Beam pipe concept (design) for eRHIC

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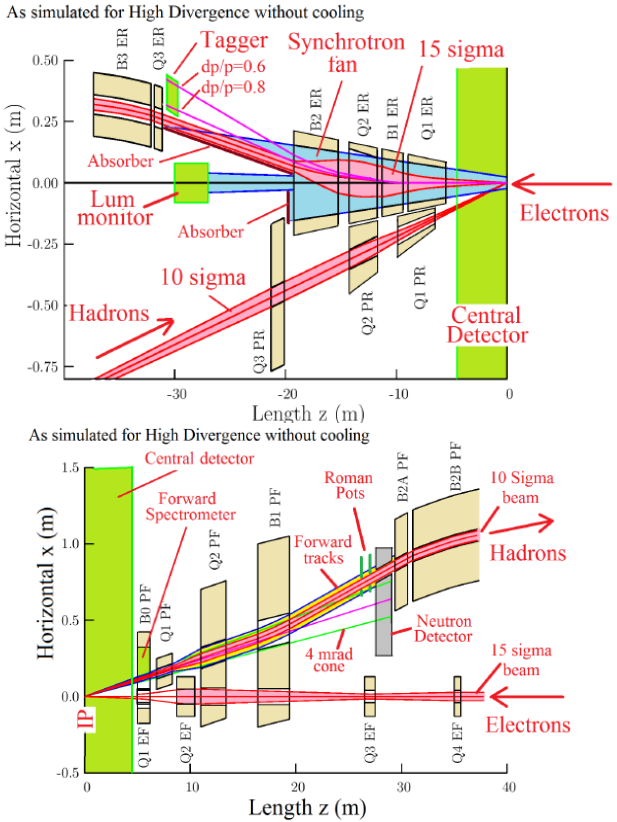
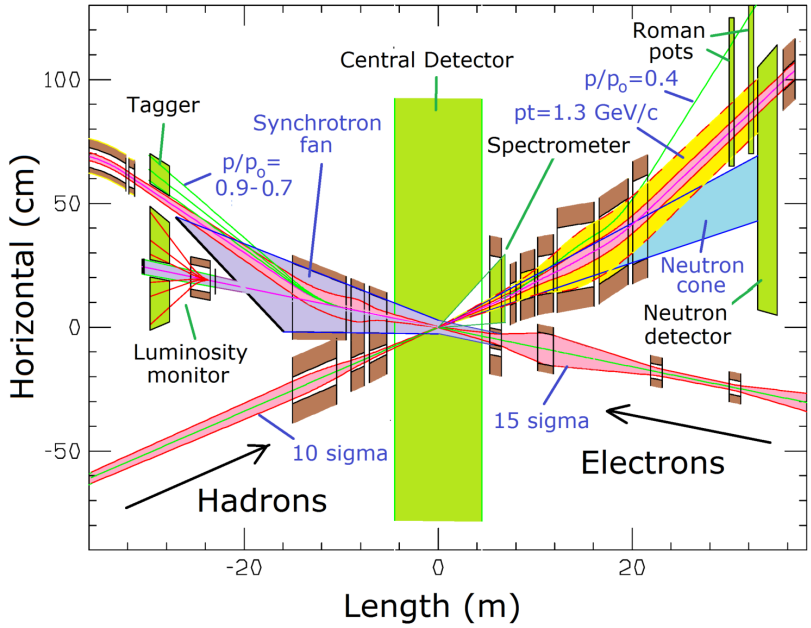
BNL EIC IR Design Bi-Weekly Meeting
November 15, 2019

Outline

I. Main assumptions
II. The model concept
III. First results
IV. Next steps

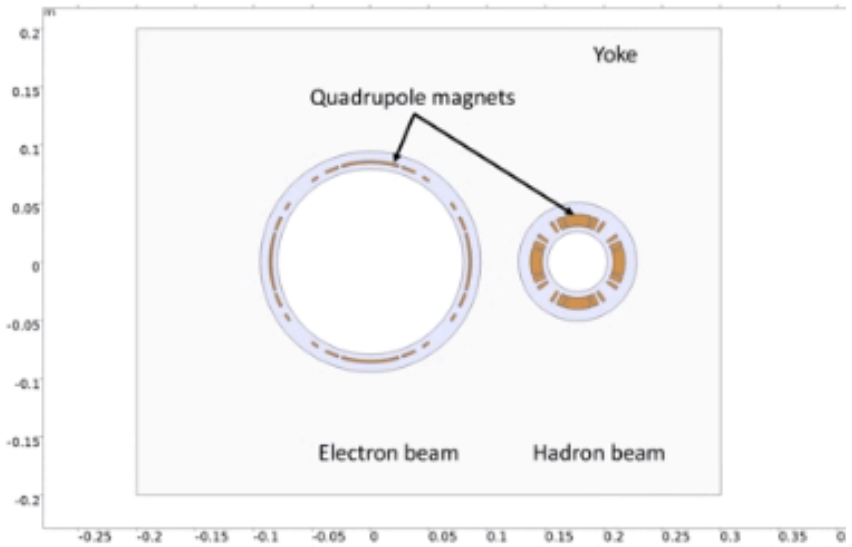
Based on Pre-Conceptual Design Report, August 2018 and IR meeting presentations

