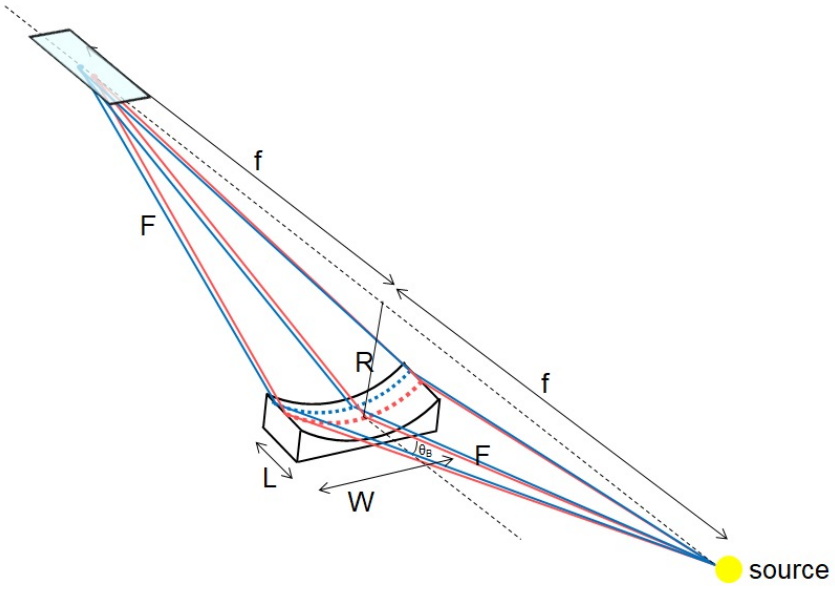
D002 MEC spectrometer

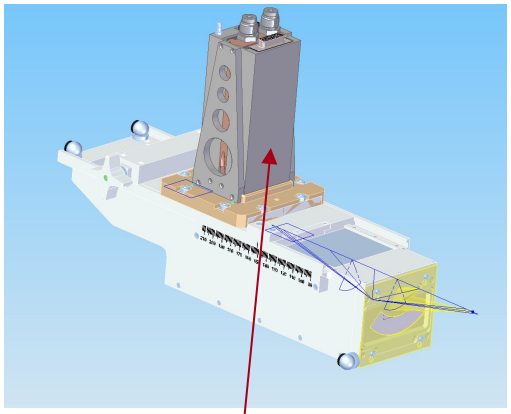
Compact HAPG XRTS spectrometer for higher X-ray photon energy

U.S. DEPARTMENT OF ENERGY | Stanford University

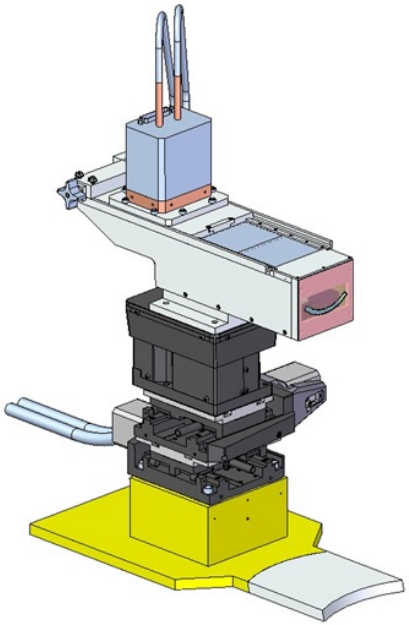
SLAC NATIONAL ACCELERATOR LABORATORY

XRTS spectrometer in Von Hamos geometry





Modified epix detector



Substrate from LEO

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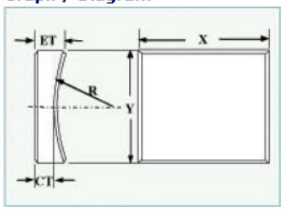
Cylindrical BK7 Plano-Concave Lenses (B-CC)

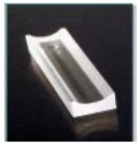
Graph / Diagram



Specifications

Diameter Tolerance:	+0/-0.005"
Thickness Tolerance:	±0.010"
Concentricity:	< 3 arc min.
Clear Aperture:	> 85% of diameter
Focal Length Tolerance	± 0.5%
Surface Figure:	1/2 for Y-direction 1/4 for X-direction
Surface Quality:	20-10 scratch-dig

Picture Image



Part No.	Material	X (mm)	Y (mm)	R (mm)	f' (mm)	CT (mm)	ET (mm)
B-CC-0503-10	BK7	12.7	6.35	5.1	-10	6.0	7.0
B-CC-1003-6	BK7	25.4	6.35	3.31	-6.35	6.0	7.4
B-CC-1005-13	BK7	25.4	12.7	6.57	-12.7	6.0	9.6
B-CC-1005-25	BK7	25.4	12.7	13.1	-19.1	6.0	7.4
B-CC-1010-50	BK7	25.4	25.4	26.3	-50.8	6.0	9.4
B-CC-1010-100	BK7	25.4	25.4	51.7	-100	6.0	7.6
B-CC-1010-500	BK7	25.4	25.4	258.5	-500	6.0	6.3
B-CC-1010-1000	BK7	25.4	25.4	517.0	-1000	6.0	6.2
B-CC-2010-25	BK7	50.8	25.4	13.1	-25.4	6.0	7.7
B-CC-2010-38	BK7	50.8	25.4	19.7	-38.1	6.0	10.7
B-CC-2010-50	BK7	50.8	25.4	26.3	-50.8	6.0	9.4
B-CC-2010-76	BK7	50.8	25.4	39.4	-76.2	6.0	8.2
B-CC-2010-100	BK7	50.8	25.4	51.7	-100	6.0	7.6
B-CC-2020-100	BK7	50.8	50.8	51.7	-100	6.0	12.7
B-CC-2020-200	BK7	50.8	50.8	103.4	-200	6.0	9.2
B-CC-2020-500	BK7	50.8	50.8	258.5	-500	6.0	7.3
B-CC-2020-1000	BK7	50.8	50.8	517.0	-1000	6.0	6.6

Nominal at 1064nm

· CaF_2 cylindrical lenses are available upon request.

1-2. B-CC-2010-50, $225 ea, 1-2 days
uncoated

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Advanced version of MEC spectrometer, XRTS II

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The choice of HAPG crystal is a part of PRD for advanced version of spectrometer

New HAPG crystal with ROC of 26.3 mm with mosaic spread of 0.1º

X-ray photon energy (keV)	projected distance, Z crystal to detector (mm)	θ_B (º)	crystal order	ROC (mm)	spectral window (eV)
8	110.7	13.4	1	26.3	2700
16	226.1	6.6	1	26.3	
16	110.7	13.4	2	26.3	
24	340.4	4.4	1	26.3	
24	168.7	8.9	2	26.3	

**** Need to decide**

OK with ROC of 26.4 mm (25.4 mm width x 50.8 mm long):

Thickness of HAPG : both 40 micron or 40 and 100 micron? Favoring resolution, consistency between 2 crystals.

