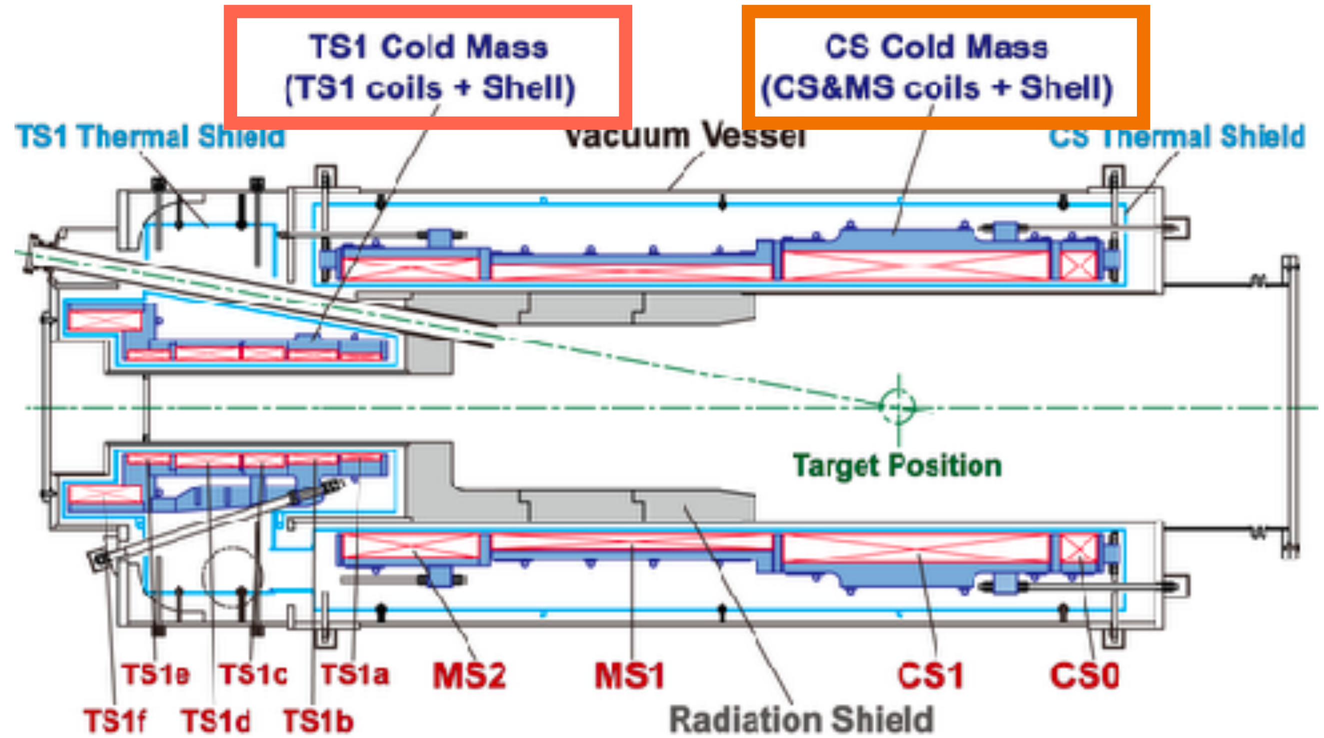


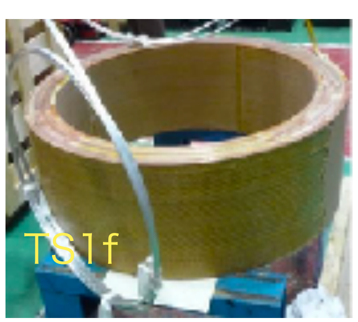


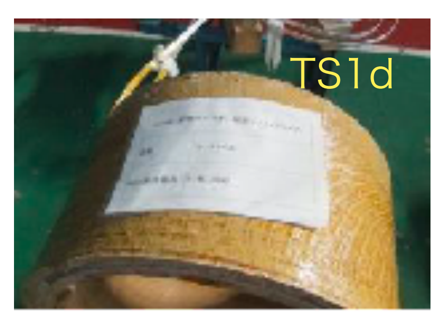


COMET Phase I Facility

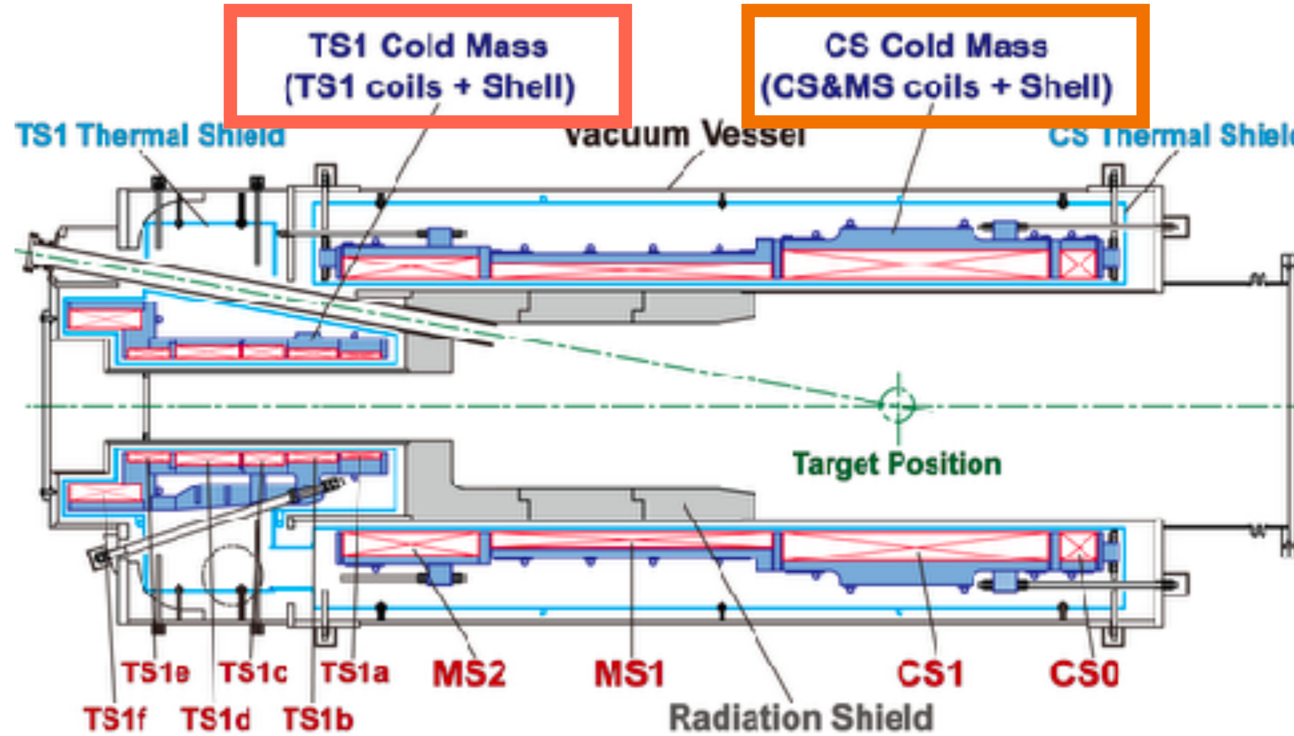
- Winding of all coil components completed at the end of March 2020
- Assembling CS Cold Mass and TS1 Cold Mass in 2020
- Cryostat construction in 2021
- Installation of cold masses into the cryostat in 2022
- Contract with Mitsubishi Elec. to deliver the Pion Capture Solenoid to J-PARC in 2022





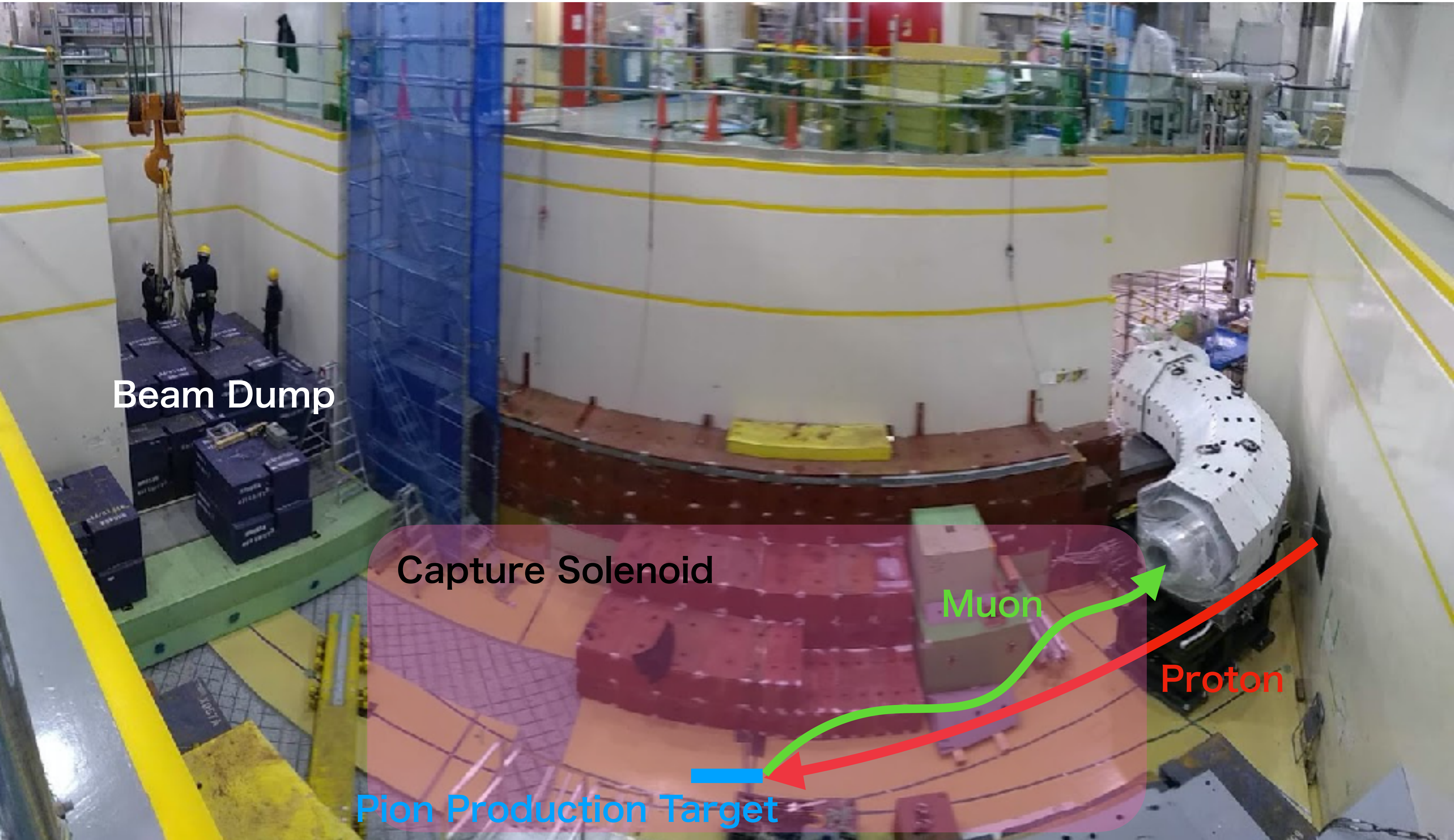


COMET Phase I Facility



As of March 2021

COMET Phase-I Facility

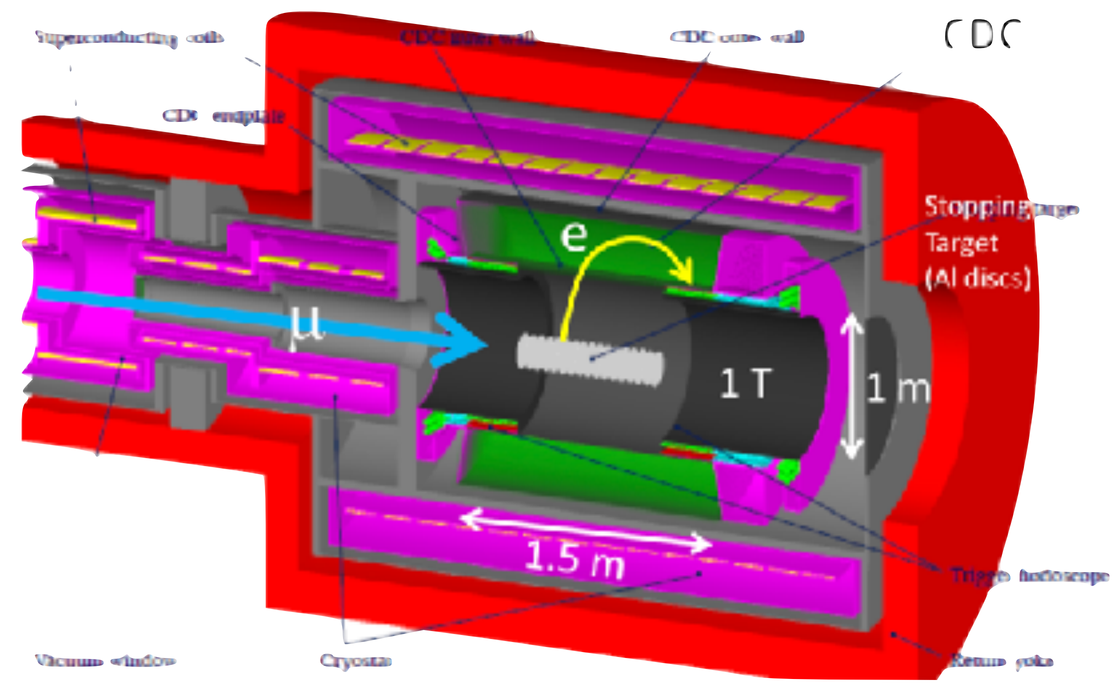


As of Feb. 2021

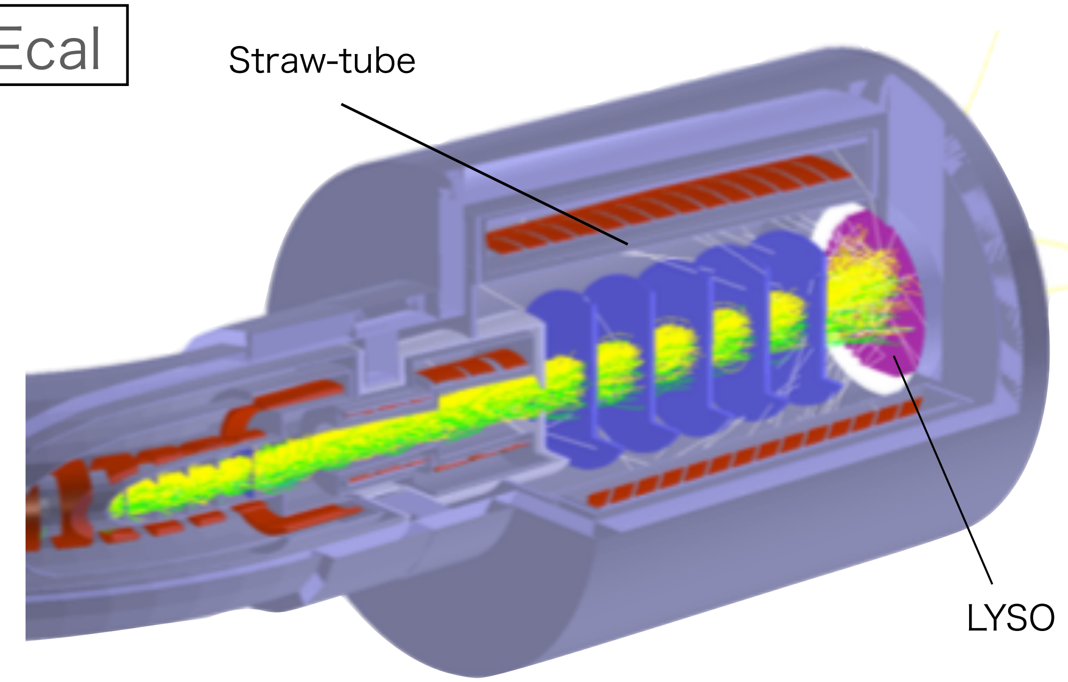
COMET Phase-I Detector

- CyDet
  - Physics measurement detector
  - Muon stopping target at the center surrounded by Cylindrical Drift Chamber (CDC)
  - Trigger hodoscope at both ends
- StrEcal
  - Planar detector for beam measurement (and as a prototype for Phase-II physics detector)
  - Straw-tube tracker
  - LYSO electromagnetic calorimeter
- Detector solenoid magnet is commonly used in two configurations

