Argonne NATIONAL LABORATORY

APS - TWG March 2013

Laser-Based Beamline Alignment Tool

21-Mar-2013

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U.S. DEPARTMENT OF ENERGY
Office of Science

APS - TWG March 2013: Laser-Based Beamline Alignment Tool

- **Need / Issue:**
  - To align x-ray optical components and samples to the x-ray beam path while system is under beamline vacuum and independent of x-ray beam to increase beam time efficiency

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- **Current process**
  - **Hands-on work only possible without x-rays being present**
  - **Either, use an iterated "burn paper" process to locate x-ray beam in a particular place for each component to be aligned**
  - **Or, watch x-rays on fluorescent screen under remote control of actuators for the device to be aligned**
  - **Either way, x-rays are required, i.e., valuable beamtime is wasted on alignment**

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- **Proposed process**
  - **Alignment tool that brings a laser beam to propagate exactly along the x-ray beam path**

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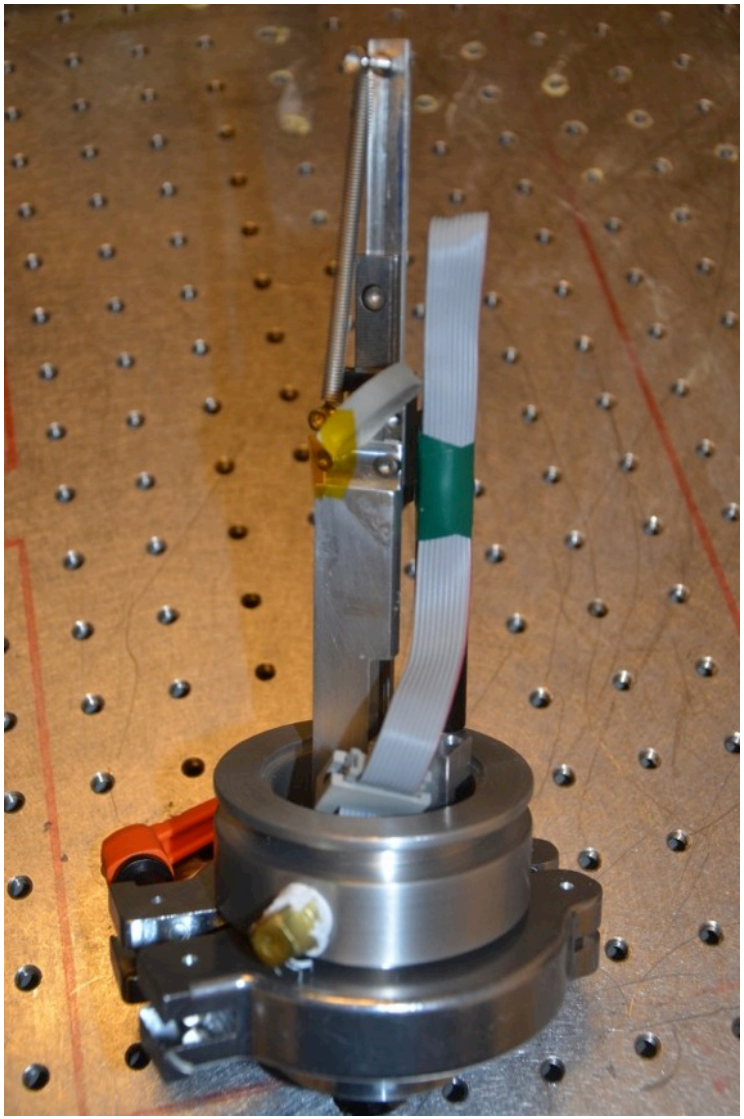

- A commissioned prototype was developed in 2012 by Bernhard Adams
- The device is designed to mount on one flange, for ease of extracting from beampipe for servicing and/or calibration
- However, functional issues warranted additional development to increase the stability of the system

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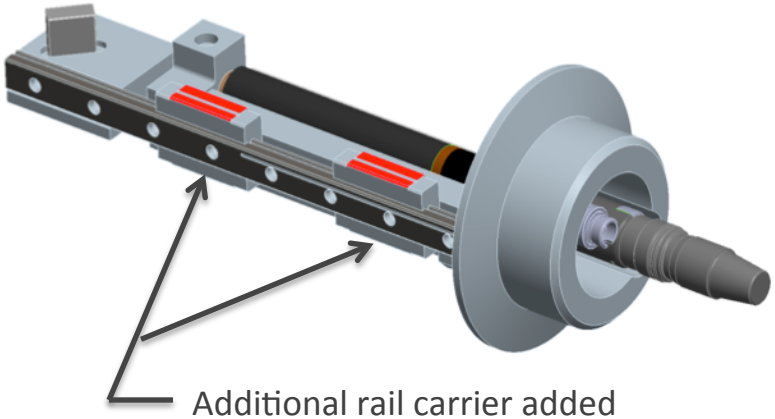
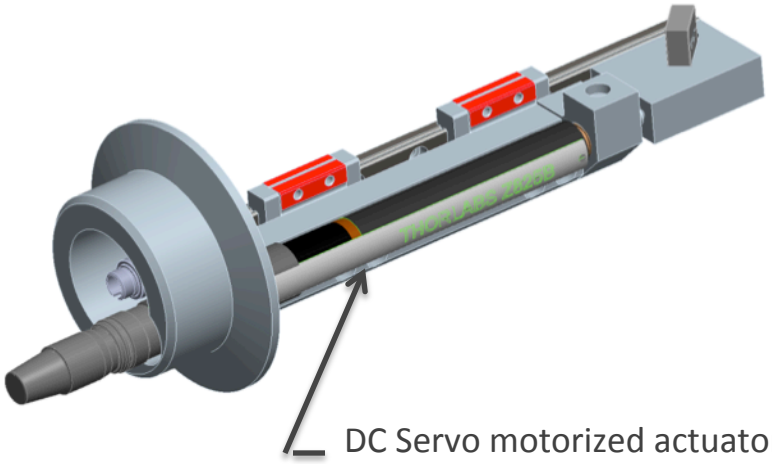