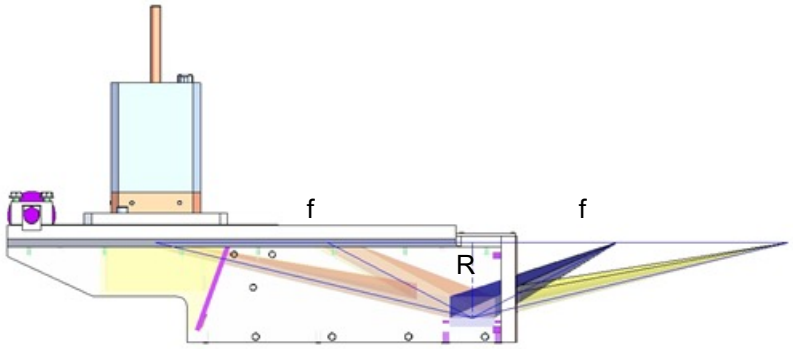
How many : 2 or 3

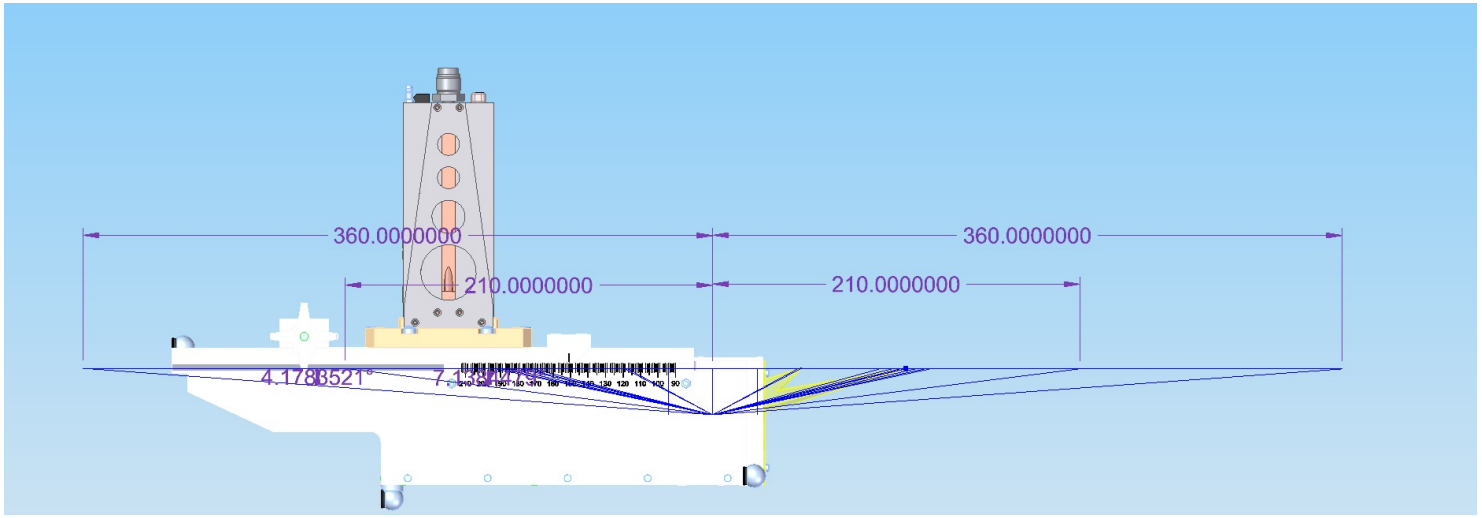
** Then I will submit an order to receive crystals before end of September

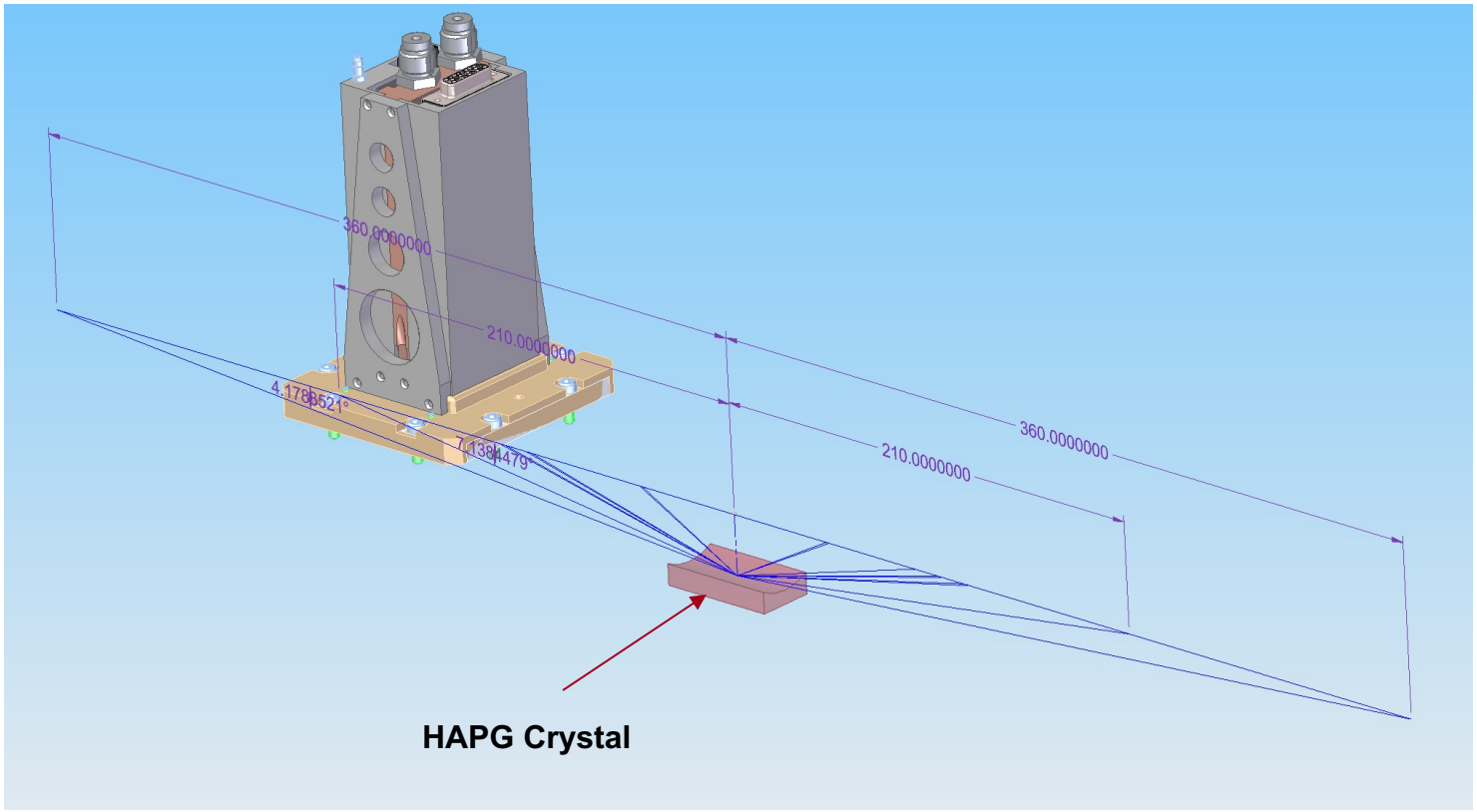
-> DONE, Optigraph, purchased!

HAPG crystal, mosaic spread ~ 0.1 degree, thickness ~40 micron, mounted to BK7 glass substrate, 50.8 mm (L)x25.4 mm (W), ROC~26.3 mm

Advanced version of MEC spectrometer, XRTS II






360.0000000
210.0000000
4.1786521°
7.1384479°
360.0000000
210.0000000
HAPG Crystal

