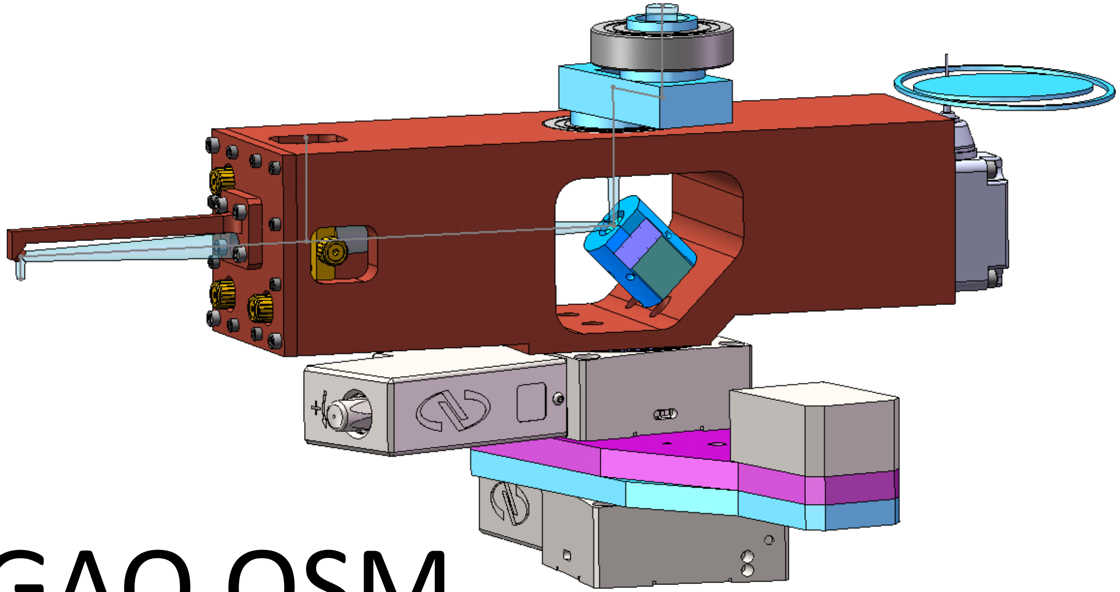

NGAO OSM

Design Study Update

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08/17/2009
Version 12

1. Conceptual design and operation

Three probes cover the entire Ø 120” (87.24 mm) Field of View.

Each probe is mounted on a 2 degrees of freedom articulated arm composed of a crank arm and a lever arm, driven by 2 corresponding rotation motors: The crank and lever motors. (See Fig. 2)

Any position in the OSM field of view can be acquired by calculating appropriate values for theta and phi, noting that two possible solutions could be found due to symmetry.

The crank motor is secured to the Sensor and rotates the crank arm, precisely about the rotation axis of the crank motor referred to as the theta axis. The lever arm motor provides the necessary second degree of freedom by rotating the lever arm and all associated optics, about the phi axis.

Each probes are a at a different distance from the Focal plane, 15mm apart, with the closest probe 5 mm upstream from the focal plane. This design allow each probe to freely roam the entire field without risk of colliding into an other probe. (See Fig. 1)

1.1 Basic Design requirements:

Mechanism Type: ϕ/θ

Patrolled Field: Ø 120” (87.24mm)

Focal Plane FoV : Ø 5” (3.635mm)

Acquisition accuracy: 40 mas (30µm)

Stability: 5 mas / 3600s (1 µm)

Position knowledge: < 1 µm (TBC)

