Report from Japan

Yoshitaka Kuno
Osaka University
MUTAC Meeting, BNL, May 29th, 2004

Outline

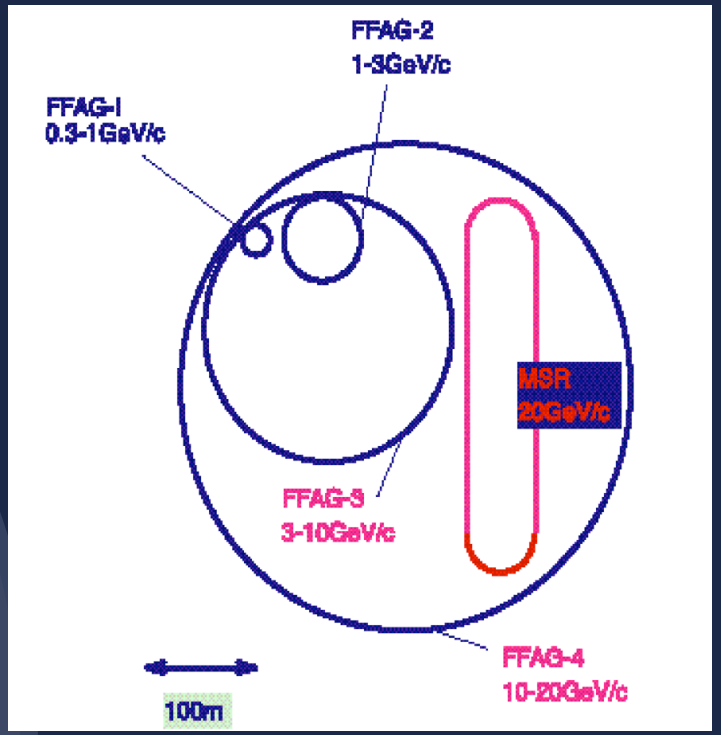
- FFAG based Neutrino Factory
- R&D Status
  - LH2 Absorber R&D (Ishimoto's talk)
  - Scifi Tracker R&D
  - Target R&D
  - FFAG R&D
    - PRISM
- Case at J-PARC
- Conclusion

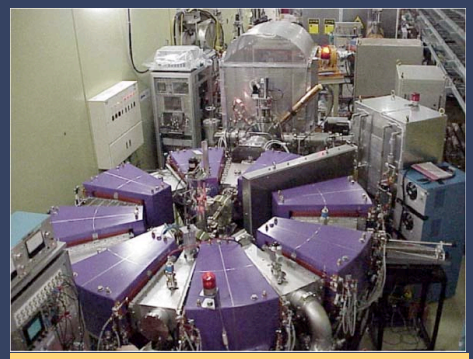
International Collaboration (in particular with US !!)

FFAG Based Neutrino Factory

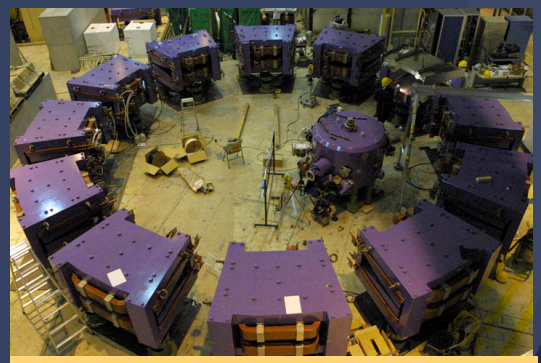
FFAG-based NF

- Japanese scheme of Neutrino factory based on FFAG muon acceleration
  - Large acceptance
  - cooling is not a must (better if avalaible)
  - simple and compact
  - R&D underway in Japan





0.5-MeV Proton FFAG
POP at KEK



150-MeV Proton FFAG
Under construction at KEK

Series of FFAGs for muon acceleration

0.3-1.0 GeV
1-3 GeV
3-10 GeV
10-20 GeV

Staging Approach

- Staging scenario (with FFAG)
  - Muon Factory (PRISM)
    - For stopped muon experiments
  - Muon Factory-II (PRISM-II)
    - Muon moments (g-2, EDM)
  - Neutrino Factory-I
    - Based on 1 MW proton beam
  - Neutrino Factory-II
    - Based on 4.4 MW proton beam
  - Muon Collider

70 MeV/c
PRISM

0.3-1 GeV/c

1-3 GeV/c
PRISM-II

3-10 GeV/c
Nufact-I

10-20 GeV/c
Nufact-II

Muon
Storage Ring

Physics outcome
at each stage

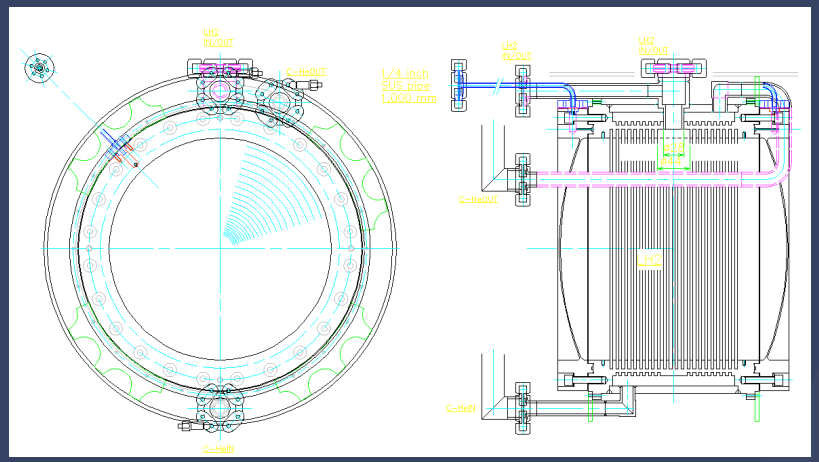
R&D

LH2 Absorber R&D

see Ishimoto's talk

- under the US-Japan program "muon sources"
- convection-type
- expect LH2 filling test at MTA/FNAL
- MICE absorber design

