QSK (CXRS) - Ausbau - Kühlung für OP2

(Ladungsaustauschspektroskopie am Neutralheizstrahl)

Design Review ??.??.2019/20

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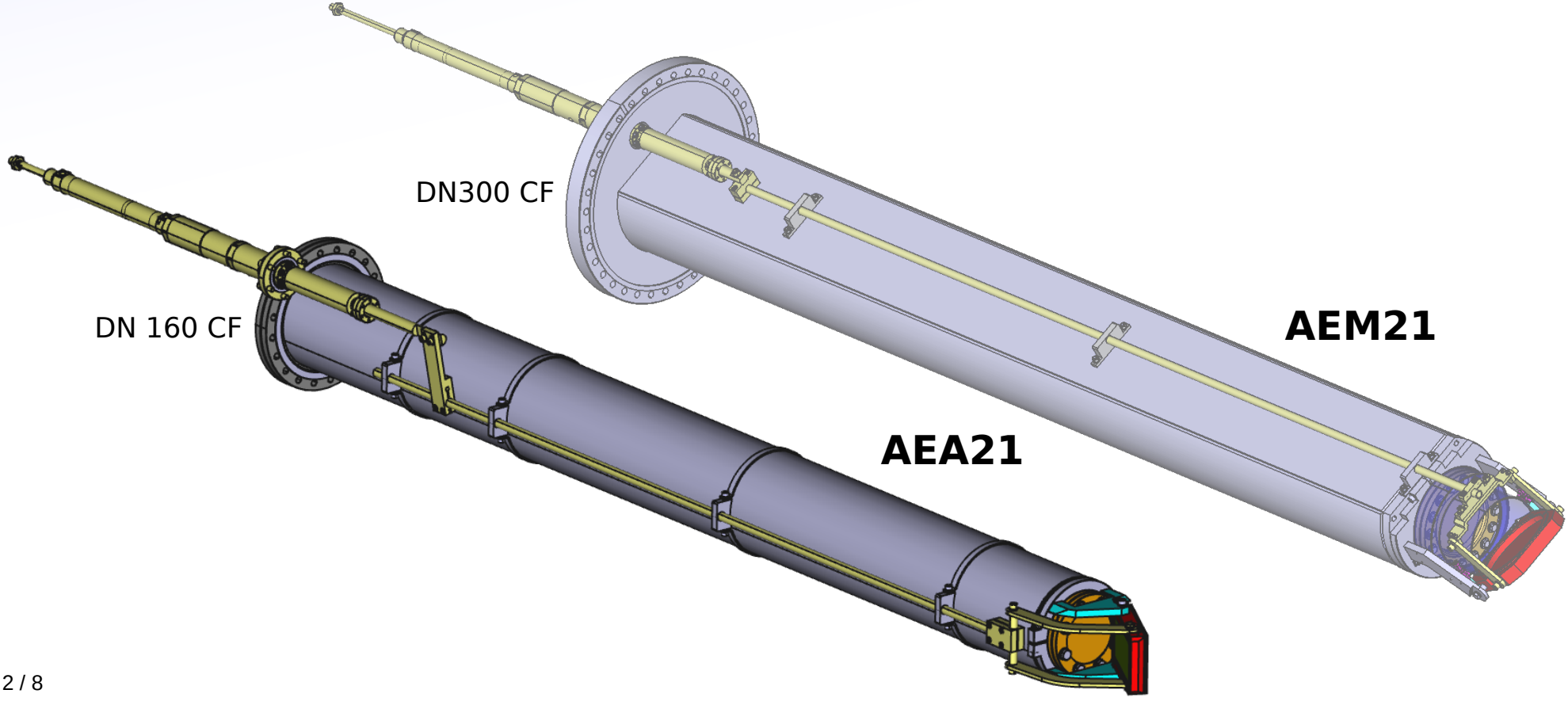
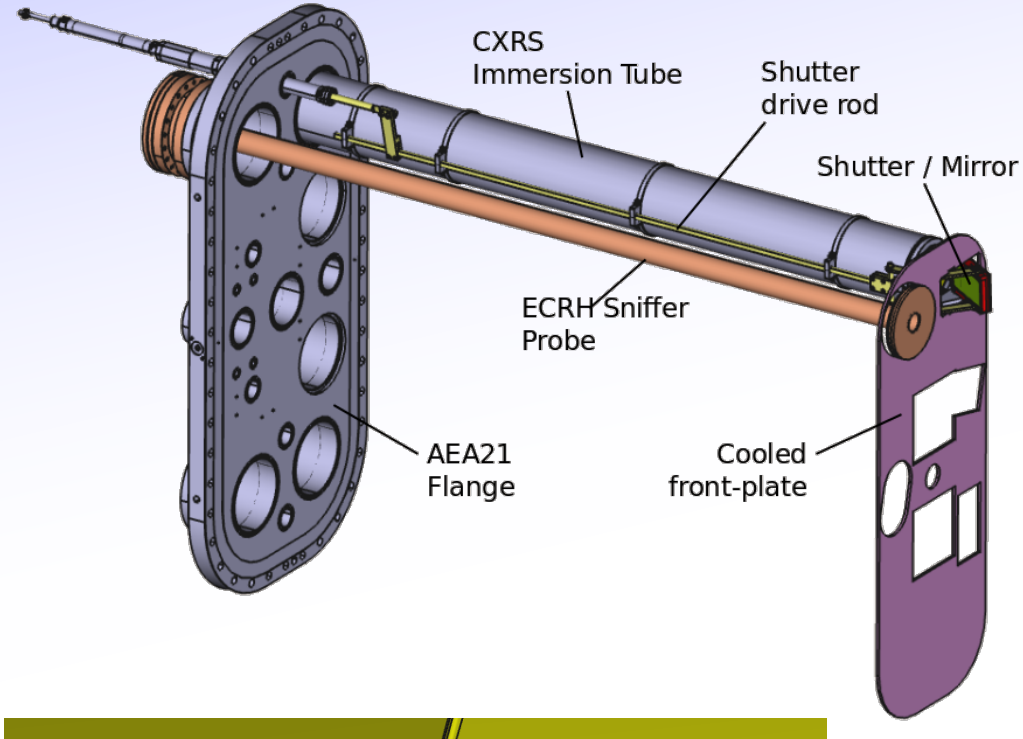
Immersion tube: AEA21 and AEM21

