



ODIN: Optical and Diffraction Imaging with Neutrons at the ESS

Status and perspectives of the ODIN Project

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Outline

- ESS overview
- ODIN overview/goals
- ODIN Project
- Design
- Science case

A European Big Science Project



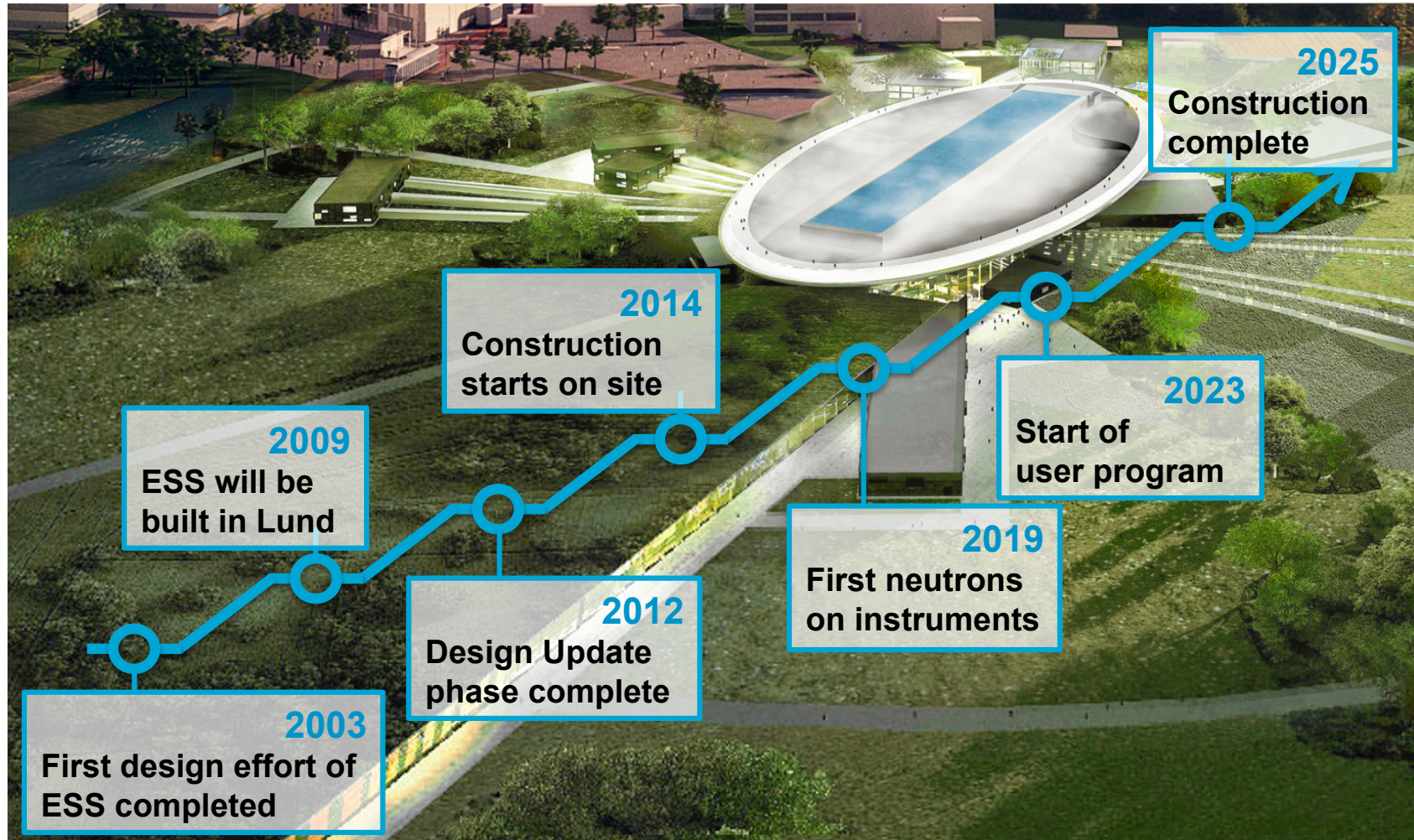
In-kind Collaborations



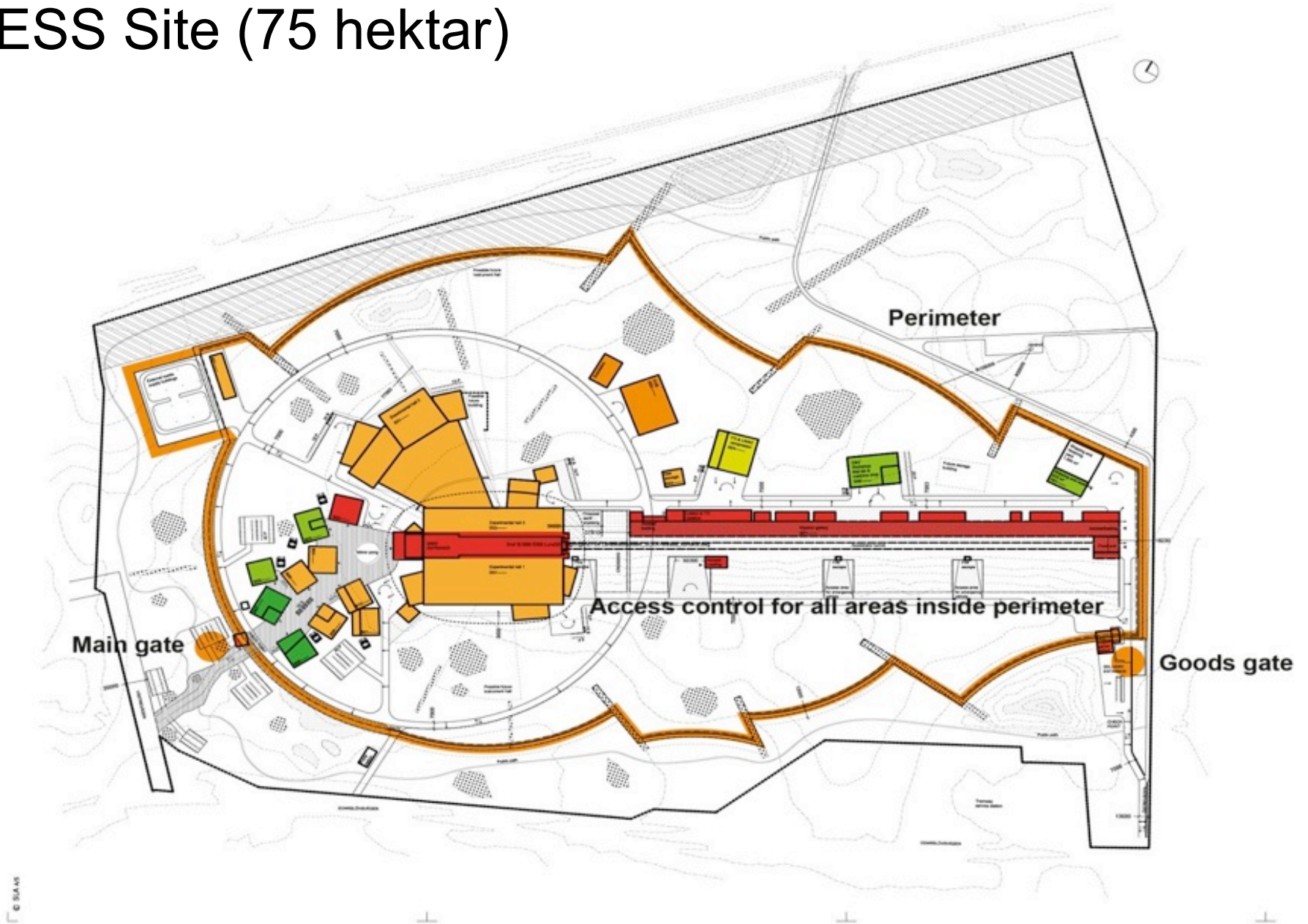
Civil Construction



ESS Roadmap

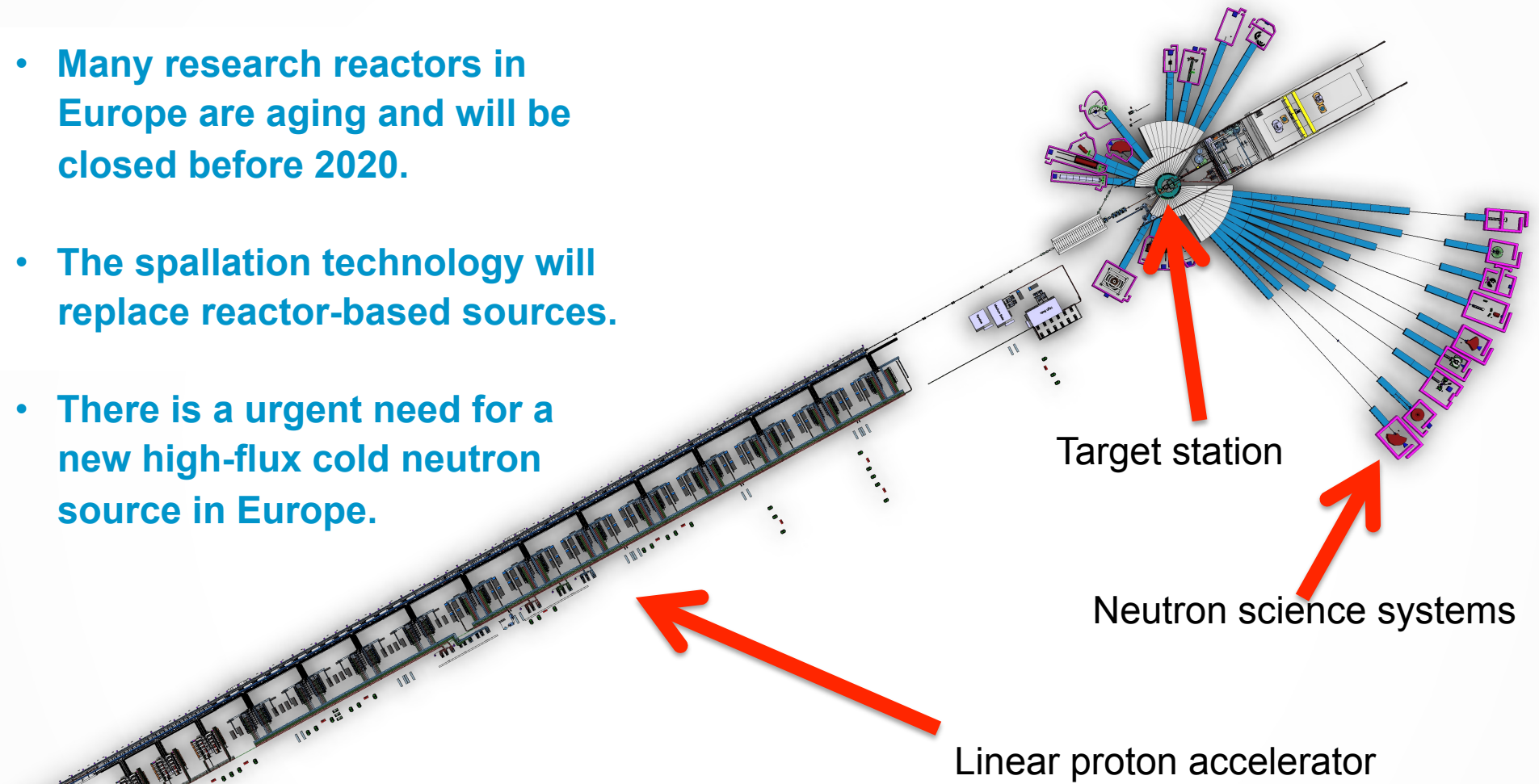


ESS Site (75 hektar)



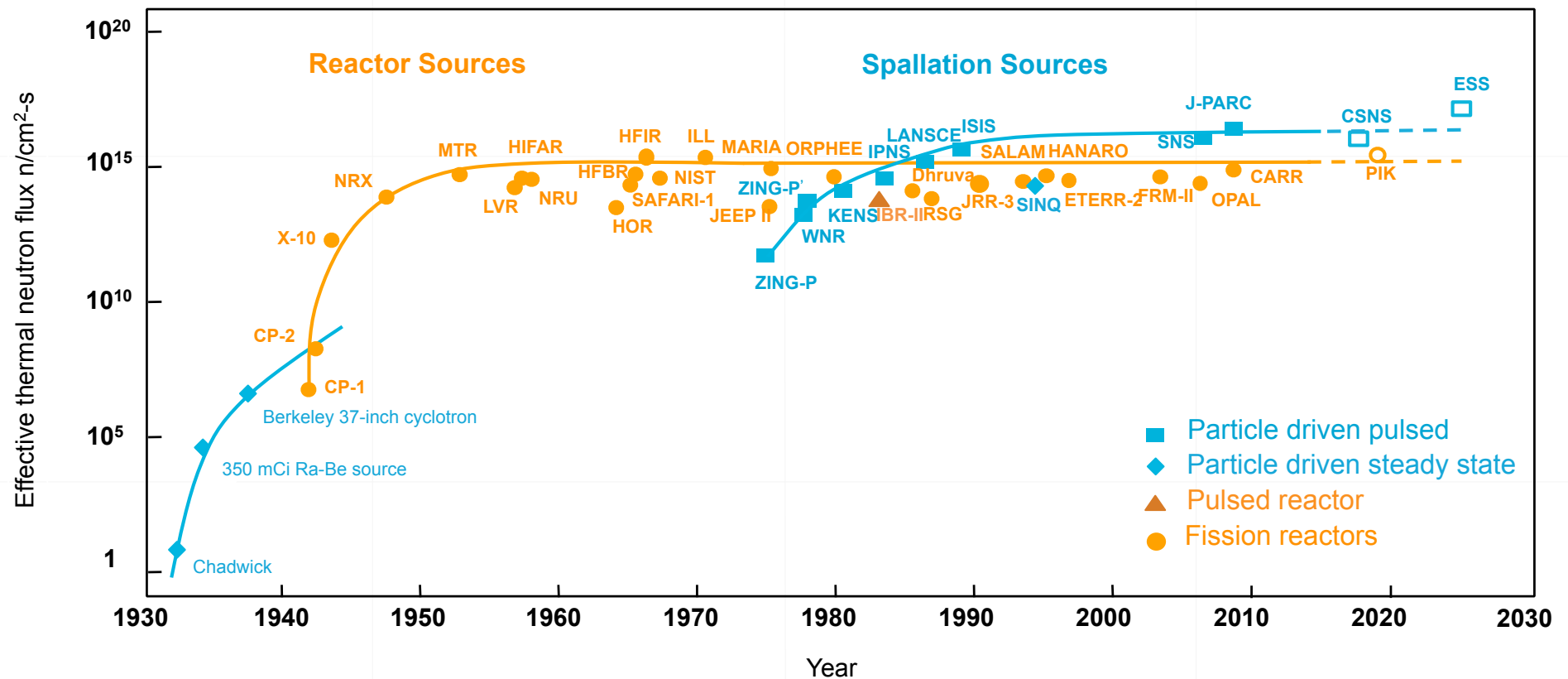
Spallation: Generating Neutrons for Science

- Many research reactors in Europe are aging and will be closed before 2020.
- The spallation technology will replace reactor-based sources.
- There is a urgent need for a new high-flux cold neutron source in Europe.



