PRISM Status

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Osaka University
TRIUMF FFAG Workshop、April 15th, 2004

- PRISM group
  - M. Aoki, Y. Arimoto, Y. Kuno, A. Sato, M. Yoshida (Osaka)
  - S. Machida, Y. Mori, Y. Yokoi, K. Yoshimura (KEK)
  - Y. Iwashita (Kyoto) and others

Outline

- Introduction to PRISM
- Lattice Design
- PRISM-FFAG Magnet
- Schedule

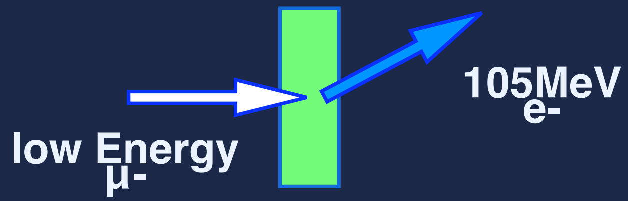
Introduction

PRISM, What ?

Phase Roted Intense Slow Muon Source

Search for Lepton Flavor violation

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



stopped μ experiment

High Intensity

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

beam repetition : 100-1000Hz

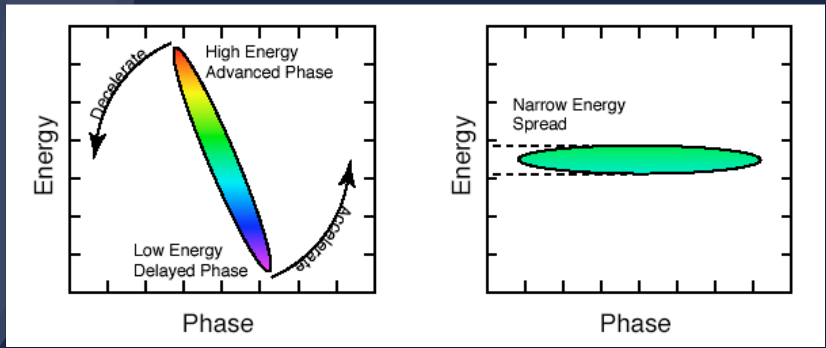
muon kinetic energy : 20 MeV (=68 MeV/c)

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

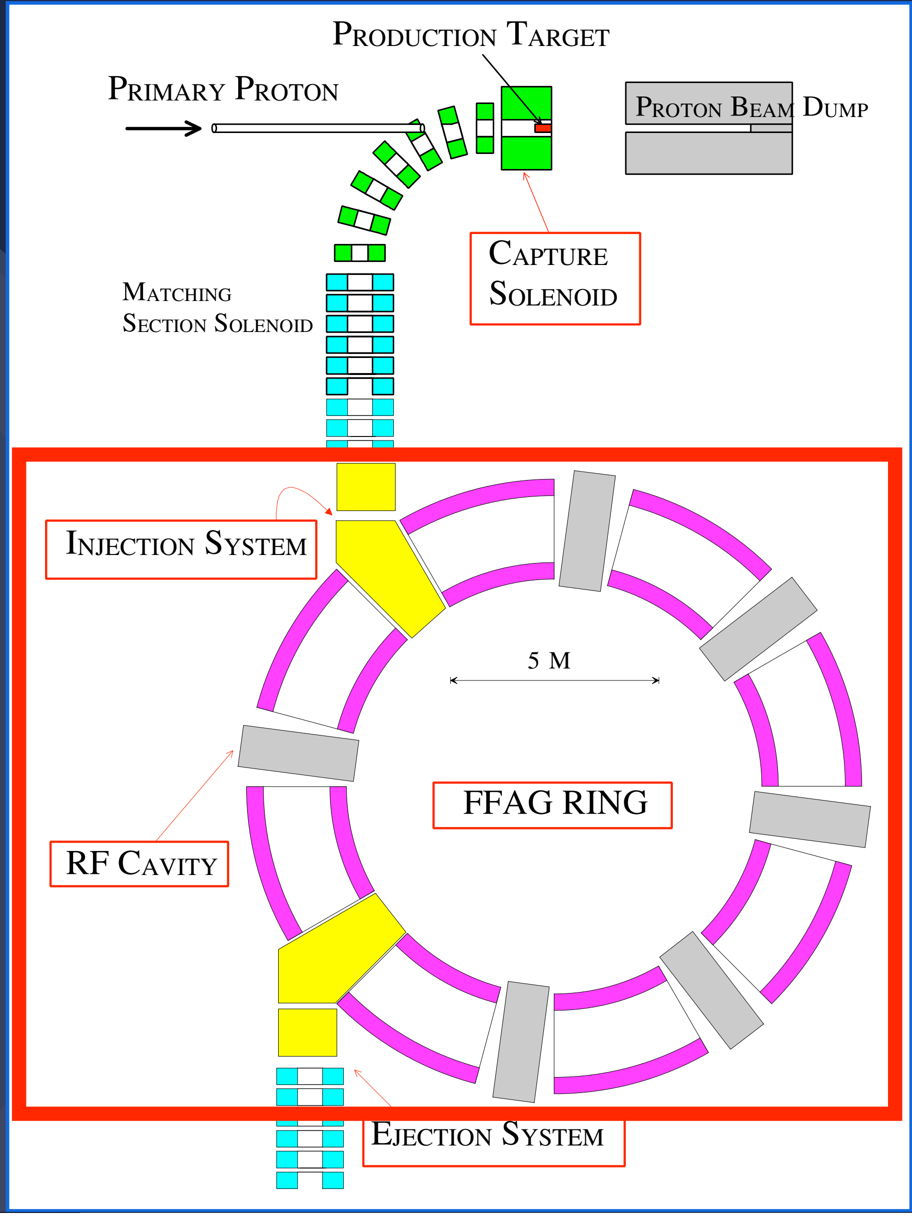
FFAG advantages:

synchrotron oscillation
necessary to do phase rotation

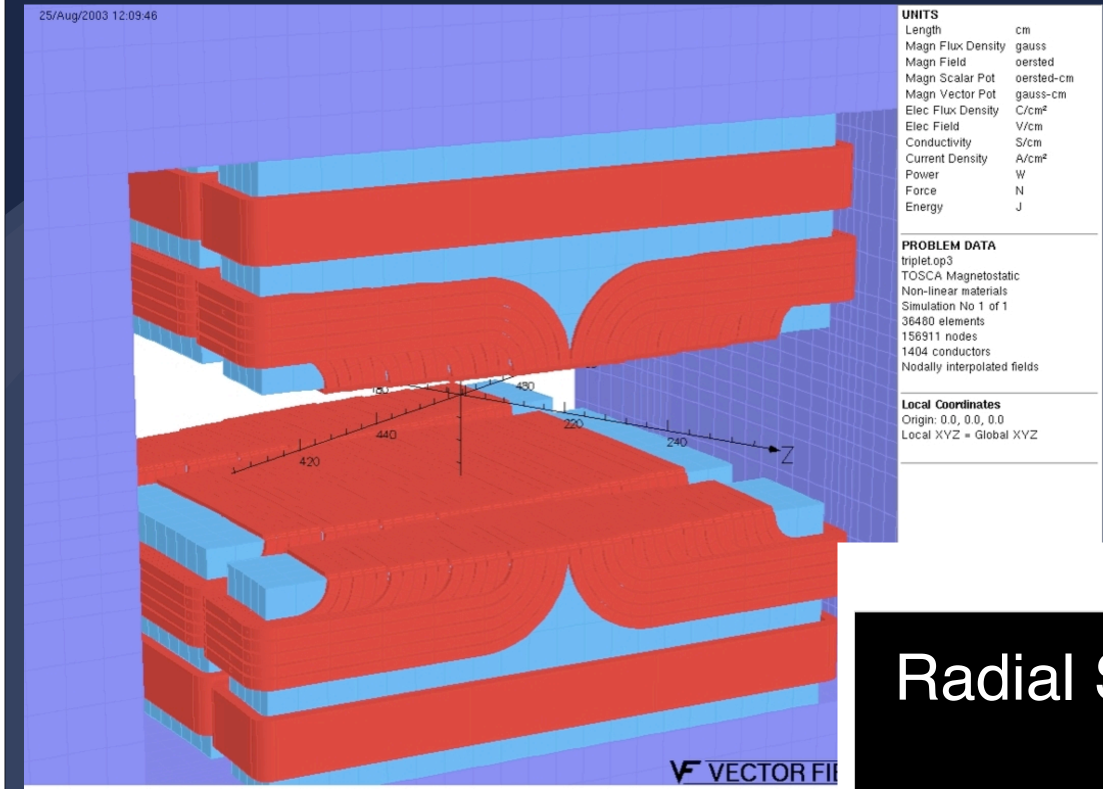
large momentum acceptance
necessary to accept large momentum distribution at the beginning to do phase rotation

large transverse acceptance
muon beam is broad in space

PRISM-FFAG ring construction has started in JFY2003.