Additional rail carrier added



DC Servo motorized actuator
Driven by motor driver by B. Adams

Transverse Assembly retracted / Laser OFF

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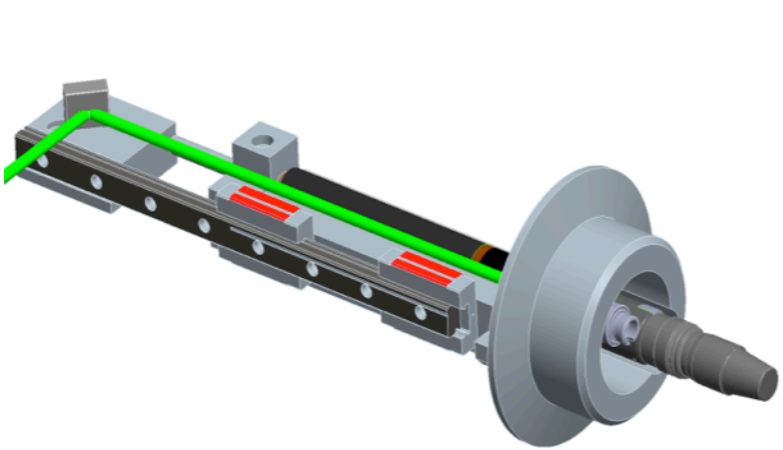

