

SAMURAI Vacuum System

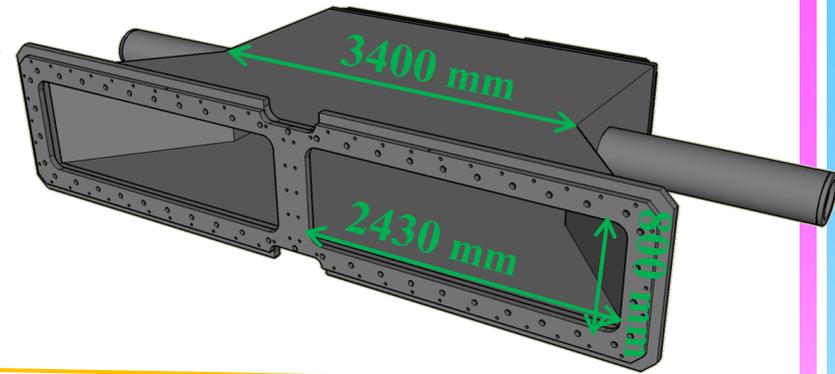
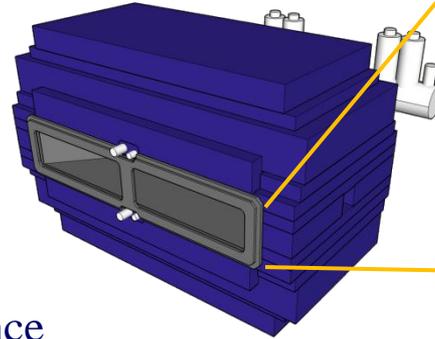
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- Common instruments
 - Magnet gap section
 - Beam line & vacuum pumping system
- Individual instruments
 - Target chamber
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 - Vacuum partitioning window
 - For neutron
 - For charged particle

Magnet gap section



• Design

• Large acceptance

- Horizontal space: 3.4 m ➔ ± 10 degrees
- Vertical gap: 0.8 m ➔ ± 5 degrees

Large angular acceptance for neutron

• Two pipes

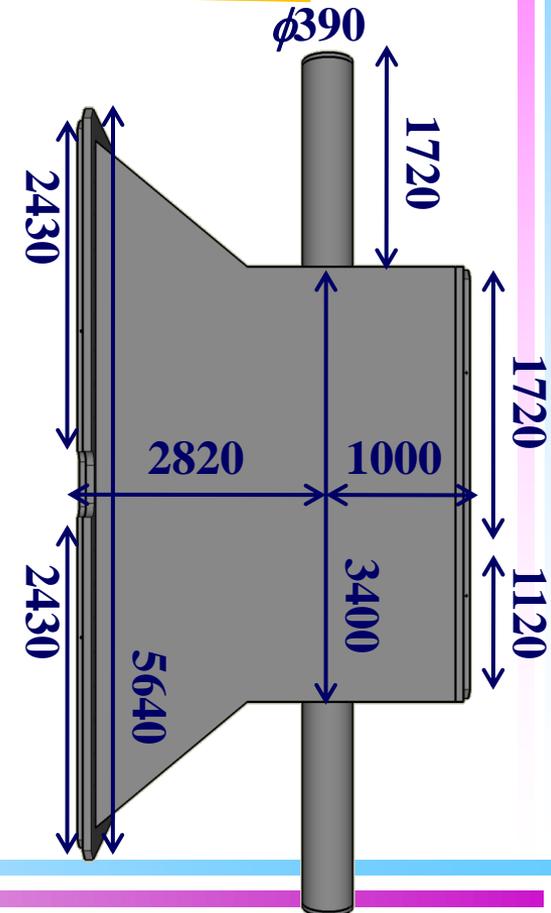
- For the (γ, p) type experiment with high momentum resolution mode
- Auxiliary usages
 - Accurate geometry calibration
 - Connection with vacuum pump system