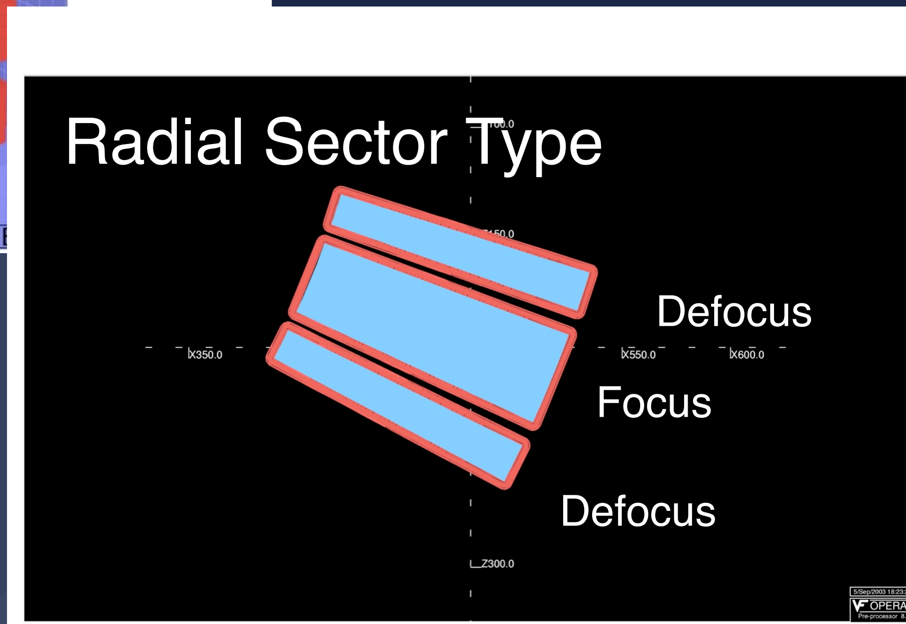
FFAG Magnet



DFD triplet magnet

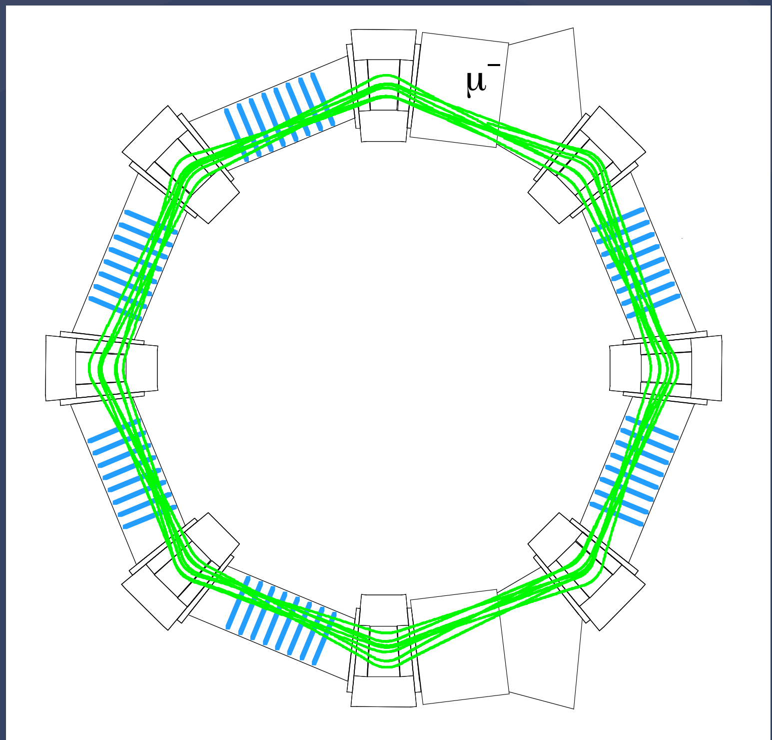
FFAG field

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



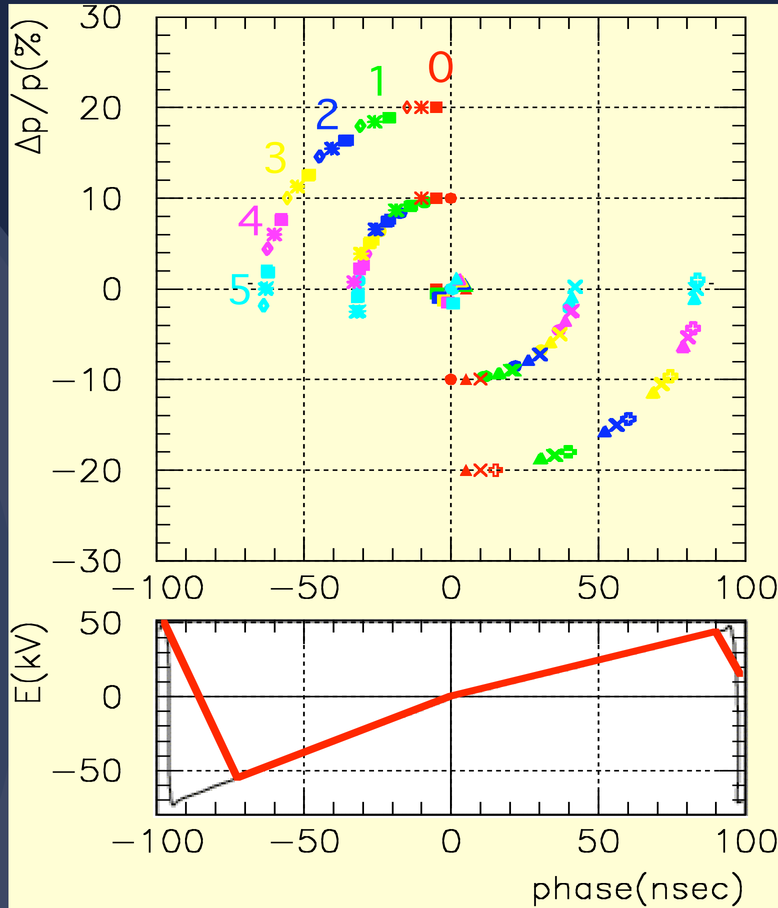
Tracking

GEANT3 simulation with TOSCA magnetic field



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

$\pm 5nsec$ muon width at given momentum



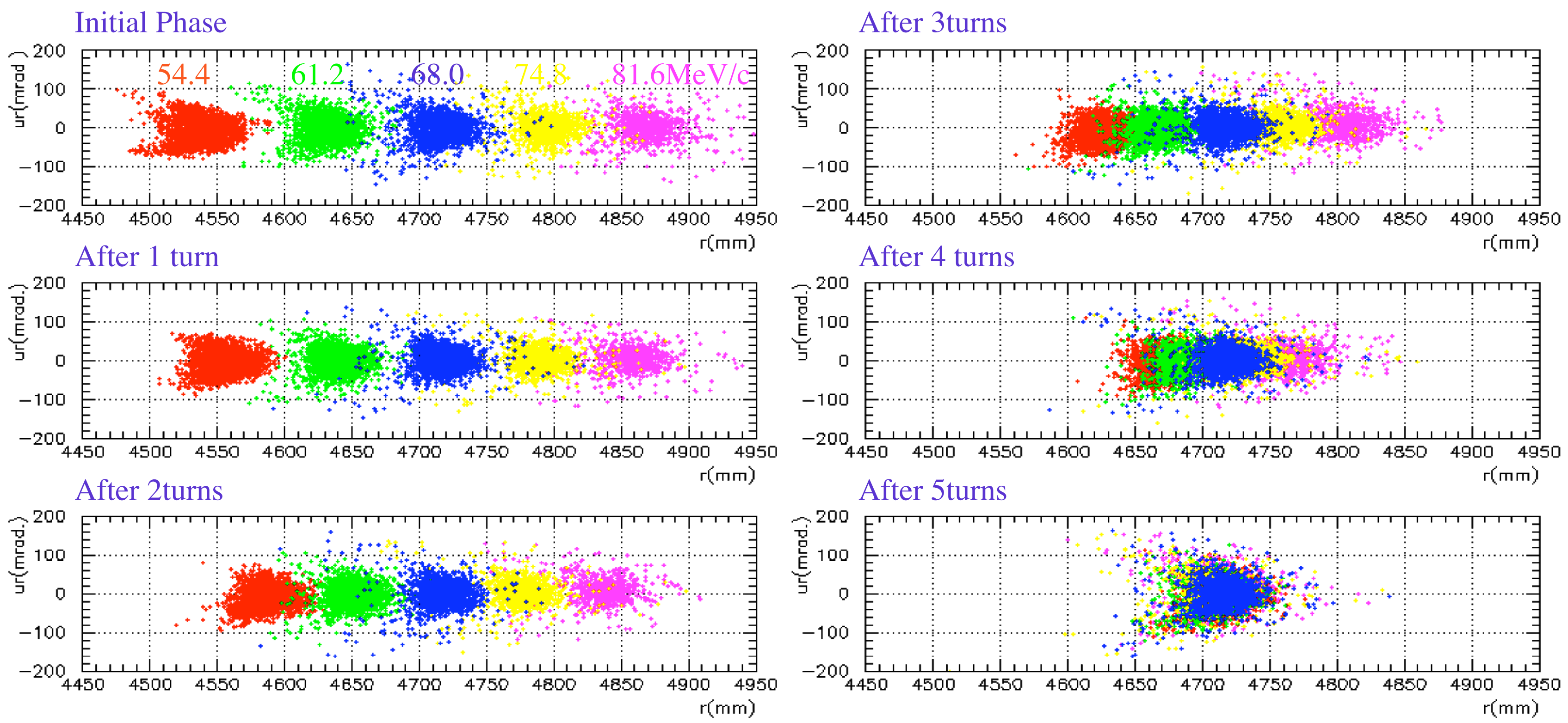
RF 5MHz, 250 kV/m

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

A. Sato

PR Simulation

Horizontal

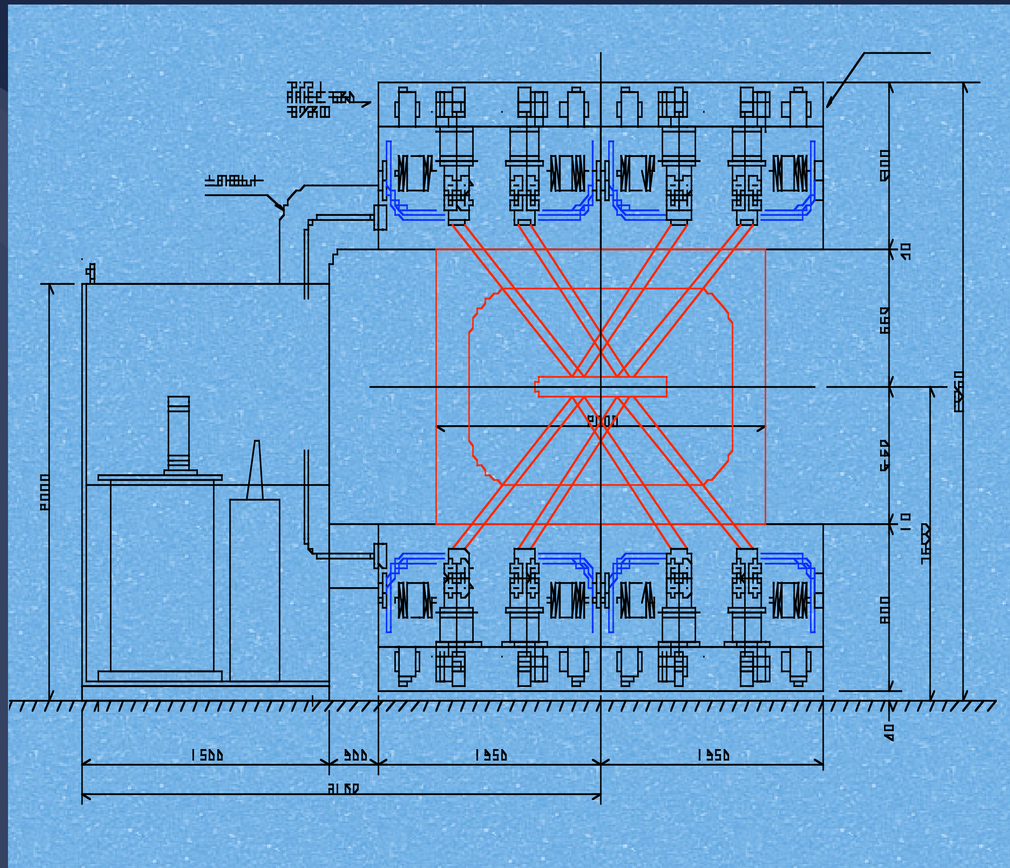


A. Sato

PRISM RF Amp.

