

# Vacuum System

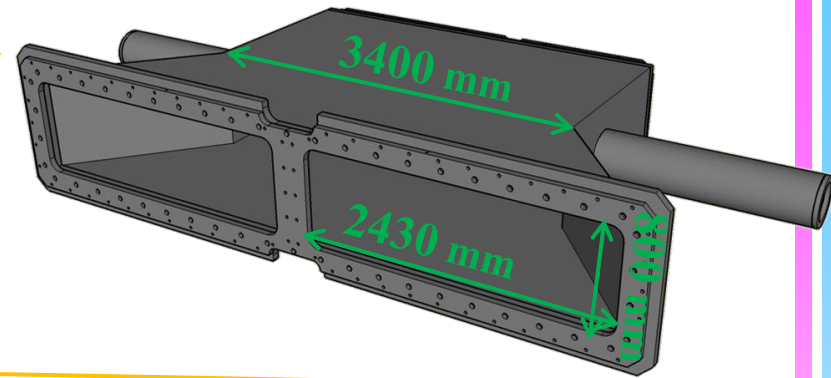
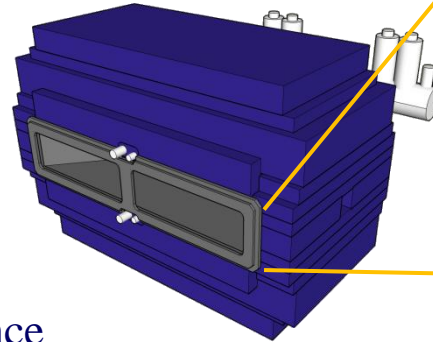
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# Contents

- Common instruments
  - Magnet gap section
  - Beam line & vacuum pumping system
- Individual instruments
  - Target chamber
  - Upstream connection section
  - Downstream connection section
  - Vacuum partitioning window
    - For neutron
    - For charged particle

# Magnet gap section



## • Design

### • Large acceptance

- Horizontal space: 3.4 m      ➔  $\pm 10$  degrees
- Vertical gap: 0.8 m      ➔  $\pm 5$  degrees

### Large angular acceptance for neutron

### • Two pipes

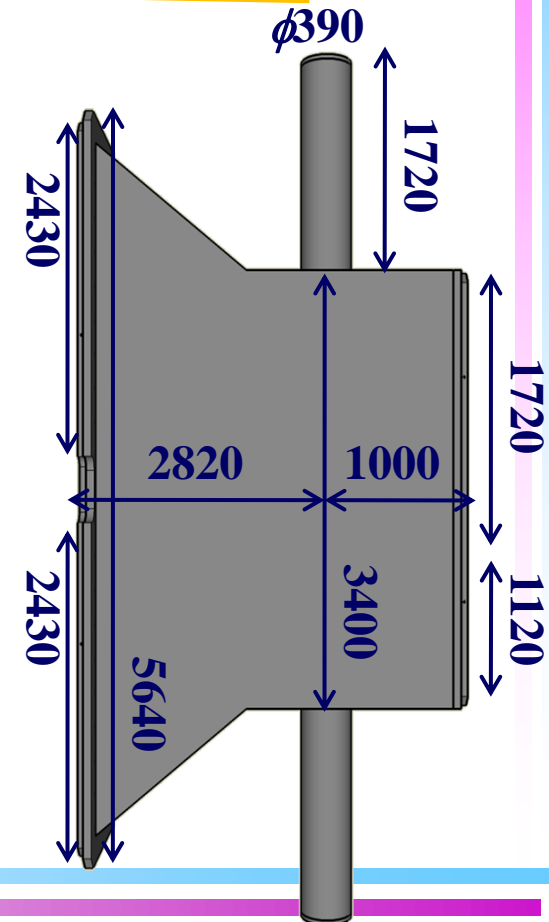
- For the  $(\gamma, p)$  type experiment with high momentum resolution mode
- Auxiliary usages
  - Accurate geometry calibration
  - Connection with vacuum pump system

