

Detector R&D

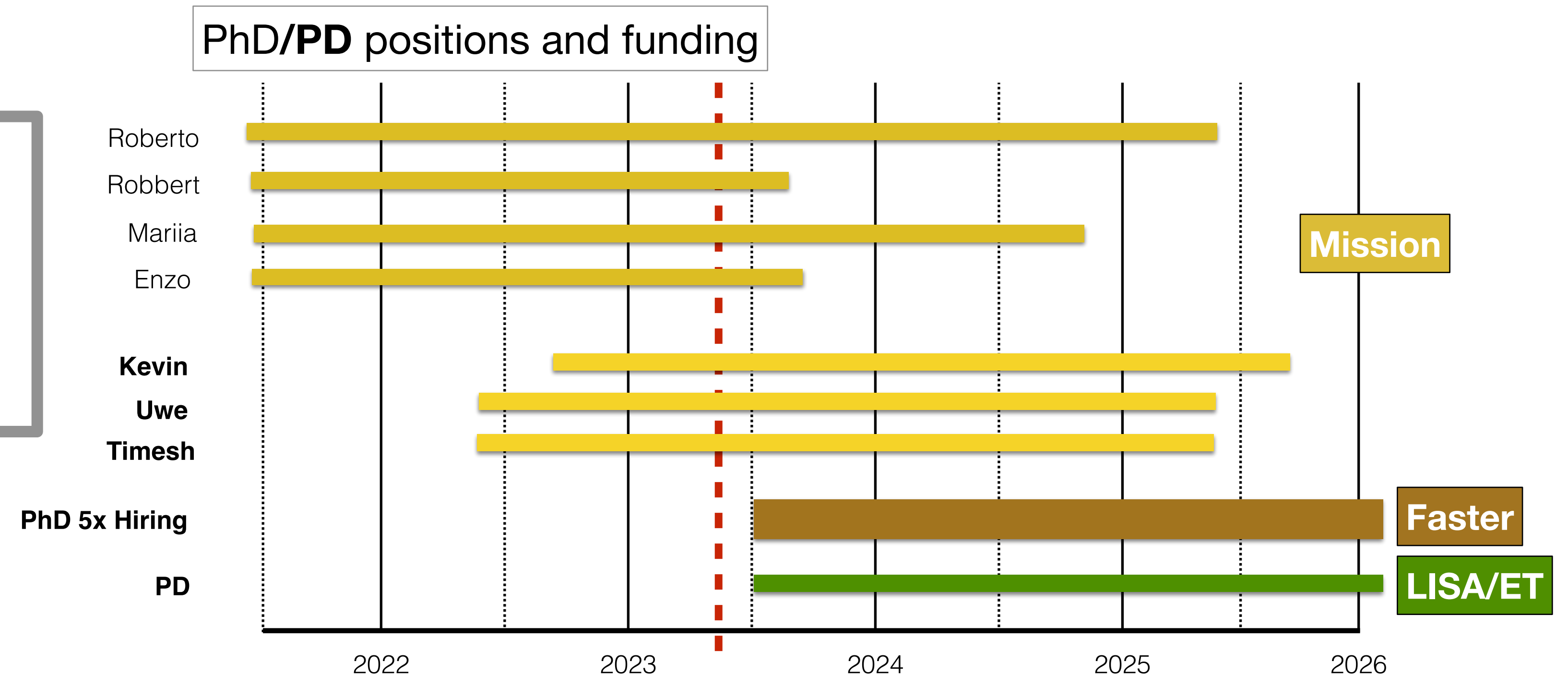


Niels van Bakel

Nikhef

Current staff count:

- Niels v Bakel, Martin v Beuzekom, Martin Fransen, Jory Sonneveld, and Matteo Tacca