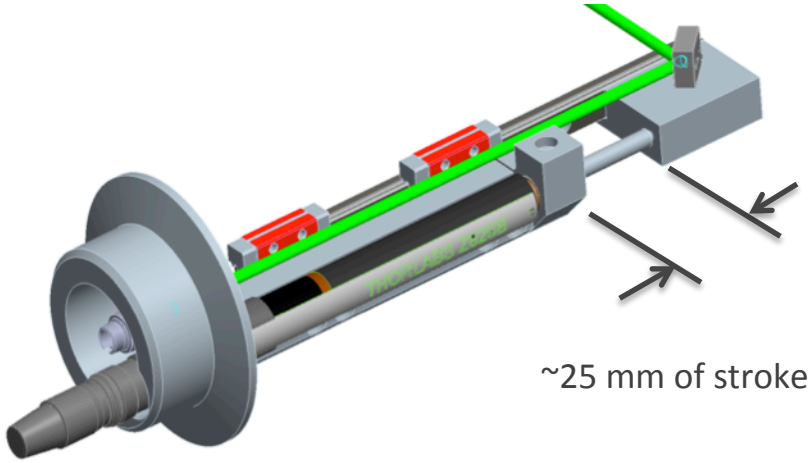

Transverse Assembly extended / Laser ON

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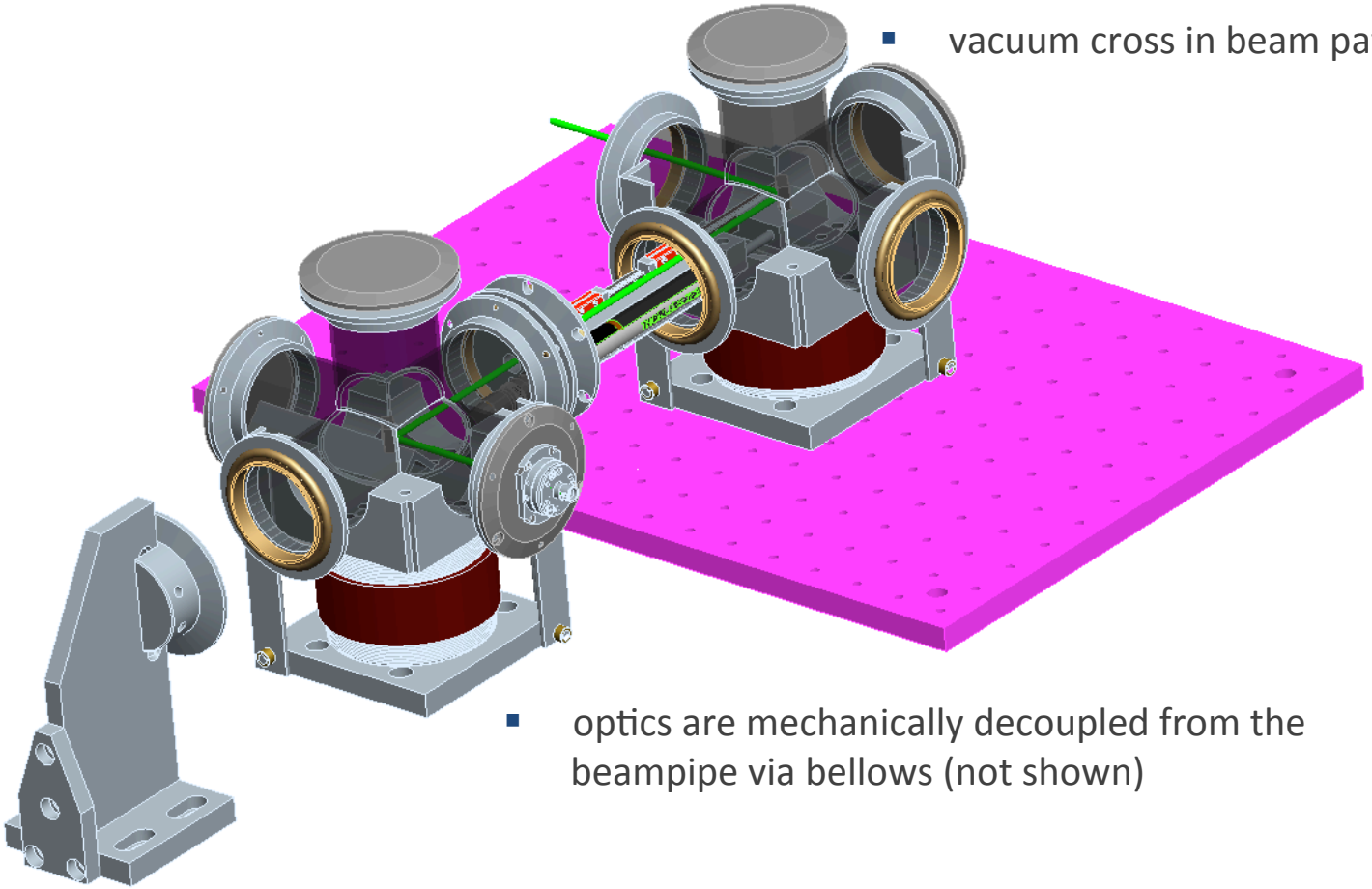

- vacuum cross in beam path
- optics are mechanically decoupled from the beampipe via bellows (not shown)
- endpiece to react to vacuum forces

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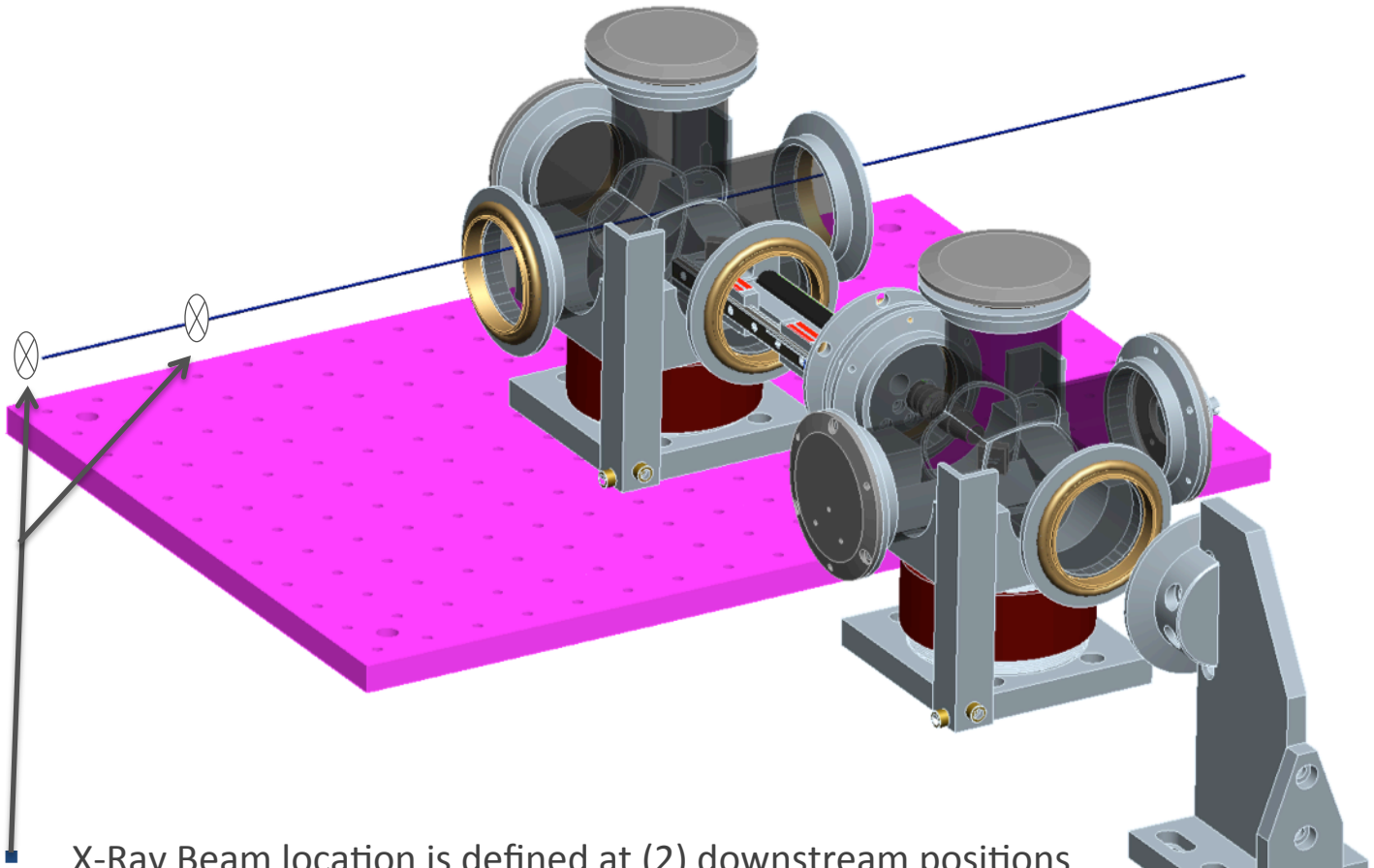