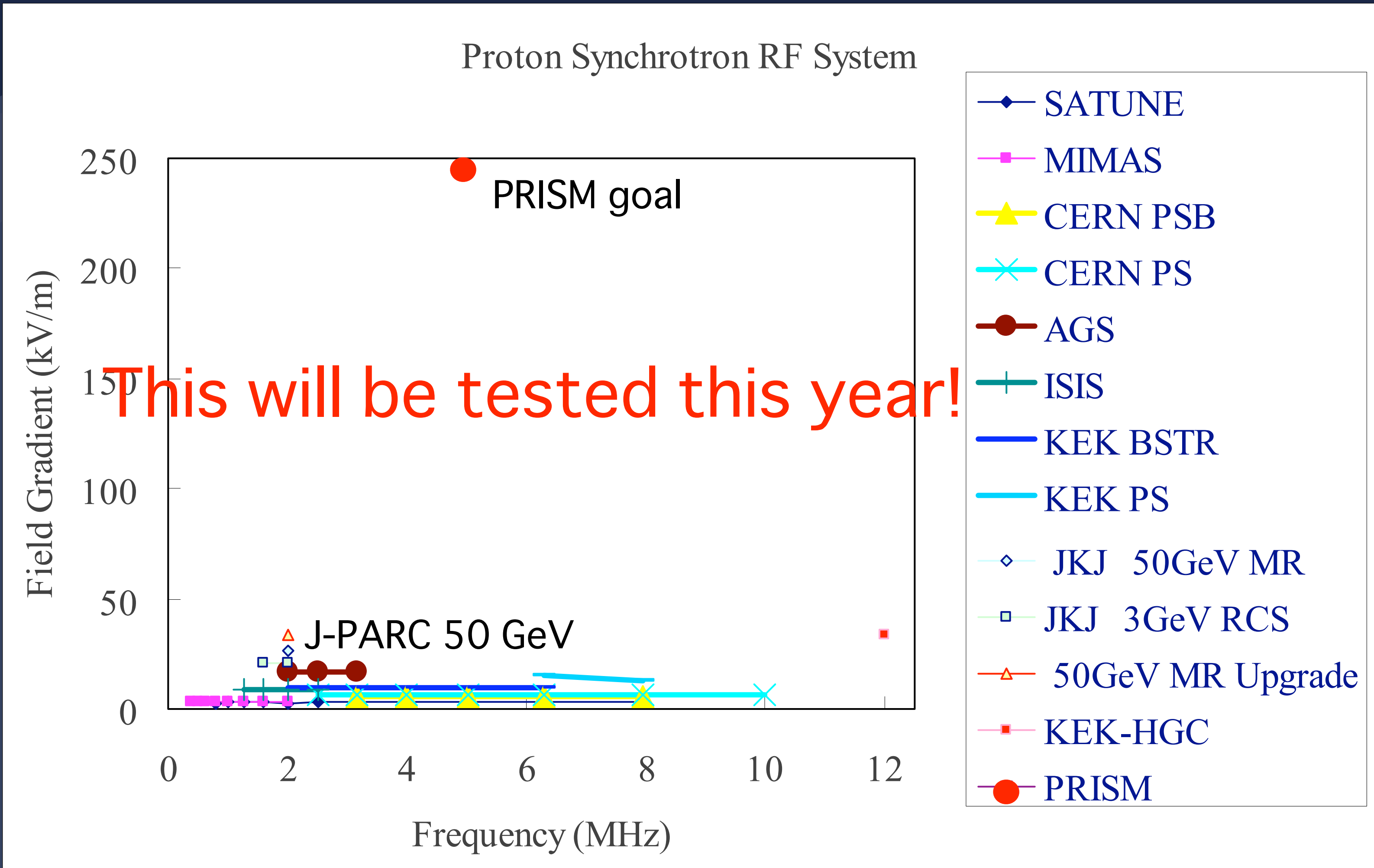
C. Ohmori, M. Aoki

Field gradient	250kV/m
# of gaps	4
Impedance	1 kohm/gap
core	MA 4 cores/gap
Duty	０．１％ air cooling
Power Tube	EIMAC 4CW150K DC35-40kV 900 kW(peak)
Amplifier	AB-class, push-pull for each gap



RF cavity and amplifiers are constructed in 2003/2004

RF Field Gradient



PRISM goal > 250 kV/m

Lattice Design

Optics Issues

Radial Sector type Scaling FFAG

- # of Cells
- k value
- F/D ratio
- and so on....

How to be quick!

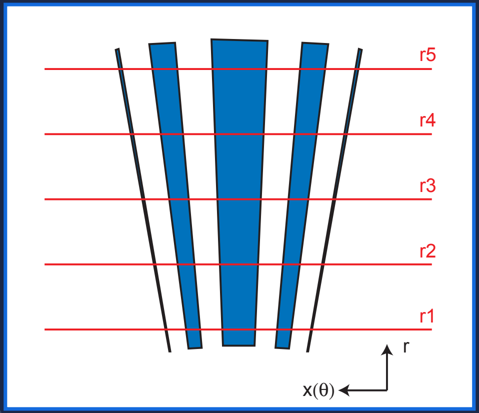
FFAG magnetic field calculation

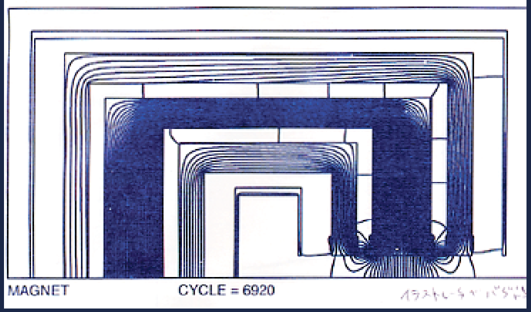
- For determination of the PRISM-FFAG lattice, calculation of non-linear FFAG magnetic field is needed, given the magnet parameters.
- In particular, fringing field is important.
  - large aperture for muon acceleration
- 3-dim. field calculation (TOSCA) is time-consuming.
- A quicker way to calculate is needed.

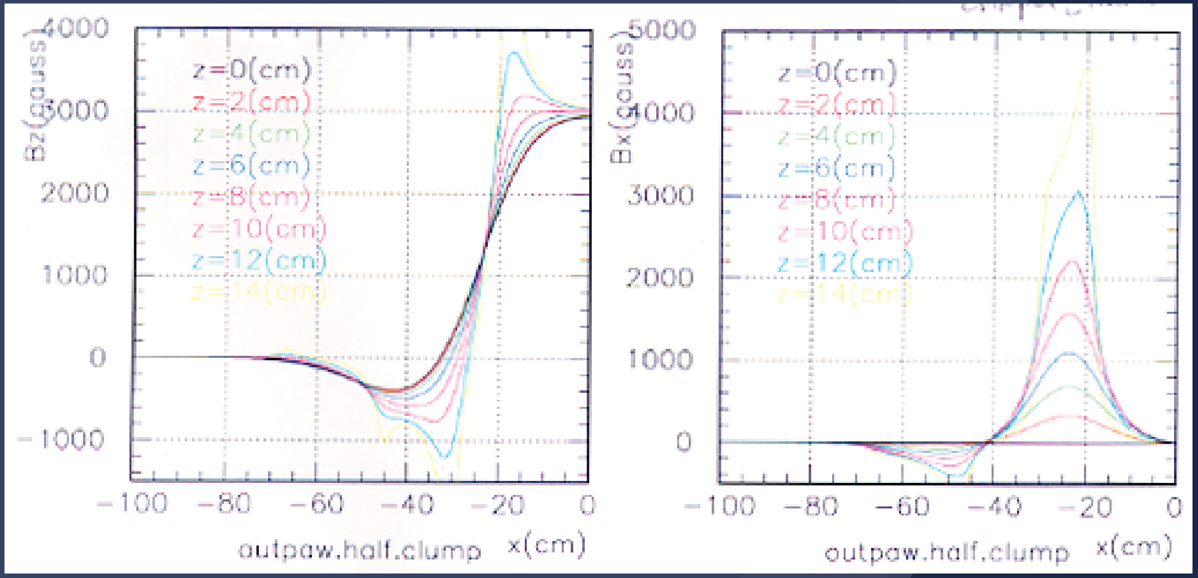
from 2 to 3 dim.

What Akira Sato came up is

- 2-dim. Poisson Calculation at 5 different positions (Bz, Bx)
- Br is given from Maxwell. eq.
- 2-dim spline interpolation



