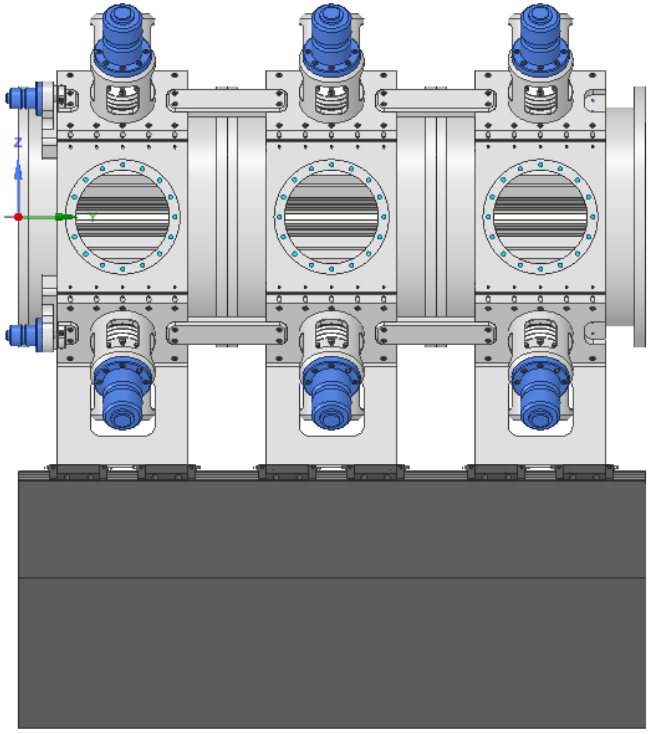
Afterburner layout considerations

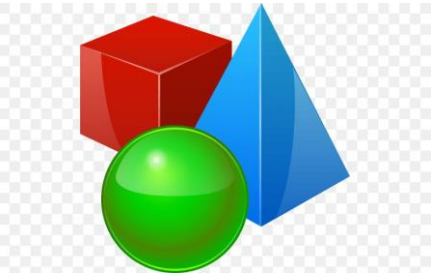
Mechanical Conceptual Design for The Compact Light Source Afterburner

Glasgow virtual meeting on 17th June 2020



Tadej Milharčič, Kyma Tehnologija d.o.o.

Kyma involvement



- Conceptualization:
  - Identification of realistic technical solutions to design objectives.
  - Realistic final dimensions, components, care for aspects of assembly, tuning and measurement … realized in 3D.
  - Considerations about load management, but no numerical analysis.
  - No fabrication information (drawings, tolerances, planarities, surface treatments, etc.).

Disclaimer

- A lot of innovative (radical) solutions.
- Toolbox for later design process.
- Some innovation is inevitable for this project.
- Have to risk to be naive in some proposals.

- *Will not go deep in technical detail in this presentation.*

Design options

Partially addresed in *Technologies for the CompactLight undulator* XLS Deliverable D5.1

- Out of vacuum / in-vacuum
- Room temperature / cryo-cooled
- Individual magnets / magnet soldering
- Traditional mag. structure / magnetic compensation
- Traditional VC / segmented VC as support structure

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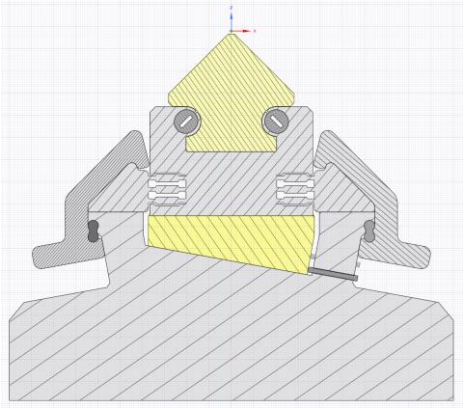
Opt 1

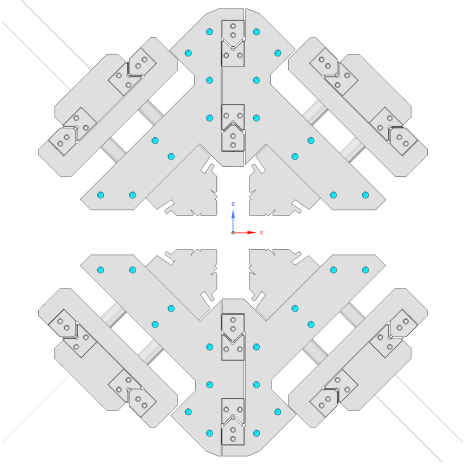
Opt 2 and Opt 3

Critical design areas

- Magnetic holder and girder design.

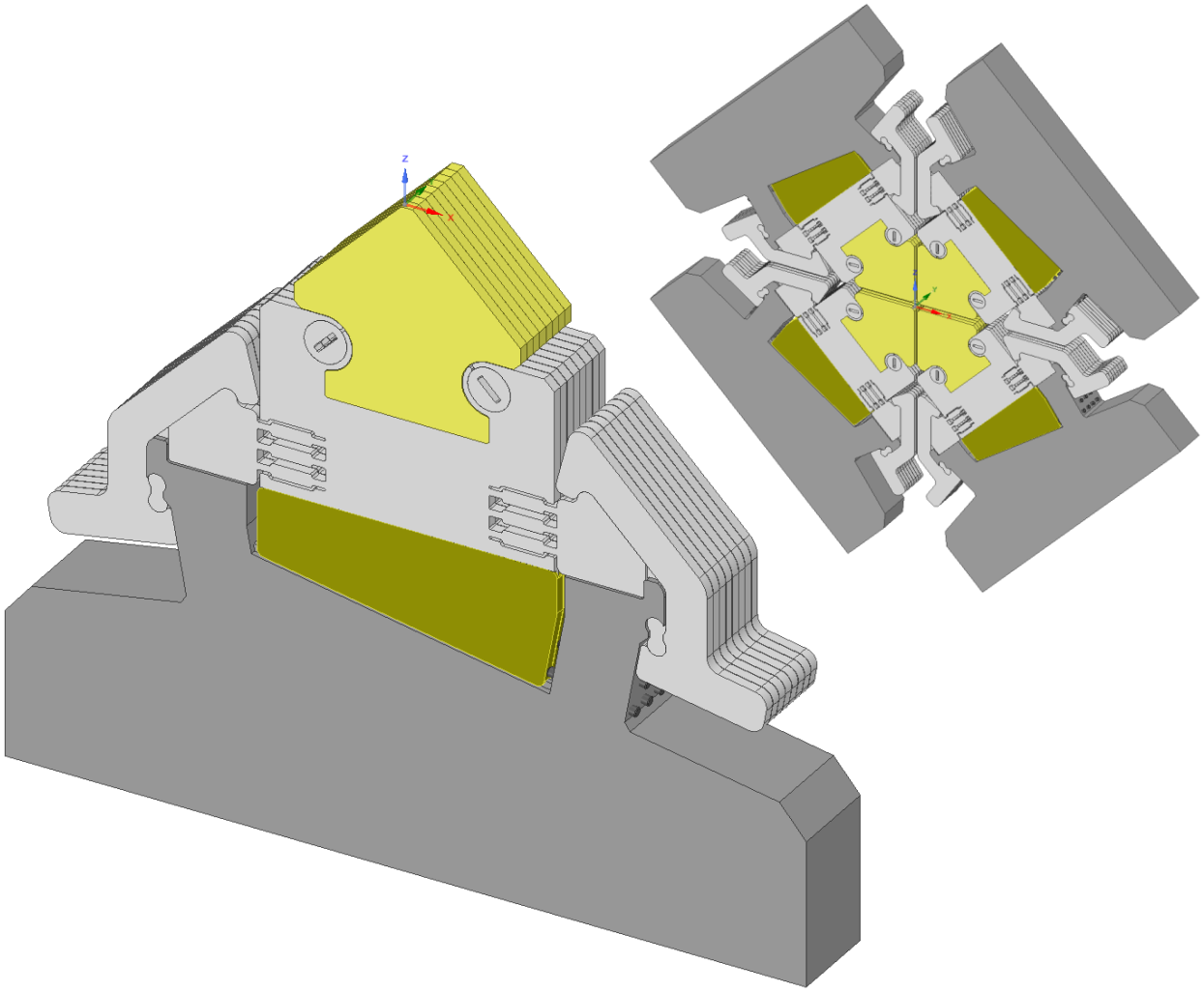


- Radial and phase mechanism design
  (has to include some VC and frame features).