X-Ray Beam location is defined at (2) downstream positions at some distance in the region of optical placement

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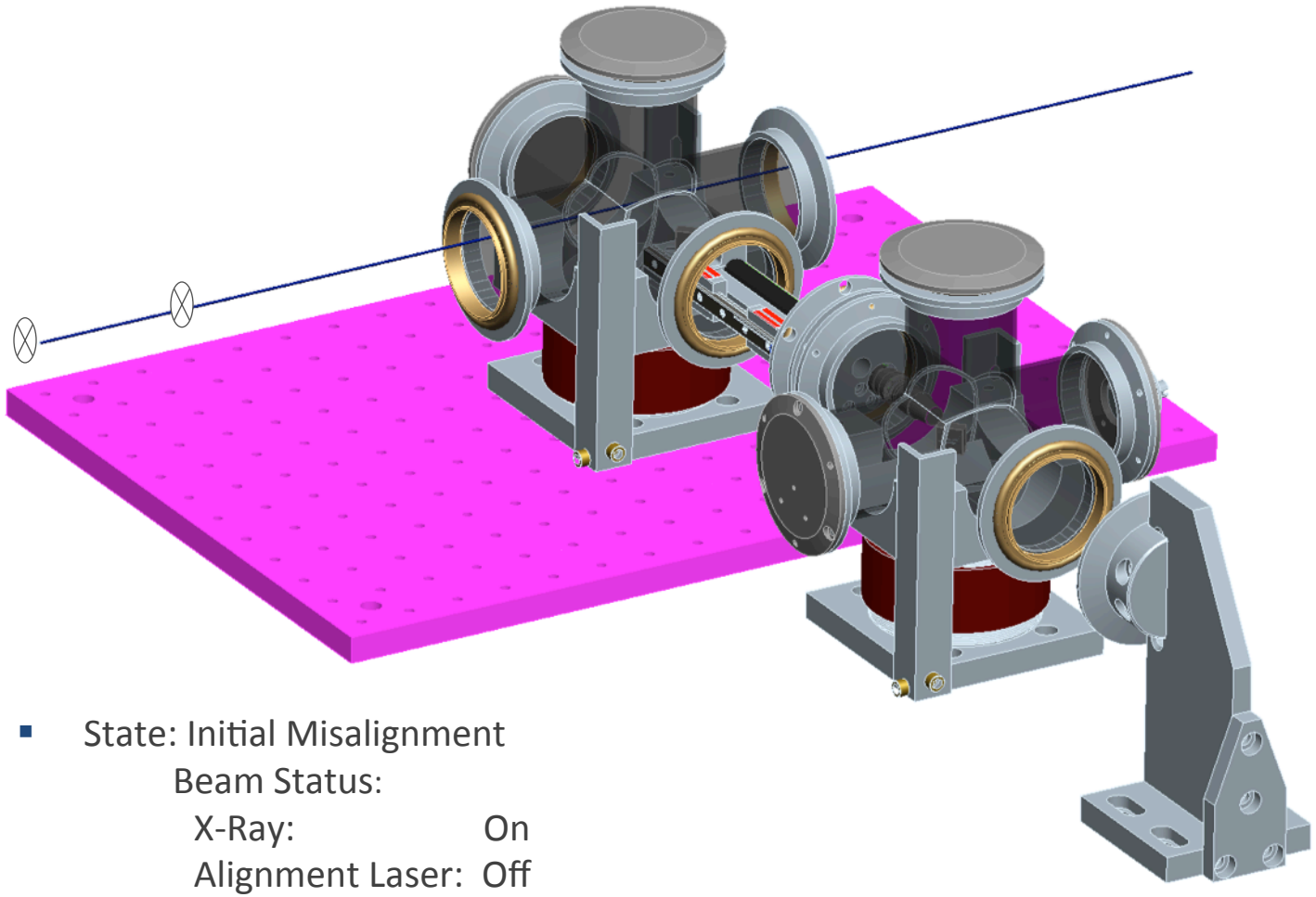

- State: Initial Misalignment

  Beam Status:

  X-Ray: On

  Alignment Laser: Off

  Transverse Assembly: retracted

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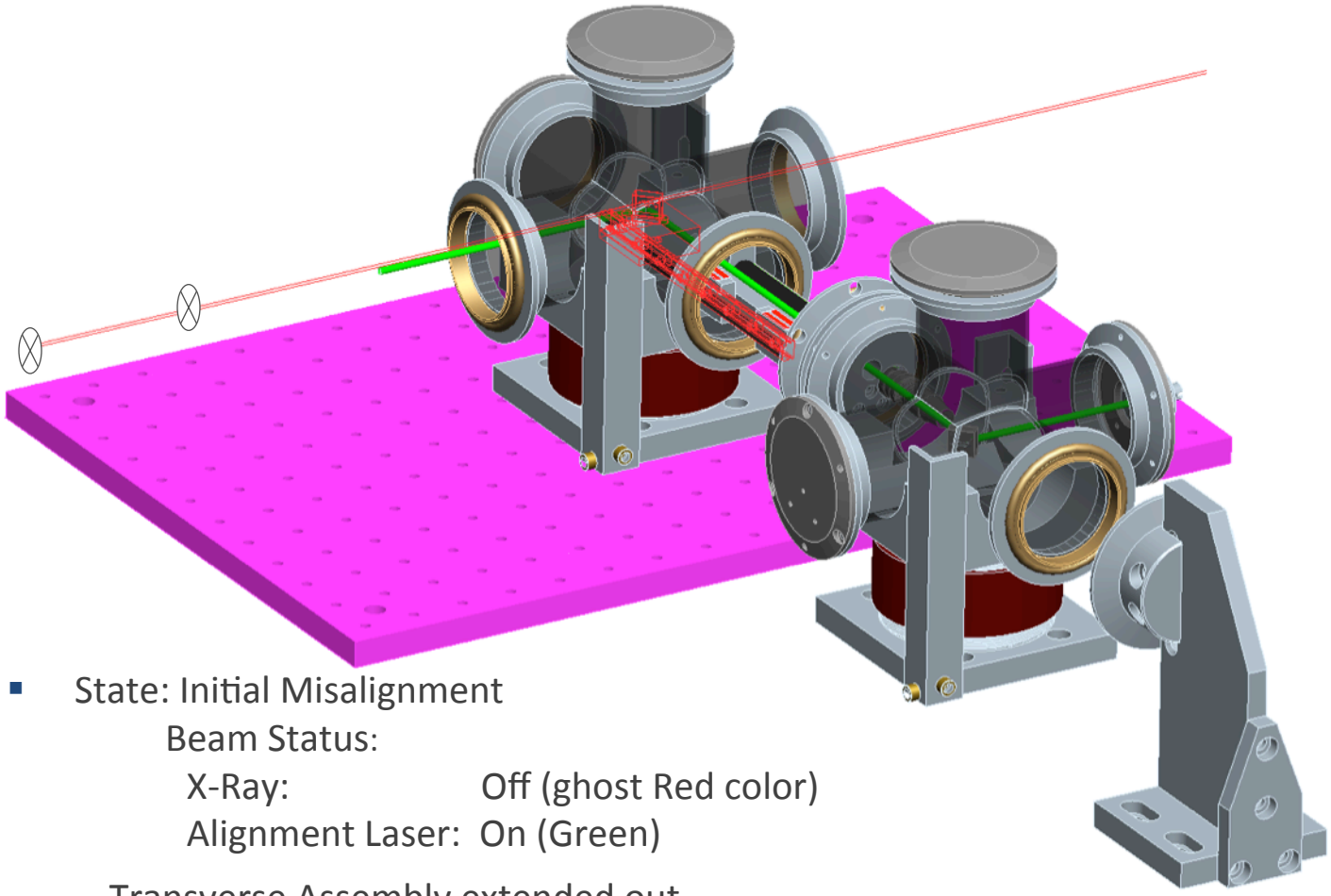

- State: Initial Misalignment

  Beam Status:

  X-Ray: Off (ghost Red color)

  Alignment Laser: On (Green)