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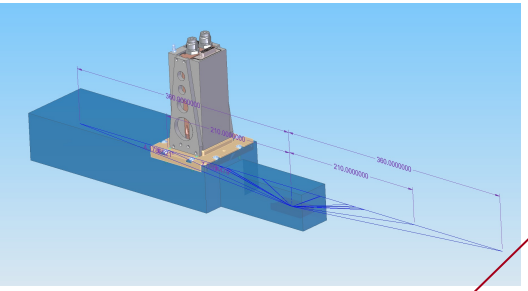
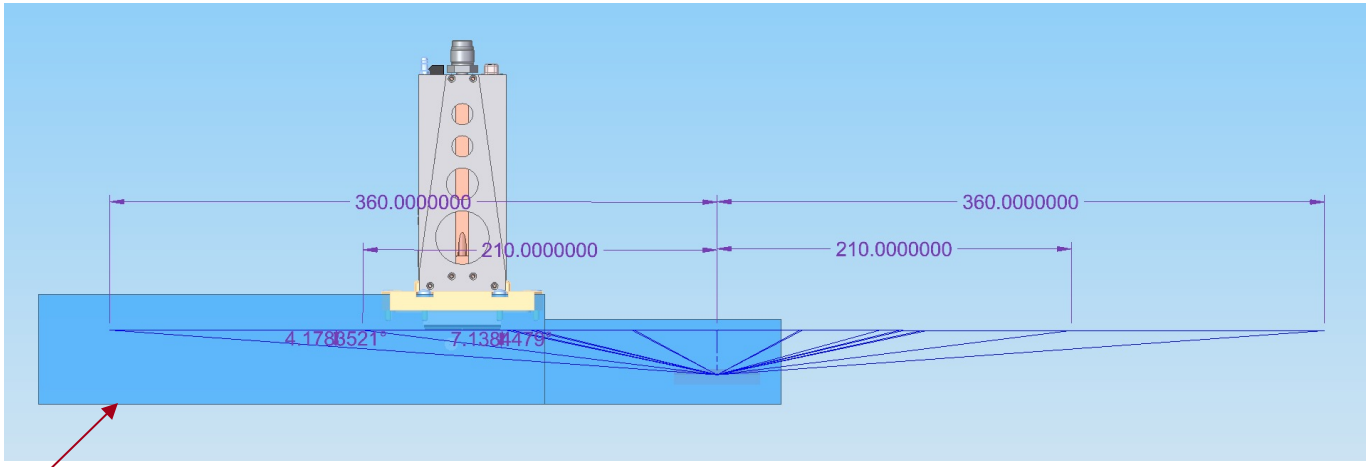
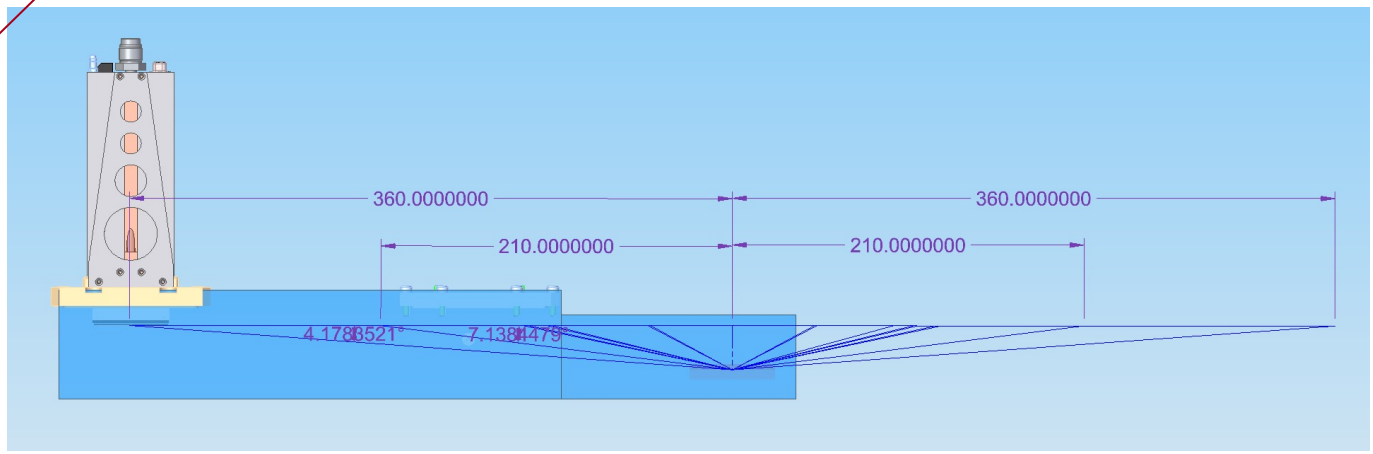
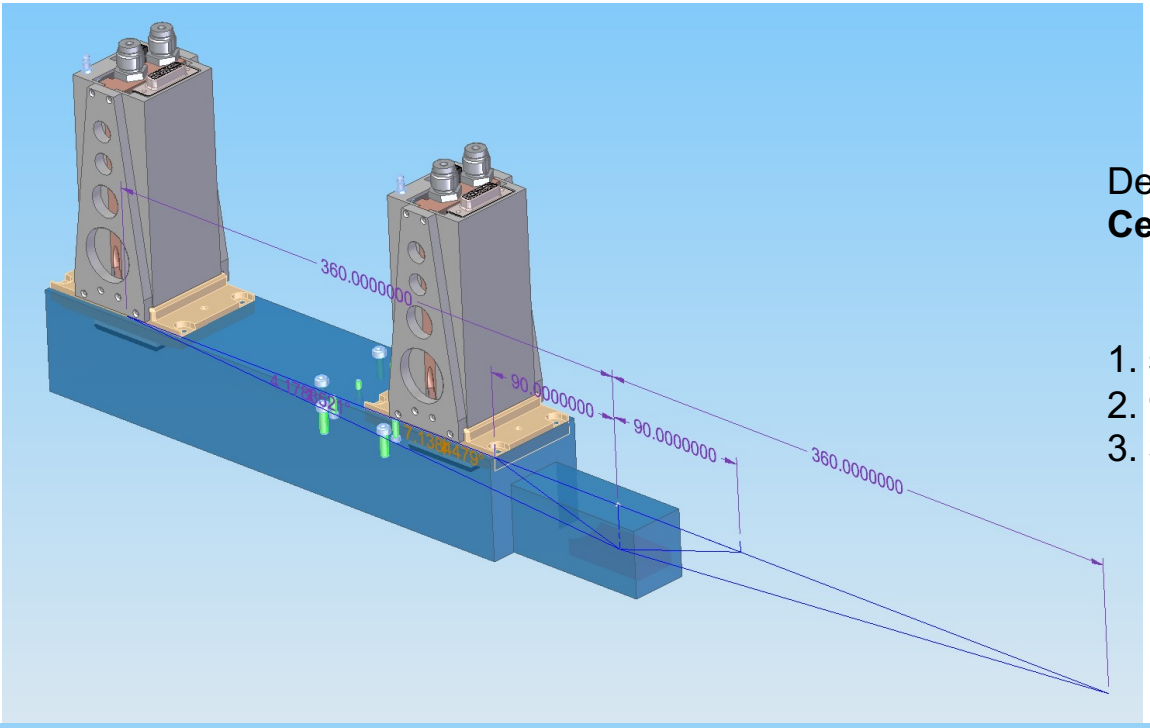
Is this configuration correct?