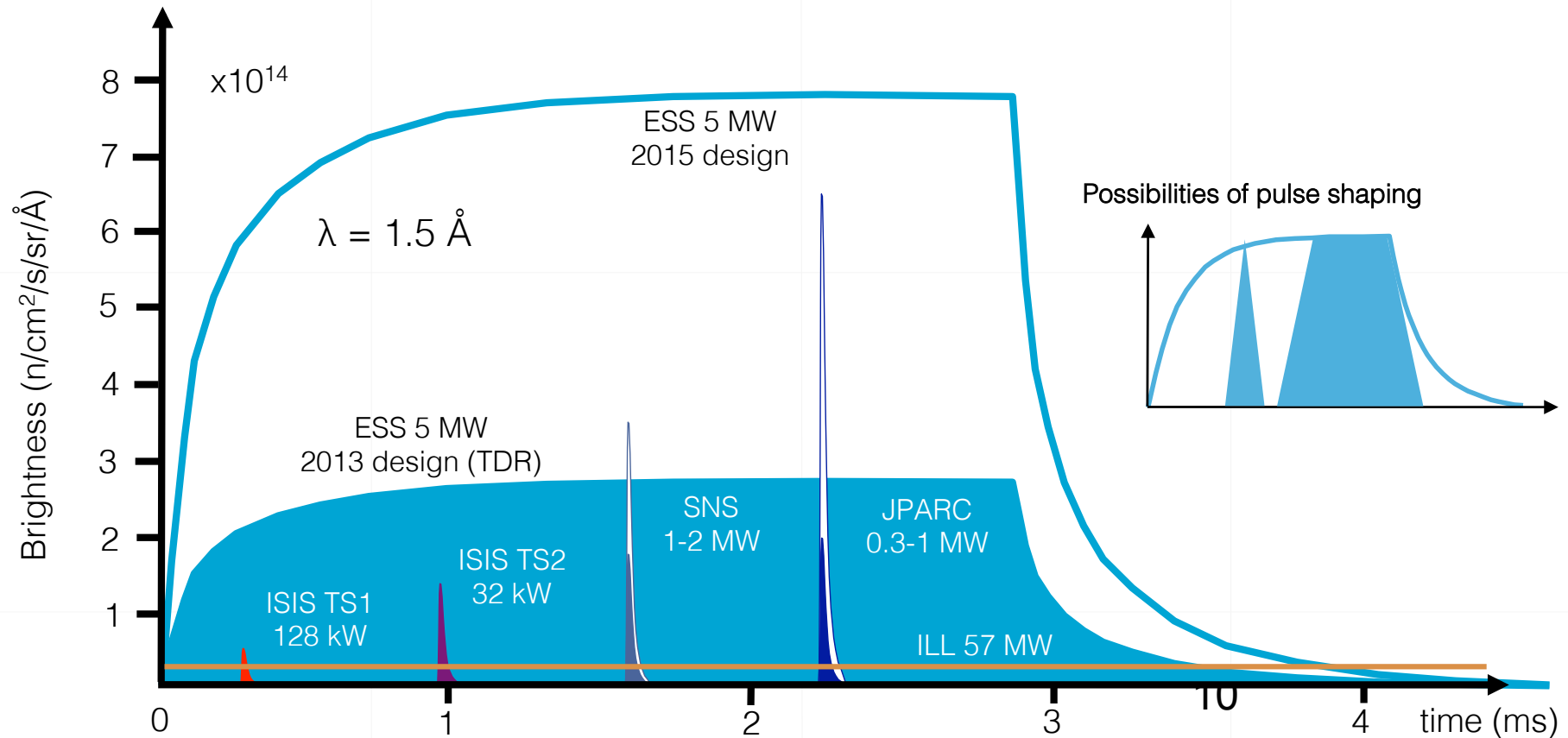
Spallation: Bridging the Gap

- ESS will be brighter than existing sources, complementing them



(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)

Long-Pulse Performance and Flexibility



ODIN at ESS

- **Optical and Diffraction Imaging with Neutrons:** Neutron radiography and ToF imaging with variable wavelength resolution
- ODIN will be the only imaging instrument installed during the first round
- It will be a “day-1” instrument: first neutrons planned for 2021
- Joint project of PSI and TUM (lead institution)
- Budget 11.6M€.

High Level Wishlist

- Conventional Imaging
 - High resolution
 - Large homogenous Field of View
 - Variable Wavelength (ultra-cold, thermal, epithermal, fast ...)
 - High time resolution (dynamic measurements)

- New (wavelength dependent) techniques
 - Variable Wavelength resolutions
 - Variable Bandwidths
 - High time resolution in quasi-stroboscopic mode.

- Synergy
 - X-ray contrast
 - Diffraction capabilities

High Level Goals

- Conventional Imaging
 - High resolution: **Real space resolution of 10 μ m**
 - Large homogenous Field of View: **20 \times 20cm² with a homogeneity of >75%**
 - Variable Wavelength: **λ -range from 1 to 20 Å**
 - High time resolution: **<70 ms in kinetic measurements**

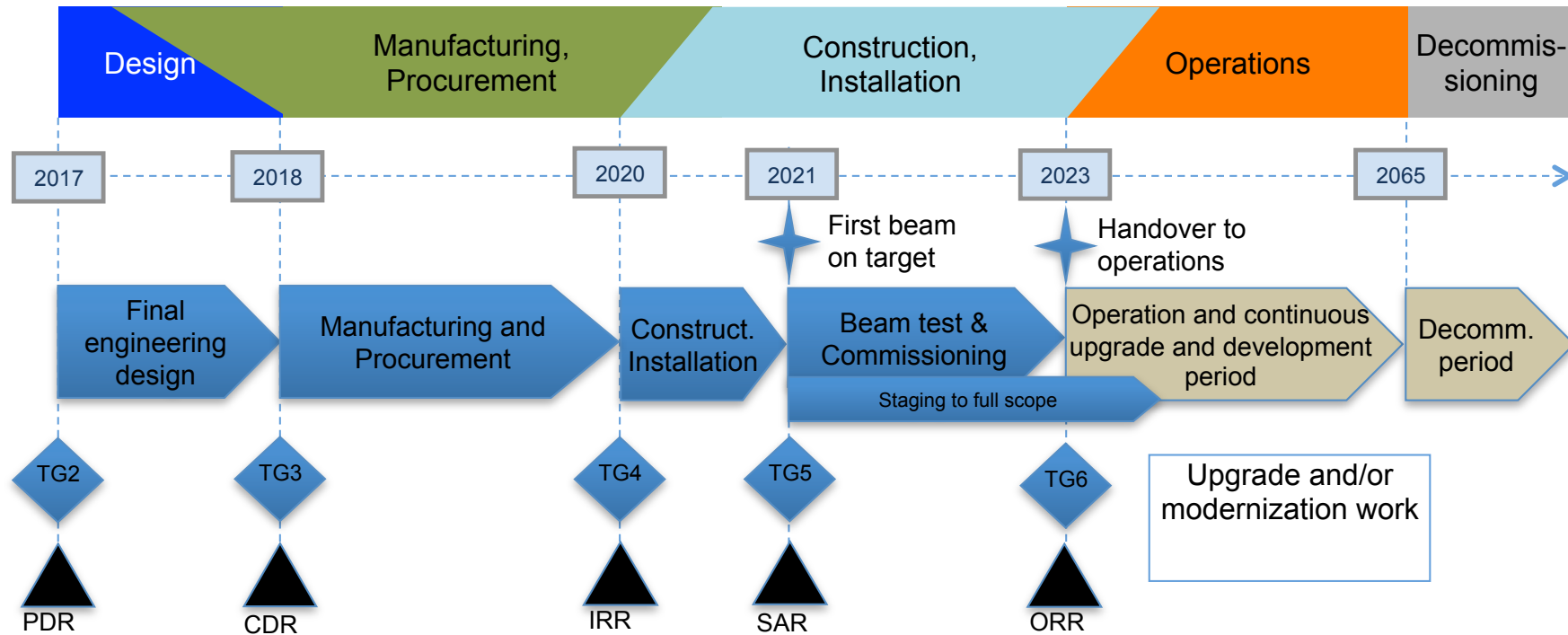
- New (wavelength dependent) techniques
 - Variable Wavelength resolutions: **10%, 1% and down to below 0.5%**
 - Variable Bandwidths: **Bandwidths of ~4.5 Å or ~9 Å selectable between 1-20 Å**
 - Time resolutions in quasi-stroboscopic mode: **~1 μ s**

- Synergy
 - X-ray contrast: **with comparable spatial resolution**
 - Diffraction capabilities: **with equivalent wavelength resolution**

ODIN Overview

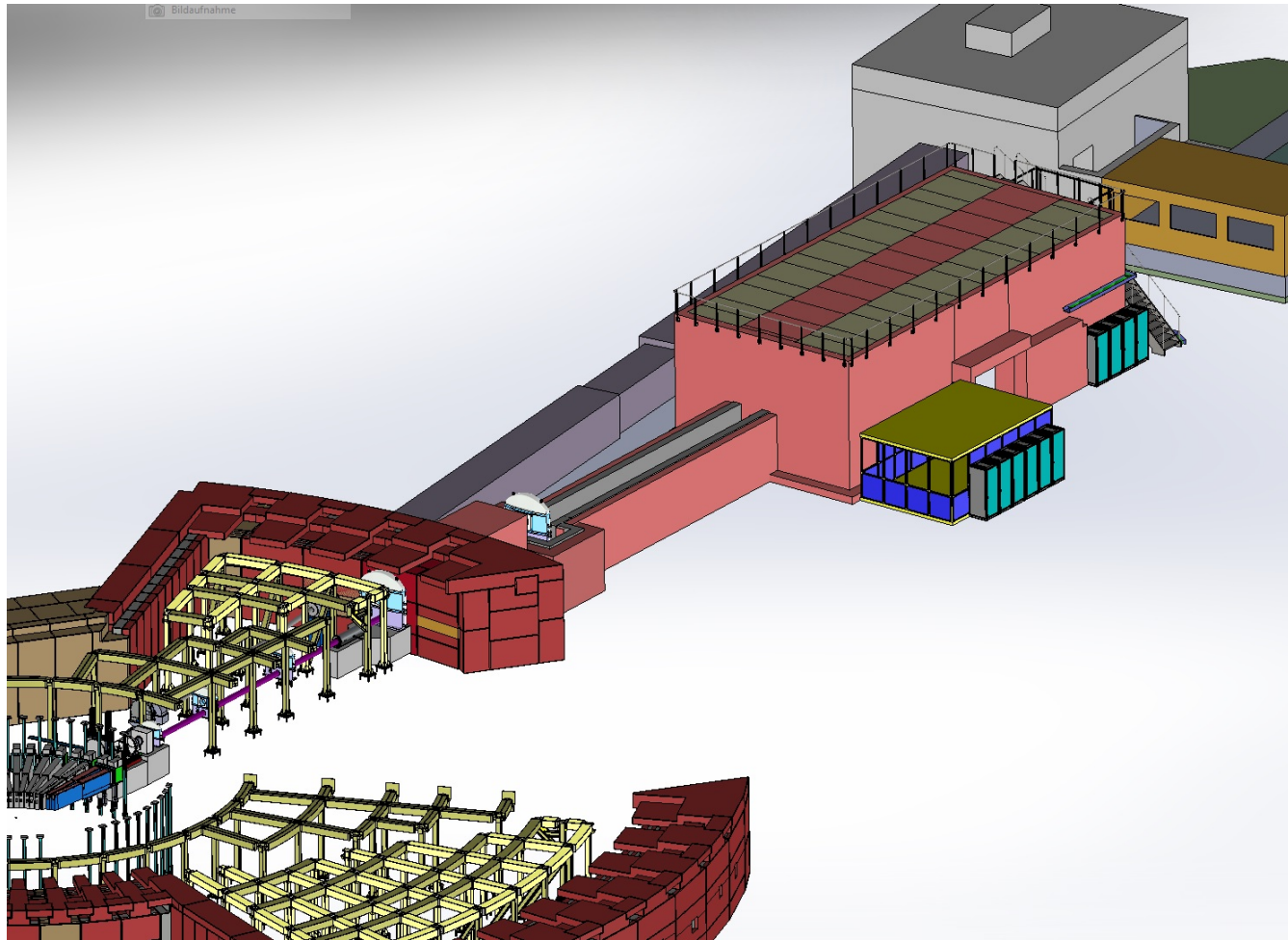
- Multi purpose imaging instrument
- 50m Source to pinhole
- Sample located up to 14m from the pinhole
- Straight beamline (direct view of the source)
- Chopper cascade consisting of 9 axis (plus 1 PPSc)
- Range of operational modes:
 - “White beam” imaging with spectral choice
 - Low Time of Flight resolution
 - Grating interferomete
 - SEMSANS imaging
 - Medium Time of Flight Resolution
 - Polarized and polarimetric neutron imaging set-up, Bragg-edge and diffraction
 - High Time of Flight Resolution: Bragg-edge and diffraction geometry set-up
 - Perpendicular X-ray imaging set-up

