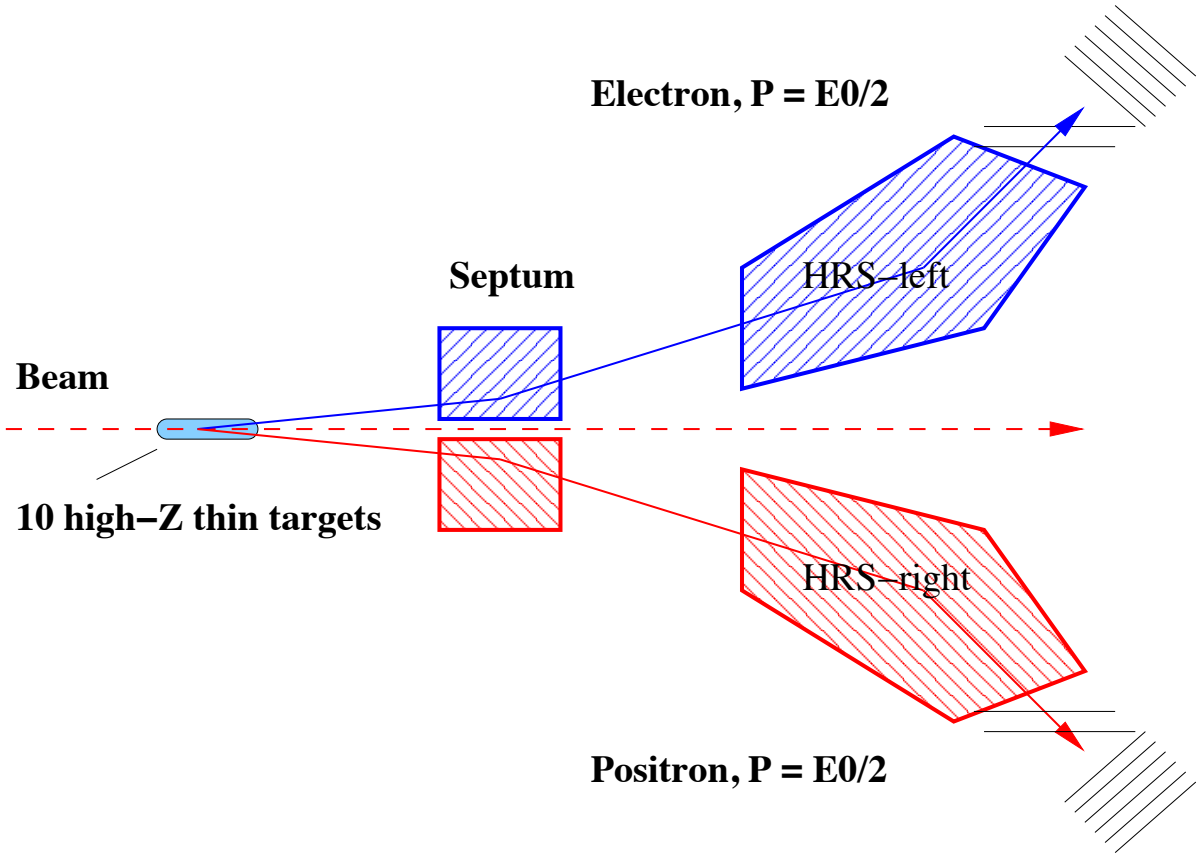
The beam line correctors and the vacuum chambers for the APEX experiment

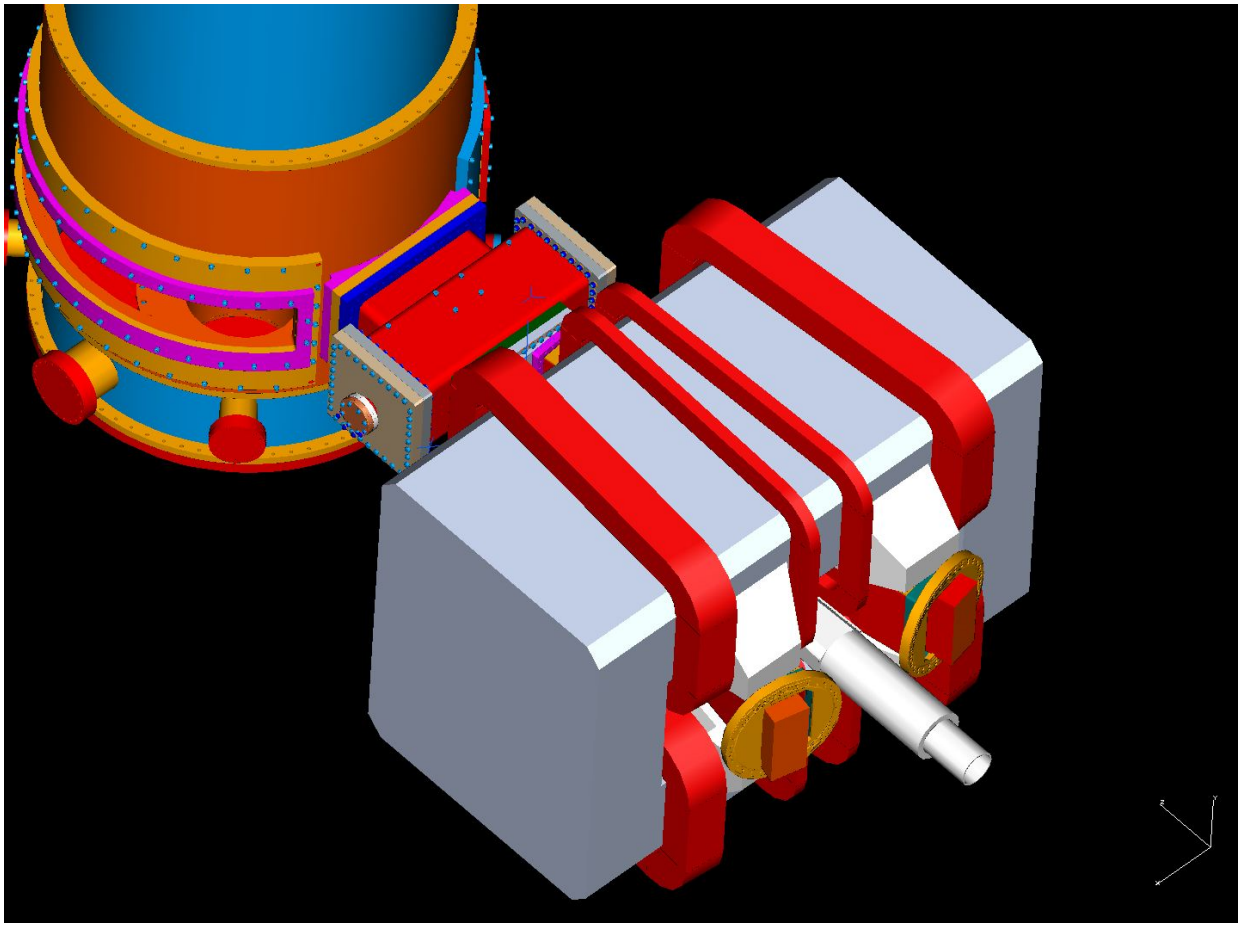
B.Wojtsekhowski

- The correctors on the beam line
- Design of the correctors
- Beam line requirements
- Considerations for the vacuum chambers
- Design project status and plans

