

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 !!)



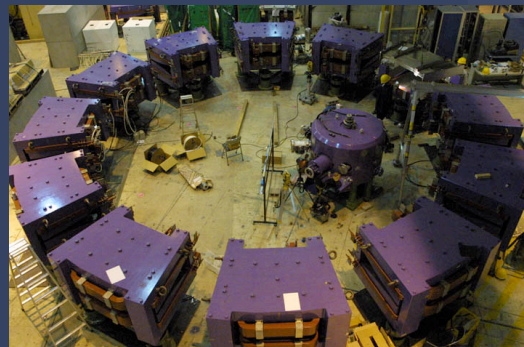
FFAG Based Neutrino Factory

FFAG-based NF

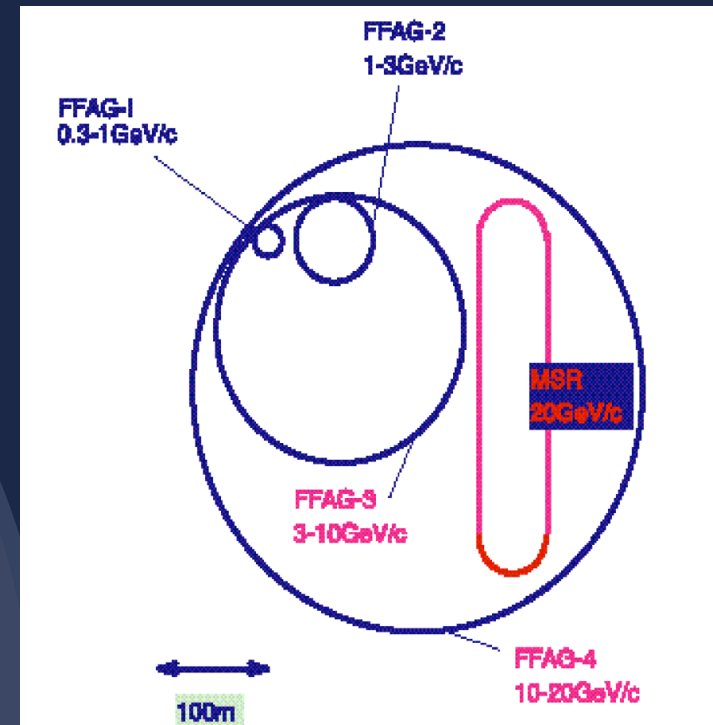
- Japanese scheme of Neutrino factory based on FFAG muon acceleration
 - Large acceptance
 - cooling is not a must (better if available)
 - simple and compact
 - R&D underway in Japan



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

Physics outcome
at each stage

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

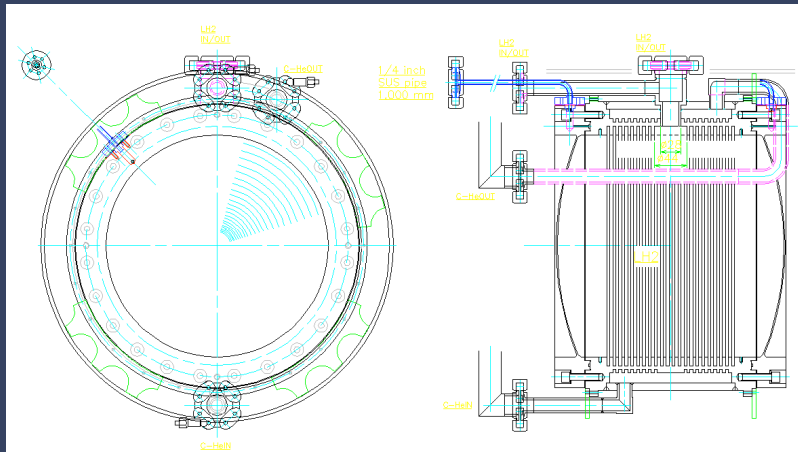


R&D

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



MICE absorber design



KEK cryostat waiting at MTA/FNAL

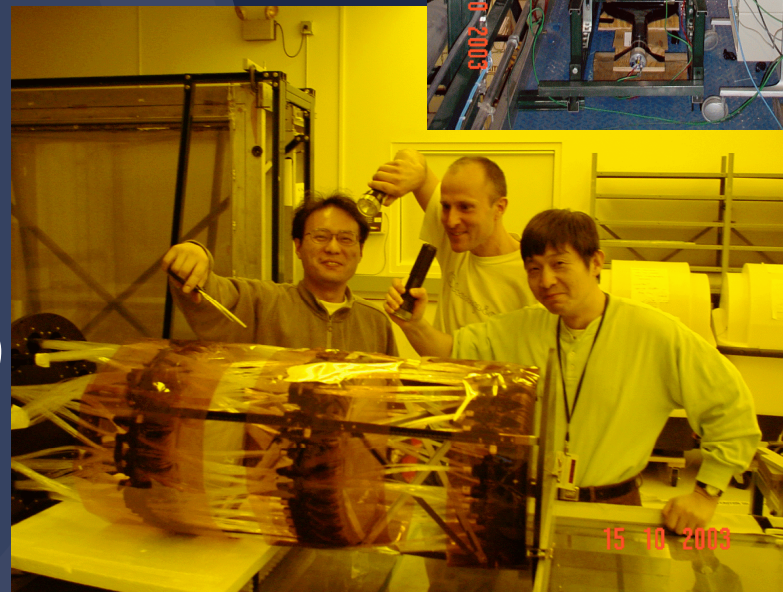
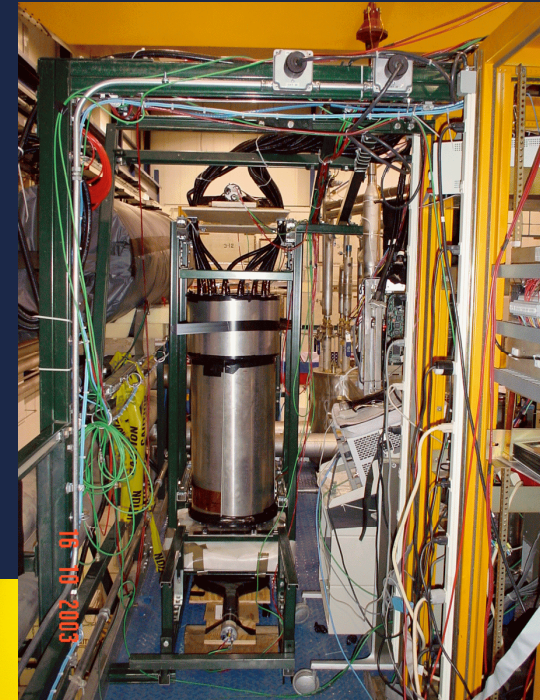


