COMET

Osaka University

Muons, Mu_02
COMET
- muon to electron conversion -

Yoshitaka Kuno
Department of Physics
Osaka University

2019 Joint workshop of
TYL /FJPPL and FKPPL
Jeju, Korea
May 10th, 2019

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Outline

- Aim
- People
- Report 2018-2019
- Plan 2019-2020
- Budget request

People

- French side
  - Frederic KAPUSTA (LPNHE/IN2P3)
  - Wilfrid da SILVA (LPNHE/SU)

COMET official Logo

- Japanese side
  - Yoshitaka KUNO (Osaka)
  - Naohito SAITO (J-PARC)
  - Satoshi MIHARA (KEK)
  - Tsutomu MIBE (KEK)
  - Akira SATO (Osaka)
  - Hajime NISHIGUCHI (KEK)
  - Yoshinori FUKAO (KEK)
  - Masashi OTANI (KEK)
  - Dorian Pieters (Osaka)

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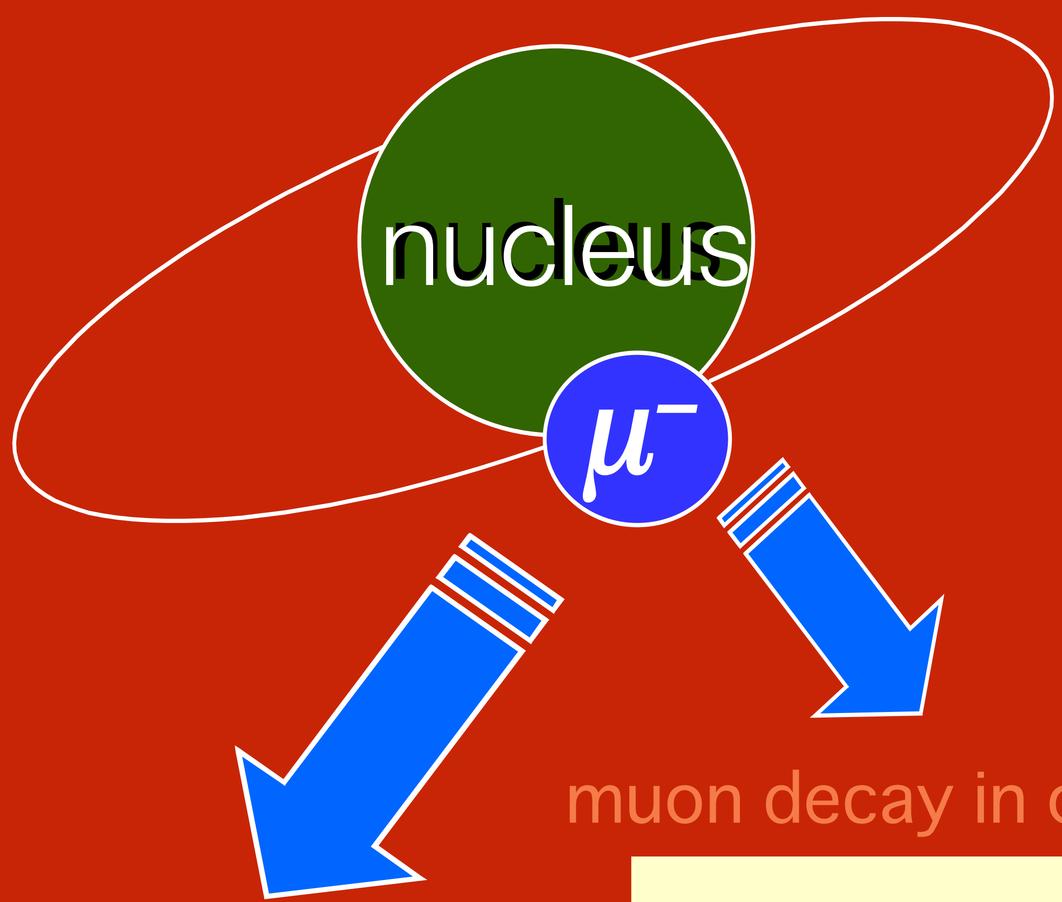
What is Muon to Electron Conversion ?

What is $\mu \rightarrow e$ Conversion ?

What is μ→e Conversion ?

1s state in a muonic atom



muon decay in orbit

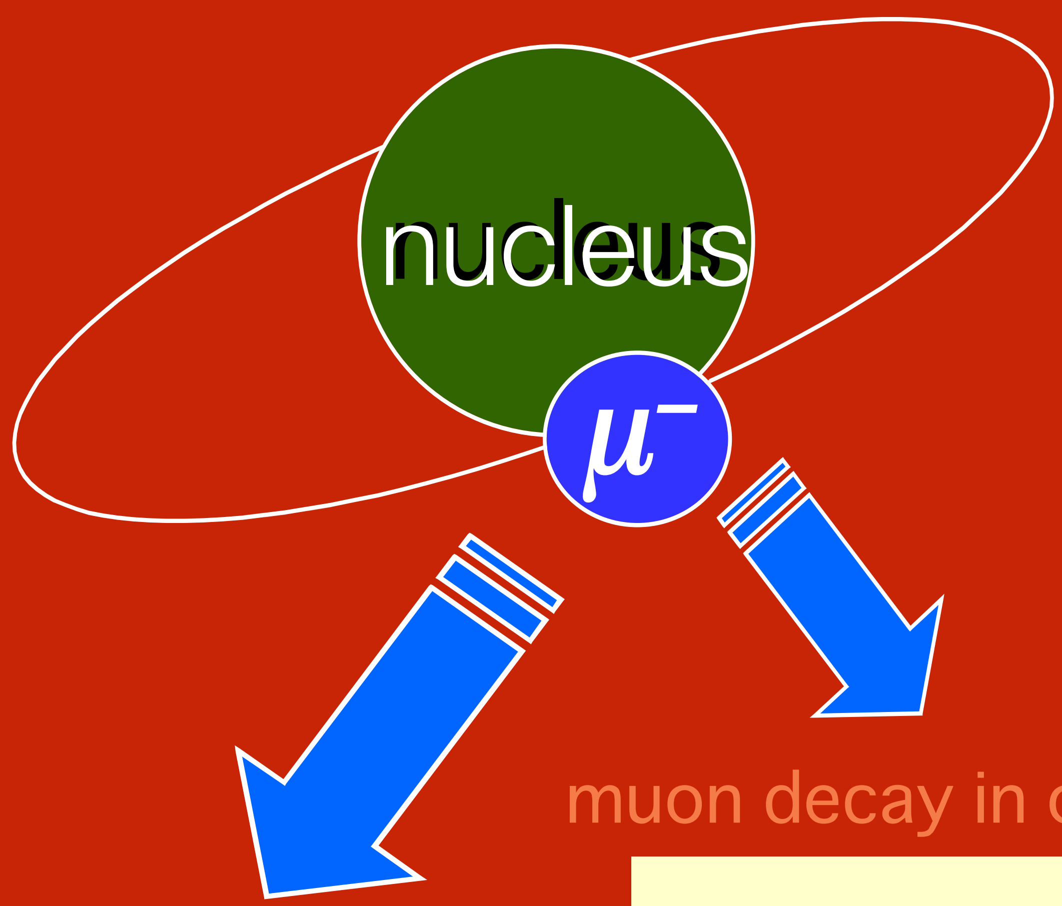
$$\mu^- \rightarrow e^- \nu \bar{\nu}$$

nuclear muon capture

$$\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1)$$

What is μ→e Conversion ?

1s state in a muonic atom



muon decay in orbit

$$\mu^- \rightarrow e^- \nu \overline{\nu}$$

nuclear muon capture

$$\mu^- + (A,Z) \rightarrow \nu_\mu + (A,Z-1)$$

Neutrino-less muon nuclear capture

$$\mu^- + (A,Z) \rightarrow e^- + (A,Z)$$

coherent process $\propto Z^5$

Event Signature :

a single mono-energetic electron of 105 MeV

Backgrounds:

(1) physics backgrounds

(2) beam-related backgrounds

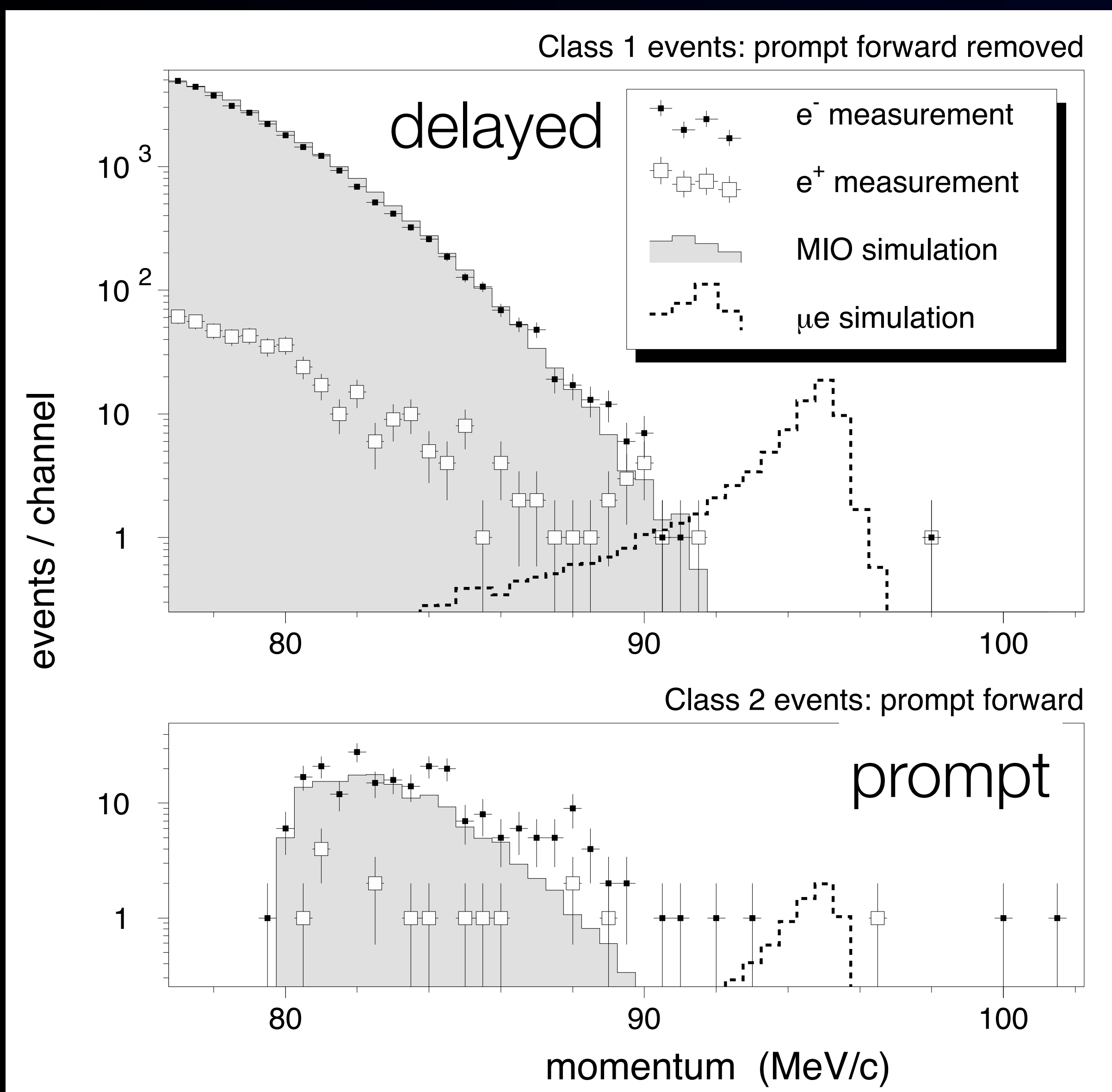
(3) cosmic rays, false tracking

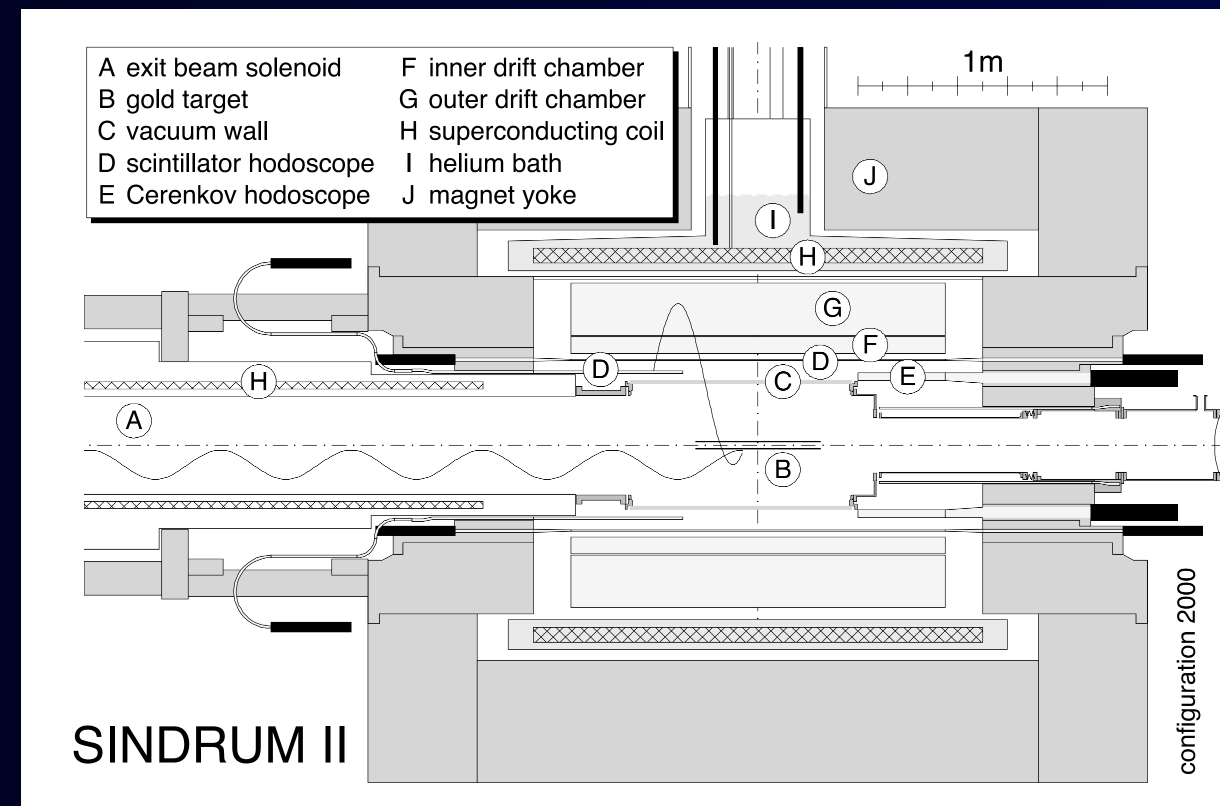
$$\mathrm{CR}(\mu^-\mathrm{N} \rightarrow e^-\mathrm{N}) \equiv \frac{\Gamma(\mu^-\mathrm{N} \rightarrow e^-\mathrm{N})}{\Gamma(\mu^-\mathrm{N} \rightarrow \mathrm{all})}$$

Current Limits on μ→e Conversion

Current Limits on μ→e Conversion

SINDRUM-II (PSI)

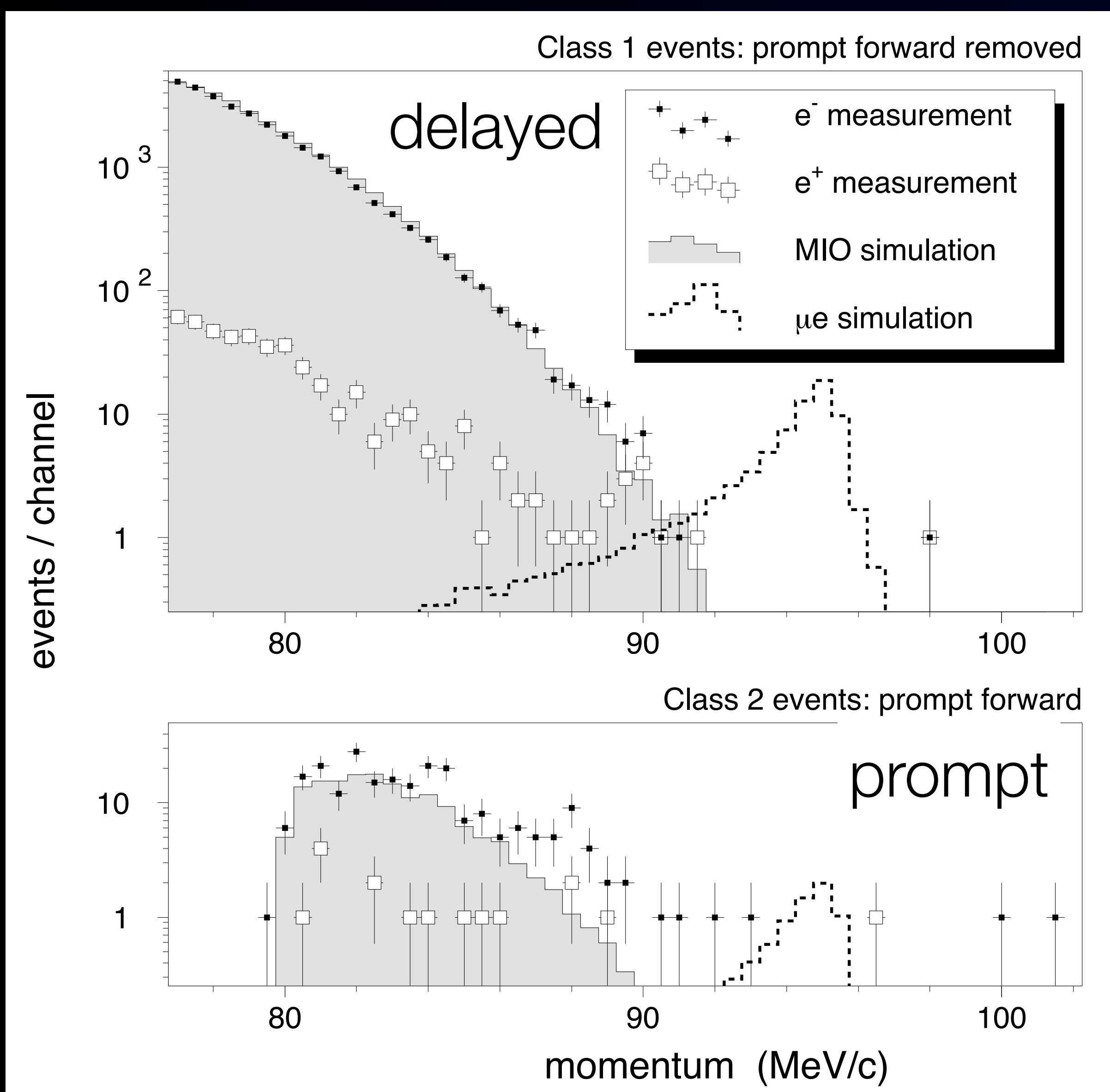




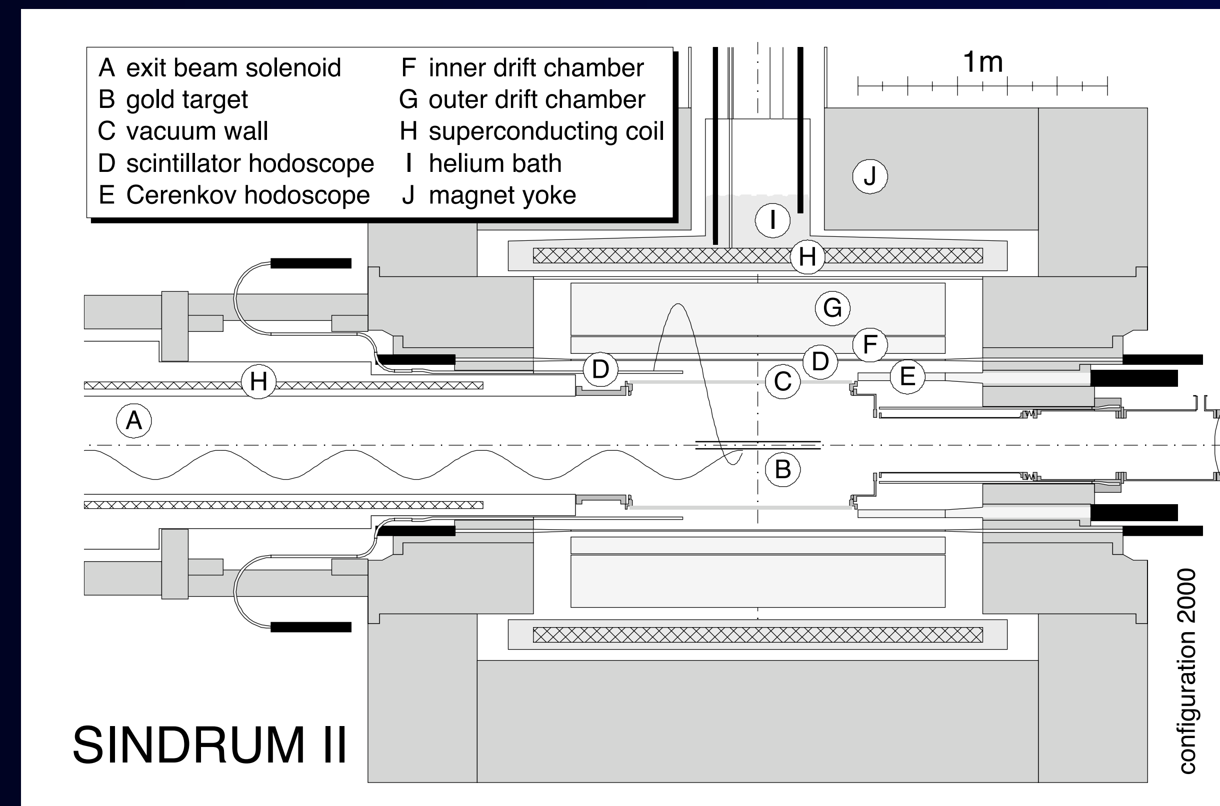
$$B(\mu^- + Au \to e^- + Au) < 7 \times 10^{-13}$$

Current Limits on μ→e Conversion

SINDRUM-II (PSI)



$$B(\mu^- + Au \rightarrow e^- + Au) < 7 \times 10^{-13}$$



	Z	S	CR limit
sulfur	16	0	7×10^{-11}
titanium	22	0,5/2,7/2	4.3×10^{-12}
copper	39	3/2	1.6×10^{-8}
gold	79	0,5/2	7×10^{-13}
lead	82	0 (1/2)	4.6×10^{-11}

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Introduction to the COMET Experiment
Phase-I and Phase-II