New Housing Envelope

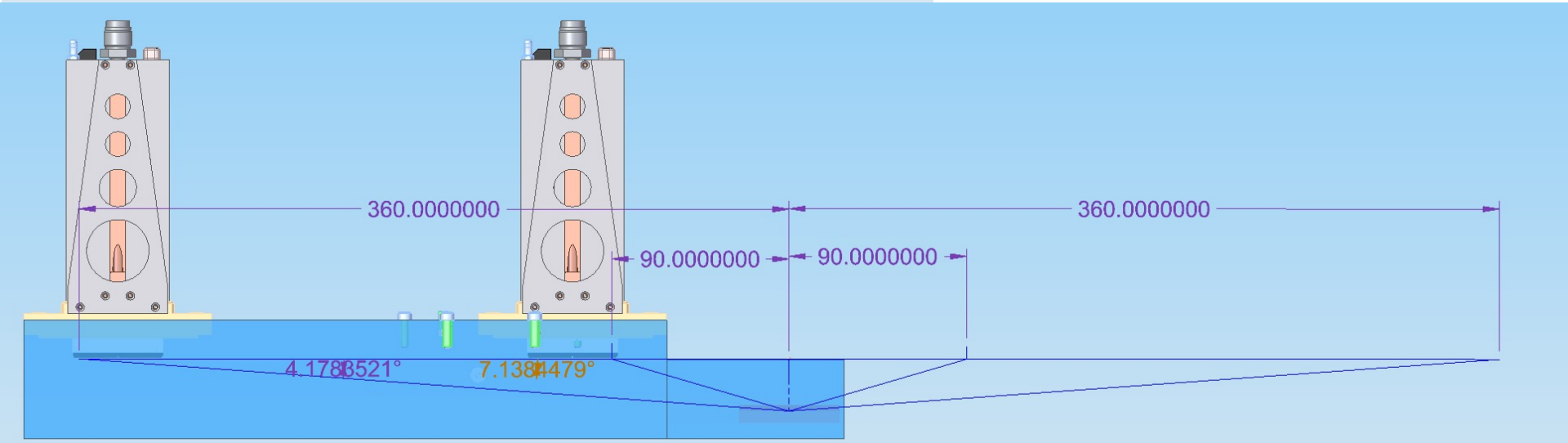




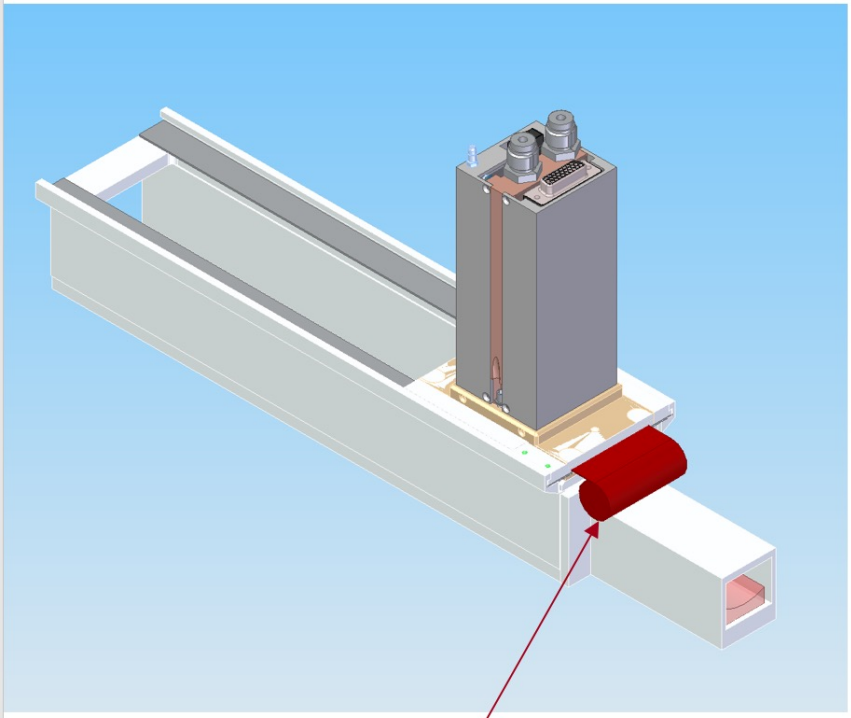


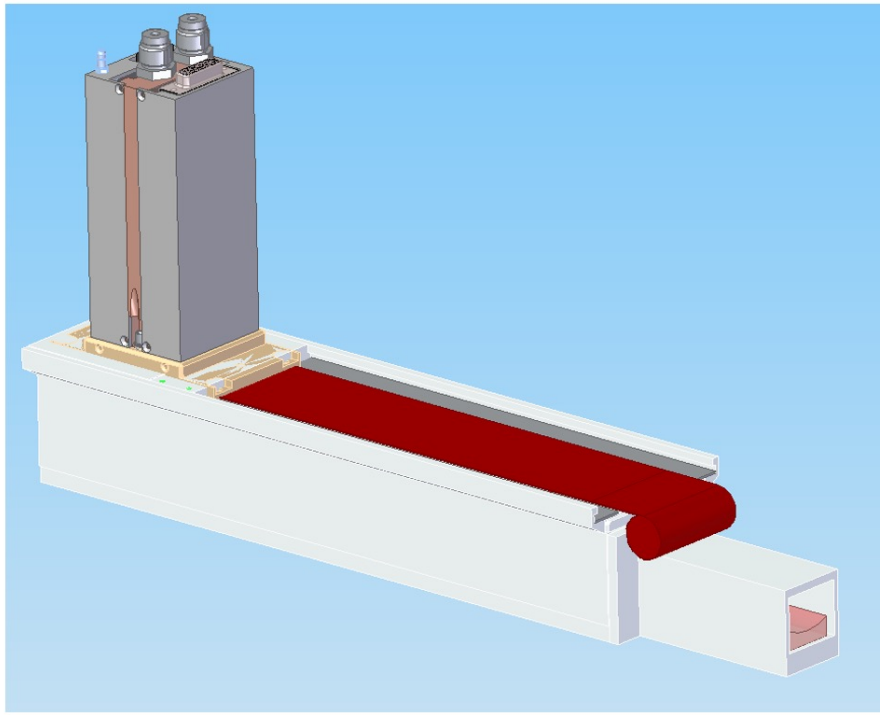
Detector chip size : 40 mm
Center of crystal to center of detector:
110 to 340 mm

1. shell cover 90 to 360 mm
2. 90 mm: center of crystal to front edge of chip
3. 360 mm: center of crystal to rear edge of chip

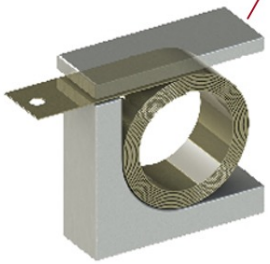


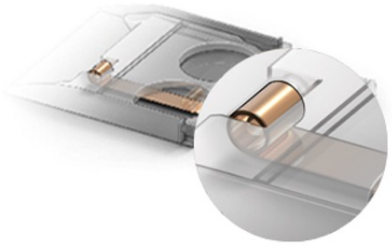
Force Spring option for light proof





Mounting options:





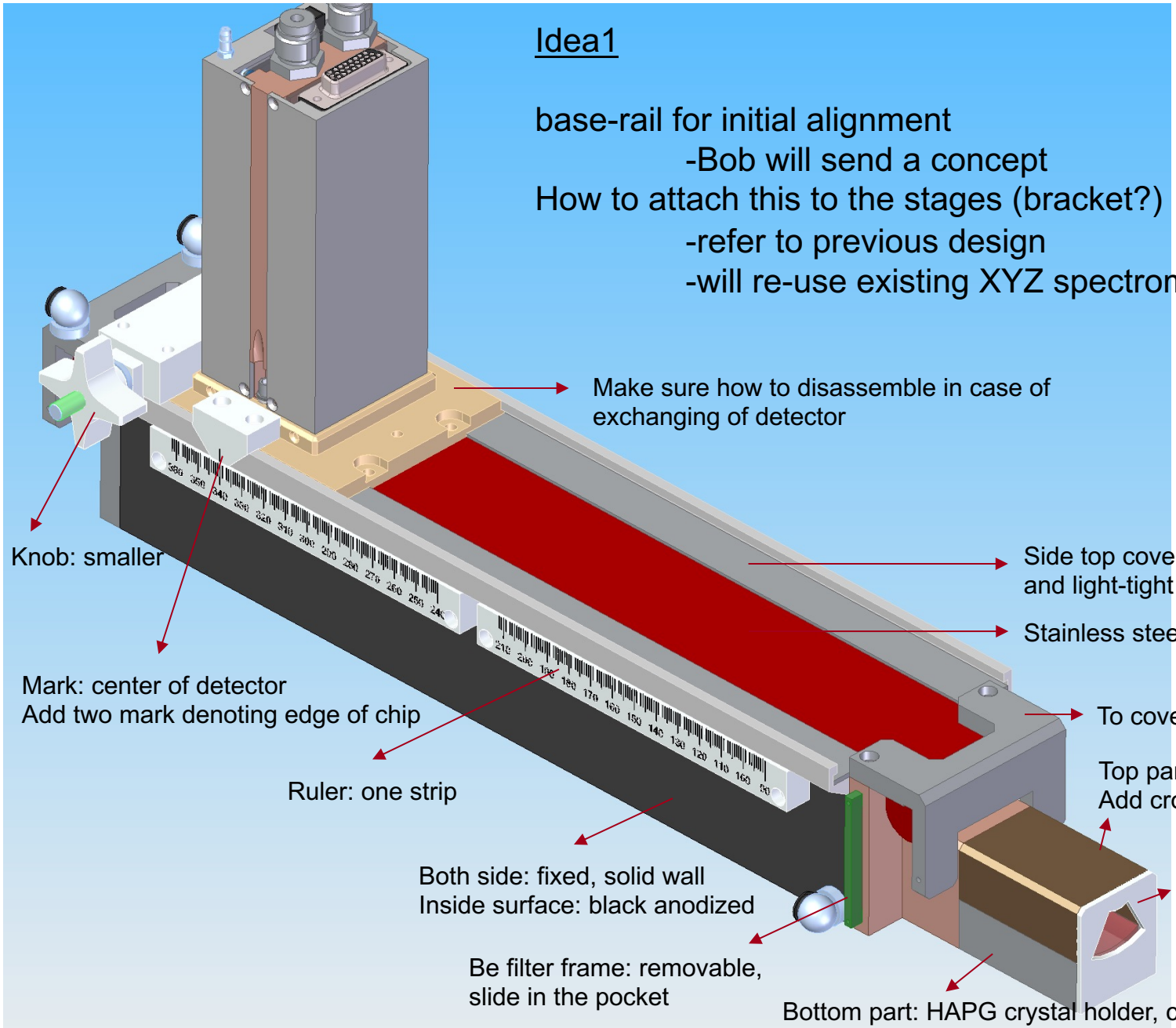
Discussion:

Strip-spring coil (stainless steel, ~300μm thin)
McMaster-Carr, constant-force spring

Be filter position
between movable detector and HAPG crystal
easy to be removable

Light-tight
Optical light-tight

Improved XRTS design



Idea1

base-rail for initial alignment
-Bob will send a concept
How to attach this to the stages (bracket?)
-refer to previous design
-will re-use existing XYZ spectrometer stages

Make sure how to disassemble in case of exchanging of detector

Knob: smaller

Side top cover: keep the strip flat and light-tight

Stainless steel strip-spring coil

Mark: center of detector
Add two mark denoting edge of chip

To cover spring roll

Top part: to cover HAPG
Add cross mark for center of crystal

Ruler: one strip

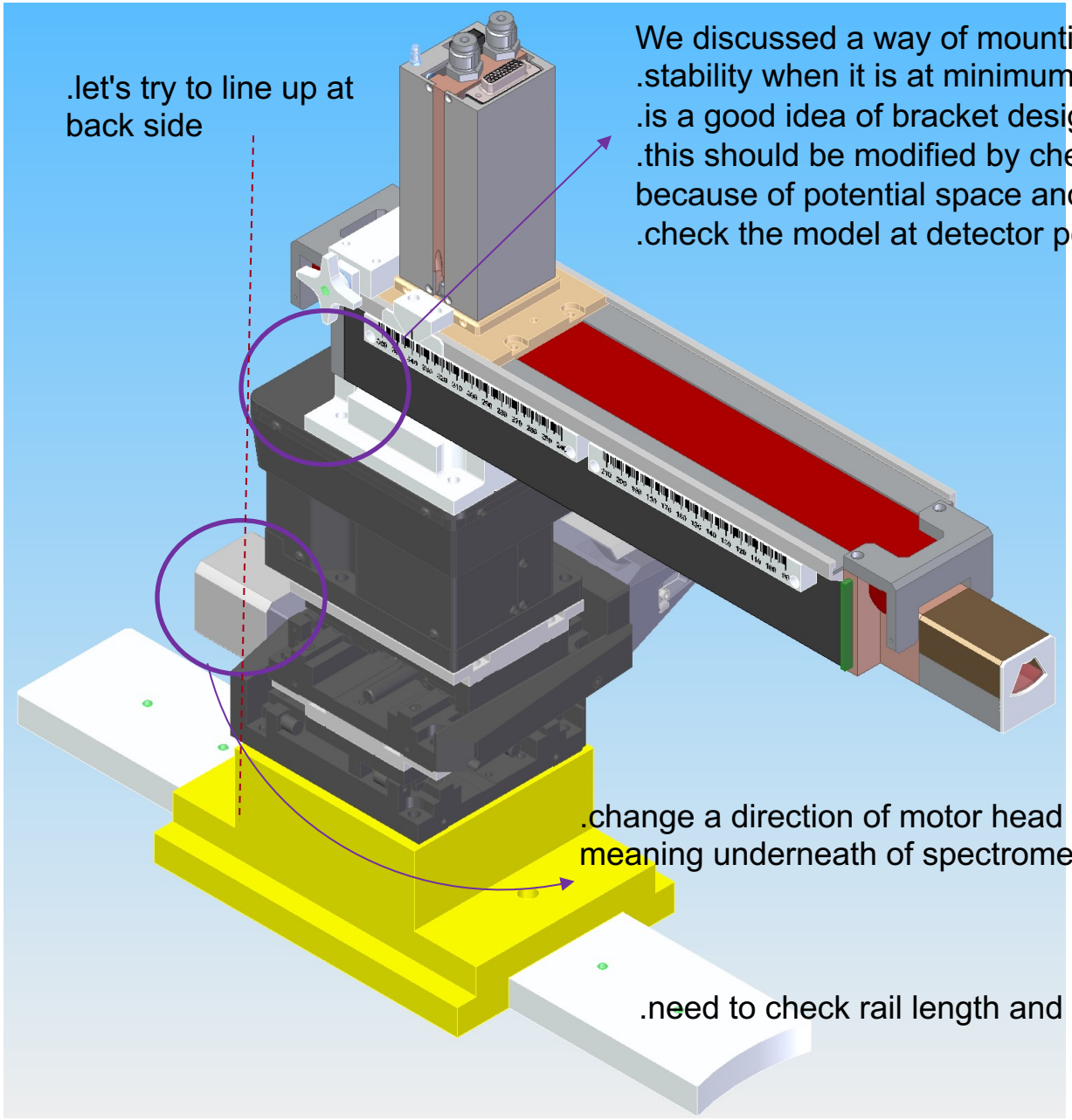
Aperture: filters, blast shield will be attached here
May need a frame for it?

Both side: fixed, solid wall
Inside surface: black anodized

Be filter frame: removable, slide in the pocket

Bottom part: HAPG crystal holder, crystal glued to the bottom

Improved XRTS design



We discussed a way of mounting spectrometer on stages
.stability when it is at minimum focal length position : f=90mm
.is a good idea of bracket design holding spectrometer at the back?
.this should be modified by checking within standard configuration
because of potential space and collision issue
.check the model at detector position of f=90, 220, 360 mm

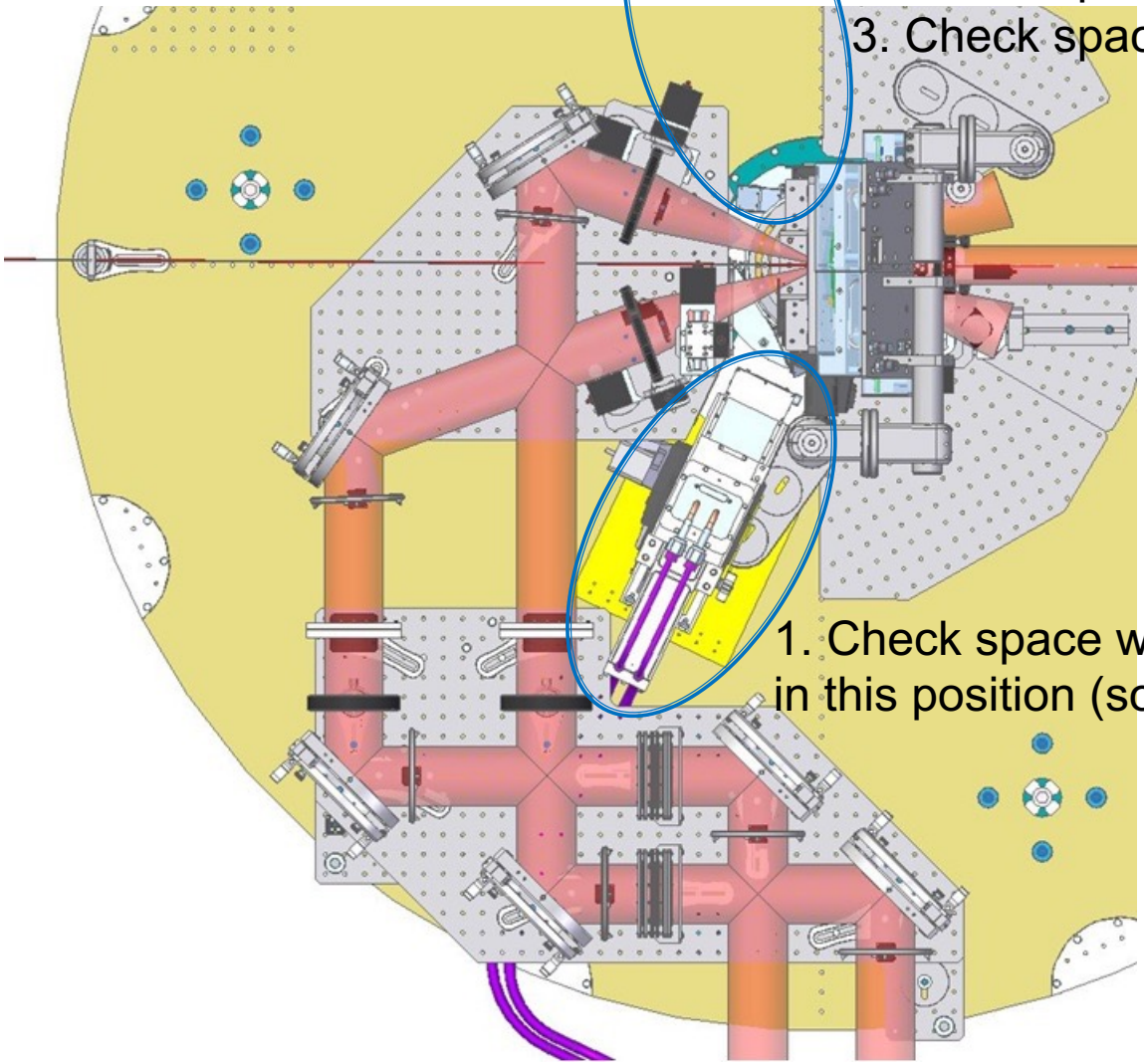
.change a direction of motor head of z-stage to target direction:
meaning underneath of spectrometer to save space

.need to check rail length and feasibility in Std. config

Improved XRTS design: How much space does XRTS occupy?