• Two windows

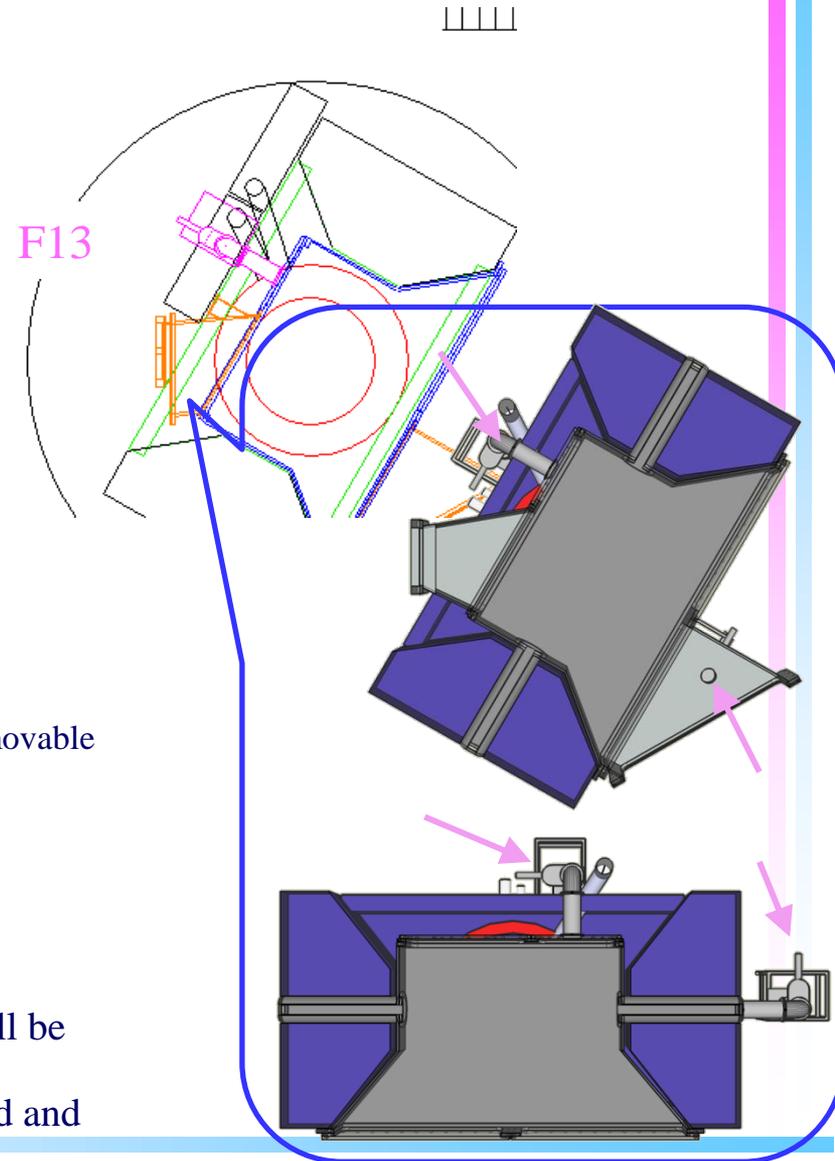
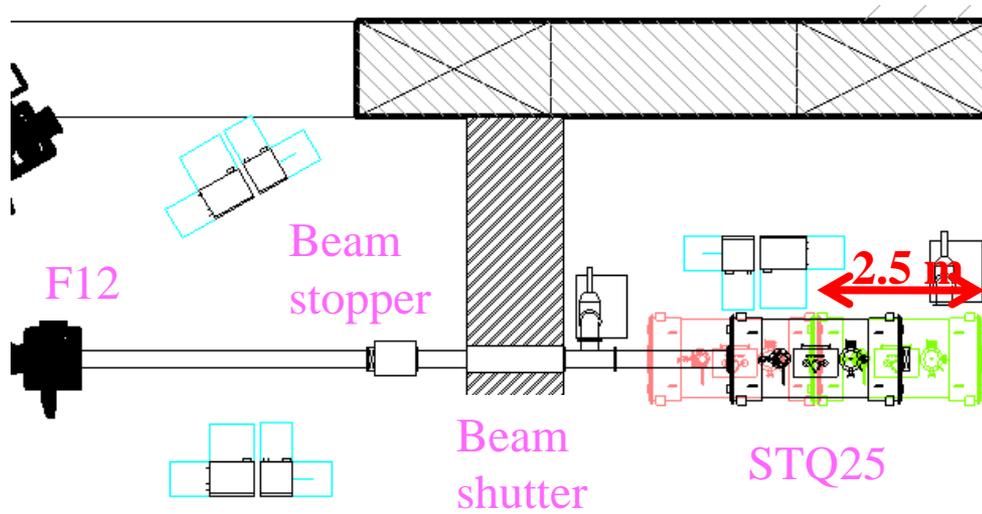
- Beam entrance & vacuum pump connection
- Separation of heavy ions and neutrons or protons