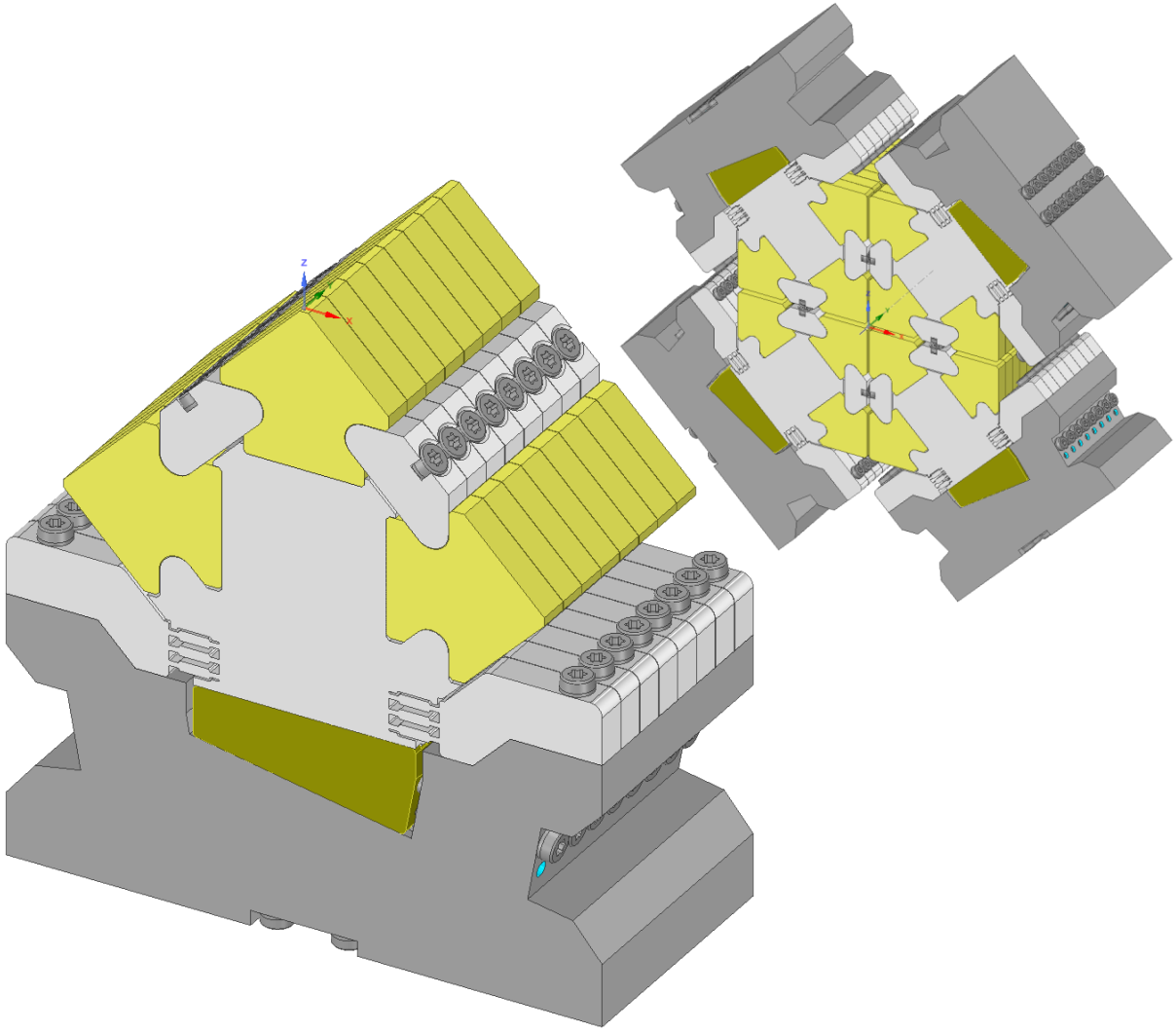
Holder Design 1

- Individual magnets (no soldering).
- ⚠ Every magnet is shimable.
- ⚠ Clamping mechanism (magnets to thin thin for screws).
- Wedge mechanism.
- Cryo-cooled version?



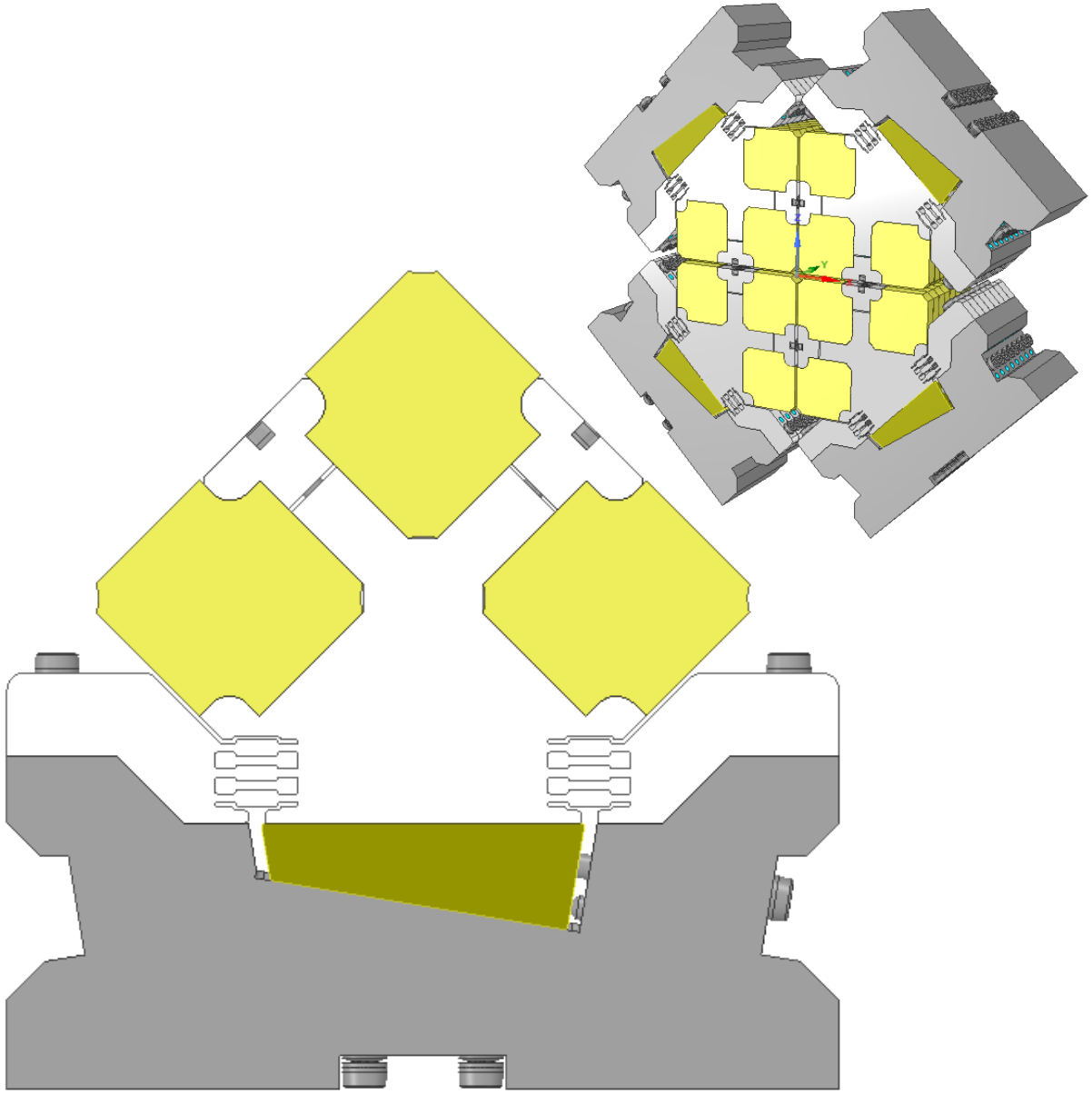
Holder Design 2

- ⚠ 4 magnets soldered (half period)
- ⚠ Magnetic compensation
  - Compensation magnets have the same cross section
- ⚠ No clamping, magnetic material can be screwed.
  - Wedge mechanism.
  - Cryo-cooled version?



