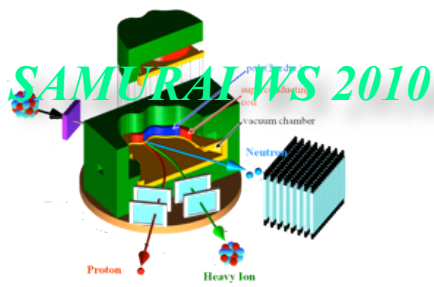


# Magnetic Field Mapping on SAMURAI dipole magnet

SAMURAI Workshop  
2010/11/22

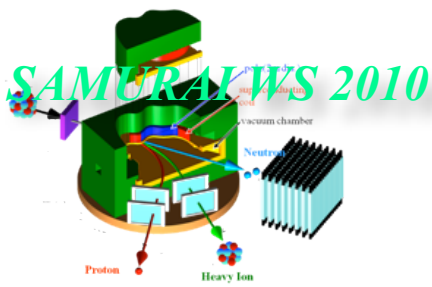
Hideaki Otsu  
RI Physics lab., RIKEN Nishina Center



# Issues



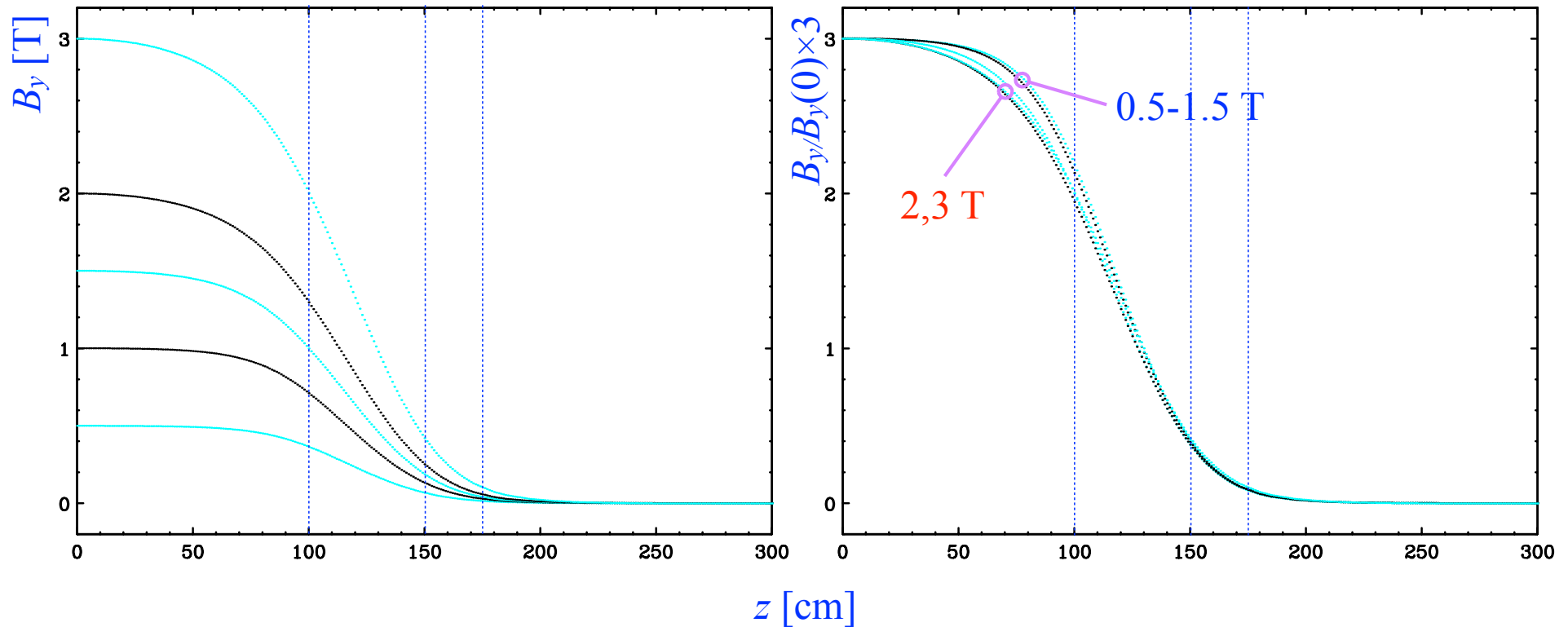
- Questions to be solved for magnetic field
  - Whether is magnetic field measurement needed or not?
  - Are calculated field results sufficient to solve momentum with 1/1000 accuracy?
  - How can we utilize the calculation magnetic field?
- Contribution for solving the questions
  - Calculated  $(B_x, B_y, B_z)$  map with TOSCA code by H. Sato
    - with ideal situation and various deviations
  - Tracking (3D) from  $X_t$  to  $X_f$  with Geant 4 code by T. Isobe
  - Working group headed by H. Otsu for final judgement and preparation for field map measurement if needed