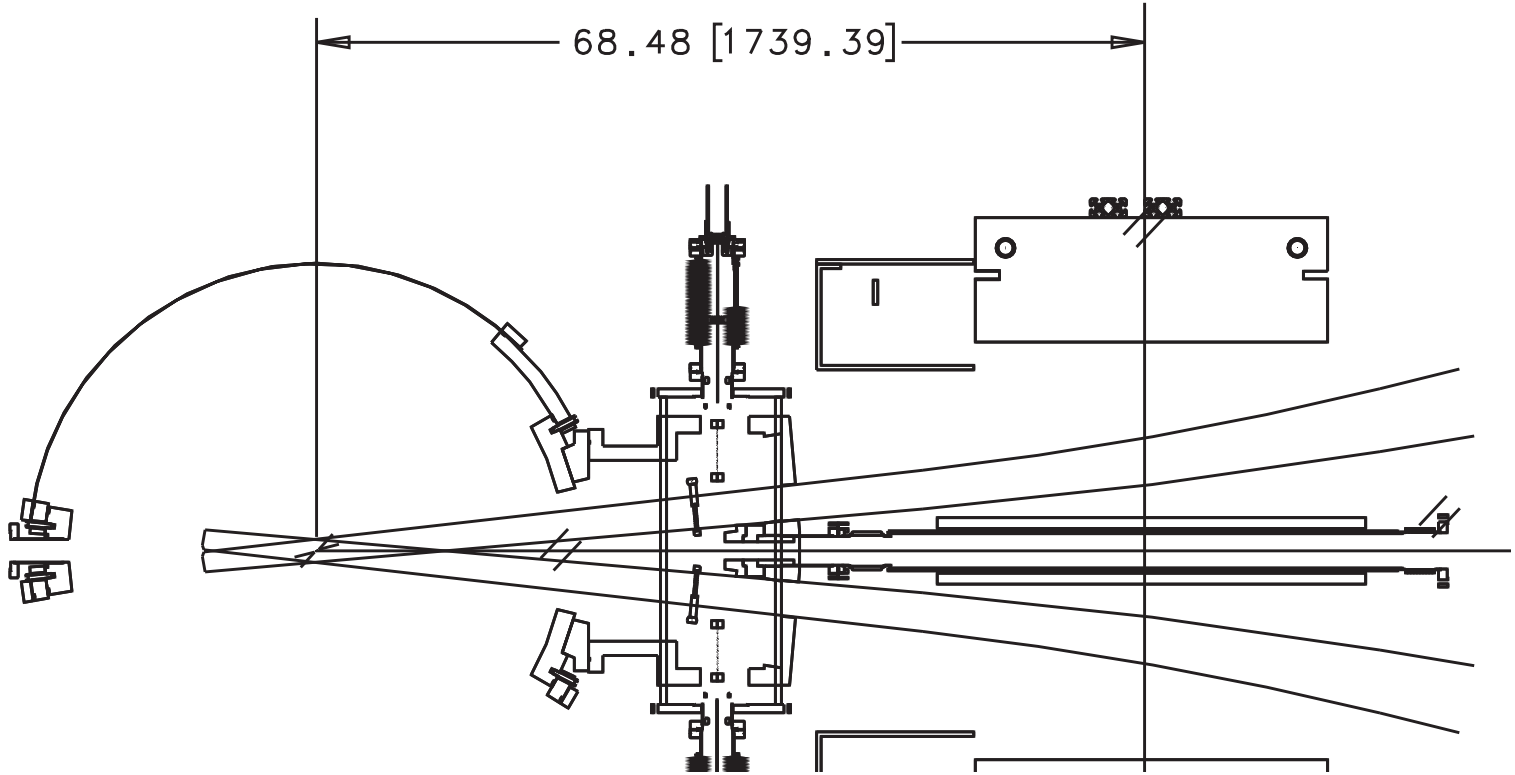
APEX experimental layout



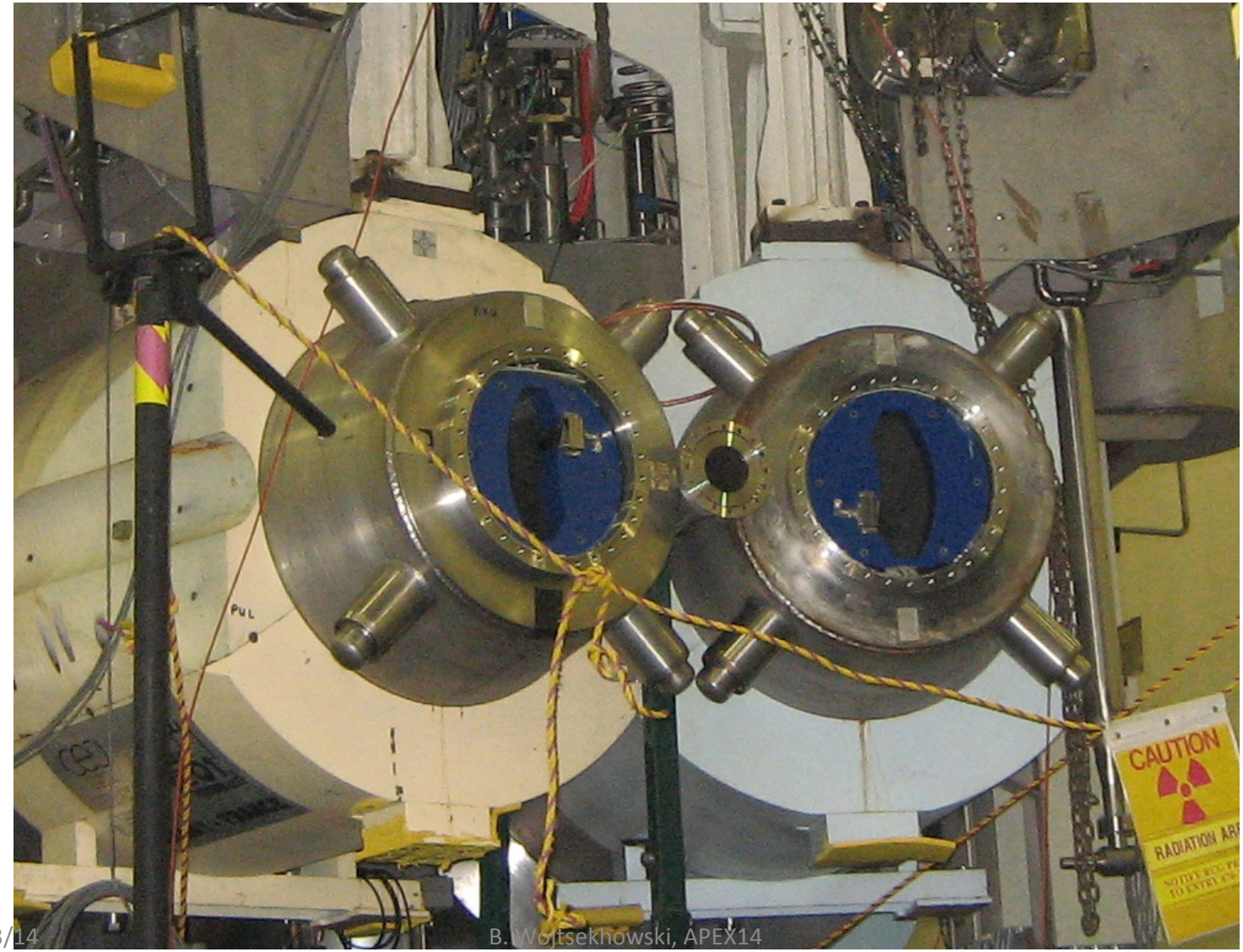
APEX experimental layout



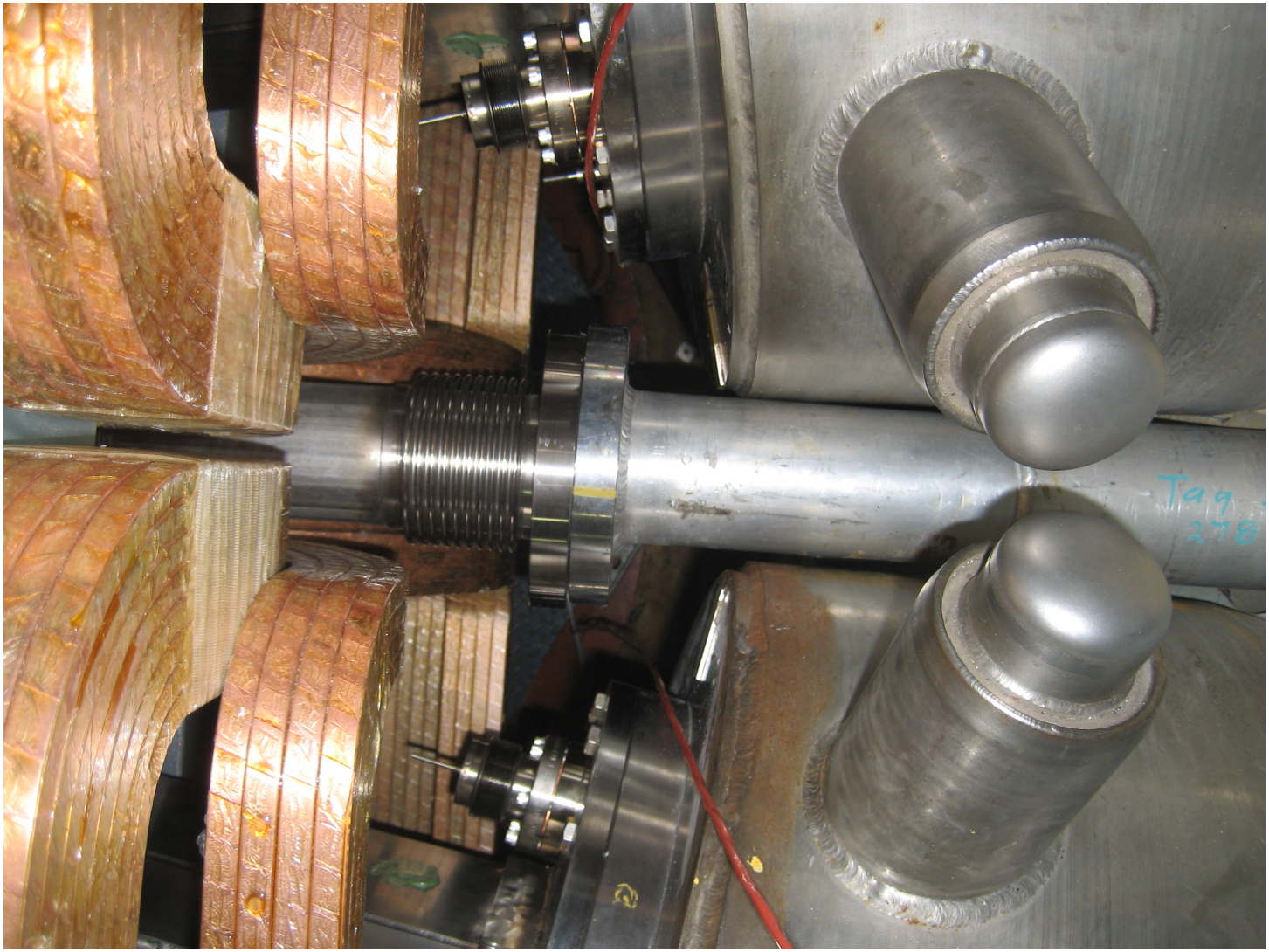
HRS and target with the septa magnet



Pictures of the equipment



Pictures of the equipment



Considerations for the correctors and the vacuum connections

i) Within +/- 0.9 degrees of the central beam path, the field integral should be less than 2000 Gauss-cm.

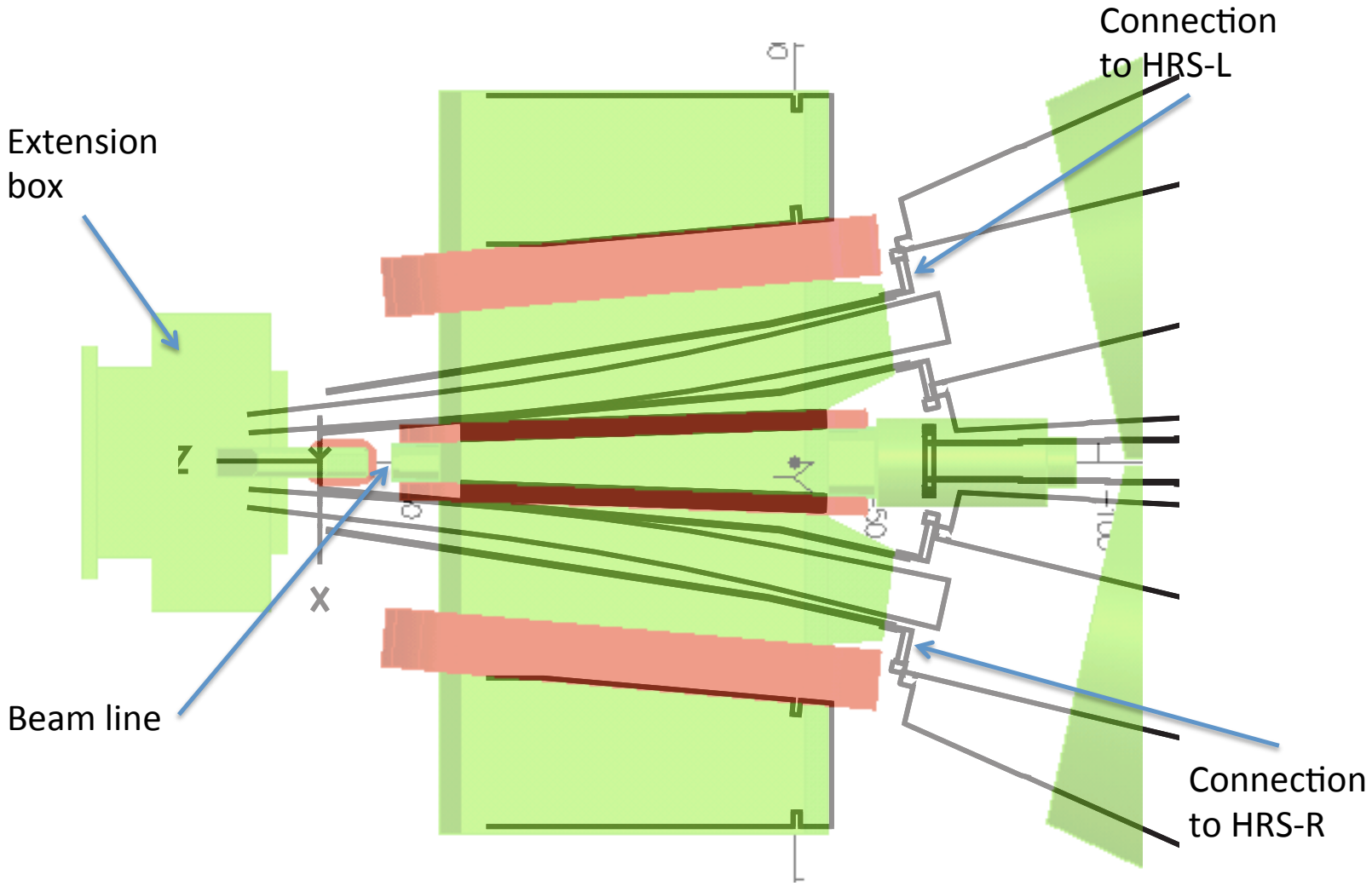
ii) Vacuum line should provide space for the correctors, the bellows for adjustments on the beam line and the HRS flanges, aperture to HRS.

iii) Extension box provides interface between the scattering chamber and three vacuum lines, hosts the sieve slits and the SciFi detectors.

