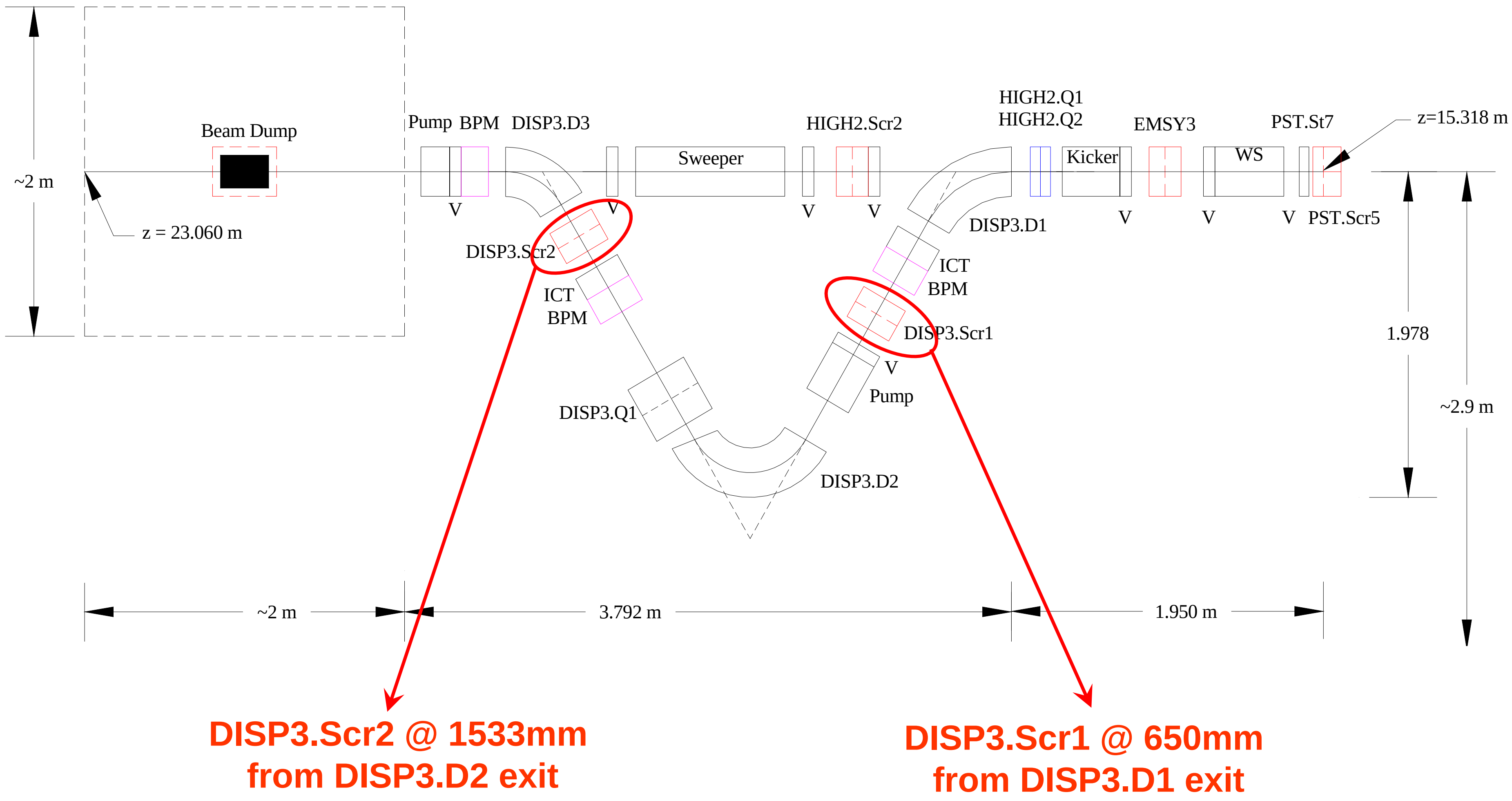
Consideration for Screen Stations in HEDA2

- Overview for screen stations in HEDA2
- Collecting of discussions and suggestion ideas for further steps

Sakhorn Rimjaem

Layout of foreseen HEDA2



DISP3.Scr1

- **Transverse distribution measurements and momentum and momentum spread measurements using**
  - **a YAG screen for the short bunch train**
  - **an OTR screen for the long bunch train**

- **Bunch length measurements using**
  - **an Aerogel screen as a Cherenkov radiator**
  - **an OTR screen as a radiator for Optical transition radiation**

- **Vertical slit for transverse slice emittance measurements**

⇩

1 Aerogel screen + 1 YAG screen + 2 OTR screens + 1 slit

DISP3.Scr1 Components

YAG (reference to J. Baehr)
- 100 um-thick silicon wafer with YAG power coated
- transverse size of 80mm × 60mm

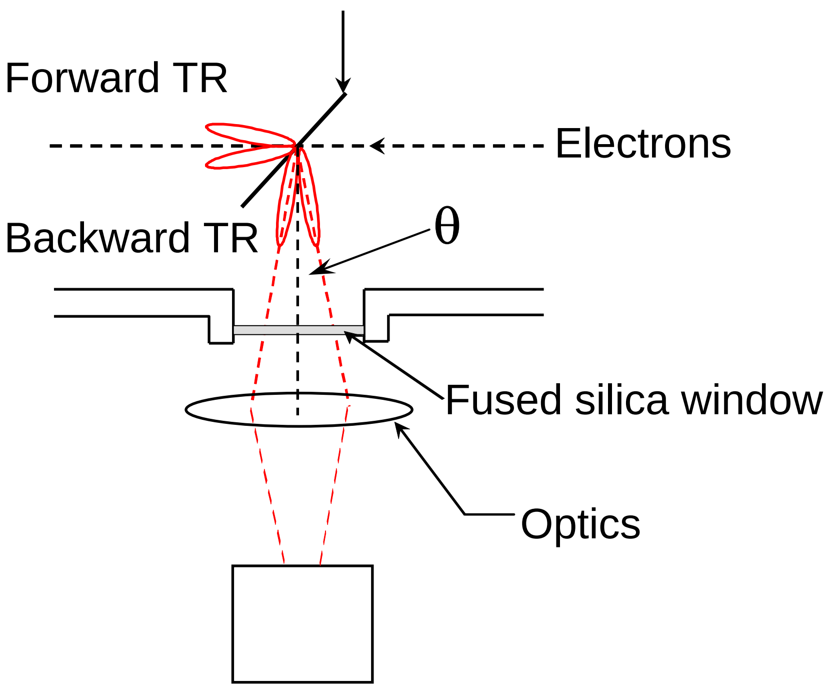
OTR (reference to J. Baehr)
- 100 um-thick silicon wafer with aluminum coated
- transverse size of 80mm × 60mm

