dRICH Inner Elements

Alex Eslinger (JLab)

2/19/2025

Introduction

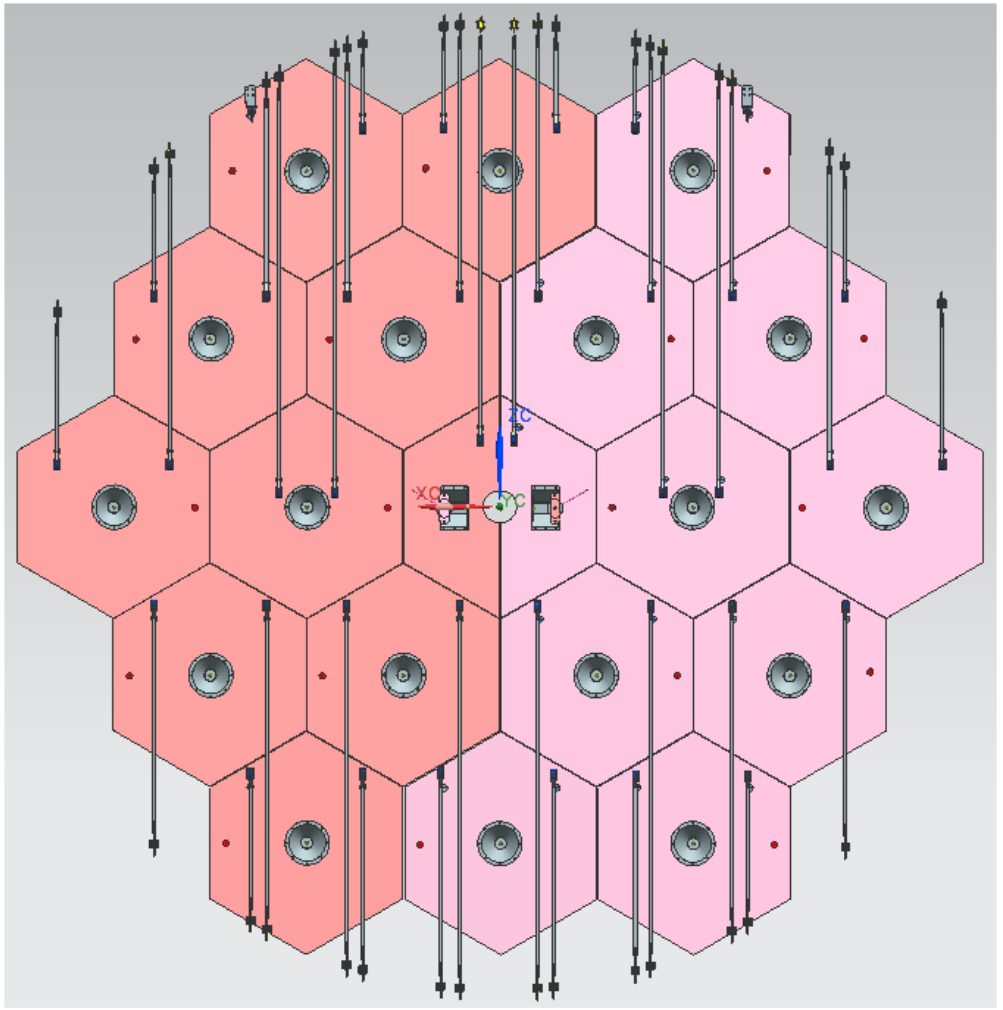
- My Current Role
  - Tasked with designing mirror and aerogel fixturing within the dRICH
    - Initially for the prototype & eventually for the final design
  - I work on the pfRICH as a lead engineer
    - Some parallels in work, such as the aerogel design
  - I also work with BNL engineers on integration concepts for the overall ePIC detector.

Motivations / Design Priority

- Several deadlines/milestones are upcoming
  1. The manufacturer for the dRICH vessel needs to know where to add inserts into the prototype to support the mirror support fixtures
  2. PDR for the PID Review on 1 & 2 April 2025
  3. The 1/6th section of a full-scale prototype beam test ~Summer 2025
- Design Priority:
  1. Prototype Mirror Fixture Concept (Complete)
  2. Prototype Mirror Fixture Design (Current Work) ***This Discussion***
  3. Prototype Aerogel Fixture Concept (Current Work)
  4. Prototype Aerogel Fixture Design (Future Work)
  5. Final Design for Aerogel system (Future Work)
  6. Final Design for Mirror Fixture and Adjustment Mechanisms (Future Work)

Prototype Mirror Concept

- Largely based on NA62 RICH detector, namely:
  - A central pin that allows for a ball-type joint for the mirror to pivot on
  - Two ribbons that run vertically two separate piezoelectric actuators which tie into the mirror at 45 degrees from the central pivot
  - An “anti-rotation” ribbon which precludes the mirror from rotating around the central pivot
- These mechanisms allow the mirror to perform minor tip-tilt adjustments in situ with the perimeter-connected piezo actuators

