PRISM-FFAG magnet

Y. Arimoto, Osaka U.

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- Magnet form
- Field calculation
- Requirement for field accuracy
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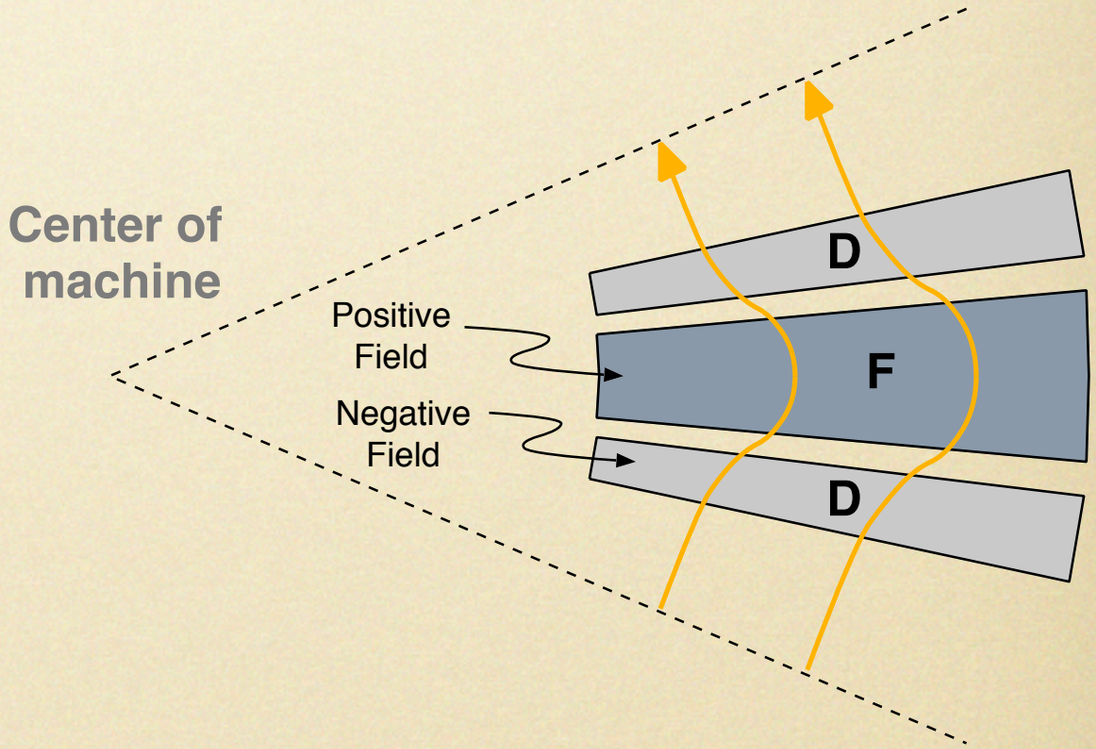
Overview of PRISM-FFAG magnet

- Radial sector type
- DFD Triplet
- Scaling type
  - Field Distribution

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

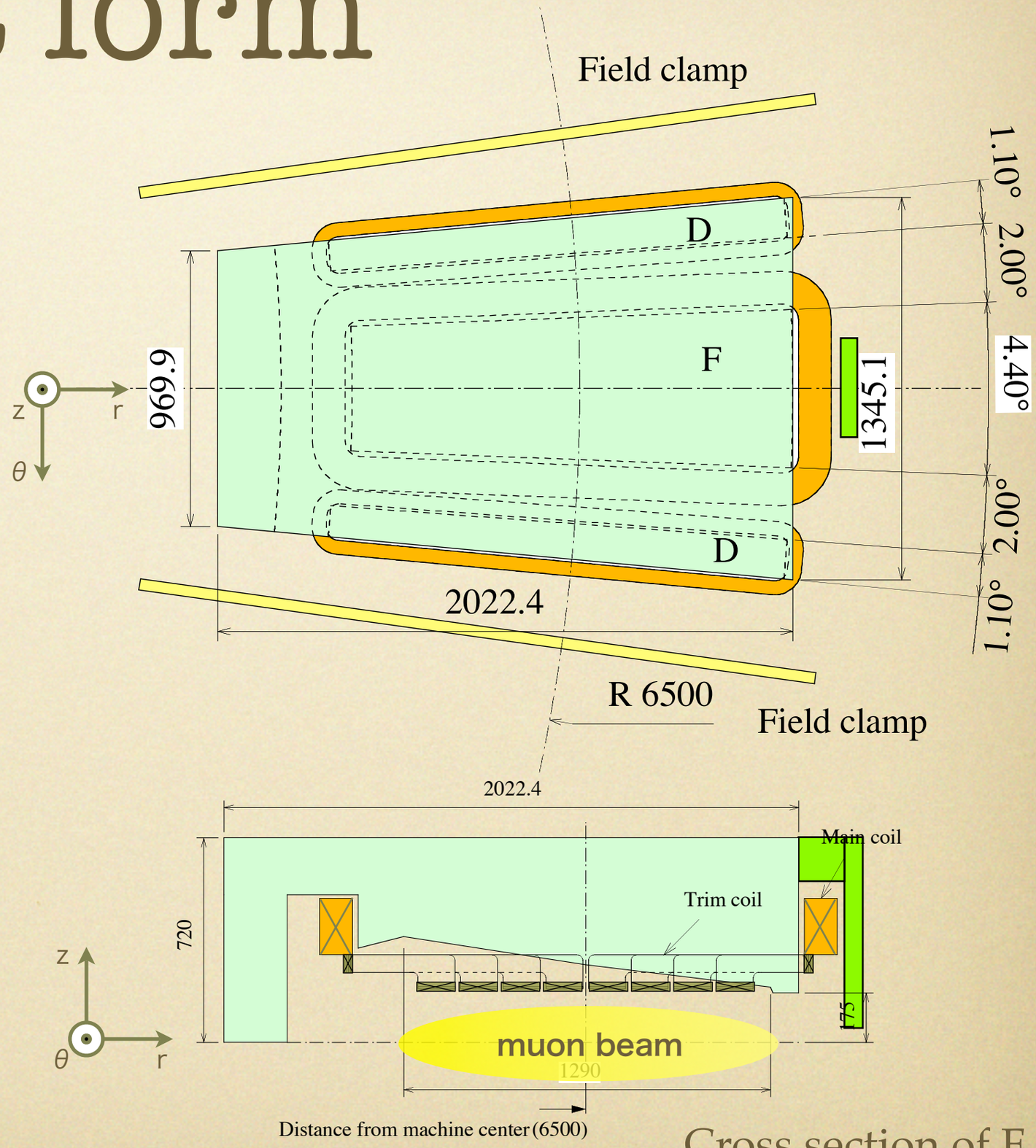


Required parameters for magnet

- Central momentum for muon : 68 MeV/c
- Equilibrium radius : 6.5 m
- Number of cell : 10
- F/D ratio : 4∼8
- k value : 4.1∼5.1
- Momentum acceptance : ± 20 %
- Aperture : 100 cm in horizontal, 30 cm in vertical
- Yoke type : C type