CyDet



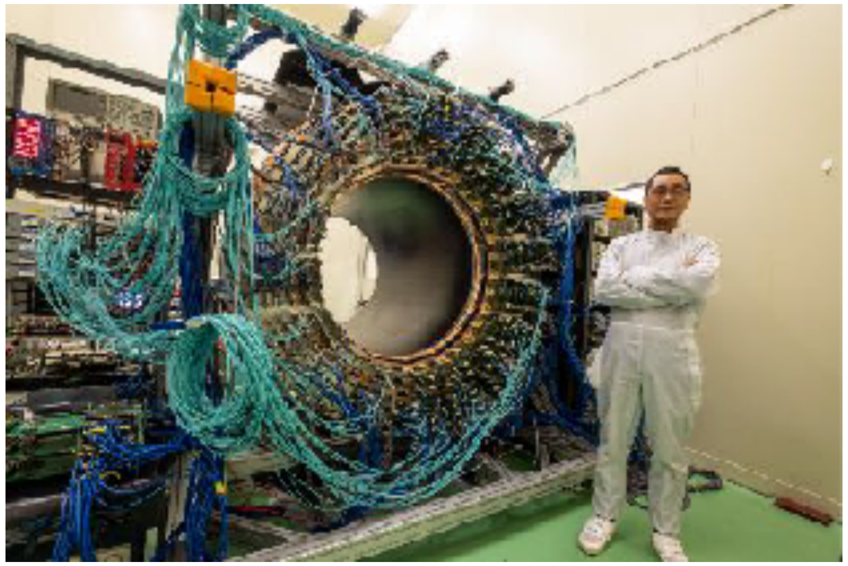
StrEcal

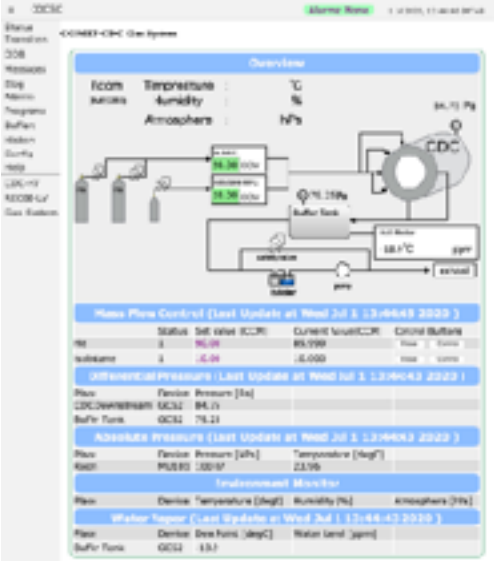


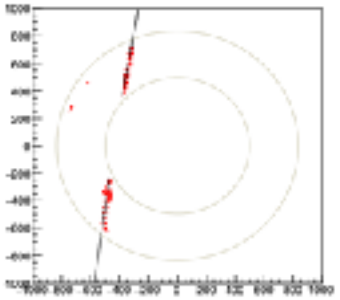
CyDet

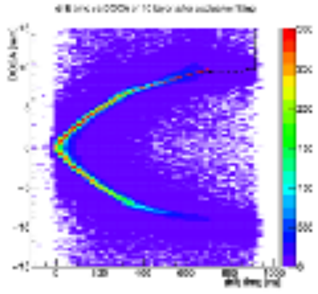
CDC

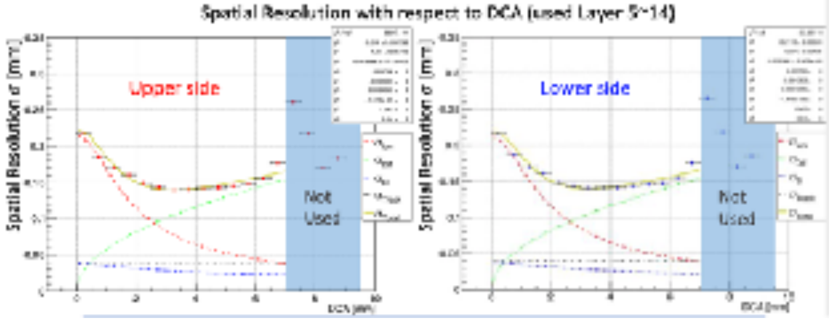
- CDC Cosmic-ray test with full DAQ electronics (Setup 6), including Slow Control and Monitors (w/o water cooling to be implemented at COMET site)
    - Change of the resolution from the previous setup (Setup5)
    - Investigating the reason to fully understand the detector operating condition (HV, threshold, noise)
- CTH - Cylindrical Trigger Hodoscope
    - Lead by Monash group
    - Two layers of scintillator and Cherenkov detectors
    - Optimization of the support structure material Al/steel
    - Photo-sensor: Fine-mesh PMTS or SiPM (MPPC)
        - Recent development of MPPC with higher radiation tolerance
        - No effect of helium atmosphere (filling the CDC inner volume) on MPPC -> Simplified structure helps to reduce unexpected background
        - Irradiation test of MPPC
            - MPPC with optical fiber read may be a solution







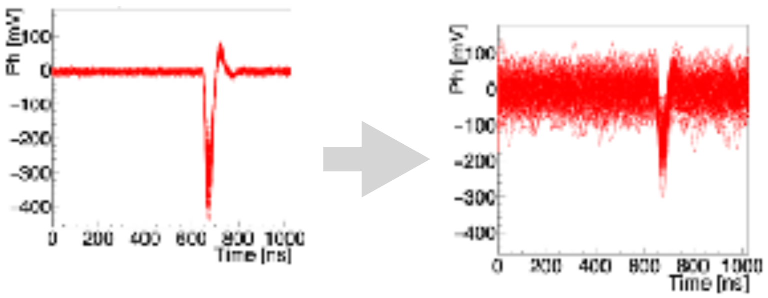


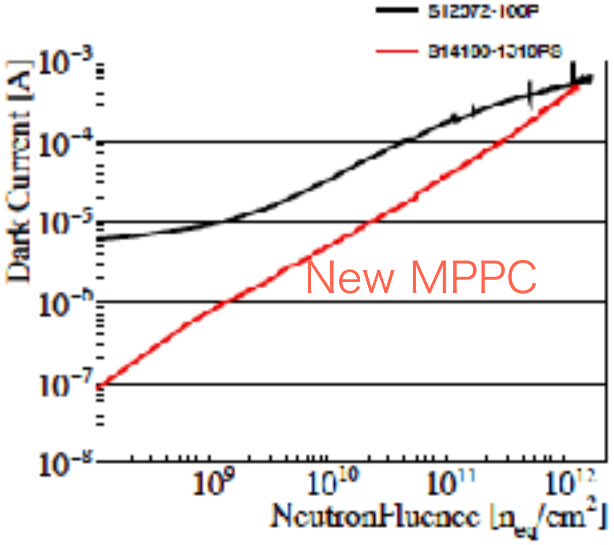


CTH

- Neutron level in 10^{11} range inside the detector solenoid

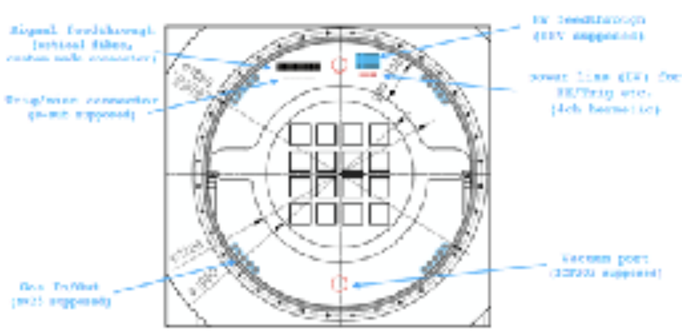
0 $\{n_{eq}/cm^2\}$ 3x10^{11} $\{n_{eq}/cm^2\}$



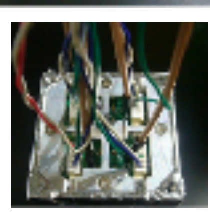


StrEcal

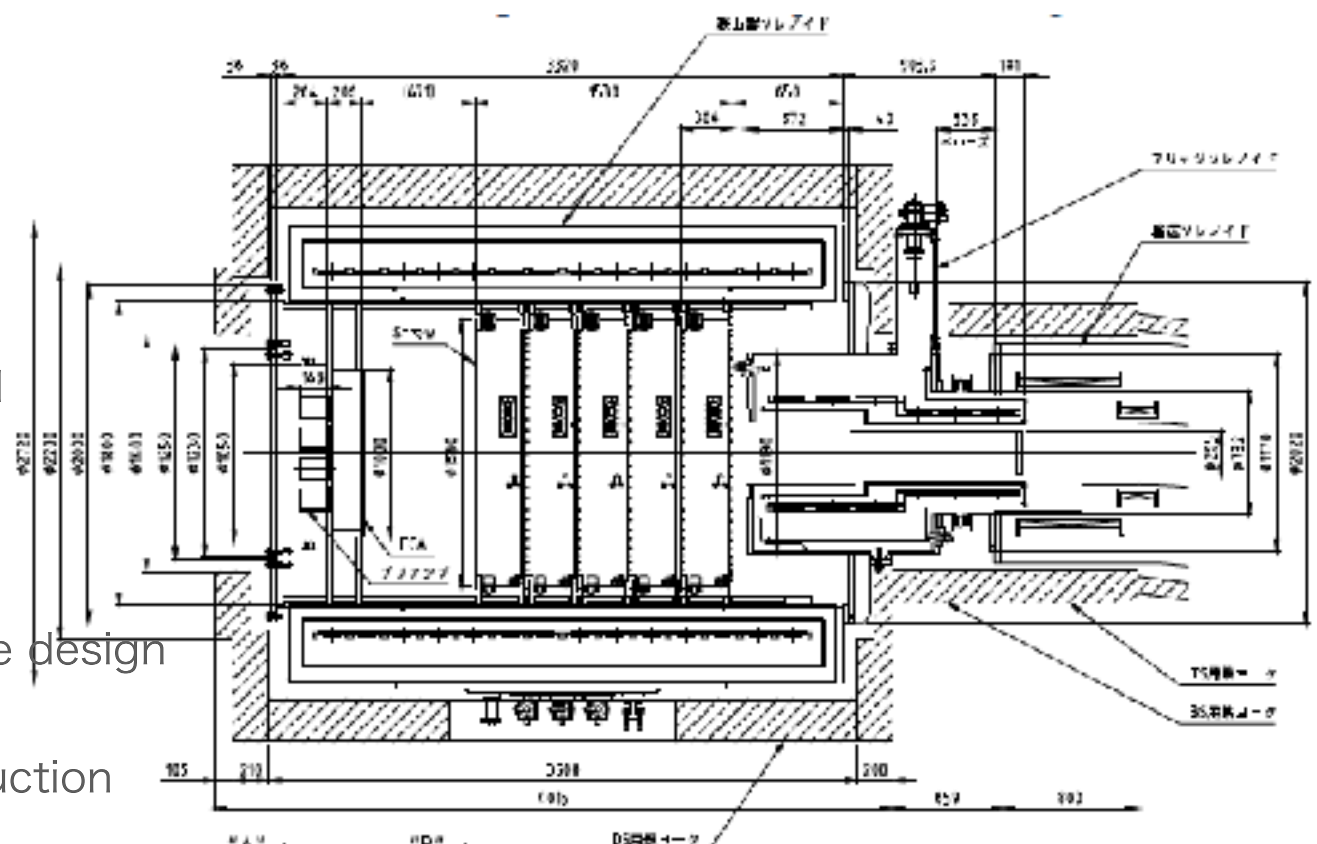
- Design work toward integration, finalized by Summer 2020
  - Mechanical analysis, protocol to install the detector, gas piping inside DS, feedthrough configurations
  - Both of Straw-tracker and Ecal are supported by DS cryostat



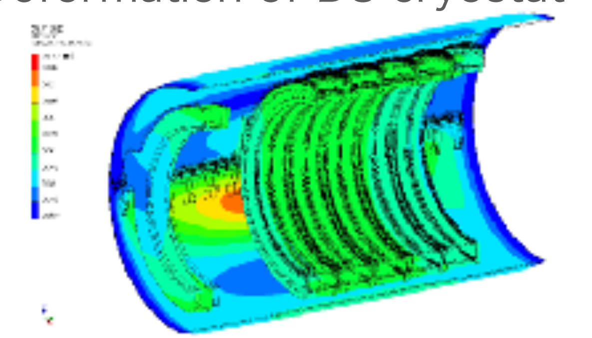
StrEcal End-plate design for Phase-I

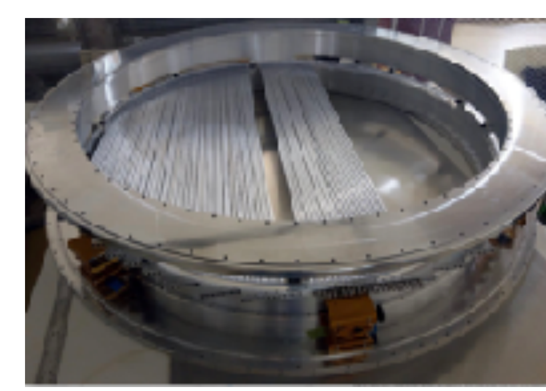


- Ecal module design finalized
- Mass production of LYSO in progress



Deformation of DS cryostat

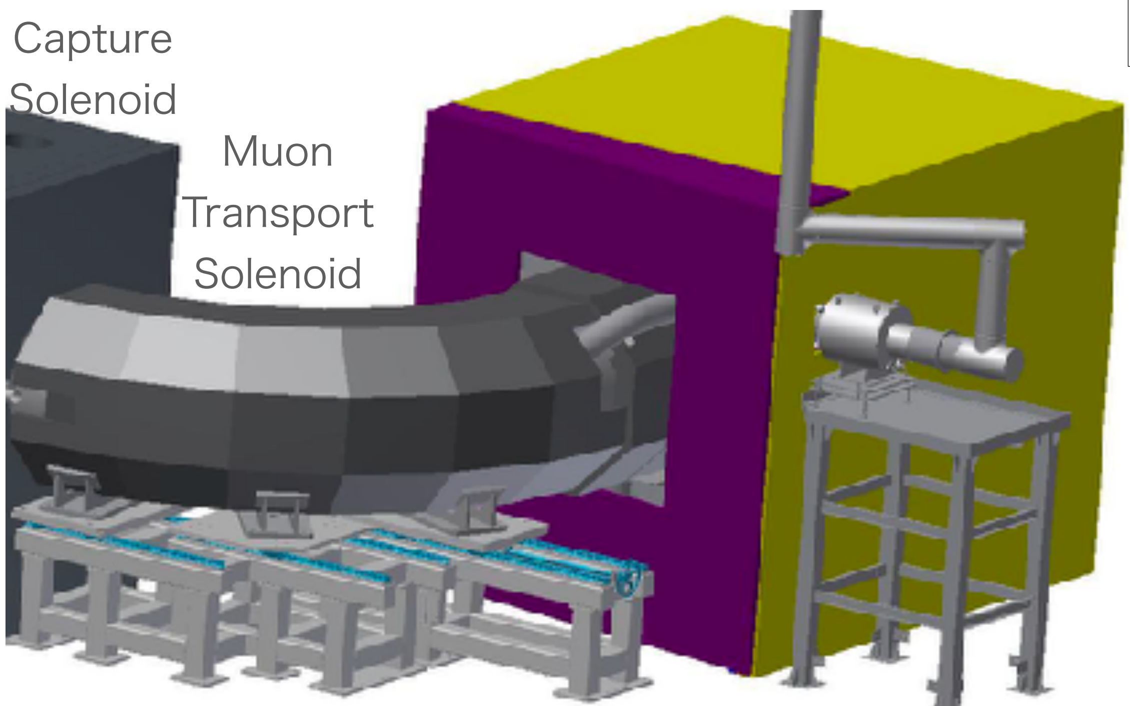




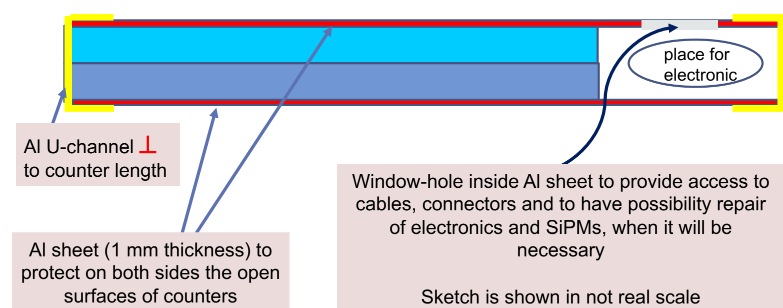
1st station of Straw-tube tracke

CRV

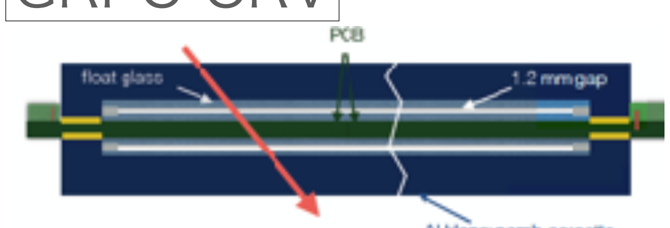
- CRV covers the detector solenoid with plastic-scintillation detector (high ε_{det}) and Glass Resistive Plate Chamber (GRPC, neutron blind)
  - Identify cosmic-ray muons arriving at the detector volume
  - DS iron return yoke and additional shield to suppress neutrons/gammas from the muon stopping target
  - Prototype construction and test at BINP (Scintillator CRV) / IN2P3 Clermont (GRPC CRV) , followed by mass-production



