Beamline Review : design, installation, slow-control

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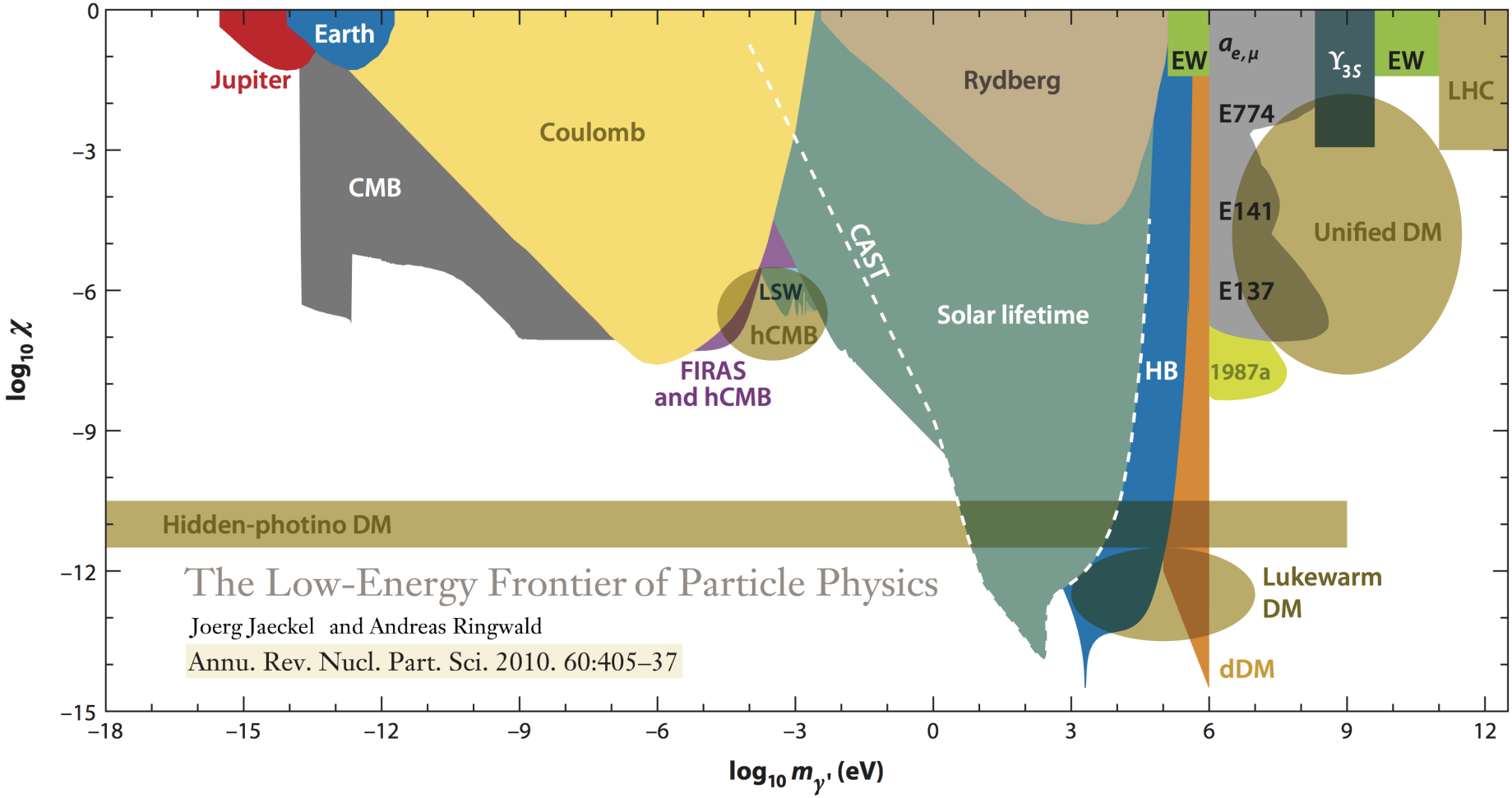
JLab Hall-B