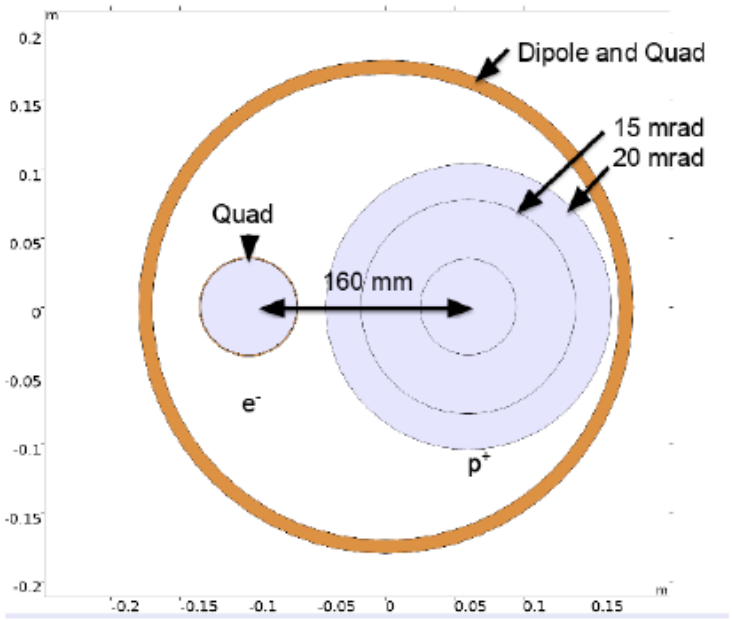




Holger Witte October 9-11, 2019 EIC Accelerator Collaboration Meeting

Final quads


Yoke
Quadrupole magnets
Electron beam
Hadron beam


Dipole and Quad
15 mrad
20 mrad
Quad
160 mm
e⁻
p⁺

Main assumptions

- The beam pipes must be separated in the region of final quads
- Incoming beam pipes in the quads preferable to have a round shape
- Outgoing conic pipes start after the central Be pipe
- Regions with unavoidable trapped modes:
  - Outgoing proton pipe near the spectrometer
  - Outgoing electron pipe near lumi monitor

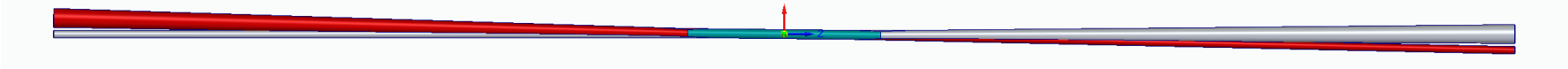
must have HOM absorbers

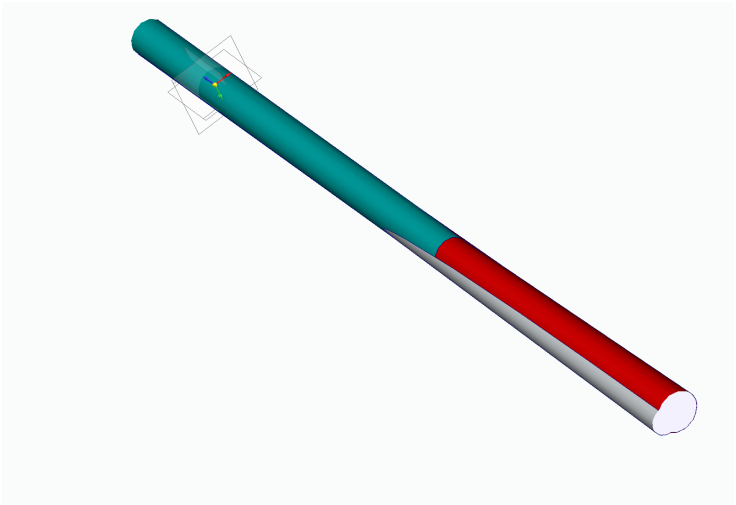
Use synchrotron radiation masks in electron beam pipe to capture radiation and in this way allow smaller beam pipe size.