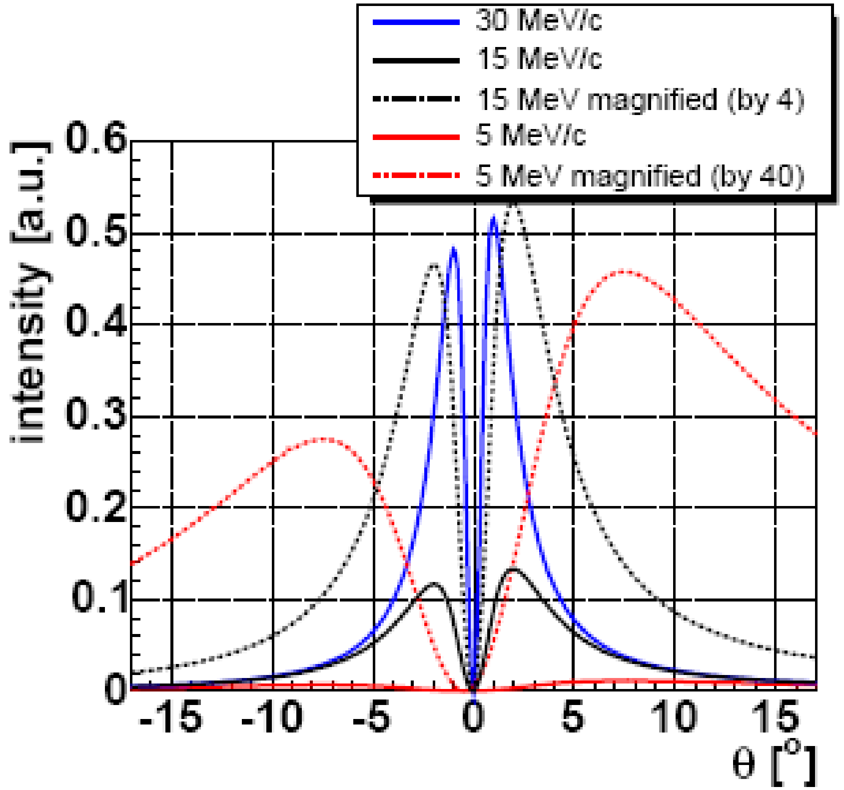
Aerogel (reference to J. Roensch)
- 5 mm-thick aerogel
- transverse size of 80mm × 18mm

Slit (reference to Y. Ivanisenko)
- vertical copper slit of opening width of 30mm and 60mm height

Note
- thicker silicon wafer for YAG and OTR screen may be used if the breaking of thin screen is experienced. Therefore, the screen holders should be designed such that ca be modified for thicker screen later (if it is needed).

Optical Transition Radiation (OTR)

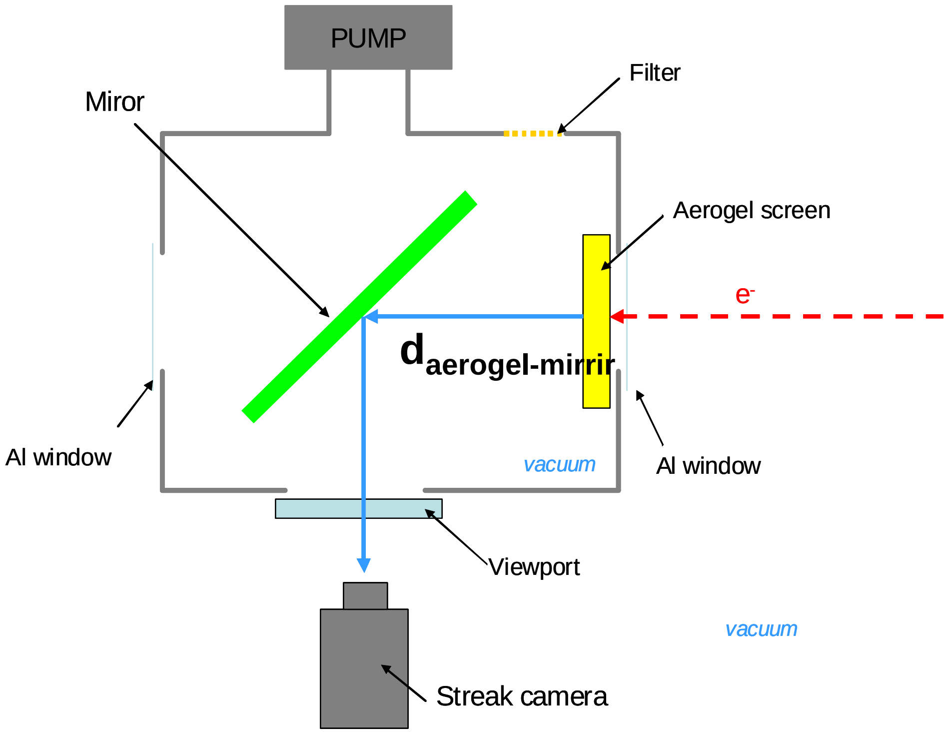


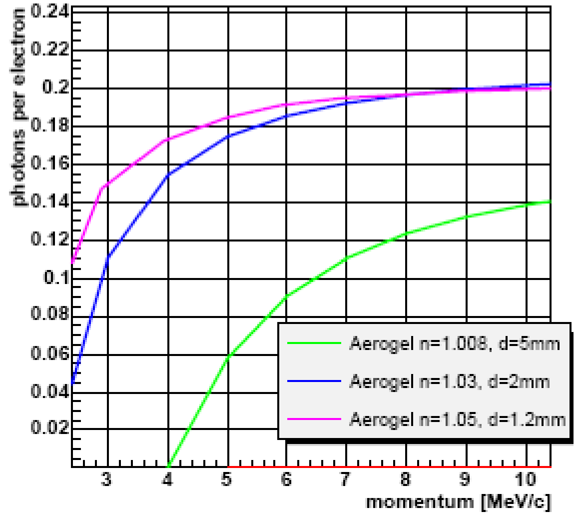


- TR is emitted when electrons passing from vacuum to the screen and the backward radiation is transported out off the vacuum chamber through the vacuum window.
- The forward radiation is emitted in the direction of the beam axis.

