



Contribution ID: 222 Contribution code: WEP33

Type: **Poster Presentation**

Innovative design strategies and development of girders using topology optimization for PETRA IV

Wednesday 17 September 2025 17:00 (1 hour)

Precise magnet alignment and mechanical stability are critical challenges in the design of support structures for the PETRA IV synchrotron radiation facility at DESY. Due to the limitations of the existing tunnel infrastructure, magnets must be pre-aligned on girders with high precision before installation, while the girders themselves must accommodate relative tunnel movement and meet stringent vibration stability requirements. A topology optimization approach was applied to develop lightweight yet stiff girder structures with high eigenfrequencies, balancing structural performance and manufacturing efficiency. A full-scale demonstrator was successfully cast, validating the feasibility of the approach. The results highlight the advantages of topology-optimized casting in terms of cost, tolerance control, and design agility, enabling faster iteration and integration of changes during the development cycle.

Footnotes

Funding Agency

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Session Classification: Wednesday Poster Session

Track Classification: ACCELERATORS: Storage Rings