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THE WEST THOMSON SCATTERING DIAGNOSTIC: PLASMA EDGE MEASUREMENT

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Motivations

- Millimetric resolution in the plasma edge
- Upper-half plasma coverage with some overlap between edge & core channels
- Real time measurements possible
- Temperature: 1 keV (pedestal) to few eV (far SOL)
- No ECE, Reflectometry or Interferometry measurement in the edge to resolve n_e profile

Constraints

- Long pulse (1000 s) measurement.
- Reach millimetric resolution
- First mirror inside the vessel & $\phi_{pupil} \sim 8$ cm
- First mirror water cooled & all in-vessel optics protected by a thermal shield
- Shutter to protect the optics against glow discharges and boronization
- Best compromise: $\phi_{pupil} \sim 8$ cm & $\Delta z = 18$ cm.
- Optical vacuum feedthrough

Specifications

- A probing zone from $Z=0,47$ to $Z=0,65$ m covers the pedestal and the SOL in most configurations
- 30 lines of sight :
 - ↳ 14 far SOL views monitored with simple fibres
 - ↳ 16 pedestal views monitored with duplexed fibres
- 6 mm height
- 7,5 mm toroidal width } for each scattered volume

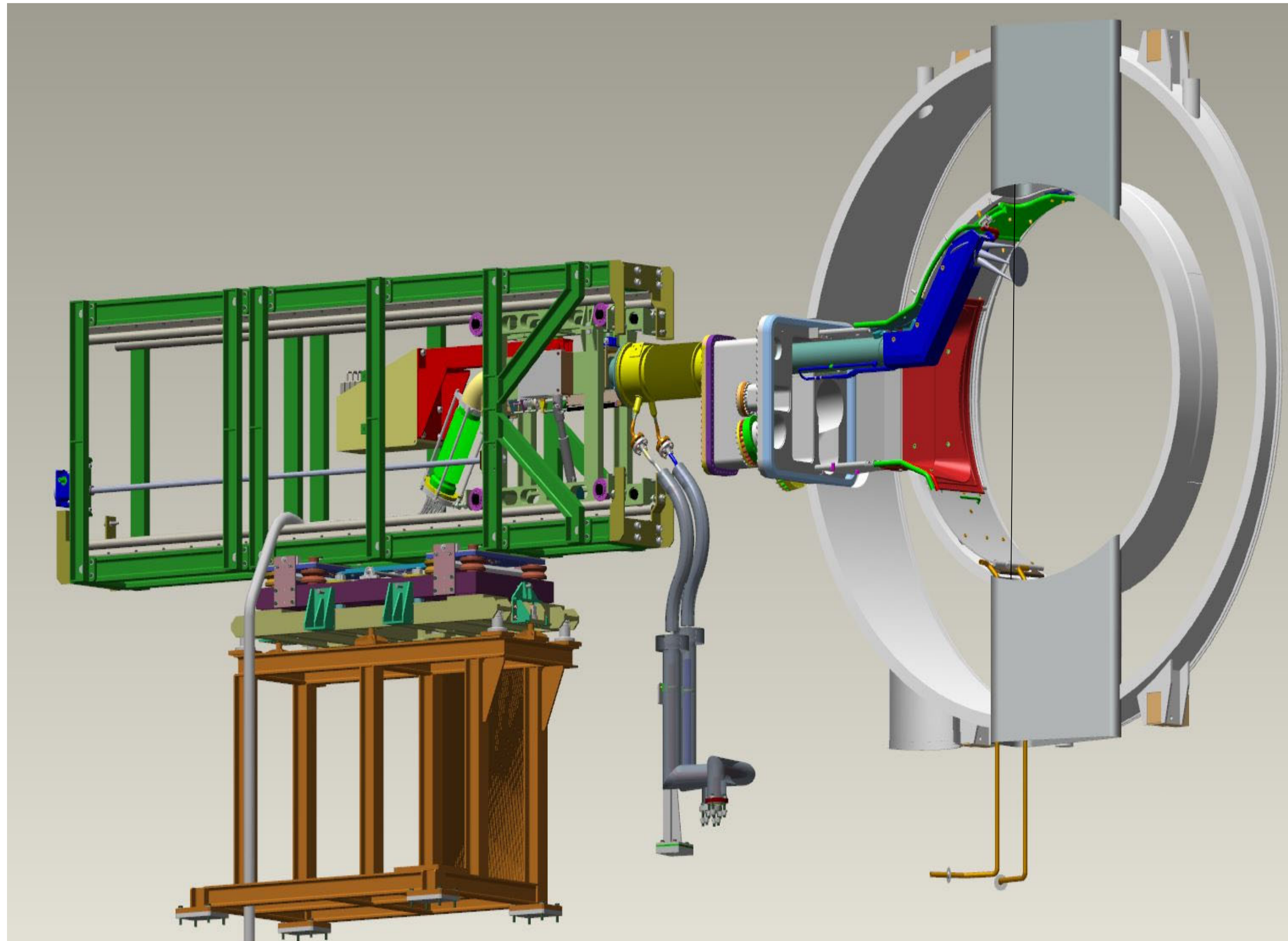


Fig 1. View of the Edge measurement system



Fig 2. Installation of the Edge Diagnostic

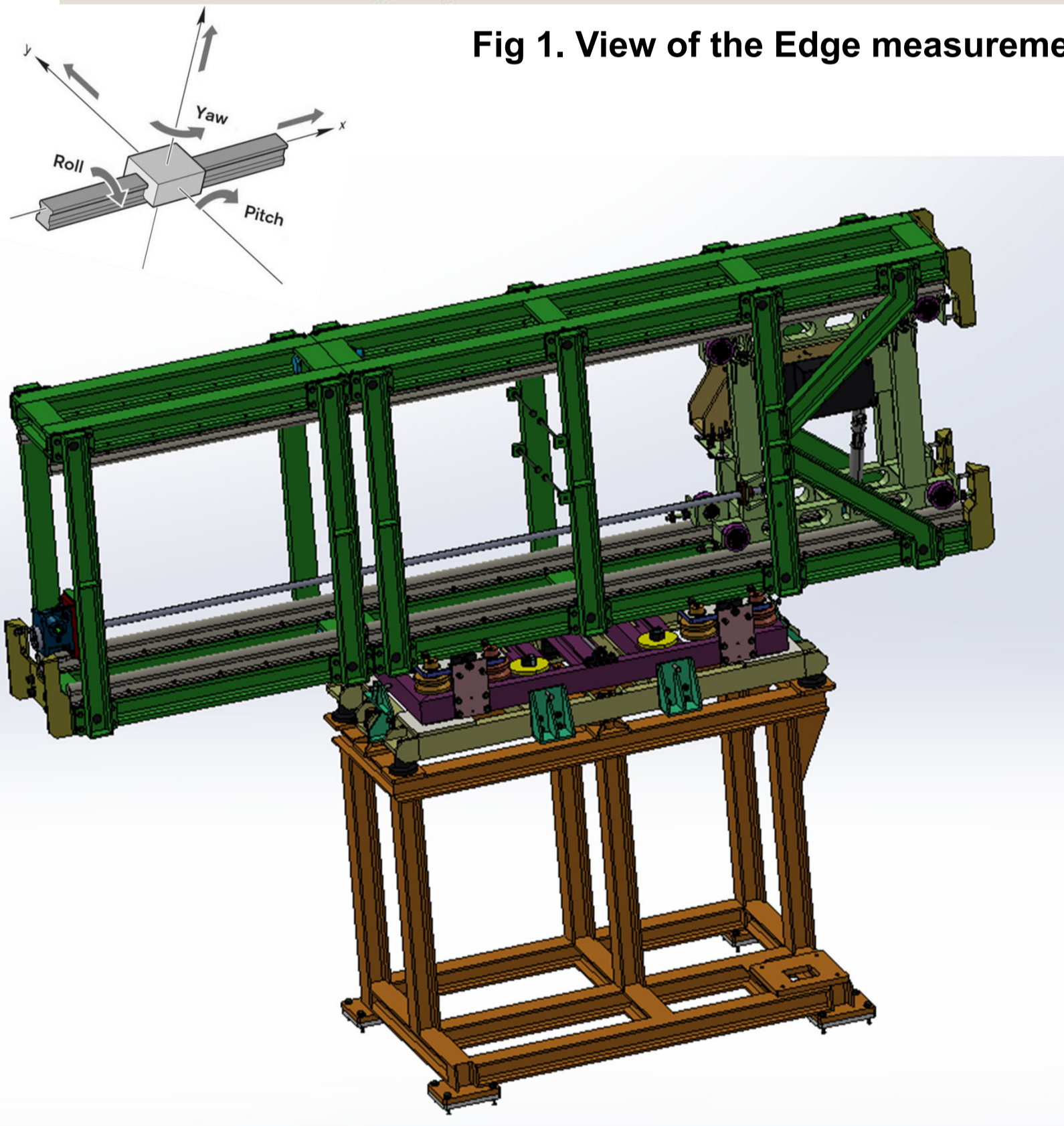


Fig 3. The frames

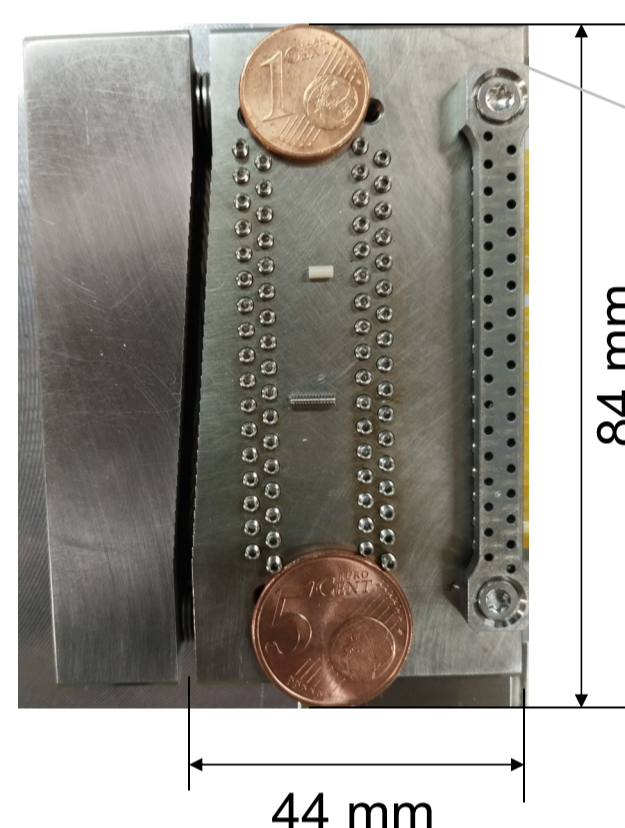


Fig 5. View of the Fibres Holder

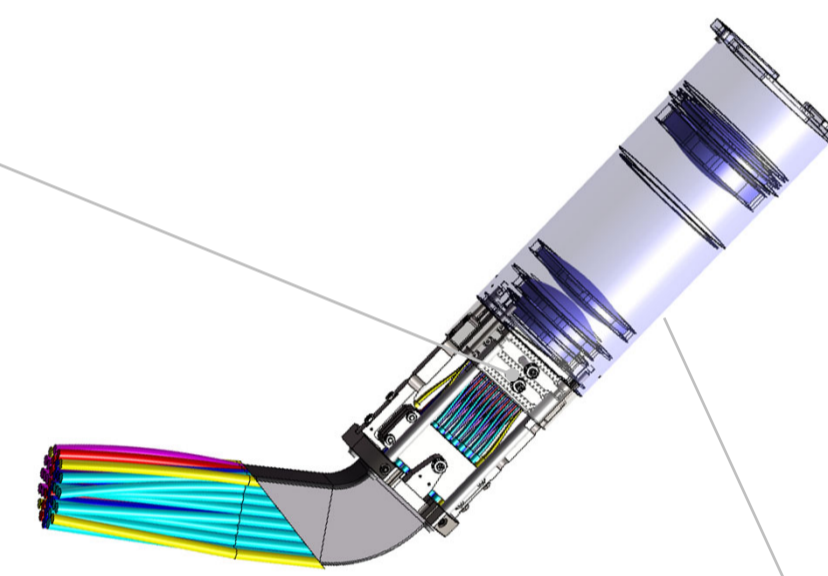


Fig 8. In-vessel optics

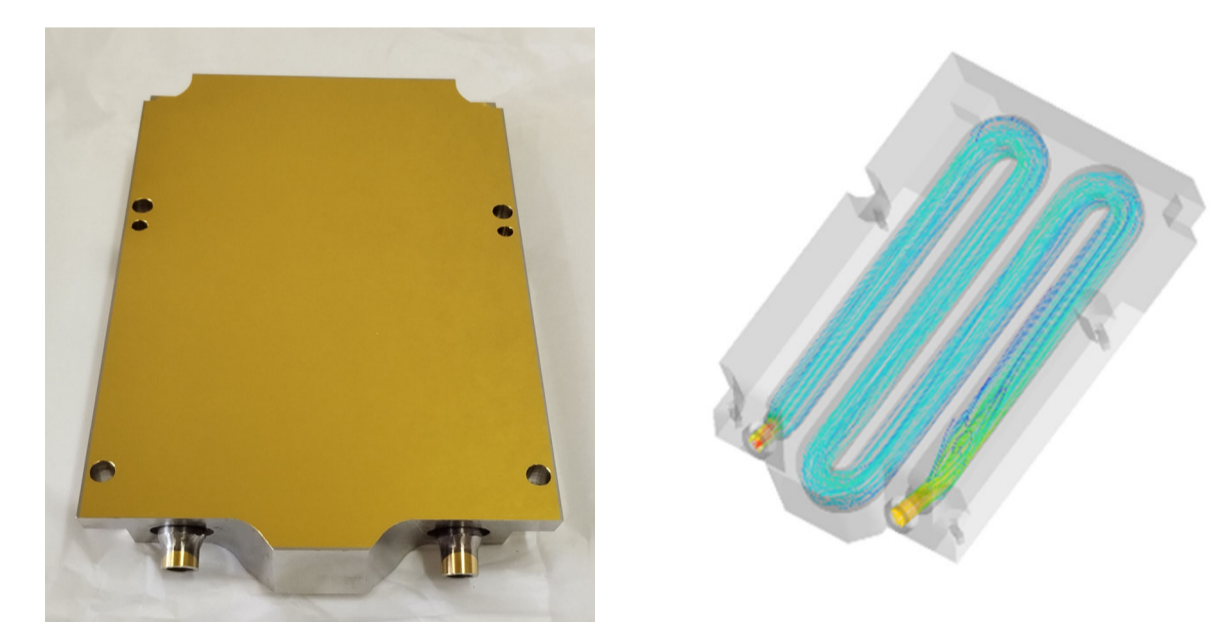


Fig 9. The actively cooled Gold Coated Mirror Hot Isostatic Pressing Manufactured

