COMET

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Osaka University

P5, BNL
December 16th, 2013

P5 Questions (from Steve Ritz)

1) a very brief summary of the physics case coupled with the explicit scope of the experiment, along with a notional timeline for construction start, data taking, and specific anticipated results by phase. How does fit in the overall picture of this area? Specifically, what are the opportunities for cooperation with Mu2e, and, if there are, how might those evolve?

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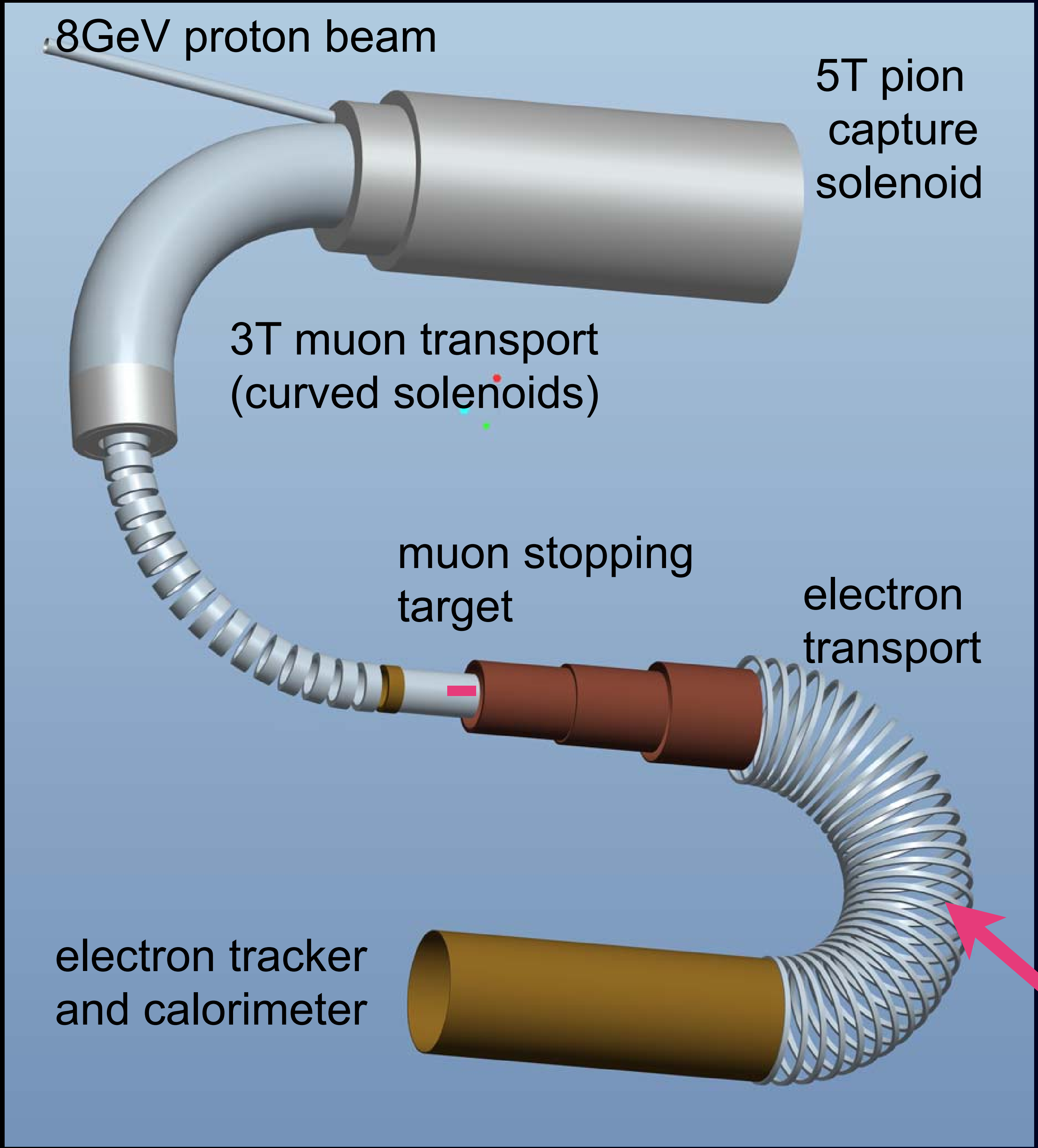
Q:physics case coupled with the explicit scope of the experiment

What is COMET (E21) at J-PARC



Experimental Goal of COMET

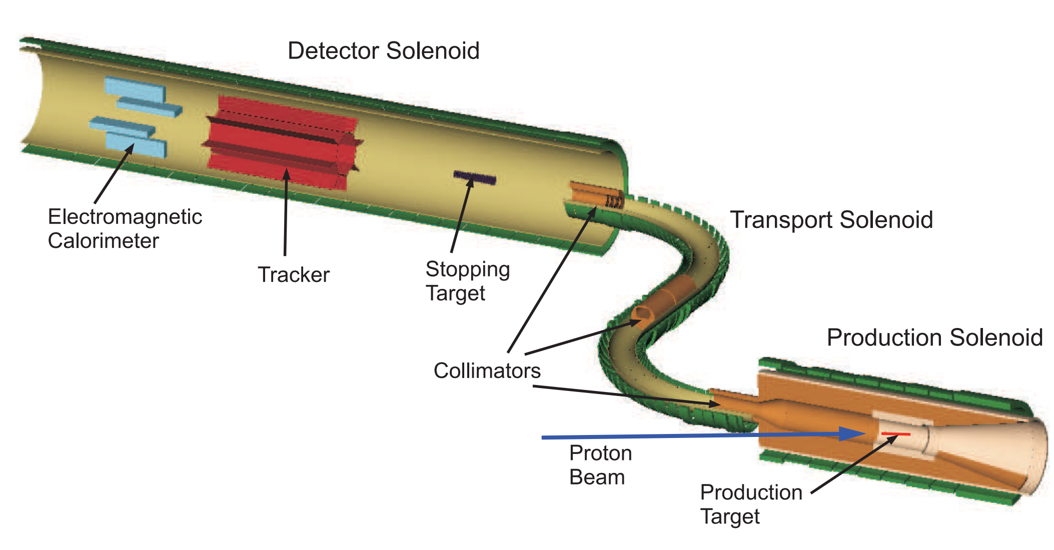
$$B(\mu^- + Al \rightarrow e^- + Al) = 2.6 \times 10^{-17}$$
$$B(\mu^- + Al \rightarrow e^- + Al) < 6 \times 10^{-17} \quad (90\% C.L.)$$