MICE absorber prototype

● ● ● 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

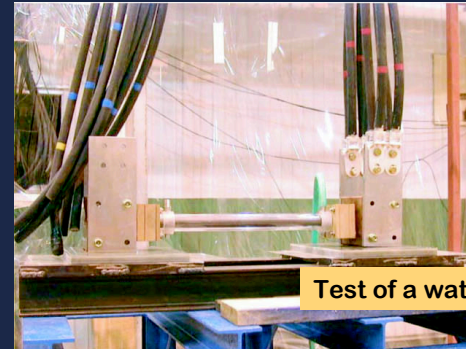
cosmic-ray test of
scifi prototype at
D0 test stand



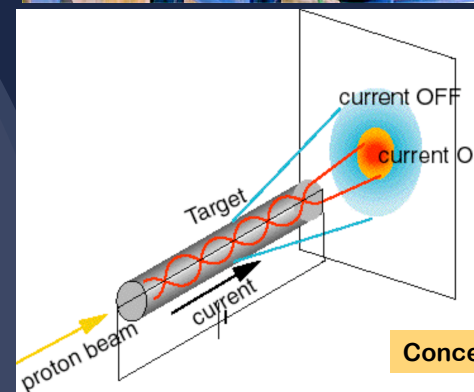
Target R&D

a la Koji Yoshimura

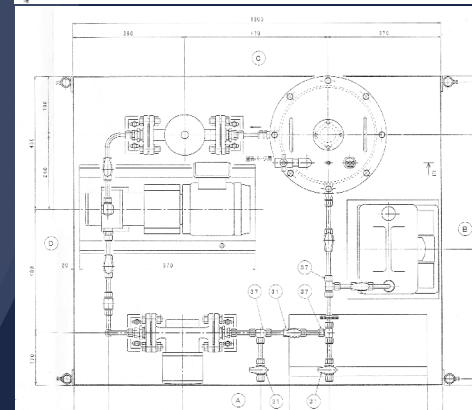
- Stationary Target
 - water cooled graphite (100kW)
 - by T2K group
- Conduction Pulsed target R&D
 - Mercury loop for bench tests
- Materials tests by irradiation at BNL
 - CERN-US-Japan collaboration
 - US-Japan Program starts JFY2004



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} - $10^{12} \mu^\pm/\text{sec}$

beam repetition : 100-1000Hz

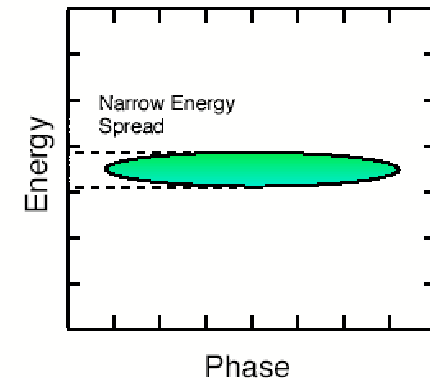
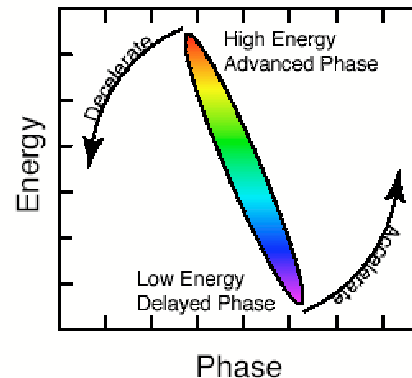
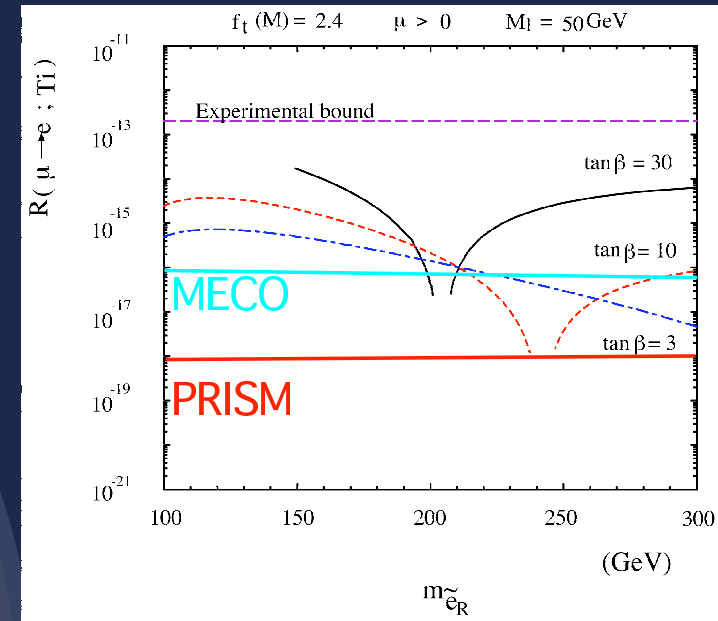
muon kinetic energy : 20 MeV (=68 MeV/c)