### • Two windows

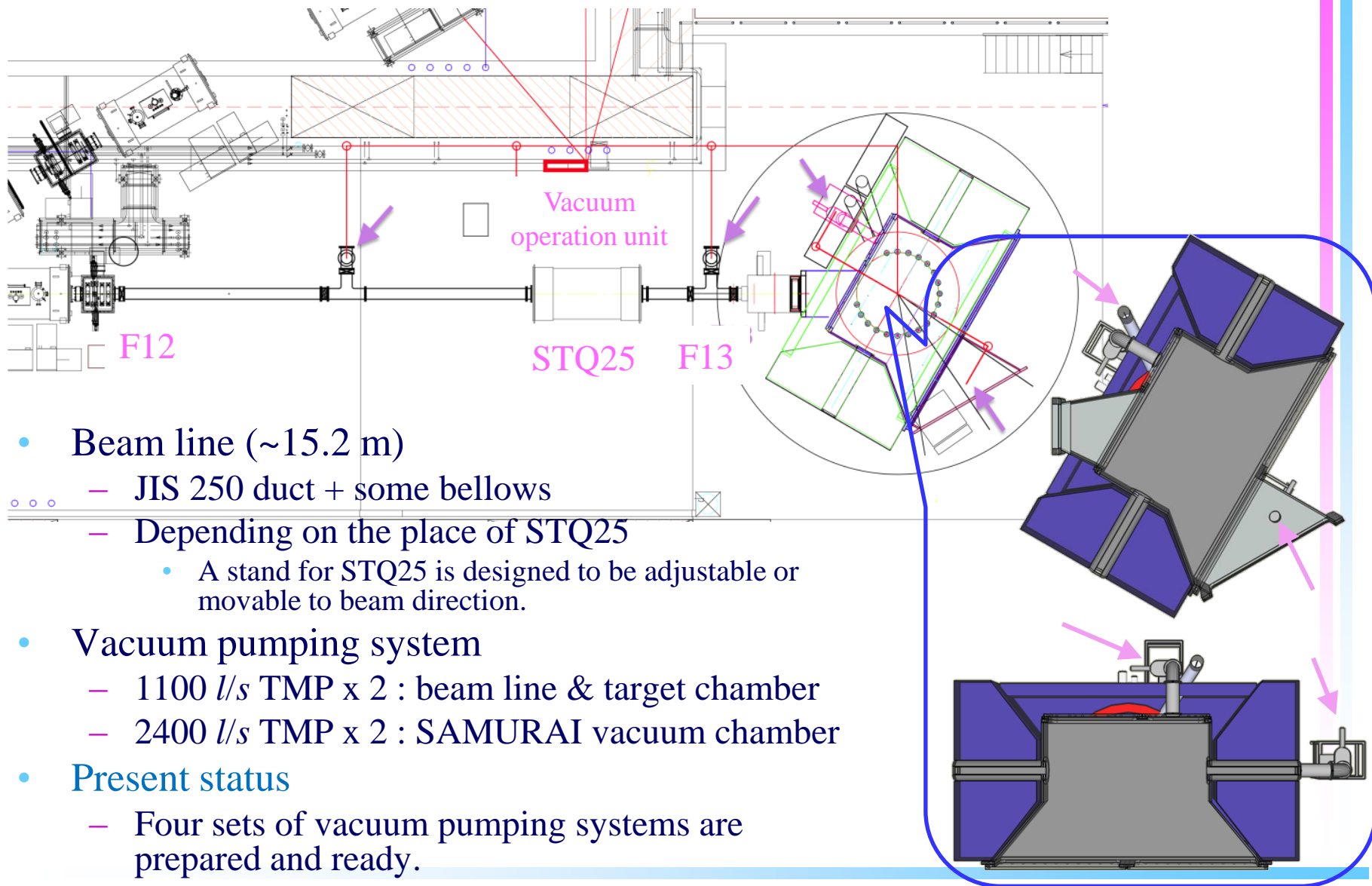
- Beam entrance & vacuum pump connection
- Separation of heavy ions and neutrons or protons

## • Present status

- ✓ All design has been finished.
- ✓ SAMURAI vacuum chamber will be installed into the superconducting dipole magnet in spring 2011.