COMET = COherent Muon to Electron Transition

COMET Phase-I : J-PARC E21

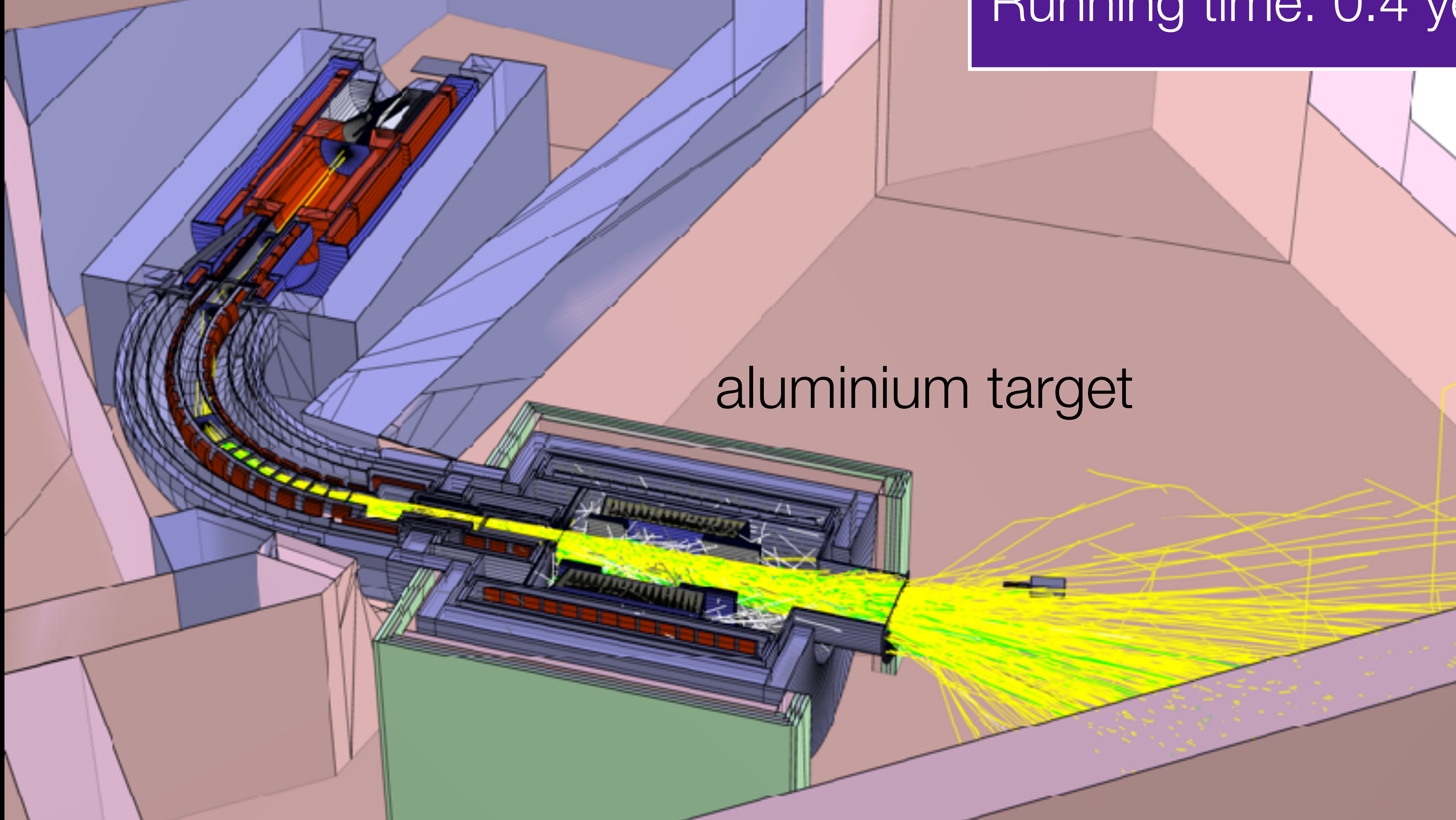
aluminium target

COMET = COherent Muon to Electron Transition

COMET Phase-I : J-PARC E21

Phase-I

proton beam power = 3.2 kW



Single event sensitivity : 2×10^{-15}

a factor of 100 improvement

Running time: 0.4 years (1.2×10^{7}s)

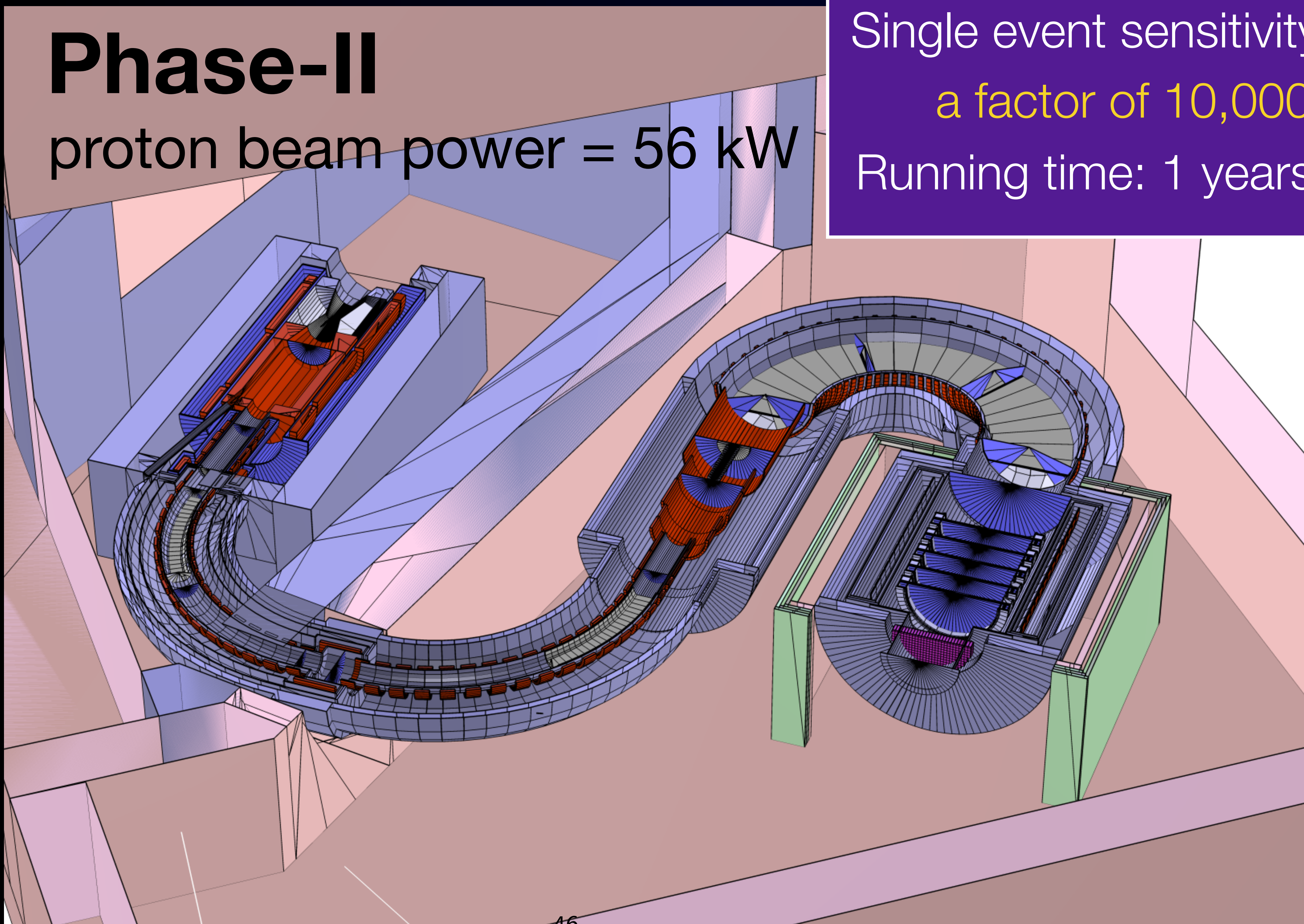
COMET Phase-II : J-PARC E21

COMET Phase-II : J-PARC E21

Single event sensitivity : 2.6×10^{-17}

a factor of 10,000 improvement

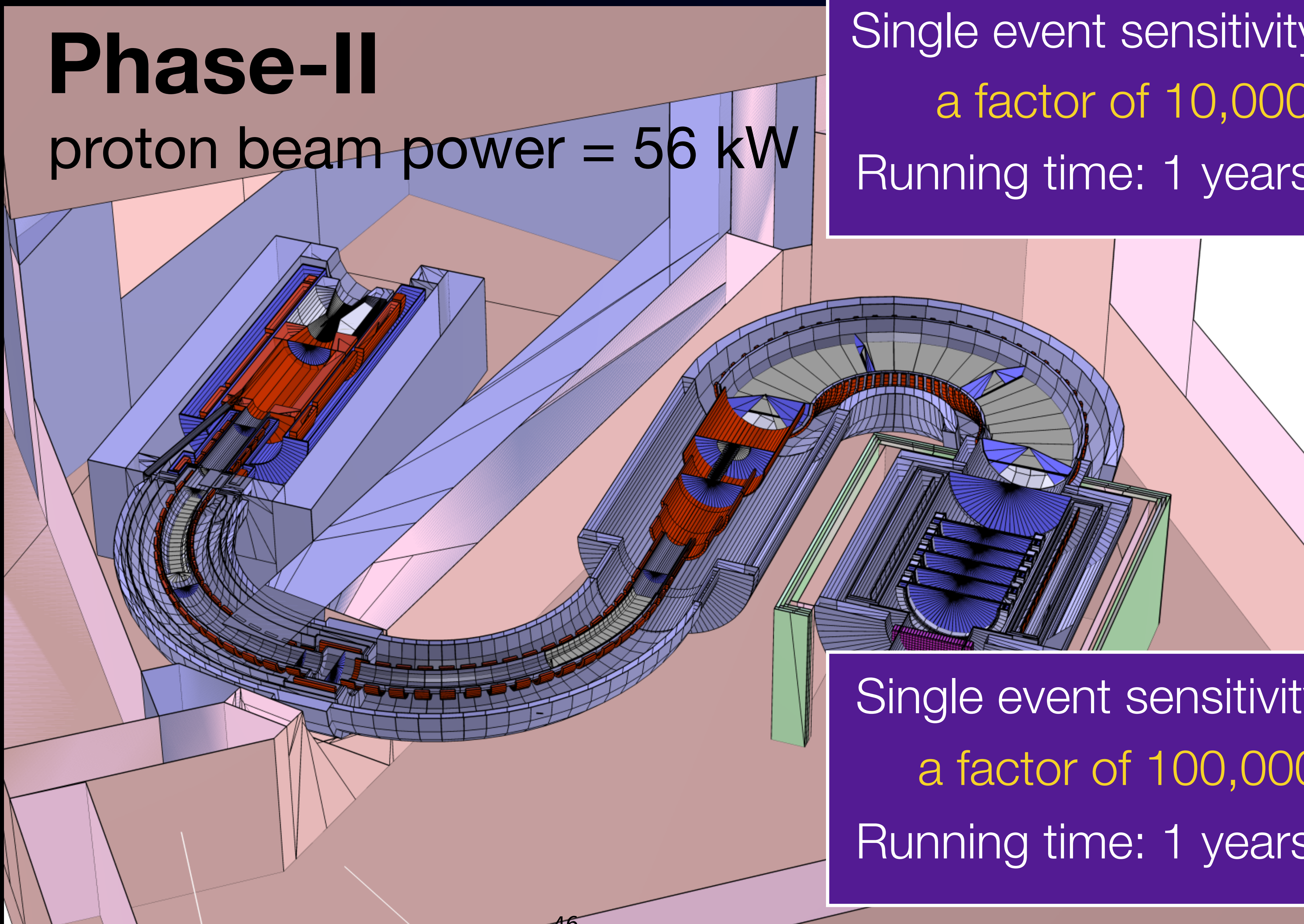
Running time: 1 years (2×10^{7}sec)



COMET Phase-II : J-PARC E21

Phase-II

proton beam power = 56 kW



Single event sensitivity : 2.6×10^{-17}

a factor of 10,000 improvement

Running time: 1 years (2×10^{7}sec)

Single event sensitivity : $O(10^{-18})$

a factor of 100,000 improvement

Running time: 1 years (2×10^{7}sec)

White Paper: COMET

COMET white paper to the 2020 update of the European Strategy for Particle Physics, by COMET collaborations.

- Scientific context
- Methodology
    - COMET Phase-II
    - Phase-I
    - PRISM
- European Contribution
- Summary

COMET

J.-C. Angélique, C. Cârloganu, W. da Silva, A. Drutskoy, M. Finger, D. N. Grigoriev, T. Kachelhoffer, F. Kapusta, Y. Kuno[1], P. Lebrun, R. P. Litchfield, D. Lomidze, D. Shoukavy, A. M. Teixeira, I. Tevzadze, Z. B. Tsamalaidze, Y. Uchida, V. Vrba, K. Zuber

A submission to the 2020 update of the European Strategy for Particle Physics on behalf of the COMET collaboration.

Abstract

The search for charged lepton flavour violation (CLFV) has enormous discovery potential in probing new physics Beyond the Standard Model (BSM). The observation of a CLFV transition would be an undeniable sign of the presence of BSM physics which goes beyond non-zero masses for neutrinos. Furthermore, CLFV measurements can provide a way to distinguish between different BSM models, which may not be possible through other means. So far muonic CLFV processes have the best experimental sensitivity because of the huge number of muons which can be produced at several facilities world-wide, and in the near future, new muon beam-lines will be built, leading to increases in beam intensity by several orders of magnitude. Among the muonic CLFV processes, $\mu \to e$ conversion is one of the most important processes, having several advantages compared to other such processes.

We describe the COMET experiment, which is searching for $\mu \to e$ conversion in a muonic atom at the J-PARC proton accelerator laboratory in Japan. The COMET experiment has taken a staged approach; the first stage, COMET Phase-I, is currently under construction at J-PARC, and is aiming at a factor 100 improvement over the current limit. The second stage, COMET Phase-II is seeking another 100 improvement (a total of 10,000), allowing a single event sensitivity (SES) of 2.6×10^{-17} with 2×10^{7} seconds of data-taking. Further improvements by one order of magnitude, which arise from refinements to the experimental design and operation, are being considered whilst staying within the originally-assumed beam power and beam time. Such a sensitivity could be translated into probing many new physics constructions up to $\mathcal{O}(10^4)$ TeV energy scales, which would go far beyond the level that can be reached directly by collider experiments. The search for CLFV $\mu \to e$ conversion is thus highly complementary to BSM searches at the LHC.

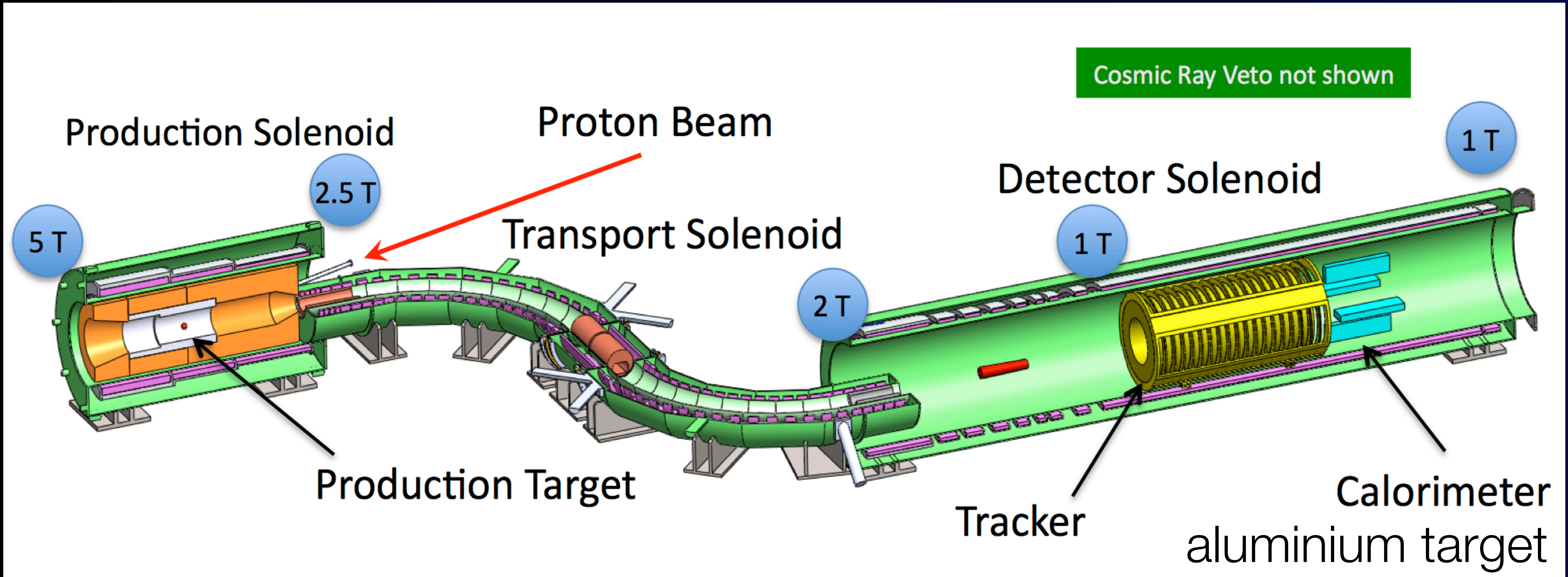
[1] contact person: kuno@phys.sci.osala-u.ac.jp.

Competition - Mu2e at Fermilab

oton beam power = 8 kW

aluminium target

Competition - Mu2e at Fermilab



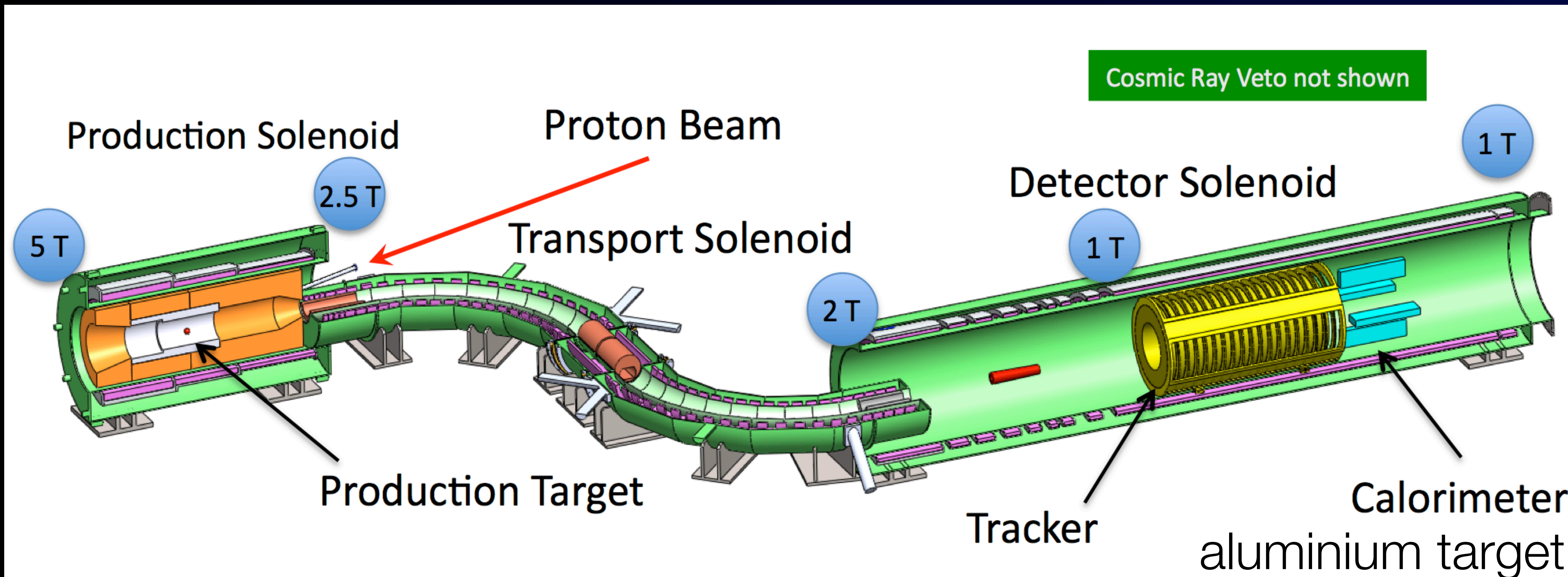
Single-event sensitivity : 2.5×10^{-17}

a factor of 10,000 improvement

Running time: 3 years

(2×10^{7} sec/year)

Competition - Mu2e at Fermilab



Single-event sensitivity : $2.5\text{x}10^{-17}$

a factor of 10,000 improvement

Running time: 3 years

($2\text{x}10^{7}$sec/year)

