MOLLER target alignment strategy

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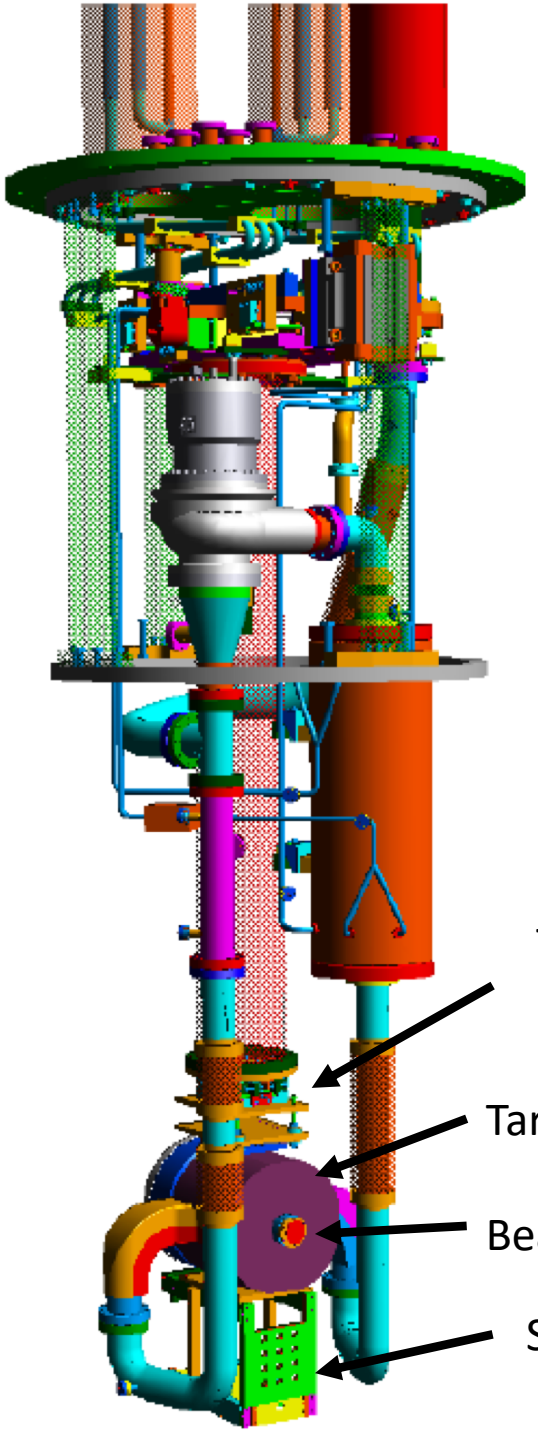
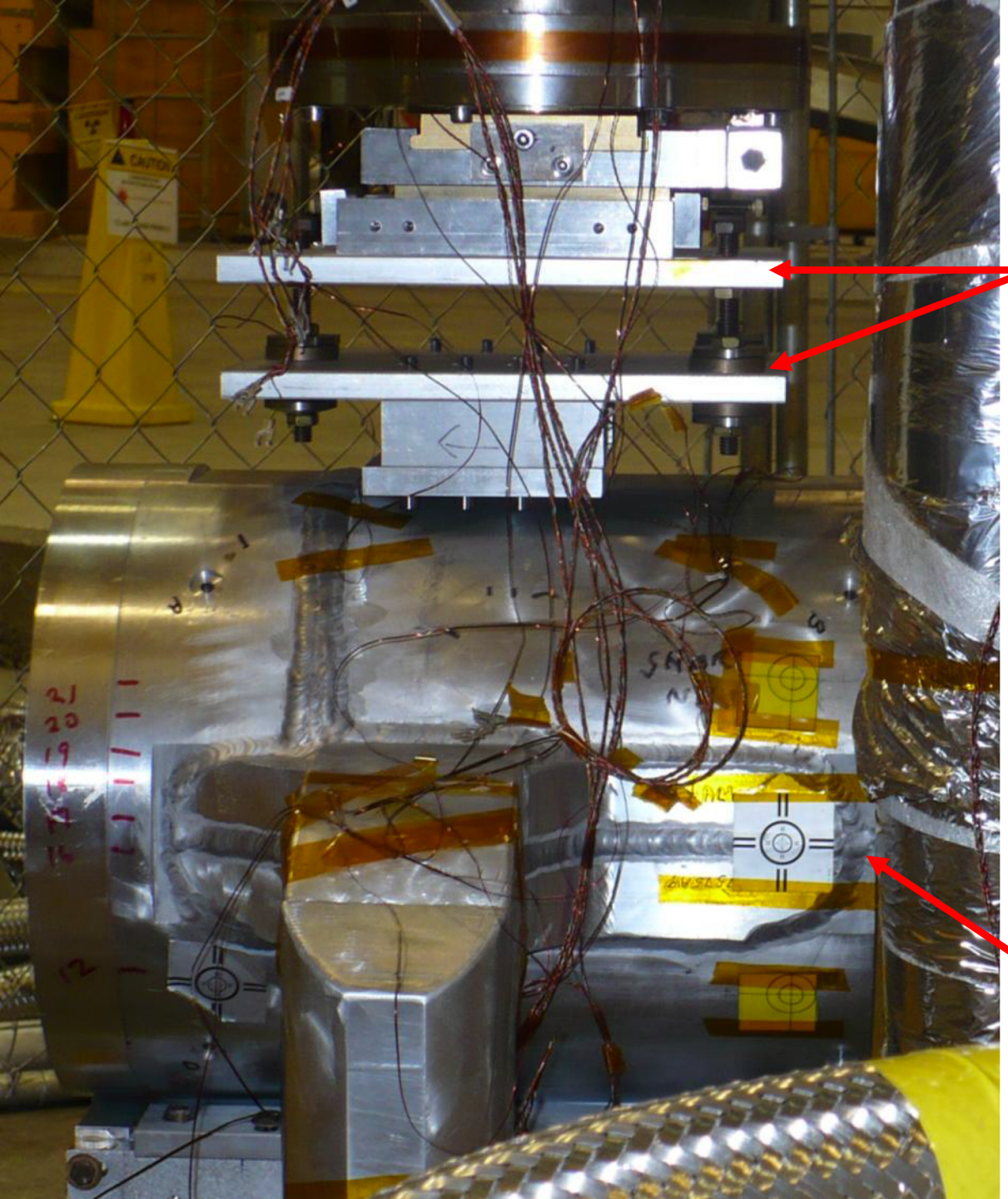
- Qweak target alignment lessons/summary
- Strategy for the MOLLER target
  1. Fiducialize the target chamber and target cell
  2. Align the target chamber to the beam line (about 1” range in x, y and z, and 0.1 mm precision)
  3. Align the target cell to the target chamber (about 0.5” range in x, y and z, 0.1 mm precision)
  4. Survey warm and align to “ideal” beam line according to the Survey and Alignment Group numbers
  5. Check the position under vacuum and cold conditions, check reproducibility
  6. If reproducible, pre-align the target warm to “ideal” beam line, cold and under vacuum