# Beam line & Vacuum pumping system

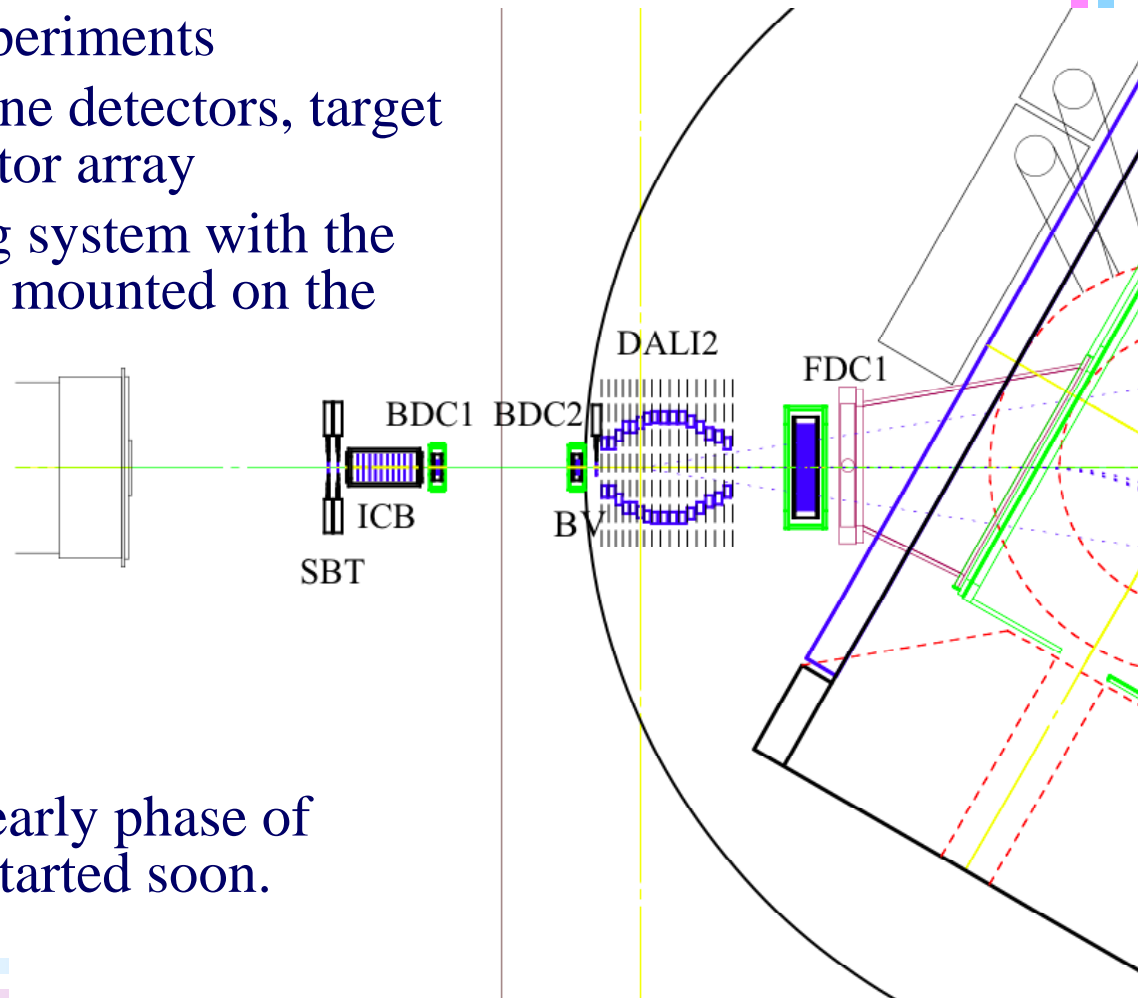


- Beam line (~15.2 m)
  - JIS 250 duct + some bellows
  - Depending on the place of STQ25
    - A stand for STQ25 is designed to be adjustable or movable to beam direction.
- Vacuum pumping system
  - 1100 l/s TMP x 2 : beam line & target chamber
  - 2400 l/s TMP x 2 : SAMURAI vacuum chamber
- Present status
  - Four sets of vacuum pumping systems are prepared and ready.

# Target chamber

- Requirements

- Depending on the experiments
- Including the beam line detectors, target itself, and  $\gamma$  ray detector array
- The vacuum pumping system with the 1100 *l/s* TMP will be mounted on the target chamber.