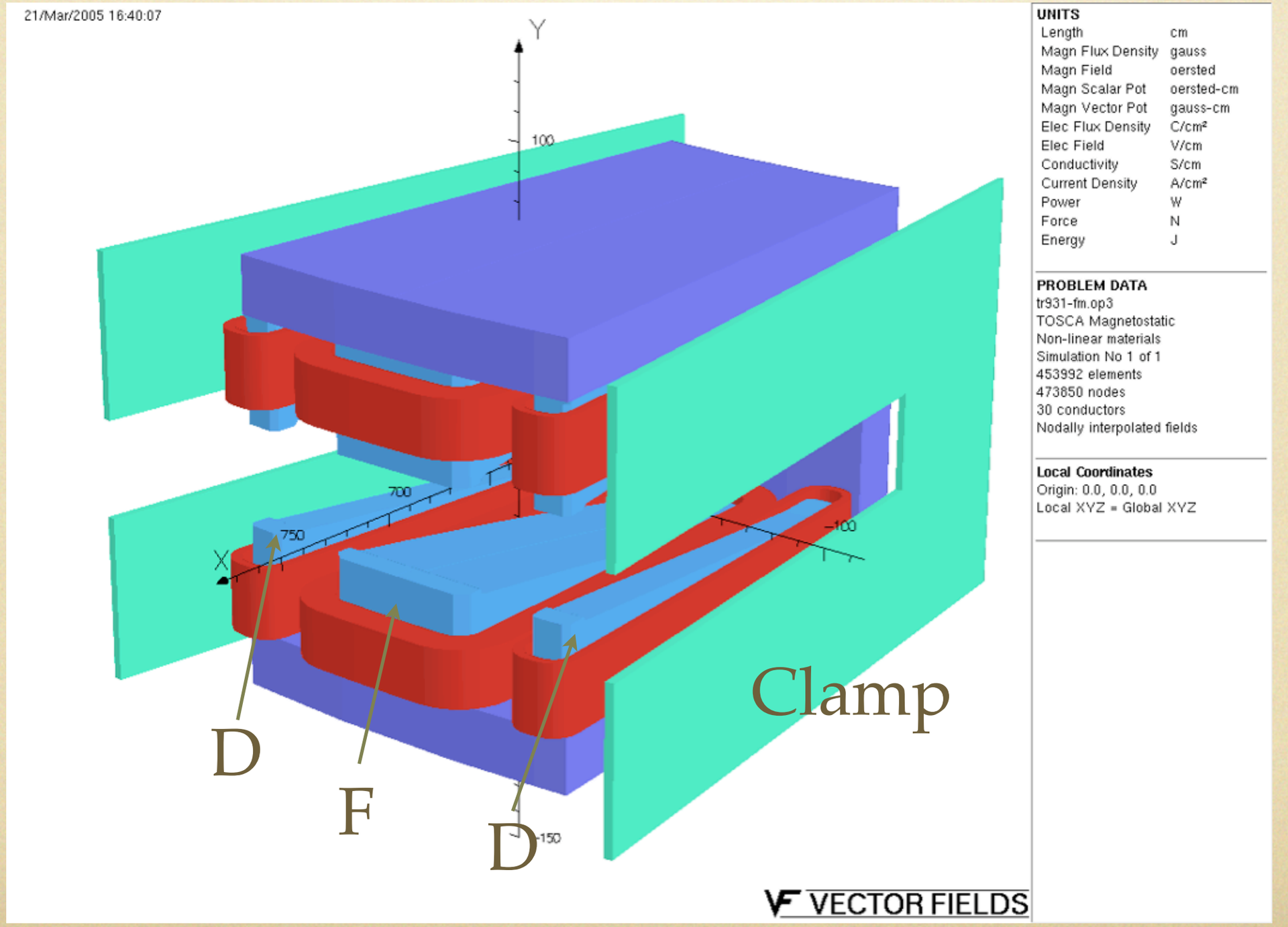
Magnet form

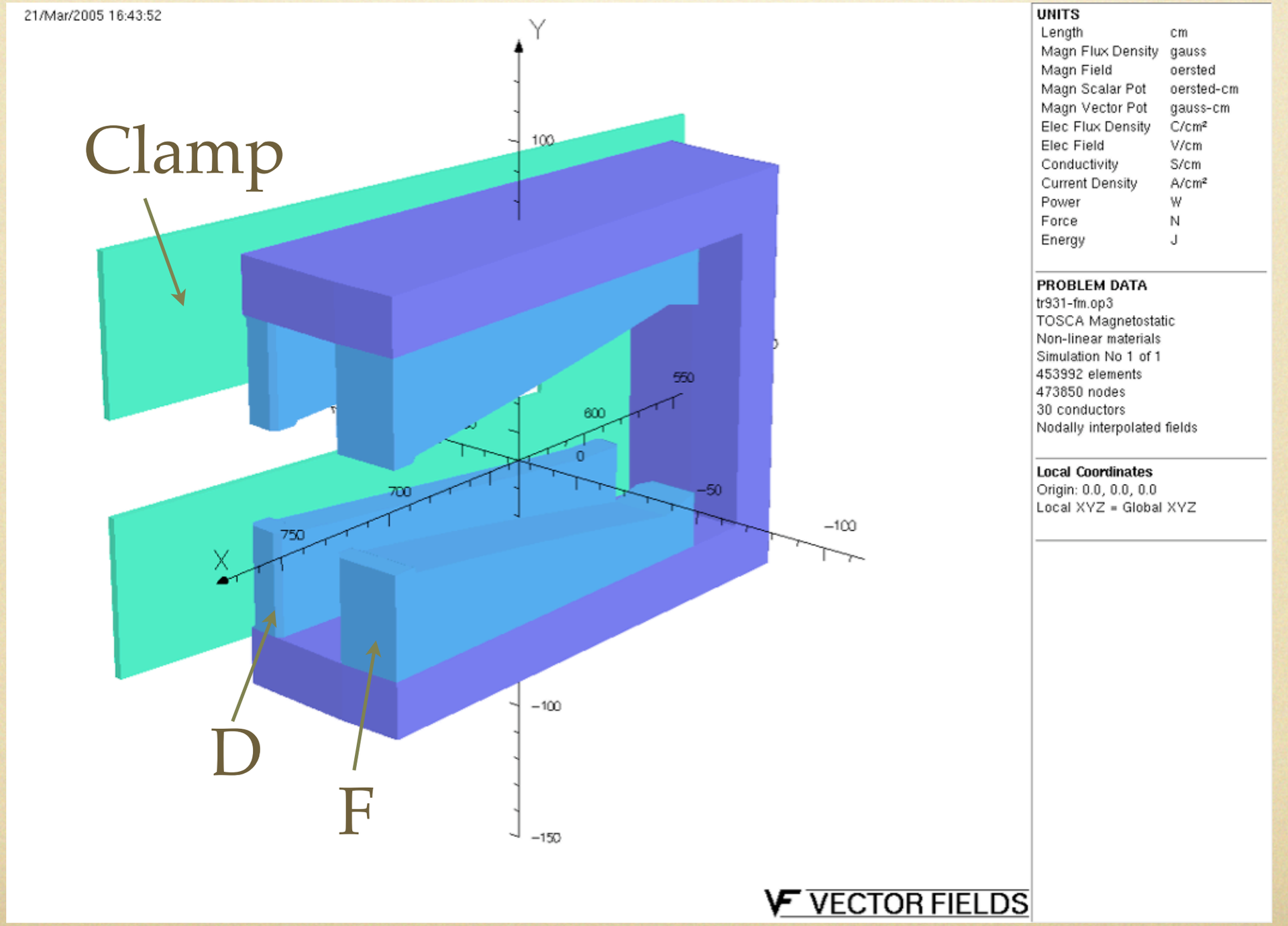
- C type
- Aperture
  - 100 cm (horizontal)
  - 30 cm (vertical)
- Slant pole produce field gradient
- Trim coils are installed to correct magnetic field



Cross section of F magnet