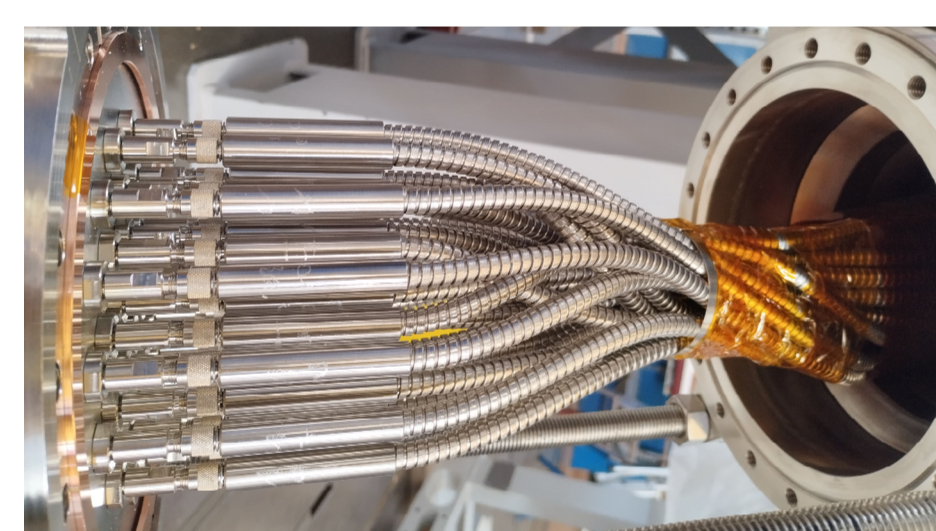


Fig 6. High Temperature Inner Fibers Bundle screwed on the Optical Feedthrough

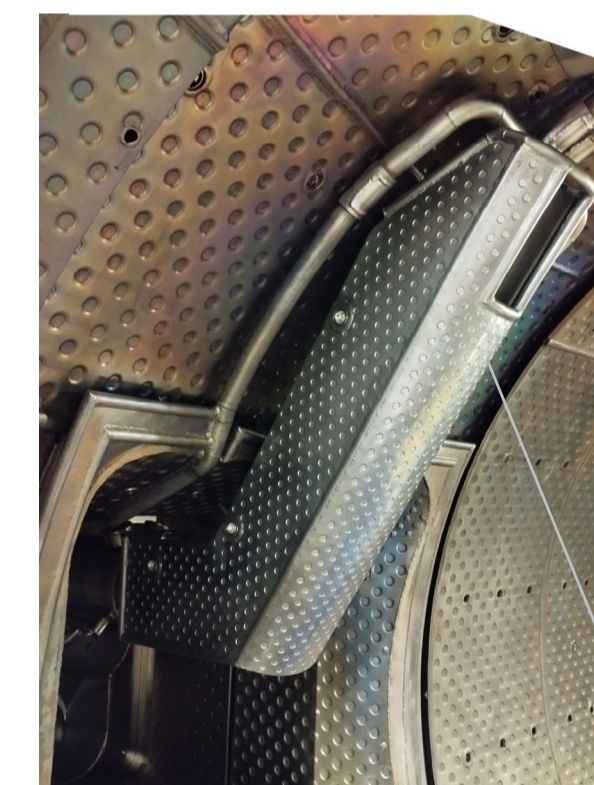


Fig 10. Real View of the Endoscope

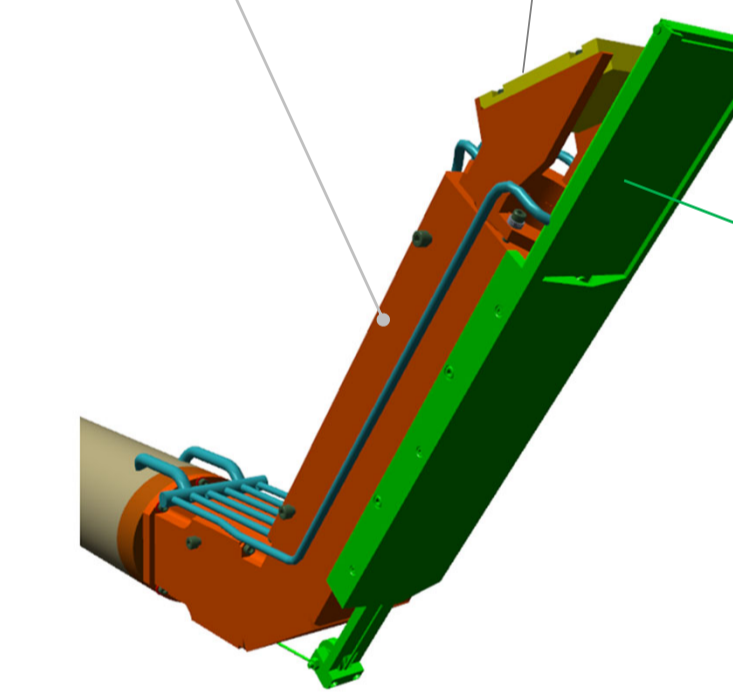


Fig 11. View of the Shutter

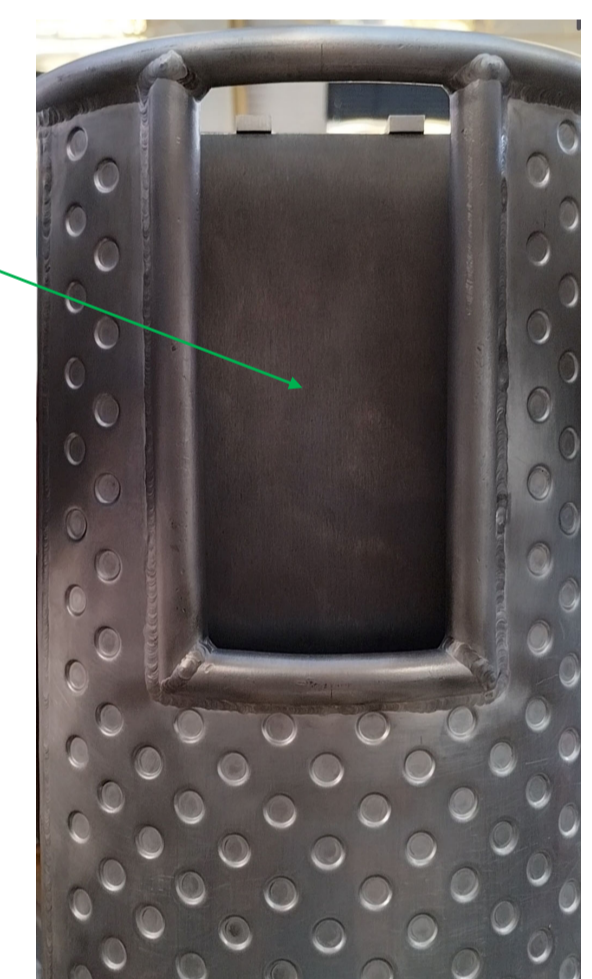


Fig 12. Thermal Shield

Global motions :

Translation along X :

Introduction of the endoscope and

Focalization of the scattered volume

PITCH : Inclination of the endoscope to able

the introduction in the vacuum vessel

Translation along Y : To ensure line-of-sight

collinearity with the laser beam

Mirror motions :