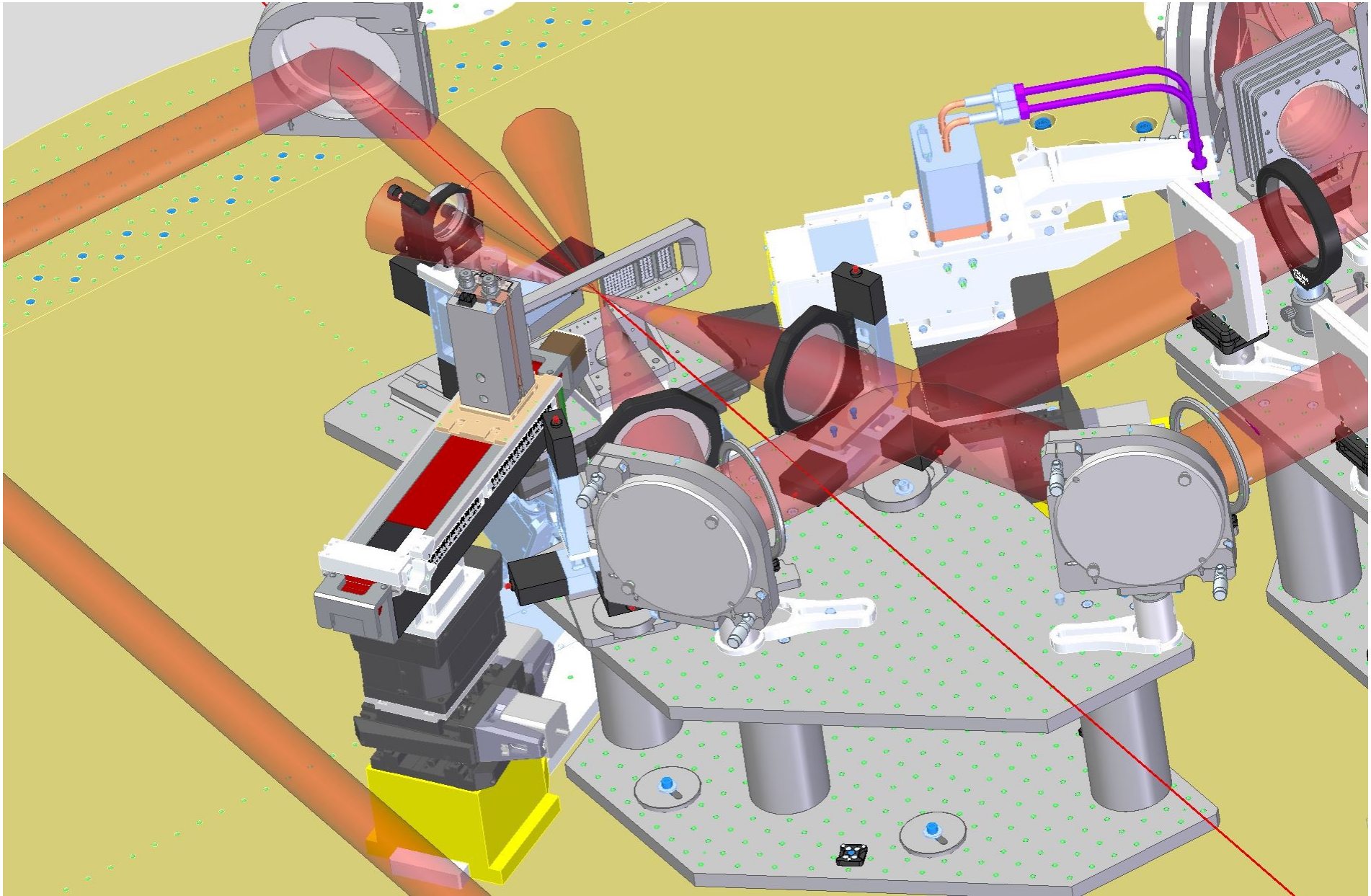
(May need to change VISAR beam path)

Put an XRTS in north-west
2. Check space with F= 250 mm
3. Check space with F=360 mm