  Transverse Assembly extended out

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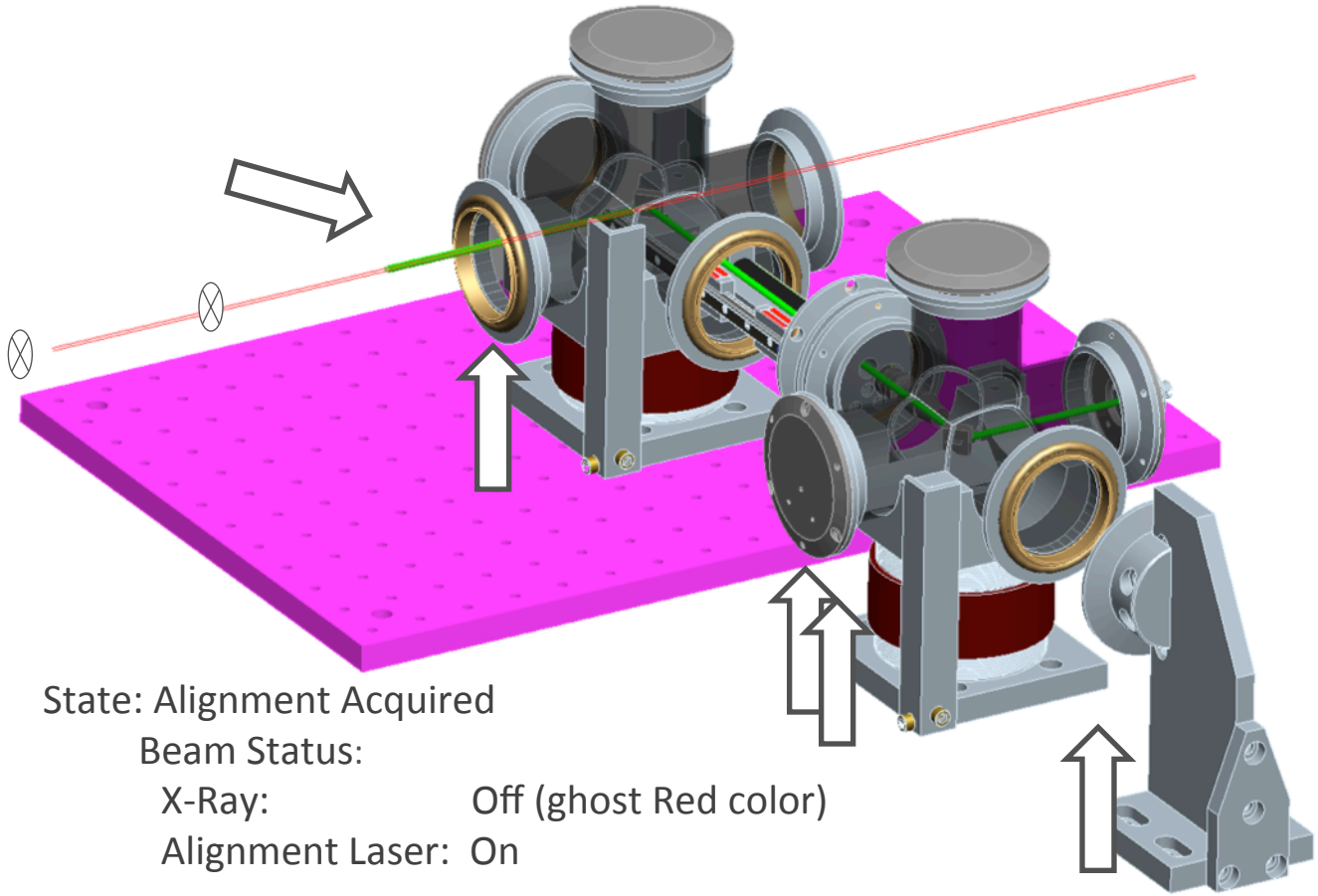

- State: Alignment Acquired
  Beam Status:
  X-Ray: Off (ghost Red color)
  Alignment Laser: On

  Transverse Assembly extended out

  Cradles are adjusted to the correct position so that Green Laser impinges both downstream positions

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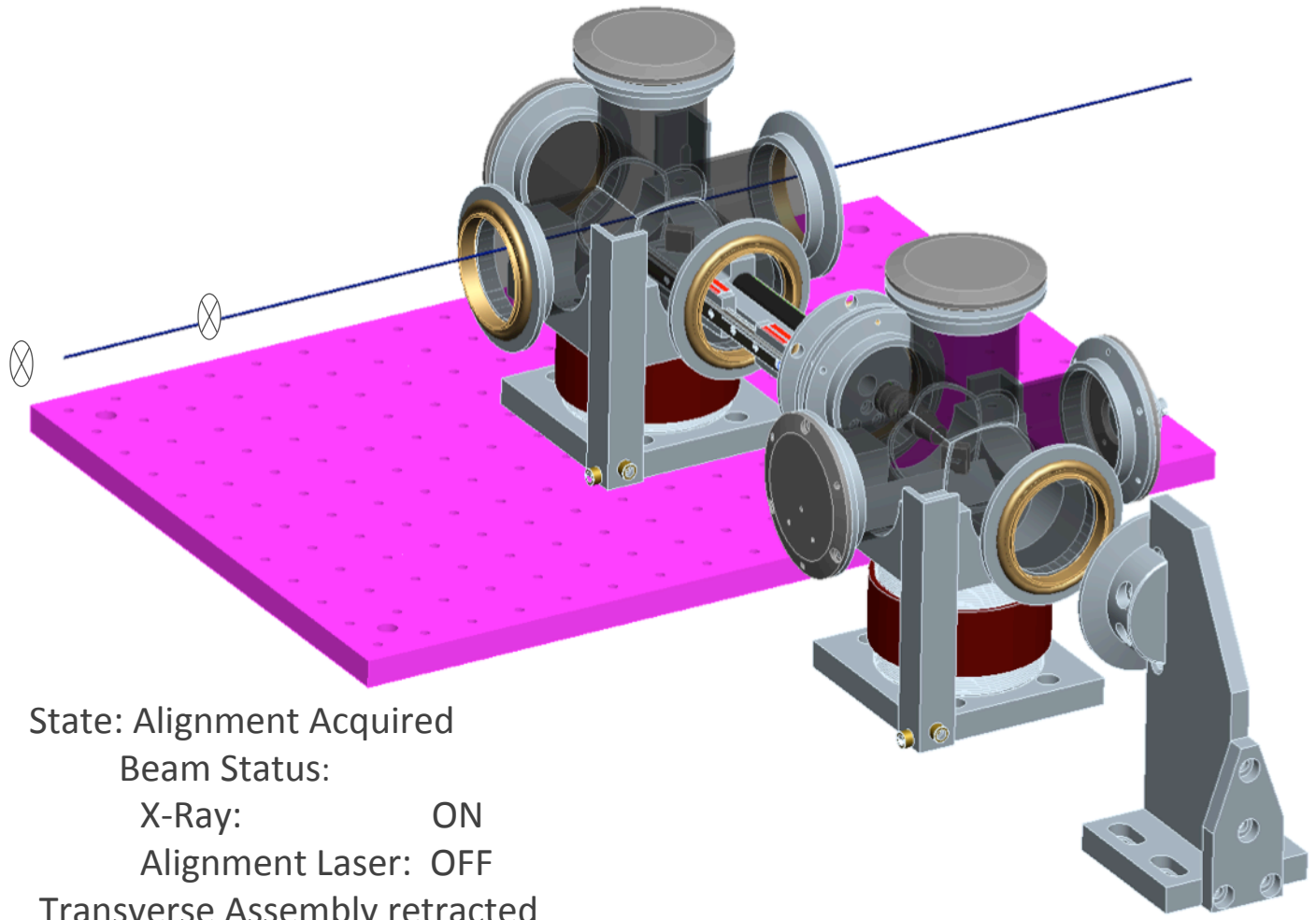