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

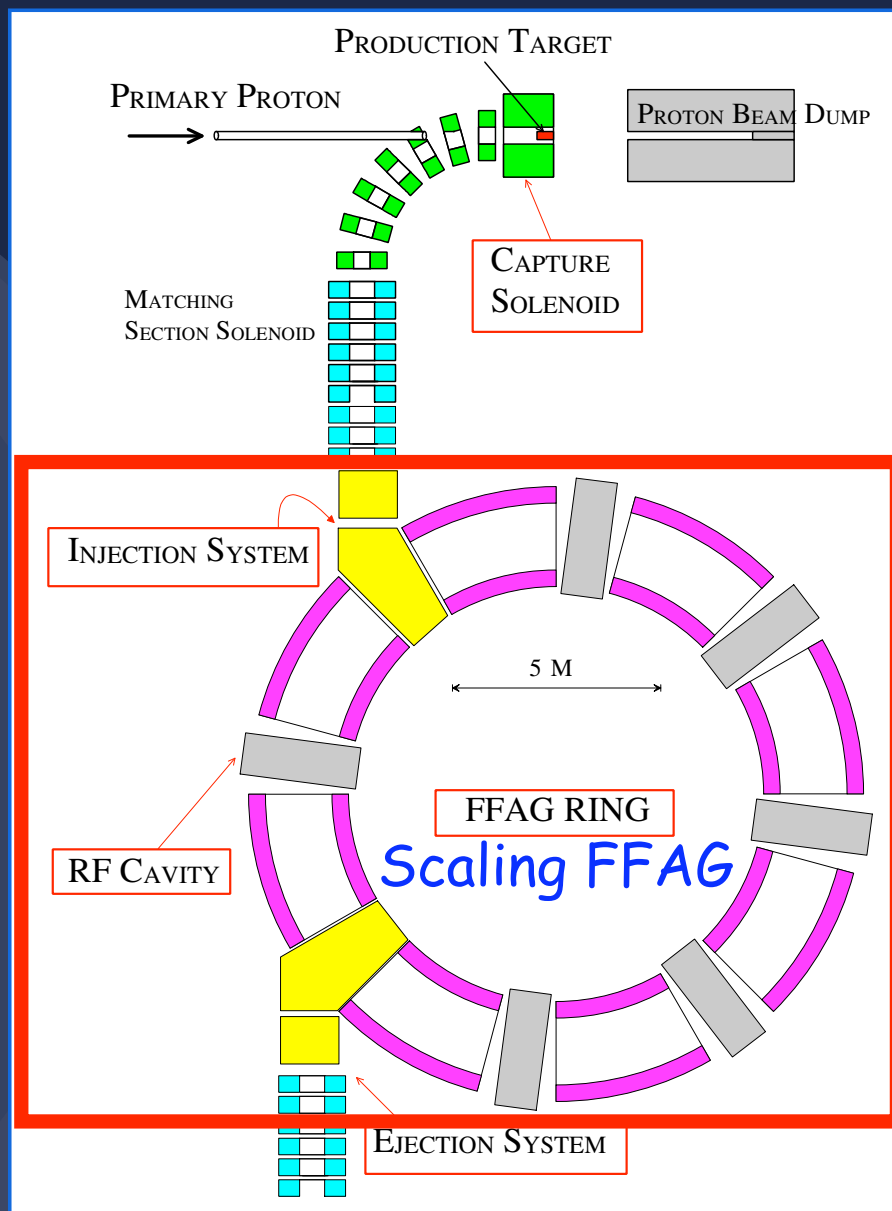
large momentum acceptance

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

large transverse acceptance

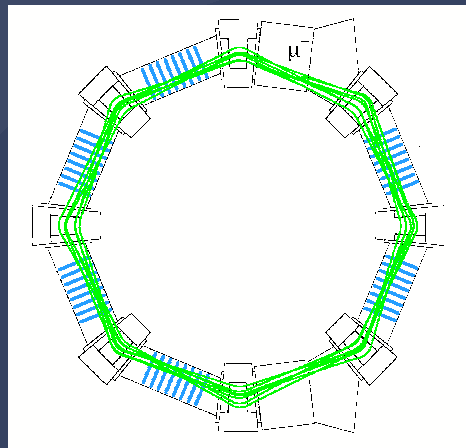
muon beam is broad in space

**PRISM-FFAG ring
construction has
started in JFY2003.**



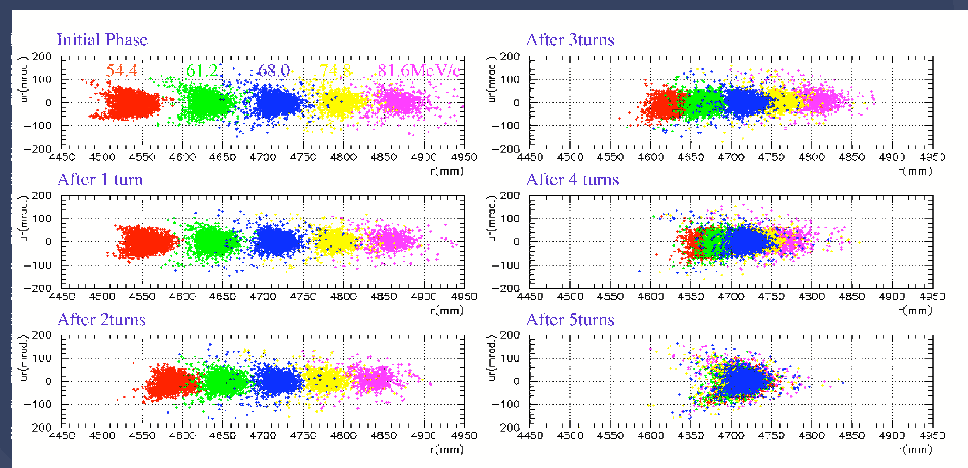
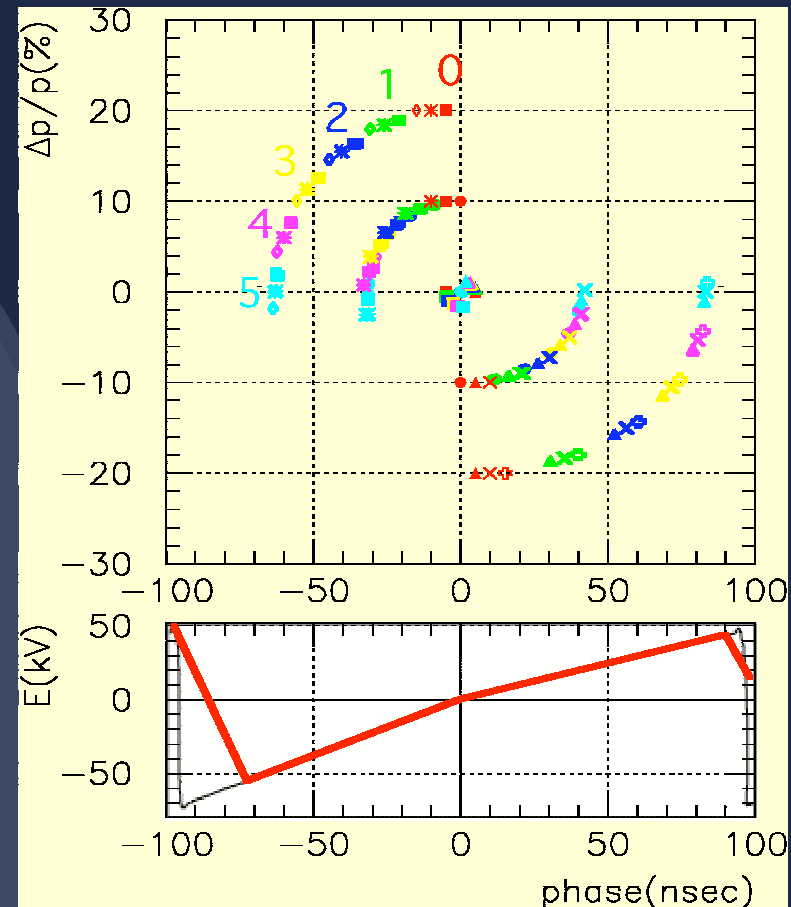
PRISM Tracking

