FXI Collimating Mirror Hard Stop Design Proposal

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December 6th, 2017

U.S. DEPARTMENT OF ENERGY | Office of Science

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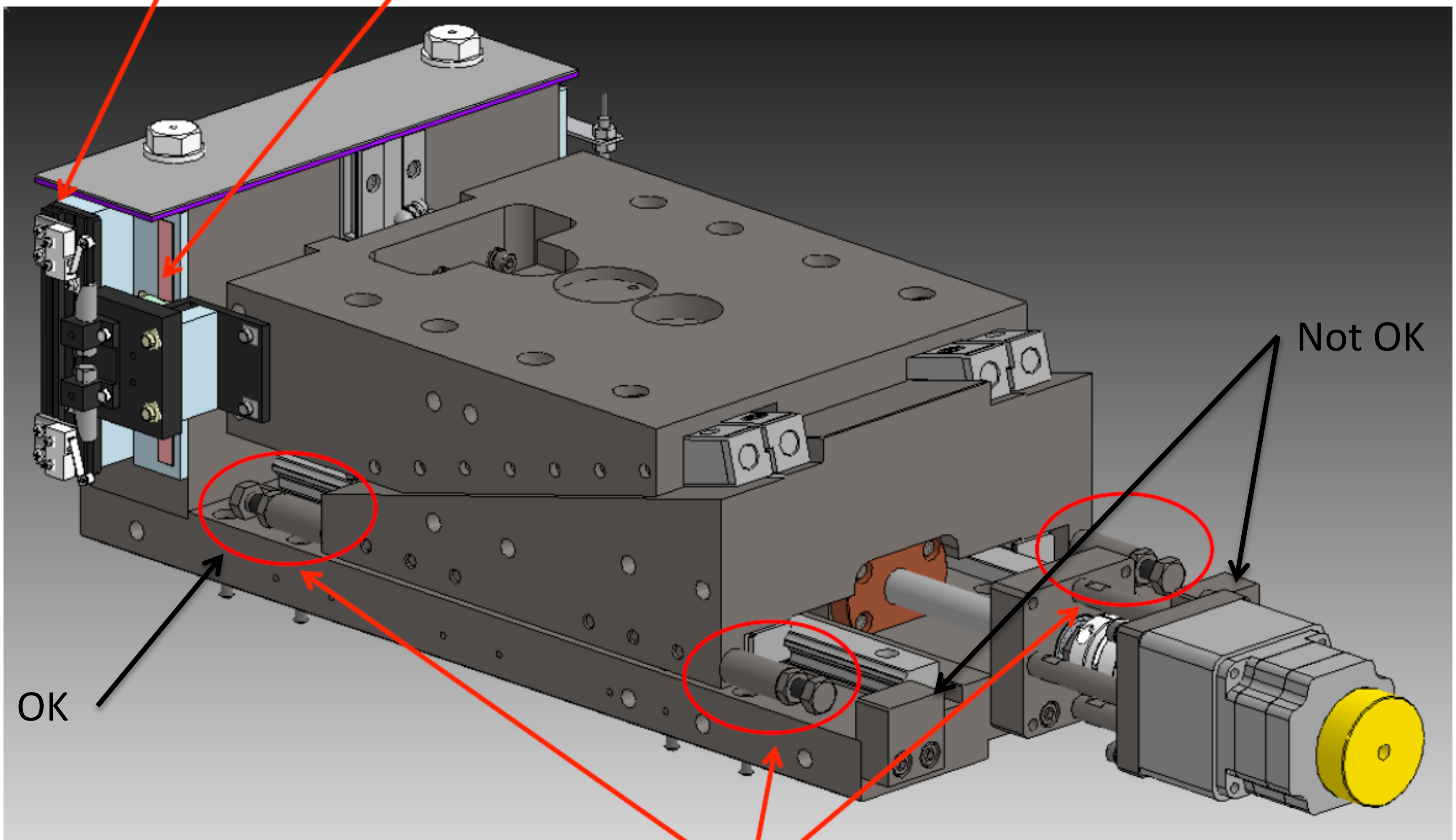
Outline

- Current hard stop design provided by Toyama
- Proposed design and its advantages over Toyama design
- Calculations
- Conclusions

Current Design of Hard Stops (Toyama)