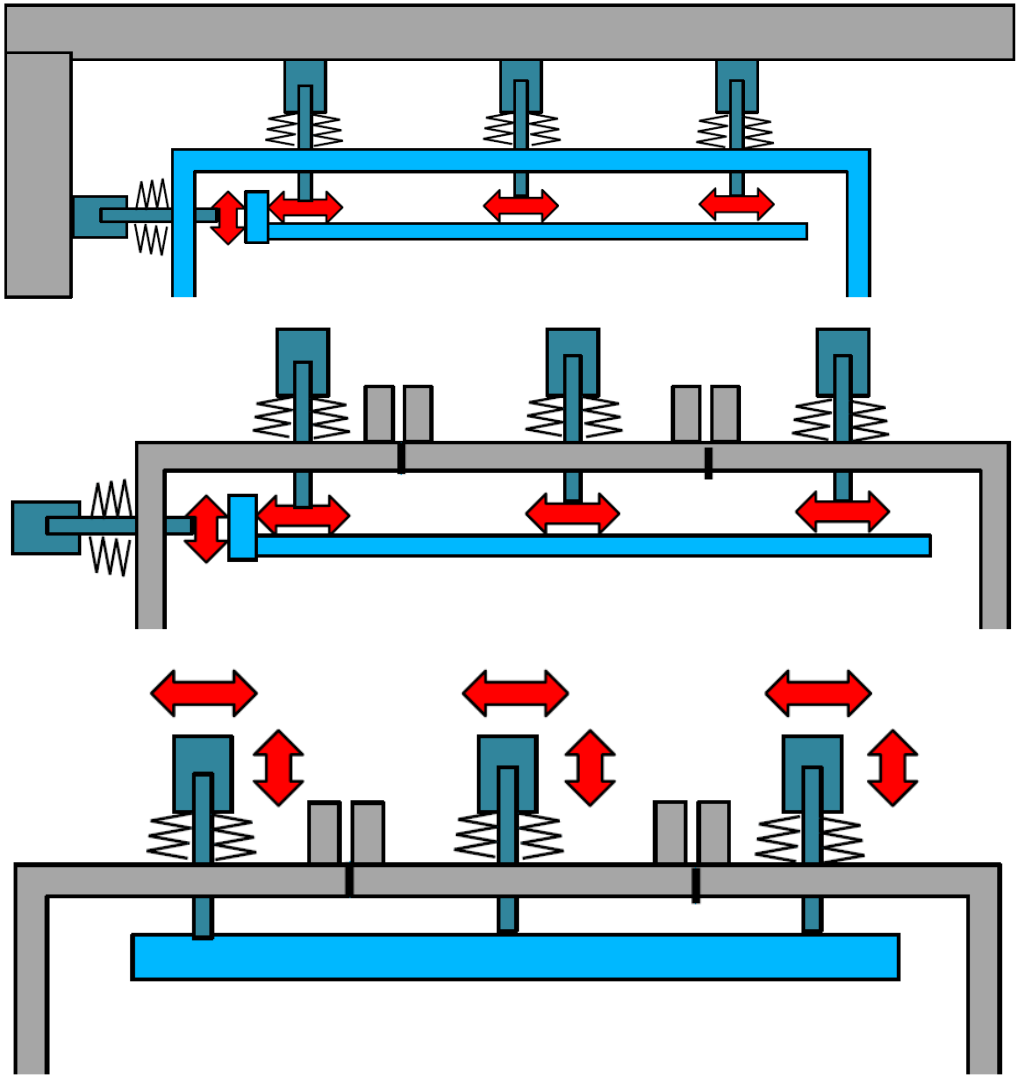
Holder Design 2+

- ⚠ Recent developement proposed by Thomas Schmidt
- Smaller cross section
- Further reduction of VC diameter.
- Is compatible with cryo-features?



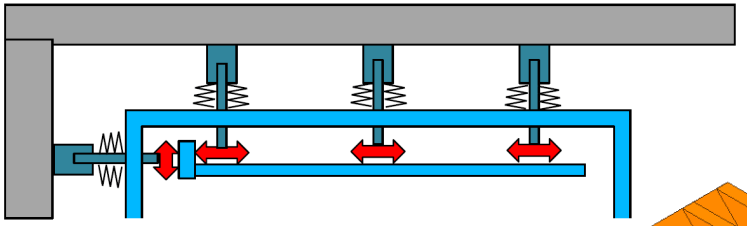
Radial and Phase Motion

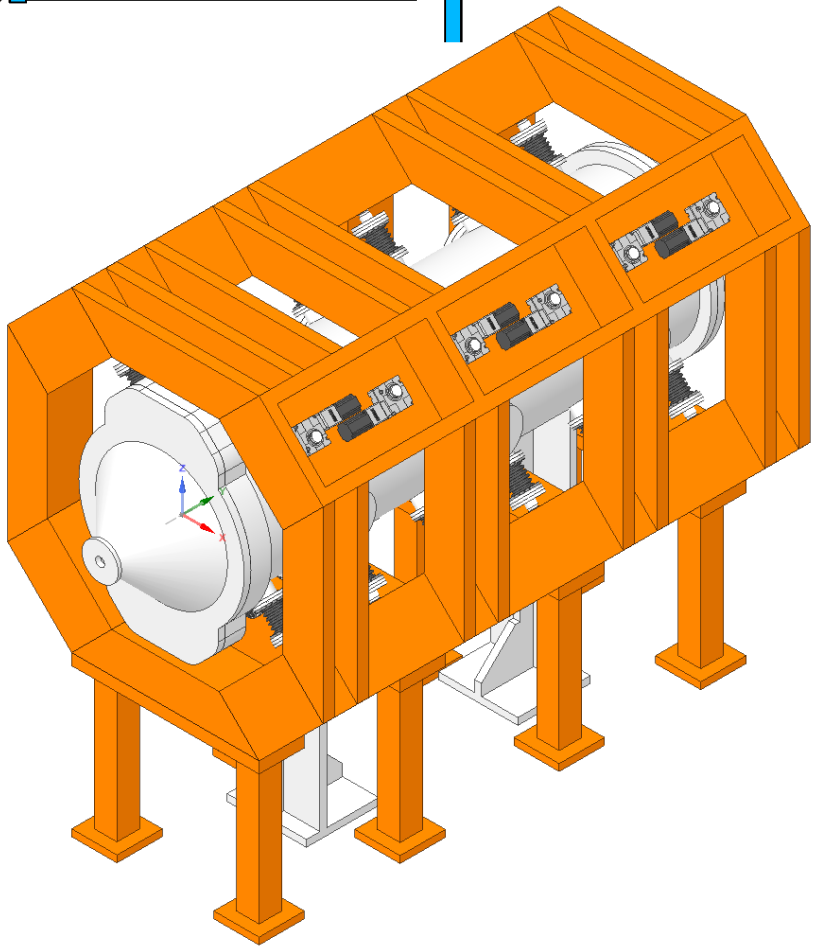
- Developement directions proposed by Thomas Schmidt (WP5)
- Provisional set of undulator parameters
- Three possible solutions for Radial and Phase Motion realization
  1. Fixed frame, traditional VC
  2. Segmented VC as support structure, separate radial and phase motion
  3. Segmented VC as support structure, combined radial and phase motion



Radial and Phase Motion (opt. 1)

