

Laser system update

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On behalf of the SY-STI-LP section

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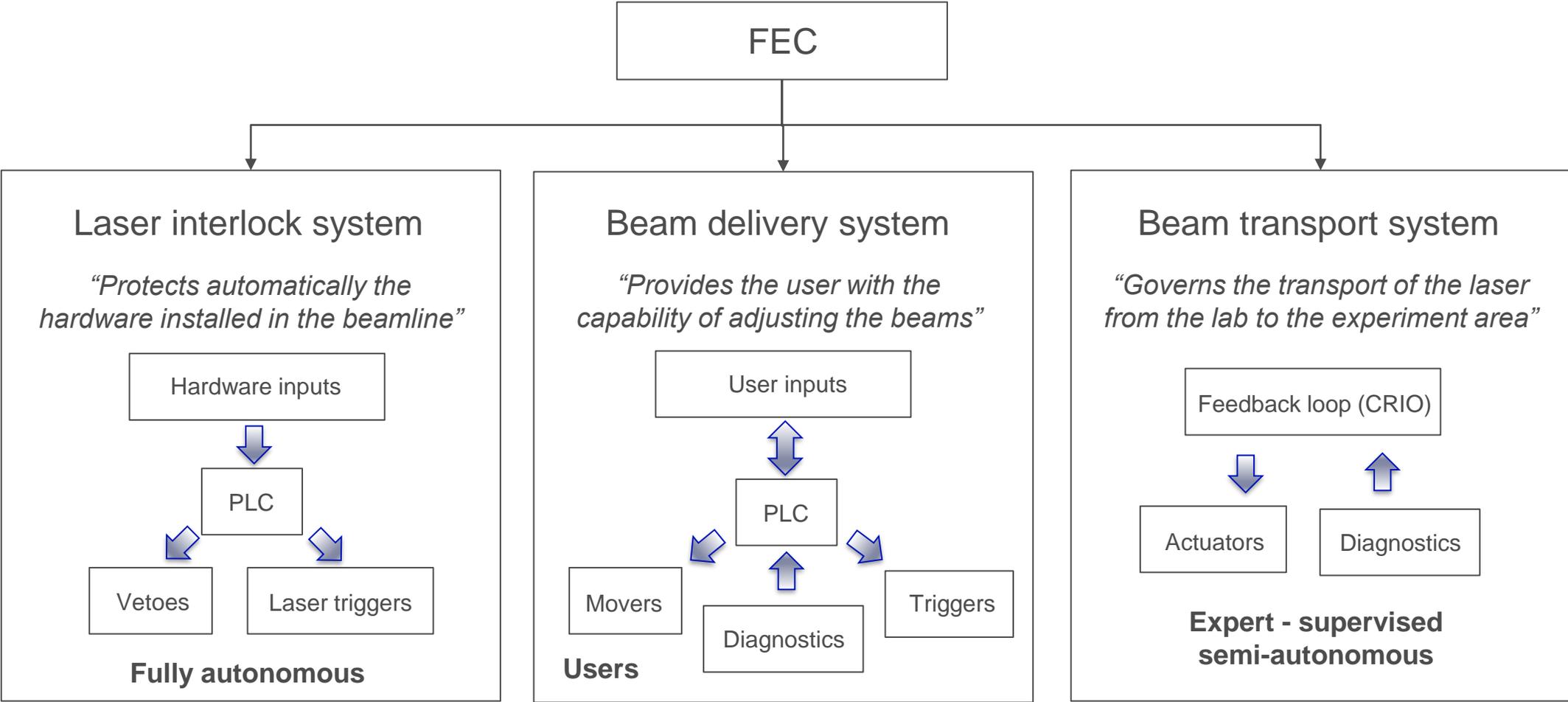
Ricardo Martinez Muniz (BE-CEM)



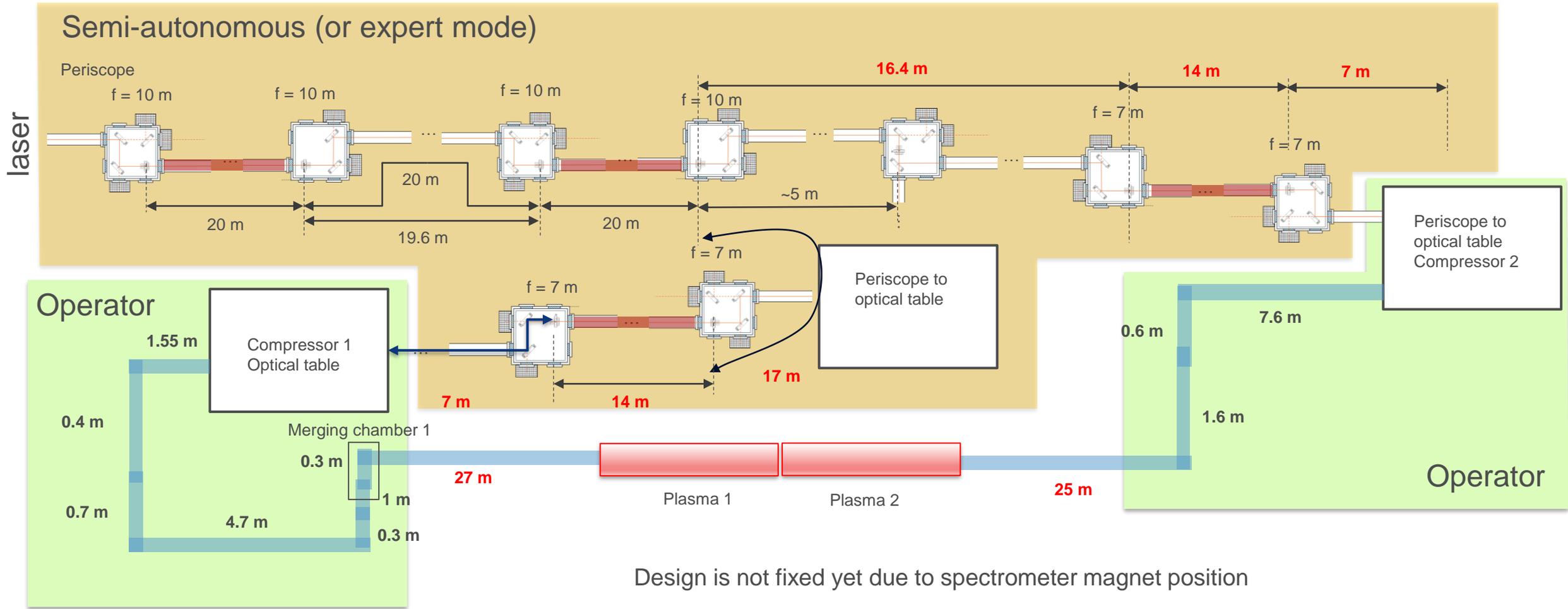
Agenda

- Control systems
 - Machine protection system (aka laser interlock)
 - Beam transport system: diagnostics and controls
 - Beam delivery system: diagnostics and controls
- Optical beamlines
 - Merging chamber 1 and 2
 - Update on beam simulation
 - Synchronization (no jitter yet, sorry!)

