

Update of experimental results from LHC fluorescence measurements

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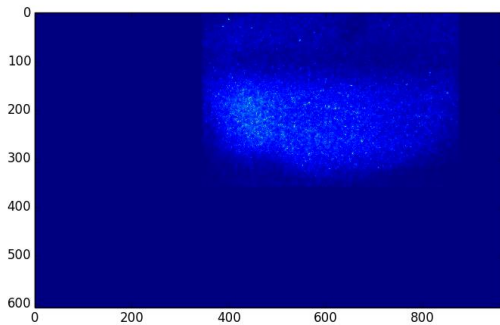
BGC Collaboration meeting, 13 June 2019

Outline:

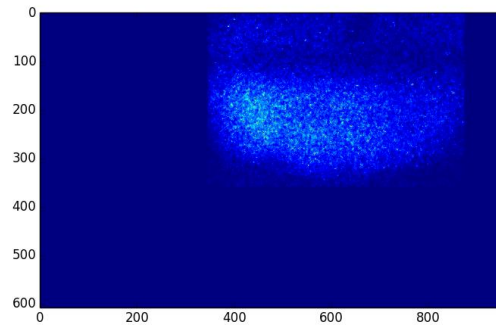
- Presentation of transverse profile from LHC:
 - p^+ at 450 GeV (19/10/2018)
 - Pb^{+82} at 450z GeV (1/11/2018)
- Status of light yield / photon count
- Conclusions and perspectives for BGC / HEL

Data from Pb+ at injection

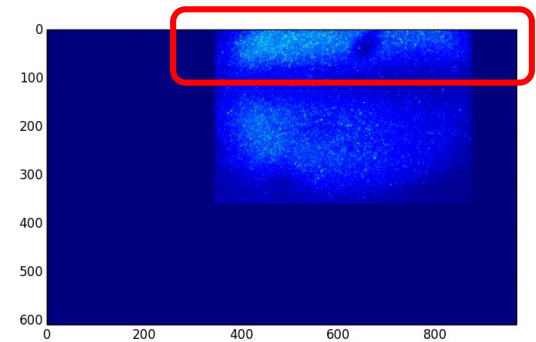
- Fill 7481, 28/11/2018. Acquired data at injection:
 - with / without gas and block filter, beam on
 - with / without gas and 585 nm filter, beam on
- Fill 7487, 30/11/2018. Acquired data at injection:
 - With gas, no beam, 585 nm filter
 - With gas, with beam, 585 nm filter



585 nm, gas **ON**, beam **OFF**
“photon counting” over 577.6 s
(1440 frames, 400 ms exp time)

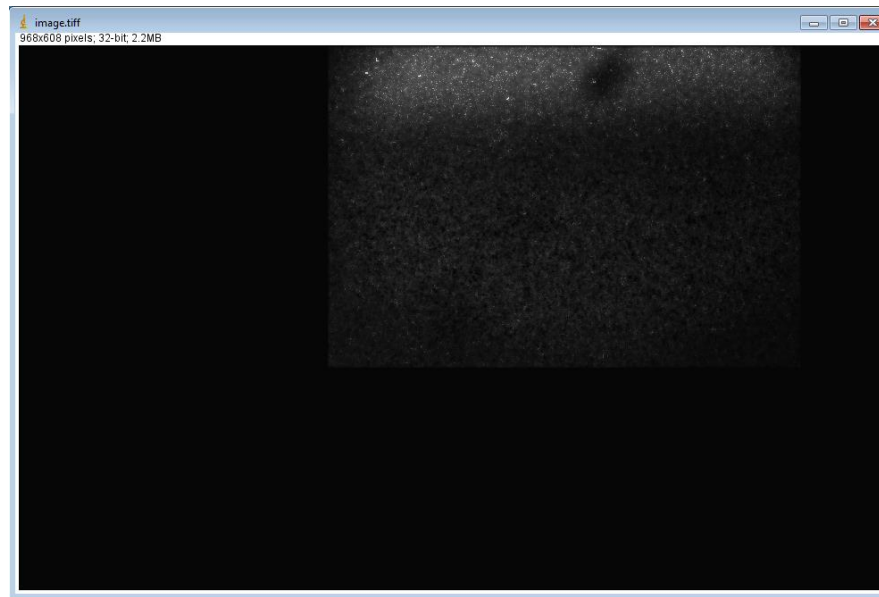


585 nm, gas **OFF**, beam **ON**
“photon counting” over 210.8 s
(527 frames, 400 ms exp time)



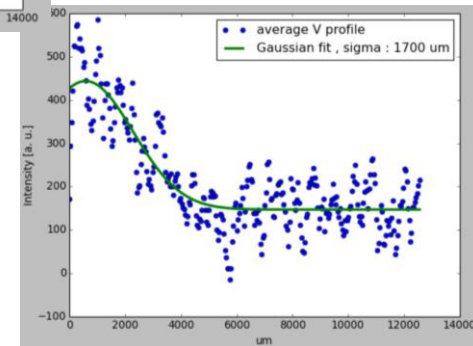
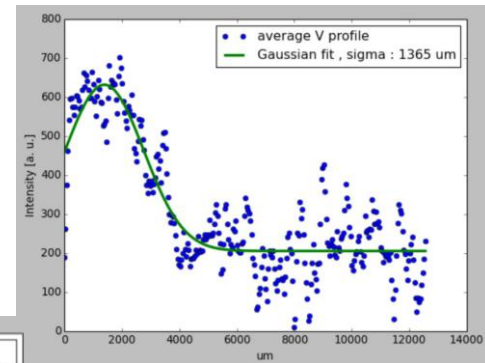
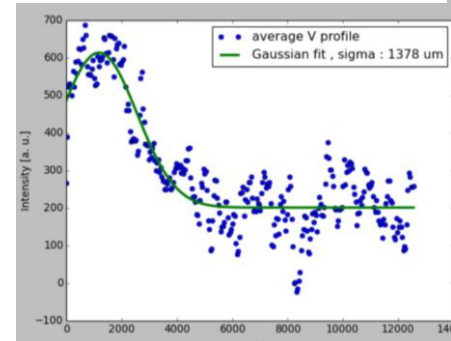
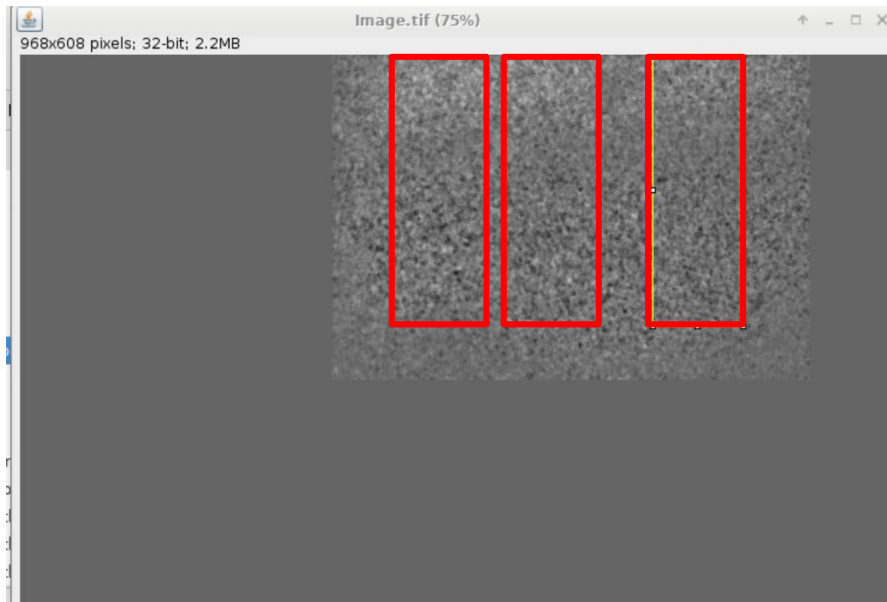
585 nm, gas **ON**, beam **ON**
“photon counting” over 1286.4 s
(3216 frames, 400 ms exp time)