Minimum Incremental motion: TBD

Operating Temperature: -10°C +/- 0.3

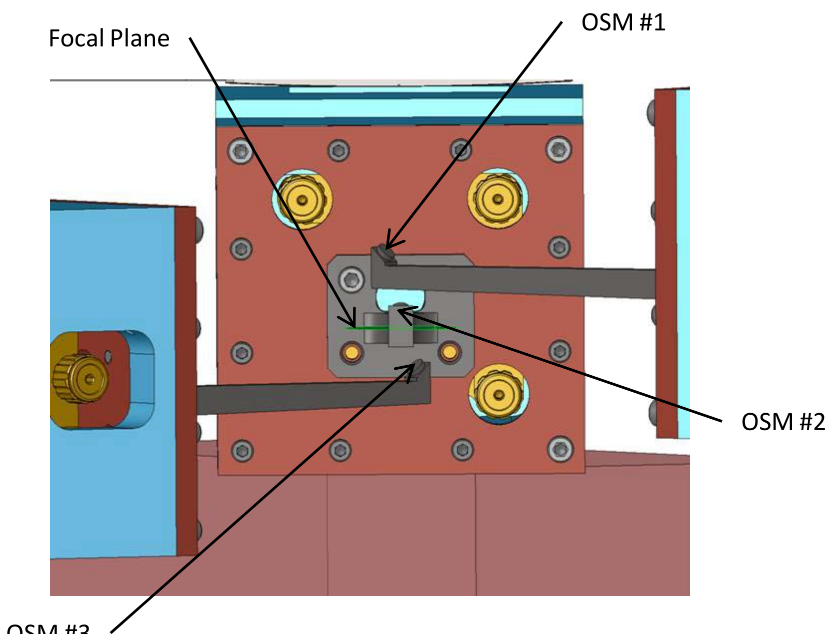


Fig. 1

1.2 Field of View:

The Field of View at the Focal Plane is Ø 5” (3.635mm)

The Field of View at the probe is defined by it’s distance from the Focal Plane / f# (See Fig. 2)