KEK cryostat waiting at MTA/FNAL



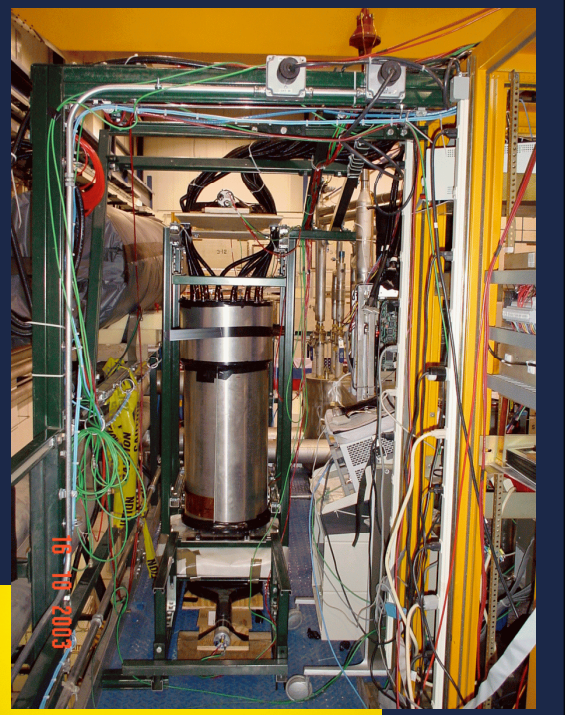
MICE absorber design

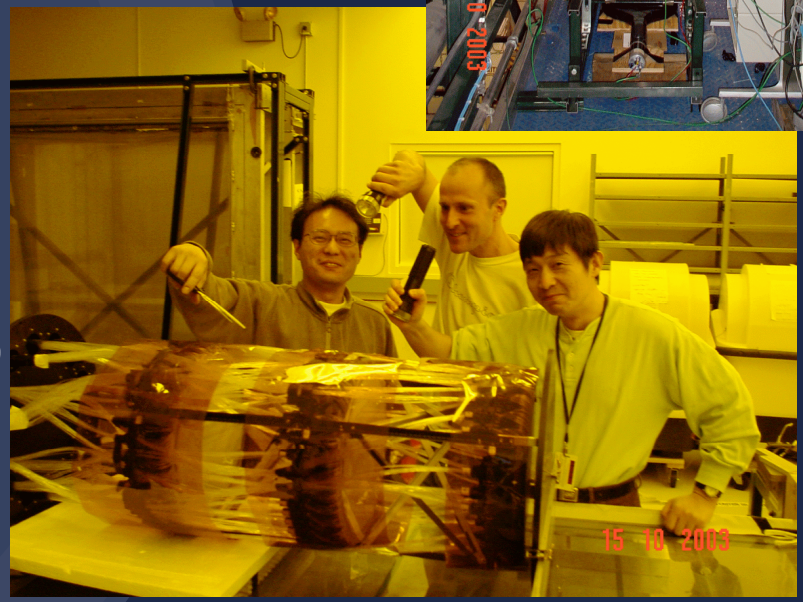
MICE absorber prototype

MICE SciFi R&D

- US/UK/Japan collaboration
- KEK beam test (May, 2004) : 3HF scifi
- SciFi Tracker prototype test@FNAL cosmic-rays (Sep.2003-March.2004)
- KEK beam test @ KEK (April, 2004) :
- SciFi prototype beam test@KEK (summer, 2005)
  - magnet, cryocooler-VLPC, readout

cosmic-ray test of scifi prototype at D0 test stand

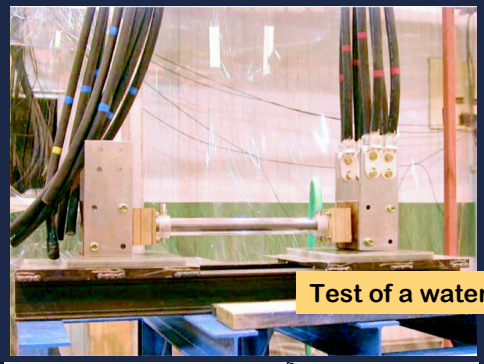




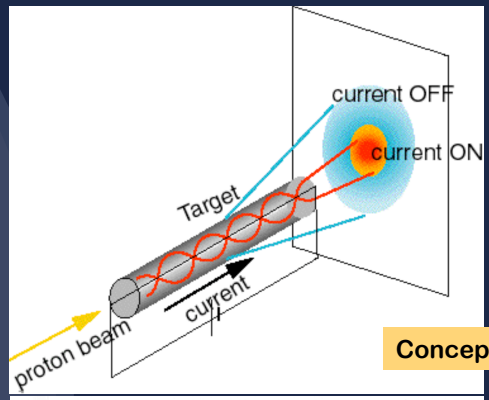
Target R&D

a la Koji Yoshimura

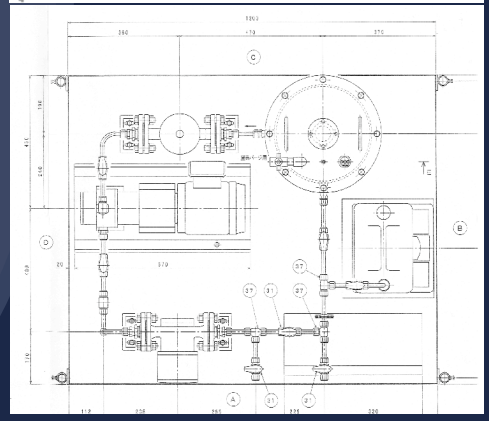
- Stationary Target
  - water cooled graphite (100kW)
  - by T2K group
- Conduction Pulsed target R&D
  - Mercury loop for bench tests
- Materials tests by irradiation at BNL
  - CERN-US-Japan collaboration
  - US-Japan Program starts JFY2004



Test of a water-cooled graphite rod



Concept of conducting target



Mercury loop

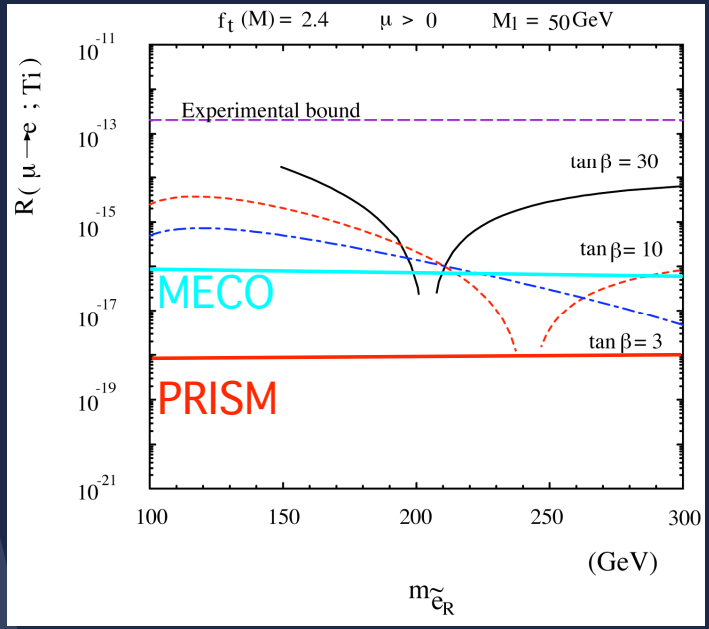
FFAG Studies

- International Studies on muon acceleration by FFAG (US, EU, JP)
- Lattice Design
  - scaling (JP) and non-scaling FFAG (US)
- Meetings
  - video meetings
  - workshops twice a year
    - 4/15-4/21/2004 at TRIUMF
    - 10/13-10/16/2004 at KEK
- 6 FFAGs construction in Japan
- PRISM (FFAG for muon acceleration)

PRISM

Search for Lepton Flavor violation

$$B(\mu^- + N \rightarrow e^- + N) < 10^{-18}$$



PRISM=
Phase Roted Intense Slow Muon Source

High Intensity

intensity : 10^{11}-10^{12} $\mu^{\pm}$/sec

beam repetition : 100-1000Hz

muon kinetic energy : 20 MeV (=68 MeV/c)

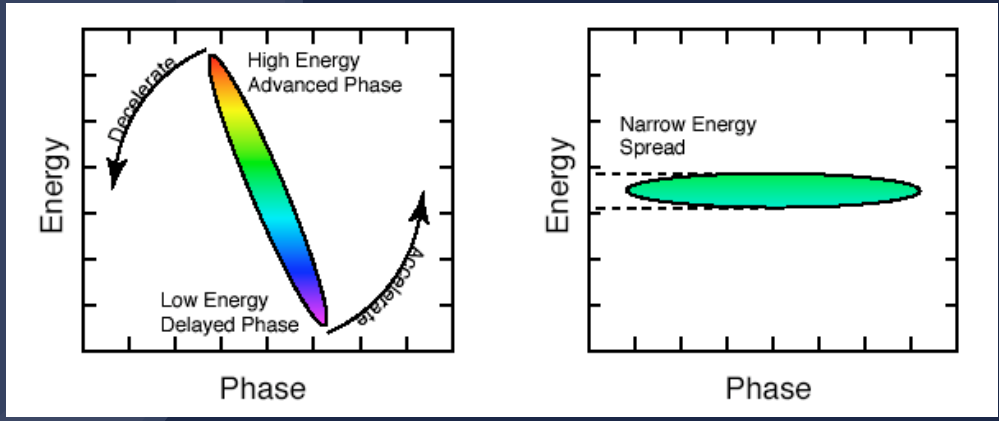
High Brightness

kinetic energy spread :