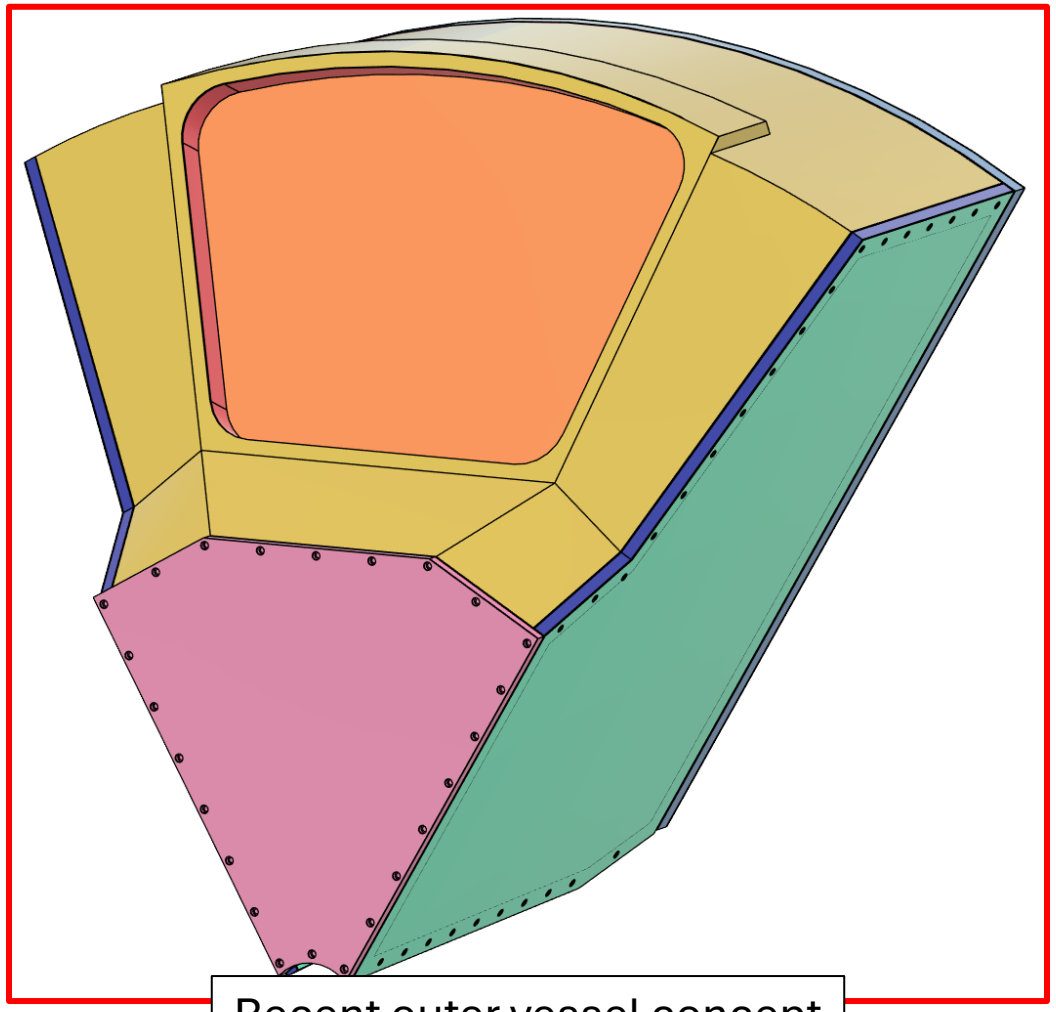


Retrieved from: *Mirror system of the RICH detector of the NA62 experiment*
https://iopscience.iop.org/article/10.1088/1748-0221/12/12/P12017