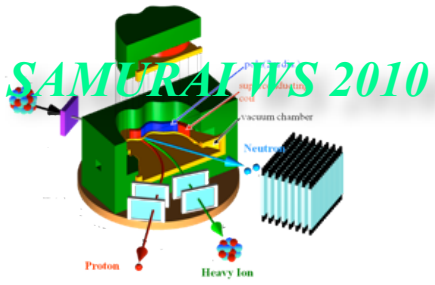
# Field distribution



- Calculated  $(B_x, B_y, B_z)$  map with TOSCA code by H. Sato
  - $x=y=0, B_y$



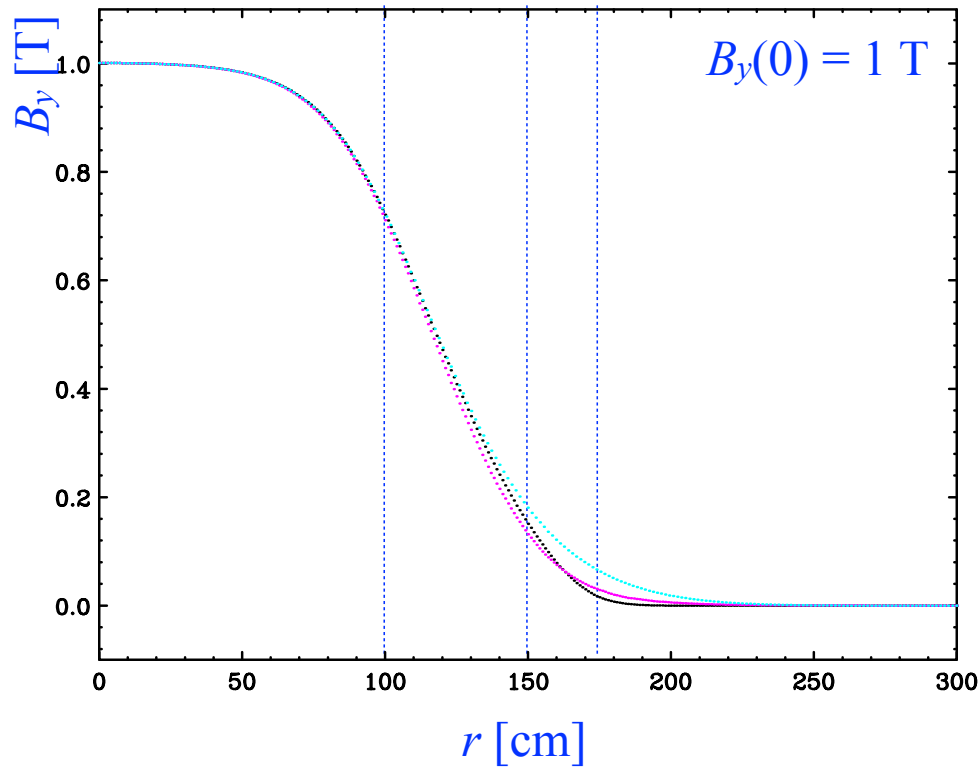
Field shape drastically changed at around 1.6 T  
 Scaling could not be always well operated