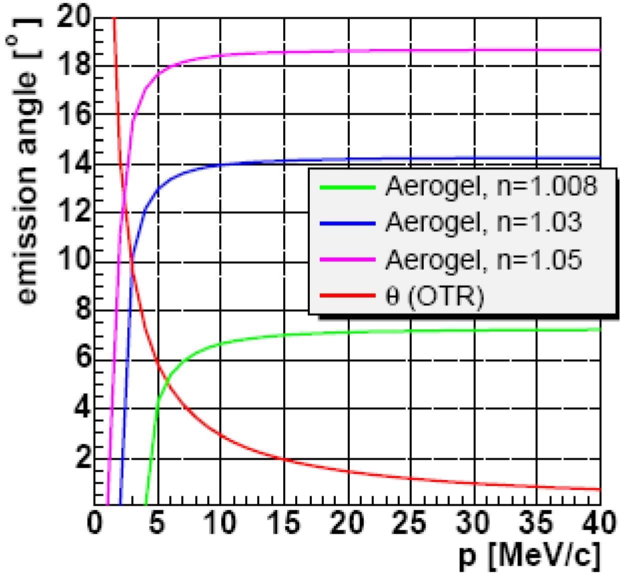
Intensity of OTR vs. radiation angle for electron momenta of 5, 15 and 30 MeV/c. [***Ref: J. Roensch, Ph.D. Thesis***]

Configurations for Aerogel Box





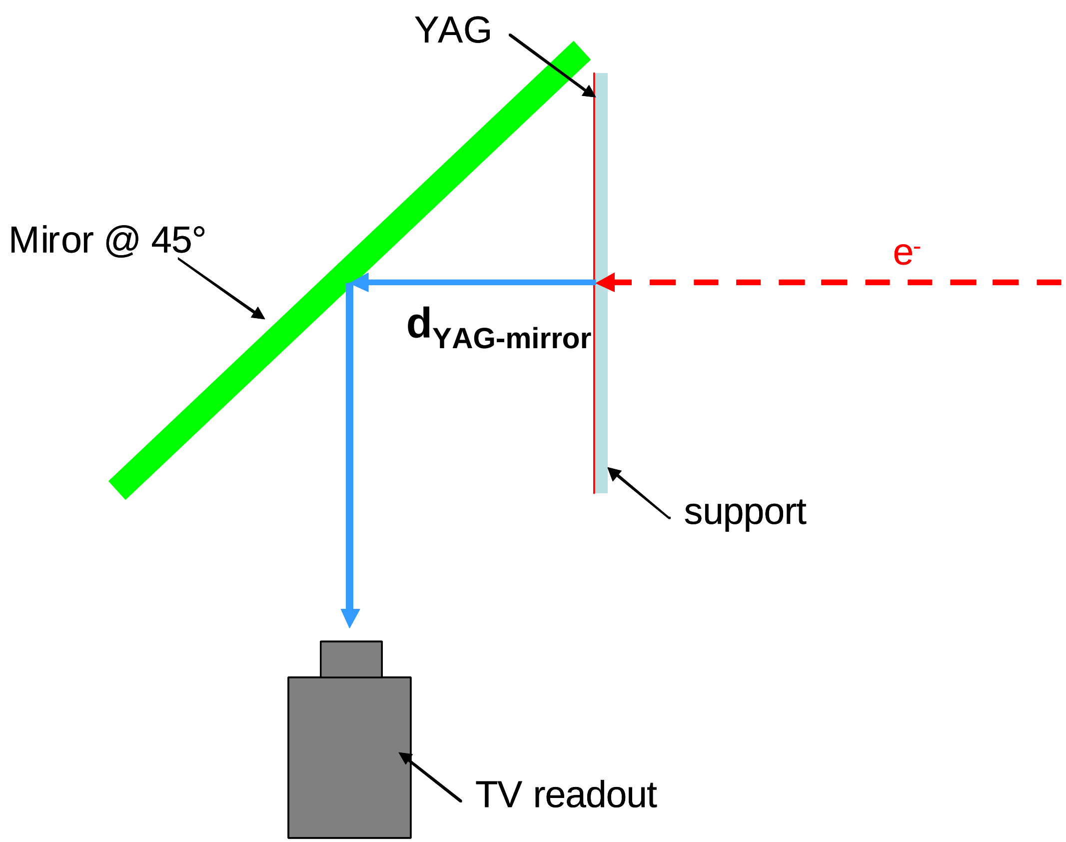
Intensity of Cherenkov radiation from aerogel vs. electron momentum. [*Ref: J. Roensch, Ph.D. Thesis*]



Emission angle of Cherenkov radiation and OTR. [*Ref: J. Roensch, Ph.D. Thesis*]