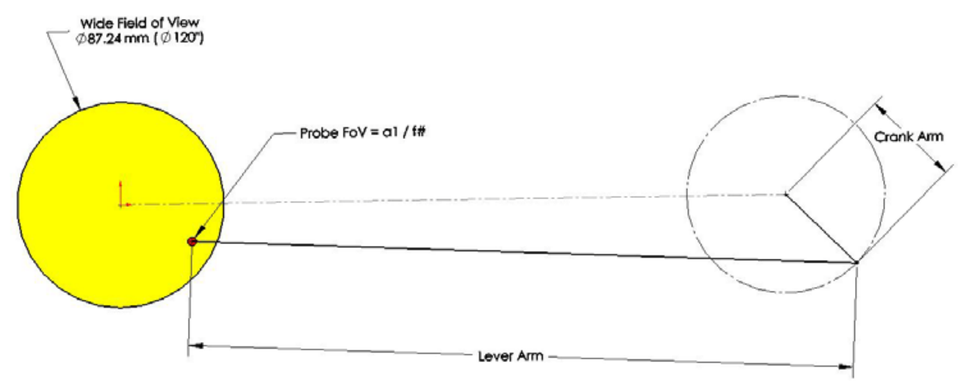


Fig. 2

2. Optical Equation

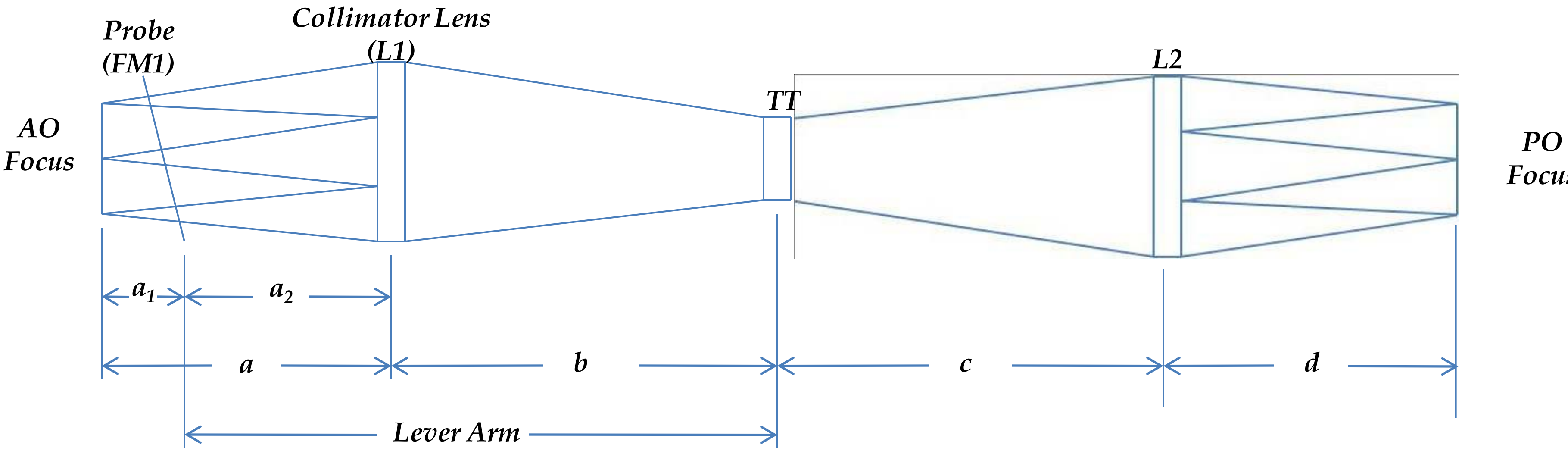


Fig. 3

Optical Layout (Fig. 3) is optimized when the following equations are verified:

2.1) $a = b = c = d$

2.2) $a + b = x\,(c + d)$

Keeping the AO Focus away from the Probe mirror (FM1) gives:

2.3) $a = a_1 + a_2$

Keeping each Lever arms on a different plane to avoid collision between each other gives a different value of a1 for each OSM

The Lever Arm Length previously determined gives:

2.4) Lever Arm length $= b + a_2$

Replacing 3.3 & 3.4 in 3.1 gives: $a = b \rightarrow a_1 + a_2 = \text{Lever Arm length} - a_2$

Solving for $a_2 \rightarrow 2a_2 = \text{Lever Arm length} - a_1 \rightarrow$ $\mathbf{a_2 = (\text{Lever Arm length} - a_1)/2}$

3. Dimensioning the Probe

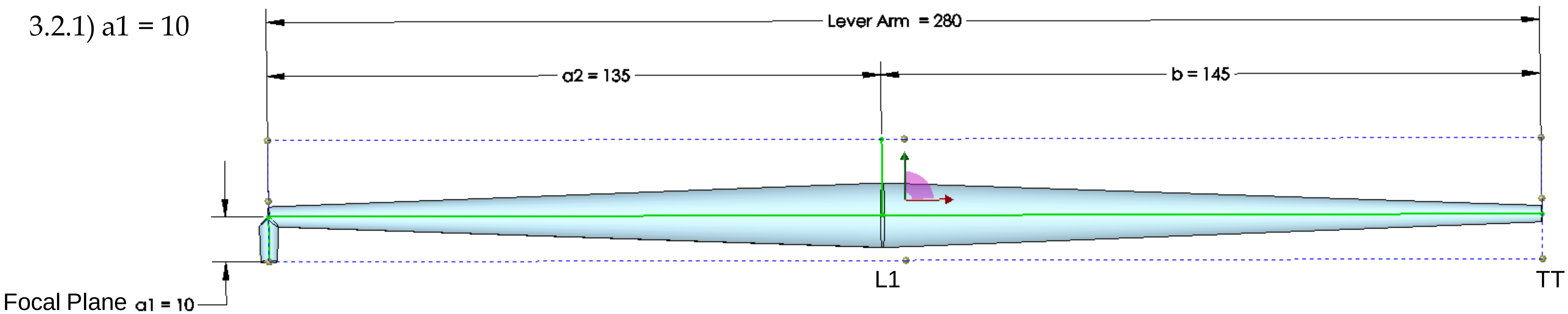
3.1) The Lens Holder size is driving a_2

3.2) Using a 280mm Lever Arm:

a1 = 10 mm for OSM #1 ➔ $10 + 2a_2 = 280$ ➔ $2a_2 = 280 - 10$ ➔ $a_2 = 135$
a1 = -5 mm for OSM #2 ➔ $-5 + 2a_2 = 280$ ➔ $2a_2 = 280 + 5$ ➔ $a_2 = 142.5$
a1 = -20 mm for OSM #3 ➔ $-20 + 2a_2 = 280$ ➔ $2a_2 = 280 + 20$ ➔ $a_2 = 150$

OSM#	a_1	a_2	$a = b = a_1 + a_2$	a+b
I	10	135	145	240
II	-5	142.5	137.5	275
III	-20	150	130	260