- Two immersion tubes installed for OP1.2b:
- Cooling may need to be added for OP2 long-pulse operation.
- Both systems have an aluminium mirror in a stainless steel shutter block.
  - Shutter only needs to be open for ~10s, so windows and mirrors only exposed for short periods.
  - Back side of shutter block directly faces plasma and may need to be actively cooled.
- AEM21: Port liner will not fit with diagnostic - Need a special solution.
- AEA21: Port protected by common cooled front plate - does not need to be considered here.

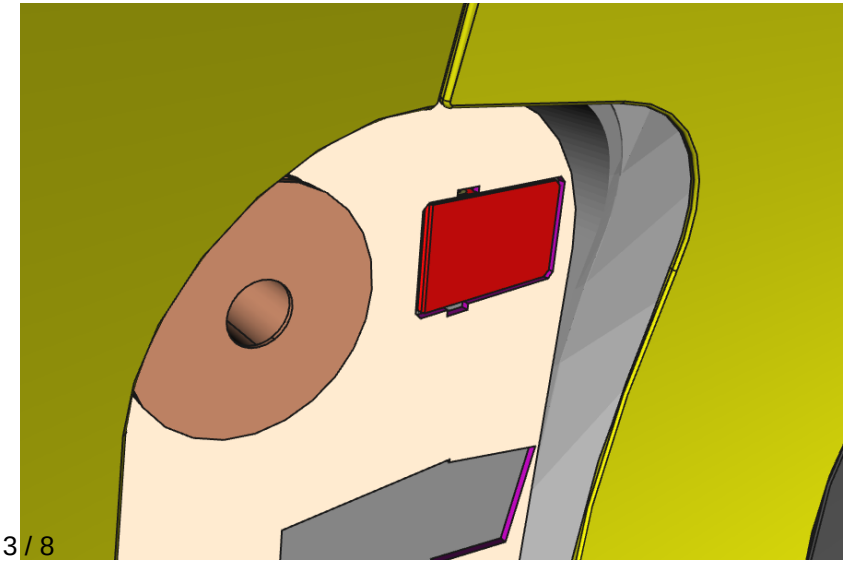


AEA21

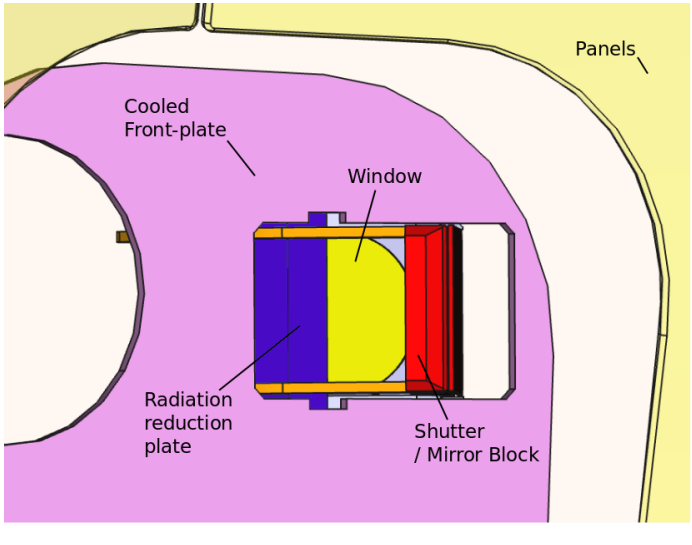


- Cooled front plate provides port protection and protection for diagnostics parts other than shutter.

- Could install additional 'sacrificial window' in front of main window to remove majority of plasma radiation (X-Ray, UV etc) from hitting vacuum window.



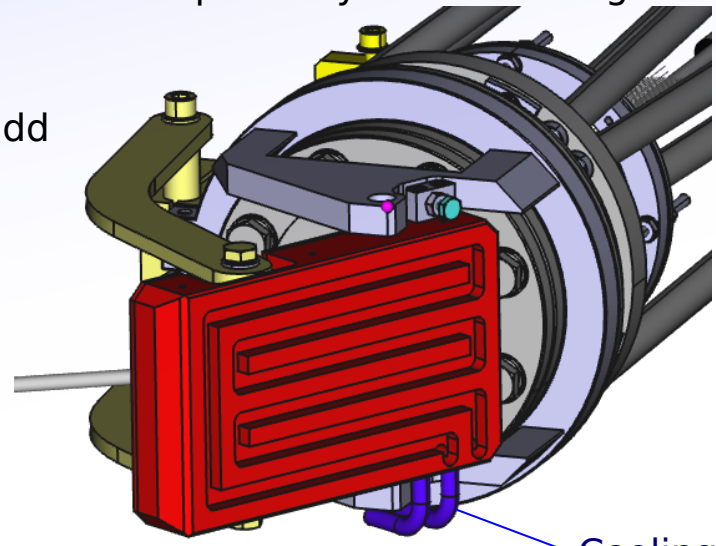
Exposure of window to plasma (Max 10s):