GEANT3 simulation with
TOSCA magnetic field



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

$\pm 5nsec$ muon width at given momentum



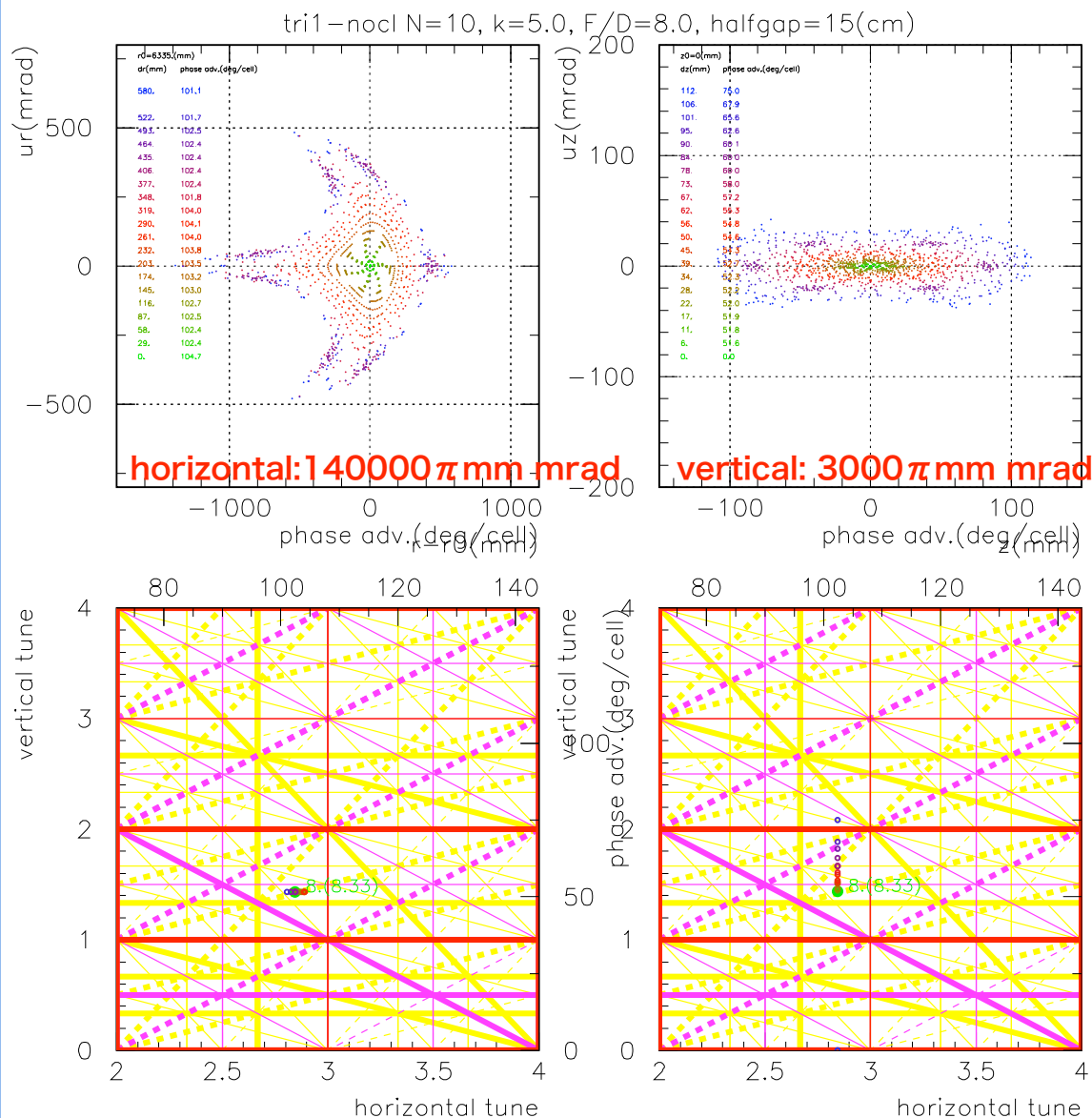
RF 5MHz, 250 kV/m

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

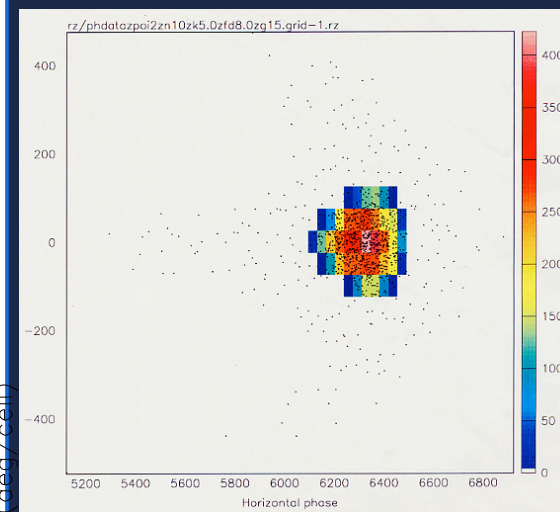
A. Sato



PRISM Acceptance



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

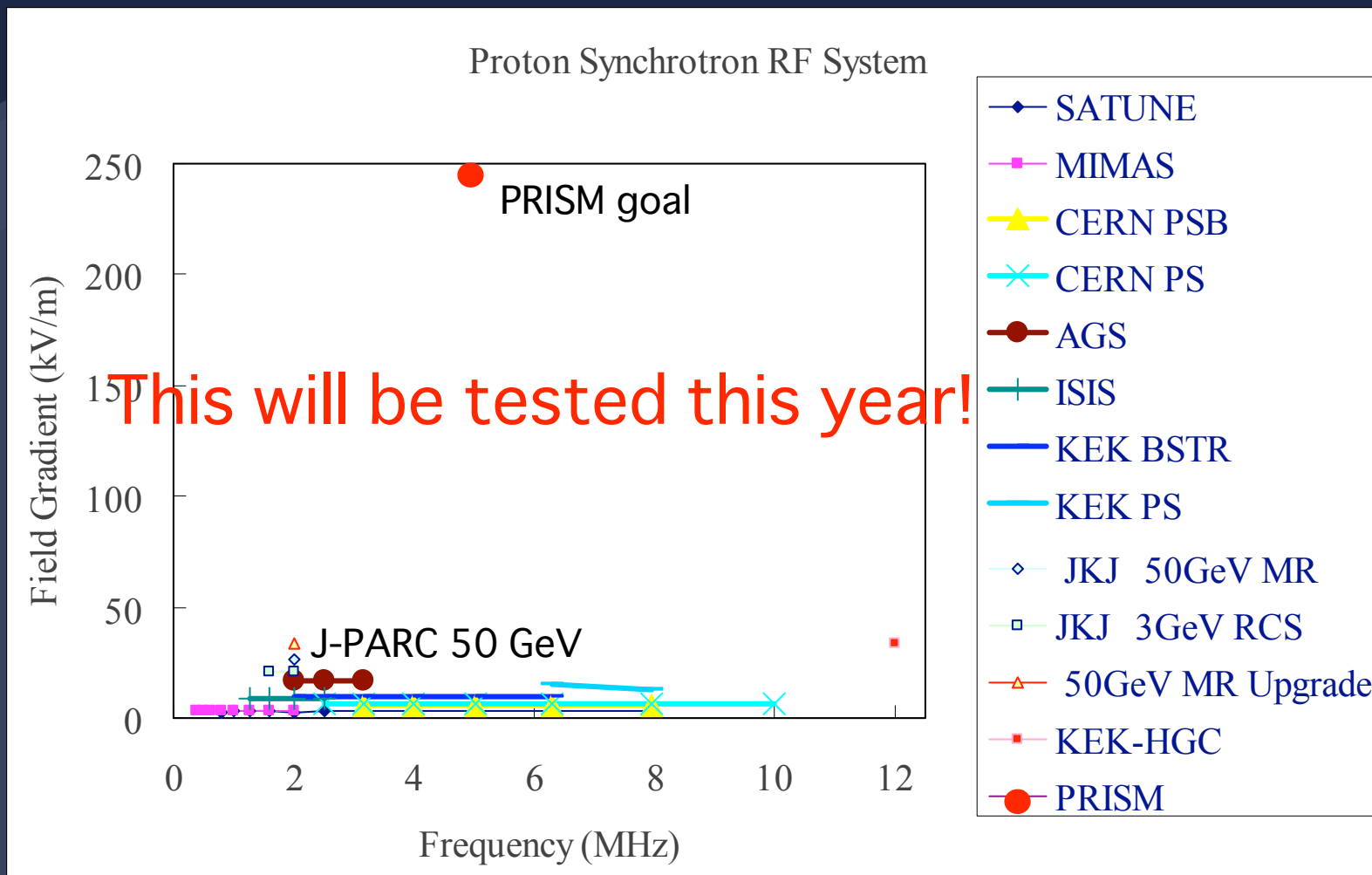


Horizontal:
 35000π mm
mrad

by Akira Sato



PRISM RF Field

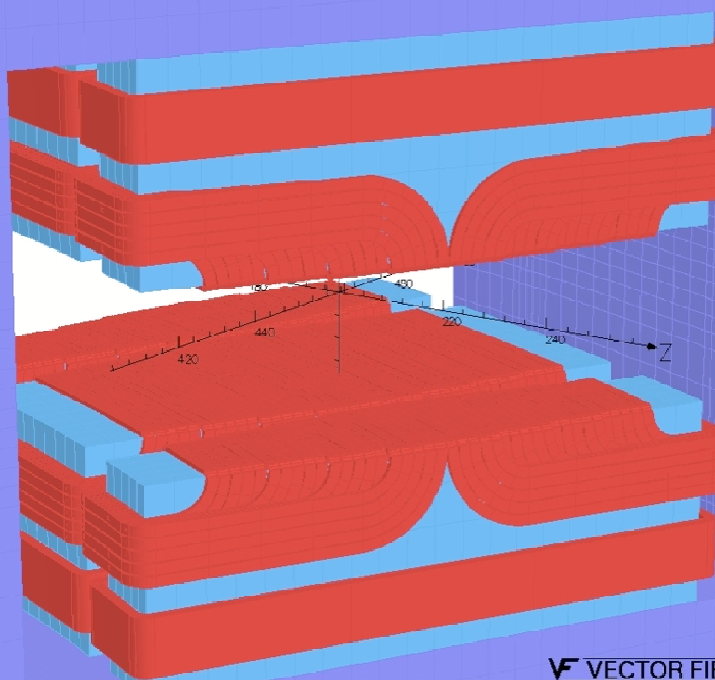


PRISM goal > 250 kV/m



PRISM Magnet

23/Aug/2003 12:09:46



UNITS	
Length	cm
Magn Flux Density	gauss
Magn Field	oersted
Magn Scalar Pot	oersted-cm
Magn Vector Pot	gauss-cm
Elec Flux Density	C/cm ²
Elec Field	V/cm
Conductivity	S/cm
Current Density	A/cm ²
Power	W
Force	N