Subtracted Pb+ image



- Subtracted image:
 - 3216 images at 400 ms exp time = 1286.4 s exp time beam & gas ON
minus
 - 1444 images at 400 ms exp time = 577.6 s exp time beam OFF gas ON
 - Only ONE BG is subtracted as images with beam on / gas off and viceversa are the same
- Different exposure times are accounted for (Signal $-(3216/1444)BG$)

Profile from Pb+ run

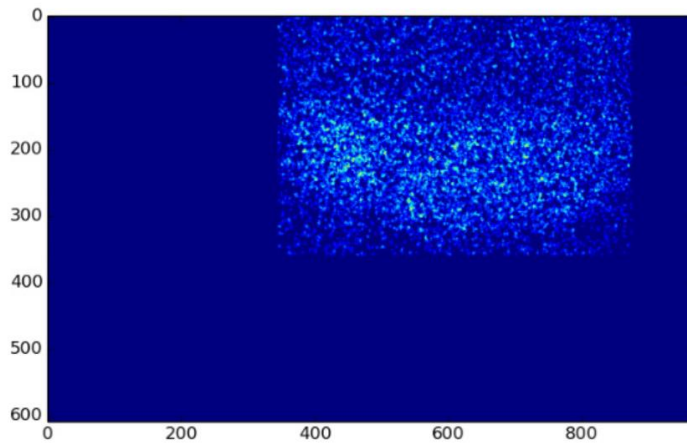


- Calculate the profile over an a 5 mm wide portion of signal (pix = 42 um, binned image, original pix size is 21 um) in three spots
- Fit with Gaussian curve, compatible with $\sigma = 1365\text{-}1700 \mu\text{m}$
- Expected profile from BSRT: $\sigma = 1930 \mu\text{m}$

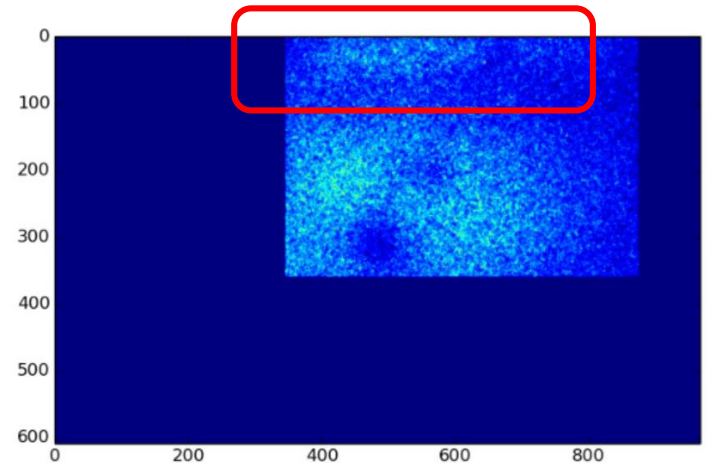
**13-41%
difference**

Data from p+ at injection

- Fill 7319, 19/10/2018. Acquired data at injection:
 - with / without gas and 585 nm filter, beam on

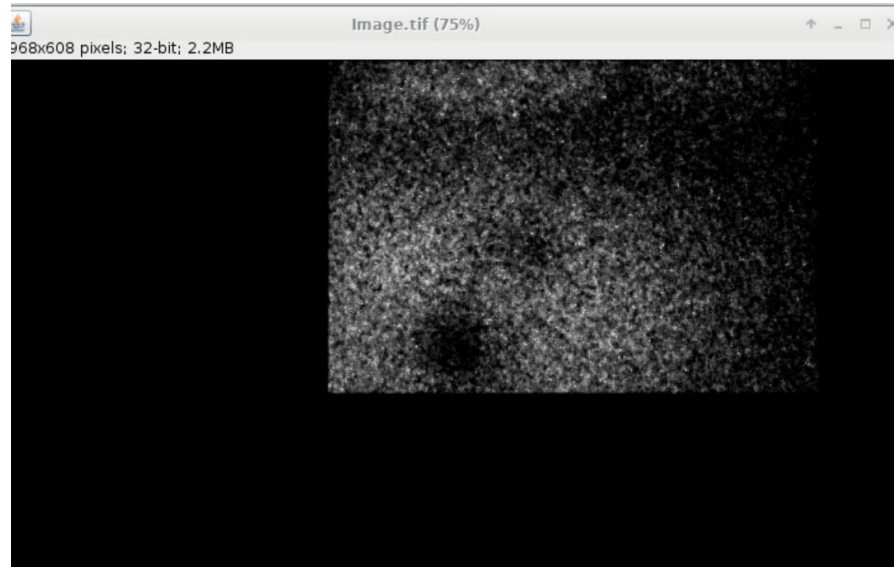


585 nm, gas **OFF**, beam **ON**
“photon counting” over 484 s
(1211 frames, 400 ms exp time)