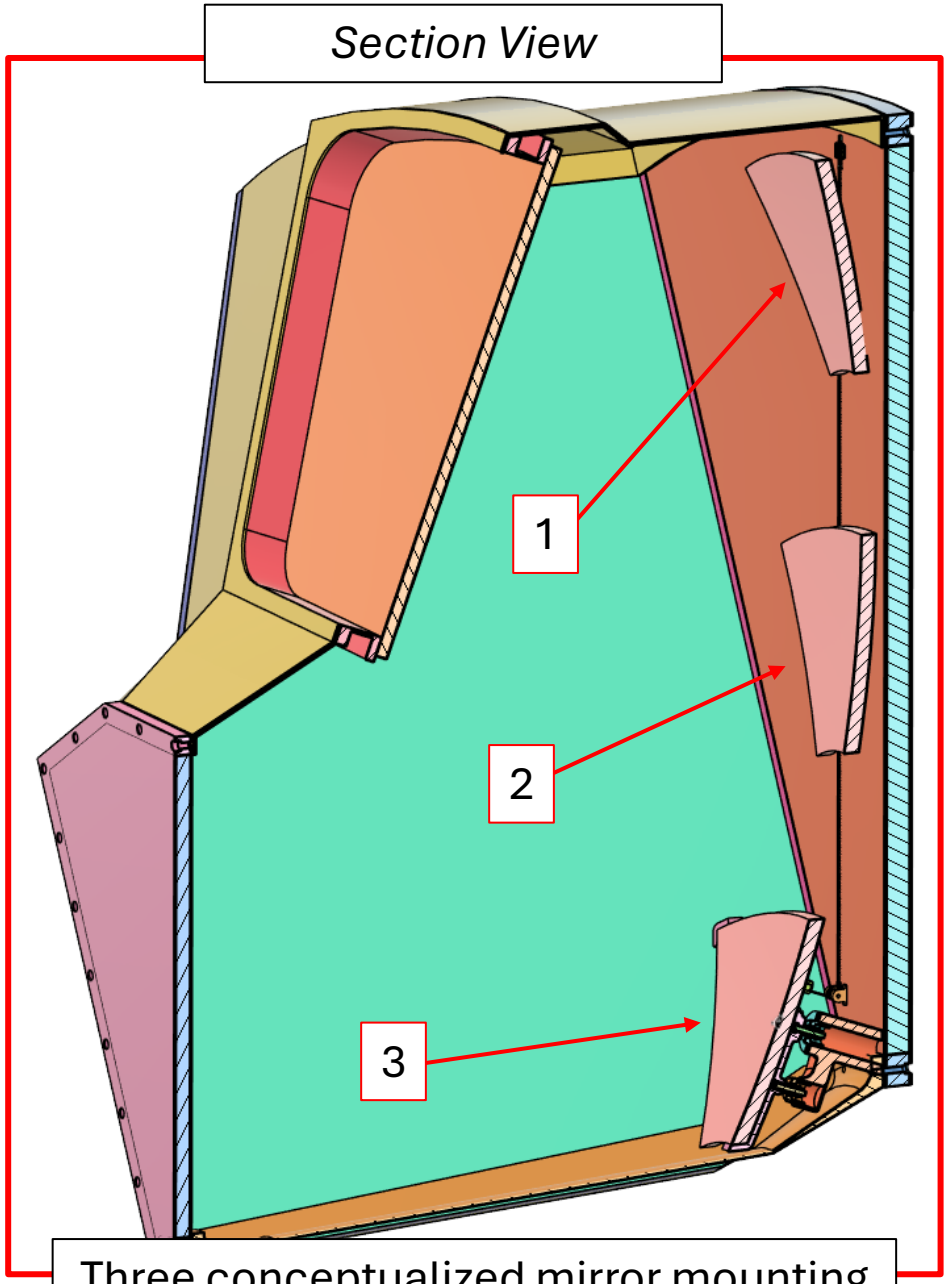
Prototype Mirror Concept Modifications & Goals

- We don’t intend to make permanent modifications to the mirror unless by necessity
  - The design has been made modular so that one “mirror holder” can be used in all three proposed positions
- The NA62 mirrors were very heavy and utilized gravity to keep tension on the ribbons that lead to the piezo actuators
  - dRICH prototype sample from CMA weighs ~500g
  - Intent is to use a spring instead of gravity
- The anti-rotation ribbons run the full length of the backplane
  - We can use a more compact mechanism to ensure our modular frame can be reused
- We intend to use the same piezo actuators and have different lengths of ribbons/belts to reduce the mounting varieties (for the prototype)
- Utilize as many off-the-shelf parts as possible to minimize engineering time, when possible