Life Cycle

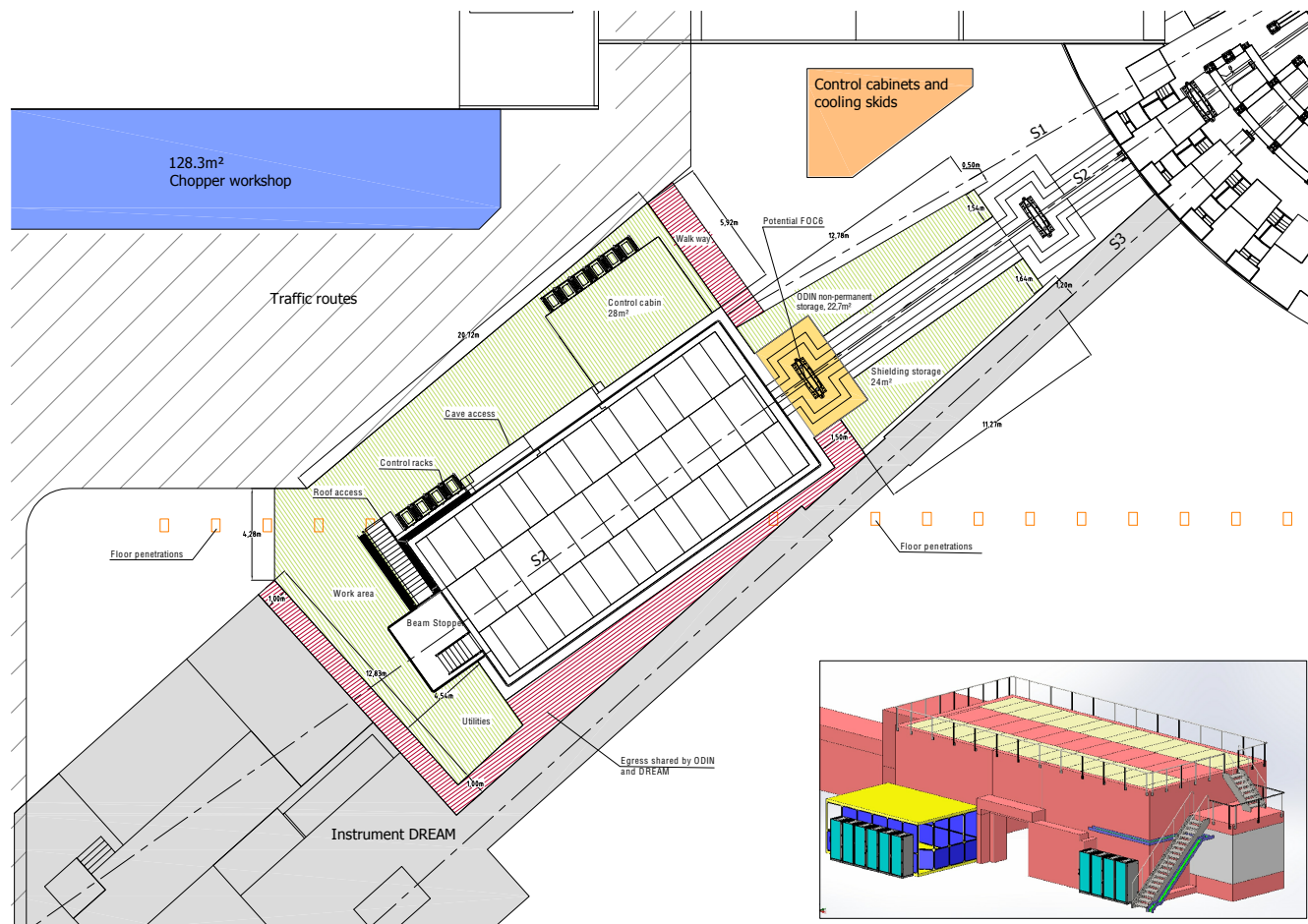


bunker wall penetration design	design monolith insert envelop	arrival in-monolith optics to ESS site	start installation in-monolith inserts	Start In-bunker installation	Partial Access D01	End In-bunker installation	Early Science (TG5)	User Programme
03-Mar-17	31-Mar-17	30-Nov-18	20-Mar-19	15-Nov-19	02-Mar-20	15-May-20	01-Feb-21	31-Aug-23