HPS Dec. 16th'13

Hidden photon constraints

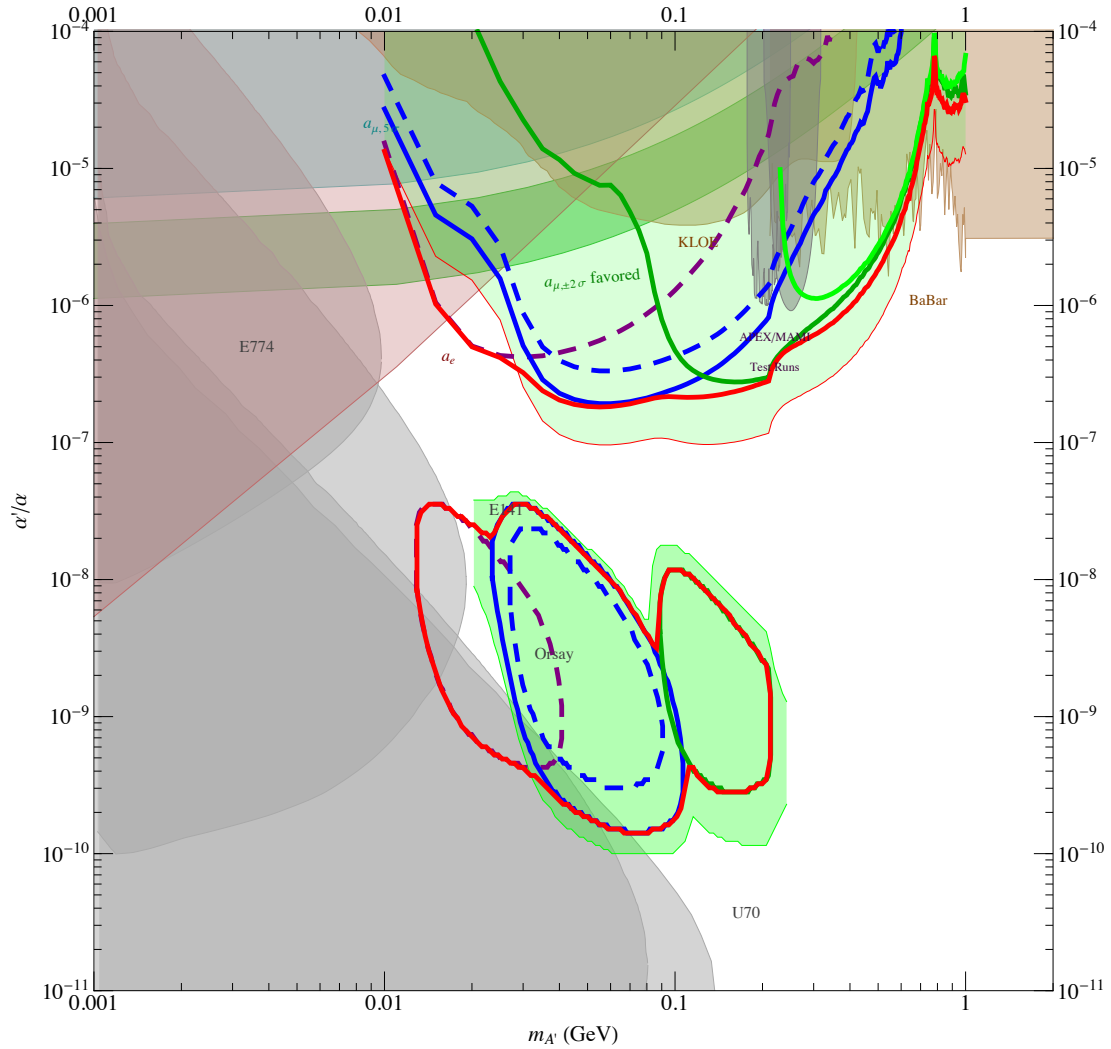


HPS reach

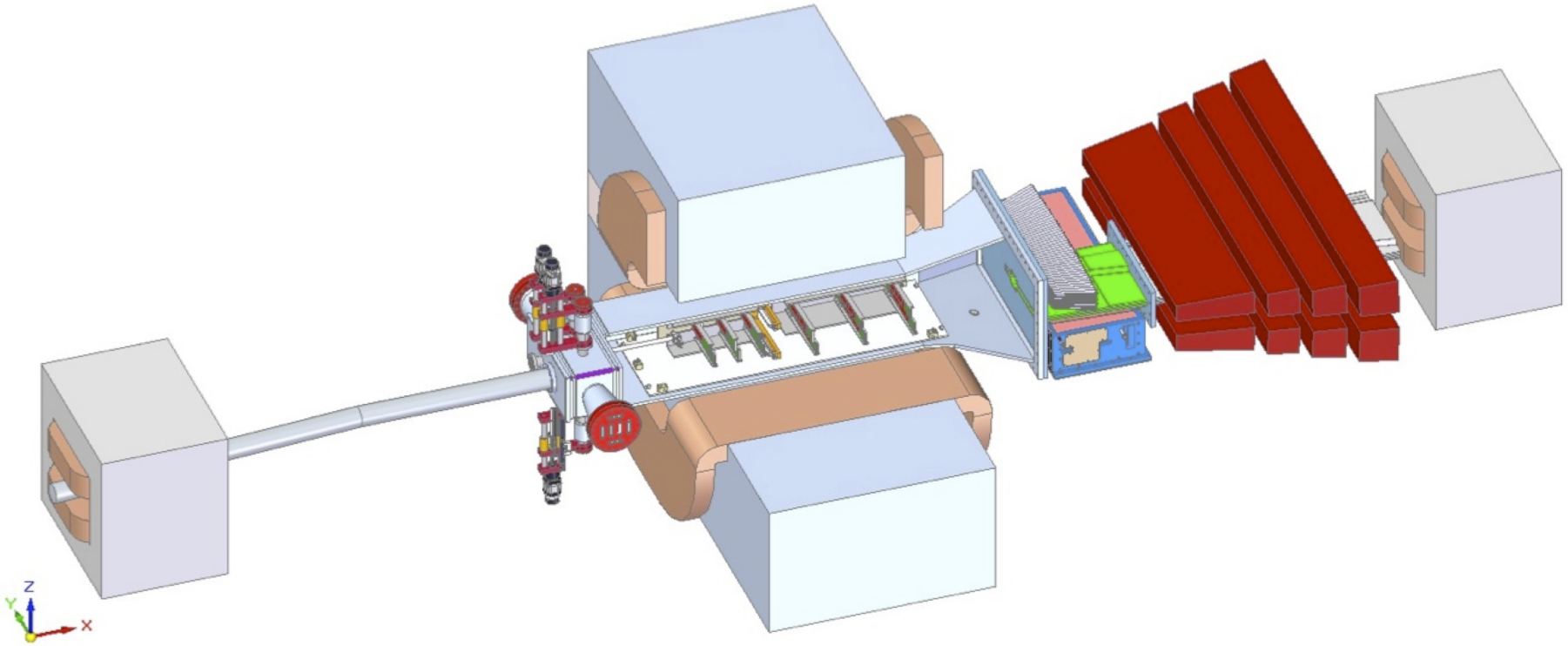
Approved by PAC for 180 days

- engineering run FY15 (Q1-Q3)
  commissioning and data taking
  1.1 and 2.2 GeV
- Production FY16-17
  2.2 and 6.6 GeV (4 weeks each)