Prototype Mirror Design

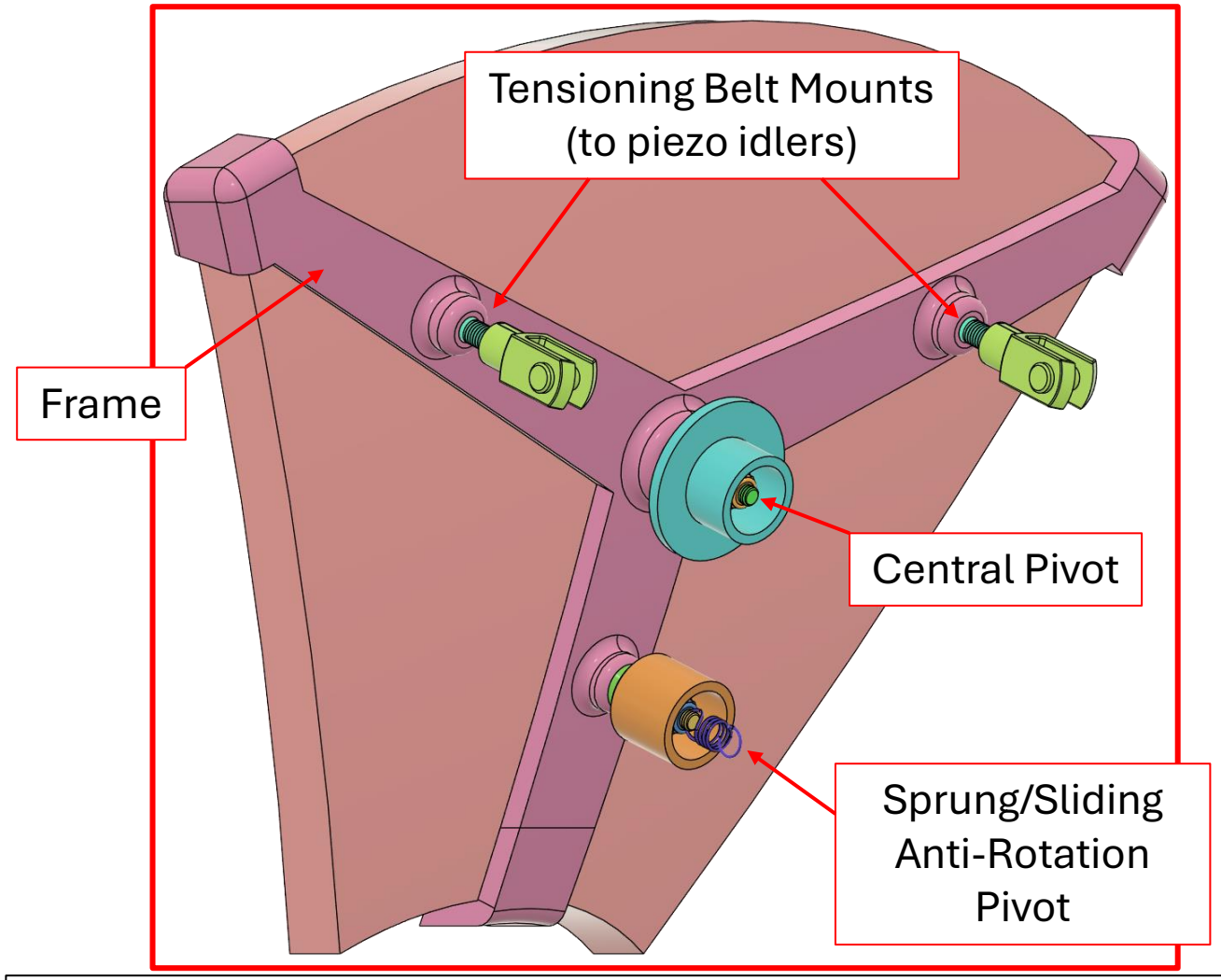


Recent outer vessel concept (Alessandro)



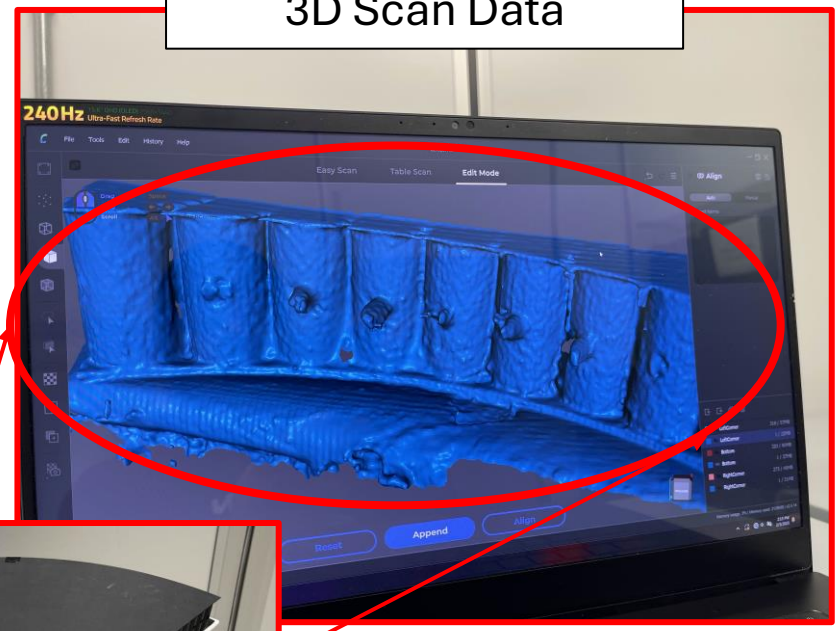
Three conceptualized mirror mounting locations for the beam test

Prototype Mirror Design



Modular Mirror Holder
(Everything pictured should be reused in all mirror positions)