±0.5-1.0 MeV

High Purity

π contamination < 10^{-18}



PRISM Layout

Solenoid Pion Capture
Pion-decay and Transport
Phase Rotation

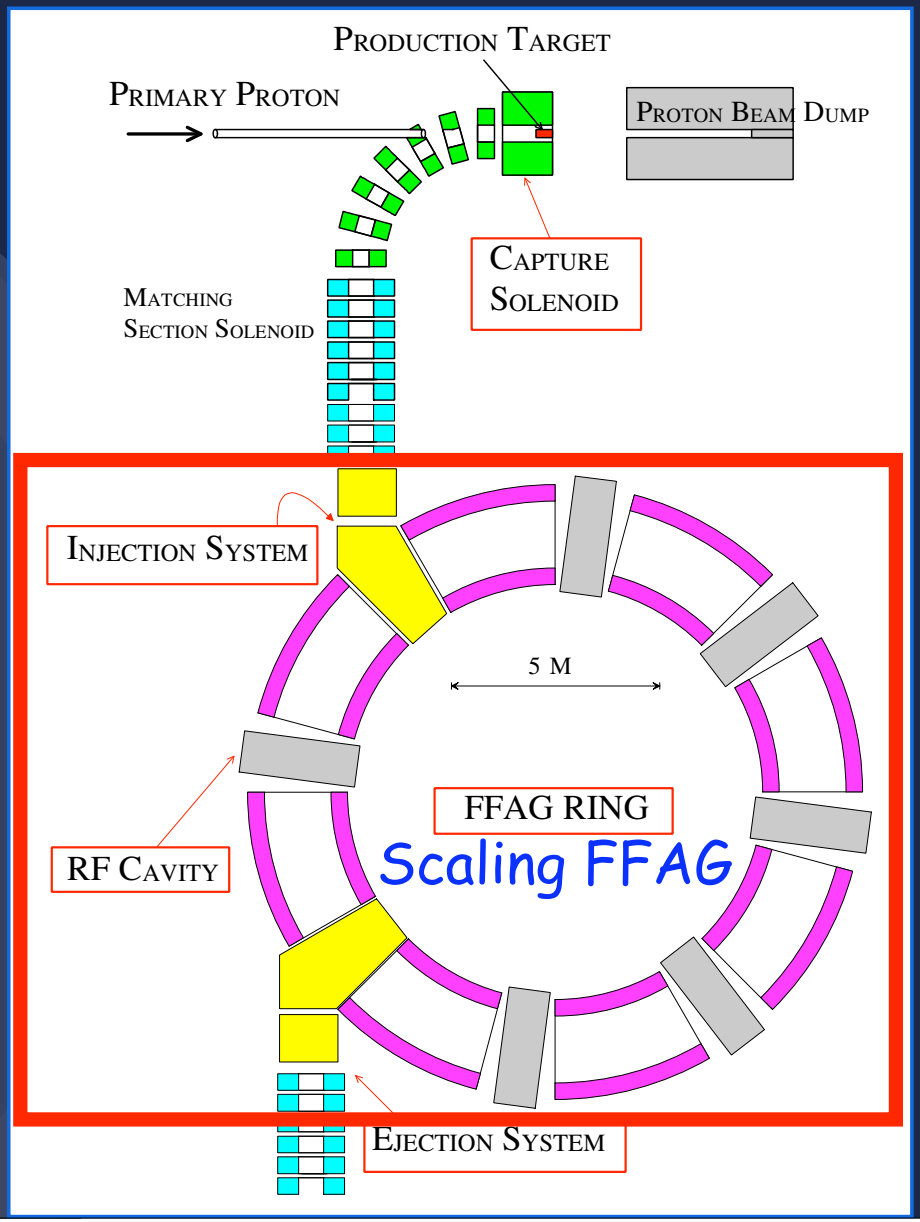
FFAG advantages:

synchrotron oscillation
necessary to do phase rotation

large momentum acceptance
necessary to accept large momentum distribution at the beginning to do phase rotation

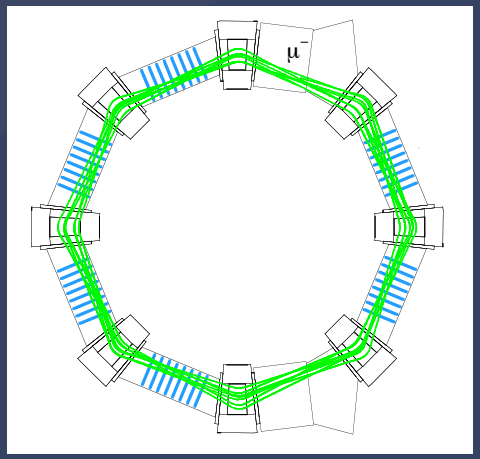
large transverse acceptance
muon beam is broad in space

PRISM-FFAG ring construction has started in JFY2003.

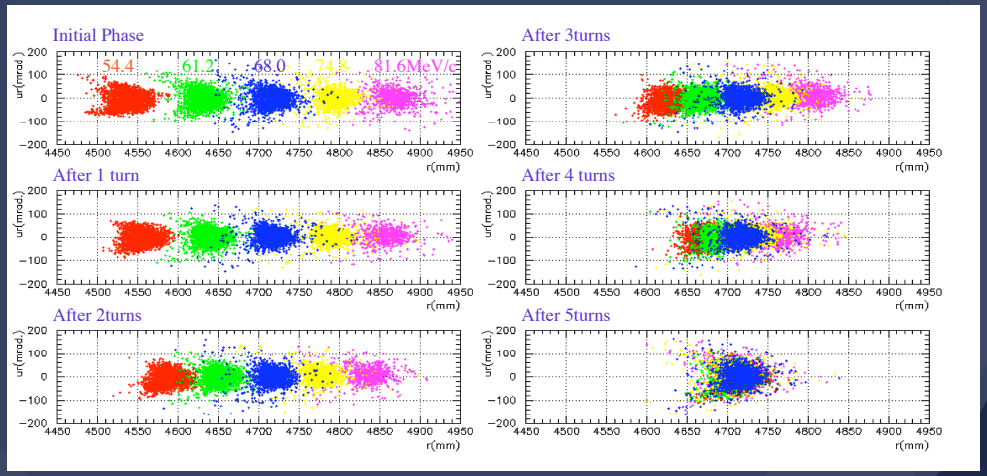


PRISM Tracking

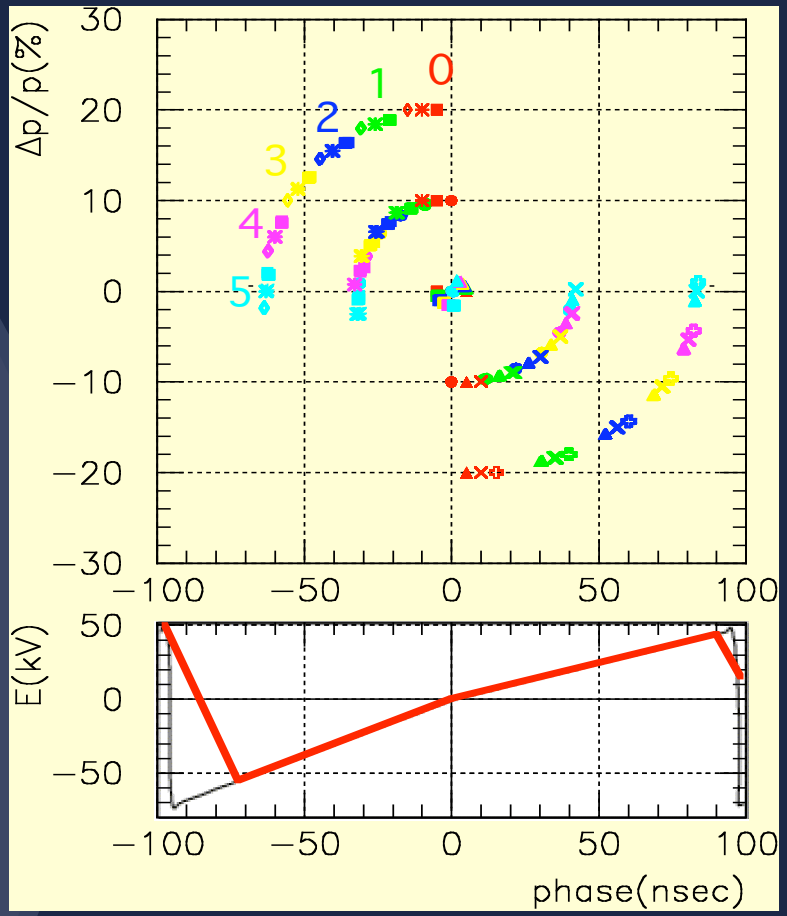
GEANT3 simulation with
TOSCA magnetic field



not a sinusoidal,
but a saw-tooth
RF shape is
needed.