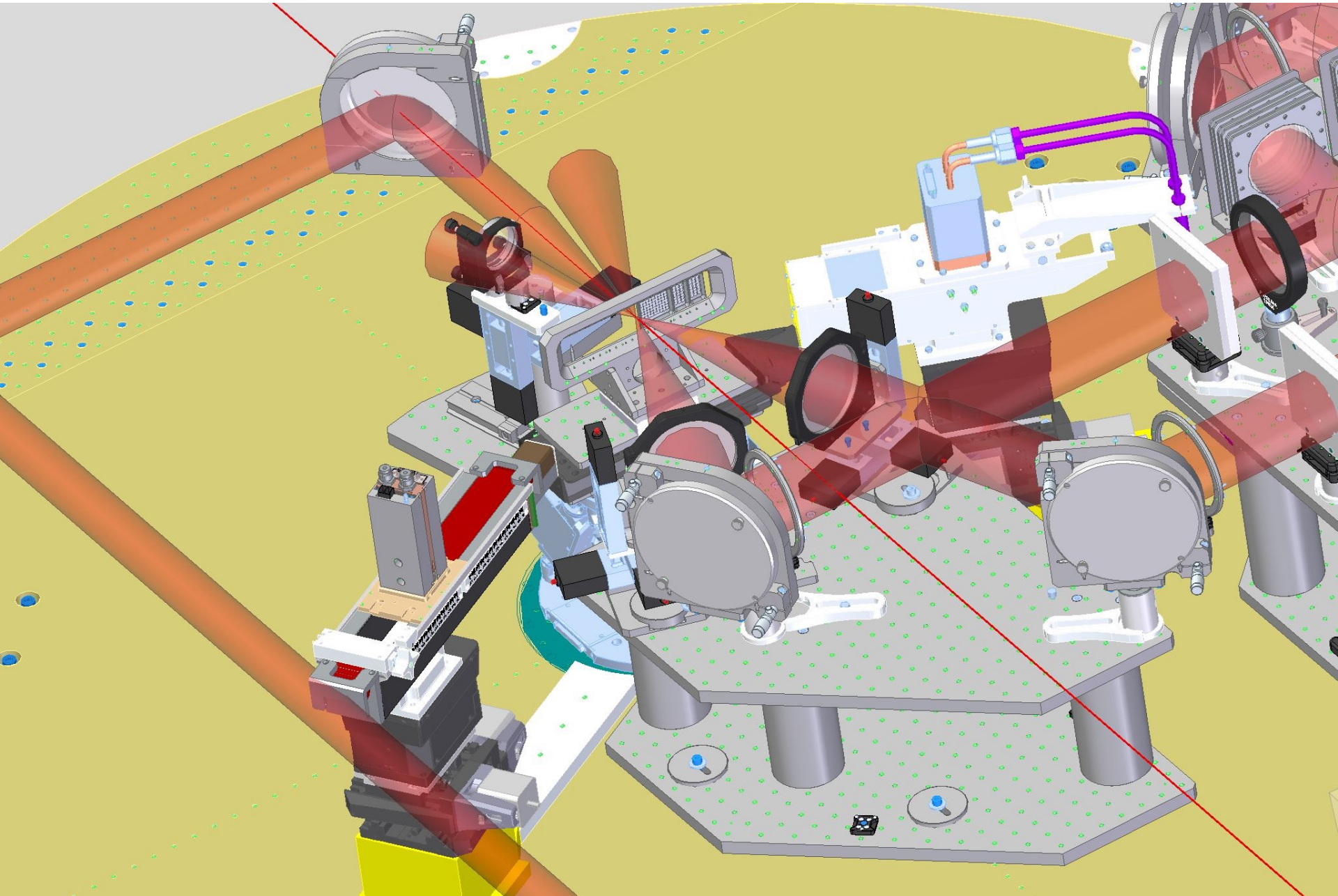


1. Check space with F= 250 mm
in this position (south-west)

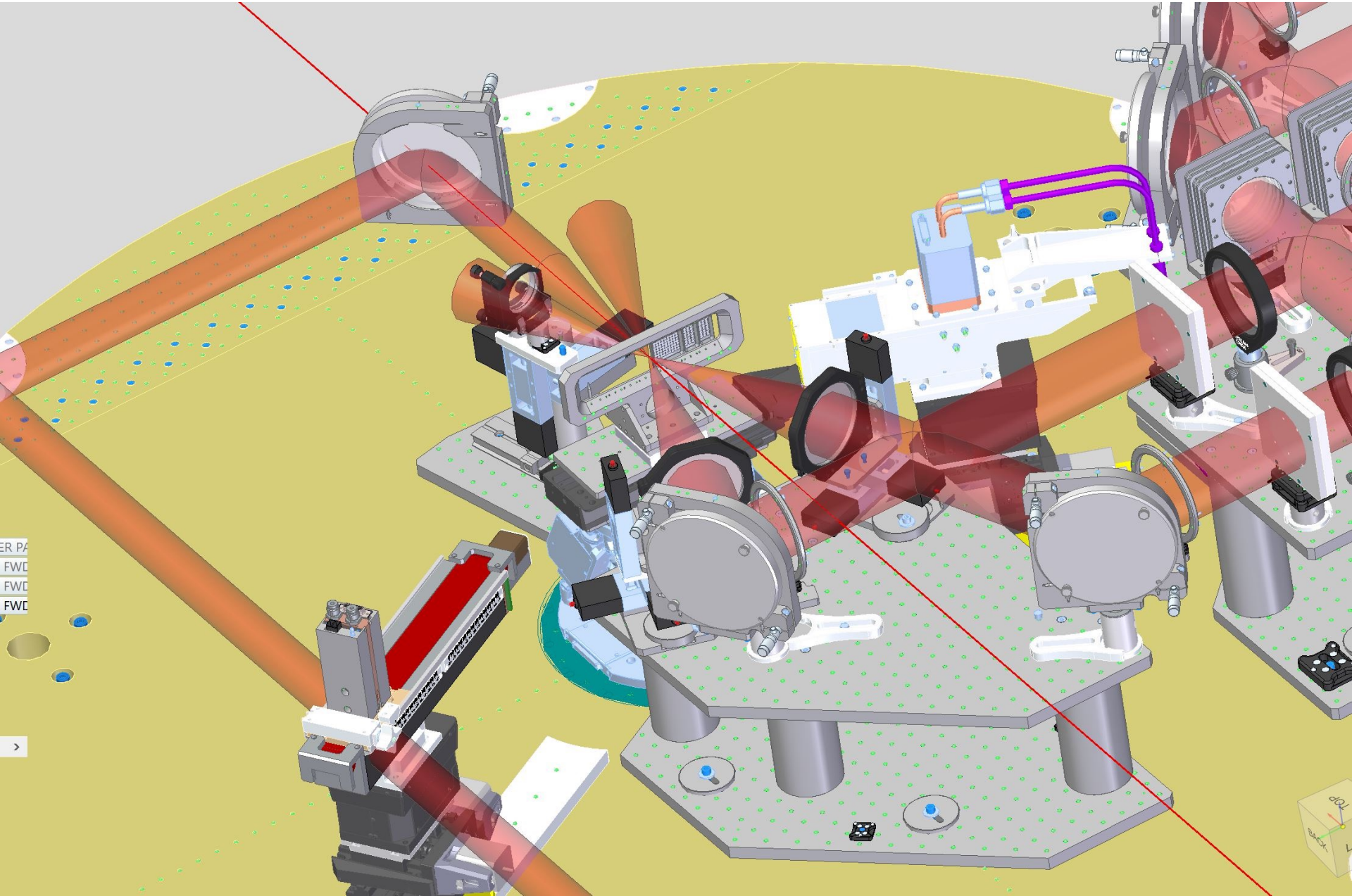
Improved XRTS design



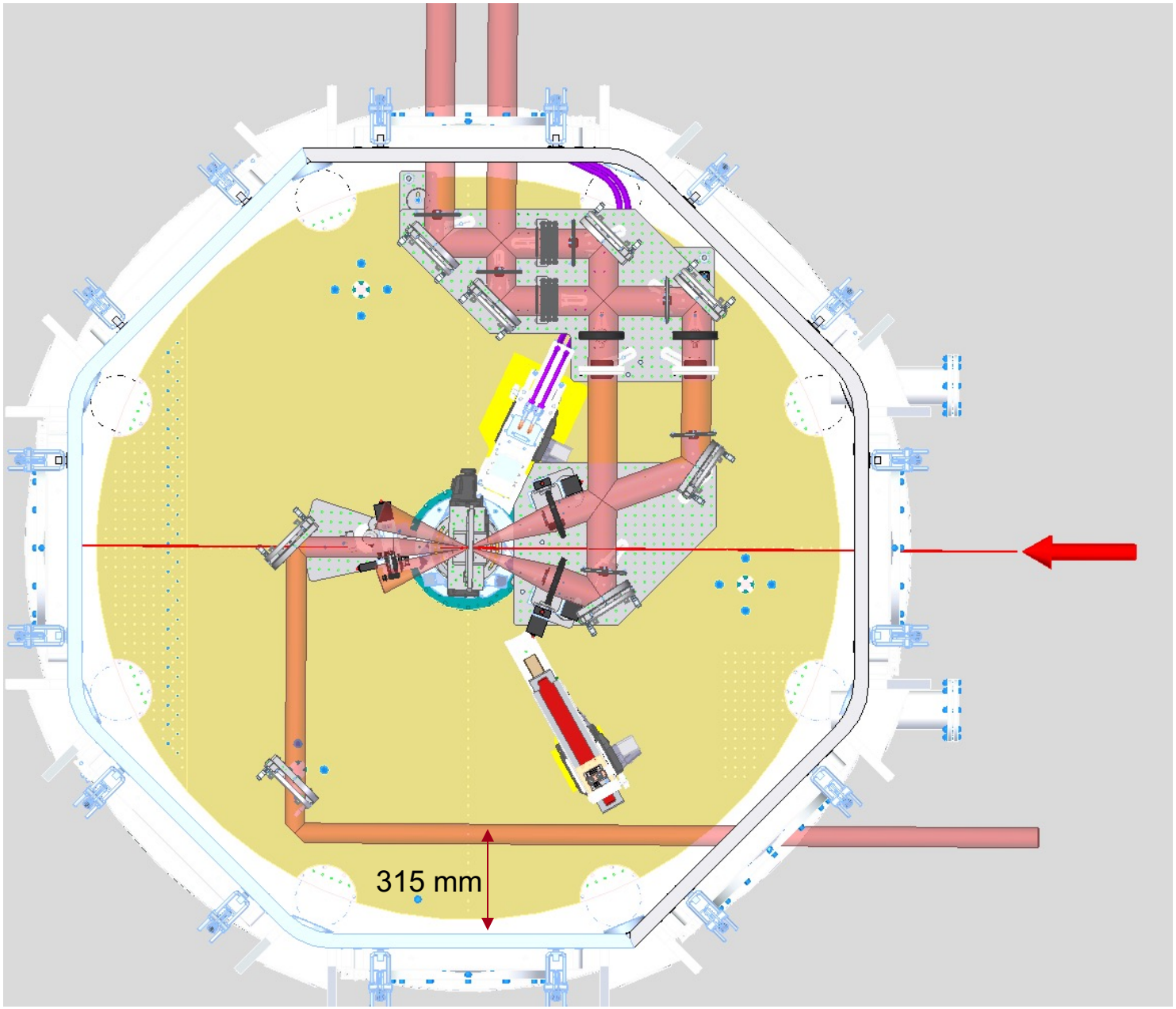
Meeting 7: improved XRTS design, 5/11

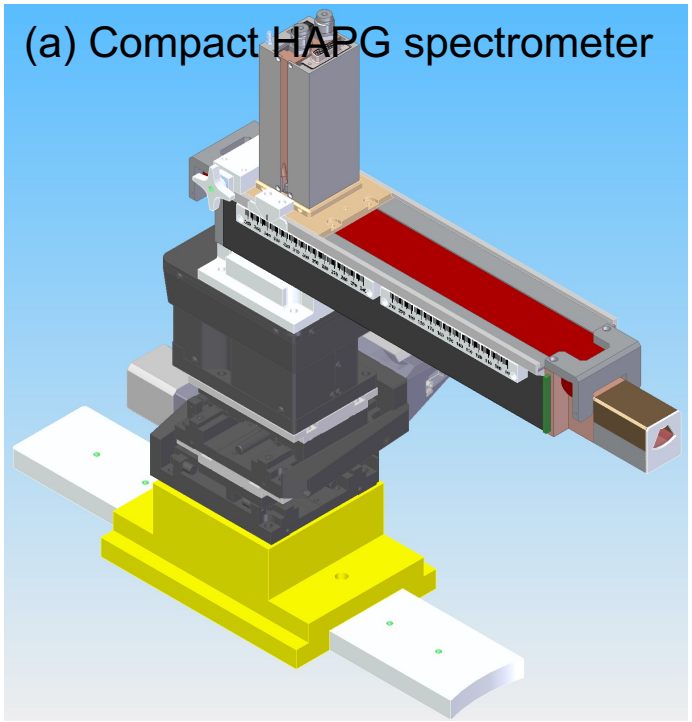


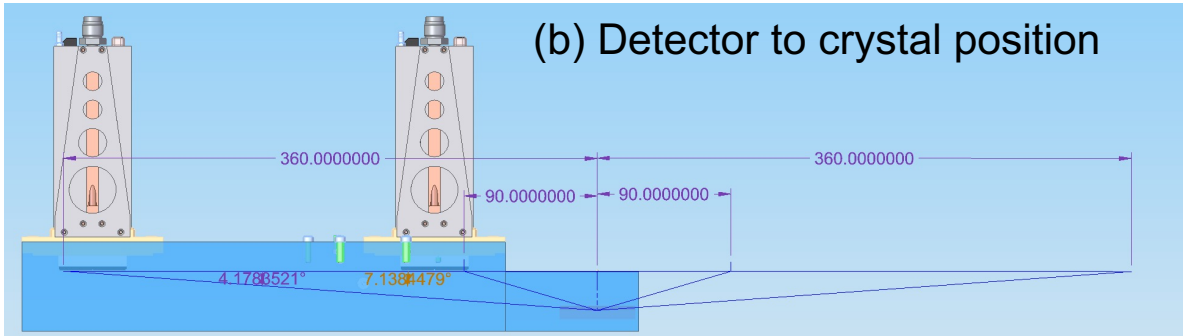
Improved XRTS design: VISAR beampath needs to be updated. Current one is false.



Improved XRTS design with updated VISAR beampath







X-ray photon energy (keV)	projected distance, Z crystal to detector (mm)	θ_B (°)	crystal order	ROC (mm)	covering spectral range by ePix (eV)