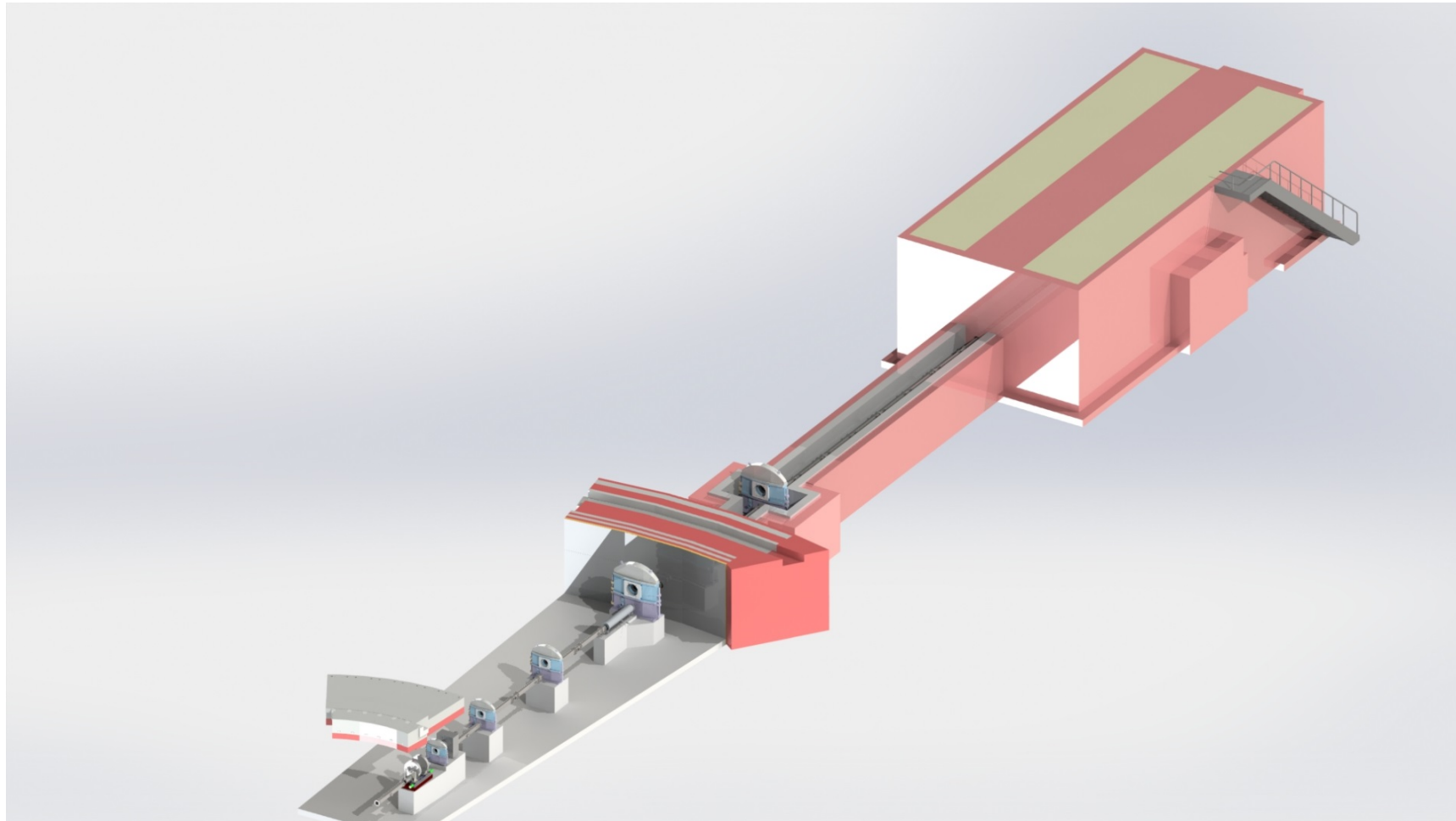
Floorplan



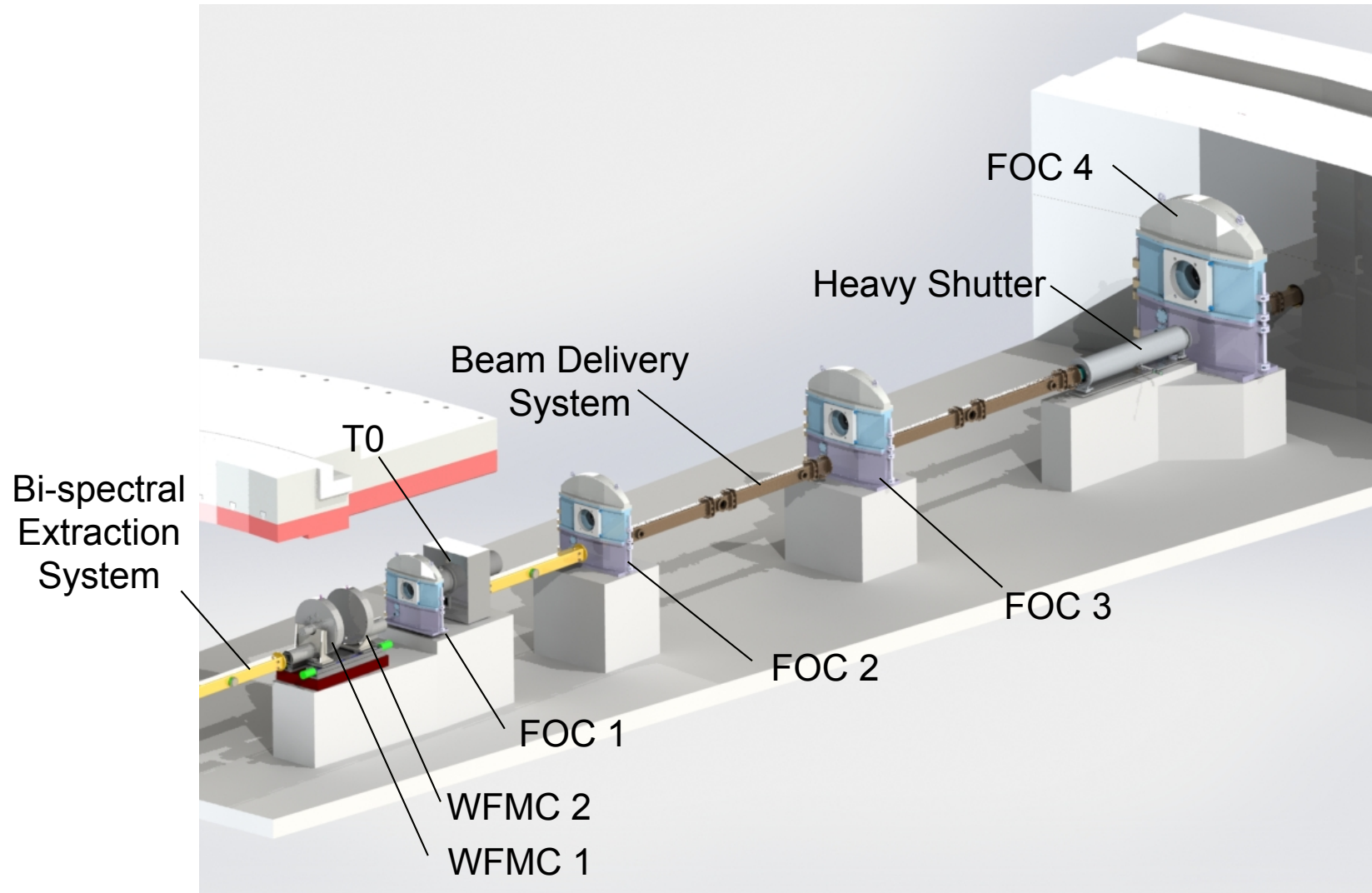
Floorplan



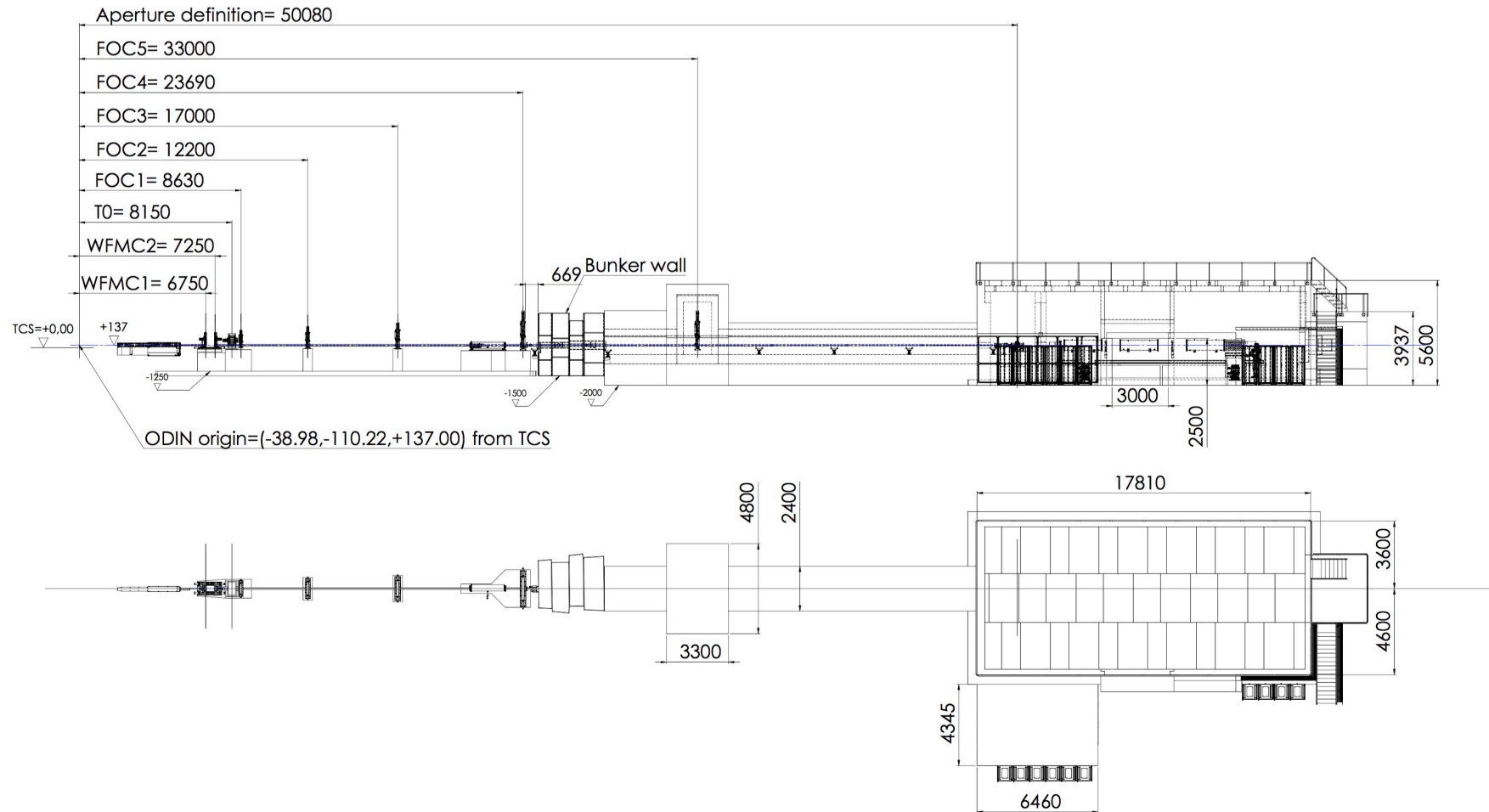
Overview



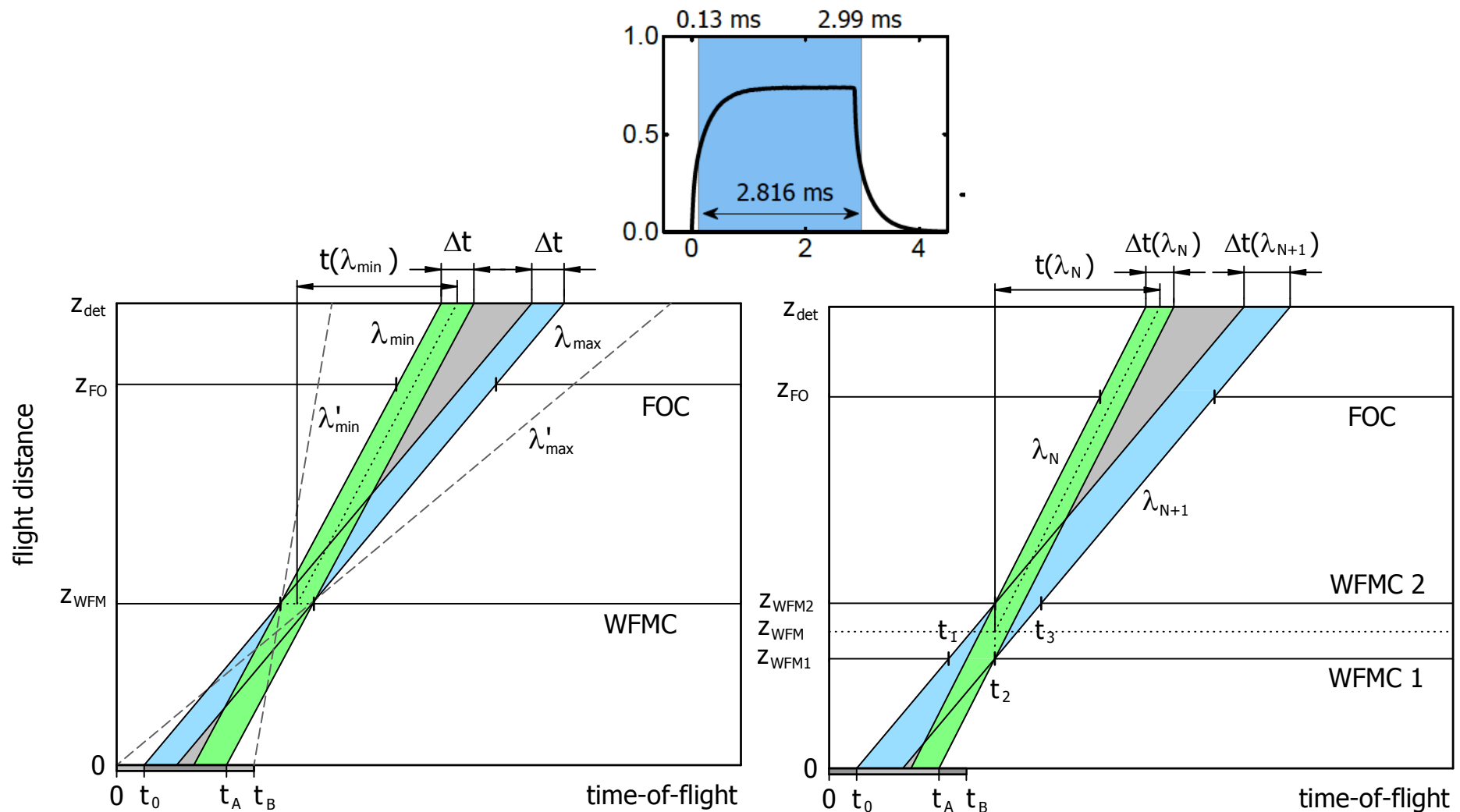
Bunker Area



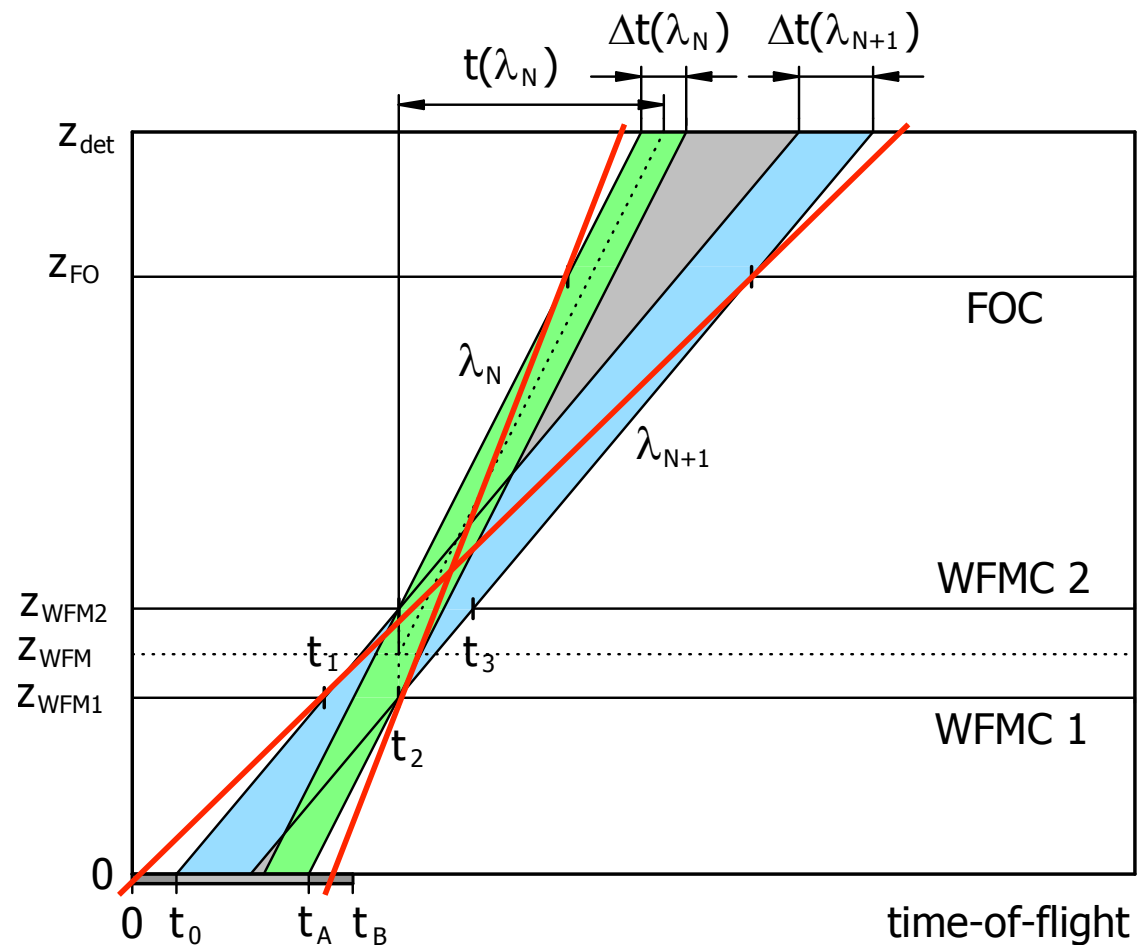
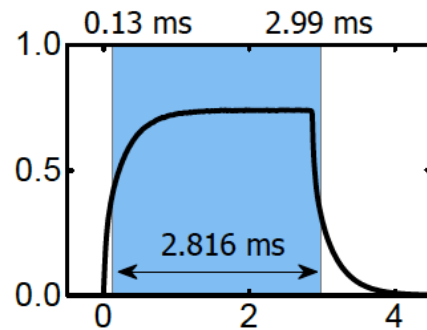
Chopper Cascade