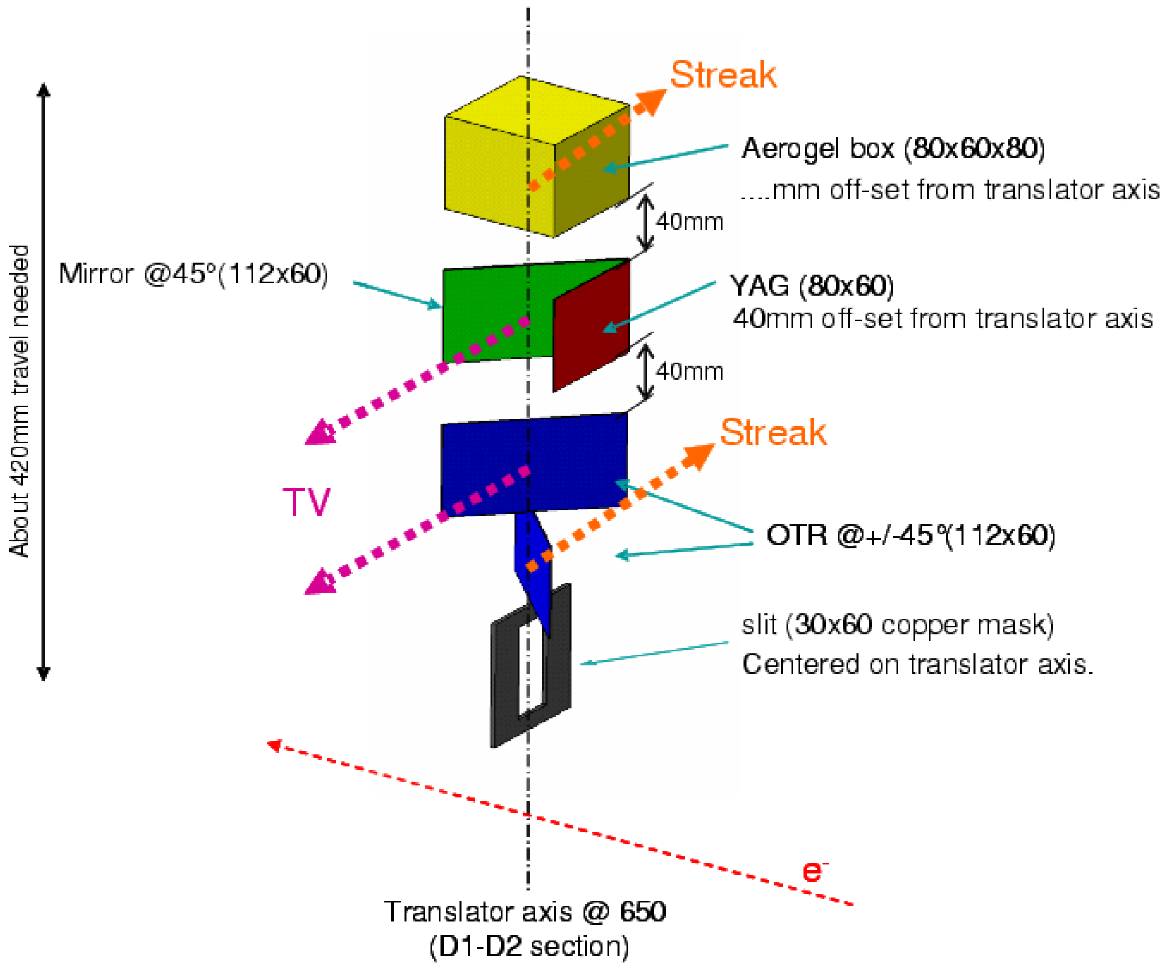
Cherenkov radiation is emitted when electrons hit the aerogel screen and it is directed out off the vacuum chamber by mirror.

Yttrium Aliminum Garnet Scintillator (YAG)



Light is emitted when electrons hit the YAG screen and it is directed out off the vacuum chamber by mirror placing at 45º w.r.t. the beam axis.

DISP3.Scr1: Configurations 1



Difficulties

1. Different radiation plane for YAG and OTR (Δd~40mm) leads to

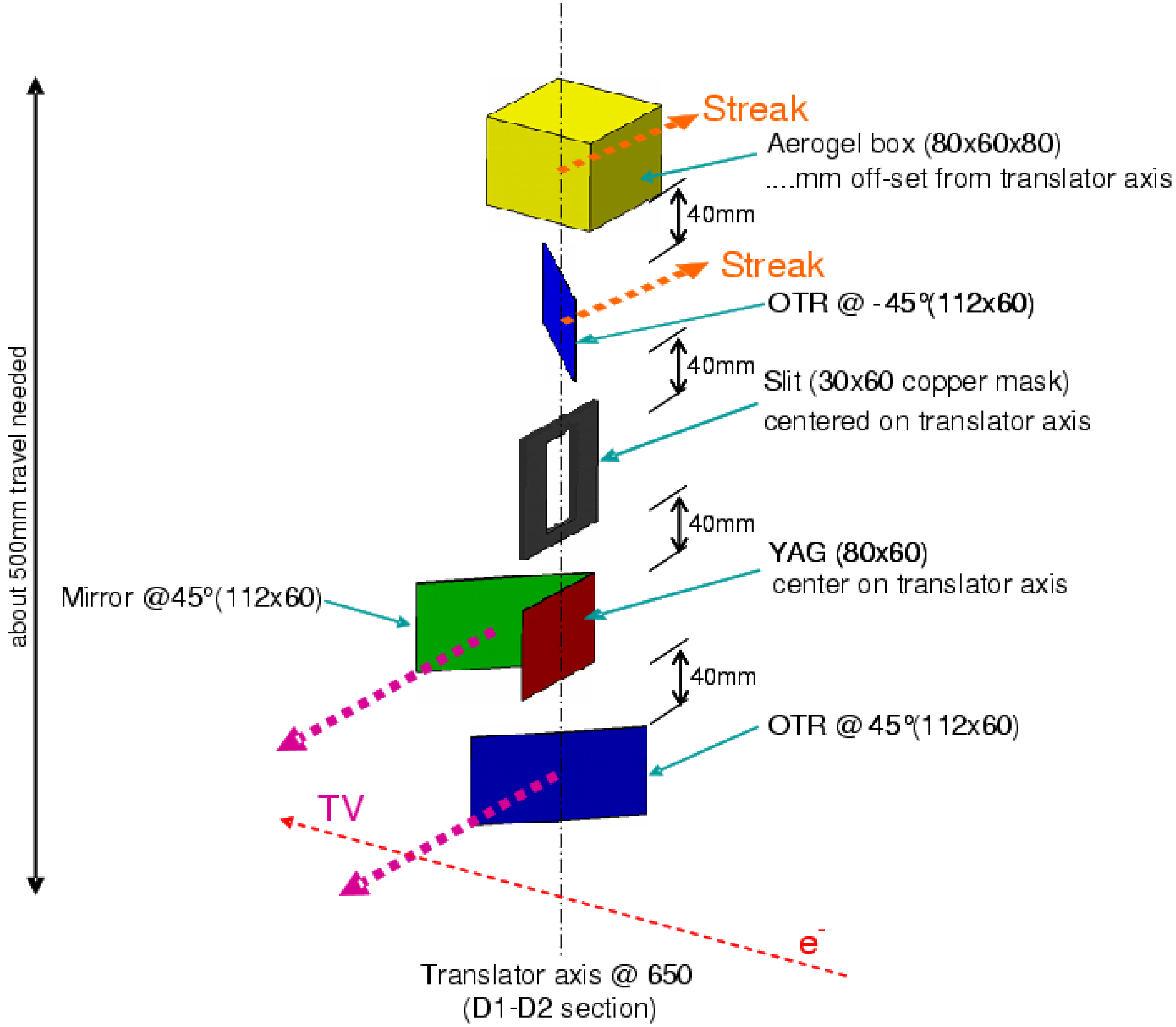
- **$\Delta p_{mean} = 2.8 \times 10^{-5}$ MeV/c**
- **$\Delta p_{RMS} = 0.015$ keV/c**

2. There is a problem with the depth-of-focus for the OTR screen for the TV readout, since the screen rotated in the dispersive plane.