Controls architecture – 3 layers

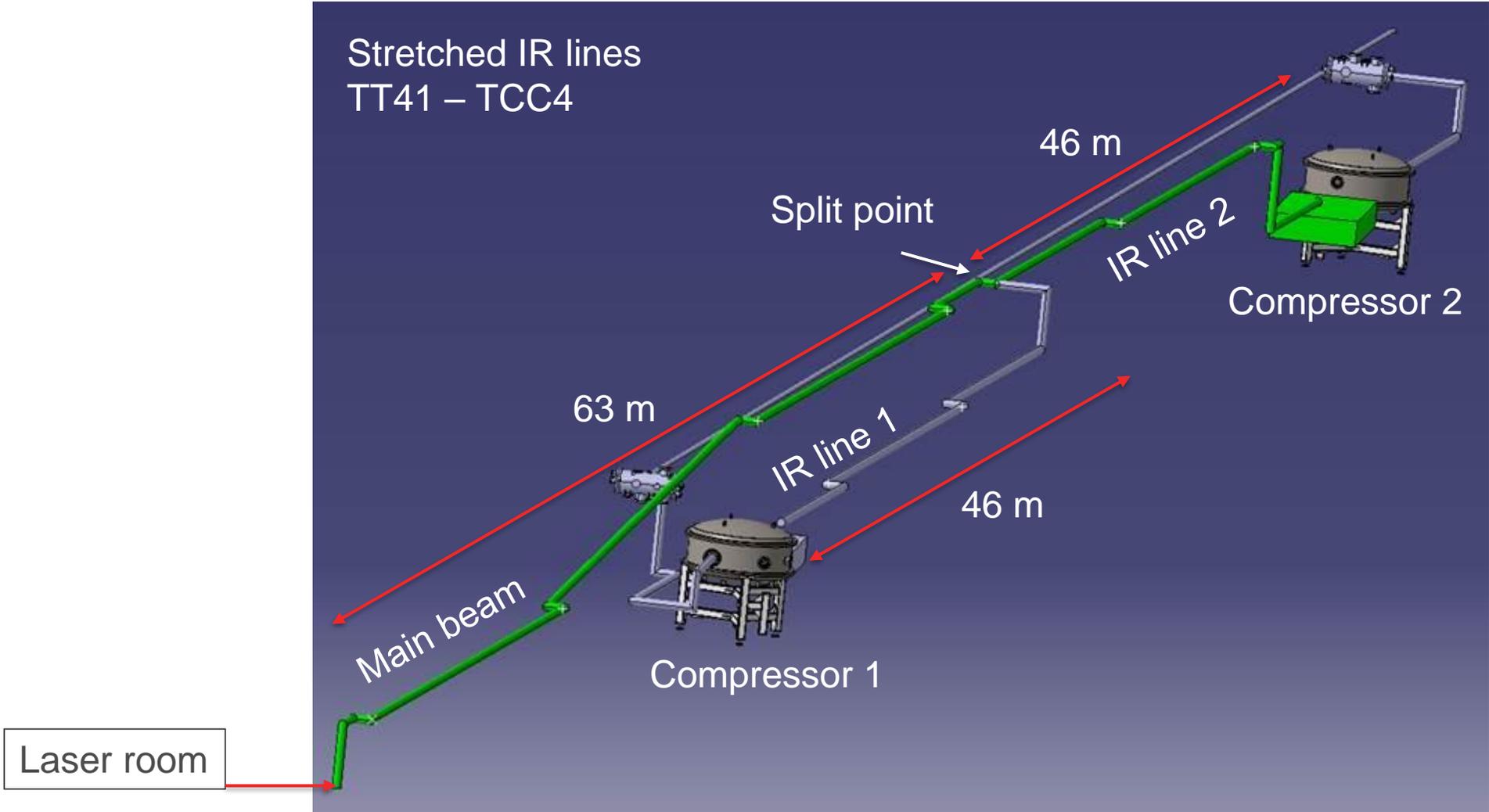


Distances and locations for compressor to be adjusted

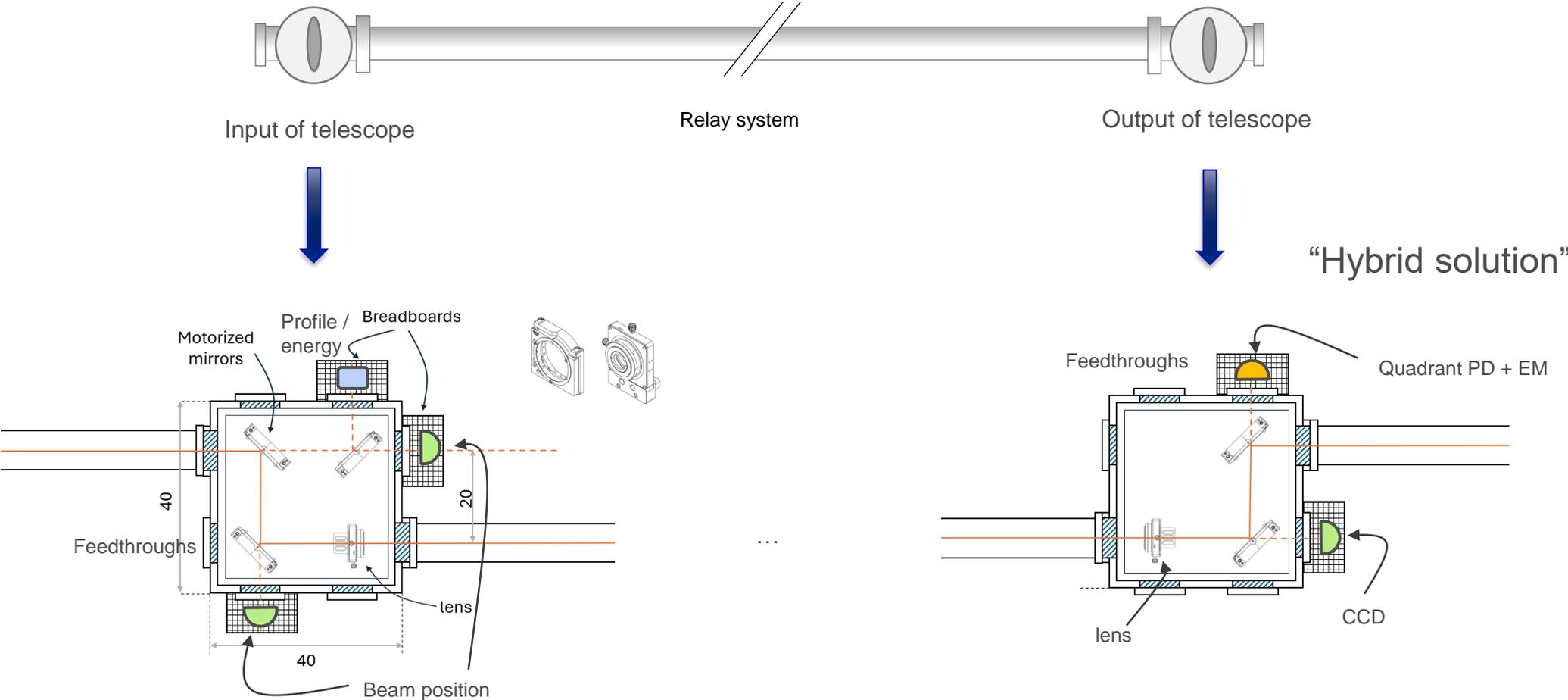


Design is not fixed yet due to spectrometer magnet position

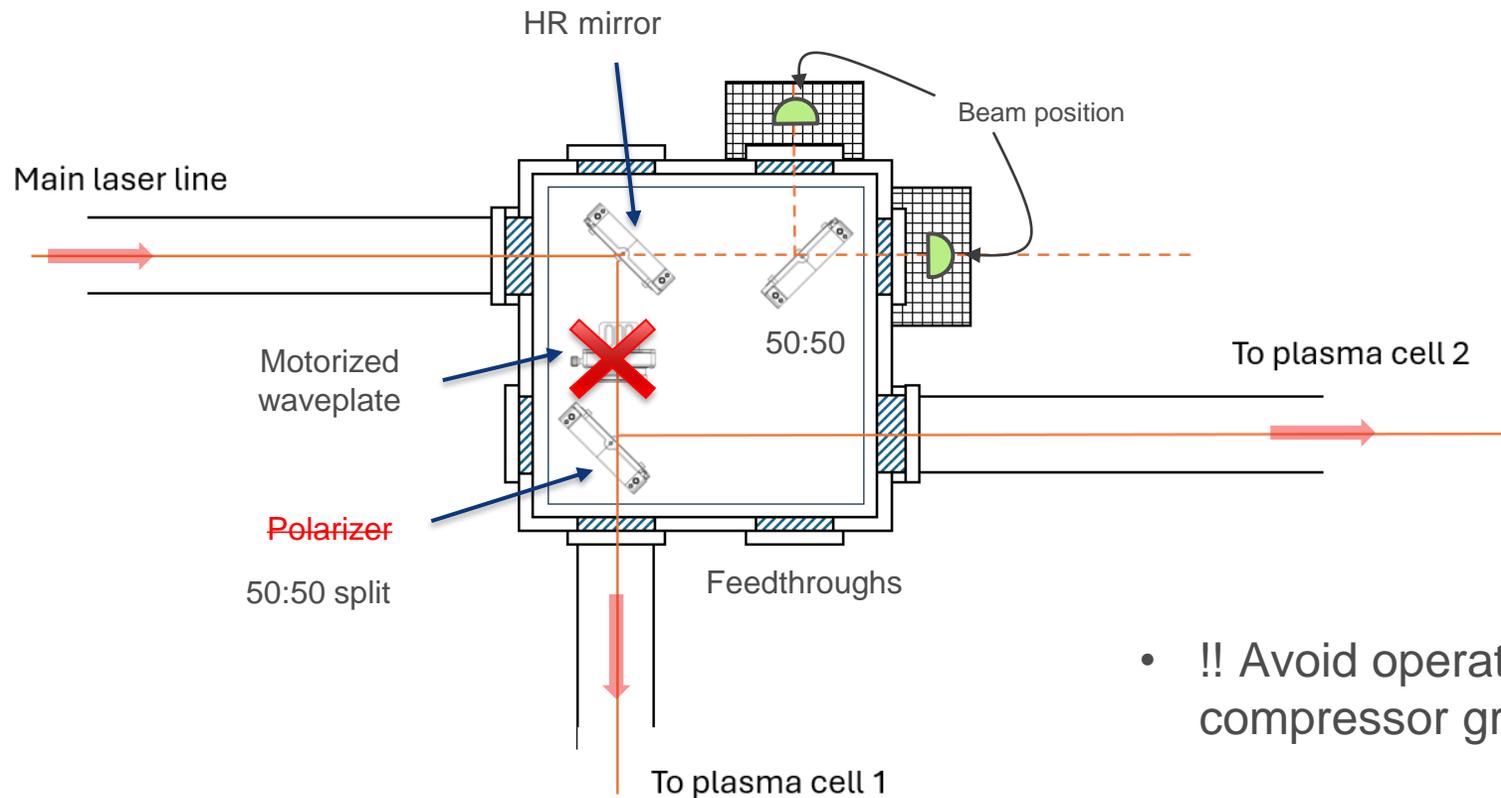
Beam transport system



Relay image system positioning system (update)



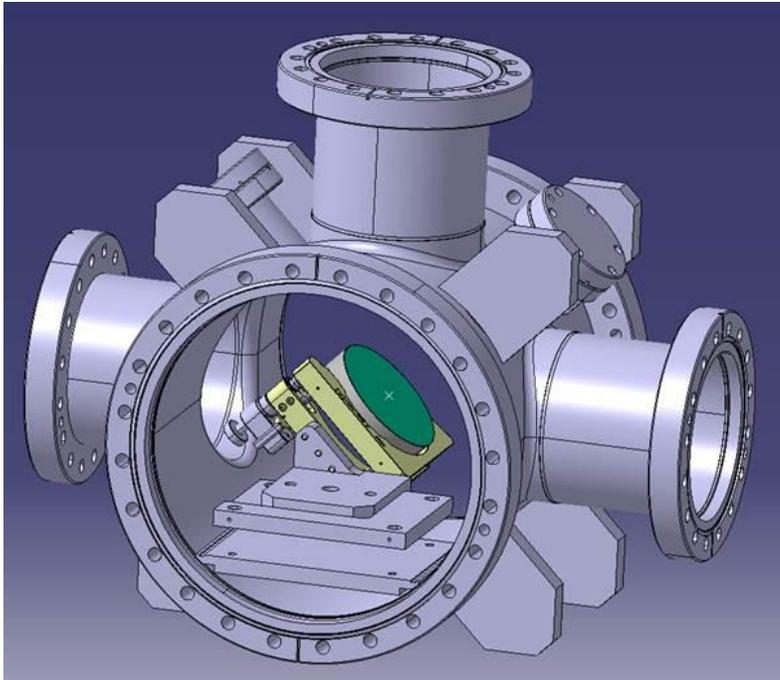
Split point plasma cell 1 & 2 (update)



- !! Avoid operators burning the compressor gratings
- Each line has its own attenuator

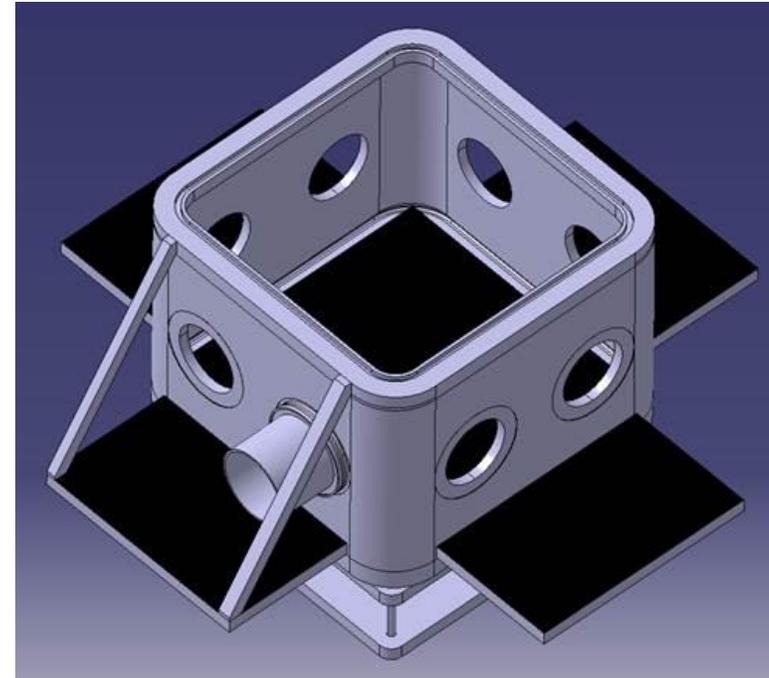
Optical boxes design

UHV turning box



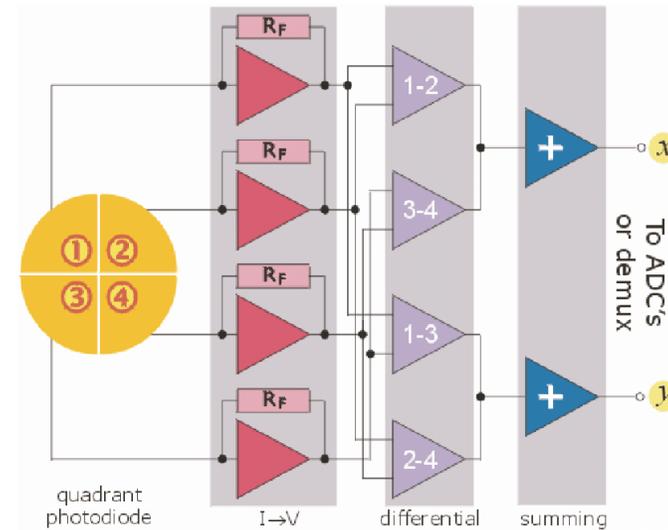
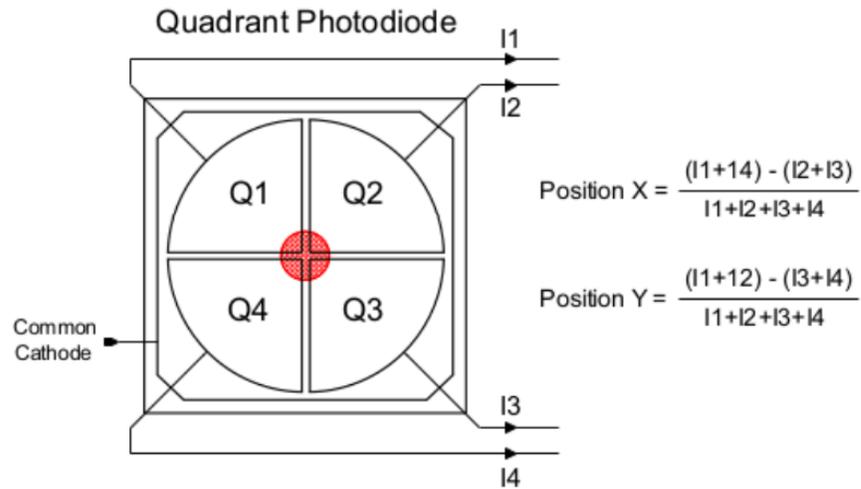
- Similar to run 1, but narrower
- Left-hand / right-hand versions
- Design of supports is next