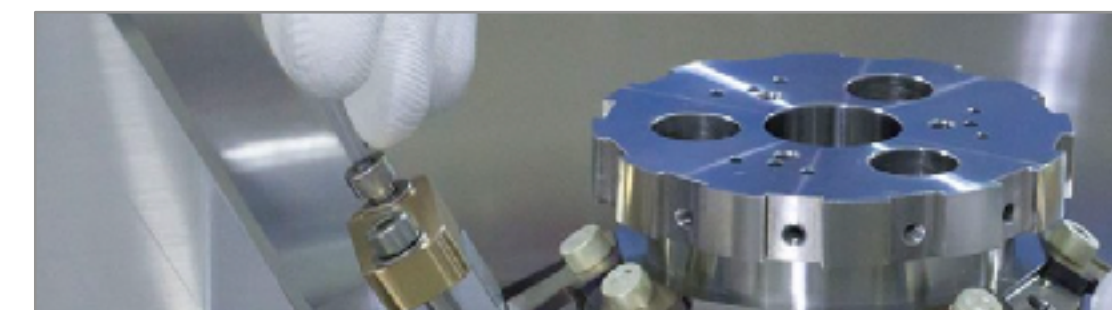
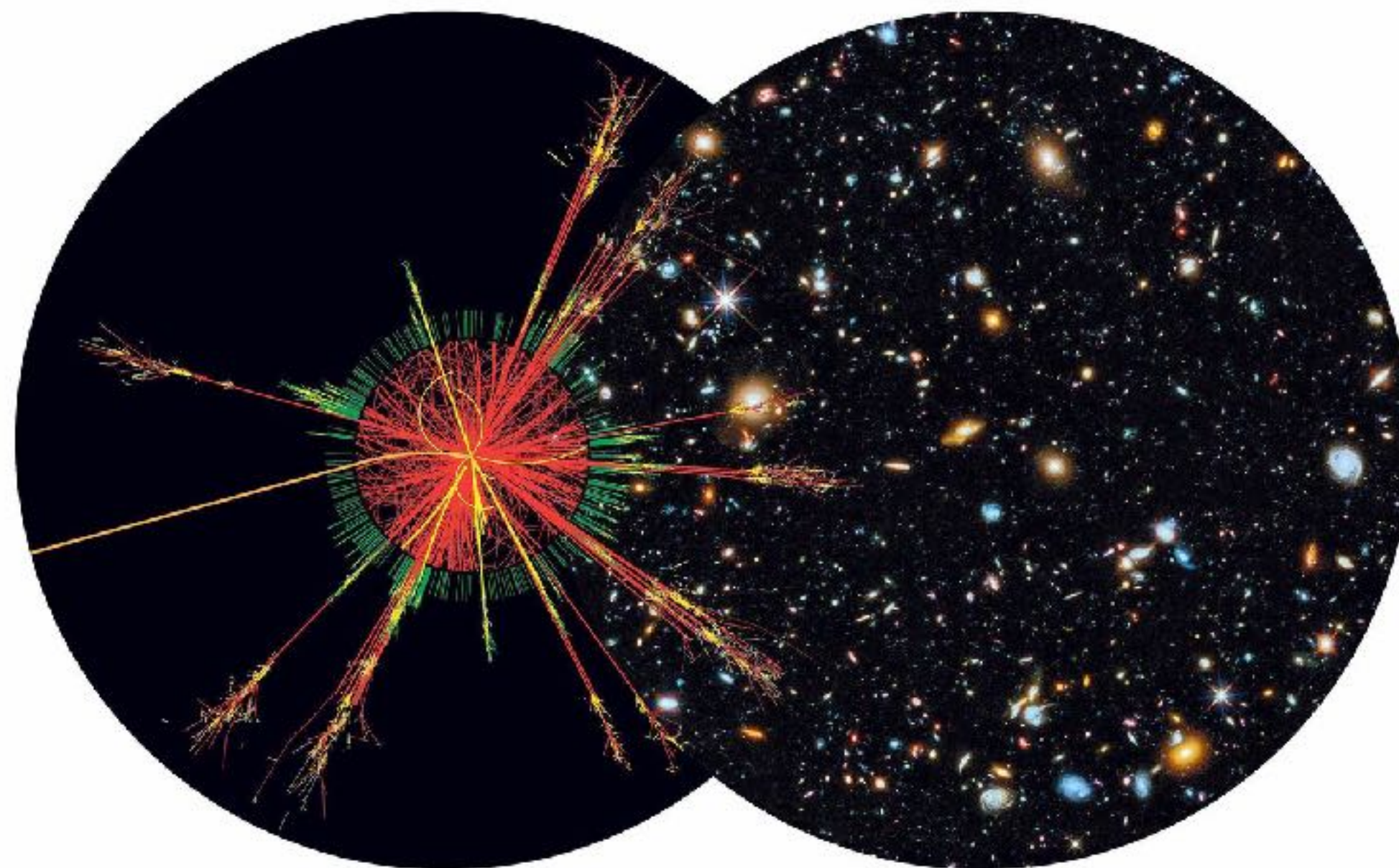
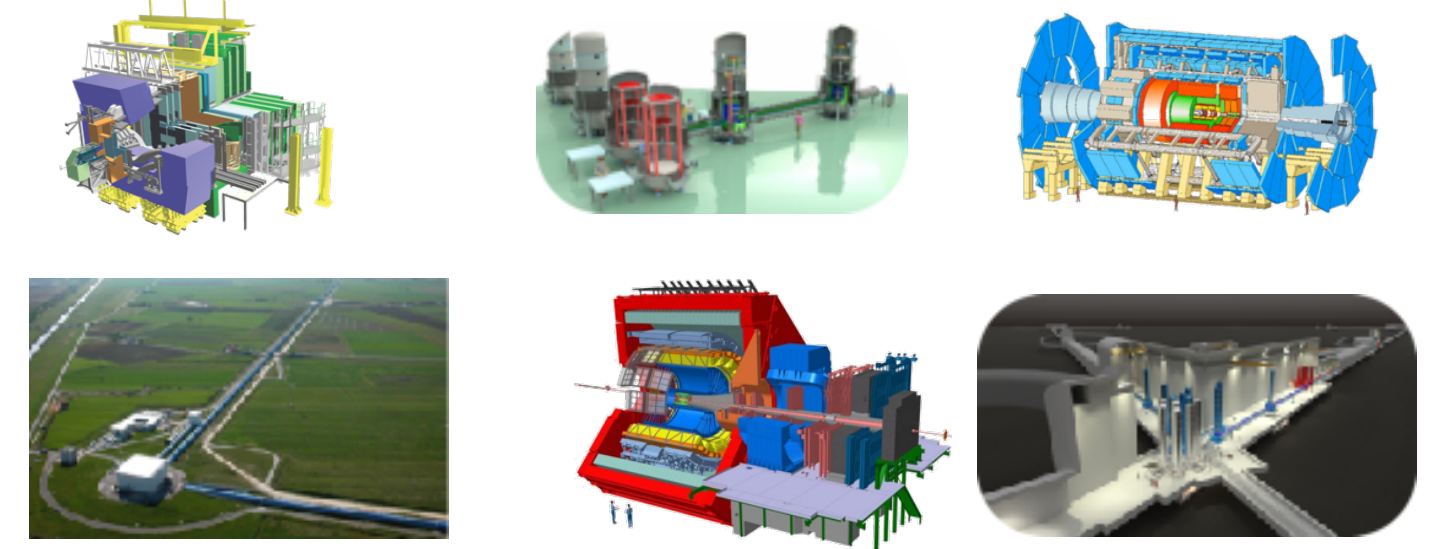


SAC May 2021: “ ... expresses strong support for Nikhef’s vision to bring its instrumentation teams in these LHC experiments together around a central well-defined theme on an essential technology for the future. The detector research theme of *4D-tracking technologies with fast timing* is perfectly in line with the European Strategy ...”

Detector R&D strategy 2017:

- Smart and fast pixel detectors
- Gravitational wave detector instrumentation
- Collaborate with high-tech industry

Experimental groups:



Mechanical technology



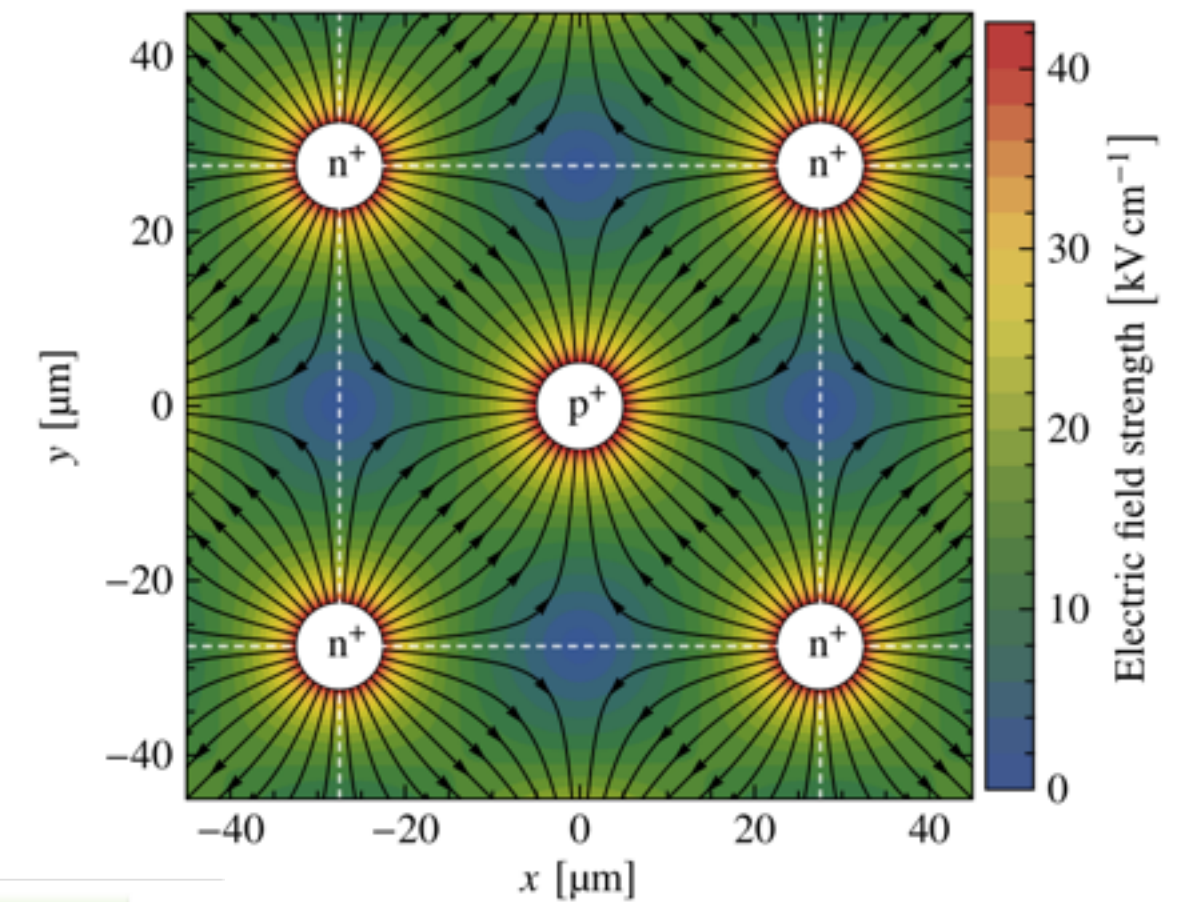
Computer technology



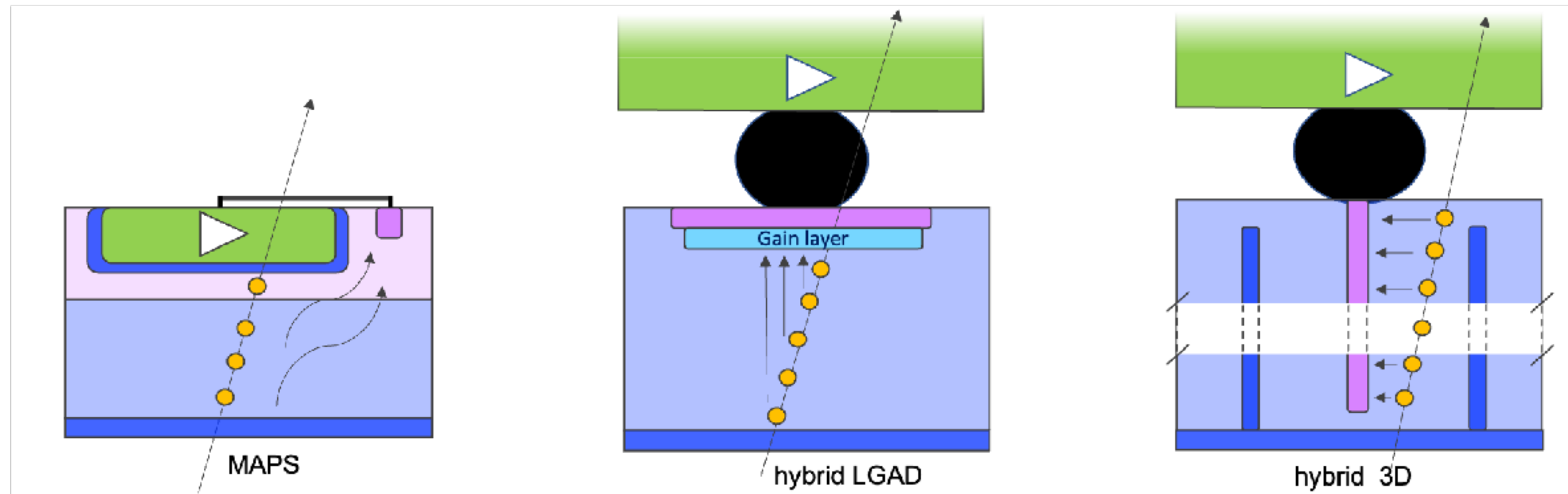
Electronics technology

Fast Silicon detectors

- Focus on pixels with fast timing
 - Driven by LHC upgrades: ALICE, Atlas & LHCb