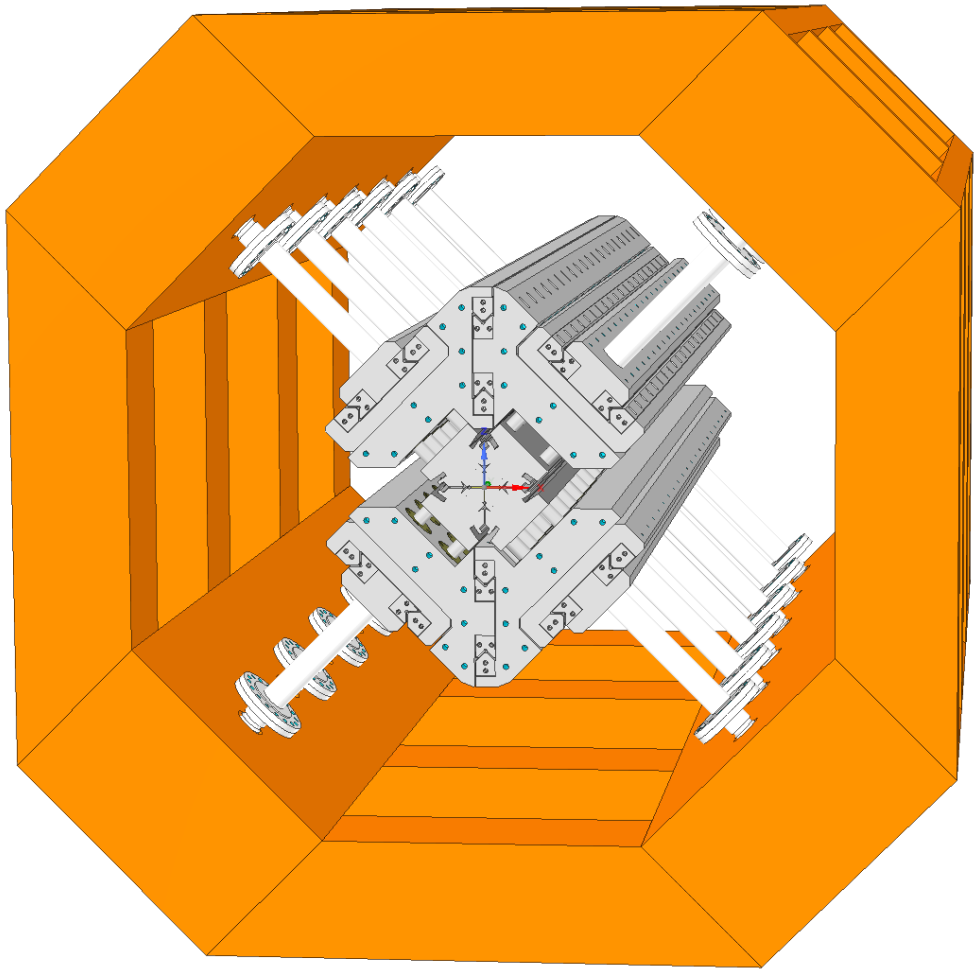
- Rigid external frame with traditional vacuum chamber
- Approach familiar to current EPU implementations.
- Suitable solution for non-compensated magnetic structure:
  - forces in all directions,
  - frame can deform (fighting forces with material is costly),
  - VC does not deform - good reference for position read-backs.





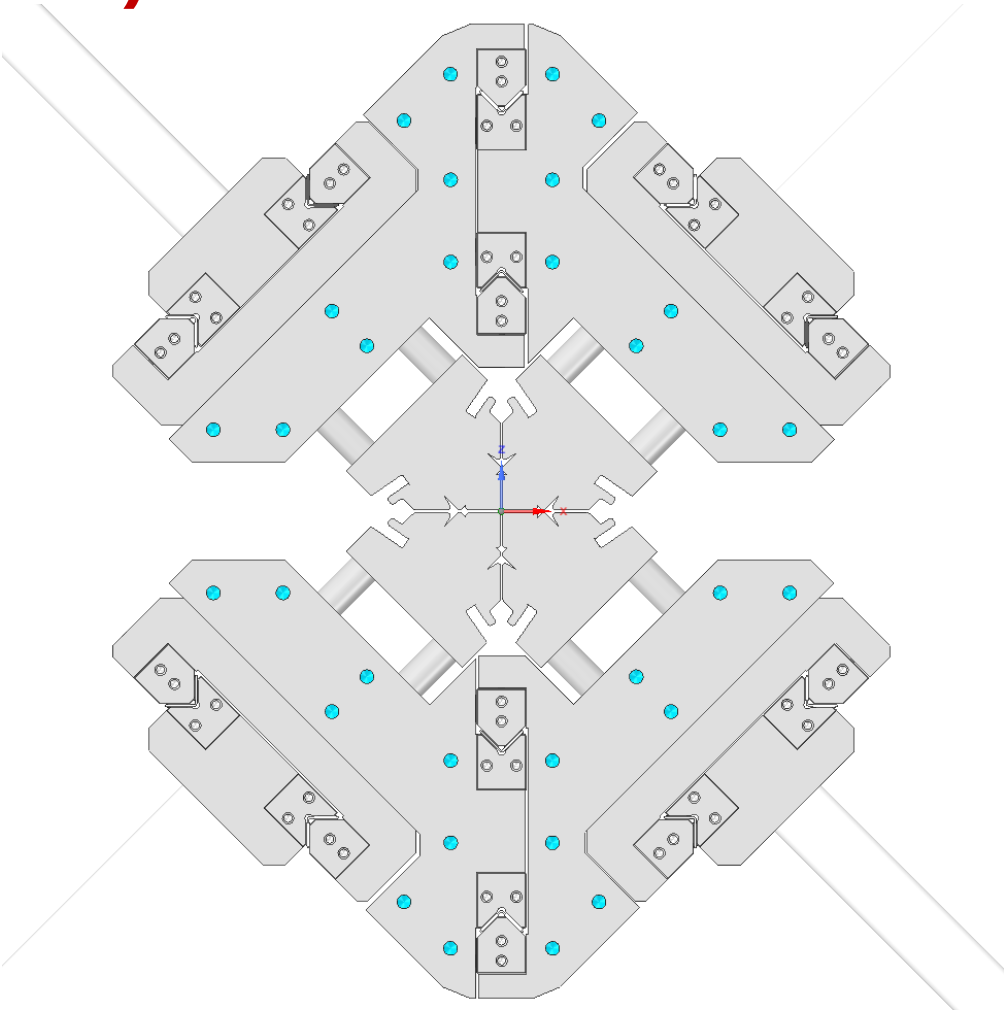
Radial and Phase Motion (opt. 1)

- Conceptually similar to classical undulators (top and bottom arrays are separate units).
- Left and right quadrant of top and bottom pair stabilize through central connection that permits phase motion.
- A series of pillars (conical rails) connect through this middle connection to the radial rail.



Radial and Phase Motion (opt. 1)

- ⚠ The middle connection is suspended. It does not need additional support.
- ⚠ External radial actuation should compensate for sheer forces in X axis between top and bottom array.
- This gives lots of free space on axis for measurement systems etc.



