BTV AD Target – Screen issue

BI-TB 13th of April 2022
S.Burger BI-PM

- New BTV setup (post LS2)
- Screen issue: 2021
- New screen: OTR from 2022
  - Measurements results
- Conclusion

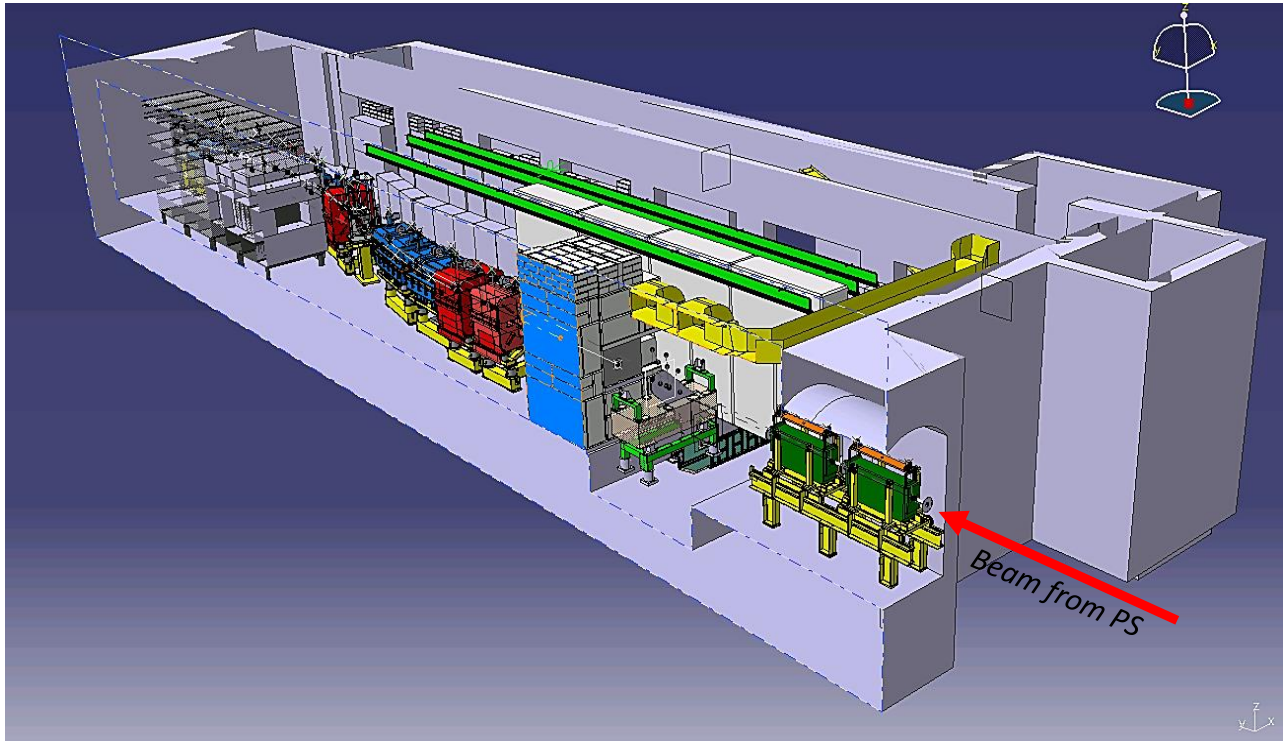
AD Target new BTV

AD Target consolidation during LS2

Request for BI (2017):

"Be able to measure beam size in front of the AD target for all extracted beams with a resolution <250um"

- Present monitoring has **poor resolution & sensitivity** (as analogue Vidicon tube detector is used for radiation purpose) and any **maintenance needs access**



Layout of the AD target area.

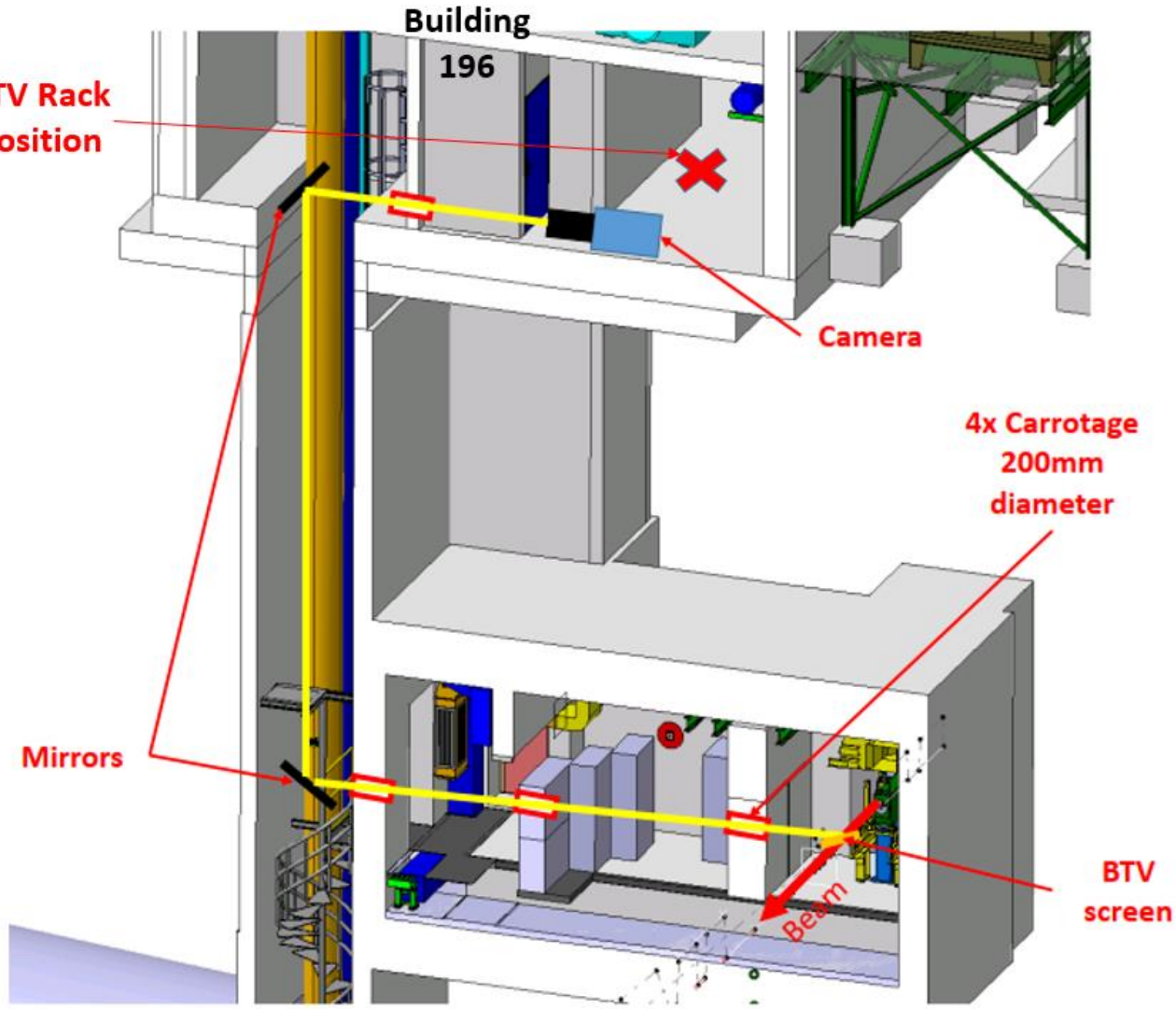
Main components for the new BTV:

- Digital camera
  - **High resolution, sensitivity**
  - **Adjustable integration time, gain, etc…**
- Optical line to locate the camera outside of the irradiated area
  - Limit the number of optical components → **No maintenance of the optical line inside the area !!**
- Keep scintillating Screen - **CHROMOX** - 0.5mm thick

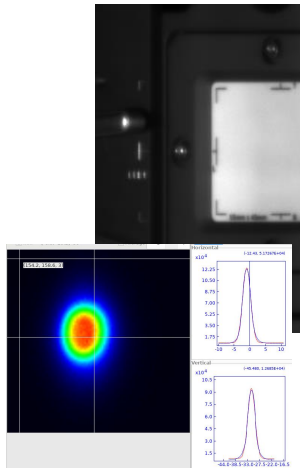
[BTV for the Post LS2 AD Target | Document AD-BTV-ES-0001 (v.1.0) (cern.ch)](#) **EDMS 2274393**

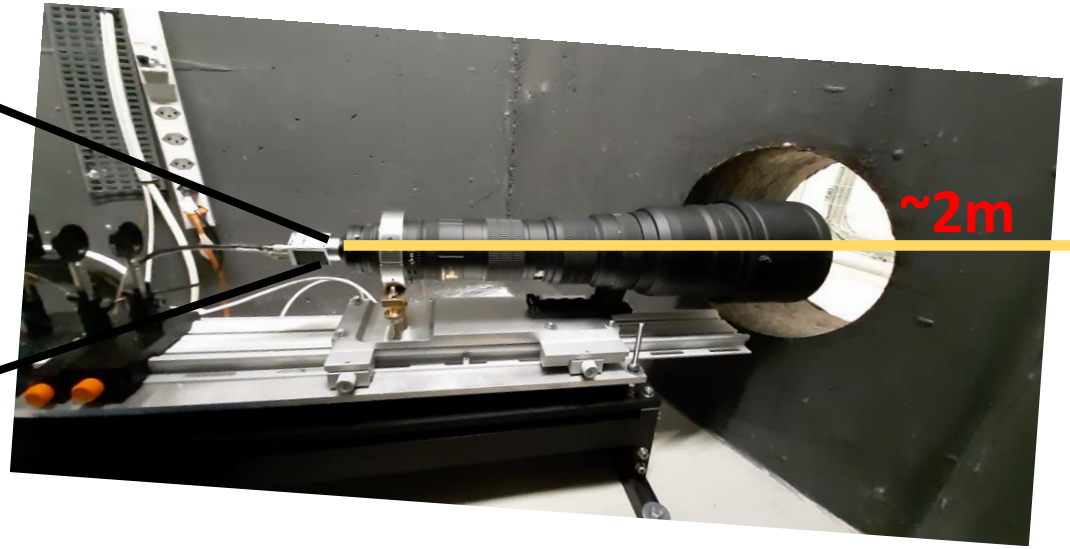
- Design of the BTV screen setup on the new target trolley