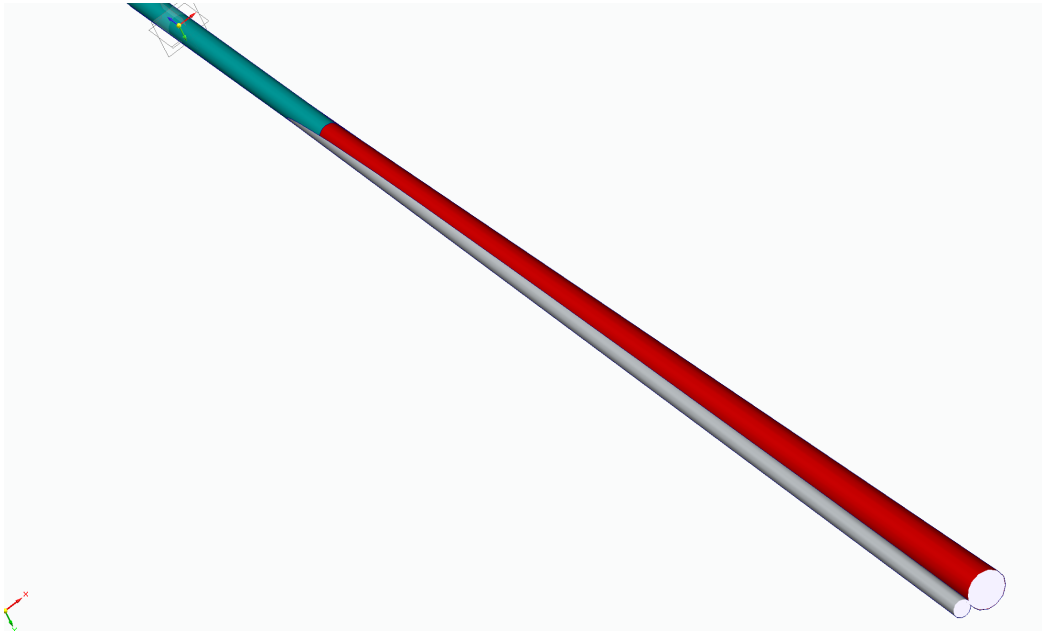
First step: smooth transitions

- In order to achieve minimum electromagnetic interaction of the colliding beams with a metal vacuum chamber of the Interaction Region beam pipe, we will try to develop a special smooth transition from two incoming beam pipes to a common pipe at the Interaction Point. The incoming pipes have inner diameter of 50 mm and the IP common pipe have inner diameter of 60 mm.
- Not all dimensions correspond to the project parameters and need some corrections

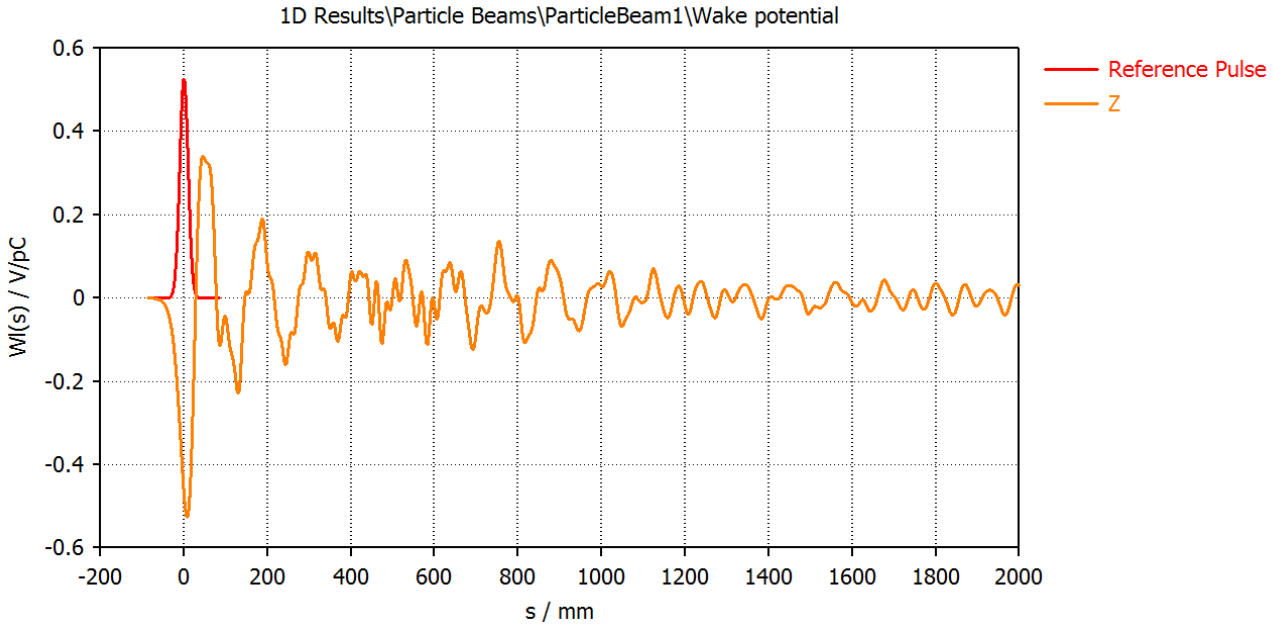
Smooth transition from a central pipe to two pipes of different sizes