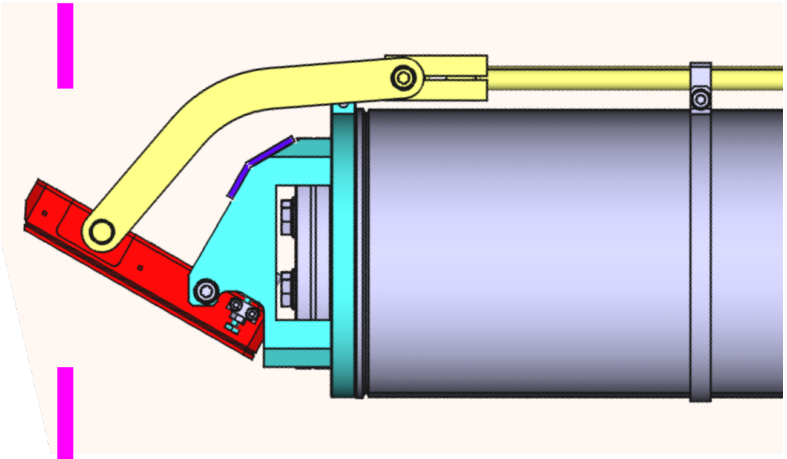
AEA21 - Shutter

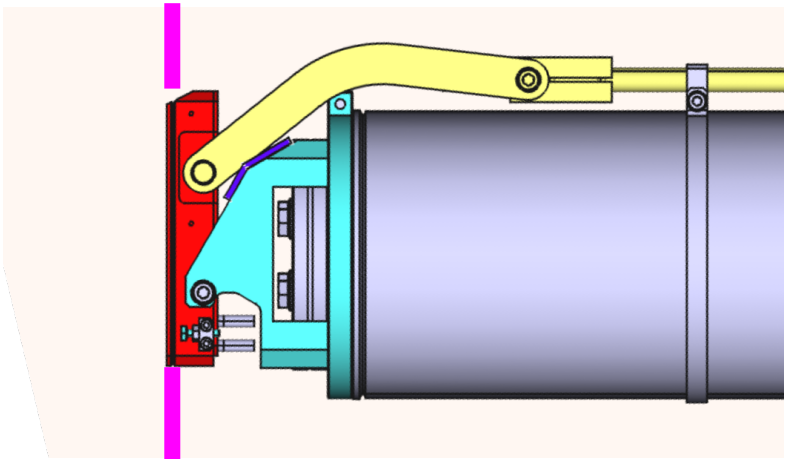
Back side of shutter exposued to full 100kW m^{-2} x 30min --> probably needs cooling.

Either:
1) Machine water channels into mirror block and add flexible cooling tubes to mirror.



2) Some kind of flexible thermal conductive strip to cooled block





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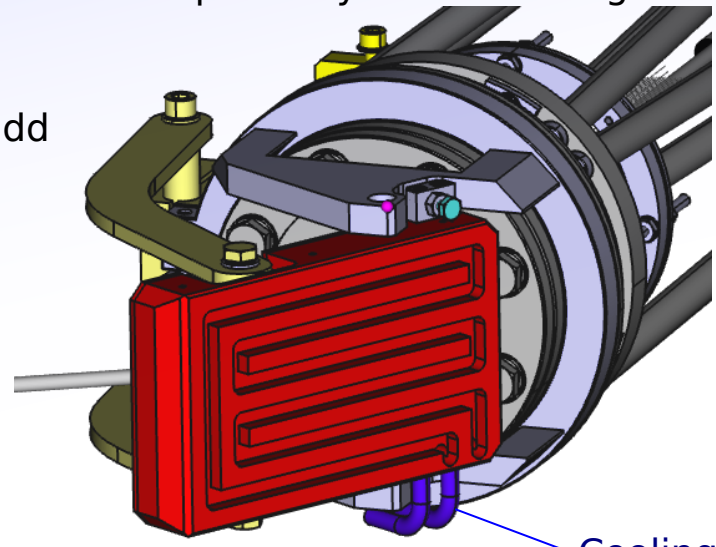