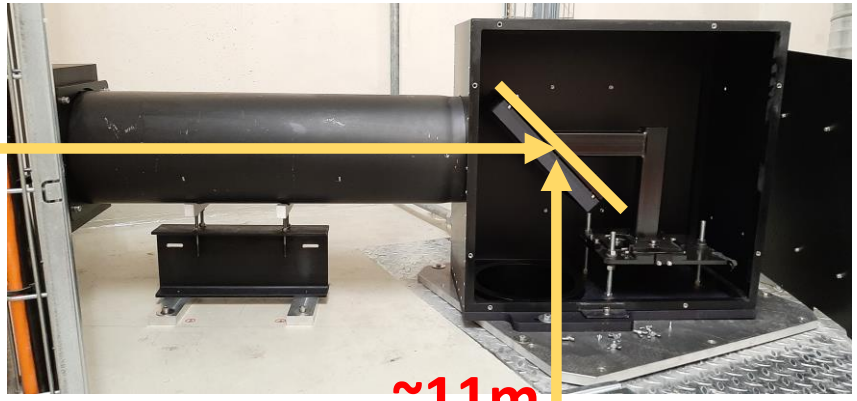
- Design of the optical line (ZEMAX simulations) :
  - Mirror base with no elements inside the radioactive area:
    - 300mm x 200mm
    - >95% reflectivity
    - Flatness lambda/5
  - Camera lens
    - F800mm/5.6NA
    - Optimization optical & spatial resolution @ F400mm



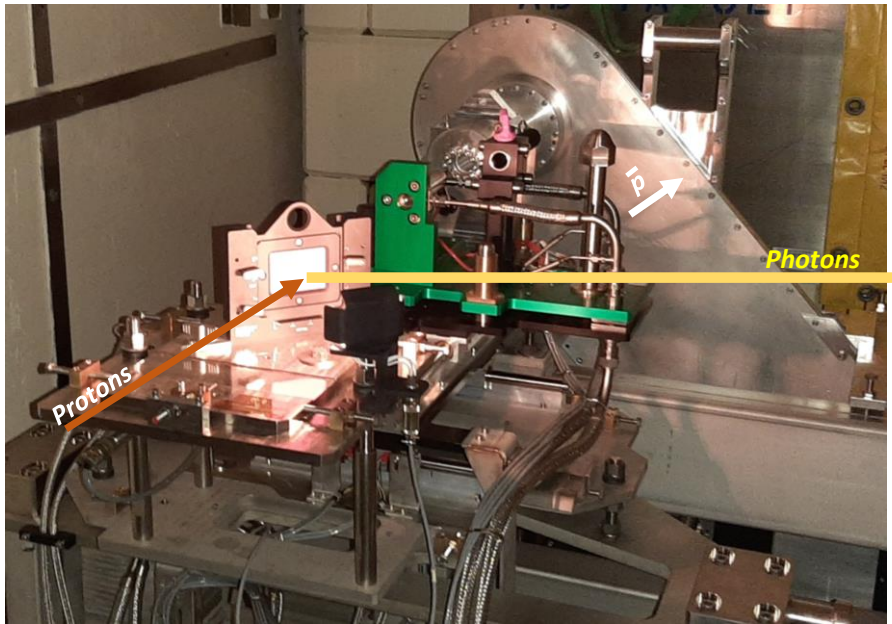
Proposal for new BTV optical line in AD Target.

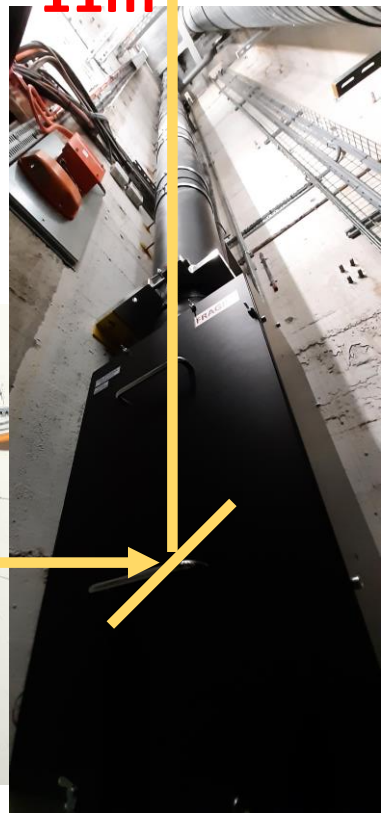






ADT BTV 20m Long Optical Line Installation

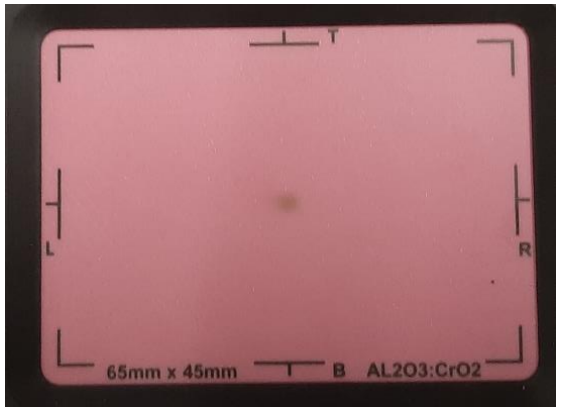




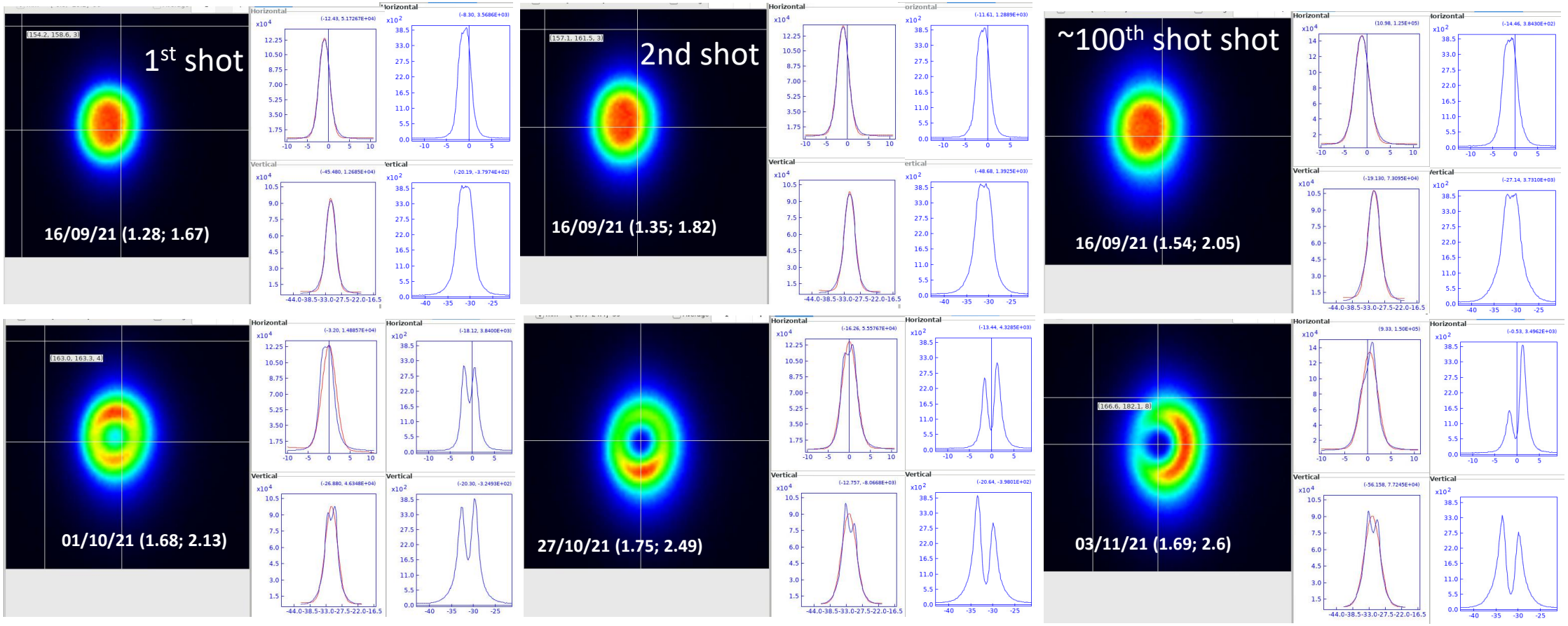
~7m

BTV AD Target – Screen issue run 2021

- Chromox screen was OK for the commissioning of the ADT with lower intensity
- With nominal intensity, screen damaged was visible after ~100 shots (noticeable before with the beam size measurement getting higher)