- The Qweak target cell was nominally 35 cm long along the beamline (z)
- The Qweak target loop was about 2 m, vertically mounted loop with about 480 mm vertical range of motion and 10 cm horizontal range of motion (the only target at jlab, so far, with 2 independent axes of motion)
- Beam entrance window of the cell was 22 mm diameter and 0.1 mm thick, made of Al-6061
- Beam exit window was ~19 cm diameter with a 15 mm diameter nipple at the center of it that was 0.125 mm thick, made of Al-7075
- The cell-block is all-Al made and connects with the rest of the target loop with flex hoses, the cell block is connected to a vertical support pipe through a 6 DOF alignment table
- The beam current nominal values: 1.1 GeV, 180 μA, 5x5 mm^2 raster area



Target cell alignment table to the target chamber, 6 DOF, a similar one will be used for the MOLLER target cell to align it to its chamber

- The Qweak target was pre-pitched warm by 4 mm at the DS end in order to level it on the beam line while under vacuum and cold
- The cell also came about 3.7 cm US from ideal position, but since the z-acceptance was pretty large it was decided not to do anything about it

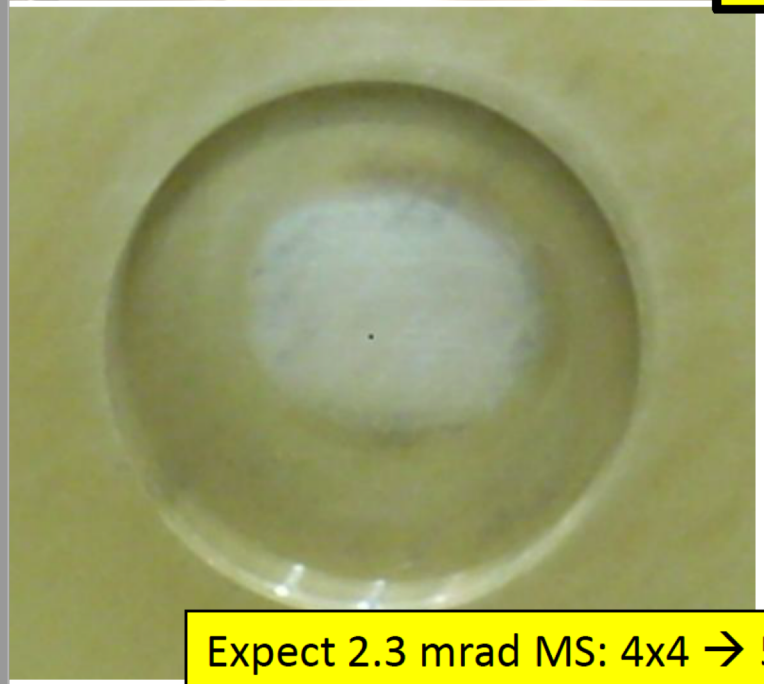
Target cell block

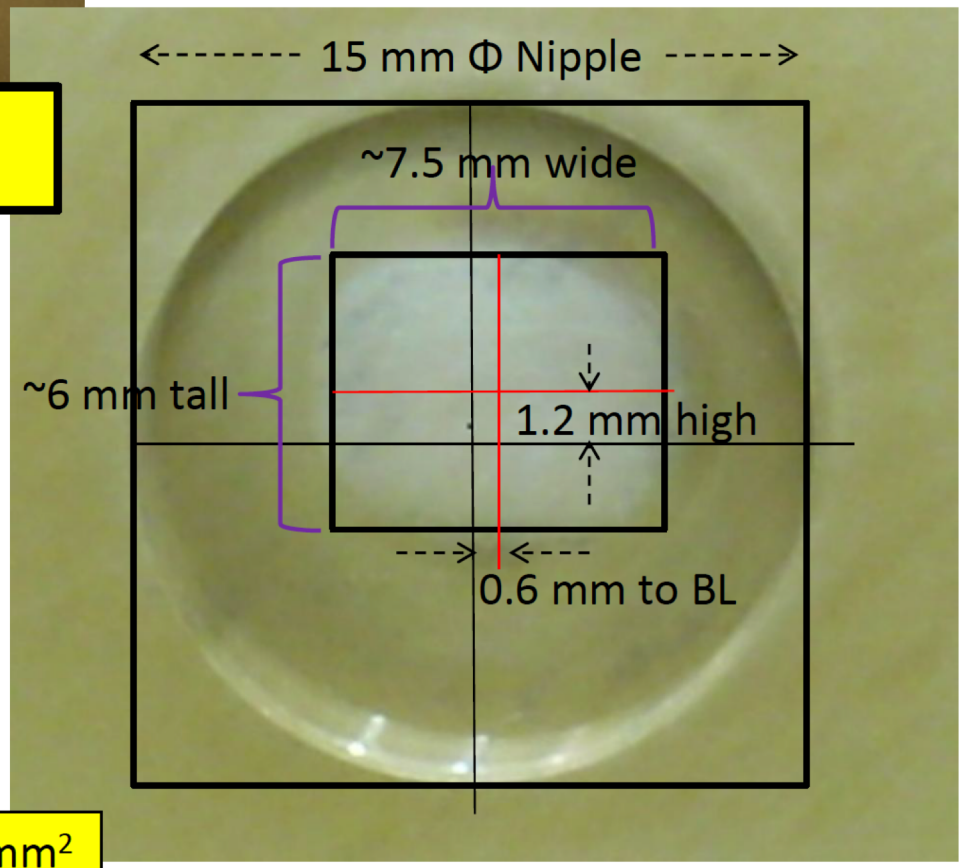
Exit Window Post Run 2

- Qweak post Run 1 and post Run2 images of the target cell beam line exit window
- The dark spot after Run 1 and clear spot after Run 2 indicate the beam raster area (we ran with raster areas between 3x3 mm^2 to 4x4 mm^2)