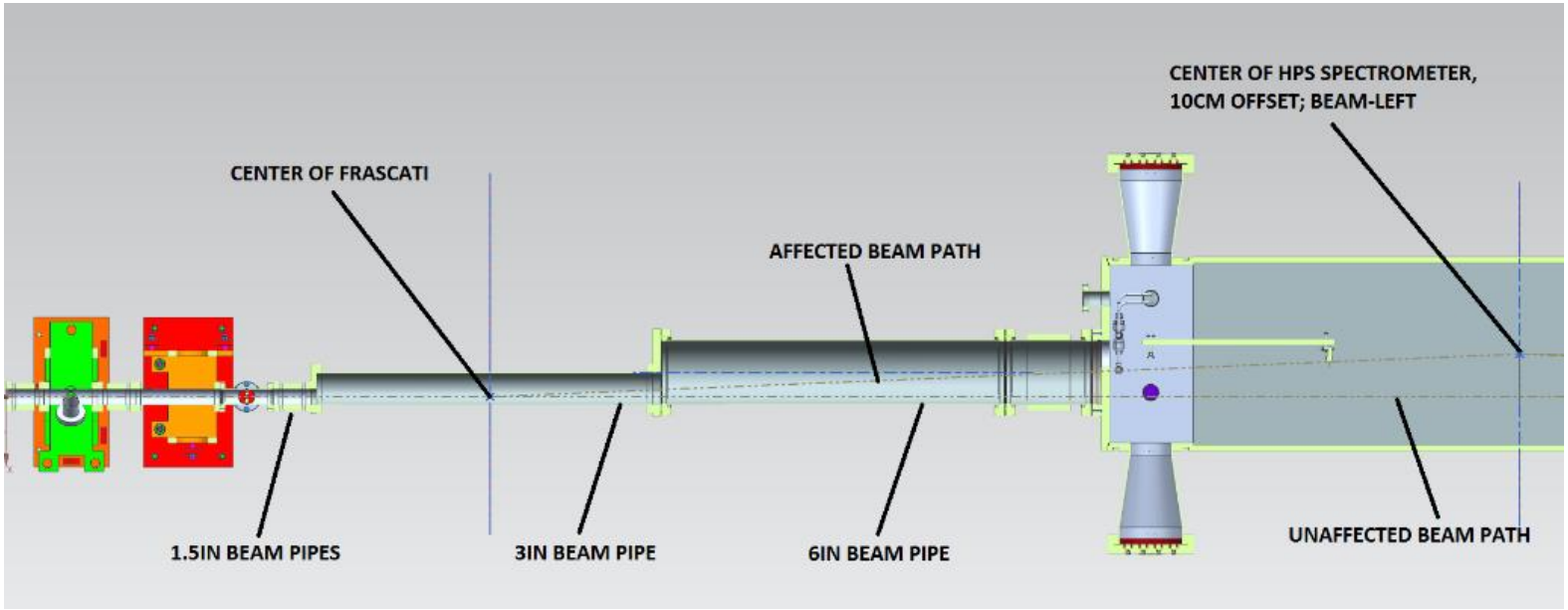
- dashed : 1 week 1.1GeV
- dashed : 1 week 2.2 GeV
- solid : 3 weeks 2.2 GeV
- e^+e^- 2 weeks of 6.6 GeV
- $\mu^+\mu^-$ 2 weeks of 6.6 GeV
- combination of above
- Green shade : 3 months
  2.2 and 6.6 GeV

