FFAG construction for PRISM

Akira SATO
Osaka University

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PRISM

Phase Rotated Intense Slow Muon source

secondary muon beam channel with

- high intensity
  - Superconducting Solenoid Magnet
- narrow energy spread
- High purity
  - Phase rotation

dedicated for the stopped muon experiments.

- intensity : 10^{11}-$10^{12}\mu^{\pm}$/sec
- muon kinetic energy : 20 MeV (=68 MeV/c)
  - range = about 3 g
- kinetic energy spread : ±0.5-1.0 MeV
  - ±a few 100 mg range width
- beam repetition : about 100Hz

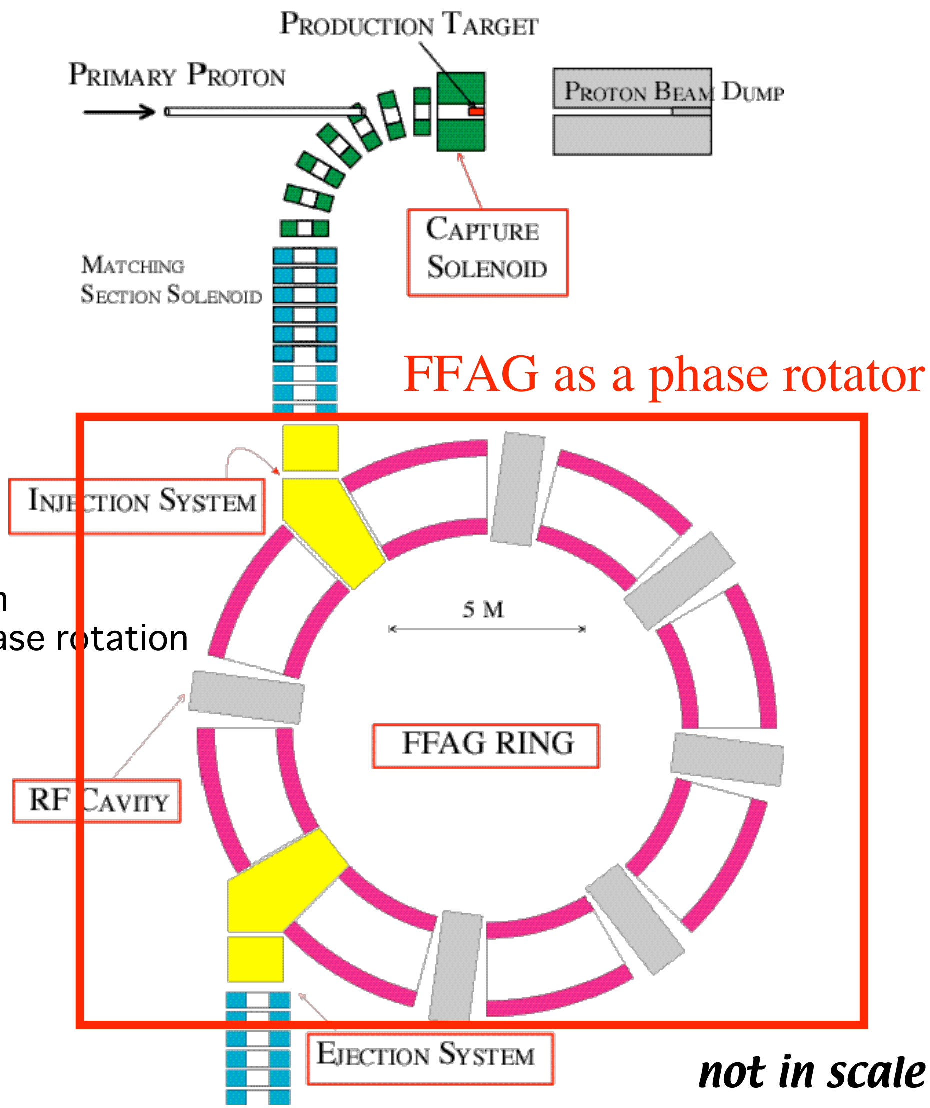
PRISM layout

- Pion capture section
- Decay section
- Phase rotation section

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

A budget for the PRISM-FFAG has been approved !
FY2003-FY2007

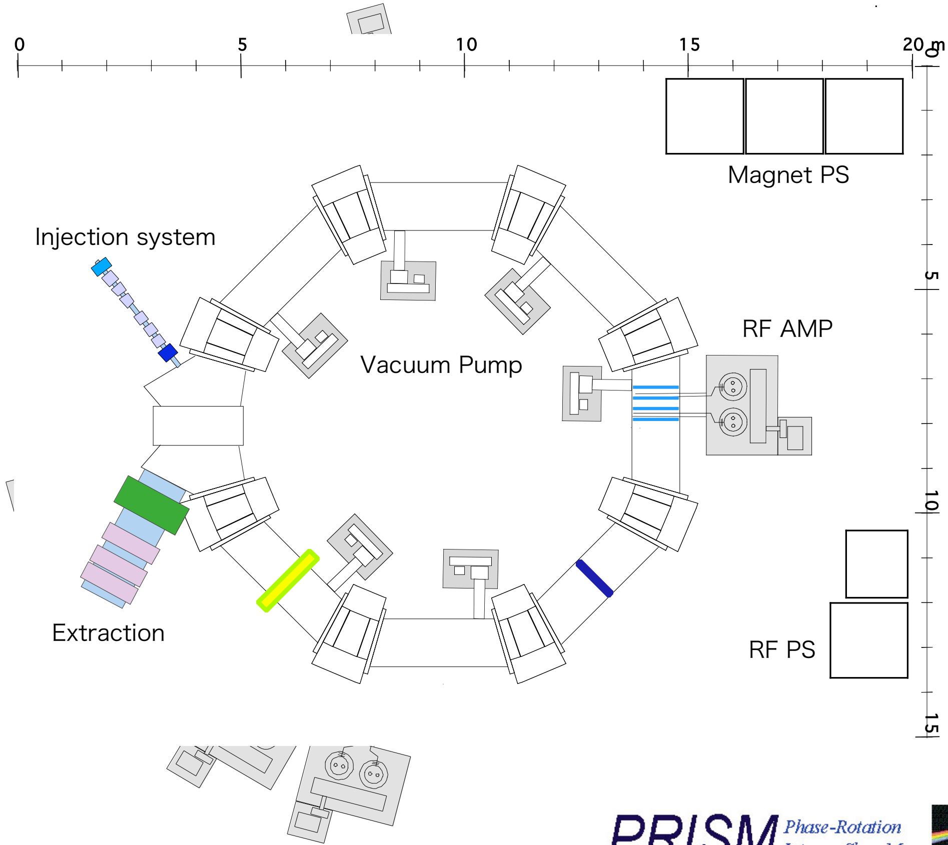


Construction of the PRISM-FFAG

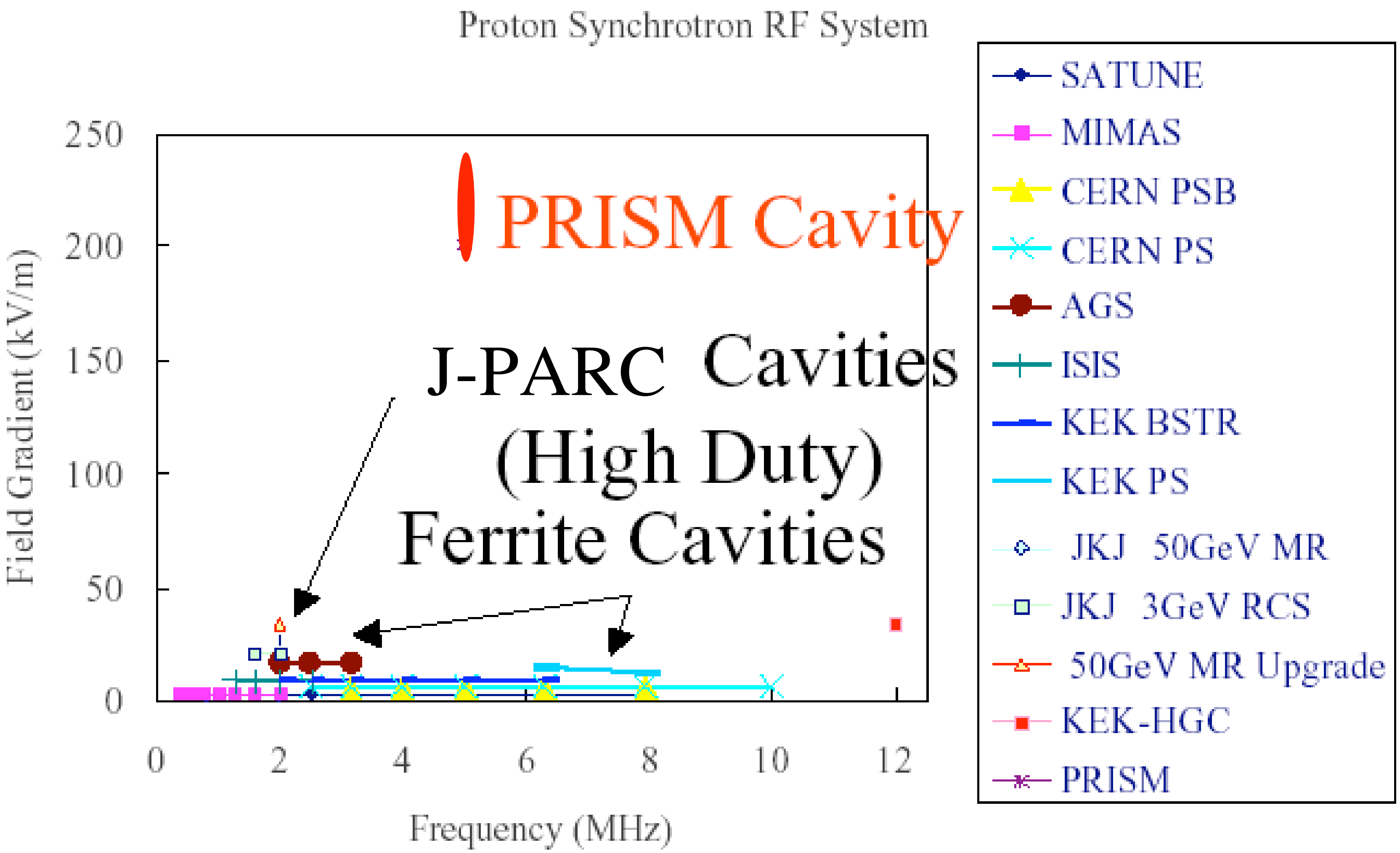
We will construct a full size PRISM-FFAG

Only 1 RF cavity and 1 kicker will be constructed.
Future budget -> Other RFs and kicker to upgrade to the full spec.