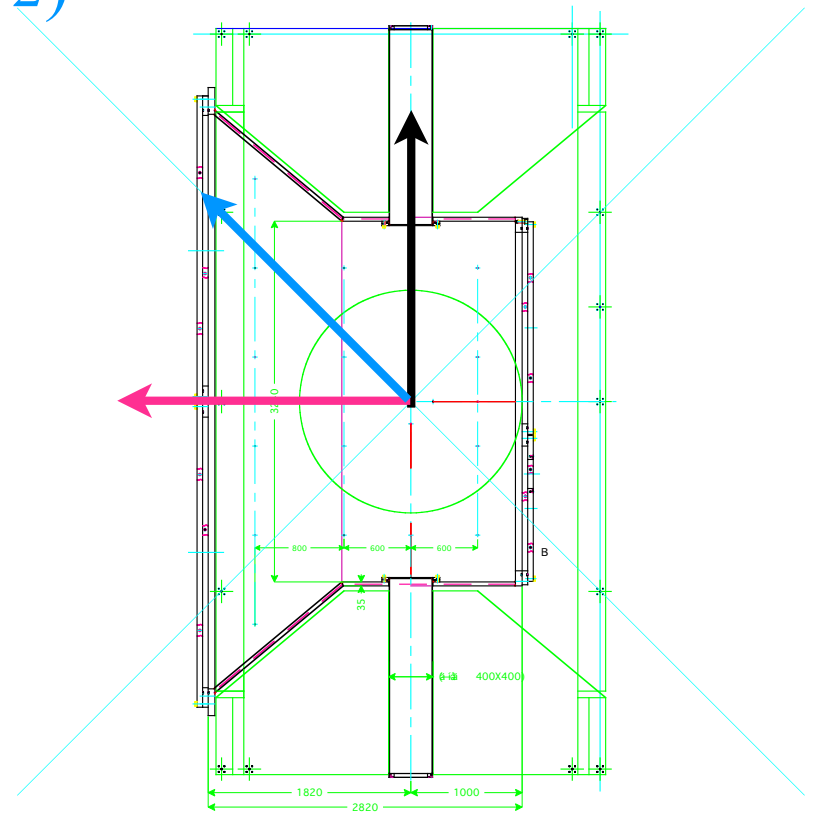
# Field distribution

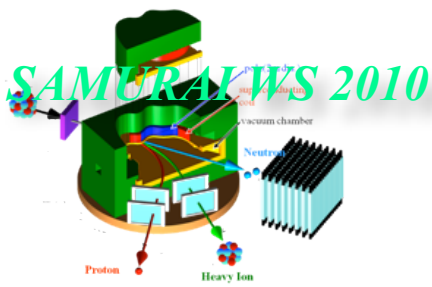


- $\theta$  dependence :  $B_y(z=0)$ ,  $B_y(x=0)$ ,  $B_y(x=z)$



$\theta$  symmetry is broken

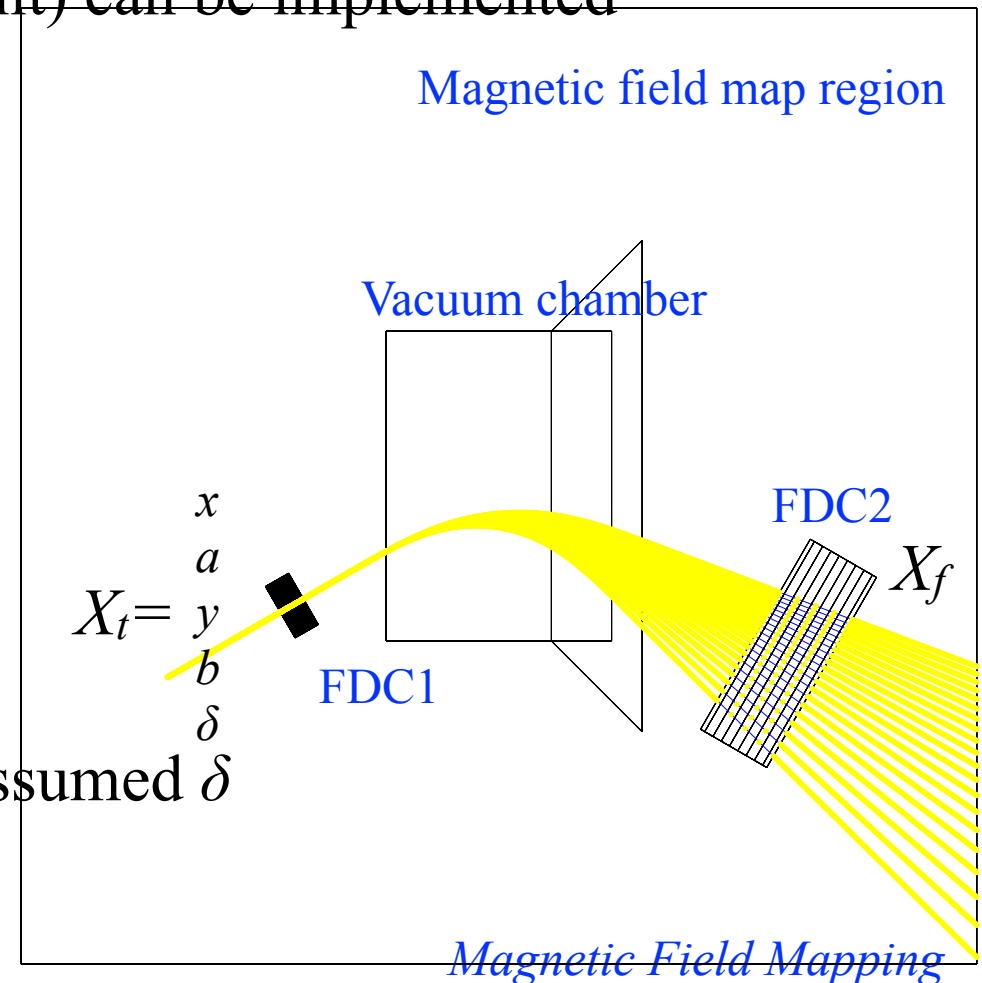


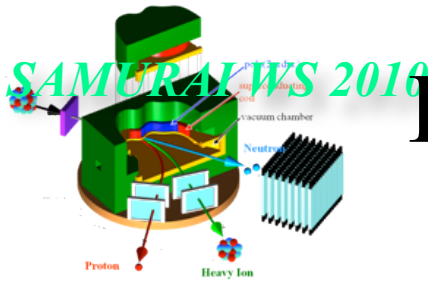


# Tracking



- Tracking code by H. Isobe using Geant 4 package
  - 3D
  - Multiple scattering (gauss shape limit) can be implemented
  - $X_t \rightarrow X_f$  tracking with given  $\delta$
  - Ideal field map
  
- To be studied
  - mesh size (1cm at present)