Mu2e-II

- 800 MeV, 100 kW from PEP-II
- aim at $2\text{x}10^{-18}$ with 3 years

a factor of 100,000 improvement

COMET Collaboration

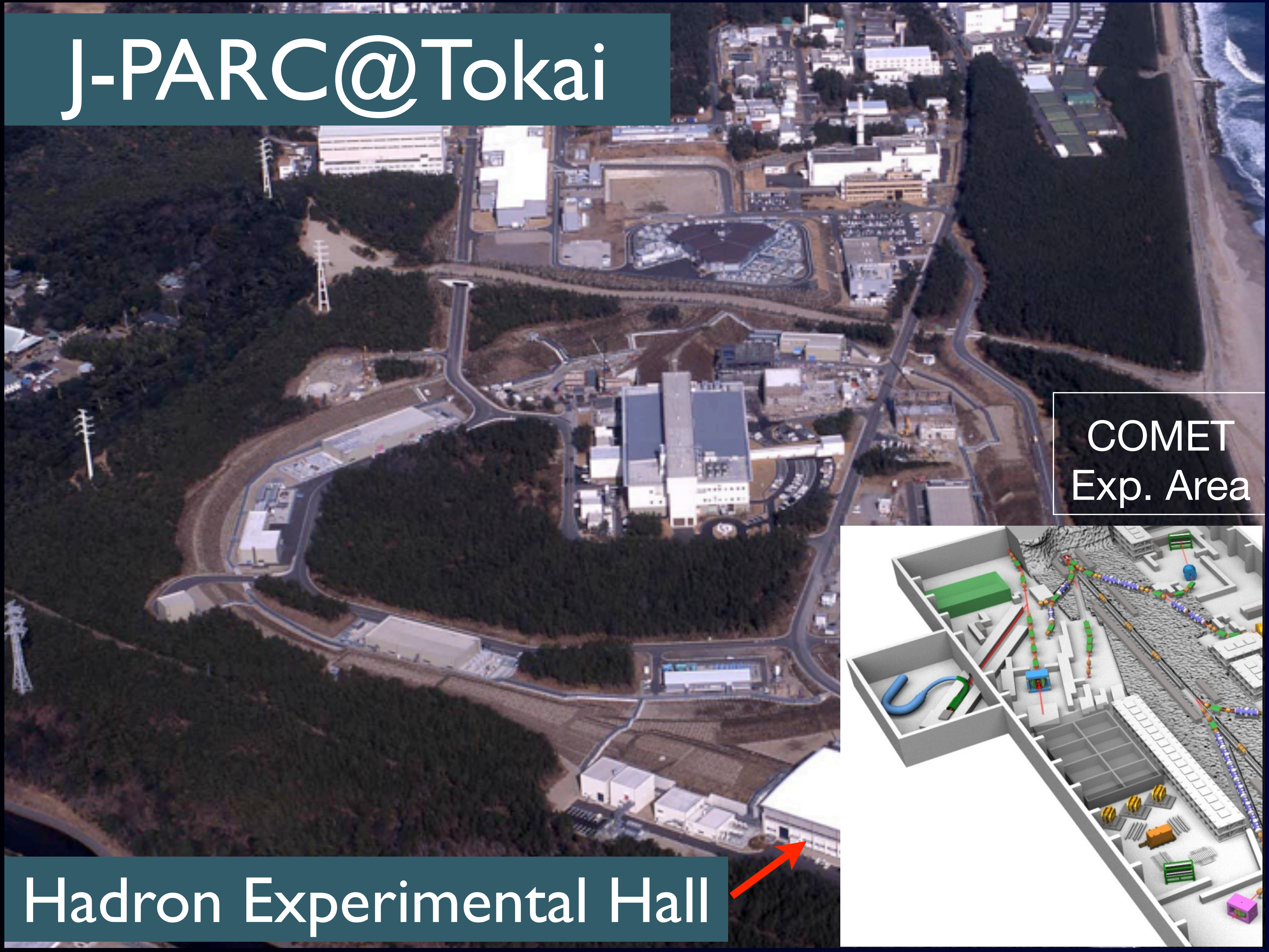
PI: Y. Kuno

The COMET Collaboration

R. Abramishvili[11], G. Adamov[11], R. Akhmetshin[6,31], V. Anishchik[4], M. Aoki[32], Y. Arimoto[18], I. Bagaturia[11], Y. Ban[3], A. Bondar[6,31], Y. Calas[7], S. Canfer[33], Y. Cardenas[7], S. Chen[28], Y. E. Cheung[28], B. Chiladze[35], D. Clarke[33], M. Danilov[15,26], P. D. Dauncey[14], J. David[23], W. Da Silva[23], C. Densham[33], G. Devidze[35], P. Dornan[14], A. Drutskoy[15,26], V. Duginov[16], L. Epshteyn[6,30], P. Evtoukhovich[16], G. Fedotovich[6,31], M. Finger[8], M. Finger Jr[8], Y. Fujii[18], Y. Fukao[18], J-F. Genat[23], E. Gillies[14], D. Grigoriev[6,30,31], K. Gritsay[16], E. Hamada[18], R. Han[1], K. Hasegawa[18], I. H. Hasim[32], O. Hayashi[32], Z. A. Ibrahim[24], Y. Igarashi[18], F. Ignatov[6,31], M. Iio[18], M. Ikeno[18], K. Ishibashi[22], S. Ishimoto[18], T. Itahashi[32], S. Ito[32], T. Iwami[32], X. S. Jiang[2], P. Jonsson[14], V. Kalinnikov[16], F. Kapusta[23], H. Katayama[32], K. Kawagoe[22], N. Kazak[5], V. Kazanin[6,31], B. Khazin[6,31], A. Khvedelidze[16,11], T. K. Ki[18], M. Koike[39], G. A. Kozlov[16], B. Krikler[14], A. Kulikov[16],
E. Kulish[16], … e[14,21],
M. Lancast… an[29],
D. Lomidze… Mao[3],
O. Markin[15]… Mo-
hamed Kam… kai[22],
T. Nakamot… chi[18],
T. Numao[36], J. O'Dell[33], T. Ogitsu[18], K. Oishi[22], K. Okamoto[32], C. Omori[18], T. Ota[34], J. Pasternak[14], C. Plostinar[33], V. Ponariadov[45], A. Popov[6,31], V. Rusinov[15,26], A. Ryzhenenkov[6,31], B. Sabirov[16], N. Saito[18], H. Sakamoto[32], P. Sarin[13], K. Sasaki[18], A. Sato[32], J. Sato[34], Y. K. Semertzidis[12,17], D. Shemyakin[6,31], N. Shigyo[22], D. Shoukavy[5], M. Slunecka[8], A. Straessner[37], D. Stöckinger[37], M. Sugano[18], Y. Takubo[18], M. Tanaka[18], S. Tanaka[22], C. V. Tao[29], E. Tarkovsky[15,26], Y. Tevzadze[35], T. Thanh[29], N. D. Thong[32], J. Tojo[22], M. Tomasek[10], M. Tomizawa[18], N. H. Tran[32], H. Trang[29], I. Trekov[35], N. M. Truong[32], Z. Tsamalaidze[16,11], N. Tsverava[16,35], T. Uchida[18], Y. Uchida[14], K. Ueno[18], E. Velicheva[16], A. Volkov[16], V. Vrba[10], W. A. T. Wan Abdullah[24], M. Warren[38], M. Wing[38], T. S. Wong[32], C. Wu[2,28], H. Yamaguchi[22], A. Yamamoto[18], Y. Yang[22], W. Yao[2], Y. Yao[2], H. Yoshida[32], M. Yoshida[18], Y. Yoshii[18], T. Yoshioka[22], Y. Yuan[2], Y. Yudin[6,31], J. Zhang[2], Y. Zhang[2], K. Zuber[37]

about 200 collaborators
41 institutes, 17 countries

COMET @ J-PARC



Pulsed Proton Beam and Measurement in COMET

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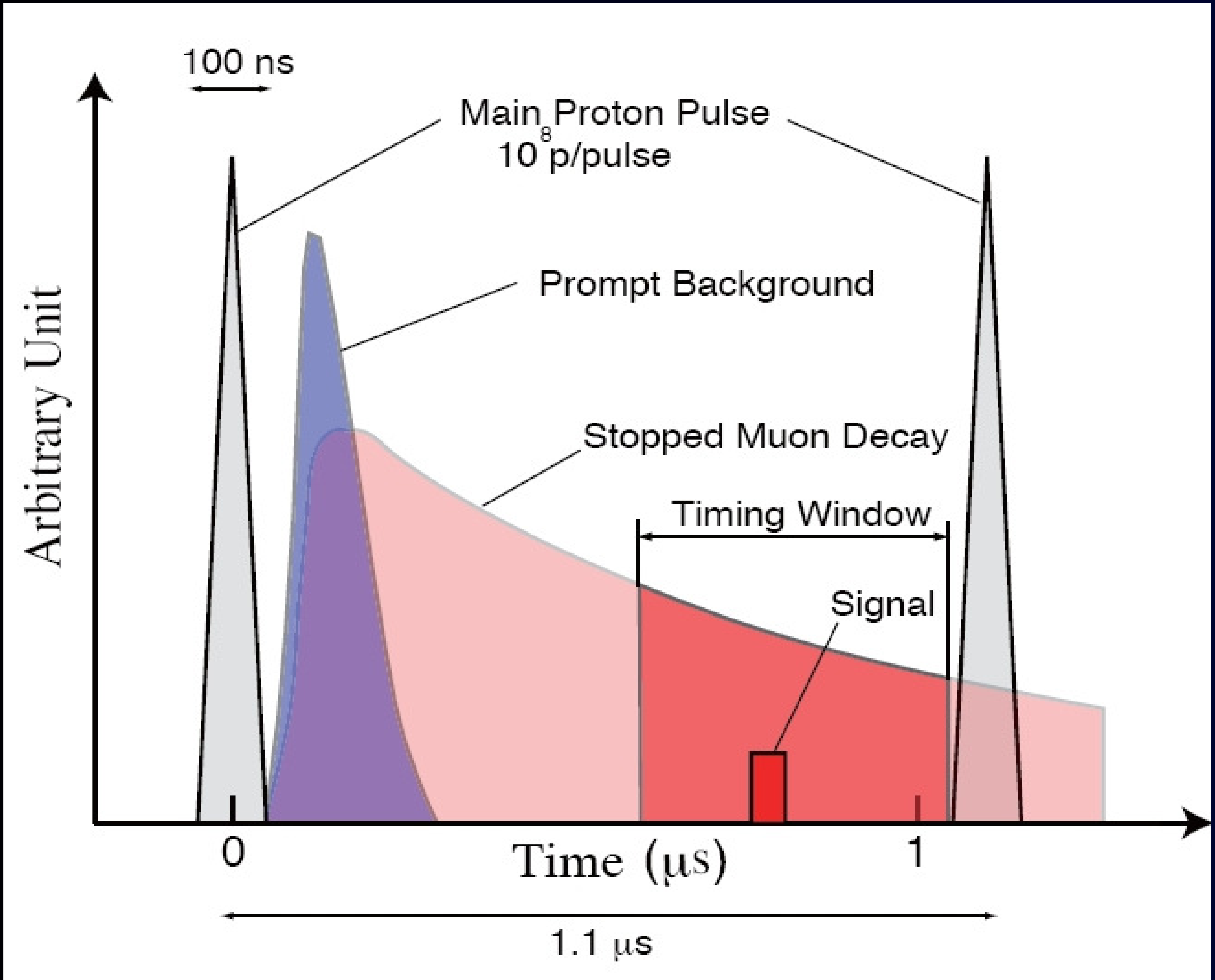
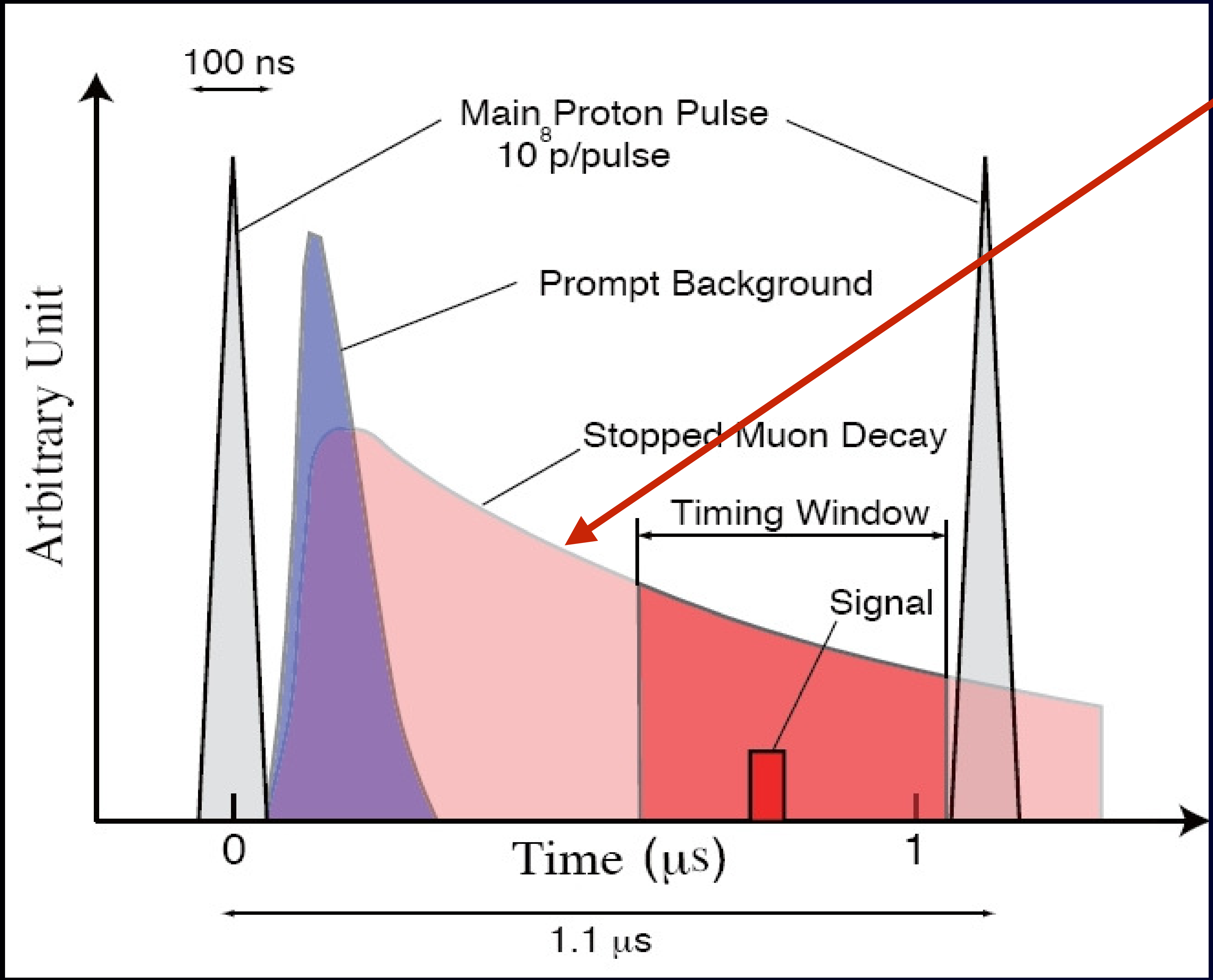


Pulsed Proton Beam and Measurement in COMET



A lifetime of a muonic atom in aluminium ~ 880 ns

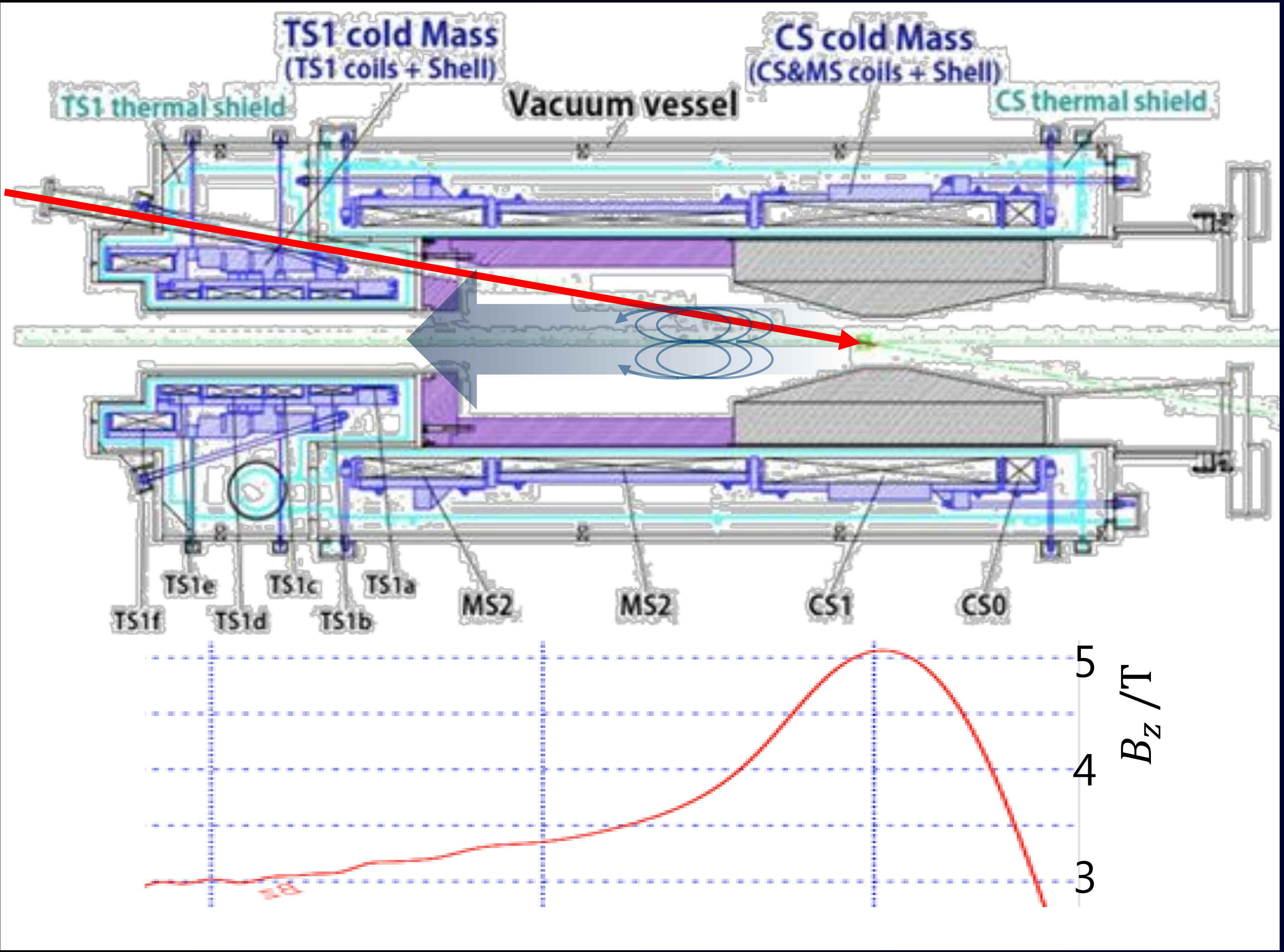
Muon Source

Muon Source

pion capture in superconducting solenoids

Muon Source

pion capture in superconducting solenoids



proton target in a solenoidal field (~5 T)

a long proton target (1.5~2 interaction length) of heavy material)

O(>10^{11}) stopped μ^-/sec for 56 kW protons

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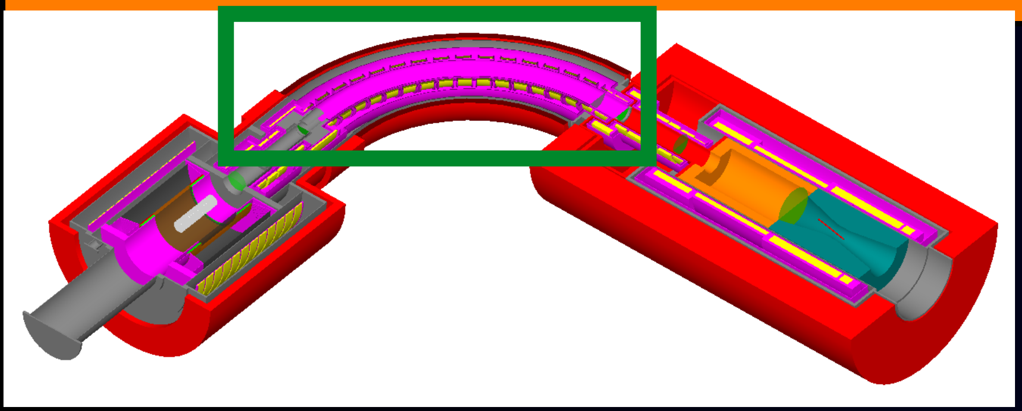
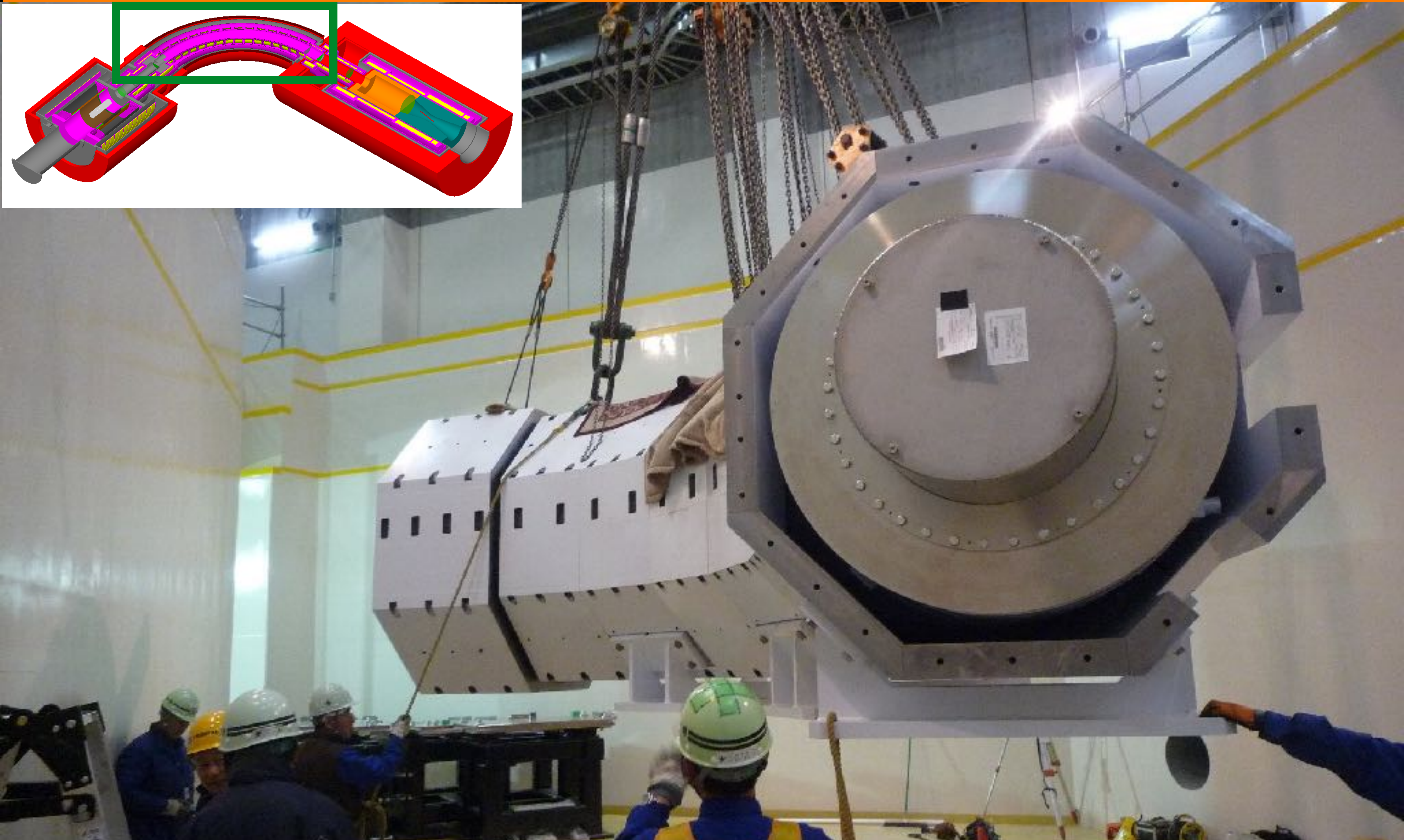
Highlights in COMET Phase-I Preparation