- To demonstrate
  - Phase rotation
  - Muon acceleration
  - (Muon ionization cooling)
- R&D components
  - RF with high
    - 5MHz, 250kV/m
  - Large aperture Magnet
    - multi coil



PRISM Phase-Rotation Intense Slow Muon
High-Intensity Low-Energy μ Source


Proton Synchrotron RF System
PRISM Cavity
J-PARC Cavities
(High Duty)
Ferrite Cavities
Field Gradient (kV/m)
Frequency (MHz)
250
200
150
100
50
0
0
2
4
6
8
10
12
SATUNE
MIMAS
CERN PSB
CERN PS
AGS
ISIS
KEK BSTR
KEK PS
JKJ 50GeV MR
JKJ 3GeV RCS
50GeV MR Upgrade
KEK-HGC
PRISM

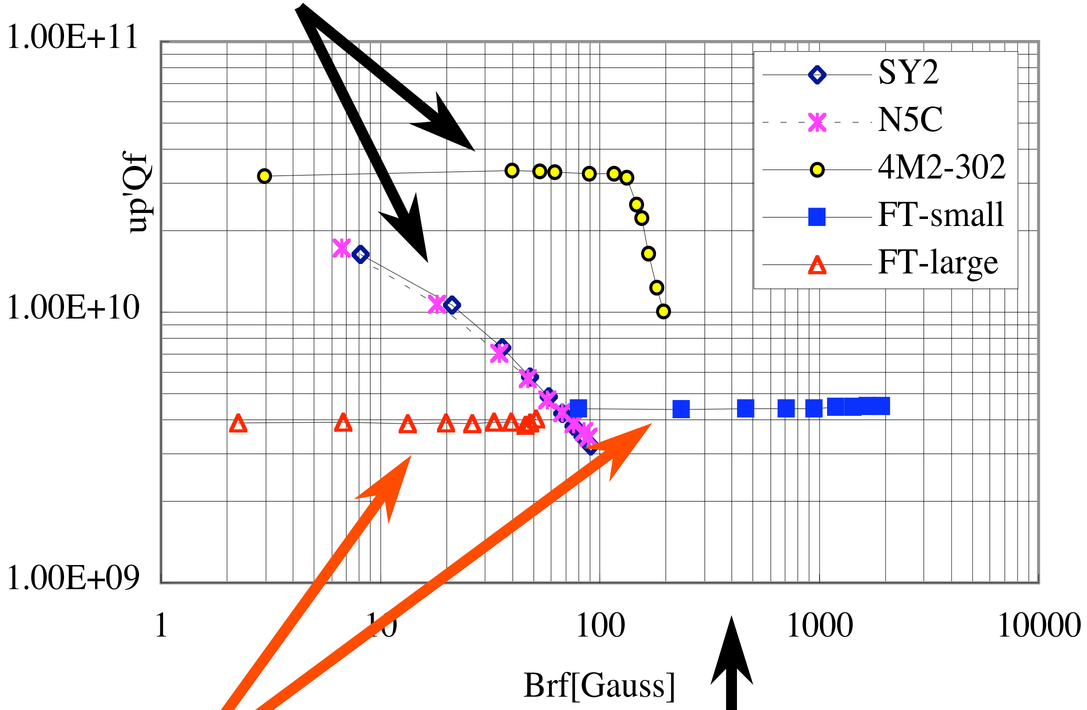
MA(Magnetic Alloy) Cavity

for high field gradient (~300kV/m) at 5MHz

- MA will be used for J-PARC synchrotron RF cavities
- Characteristics of MA
  - Thin Tape , 18 μm
  - High Field Gradient
    - Voltage limit: Brf <Bsat. (1T) and Voltage per layer < 5 V
  - High Curie Temperature
  - Large core, Rectangular Shape
  - Large permeability(about 2000 at 5MHz)
  - Original Q value is small(0.6).
  - High Q is possible by cut core configuration
  - Thickness -35mm (50mm in future)