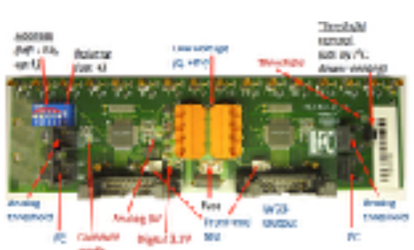
Scintillator CRV



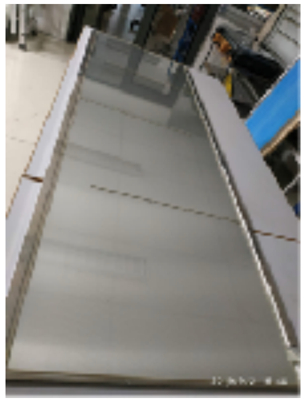
GRPC CRV



GRPC detector module: two single gap GRPCs with common readout



FE board

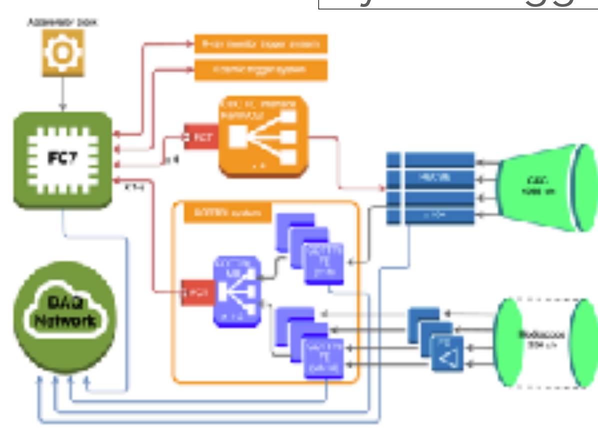


GRPC Mechanical mock-u

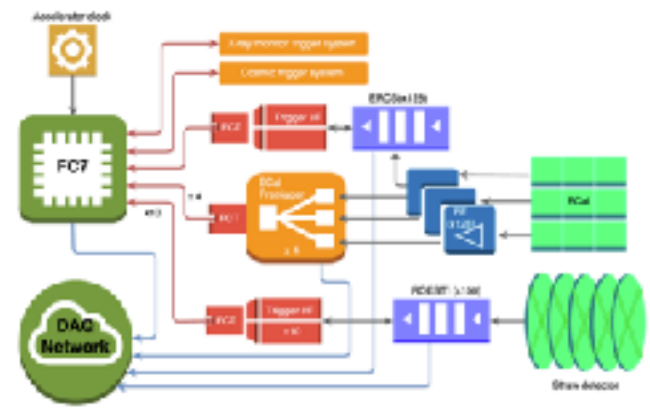
Trigger & DAQ

- Distinct but similar DAQ and trigger system for CyDet and StrEcal
    - CRV provides a veto signal (flag) as well as a calibration trigger
- Trigger logic development is in progress to cope with the highest DAQ rate of 20kHz
- Radiation hardness test of hardware components carried out up to 1.45 kGy
- COMET DAQ employs standard Ethernet network with commercially available components.
    - MIDAS DAQ software
    - Hardware installation started in the counting room !
    - Data writing test and transfer test as well!

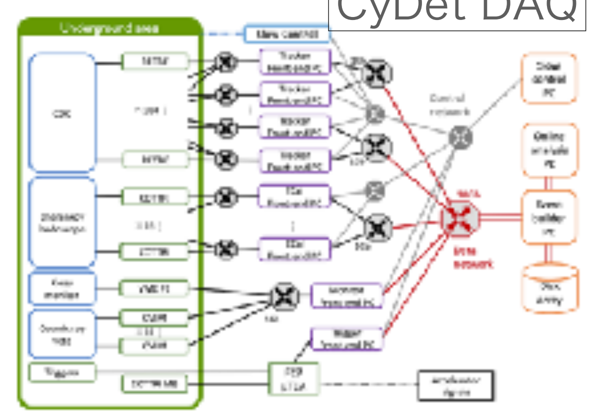
CyDet Trigger



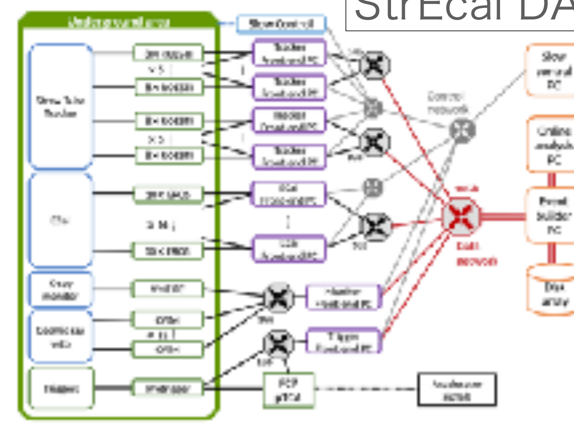
StrEcal Trigger

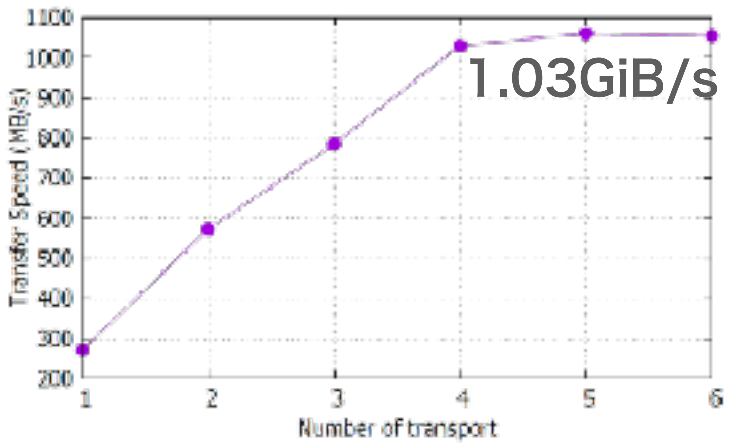


CyDet DAQ



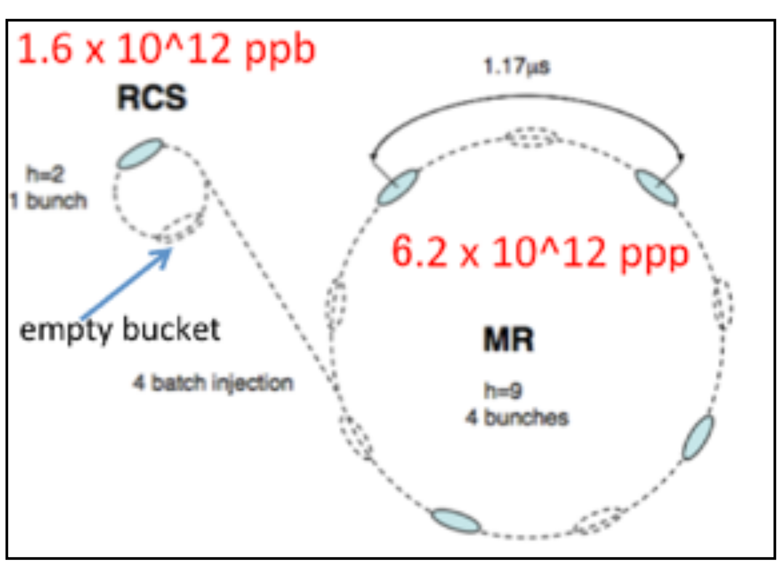
StrEcal DAQ

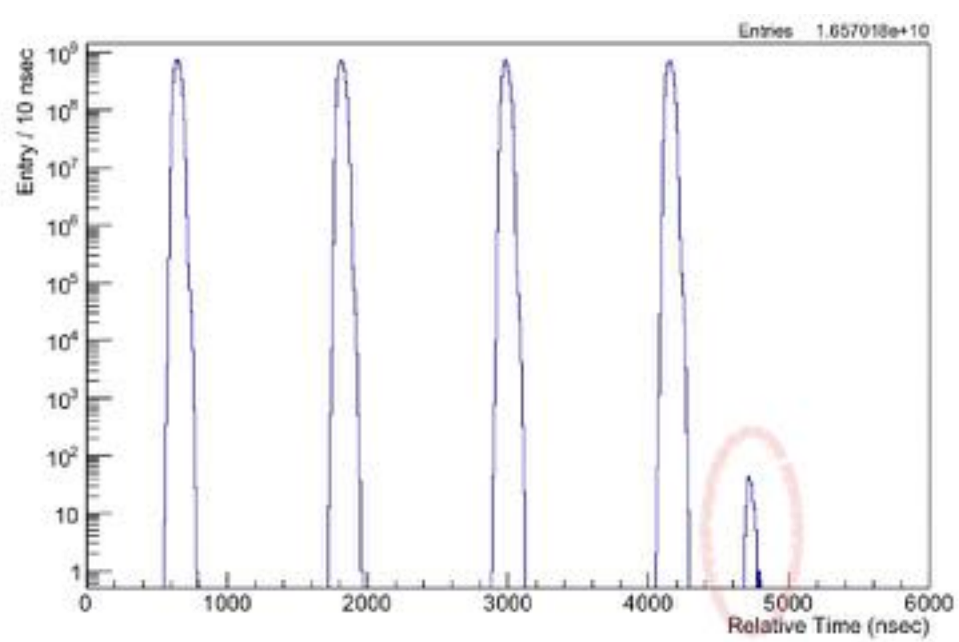


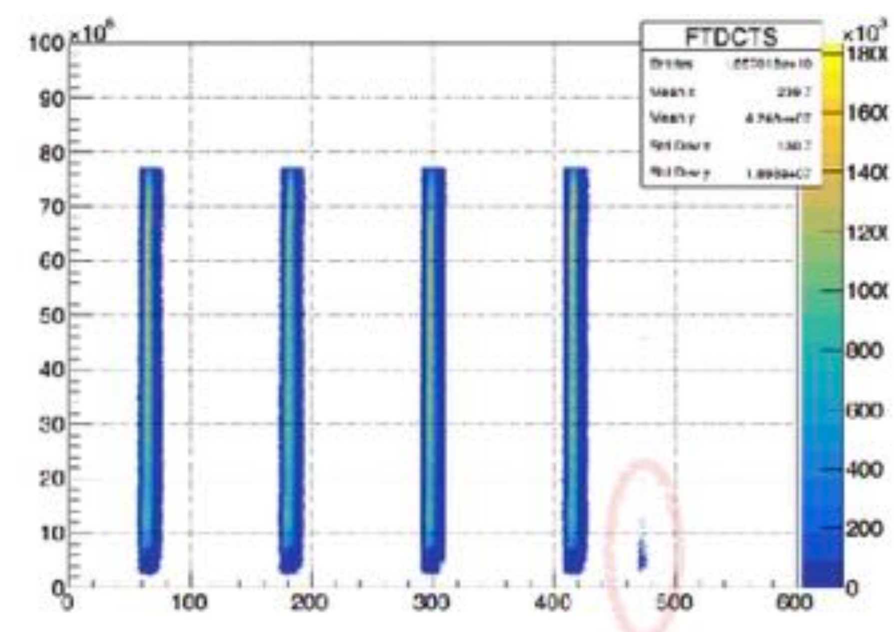


COMET Proton Beam R&D

- COMET requires MR operation at 8GeV (instead of 30GeV for HD hall experiments and T2K)
- Proton beam extracted from MR without destroying the bunch structure to generate pulsed-muon beam with a suitable pulse timing
- Proton beam extinction factor measurement using secondary beam in 2018
  - $1\text{-}2\times10^{-10}$ extinction factor has already been achieved by masking K4 rear bunch