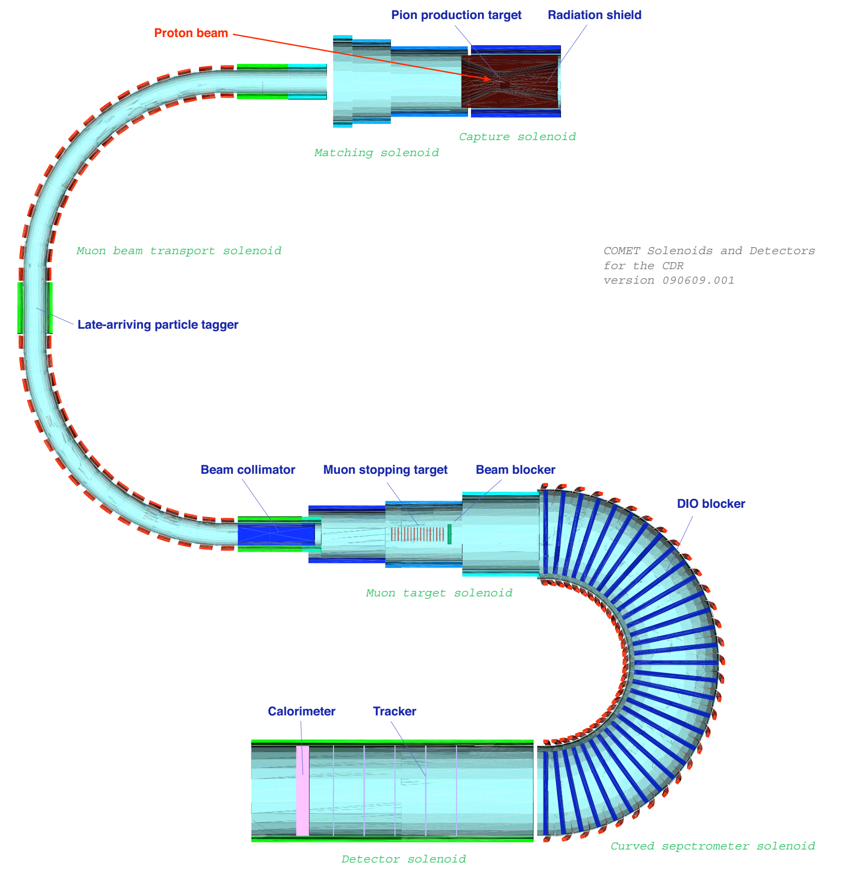
- 10^{11} muon stops/sec for 56 kW proton beam power.
- 2×10^7 running time (~1 year)
- C-shape muon beam line
- C-shape electron transport followed by electron detection system.
- Stage-1 approved in 2009.

Electron transport with curved solenoid would make momentum and charge selection.

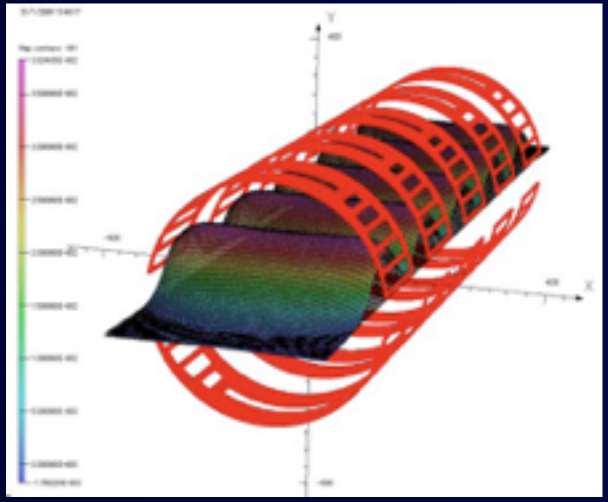
Q:physics case coupled with the explicit scope of the experiment

Mu2e vs. COMET





	Mu2e	COMET
muon beam line	2x 90° bends (opposite direction)	2x 90° bend (same direction)
electron spectrometer	straight solenoid	curved solenoid