High Gradient Cavity

Ferrites



Magnetic Alloys

B=V/□S=25kV/2pX5MHzX5cmX40cm=400Gauss

250kV/m 4gap 5MHz

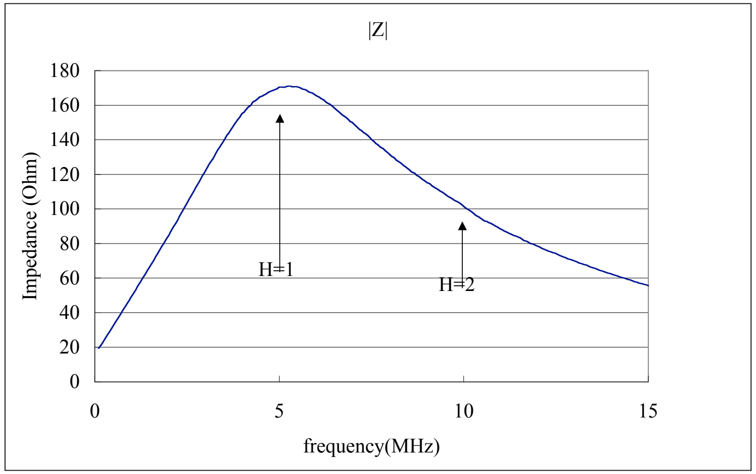
MA Cavity using Cut Core

- Low Q=large inductance

vs. Resonant frequency = 5MHz

vs. RF power for 250kV/m

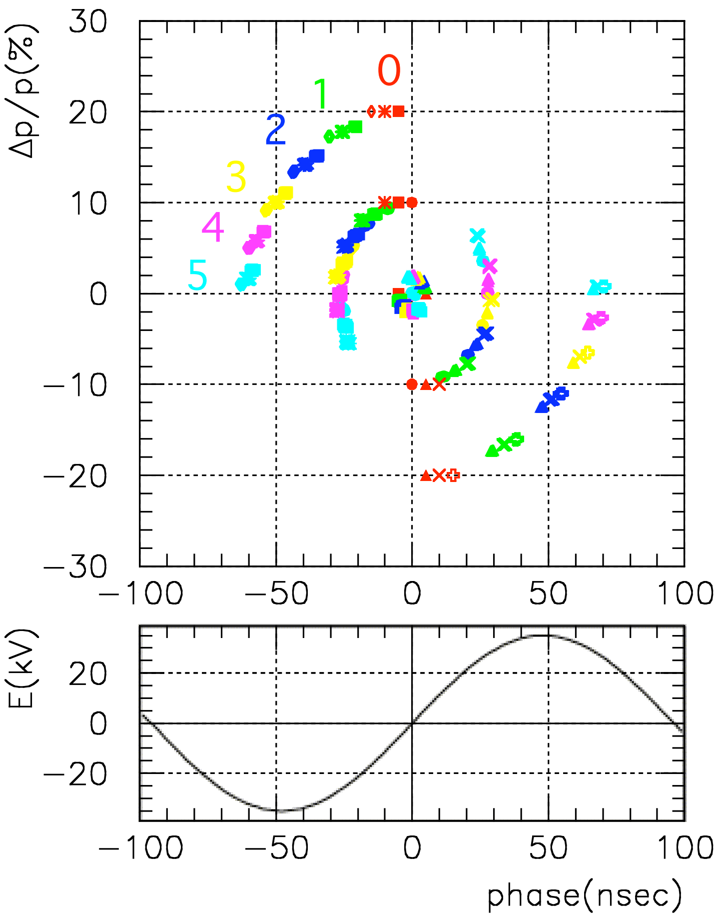
  - Resonant capacitance > 50-100 pF by structure
  - Large inductance in case of no cut MA (not good).
    - Can be reduced by using cut core
- Solution
  - Q=1 at 5MHz with Cut Core (1.5mm gap)
    - C=100pF and Rp=500 W /gap
    - Or C=50 pF and Rp=1 k W/gap
    - To obtain 40kV/gap, 800kW is necessary.

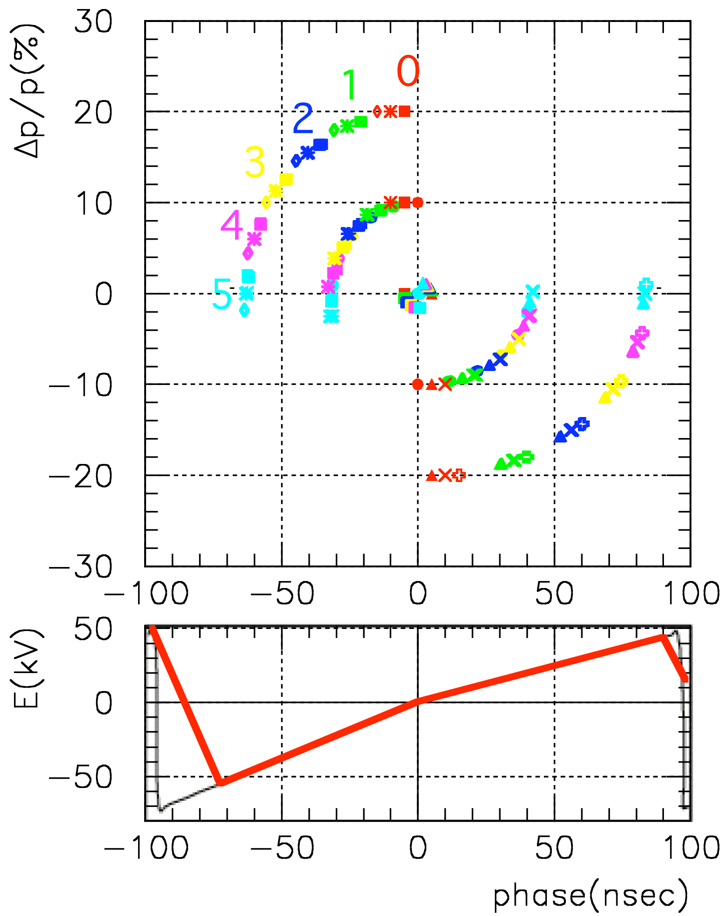


Measured using a core for J-PARC cavity
Need a model cavity to confirm.