3D calculation





UNITS

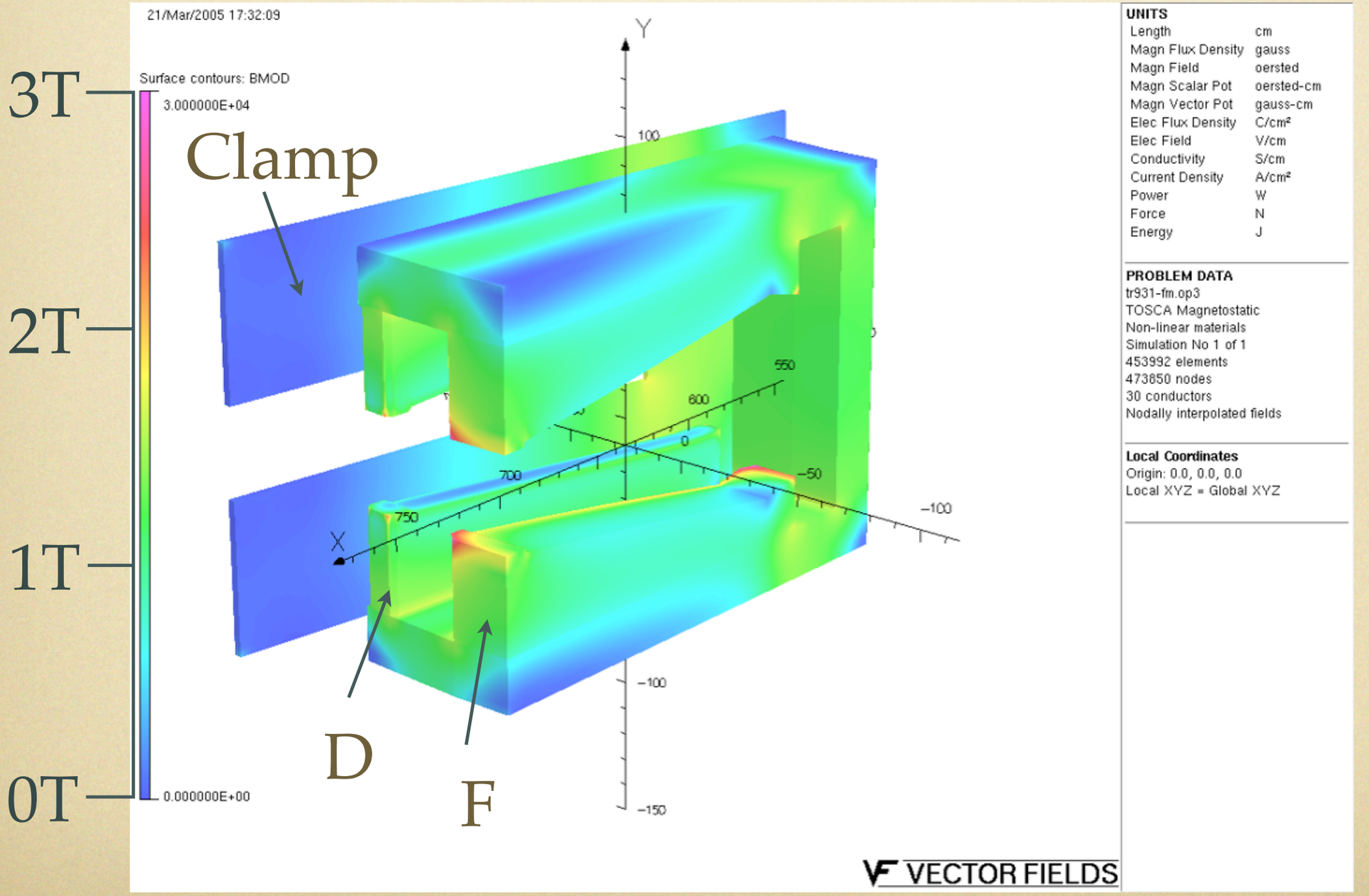
Length	cm
Magn Flux Density	gauss
Magn Field	oersted
Magn Scalar Pot	oersted-cm
Magn Vector Pot	gauss-cm
Elec Flux Density	C/cm²
Elec Field	V/cm
Conductivity	S/cm
Current Density	A/cm²
Power	W
Force	N
Energy	J