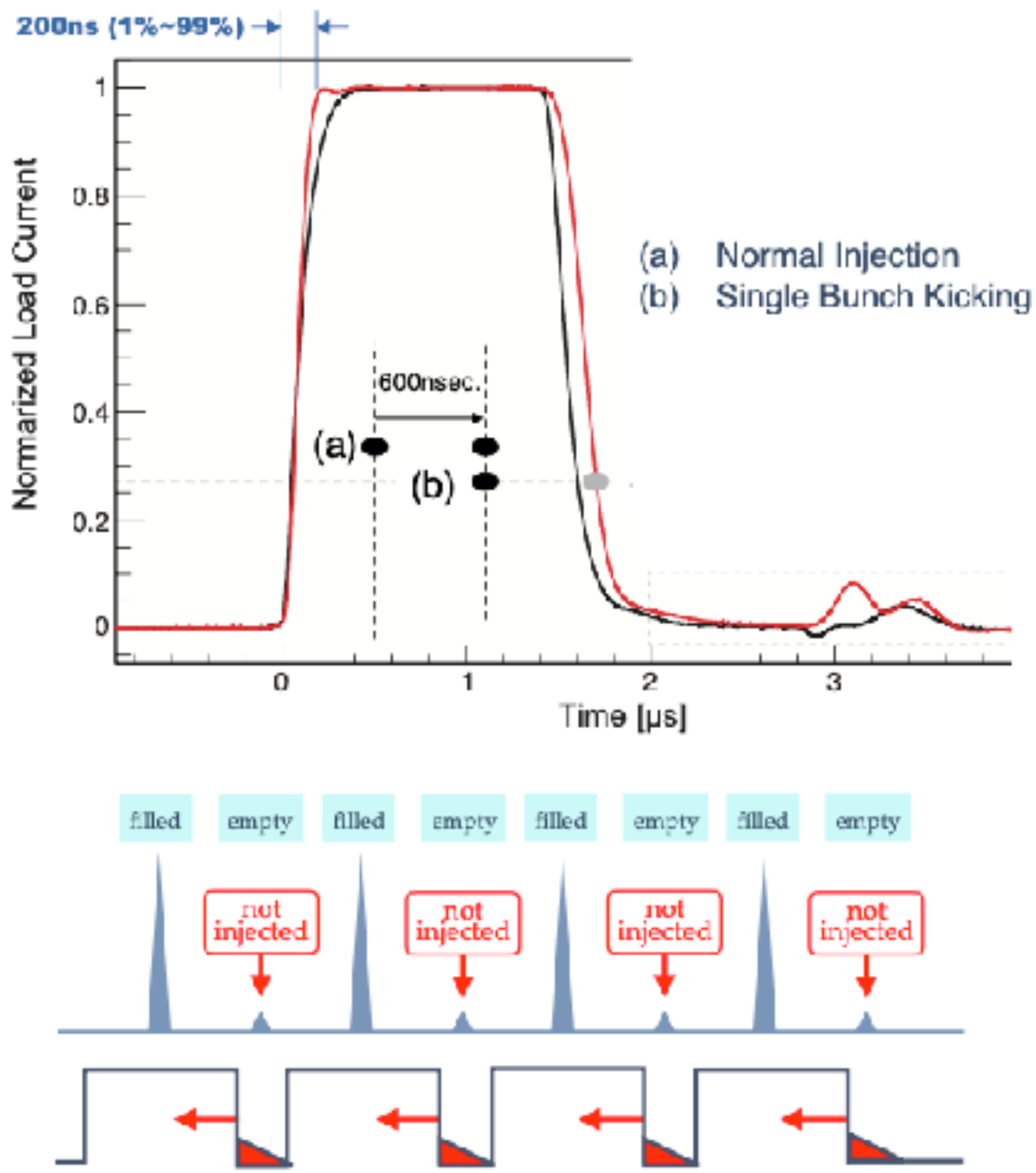


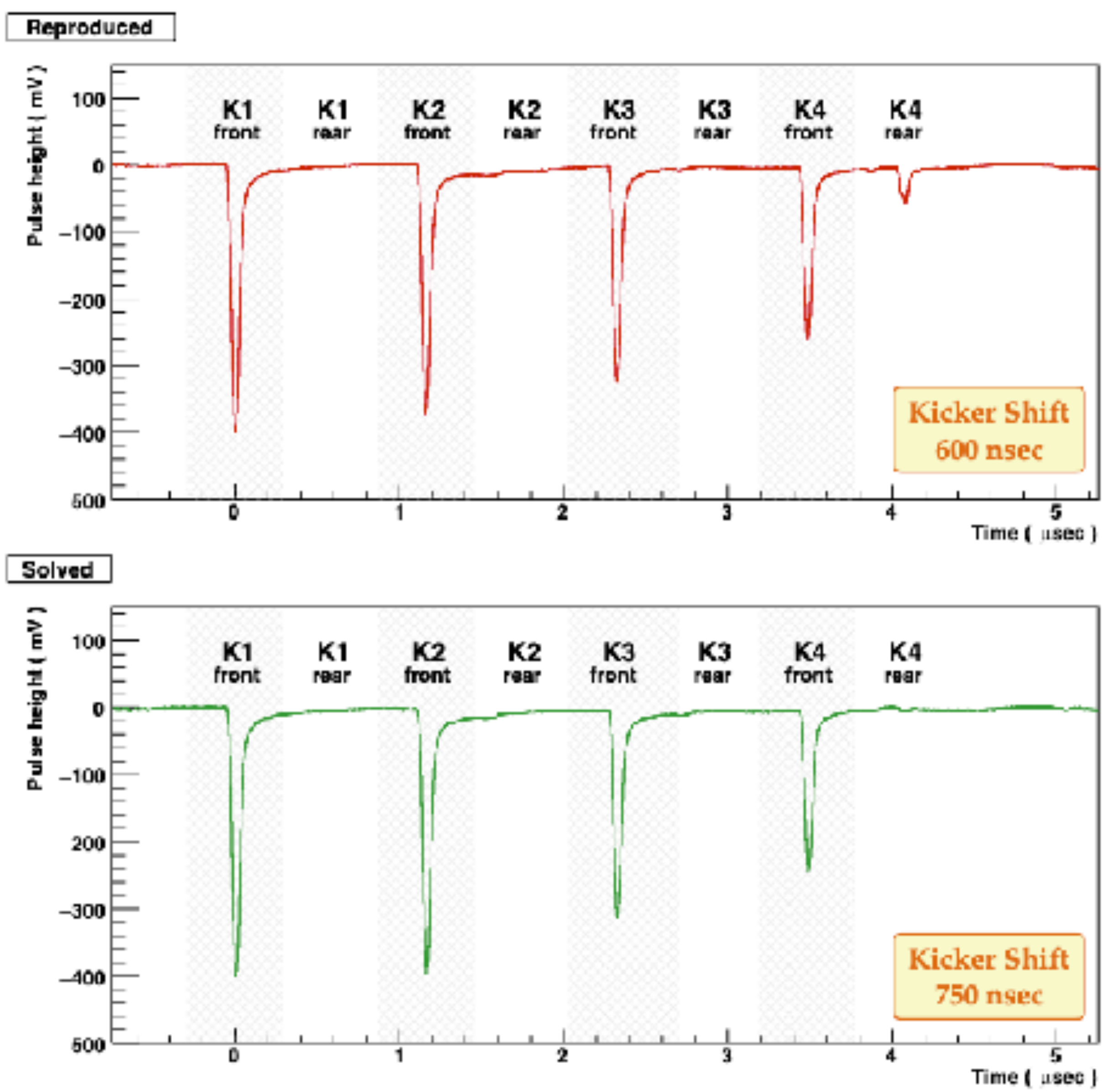




COMET Proton Beam R&D

- Injection kicker timing optimization



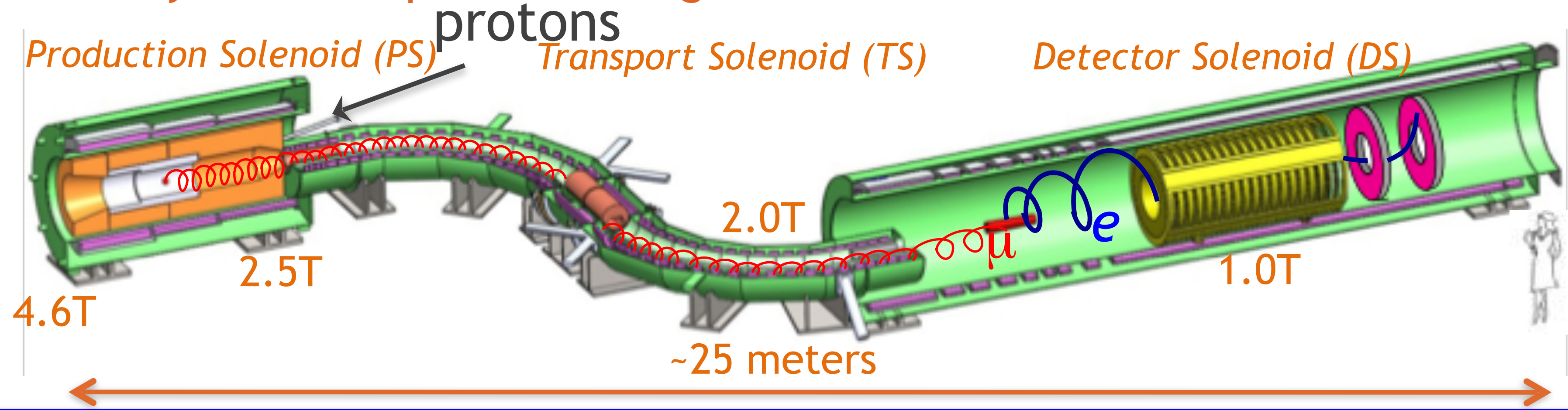


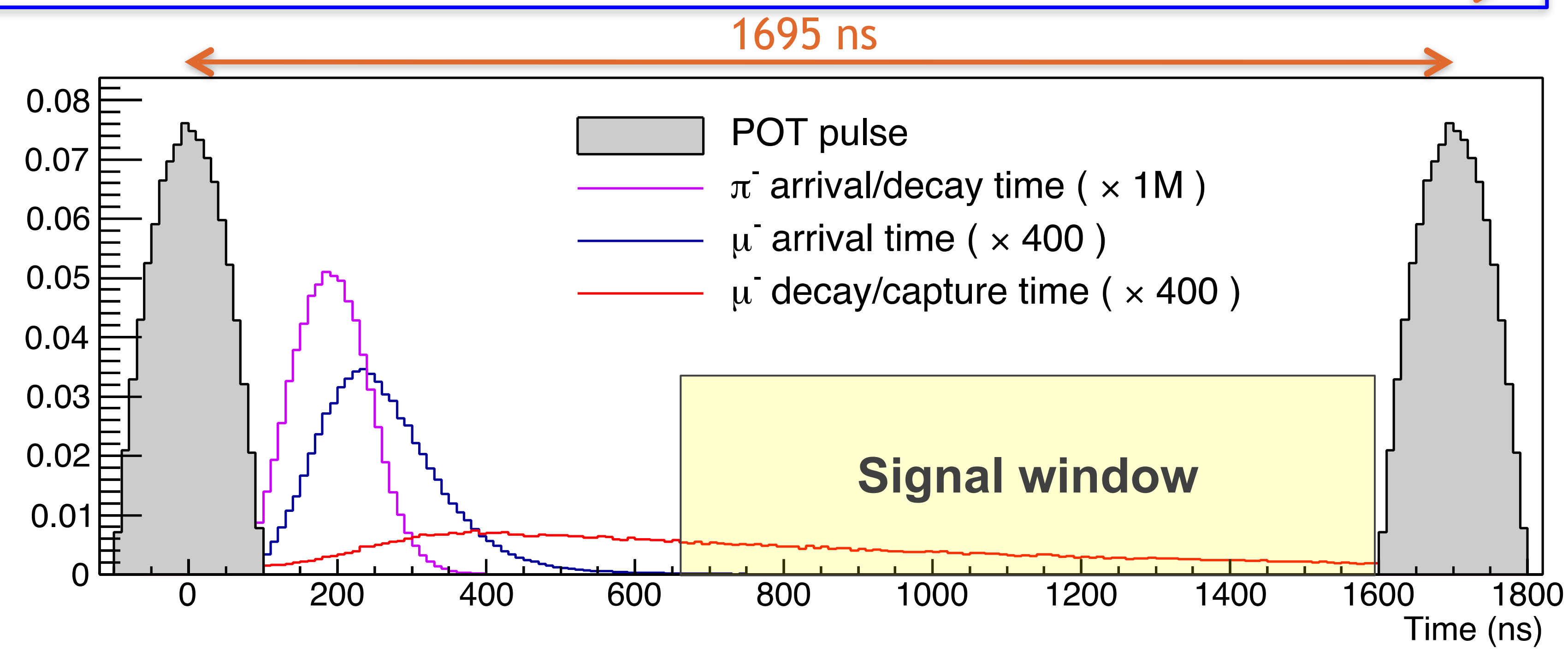
Mu2e at FNAL

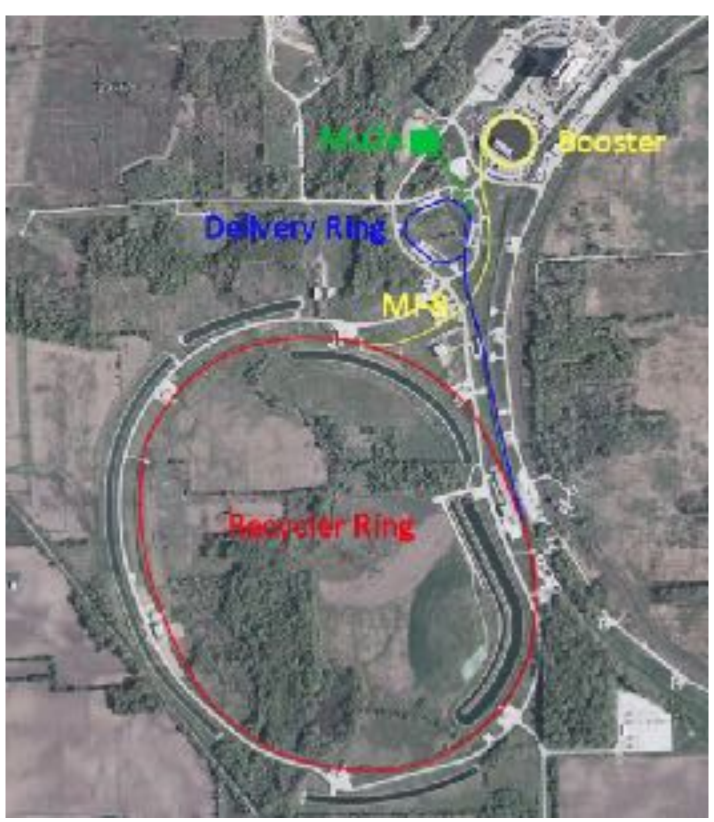
Mu2e

- **A search for Charged Lepton Flavor Violation:** $\mu N \rightarrow eN$
  - Expected sensitivity of 6×10^{-17} @ 90% CL, x10,000 better than SINDRUM-II
  - Probes effective new physics mass scales up to 10^4 TeV/c^2
  - Discovery sensitivity to broad swath of NP parameter space

A System of superconducting solenoids and an intense muon beam





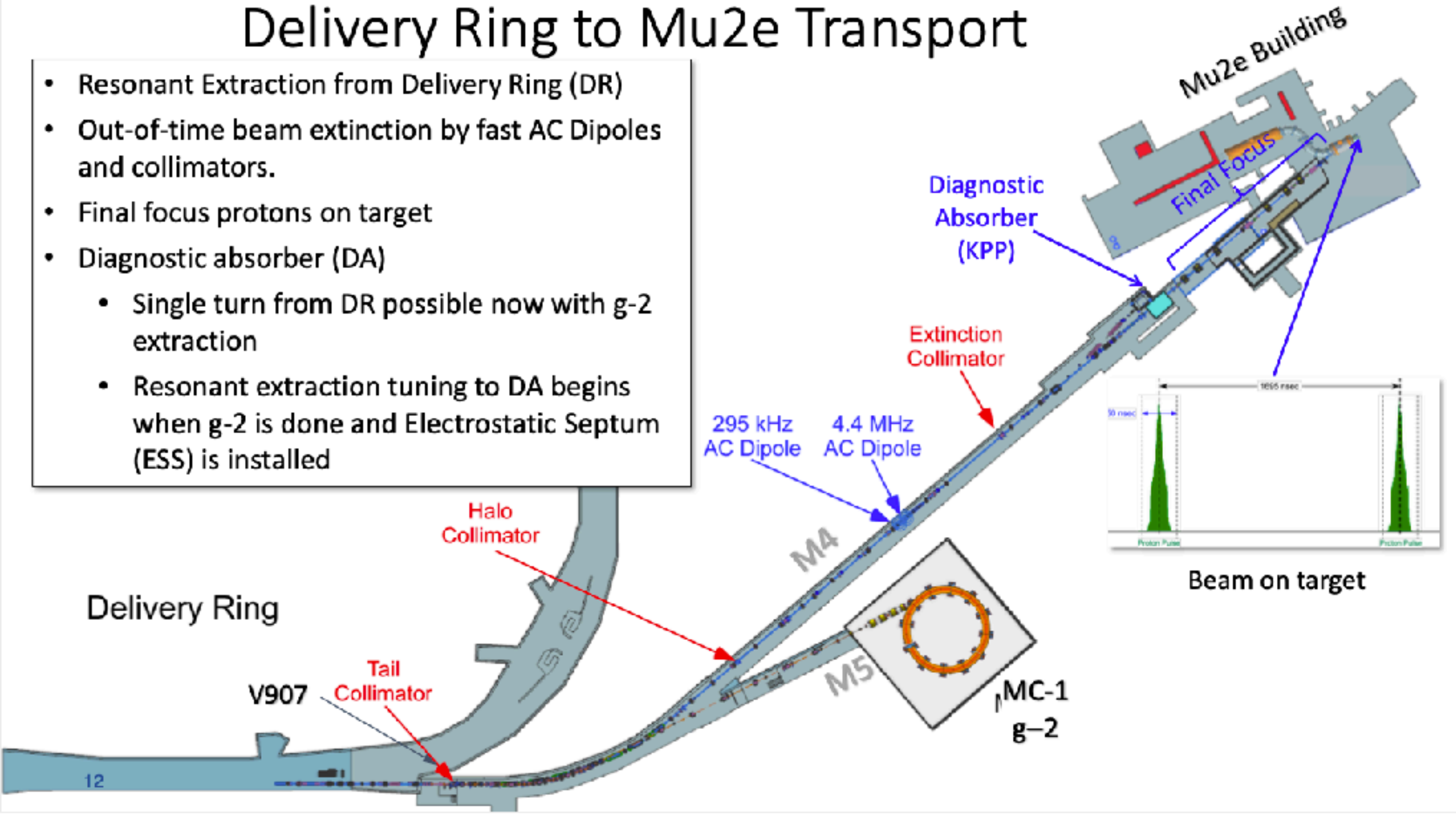


- **Mu2e makes use of existing infrastructure at Fermilab**
- **Mu2e uses 8 kW of protons**
  - From the Booster (8 GeV) & Re-bunched in the Recycler
  - Slow-spill from Delivery Ring
    - Accumulator/Debuncher for Tevatron anti-protons
    - Revolution period 1695 ns
- **Mu2e will run simultaneously with NOvA and SBN**

Unravelling the mysteries of matter, life and the universe.

Delivery Ring to Mu2e Transport

- Resonant Extraction from Delivery Ring (DR)
- Out-of-time beam extinction by fast AC Dipoles and collimators.
- Final focus protons on target
- Diagnostic absorber (DA)
    - Single turn from DR possible now with g-2 extraction
    - Resonant extraction tuning to DA begins when g-2 is done and Electrostatic Septum (ESS) is installed



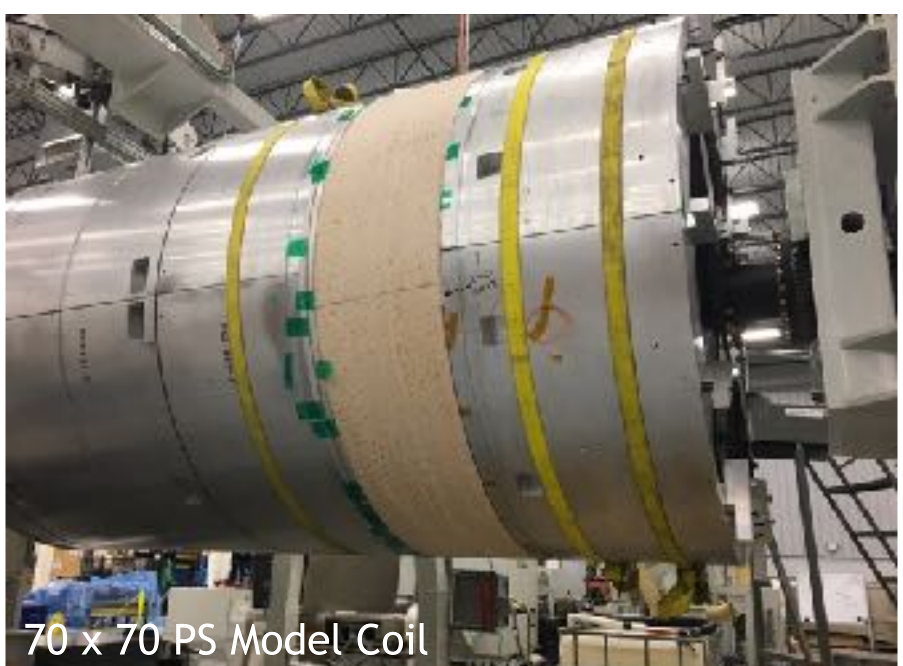
J. Miller COMET Seminar 2021

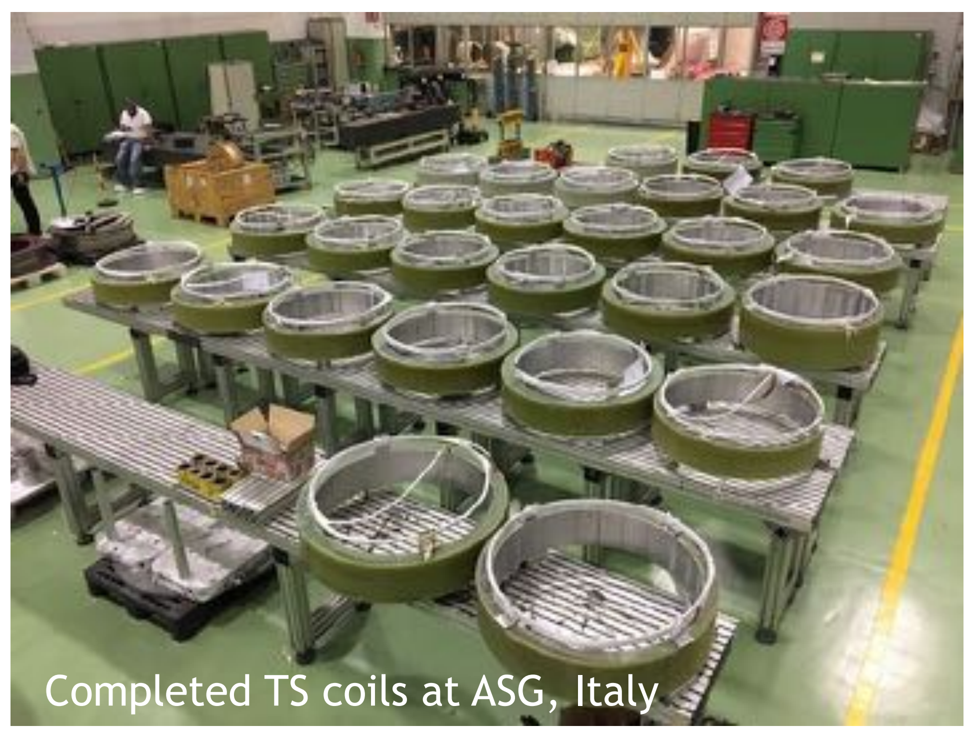
Mu2e Status

- Installation of beamline magnets complete
- TS components being devolved to FNAL -> complete in Nov. 2020
- PS model coil successfully completed
- Cryogenics in preparation