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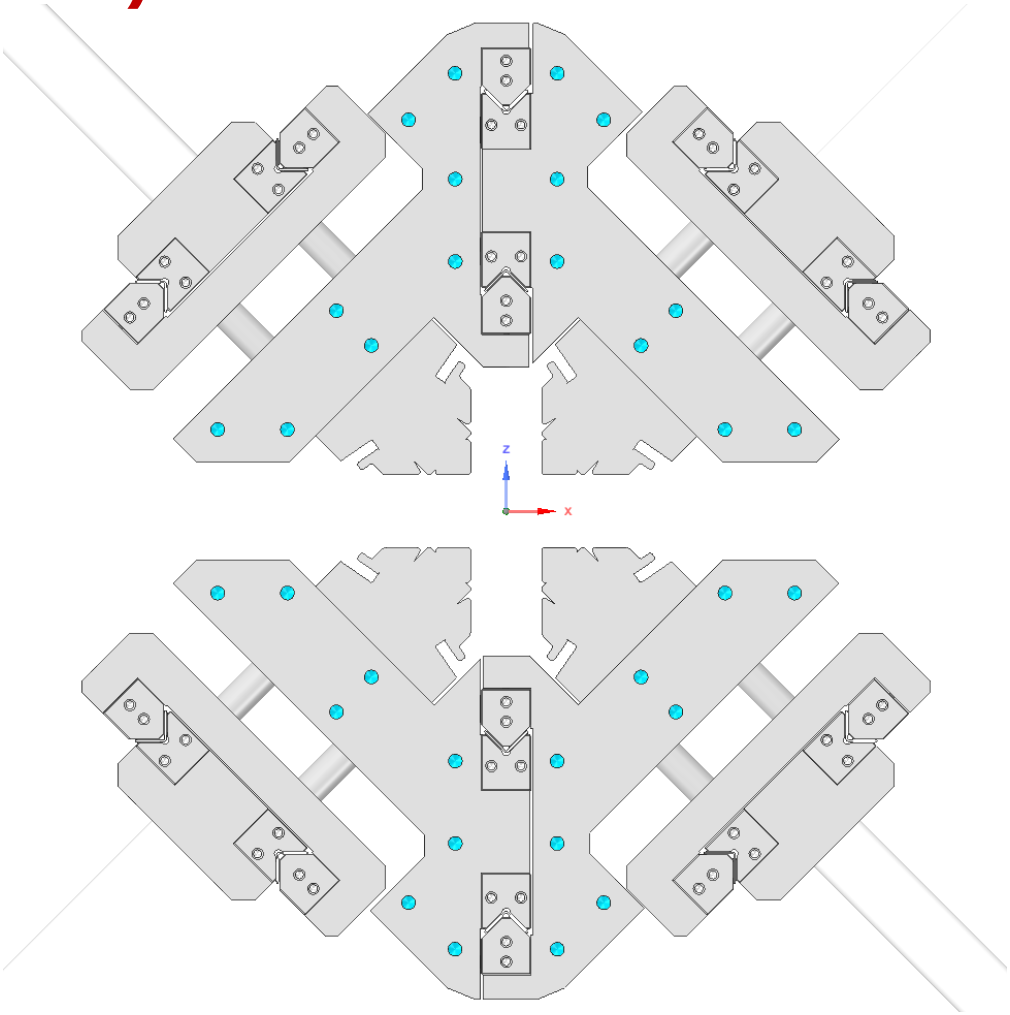
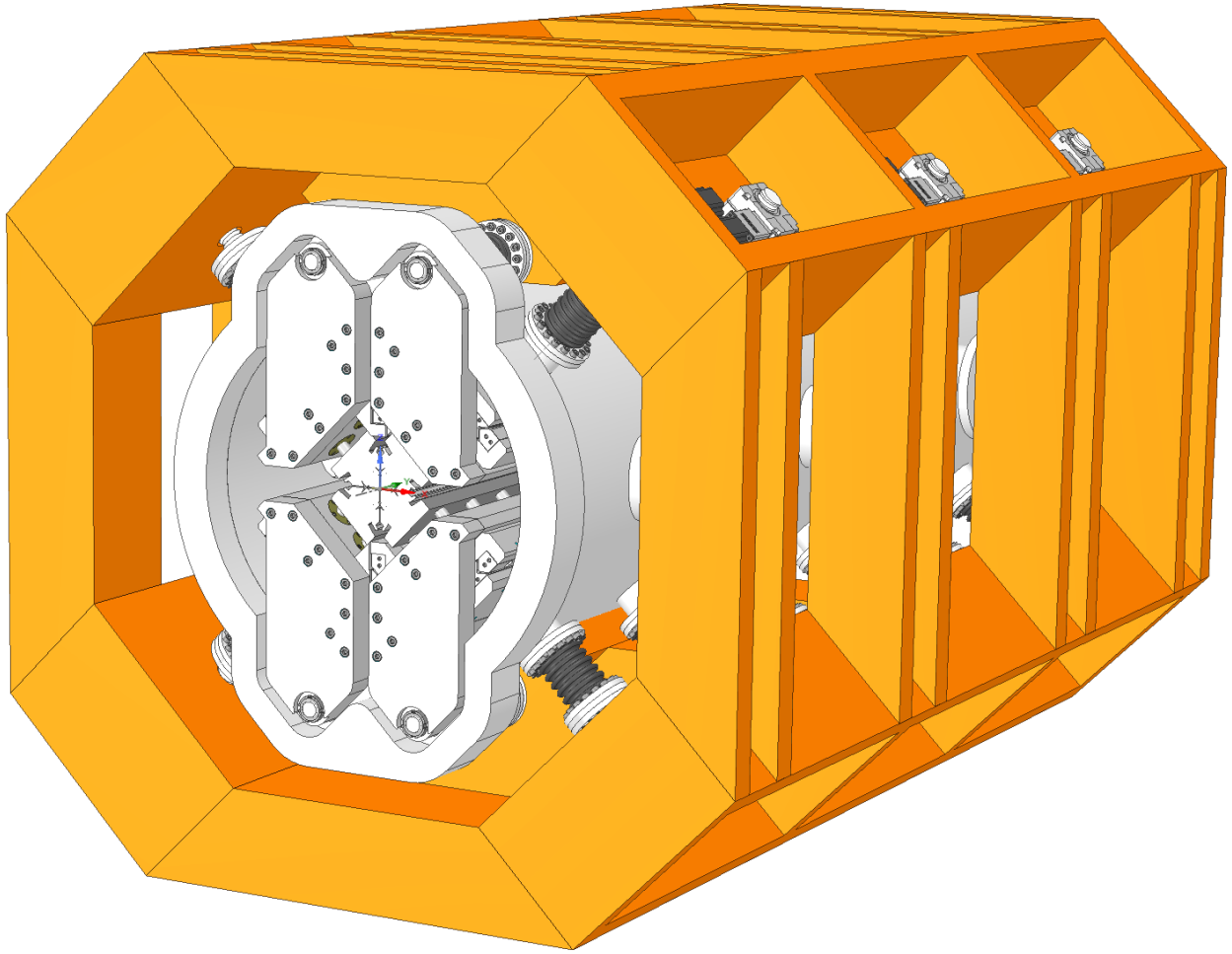


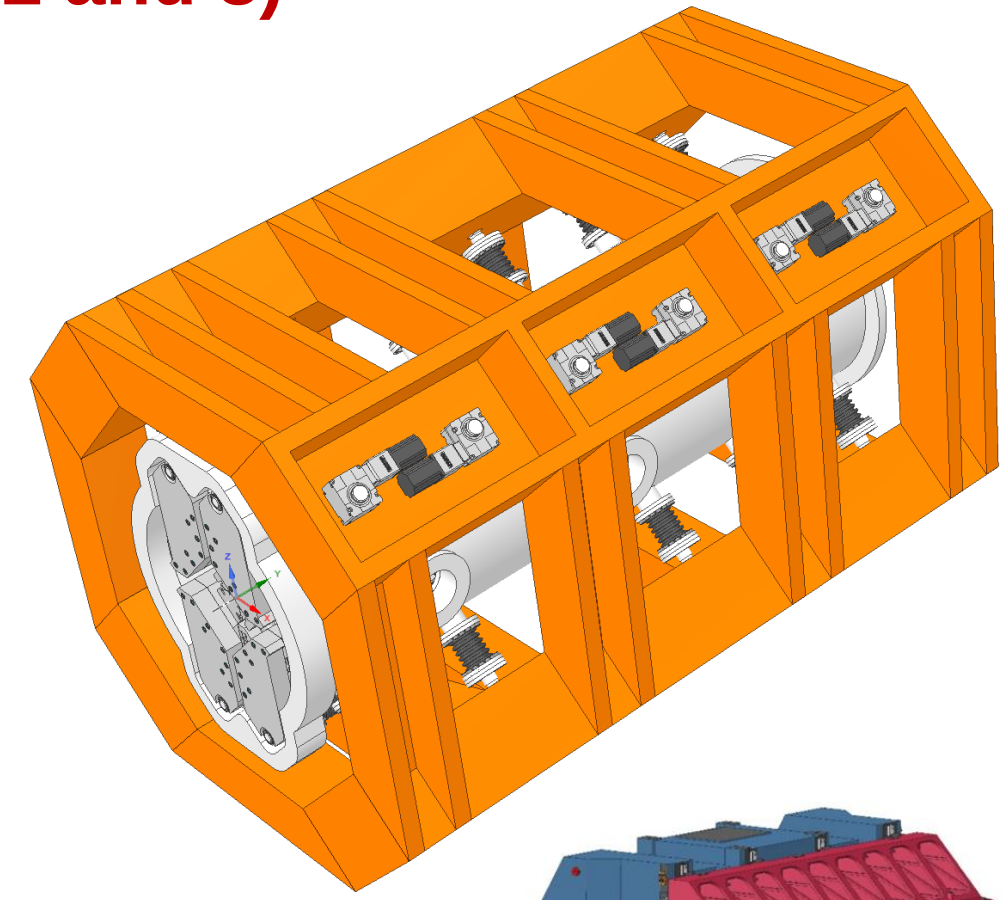
Radial and Phase Motion (opt. 1)

- ⚠ The phase movement is transferred to the structure through a special flange - single solid piece.
- Again, forces are transferred only to the external frame and not to the VC.

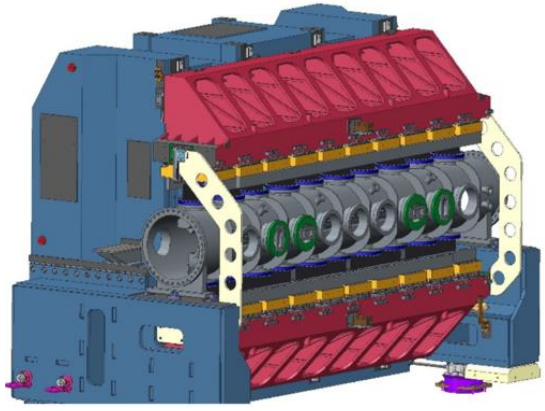


Multiple actuators (opt. 1, 2 and 3)

- Multiple actuators per quadrant.
- Proposed already by Thomas Schmidt.
- Increased cost for actuators, more complex control system.
- Avoid bulky beam and rails to guide the beam, much cheaper support structure.