• Present status

- ✓ SAMURAI vacuum chamber has been already installed into the superconducting dipole magnet.



Beam line & Vacuum pumping system

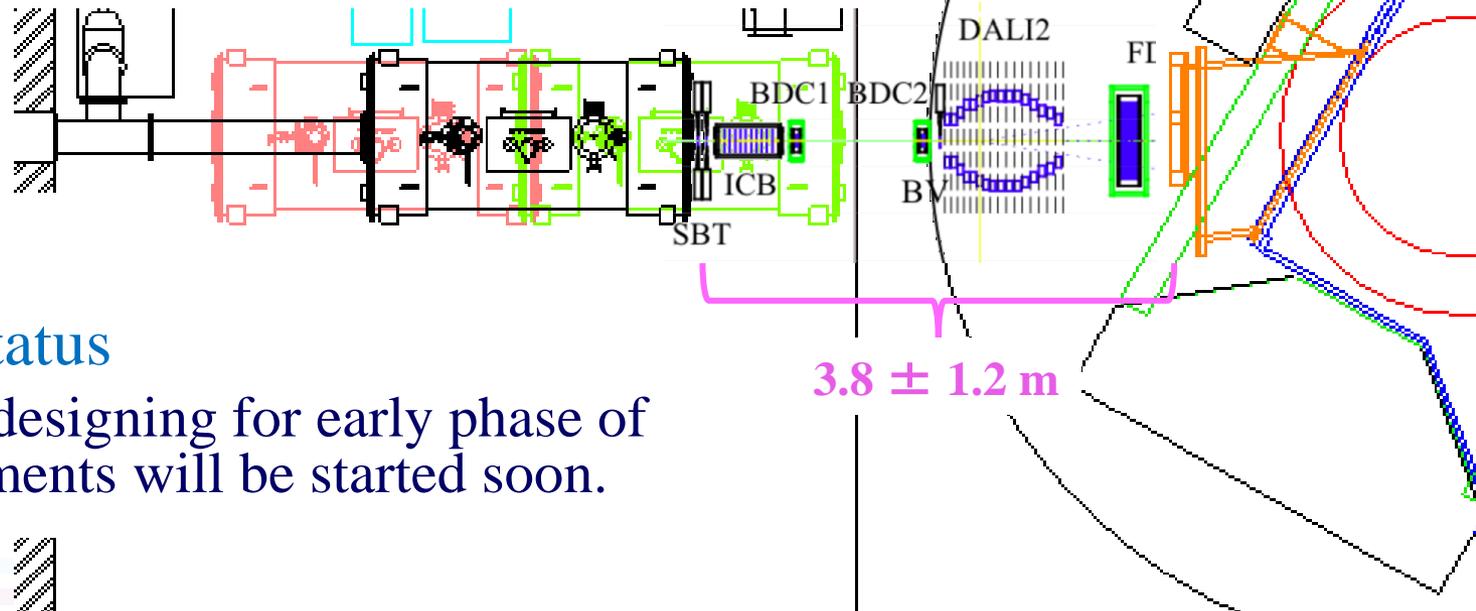


- Beam line (~15.2 m)
 - JIS 250 duct + some bellows and GVs
 - Beam stopper and beam shutter
 - Depending on the place of STQ25
 - A stand for STQ25 is designed to be adjustable or movable to beam direction (2.5 m).
- Vacuum pumping system
 - 1100 l/s TMP x 2 : beam line & target chamber
 - 2400 l/s TMP x 2 : SAMURAI vacuum chamber
- Present status
 - The beam stopper, beam shutter, and beam line will be constructed on former half of 2011.
 - 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 γ ray detector array
- The vacuum pumping system with the 1100 *l/s* TMP will be mounted on the target chamber.