$\pm 5nsec$ muon width at given momentum

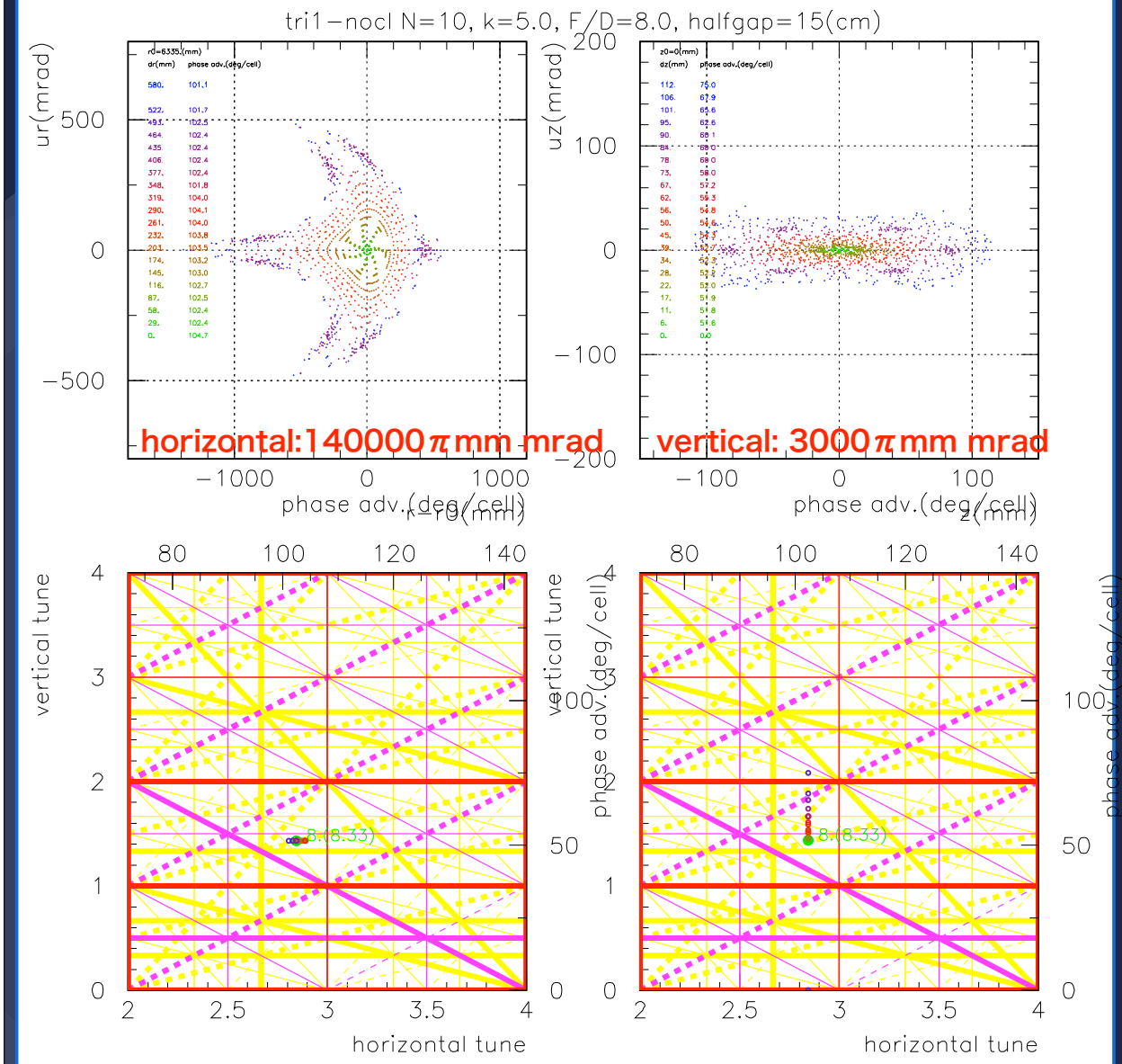


RF 5MHz, 250 kV/m

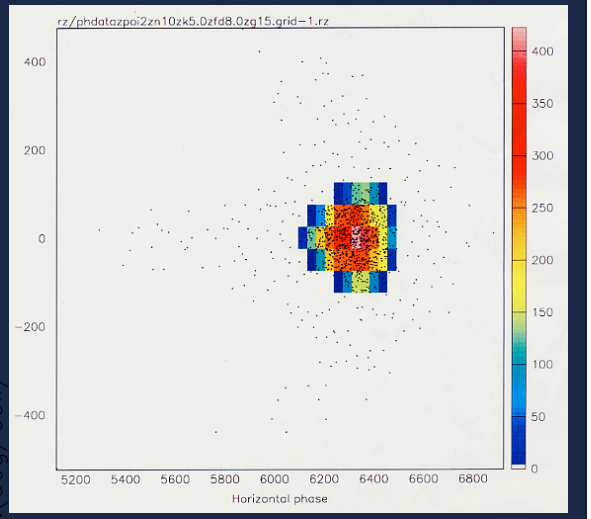
$\Delta p/p = \pm 3\ \%$

A. Sato

PRISM Acceptance



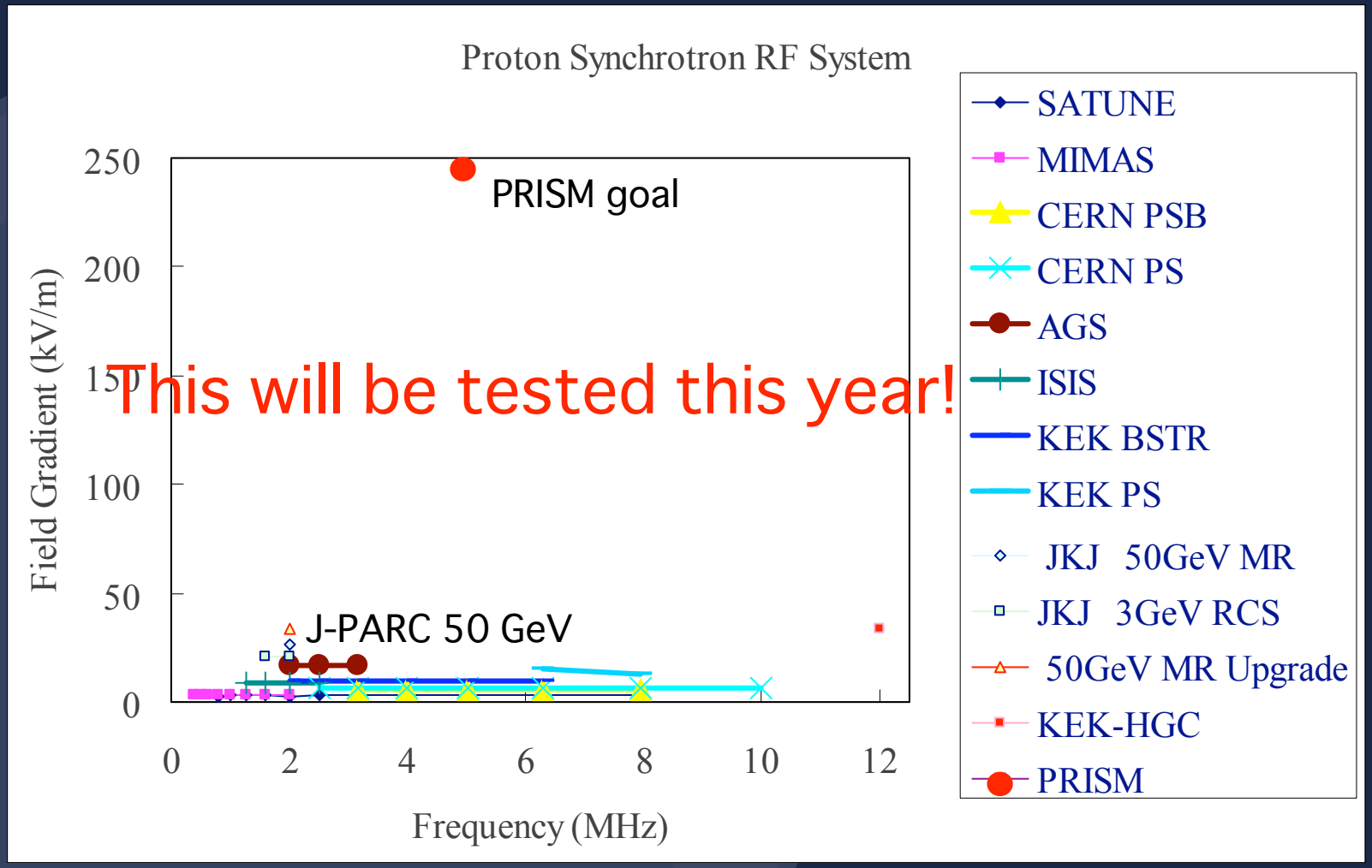
N=10
F/D=8
k=5
r0=6.5m



Horizontal:
35000π mm
mrad

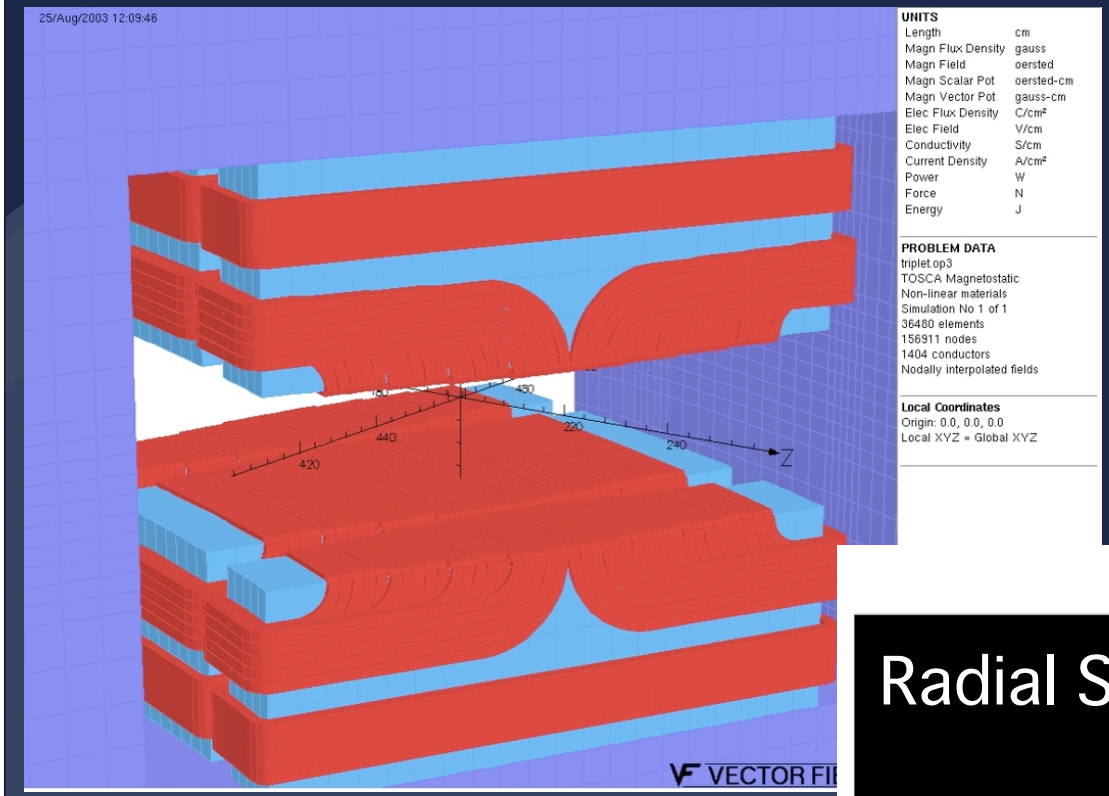
by Akira Sato

PRISM RF Field



PRISM goal > 250 kV/m