Limit switches and absolute encoder



OK

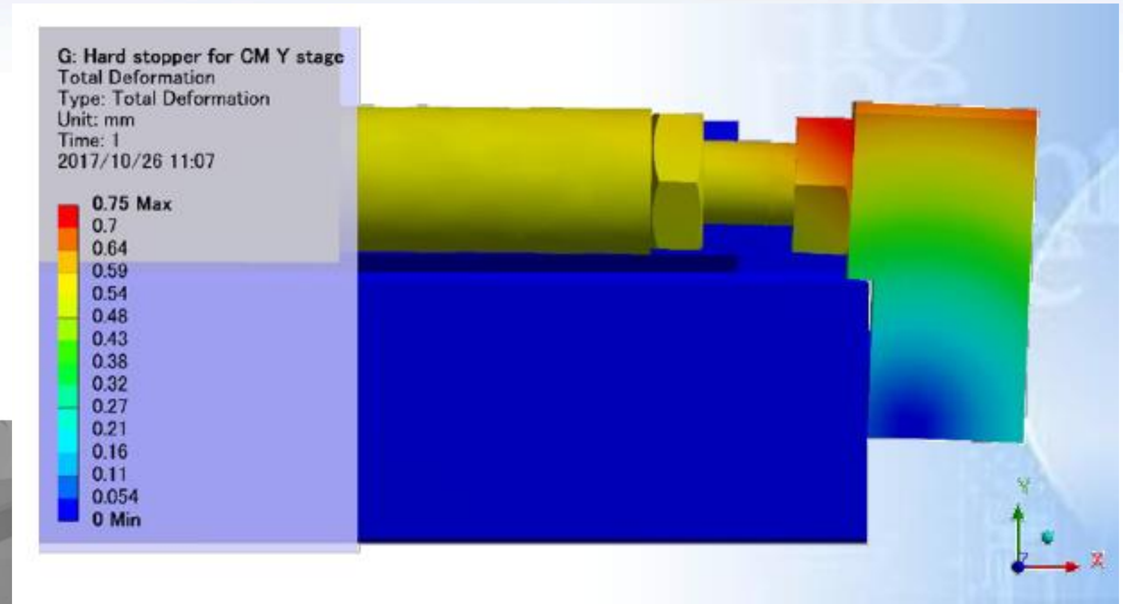
Not OK

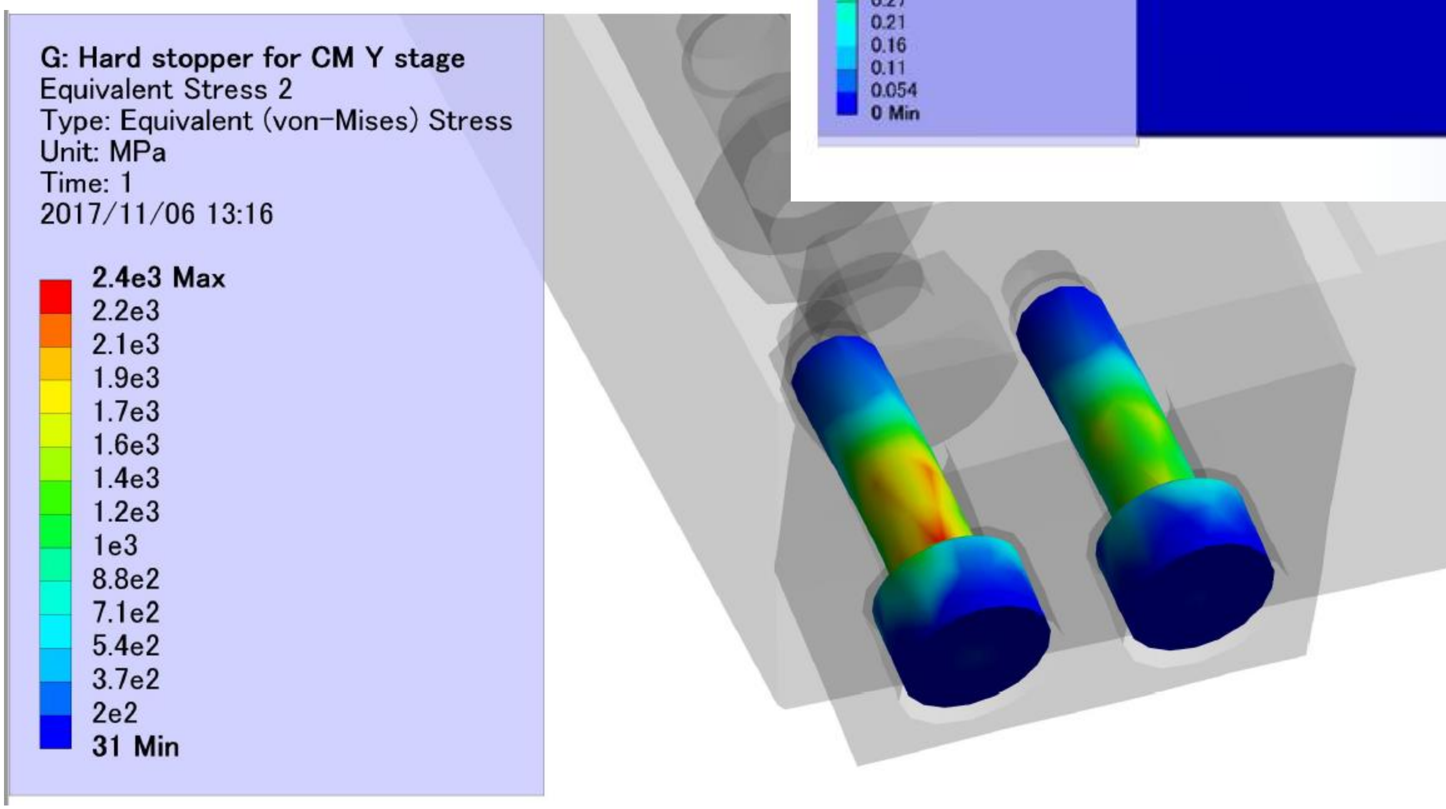
New design hard stops