Chromox screen degradation after 2 months of operation



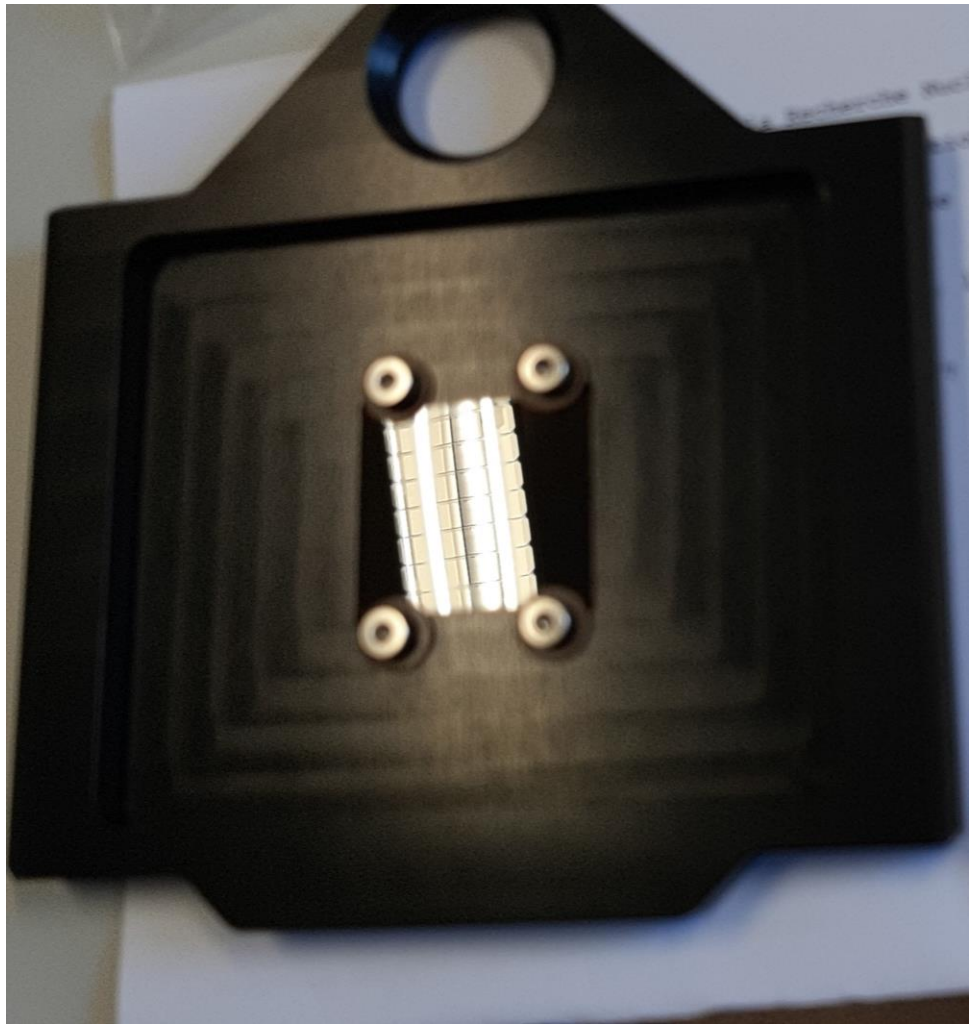
New Screen for AD Target BTV (1)

OTR GlassyC (HiRadMat experience)

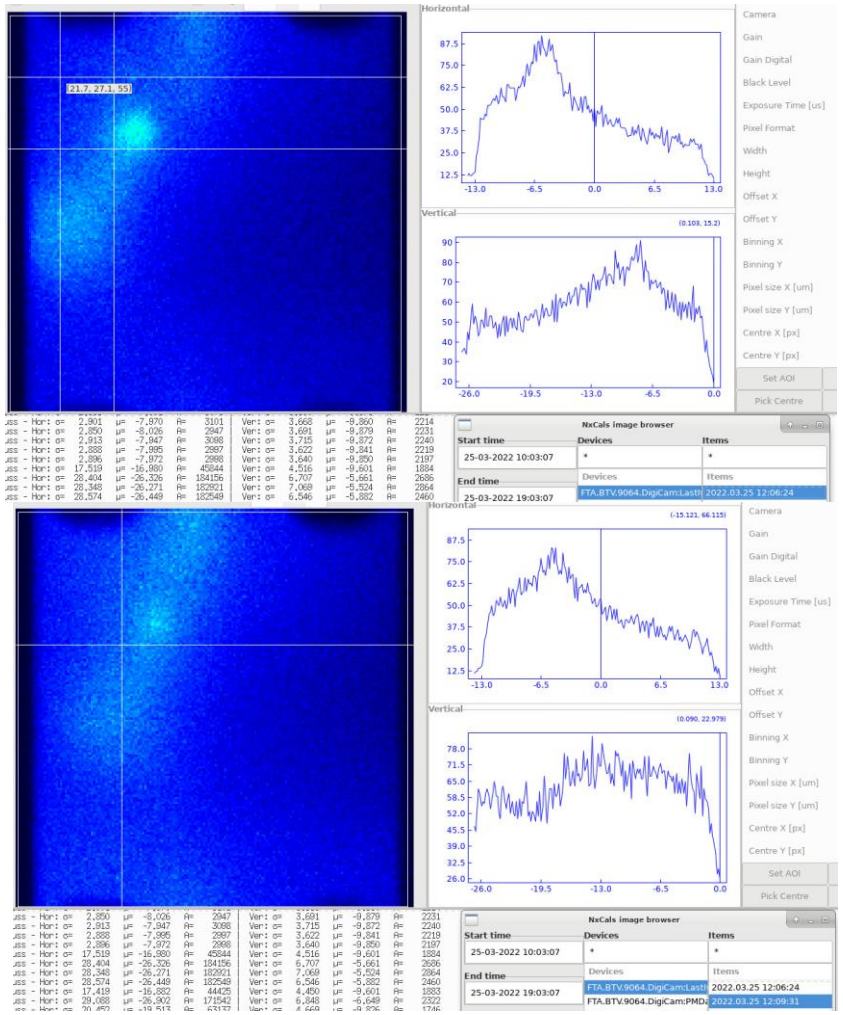
- Lower yield than Chromox
- Specific angular emission

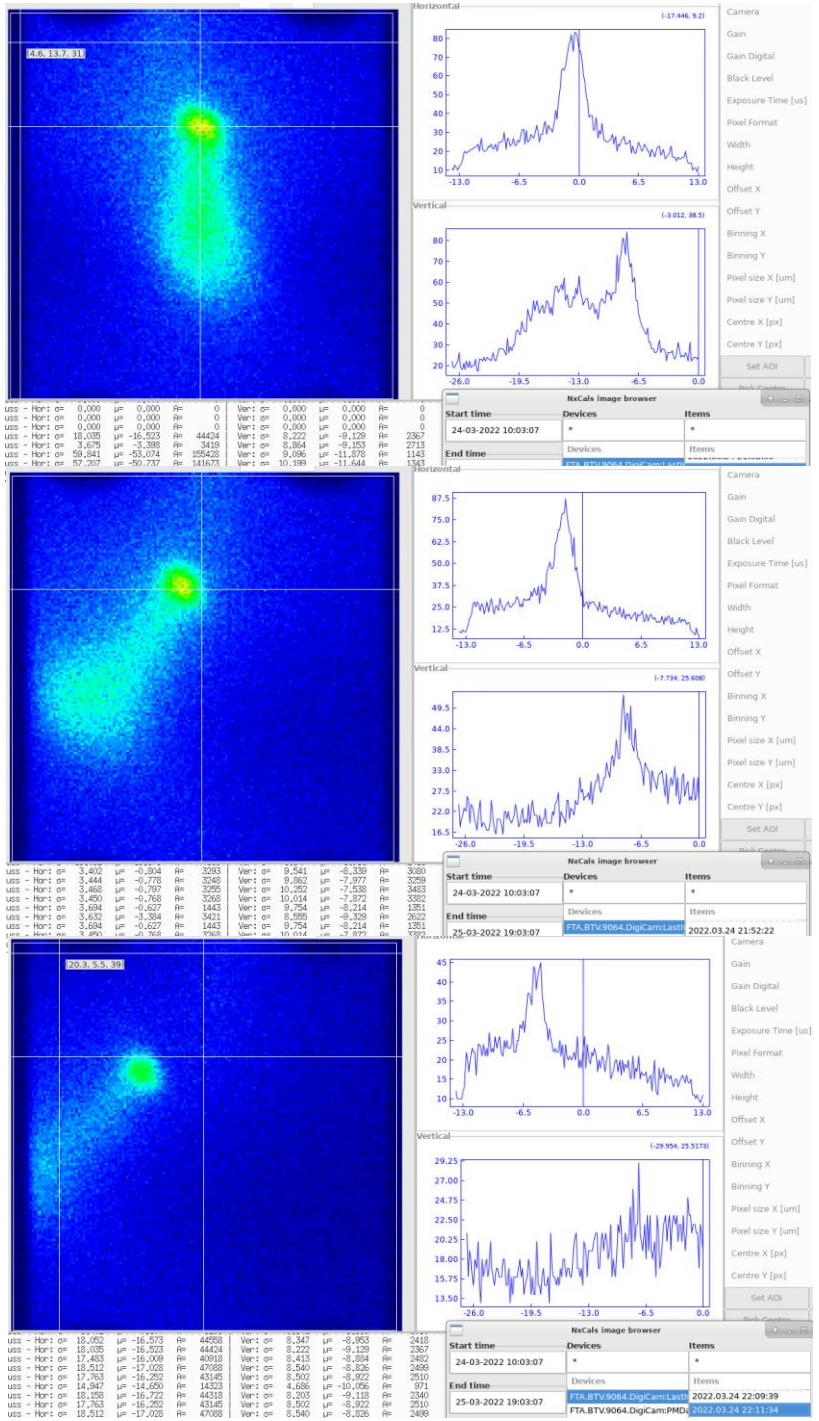
- Large emission angle
- Gain of digital camera (x200)
- Image intensifier if needed (thanks Stefano, Enrico!)