PROBLEM DATA

tr931-fm.op3
TOSCA Magnetostatic
Non-linear materials
Simulation No 1 of 1
453992 elements
473850 nodes
30 conductors
Nodally interpolated fields

Local Coordinates

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


21/Mar/2005 17:32:09
Surface contours: BMOD
3.000000E+04
0.000000E+00
3T
2T
1T
0T
Clamp
D
F
Y
X
100
550
600
0
700
750
−50
−100
−100
−150
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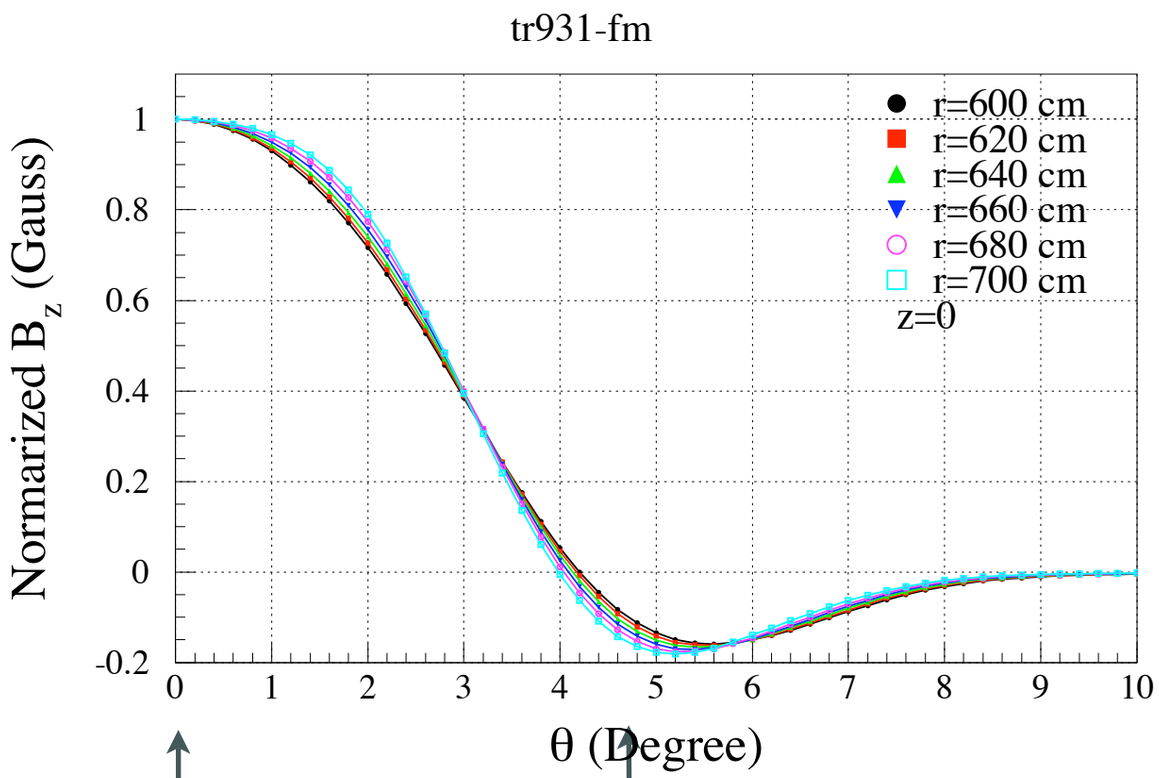
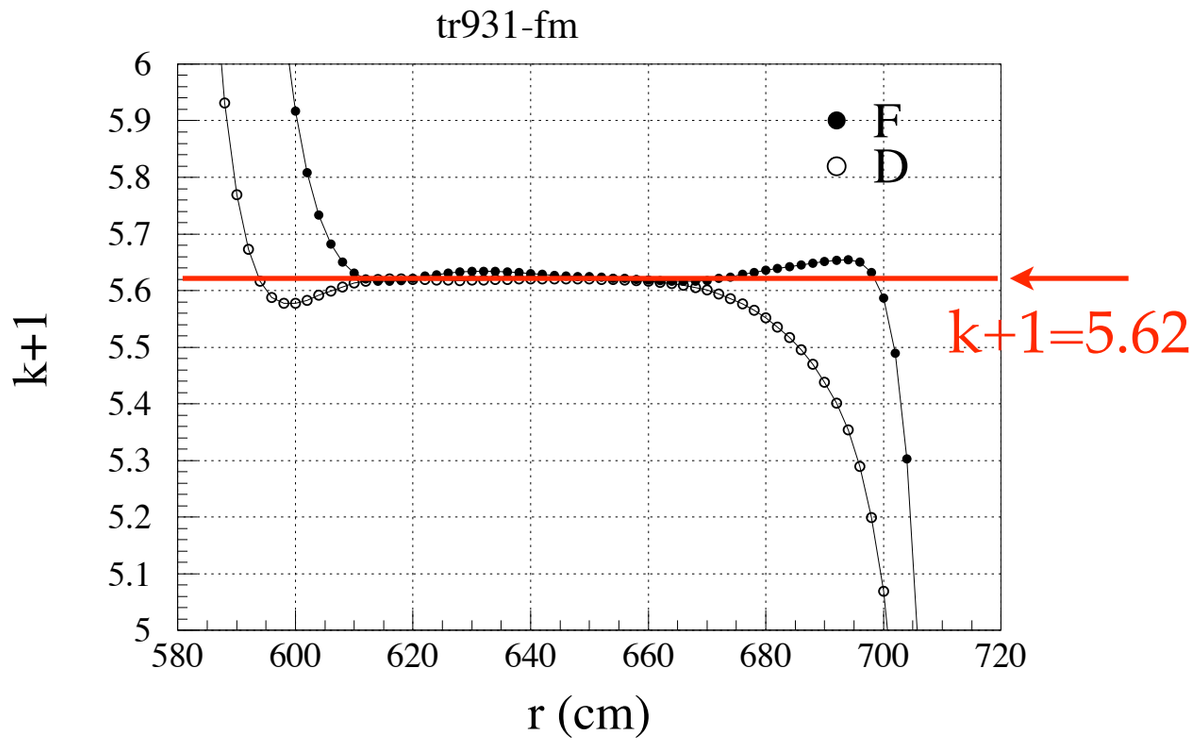
VECTOR FIELDS