Analysis of Current Hard Stop Design

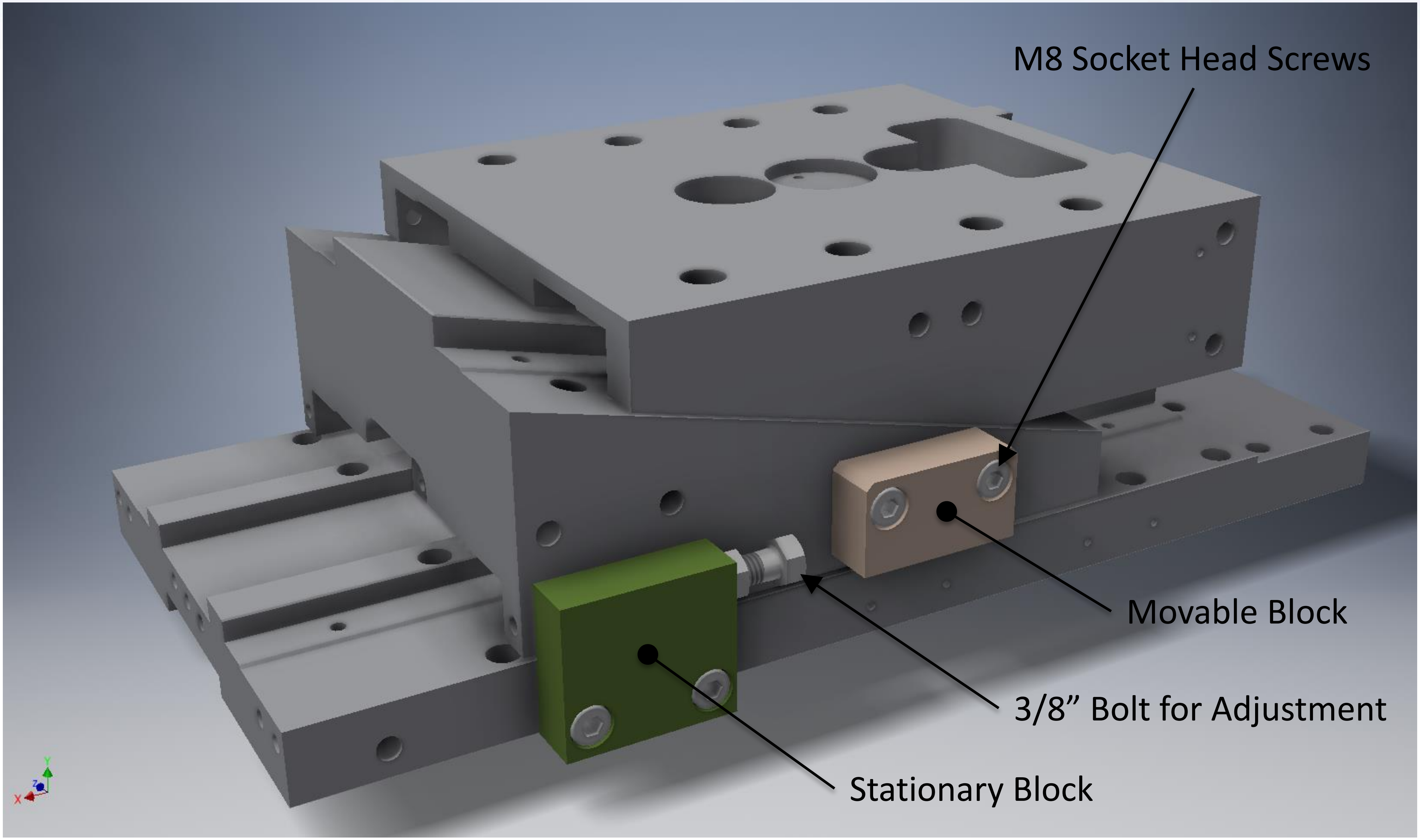
FEA provided by Toyama shows a failure of the M6 screws under loading.