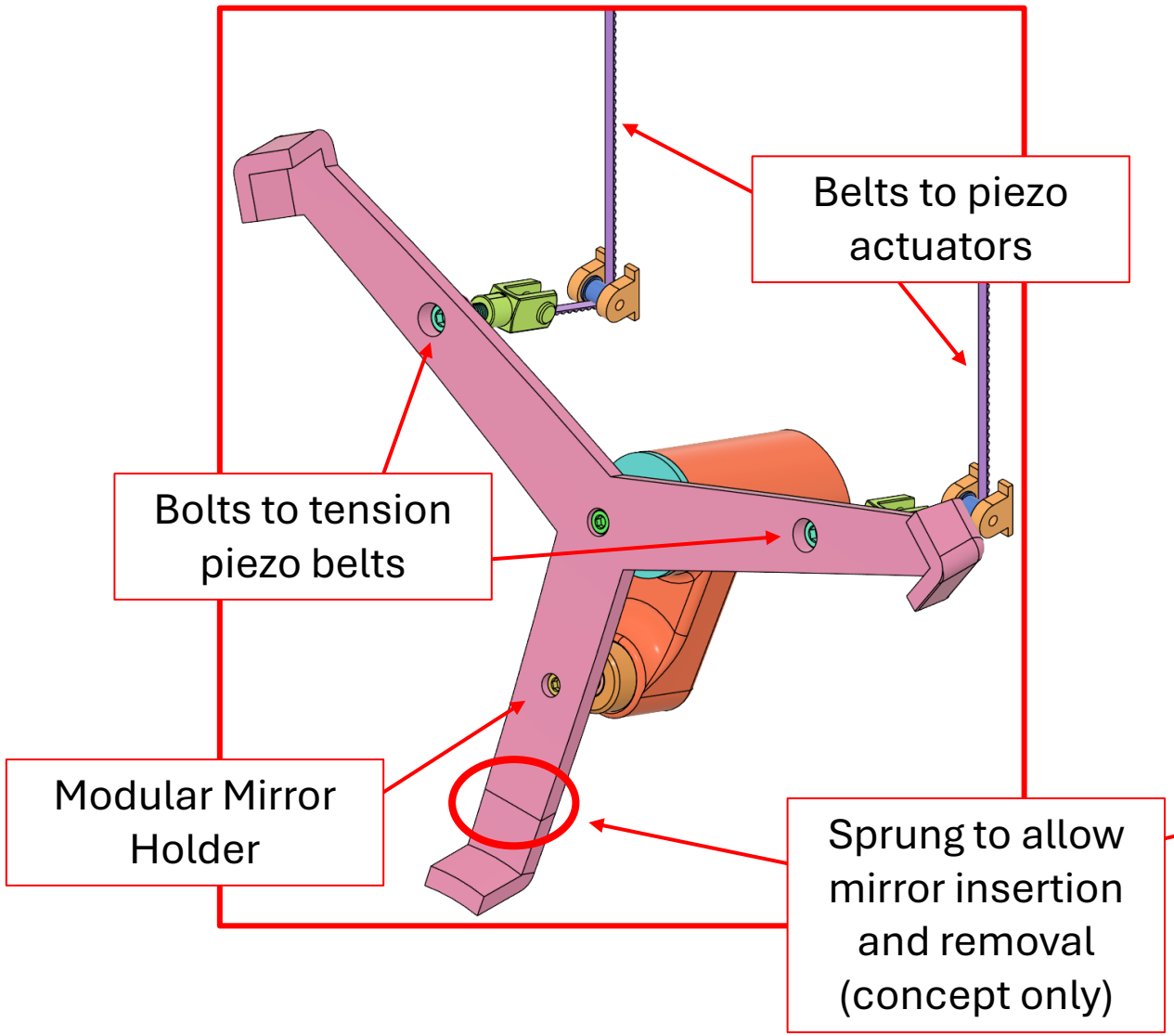
3D Scan Data

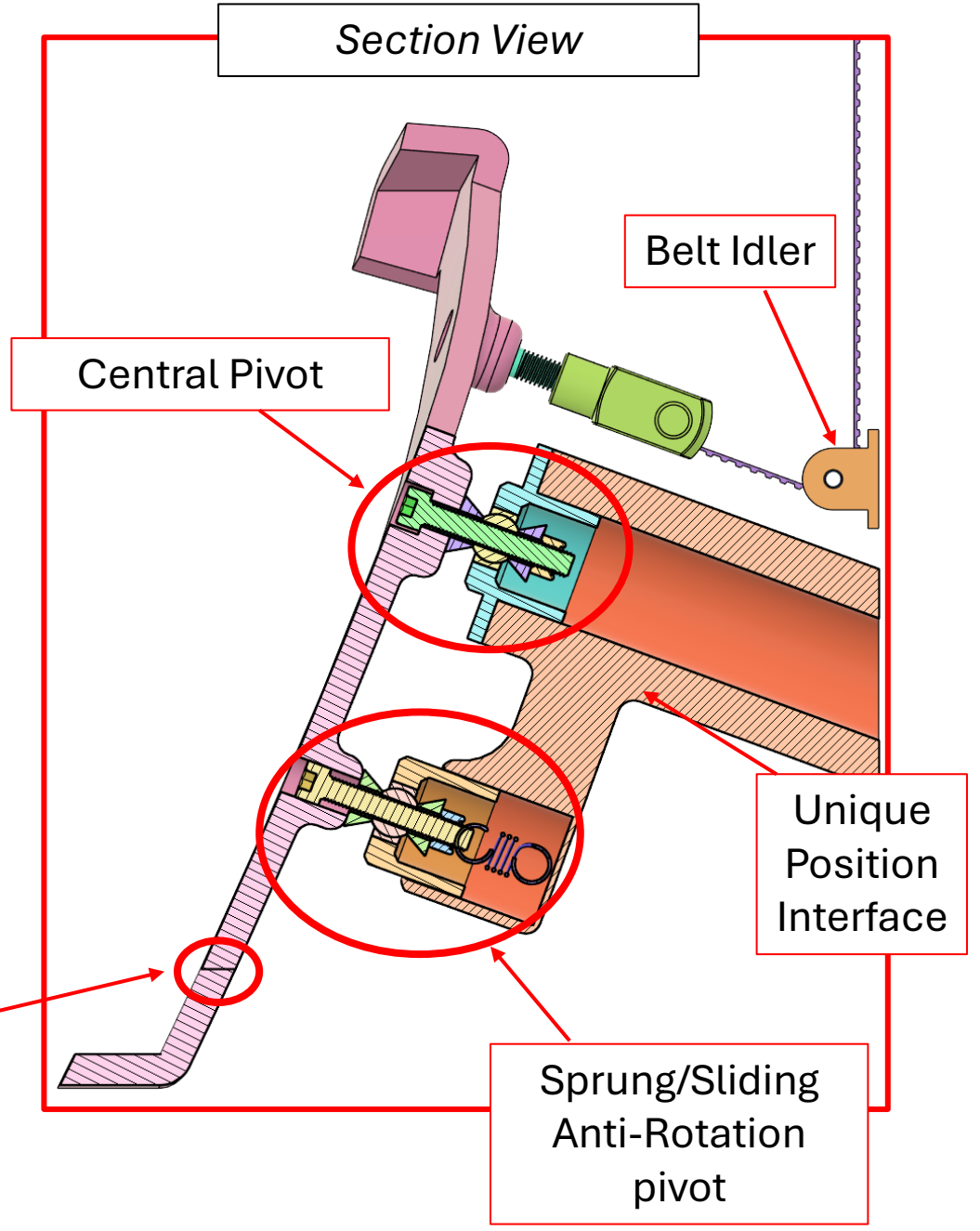


3D Scanning

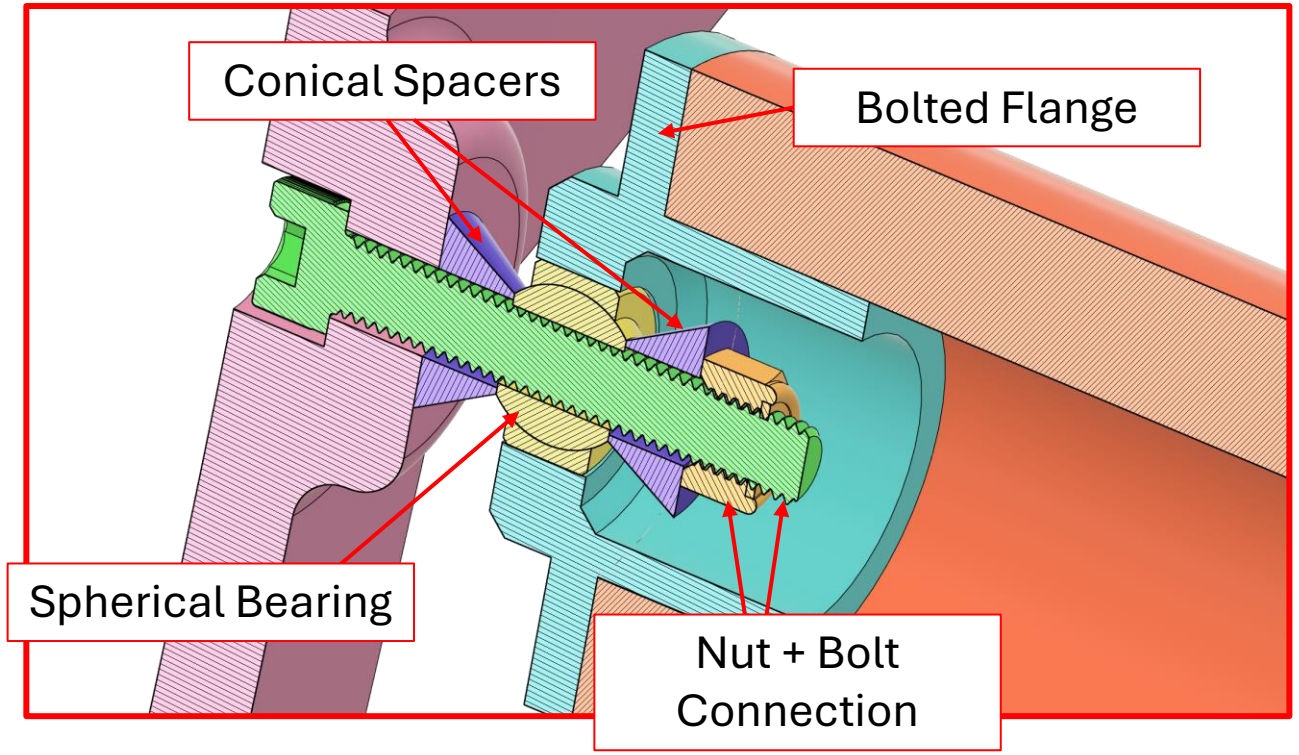
Took my personal (hobby-grade) 3D scanner and captured the features on the actual mirror that could be utilized for the modular mirror holder. I will utilize this information downstream in the design