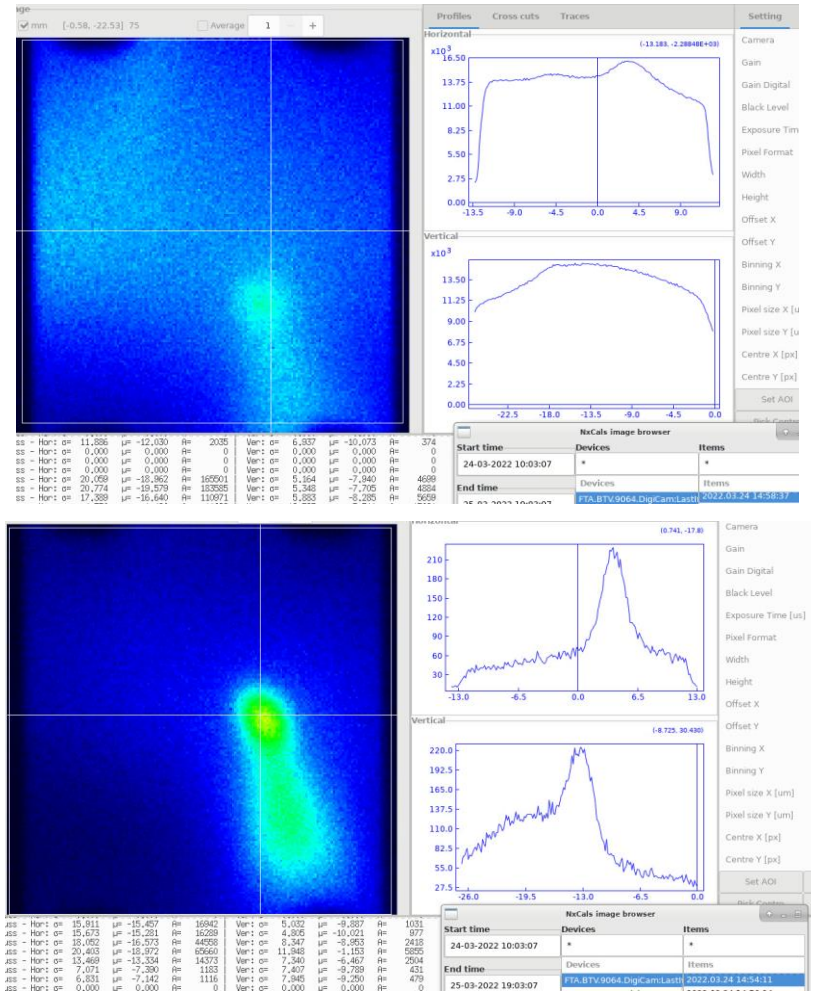
First measurement very encouraging as we had enough light with 20% of the nominal intensity no focused yet



New OTR GlassyC screen ready for installation on ADT BTV.







Beam measurement examples

(during beam commissioning)

This was during commissioning period

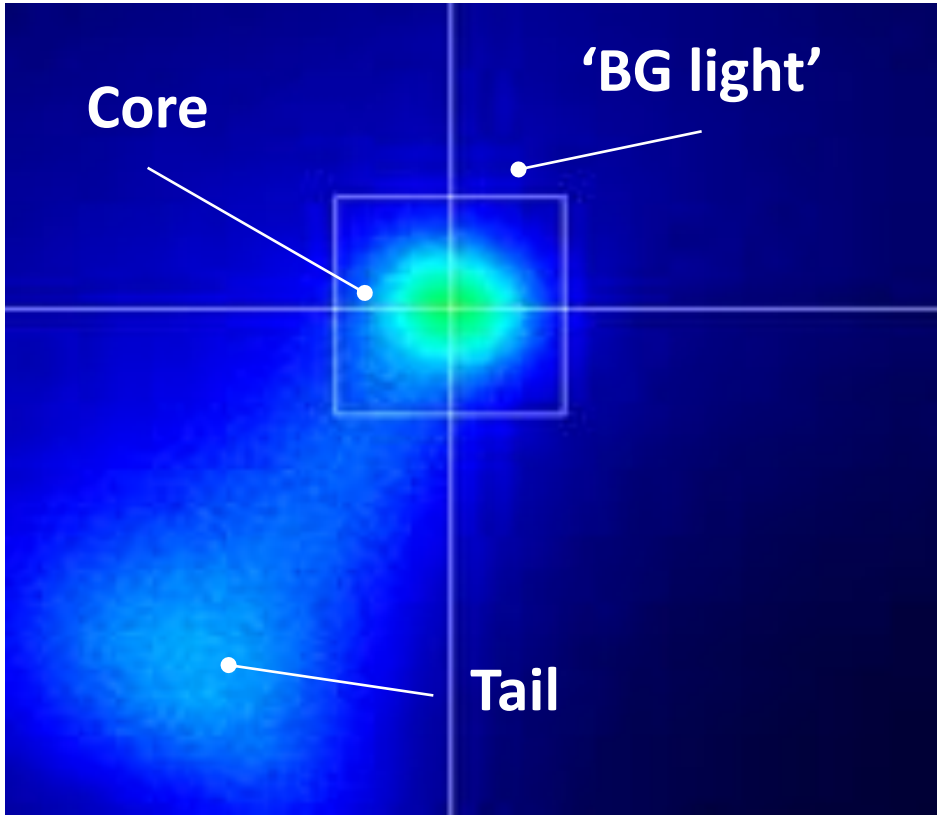
→ Shape and/or parasitic light could be beam, losses, etc…

New Screen for AD Target BTV (2)

Nevertheless, there is:

- **A huge background** on the entire reflective surface → Luminescence ? OTR reflections?
- **A tail** → Luminescence ? Forward OTR from last 'beam window' ?

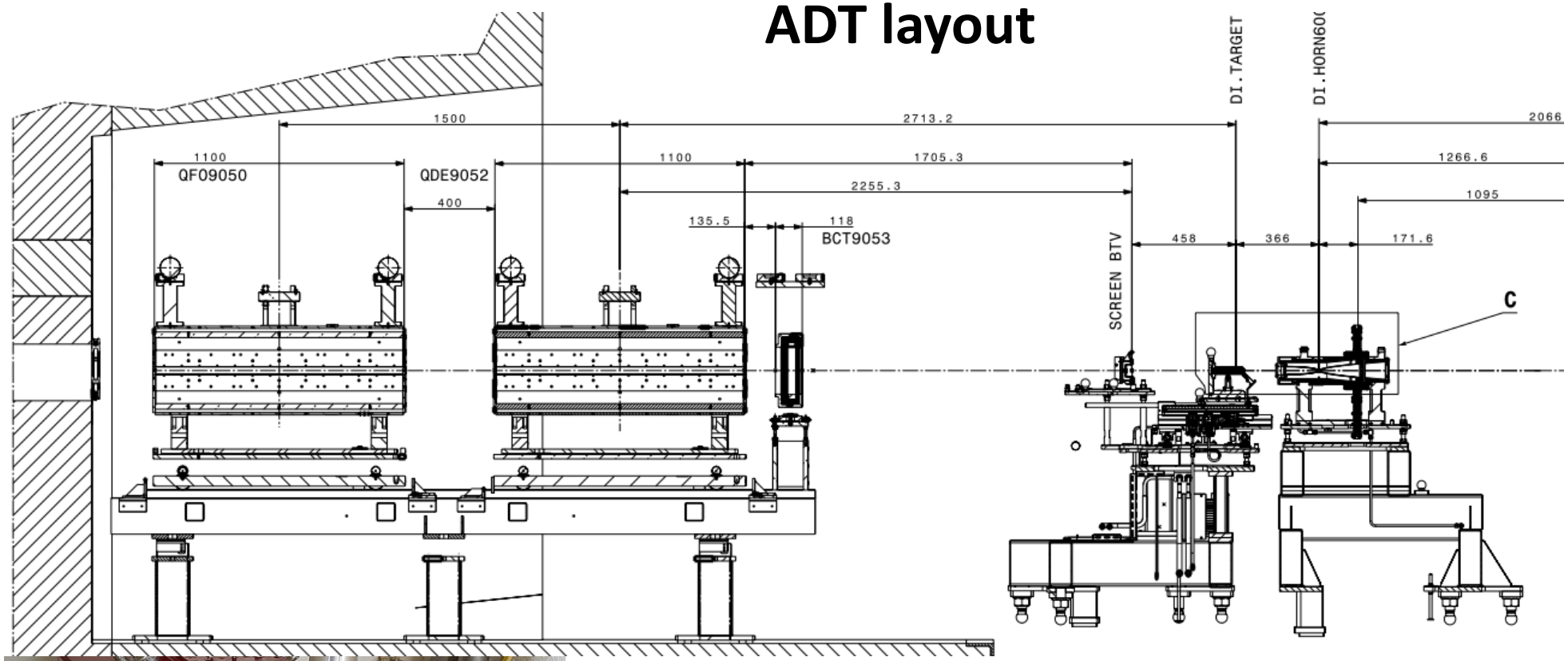
- *This was not seen with the Chromox screen in 2021*



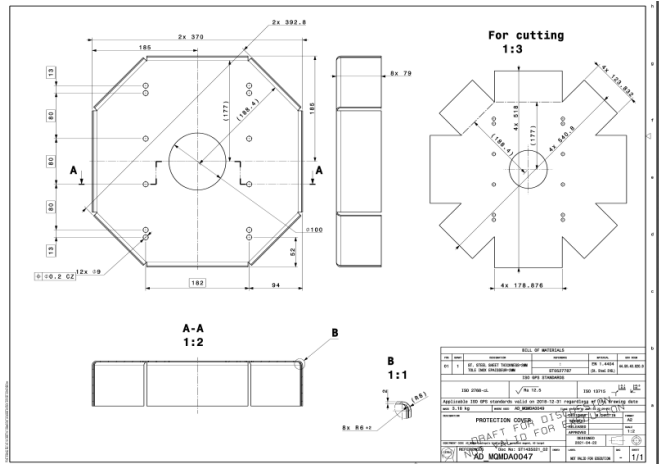
Example of measurement of ADT beam

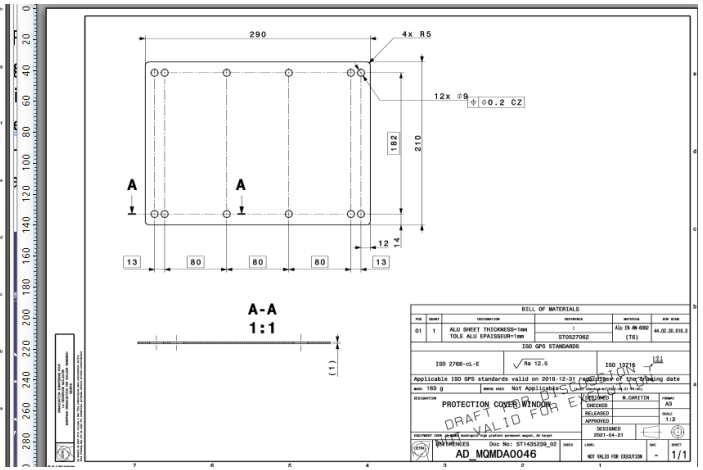
→ Despite the parasitic effects, OP AD prefers to keep this screen which gives very stable measurements