PRISM Phase-Rotation Intense Slow Muon
High-Intensity Low-Energy μ Source

Sinusoidal or Saw-tooth





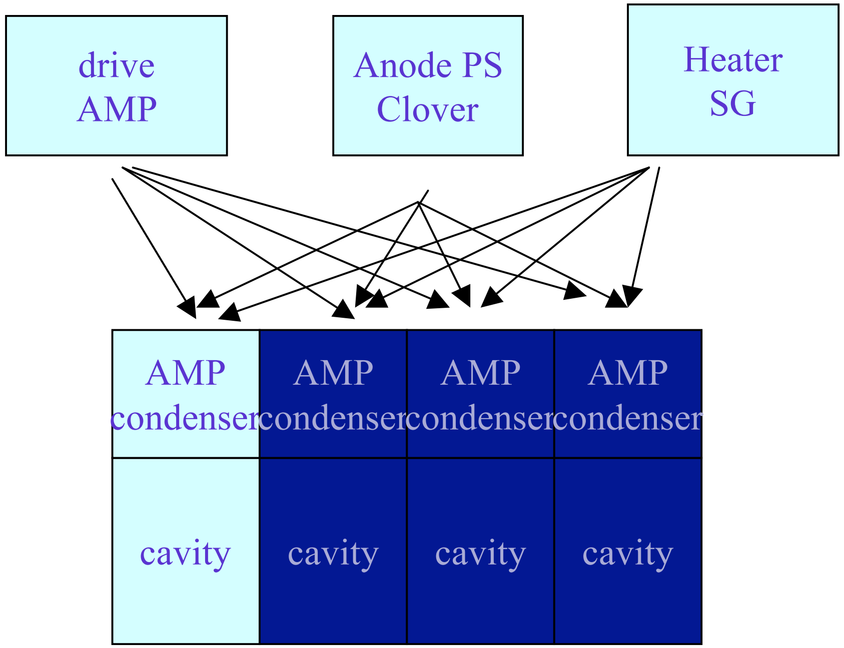
- RF : 5MHz, 128kV/m

Δ E/E = 20MeV+12%-10%

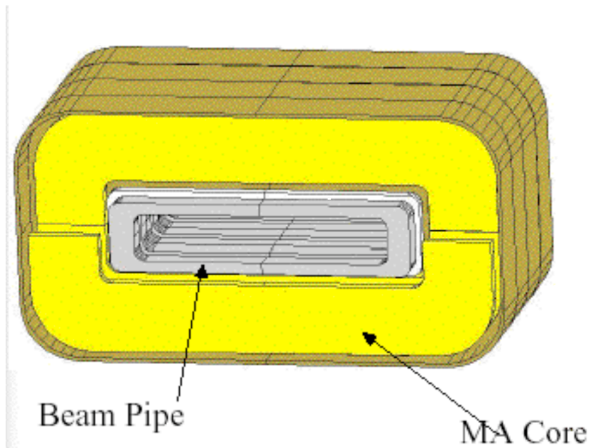
- RF : 5MHz, 250kV/m

Δ E/E = 20MeV+4%-5%

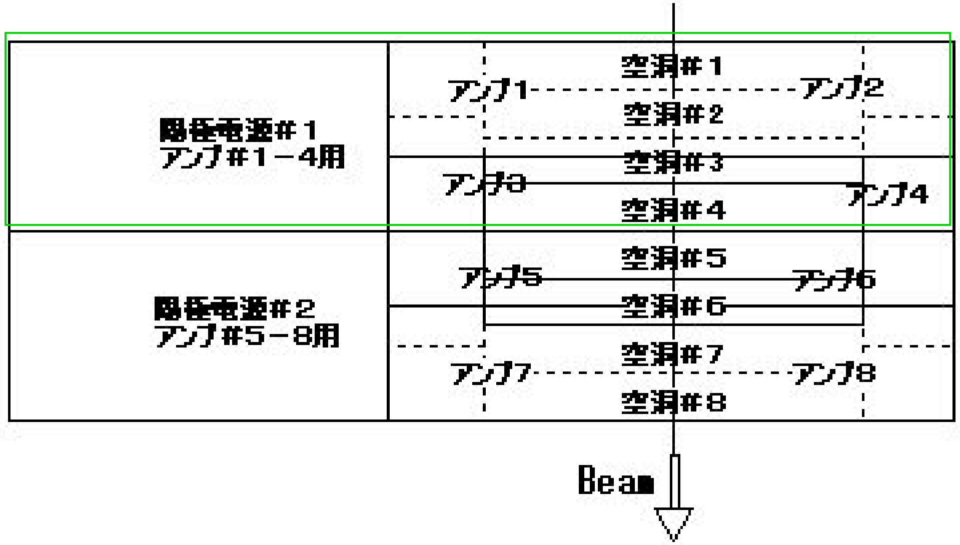
PRISM RF plan



	PRISM RF Plan
Power tube	EIMAC 4CW150K DC35-40kV900-kW(peak)
Field gradient	62.5- kV/cavity 250- kV/m
Gaps/cavity	1 gaps, 31.25-kV/gap, 25cm
Impedance	1k □/gap　以上
# of cores	4 cores /gap（2.5- 3 c mcore）
Cooling	Air cooling