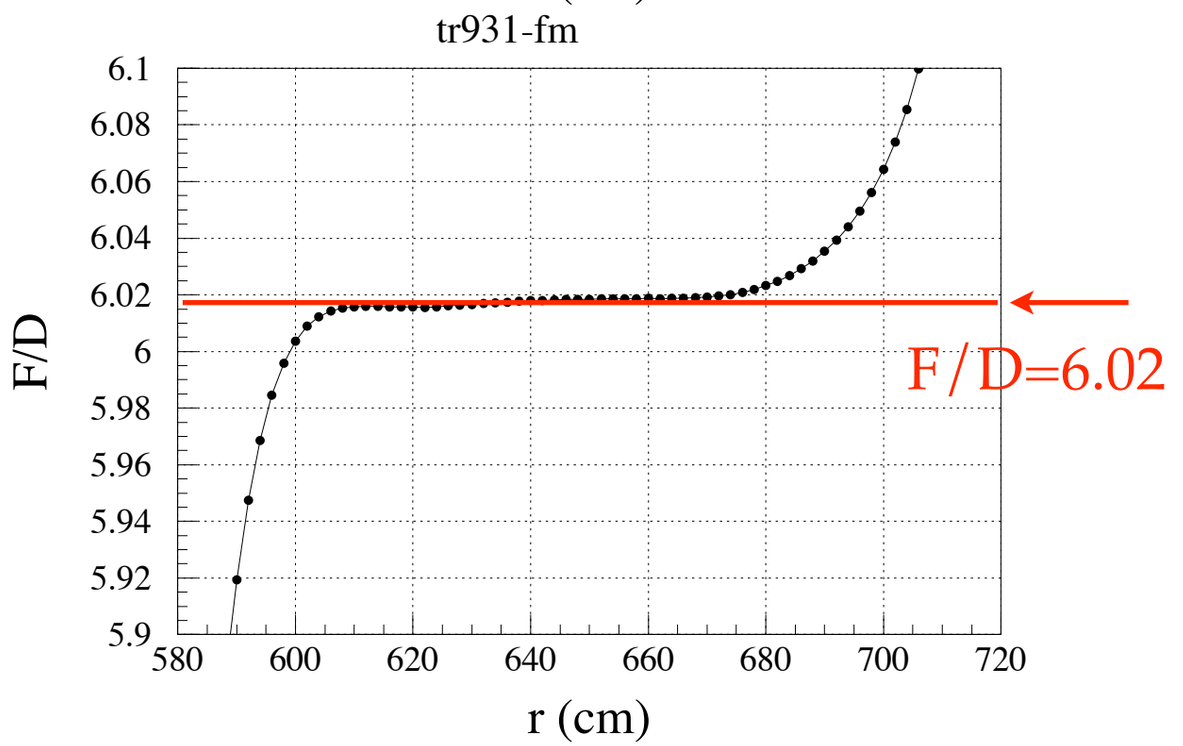
Magnetic filed distribution



Center of F magnet

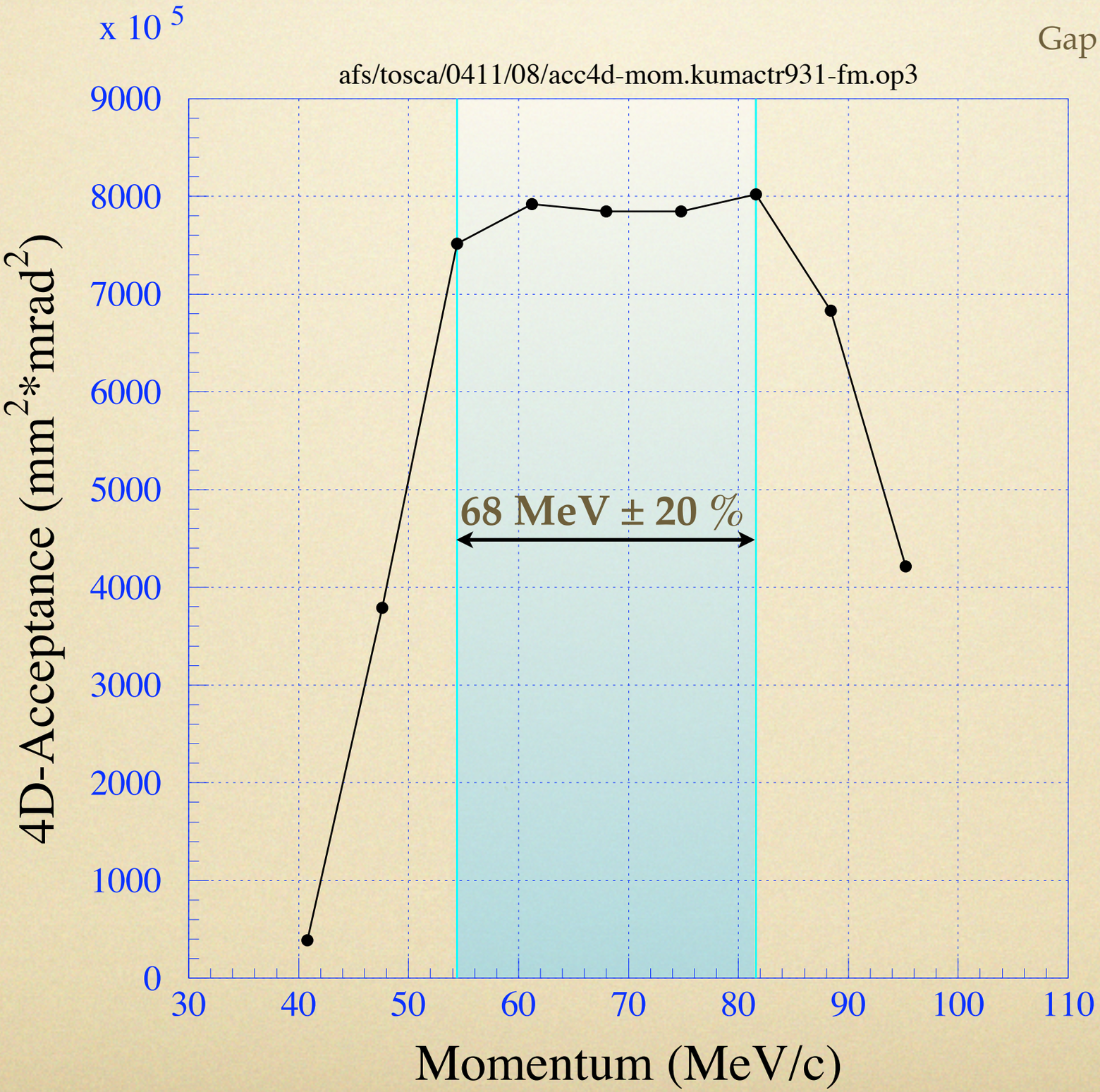
Center of D magnet





Momentum acceptance

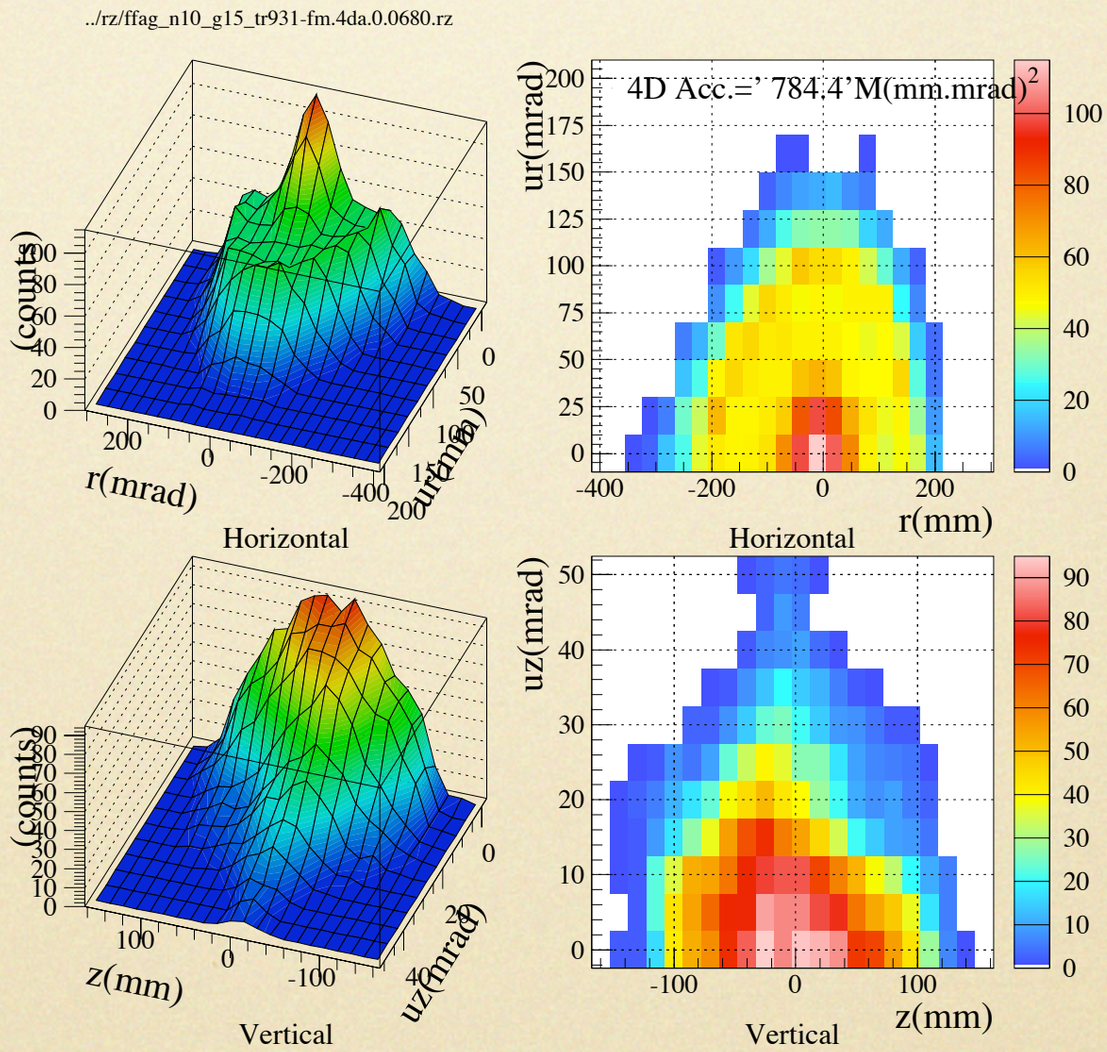
Gap height = ± 15 cm