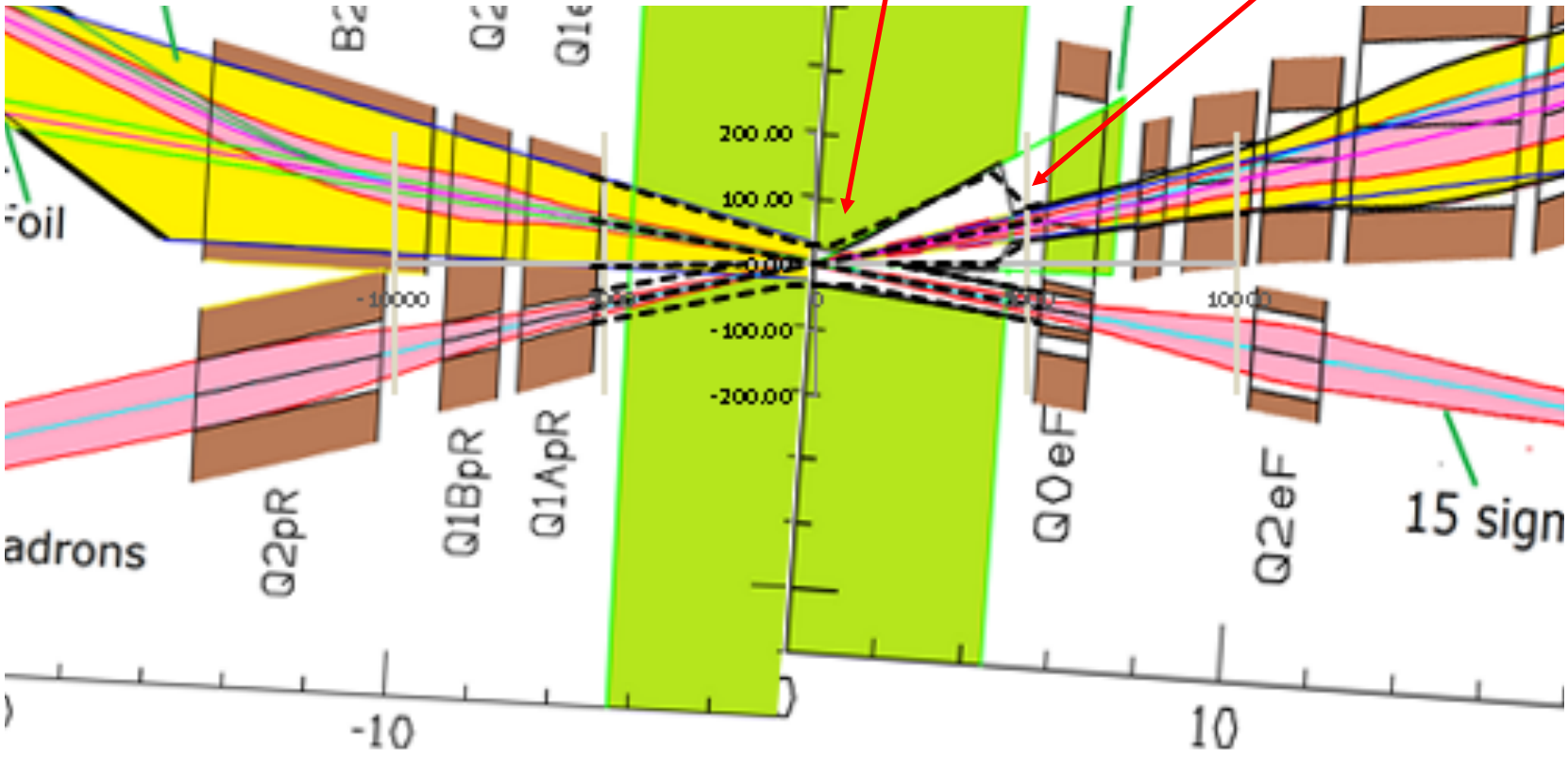


Wake field calculations

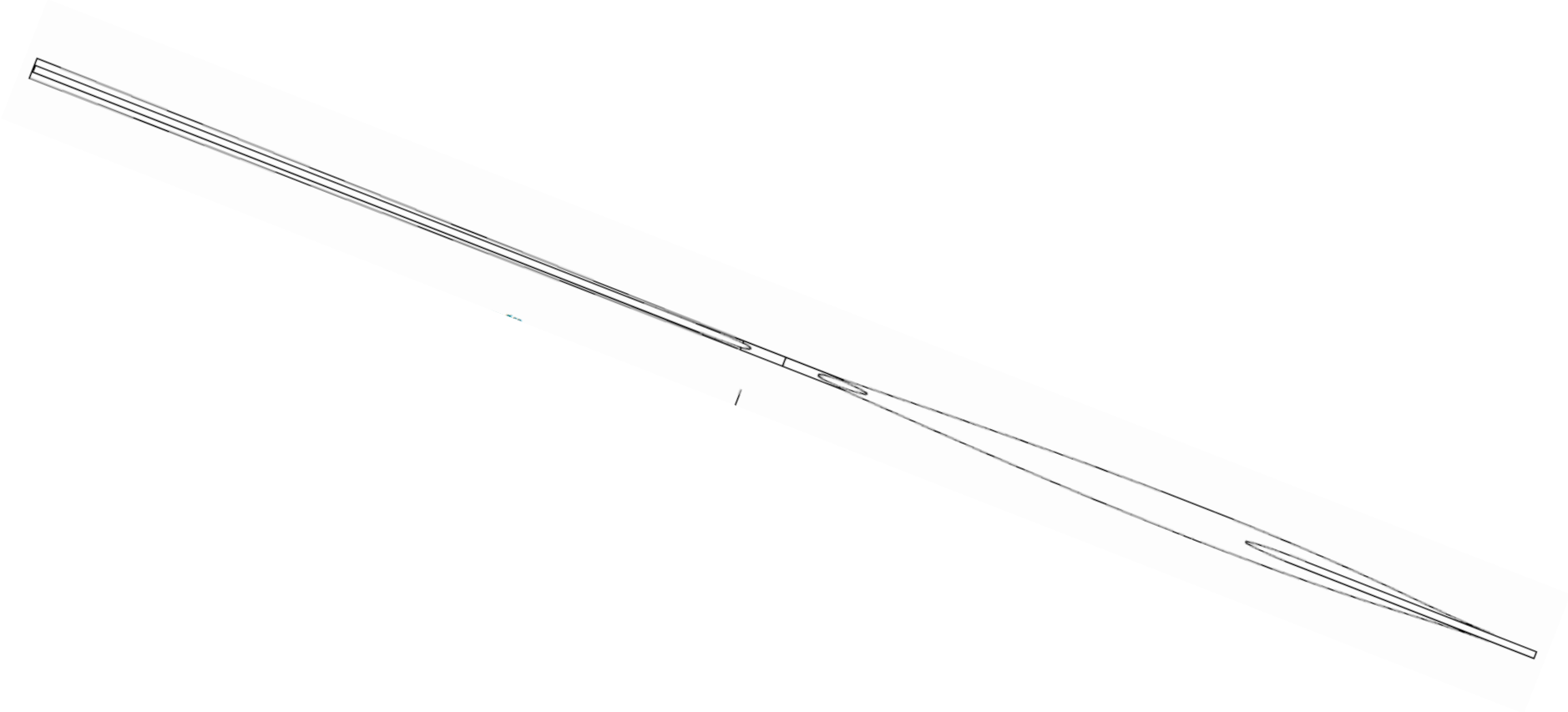


It can be seen that the wake field almost follows the shape of a bunch charge, that means that a beam energy loss mainly correspond to the creation of the additional self electromagnetic field in the pipe of a larger size.