Energy	J

PROBLEM DATA
 triplet.q3
 TOSCA Magnetostatic
 Non-linear materials
 Simulation No 1 of 1
 36400 elements
 156911 nodes
 1404 conductors
 Nodally interpolated fields

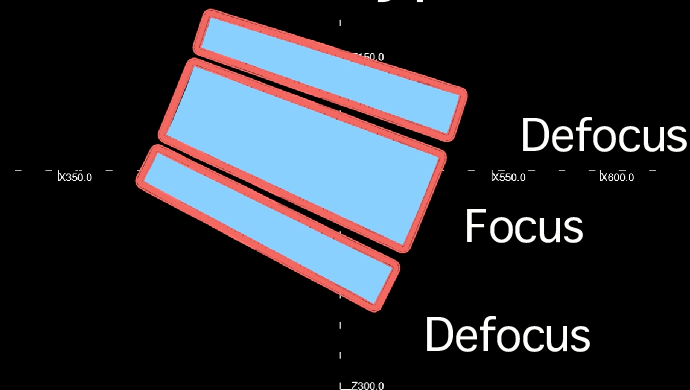
Local Coordinates
 Origin: 0.0, 0.0, 0.0
 Local XYZ = Global XYZ

FFAG field

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

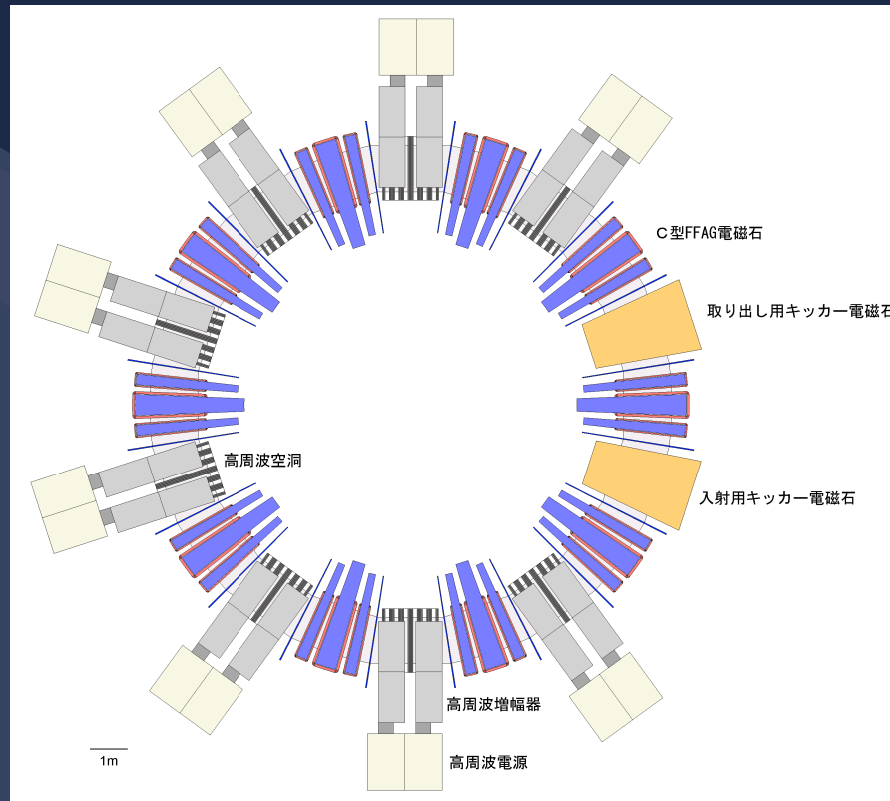
DFD triplet magnet

Radial Sector Type



PRISM Lattice

- N=10
- $k=5(4.6-5.2)$
- $F/D(BL)=8$
- $r_0=6.5\text{m}$ for $68\text{MeV}/c$
- half gap = 15cm
- mag. size 110cm @ F center
- Triplet
 - $\theta_F=2.20\text{deg}$
 - $\theta_D=1.86\text{deg}$
- tune
 - $h : 2.86$
 - $\nu : 1.44$
- acceptance
 - $h : 140000 \pi \text{ mm mrad}$
 - $\nu \rightarrow 35000 \pi \text{ mm mrad}$
 - $\nu : 3000 \pi \text{ mm mrad}$