 - Pay off from our chip and readout system developments over many years
 - **Expand sensor activities** - including TCAD simulations

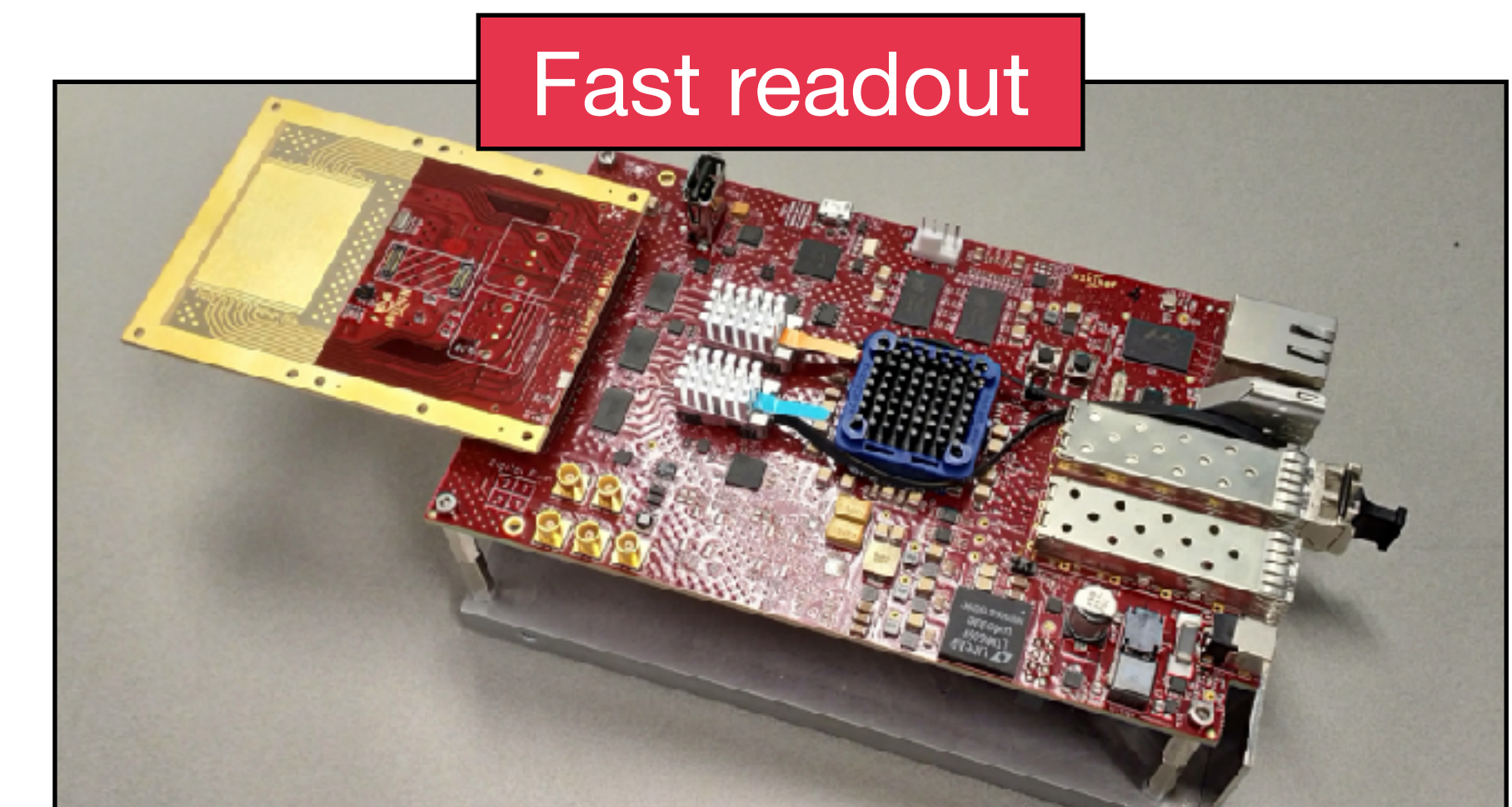
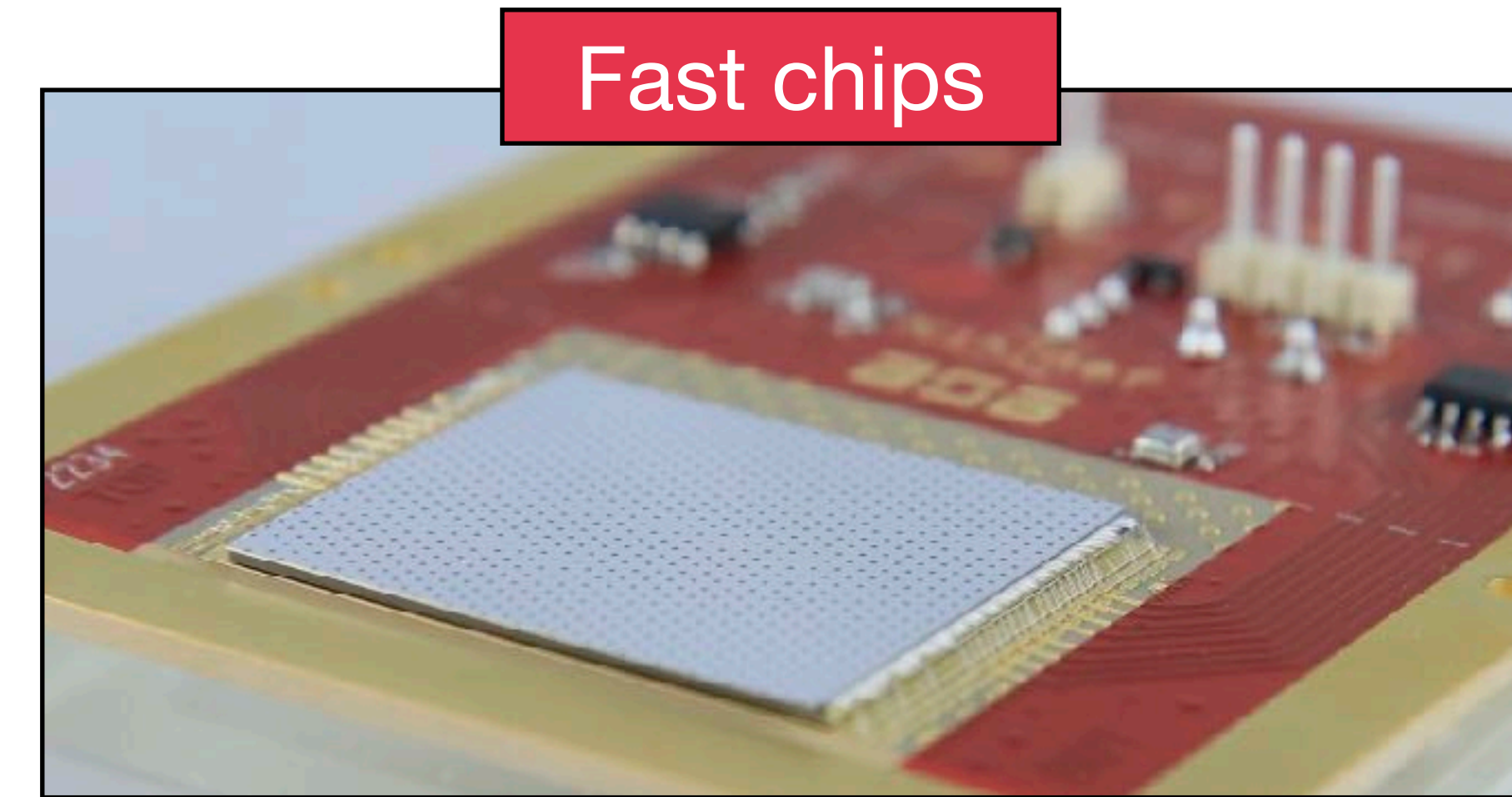