PITCH : ensure the height of the line-of-sight

ROLL : Motion to ensure the line-of-sight

collinearity with the laser beam

YAW : Fine motion to ensure the line-of-sight

collinearity with the laser beam

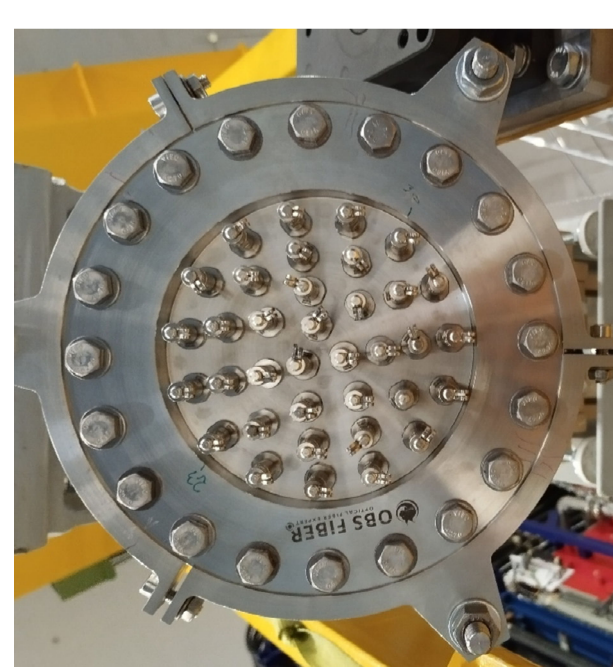


Fig 7. The Optical Feedthrough

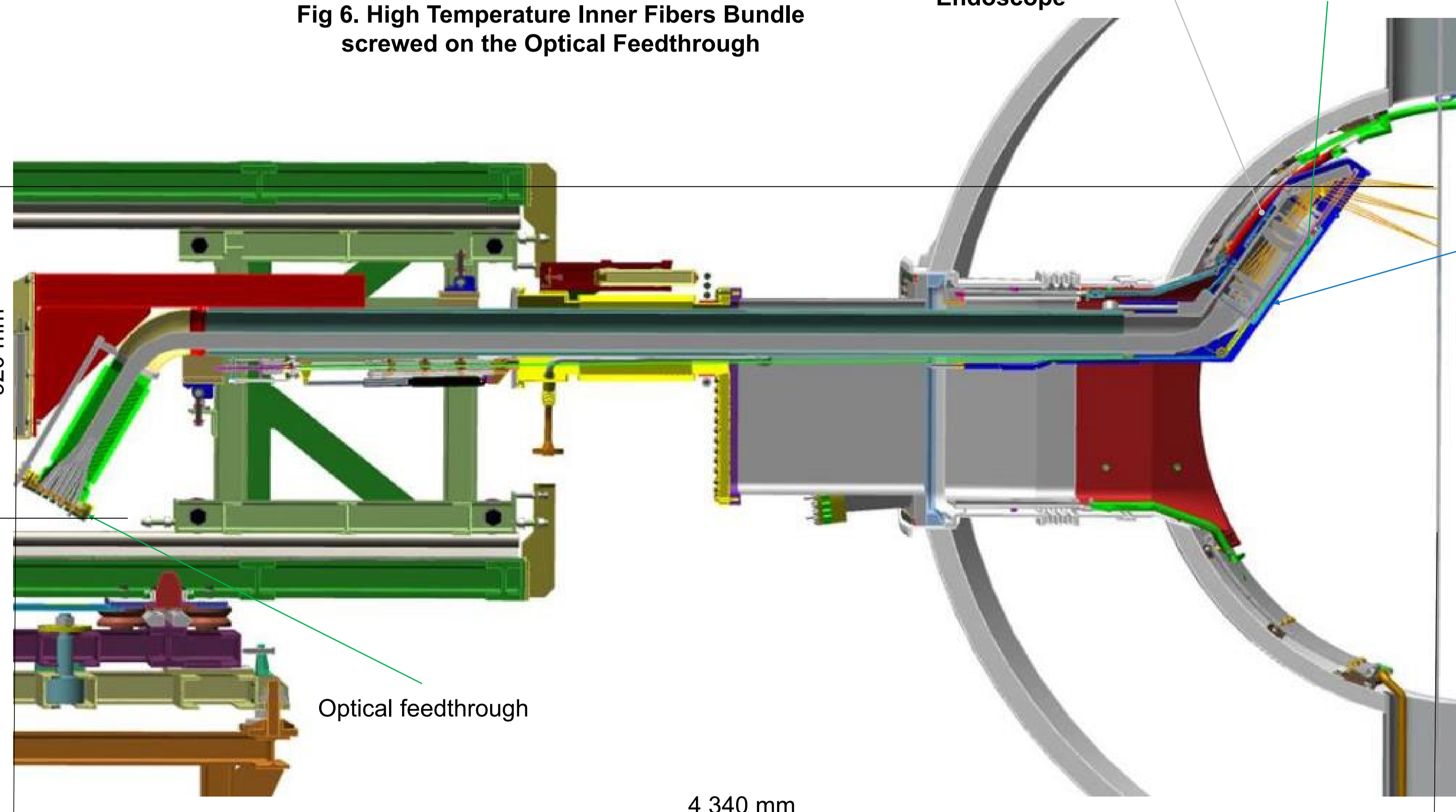


Fig 4. Cross-section of the Endoscope for the Edge Measurement

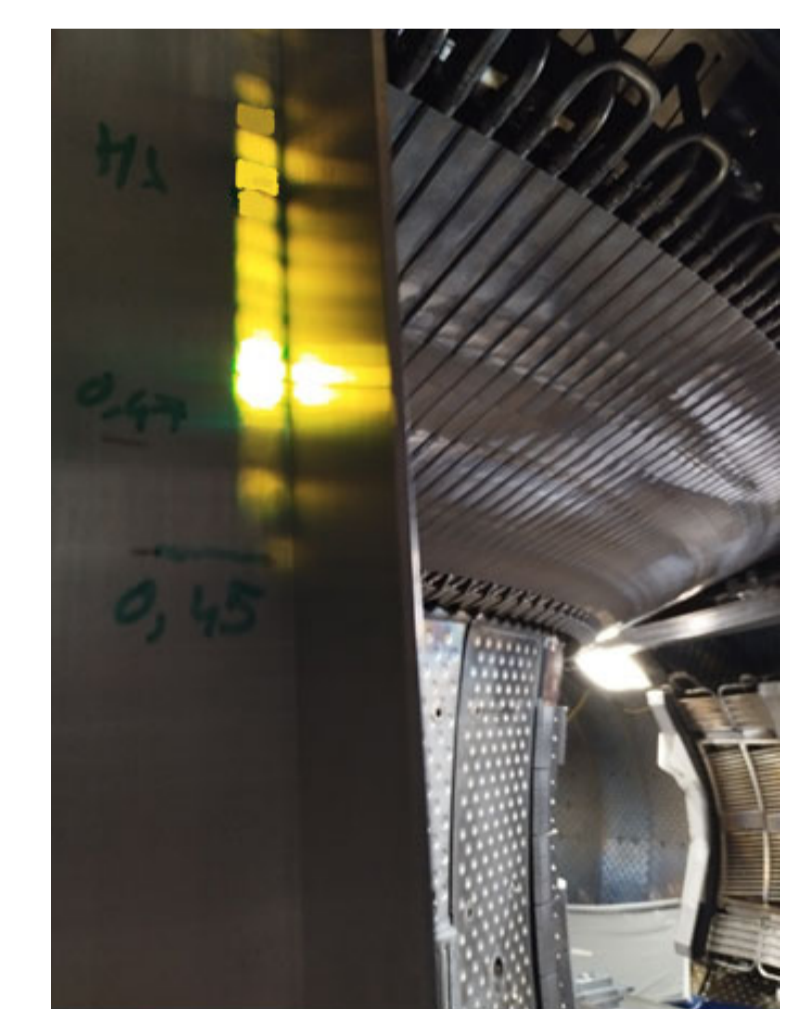


Fig 13. In-vessel alignment

DIAGNOSTIC INSTALLED AND READY FOR THE NEXT CAMPAIGN

Lasers, Electronic and Acquisition

- ✓ 2 lasers of 2J - 6nsec pulse - 30Hz each
- ✓ 180 to 200 data acquisition channels
- ✓ 10 to 30 ns diffused LASER light pulses
- ✓ 100 Hz LASER periodic trigger rate
- ✓ Data acquisition window : 1 μ s for each trigger
- ✓ Sampling frequency : > 1GHz
- ✓ Amplitude resolution : ~12 bits