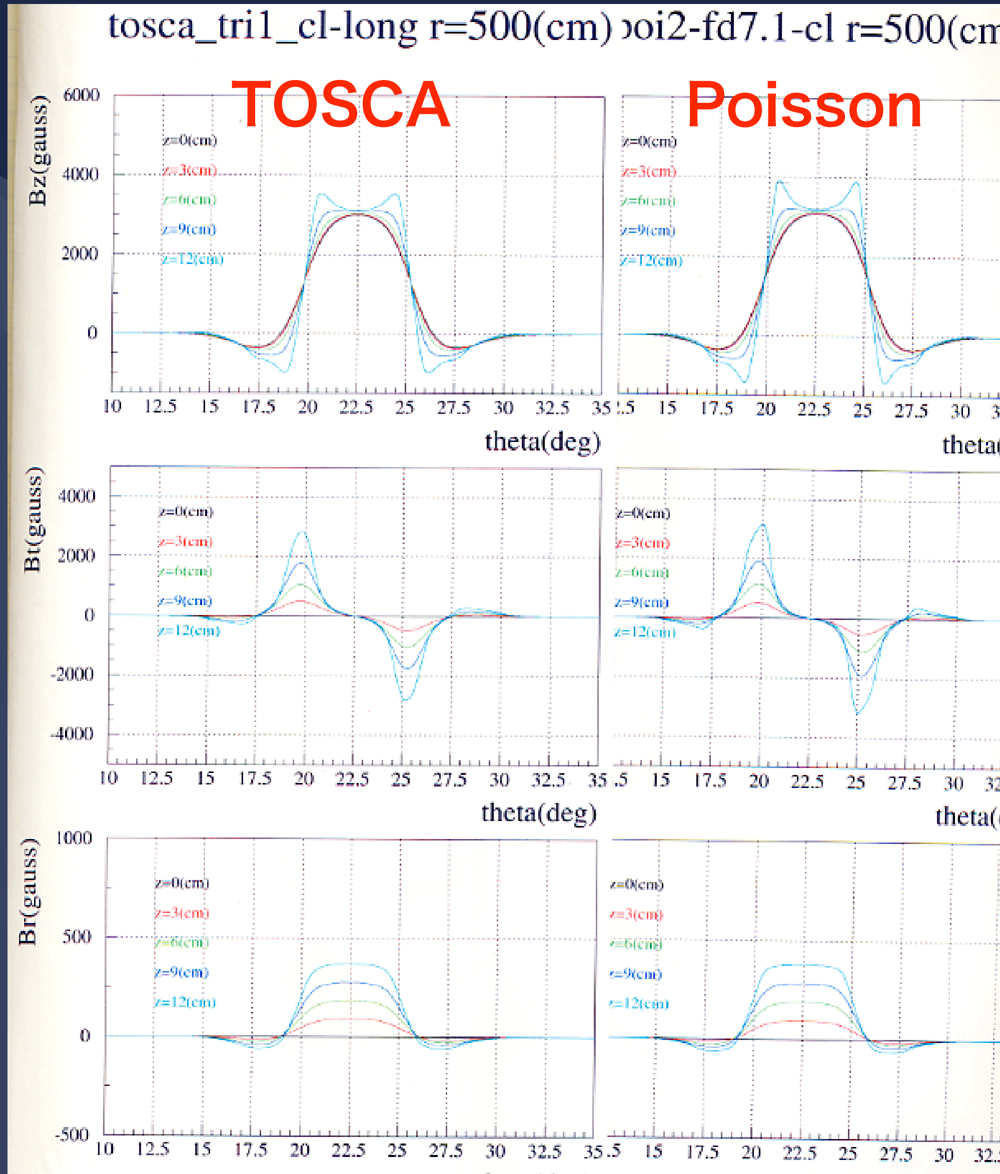




Fringing field is well taken into account.

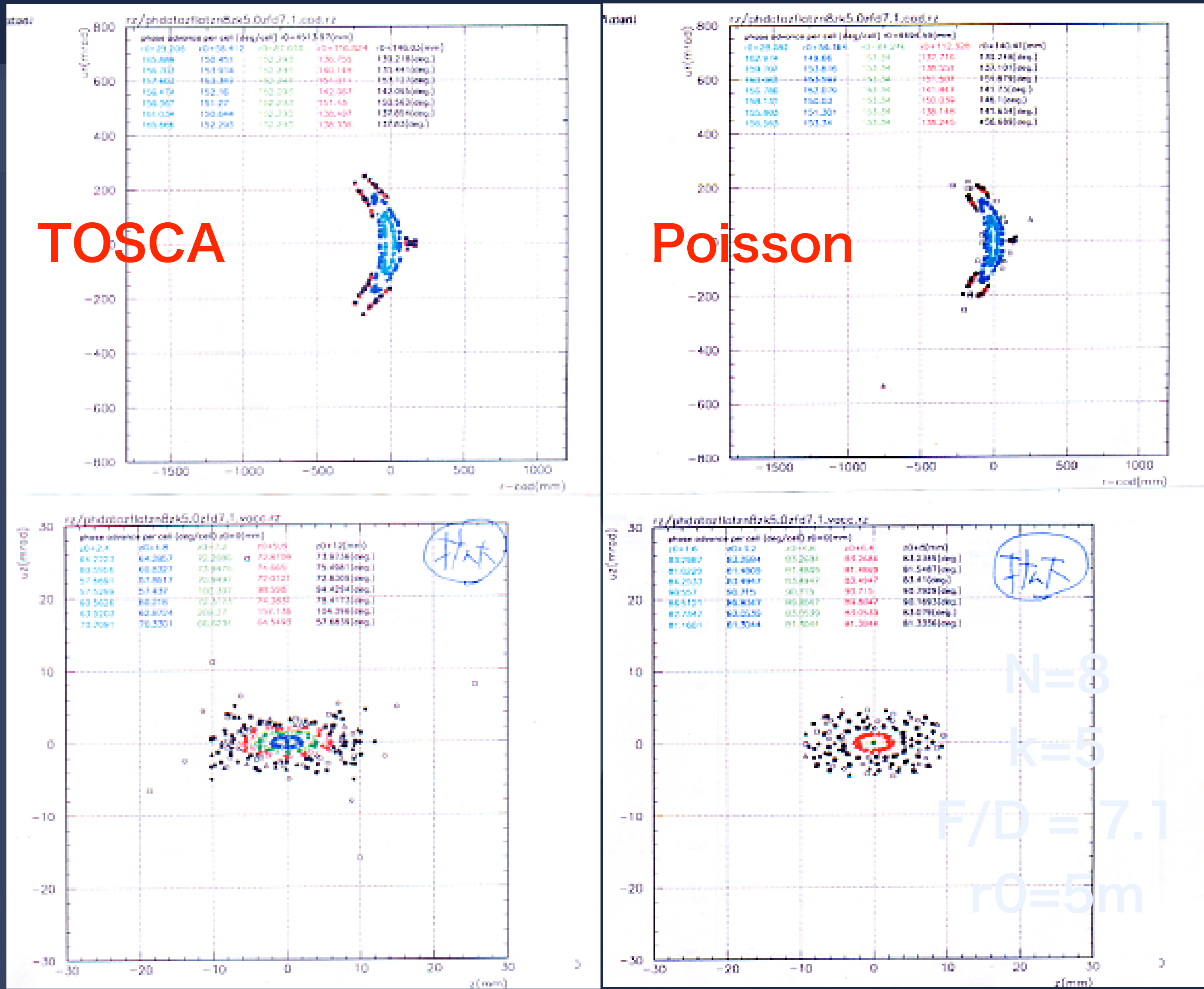
Comparison(1)

magnetic fields



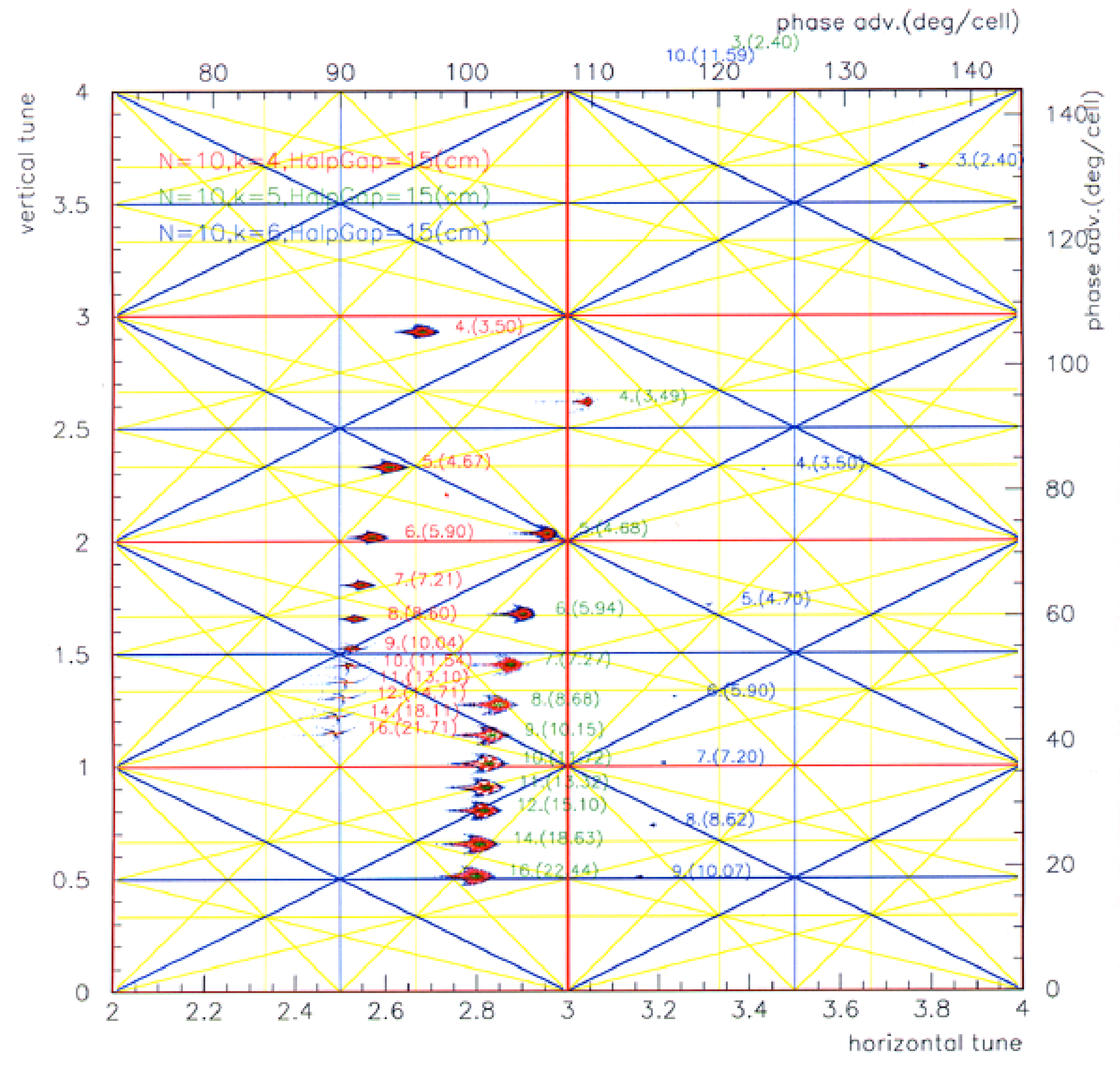
Comparison(2)