Fast sensors



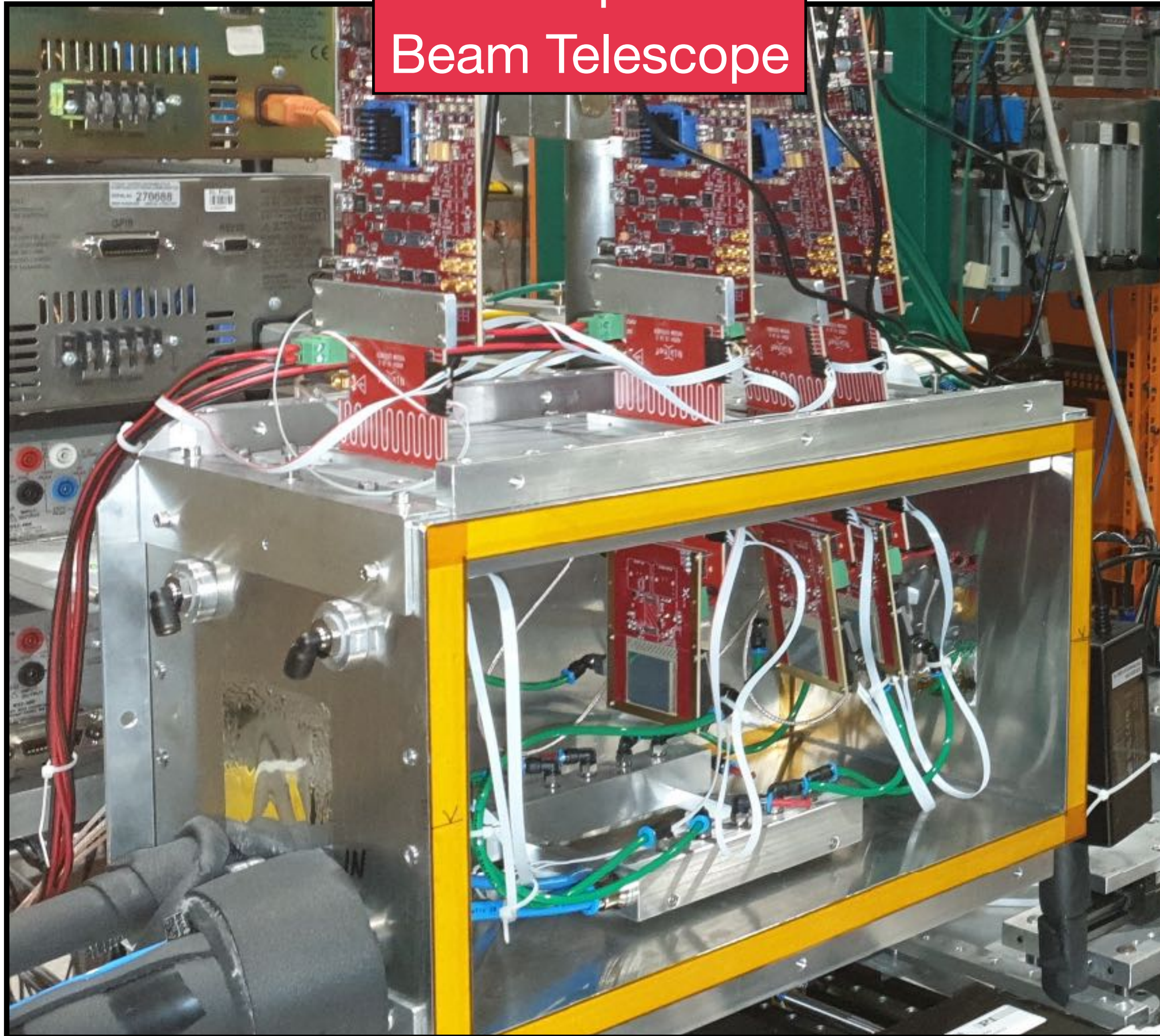
Involved in Medipix, RD50 & RD53, AIDAinnova, and CERN EP R&D en ECFA DRD (3,5,7)