- State: Alignment Acquired
  Beam Status:
  X-Ray: ON
  Alignment Laser: OFF
  Transverse Assembly retracted
  System is ready for use

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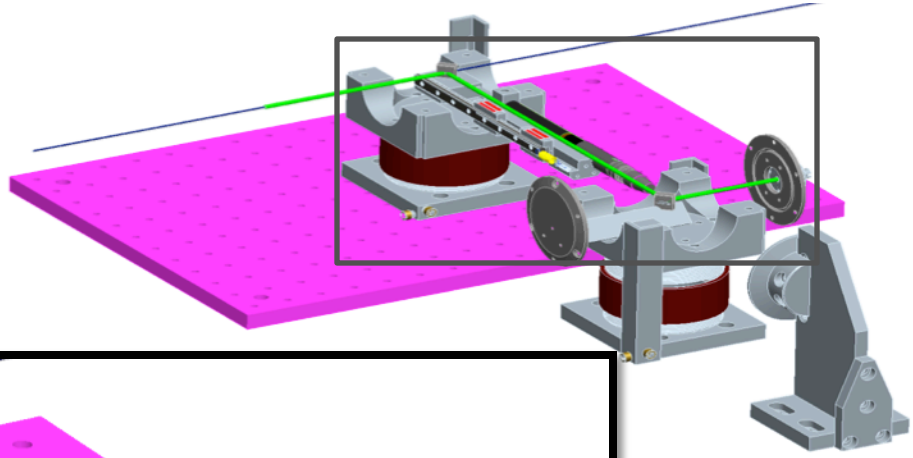

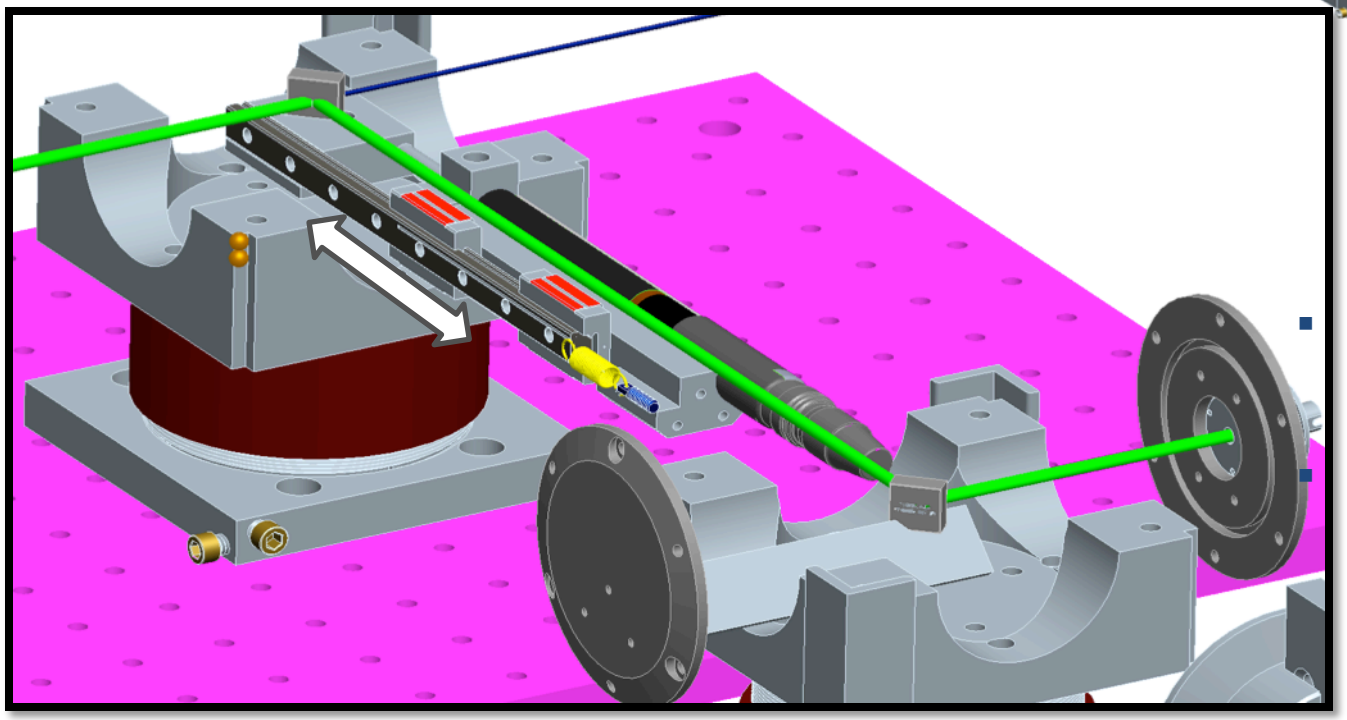

- 4 DOF fiber port to launch laser
- Positioning of laser is to parallel at an offset from the X-Ray beam