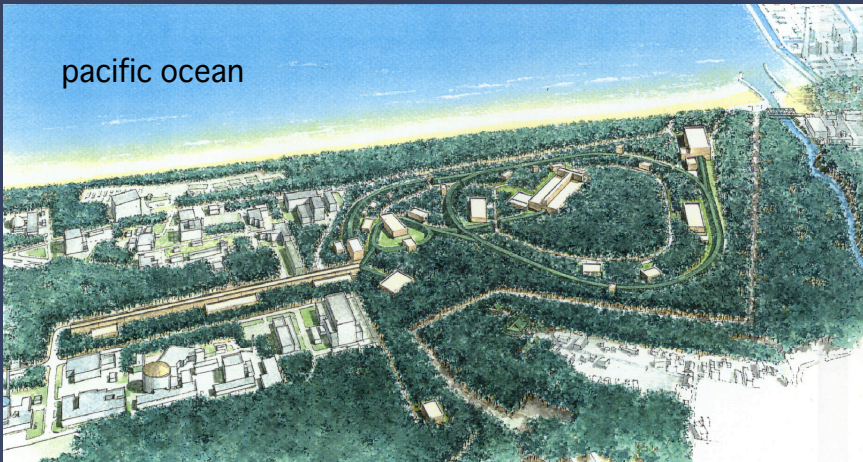
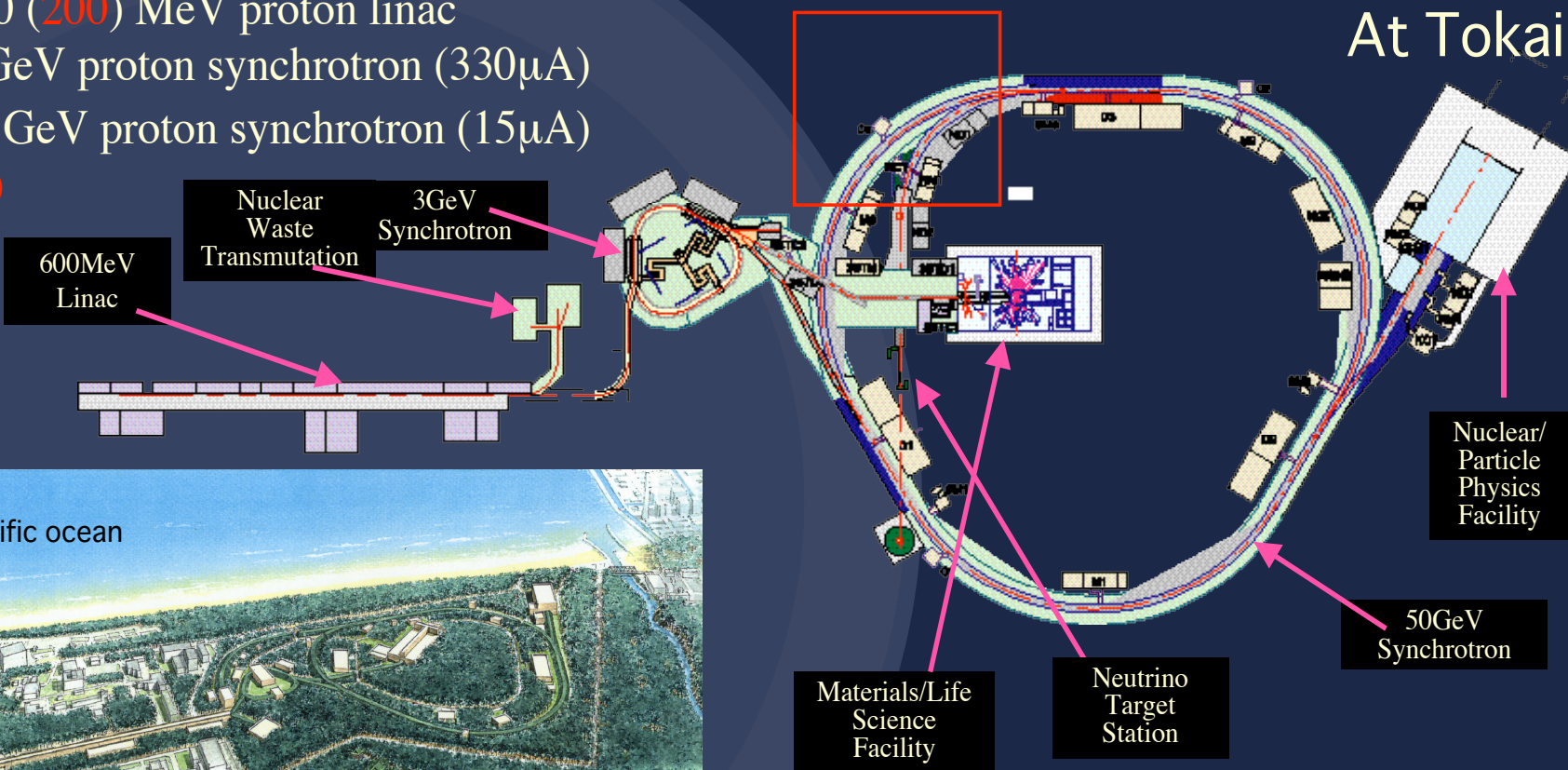


JFY2003: RF amplifier constructed
 JFY2004: RF cavity, FFAG magnet
 JFY2005-2006: FFAG magnet
 JFY2007: kicker magnet, test