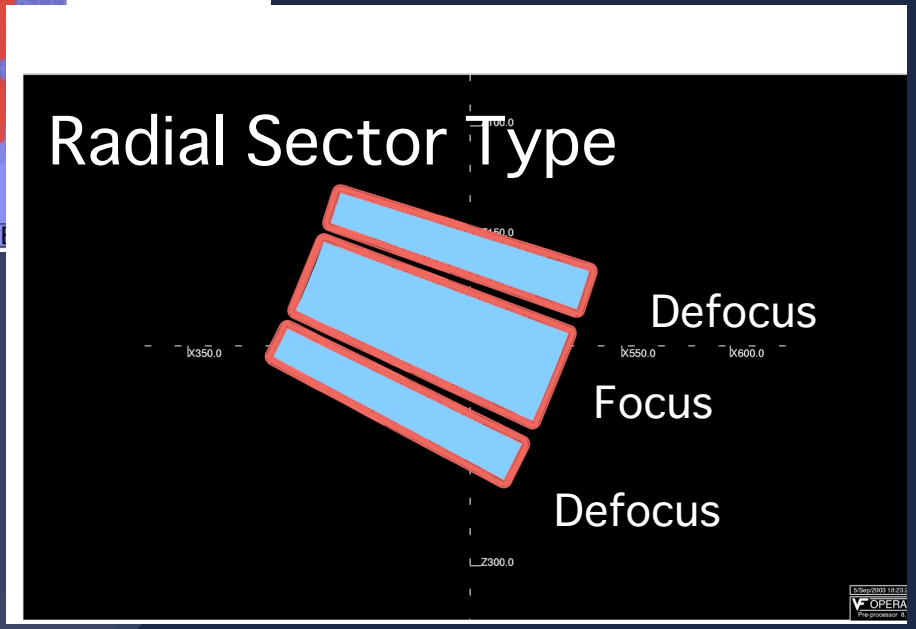
PRISM Magnet



FFAG field

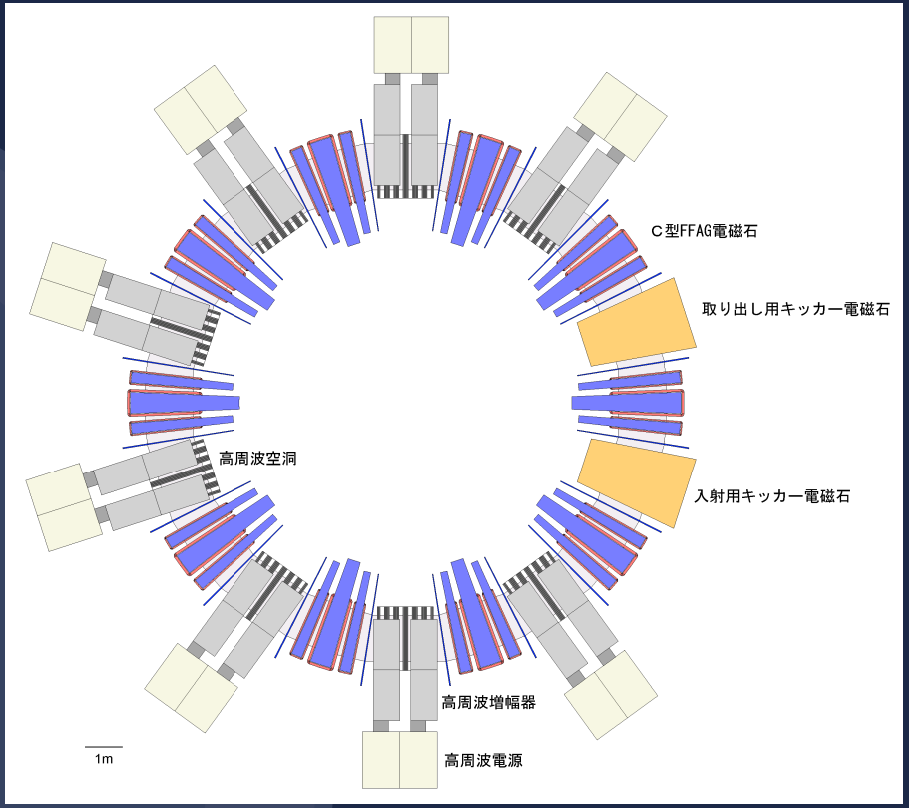
$$B(r) = B_0 \left(\frac{r}{r_0} \right)^k$$

DFD triplet magnet



PRISM Lattice

- N=10
- k=5(4.6-5.2)
- F/D(BL)=8
- r0=6.5m for 68MeV/c
- half gap = 15cm
- mag. size 110cm @ F center
- Triplet
  - θ_F=2.20deg
  - θ_D=1.86deg
- tune
  - h : 2.86
  - v : 1.44
- acceptance
  - h : 140000 π mm mrad