Dipole Coils

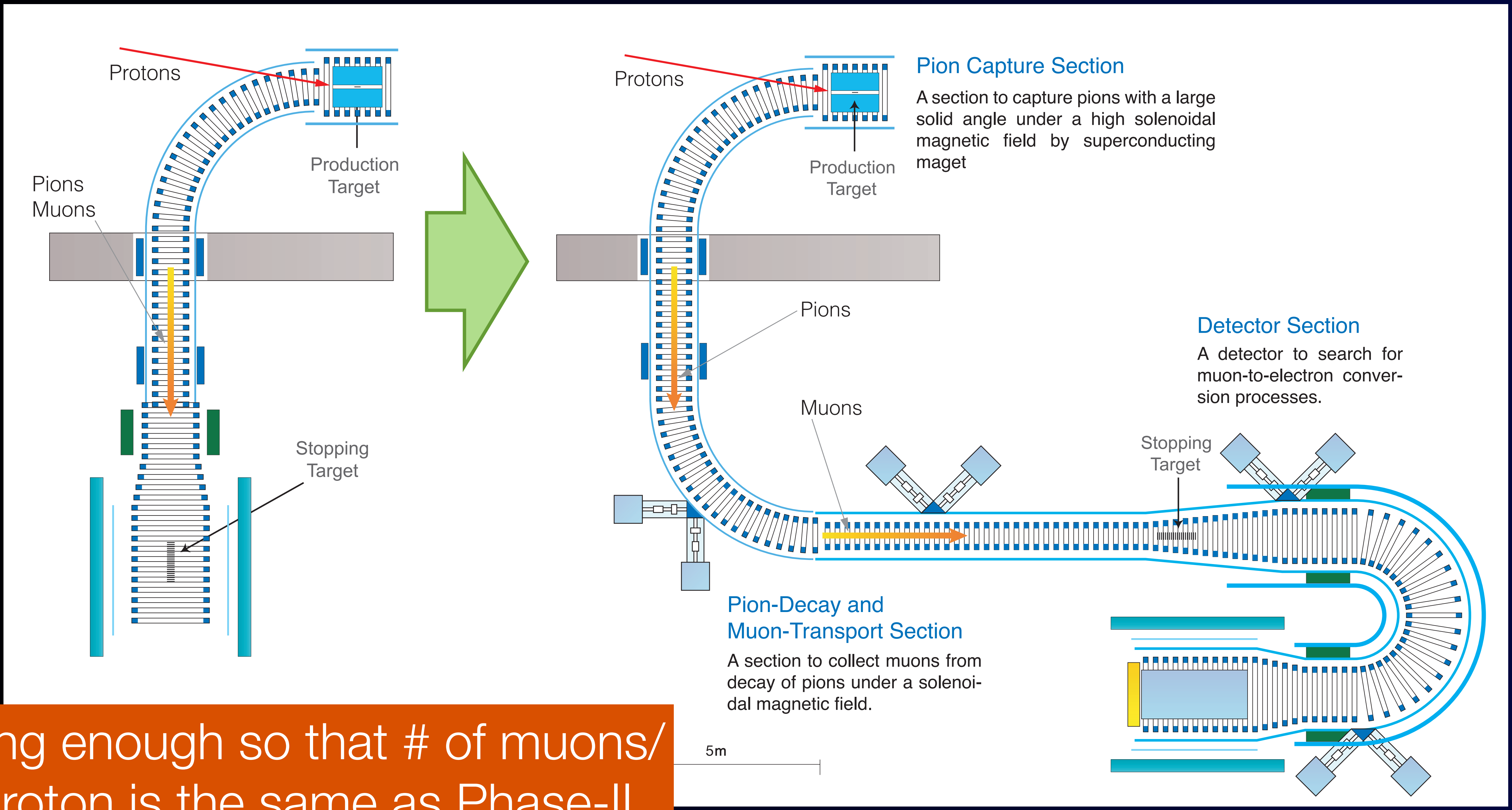
COMET curved solenoids have dipole coils on top of the solenoids, to keep muons with momentum of interest in the bending plane.

Q:physics case coupled with the explicit scope of the experiment

COMET Staged Approach (2012~)

COMET Phase-I

COMET Phase-II



long enough so that # of muons/ proton is the same as Phase-II.

physics case coupled with the explicit scope of the experiment

Goals of COMET Phase-I

Osaka University

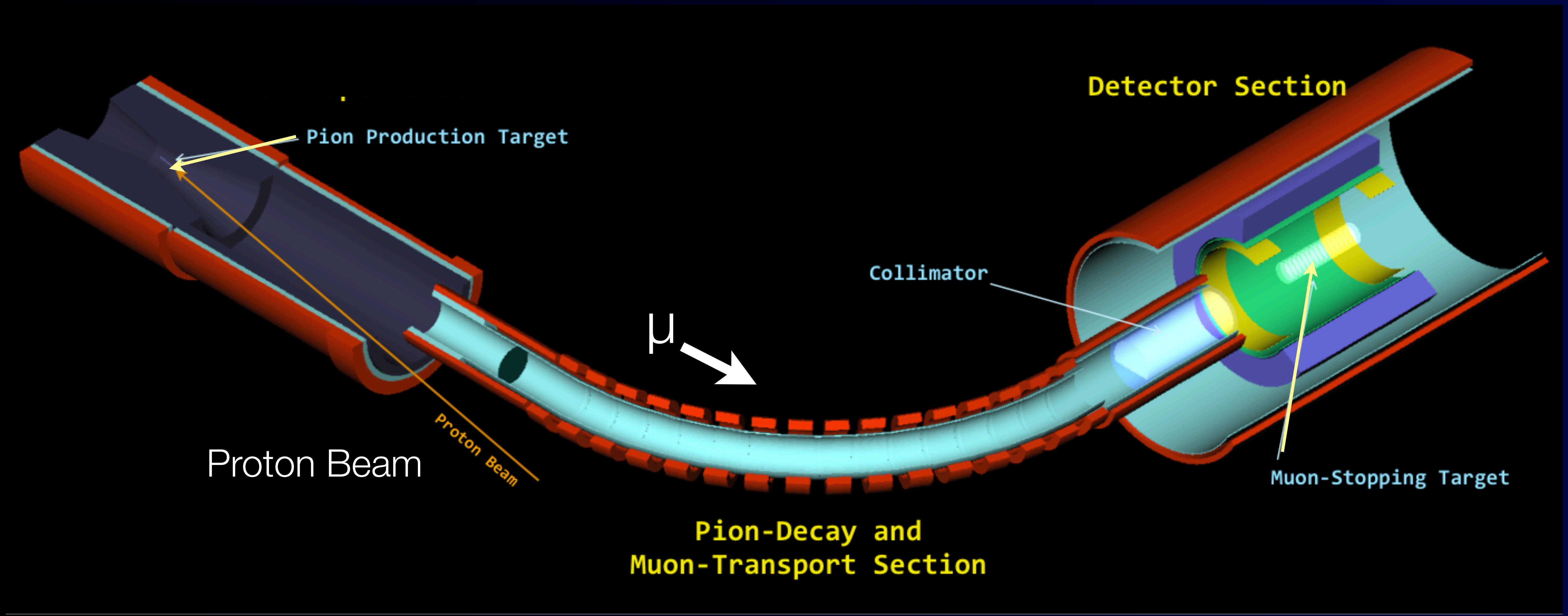
1 Background Study for COMET Phase-II

direct measurement of potential background sources for the full COMET experiment by using the actual COMET beam line constructed at Phase-I

2 Search for μ-e conversion

a search for μ^-–e^- conversion at intermediate sensitivity which would be more than 100 times better than the SINDRUM-II limit

COMET Phase-I Experimental Layout



COMET muon beam-line：

$(1\sim3)\times10^9$ muon/sec with 3kW beam produced. The world highest intensity.