Curved Solenoids for Muon Transport

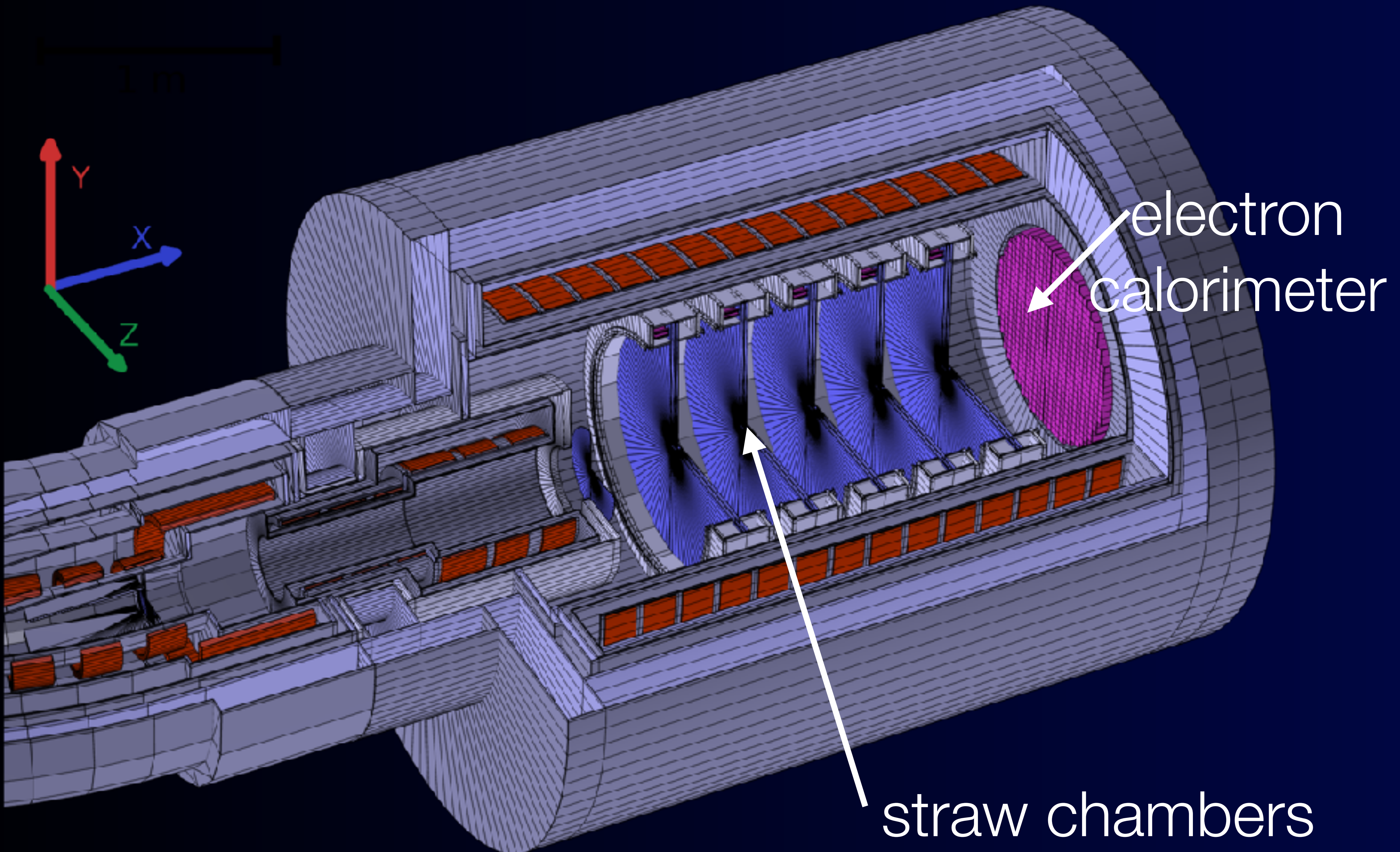
Curved Solenoids for Muon Transport



Curved Solenoids for Muon Transport

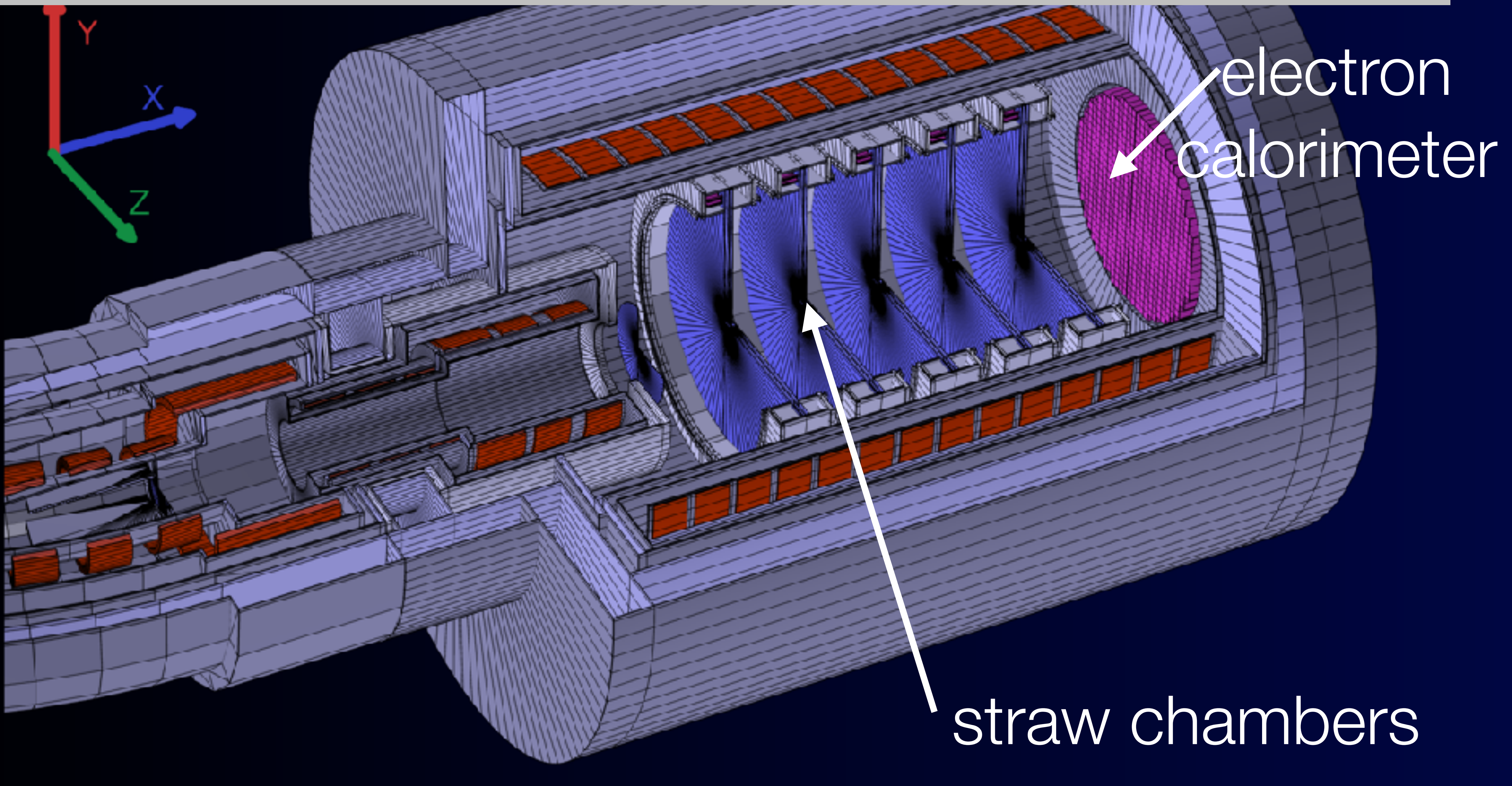


StrECL Detector in COMET Phase-I

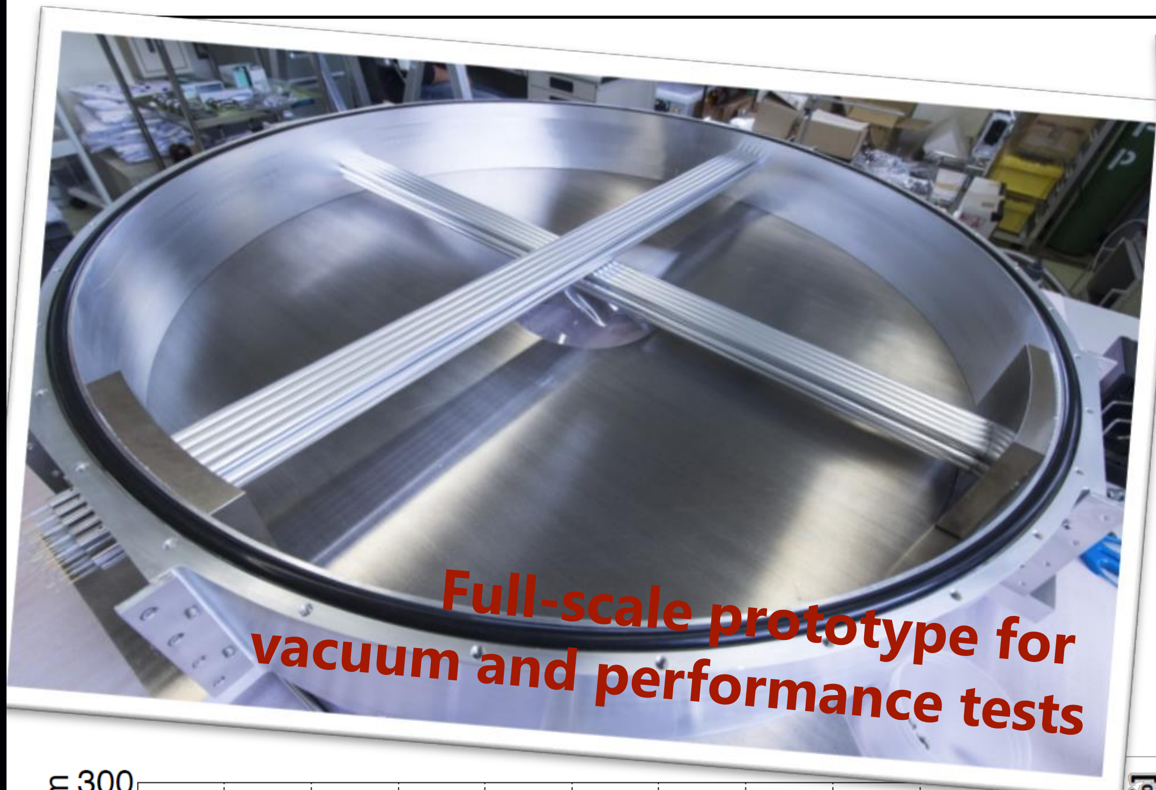


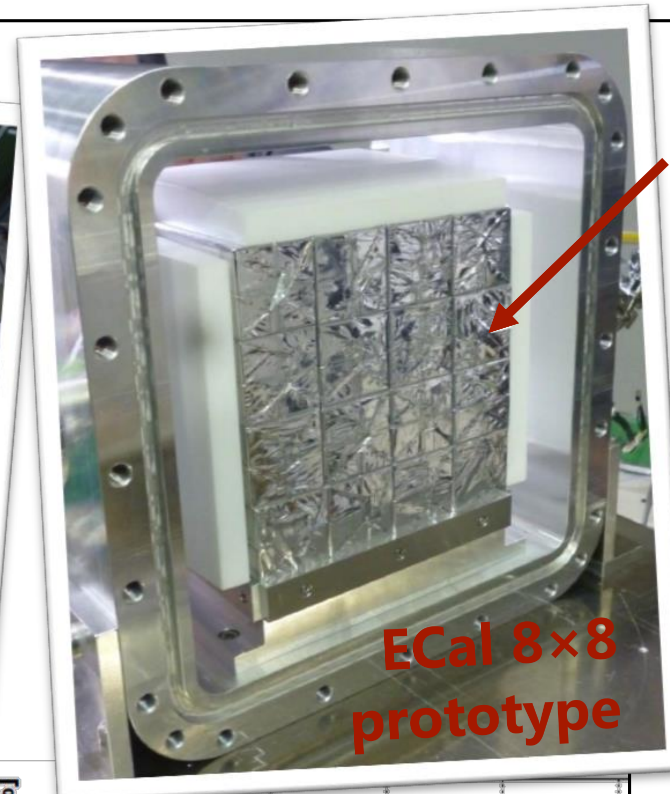
StrECL Detector in COMET Phase-I

an apparatus to measure a muon beam at Phase-I
and a prototype for Phase-II



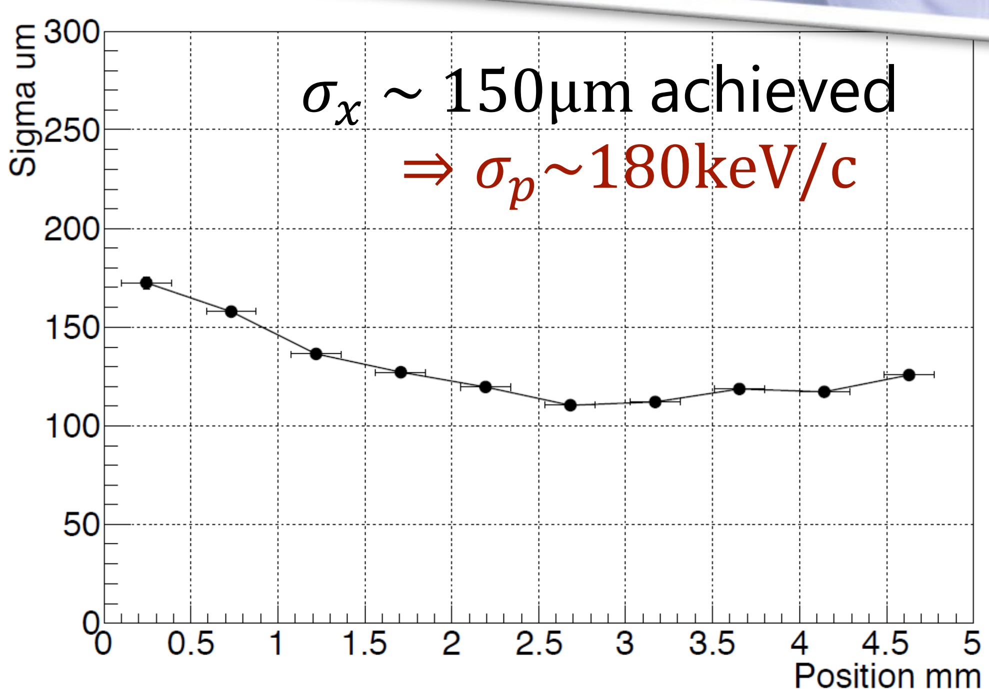
Progress of Straw Chambers and ECAL

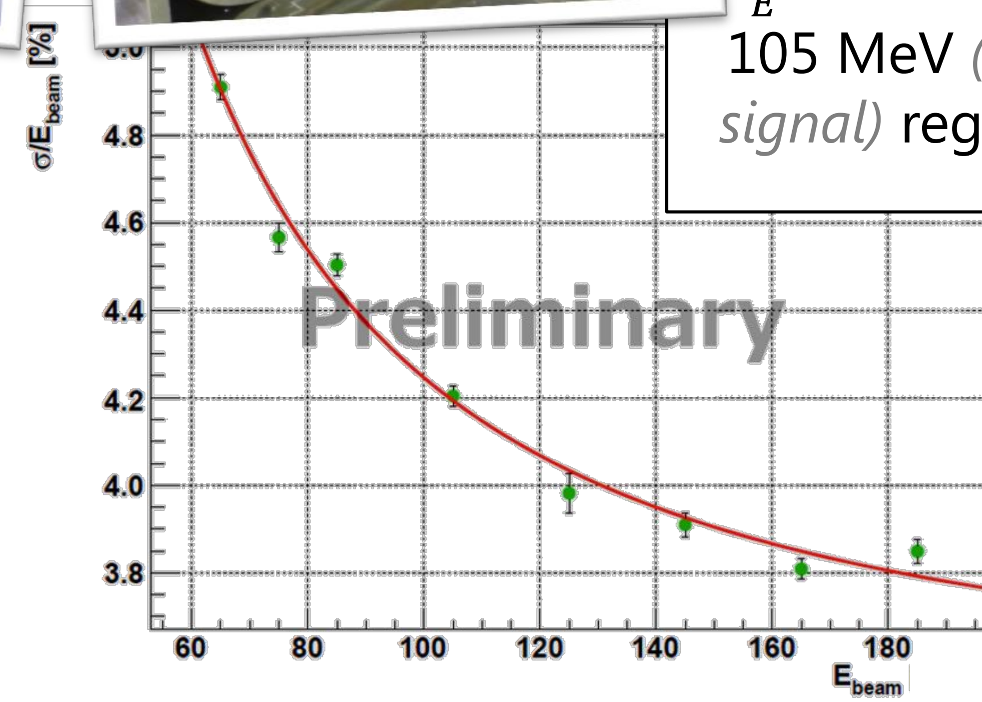




ECal Crystals
(2x2 bundle in
Al-mylar.)

LYSO crystal

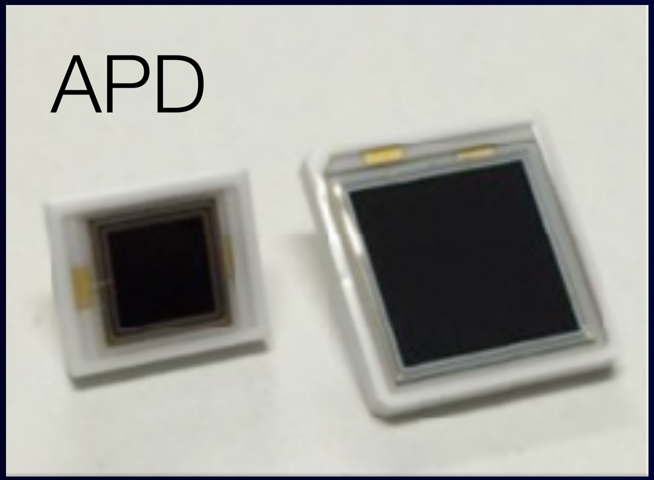


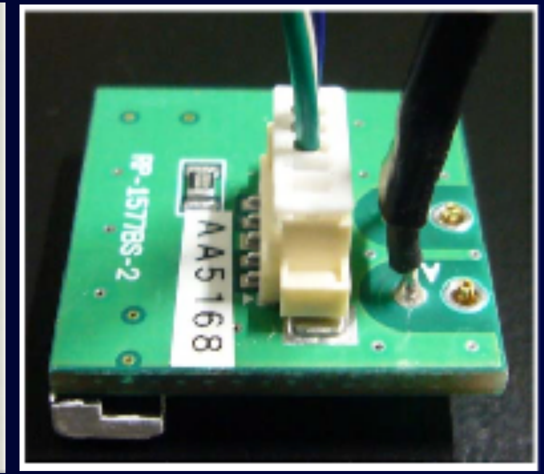


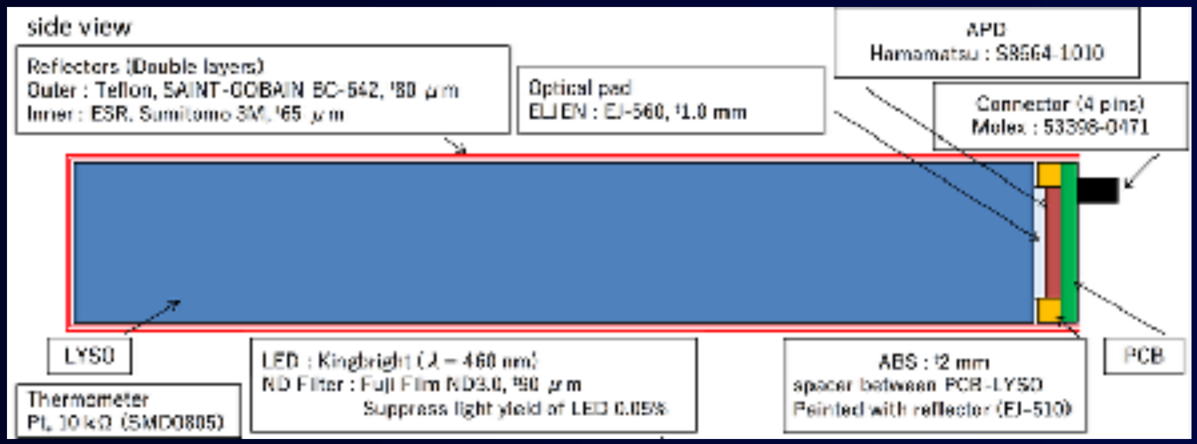
$\frac{\sigma_E}{E} \sim 4.2\%$ in 105 MeV *(i.e. signal)* region

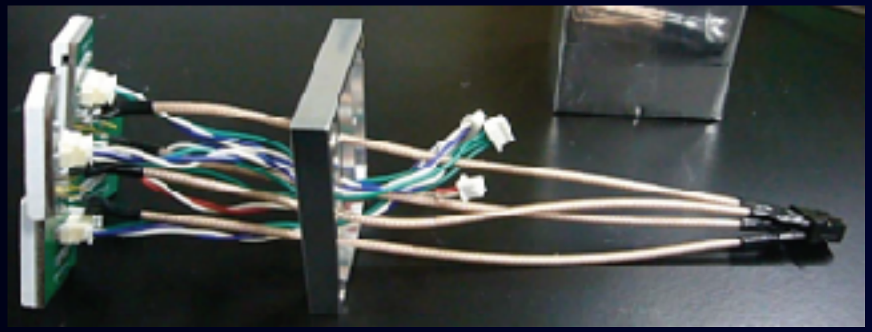
ECAL

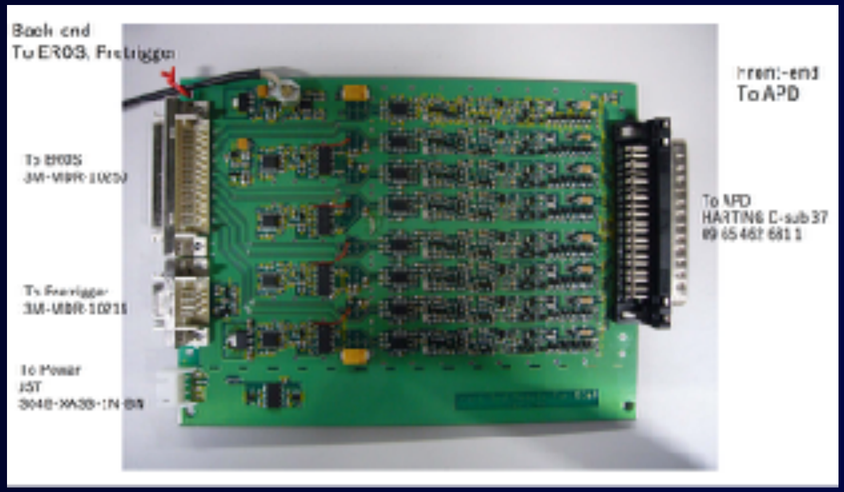
- LYSO Crystals
  - Saint-Gobain (SG) & OXIDE & JTC
  - about 500 for Phase-I need
- APD
  - HPK S8664-1010 10x10mm^2
  - PCB design fixed, production
- Crystal Module
  - design fixed
- Intermediate Board
  - 4x4 packing, slow control monitors
- Feedthrough Board
- Readout Electronics
  - preamp/pretrigger
  - designed by BINP