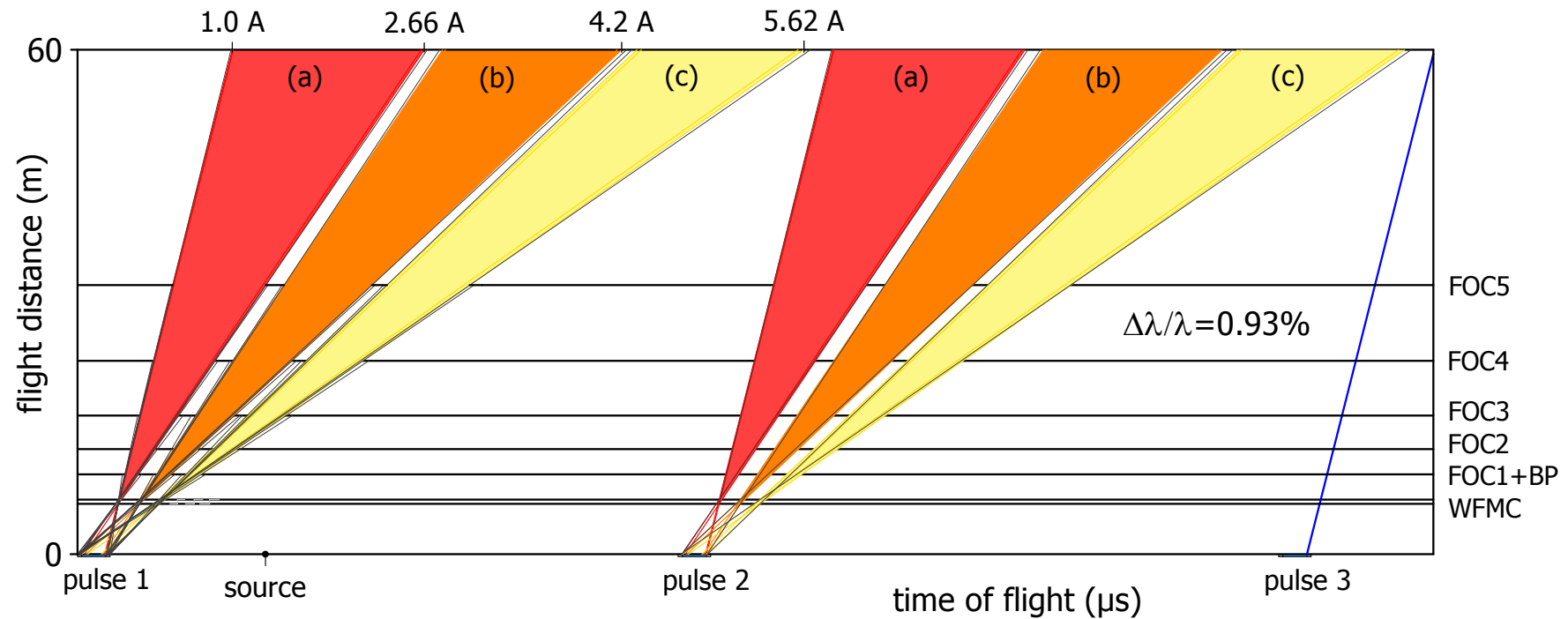
Wavelength Frame Multiplication Chopper



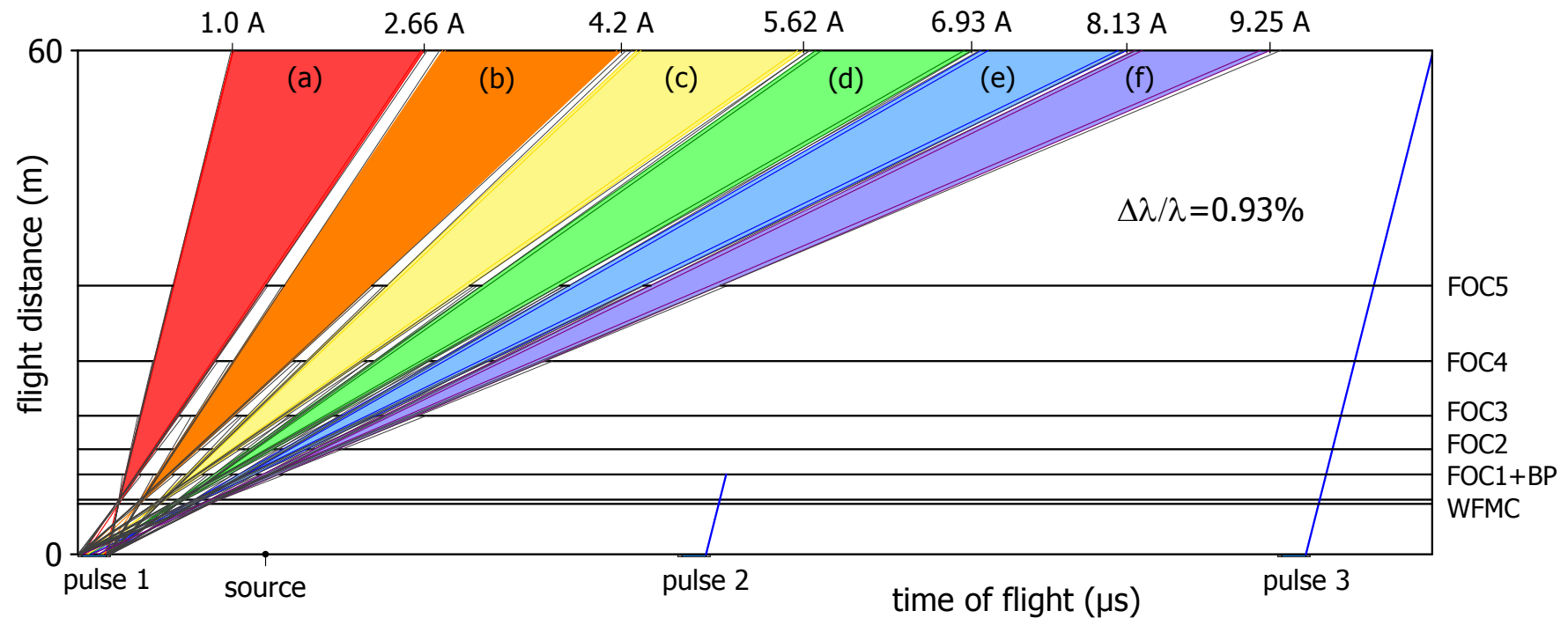
Wavelength Frame Multiplication Chopper



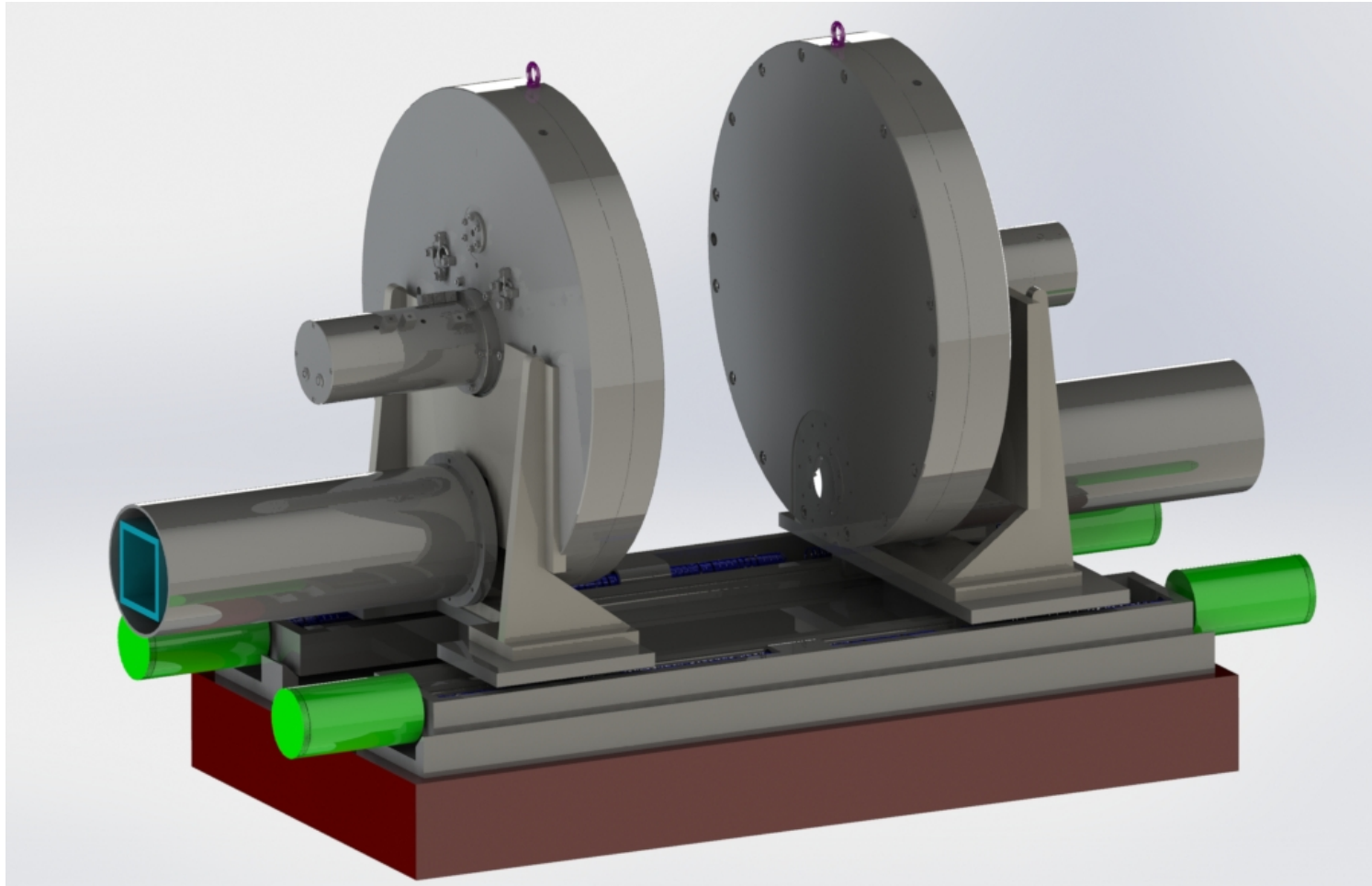
Chopper System: Every Pulse



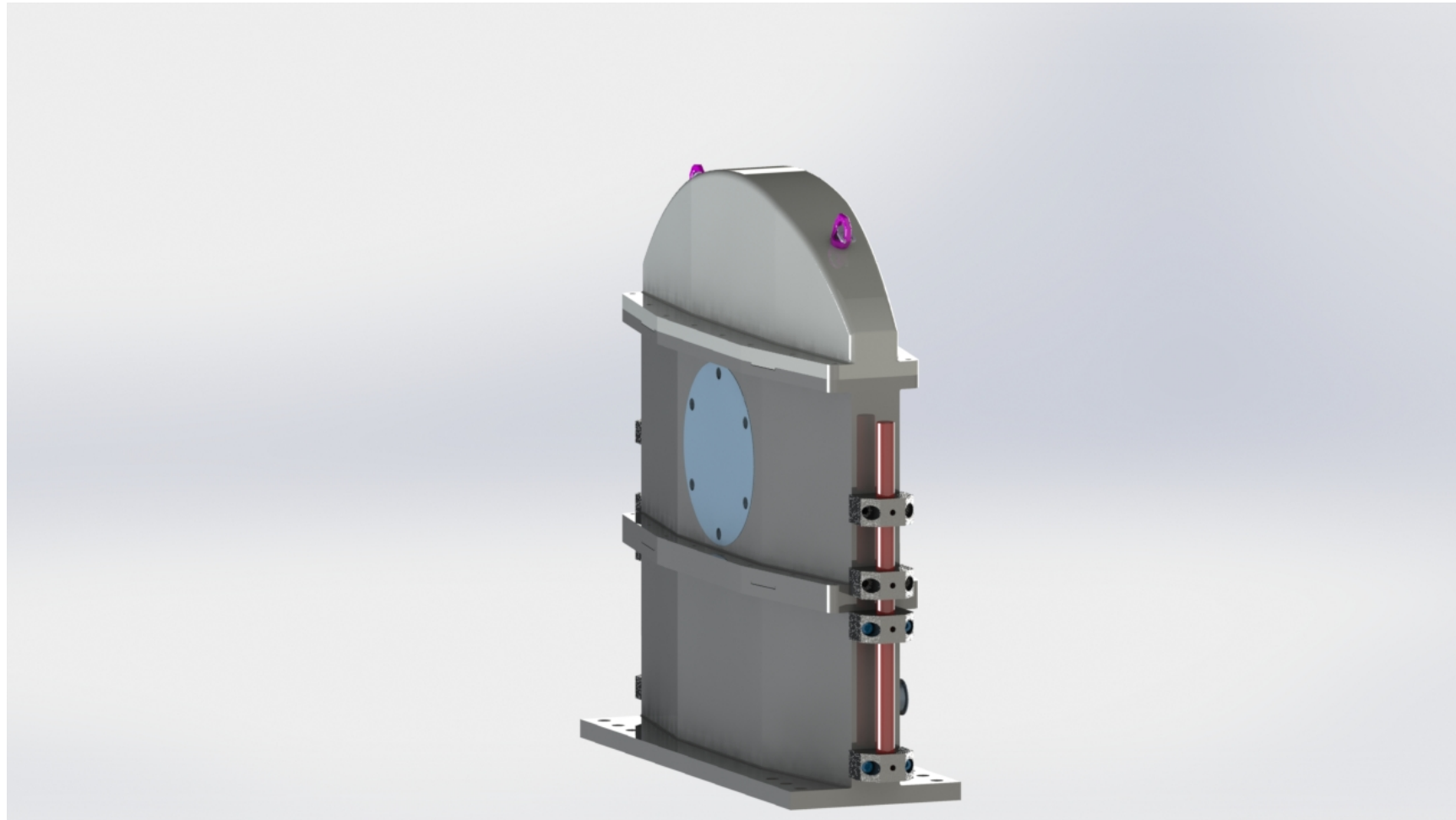
Chopper System: Every 2nd Pulse



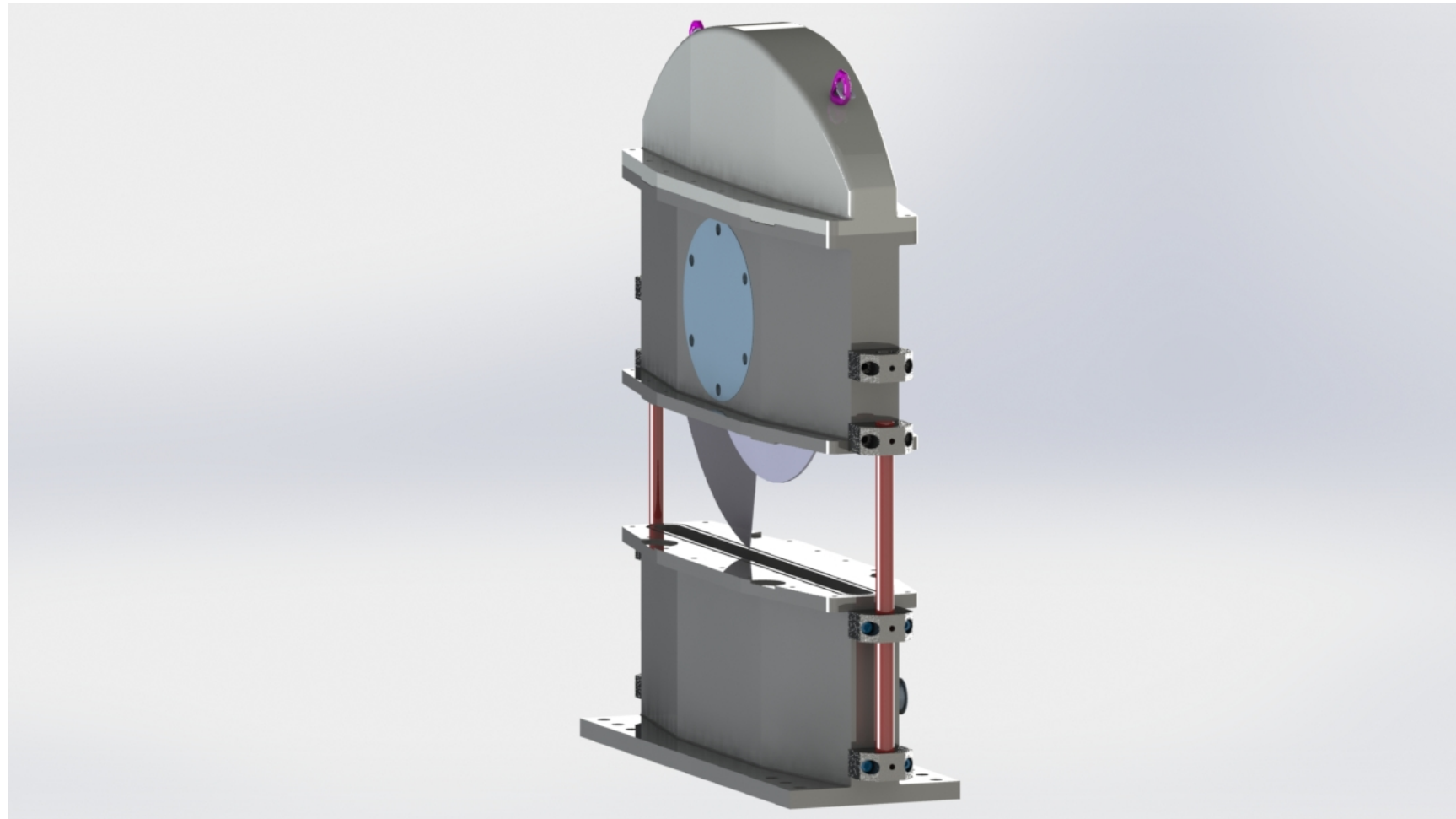
Wavelength Frame Multiplication Choppers