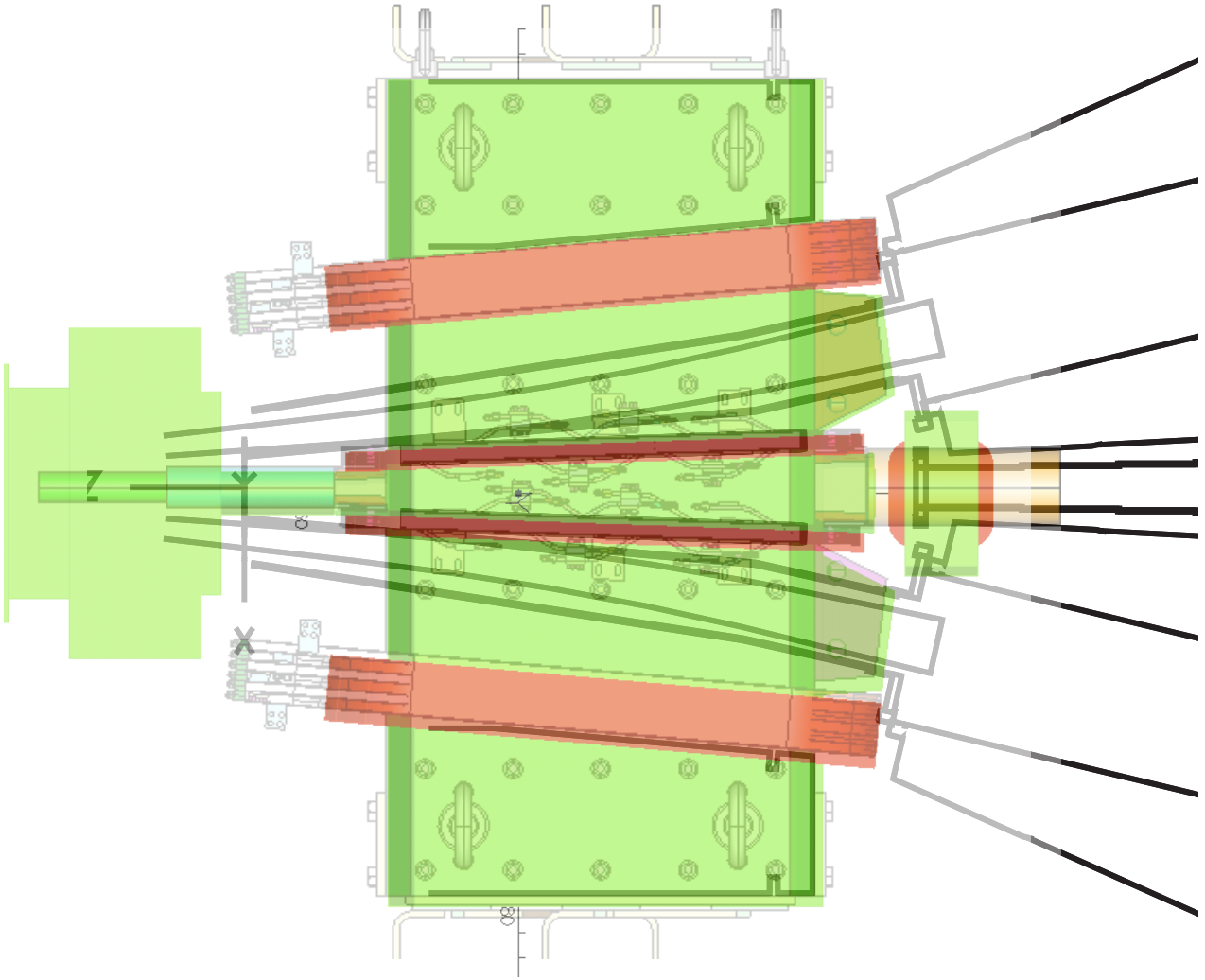
iv) All flanges use metal vacuum seals due to high radiation level.

v) Septa beam line limits beam aperture to +/- 1.0 deg. The old down-stream beam line, which limits aperture to +/- 0.9 deg.