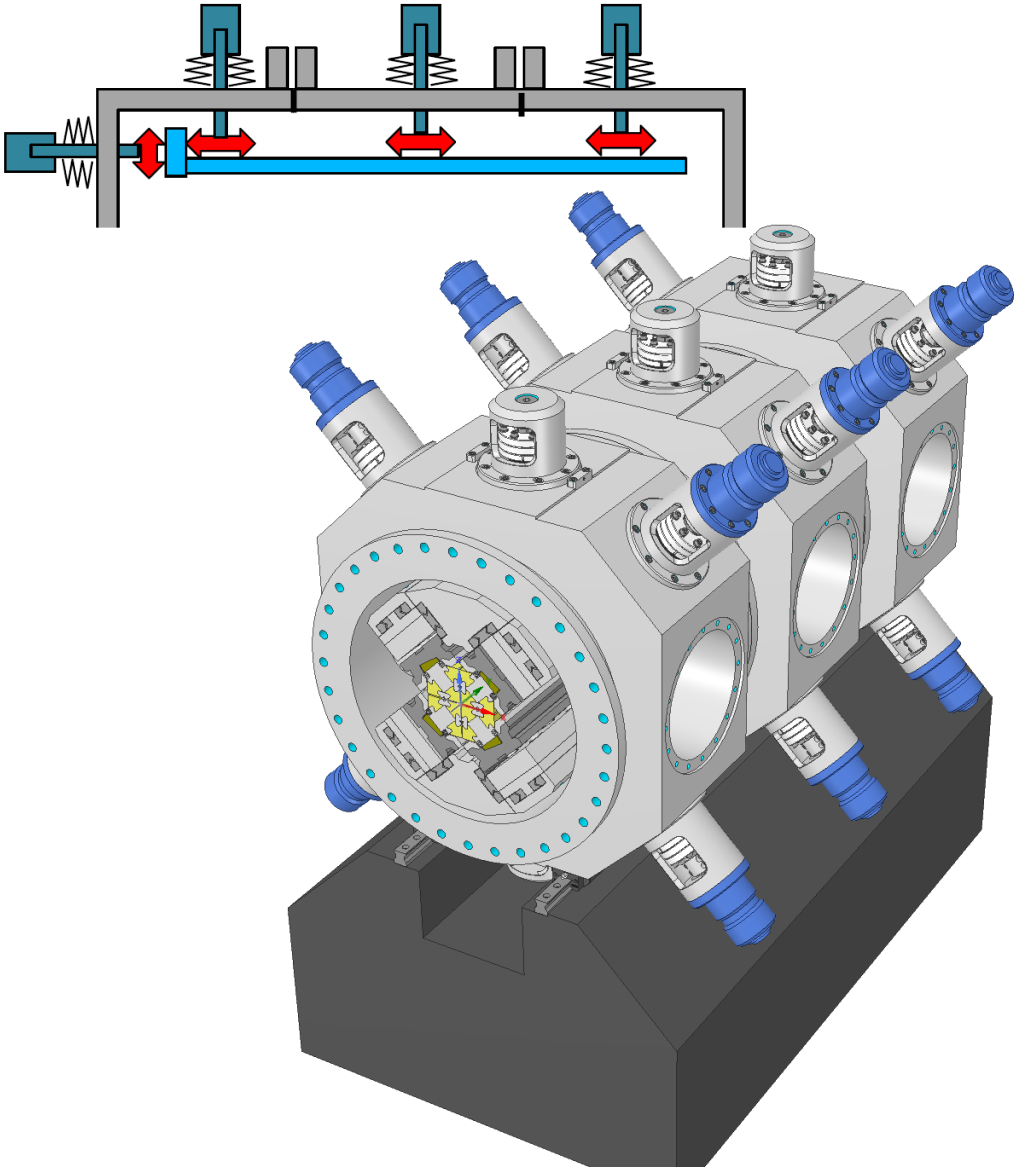


BESSY APPLE III IVU →



Radial and Phase Motion (opt. 2)

- Segmented vacuum chamber
  - vacuum chamber acts as support structure
  - machined from bulk Al solids (faster, cheaper),
- Suitable for compensated structure - only radial forces,
- Radial action as opt. 1 + middle connection between quadrants.
  - Easier installation and alignment,
- Lighter structure, more compact solution.



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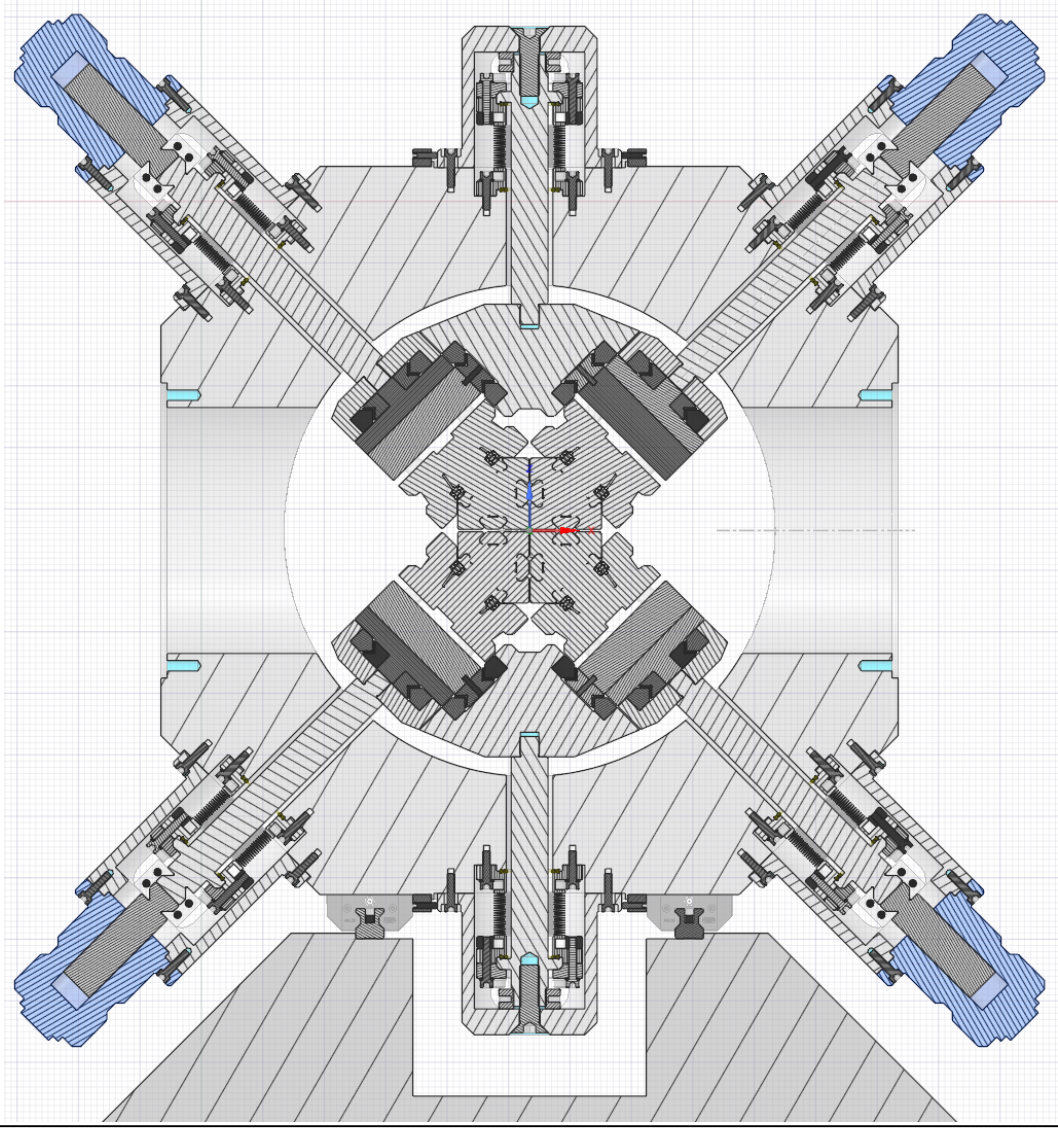
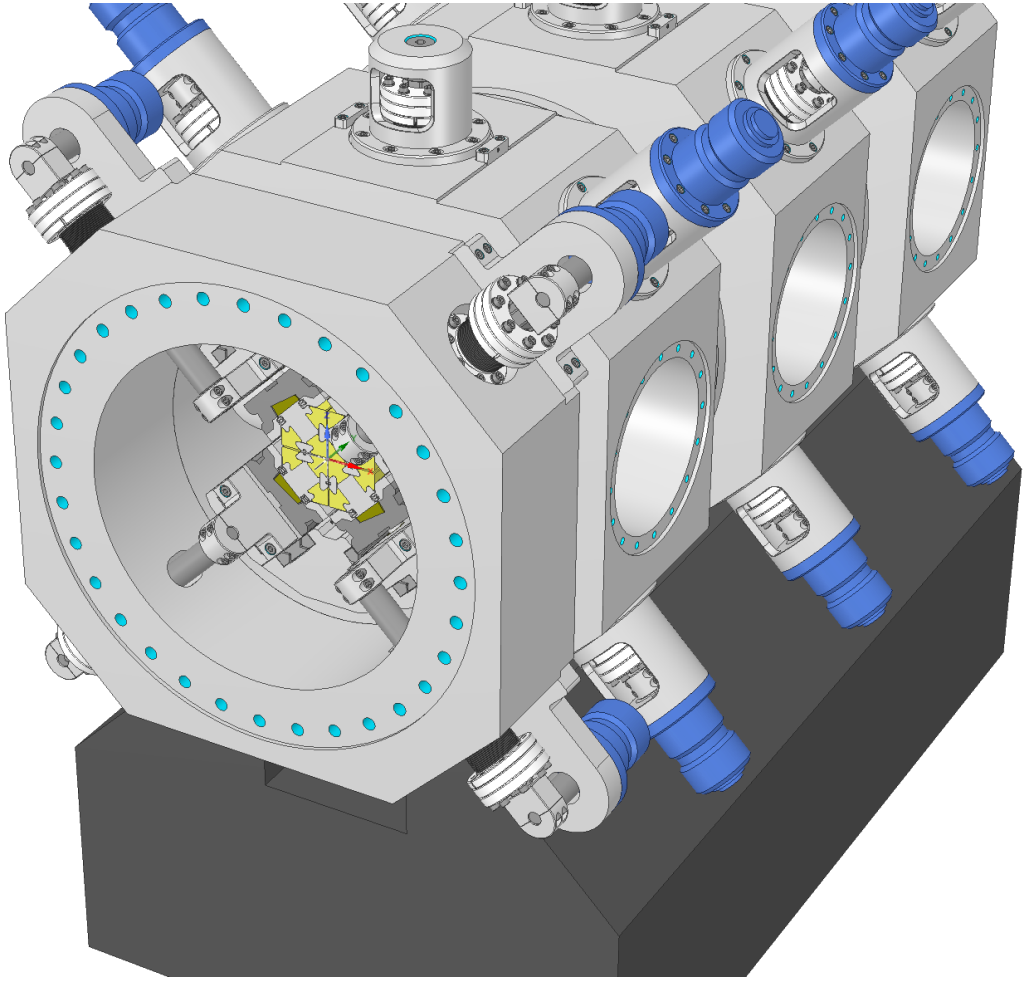