- **It is foreseen to be solved by an optical method "Scheingflug" [J. Baehr].**

3. There is a different radiation outputs to
- streak readout for OTR and aerogel
→ Larger viewport window is required.

DISP3.Scr1: Configurations 2



Difficulties

1. There is a problem with the depth-of-focus for the OTR screen for the TV readout, since the screen rotated in the dispersive plane.

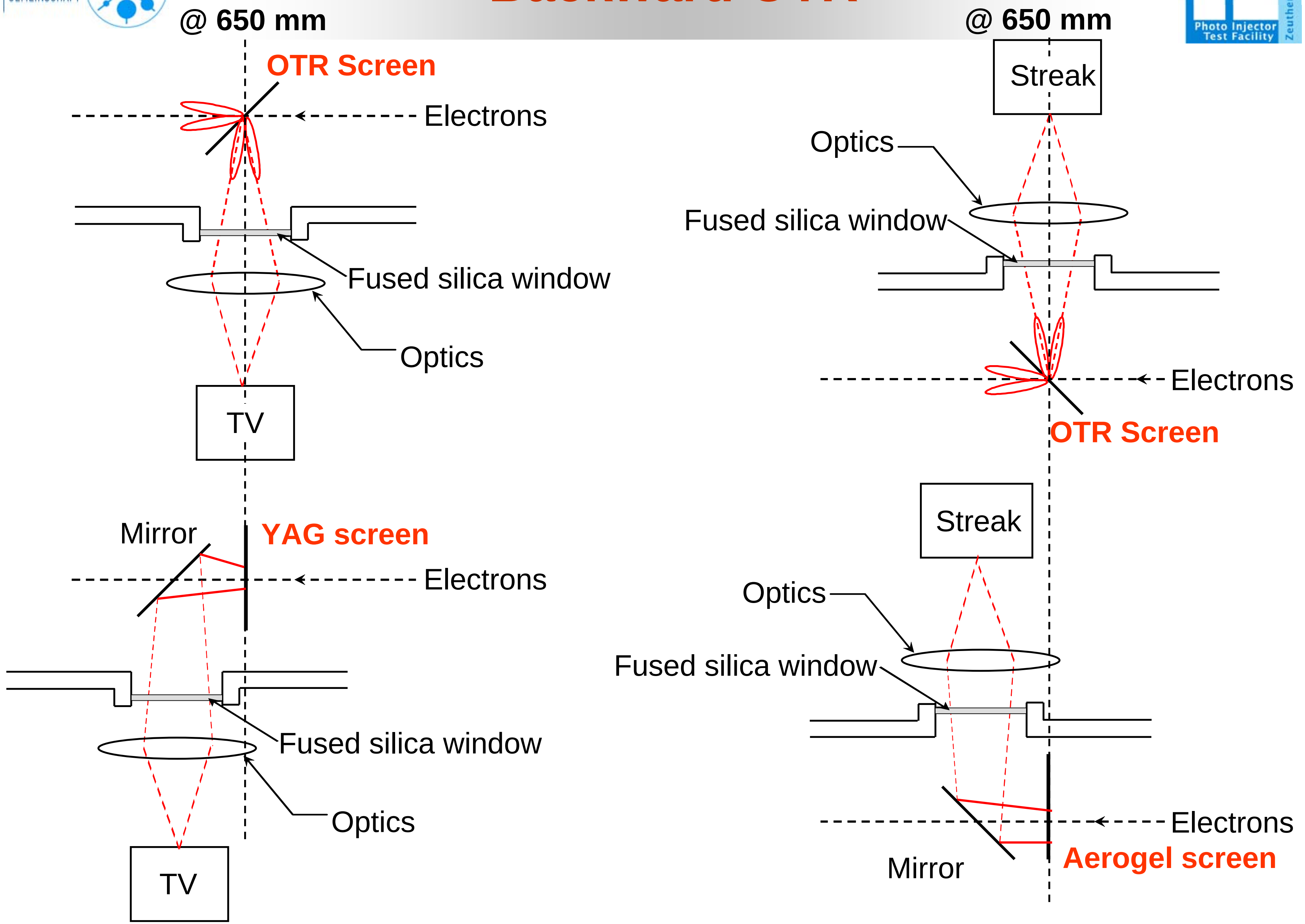
- **It is foreseen to be solved by an optical method "Scheingflug" [J. Baehr].**

2. There is a different radiation outputs to
- **TV readout for OTR and YAG**
- **streak readout for OTR and aerogel**

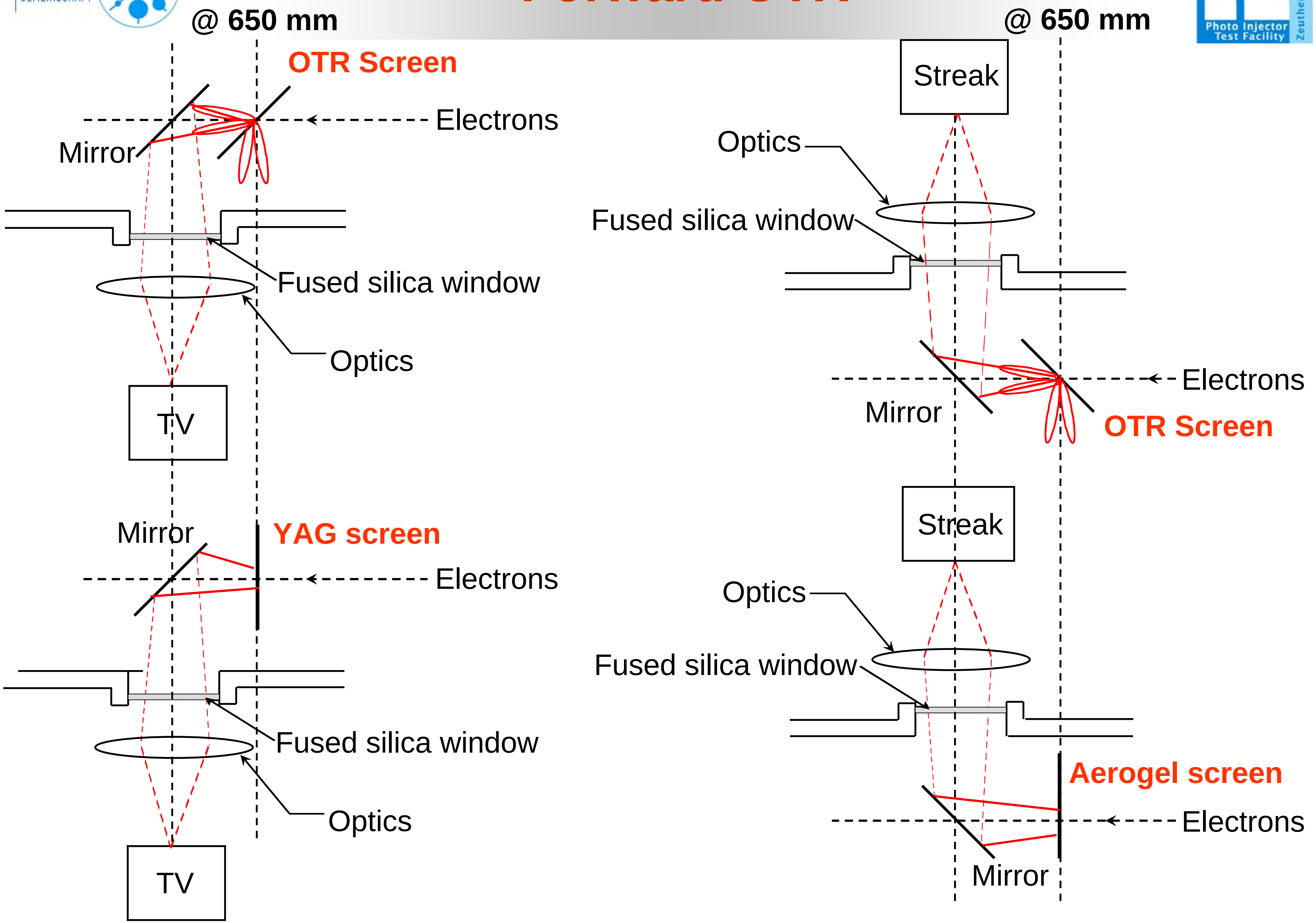
→ Larger viewport window is required.