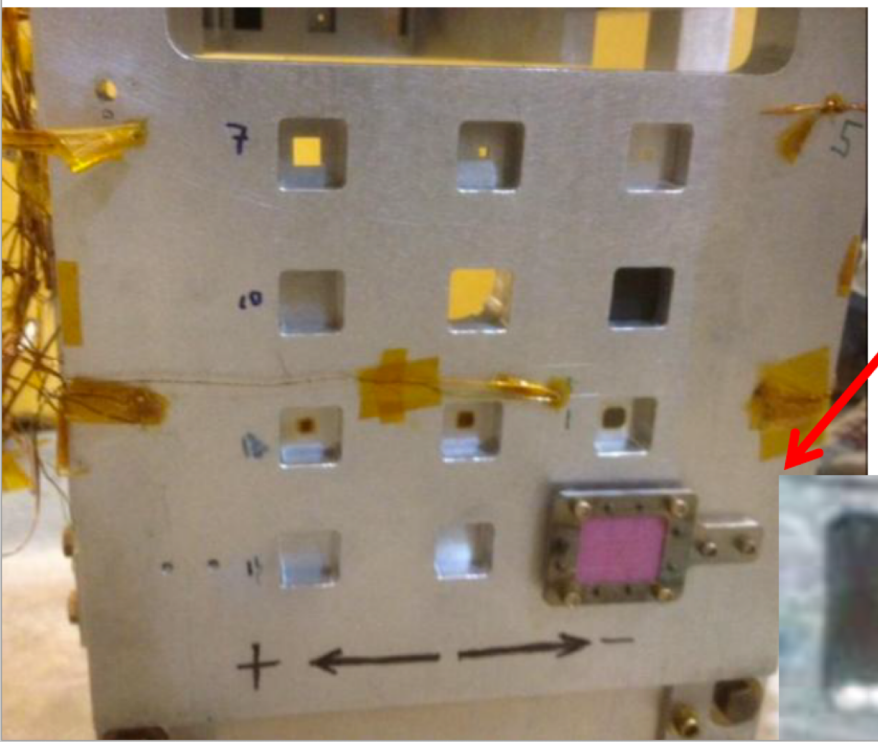
UNusual: beam spot is shiny, not black.
Hall effect gauge: 0.0049" thick (124 µm) variation ± 0.0001".