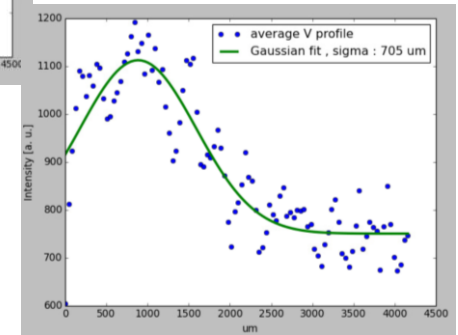
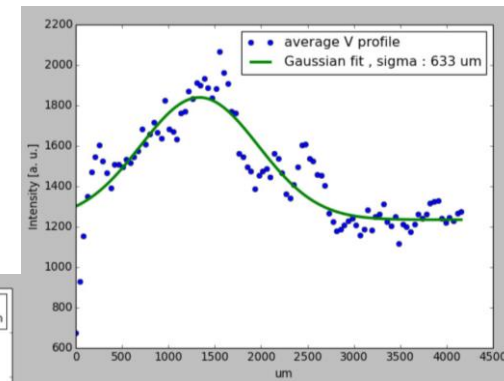
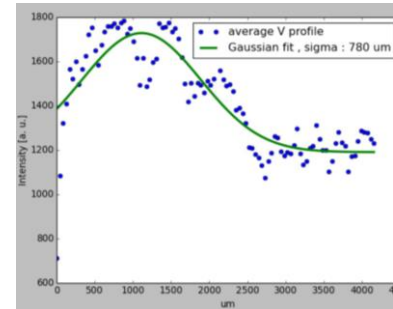
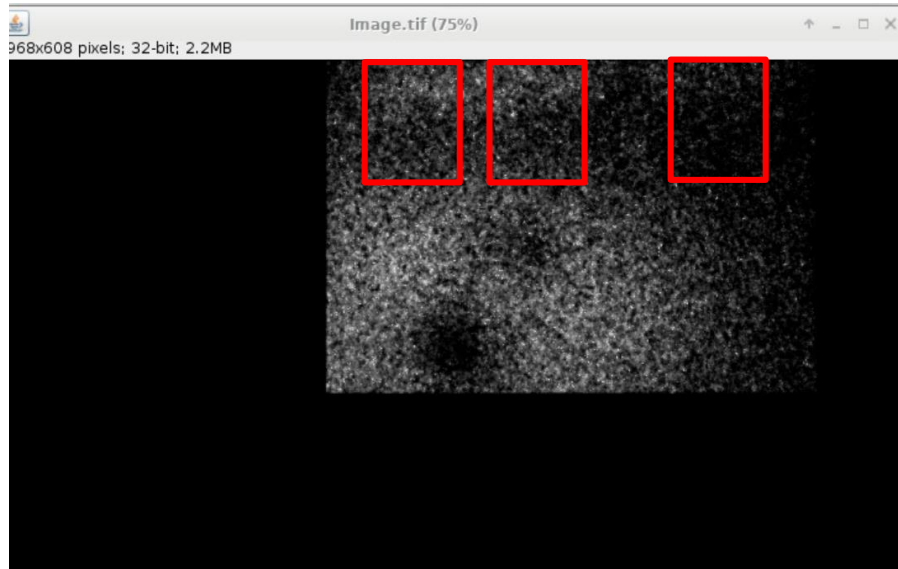
585 nm, gas **ON**, beam **ON**
“photon counting” over 201 s
(503 frames, 400 ms exp time)

Subtracted p+ image



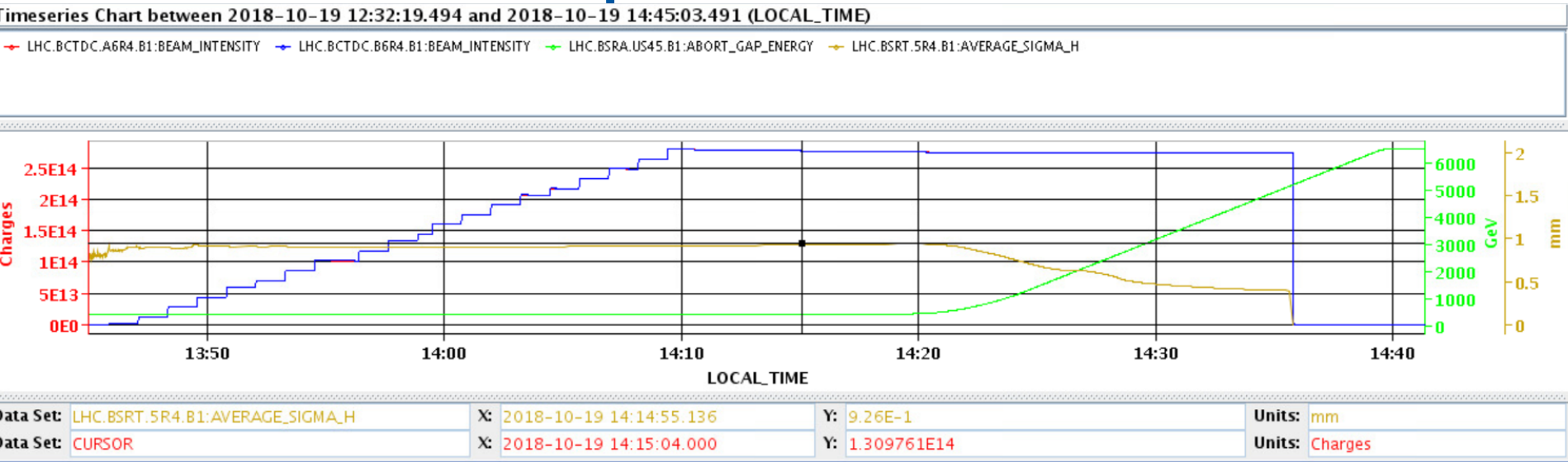
- Subtracted image:
 - 503 images at 400 ms exp time = 201 s exp time beam & gas ON
minus
 - 1211 images at 400 ms exp time = 484 s exp time beam OFF gas ON
- Different exposure times are accounted for (Signal $-(1211/503)BG$)