Phase space distribution

Gap height = ± 15 cm

Horizontal phase space



Vertical phase space

Horizontal acceptance : 35,000 π mm mrad

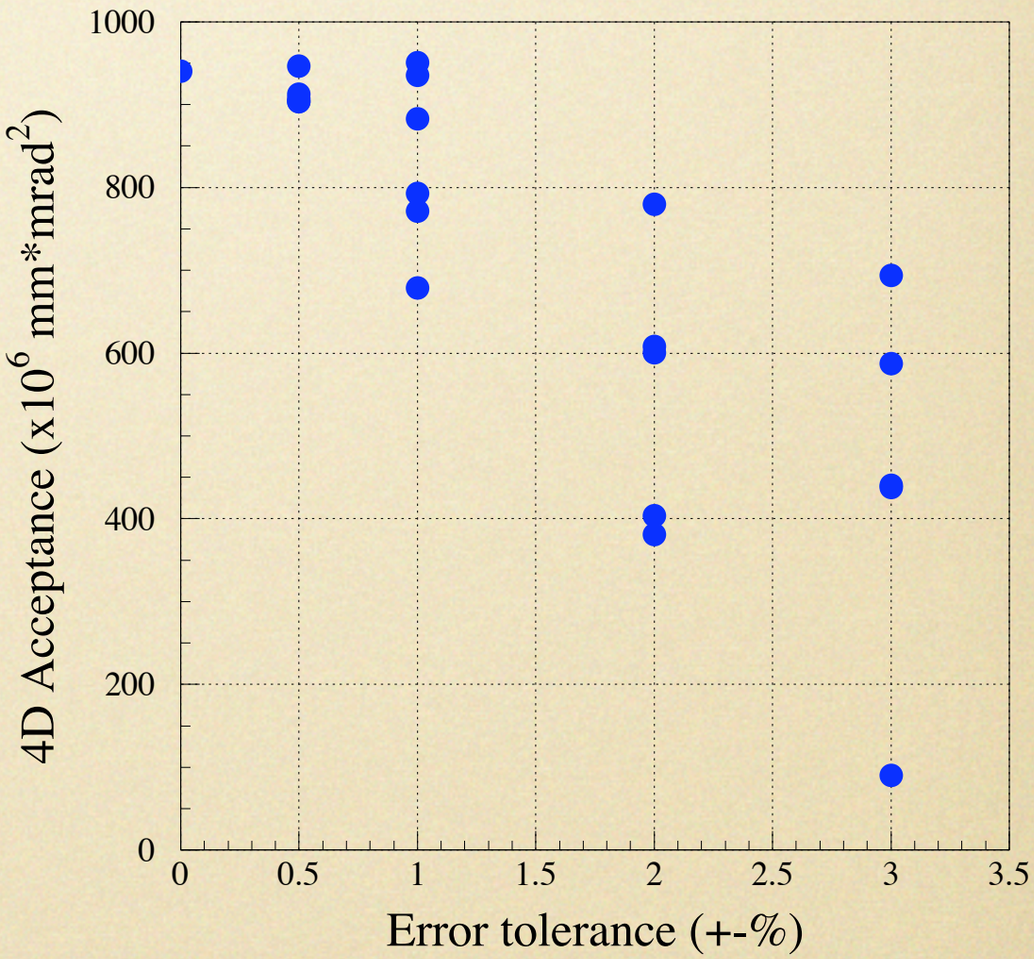
Vertical acceptance : 5,000 π mm mrad

4D acceptance with field error

by S. Nakaoka