Primary vacuum - transport



- Built in-house, design stage not completed
- Top cover attachment under study (hinges)
- Clamping -> ISO-KF 100 for now

Quadrant detectors



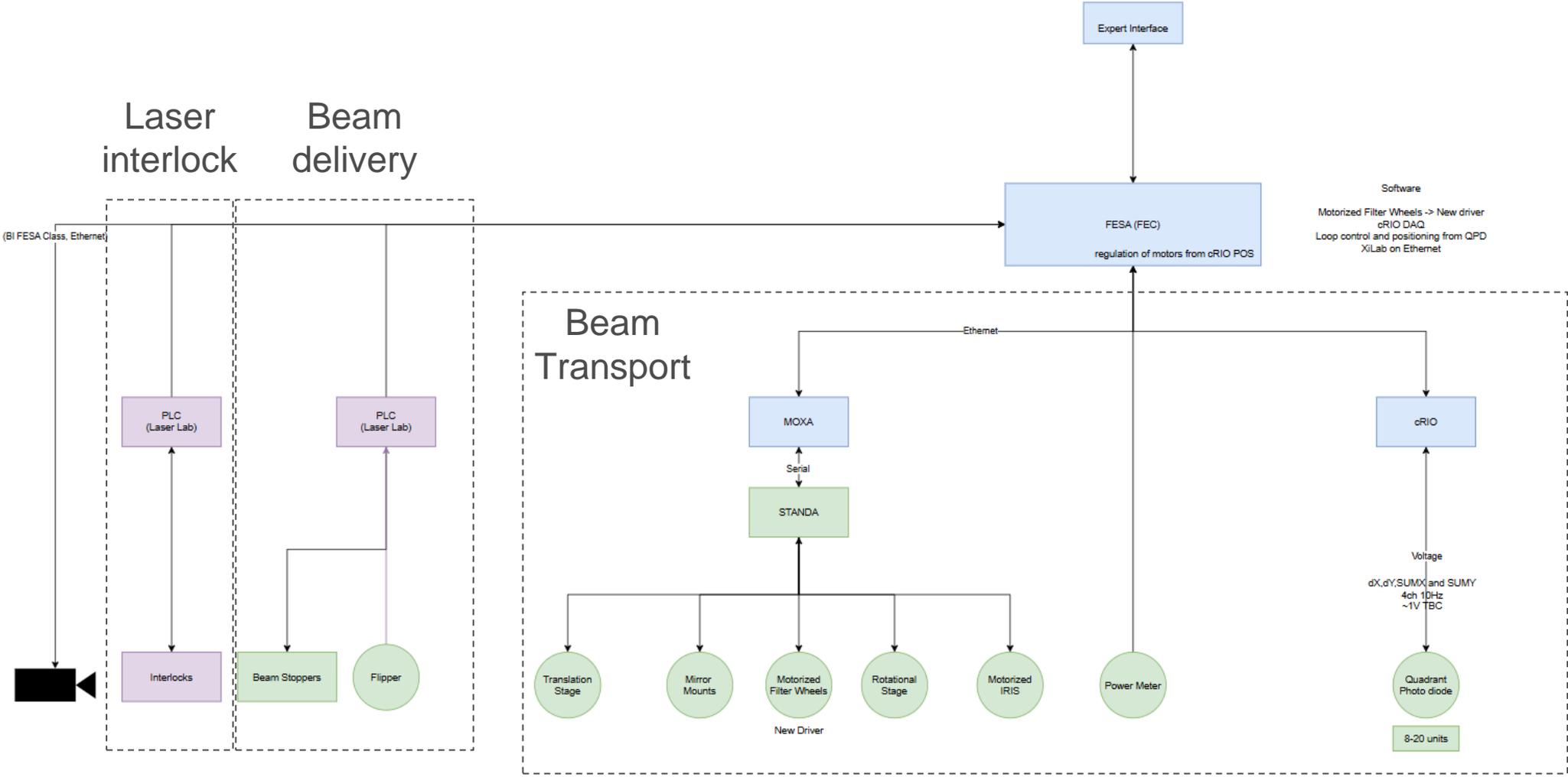
PROs:

- High bandwidth / low latency
- Robust and compact, great dynamic range (think of high power and low power shots)
- Possibly does not need filterwheel
- Insensitive to ambient light
- Similar price to a CCD camera
- Energy measurement possible

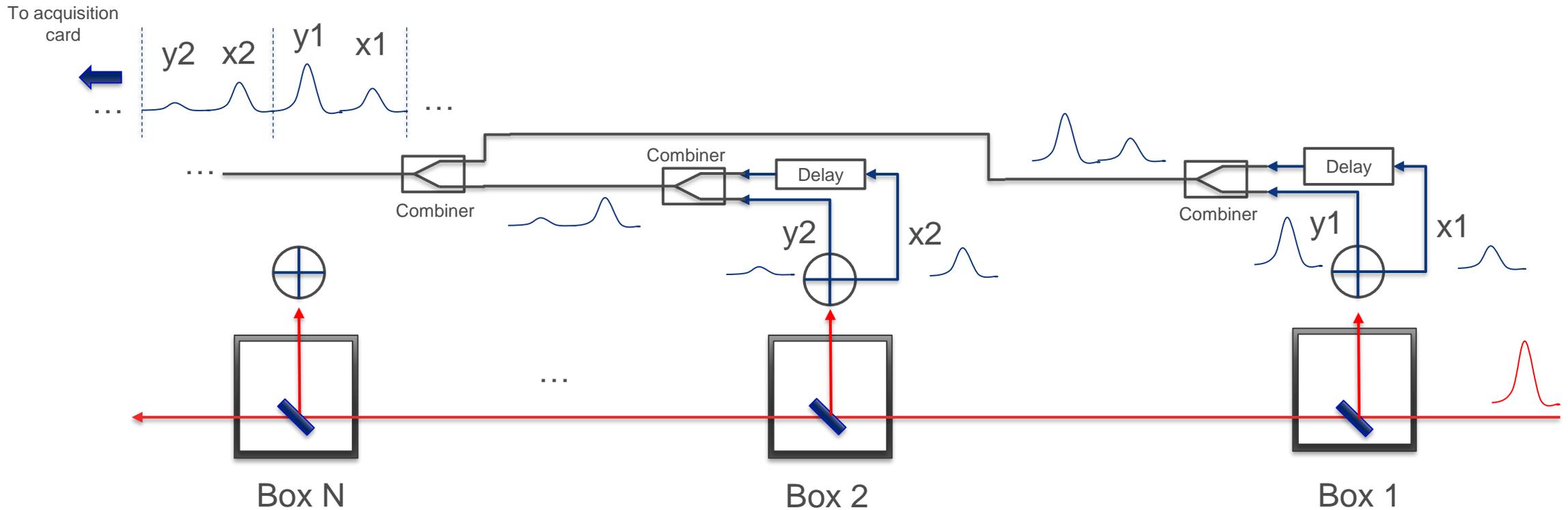
CONs:

- Requires development, and integration into DAQs
- No beam profile information (what if shape changes?)
- Requires accurate centering (if large drift happens?)

Controls architecture

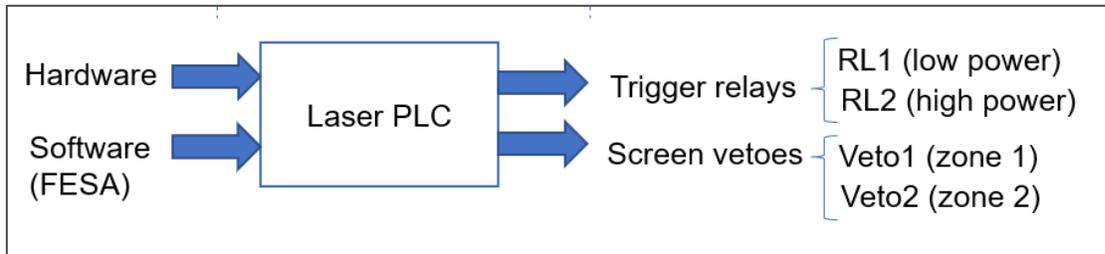
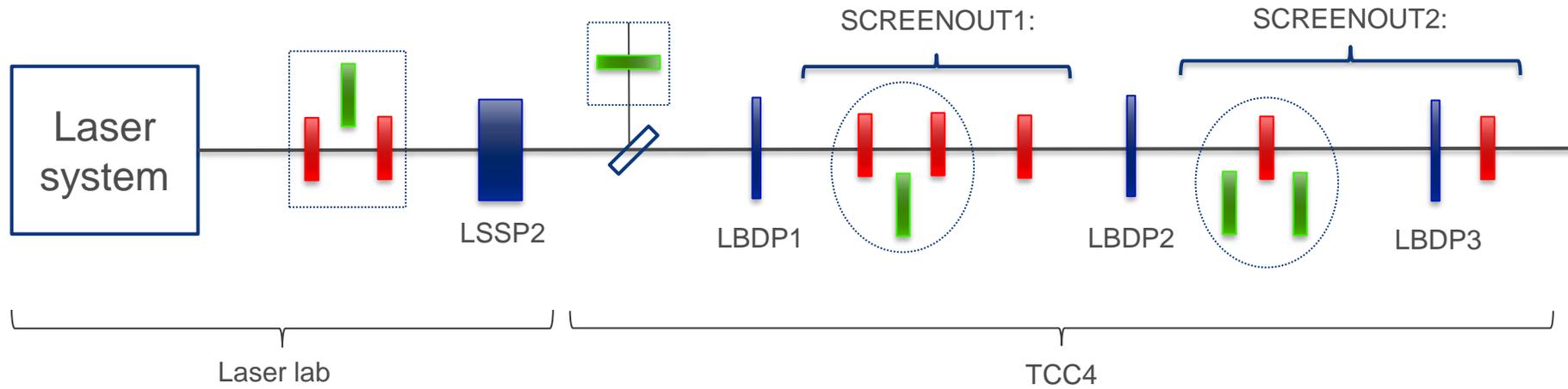


Multiplexing QPDs (BI team idea)