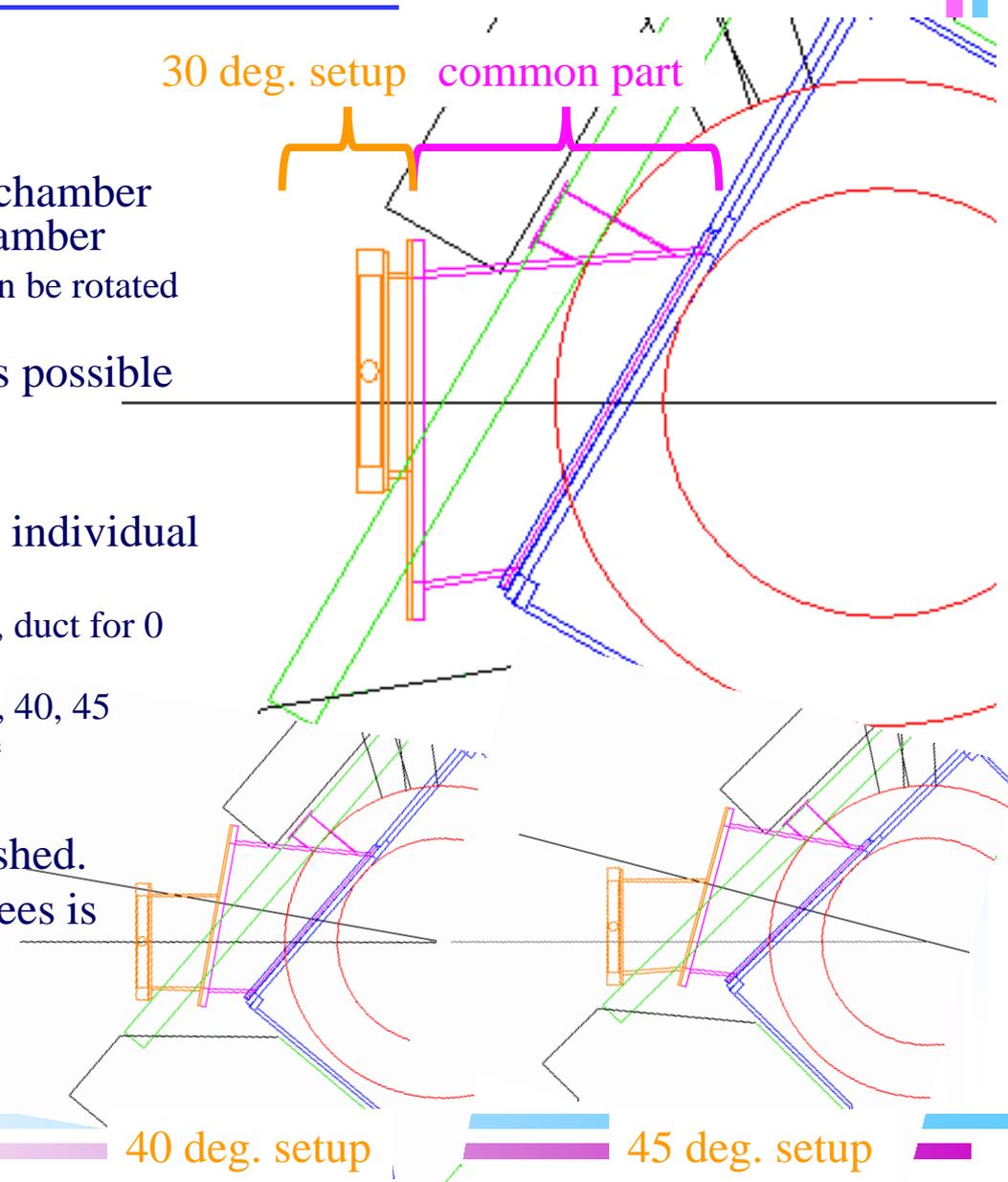


- Present status

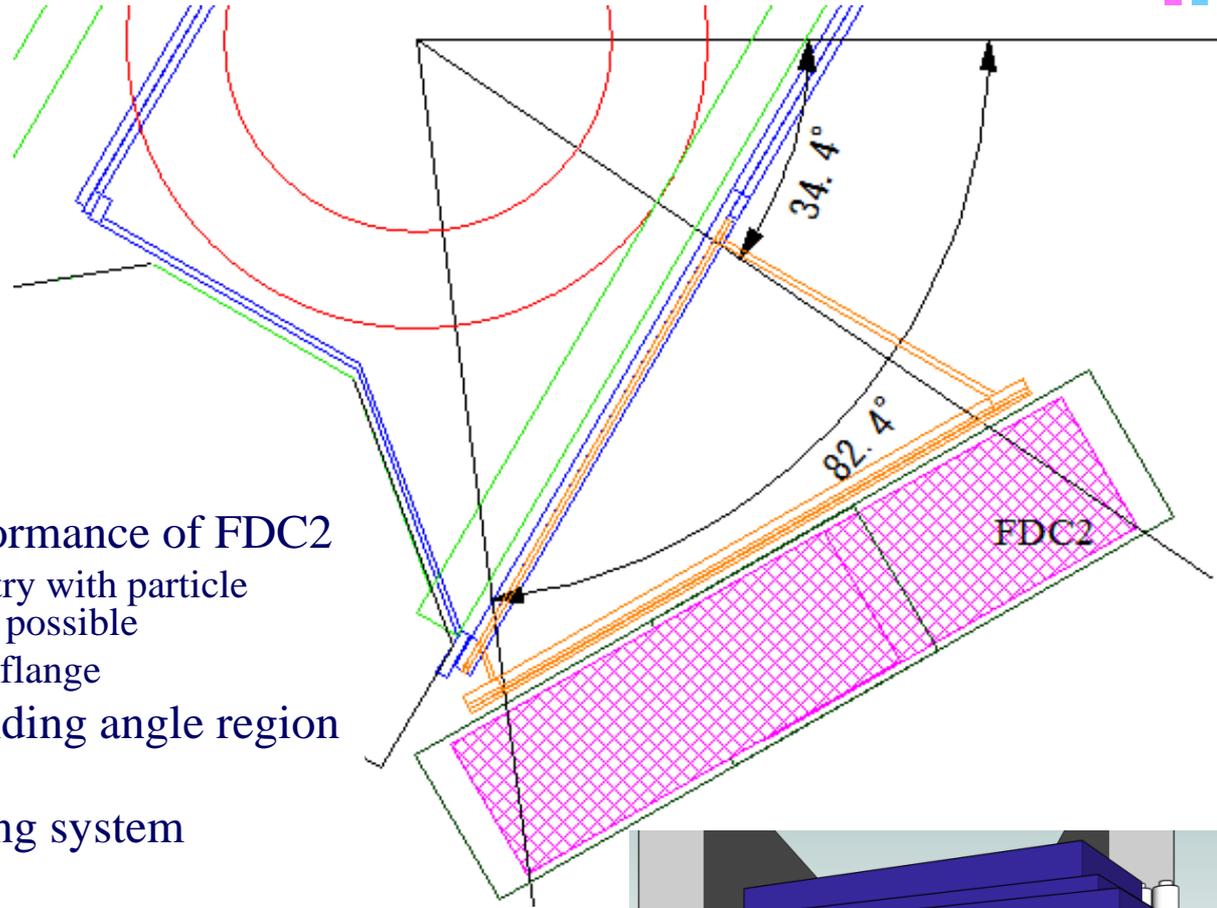
- Detail designing for early phase of experiments will be started soon.