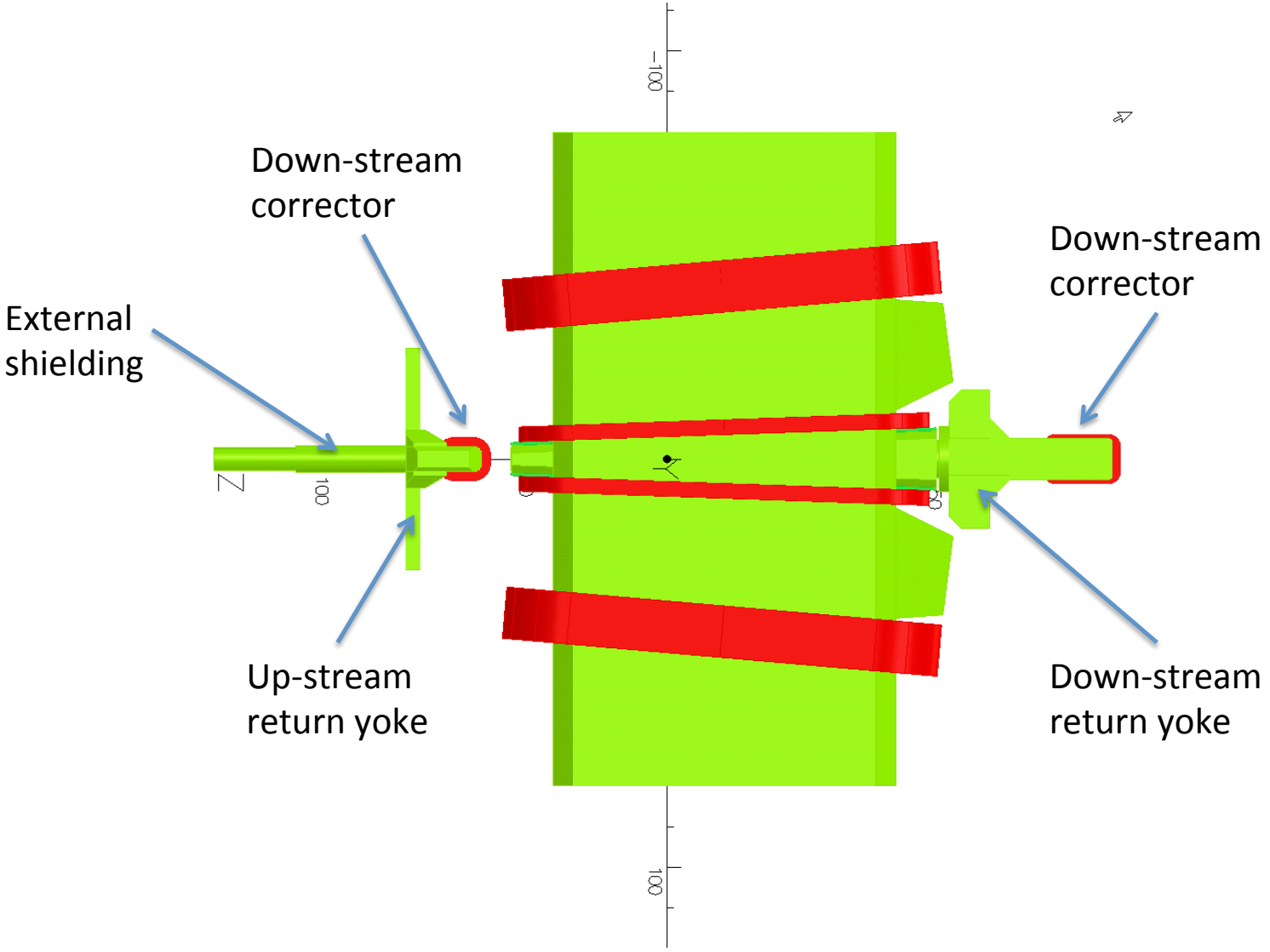
The vacuum chambers



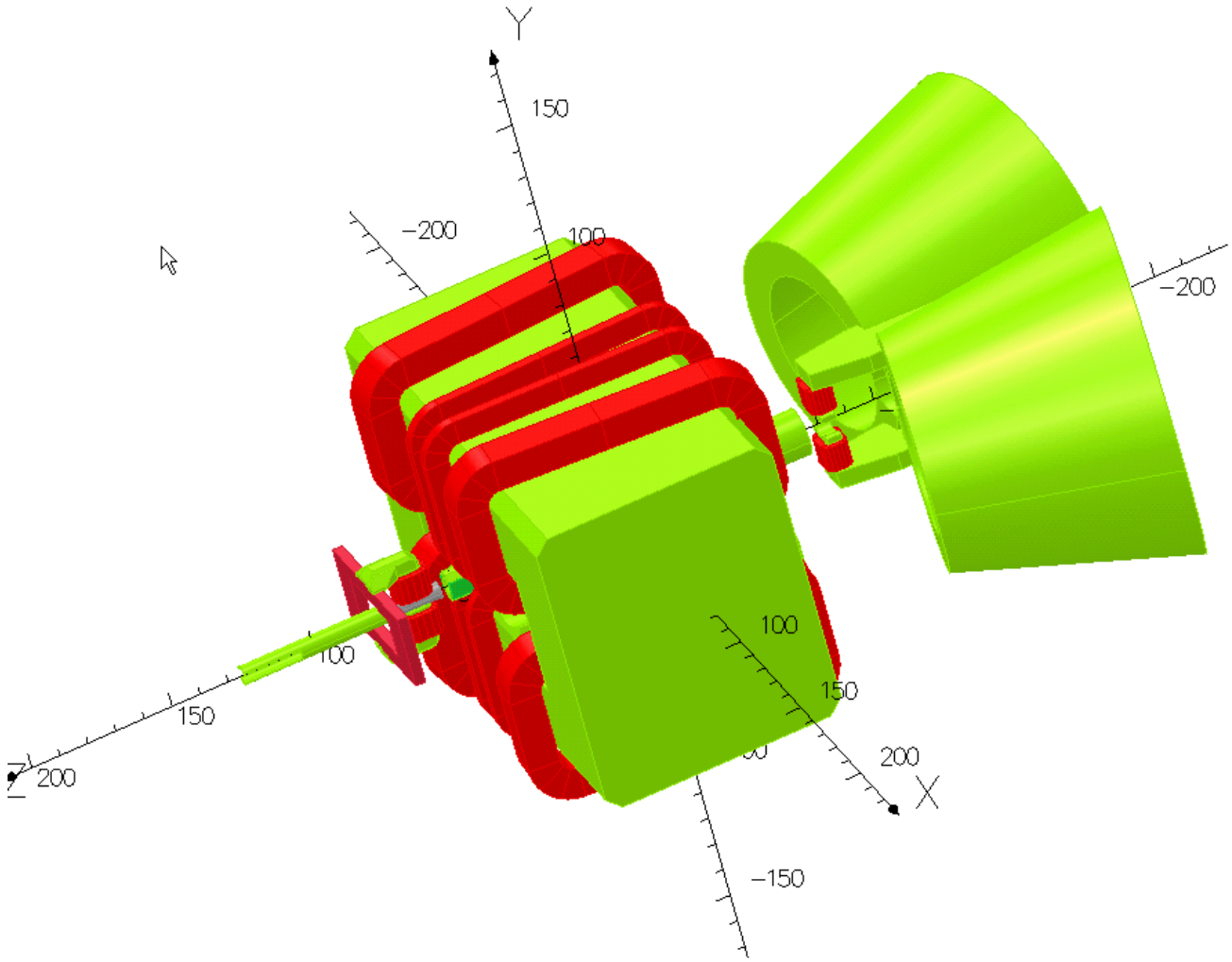
The correctors version #1



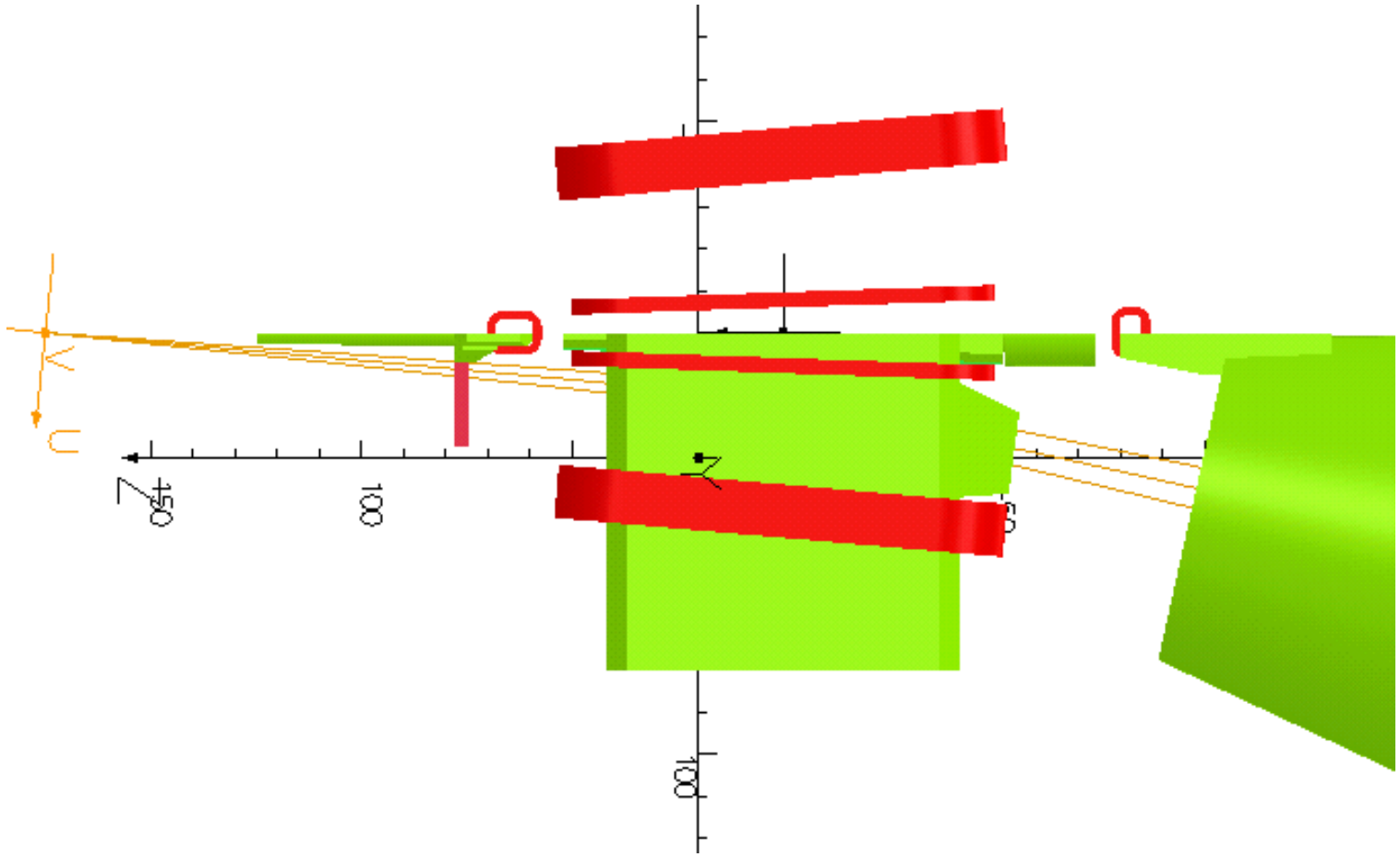
The correctors version #2



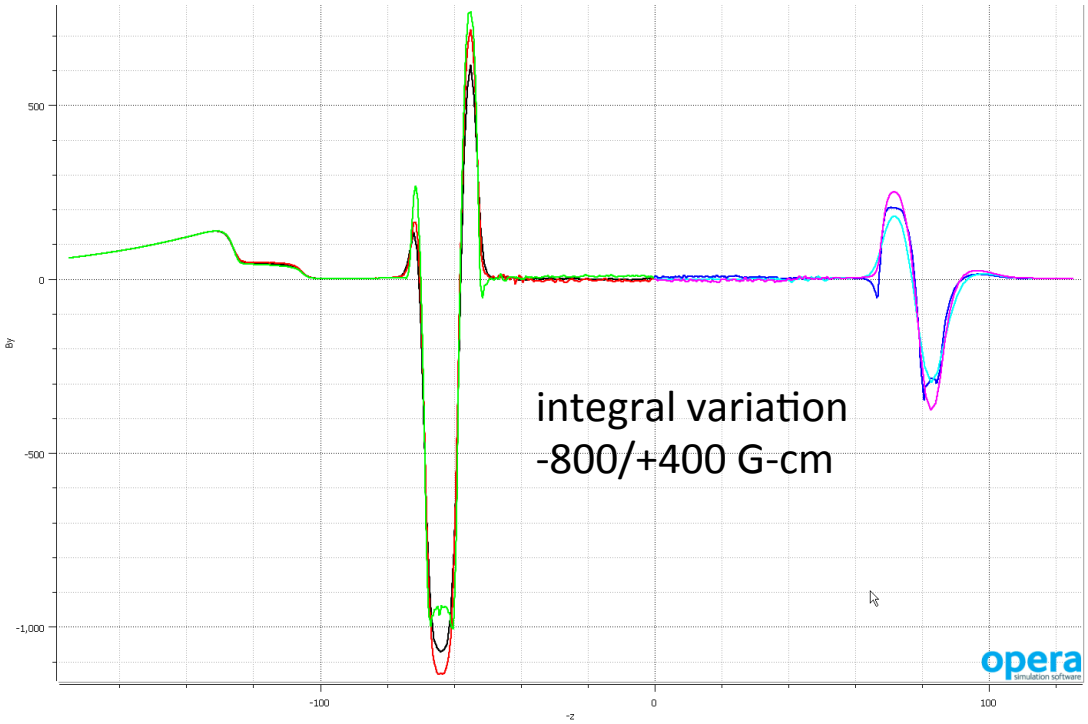
Magnet with correctors (v#3) and Q1s



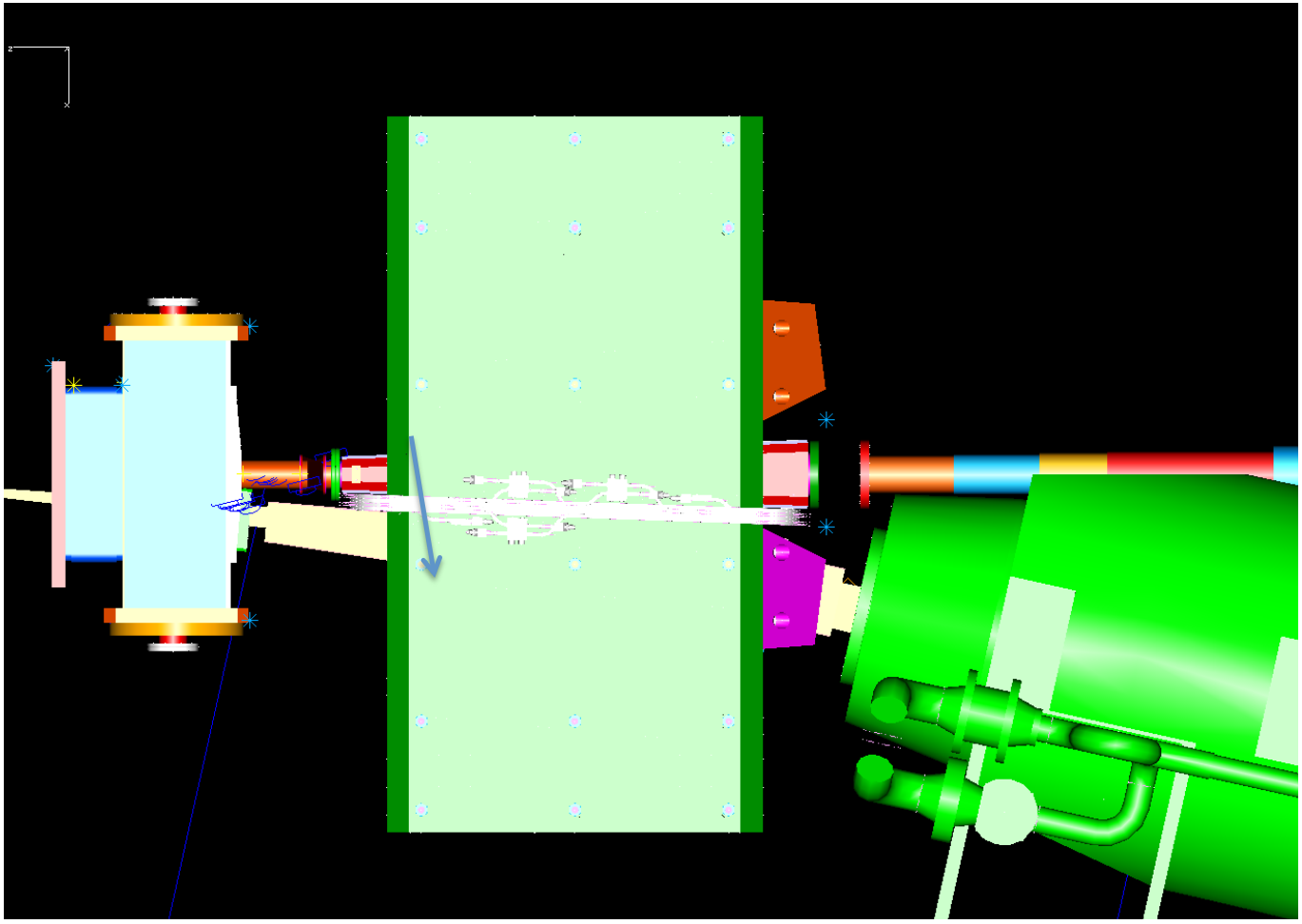