Frame Overlap Chopper

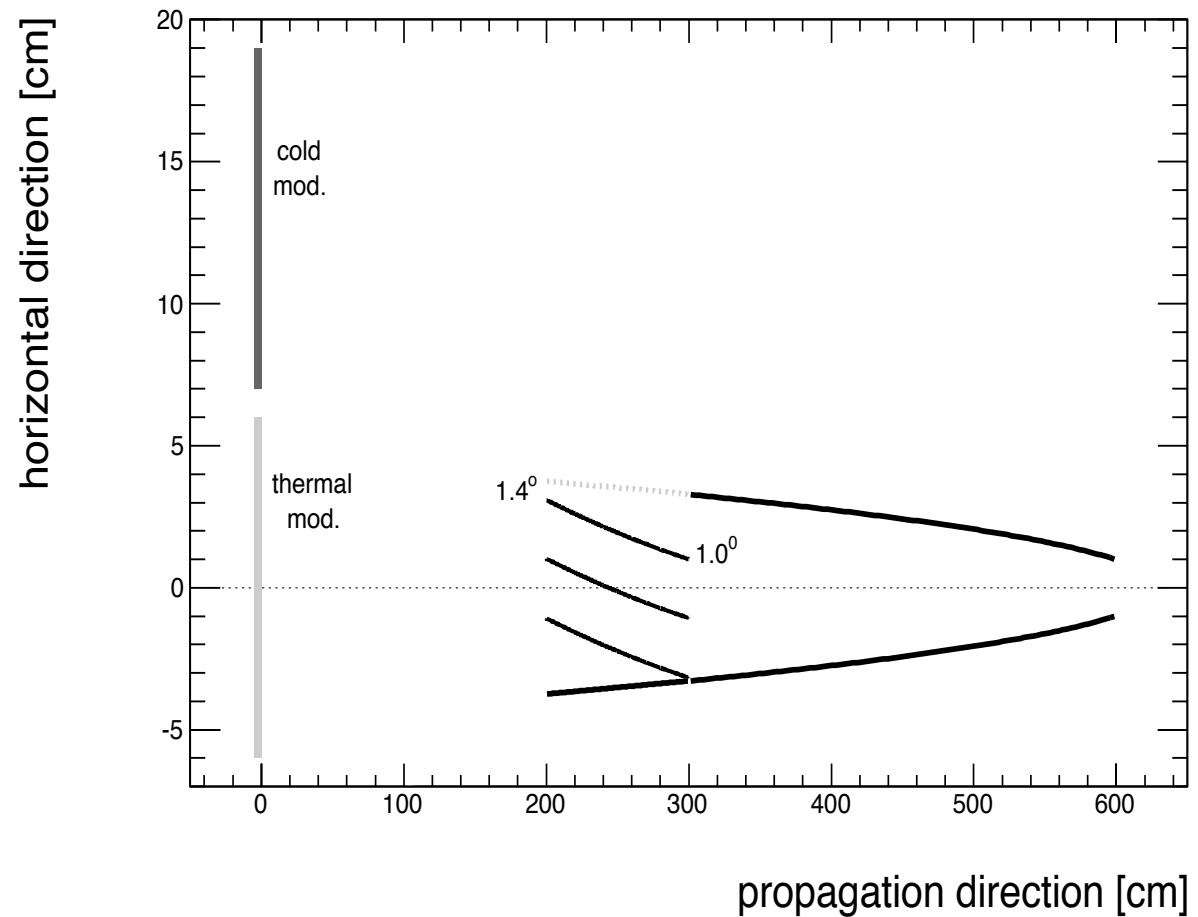


Frame Overlap Chopper

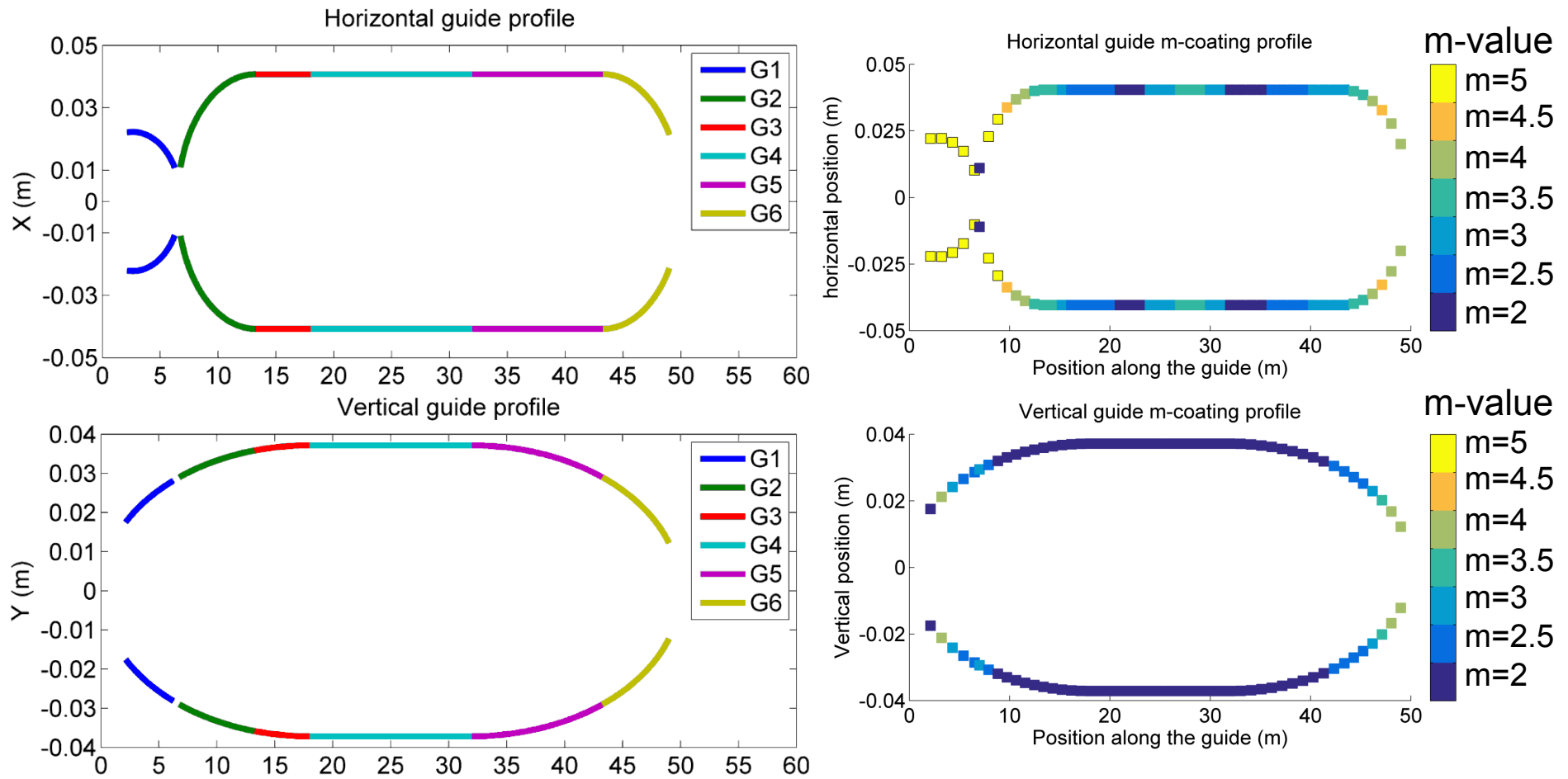


Bi-spectral Extraction System

- Schematic

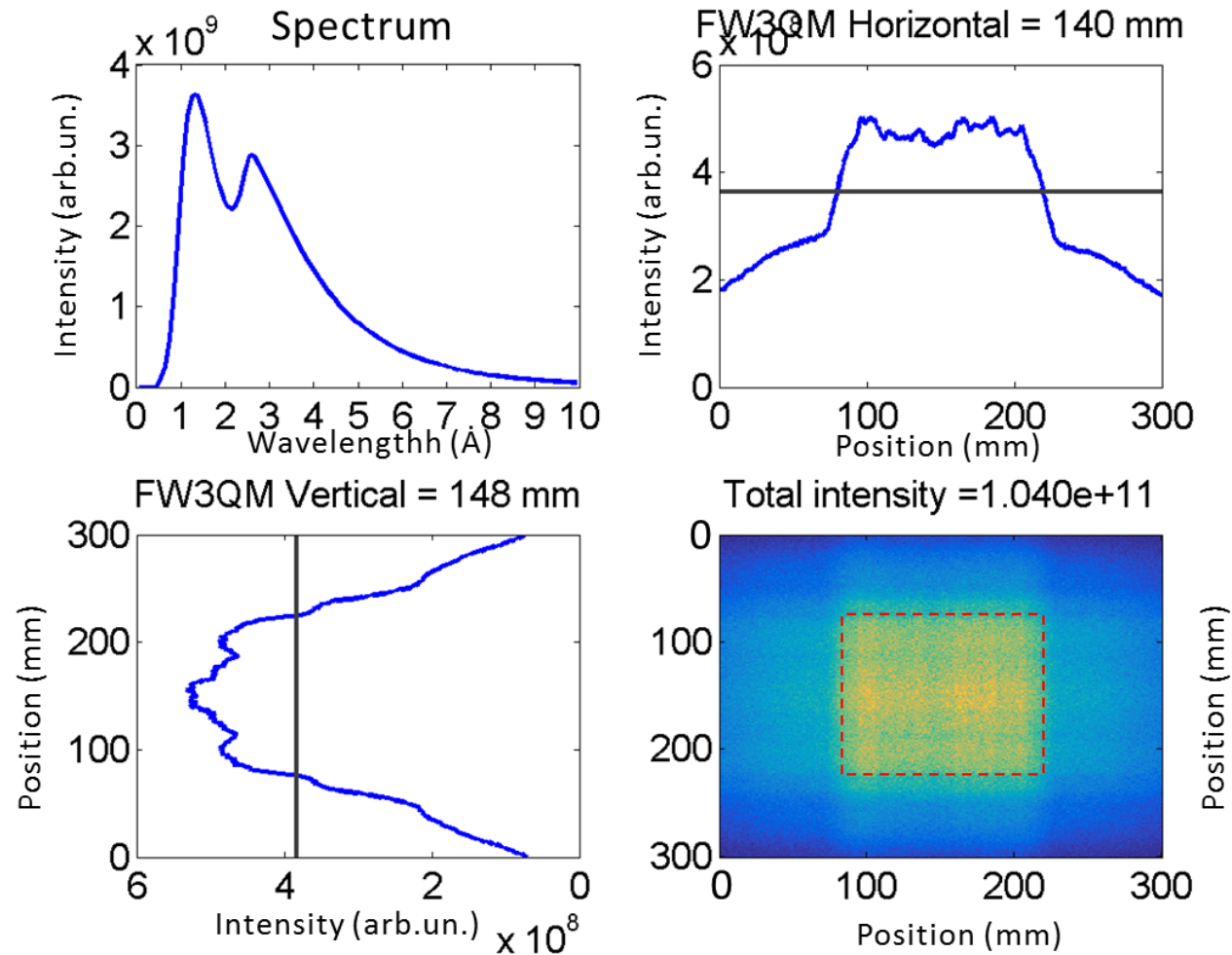


Neutron Guide Shape and Coating

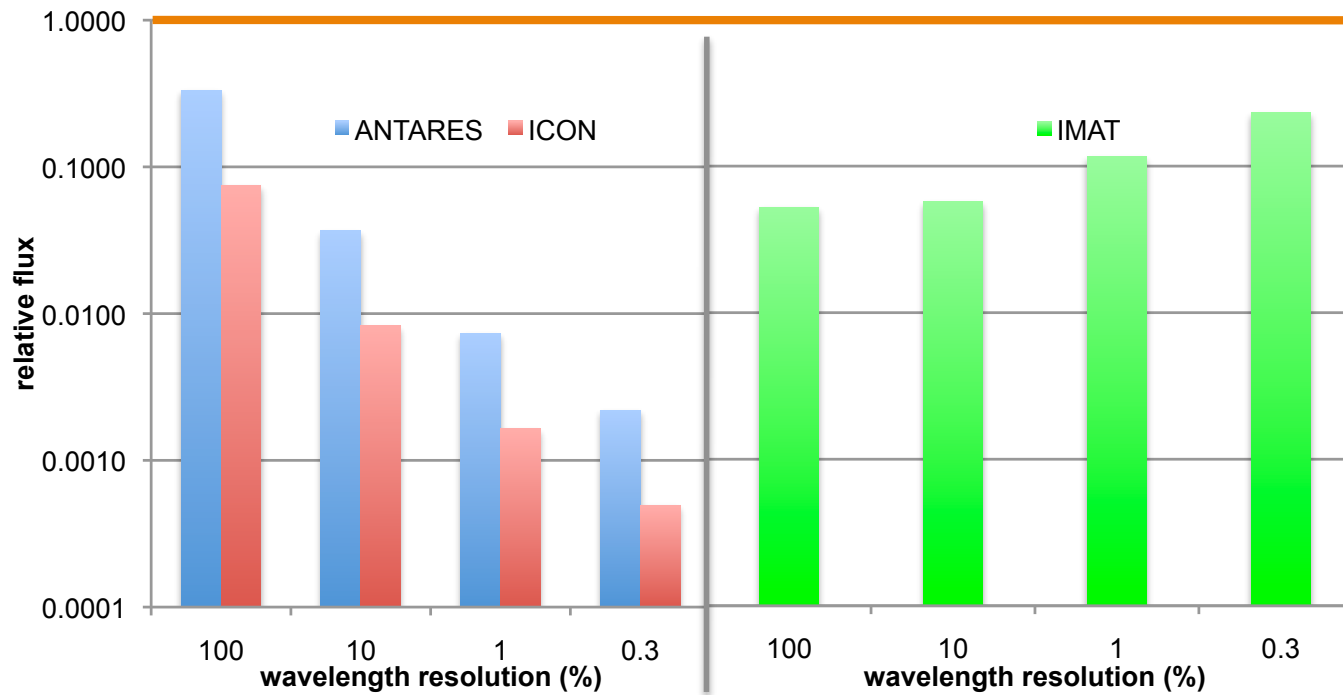


Intensity Distribution

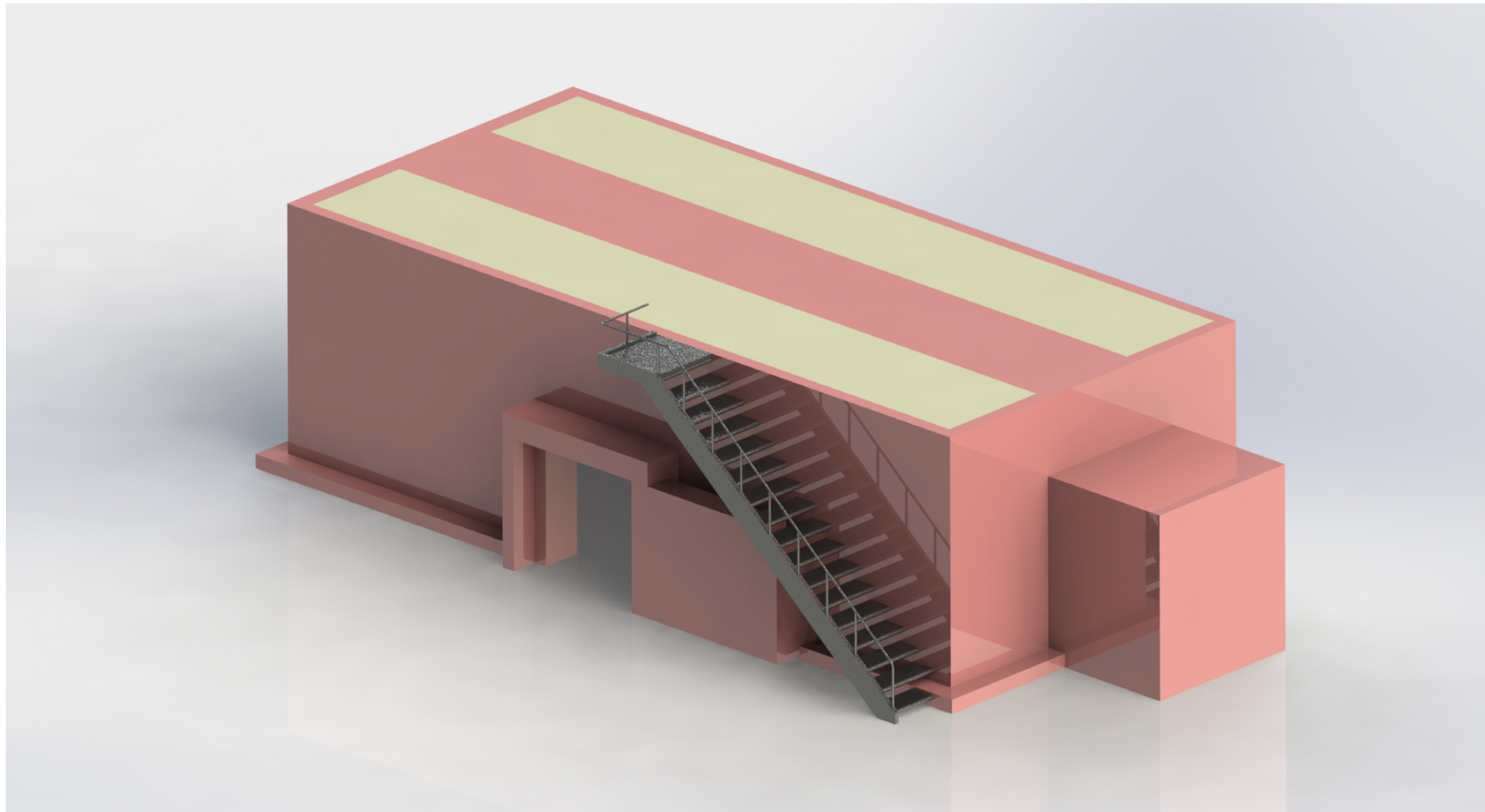
FoV at 10m position



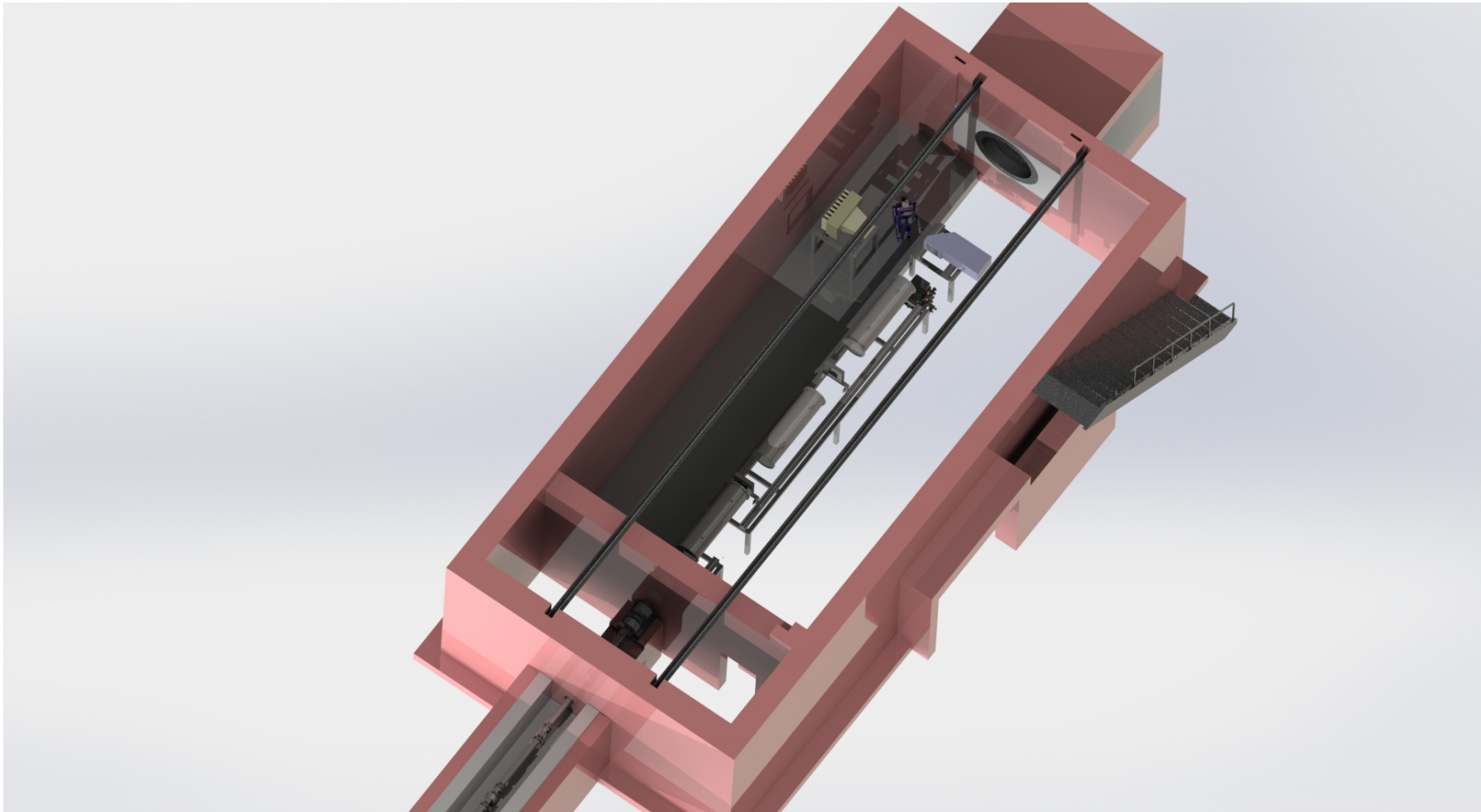
Flux Comparison



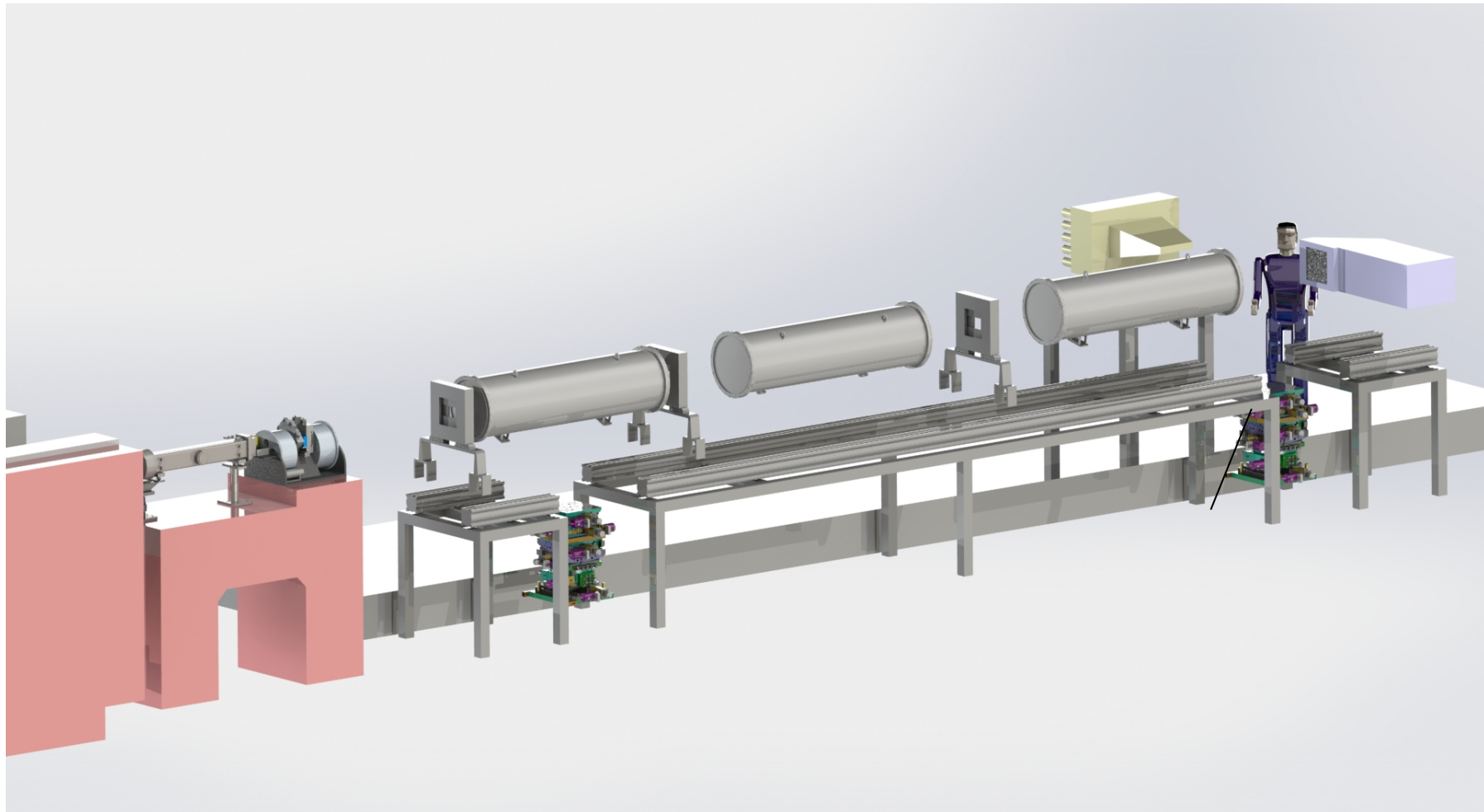
Cave



Cave Interior

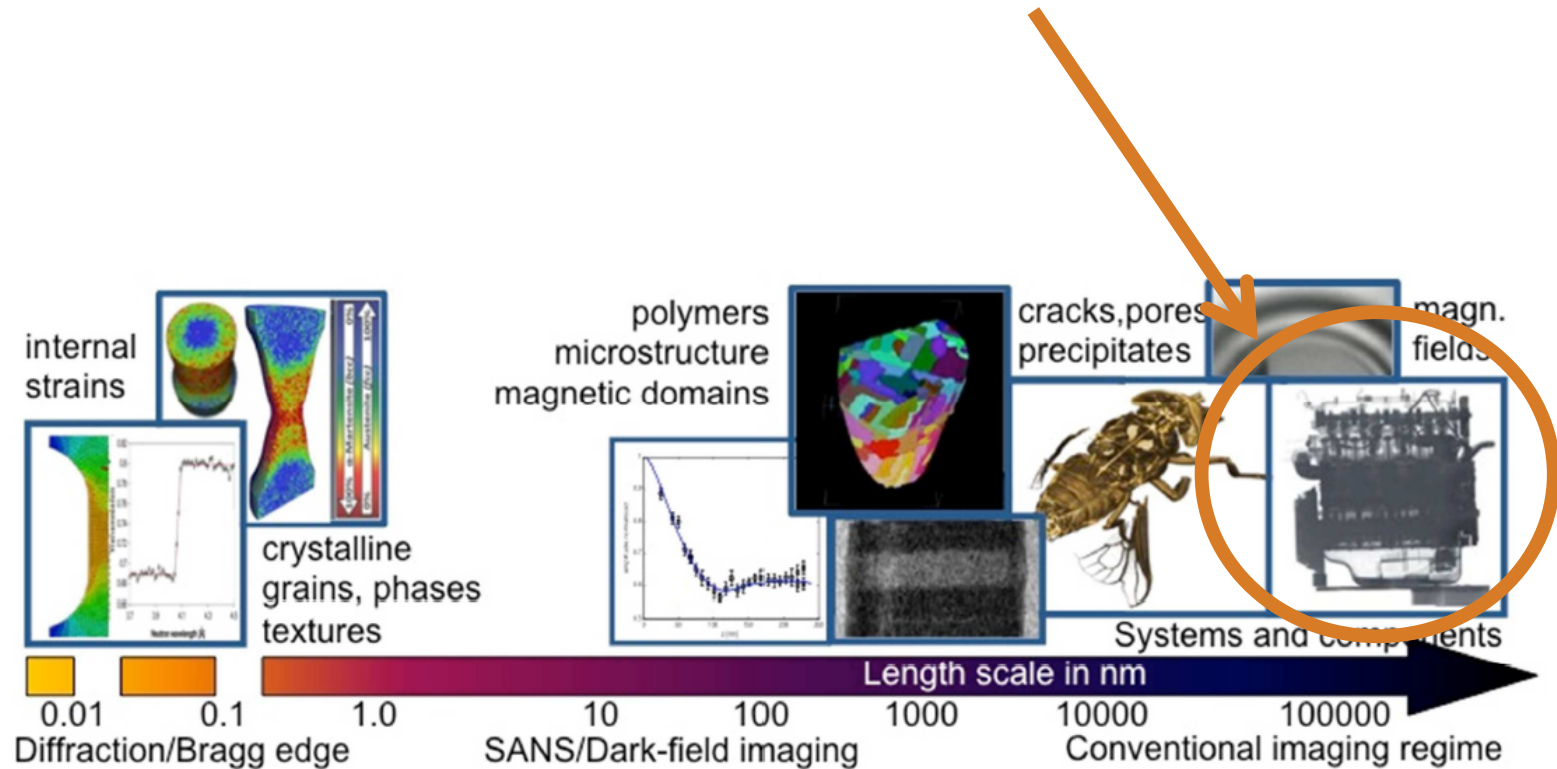


Cave Interior



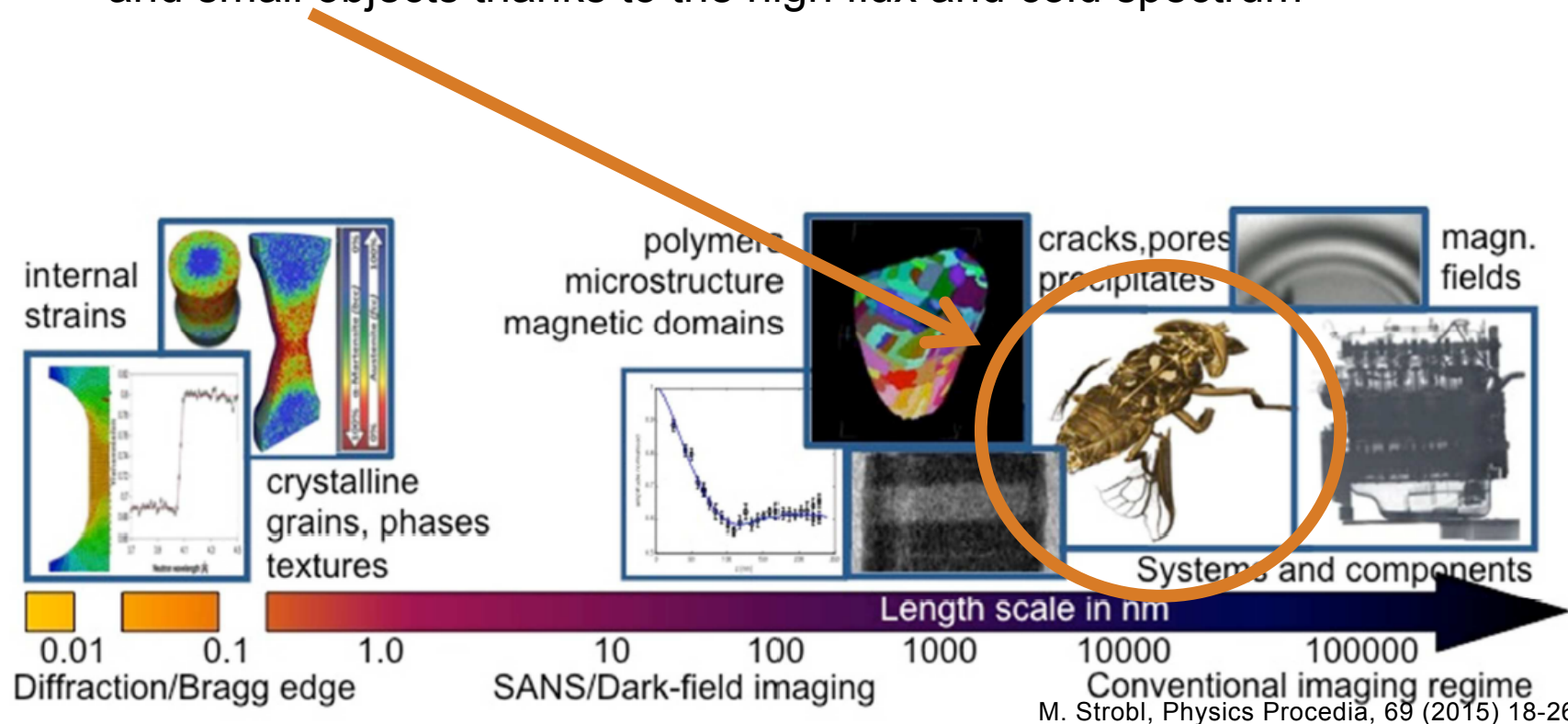