Beam pipe including a synchrotron mask and a spectrometer foil

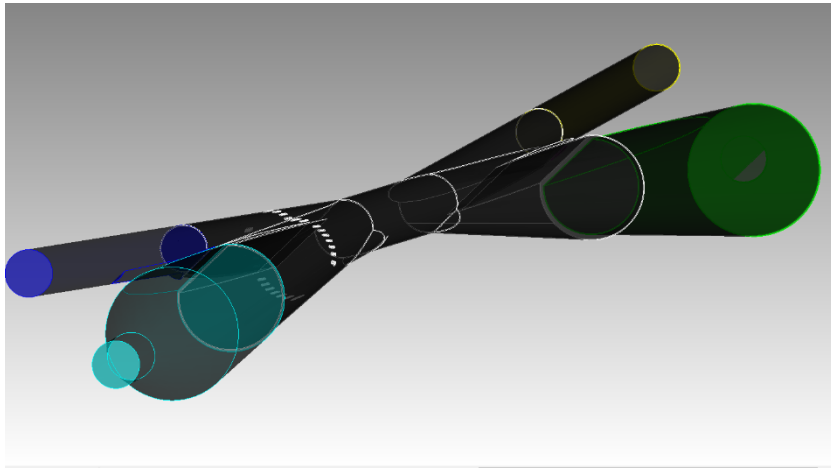


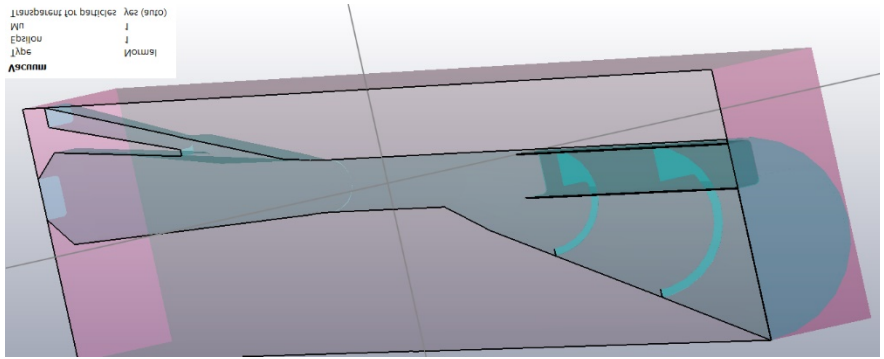
2D plot



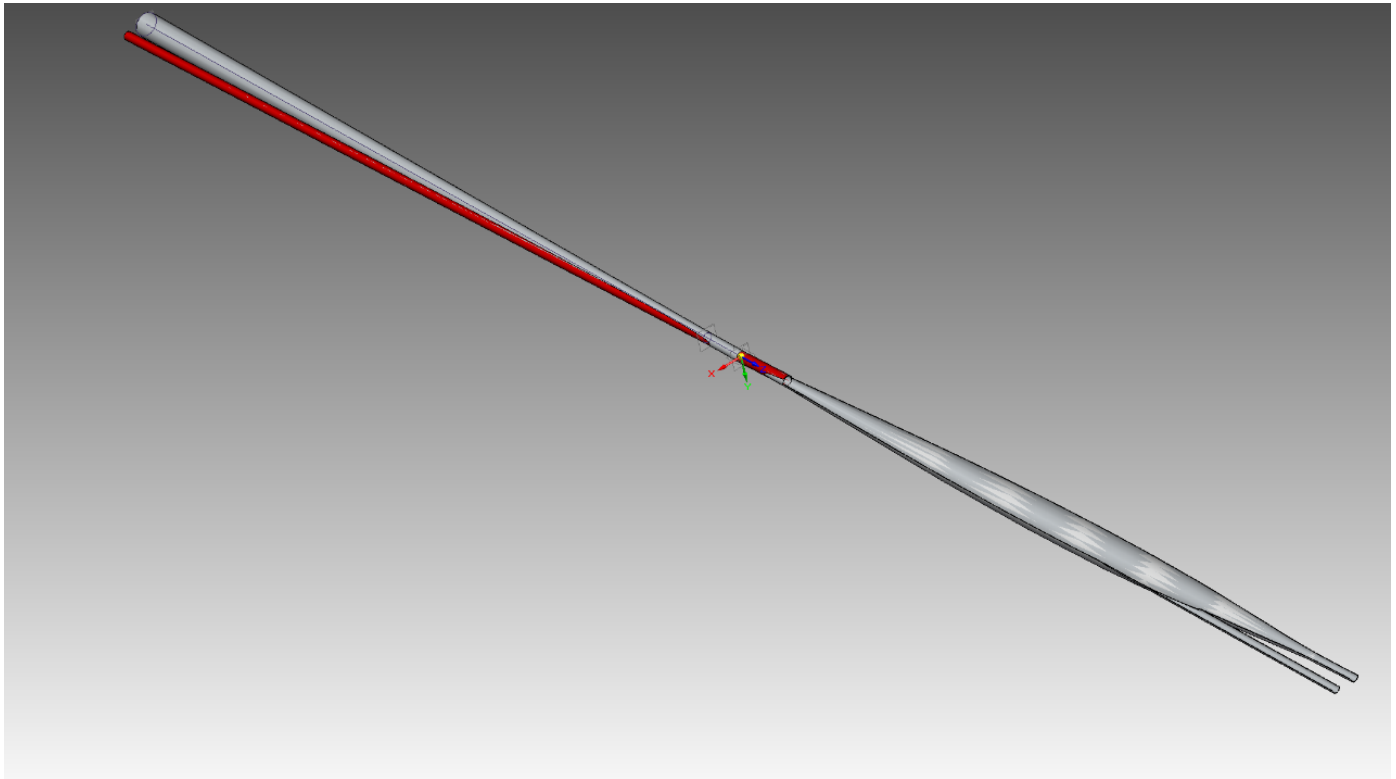
3D model

Round pipes vs rectangular pipes (one of the previous version, not final)