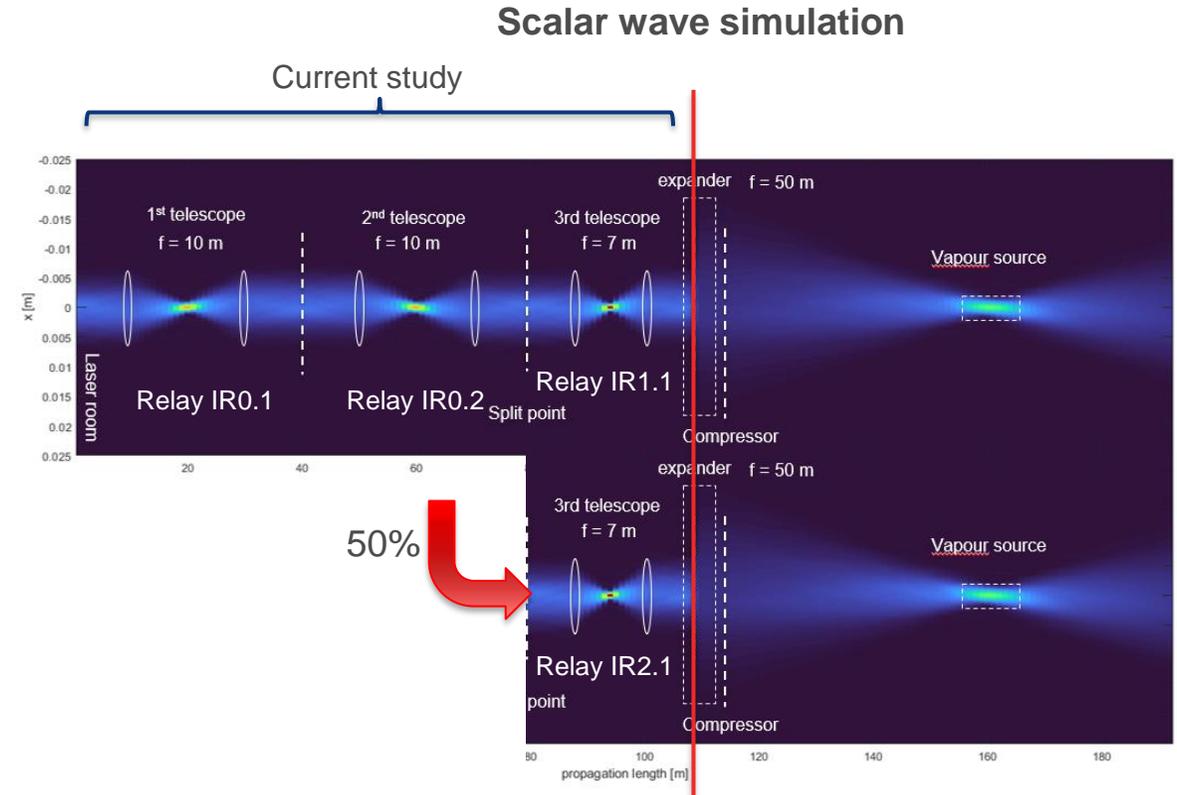
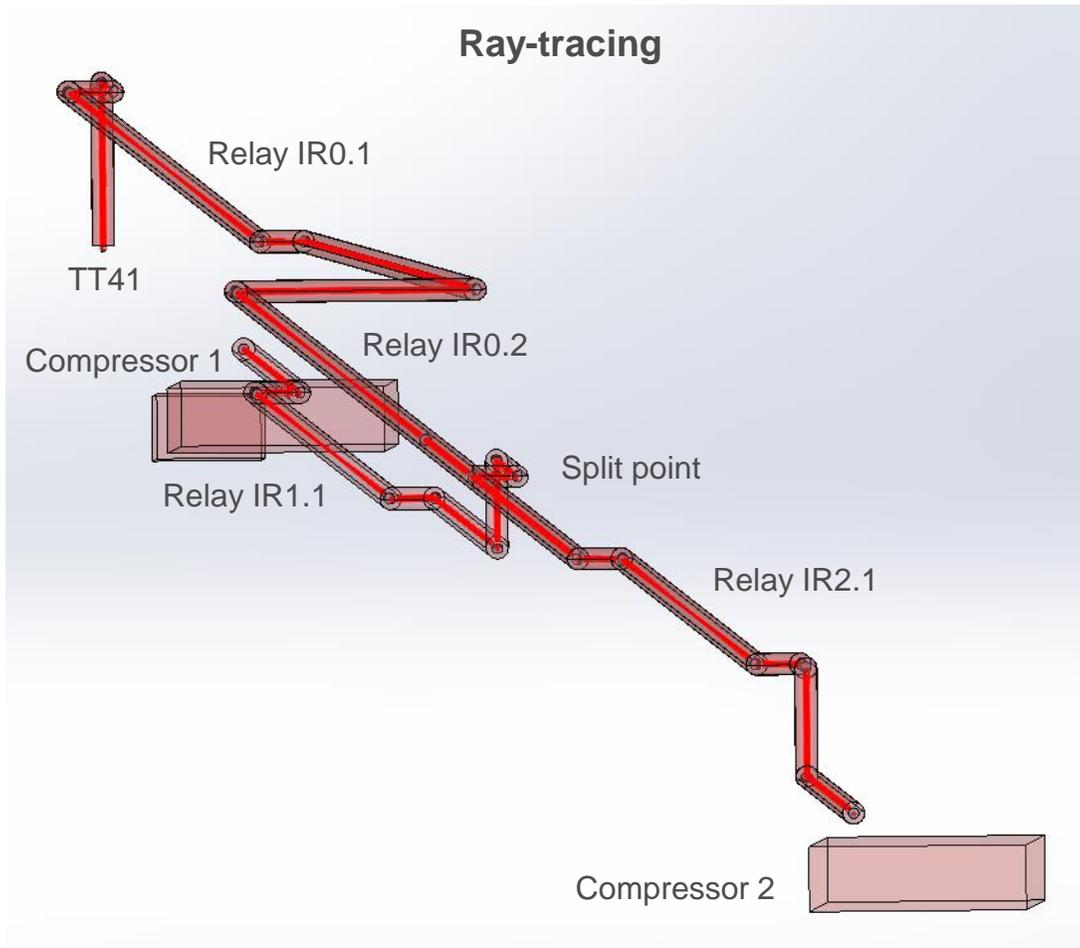
In principle, a single BNC-type cable connecting the boxes could act as 'bus', and the entire signal decoded using a single acquisition card. In reality we will probably do sample-and-hold with a cRIO.

Laser interlock system run 2c



- ScreenOut1: Signal provided by BI, notifies the laser PLC that all screens in zone 1 are out of the beamline.
- ScreenOut2: Signal provided by BI, notifies the laser PLC that all screens in zone 2 are out of the beamline.

Beam transport simulations

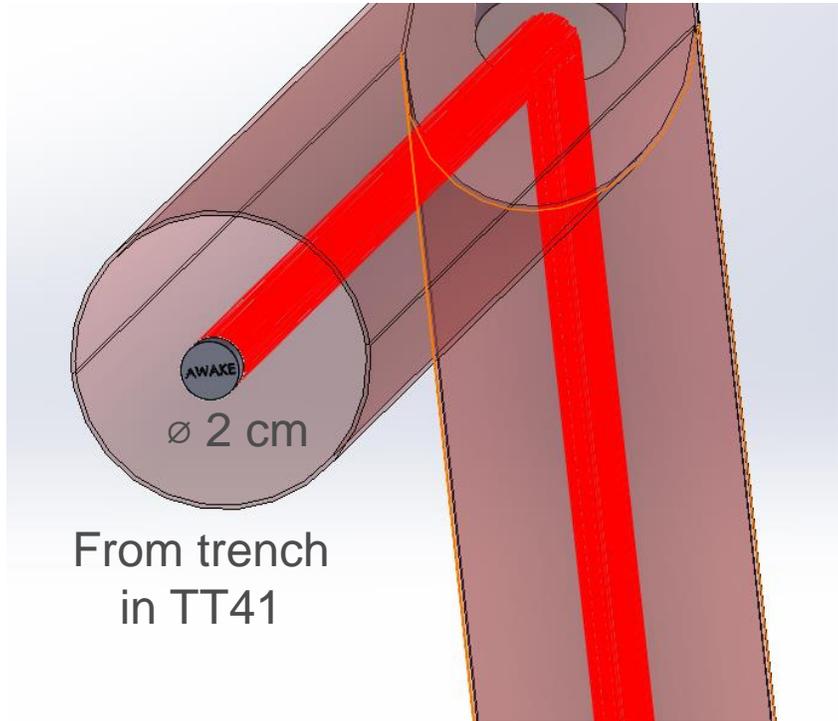


Allows us to:

- Check beam path mismatches
- Chromatic effects and aberrations
- Tolerances and transport losses, damage threshold