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 connected duct for 30 degrees is under construction.



Downstream connection section

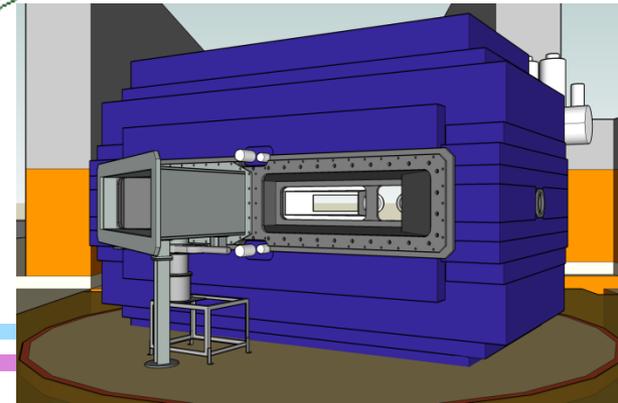


- Requirements

- 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

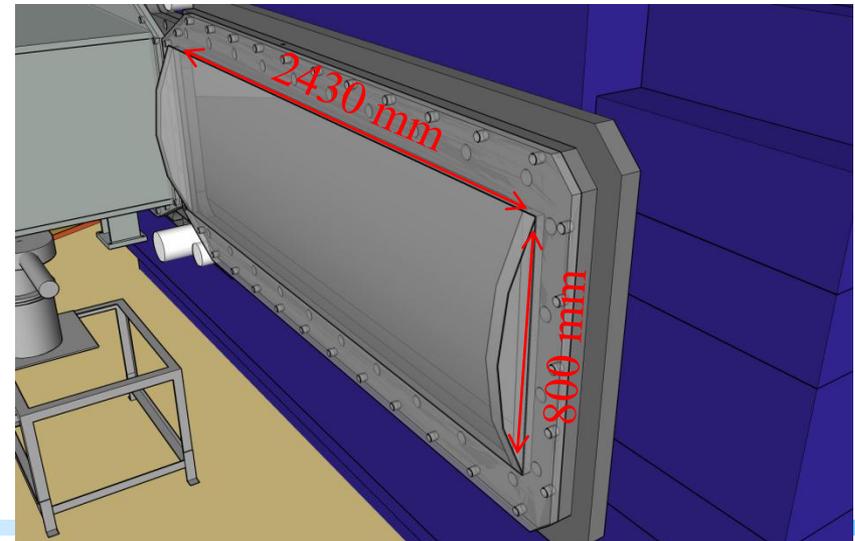
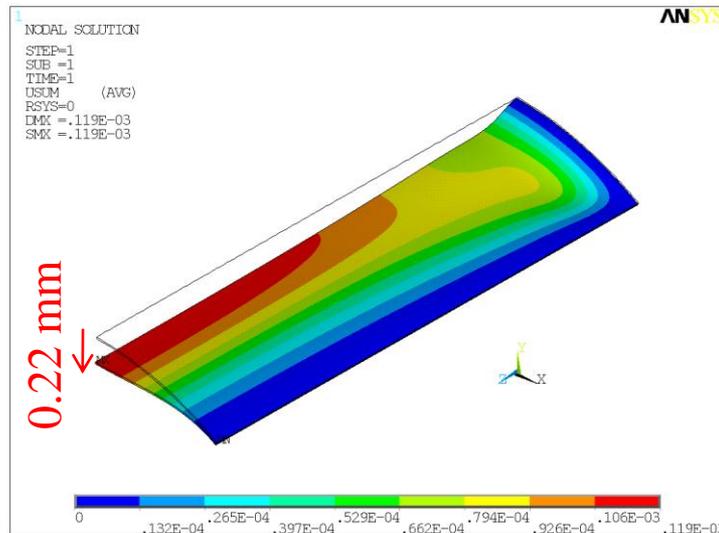
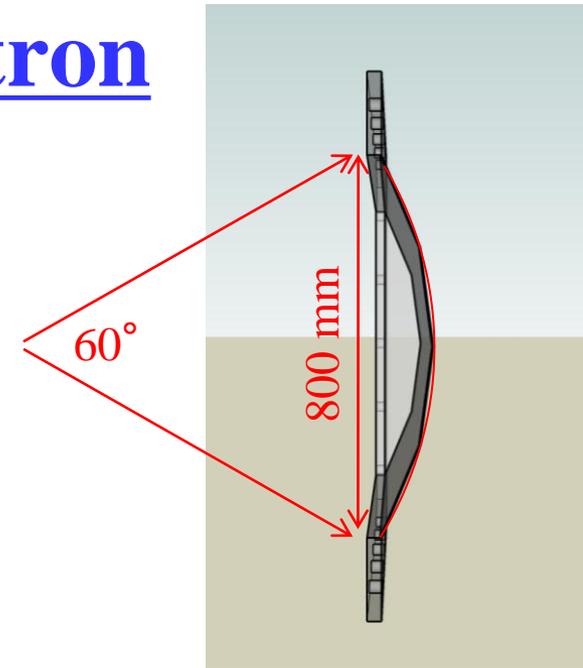
- Present status