→ Using forward OTR ???

Backward OTR



Forward OTR


@ 650 mm
OTR Screen
Electrons
Mirror
Fused silica window
Optics
TV
Mirror
YAG screen
Electrons
Fused silica window
Optics
TV
@ 650 mm
Streak
Optics
Fused silica window
Electrons
Mirror
OTR Screen
Streak
Optics
Fused silica window
Aerogel screen
Electrons
Mirror

Advantages & Disadvantages

Backward OTR

Advantages:
- conventional OTR setup at PITZ
- no mirror after OTR screen

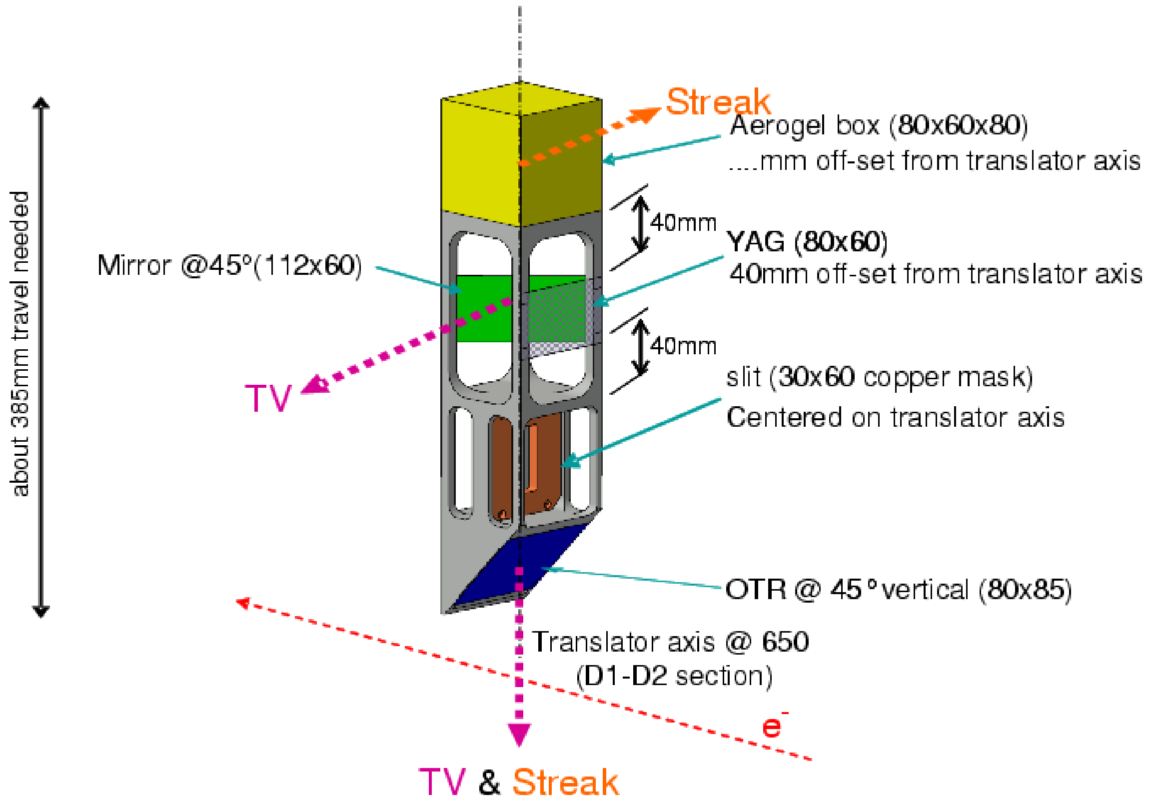
Disadvantages:
- 2 TV readouts for YAG and OTR screen
- 2 streak readouts for Aerogel and OTR screen
- larger window
  (100mm + $d_{YAG\text{-}mirror}$ or $d_{aerogel\text{-}mirror}$)

Forward OTR

Advantages:
- only o1 TV readout for YAG and OTR screen
- only 1 streak readout for Aerogel and OTR

Disadvantages:
- new concept of OTR setup at PITZ
- a mirror after OTR screen is required
- OTR and electron beam are in the same plane