    - sufficient or more than enough
  - calibration method
  - ...
- To be implemented
  - Trace back routine :  $X_f \rightarrow X_t$  with assumed  $\delta$
  - Various field map
  - ...

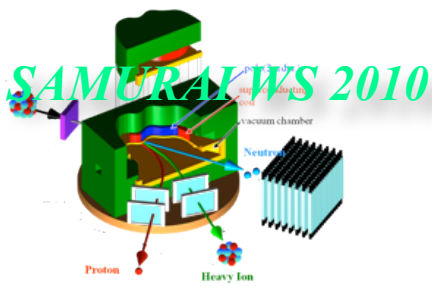




# Deviation from ideal field map



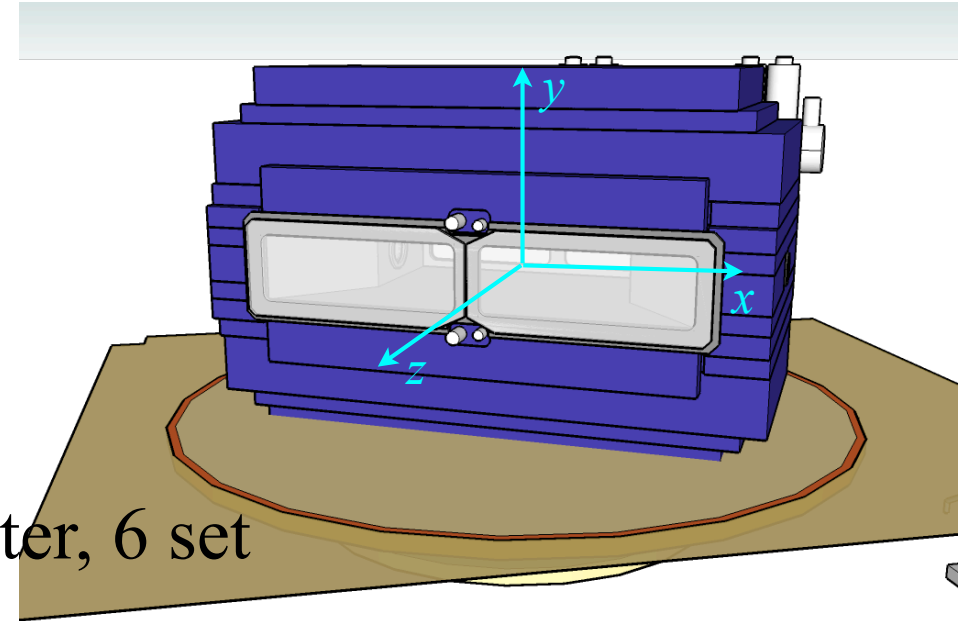
- Controllable
  - Coil position deviation  $(x,y,z)$
  - Pole position deviation  $(z,x)$
  - ...
- Uncontrollable
  - Iron  $\mu$  inhomogeneity
  - Peripheral iron materials other than magnet itself
  - ...