    - --> 35000 **π mm mrad**
  - v : 3000 π mm mrad



JFY2003: RF amplifier constructed
JFY2004: RF cavity, FFAG magnet
JFY2005-2006: FFAG magnet
JFY2007: kicker magnet, test

Case at J-PARC

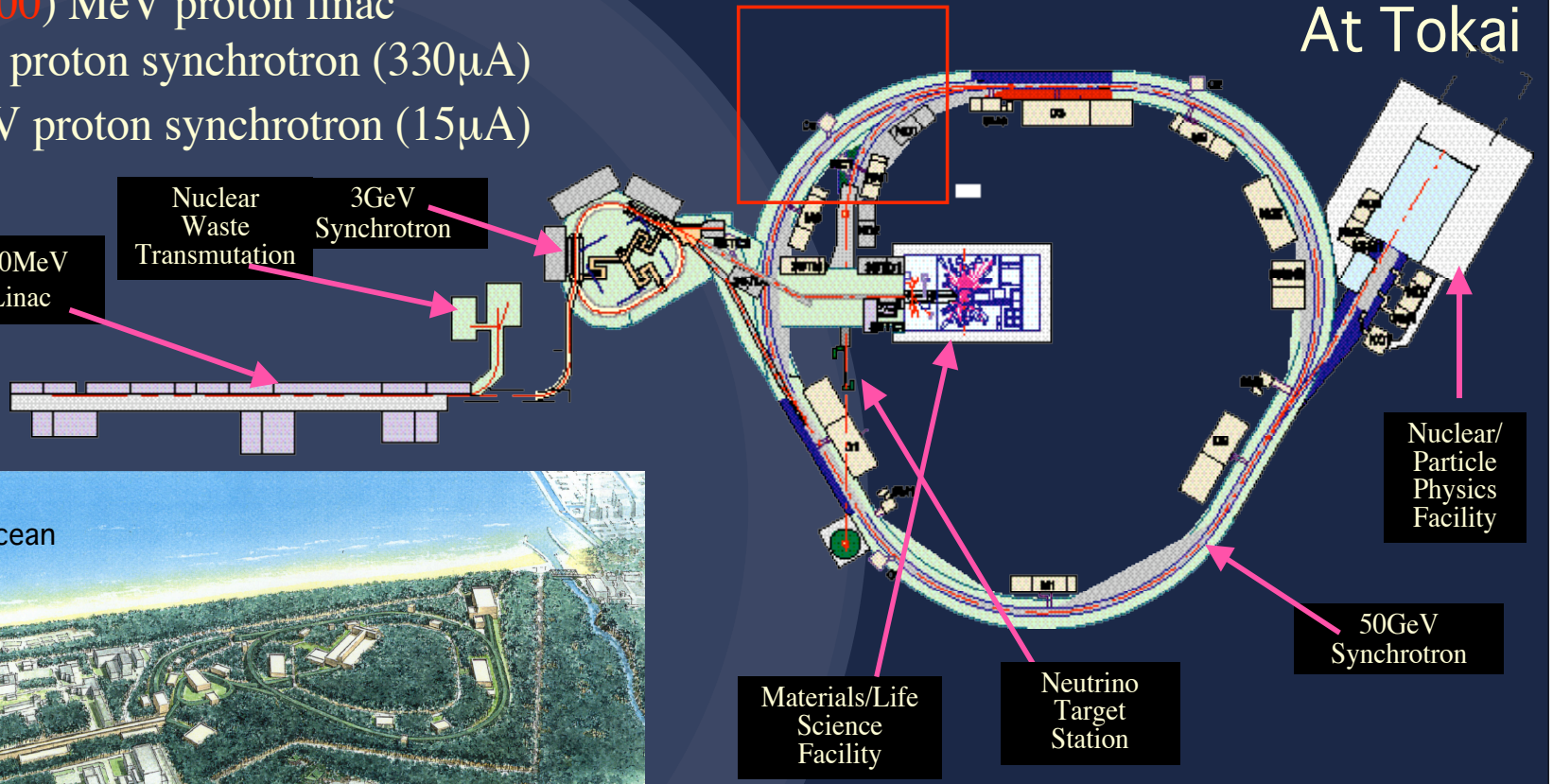
Proton Machine

J-PARC = Japan Proton Accelerator Research Complex

400 (200) MeV proton linac
3 GeV proton synchrotron (330μA)
50 GeV proton synchrotron (15μA)
(40)