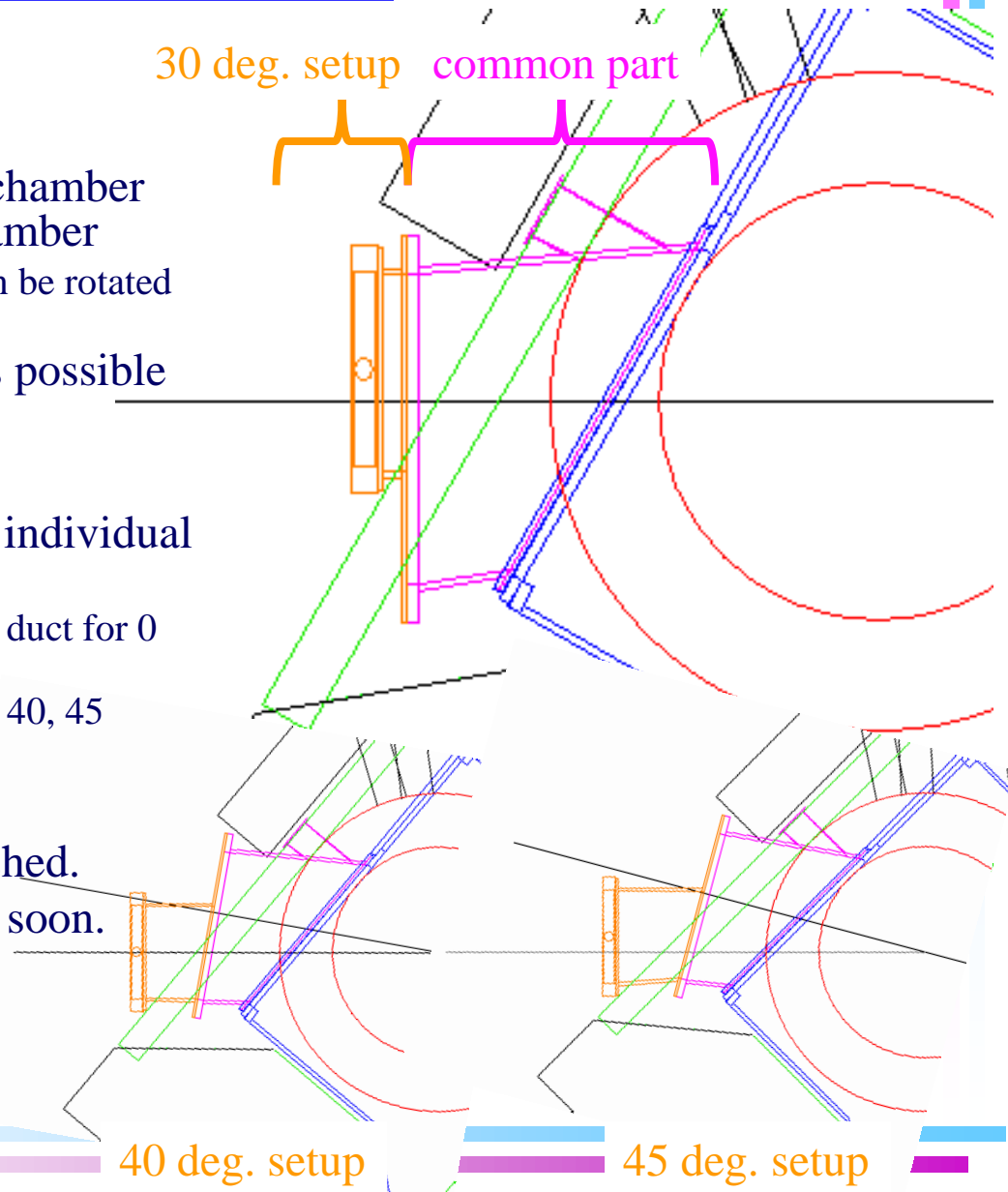


- Present status

- Detail designing for early phase of experiments will be started soon.

# Upstream connection section

- Requirements
  - Connection between the target chamber and the SAMURAI vacuum chamber
    - The SAMURAI spectrometer can be rotated at 0, 30, 40, and 45 degrees.
  - To cover as much solid angle as possible for the scattered particles.
- Design
  - Separation of common part and individual part
    - Common part: large acceptance, duct for 0 degree
    - Individual part: chambers for 30, 40, 45 degrees, vacuum partition flange
- Present status
  - All design has been almost finished.
  - The construction will be started soon.