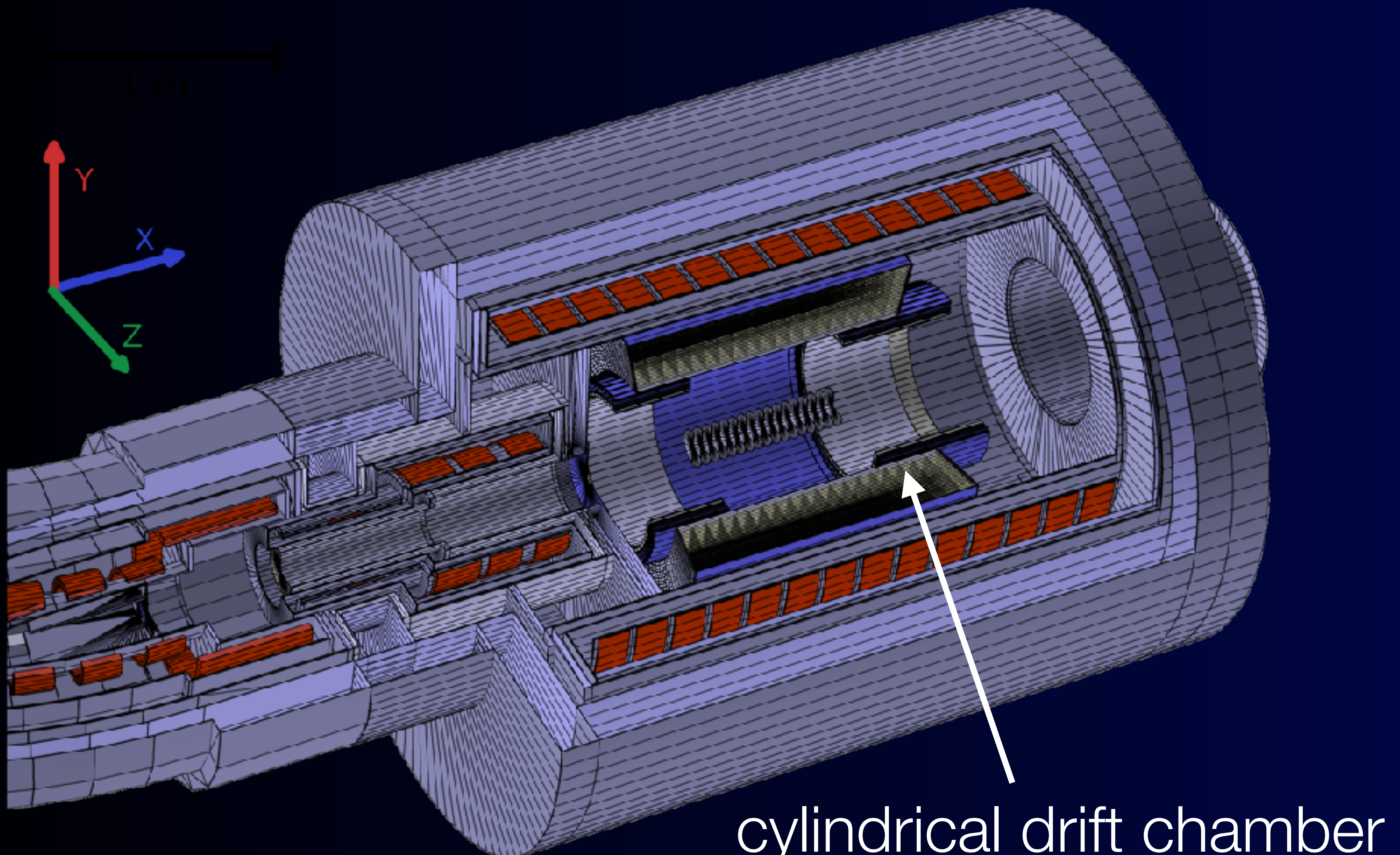






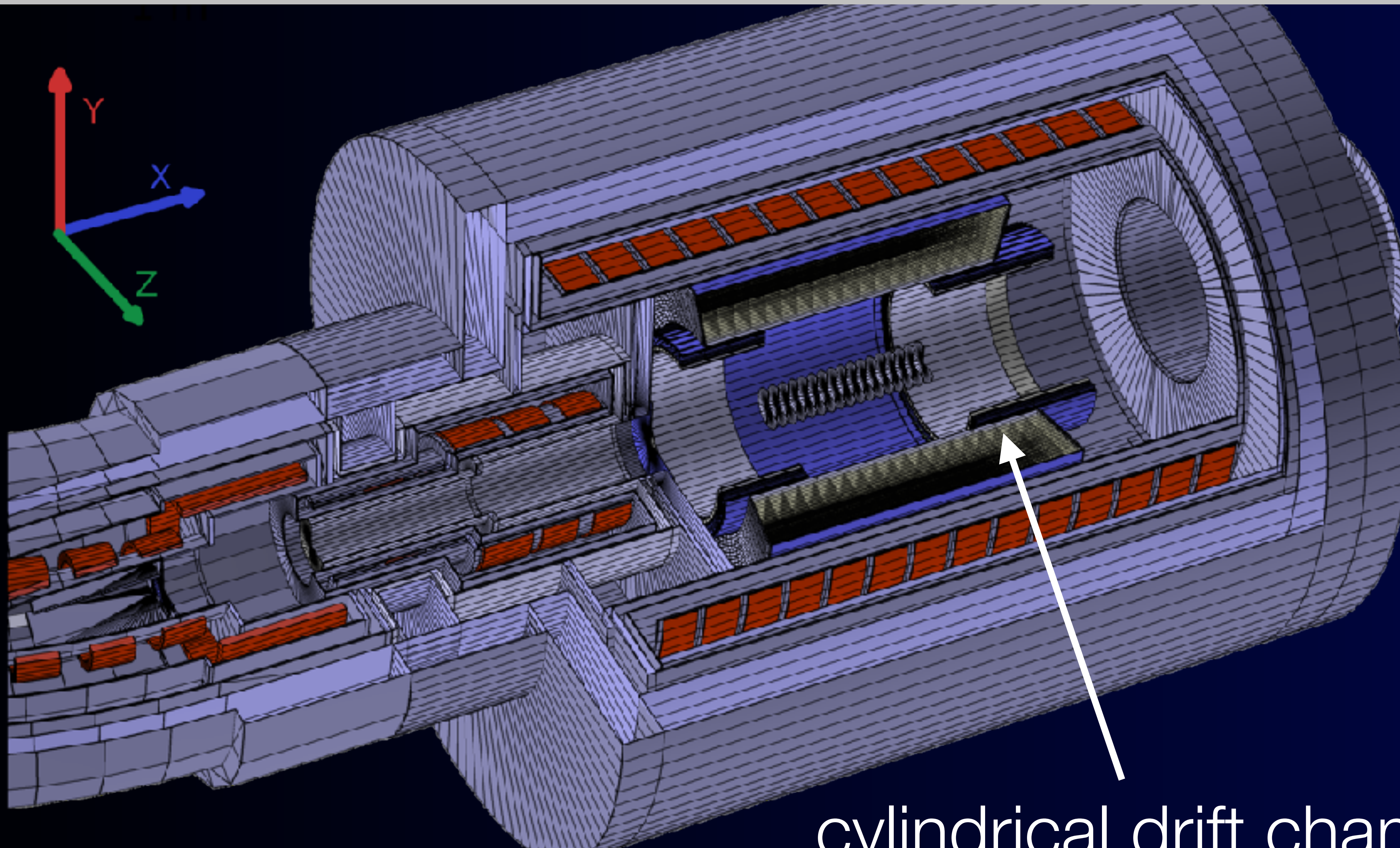


CyDet (cylindrical detector) in COMET Phase-I



CyDet (cylindrical detector) in COMET Phase-I

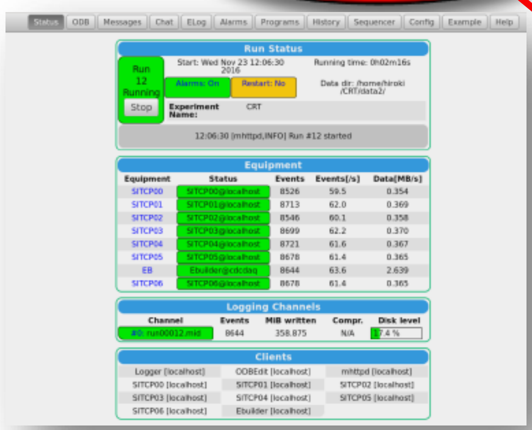
an apparatus to search for μ-e conversion at Phase-I



CDC under Cosmic-ray Tests

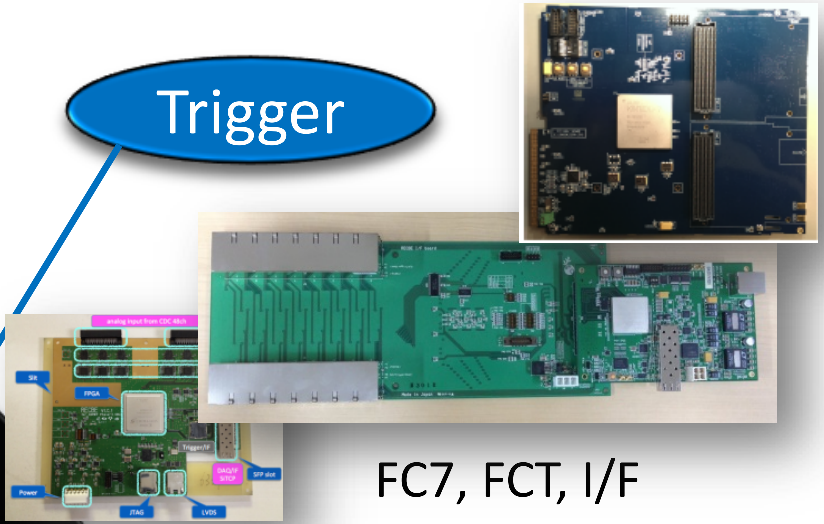
Cylindrical drift chamber (CDC)
takes more data
at the Fuji experimental hall

DAQ



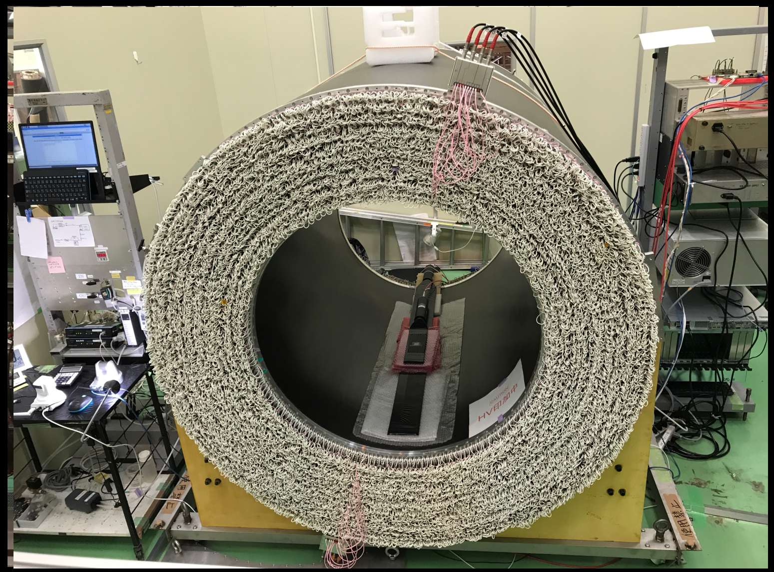
MIDAS

Trigger



FC7, FCT, I/F

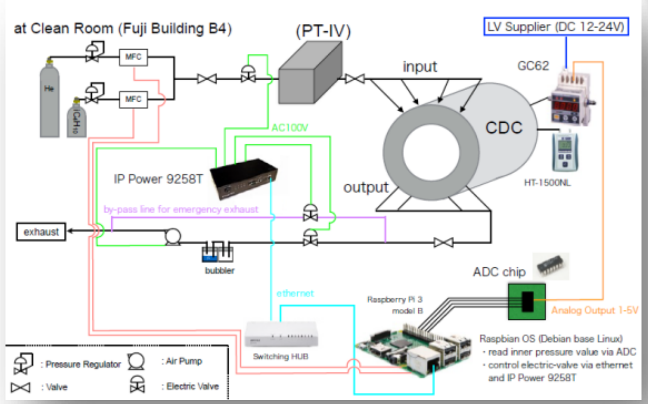
CDC



CDC Cosmic-Ray Test

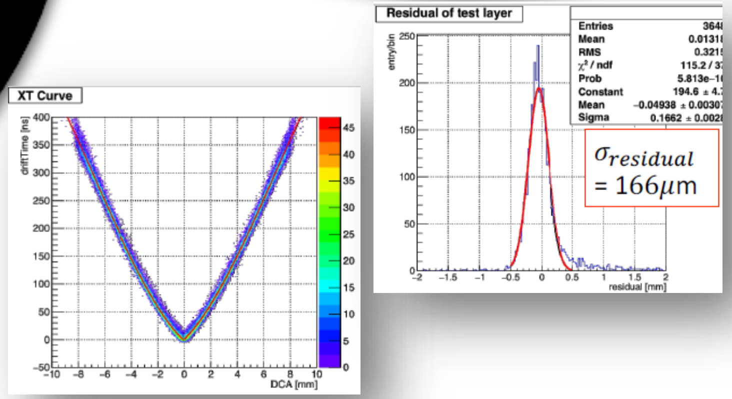
HV: 1850 V
Gas mixture: He/i-C_4H_{10}=90/10
flow rate: 100 ccm

Slow Control



HV, Gas flow rate, Valve,
Pressure, Temperature, Humidity

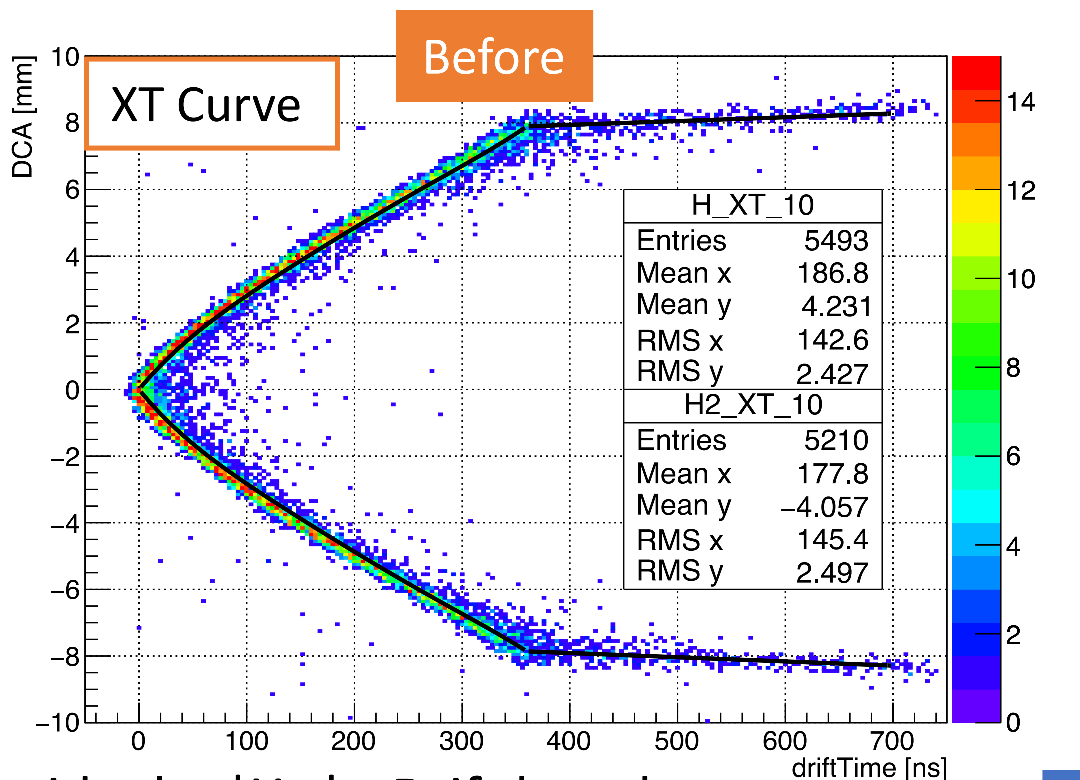
Analysis

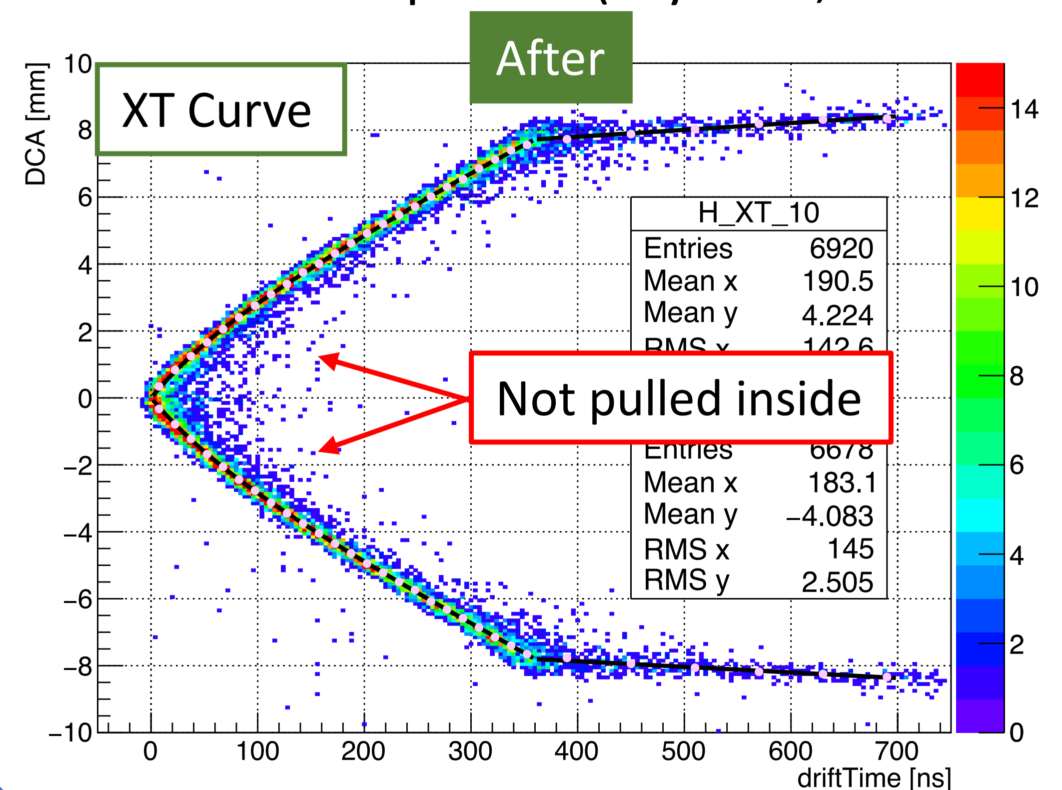


Performance evaluation,
Detector response,
Calibration framework

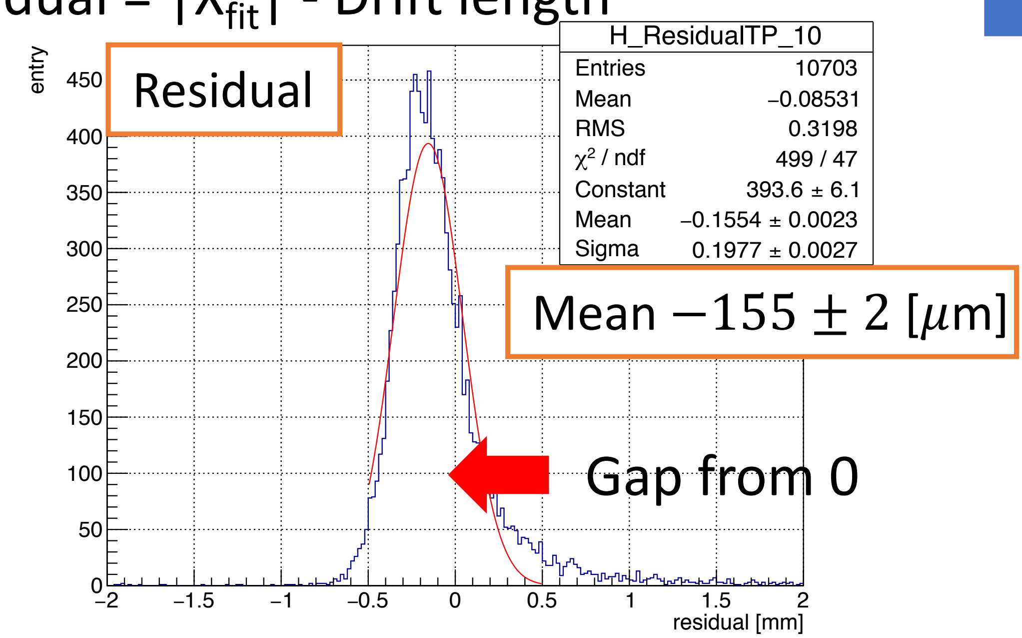
CDC Study : XT curve

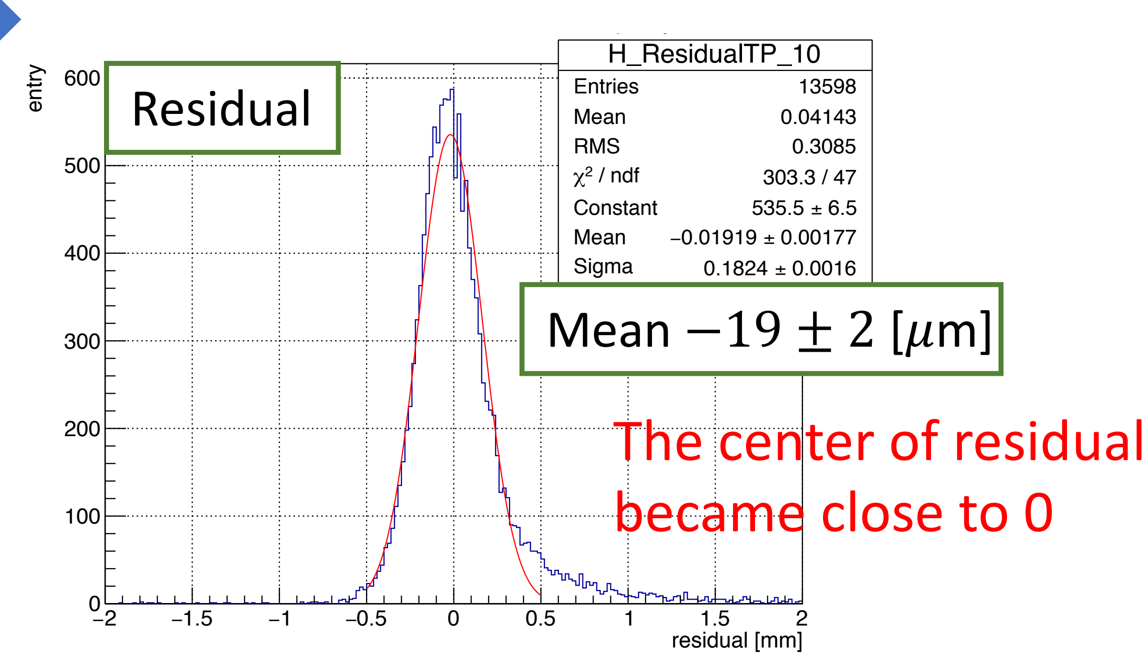
- Thanks to improvement of fitting, XT Curve and residual also improved.(Layer 10, Iteration = 1)