Geant Tracking comparison



N=8
k=5
F/D = 7.1
r0=5m

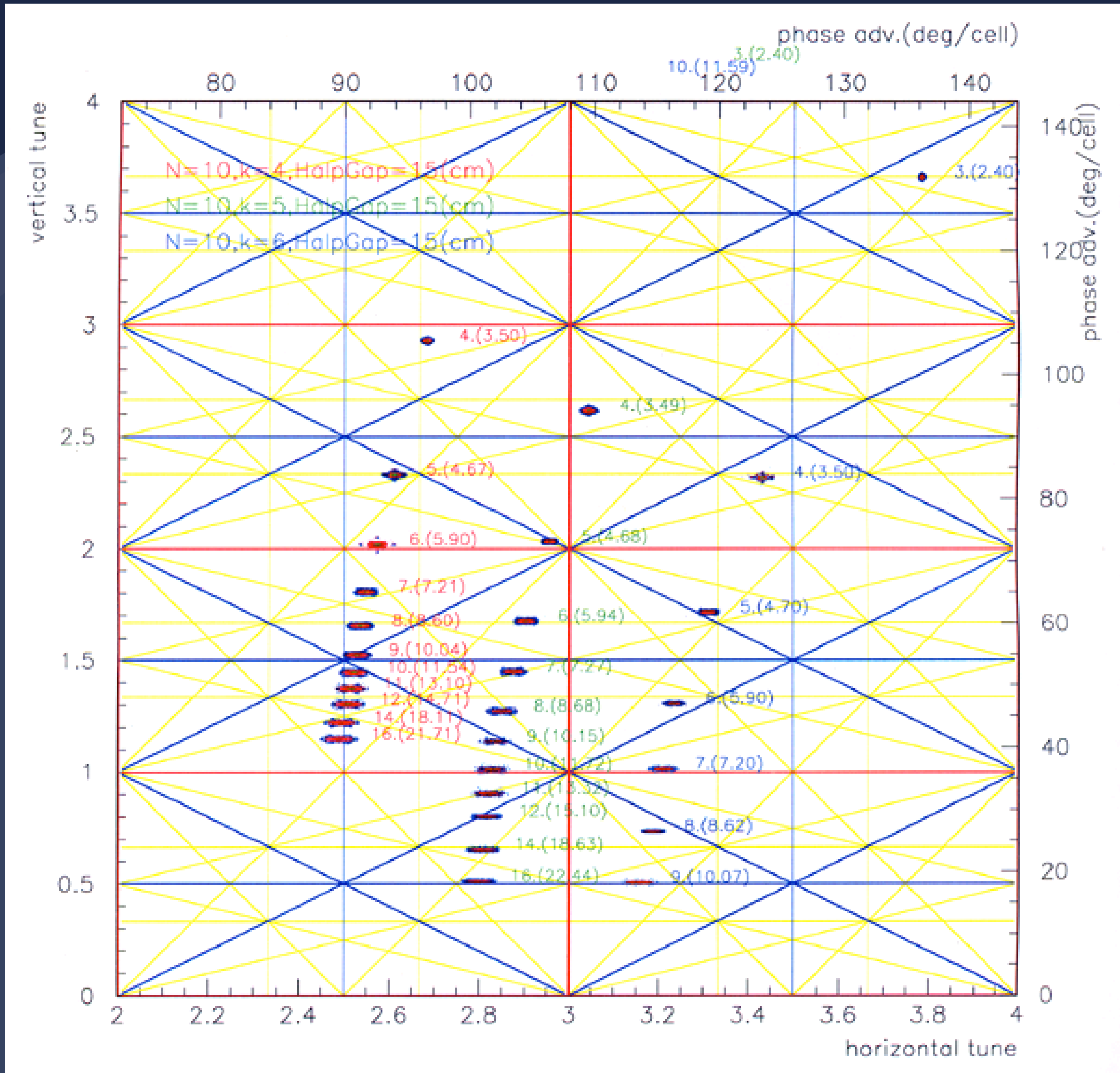
Tune Diagram



DFD Triplet
#sectors = 10
half gap = 15cm
r0 = 6.5 m
68 MeV/c
without field clamp

by Akira Sato

Tune Diagram



DFD Triplet
#sectors = 10
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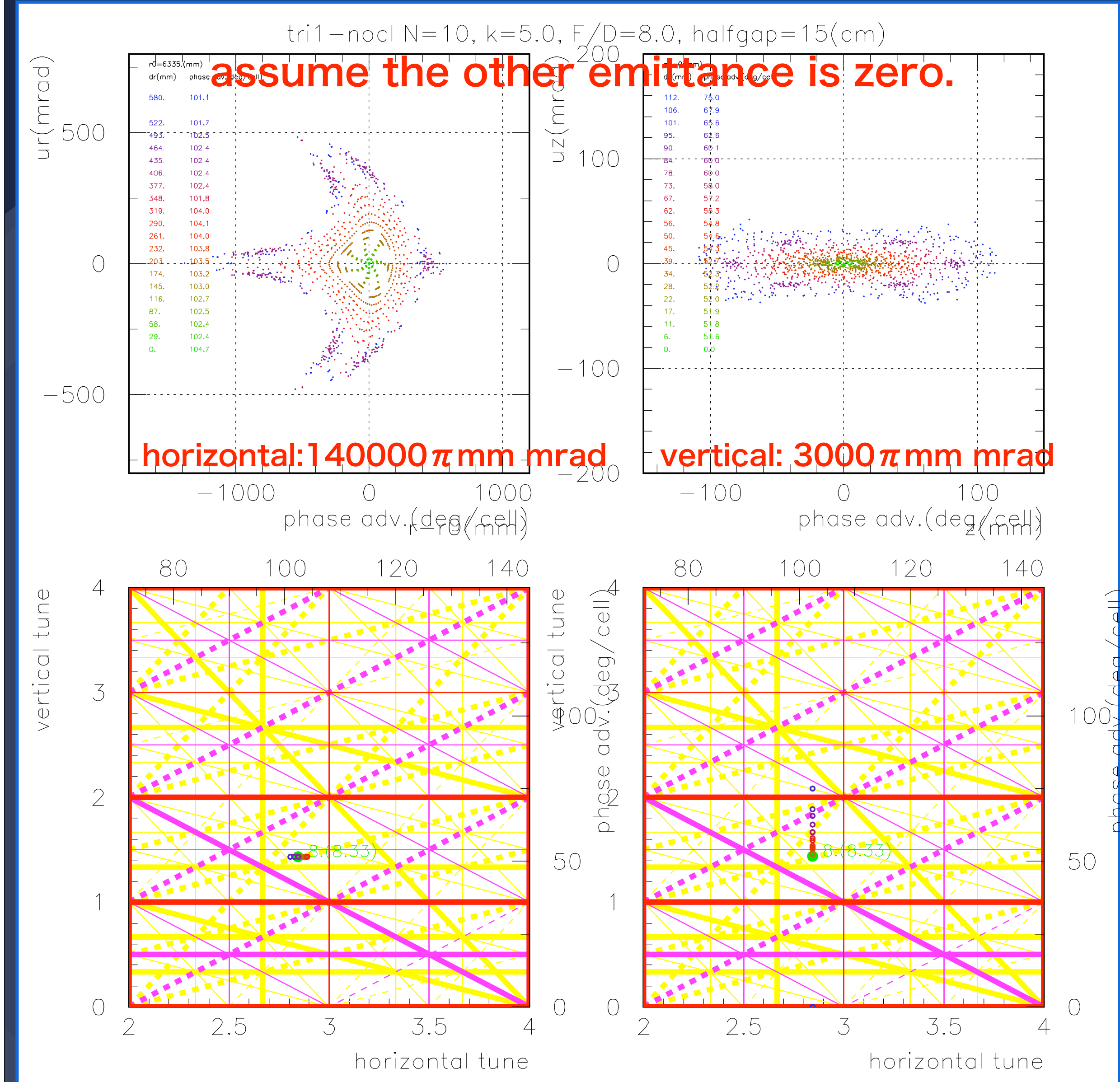
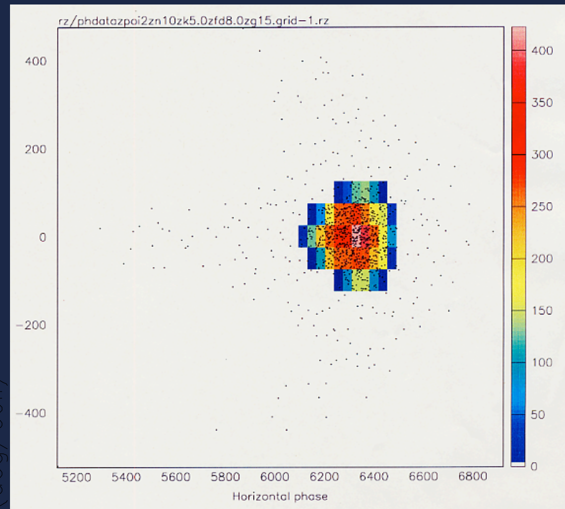
r0 = 6.5 m
68 MeV/c
without field clamp