3.2.1) a1 = 10

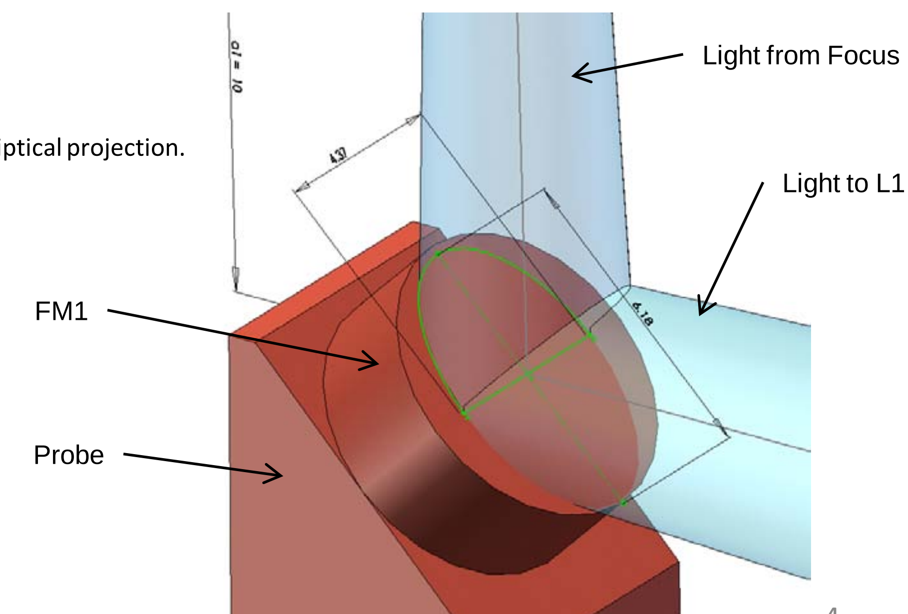


3.2.1.1) Probe FoV

The probe Fold Mirror intercept the light beam at a 45 degree angle creating an elliptical projection.

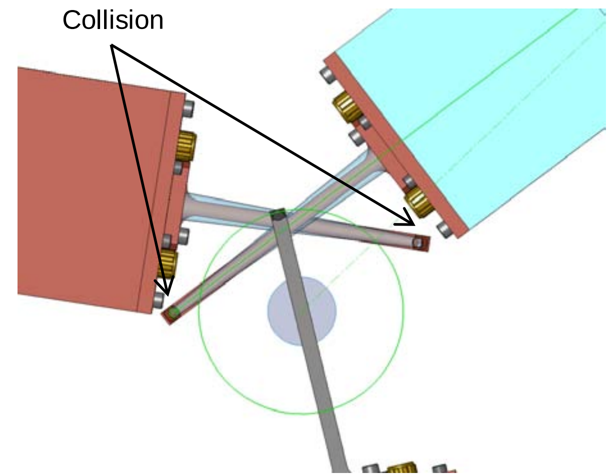
Ellipse Minor Diameter
d = d at Focus Plan + (a1 / f#)
= 5 X 0.727 + (10 / 13.66)
= 3.635 + 0.732
= 4.367 mm