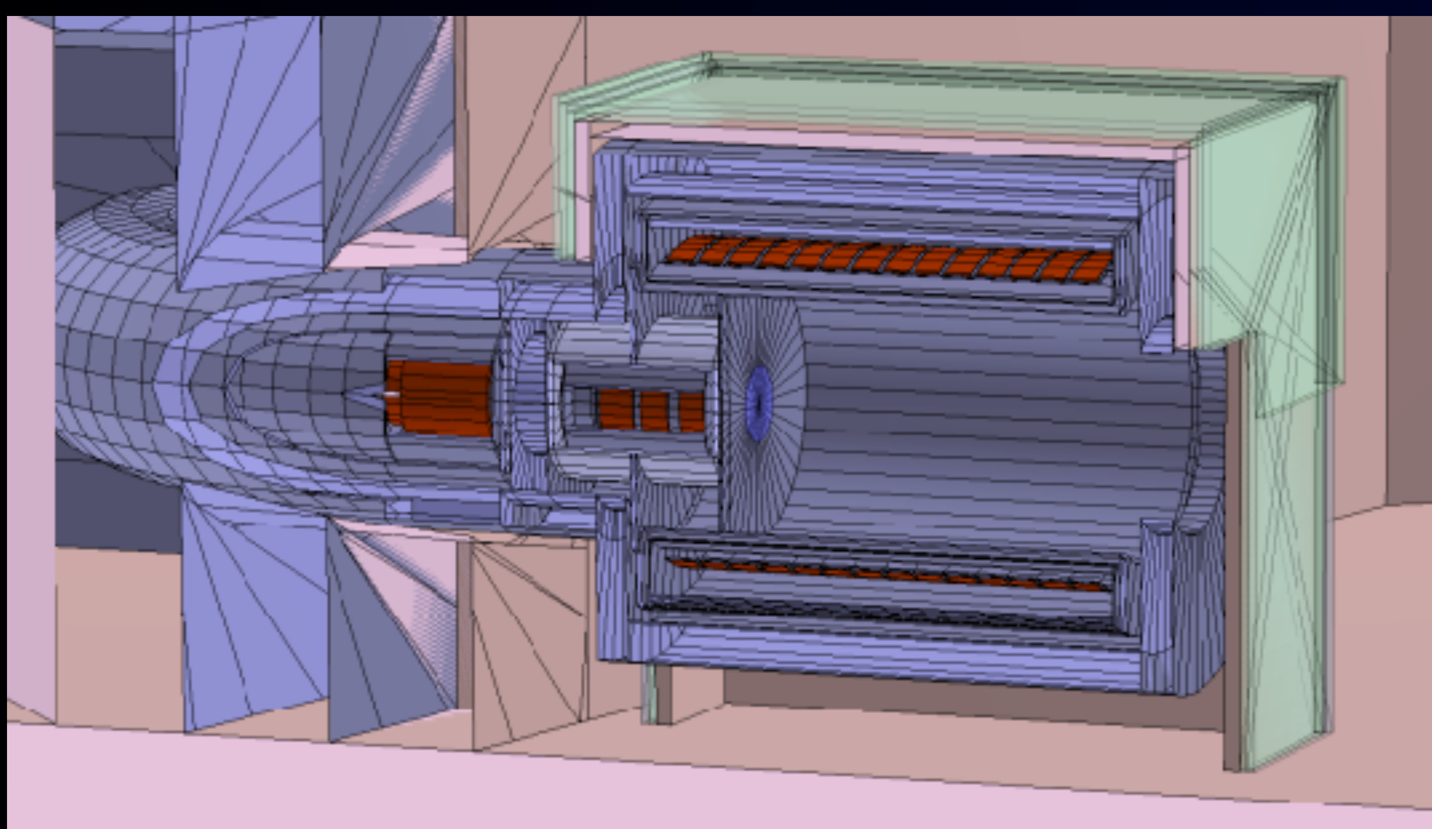
Residual = $|X_{fit}|$ - Drift length

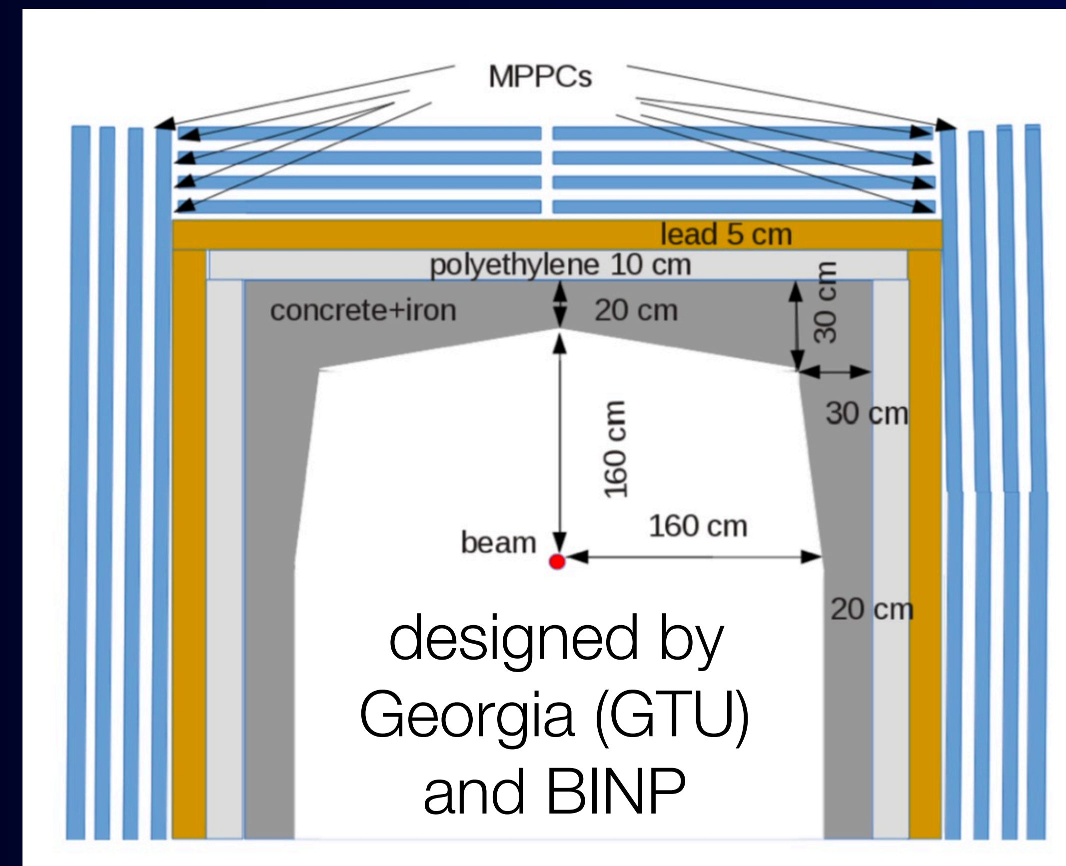


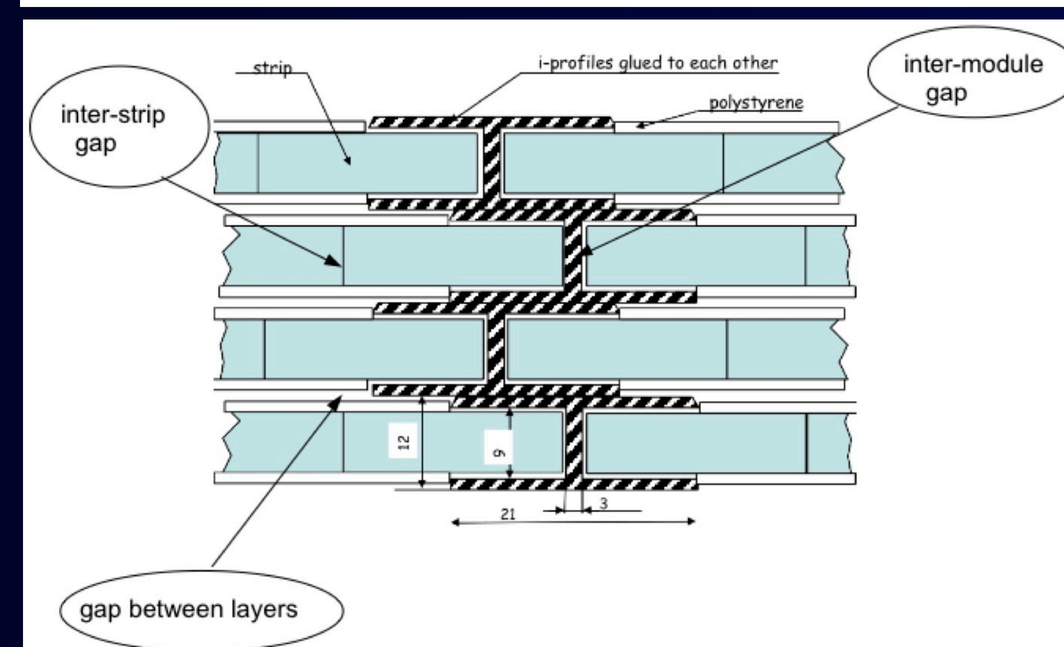


Active Cosmic Ray Veto System

- Scintillator slabs with Sci-fibers embedded
  - SiPM readout, need radiation tolerance
  - 5 walls, each wall composed of panels
  - readout ASIC from LHCb from LPC
- Resistive Plate Chamber (RPC)
  - used in high neutron yield area.
  - LPC design, radiation tolerance

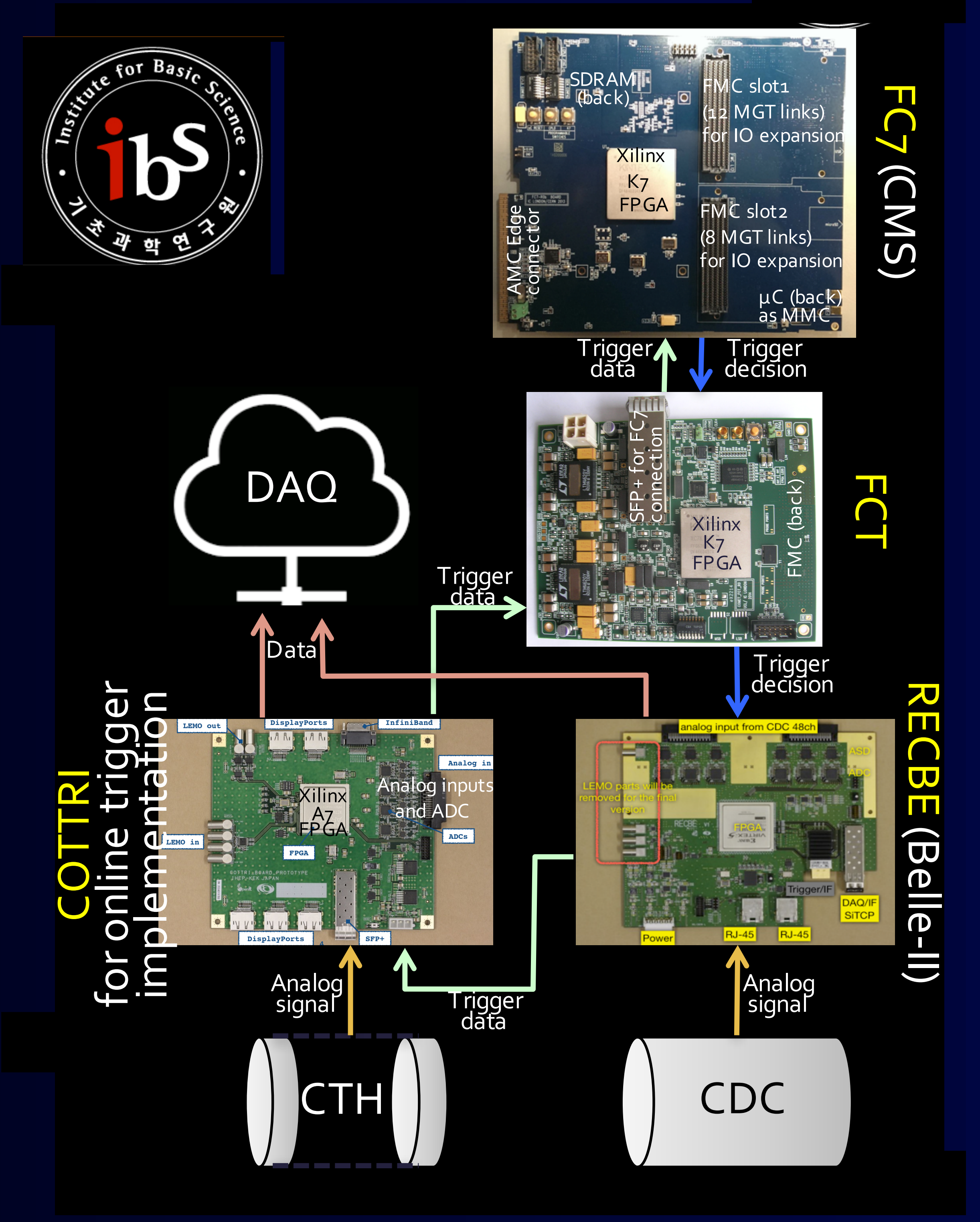






Trigger and DAQ Development for Phase-I in Korea

- High trigger rate (20-30 kHz) for DAQ
  - Mostly background hits
  - Beam electron, secondary from capture neutron/gamma
  - Online trigger suppress BG hits
  - A configurable and flexible
- Trigger system
  - Central system based on commercial CERN product and a custom interface board
  - Ensuring commonality in interfacing with different systems.



MyeongJae Lee (IBS/CAPP)

COMET Phase-I
Physics Sensitivity (a la TDR)

Event selection	Value	
Online event selection efficiency	0.9	
DAQ efficiency	0.9	
Track finding efficiency	0.99	
Geometrical acceptance + Track quality cuts	0.18	
Momentum window ($\varepsilon_{\rm mom}$)	0.93	$103.6 < p_e < 106.0$ MeV/c
Timing window ($\varepsilon_{\rm time}$)	0.3	$700 < t_e < 1170$ ns
Total	0.041	

$$B(\mu^- + \mathrm{Al} \to e^- + \mathrm{Al}) = \frac{1}{N_\mu \cdot f_{\rm cap} \cdot f_{\rm gnd} \cdot A_{\mu\text{-}e}},$$

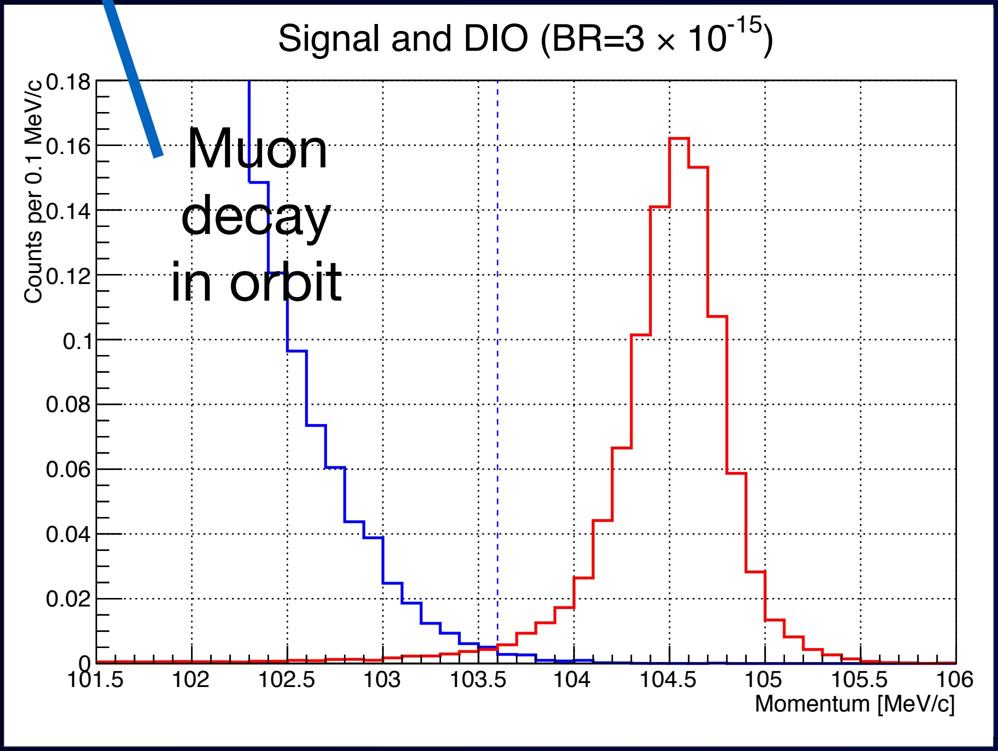
- N_μ: Number of muons stopped inside targets
- $f_{\rm cap}$: Fraction of muons to be captured by Al target = 0.61
- $f_{\rm gnd}$: Fraction of μ-e conversion to the ground state = 0.9
- $A_{\mu\text{-}e}$: Total = 0.041 (from the table)

- 3×10^{-15} S.E.S. achievable in ~150 days of DAQ time corresponds to $N_\mu = 1.5\times10^{16}$

COMET Phase-I Backgrounds (a la TDR)

Type	Background	Estimated events
Physics	Muon decay in orbit	0.01
	Radiative muon capture	0.0019
	Neutron emission after muon capture	< 0.001
	Charged particle emission after muon capture	< 0.001
Prompt Beam	* Beam electrons	
	* Muon decay in flight	
	* Pion decay in flight	
	* Other beam particles	
	All (*) Combined	≤ 0.0038
	Radiative pion capture	0.0028
	Neutrons	$\sim 10^{-9}$
Delayed Beam	Beam electrons	~ 0
	Muon decay in flight	~ 0
	Pion decay in flight	~ 0
	Radiative pion capture	~ 0
	Anti-proton induced backgrounds	0.0012
Others	Cosmic rays†	< 0.01
Total		0.032

† This estimate is currently limited by computing resources.



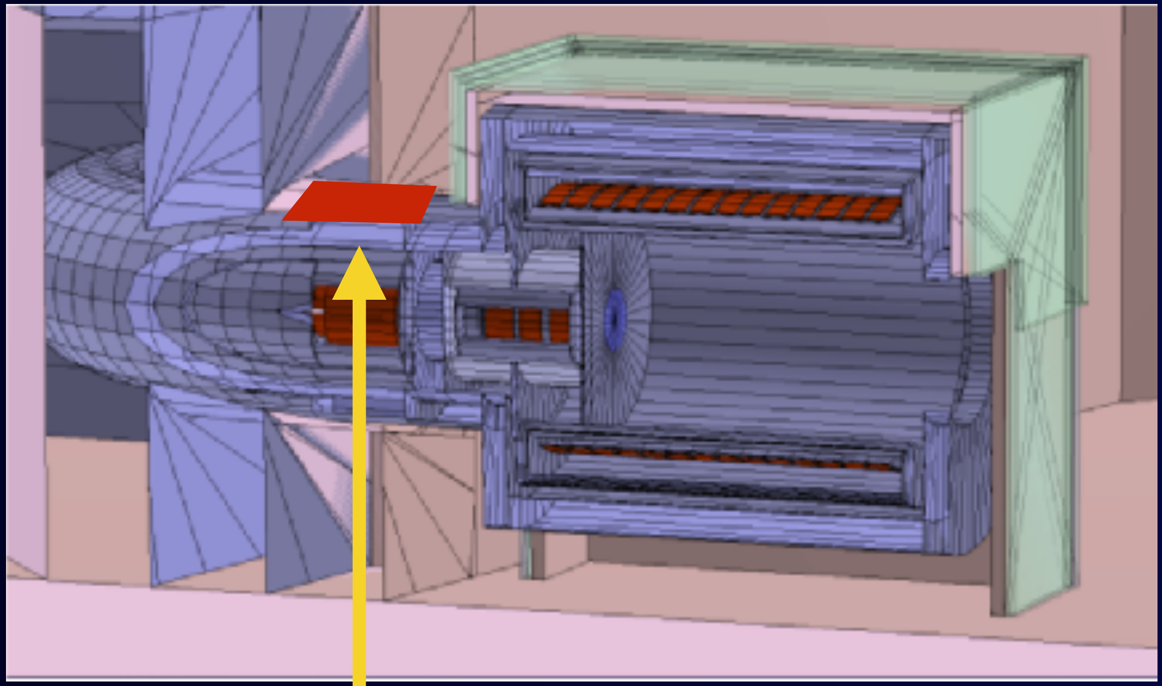
Reports 2018 - 2019 (France)

COMET France Collaboration

- In 2018-2019, a new rise of the French common activities for COMET Phase-I has occurred.
- On July 11-13, the COMET workshop (which YK visited by using the FJPPL budget) was held, being very successful to expand the COMET French group and start a written version of its coherent aim.
- In the end of 2018, the approval of the COMET-France Collaboration has been made. Currently the COMET-France Collaboration includes LPNHE, LPC-Caen, LPC-Clermont, IPNL-Lyon and CC-IN2P3.

Activities in LPC-Clermont

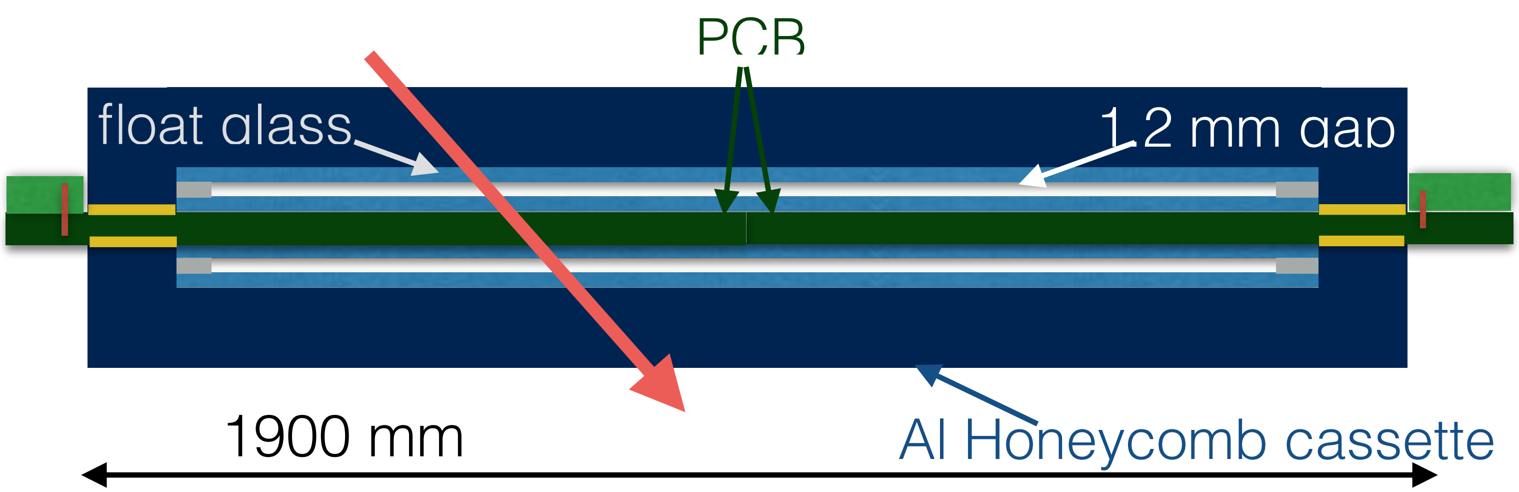
- LPC-Clermont works on the Cosmic Ray Background affecting COMET. A dedicated simulation that includes atmospheric muons of low momenta, heavily scattered, should reduce significantly the uncertainty on the current estimation of this background. At the same time, they investigate a possible extension of the CRV in the region between the muon transport section and the detector section (Bridge CRV) using Glass Resistive Plate Chambers (GRPC).
- The advantage of GRPCs is that it is not sensitive to neutrons, contrary to the original CRV system based on plastic scintillators. Prototype chambers are currently being built and will be tested in the near future.