M4/M5 Beamline


Delivery Ring installation Complete
(in operation for Muon g-2 experiment)

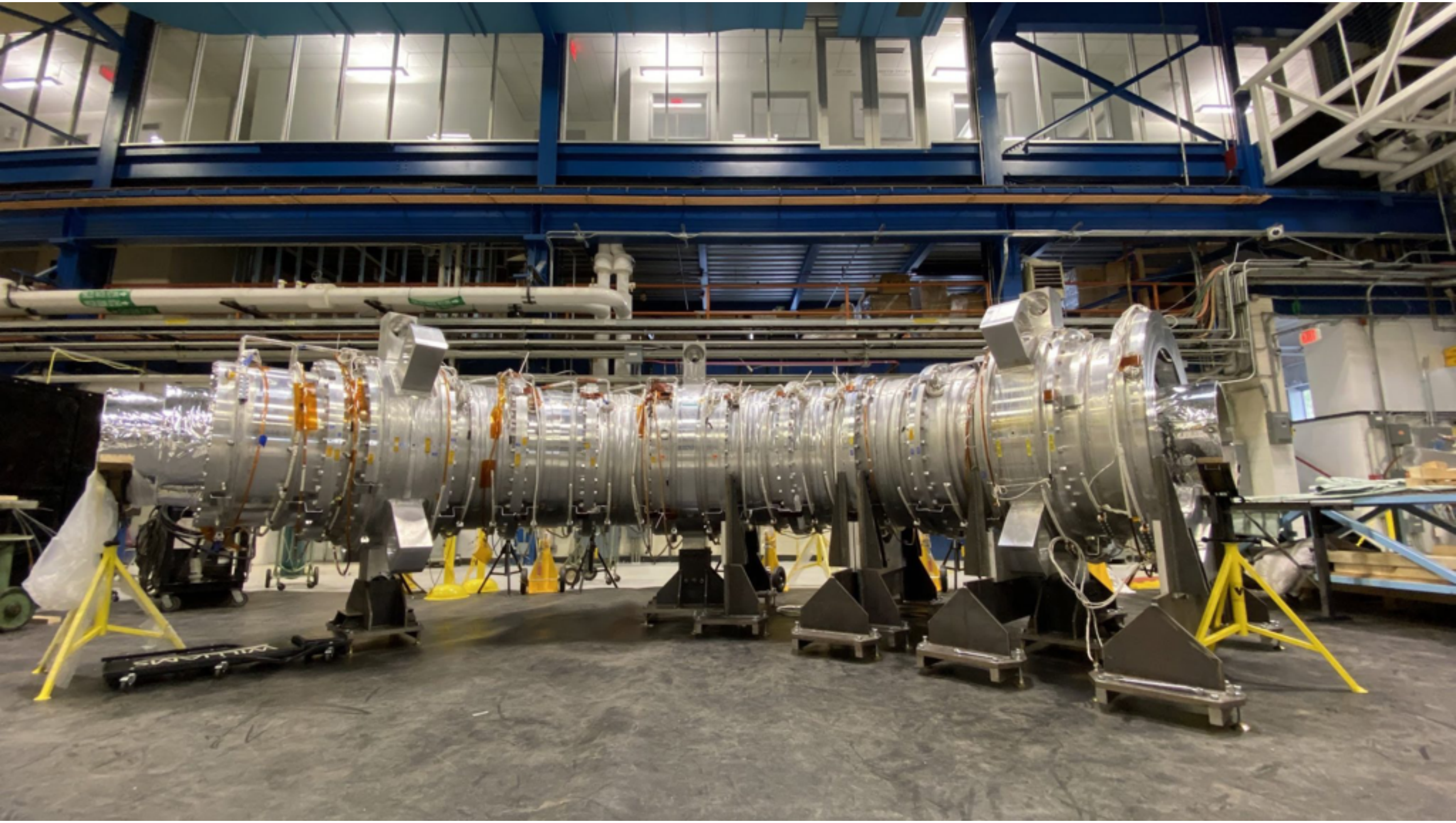

70 x 70 PS Model Coil


Completed TS coils at ASG, Italy


Completed TS Unit (4 coils)

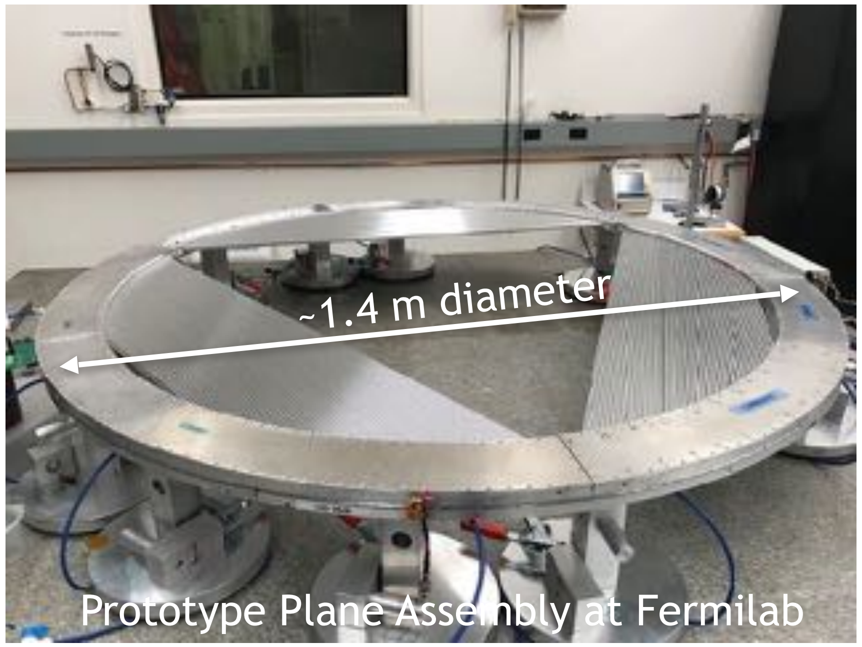
Mu2e Status

Fermilab news Nov. 2020



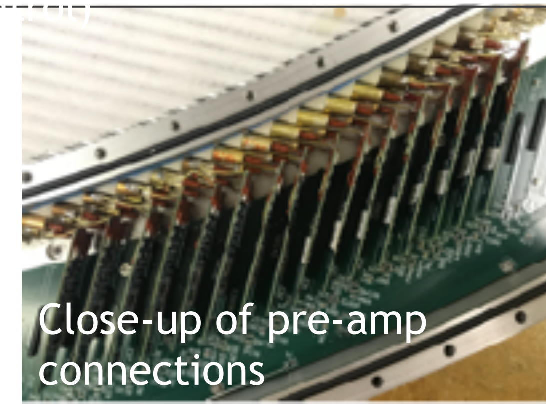
Mu2e Detectors

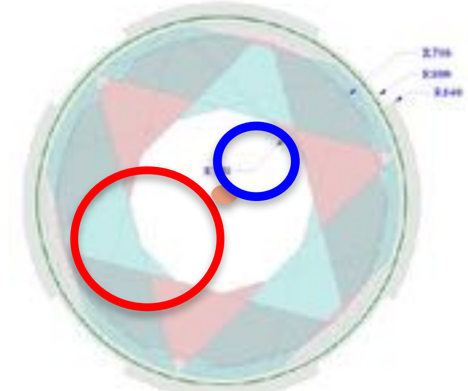
Straw-tube tracker

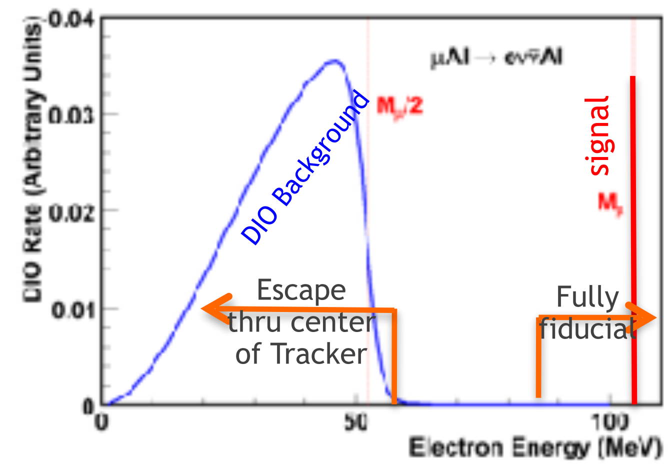


Prototype Plane Assembly at Fermilab

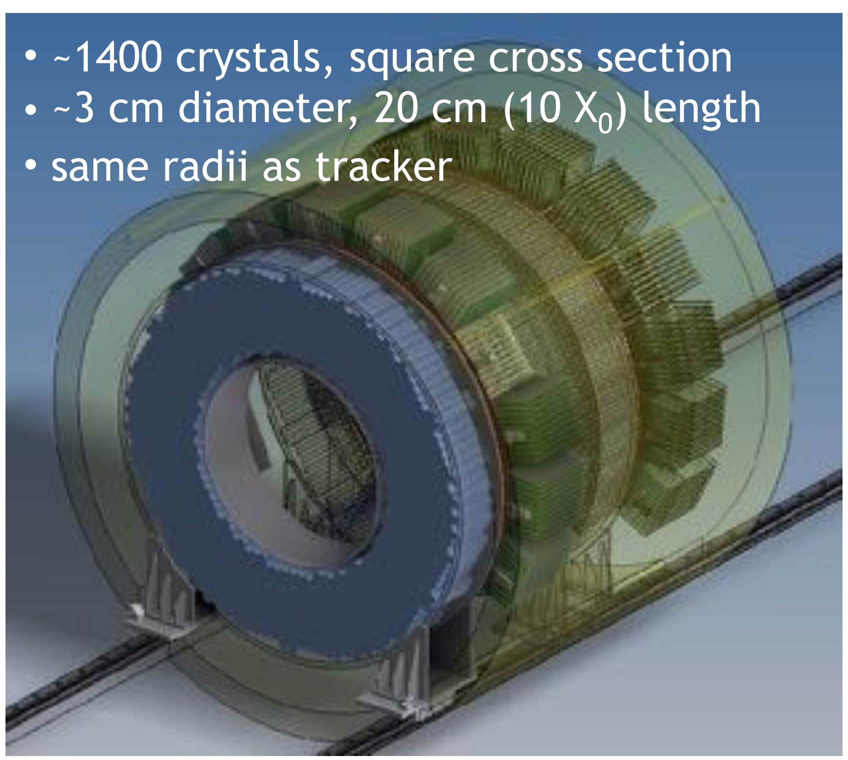
Prototype DRAC board
(Digitization Readout And


Close-up of pre-amp connections





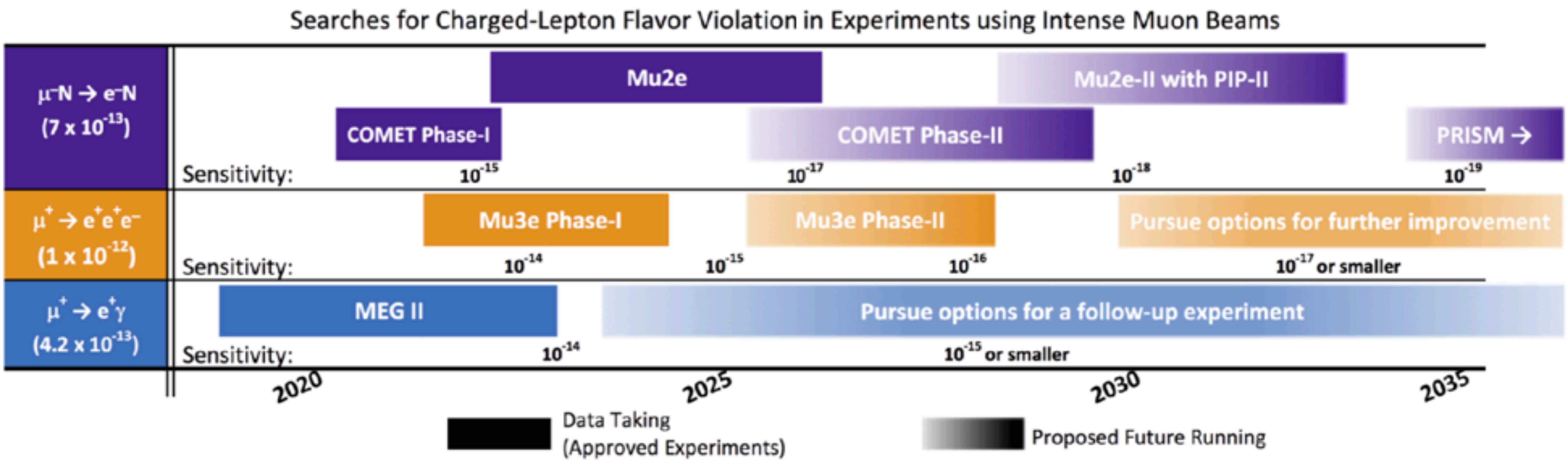
CsI Calorimeter




Prototype crystals for testing

- CsI crystal calorimeter
  - Important for particle ID
  - ~7% energy resolution @ 105 MeV
  - <200 ps timing resolution
- 2 disks oriented transverse to beam line, 70 cm apart
- Readout : 2 photo-sensors per crystal (MPPCs)

A Possible Time Line

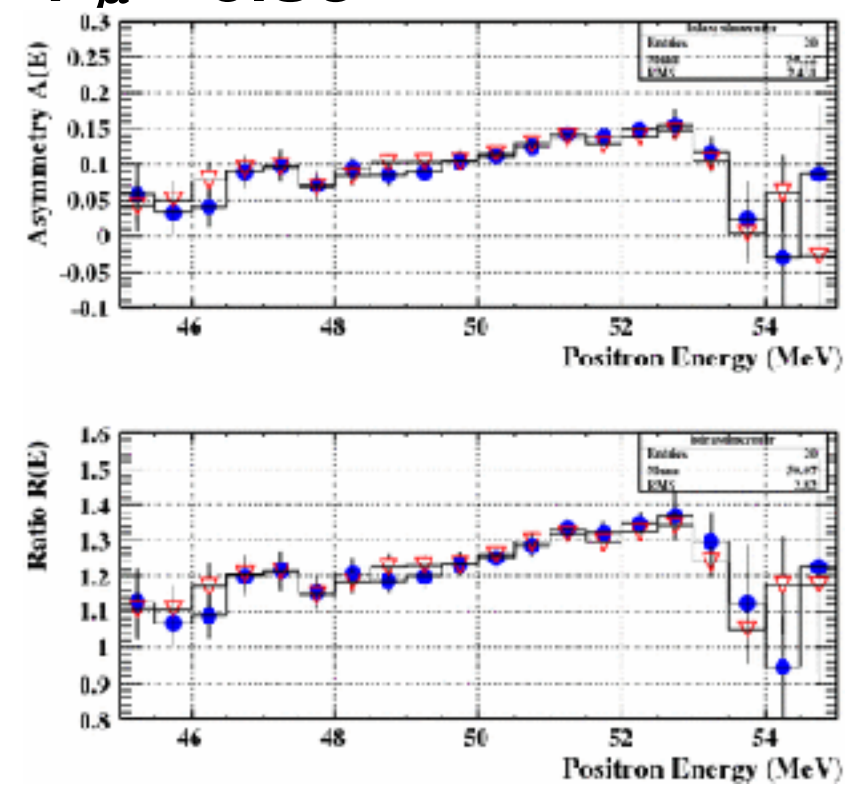


Input to Eur. Particle Physics Strategy
"Charged Lepton Flavour Violation using Intense Muon Beams at Future Facilities"

Once the signal is found...