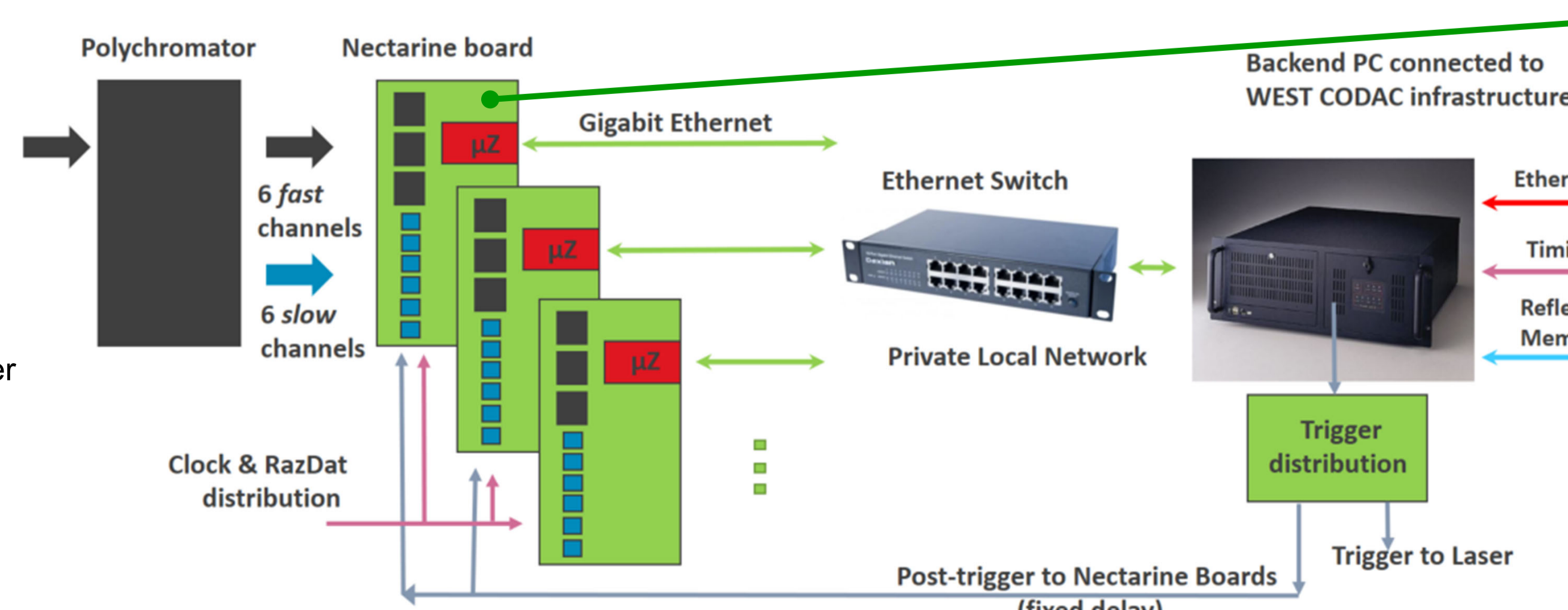


Fig 14. Modular and scalable architecture

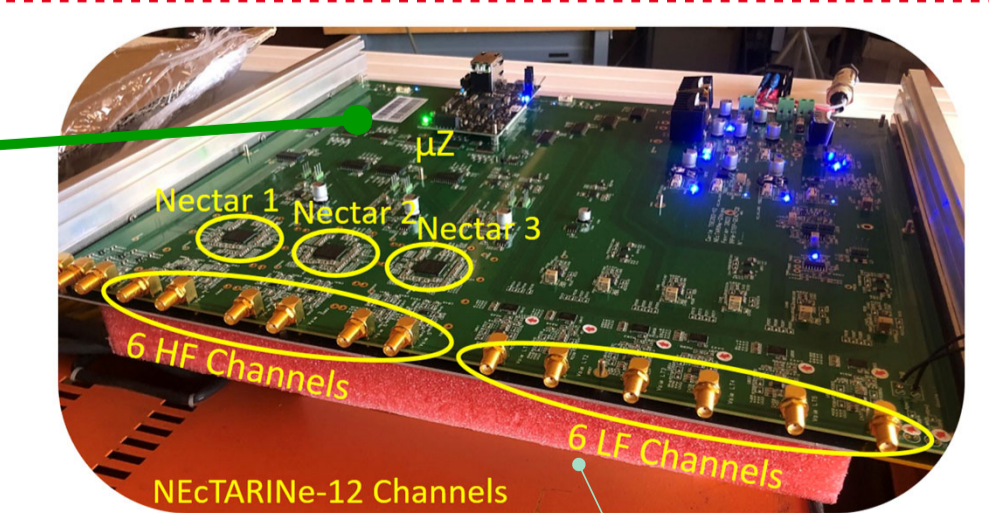


Fig 15. Overall view of the Nectarine⁽¹⁾ data acquisition board

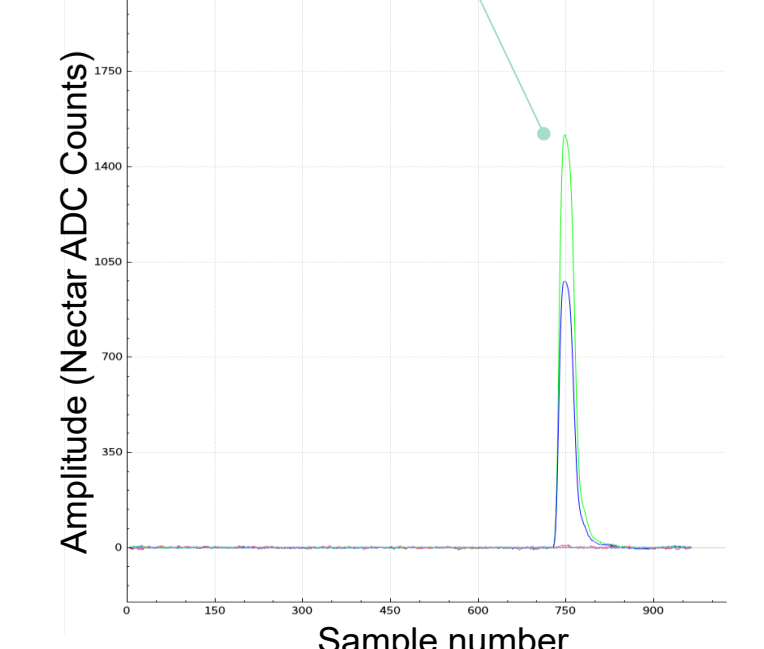


Fig 16. Sample of fast channel acquisition

(1) : Nouvelle Electronique Thomson Acquisition Rapide Intégrant des Nectars -12Voies (New Thomson Rapid Acquisition Electronics Integrating 12-Channel Nectars)

References : IEEE Transactions on Nuclear Science - The Data Acquisition System of WEST's New Thomson Scattering Diagnostics - 2024 - Ch. Bouchand, Y. Moudden