Profile from p+ run



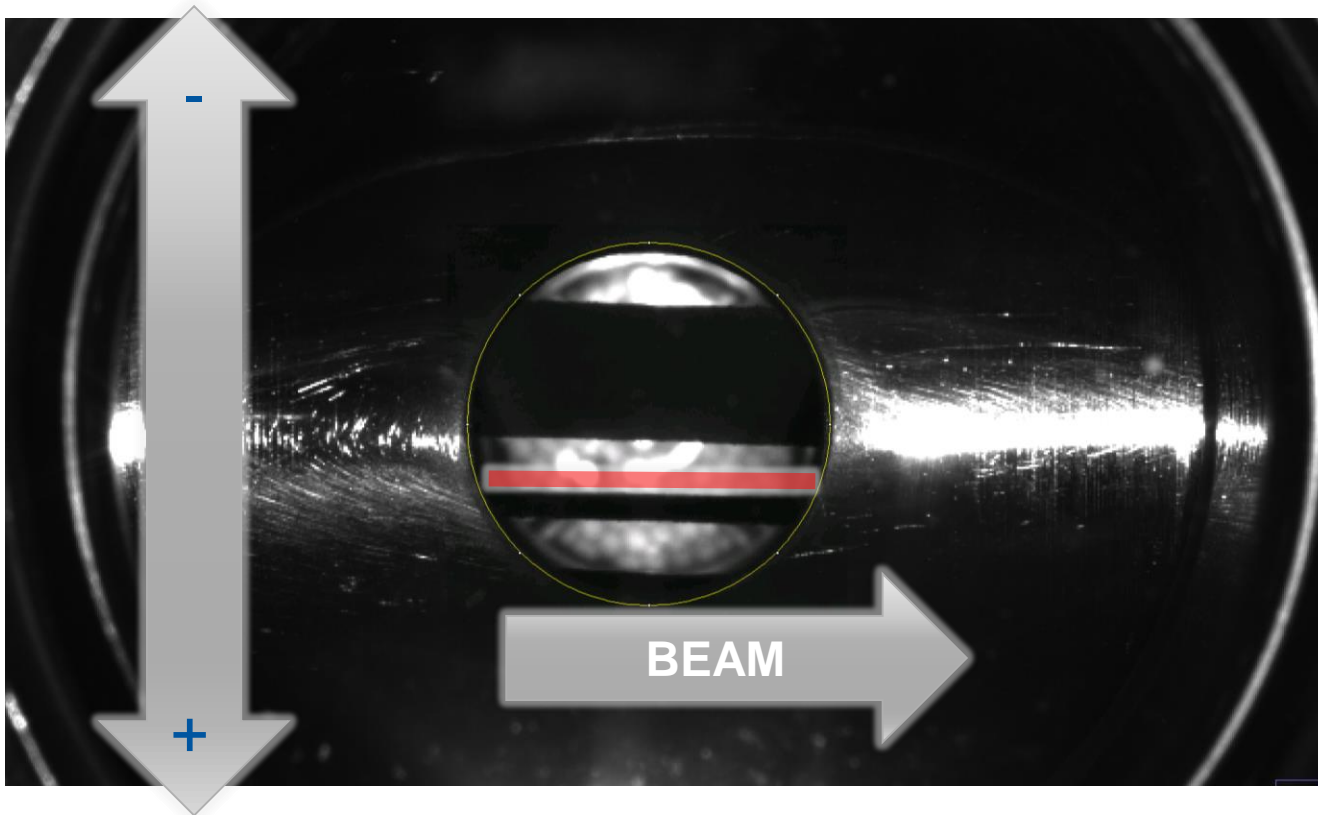
- Same method of Pb profile.
- Signal is visible at same Pb+ spot, but central part of image at same intensity: at present no explanation
- Fit with Gaussian curve, compatible with $\sigma = 630\text{-}780\text{ um}$

Profile from p+ run



- Same method of Pb profile.
 - Signal is visible at same Pb+ spot, but central part of image at same intensity: at present no explanation
 - Fit with Gaussian curve, compatible with $\sigma = 630-780 \text{ um}$
 - **Measured** profile from BSRT: $\sigma = 926 \text{ um}$
- } **19-45% difference**

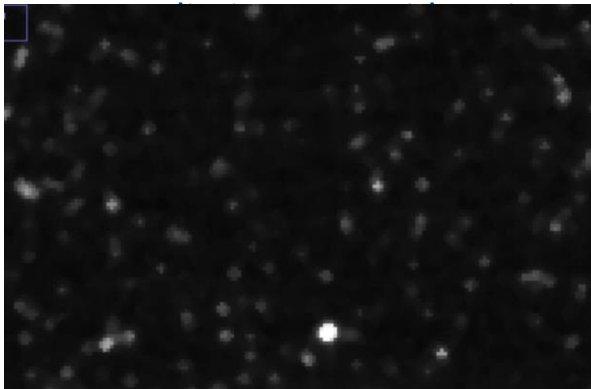
Reminder: beam is 1.5 mm off



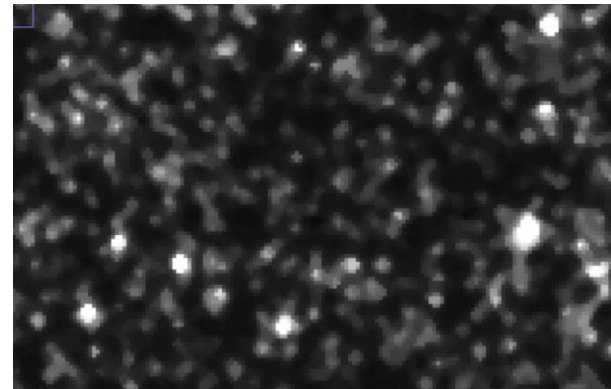
- When compared to the centre of the viewport and beam screen, the beam appears to be approx. + 1.5 mm off
- Closest BPM reads -0.5 mm

Light yield / photon count

- Some preliminary data presented on April the 30th were **wrong**
- For light yield / photon count estimation needed is:
 - Benchmark between CERN and CI intensifier. Tests performed this week at CI. It looks like the CERN camera can detect single photons. 60-80% of the counts of CI camera (**PRELIMINARY**)
 - Benchmark CERN and CI photon detection algorithm (or use the same). **TO BE DONE**



Pb+ close-up: counts



p+ close-up: clusters



Integration time for p+ probably too high for photon counting !! (OK for profile though)