COMET Phase-I detector：

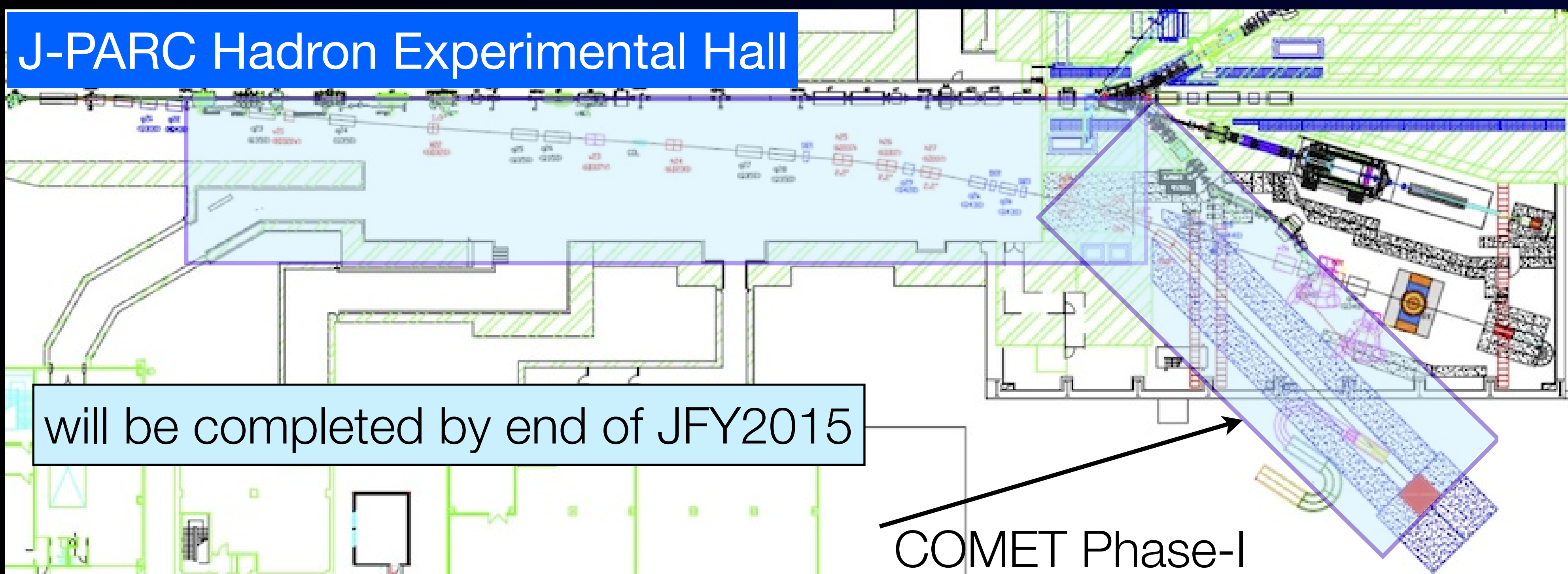
Cylindrical drift chamber (CDC) for μ-e conversion is used. Straw chamber and ECAL are for beam studies.

physics case coupled with the explicit scope of the experiment

Funds for Phase-I is secured.....

Osaka University

Budget for COMET Phase-I has been approved.



JFY2012 Supplemental budget

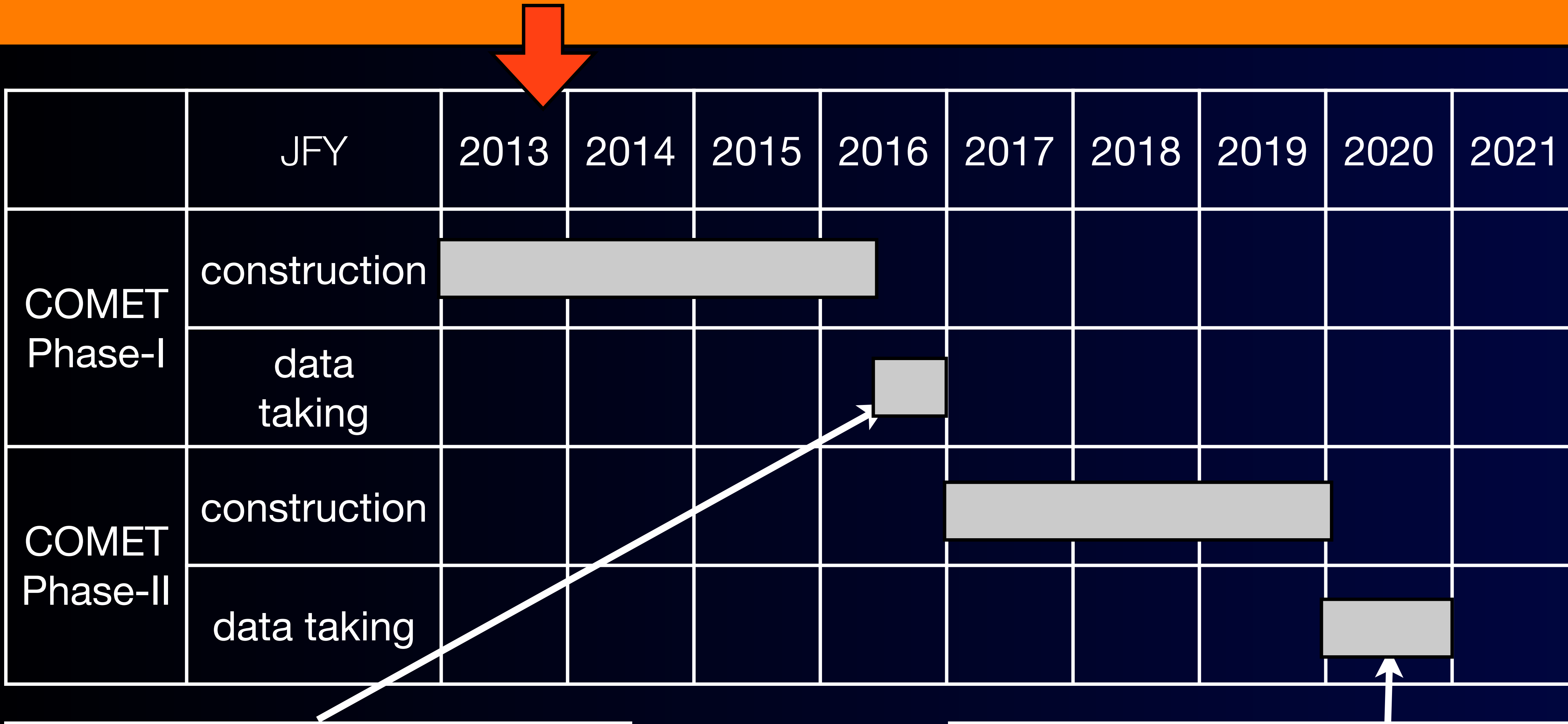
High momentum proton beam line for nuclear physics