- The design has been almost finished.
- The extended duct is under construction.



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 mm².
- Design
 - SUS304 with a thickness of 3 mm
 - Sectorial cylinder which has a central angle of 60 degrees.
 - Safety factor is required to be 10.
- Present status
 - Deflection and stress are calculated by using ANSYS.
 - Deflection: 0.22 mm
 - Stress: 45 MPa ← Tensile strength: 520 MPa
 - Test using one-eighth-scale window.
 - 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 mm².
- Upper limit of thickness: radiation length of $L/L_R \sim 10^{-3}$
 - To achieve the momentum resolution of 1/700
- Hold vacuum

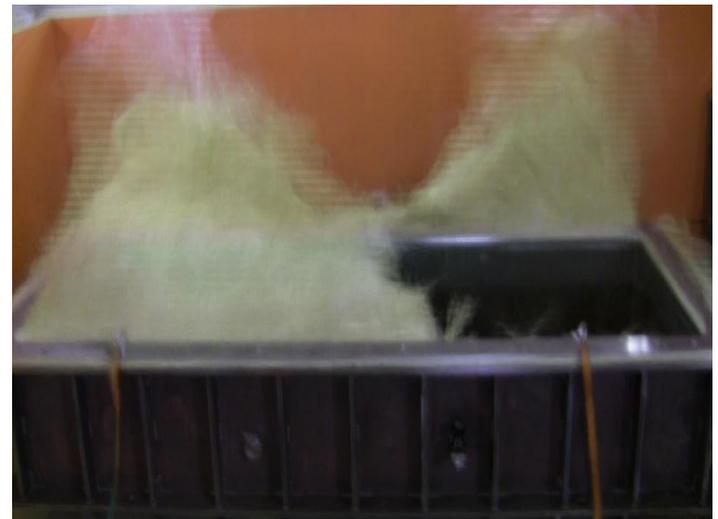
Combination of Kevlar and Mylar

- Test of large exit window

- Test window
 - 2800 x 1000 mm²
 - 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 just sandwiched without gluing, glued with 4 mm, 30 mm or 50 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 8 kPa, 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
 - Carbon cloth
 - The Young's module of carbon cloth is higher than that of Kevlar cloth.
 - At KEK, window of 1.0 m x 0.8 m was covered with a polyester film supported by carbon cloth.



Collapsed case at RIBF

Summary

- The SAMURAI vacuum chamber has already been installed into the superconducting dipole magnet.
- The vacuum pumping system is prepared and ready.
- The beam line will be constructed on former half of 2011.
- The target chamber for the (γ, n) type experiment with 30 degree configuration will be started soon.
- The upstream connected duct for 30 degree configuration and the downstream extended duct are under construction.
- The vacuum partition window is under study for feasibility.