pulsed proton beam facility

At Tokai

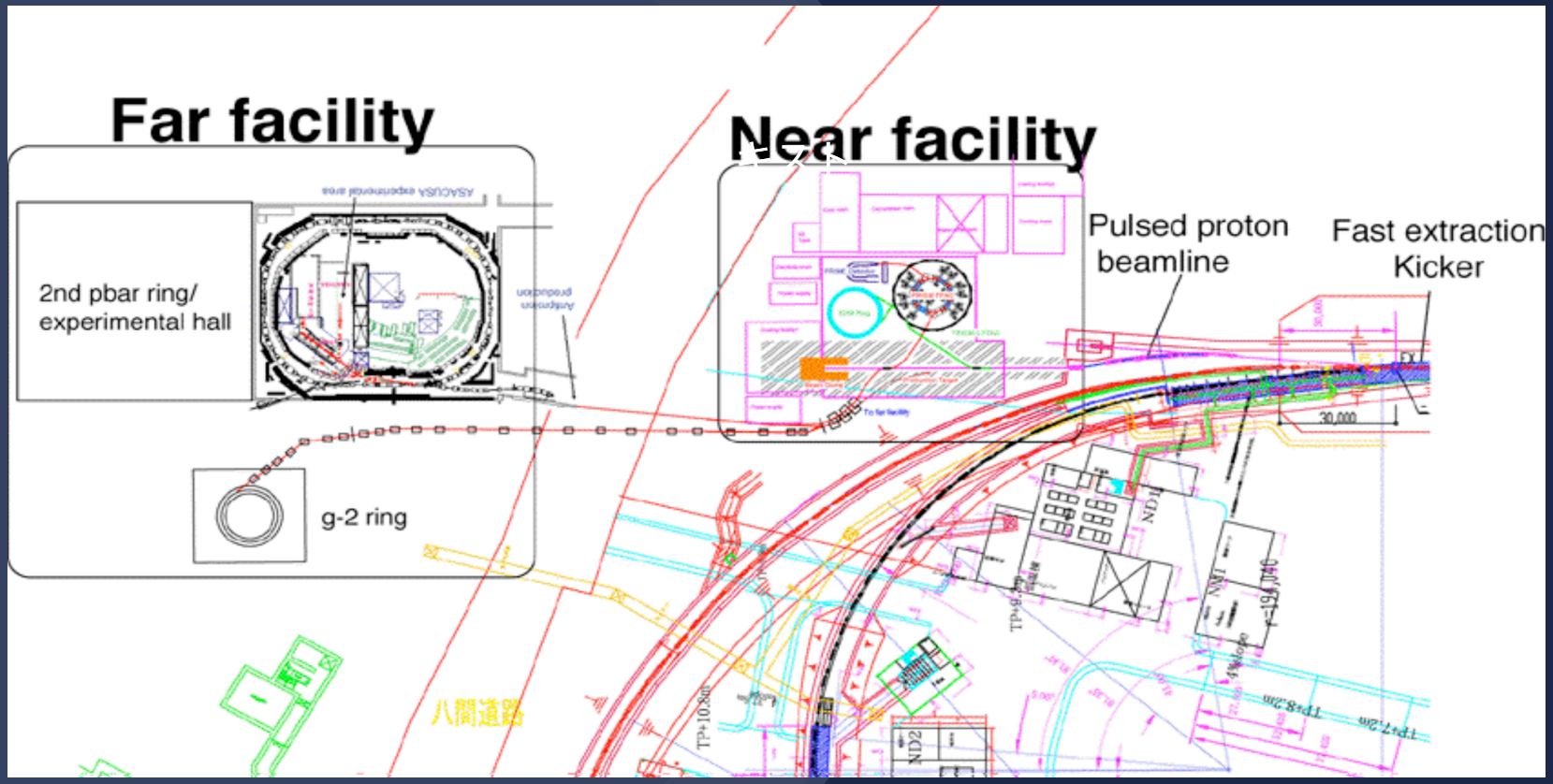


Muon Factory

Pulsed Proton Beam Facility is newly requested to J-PARC.

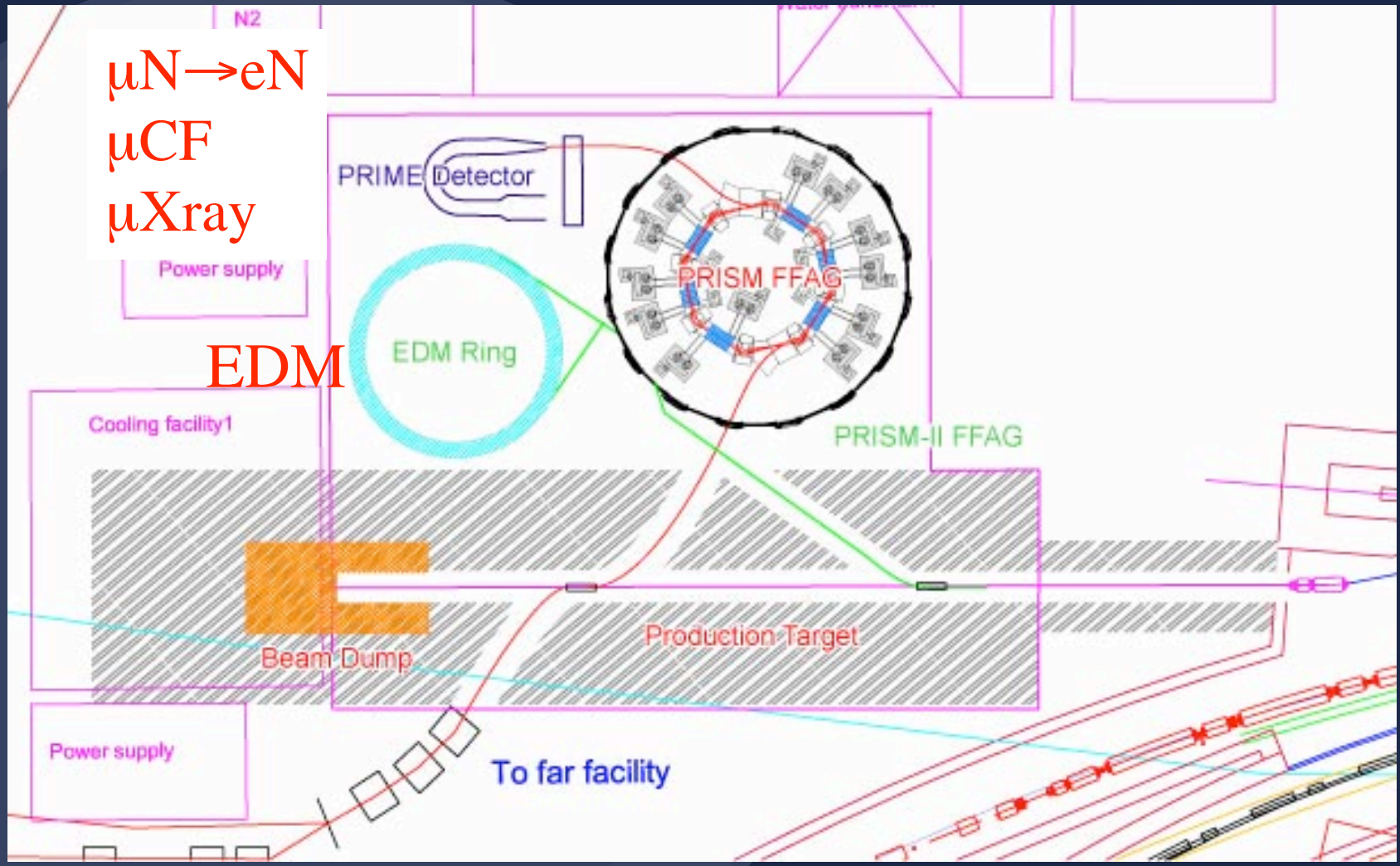
muon g-2
and anti-protons

PRISM and
PRISM-II(muon EDM)