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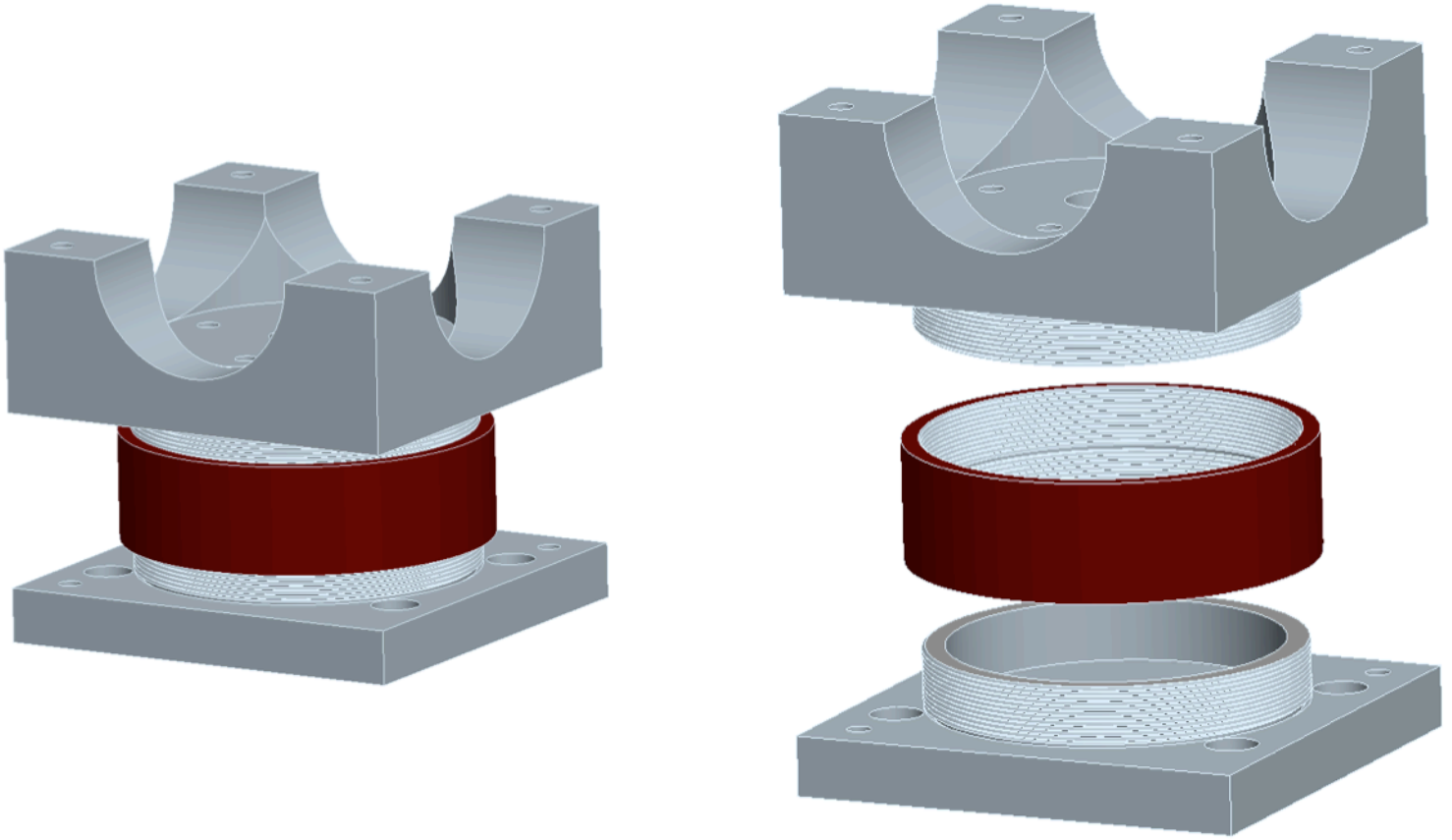

3.500” diameter turnbuckle cradles fabricated from conventional steel tubing for cost effectiveness and 24 TPI for vertical precision and robust strut design

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- **Advantage:**
  - **Pre-alignment to with 0.1 .. 1mm can be done without x-rays**
  - **Both during shutdown days, and for much more rapid alignment during x-ray operation, using full 3-D beam information instead of having only "burn" points on paper**
  - **X-ray beam time is more efficient, resulting in a better chance of getting into data-acquisition mode by midnight of 1st day of beamtime – no sleep deprivation**
  - **careful design to match mechanical constraints to DOF, and manufacturability**