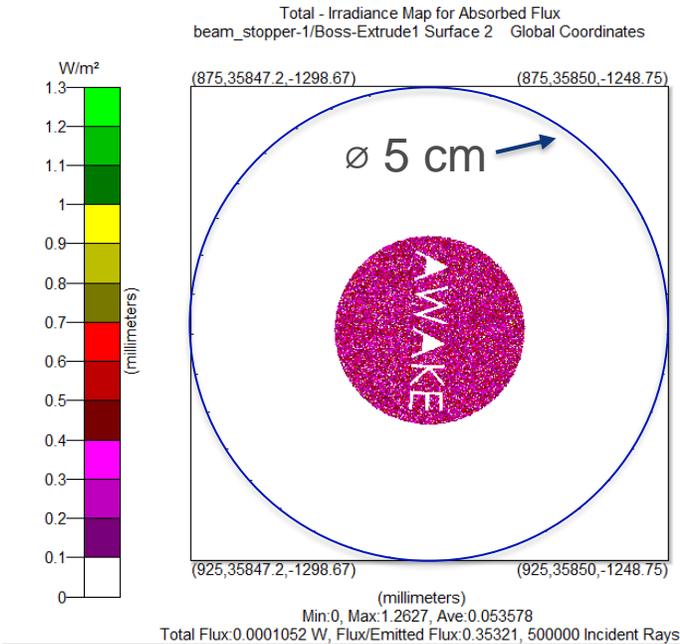
Ray-tracing simulations

Masked beam “AWAKE” at wavelengths in the **750 – 850 nm** range

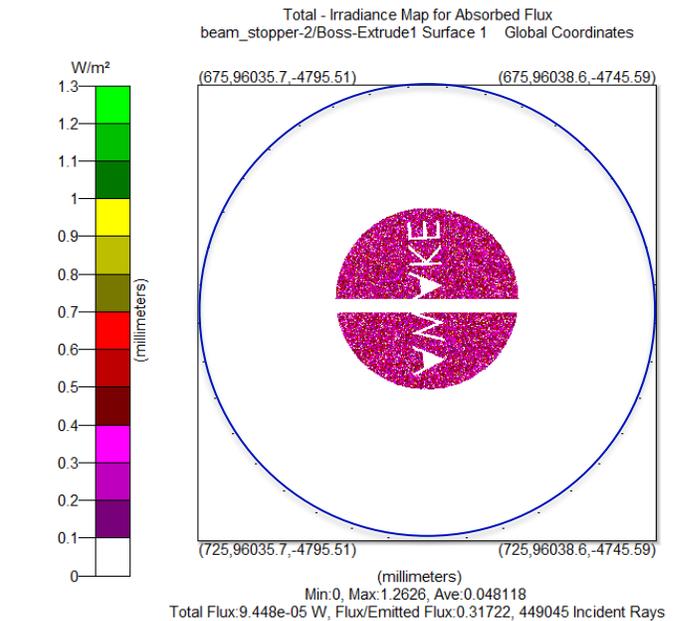


For transmission calc: input is 1 W/m²

IR 1 beamline



IR 2 beamline



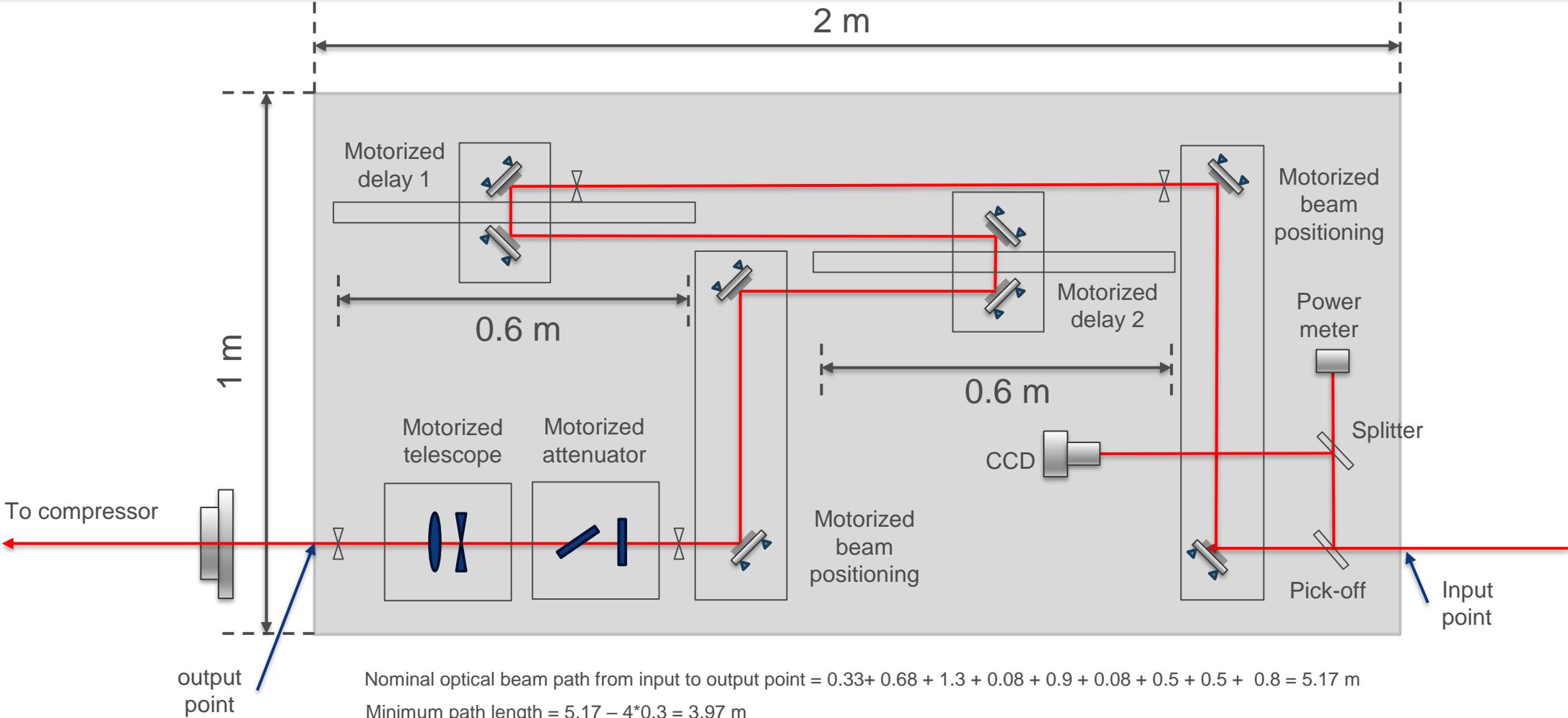
- One is the “mirror image of the other one”. There is tilt -> caution with mirrors and polarization (!!)
- IR line 2 is not centered on beamline axis due to beam splitter

Beamline	OPL [m]
TT41 - Compressor 1	97.3678
TT41 - Compressor 2	99.3813

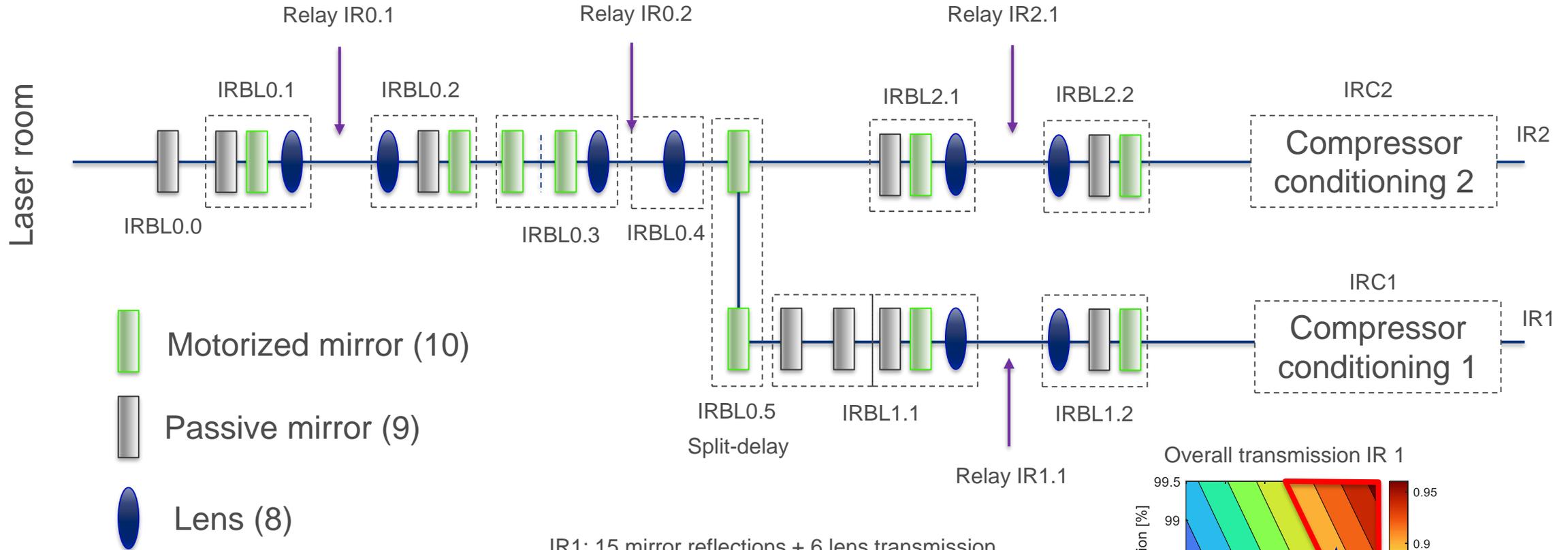


To be adjusted by moving the split point

Compressors optical tables



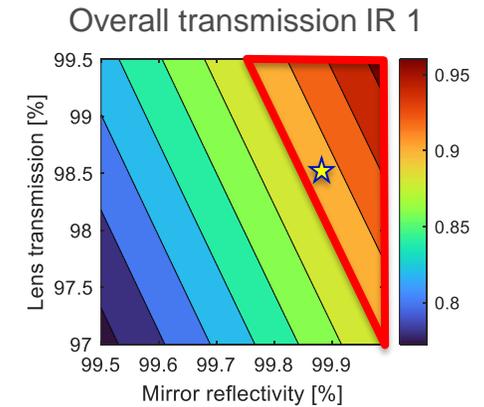
Beam transport system – optical elements (losses)



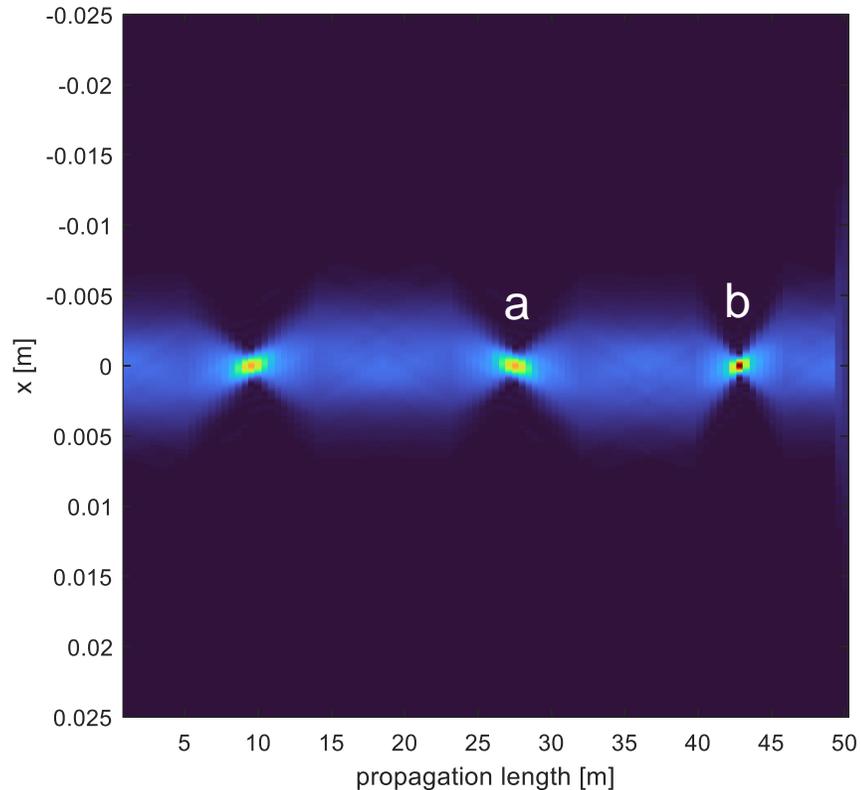
IR1: 15 mirror reflections + 6 lens transmission
 IR2: 12 mirror reflections + 6 lens transmission

99.9% reflectivity per mirror
1.5% loss per lens

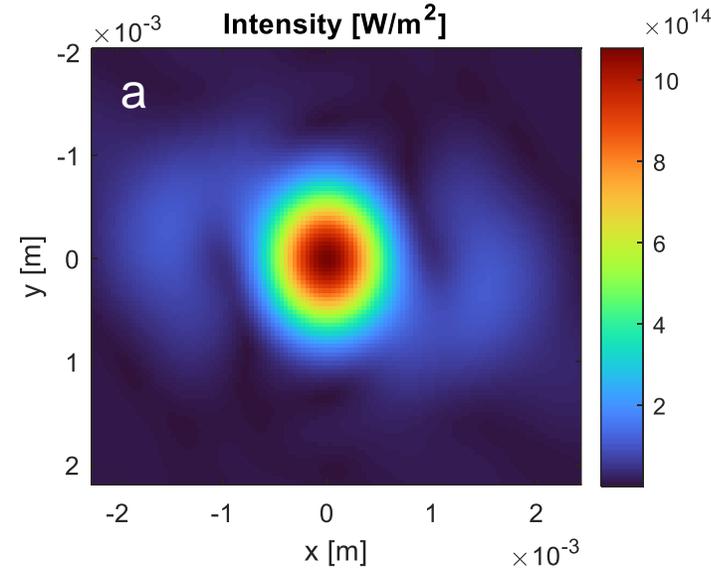
(might need waveplates for s-pol)



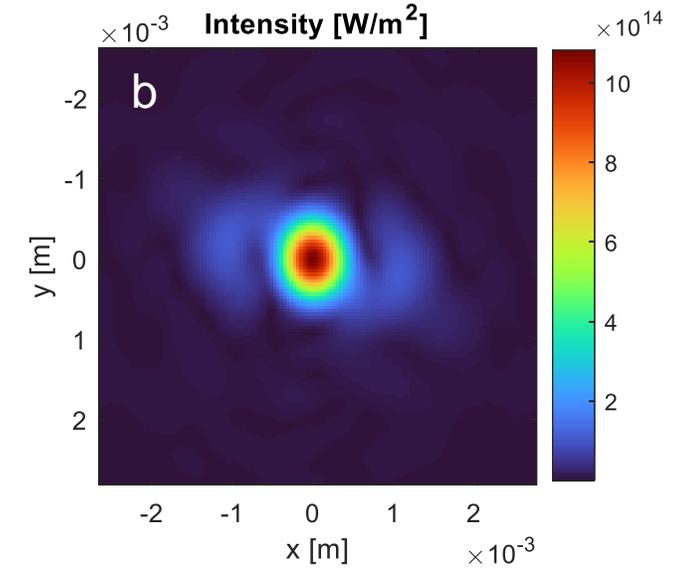
Estimating vacuum requirement for transport line



10 m telescopes (focus)