ADT layout

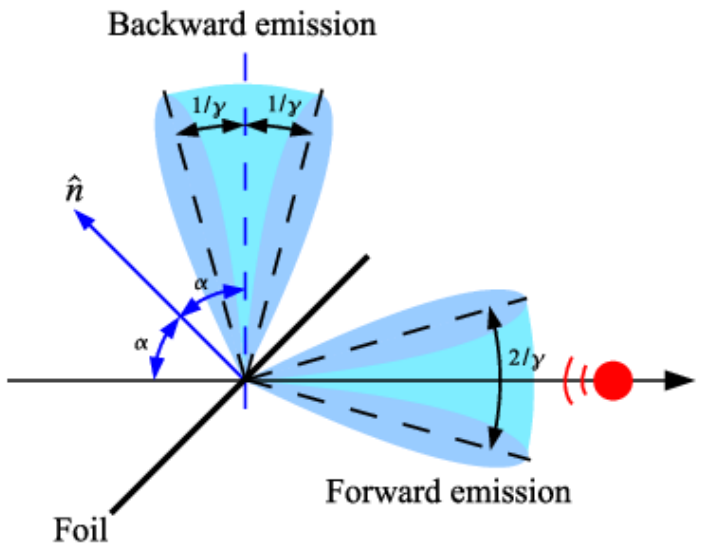


- Stainless steel hexagonal cover with 188mm hole
- Hole closed with 1mm thick Al plate

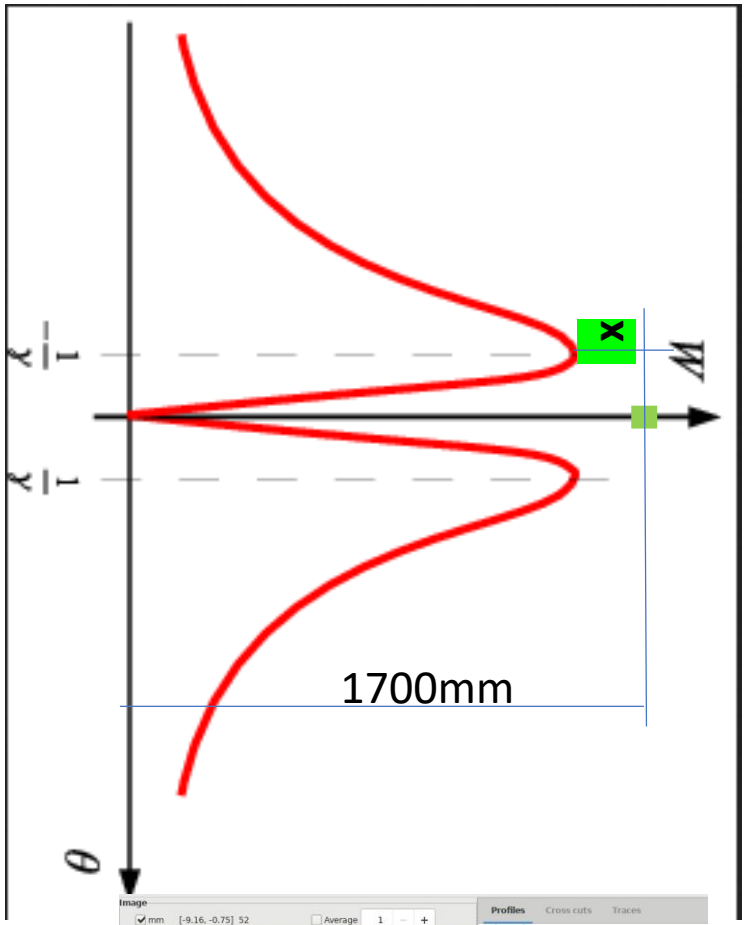




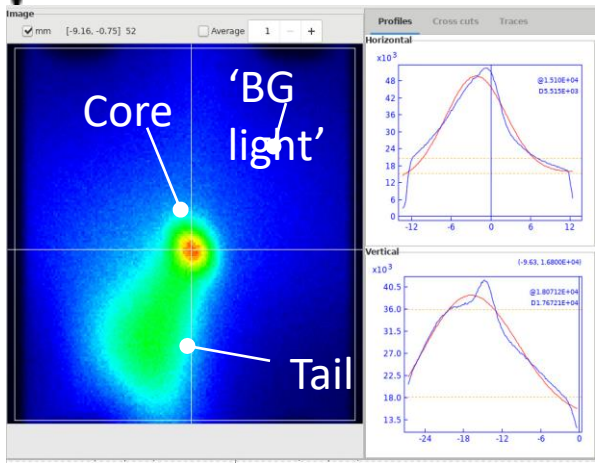
Forward OTR From Last Permanent Magnet Cover



- **Emission angle**
  1/γ = 1/26 ~ 38mrad
- **Distance** Magnet Cover – BTV Screen
  1700mm
- **Transverse OTR peak position** @ screen
  x = 64.6mm
- **Screen size**: 25 mm x 35mm



This confirms that **the tail is probably not FW OTR from the magnet cover**.
But the 'BG light' could still be from the FW OTR !!
→ A blocking foil can be mounted to eliminate this parasitic light.
→ It will produce FW OTR as well
@ 5cm, **Transverse OTR peak position gives ~2mm that could be visible on the measurement → TBC, maybe not as the DOF is large with this long optical line.**



Calculations: OTR & Scintillation (luminescence) Yield

Based on calculation model used by B.Biskup for HRM calculations

OTR

$$NOTR(E) := 2 \cdot R \cdot \frac{2\alpha}{\pi} \cdot \ln\left(\frac{\lambda b}{\lambda a}\right) \cdot \left(\ln(2\gamma(E)) - \frac{1}{2}\right)$$

Scintillation

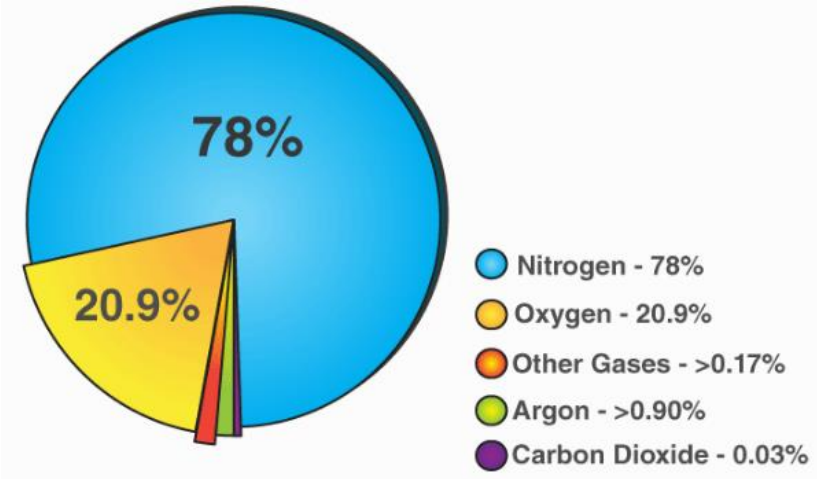
$$Nscintillation(L, \alpha) := \frac{\rho \cdot Na}{28.9} \cdot \left(\frac{Pe}{Pi}\right) \cdot \sigma sc \cdot L \cdot \frac{\alpha}{4\pi}$$

	OTR	Scintillation
Total Yield [photons/p]	1.66e-02	3.37e+0
Emission	1/26GeV → ~38mrad	4PI
Optical acceptance	150mm @20m → ~3.75mrad	150mm @20m → ~3.75mrad
Captured in optical line	**1.62E-04**	**2.11e-7**

TBC !!

High-pass filter test (1)

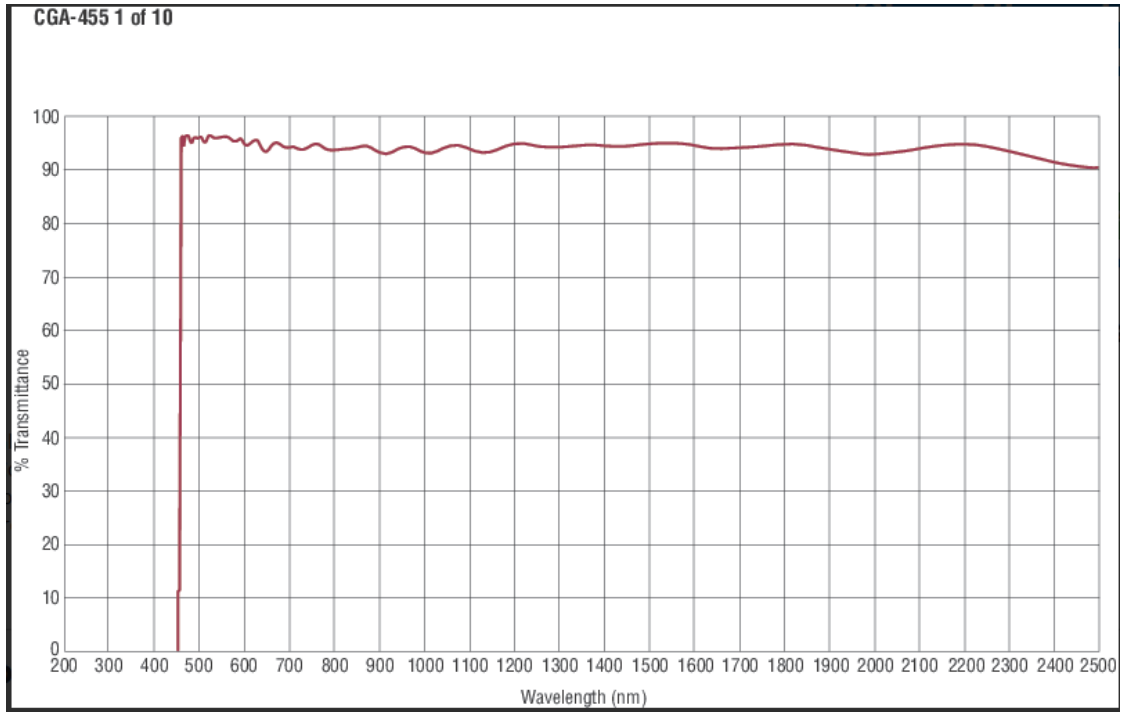
Air Composition



Goal: Filter the ~400nm wavelength (blue)