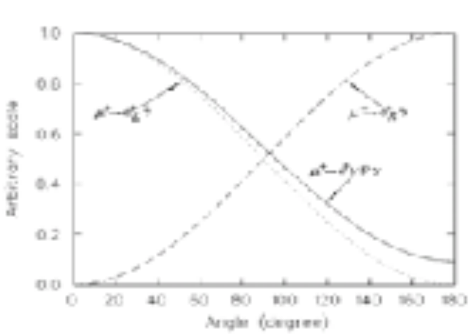
- MEG II
  - Muon bram is polarized (P_μ=-0.85)
  - Gamma angular distribution
- Mu3e
  - Invariant mass distribution $m_1(e^+e^-)$ vs. $m_2(e^+e^-)$

P_μ=-0.85

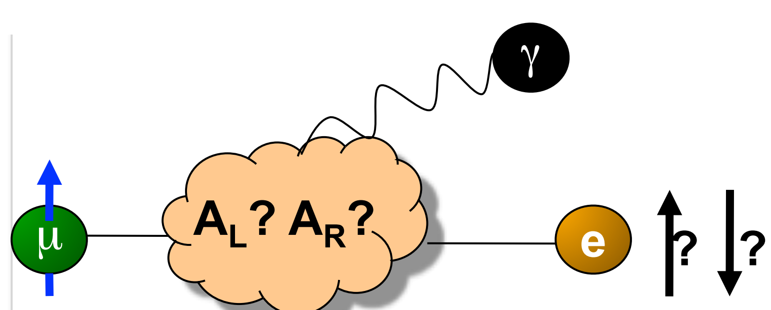


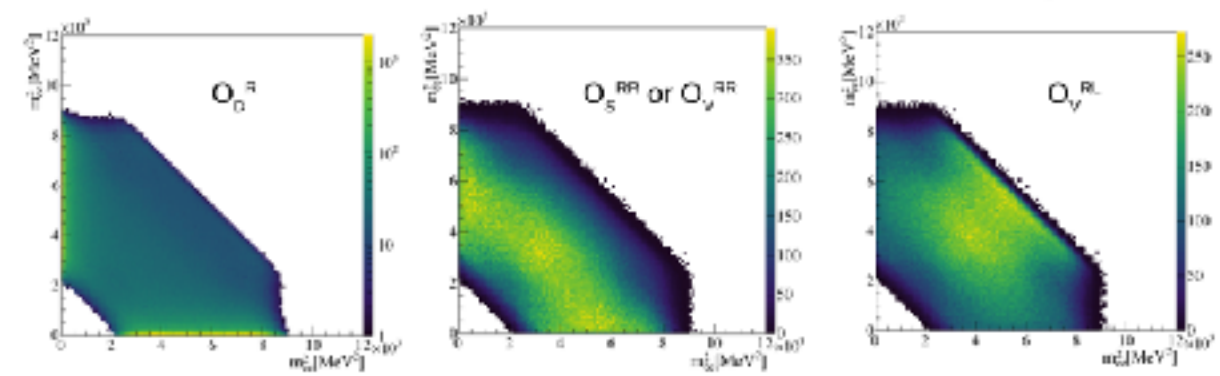
MEG, EPJ 2016 76:223

$$\mathscr{L}_{\rm eff} = \frac{1}{\Lambda^2}\left[C_D^L \mathscr{O}_D^L + C_D^R \mathscr{O}_D^R + C_S^{LL} \mathscr{O}_S^{LL} + C_S^{RR} \mathscr{O}_S^{RR} + C_V^{LL} \mathscr{O}_V^{LL} + C_V^{RR} \mathscr{O}_V^{RR} + C_V^{LR} \mathscr{O}_V^{LR} + C_V^{RL} \mathscr{O}_V^{RL} \right] + \text{h.c.}$$



Kuno and Okada, PRL 77(1996)434

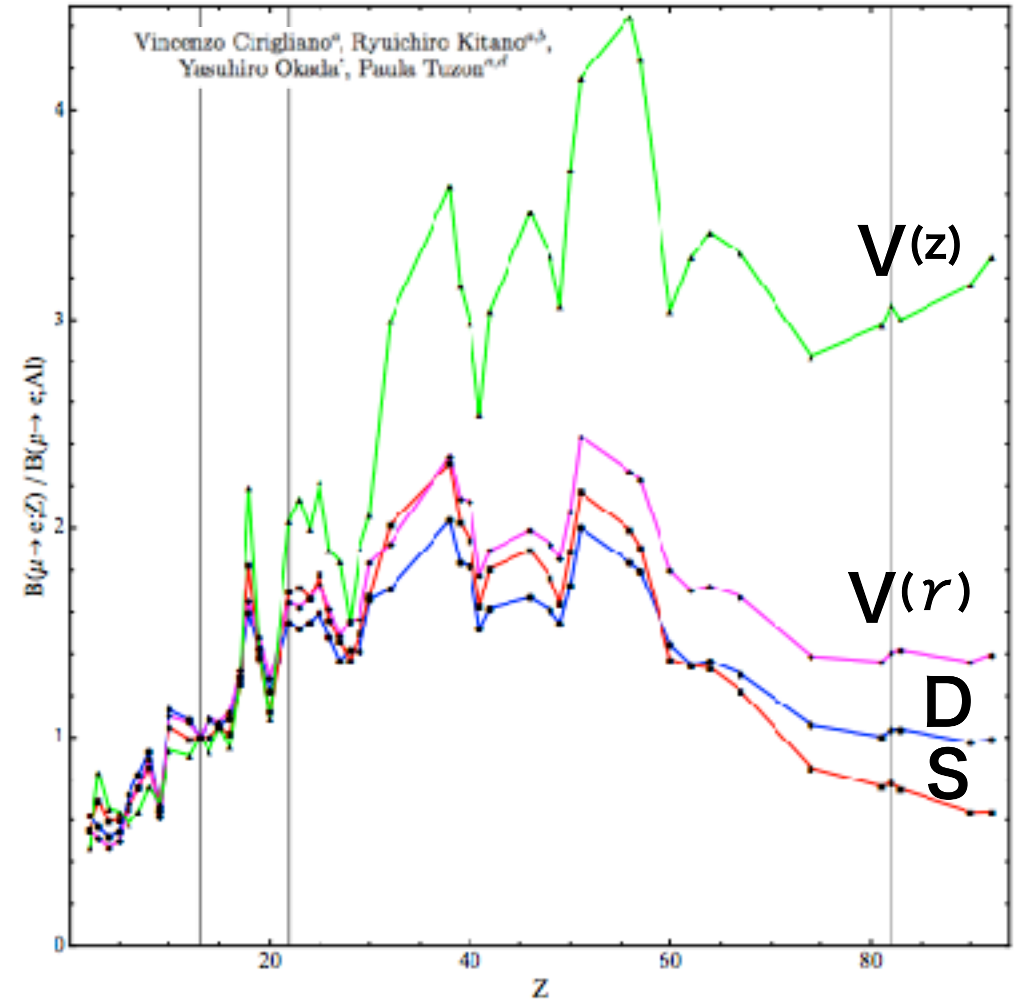




thesis A.-K.Perrevoort

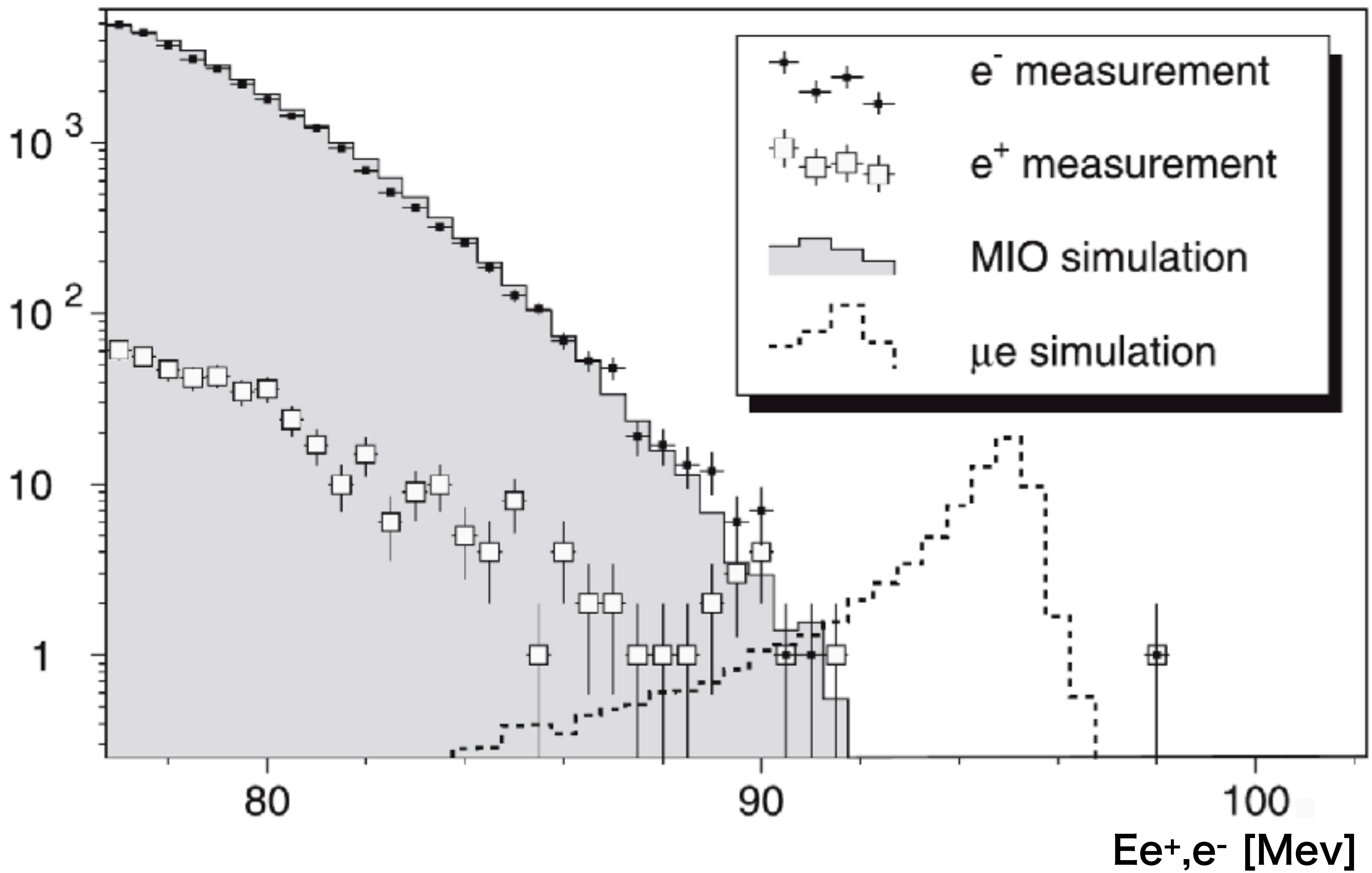
Once the signal is found...

- Comparison of signal rates of μ→eγ, μ→eee, and μ-e conversion will clarify the physics behind cLFV reactions
- Even discovery only in μ-e conversion
  - Different target material contains different quark contents
  - May be possible to see the target dependence on the mu-e conversion rate
  - Discriminate the principal interaction of the mu-e conversion?
    - Vector type, Dipole type, or Scaler type?
- Possible taget
  - DeeMe: C (& Si)
  - COMET & Mu2e: Al (& Ti in future? & Pb in far future ??)



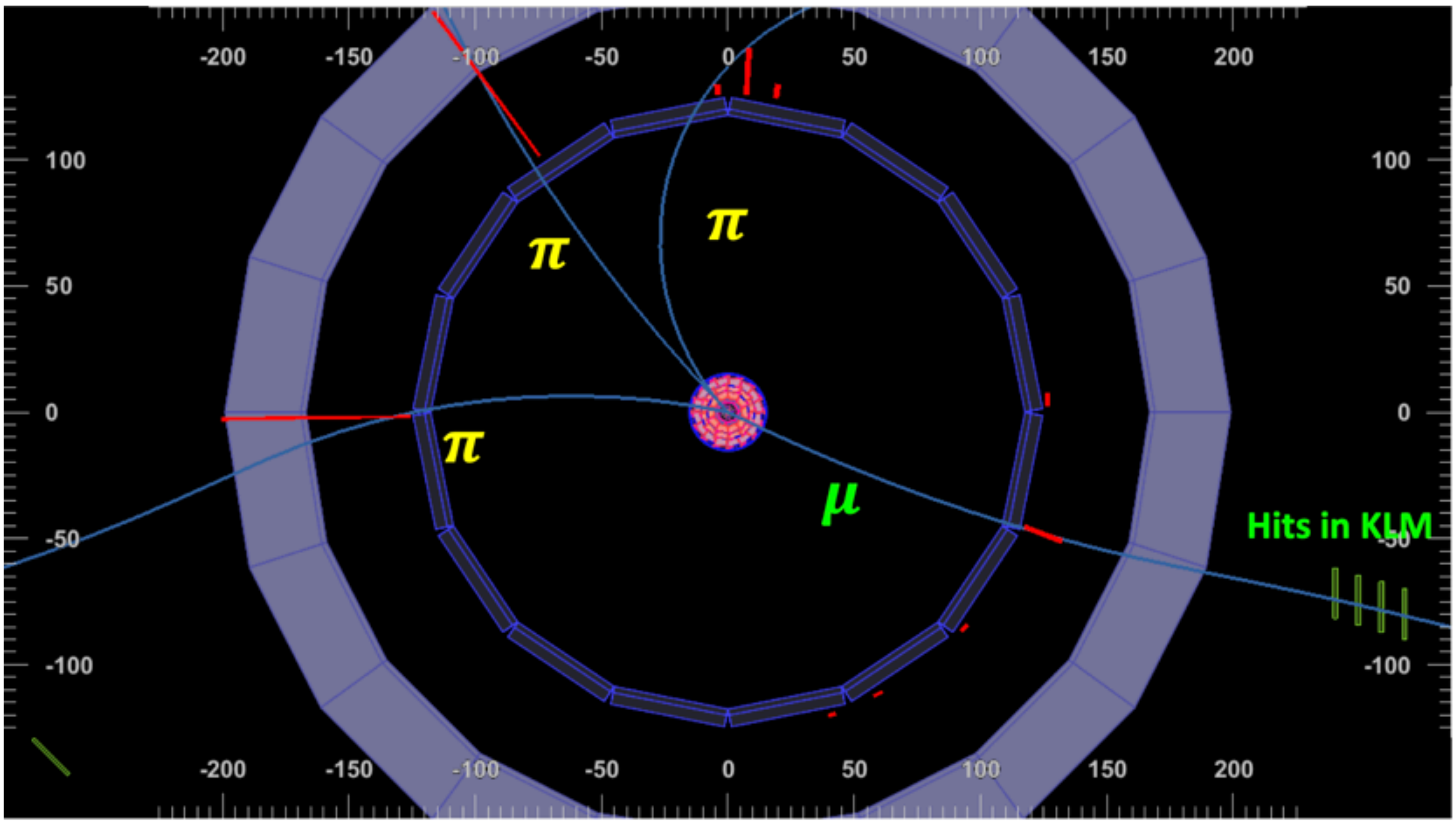
	Al	Ti
lifetime	864 ns	330 ns
time window	0.3	0.2
signal	1	1.5
net	0.3	0.3

Lepton Number Violation?