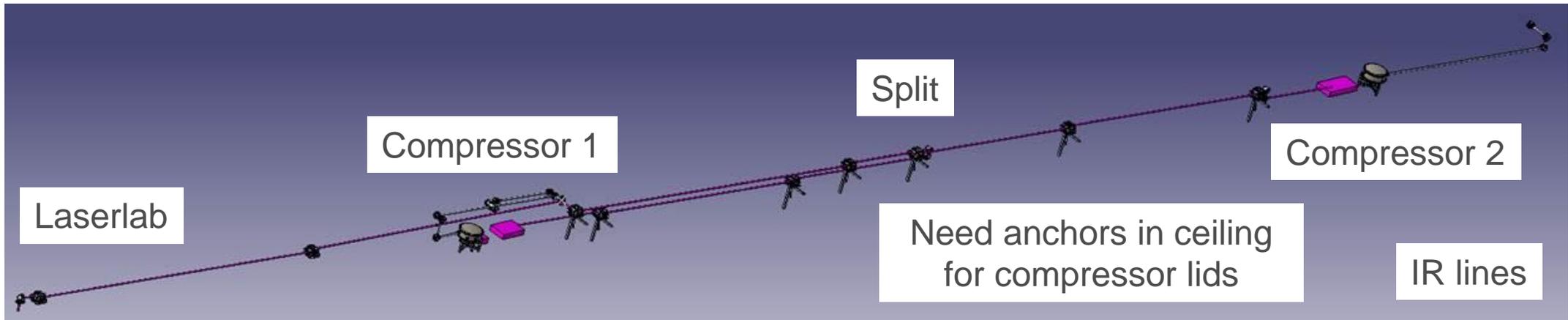
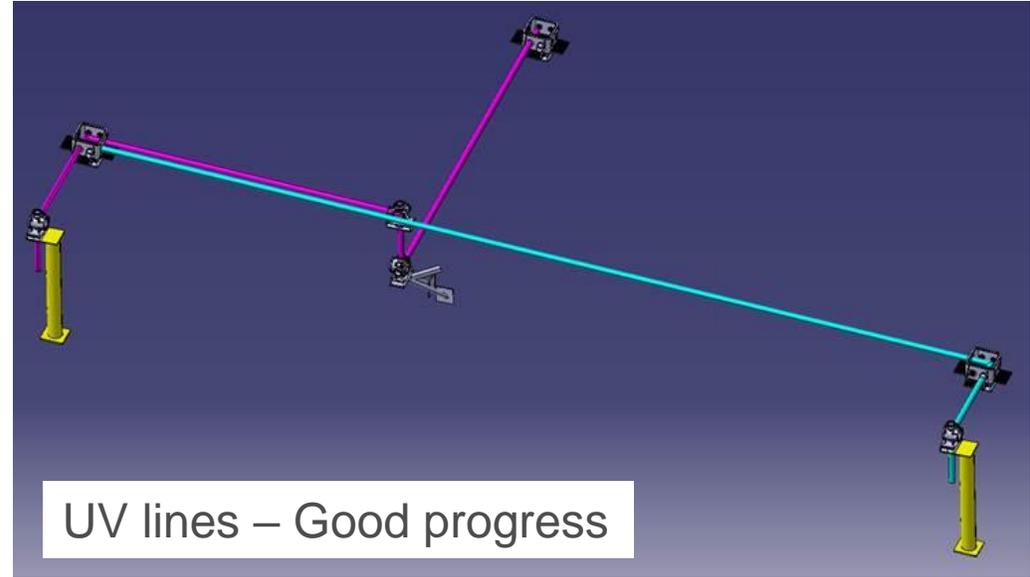
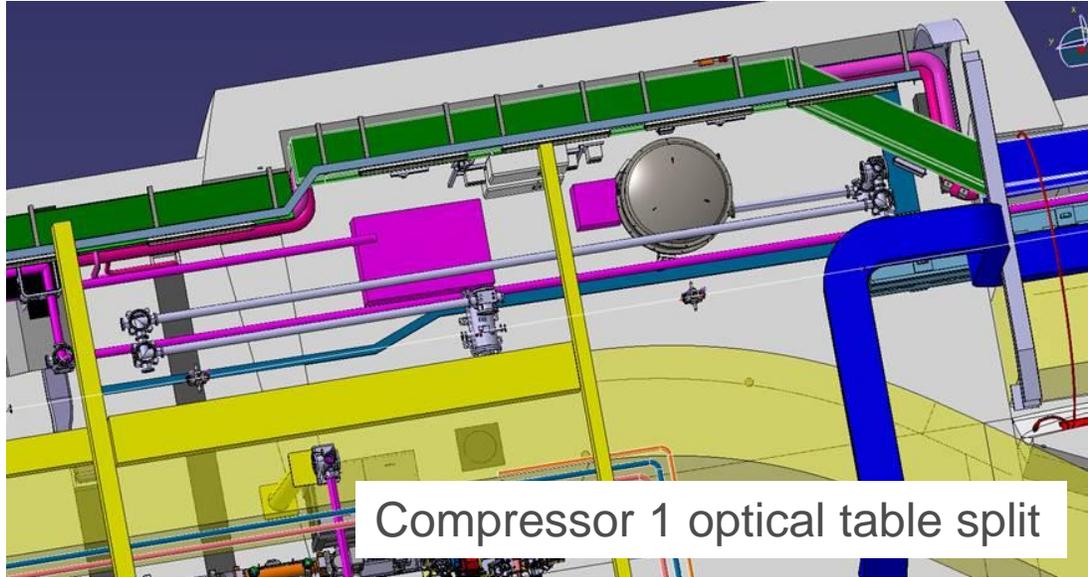


7 m telescopes (focus)



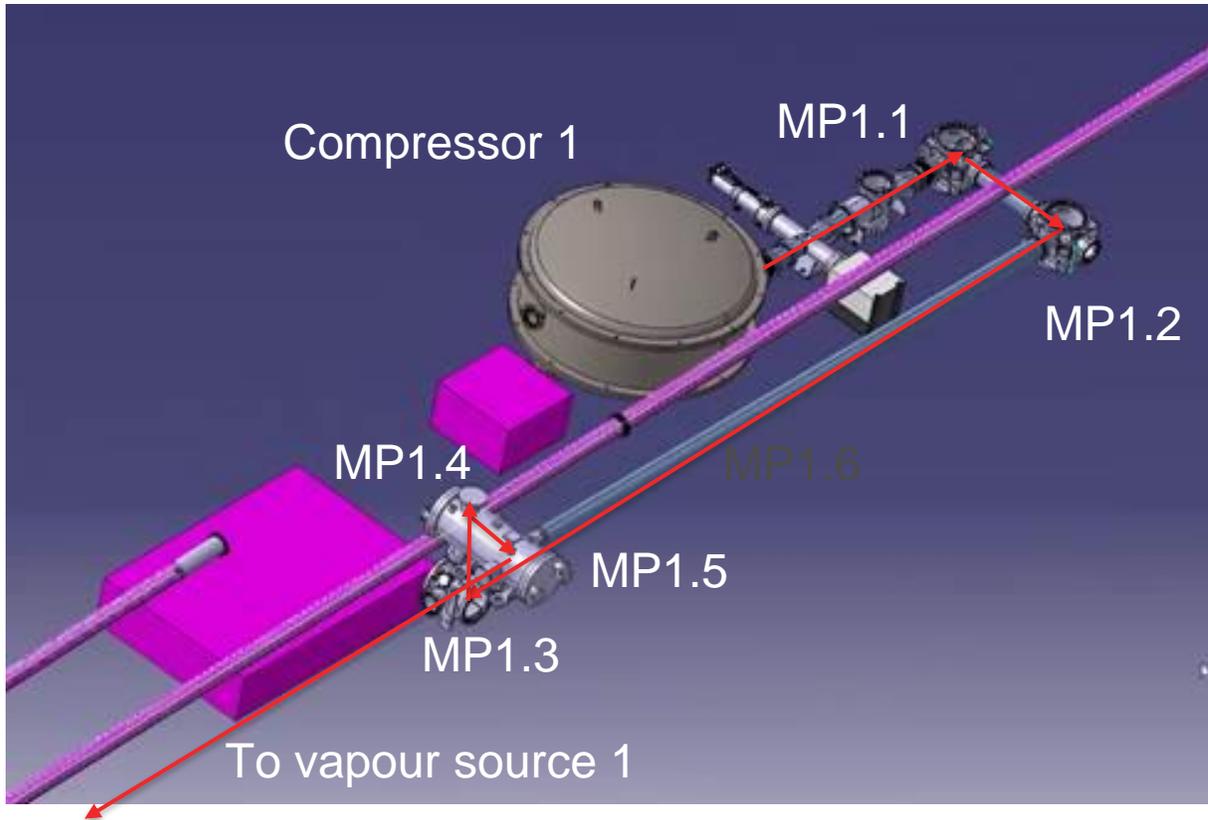
- Approximately the same intensity at focus because:
 - Splitting reduces power by 50%
 - Compensates for the smaller spot
- Both cases the peak intensity is roughly 10^{15} W/cm²
- 10^{-2} – 10^{-3} mbar should be 'safe'. 1 pumping group enough

Integration progress

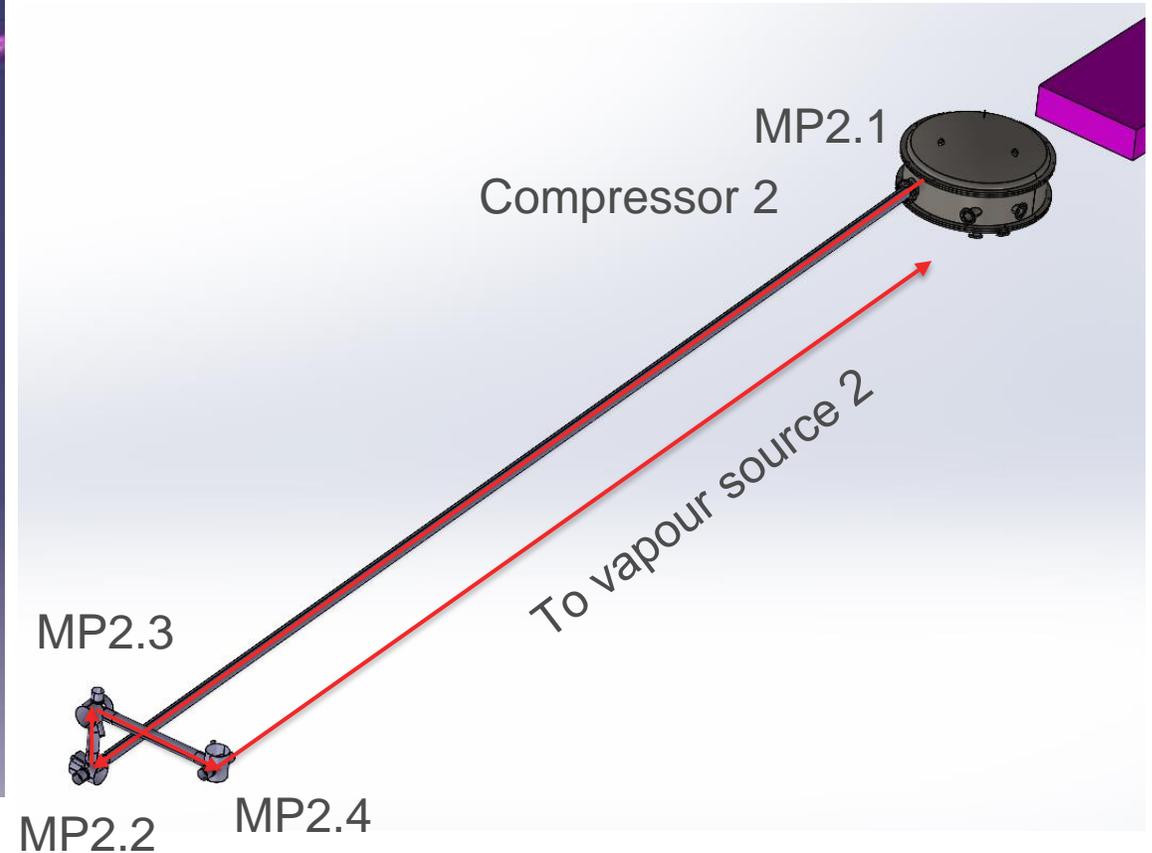


Beam delivery system

IR beamline 1 (IR1)