by Akira Sato

Acceptance



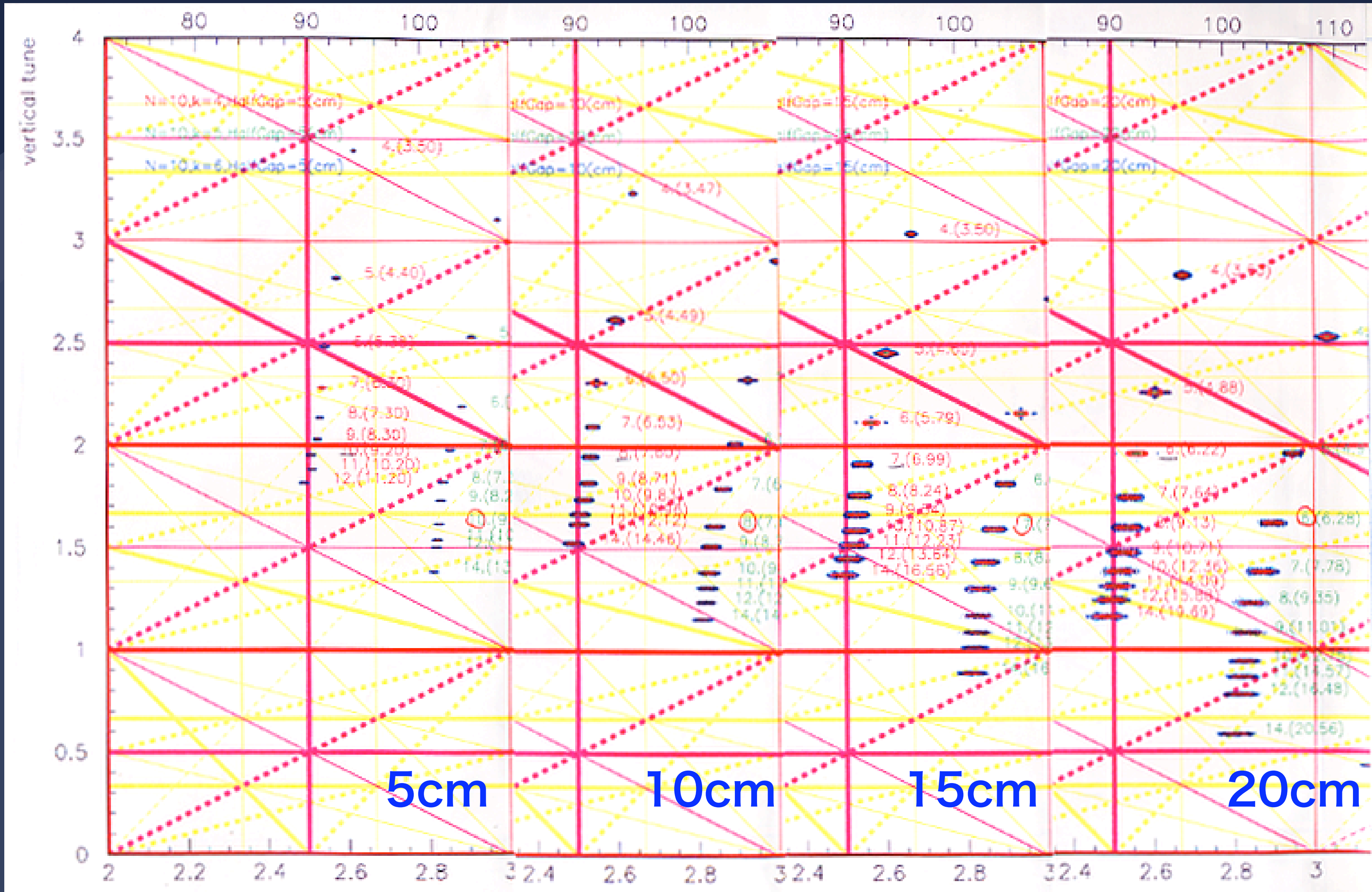
N=10
F/D=8
k=5
r0=6.5m



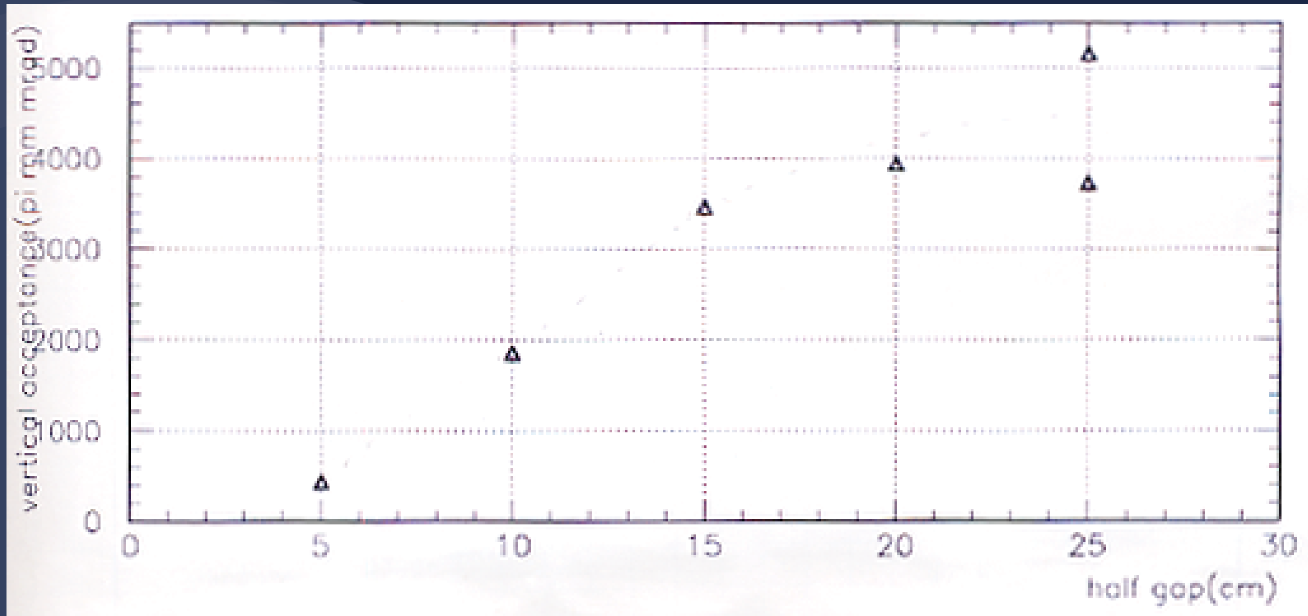
Horizontal: 35000πmm mrad

by Akira Sato

Gap Dependence



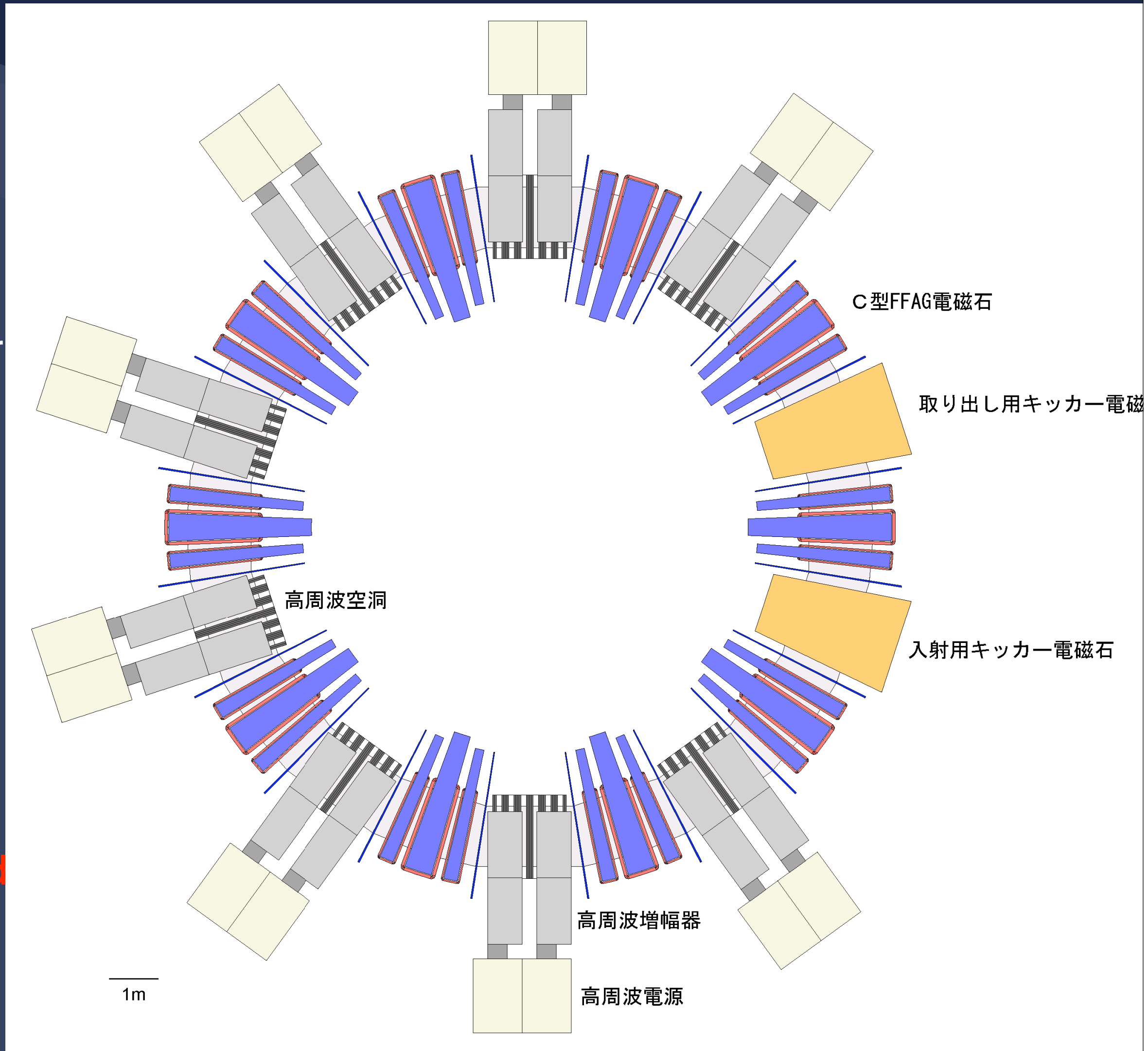
Vertical Aperture



Half gap of 15cm might be sufficient.

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=4.40deg
  - 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



Magnet

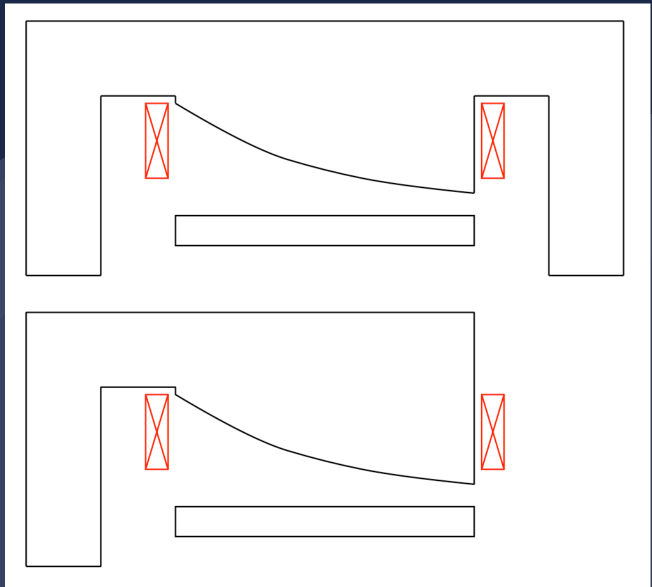
Specifications

- Central Momentum: 68 MeV/c
- Central Orbit Radius: 6.5 m
- # of cells: 10
- F/D ratio: 8 (variable)
- k value: 4.4~5.2 (variable)
- BL integral: 6.4Tm (@6.5m)
- Effective Field Region
  - R: 595-705cm (width=110cm)
  - Z ：+-15cm
- Residual field at RF core < 100 G

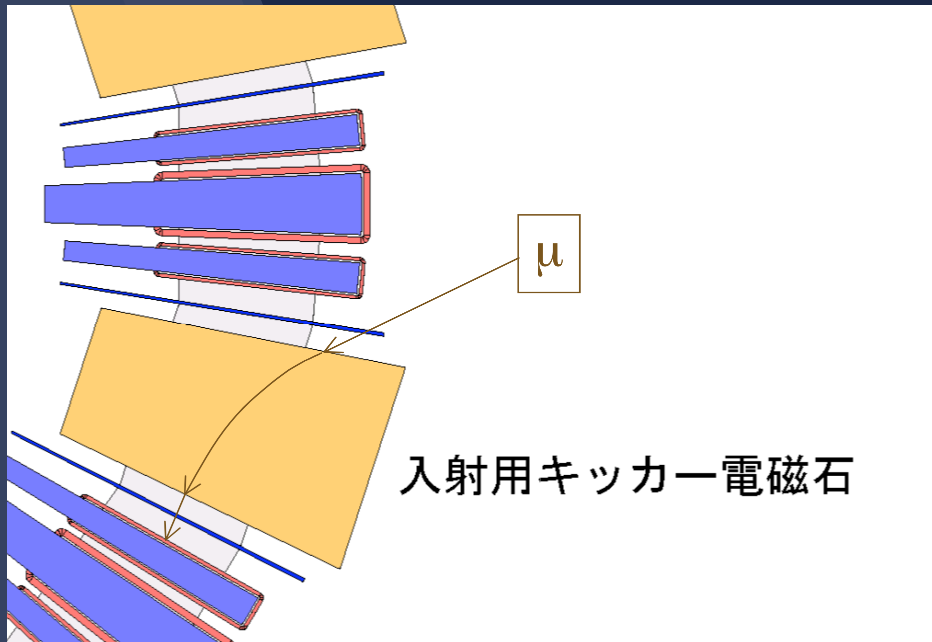
New Features

- C-type magnet
  - beam injection and extraction
- Variable k value by trim coils (Horizontal tune)
- Variable F/D ratio (vertical tune)
- Intermediate (uisotropic) yoke
  - reduce # of trim coils
  - no precise machining of yoke needed
  - fringing field trimming