Bridge-CRV based on Glass Resistive Plate Chambers
1900 mm x 600 mm x 3 (top, right, and left).
Rejection factor : 10000

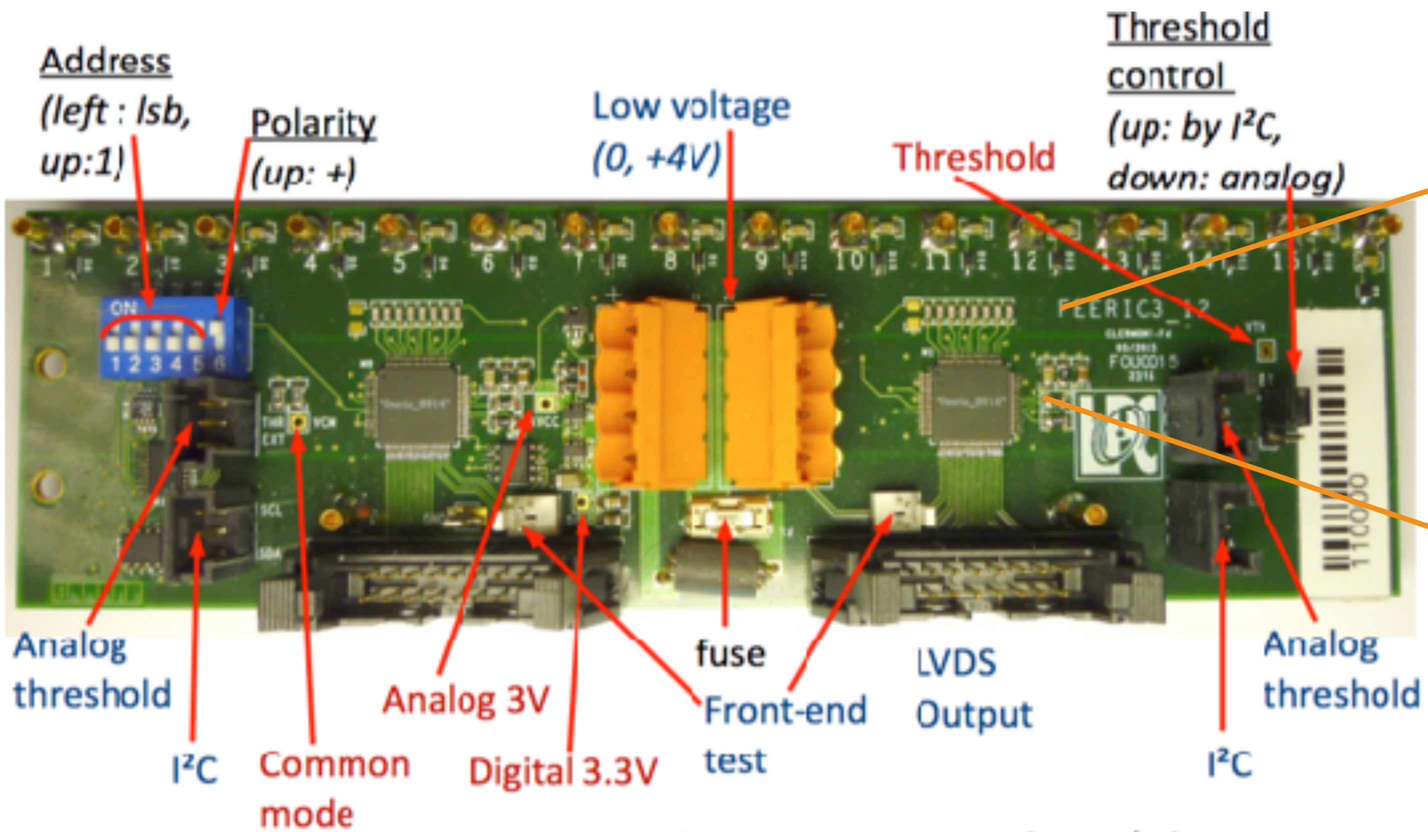
Activities in LPC-Clermont : GRPC for Bridge CRV

A detector module: two single gap GRPCs with common readout



- GRPCs run in avalanche mode
- gas mixture: 98% TFE, 2% SF_6
- readout: 2 layered PCB with x,y strip readout on top and bottom
- ~60/95 long strips, ~5 mm wide
- module thickness: <25 mm
- module efficiency: ~98%
- time resolution: ~ns

Readout electronics takes advantage of developments for ALICE upgrade:



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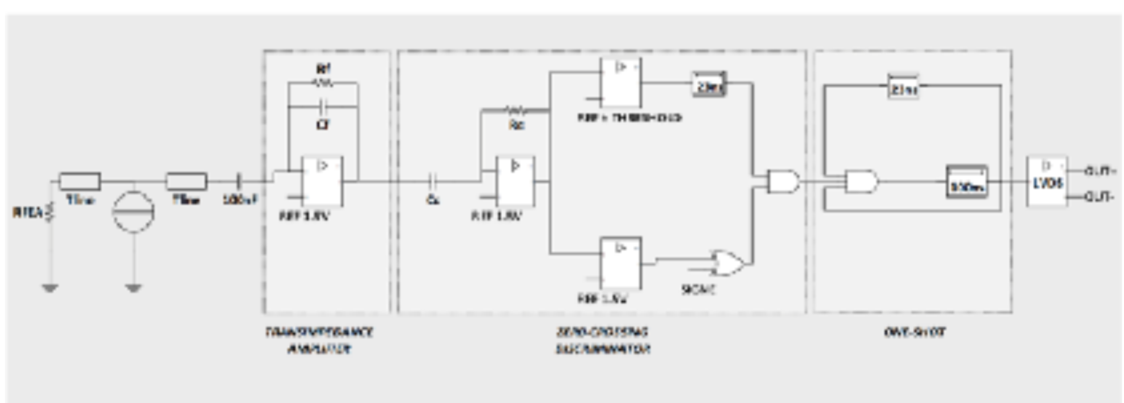
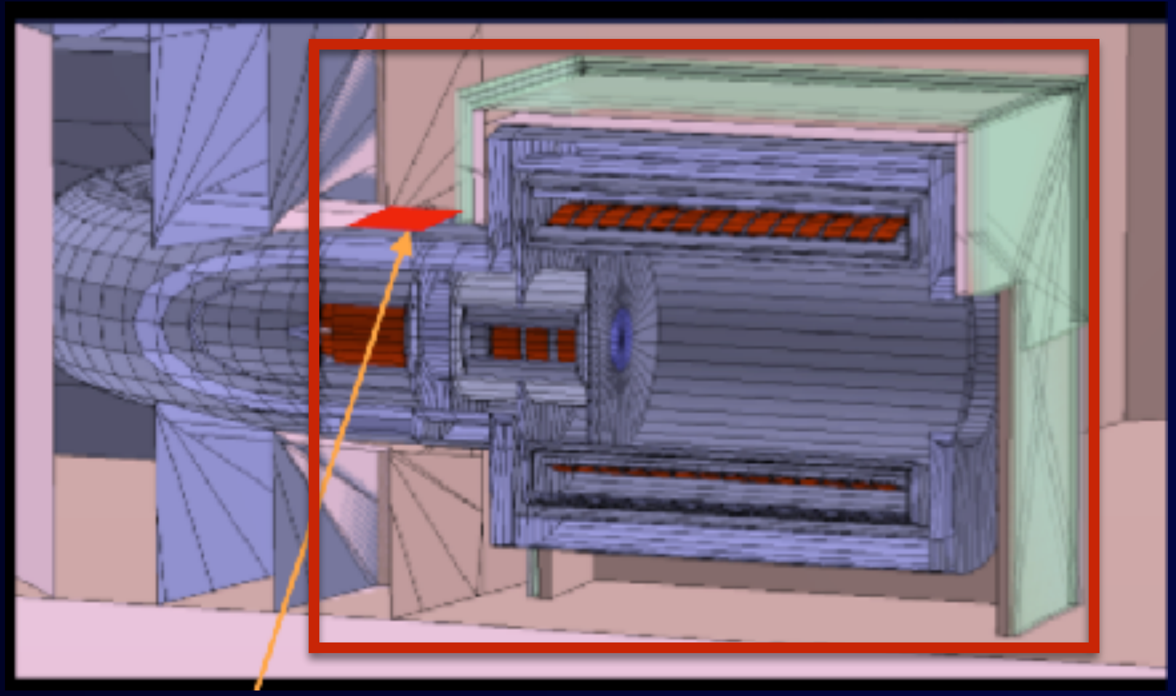


Activities in LPC Clermont : CR induced background study

To make the CR background simulation more efficient, atmospheric muons are generated underground, close to the detector according to a prior distribution.

- each muon is backward-transported up to the sea-level using a transport engine (PUMAS) that simulates in a very detailed way the local environment (transport magnets, experimental hall, etc)
- each muon is reweighed such as their flux at the surface reproduces the measured atmospheric muon flux at sea level.
- the muons are injected into the COMET simulation stream as usual, but each of them carries a weight that allows to efficiently take into account rare events



“Backward Monte-Carlo applied to muon transport”,

Comput.Phys.Commun. 229 (2018) 54-67 (2018-08), arXiv:1705.05636

Activities in LPC Clermont : CR induced background study

A full library of software tools was developed for sampling atmospheric muons by backward Monte Carlo (BMC), using a Modular approach (C libraries) & open source (LGPLv3). In particular, a Geant4 binding developed for COMET (G4Goupil) allows using directly the Geant4 geometry and hides the details of the BMC to the end-user, who manipulates a G4SingleParticleSource-like object.

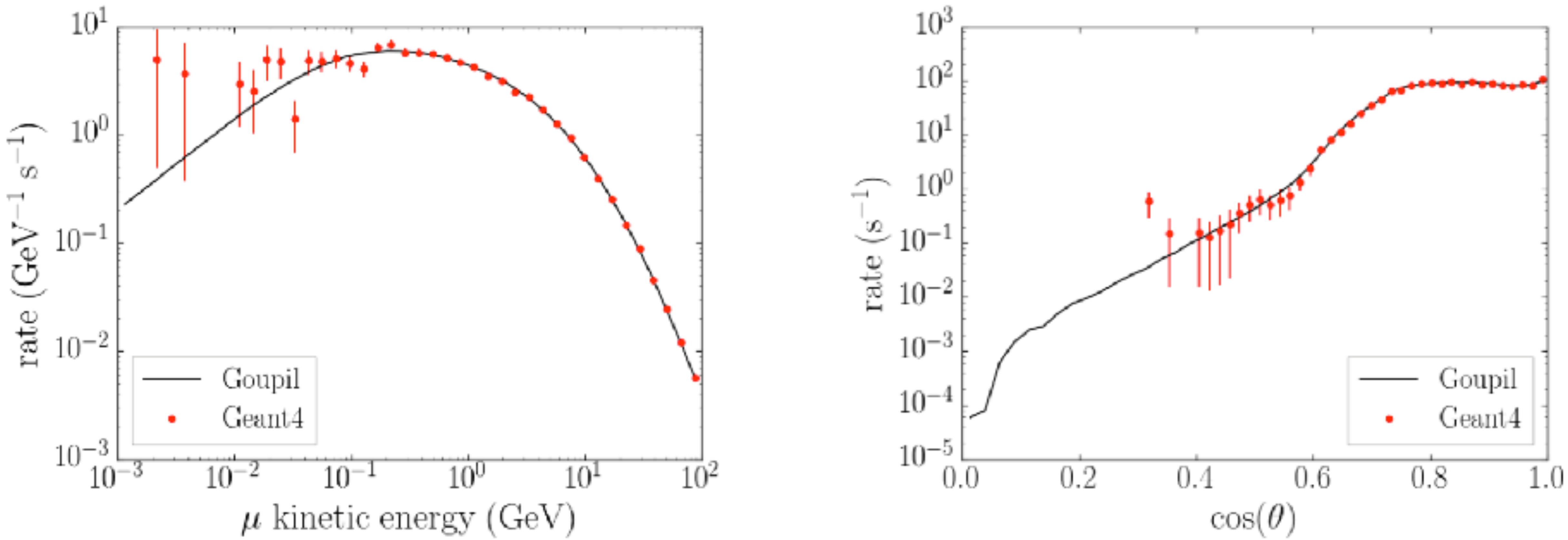
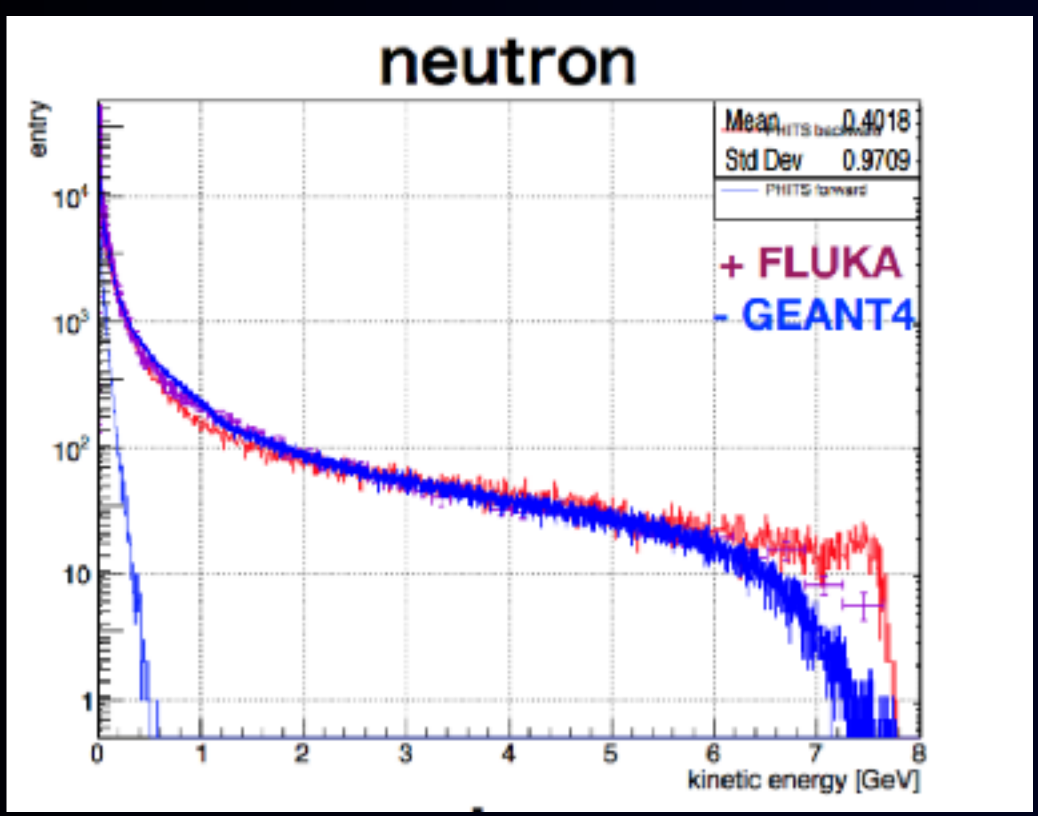
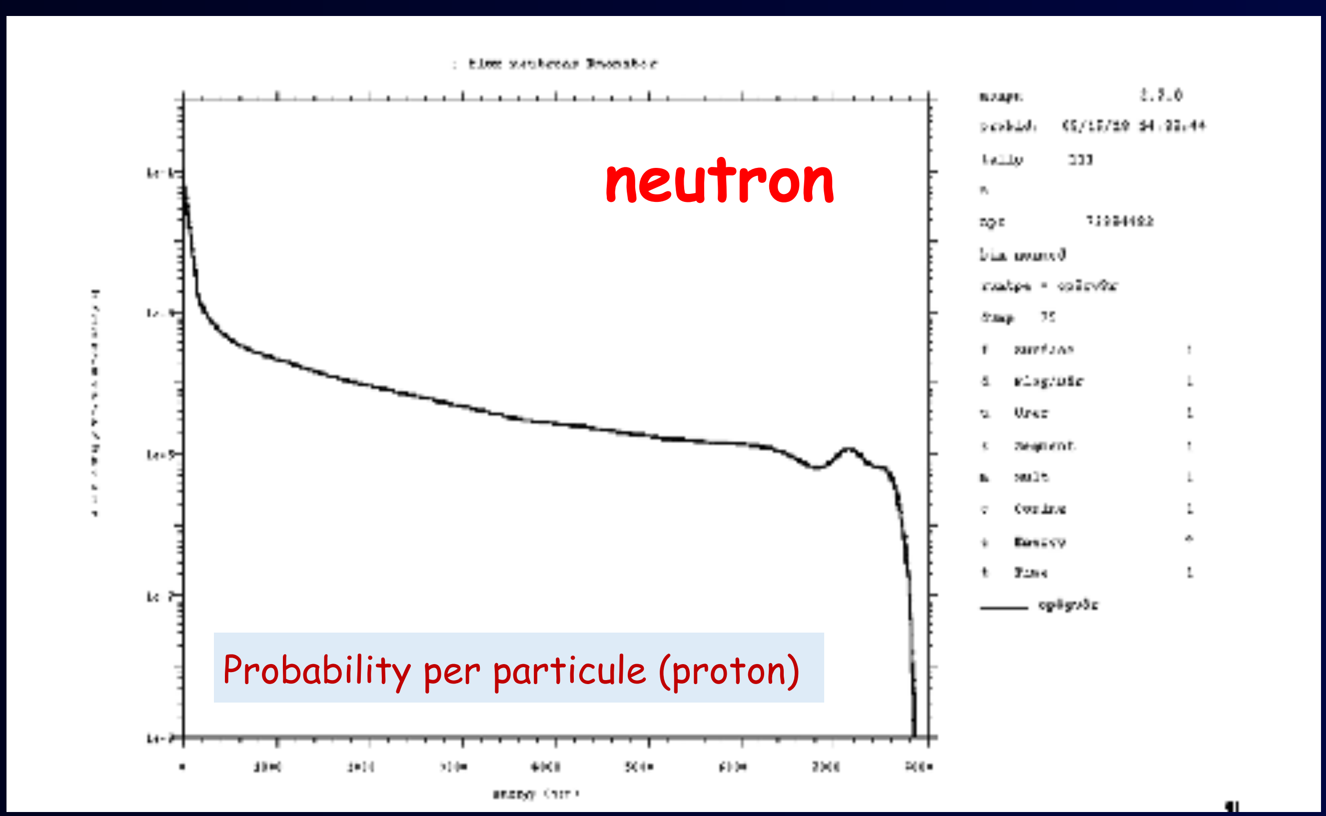


Figure 3: Left: μ energy spectrum in the target plane. Right: μ angular distribution. Geant4: 28 CPU-days. G4Goupil: 7 CPU-hours.

Activities in LPC-Caen

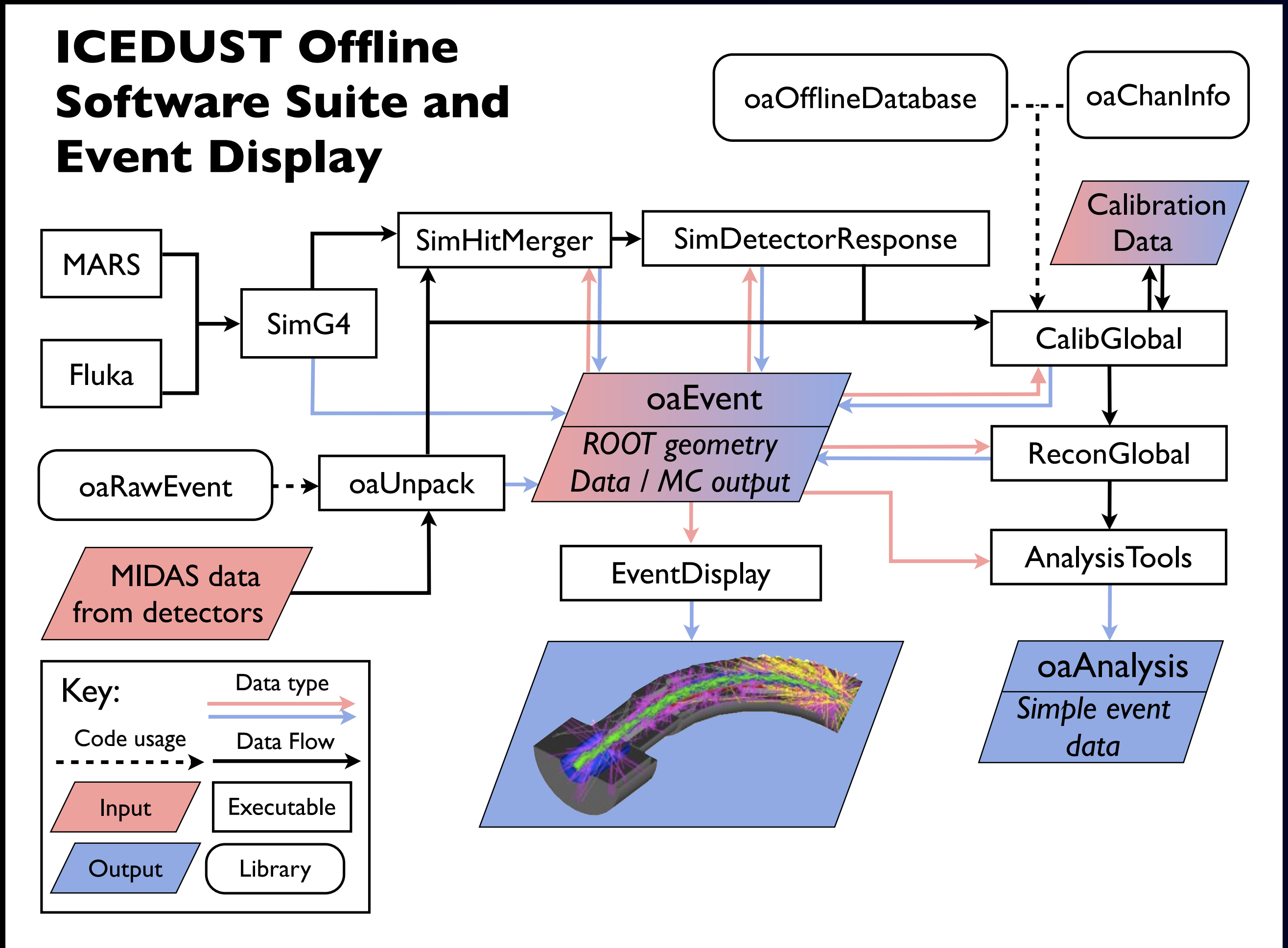
- LPC-Caen has started then simulations at the particle productions (in particular neutrons) at the proton target using MCNPX. It is important and should be cross-checked since neutron fluence is one of the issues of the COMET experiment since they are a source of background hits and cause radiation damages caused to detectors and readout systems.





Activities in CC-IN2P3 (Lyon, France)

- The software development and the management of Monte-Carlo simulation production and data storage at CC-IN2P3. Furthermore, a specific production of simulation data for the study of Phase II sensitivity was launched.



ICEDUST (COMET offline software)

CC-IN2P3

Activities in LPNHE :
Track finding by Apollonius circles

Test the Apollonius method on signal + background event seems promising but consuming computing time analysis ongoing in the framework of FCPPL agreement.

Build all Apollonius circles using all COMET Drift Chamber (CDC) drift distance hit triplets and vote ↘

Apollonius's problem : construct circles that are tangent to three given circles in a plane

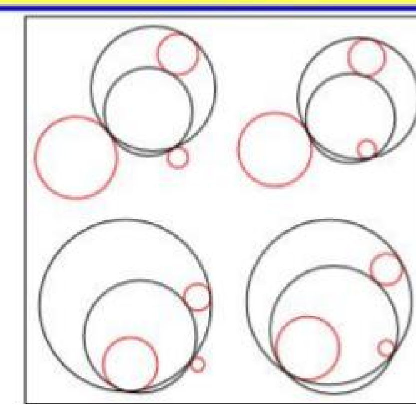
Greek Apollonius of Perga (200 BC)

Compass constructions by French François Viète (1600)

Algebraic solution (cyclographic model) :

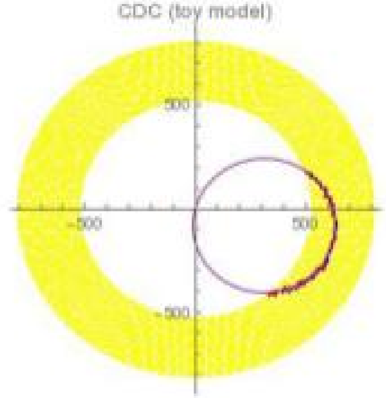
$$(-x_1+x_s)^2+(-y_1+y_s)^2=(r_s-r_1\ s_1)^2$$
$$(-x_2+x_s)^2+(-y_2+y_s)^2=(r_s-r_2\ s_2)^2$$
$$(-x_3+x_s)^2+(-y_3+y_s)^2=(r_s-r_3\ s_3)^2$$

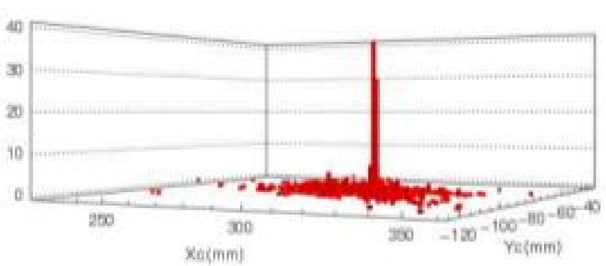
with $s_{1,2,3}=\pm 1$

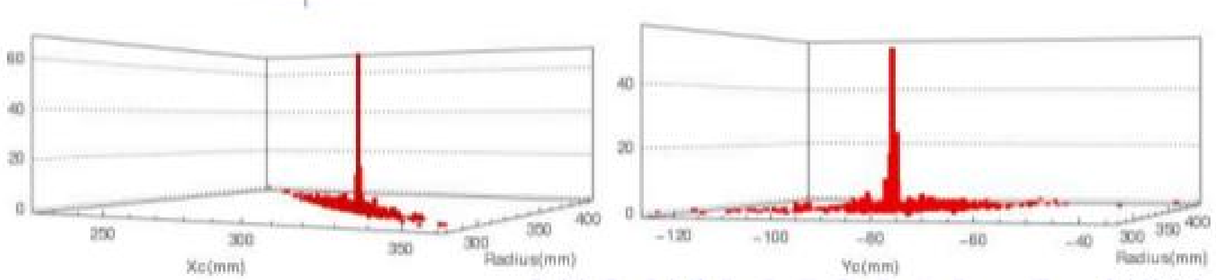


Pseudo code

1. Order hits by nearest distance (First hit with lowest x-coord.)
2. Take 3 hits not too near (here : distant of 16 cell size)
3. Compute the 8 Apollonius circles
4. Store Xc, Yc center and Radius of all Apollonius circle in 3D accumulator,
5. Redo with 3 new hits · · · until end.
6. Plot distribution results (left figure)