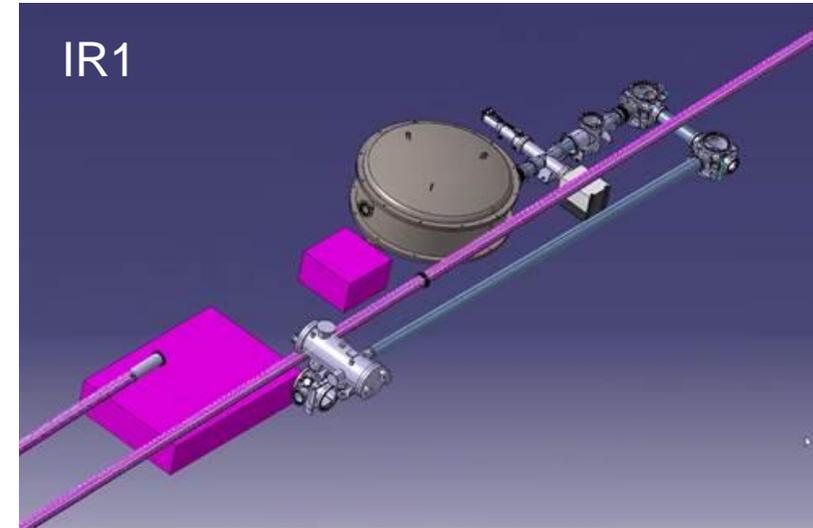
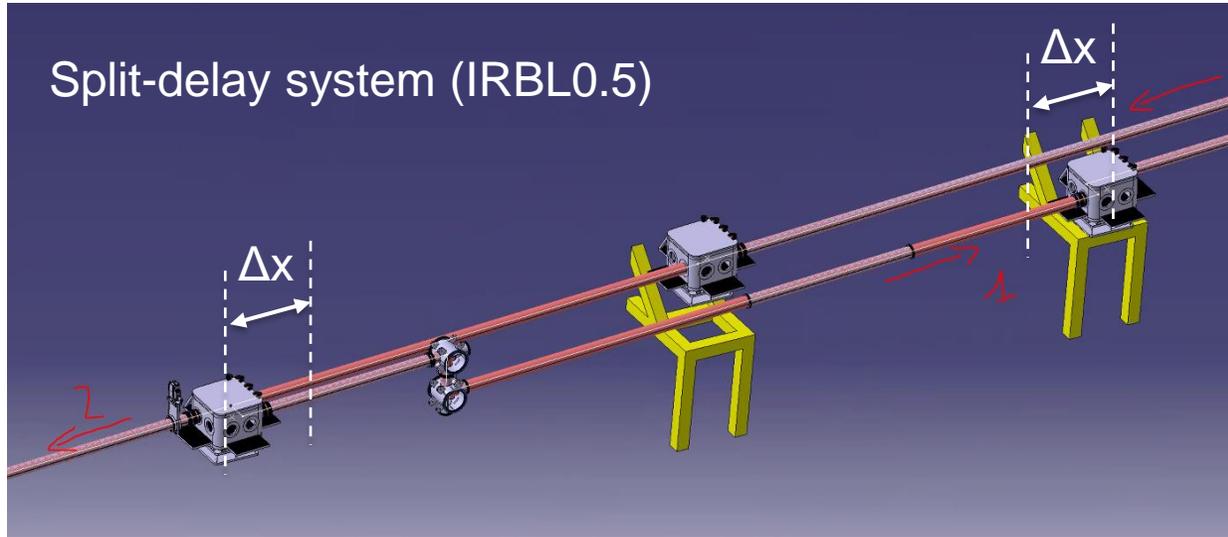


IR beamline 2 (IR2)

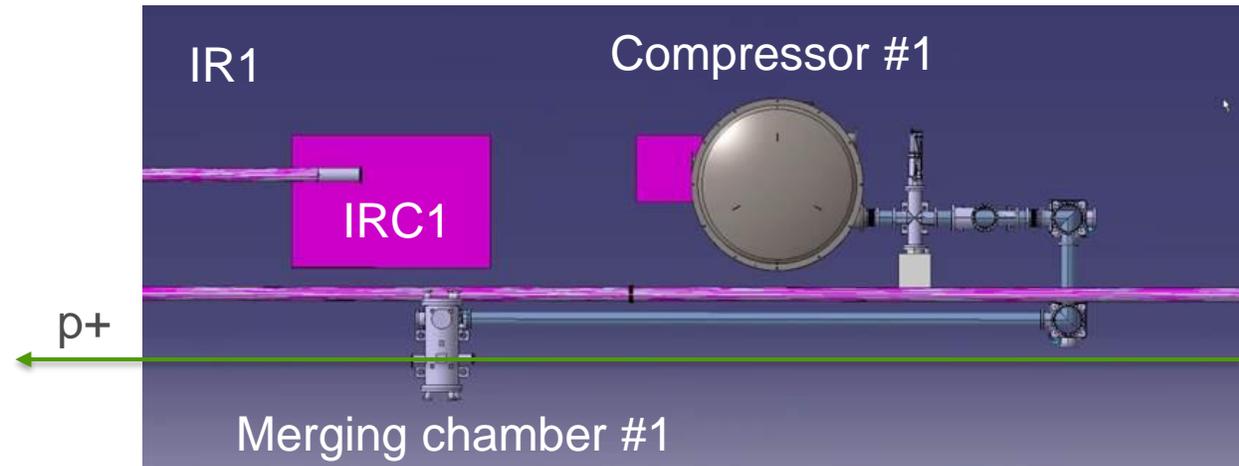


Focal length ~ 42 m

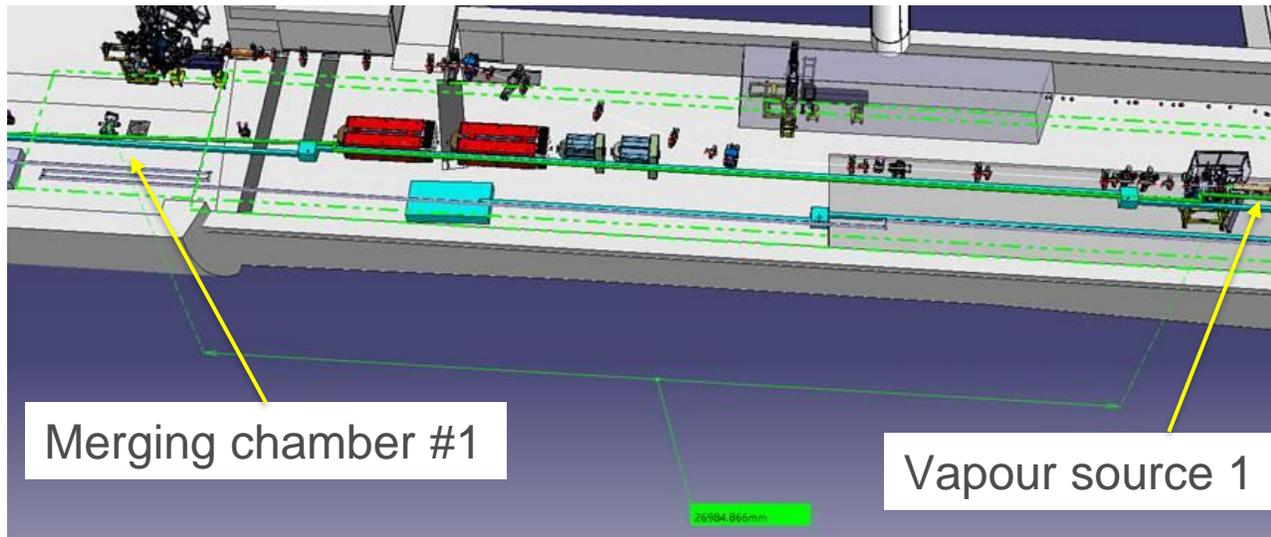
IR 1 sub-system



- Δx movement -> results in $2\Delta x$ mismatch
- (!) imaging condition should be satisfied

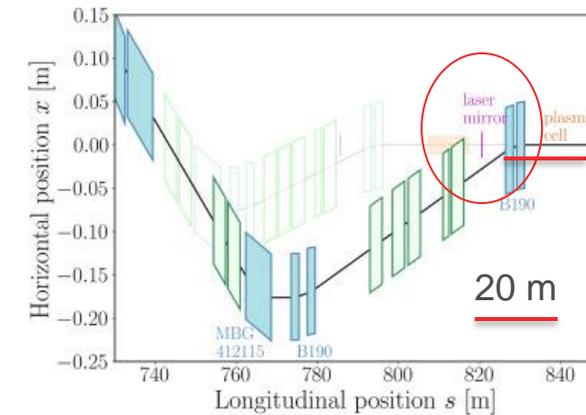


Position of the merging chamber #1 in run 2c

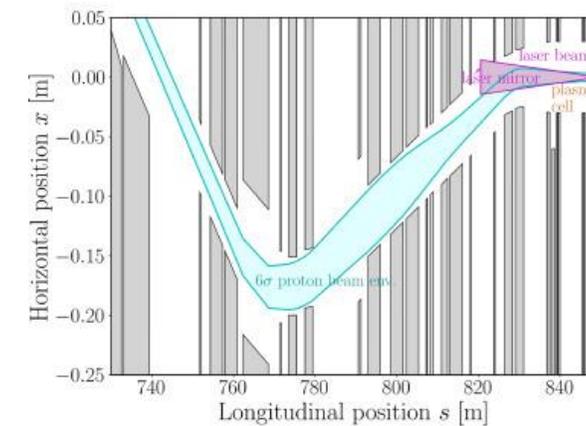


Nicolas Chritin

distance = ~ 27 m
(+5 meters compared to run2b)

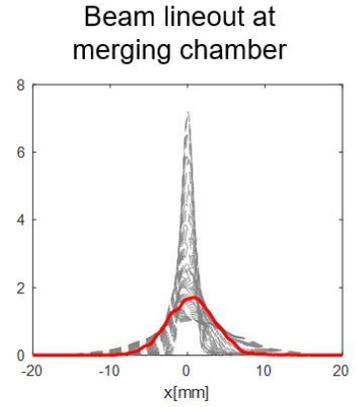
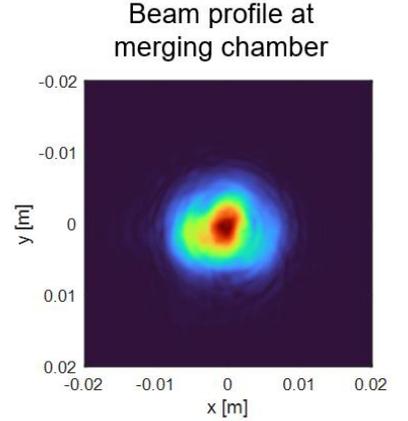
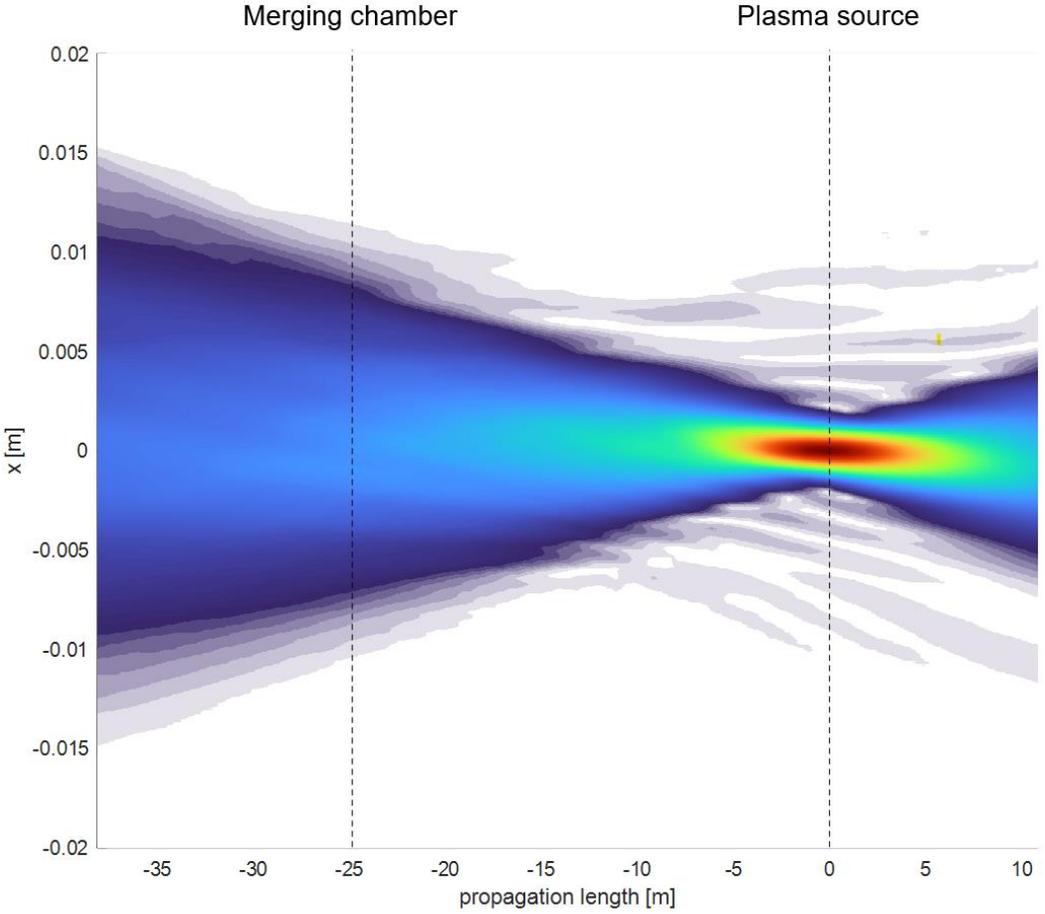