Full scope of ODIN

- White beam imaging with best spatial resolution and variable FoV:
 - Big objects thanks to the 20 x 20 cm² FoV and cold to thermal spectrum...



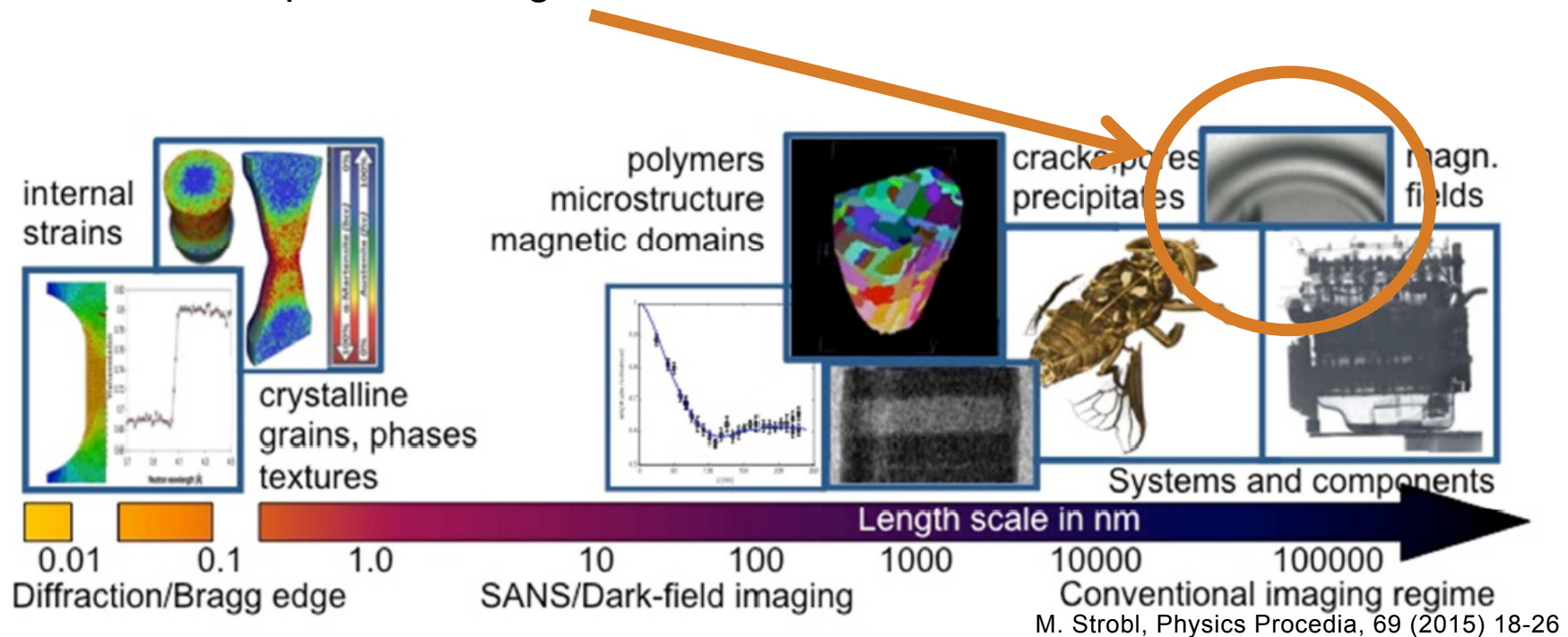
Full scope of ODIN

- White beam imaging with best spatial resolution and variable FoV:
 - Big objects thanks to the 20 x 20 cm² FoV and cold to thermal spectrum,
 - and small objects thanks to the high flux and cold spectrum



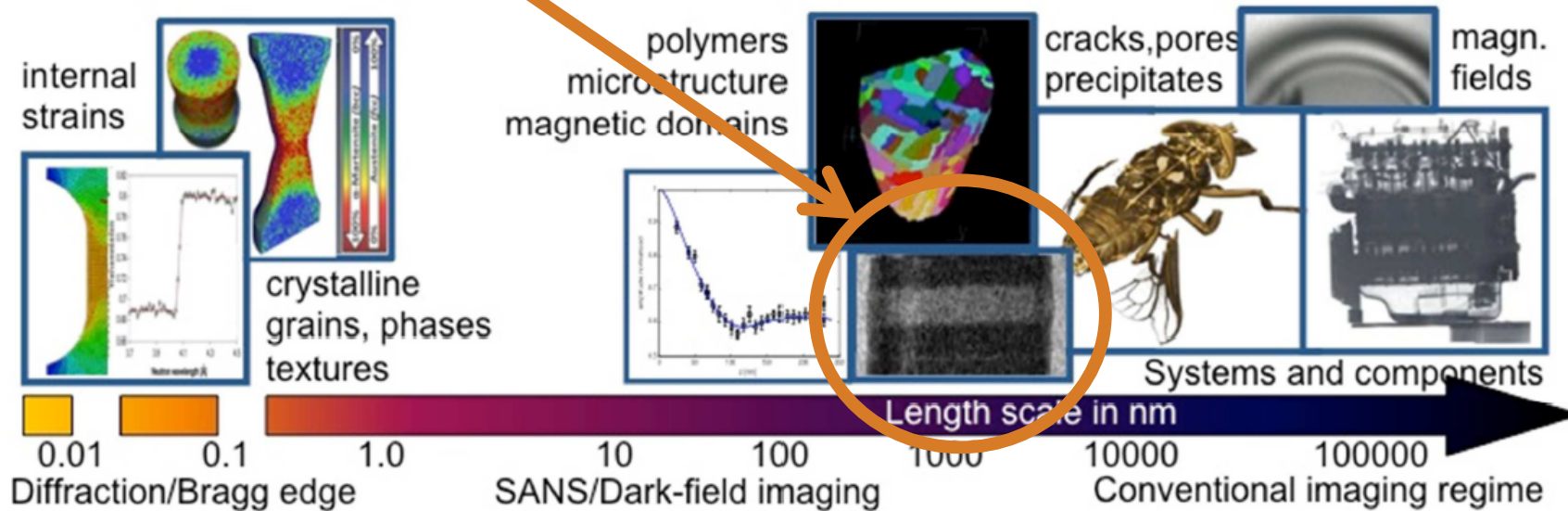
Full scope of ODIN

- White beam imaging with best spatial resolution and variable FoV:
- Polarized neutron imaging