4D acceptance was calculated when different random factors are applied to each triplets.

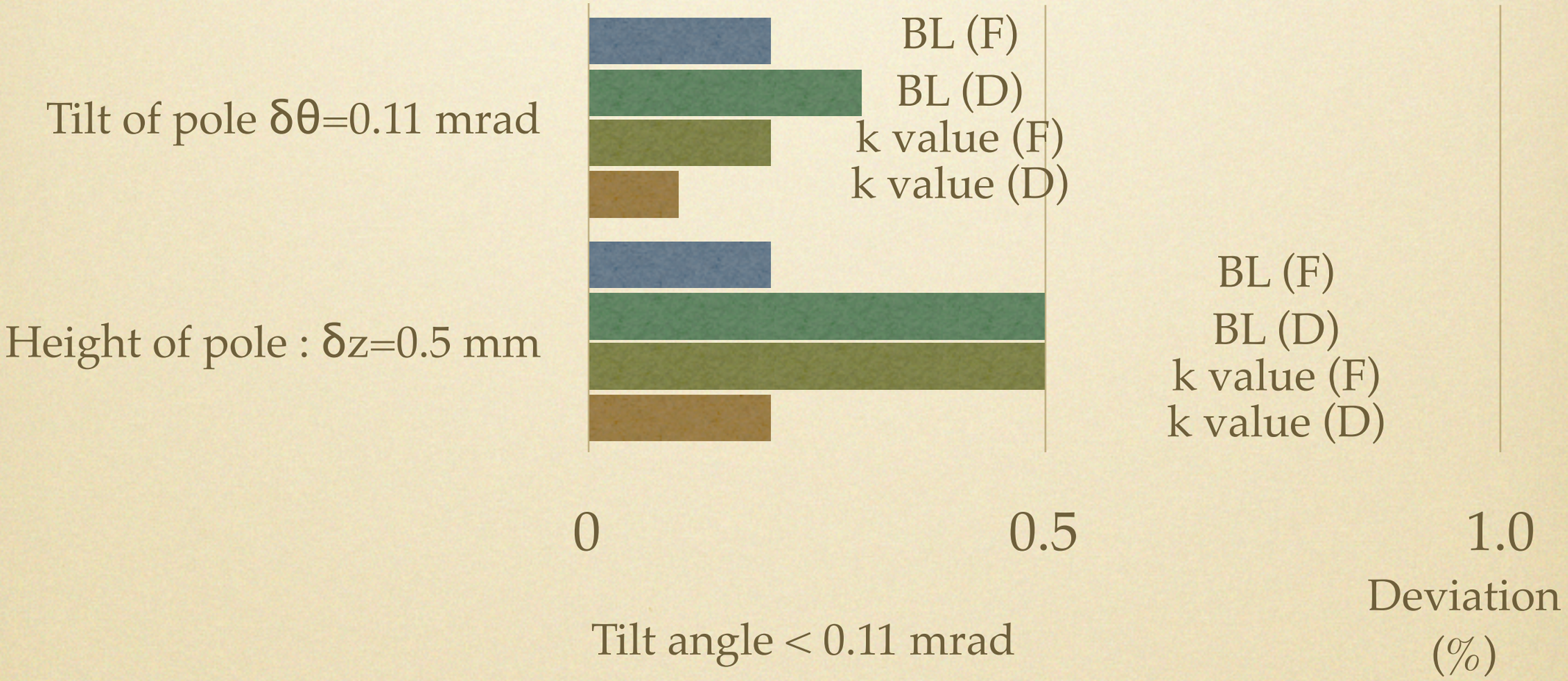
- $B_i(r)=(1+\delta B_i)B(r)$
  - i : cell ID number (1~10)
  - δB_i : random error-factor within error tolerance