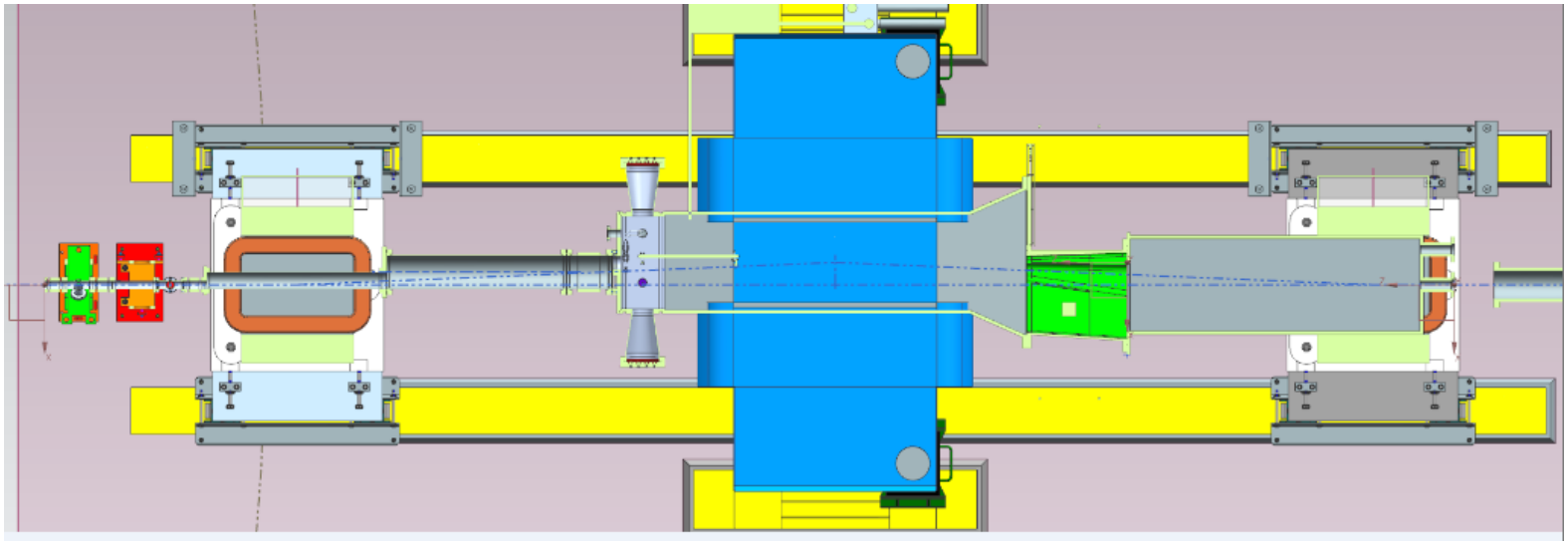


HPS detector



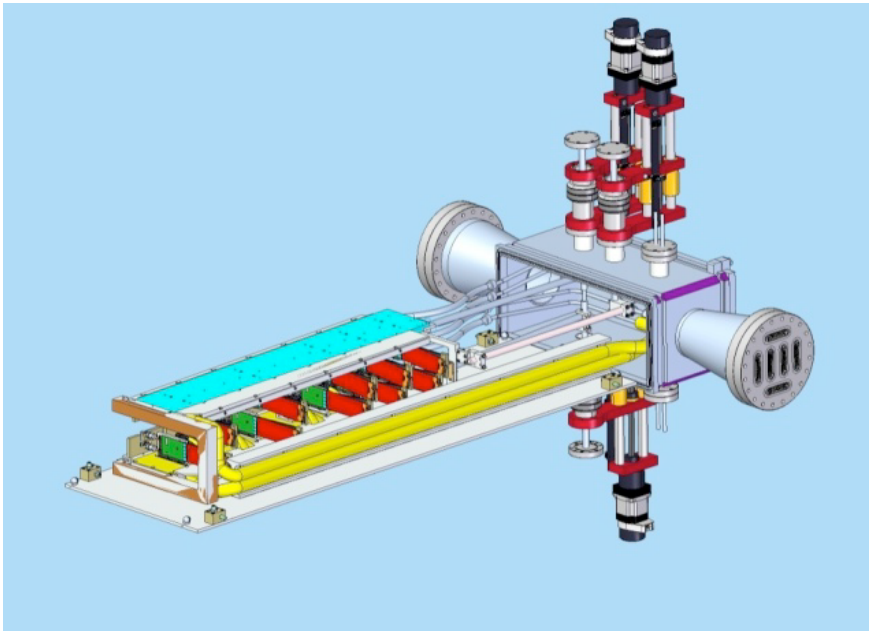
HPS beamline

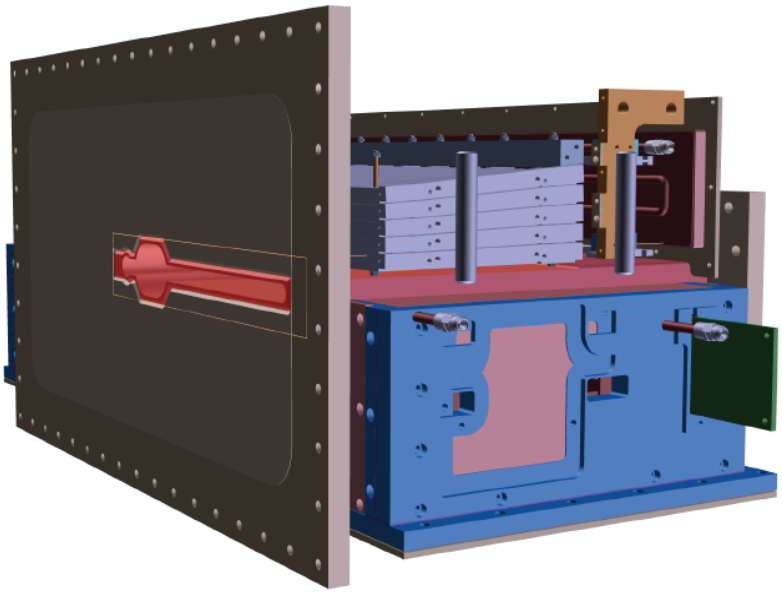




HPS split design

- Both the Silicon Vertex Tracker (SVT) and the Ecal are split vertically, to avoid the "sheet of flame".



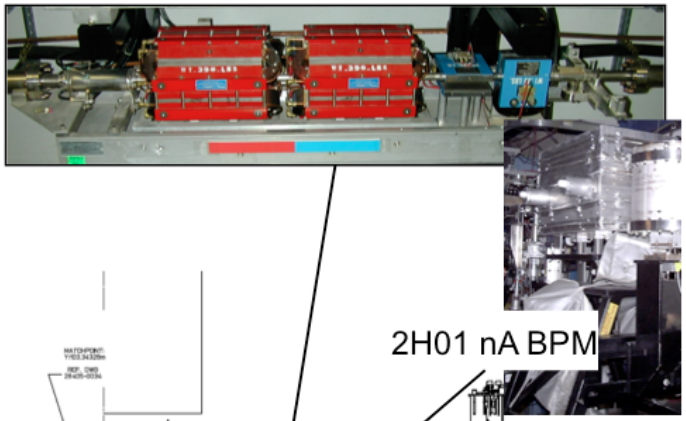


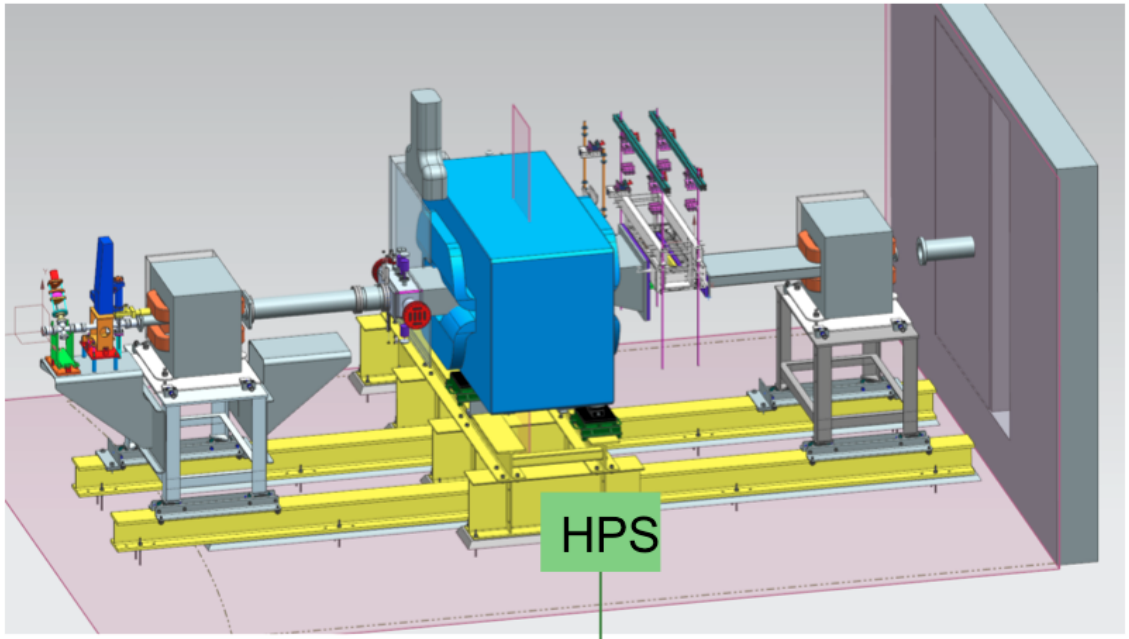
- The first layer of the SVT comes within 0.5 mm of the beam to allow acceptance at 15 mrad, so precision movers, working in vacuum, are needed to position it accurately w.r.t. the beam
- The beam passes between the upper and lower halves of the Ecal through the Ecal vacuum chamber, which accommodates the photons radiated at the target, the multiple scattered electron beam, and the "sheet of flame".