Ellipse Major Diameter
D = d√2
= 4.367√2
= 6.175 mm

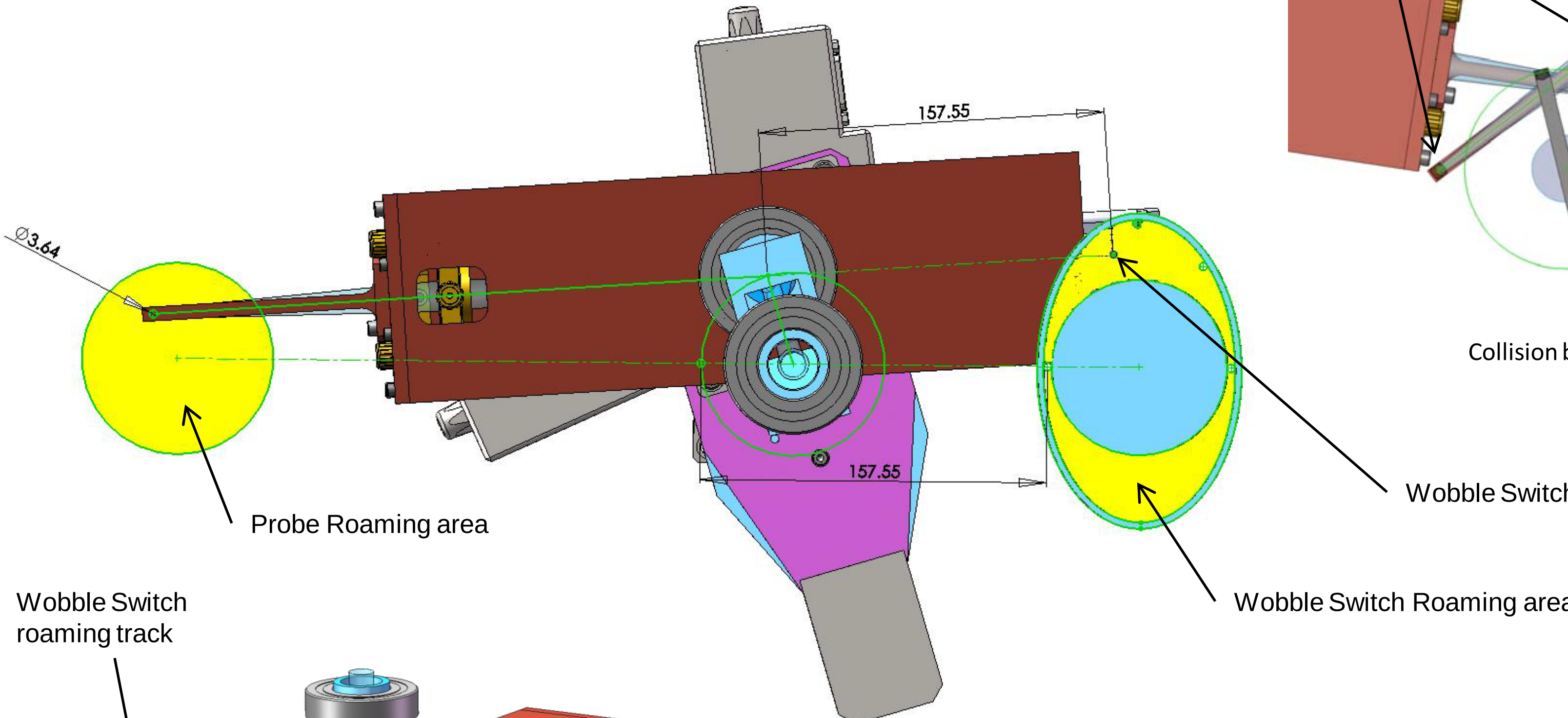


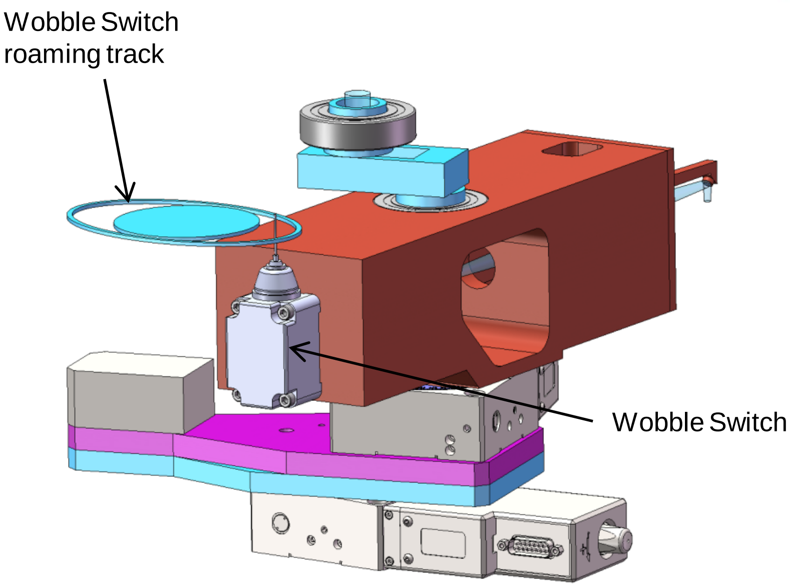
3.3) Probe Collision avoidance

Collision between probes and neighboring probe bodies due to a software or operator error is a major risk that is eliminated by the use of a limit switch (wobble switch) located into a track that reproduces the maximum expected probe roaming area.