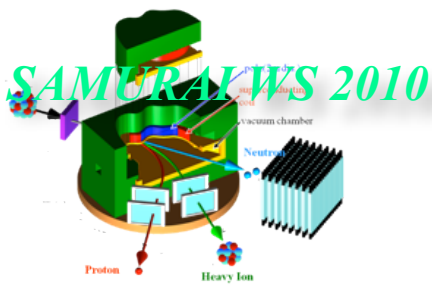


# Time estimation of magnetic field measurement



- Volume to be measured : [mm<sup>3</sup>]
  - X : -1500 ~ 1500
  - Y : -400 ~ 400
  - Z : -2500 ~ 2500
- Magnet setting : 0.5 - 3.0 T at center, 6 set
- Every 1cm pitch :  $9e6$  points \* 6 =  $5.4e7$
- 1sec/1 point (very optimistic)  $\rightarrow 5.4e7/8.64e4 = 625d \sim 2$  year...
- Every **5cm pitch**, 10 sec/1 point  $\rightarrow 50d$  (24h work/1d)
- +-X, +-Z symmetry assumed, +-Y symmetry not assumed
  - Then 12.5d(24h work/1d) = **37.5d** (8h work hour/1d)

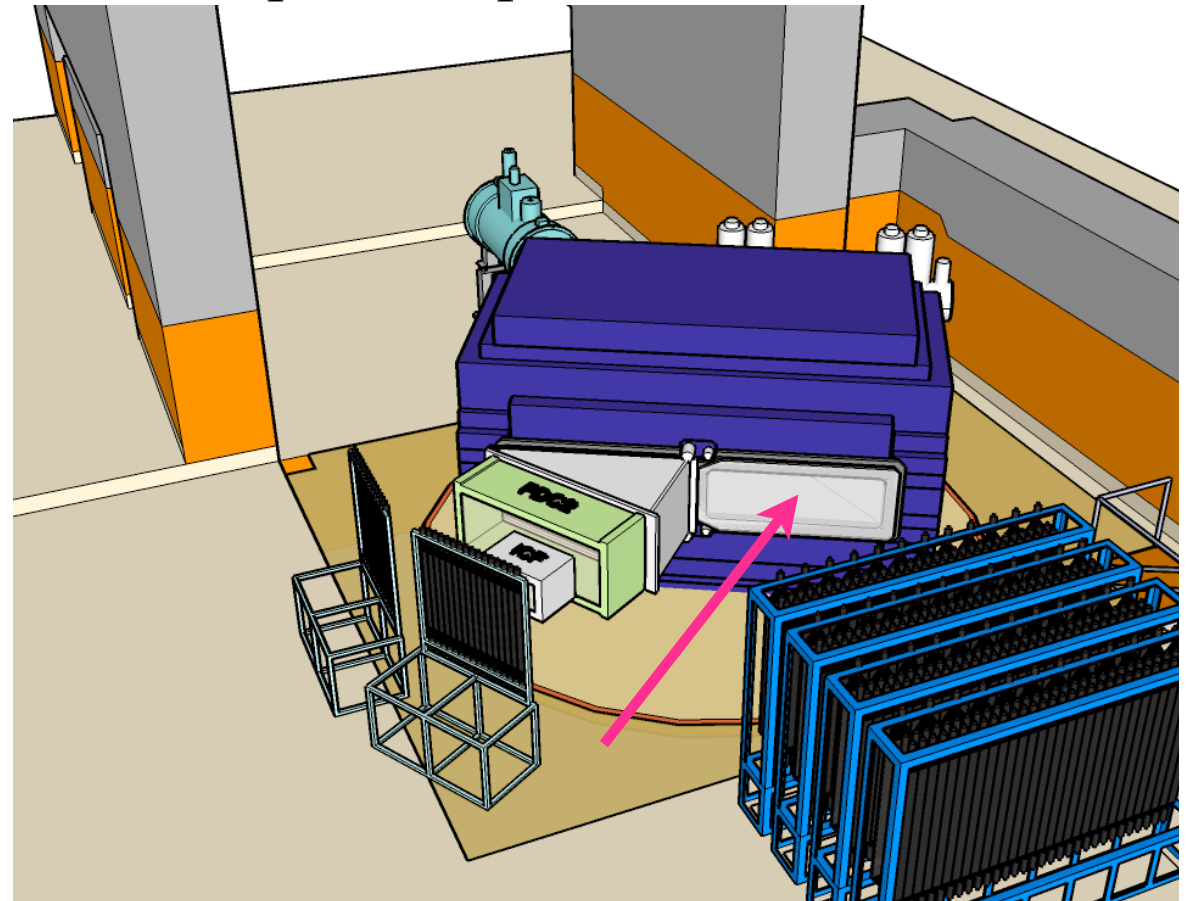




# Realistic solution of magnetic field measurement

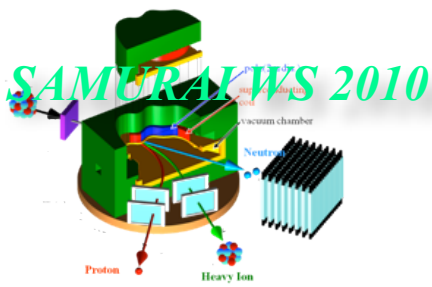


- Good candidate period for the measurement
  - 2012 summer break
  - after commissioning 2012/03 and first phase experiments
- Method
  - hall probe
  - 1/4 region at accessible region from Neutron window
  - w/o removing detectors



*Magnetic Field Mapping*





# Precise position measurement with Photo Grammetry system



- Photo Grammetry system **V-STAR S/E5-M** would be introduced
  - 3D position determination with **40  $\mu\text{m}$  at 4 m scale**.