Mirror pivots by large

AEA21 - Shutter

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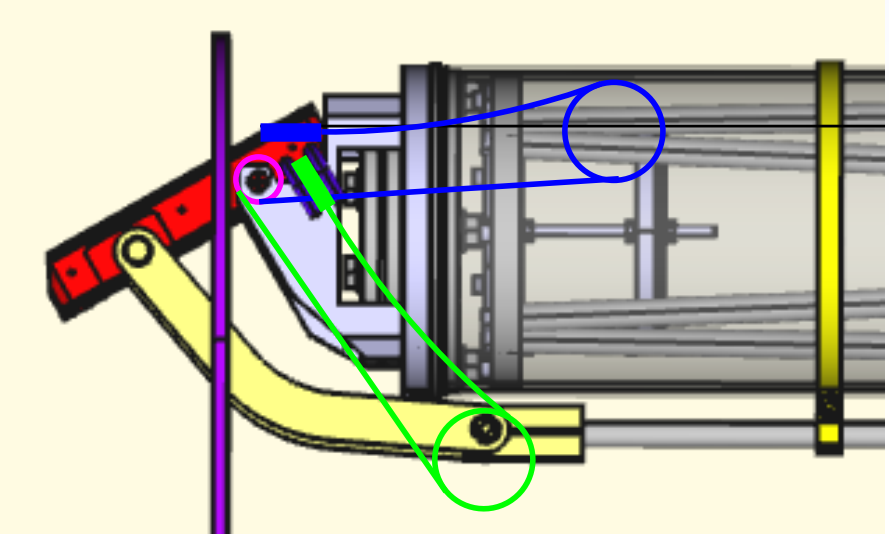
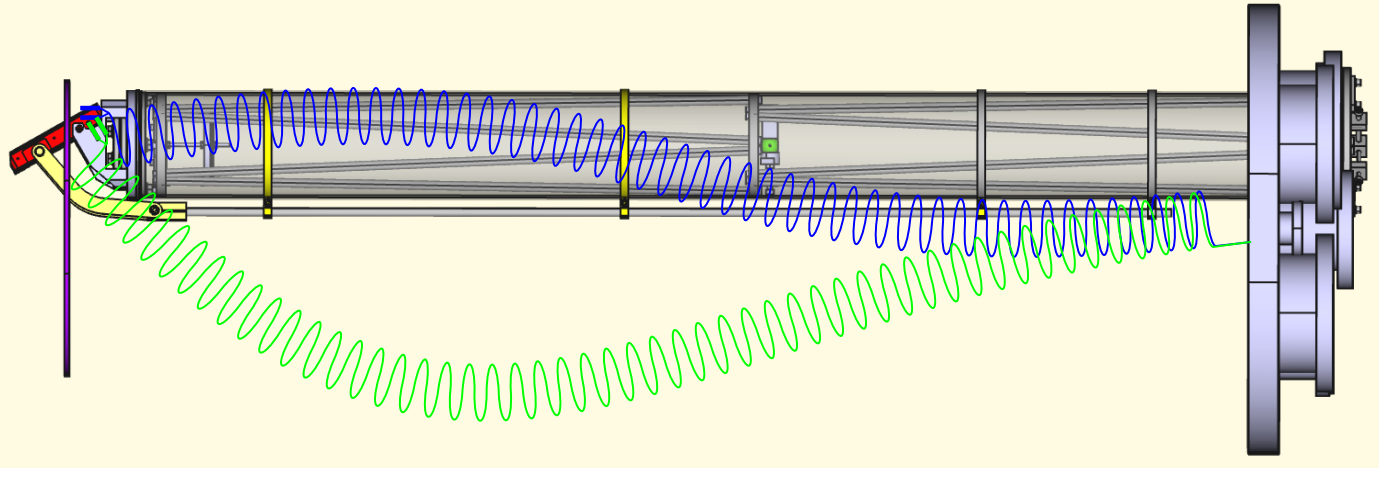
1) Machine water channels into mirror block and add flexible cooling tubes to mirror.

Mirror pivots by 60° and shifts by a few cm - difficult to allow sufficient movement to water cooling pipes.



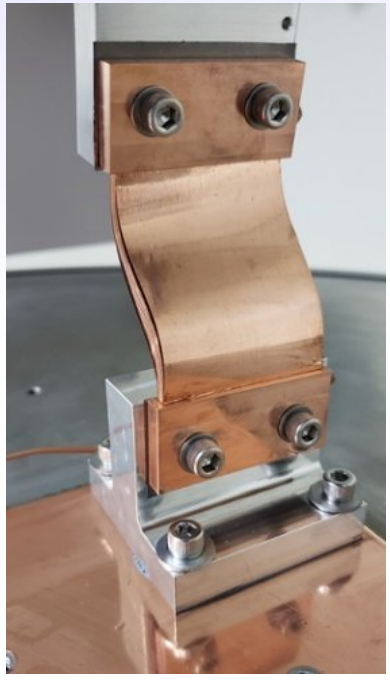
Two coils of pipe required to deal with offset as well as rotation.