Error tolerance < 0.5~1.0 %

Change of magnetic field due to deviation from design value

Calculated result with TOSCA



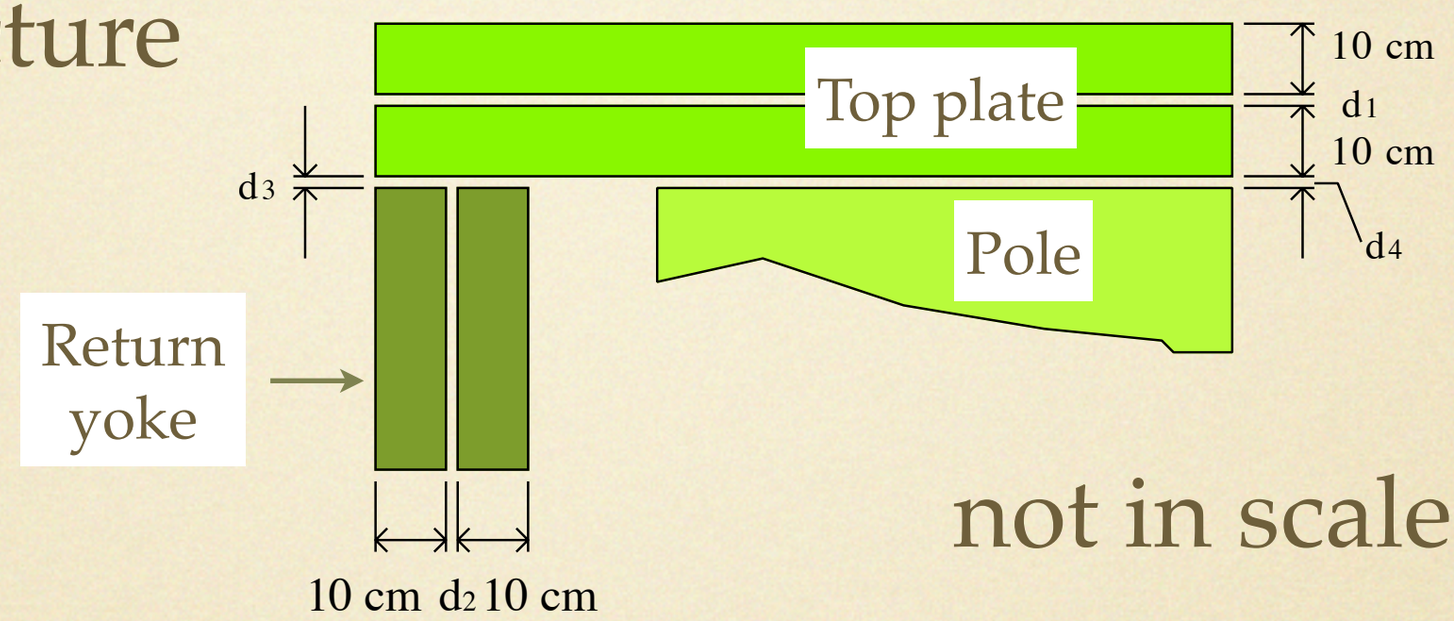
Tilt angle < 0.11 mrad

Displacement of pole surface < 0.5 mm

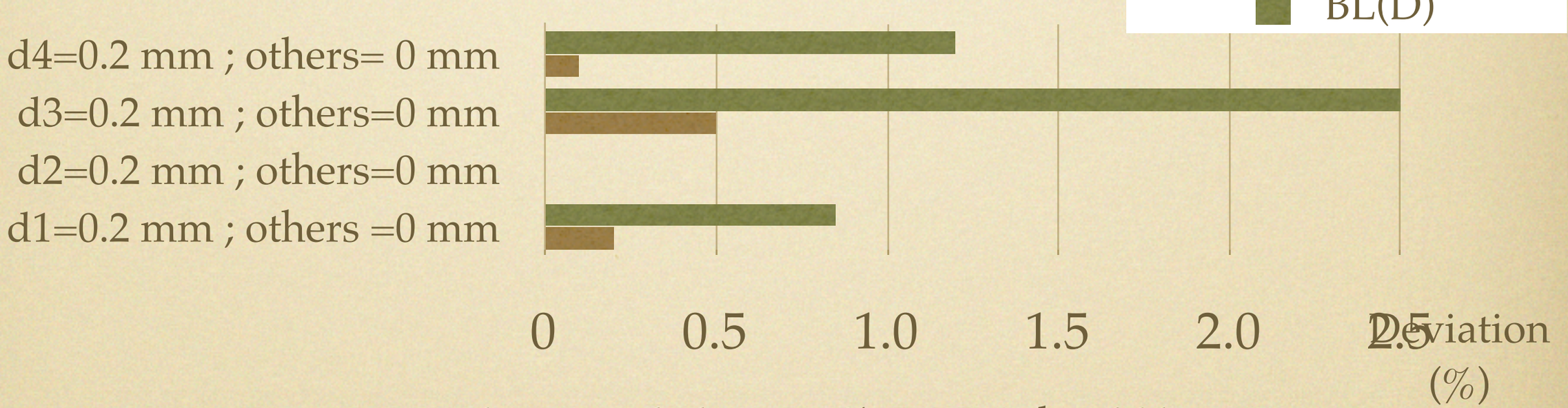
These value is not difficult for manufacturing

In case of magnet constucted from 100 mm iron plate

Yoke structure



not in scale



To suppress deviation below 0.5 %, D3,D4 should be less than 0.2 mm.
At least, less than 0.05 mm.

Construction status

- Production of 40 set of D coils have been finished.
- Production of several F coils have been finished

D coils

Magnet parameters

Weight of magnet		17 t/1 cell
Current (per 1 coil)	Fmagnet	1750 A/ 84000 A*T
	Dmagnet	1034 A/ 30000 A*T
Power		100 kW/ 1 cell
Flow rate of cooling water	Fmagnet	61.7 ℓ /min
	Dmagnet	38.3 ℓ /min
Pressure drop (per 1path)	Fmagnet	4.8 kg/cm^2
	Dmagnet	1.9 kg/cm^2

Summary

- The design of the magnet have been almost completed.
  - The momentum acceptance is 68 MeV/c ± 20 %
  - The error tolerance of the field factor should be less than 0.5 ~ 1 %
- Production of D coils have been finished.

Next plan

- Fiscal 2005:
  - Production of F coils.
  - Production of 4~5 magnet bodies.
- Fiscal 2006:
  - Production of rest of magnet bodies.