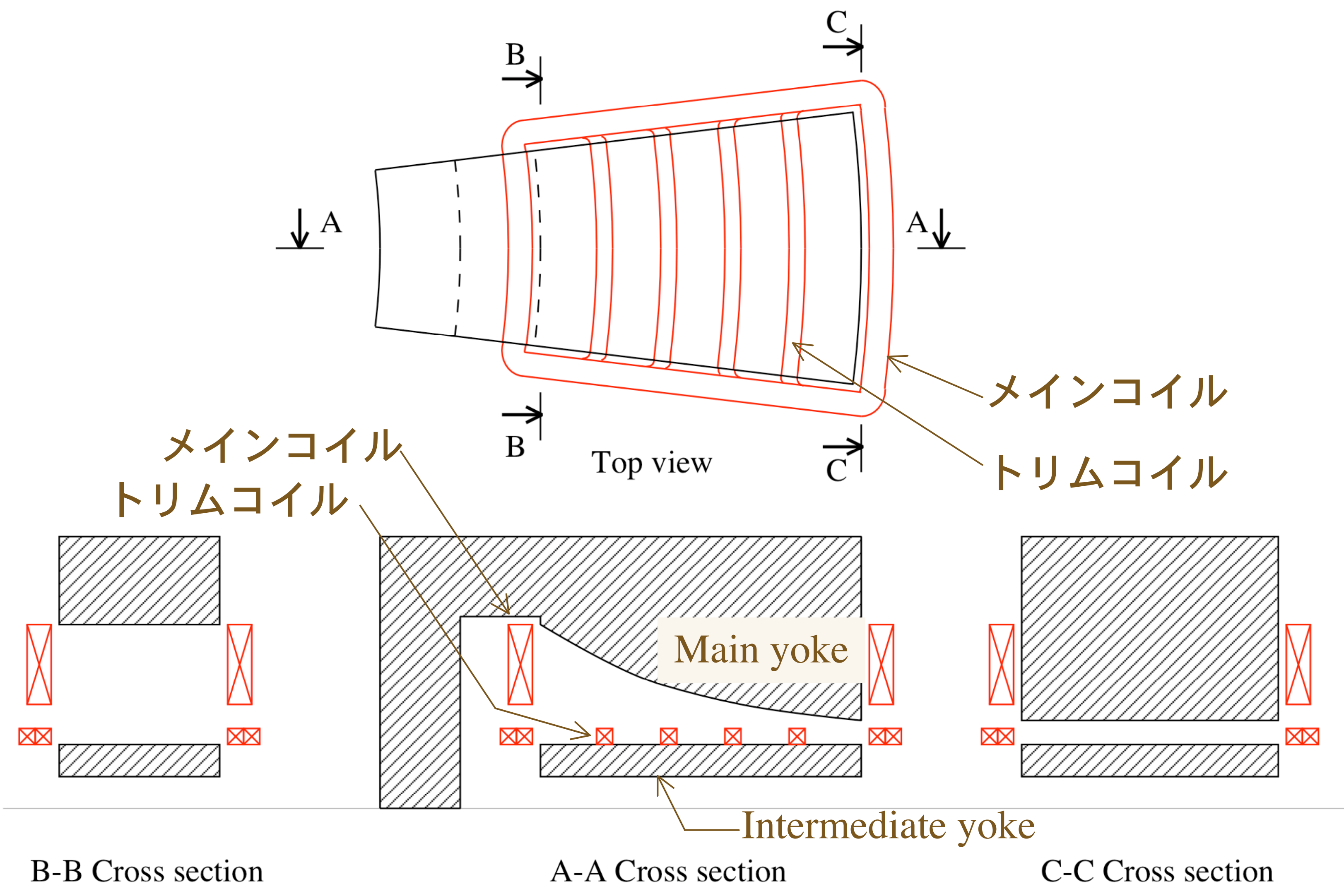
C-Magnet



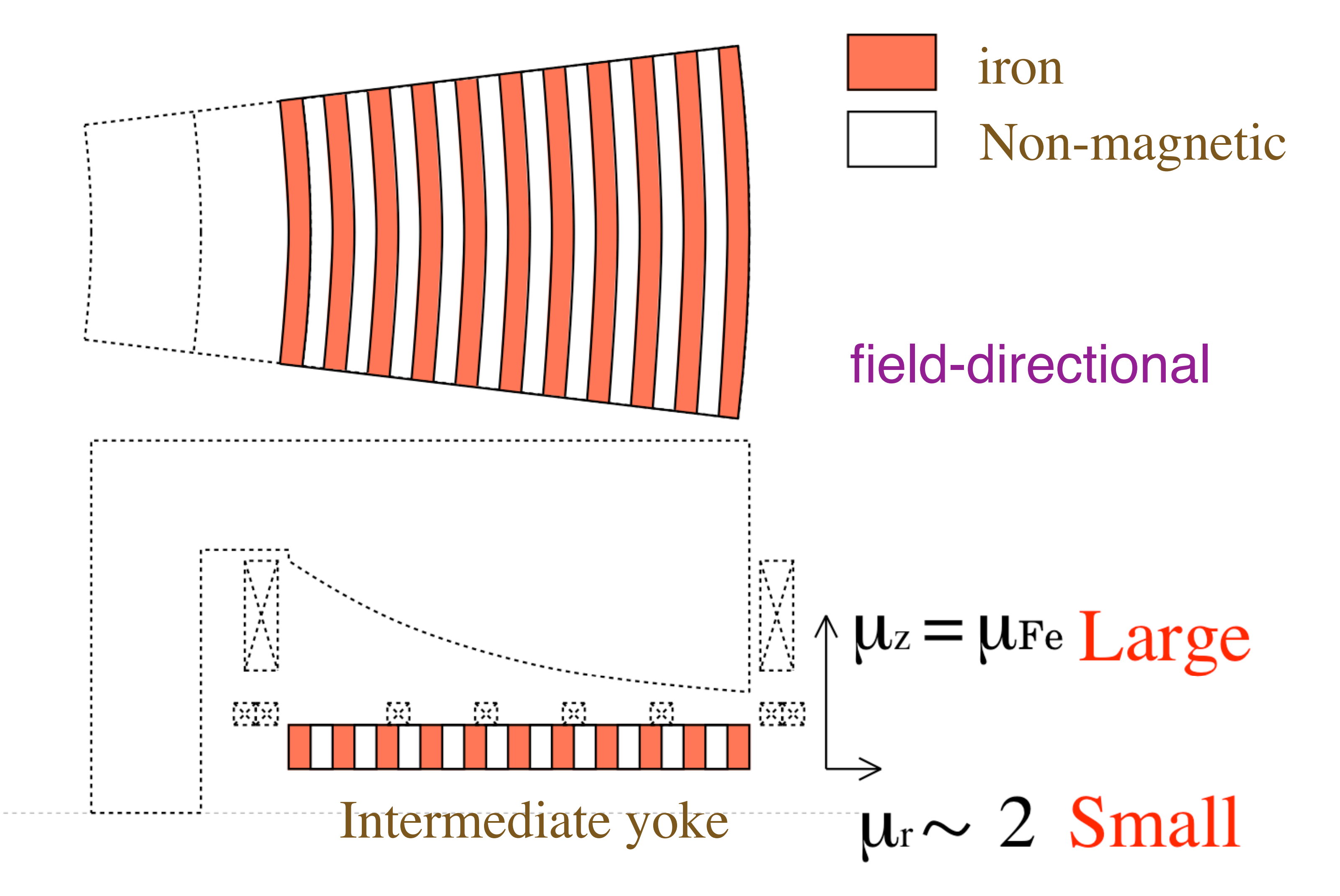
C-magnets are under consideration so as to make injection and extraction of muons easier.