 - To visualize (and quantify thanks to ToF information) magnetization in bulk samples and magnetic field outside



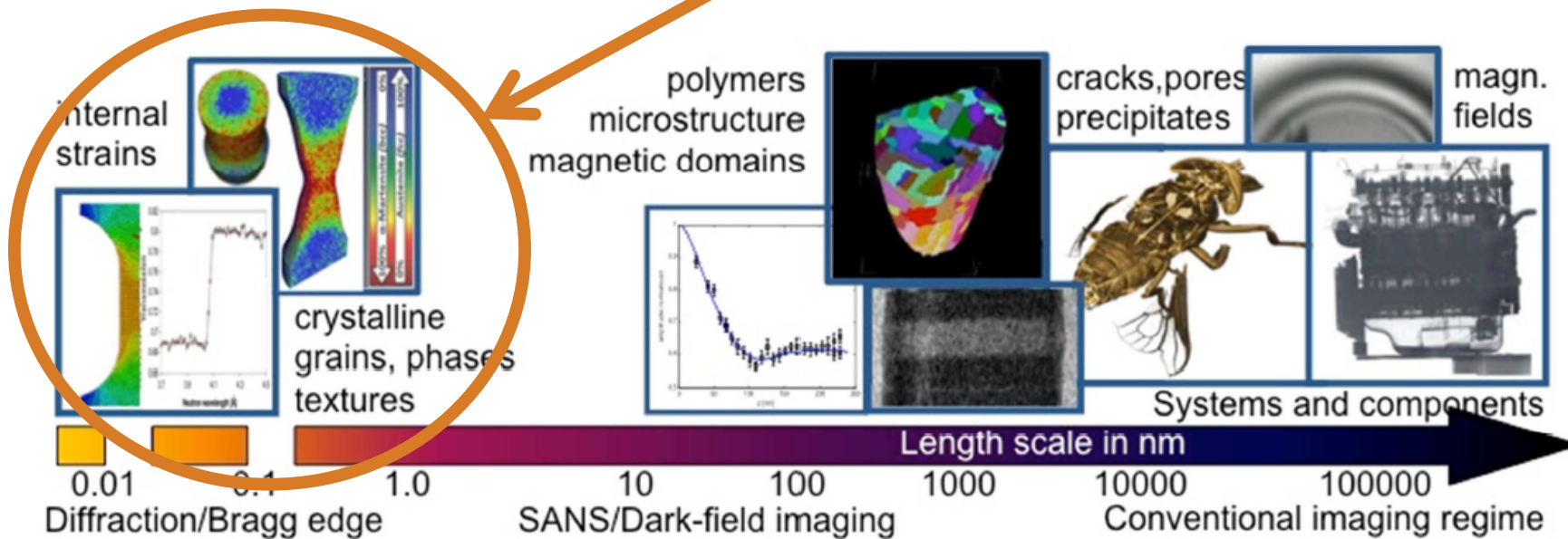
Full scope of ODIN

- White beam imaging with best spatial resolution and variable FoV:
- Polarized neutron imaging
- Dark field imaging
 - To visualize magnetic domains
 - Microstructures beyond the image resolution qualitatively



Full scope of ODIN

- White beam imaging with best spatial resolution and variable FoV:
- Polarized neutron imaging
- Dark field imaging
- Wavelength resolved Bragg edge imaging
 - To visualize grains, phases, strains and texture





Thank You!