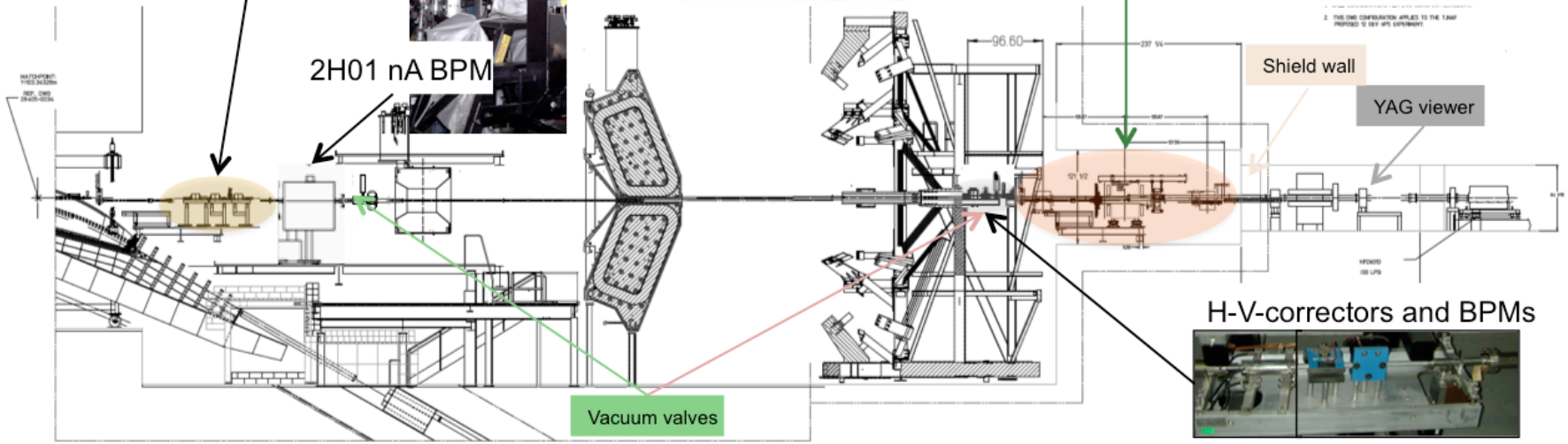
HPS installation

- Most of Hall-B beam line will be unchanged
- Two new girders – one on space frame, one on forward carriage