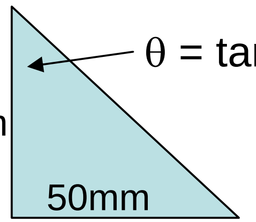
DISP3.Scr1: Configurations 3



Difficulties

1. There are 2 readouts for TV and also for streak camera.

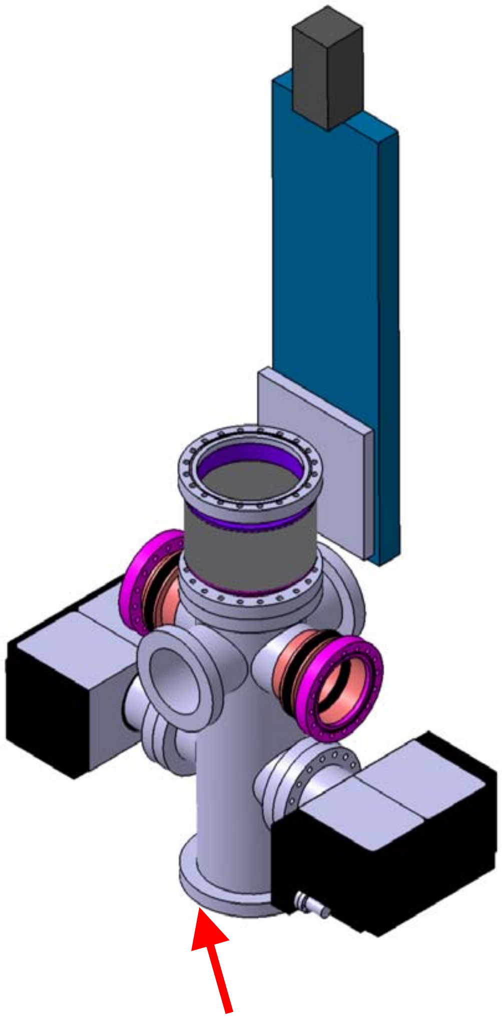
- **A TV and streak readout from the bottom of the beam line**
- **The optical system for the readout to the bottom of the beam line does not exist at PITZ.**
- **A long vacuum tube for long the actuator support leads to small radiation angle acceptance and also limits the space for the optics system**



$\theta = \tan^{-1} 50/400 = 7.12^o$

$$\theta_{max} \approx \frac{1}{\gamma} = 1.8^o$$ for OTR of 15 MeV/c

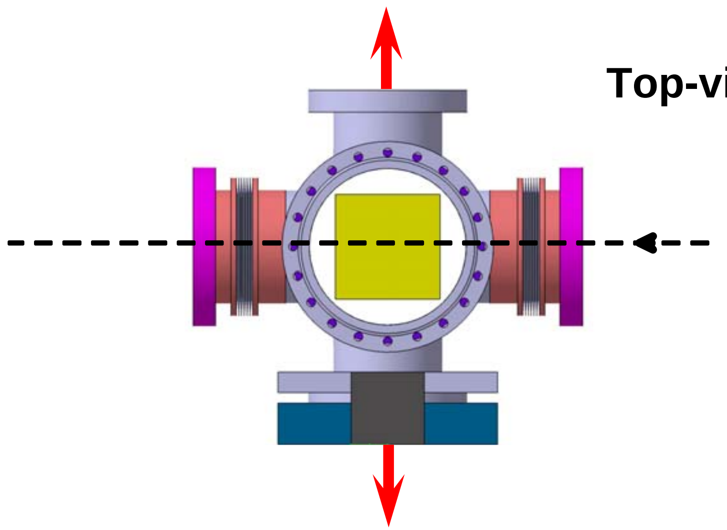
Assembly of DISP3.Scr1 Screen Station



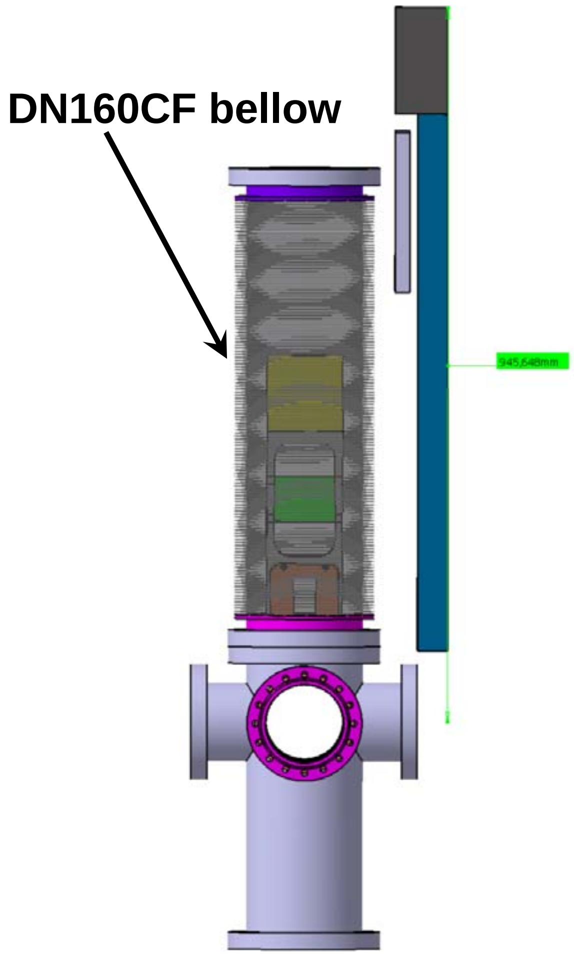
Blind flange or vacuum window for configurations 2

Technical requirements for linear actuator:

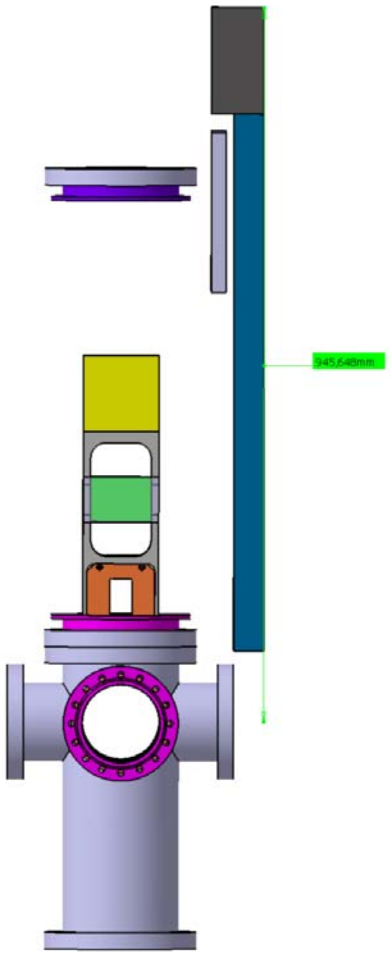
- movement stroke of up to 500mm (configuration 3)
- movement accuracy of ~0.1mm
- required the force effort of ~3000N (DN160CF welded bellow to reduce the height and improve the movement stability)
- max. speed of ~0.01m/s (full travel ~1 minute)
- no movement when no current