Case at J-PARC

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

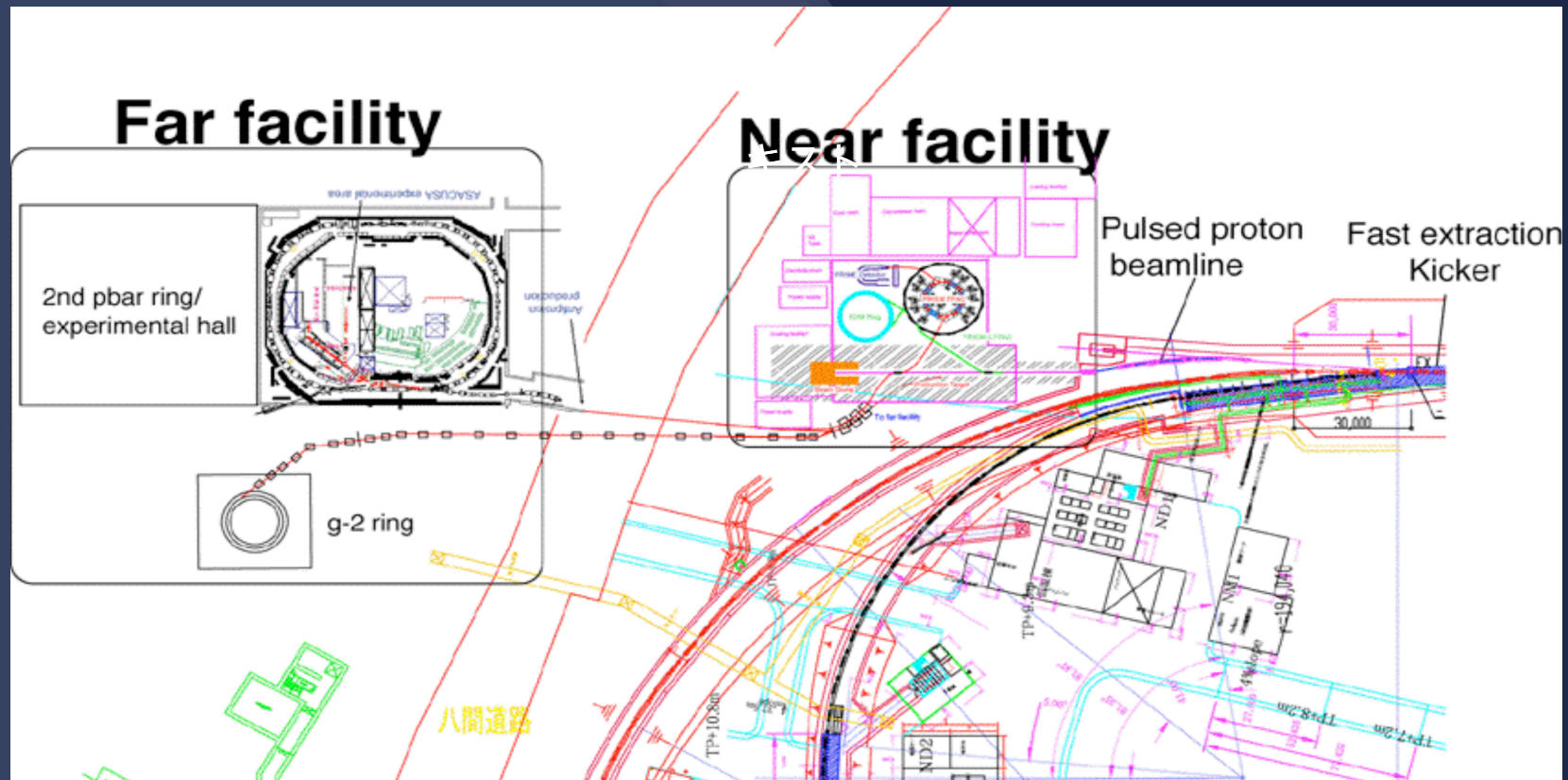


●●● Muon Factory

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

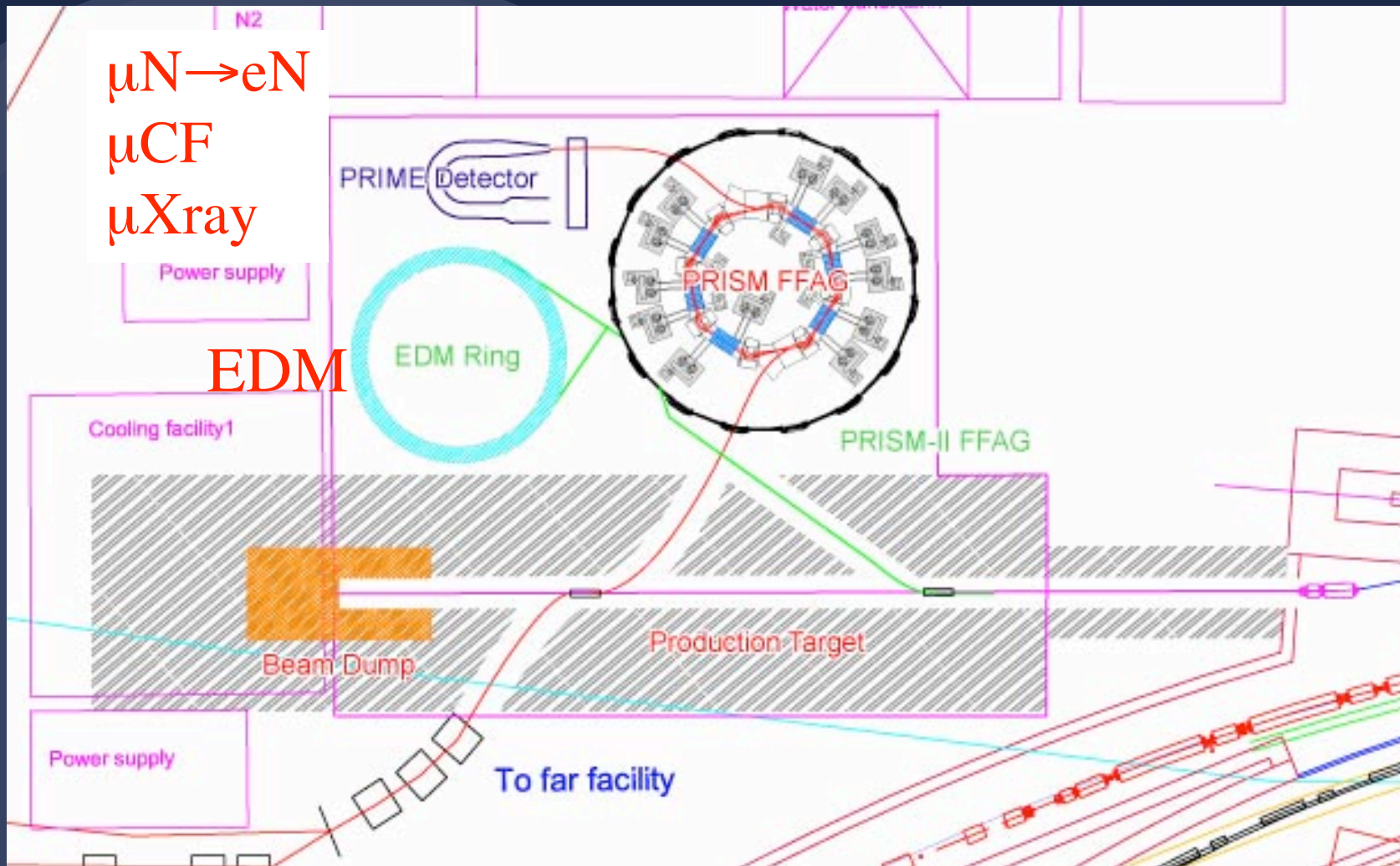
muon g-2
and anti-protons

PRISM and
PRISM-II(muon EDM)