BPM, 2-QA, and H-V-correctors







H-V-correctors and BPMs

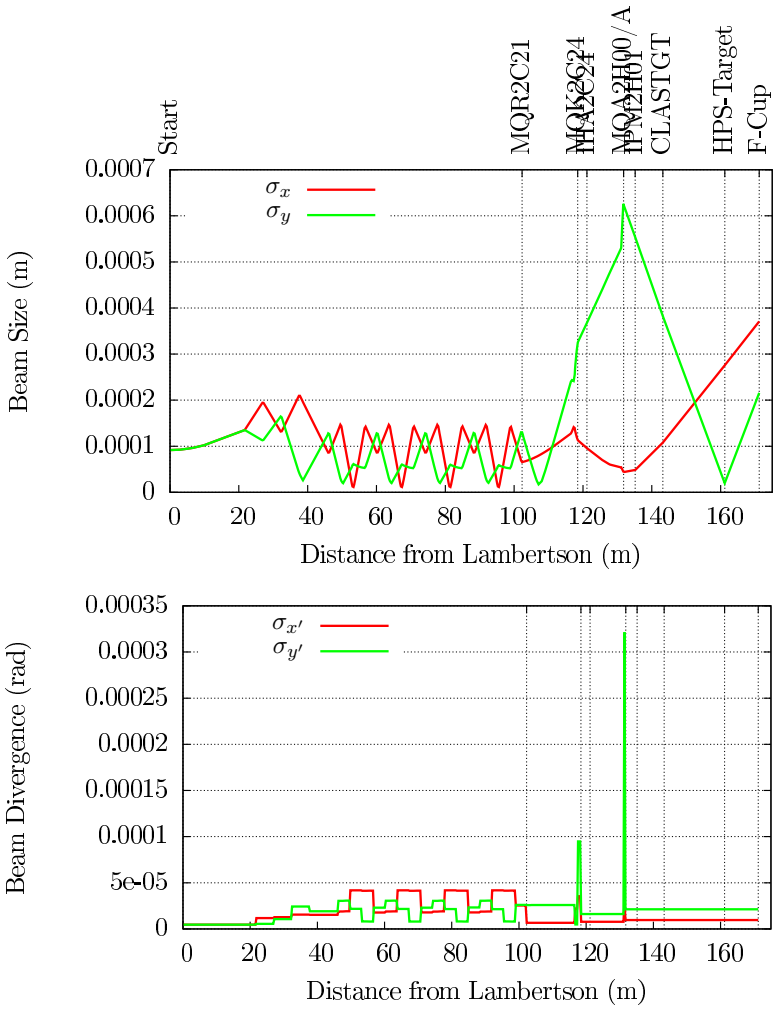
HPS beamline elements

Element Name	Distance to Start (m)	Distance to Center of Hall (m)	Owner	Comment
MQR2C20	98.92856	-44.27891		
IPM2C21	101.76391	-41.44356		
MQR2C21	102.13825	-41.06922		
MQA2C21A	103.56545	-39.64202		
IHA2C21	104.37045	-38.83702	Hall-B:	
IPM2C21A	105.56825	-37.63922		
IPM2C22	116.34875	-26.85872		
MQK2C22	116.69875	-26.50872		
MQK2C23	117.44023	-25.76724		
MQK2C24	118.30841	-24.89906		
IPM2C24A	118.66841	-24.53906		
IHA2C24	121.15381	-22.05366	Hall-B:	
ATAGGER	125.5601	-17.64737		
COLA	127.9221	-15.28537		
IPM2H00	130.9221	-12.28537	Eng.	New
MQA2H00	131.29675	-11.91072	Eng.	Spare
MQA2H00A	131.59675	-11.61072	Eng.	Spare
MBD2H00H	131.93990	-11.26757	Eng.	Spare
MBD2H00V	132.13599	-11.07148	Eng.	Spare
ITV2H01	135.16210	-8.04537	Eng.	Existing nA stand
IPM2H01	135.16210	-8.04537	Eng.	recommission
CENTEROFHALL	143.20747	0		
IPM2H02	155.20747	12. ?	Eng:	New
MBD2H02H	155.20747	12. ?	Eng.	New, precise
MBD2H02V	155.20747	12. ?	Eng:	New, location TBD
IPM2H03	157.27529	14.06782	Eng:	New
IHA2H03	157.27529	14.06782	HPS:	Moved 2H00 Harp
ETA2H03	157.68647	14.47900	HPS:	Collimator
ETA2HHPS	160.23815	17.03068	HPS:	
IFY2D00	170.23815	27.03068	HPS:	

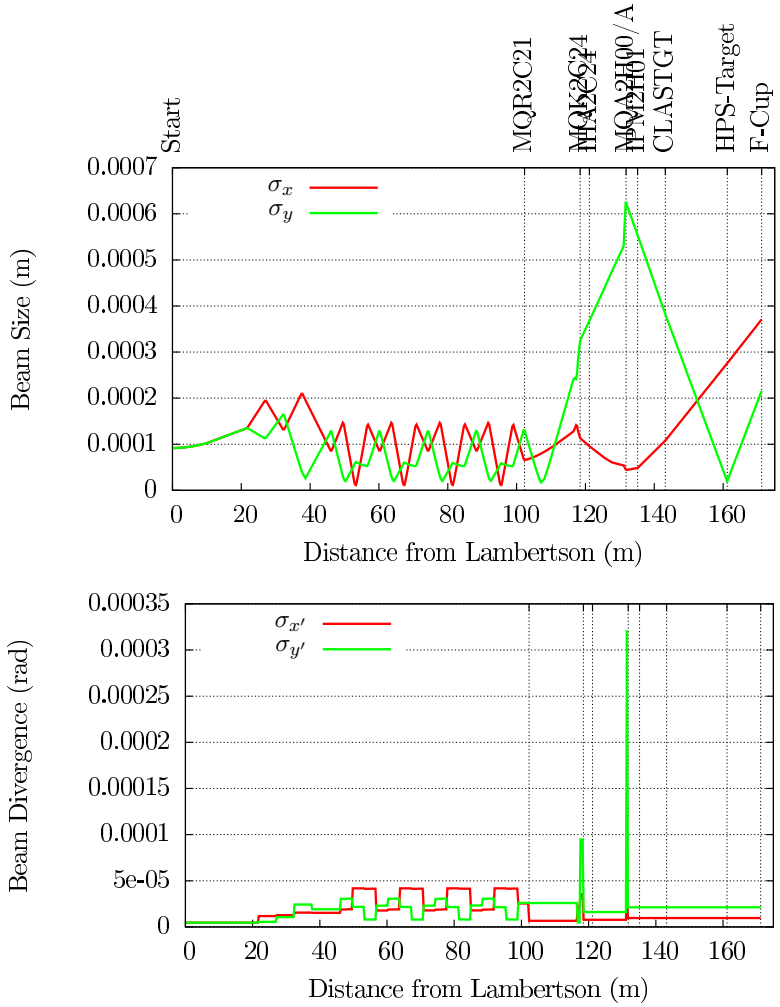
HPS beam requirements

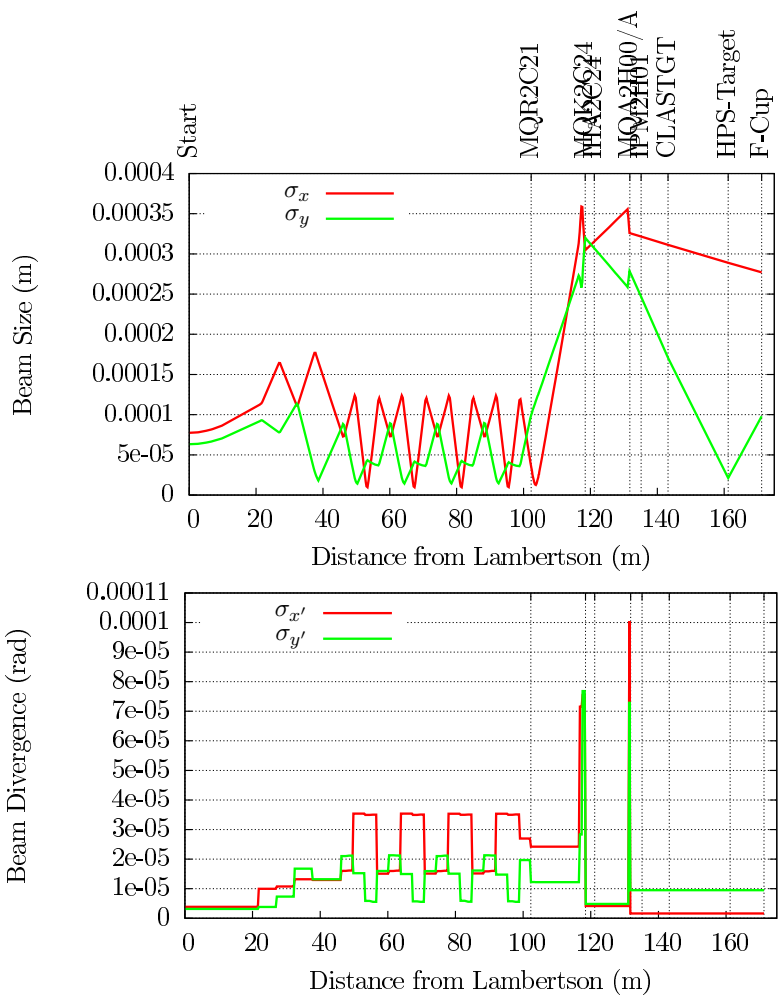
Parameter	Requirement			Unit
E	1100	2200	6600	MeV
δE/E	$< 10^{-4}$			
Current	< 200	< 400	< 500	nA
Current Instability	< 5			%
σ_x	< 300			μm
σ_y	< 50			μm
Position Stability	< 30			μm
Divergence	< 100			μrad
Beam Halo ($> 5\sigma_Y$)	$< 10^{-5}$			

asymmetric beam to improve track momentum resolution, without overheating the target foil
fast feedback orbit locks for beam position stability
vacuum throughout the system to keep occupancies low