SINDRUM II

cLFV Physics with tau Leptons

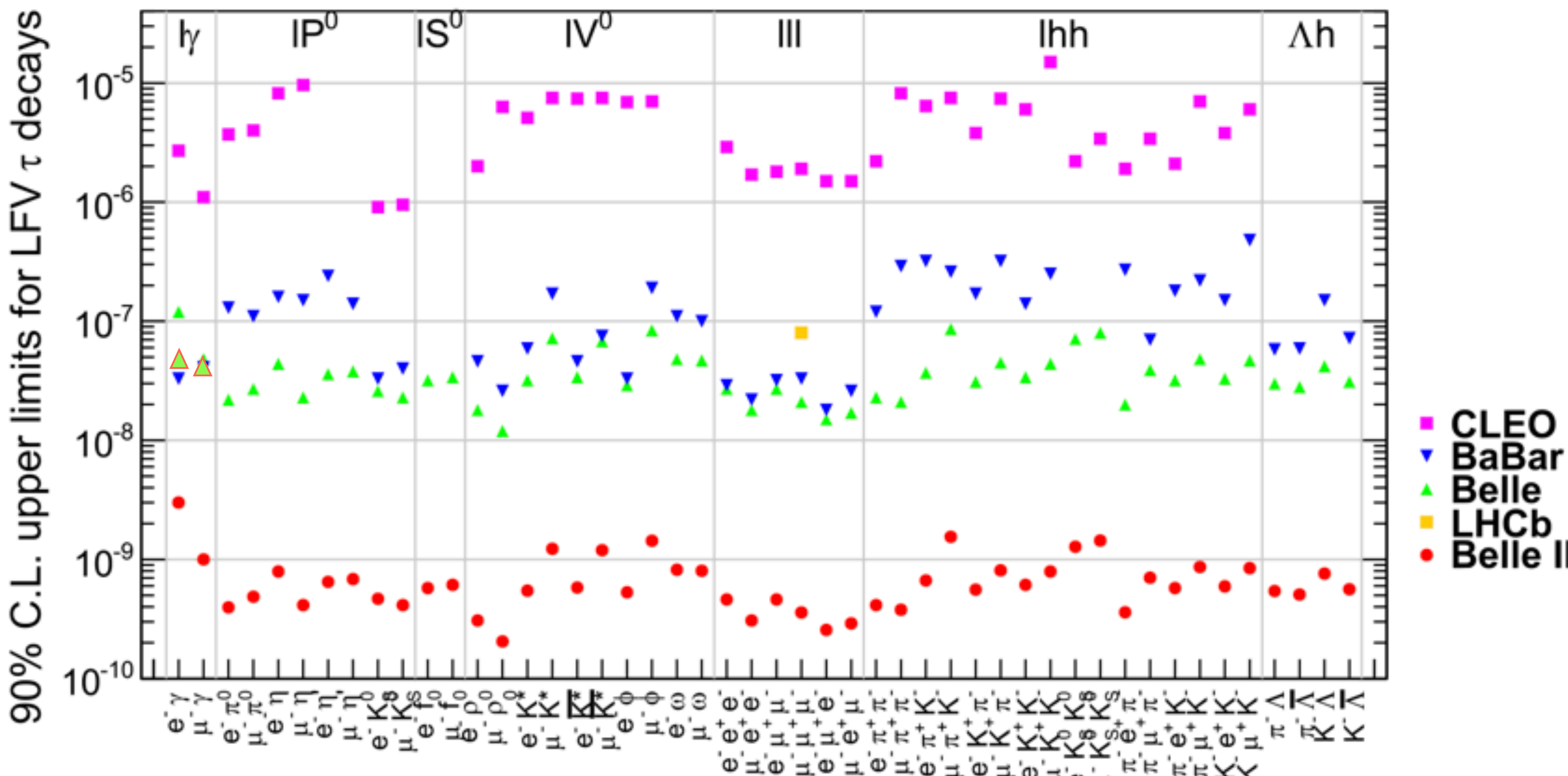


Belle II

cLFV Physics with tau Leptons

- $Br(\tau \to \mu\gamma) < 4.2\times10^{-8}$
- $Br(\tau \to e\gamma) < 5.6\times10^{-8}$

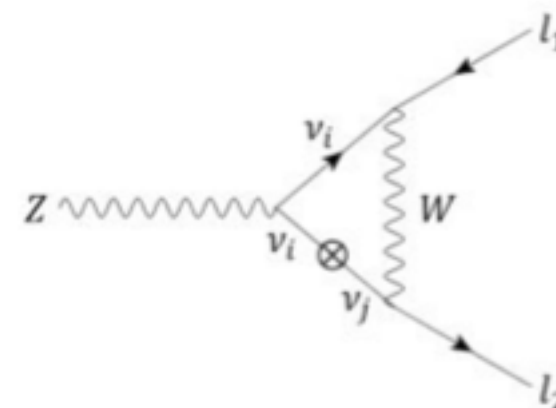
Moriond 2021

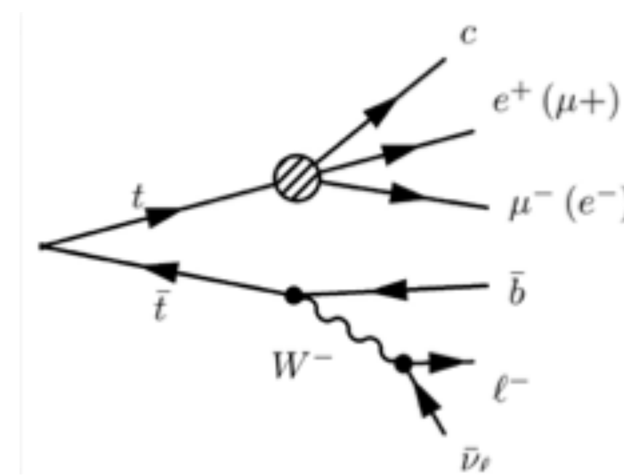


The Belle II Physics Book arXiv:1808.10567

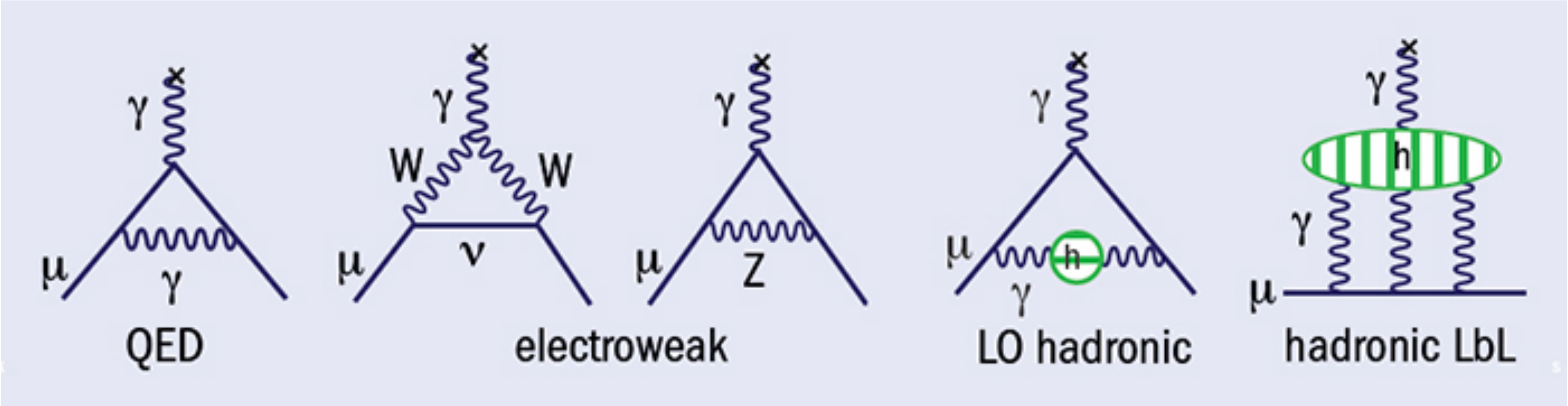
cLFV Physics at Collider Experiments

- CMS & ATLAS
  - LFV Z decays:
    - $B(Z \to \mu e) < 7.3\text{-}7.5 \times 10^{-7}$, $B(Z \to \tau\mu) < 1.3 \times 10^{-5}$
    - LEP has equivalent or slightly better upper limits
  - LFV top decays:
    - $B(t \to ll'q) < 1.86 \times 10^{-5}$, $B(t \to e\mu q) < 6.6 \times 10^{-6}$
  - LFV Higgs decays:
    - $B(H \to \mu\tau) < 0.25\text{-}0.28\%$, $B(H \to e\tau) < 0.47\text{-}0.61\%$



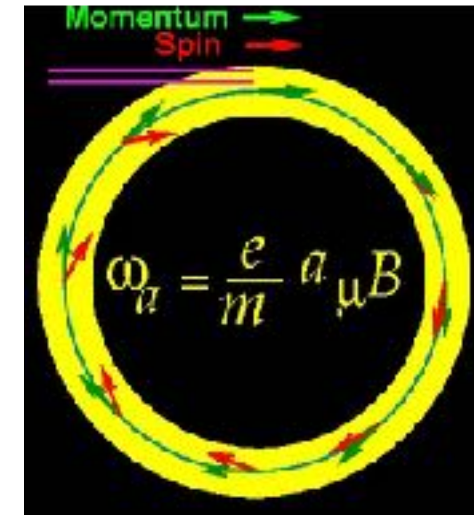


Muon g-2 & EDM



CERN Courier

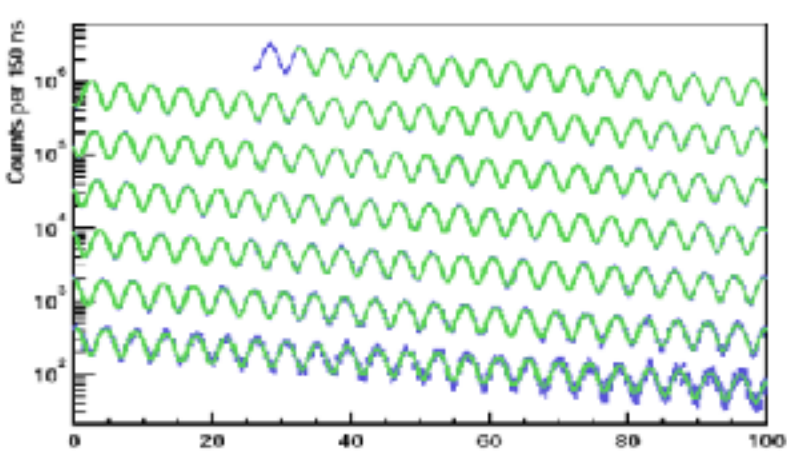
Final Muon g-2 Measurement



- In uniform magnetic field, muon spin rotates ahead of momentum due to **g-2≠0**
- General form of spin precession vector:

$$\vec{\omega} = -\frac{e}{m}\left[a_\mu \vec{B} - \left(a_\mu - \frac{1}{\gamma^2 - 1}\right)\frac{\vec{\beta}\times\vec{E}}{c} + \frac{\eta}{2}\left(\vec{\beta}\times\vec{B} + \frac{\vec{E}}{c}\right)\right]$$

BNL/FNAL approach
γ=29.3 (P=3.09 GeV/c)

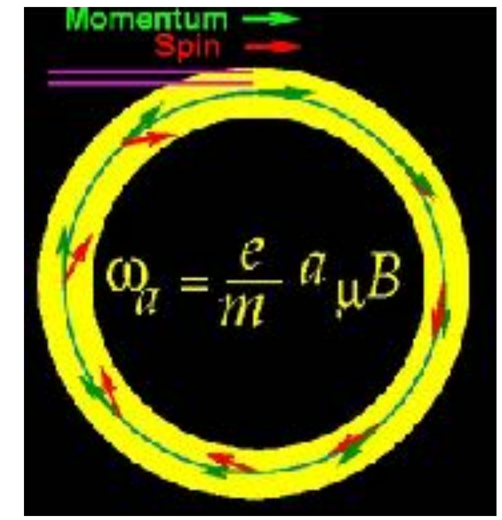


$$\vec{\omega} = -\frac{e}{m}\left[a_\mu \vec{B} + \frac{\eta}{2}\left(\vec{\beta}\times\vec{B} + \frac{\vec{E}}{c}\right)\right]$$

KEK
Unravelling the mysteries of matter, life and the universe.

J-PARC

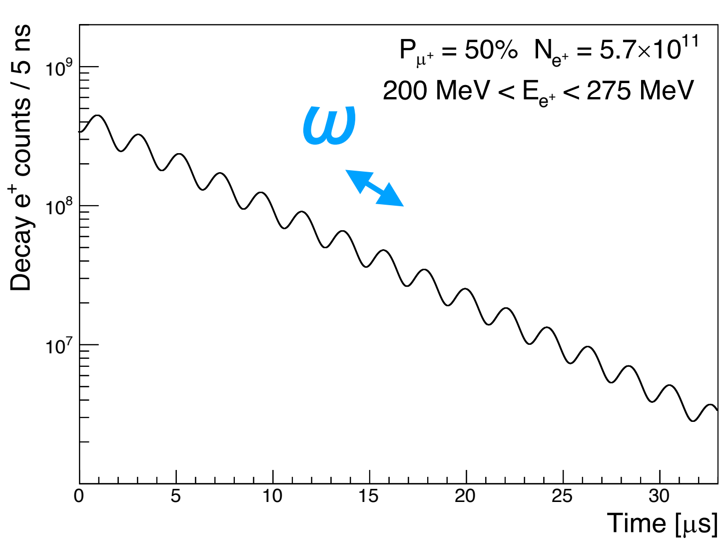
J-PARC Muon g-2/EDM Measurement



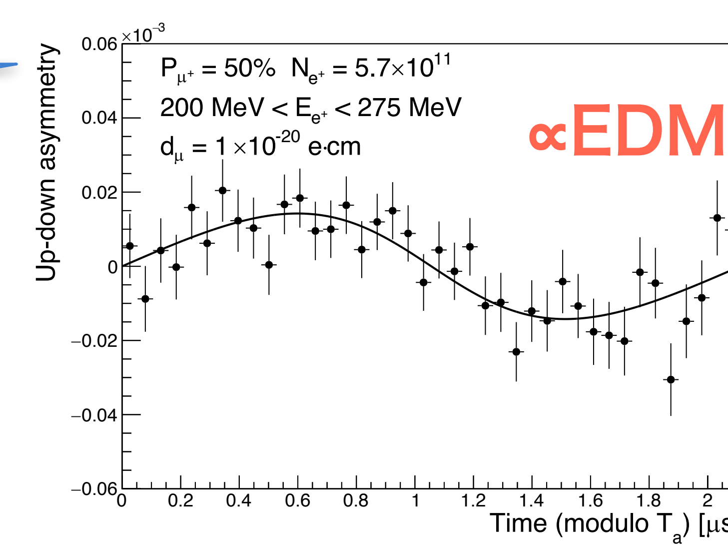
- In uniform magnetic field, muon spin rotates ahead of momentum due to g-2≠0
- General form of spin precession vector:

$$\vec{\omega} = -\frac{e}{m}\left[a_\mu \vec{B} - \left(a_\mu - \frac{1}{\gamma^2 - 1}\right)\frac{\vec{\beta}\times\vec{E}}{c} + \frac{\eta}{2}\left(\vec{\beta}\times\vec{B} + \frac{\vec{E}}{c}\right)\right]$$

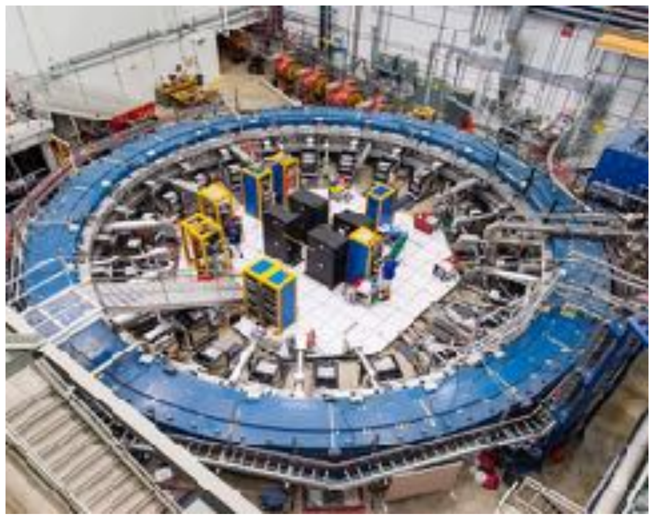
J-PARC approach
E = 0 at any γ



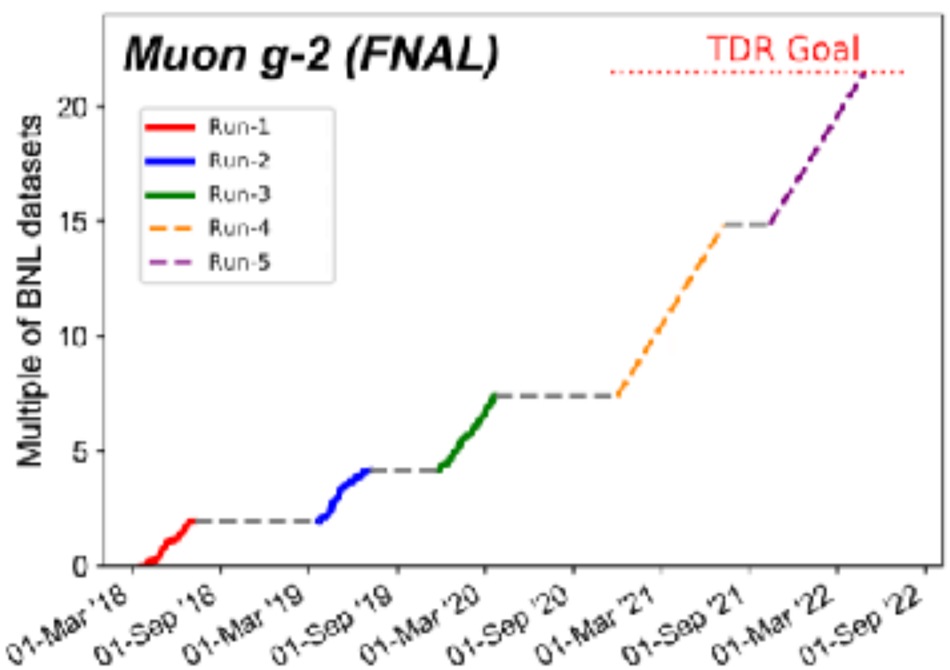
$$\vec{\omega} = -\frac{e}{m}\left[a_\mu \vec{B} + \frac{\eta}{2}\left(\vec{\beta}\times\vec{B}\right)\right]$$