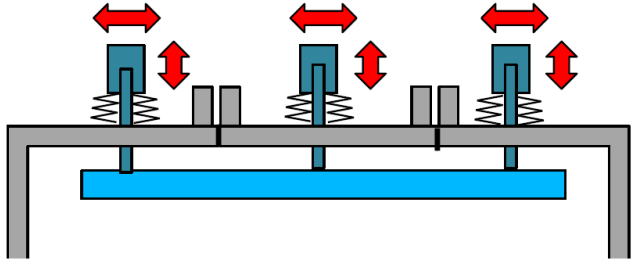
Radial and Phase Motion (opt. 2)

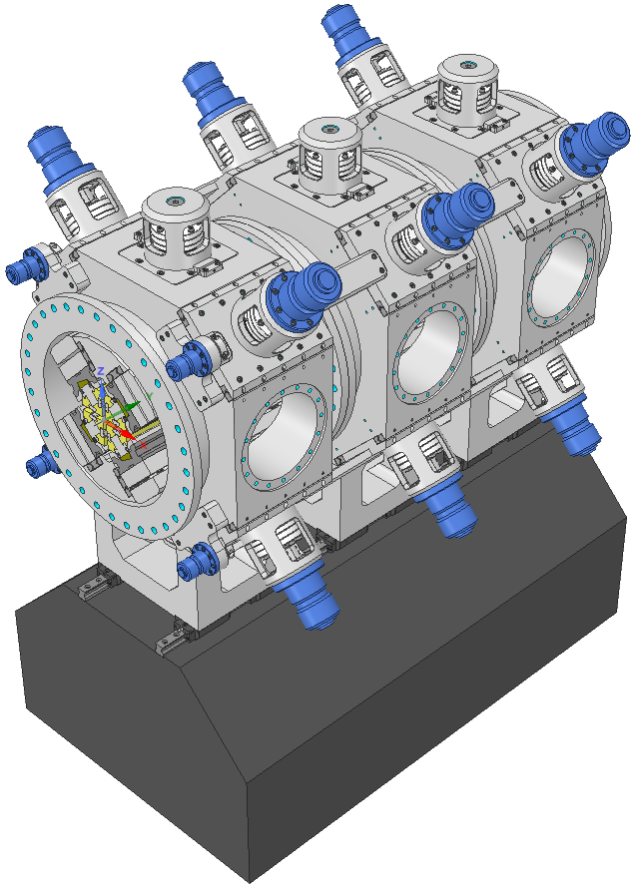
- Challenging phase motion mechanism.
- Additional VC segment with phase motion.
- Current implementation not elegant.
- It affects the terminal sections of the girder!



Radial and Phase Motion (opt. 3)

- Segmented vacuum chamber.
- Suitable for compensated structure - only radial forces.
- Focus on combining the radial and phase motion.
- Elegant external phase actuation.
- Smaller vacuum chamber.
- Fewer guiding elements inside the vacuum.
- Liberates extremities for features like flexible taper.
- Taper could be non-flexible!





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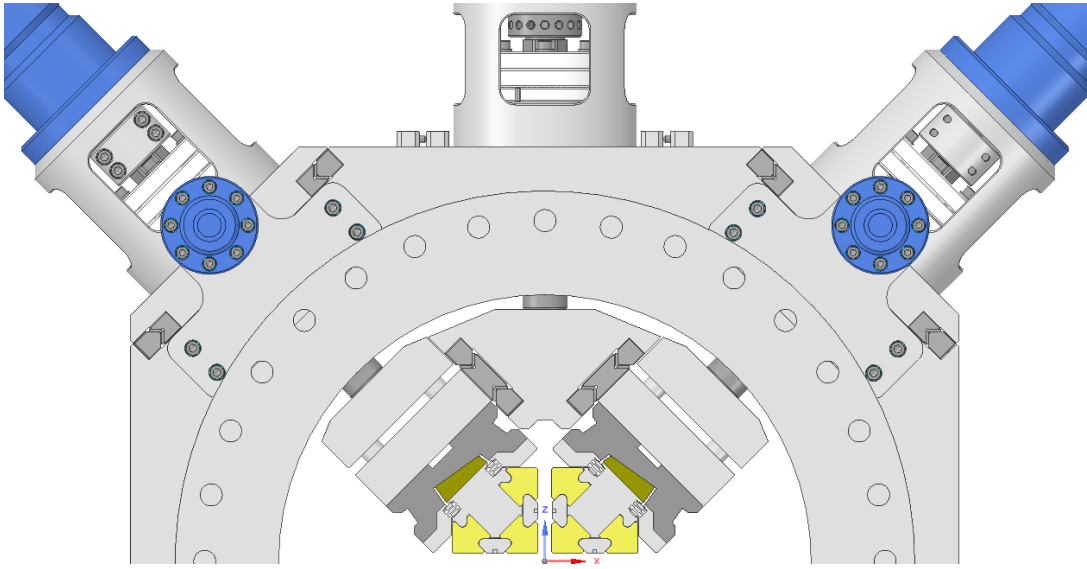