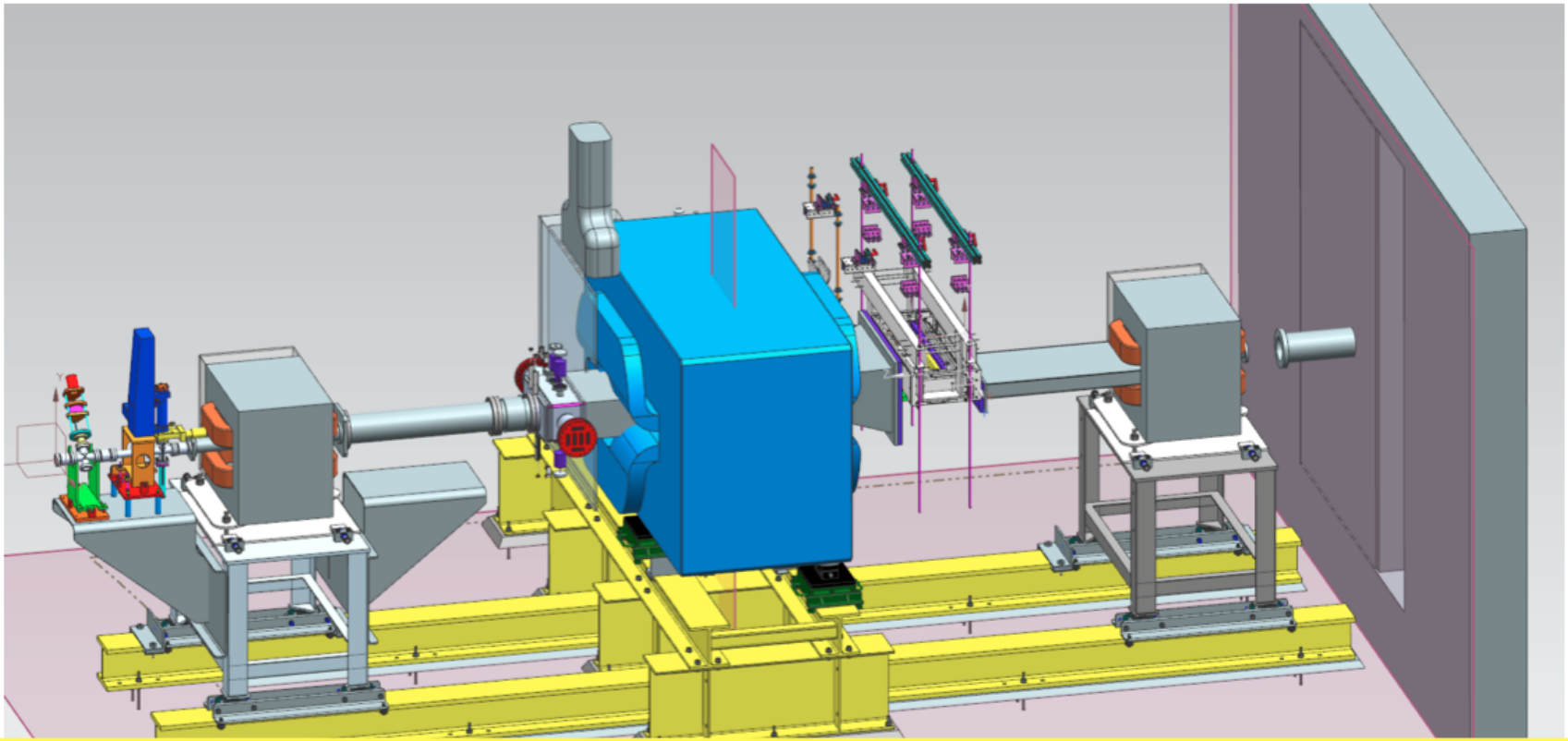
HPS beam requirements





HPS installation

- Design of major parts of the magnet supports are complete
- Drawings will be ready for purchasing components in December
- Most of beamline elements do exist