8	110.7	13.4	1	26.3	2600
16	226.1	6.6	1	26.3	2700
16	110.7	13.4	2	26.3	5400
24	340.4	4.4	1	26.3	3200
24	168.7	8.9	2	26.3	5500
25	354.7	4.2	1	26.3	3400

Original X-ray HAPG Spectrometer: Von Hamos Geometry

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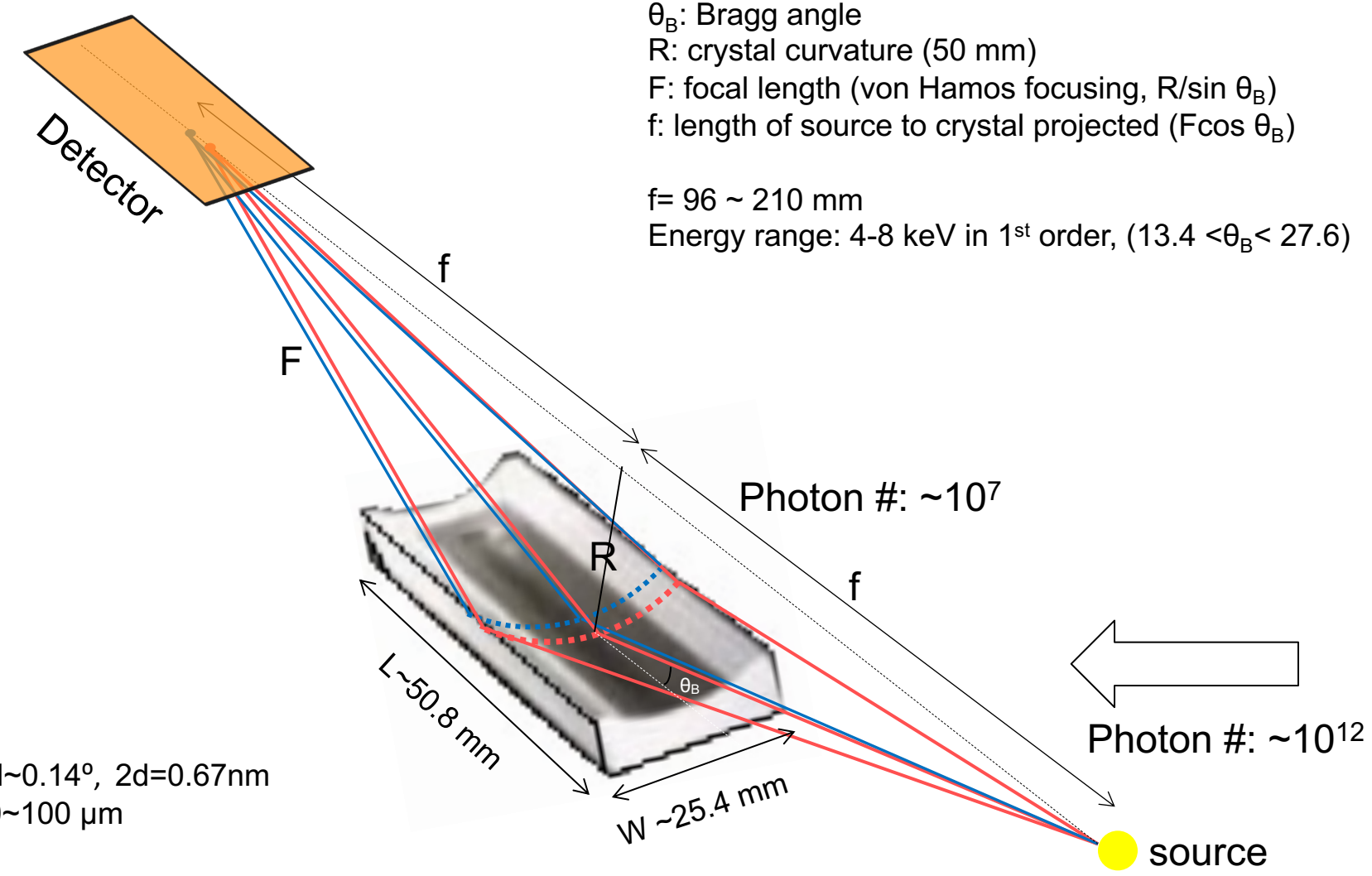
- New HAPG crystal in Von Hamos Geometry

Photon #: 100~1000



θ_B: Bragg angle
R: crystal curvature (50 mm)
F: focal length (von Hamos focusing, R/sin θ_B)
f: length of source to crystal projected (Fcos θ_B)

f= 96 ~ 210 mm
Energy range: 4-8 keV in 1st order, (13.4 <θ_B< 27.6)

Mosaic spread~0.14º, 2d=0.67nm
Thickness : 30~100 μm