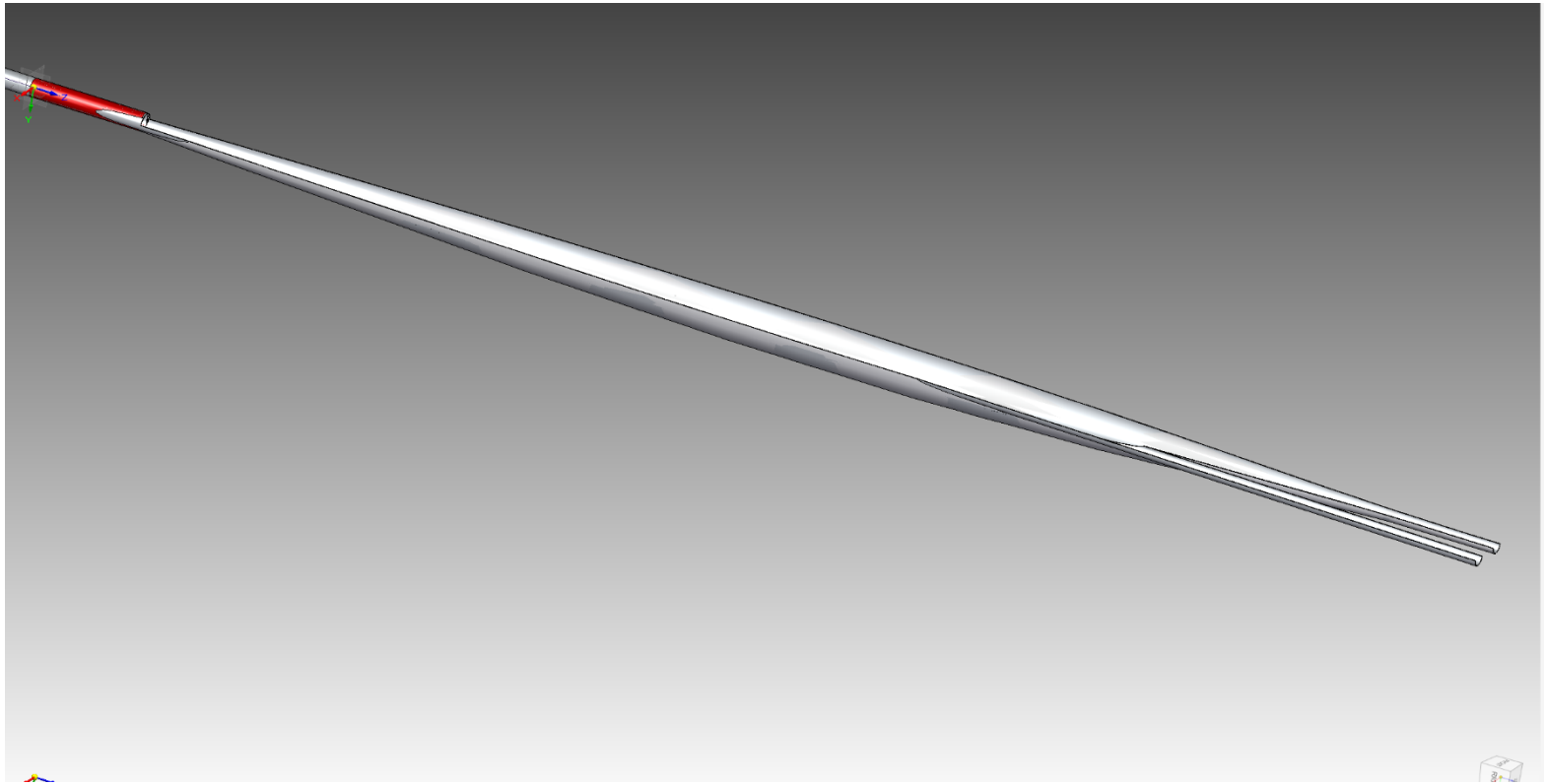




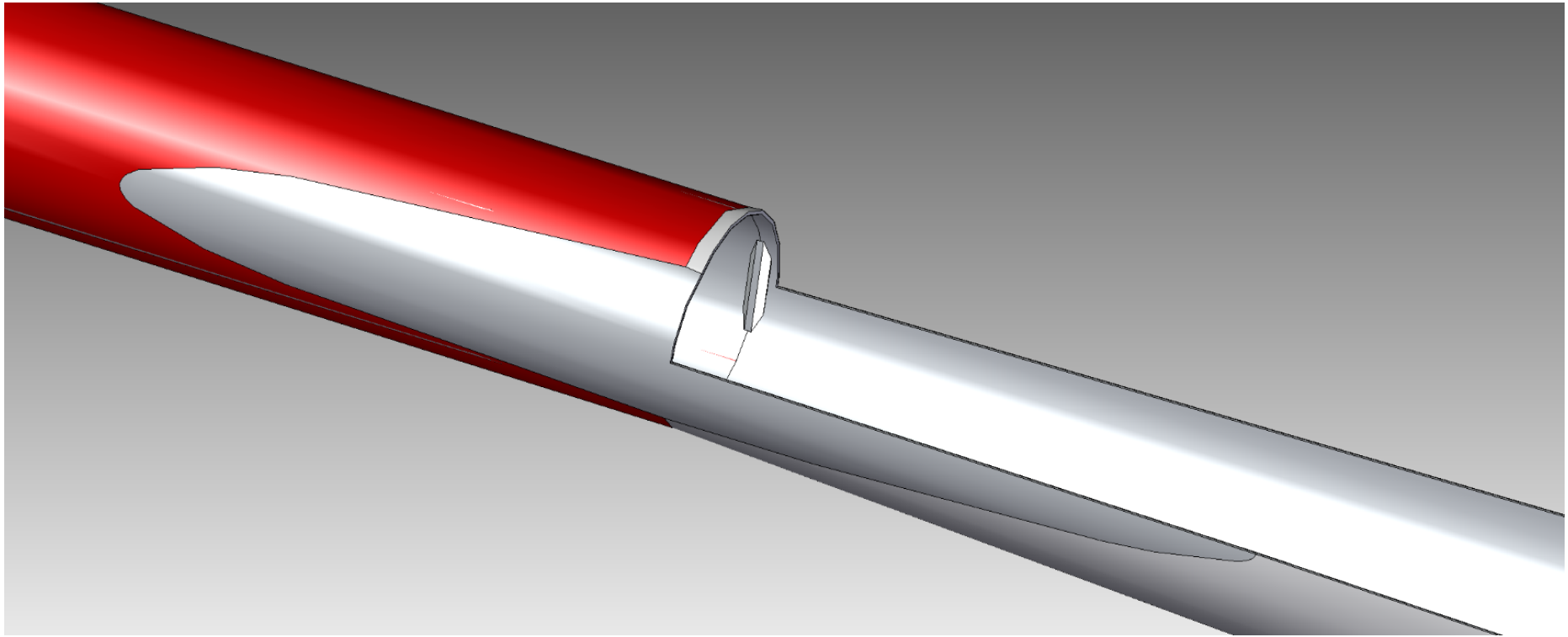
3D plot with cuts



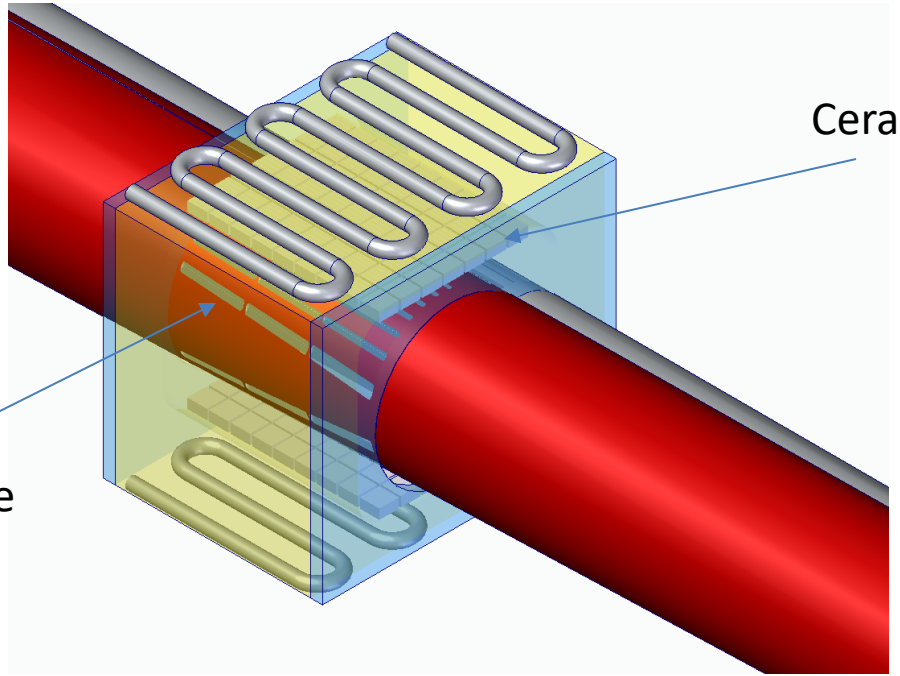
More details



Synchrotron mask (M. Sullivan)

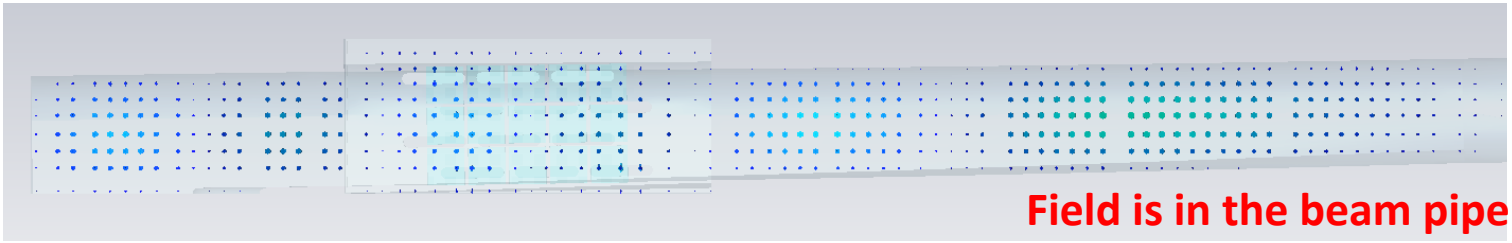


HOM absorber near the spectrometer

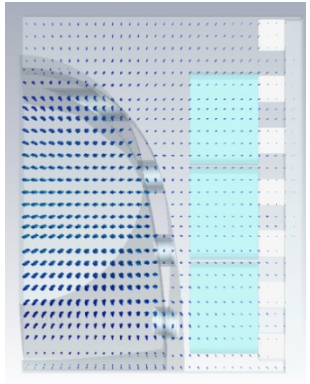


Simulation of the HOM absorber effect

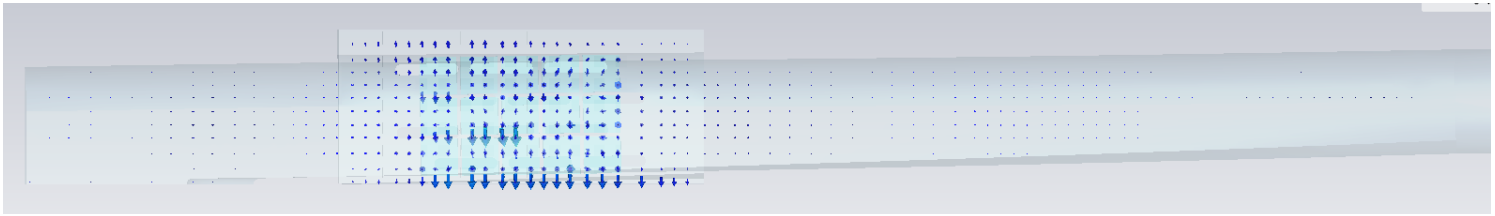
HOM mode in the IR region when ceramic tiles have vacuum parameters : $\varepsilon=1$, $\delta=0$
Effectively no absorber



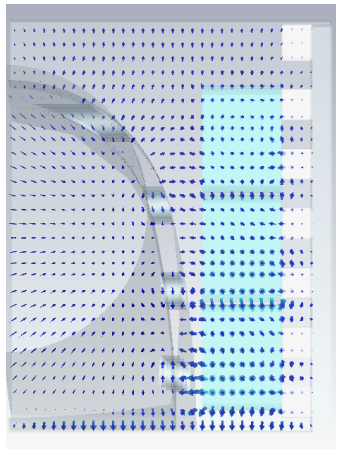
Field is in the beam pipe



HOM mode in the IR region when ceramic tiles have real parameters : $\varepsilon=22$, $\delta=0.1$
HOM absorber in action



Field is concentrated in the absorber region and in the ceramic tiles



Summary and next steps

- A smooth transition from two incoming pipes to a common IP pipe has been designed to minimize the impedance of the Interaction Region.
- Special HOM absorber is needed to damp unavoidable trapped modes
- The heat load coming from the resistive–wall wake fields must be taking into account
- Continue calculations with approved dimensions