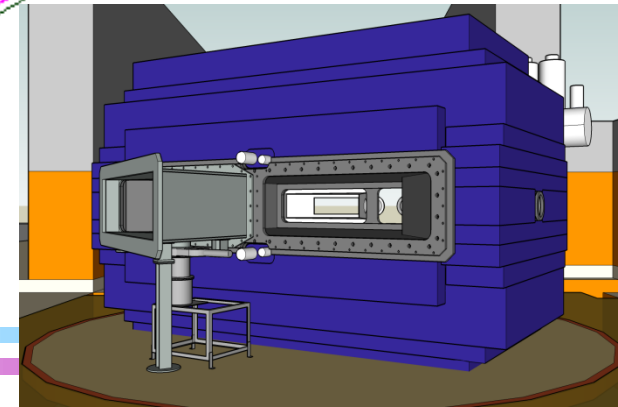
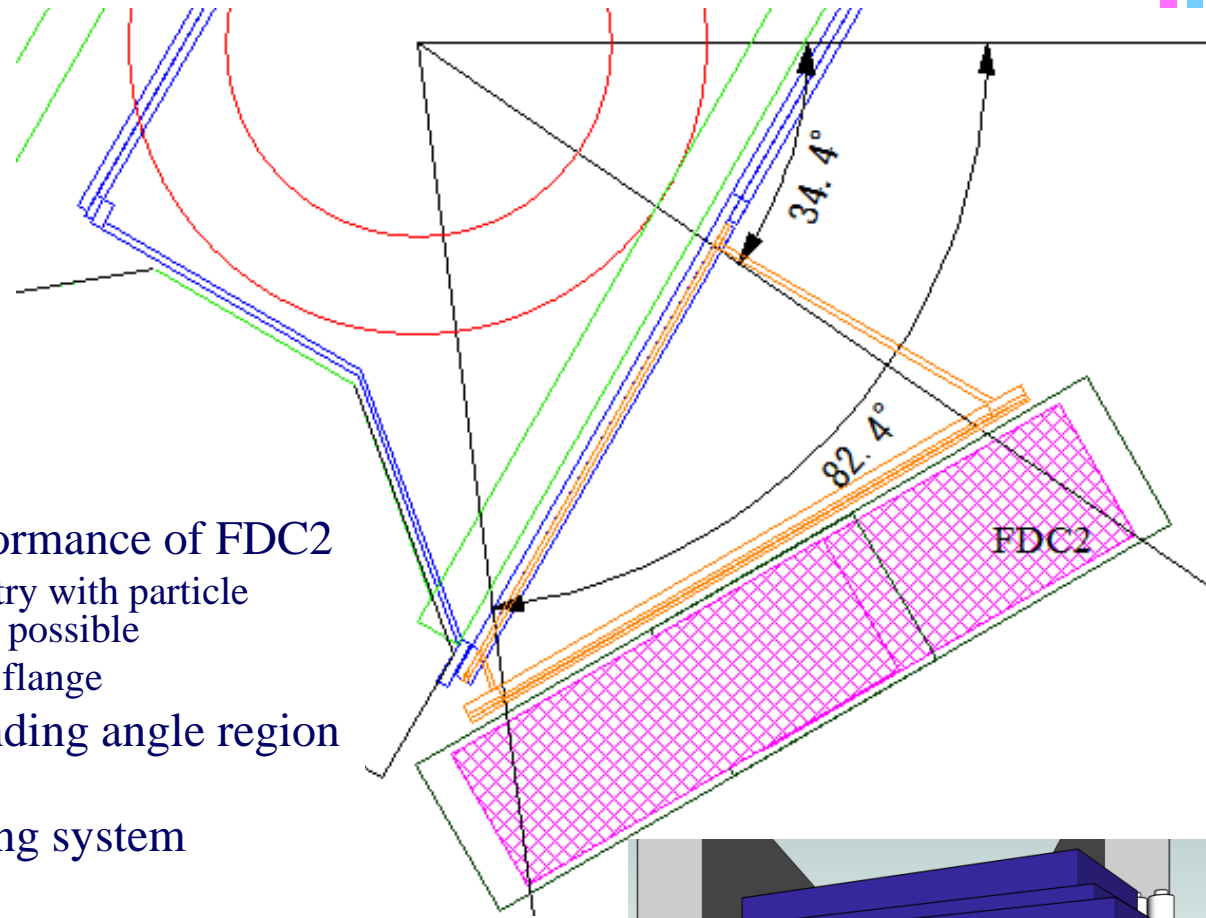
# Downstream connection section

- Requirements

- To maximize the performance of FDC2
  - Perpendicular geometry with particle trajectories as well as possible
  - Additional 30 degree flange
- To cover the large bending angle region
  - Rectangular triangle
- To connect the pumping system