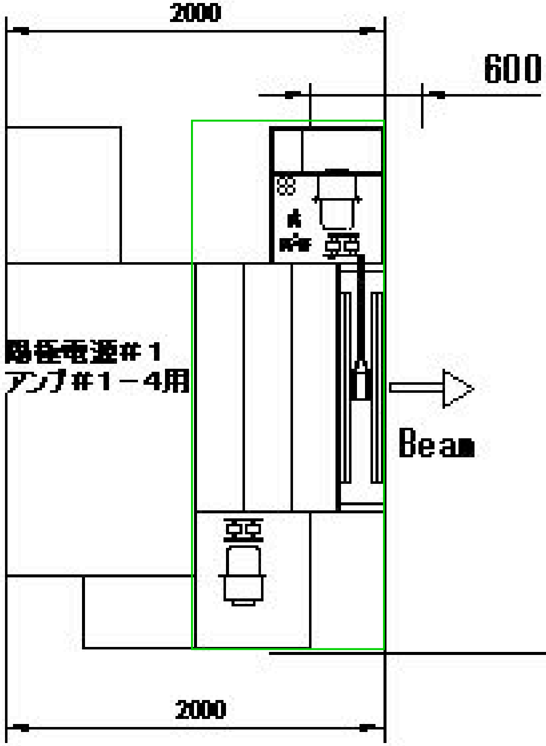


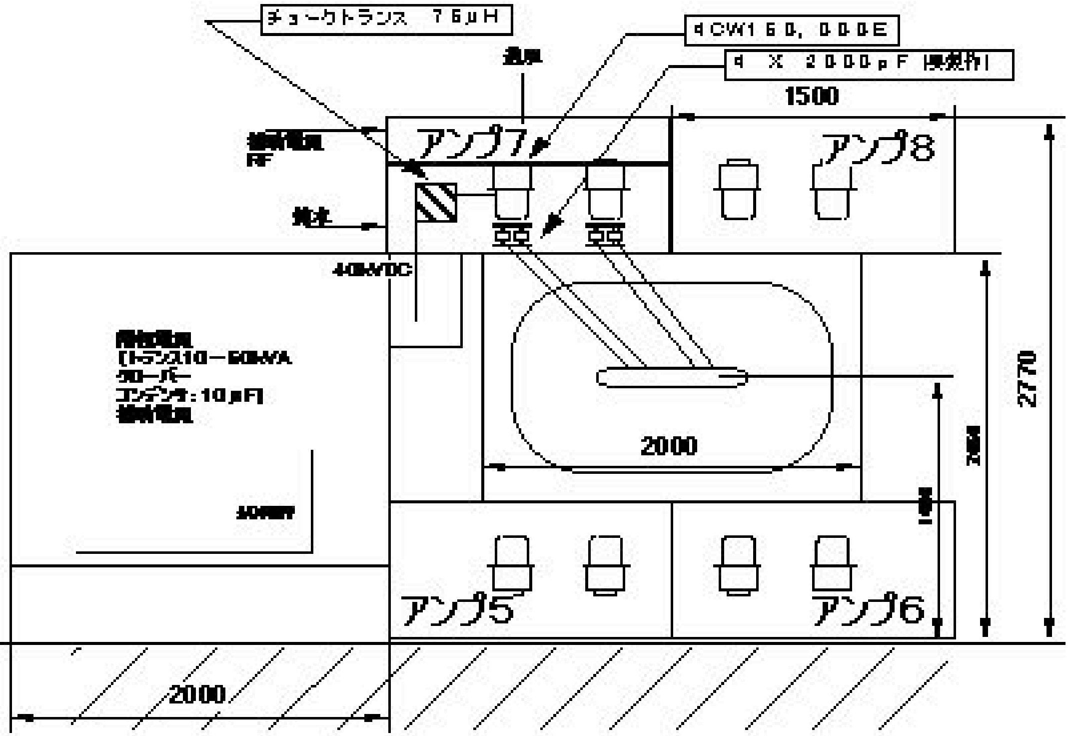
上下からのフィードの場合



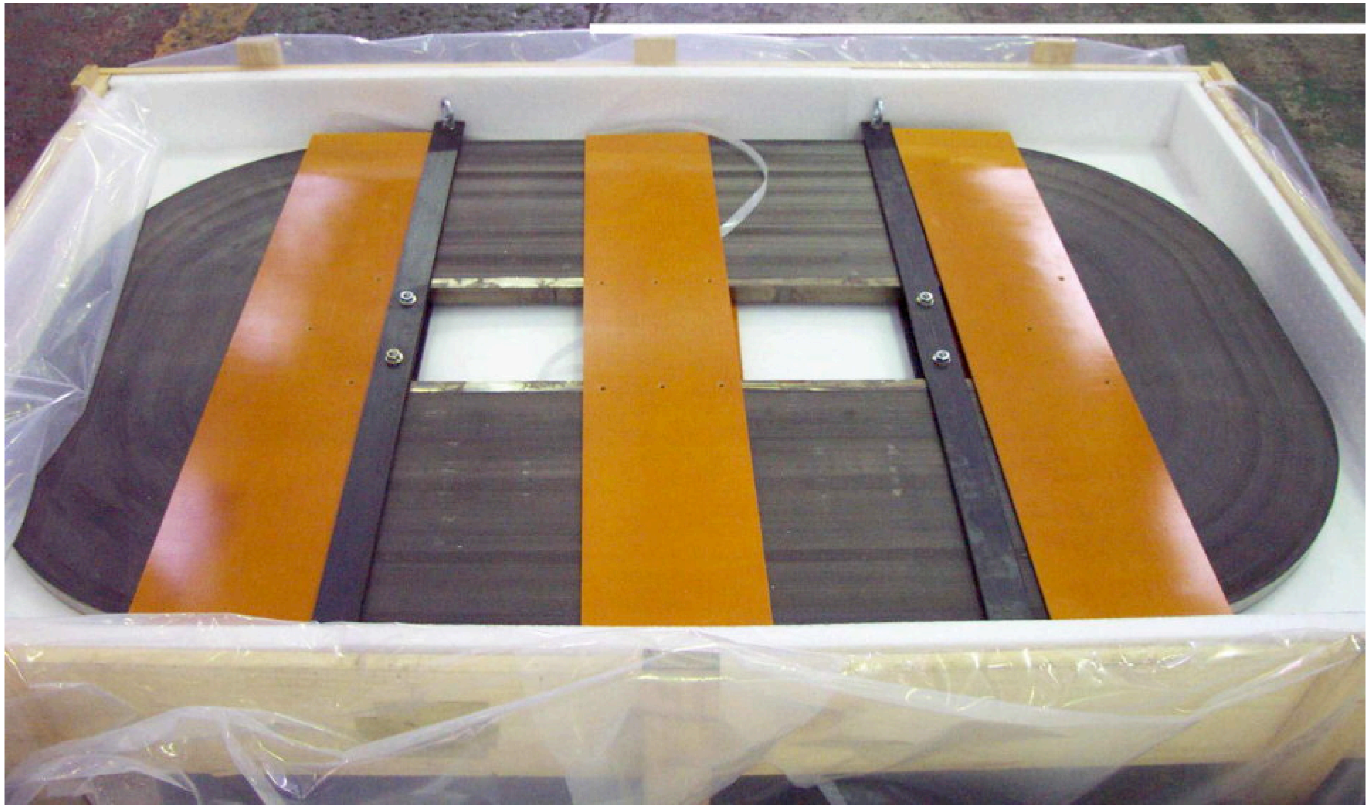
プランB
直線部配置例

今回は
陽極電源#１
アンプ#１－４
空洞#１－４
を製作する。





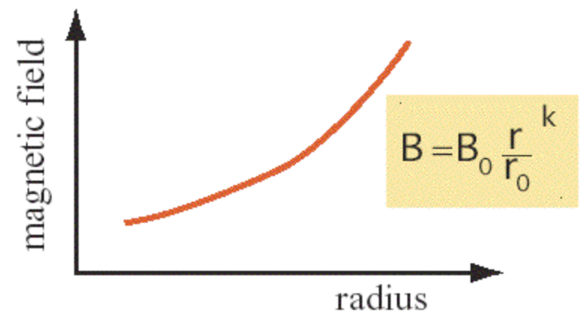
MA core



MA core for 150MeV FFAG

1.7m x 0.985m x 30mm

PRISM-FFAG Magnet



Pole shape type

PoP
150-MeV

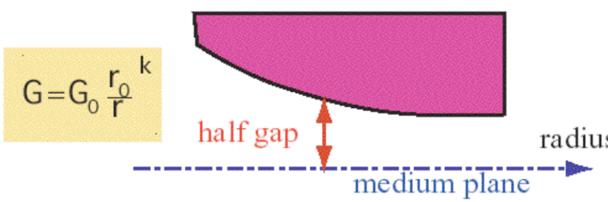
- merit
  - Established scheme
  - Easy to design
- demerit
  - Has small Gap
    →acceptance is limited by gap size
  - k-value unchangeable