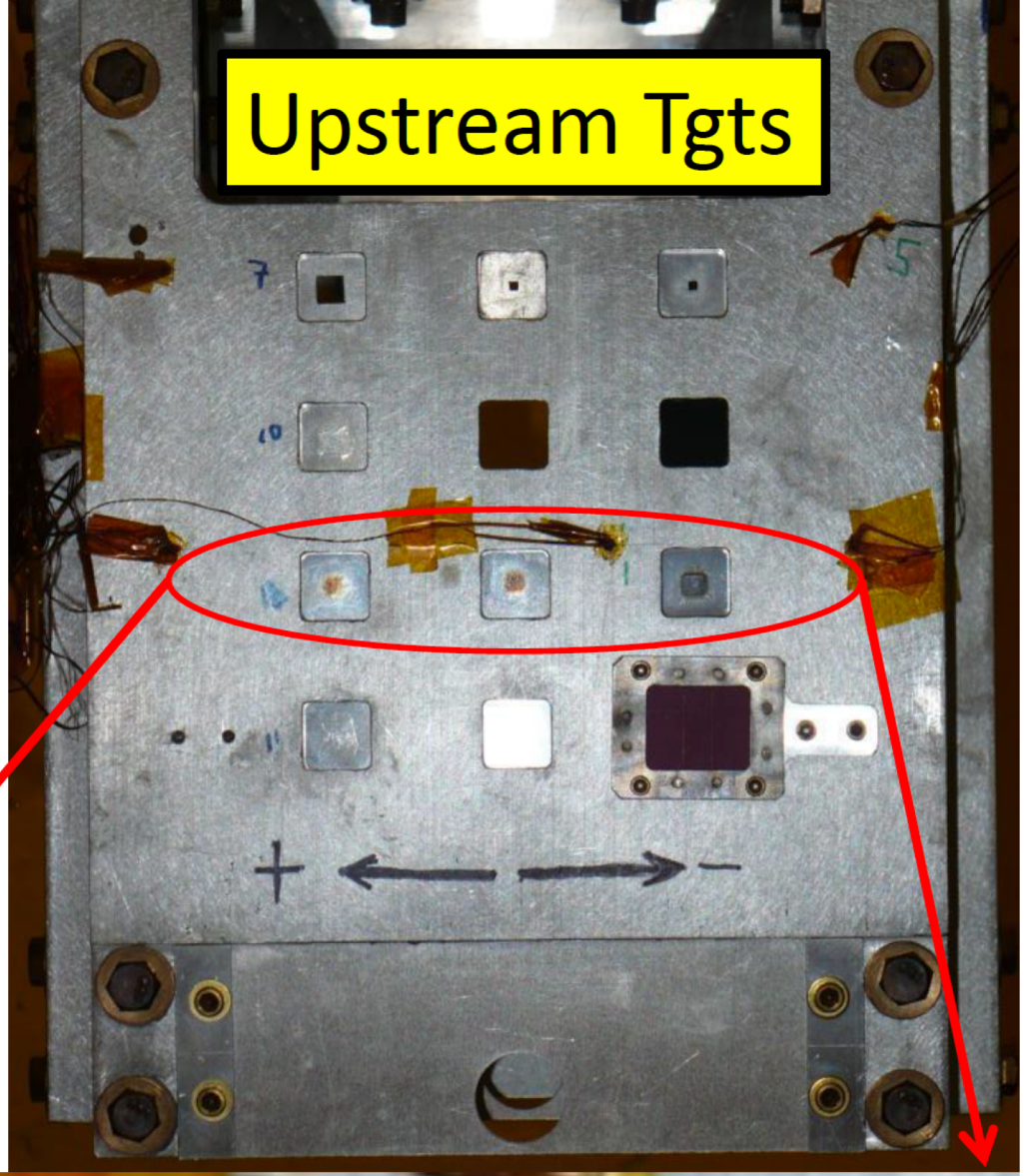
Run 2





Expect 2.3 mrad MS: 4x4 → 5.4x5.4 mm^2

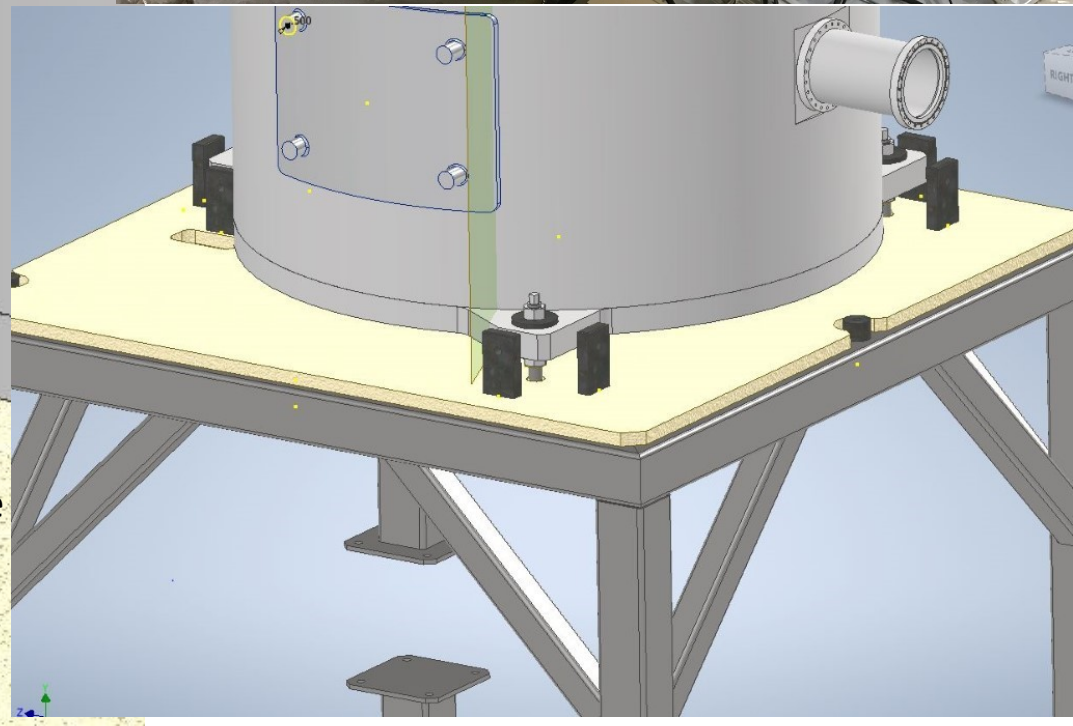




- Qweak post Run 1 and post Run2 images of the solid targets ladders, which were bolted rigidly to the LH2 cell
- The dark brown spots on the solid targets indicate the beam raster area (4x4 mm^2)

MOLLER target chamber alignment jacks

- large leveling screws for vertical adjustment with pusher blocks (black blocks) for ZX plane adjustment
(pusher screws not shown in pusher blocks)



Summary

- Recently, in Hall C the target chamber alignment had to be adjusted with respect to the SHMS by 1.7 mm in some direction, the target crew moved it by manually actuating the alignment jacks 10 microns at a time until they achieved 1.65 mm. Motion steps/precision of 50 microns are routine for the alignment jacks. These jacks are made in house. Once an ideal position is found the jacks are locked.
- The alignment jig for the target cell is also made in house, it is all-metal and can also be locked in a position, motion steps/precision expected is under 0.1 mm
- Overall it is expected that the MOLLER target cell and solid/optics targets could be aligned to the beam line to 0.1 mm theoretically, and practically 0.25 mm
- We should be careful about which origin the S&A group uses, as not all coordinate systems are created equal!