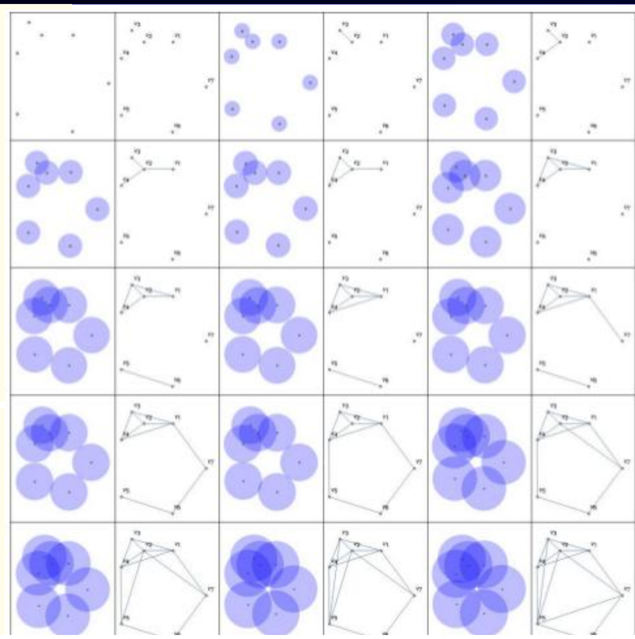


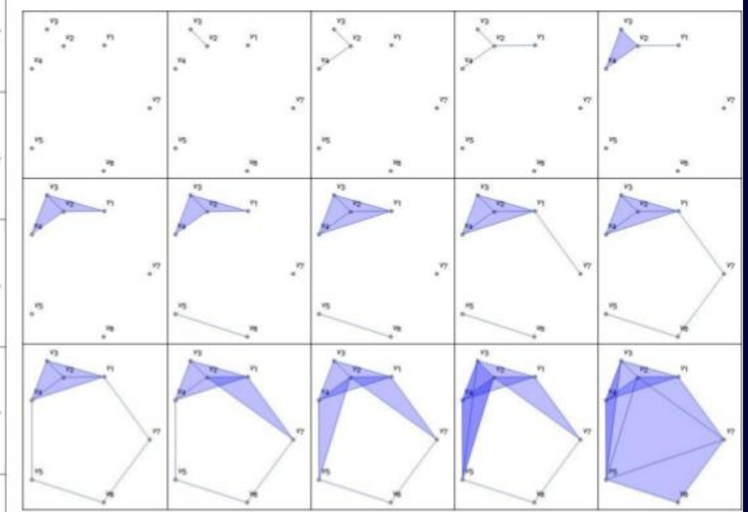


W. Da Silva (SU) and D, Pieters (Osaka)

Activities in LPNHE :
Track finding by persistent homology

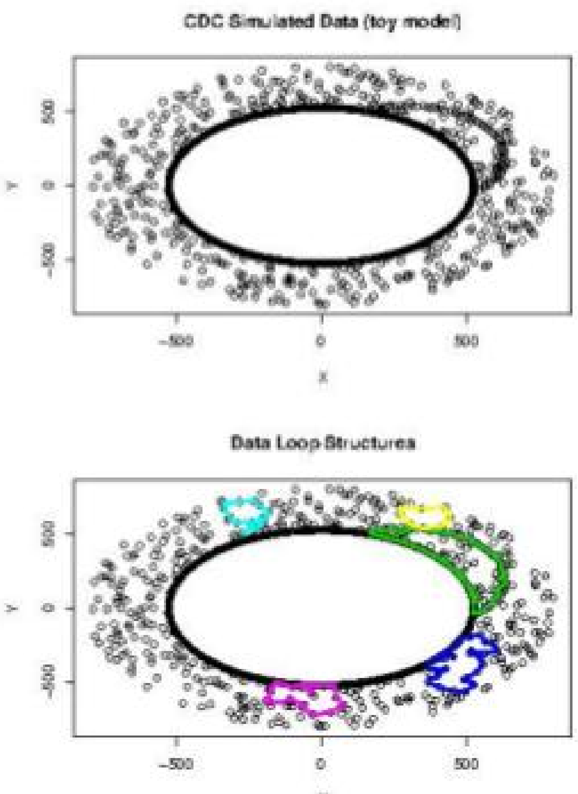
Vertices : replace data points by vertices
Edeges : link two vertices if their distance is lower than the ball diameter
Increase the ball diameter · · ·
To fill the loops :
Vietoris-Rips rules : fill the triangle
notion of peristence (see main loop) ⇒

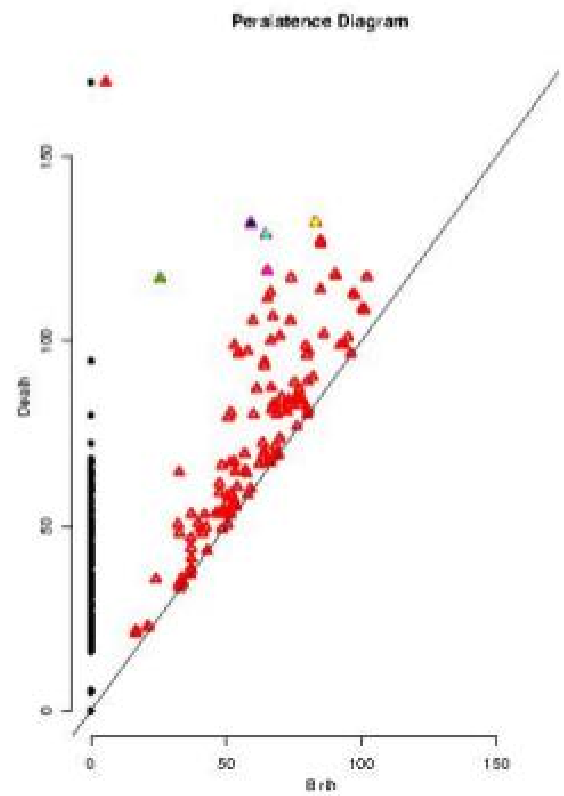




Build the Persistence Diagram and have a look on loops having the larger lifetime
Analysis ongoing in the framework of FCPPL agreement. ↘

- PH : computing time ∼ 30 s
- All finding loops are represented by a red or colored triangles in the Persistence Diagram (left figure).
- Points near the diagonal represent generally the background (dead radius ∼ birth radius)
- Finding loops with highest dead radius are schown and colored (yellow, green (track !), blue light, blue dark, · · ·
- The signal (green) seems still well separed from the background

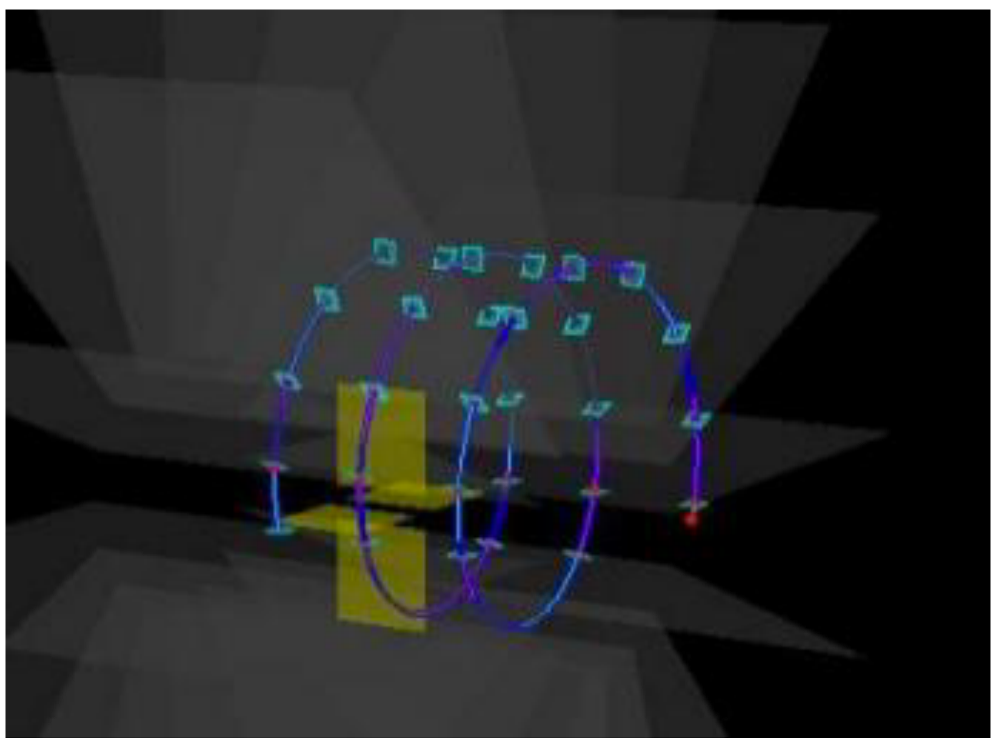




W. Da Silva (SU) and D, Pieters (Osaka)

Tracking study of silicon pixel vane detectors for the future (1)

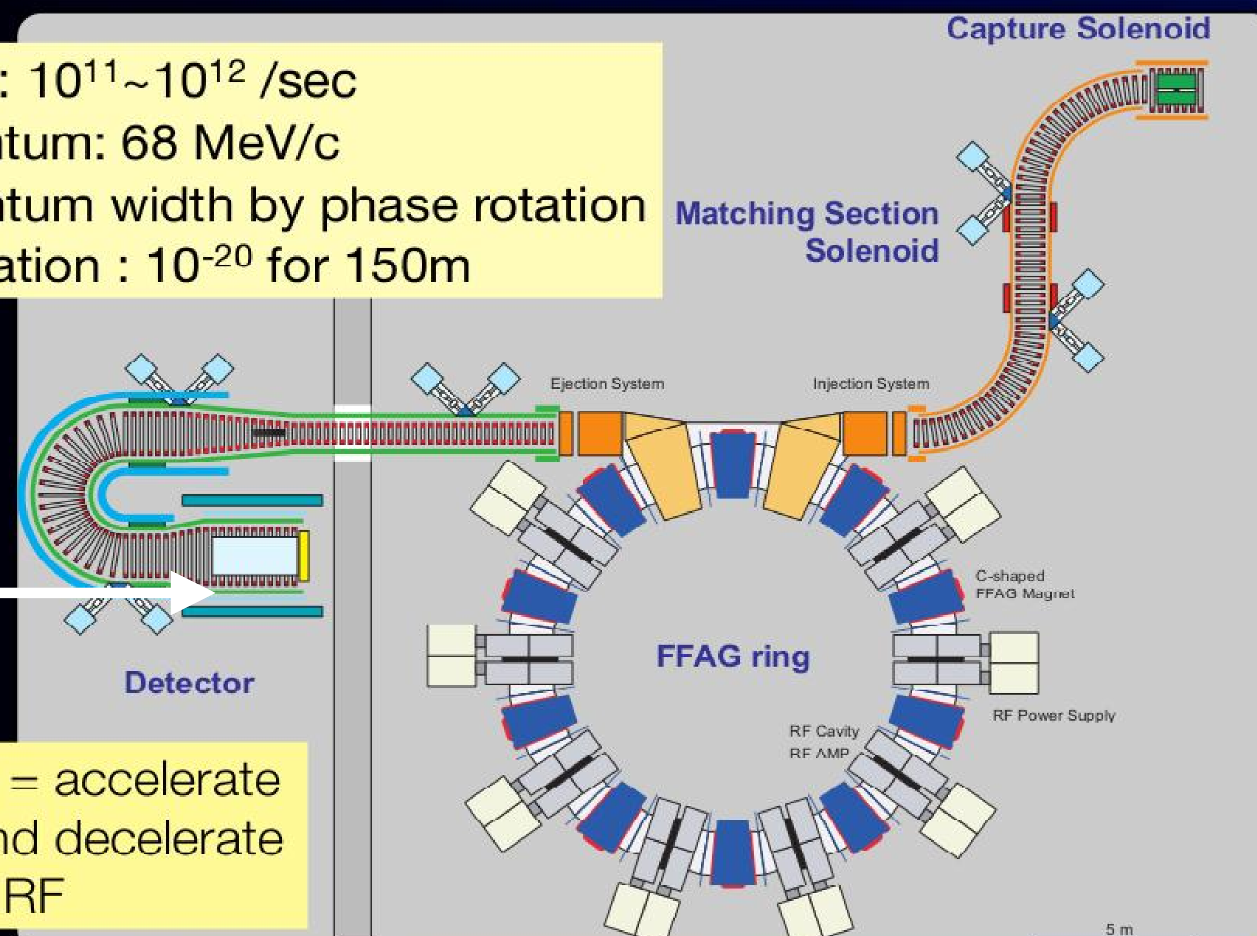
Explore the possibility of :
Silicon radial vanes for Stopping Target (yellow)
Silicon vane detector for the tracking of electrons (gray)



PRISM=Phase Rotated Intense Slow Muon source

PRISM Muon Beam

- muon intensity: 10^{11}~10^{12} /sec
- central momentum: 68 MeV/c
- narrow momentum width by phase rotation
- pion contamination : 10^{-20} for 150m



Phase rotation = accelerate slow muons and decelerate fast muons by RF

Tracking study of silicon-pixel vane detectors for the future (2)

GENFIT modification currently underdevelopment

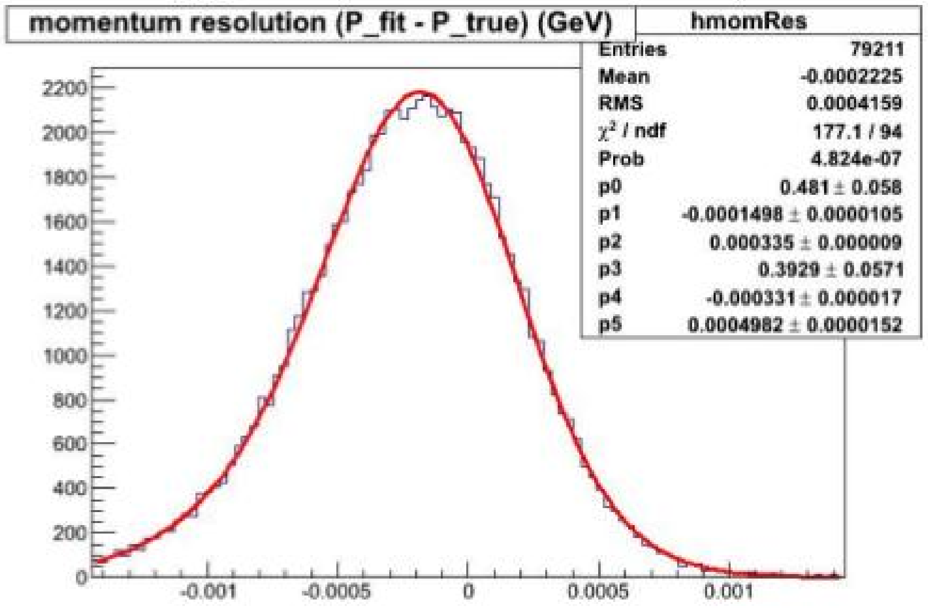
1. Total rewriting of the method giving the estimation track extrapolation length. Now no approximation of a linear trajectory of the particle is made. We now assumed that the trajectory is an helix given by a constant magnetic field whose value is taken at the starting point of the extrapolation.
2. Modification of Kalman Filter method in order to give the measurement points to the method which compute the estimation track extrapolation length.
3. Do the same for the DAF, Reference Kalman filter, · · ·

Some very preliminary results

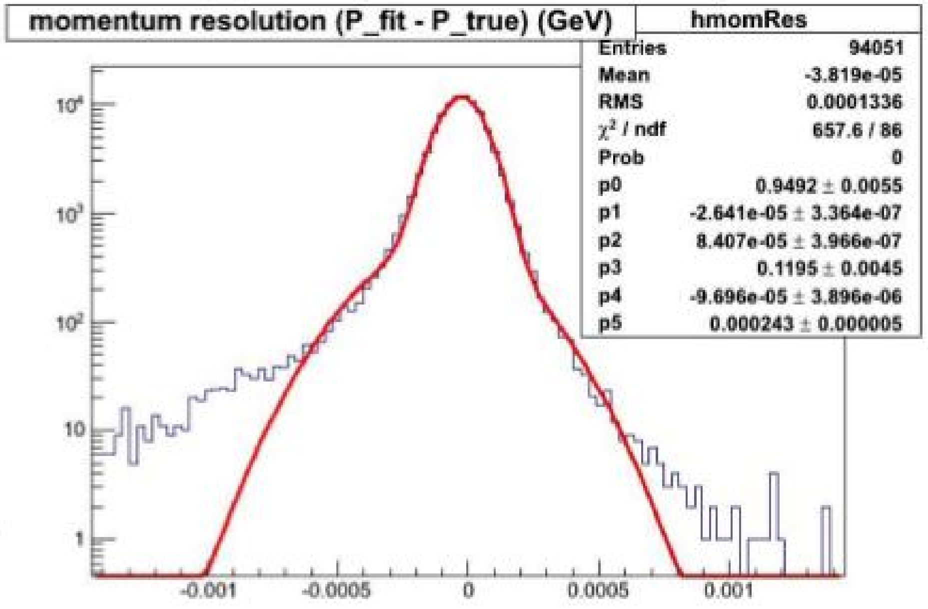
N_{vane}	thickness (μm)	$\varepsilon_{\mathrm{fitting}}$	σ_1 (keV)	σ_2 (keV)	$\mathrm{fraction}_1$
8	50	63%	85	243	89 %
8	300	52%	335	499	55%
16	50	84%	143	374	86%
16	300	72%	394	605	8%

$\Rightarrow$ Need more study on extrapolation (20% lost suspected ?)
$\Rightarrow$ Need more study on χ^2 by hit (10% lost suspected ?)
$\Rightarrow$ Study the track finding, test for other type of measurements ·

$N_{\mathrm{vane}} = 8$, thickness $= 300\ \mu$m



$N_{\mathrm{vane}} = 8$, thickness $= 50\ \mu$m



COMET

Osaka University

Plan in 2019-2020

Plan 2019-2020

- Simulation works
  - development of software, simulation and data management
  - planning of the mass production of larger simulated data
- Tracking developments
  - track finding and tracking with GENFIT2
- Design work on a new tracking device with silicon detectors (Paris)
- Workshop
  - COMET workshop in Paris is planned

- Joint supervised students:
  - Dorian Pieters, a French PhD student at Osaka University

Budget Request Summary

- French side
  - Two Travels to Japan, 1000 euro x 2 = 2000 euro
  - Local expense, 150 Euro/day x 16 days = 2400 euro
  - requested to IN2P3 with total 4400 euro

- Japanese side
  - one travel to France, 200 k yen x 1 = 200 k yen (PhD student)
  - Local expenses, 20 euro/day x 5 days = 100 k yen
  - requested to KEK with total 300 k yen

  - Additional request to Osaka University or Kakenhi for 200 k yen for one more travel (PhD student).

COMET

Osaka University

Future Prospects

White Paper: muonCLFV

muon CLFV white paper to the 2020 update of the European Strategy for Particle Physics, by COMET, MEG, Mu2e and Mu3e collaborations.

Charged Lepton Flavour Violation using Intense Muon Beams at Future Facilities

A. Baldini, D. Glenzinski, F. Kapusta, Y. Kuno, M. Lancaster,
J. Miller, S. Miscetti, T. Mori, A. Papa, A. Schöning, Y. Uchida

A submission to the 2020 update of the European Strategy for Particle Physics on behalf of the COMET, MEG, Mu2e and Mu3e collaborations.

Abstract

Charged-lepton flavour-violating (cLFV) processes offer deep probes for new physics with discovery sensitivity to a broad array of new physics models — SUSY, Higgs Doublets, Extra Dimensions, and, particularly, models explaining the neutrino mass hierarchy and the matter-antimatter asymmetry of the universe via leptogenesis. The most sensitive probes of cLFV utilize high-intensity muon beams to search for $\mu \to e$ transitions.

We summarize the status of muon-cLFV experiments currently under construction at PSI, Fermilab, and J-PARC. These experiments offer sensitivity to effective new physics mass scales approaching $\mathcal{O}(10^4)$ TeV/c^2. Further improvements are possible and next-generation experiments, using upgraded accelerator facilities at PSI, Fermilab, and J-PARC, could begin data taking within the next decade. In the case of discoveries at the LHC, they could distinguish among alternative models; even in the absence of direct discoveries, they could establish new physics. These experiments both complement and extend the searches at the LHC.

Contact: André Schöning [schoning@physi.uni-heidelberg.de]

CLFV Schedule in 2025 and beyond

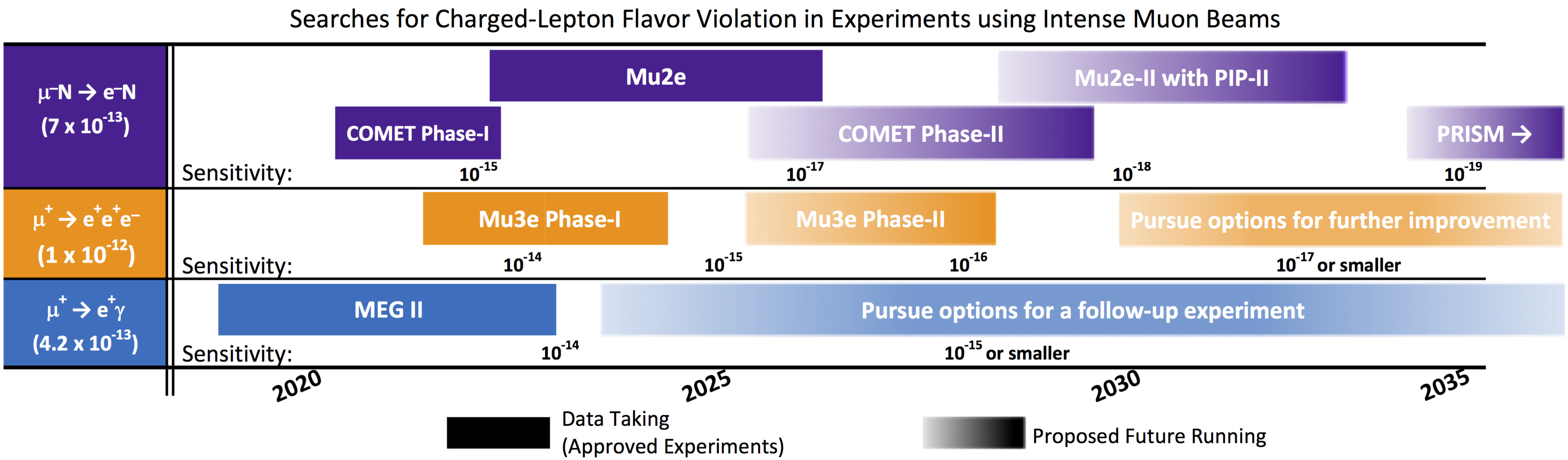


Figure 1: *Planned data taking schedules for current experiments that search for charged-lepton flavor violating $\mu \to e$ transitions. Also shown are possible schedules for future proposed upgrades to these experiments. The current best limits for each process are shown on the left in parentheses, while expected future sensitivities are indicated by order of magnitude along the bottom of each row.*

Summary

Summary

- CLFV, would give good opportunity to search for BSM.
- Muon to electron conversion could be one of the important CLFV processes.
- COMET is seeking for muon to electron conversion at J-PARC.
- COMET Phase-I is aiming at a factor of 100 improvement over the current (S.E. sensitivity of 3×10^{-15}), whereas COMET Phase-II aims at a factor 10,000 (100,000) improvement.
- There are several progress in the Japanese side as well as the French side (and Korean side).

Summary

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my dog, IKU