(some) conclusions

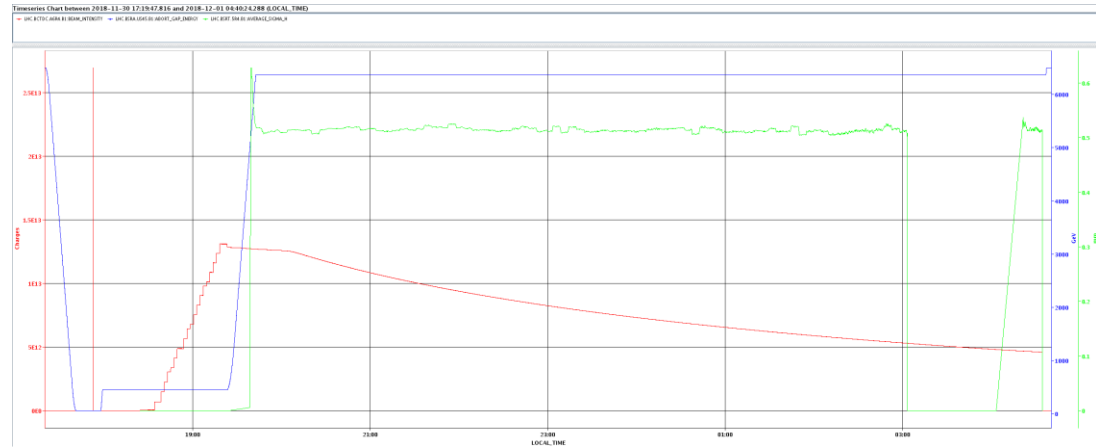
- In both Pb+ and p+ images there is some signal present in the images after BG subtraction ✓
- Pb+ profile matches within 13-41 % with expected ✓
- p+ profile matches within 19-45 % with measured ✓
- beam traces are not where expected. Off by +1.5 mm ✗
- CERN camera can detect single photons. Between 60 and 80% of counts of CI camera (preliminary) ✓
- Algorithm to be validated to check if measured Pb+ counts match with expected cross section ?
- Probably photon counting with p+ data either very inaccurate or impossible ✗



Our signal is likely **Beam Induced Fluorescence!**



Profile



- Fill 7487. No profile data available at injection energy. BSRT (green) measures 510 μm at 6.5Z TeV
- Estimation: $\varepsilon^* = \varepsilon\gamma = \sqrt{\beta\sigma\gamma}$ where ε^* norm. emittance, γ Lorentz factor, β beta function, σ beam size. That is

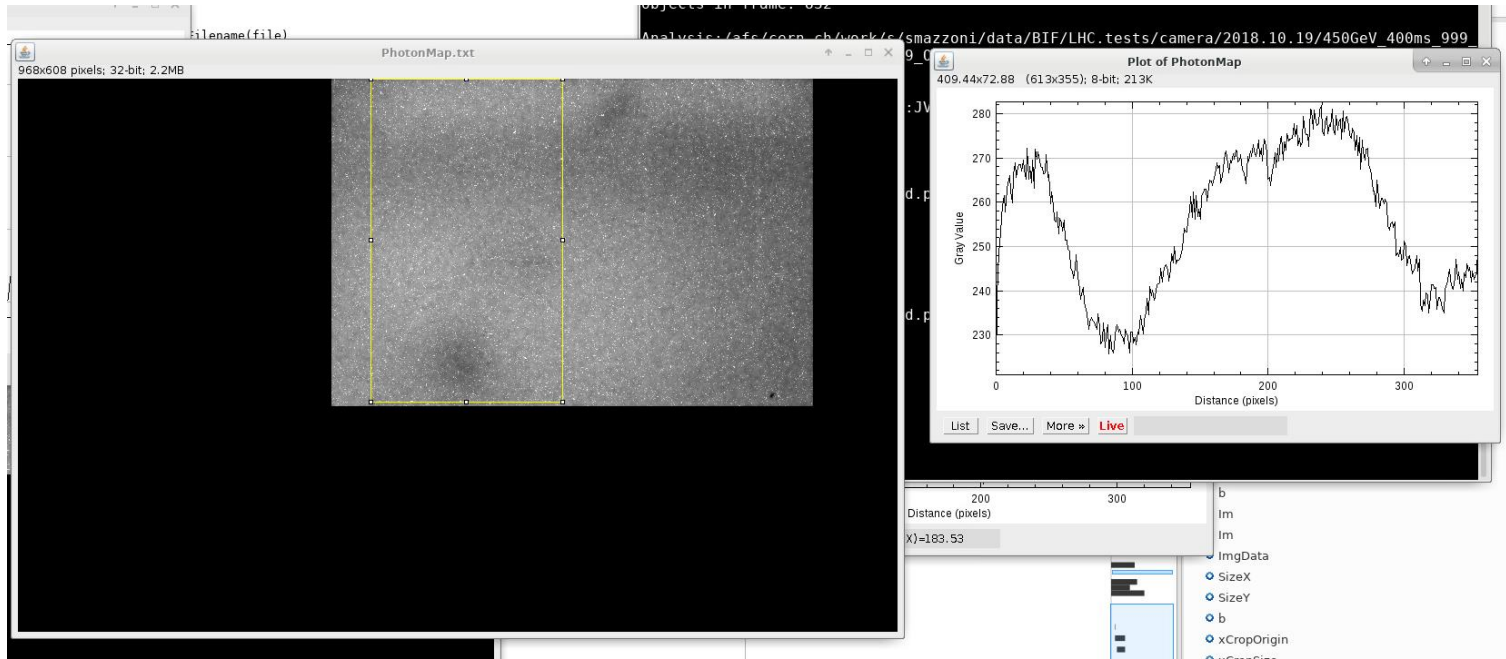
$$\sigma_{450} = \sqrt{\frac{6500}{450}} \sigma_{6500} = 1930 \mu\text{m}$$

That is 30% off (possible...)