  - Estimated value 1659 man JY (TACC co. ltd.)

Property	
High precision	40 $\mu\text{m}$ on 4m scale
Portability	Digital Camera with Lens
Quickness	Copy to PC and analysis
Non attached	Position of target marker
Camera Property	
Sensor	12.2 Mpixel CCD
Opening Angle	67° × 47°
Focal length	17mm
Size / Weight	157x157x86 mm <sup>3</sup> , 2kg

## Configuration

Single-lens reflex Camera w/ special lens

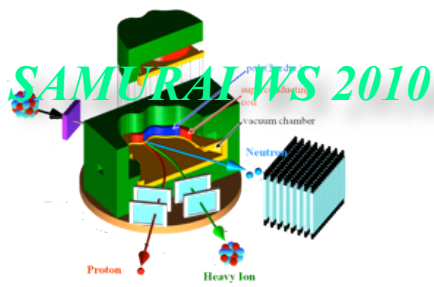
Windows PC w/ Software



Target Marker

Instruments for axes

*Magnetic Field Mapping*



# Summary



- Field mapping
  - Calculated ( $B_x, B_y, B_z$ ) map with TOSCA code by H. Sato
    - Ideal field and Various deviations
  - Tracking (3D) from  $X_t$  to  $X_f$  with Geant 4 code by T. Isobe
    - to be upgraded as :
      - reverse solving method  $X_f \rightarrow X_t$
  - Field map measurement parameters
    - pitch 1cm/5cm ?
    - important region ?
- Field map measurement
  - Not well determined yet.
  - 2012 summer break is good chance if measurement would be done.
    - After commissioning and first phase experiments
- Device for Accurate position measurement