Prototype Mirror Design

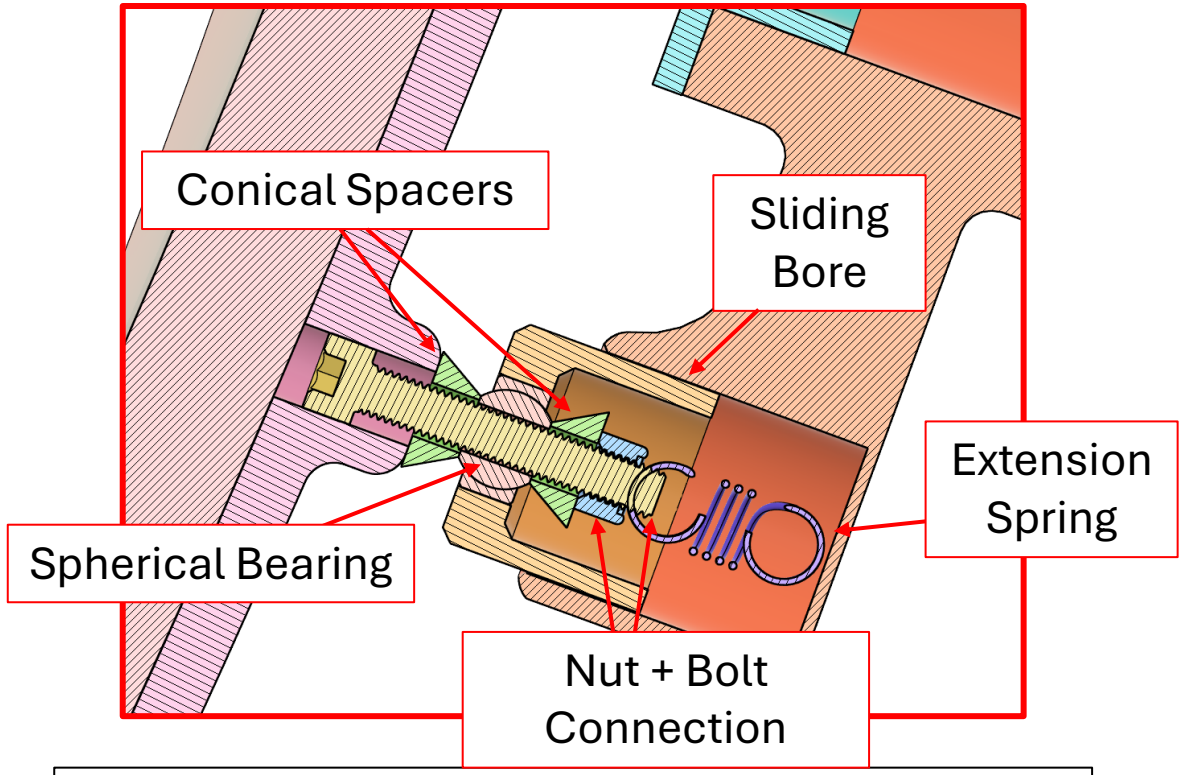




Prototype Mirror Design



Central Pivot

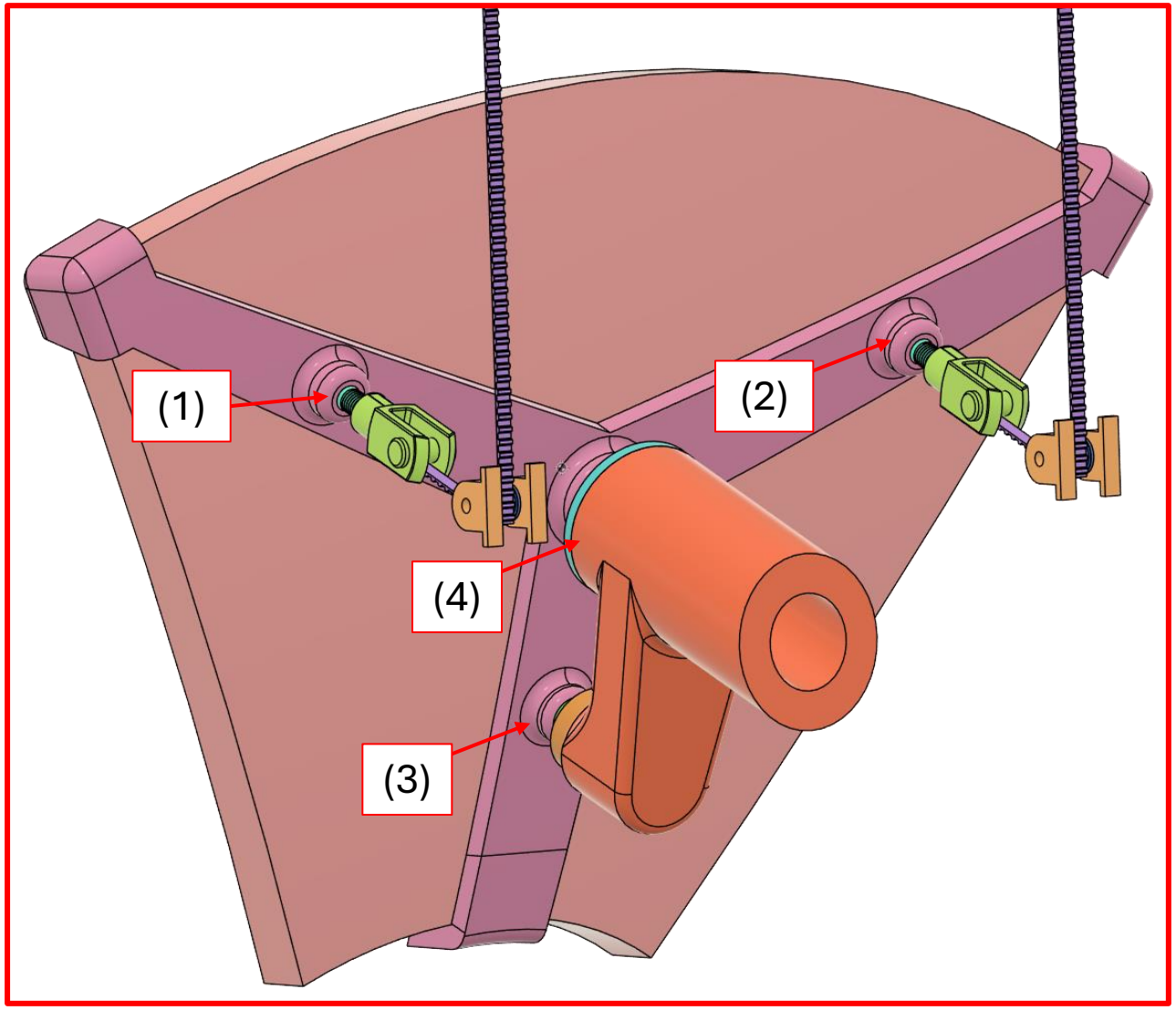


Sprung / Sliding Anti-Rotation Pivot

Prototype Mirror Design

Proposed Kinematics:

1. In a neutral state, the tension in the system is adjusted by tightening bolts to create equal tension at (1) and (2).
    - Secondarily, the spring located in the Sprung/Sliding joint at (3), maintains constant tension against the piezo belts
2. To tip the mirror up and down, both piezo belts are released or tensioned by the piezo actuators
    - The spherical bearing at (4) accommodates this movement
    - The sliding joint and the spherical bearing at (3) accommodate this movement
3. To tilt the mirror side to side, one piezo actuator is relaxed, while the other is tensioned
    - The spherical bearing at (4) accommodates this movement
    - The spherical bearing at (3) accommodates this movement, but does not allow the mirror to rotate about the axis created at (4)



Conclusion/Challenges

- **Work in-progress!** Everything shown is still conceptual and has only been through a few iterations
- A simple prototype may be used to verify the kinematics concept
- Several interferences still exist with the vessel which will be accommodated in a following design iteration
- The middle mirror position may mean rework or optimization for the system or a repositioning, if necessary (due to space constraints)
- The final design will utilize concepts from this design, but will have the additional challenge of tiling the mirrors

Questions?