Filter

Reference: 5CGA-455
MICRO-CONTROLE Spectra-Physics S.A.S
Longpass Filter, Colored-Glass Alternative, 12.7 mm, 455 nm Cut-on

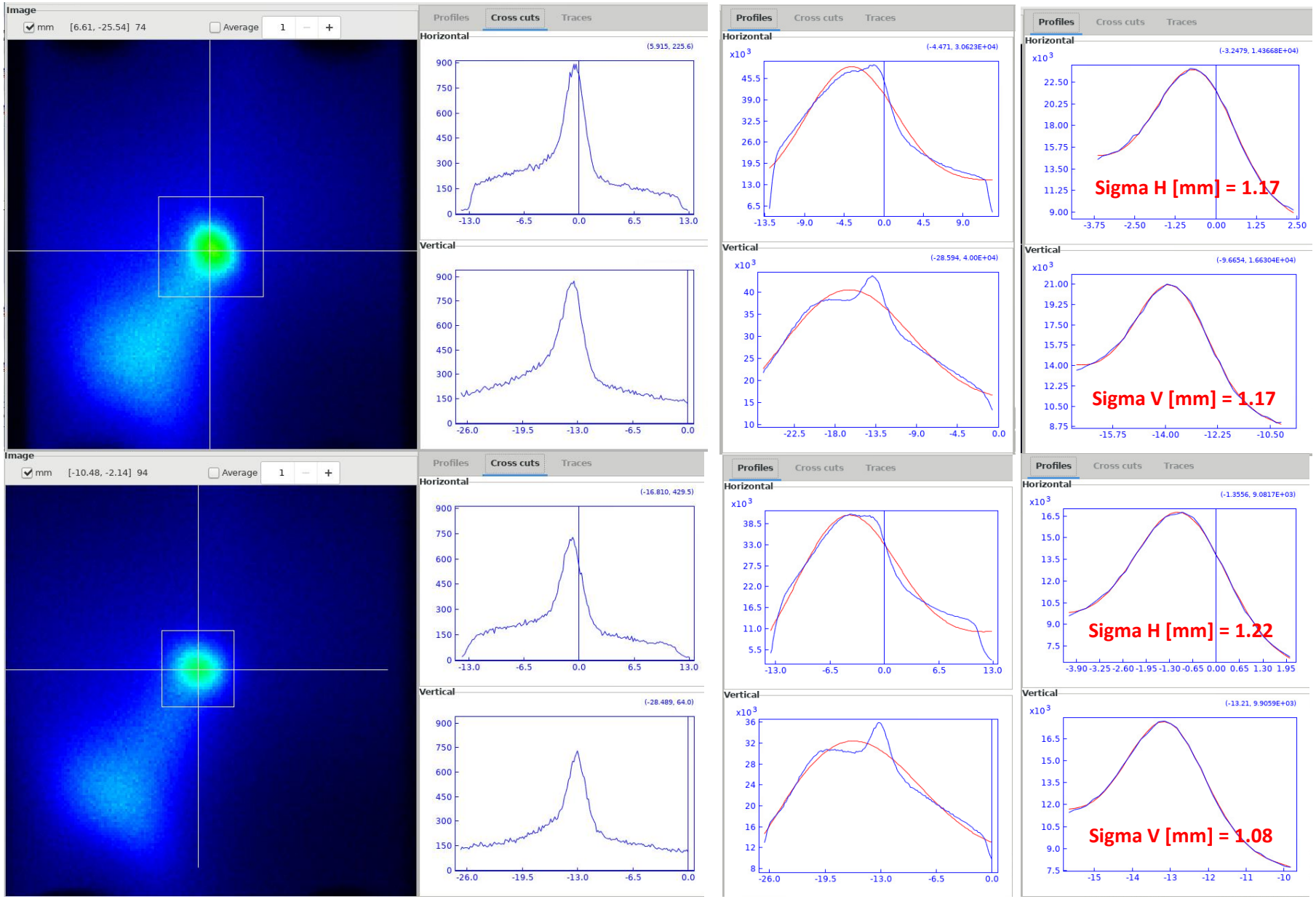


5CGA-455 filter spectral response

High-pass filter test (2)

No filter

High Pass filter



Cross cut *Profile image* *Profile ROI*

Differences

- Uniform amplitude reduction ~ 20%
- Beam & Tail shape

Conclusion

→ No strong mitigation

Conclusion

- An **OTR screen for the new AD Target** was installed as replacement for the Chromox screen type that was rapidly degraded when used in air
- Works fine in term of signal to noise
- But **parasitical light appears:**
  - BG light → FW OTR to be confirmed with a blocking foil
  - Luminescence → tested → weak due to the low aperture of the optical line

→ **We keep the OTR screen despite the parasitic light as it is very stable**

- Next steps:
  - **Bandpass filter / polarizer** test to try to understand the source of parasitical light
  - Blocking foil test (*tested in October 2022 see last slide)

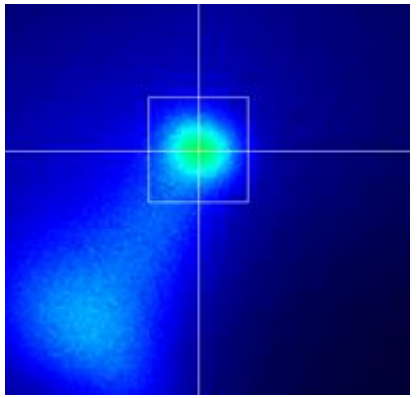


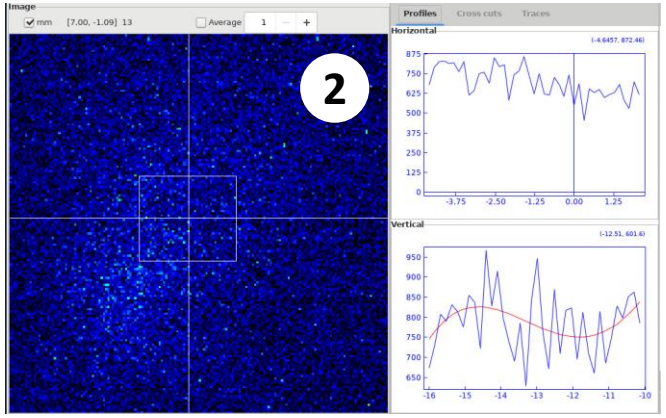
Image Acquisition Using Different Filters

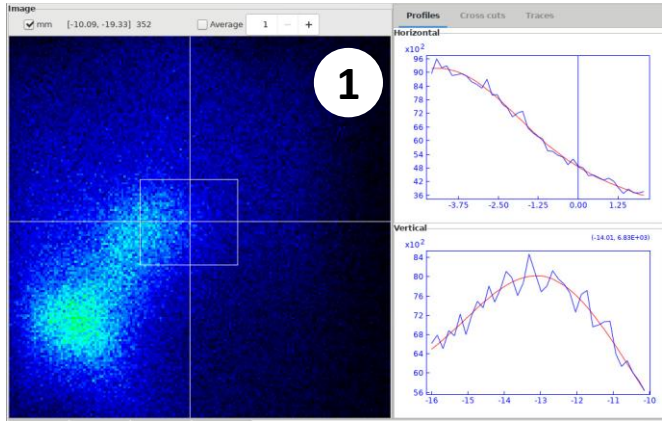
2022_04_19

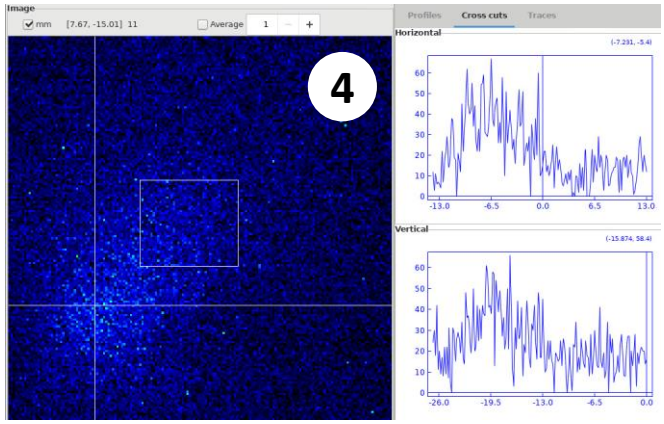
Pass-band filters from CORION

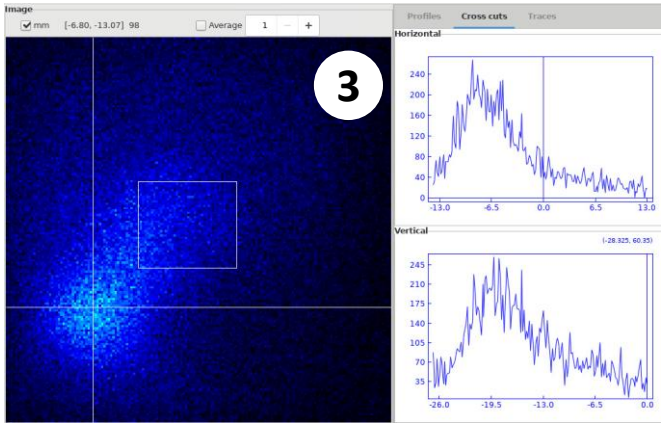
	Wavelength [nm]	FWHM [nm]	Gain BASLER	Max px Amp. [a.u.]
1	550	40	x200	480
2	620	10	x200	60
3	650	40	x200	245
4	750	40	x200	60
5	>450nm	-	0	700
REF	All	-	0	900

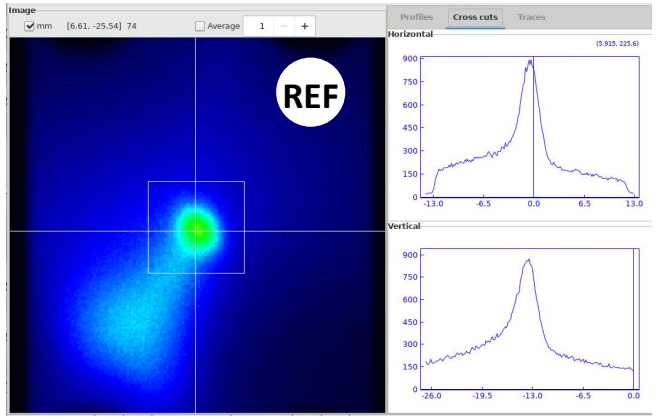
→ 10ns FWHM is not enough without intensifier
→ Very little light @750nm
→ Using passband filters seem to remove the light of the core
→ Core light emission wavelengths seems to be
620nm < γ < 750nm (?)