Findings of 11/7/17 design review concurred.





Proposed Hard Stop Design for Collimating Mirror



Advantages of Proposed Design

- Uses larger M8 bolts that are in shear as opposed to M6 bolts which are in tension. M8 bolt in shear can withstand ~9,000 lbs.

- When properly torqued, M8 screws provide enough clamping force such that the resulting friction between the stop blocks and the stage can bear almost 4000 lbs.

- Utilizes existing holes in the stage to mount hard stop components, no need for in-situ drill and tapping of new holes.

- Components are simple and inexpensive to fabricate.

One disadvantage is that this design cannot easily be applied to both sides of the stage as the far side is not easily accessible.

Friction Calculation

Torque-Tension Relationship for Metric Fasteners

Nominal Dia. (mm)	Pitch	Class 4.6 Clamp Load (lbs)	Class 4.6 Tightening Torque Lubricated (ft-lbs)	Class 4.6 Tightening Torque Zinc Plated (ft-lbs)	Class 4.6 Tightening Torque Plain&Dry (ft-lbs)	Class 8.8 Clamp Load (lbs)	Class 8.8 Tightening Torque Lubricated (ft-lbs)	Class 8.8 Tightening Torque Zinc Plated (ft-lbs)	Class 8.8 Tightening Torque Plain&Dry (ft-lbs)	Class 10.9 Clamp Load (lbs)	Class 10.9 Tightening Torque Lubricated (ft-lbs)	Class 10.9 Tightening Torque Zinc Plated (ft-lbs)	Class 10.9 Tightening Torque Plain&Dry (ft-lbs)	Class 12.9 Clamp Load (lbs)	Class 12.9 Tightening Torque Lubricated (ft-lbs)	Class 12.9 Tightening Torque As-Received (ft-lbs)	Class 12.9 Tightening Torque Plain&Dry (ft-lbs)
4	0.7	333	0.7	0.7	0.9	858	1.7	1.9	2.3	1228	2.4	2.7	3.2	1436	2.8	3.2	3.8
5	0.8	538	1.3	1.5	1.8	1387	3.4	3.9	4.5	1985	4.9	5.5	6.5	2319	5.7	6.5	7.6
6	1	763	2.3	2.6	3.0	1968	5.8	6.6	7.7	2816	8.3	9.4	11.1	3291	9.7	11.0	13.0
7	1	1095	3.8	4.3	5.0	2822	9.7	11.0	13.0	4039	13.9	15.8	18.5	4720	16.3	18.4	21.7
8	1.25	1389	5.5	6.2	7.3	3580	14.1	16.0	18.8	5123	20.2	22.9	26.9	5987	23.6	26.7	31.4
10	1.5	2200	10.8	12.3	14.4	5671	27.9	31.6	37.2	8115	39.9	45.2	53.2	9484	46.7	52.9	62.2

Clamp Load for a high quality M8x1.25 bolt is ~**6000 lbs.**
Coefficient of Static Friction (steel on steel) is **0.31**

2 Bolts x 6000 lbs x .31 = **3720 lbs**

If stage components are stainless steel, the tightening torque will be reduced so as not to strip the threaded holes. Clamping force will be reduce accordingly.

Conclusions

- The proposed hard stop design is more robust than the current design provided by Toyama and should be sufficient to stop all motion of the stage.

- The components for this hard stop design are inexpensive to fabricate and simple to install, requiring no in-situ drilling/tapping.

- This hard stop design cannot easily be installed on the far side of the stage due to limited access. If installed on the near side as proposed, the hard stop would bear the entire load of the stage.