PRISM Magnet Structure



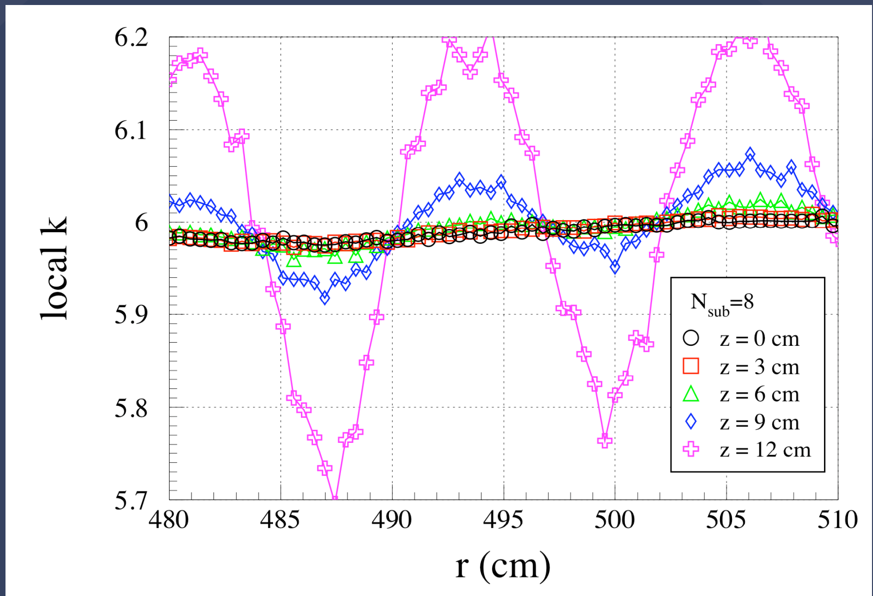
Intermediate Yoke

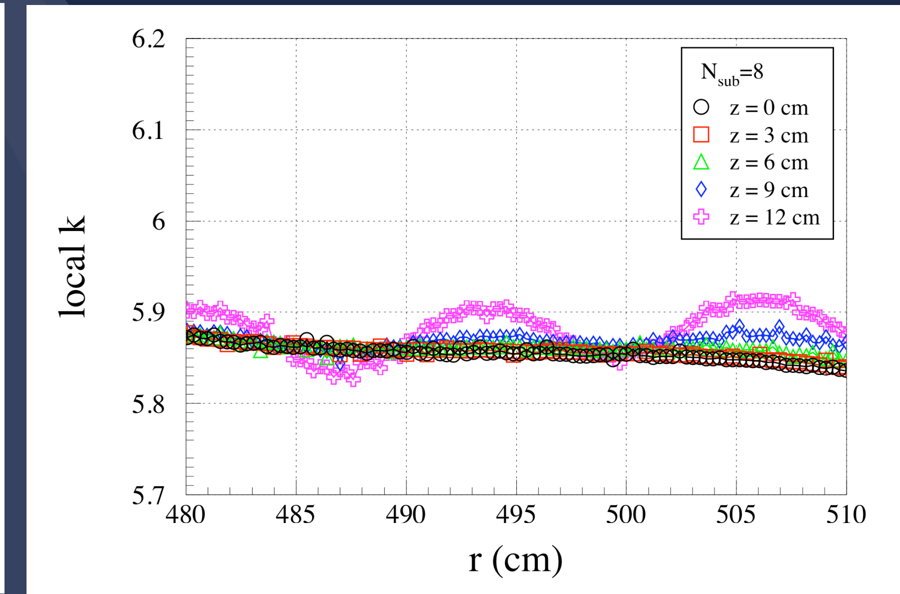


Advantage

Intermediate yoke

$$local\_k = \left(\frac{\partial B_z}{\partial r}\right)\frac{r}{B_z}$$

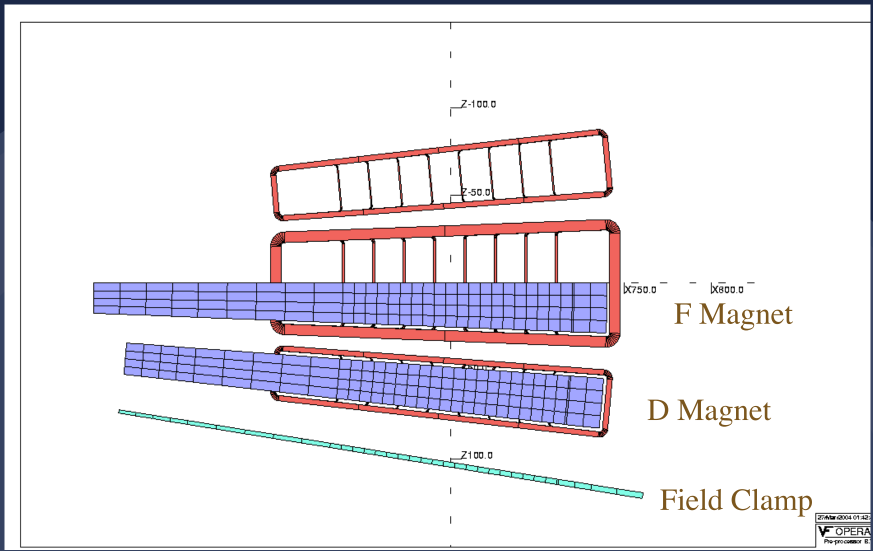


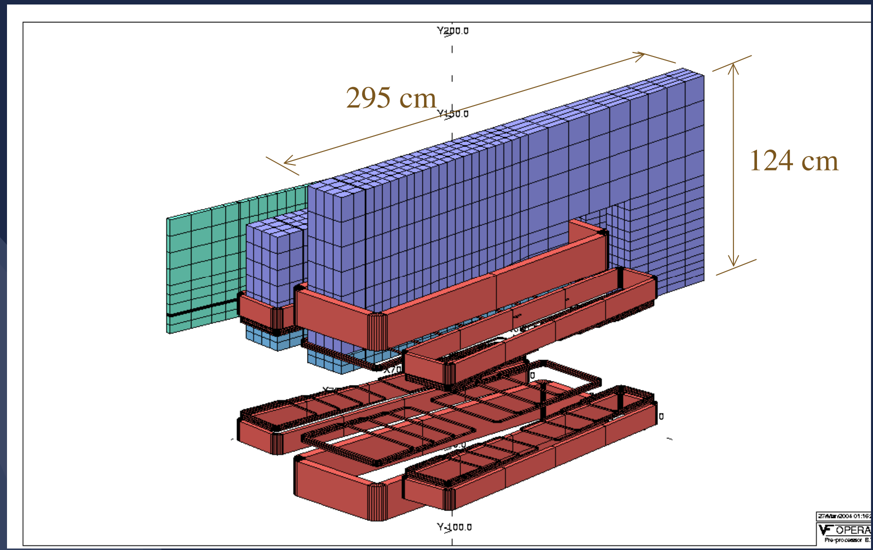


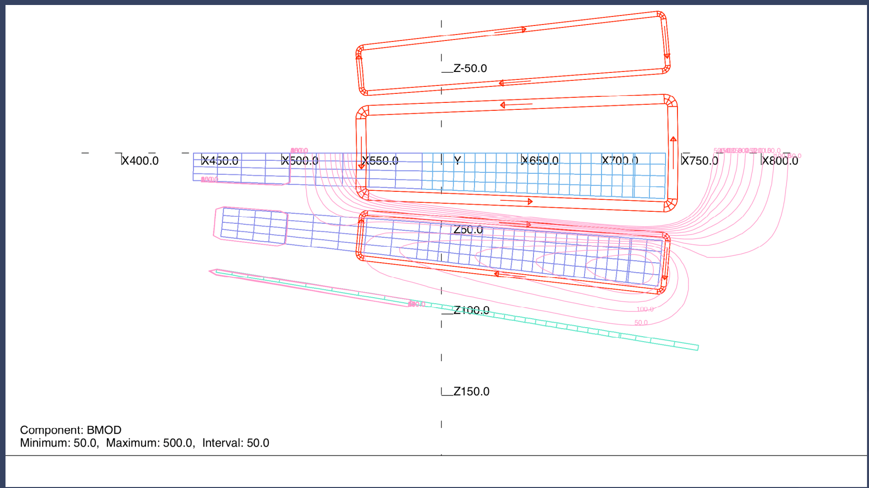
without directional intermediate yoke

with directional intermediate yoke

TOSCA Calculation







Magnet Design

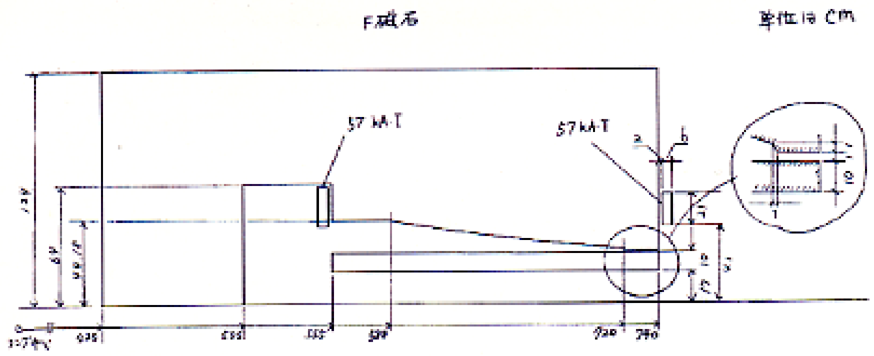


図 2: F 磁石正面図

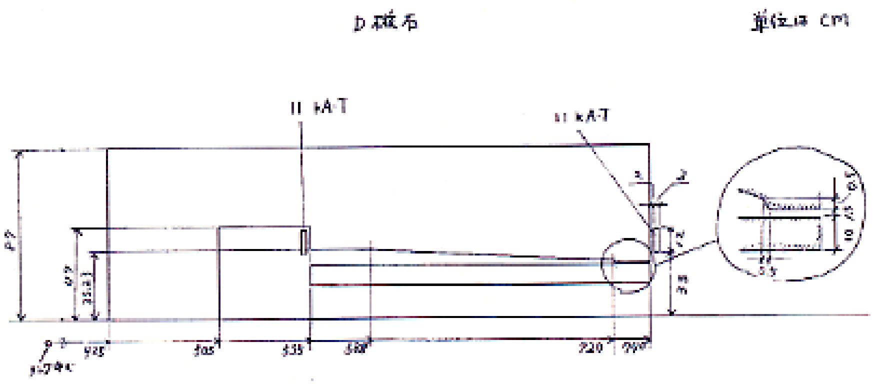


図 3: D 磁石正面図

F 磁石メインコイル電流	57 kA·T
D 磁石メインコイル電流	11 kA·T
k 値 (目標値)	4.6
F/D 比 (目標値)	8
F 磁石開口角	4.4
D 磁石開口角	2.2
BL 積で見た時の積分磁場	6.4 T·cm
ギャップ幅	± 15 cm
中間磁極の厚み	10 cm

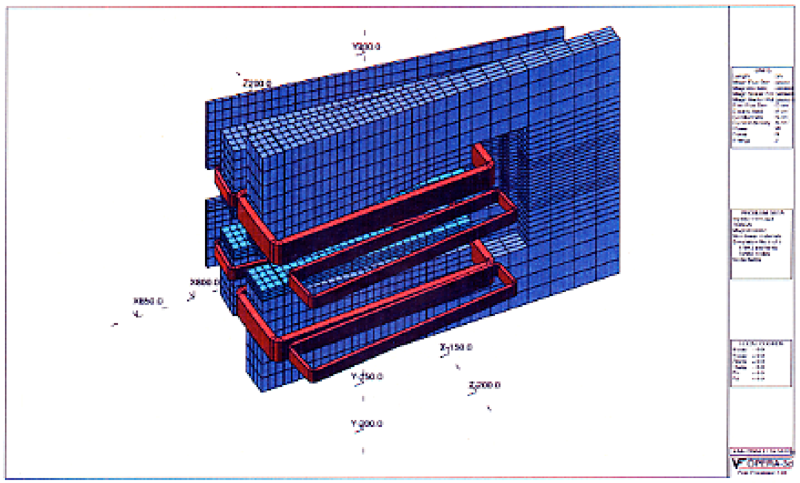


図 1: 外観図

The design has to been set soon.

COOLING@PRISM

- a study will come soon.....

Schedule

- JFY2003: RF amp. production
- JFY2004: RF cavity construction, FFAG magnet construction
- JFY2005: FFAG magnet production (continue)
- JFY2006: FFAG magnet construction (completed)
- JFY2007: test muon acceleration and phase rotation, test cooling?