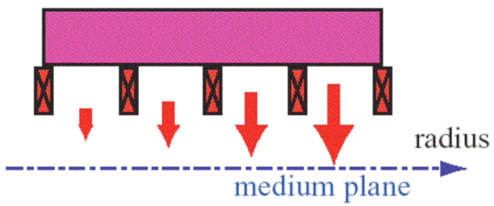
Multi coil type

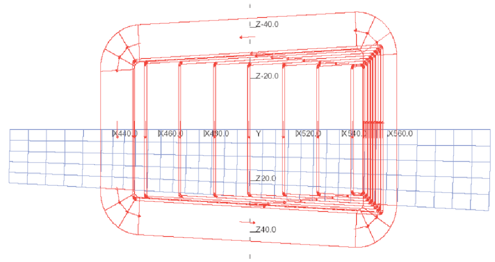
PRISM-FFAG

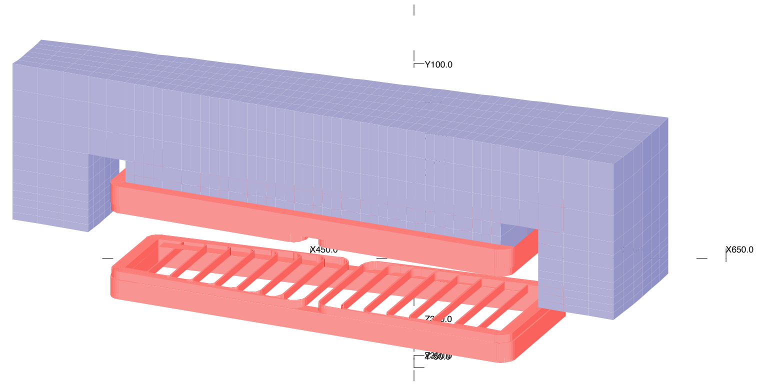
New

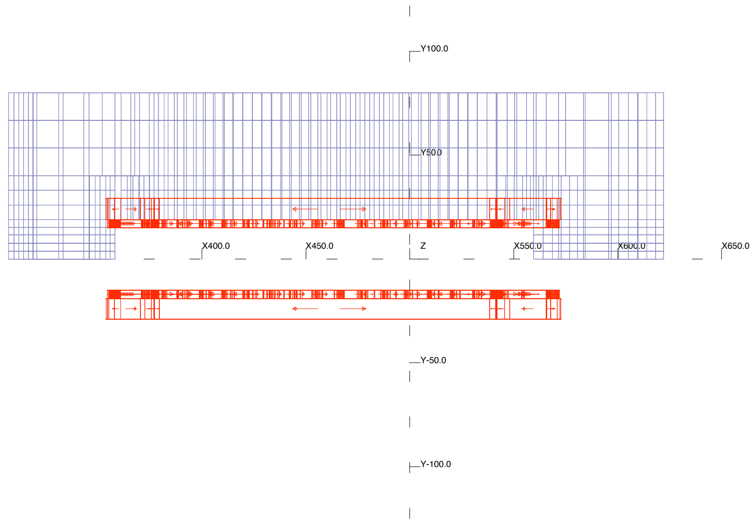
- demerit
  - Not easy to design
  - Needs current control
- Merit
  - Flat gap, large gap
    →large acceptance
  - k-value changeable