- **Fast timing pixel chips**
 - *Timepix4 for sensor testing*
 - *Picopix demonstrator (28 nm): order 50 ps*
 - *MAPS with timing for ALICE LS3*
- **Nikhef ASIC expertise**
 - *Time-to-Digital Convertor, incl. Phase Locked Loops*
 - *Serializers for 25+ Gbps*
 - *Verification prior to submission*
- **High bandwidth readout**

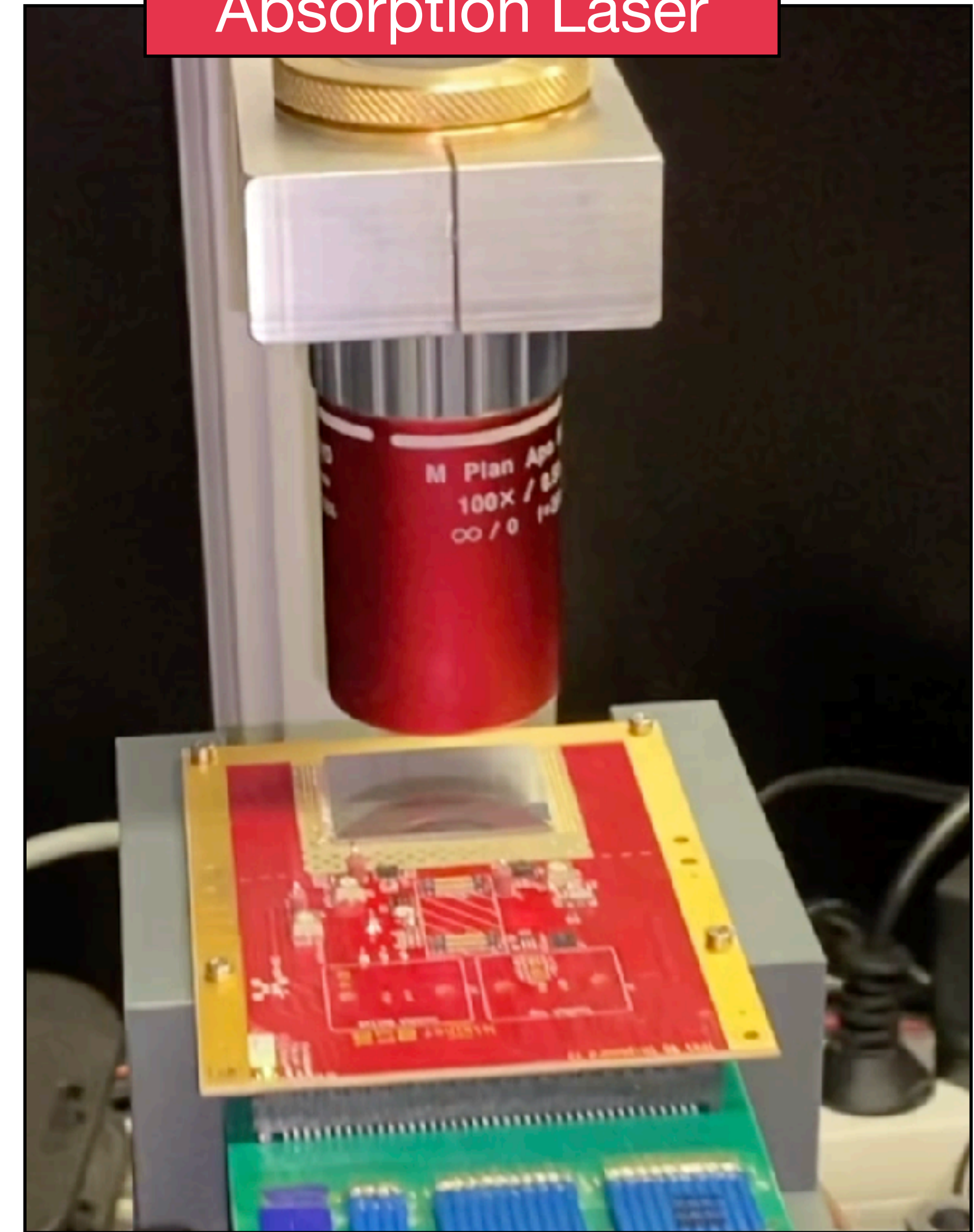


Detector characterization

Timepix4
Beam Telescope

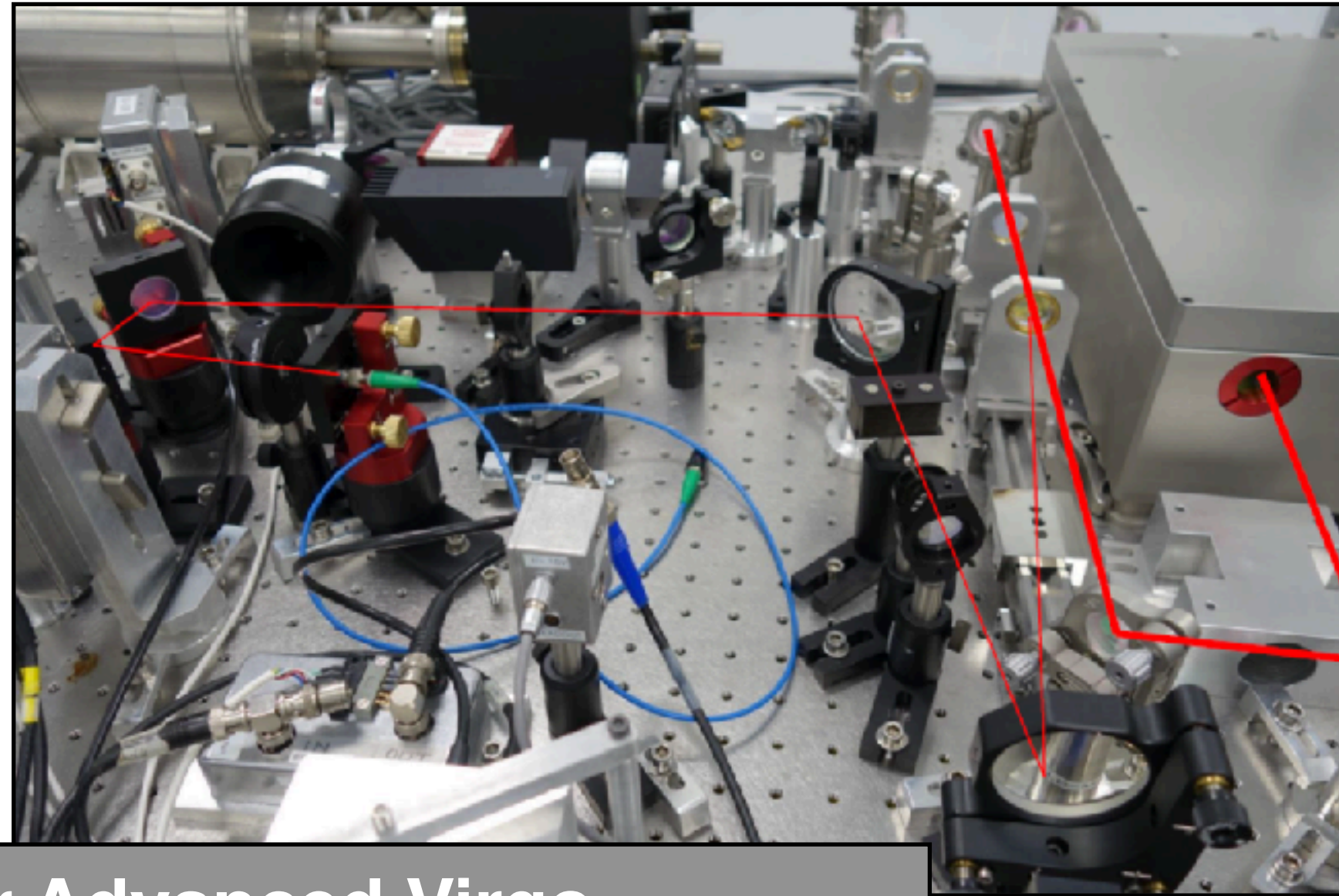
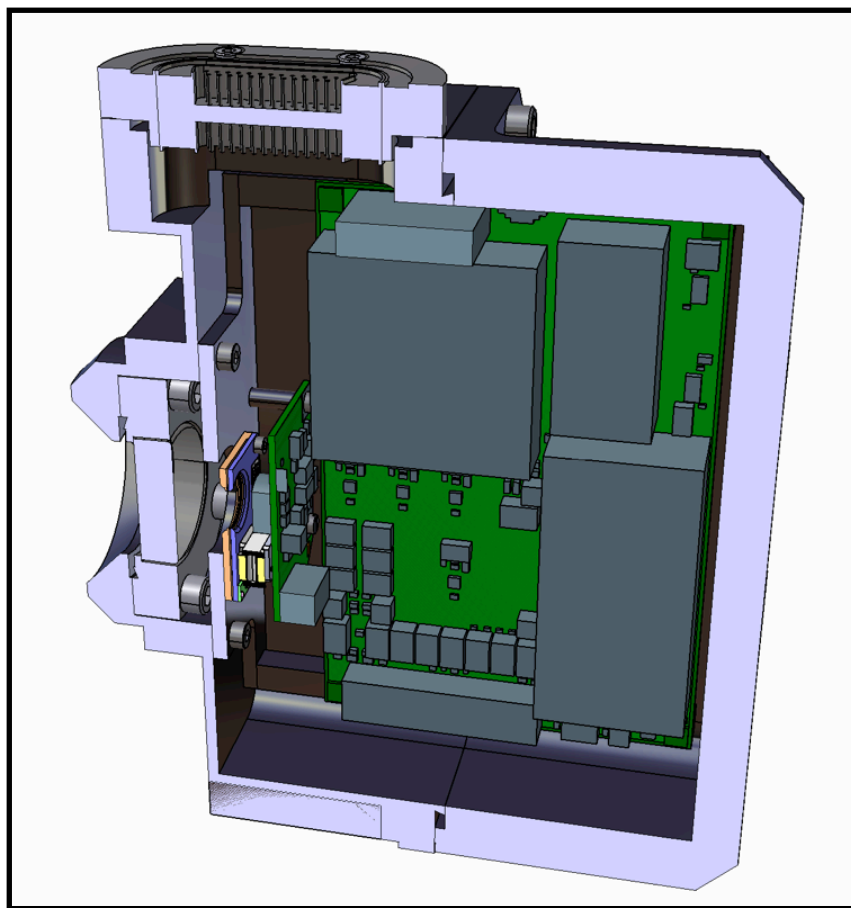