Fill 7319

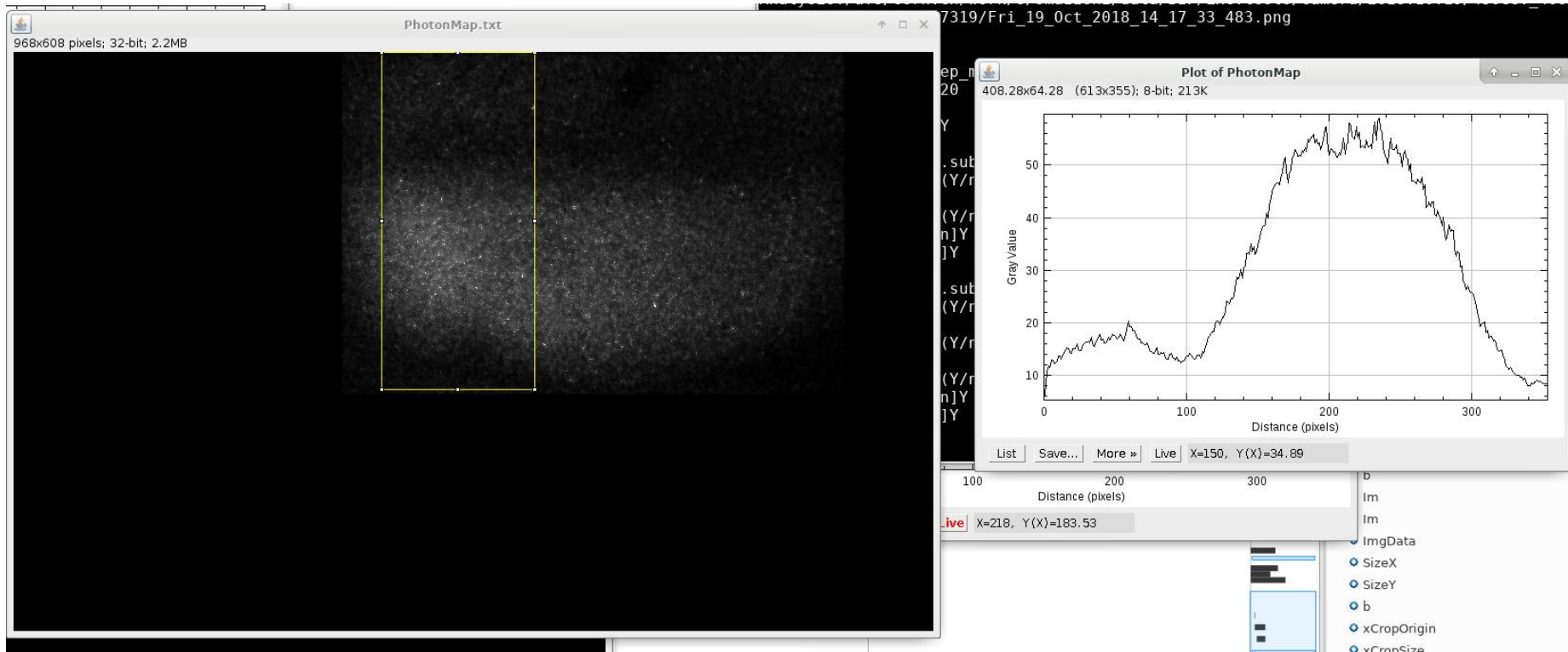


Signal images



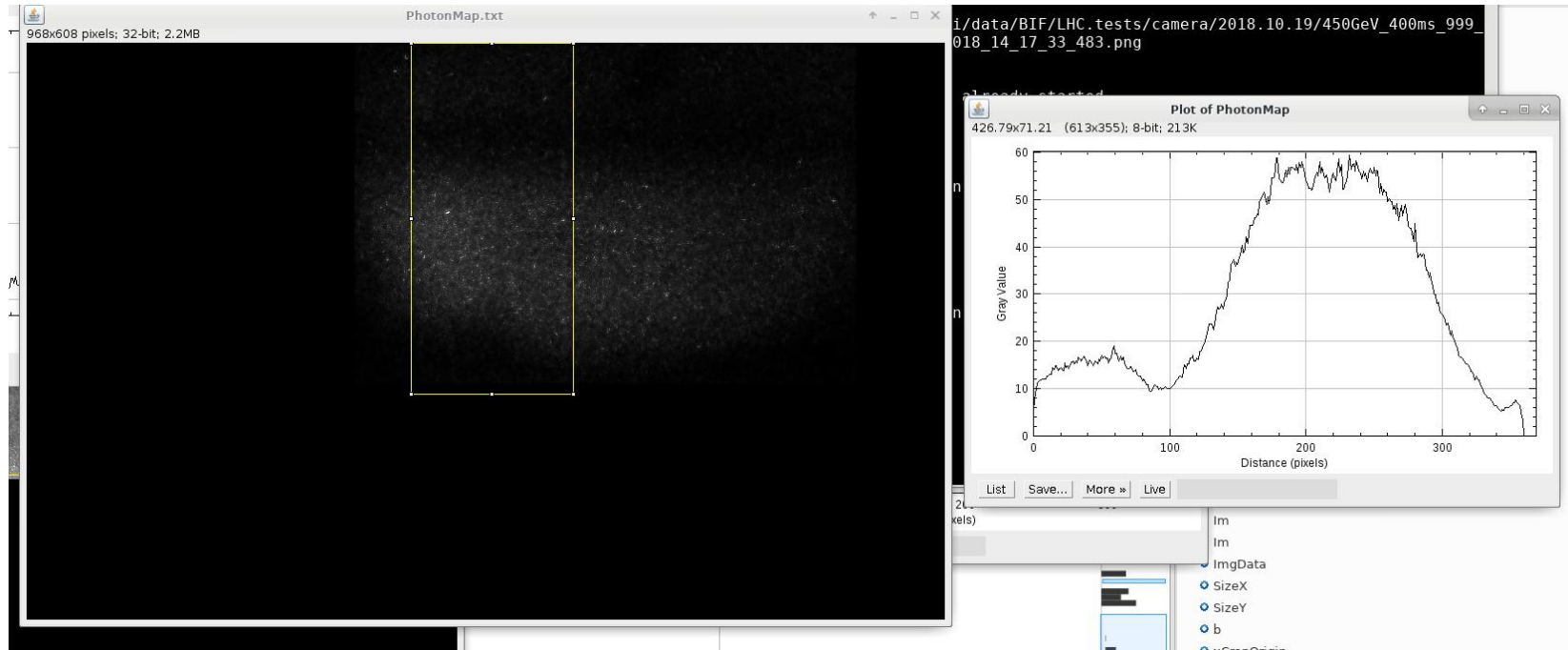
- Signal images. Central region higher than upper steak