4, 5, and 6 degree trajectories

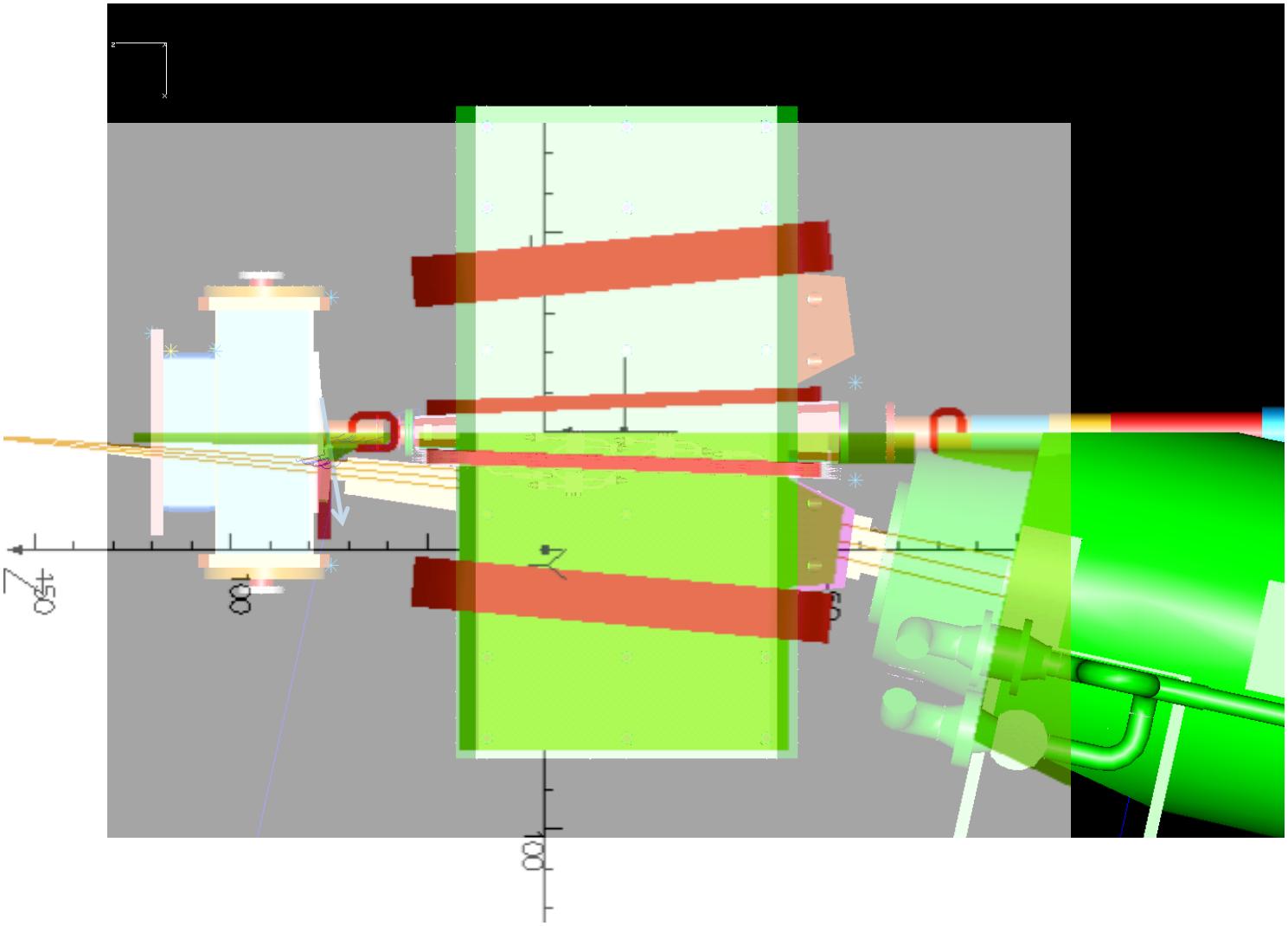


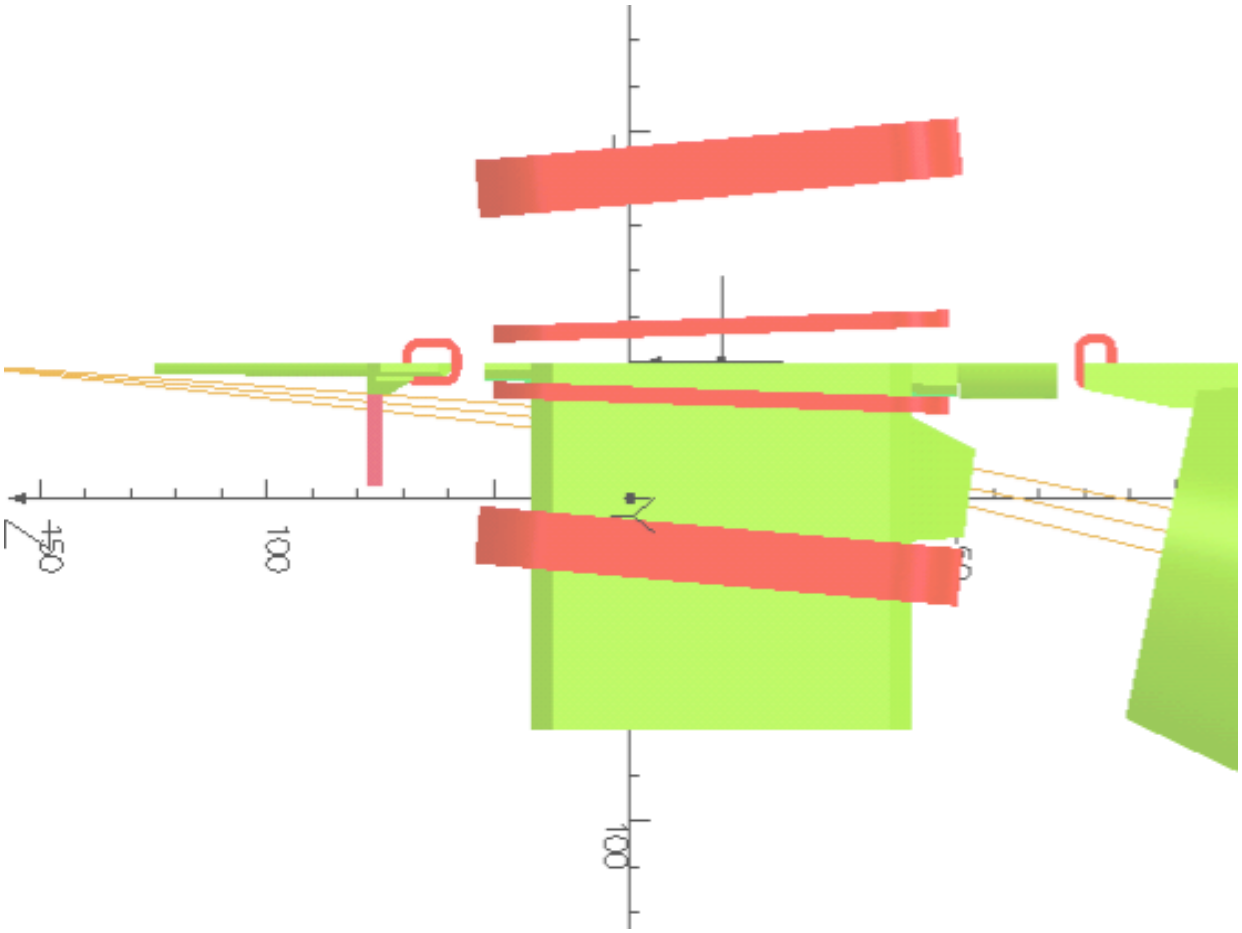
Field along the beam line (+/- 0.9 deg.)

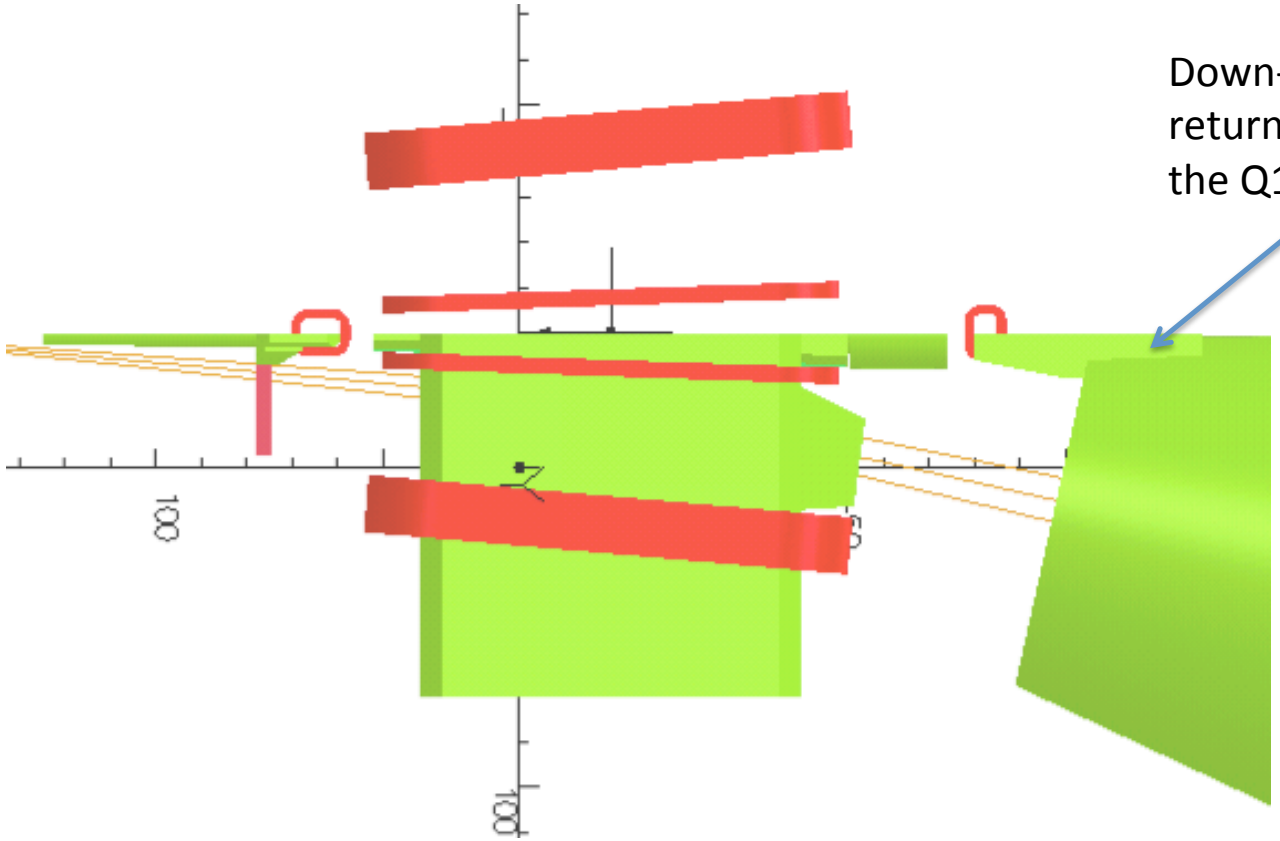


With a 4.4 GeV beam energy this residual field leads for a deviation of the 100 MeV electron trajectory from the beam line axis by max 1 cm