Two-Photon-
Absorption Laser

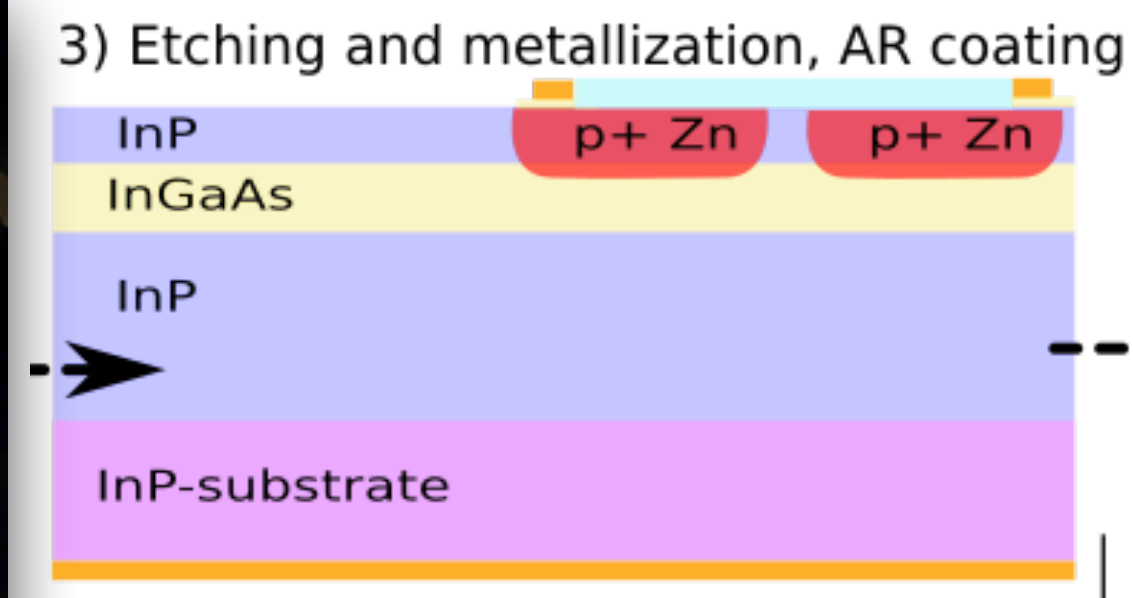
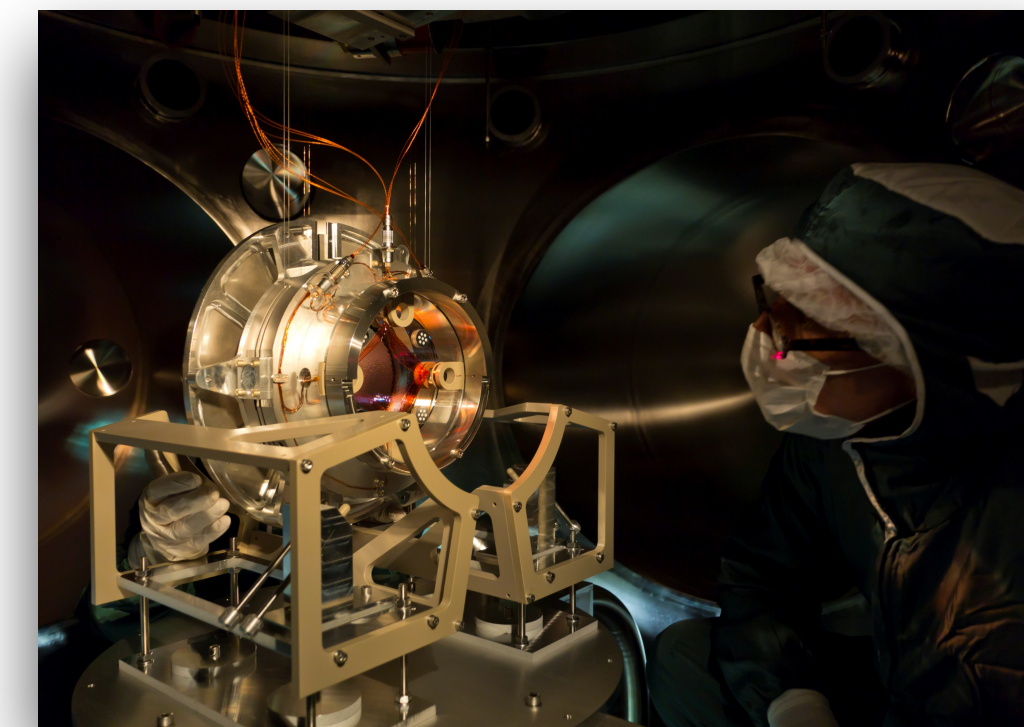
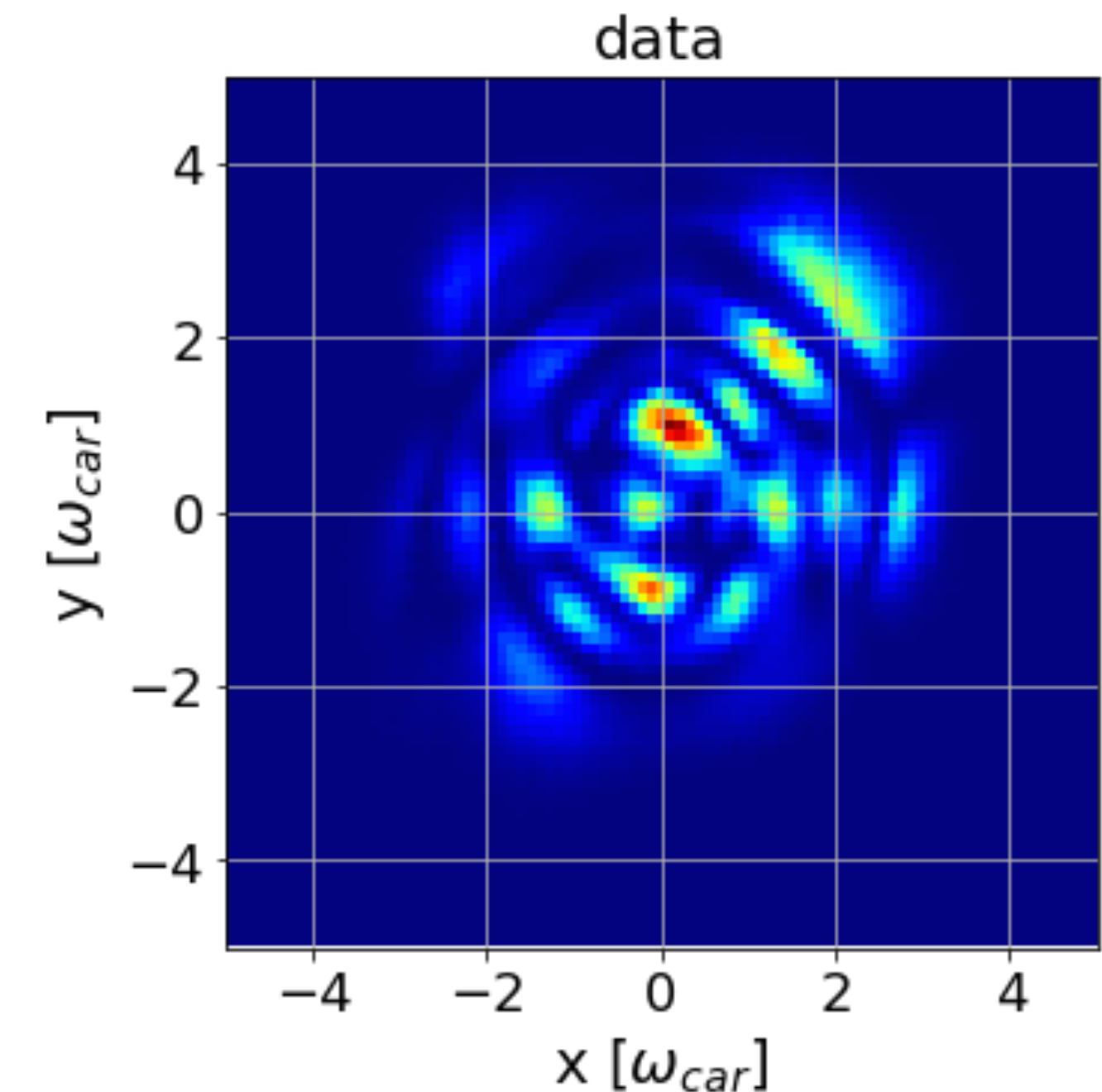