Items		done by
proton beam line	general use	KEK
muon beam line		
COMET detector	exp. proper	COMET collaboration

Detector budget (CDC and detector solenoid) has been secured.

timeline for construction start, data taking, anticipated results

Schedule of COMET Phase-I and Phase-II



COMET Phase-I :
2016 ~
S.E.S. ~ 3×10^{-15}
(for 1~3 months
with 3,2 kW proton beam)

COMET Phase-II :
2020~
S.E.S. ~ 3×10^{-17}
(for 2×10^{7} sec
with 56 kW proton beam)

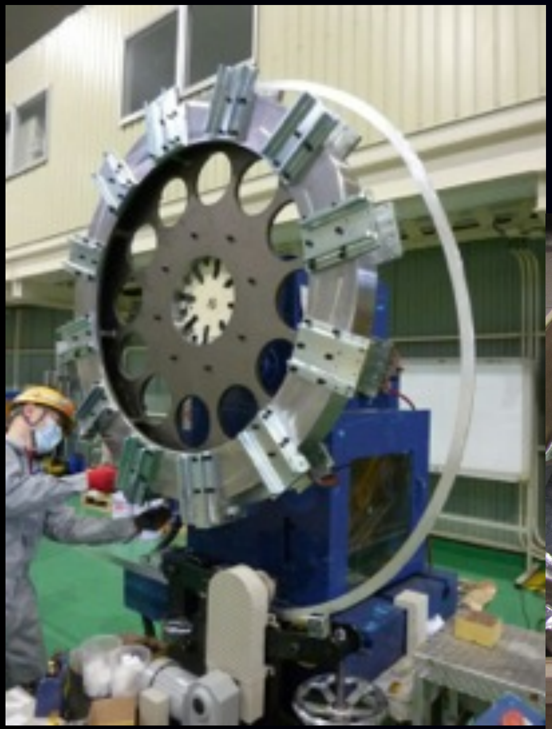
opportunities for cooperation with Mu2e

Superconducting Magnet R&D (2010~)

...through the US-Japan Program

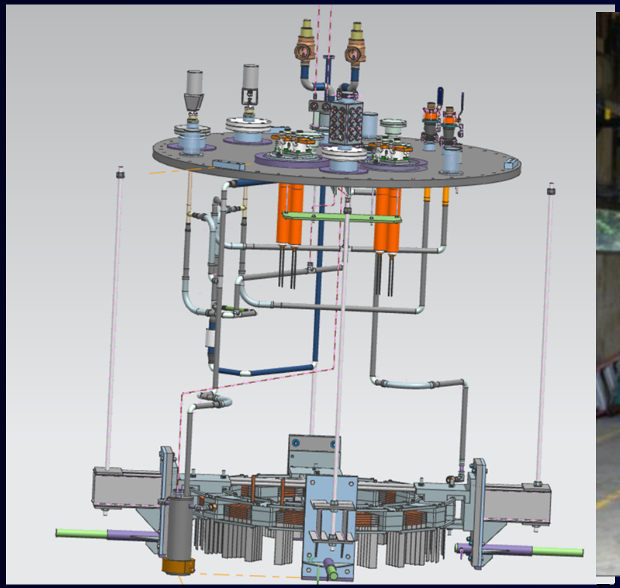
R&D of solenoid coils with aluminum-stalibized superconductors

Japan



Prototype coil of aluminum-stabilied superconductors were wound in Japan and sent to FNAL (2010-2012).

U.S.



Indirect cooling test bench was prepared at FNAL to test the prototype coil (2013~, not yet?)