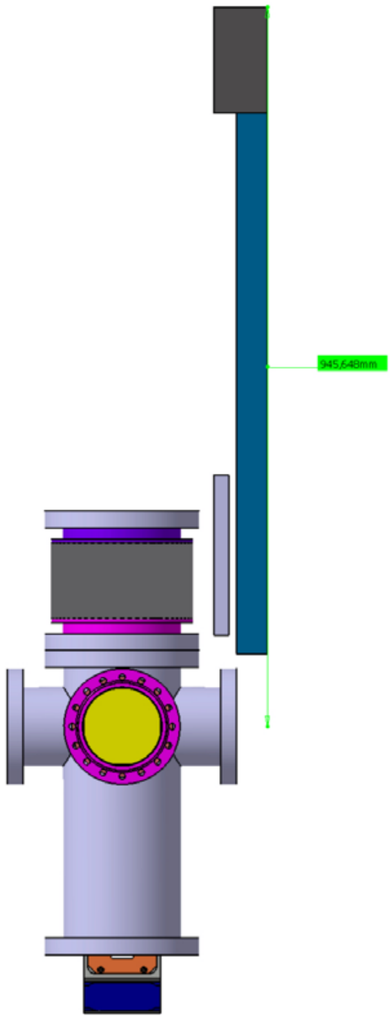
AXMO linear actuator with screen holder inside the big bellow



Screen holder all the way out from the beam tube with bellow

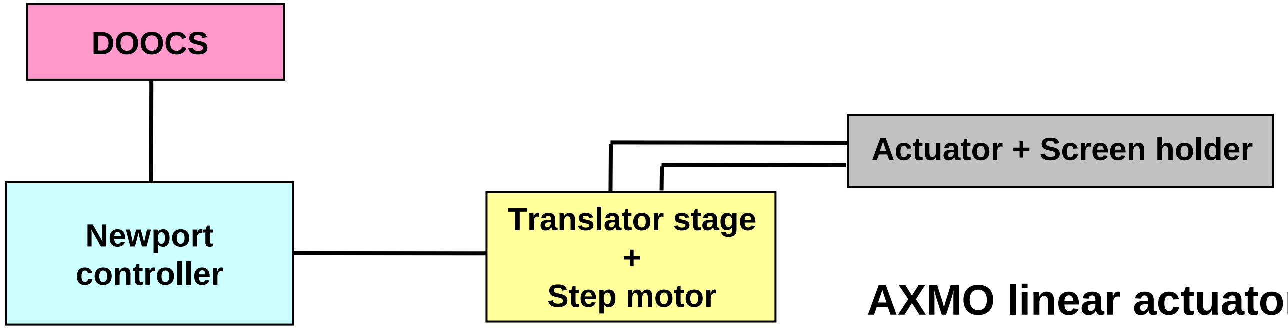


Screen holder all the way out from the beam tube w/o bellow



Screen holder all the way inside the beam tube

Actuator Control for DISP3.Scr1 Screen Station



AXMO linear actuator:

- **compatible with Newport controller**
- **can hand the effort for 3000N (according to company)**

DISP3.Scr2

- Transverse distribution measurements and momentum and momentum spread measurements for transverse slice emittance measurement using
    - a YAG screen for the short bunch train
    - an OTR screen for the long bunch train

- Transverse beam distribution monitor for the control of beam size before passing through the 3rd dipole magnet

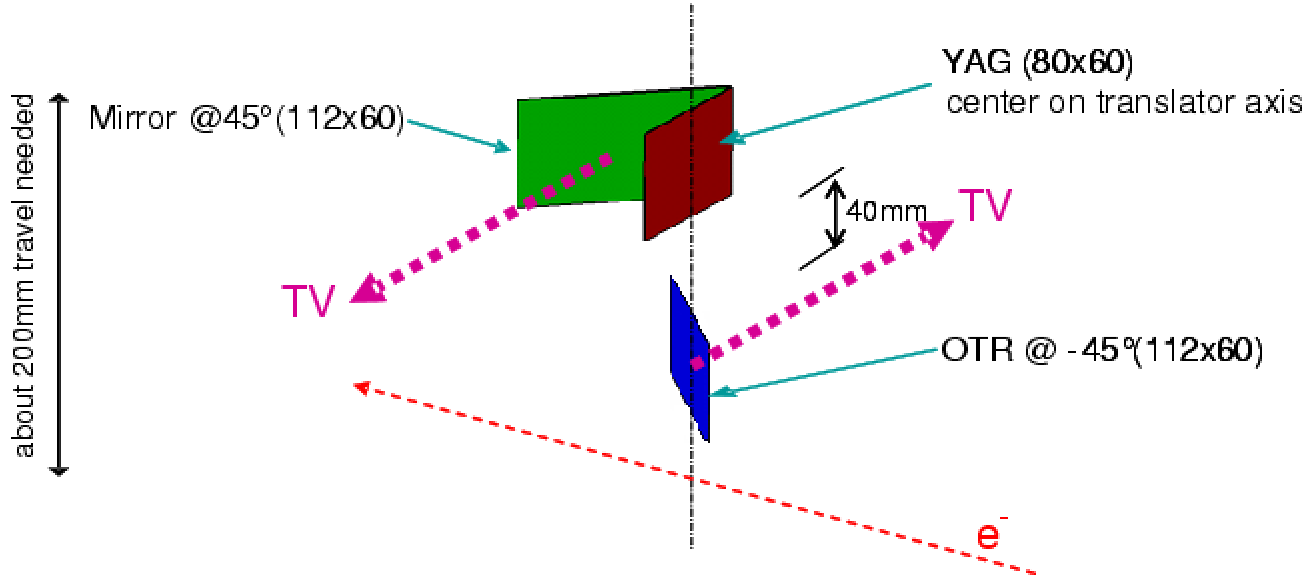
⬇

YAG screen + OTR screen

DISP3.Scr2 Components

YAG (reference to J. Baehr)
- 100 um-thick silicon wafer with YAG power coated
- transverse size of 80mm × 60mm

OTR (reference to J. Baehr)
- 100 um-thick silicon wafer with aluminum coated
- transverse size of 80mm × 60mm



Translator axis @ 1533 mm after DISP3.D2 exit
(D2-D3 section)

Two readout ports for TV at the opposite side of the cross