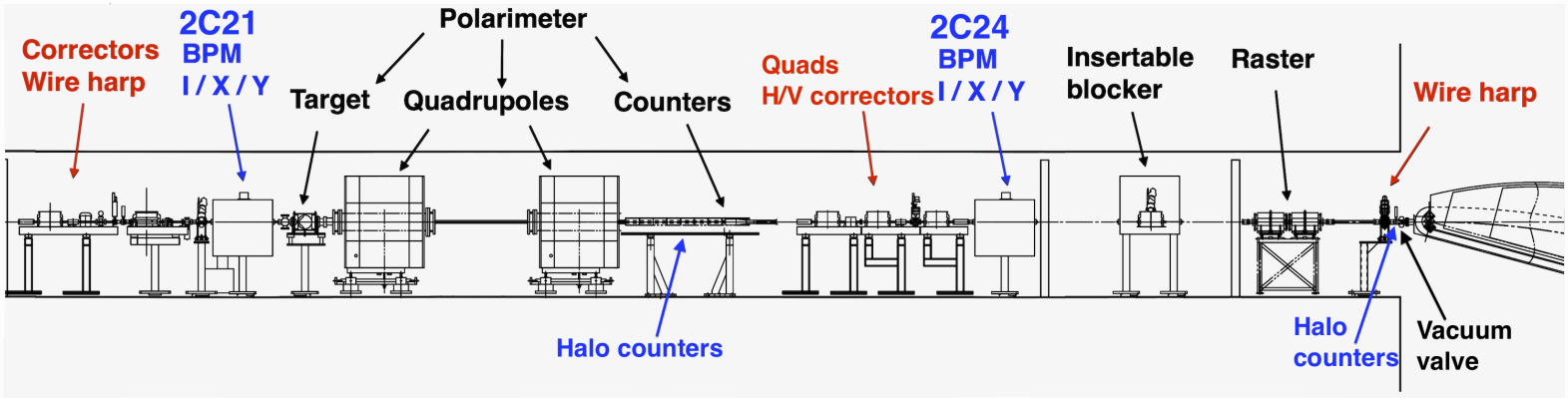


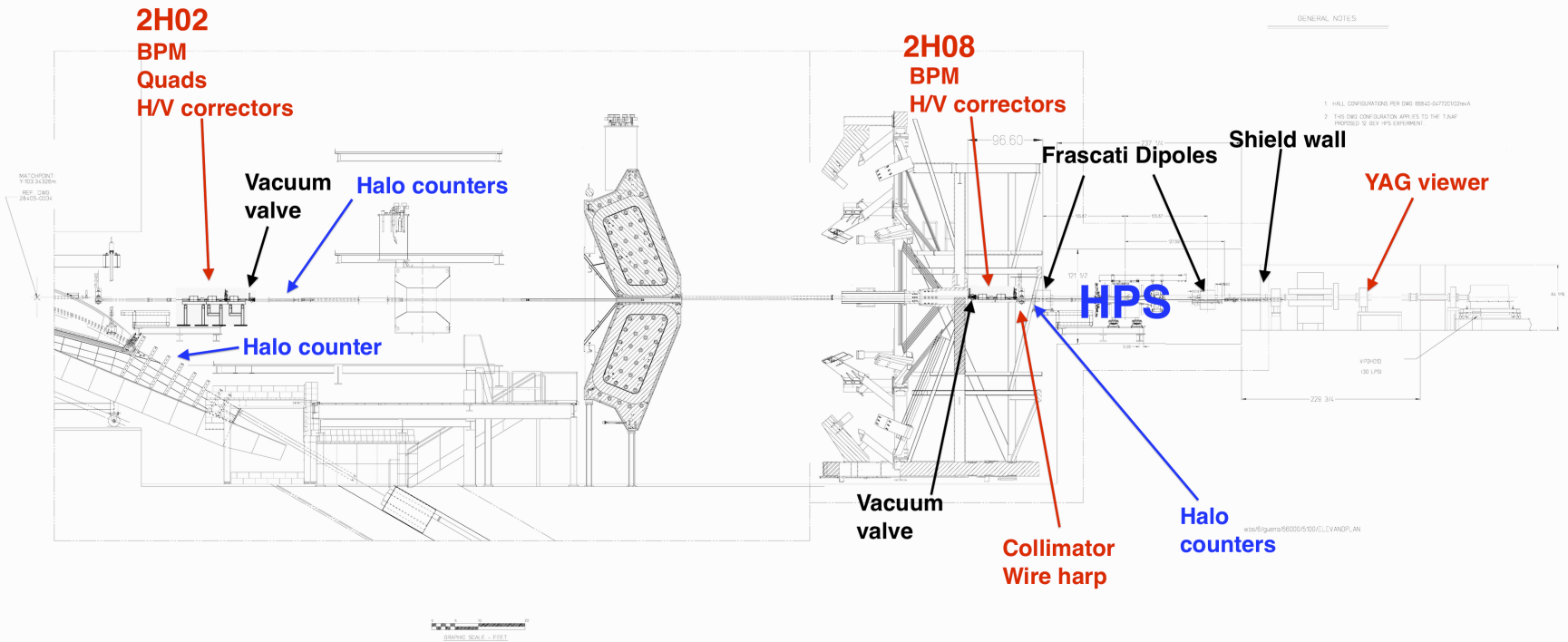
Critical milestone: magnets must be installed in alcove before June 2014 not to interfere with CLAS12 torus assembly

Procedure for bringing beam on target

- Establish beam to the tagger dump at 5 nA
  Check beam profile with harp scan (2C21 ans 2C24)
- Establish beam to the Faraday cup without HPS chicane
  Silicon detector in retracted position, voltages off, cooling on and temperature monitored. Protection systems activated
  Target and protection collimator retracted
  Start with tuned beam, then harp scan at 5 nA
  Check beam position and profile with insertable Yag viewer
- Beam off, energize HPS chicane at nominal values (0.25 Tm for 1.1 GeV)
  Optimize Frascati dipoles using downstream halo counters and Yag viewer
- Fine adjustements of the beam profile and position
  using collimator and target wires, as well as 2H08 harp
- SVT protection collimator inserted in the beam path
  check collimator position using fiducial wires on the target ladder
  check beam profile using 2H08 harp
- Turn on chicane
  Set proper FSD limits for halo counters
- Check beam size using target wires and signals in ECal, (Muon detector,) and halo counters
  Turn on SVT voltages
- Measure rate as a function of position while inserting the SVT into position

HPS beamline slow-control





HPS beamline slow-control

- 2C21 wire harp motor control
- Moller target, Helmholtz coils, quadrupoles, and coincidence counters
- 2C24 wire harp motor control
- Beam halo counters, throughout the system
  2 upstream, 2 on the spaceframe, 4 in the downstream alcove
- Tagger magnet
- 2H08 wire harp motor control
- "Radiator long" motor control
- 2 motors for the SVT with encoders
- Pair spectrometer (HPS analyzing magnet) power supply
- Frascati dipoles power supply
- Hall probes
- Insertable Yag viewer
- Faraday cup insertable beam absorber
- Beam helicity measurement and control
- Beam sixty Hertz and higher order harmonics measurements

Summary

- HPS will operate under large electromagnetic backgrounds
- Design with calorimeter for trigger and SVT close to the beam
- Beam quality essential to achieve physics goals
- Beam requirements include asymmetric beam spot, very small in the vertical direction
- FSD system and collimator for SVT protection
- Most elements, including for optics, already exist
- Slow-control standard for Hall-B operation, but needs to be brought back to like
- Engineering run next fall
- Data production run simultaneous with CLAS12 torus installation