Collision between probes



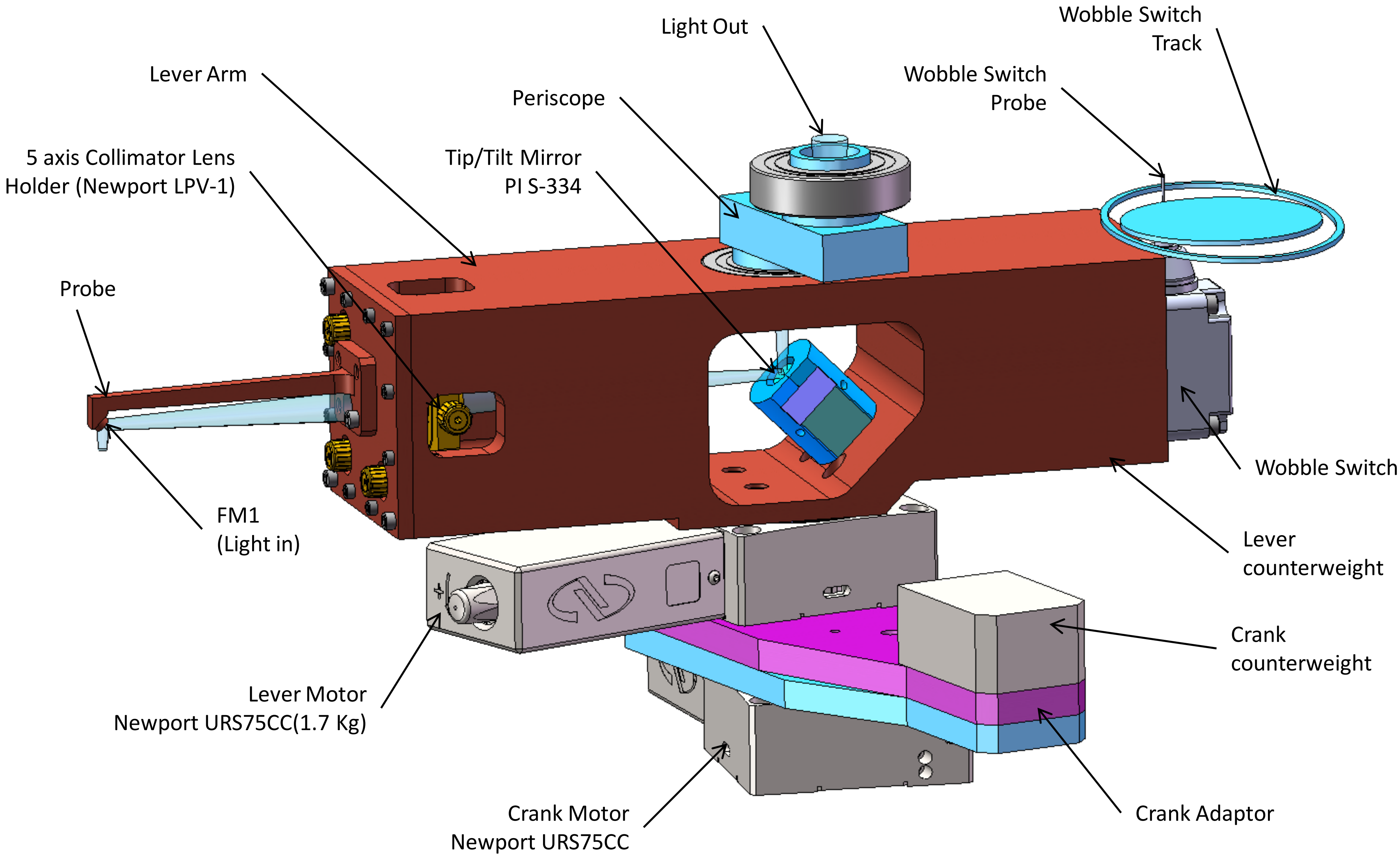


3.4 Position Accuracy

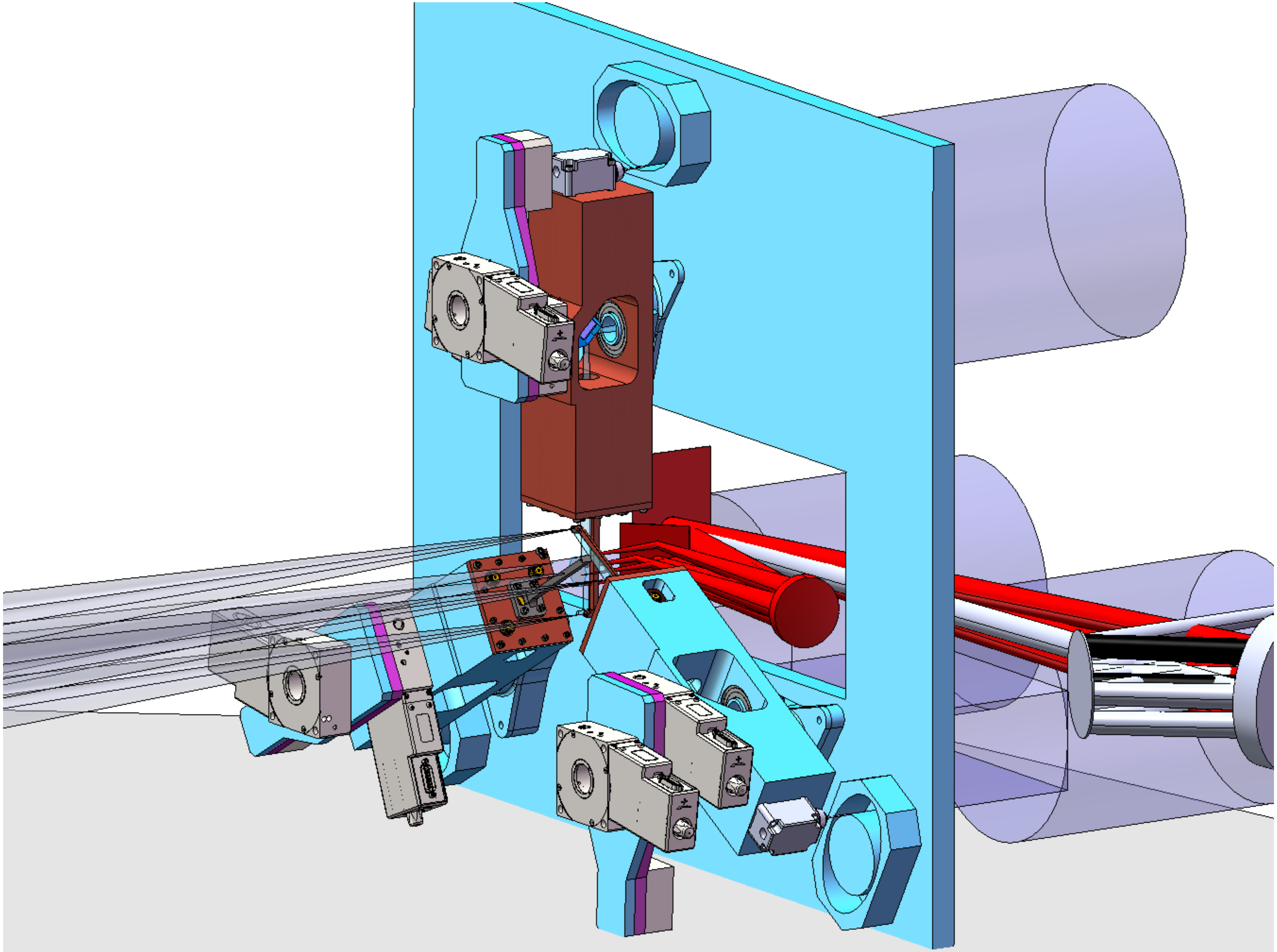
Probe Position within the field is measured using absolute encoders position. Total Position Accuracy of 30µm at the furthest position across the field requires a minimum crank rotation accuracy of:

$\sin \alpha = 30\mu m / (280mm + 41.8025\ mm) \rightarrow \sin \alpha = .03 / 321.8025 \rightarrow \alpha = 0.005° = .012\ \pi / 180 = .00021\ rad = 210\ \mu rad$

Design With Stages Upstream the light path



LOWFS OSM Assy with stages upstream



Remaining work to be done

-Analyze Tip/Tilt Mirror Vibrations and Impact on Probe stabilization.
- System rigidity Analysis

Questions:

-Probe position Accuracy: 40 (KAON 562) or 70 mas (Contour)
- Minimum Incremental motion ?
- Max Wobble?
- Position Stability (5 mas / 3600 s) TBC
- TT Requirements (Deflection, response, resolution,…)