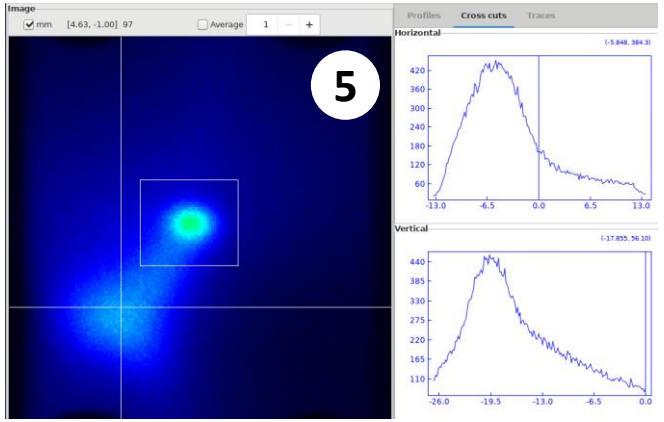




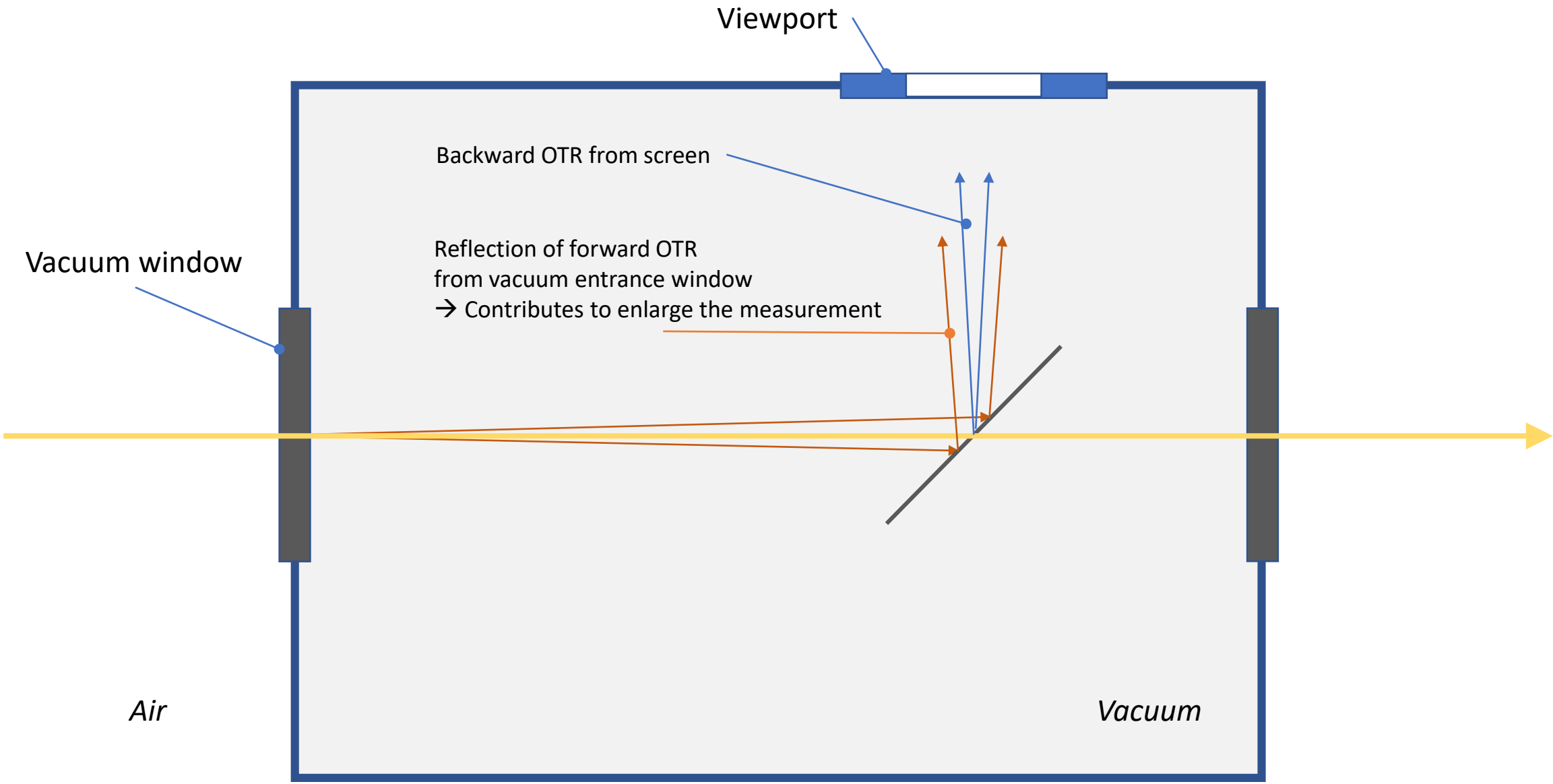




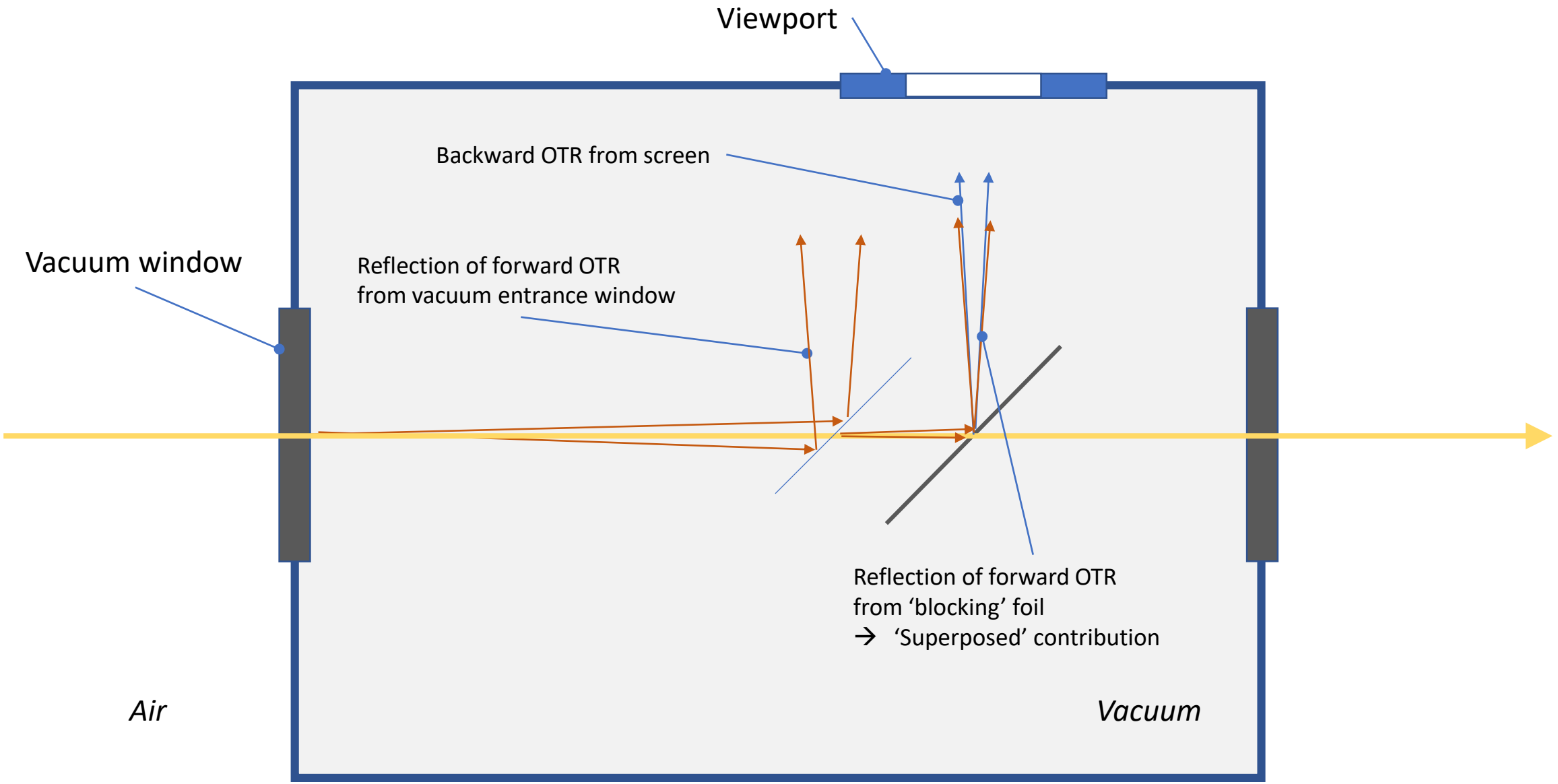




FW OTR effect on BW OTR screen (1)