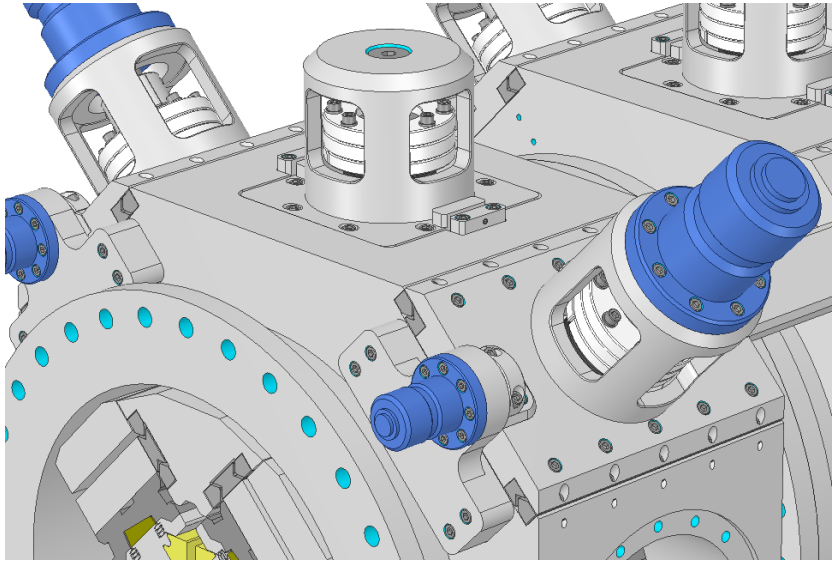

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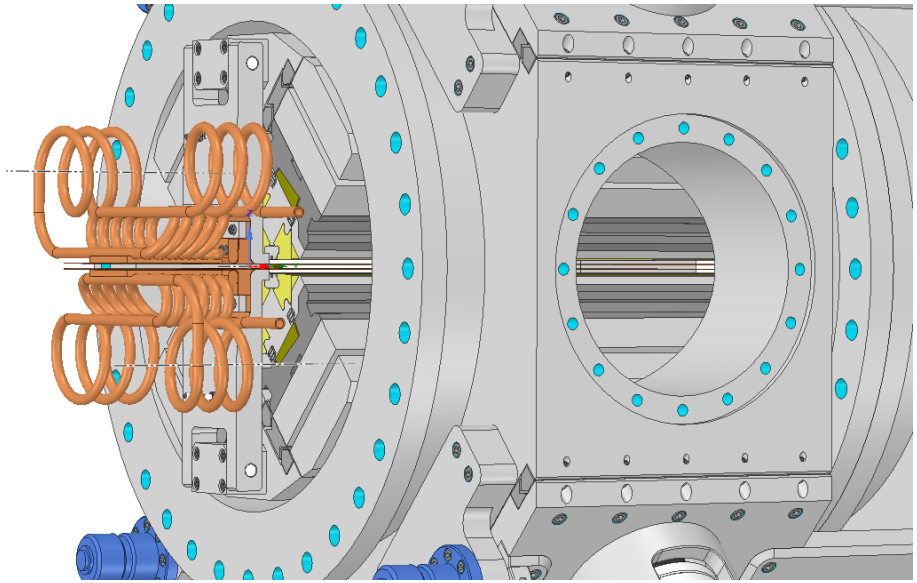

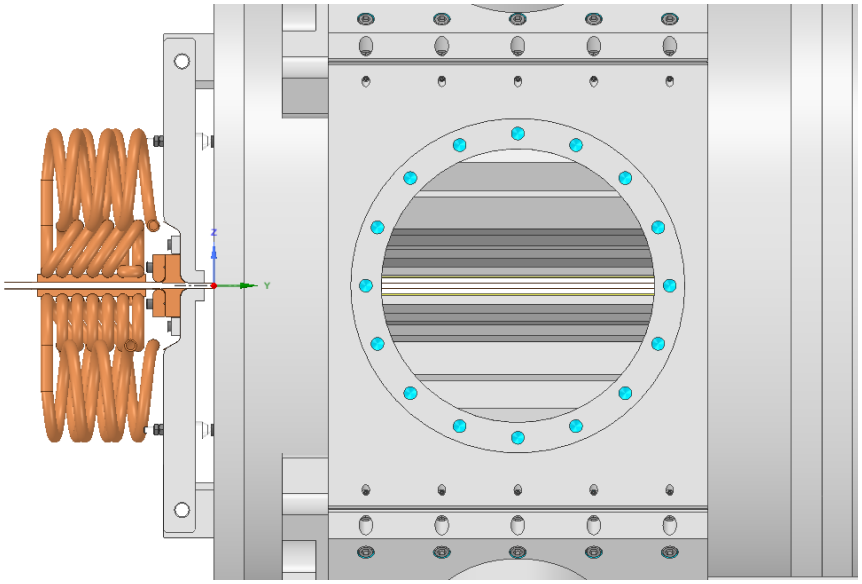

Funded by the
European Union

Thank you!

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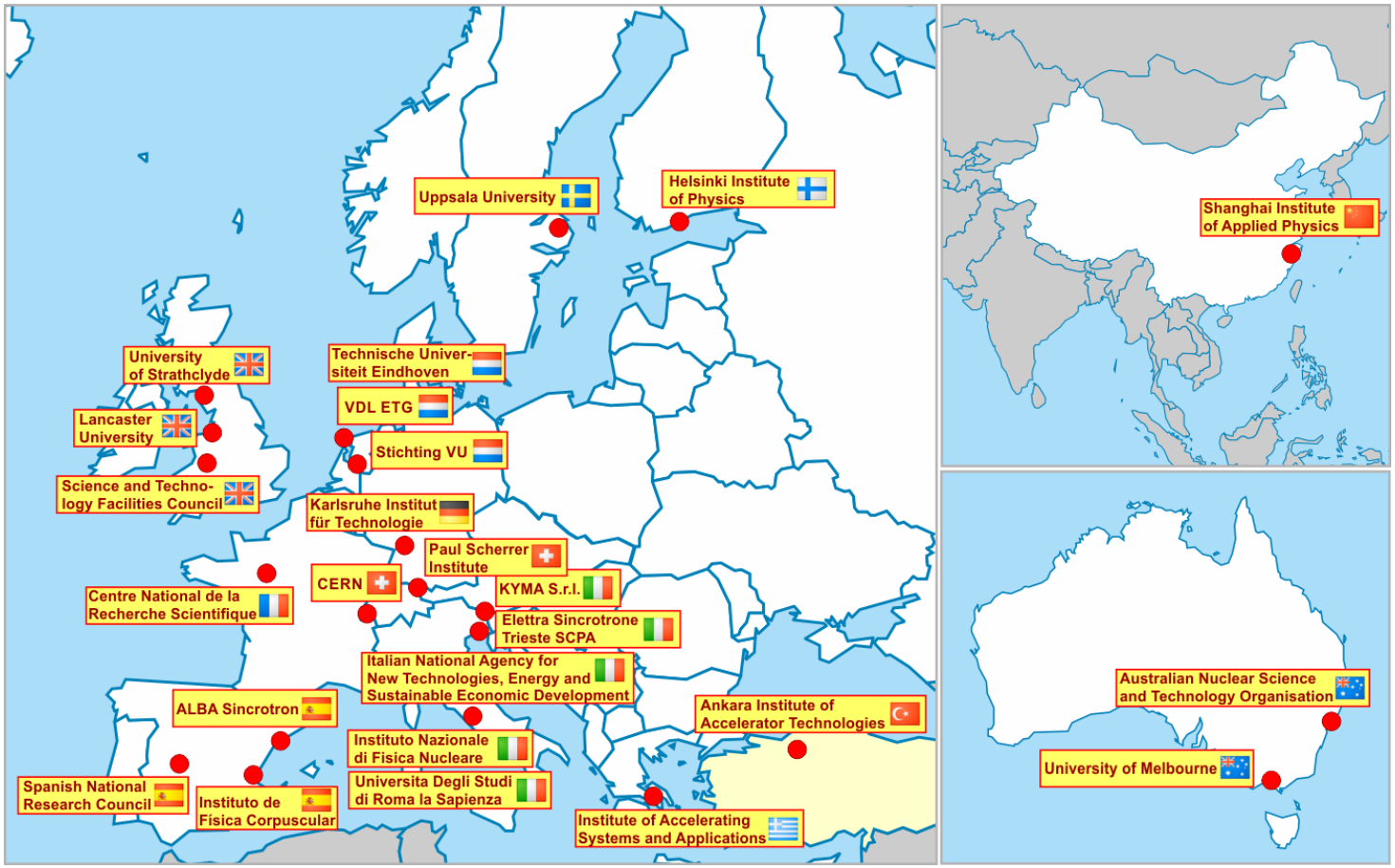

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