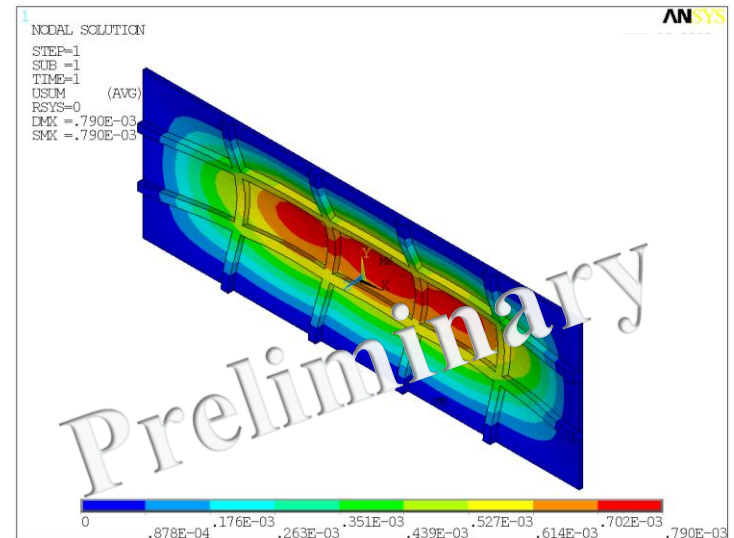
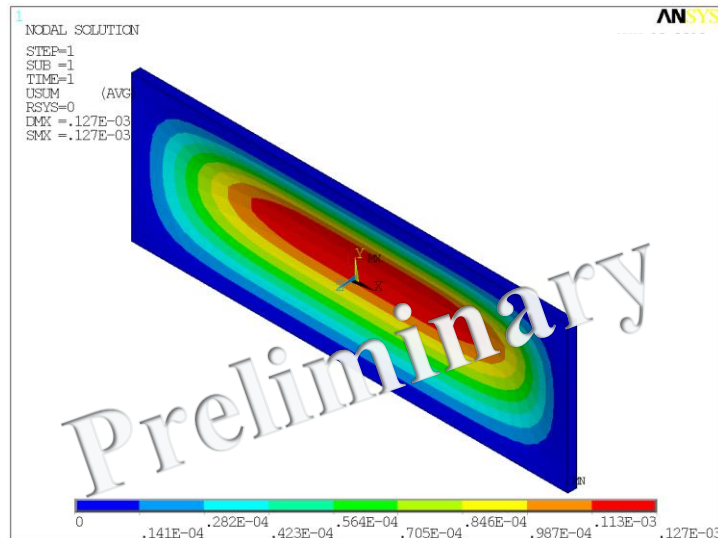
- Present status

- The design has been almost finished.
- The construction will be started soon.



# Vacuum partition for neutron

- Requirements
  - Lower reaction loss on partition window material
  - To support itself with sufficient strength
  - The area to be covered is 2430 x 800 mm<sup>2</sup>.
- Design
  - Al plate with a thickness of 50 mm
  - Al plate + lib with a thickness of 20 mm
  - and more...
- Present status
  - Deflection and stress will be simulated by using ANSYS.
  - Test of exit window will be performed by using test vacuum chamber.





# Vacuum partition for charged particle

- Requirements

- Lower multiple scattering and lower energy loss on the partition window
- The area to be covered is 2940 x 800 mm<sup>2</sup>.
- Upper limit of thickness: radiation length of  $L/L_R \sim 10^{-3}$ 
  - To achieve the momentum resolution of 1/700
- Hold vacuum

## *Combination of Kevlar and Mylar*

- Test of large exit window

- Test window
  - 2800 x 1000 mm<sup>2</sup>
    - 20 % larger in length than SAMURAI vacuum chamber' window.
- Trial foil
  - Kevlar cloth (K49 fiber) with thickness of 0.28 mm and width of 1270 mm
  - Polyethylene foil with thickness of 0.10 mm and width of 1400 mm
- Both are available on a commercial basis.
  - If some of commercial maker provide a roll of Mylar or Kapton foil with more than 1200 mm width, we would choose them.

# Test of large exit window

- Test using the trial foil
  - Several conditions have been tested as without gluing, glued with 4 mm or 30 mm width of araldite.
- Collapse
  - When the gluing was not sufficient, the collapse of foil occurred.
    - Important point: gluing sufficiently!
  - When the vacuum pressure was achieved to less 100 mbar, the collapse of foil occurred.
    - More length or more thickness.
  - The collapse of foil damages not only the downstream detectors but also upstream instruments.
- Next trial
  - Custom made Kevlar cloth
    - Width: > 1.5 m
    - Other fiber: K129 fiber



Collapsed case at RIBF



Collapsed case at RCNP

# Summary

- The SAMURAI vacuum chamber will be fabricated in the same timing of fabrication of the superconducting dipole magnet.
- The vacuum pumping system is prepared and ready.
- The beam line will be constructed on former half of FY2011.
- The target chamber for the  $(\gamma, n)$  type experiment with 30 degree configuration will be started soon.
- The upstream connection duct and the downstream extension duct will be finally designed soon and fabricated on the end of FY2011.
- The vacuum partition window is under study for feasibility.