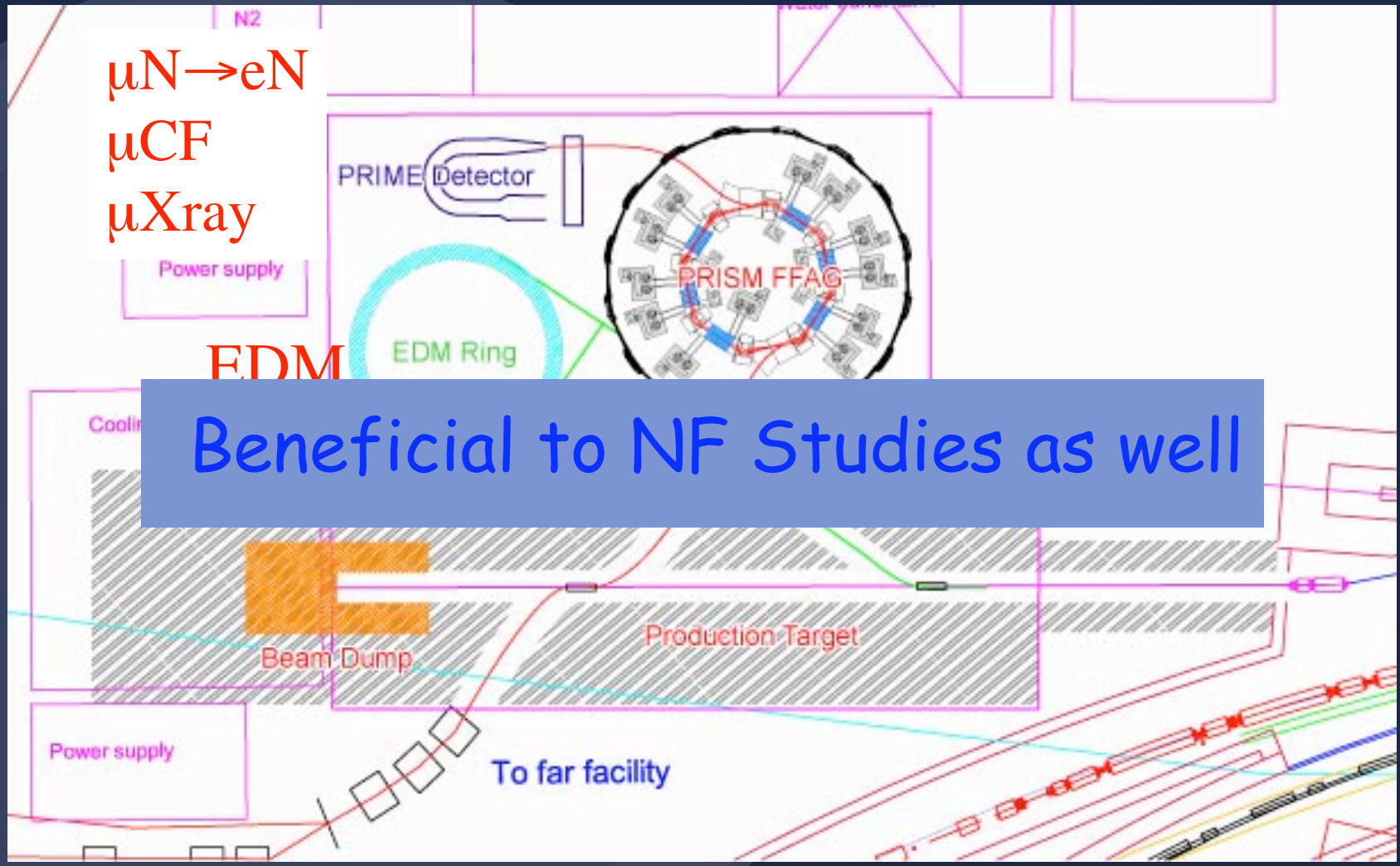
Muon Factory

Pulsed Proton Beam Facility is newly requested to J-PARC.



Muon Factory

Pulsed Proton Beam Facility is newly requested to J-PARC.



Beneficial to NF Studies as well

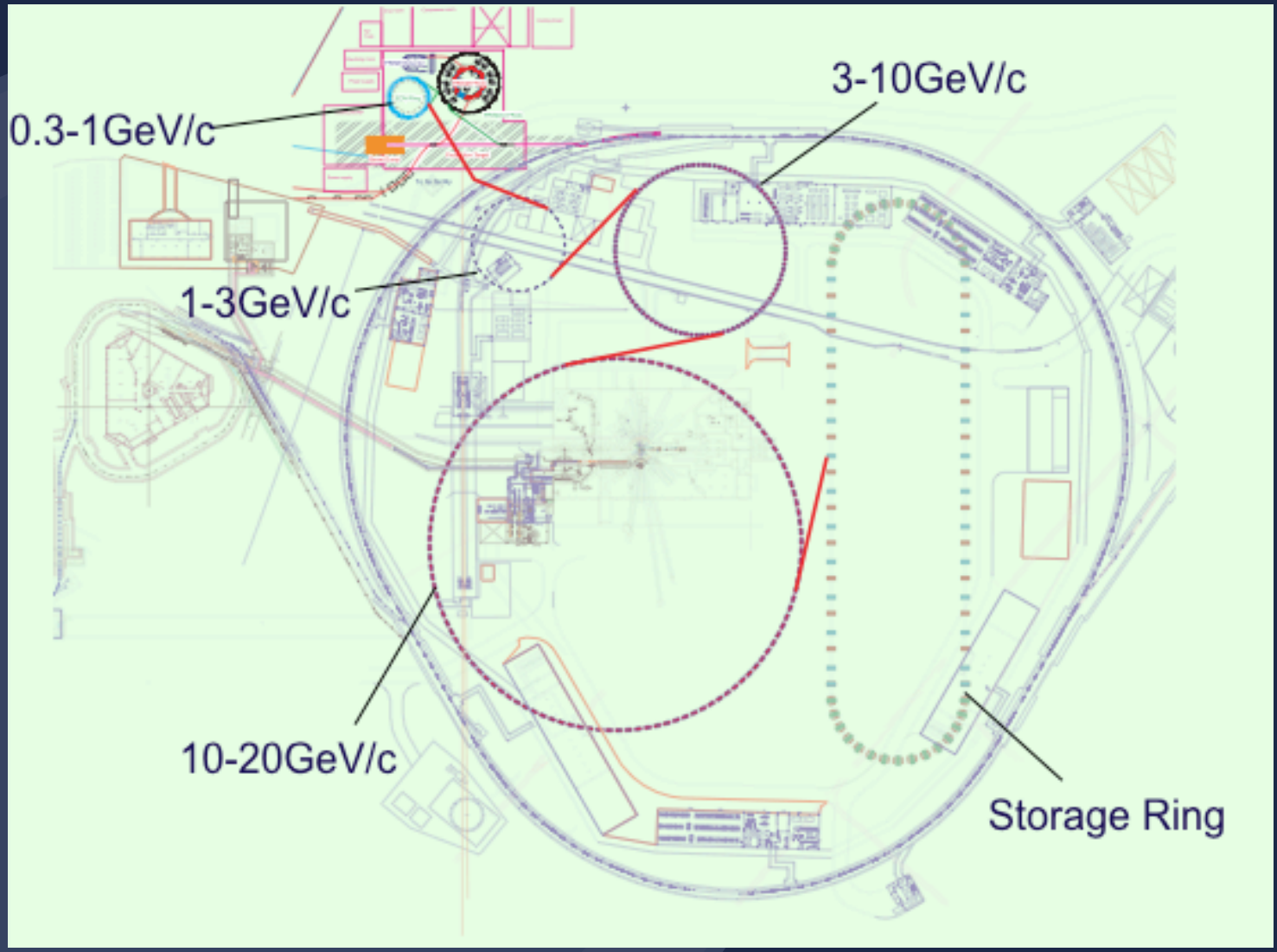
LOI to J-PARC

for muon particle physics

	title	contact persons
1	The PRISM Project - A Muon Source of the World-Highest Brightness by Phase Rotation -	Y. Mori, K. Yoshimura, N. Sasao, Y. Kuno
2	An Experimental Search for the μ-e Conversion Process Towards an Ultimate Sensitivity of the Order of 10^{-18}	Y. Mori, K. Yoshimura, N. Sasao, Y. Kuno
3	Request for A Pulsed Proton Beam Facility at J-PARC	R.S. Hayano, Y. Kuno
4	A Study of Neutrino Factory in Japan	Y. Mori, Y. Kuno
5	Search for a Permanent Muon Electric Dipole Moment at 10^{-24} ecm Level	Y. Semertzidis, J. Miller, Y. Kuno
6	An Improved Muon (g-2) Experiment at J-PARC	L. Roberts
7	A Study of a Target System for a 4-MW, 50-GeV Proton Beam	K. McDonald, H. Kirk, Y. Kuno, Y. Yoshimura

A pulsed proton beam is required for all.

NF at J-PARC



Summary

- FFAG-based neutrino factory has been studied in Japan.
- International R&D (including JP) is underway
  - FFAG (scaling and non-scaling)
  - muon tracker (SciFi) R&D
  - LH2 absorber R&D
  - Target R&D
  - PRISM is under construction……
- We need strong collaboration in the world-wide.