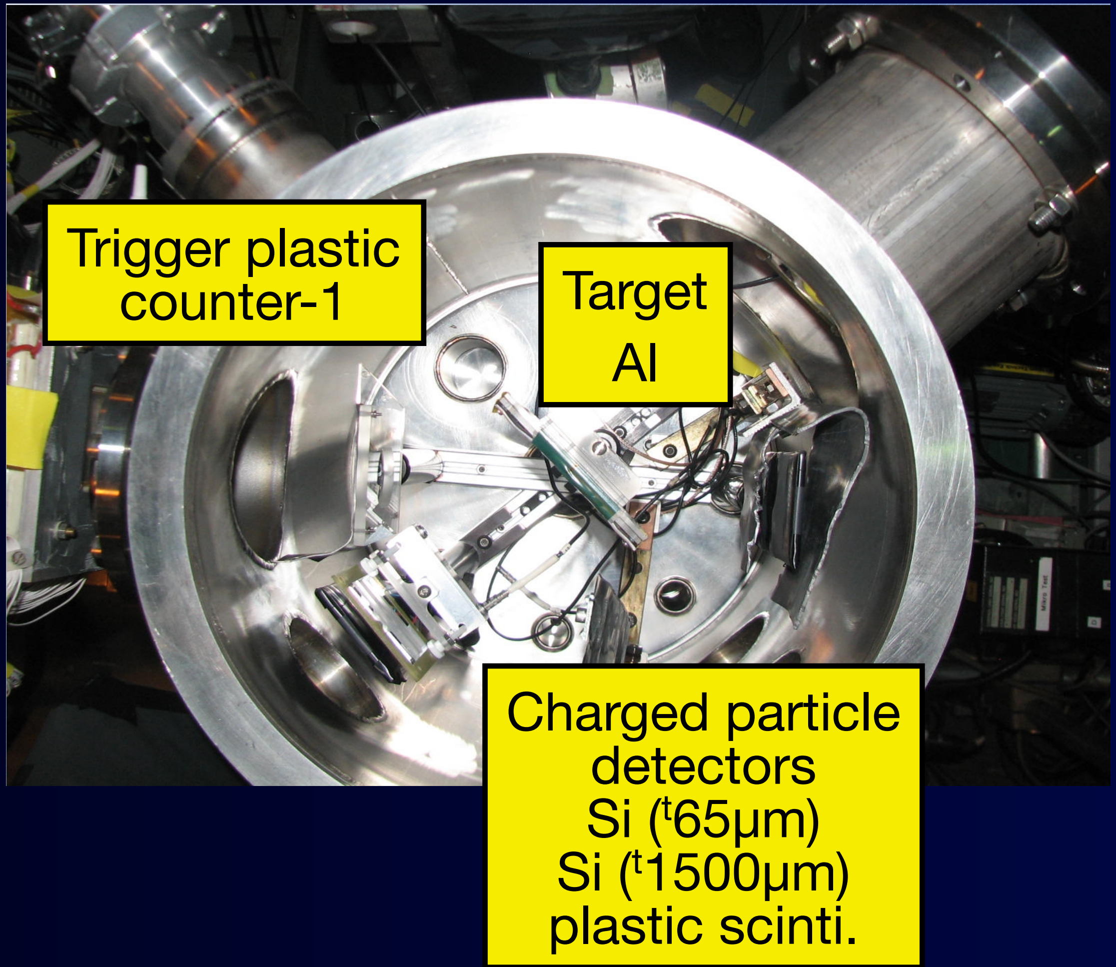
opportunities for cooperation with Mu2e

AlCap Experiment at PSI (2013~)

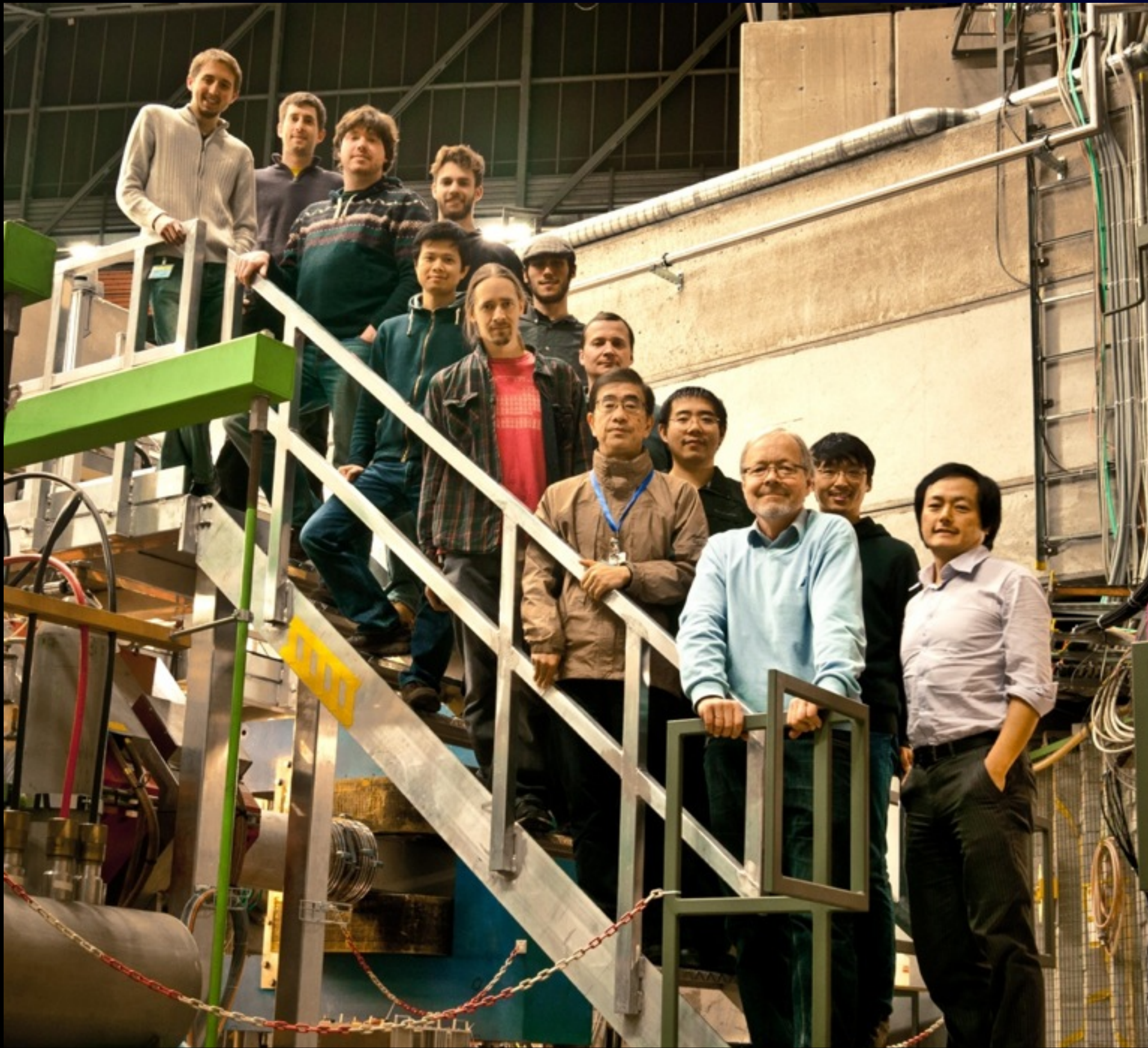
...through the US-Japan Program

Measurements of particle (proton) production after muon capture on Al.

- Proton emission rate after muon capture is important, since it determines single rates of tracking chambers if no charge selection is made before detection.
- That rate for aluminum has not been measured.
- As a joint effort of Mu2e and COMET, the AlCap experiment (P. Kammel (UW) and YK (Osaka), co-spokespersons) is being done at PSI in December, 2013.
- The measurements of neutron emission will be done in 2014?



opportunities for cooperation with Mu2e



AlCap@PSI

Dec. 13

opportunities for cooperation with Mu2e

AlCap@PSI

Dec. 13

C COMET

M Mu2e

How might these evolve ?

...through the US-Japan Program

Each year we have to submit the proposal to the US-Japan program. The future plan should be discussed between Mu2e and COMET.

テキスト

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COMET Collaboration is international.

129 collaborators
28 institutes, 11 countries

The COMET Japan group funded.

The COMET China group funded.

The COMET JINR group funding underway.