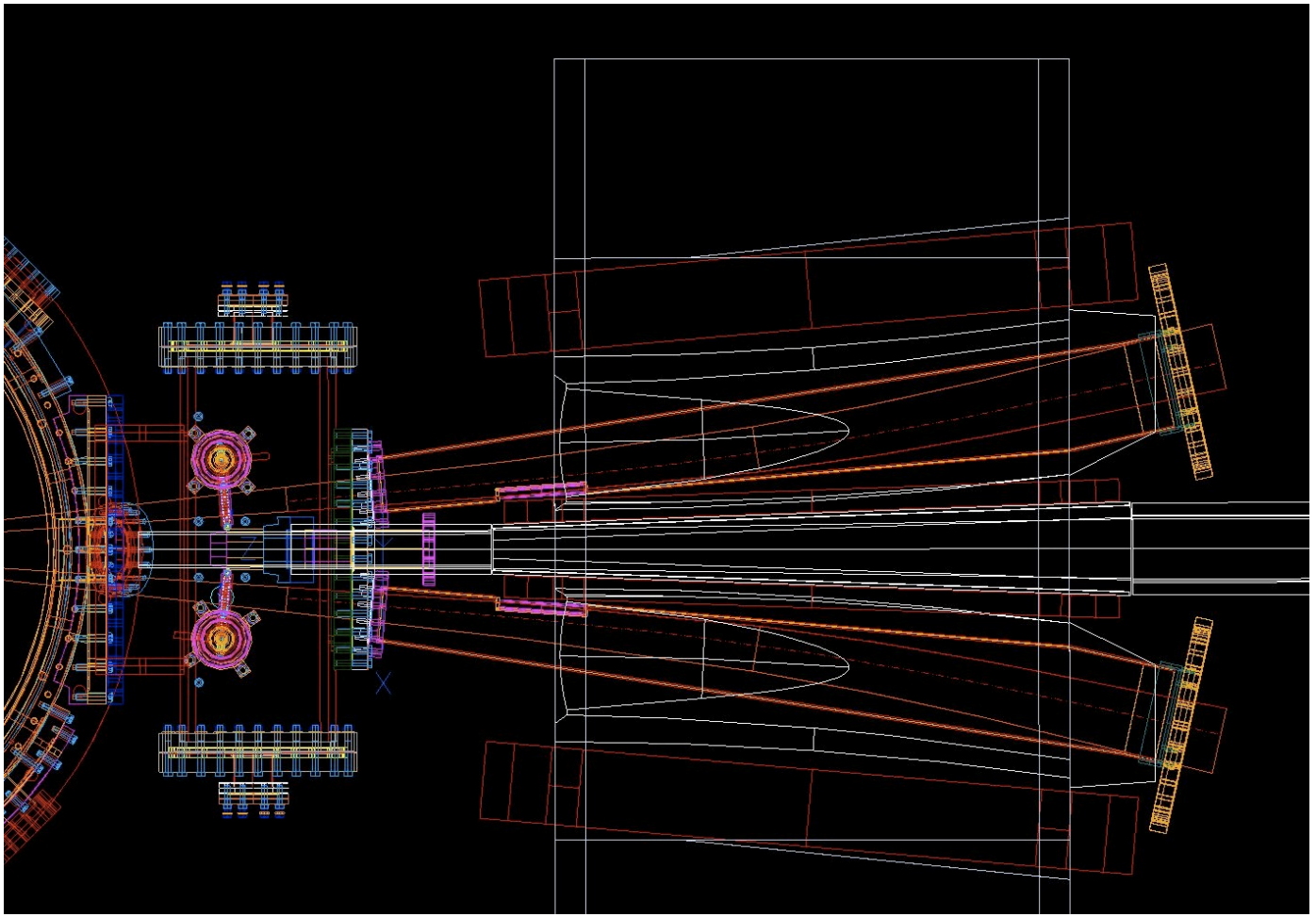



Z
150
100
100
50

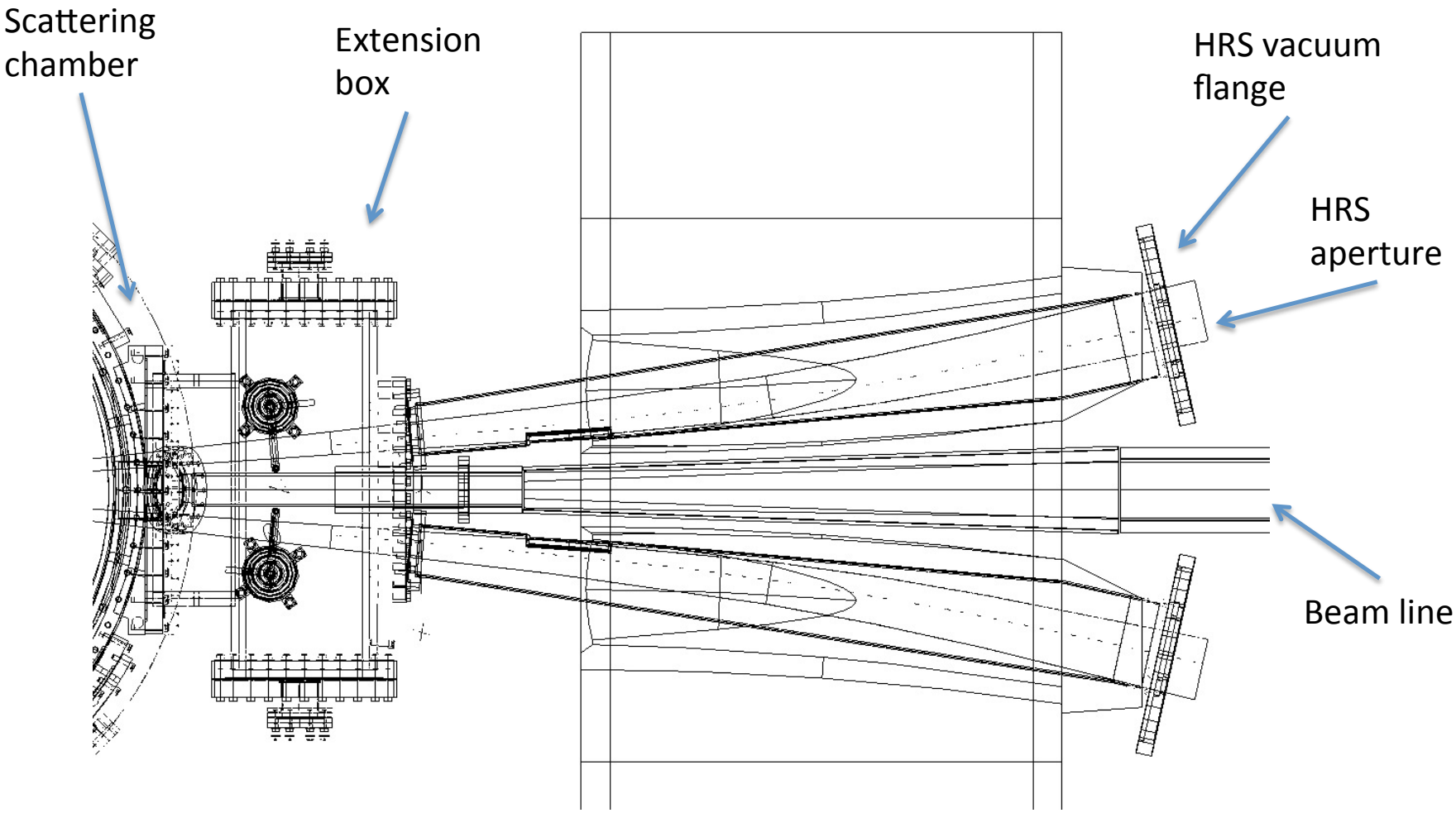

Z
150
100
100
69


Down-stream
return yoke use
the Q1 body

Top view of the magnet and vacuum chambers

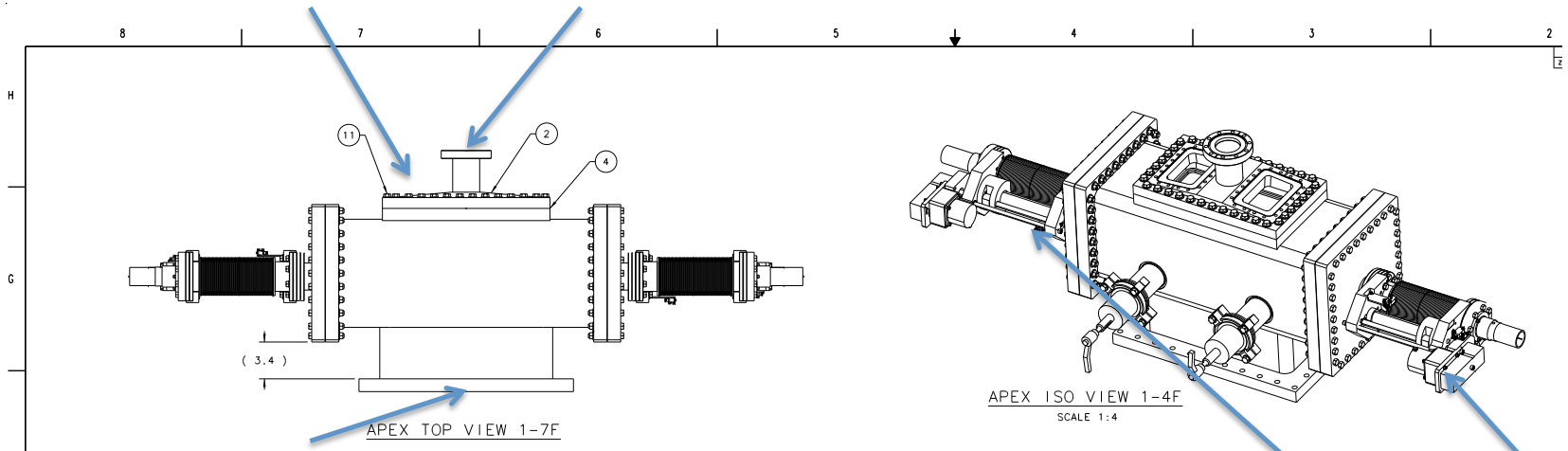


New septa geometry and vacuum items

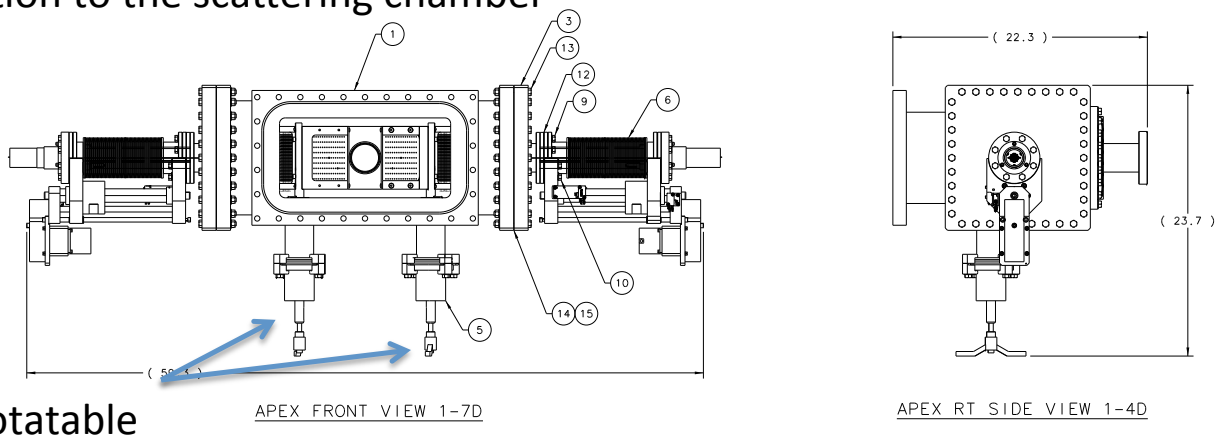


Extension box between the scattering chamber and the septum magnet

Connection to the HRSs and beam line



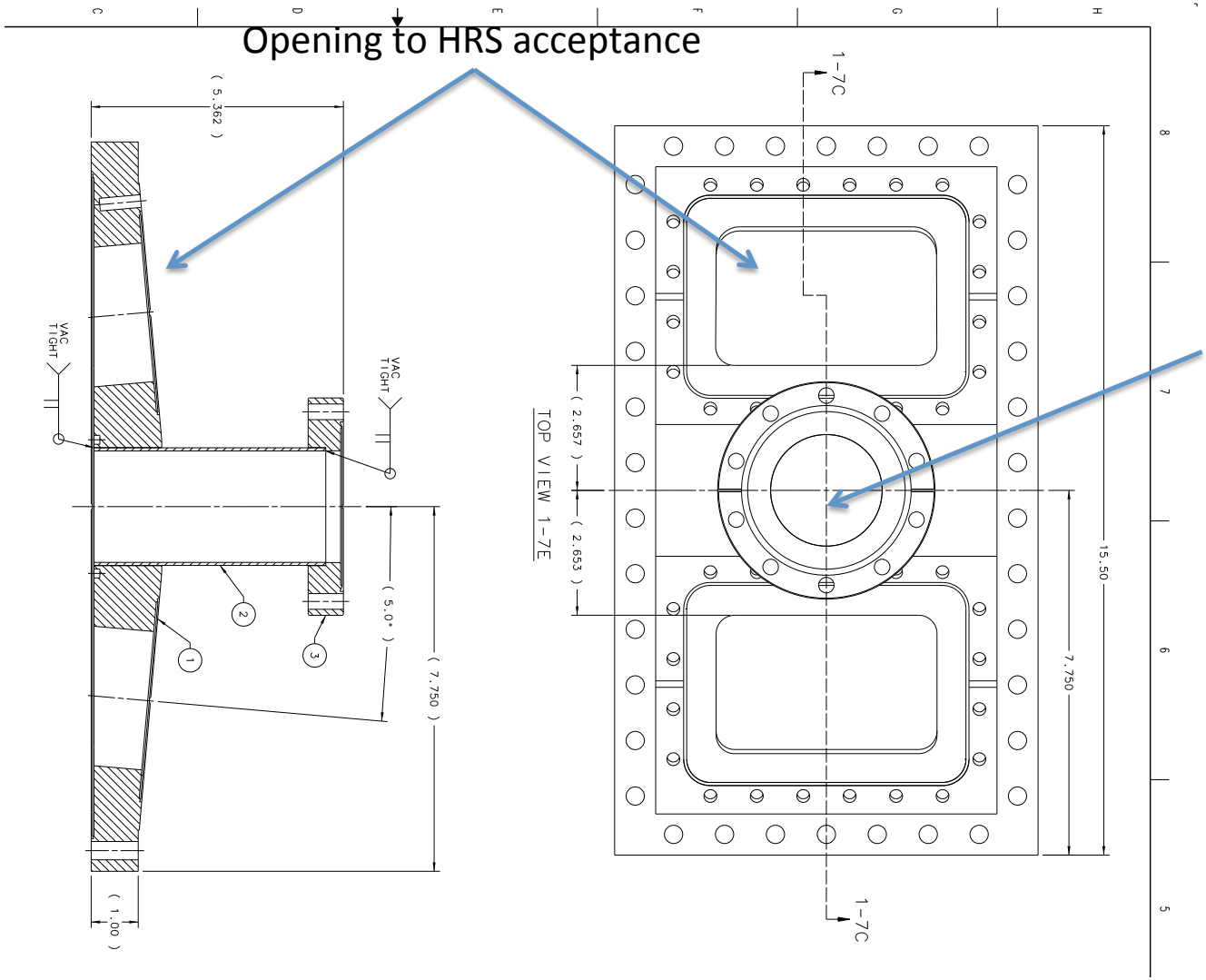
Connection to the scattering chamber



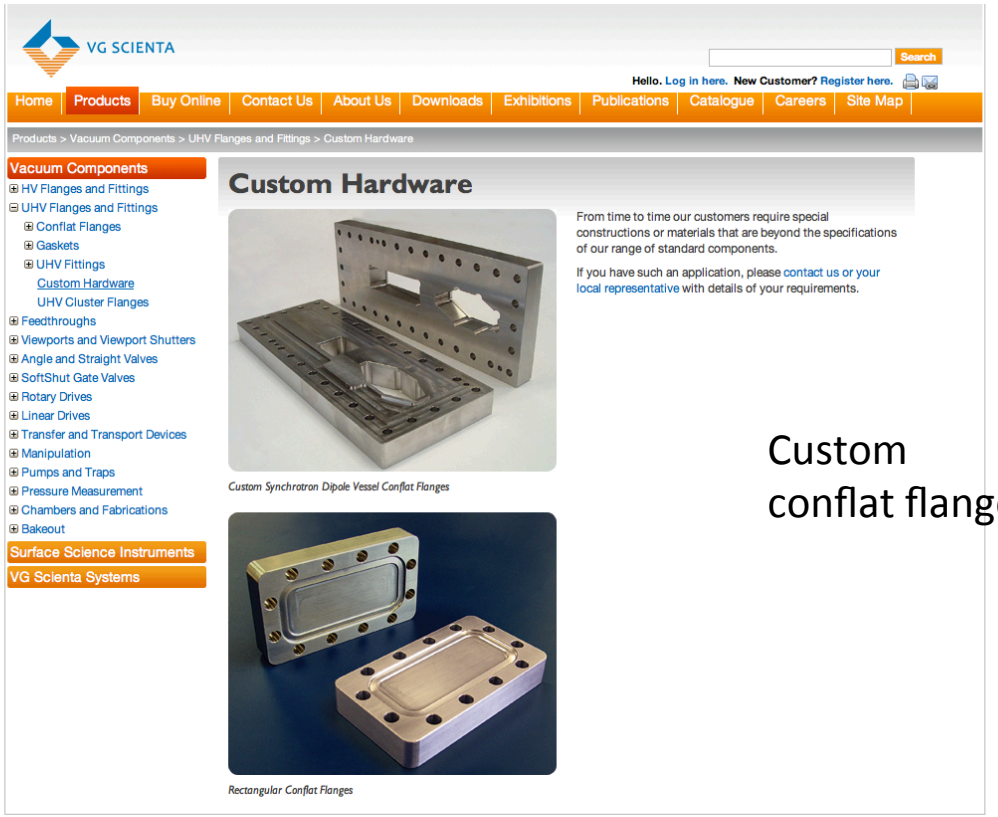
SciFi detector motion mechanisms

Rotatable tungsten sieve slits

Extension box flange

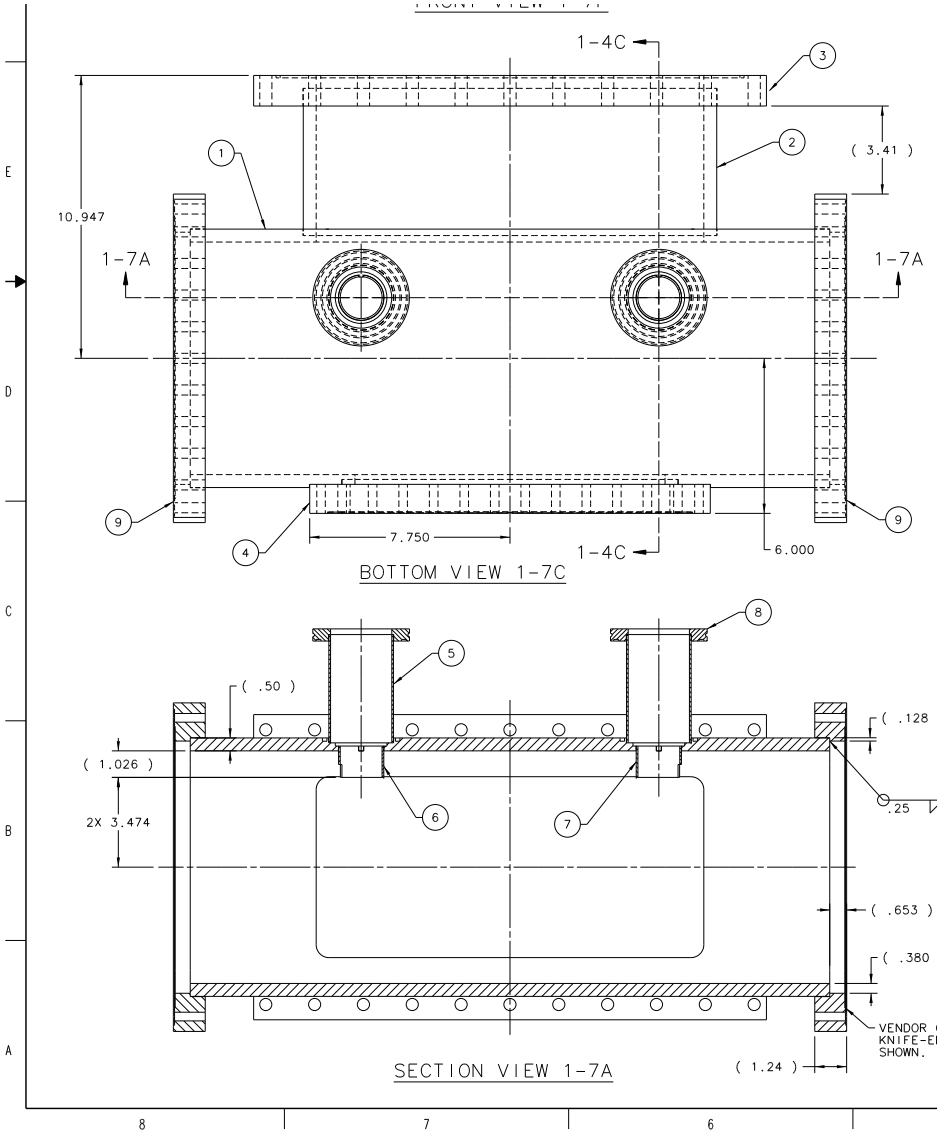


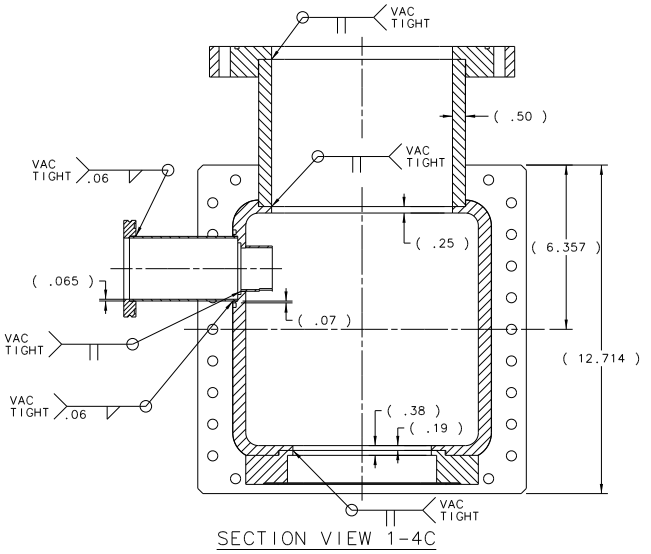
Extension box flange



Custom conflat flanges

Extension box between the scattering chamber and the septum magnet





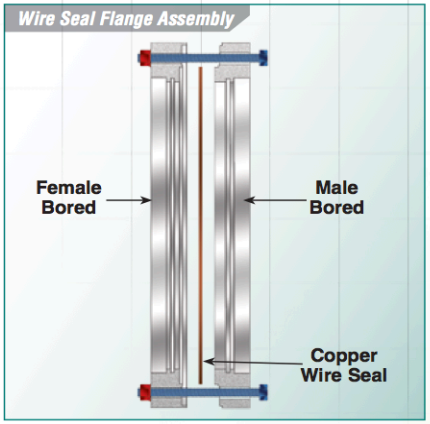
Construction cost was estimated by vendor at $40k in 2012.

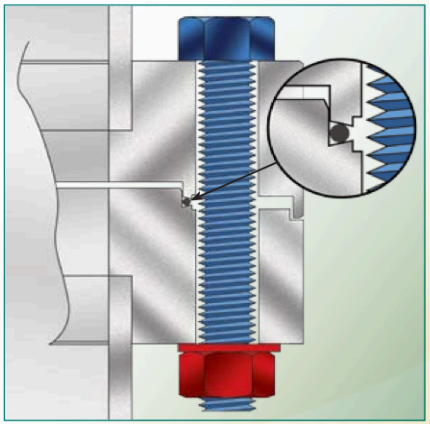
Large cost/weight due to use of the custom copper conflat seals and massive 0.5” walls

A new design will use

1. Viton o-ring for SciFi flanges
2. Soft Al wire seals for HRS lines
3. Round conflat for the beam line
4. Thinner walls of extension box: 0.25”

Wire Seal Flange System





The Wire Seal flange system provides a complete range of flanges to mount with tubing sized 10" up to 24" outer diameter. The Wire Seal assembly consists of 3 types of sub-components, two flanges, a sealing gasket and a fastener to compress the seal between the two flanges.

Wire Seal Flanges are available two general designs; Male and Female. Female flanges accept the sealing gasket while the male flange has a protruding circular ridge that fits into the gasket groove on the receiving female flange. Upon compression the gasket material cold flows under this pressure and fills microscopic surface imperfections on the sealing surfaces creating a vacuum tight seal capable of withstanding temperature extremes from –200°C up to 450°C and pressures as low as $1X10^{-13}$ Torr. There are no standard rotatable Wire Seal flanges so great care must be taken to specify bolt hole orientation on chambers and fittings that are assembled with these flanges.

Wire Seal Gaskets are made of either OFHC® electronic grade copper wire or Viton® elastomer. Copper gaskets are by far the most commonly used with the Wire Seal flange system and when compressed between the flanges provide a vacuum tight seal capable of achieving Ultrahigh Vacuum pressures and temperatures as high as 450°C. A&N does not recommend using a Wire Seal copper gasket for more than one seal. Viton® gaskets are capable of high vacuum pressures and temperatures as high as 150°C (204°C intermittent use). Viton® gaskets are reusable and can be used many times to make new vacuum tight seals.

Wire Seal Fasteners are hex-head bolts, nuts and washers made of high tensile strength stainless steel.