BG1 images: beam, no gas



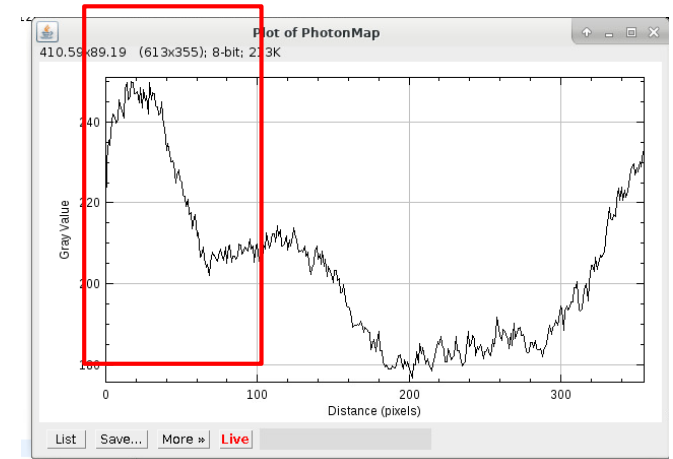
- Most of the light is present in the central part of the image

BG2 images: gas, no beam



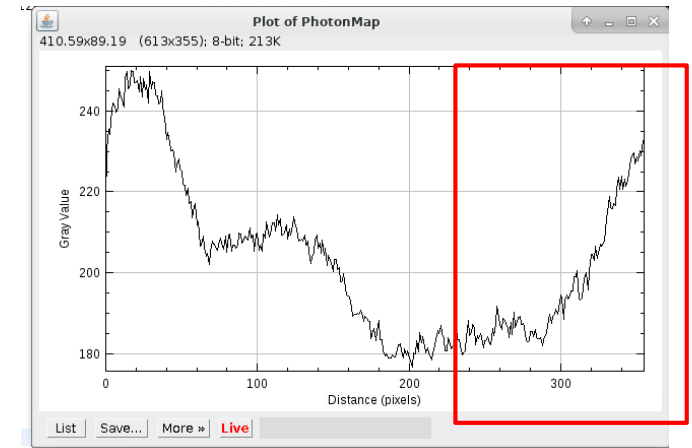
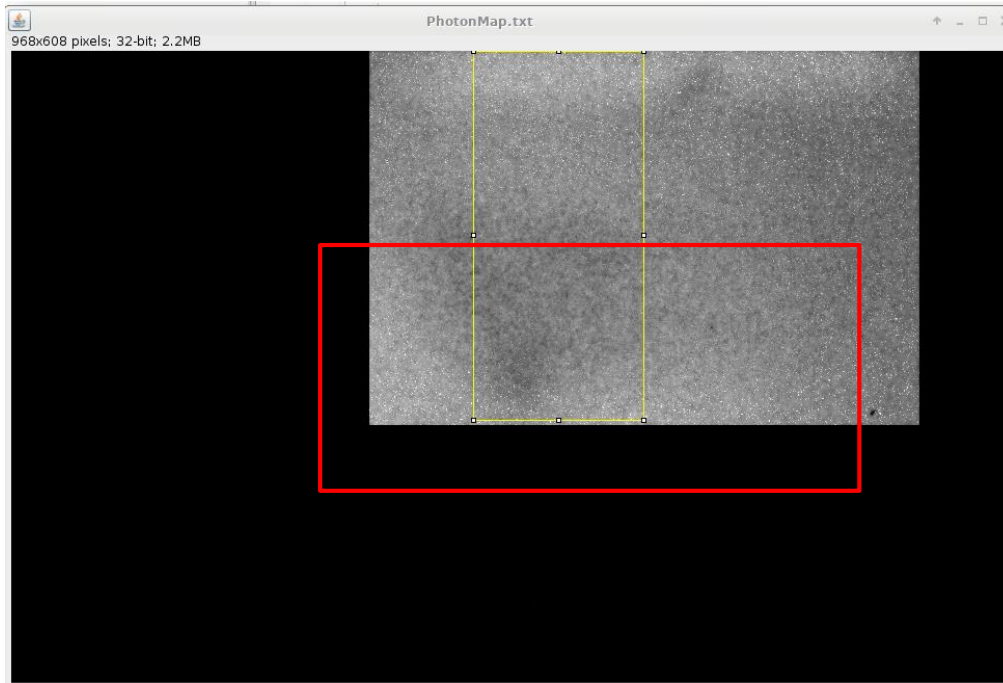
- Very similar to BG1 images. Could mean that light is present in the beam pipe due to other sources (eg hot filament gauges, ...)

Subtracted images



- After BG subtraction:
 - upper streak visible

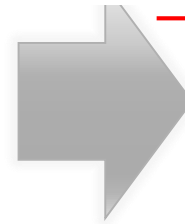
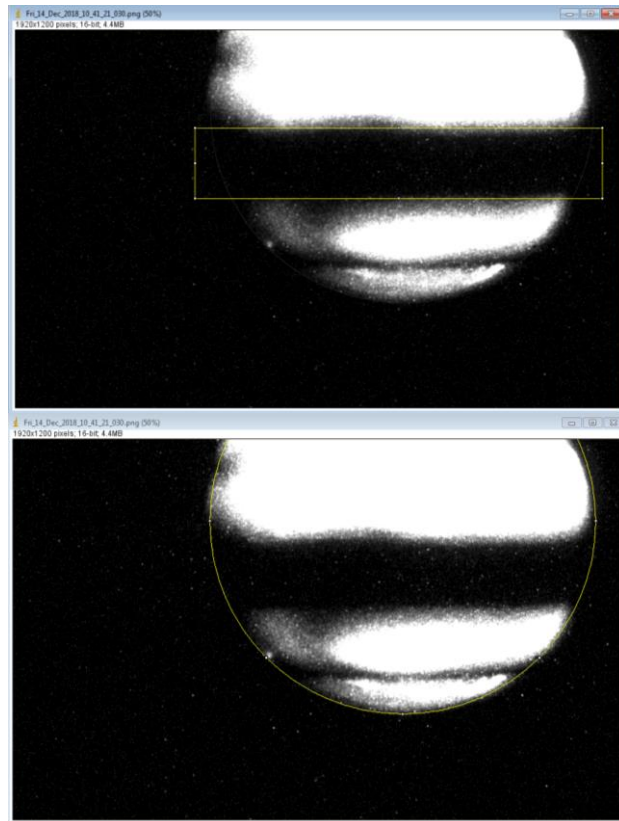
Subtracted images



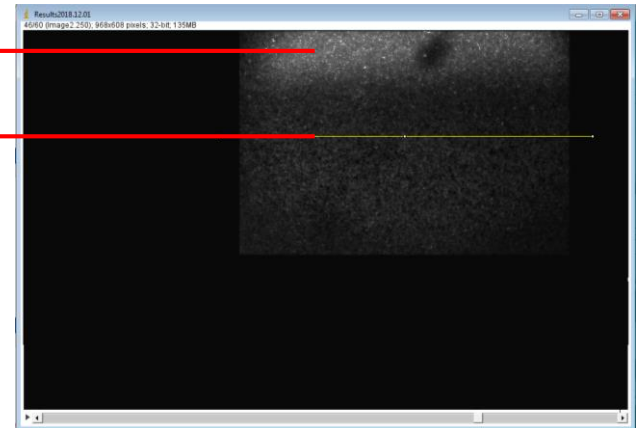
- After BG subtraction:
 - upper streak visible
 - However, lower part of image: some signal present, not clear if this is related to fluorescence.