The COMET Collaboration

R. Akhmetshin[3], K. Akuma[17], M. Aoki[22], R. B. Appleby[19], Y. Arimoto[12], Y. Bagaturia[7], W. Bertsche[19], A. Bondar[3], D. Bryman[2], B. Chiladze[5], M. Danilov[10], W. daSilva[16], P. Dauncey[8], G. Devidze[5], P. Dornan[8], A. Drutskoy[10], S. Dymov[11], A. Edmonds[25], L. Epshteyn[3], P. Evtoukhovich[11], G. Fedotovich[3], Y. Fukao[12], M. Gersabeck[19], D. Grigoriev[3], K. Hasegawa[12], I. H. Hasim[22], O. Hayashi[22], M. I. Hossain[18], Z. Ibrahim[17], F. Idris[17], Y. Igarashi[12], F. Ignatov[3], M. Ikeno[12], S. Ishimoto[12], T. Itahashi[22], S. Ito[22], T. Iwami[22], Y. Iwashita[13], X. Jiang[4], P. Jonsson[8], V. Kalinnikov[11], F. Kapusta[16], H. Katayama[22], K. Kawagoe[15], V. Kazanin[3], B. Khazin[3], A. Khvedelidze[11], M. Koike[26], G. Kozlov[11], B. Krikler[8], A. Kulikov[11], Y. Kuno[22], Y. Kuriyama[14], A. Kurup[8], B. Lagrange[14], M. Lancaster[25], H. B. Li[4], W. Li[4], A. Liparteliani[5], G. Macharashvili[11], Y. Makida[12], Y. Matsumoto[22], T. Mibe[12], S. Mihara[12], A. Moiseenko[11], Y. Mori[14], N. Mosulishvili[5], E. Motuk[25], Y. Nakai[15], T. Nakamoto[12], T. H. Nam[22], J. Nash[8], M. Nioradze[5], H. Nishiguchi[12], T. Numao[24], T. Ogitsu[12], K. Okamoto[22], C. Omori[12], K. Ooishi[15], T. Ota[23], H. Owen[19], R. Palmer[1], C. Parkes[19], J. Pasternak[8], A. Popov[3], V. Rusinov[10], A. Ryzhenenkov[3], B. Sabirov[11], N. Saito[12], H. Sakamoto[22], P. Sarin[6], K. Sasaki[12], A. Sato[22], J. Sato[23], D. Shemyakin[3], V. Shmakova[11], M. Sugano[12], W. Tajudeen[17], Y. Takubo[12], M. Tanaka[12], C. V. Tao[21], E. Tarkovsky[10], Y. Tevzadze[5], N. D. Thong[22], V. Thuan[9], J. Tojo[15], M. Tomizawa[12], I. Trekov[5], N. M. Truong[22], Z. Tsmalaidze[11], N. Tsverava[11], S. Tygier[19], T. Uchida[12], Y. Uchida[8], K. Ueno[12], S. Umasankar[6], E. Velicheva[11], A. Volkov[11], M. Warren[25], M. Wing[25], C. Wu[4], G. Xia[19], K. Yai[22], A. Yamamoto[12], M. Yamanaka[20], M. Yoshida[12], Y. Yoshii[12], K. Yoshimura[12], T. Yoshioka[15], Y. Yuan[4], Y. Yudin[3], Y. Zhang[4]

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US Contribution

Osaka University

Mu2e and COMET are cooperating in various aspects.

In the past

(1) Superconducting magnet R&D
(2) muon capture experiment at PSI (AlCap).

COMET is looking forward to more cooperation in the future.

ex: COMET would invite Mu2e to participate in the measurements of physics background (muon decay in orbit, radiative muon capture, etc.) for COMET Phase-I (2016~), hopefully with detectors (components).

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R&D

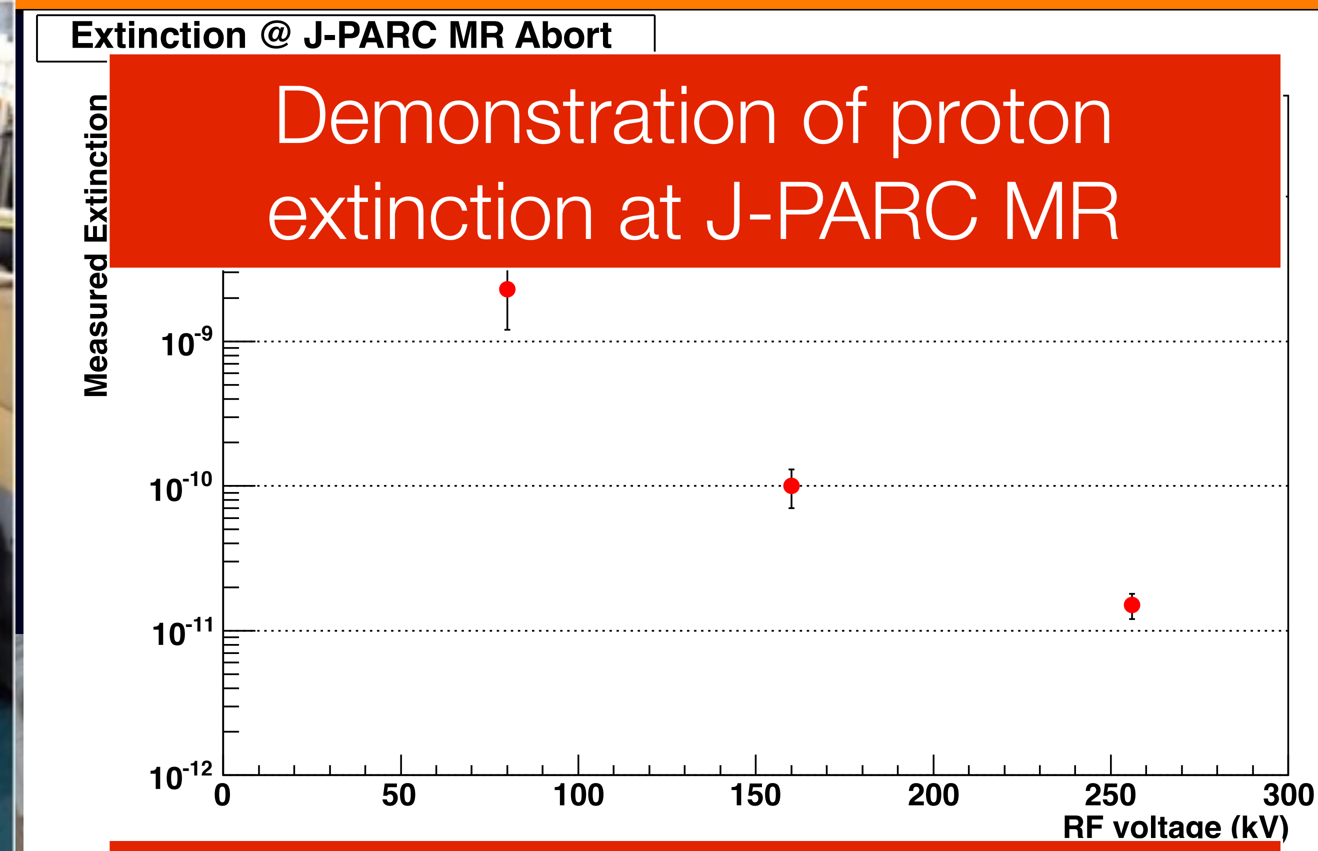
No more major R&D for COMET is needed.