(a)

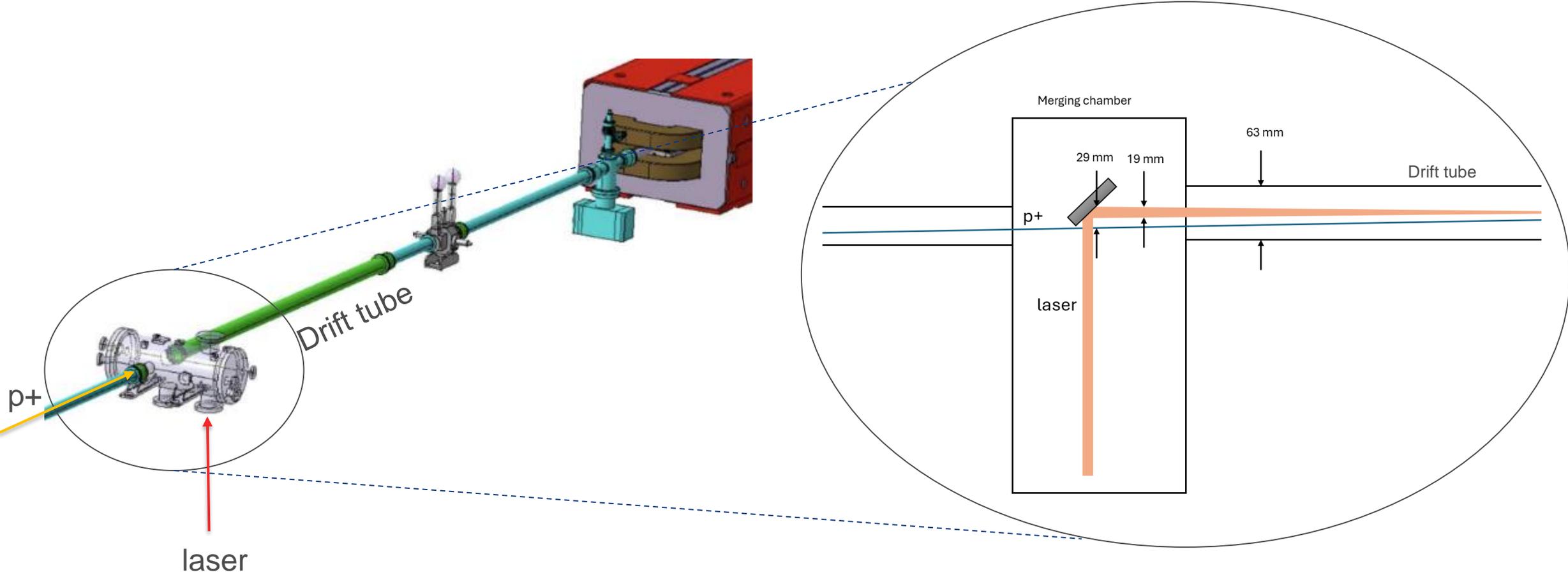


(b)

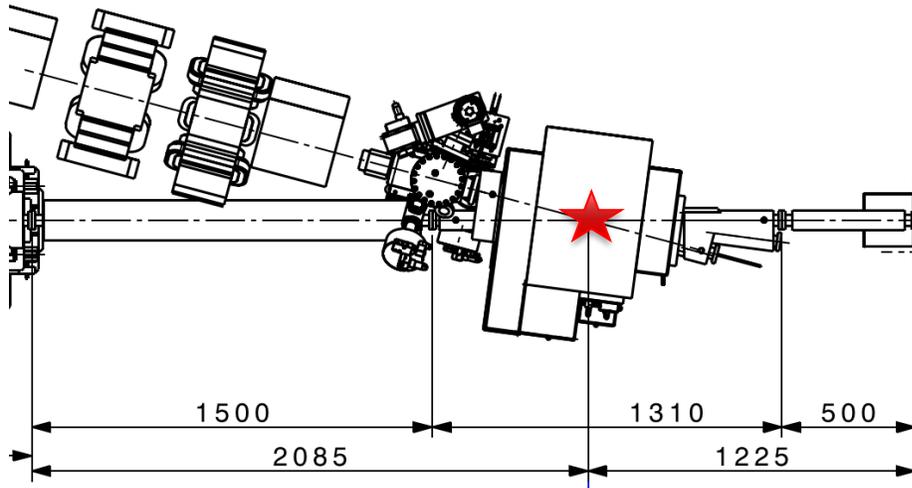
Laser beam envelope at merging chamber #1



Laser beam envelope at merging chamber #1

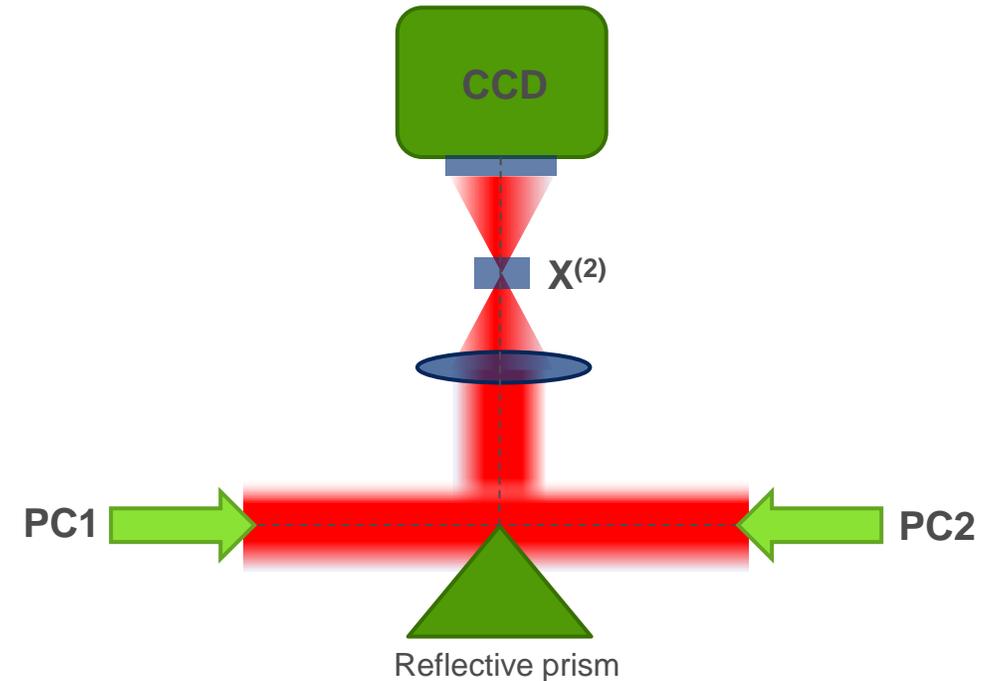


IR timing



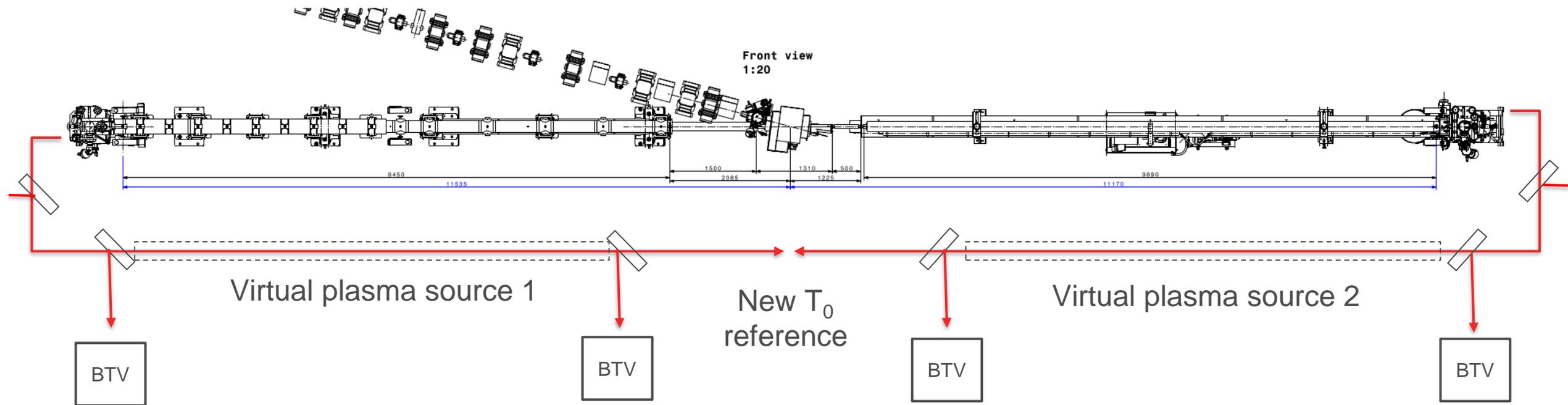
Definition of IR beam crossing point:

- For initial timing, cross-correlator will be needed
- After synchronization is achieved, the correlator will be placed in the virtual lines

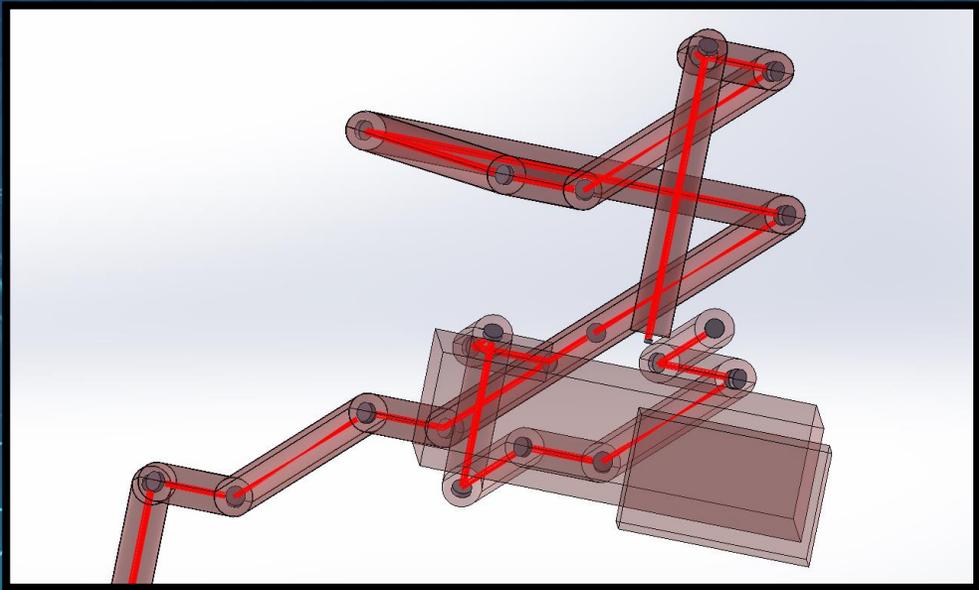


Unfortunately this device is located at the injection point of e- bunch to 2nd cell

IR timing



Vapor source #2 is shifted downstream by 0.5 m, making the IR beam delivery path #2 longer. Easy to compensate by using the delay lines in the compressor #2 conditioning optical table.



Thank you for
your attention!