Position

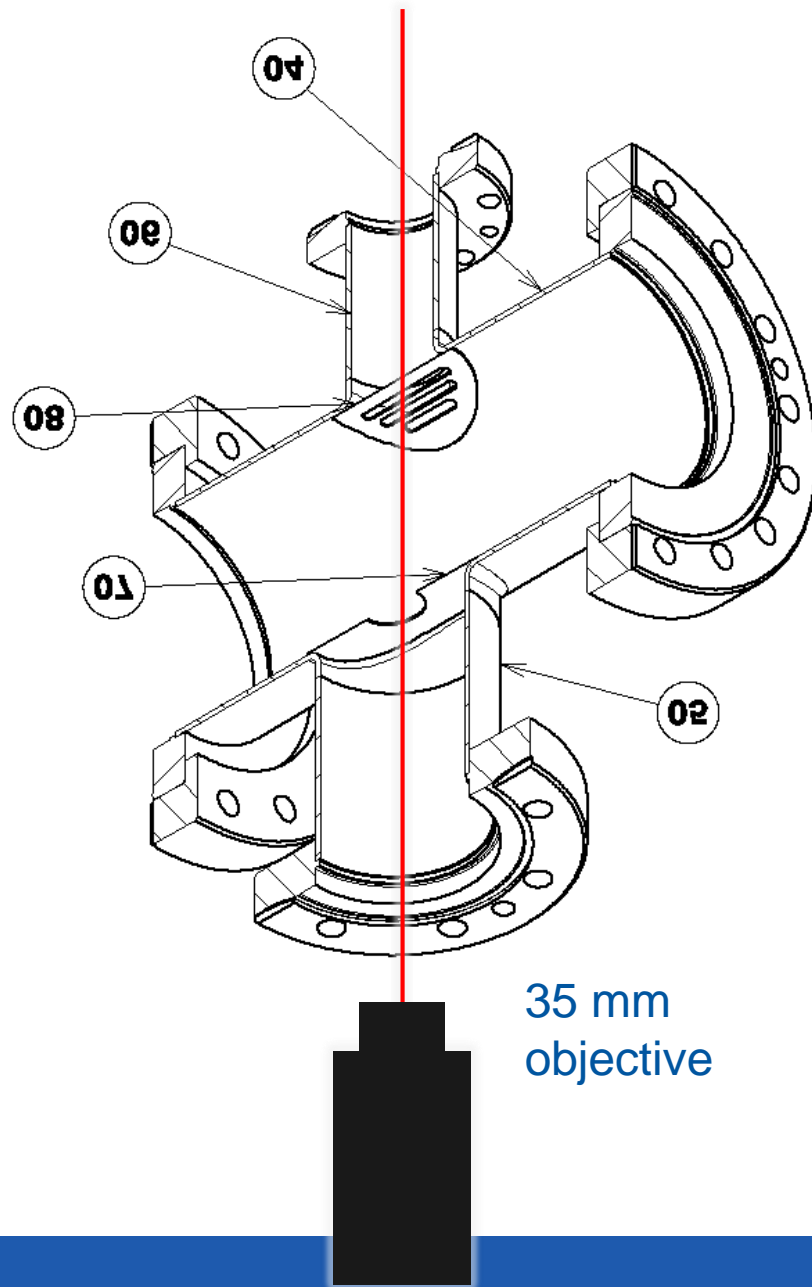
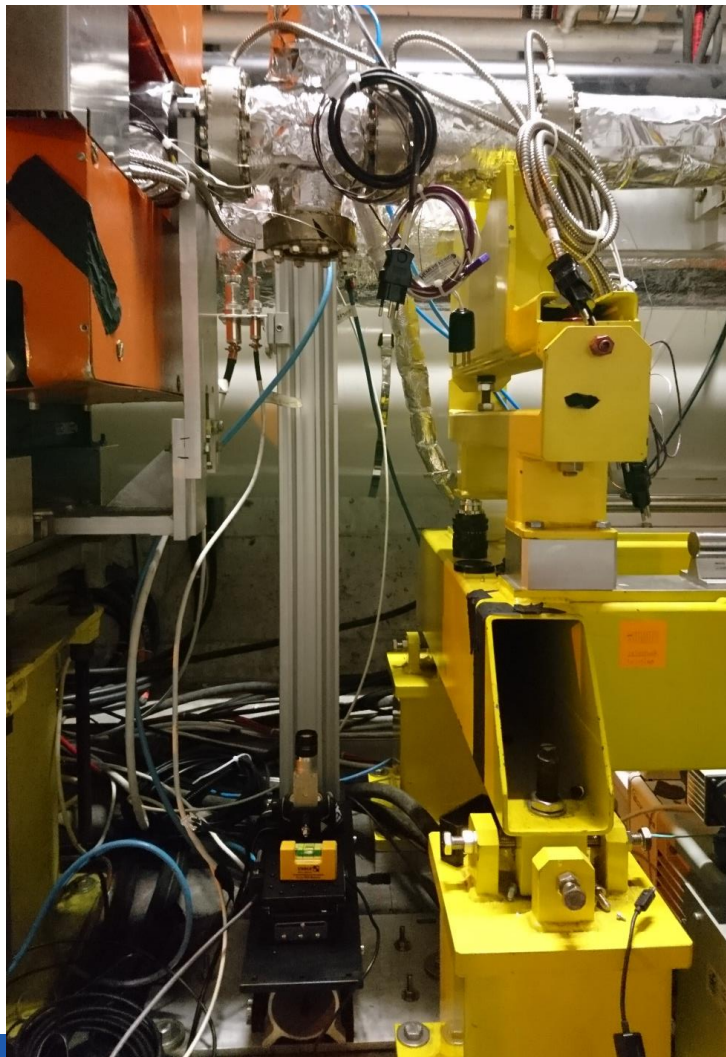
Horizontal position off by 5.5 mm.



Vertical offset: 5.5 mm



Position



Position