Wavefront sensors for future GW detectors

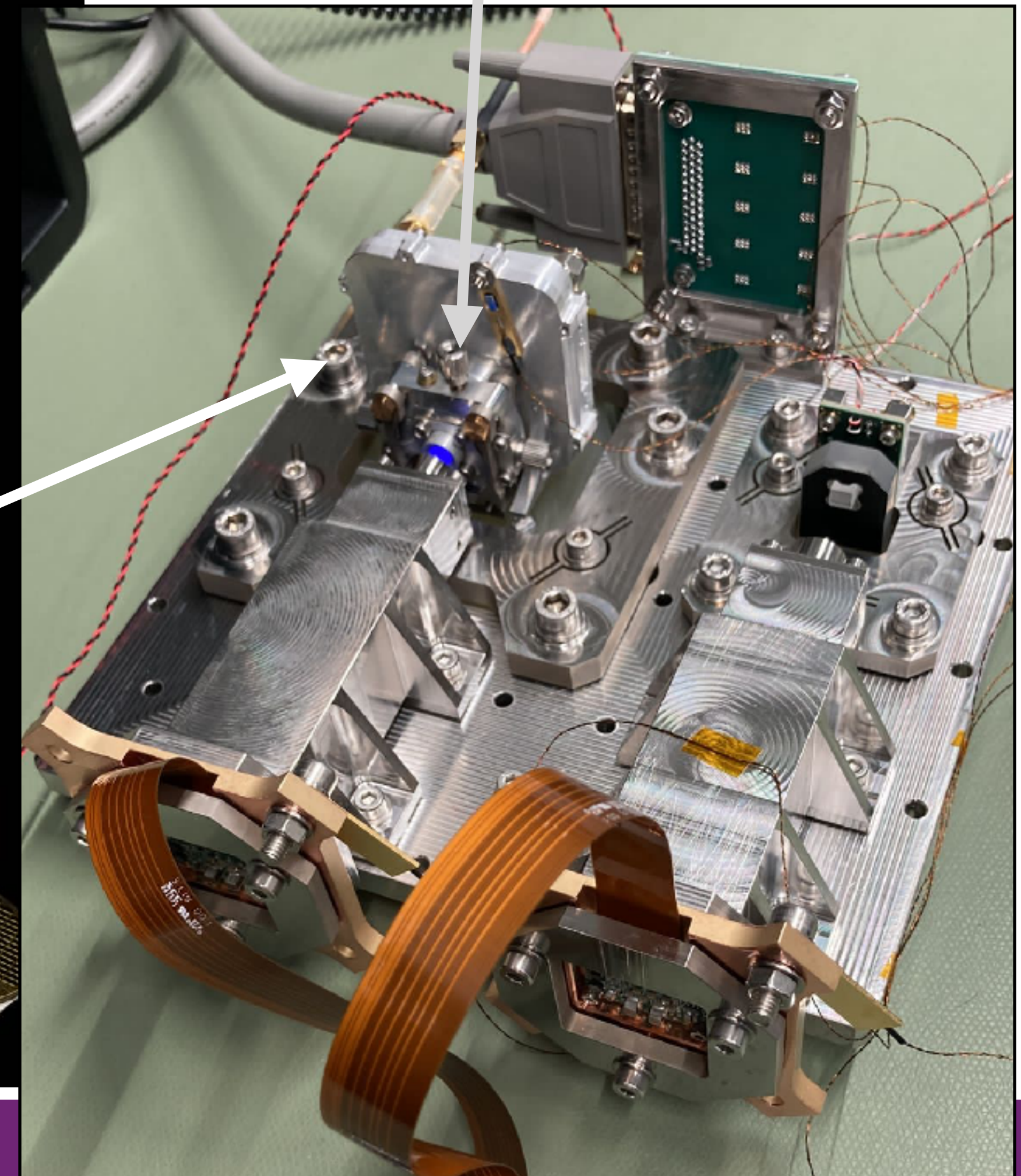
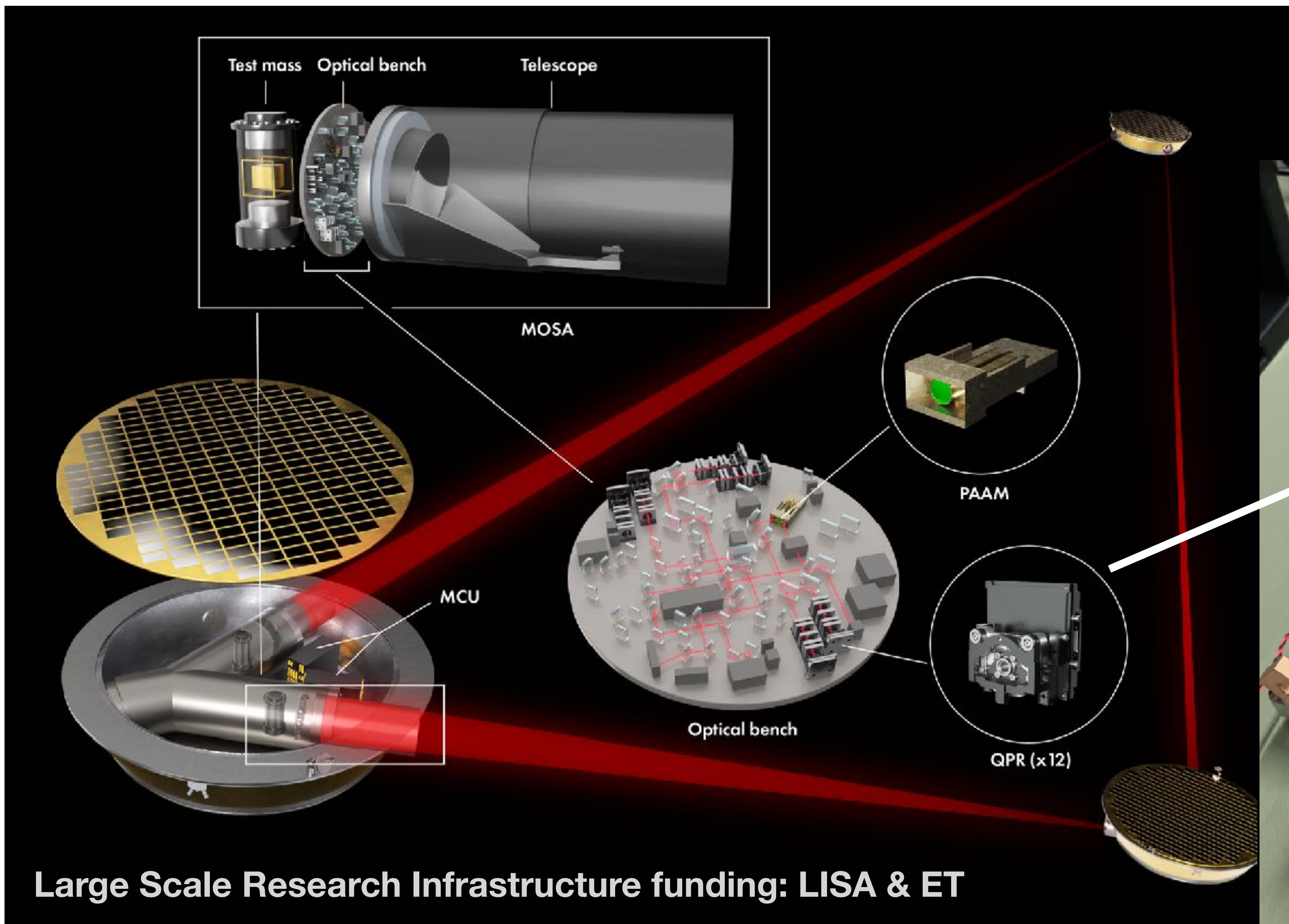
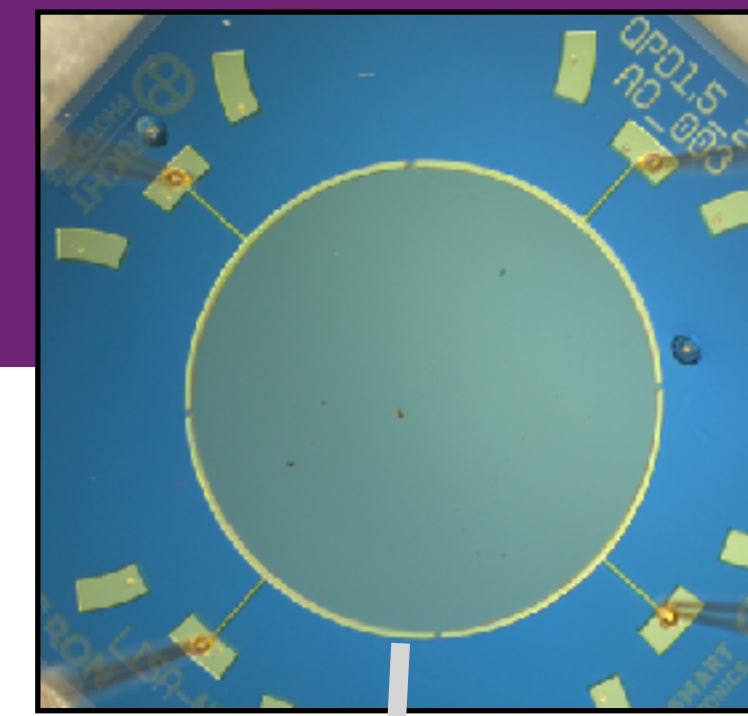
- Alignment & controls of test masses
 - Based on developments for Advanced Virgo 10+ years ago
 - **NWA funding 2017** - started InGaAs photodiode development
 - Selected as baseline for LISA Quadrant Photo Receiver



Instrumentation for Advanced Virgo,
Einstein Telescope and LISA



Photodiodes for LISA & ET



Large Scale Research Infrastructure funding: LISA & ET



Go beyond the current limit of fundamental noises

- Develop wave-front sensing techniques
 - **Phase camera**
 - **Test photo-diodes**
- Study higher-order-modes and non-gaussian beams
 - **Different beam profiles with compatible mirrors**
- Improve sensing and controls schemes
 - **Small IFO with suspended mirrors**
- Student projects

- Fast timing takes off
 - *Critical mass* \Rightarrow funding via 'Faster' - working on LHC roadmap proposal
- Wavefront sensors for GW detectors
 - *Quadrant photo-diodes* \Rightarrow funding via LISA/ET roadmap
- What has been 'stopped'
 - *Micro-pattern gas detectors (GridPix)*
 - *Fast photon detector (TIPSY) - transmission dynodes*
 - *Reduced x-ray imaging activities since 2021*

- What about the long term?



- What are long term HEP and APP needs?
- Explore new and emerging technologies?
 - ➡ e.g. quantum sensors
- Sufficient room for blue-sky R&D?