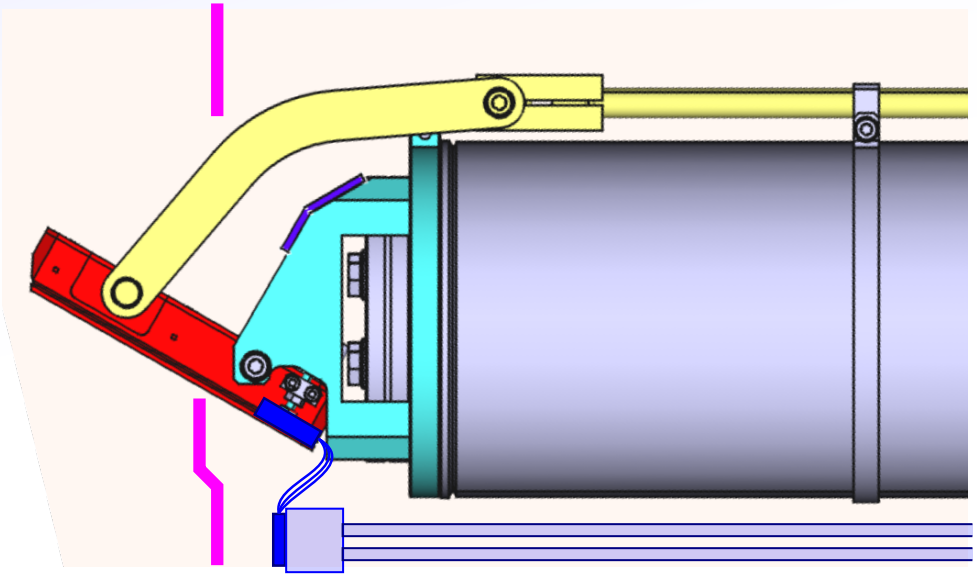
Alternative Idea:
Long coil above/below, using up whole width of port.

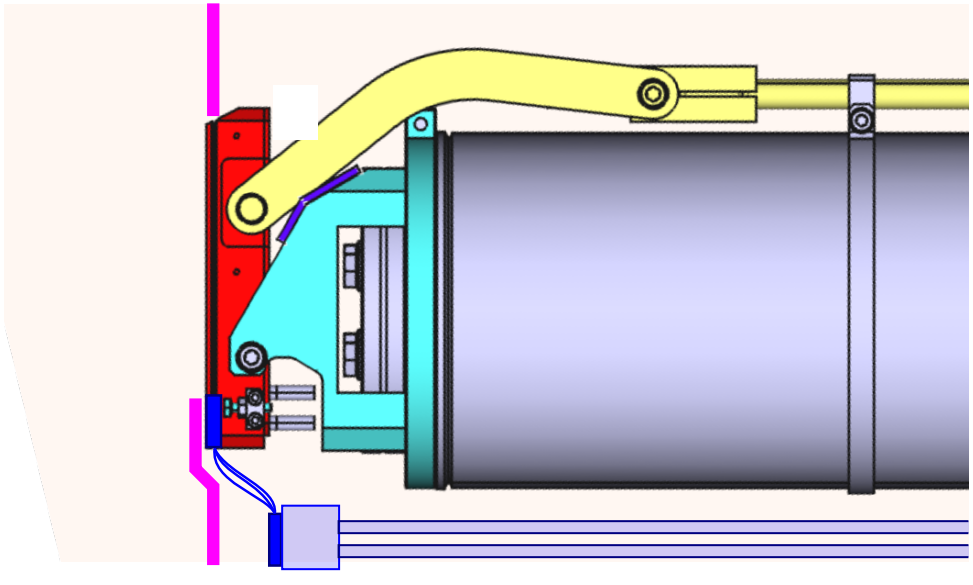


AEA21 - Shutter

Alternatively, we could use a thermal strap:







Thermal conductivity:
- Aluminium: 225 $Wm^{-1}K^{-1}$
- Copper: 450 $Wm^{-1}K^{-1}$
- Graphene: 2500 $Wm^{-1}K^{-1}$

Is this enough to cool shutter block??

130 x 80mm = 0.01m^2

100kW m^{-2} x 0.01m^2 = 1kW

dT = 1kW / 450 $Wm^{-1}K^{-1}$ x 10cm = 0.04K

AEM21

- AEM21 requires protection for port.
- Basic concept is some kind of steel 'pot' with cut-out for required view