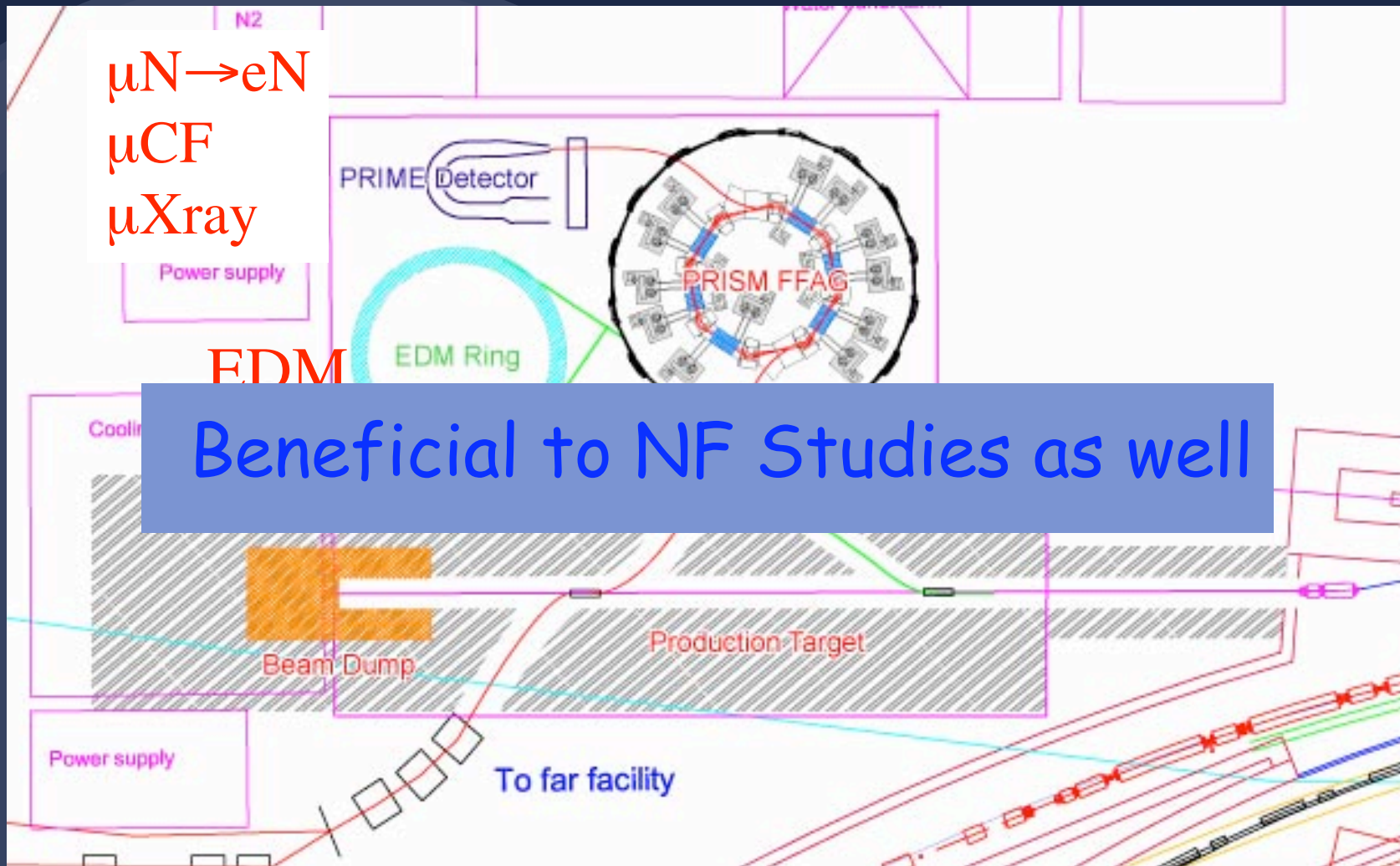
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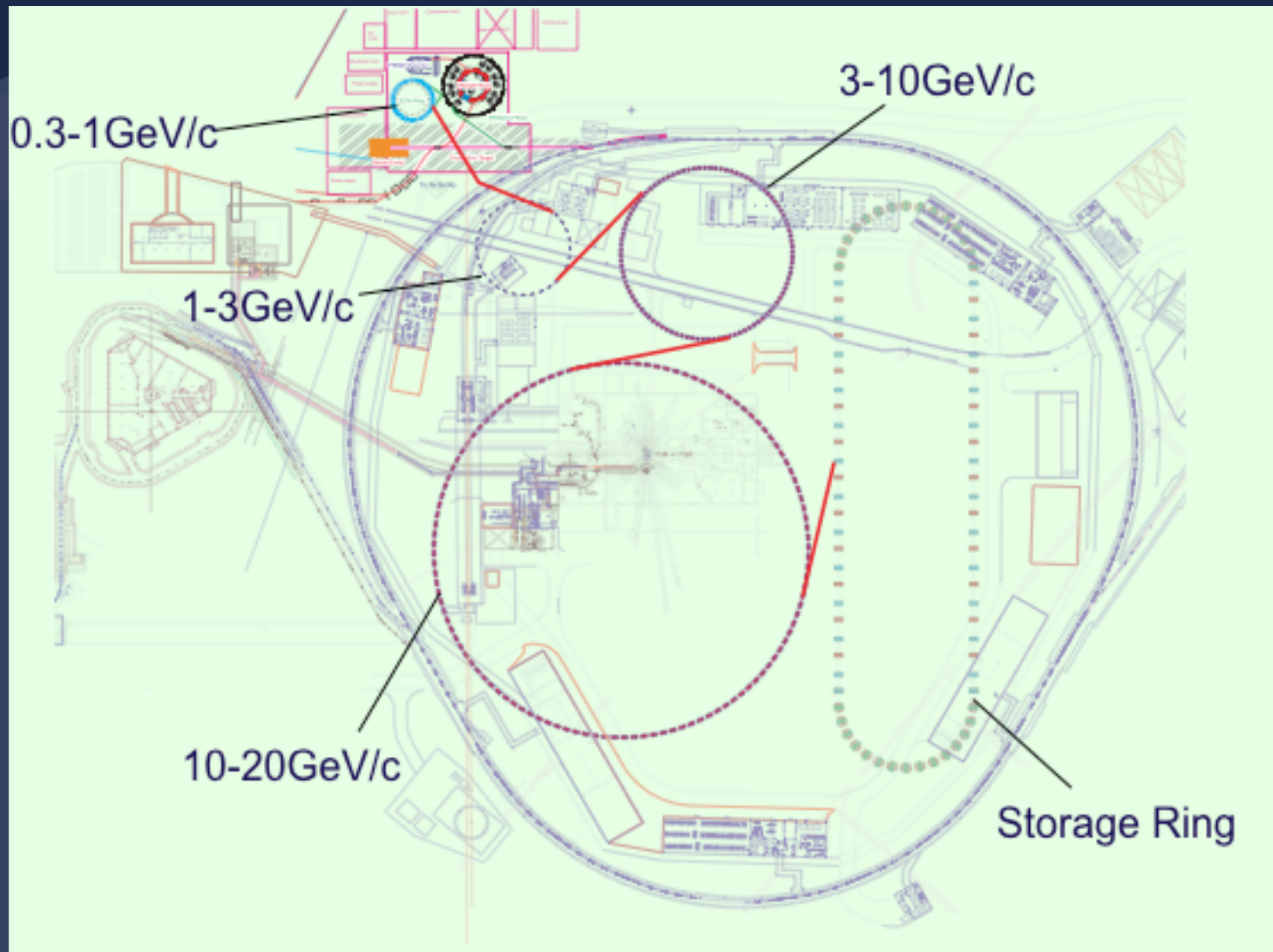
LOI to J-PARC

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.