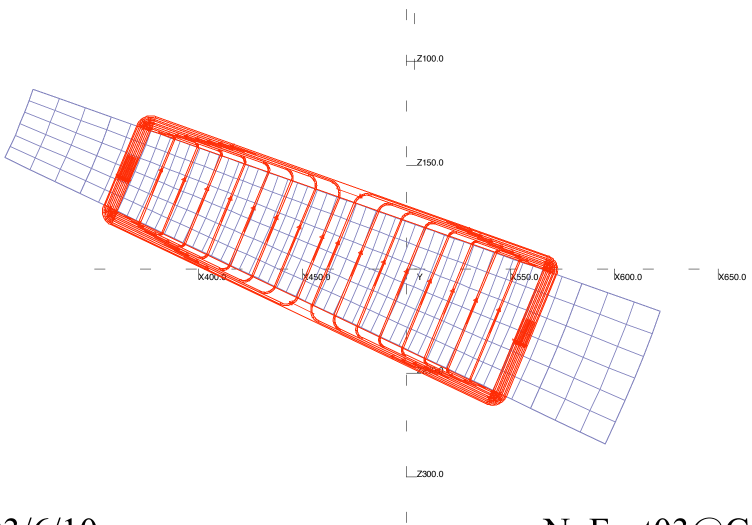






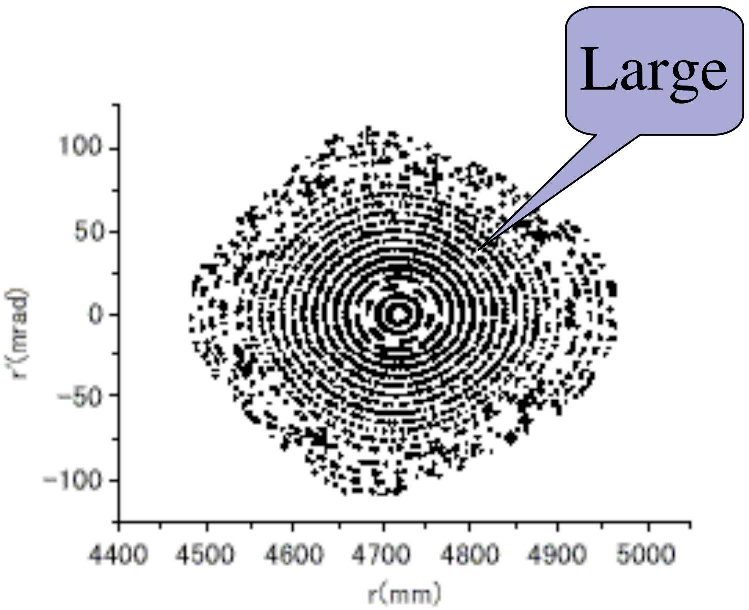




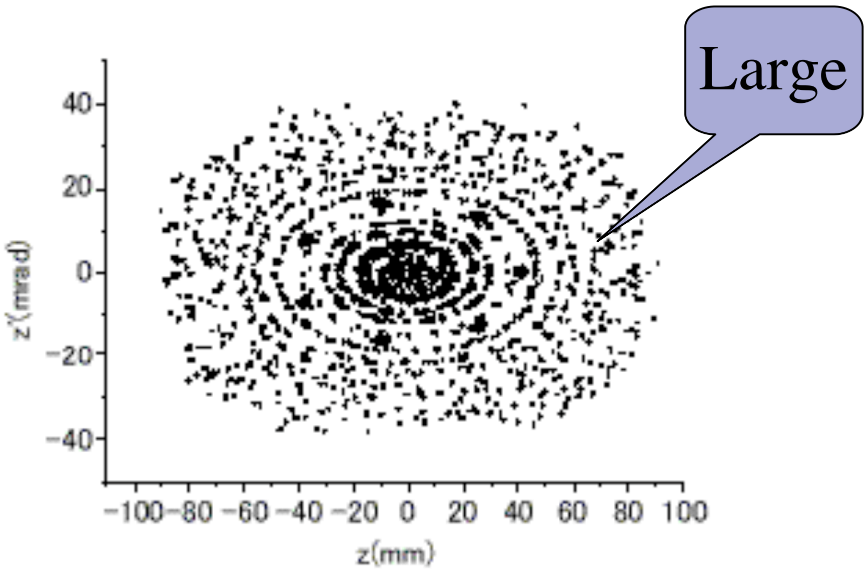


Magnet design is undergoing.

Acceptance Simulations



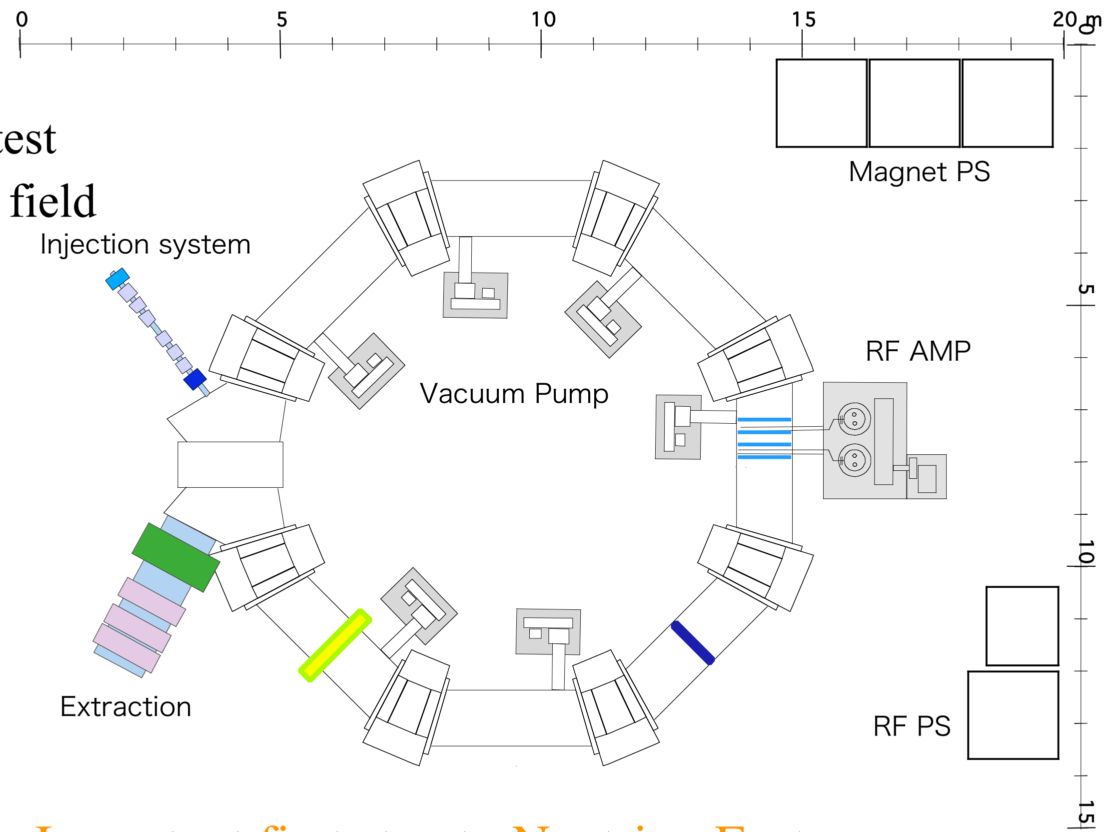
Horizontal
More than 20,000pi mm-mrad.



vertical
～3,000pi mm-mrad.

Schedule of the PRISM-FFAG construction

- FY2003
  - Lattice design, Magnet design
  - RF R&D
- FY2004
  - RFx1gap construction & test
  - Magnetx1 construction & field meas.
- FY2005
  - RFx4gap tuning
  - Magnetx7 construction
  - FFAG-ring construction
- FY2006
  - Commissioning
  - Phase rotation
- FY2007
  - Muon acceleration
  - (Ionization cooling)



Important first step to Neutrino Factory