Some remaining issue is
8 GeV J-PARC MR operation and beam extraction.
(COMET requests to J-PARC.)

Major R&Ds that have been done...

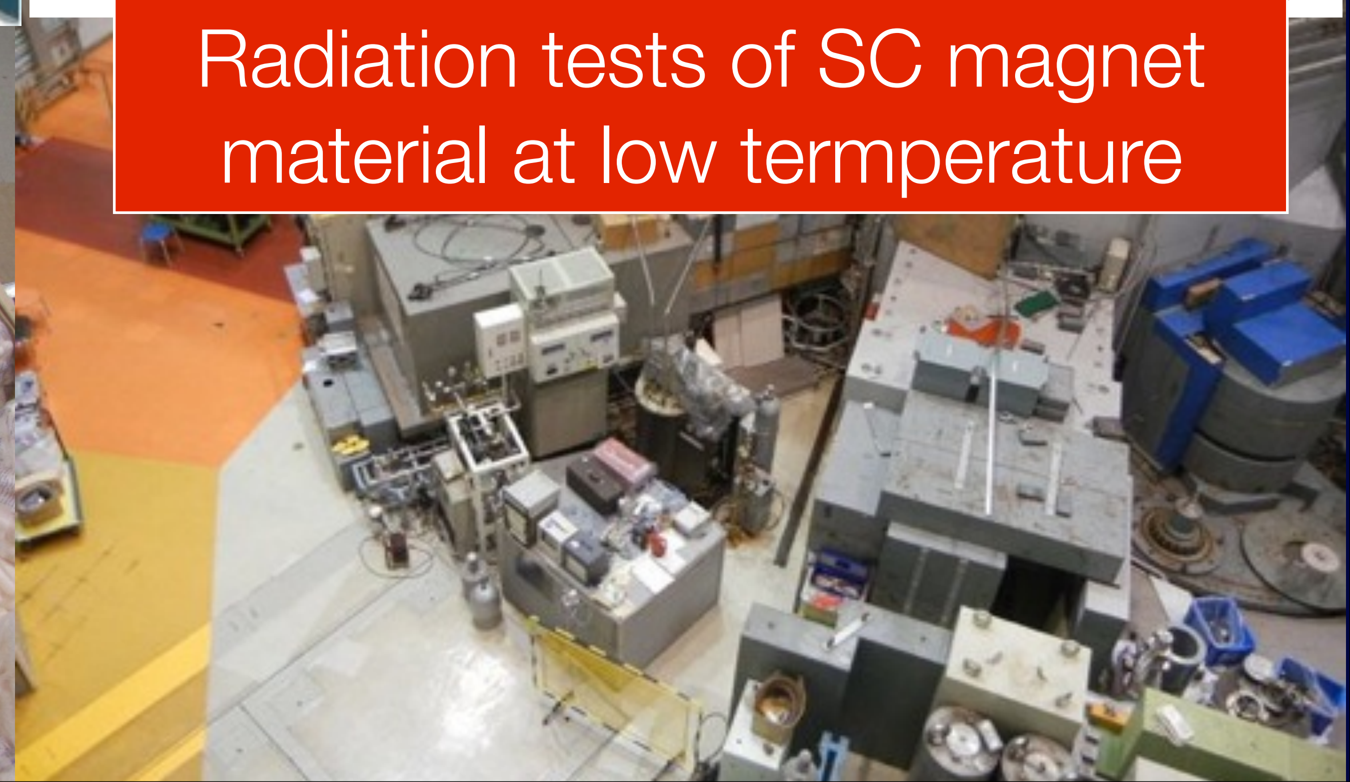
Demonstration of 10^3 increase of muon yields at MuSIC, Osaka U.

Demonstration of proton extinction at J-PARC MR



Production of aluminum stabilized SC coil prototype

Radiation tests of SC magnet material at low termperature



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CLFV = charged lepton flavor violation

To P5, we like to bring the message that....

CLFV is unique and important to find new physics beyond the SM.

CLFV is sensitive to NP at high energy scale Λ.

others

amplitude

$$|A_{\rm SM} + \varepsilon_{\rm NP}|^2 \sim |A_{\rm SM}|^2 + 2Re(A_{\rm SM}\varepsilon_{\rm NP}) + |\varepsilon_{\rm N}|^2$$

subject to uncertainty of SM prediction

CLFV

rate

$$|A_{\rm SM} + \varepsilon_{\rm NP}|^2 \sim \cancel{|A_{\rm SM}|^2} + 2Re(\cancel{A_{\rm SM}\varepsilon_{\rm NP}}) + |\varepsilon_{\rm N}|^2$$

could go higher energy scale

$$R \propto \frac{1}{\Lambda^4}$$

CLFV for muons can be improve by a factor of 10,000 or more, implying 10 times in energy reach.

To P5, we like to bring the message that ...

Having the two experiments, Mu2e and COMET, is very important.

- Comparison of the two experimental results is always important to justify them.
- Muon beams are different for Mu2e and COMET, and therefore potential background sources (beam-related backgrounds and environmental backgrounds) are different.

Summary

- COMET Phase-I
  - from 2016
  - S.E.S. of $3x10^{-15}$ (for 1~3 month running)
  - background measurements
- COMET Phase-II
  - from 2020
  - S.E.S. of $3x10^{-17}$ (for $2x10^{7}$ sec)

Backup

μ-e conversion at S.E. sensitivity of 3×10^{-19}
PRISM/PRIME (with muon storage ring)