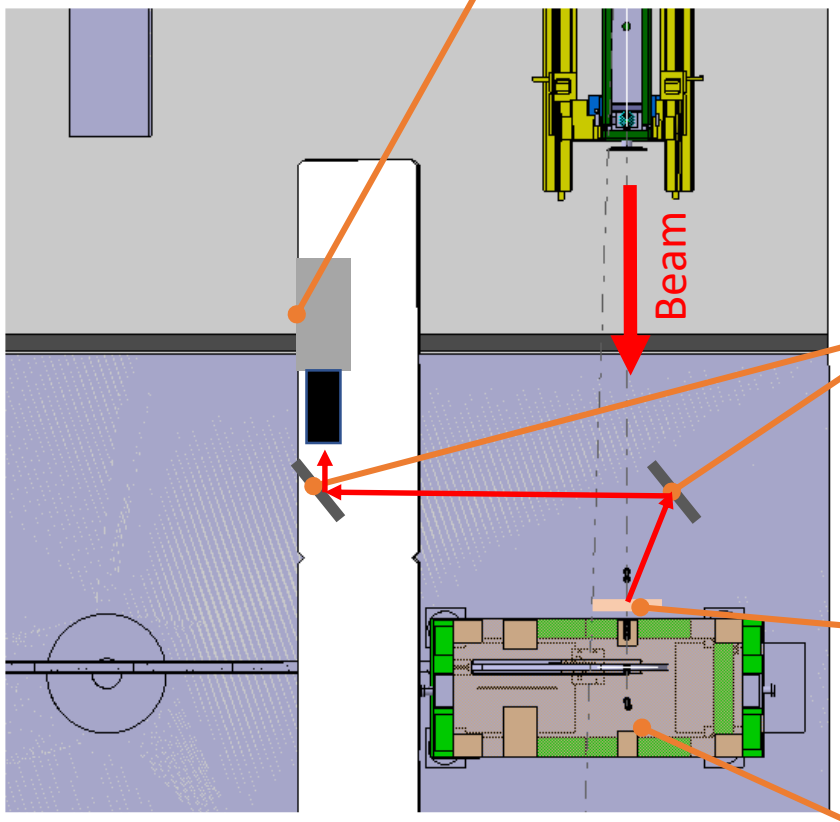


FW OTR effect on BW OTR screen (2)

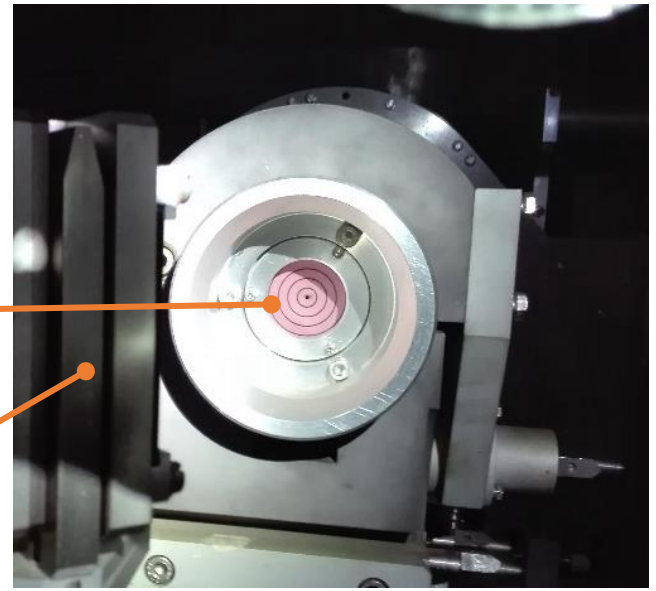


Consolidation of the AD target BTV beam Instrumentation

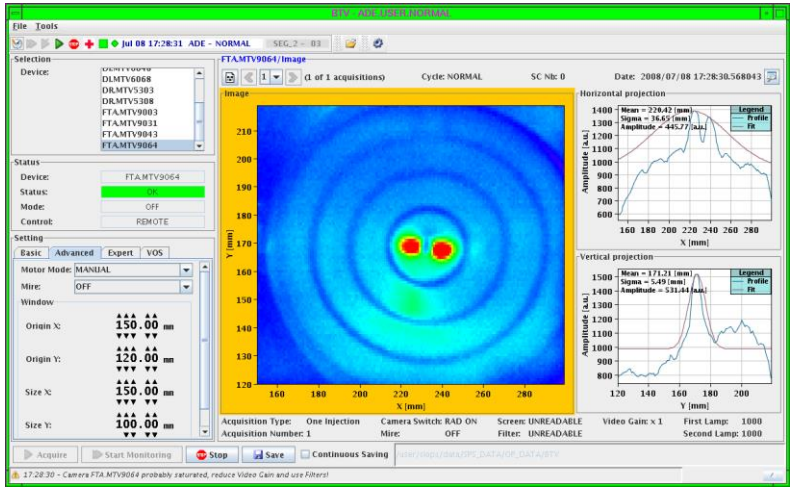
Operational name FTA.BTV9064



Present layout: Top view



Picture of the FTA.BTV9064 screen.



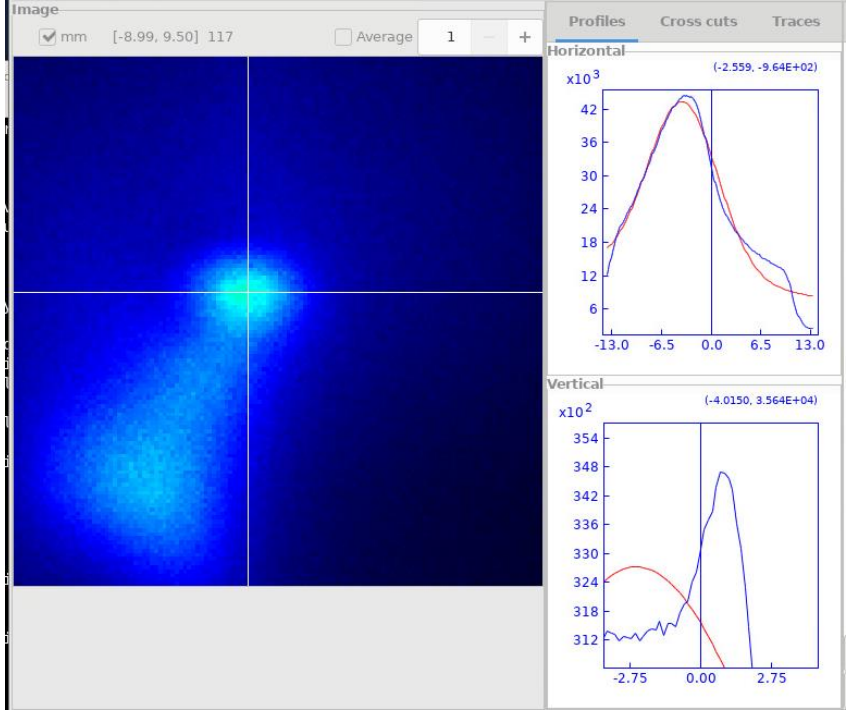
Beam measurement using the BTVI application.

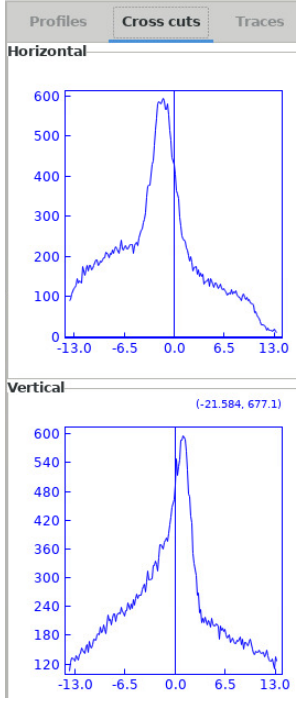
AD target beam Instrumentation

The mirror is not attached to the target chariot but on the wall, as the illumination system !!


NGER
DIATION

01/09/2022
15:12:42





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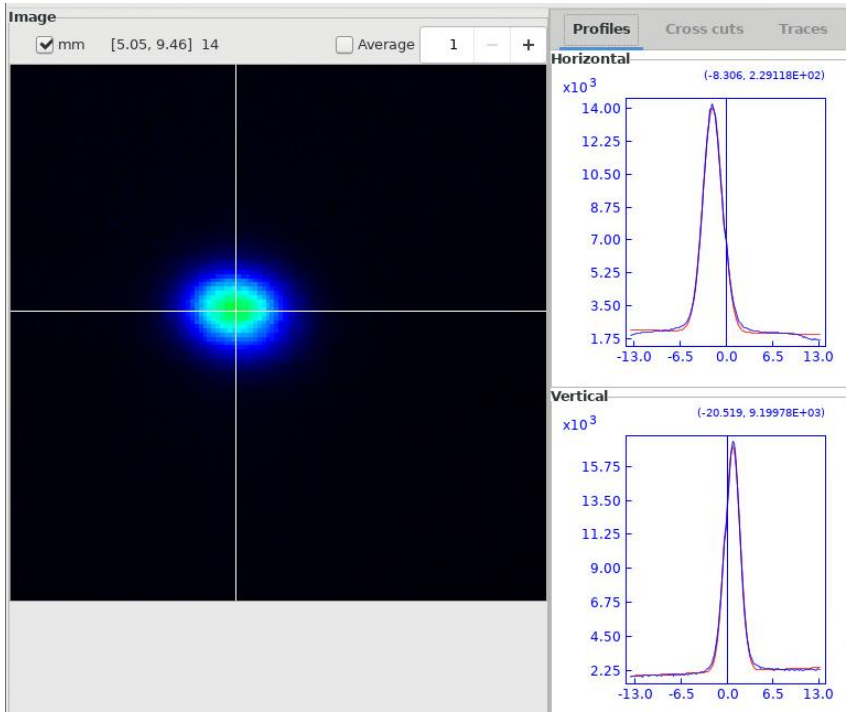

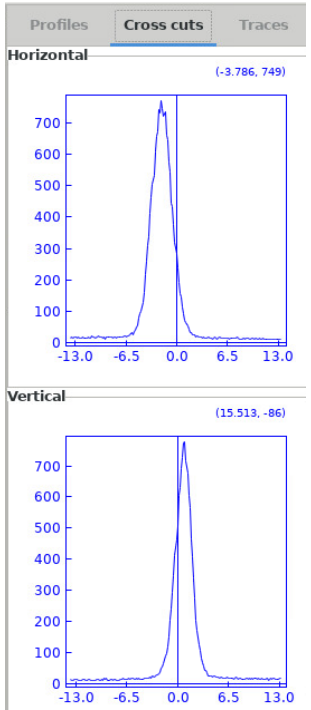

Comparison OTR with/without blocking foil