Wire Seal Assembly follows the same guidelines as the CF flange system except for the maximum torque ratings which are included on this page. *1

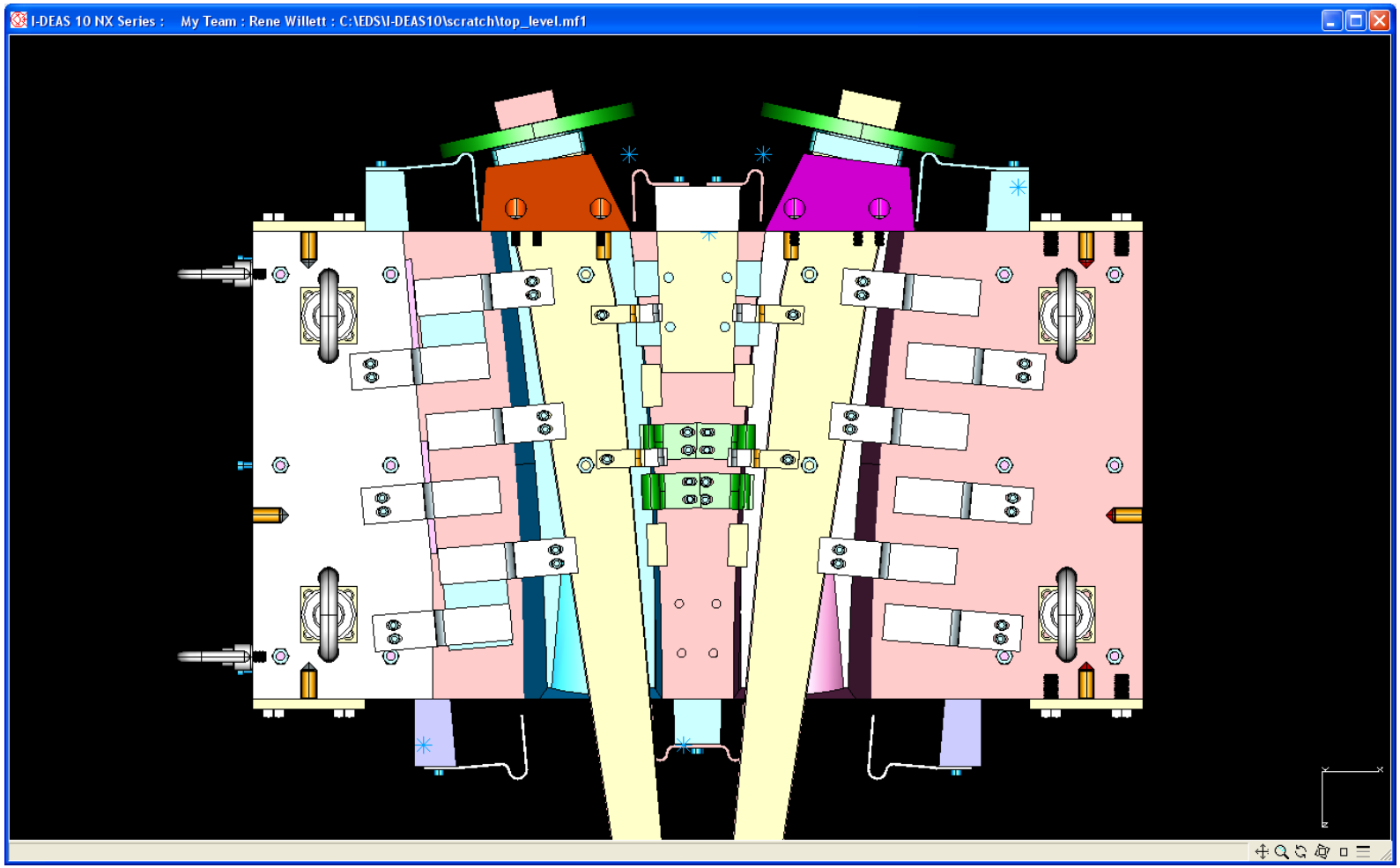
Wire Seal flanges are ideal for those applications that require large diameter ports and extremely low ultimate vacuum pressure. Common examples are bell jar systems, vacuum furnaces, deposition systems and environmental chambers.

Flange Size	Maximum Torque Copper Gasket	Viton® Gasket
WS1200	26 ft./lbs.	7-10 ft./lbs.
WS1400	26 ft./lbs.	7-10 ft./lbs.
WS1700	33 ft./lbs.	7-10 ft./lbs.
WS1900	33 ft./lbs.	7-10 ft./lbs.
WS2200	33 ft./lbs.	7-10 ft./lbs.
WS2700	33 ft./lbs.	7-10 ft./lbs.

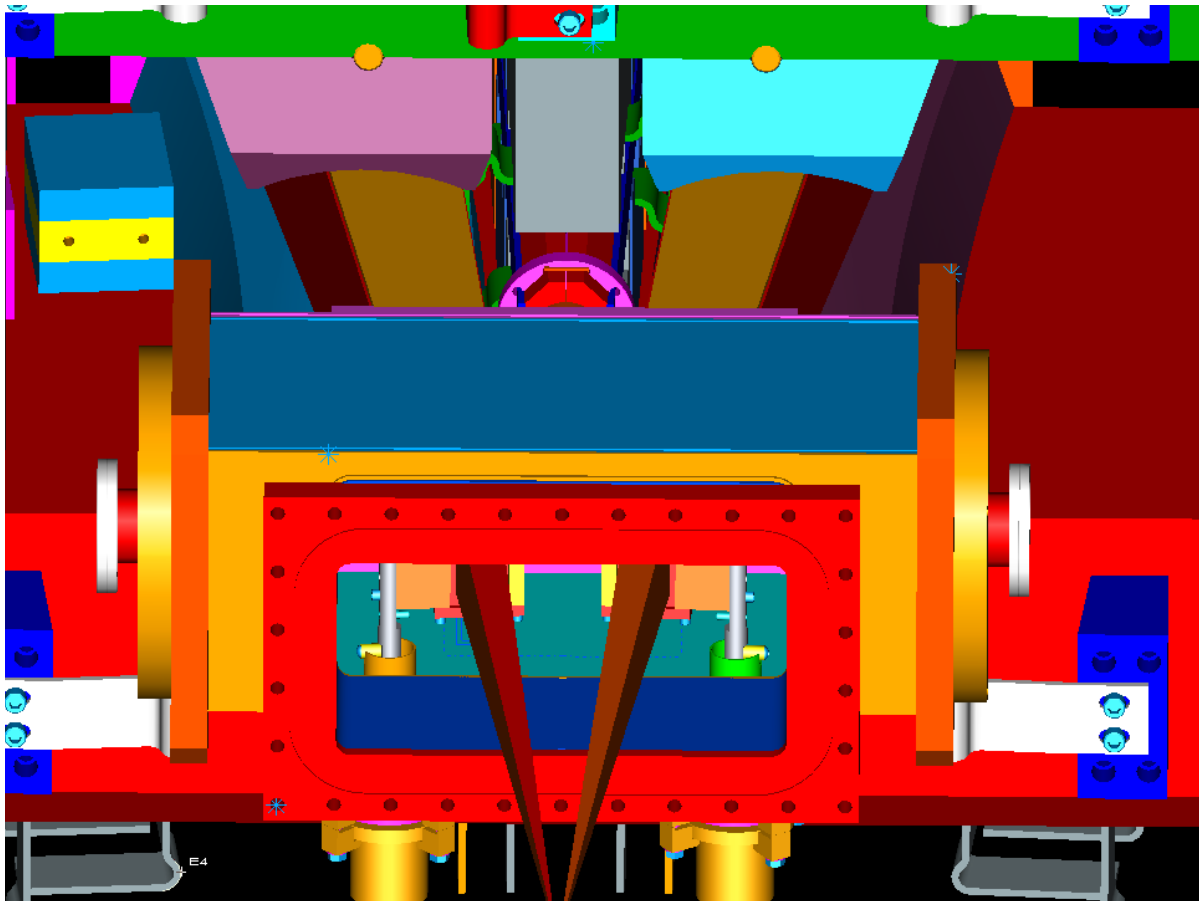
For More Info...
*1 See pg. 4.5 for CF assembly guidlines.

Copper wire seal design

View of the open septa magnet



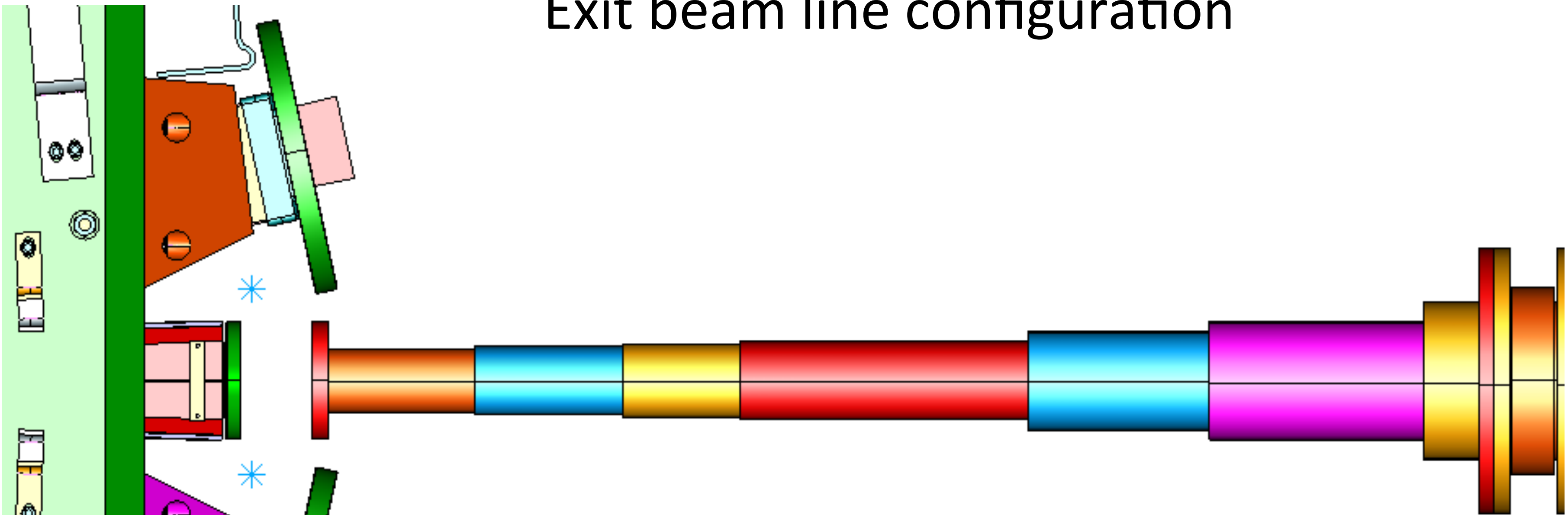
View from the target to the extension box

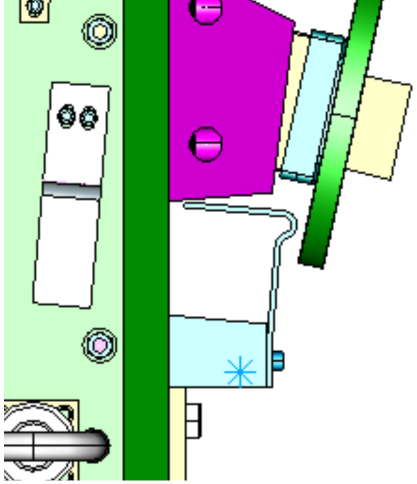


Summary/Plans

1. The correctors and vacuum chambers for APEX are on the design stage.
   Projected completion date is August 2014.
2. To do list after design completion:
   - check of the drawings by Hall A engineer
   - find qualified vendors, get budget estimates
   - identify funding by September 2014
   - order in October 2014
   - acceptance check in May 2015
   - vacuum/installation checks in June 2015

Exit beam line configuration





Item (end)	OD	ID(“)	distance to ref. point	th(HRS)/th(old)	req. ID(“)(1.1 deg)
flange	3.25	3.01	25.1”	1.64/0.92	3.61”
orange	3.50	3.26	33.3”	1.53/0.91	3.92
cyan	3.75	3.51	40.8”	1.47/0.92	4.21
yellow	4.00	3.76	46.3”	1.46/0.94	4.42
red end		4.76	61.4”	1.53/1.05	5.00
blue end		5.76	70.6”	1.68/1.18	5.36
magenta		7.83	81.5”	2.06/1.49	5.76

Distance: the hall pivot to the ref. point (with Septa) is 175 cm (68.9”)

Distance: the hall pivot to the ref. point is 70 cm (27.6”)

Old Extension Box