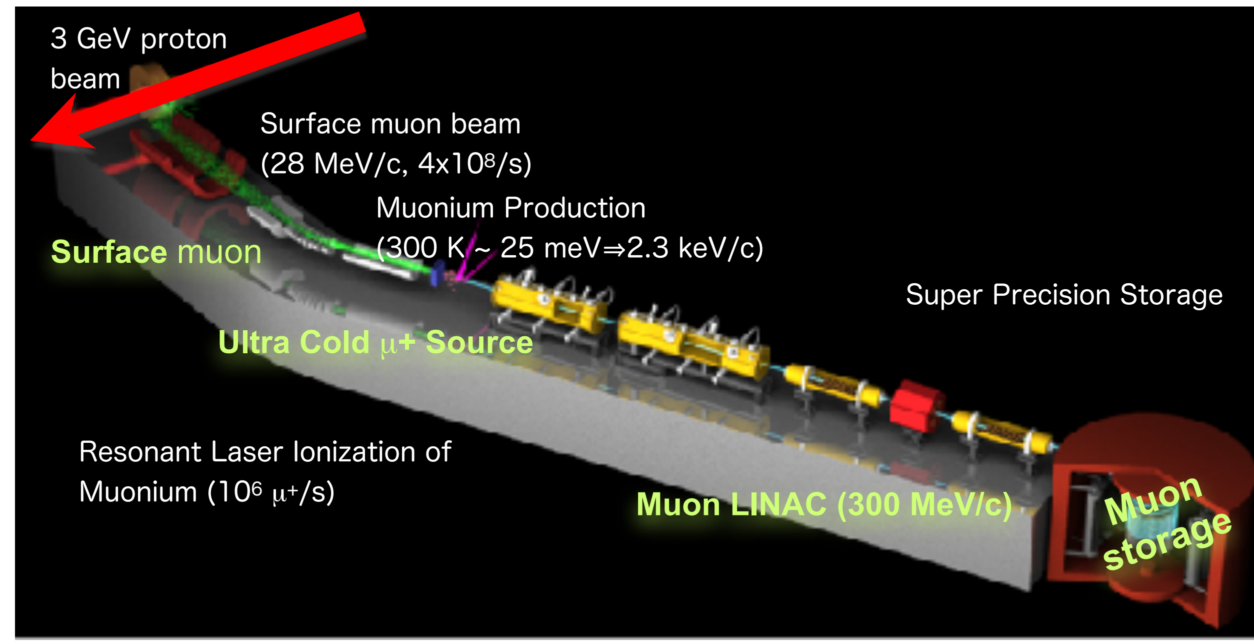
Muon g-2/EDM Experiments

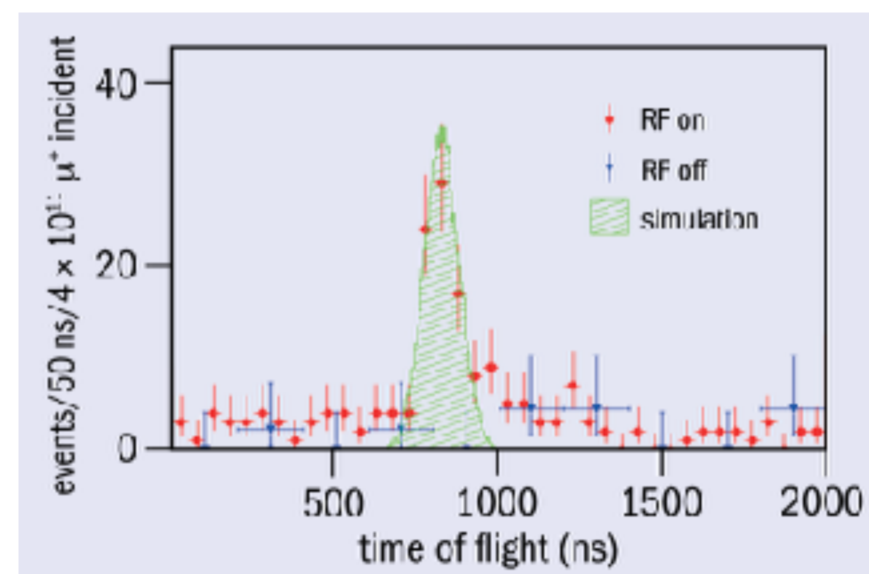


FNAL E989



J-PARC E34(g-2/EDM)





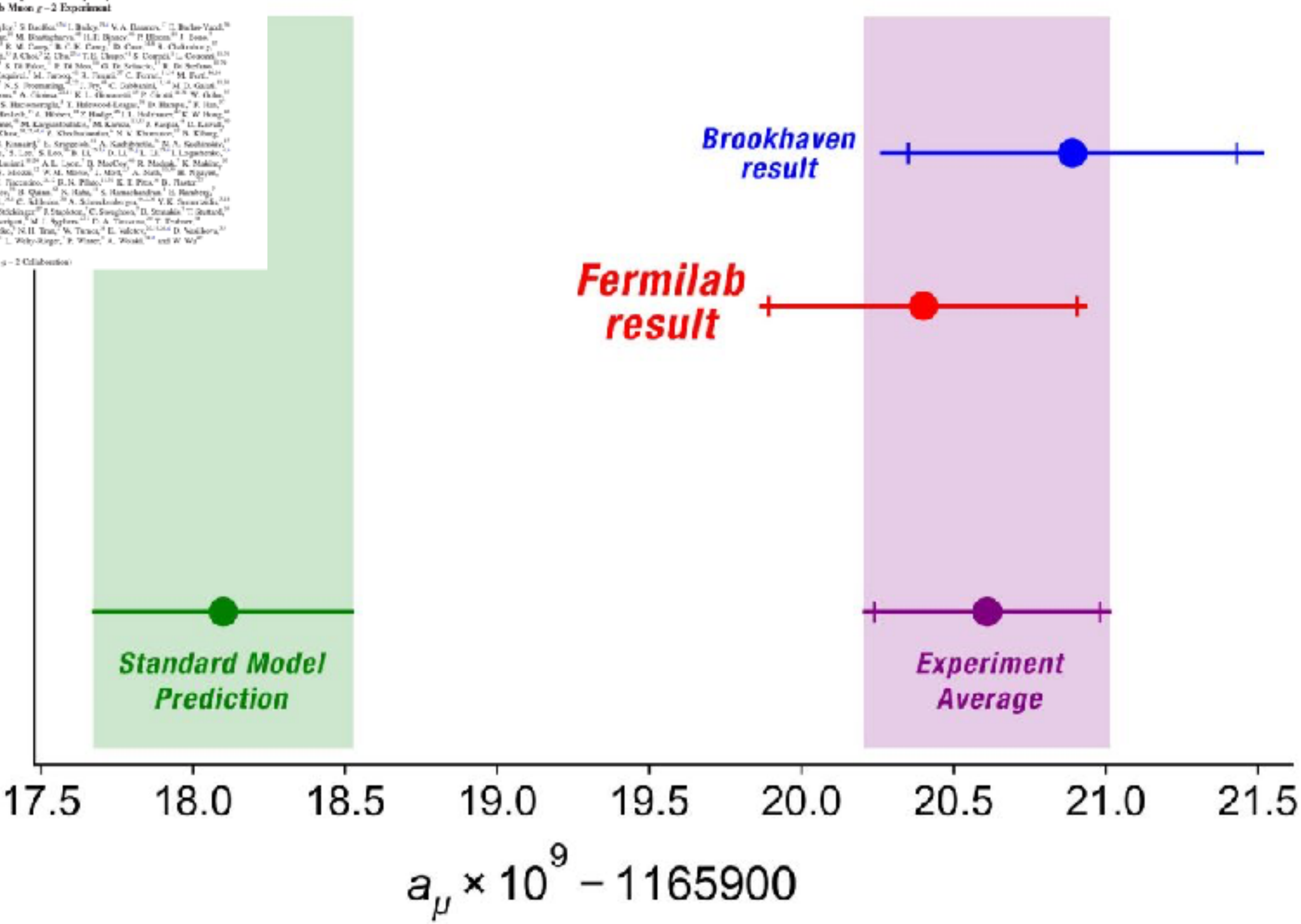
"Muons accelerated in Japan"
July 2018, CERN Courier

- Run 1 data analysis result released !
- Run 2-3 data collection complete in 2019
- Run 4 data acquisition in preparation

FNAL g-2 new result !


PHYSICAL REVIEW D 103, 072002 (2021)

Measurement of the anomalous precession frequency of the muon in the Fermilab Muon g − 2 Experiment

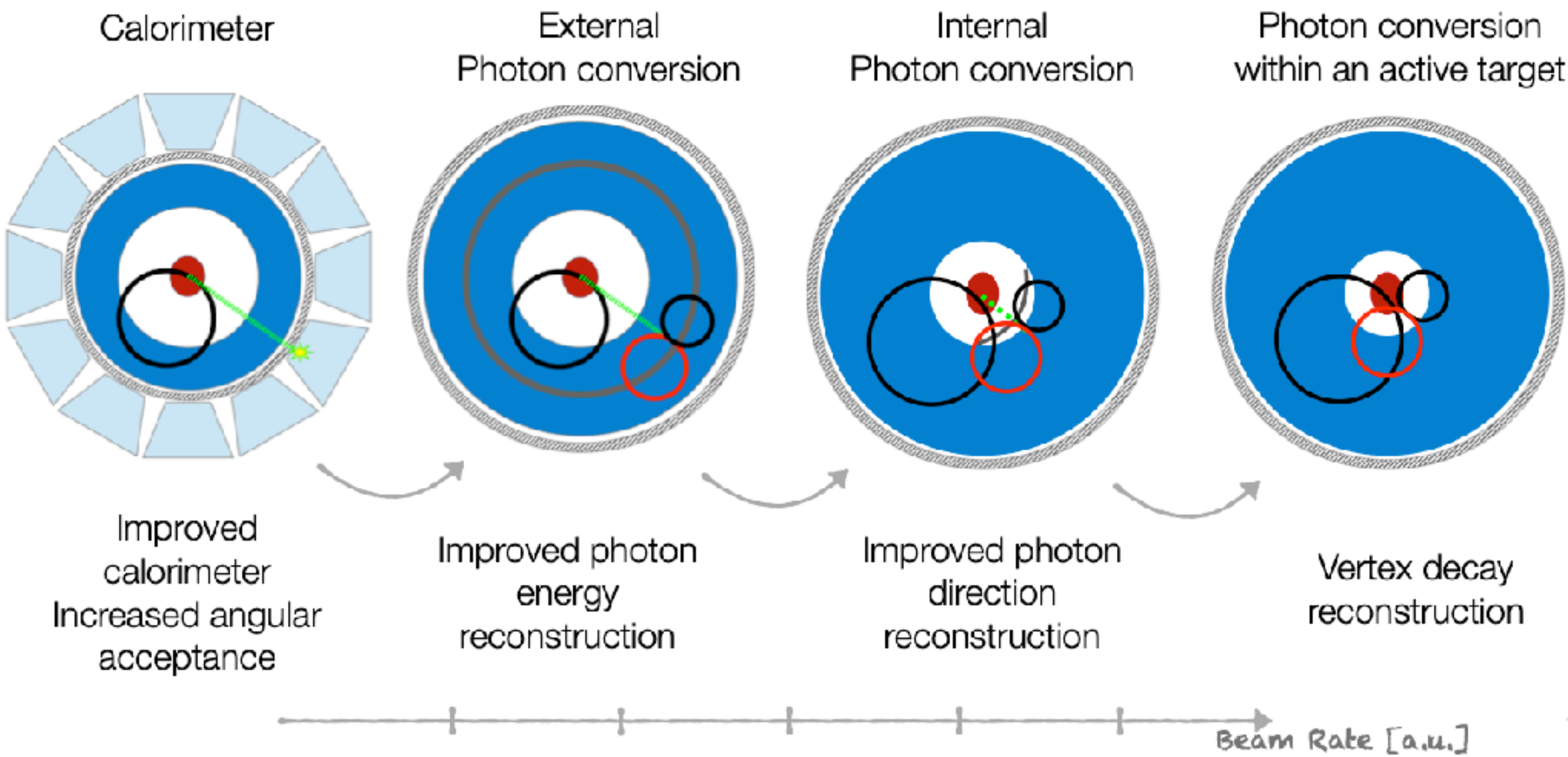


Summary

- Strong physics motivation to search for muon CLFV reactions
- Future plans of muon CLFV experiments
  - MEG II & Mu3e
  - COMET & Mu2e
- Important to achieve similar sensitivities in all channels to clarify the physics behind signal (even in case of exclusion)
- More physics results expected in coming years

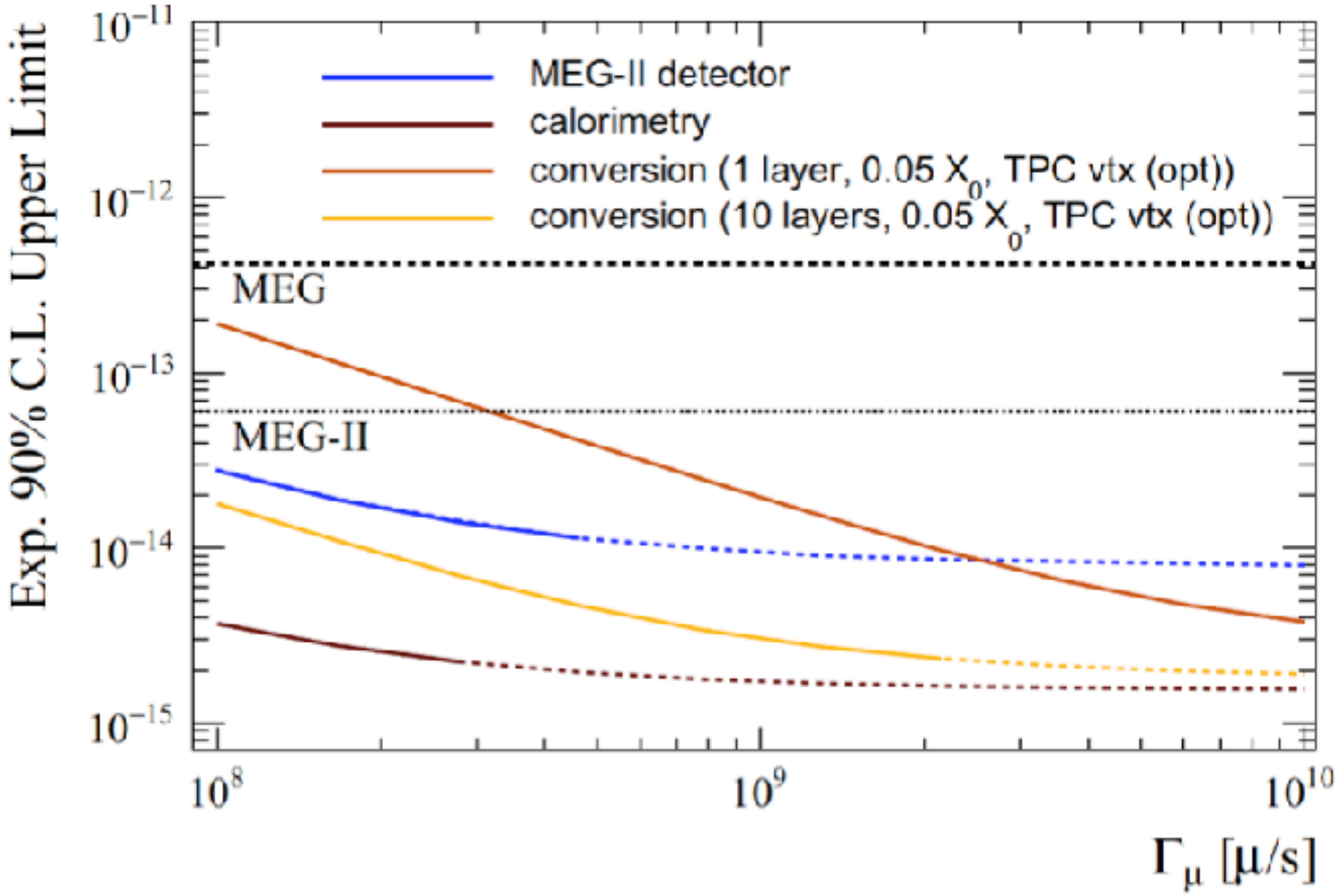
Beyond MEG II

Experimental approached as a function of the beam rate



Beyond MEG II
Projections

- Based on the current technology development the calorimetry is still an option for beam rate not higher than 5 10^8 mu/s



Calorimetry("MEG" approach):

E_γ : 0.8%

t_γ = 30 ps

X_γ ~ O(3-5) mm

ε_{det} : 60%

Acceptance : 70%

A. Papa @ HIMB Workshop 2021