

FCC-ee vertex detector R&D workshop
Thursday, 30th October 2025, INFN Pisa

ETH zürich



Institute of Particle Physics and Astrophysics (IPA)

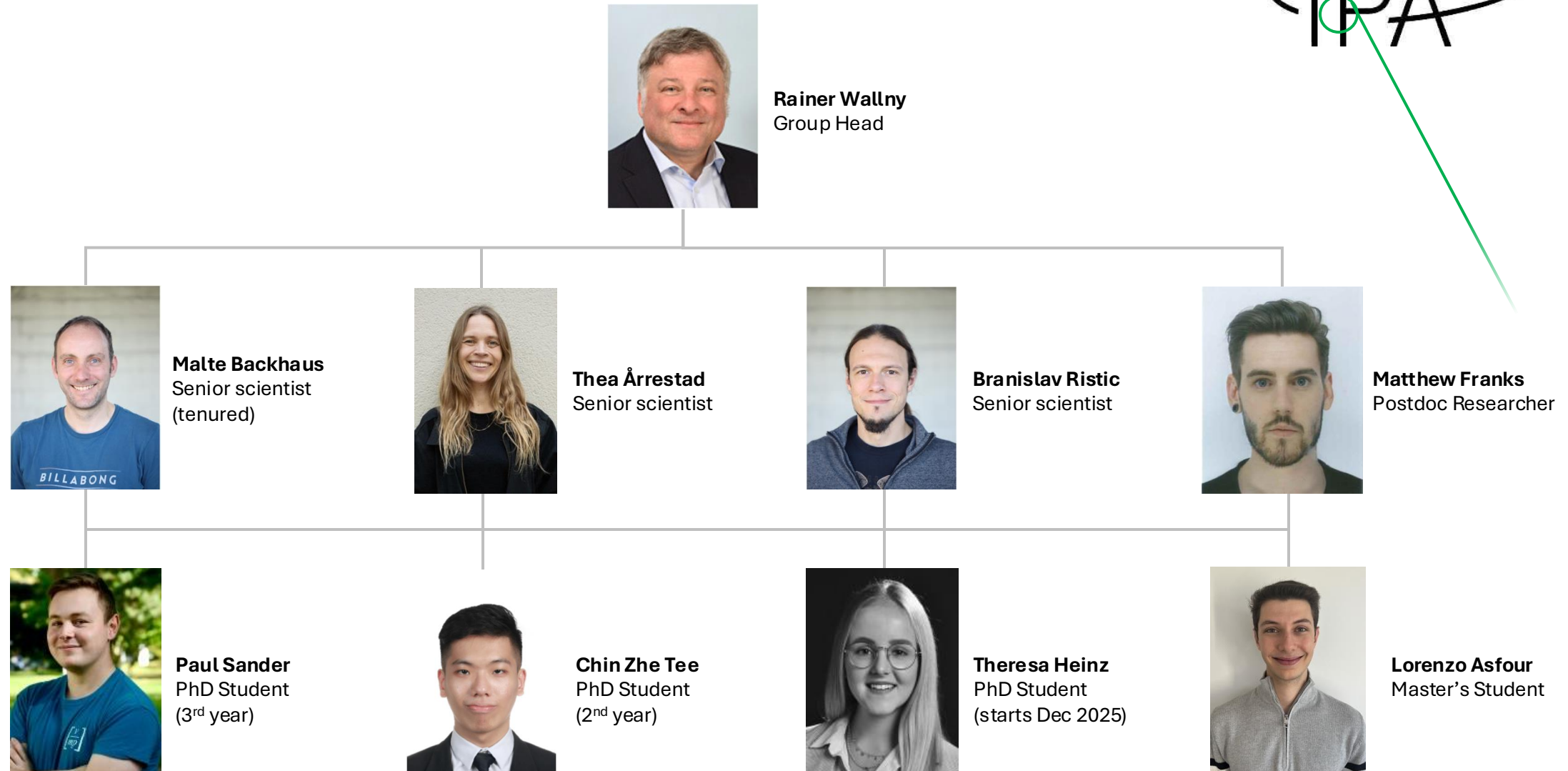
Matthew Franks^{1,*} on behalf of the IPA

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FCC-ee vertex R&D team



Current involvement



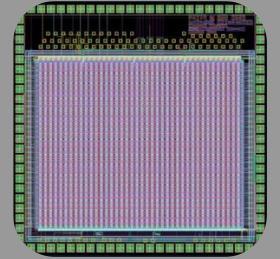
CMS

- ← Extensive involvement in Phase 0 and 1 upgrade
- ← Development of diamond sensors
- ↓ Phase 2 Inner Tracker Module R&D
 - Development of passive planar CMOS pixel sensors
 - HDI and cooling plate design, production, testing
 - Definition and implementation of module QA and QC software
- Assembly of prototype modules and production of ~500 modules

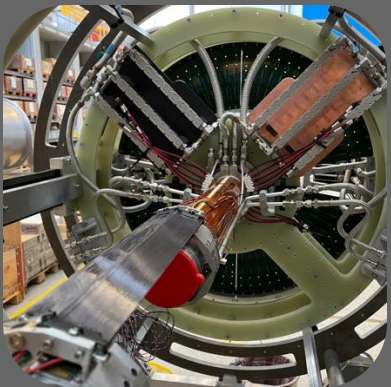
DMAPS R&D

(In collaboration with PSI)

- ← MoTiC development &
- PANTHER development
 - Chip design
 - DAQ development
 - Characterisation



- (at ETH) OCTOPUS involvement
 - WP4: Characterisation & Testing (M. Franks co-convenor)



Mu3e

- ← Commissioning of HV-MAPS vertex detector
- ← SciFi R&D construction, commissioning
- ↓ Full detector DAQ and readout (SciFi + HV-MAPS pixels)
- Online event reconstruction with GPUs

Machine learning

- Aim: address increased data rate problem future vertex detectors (layer 1)
- Either: on-detector compression, frontend filtering
- “Smart pixels”
 - In-pixel intelligence to reduce data
 - Extract particle features from single layer

...and much more! ipa.phys.ethz.ch

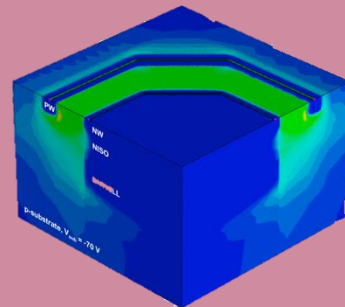
FCC-ee vertex R&D: Monolithic Active Pixel Sensors (MAPS)

Design

- Cadence virtuoso licenses available through ETH
- ETH maintains contacts to (most) MPW providers
- Access to many CMOS Process Design Kits (PDKs)
 - TSMC 65 nm
 - IHP 130 nm
 - GlobalFoundries (various)
 - TPSCo 65 nm (NDA signed)
 - ...

Simulation

- Sentaurus Synopsys TCAD licenses available through ETH
 - Process simulations
 - Structure simulations
 - Device simulations
- Large computing clusters available



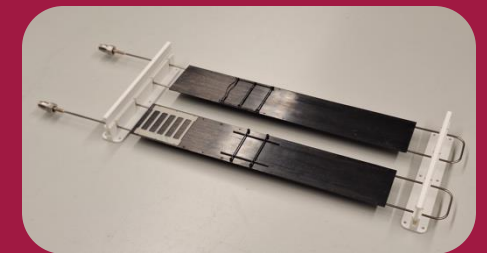
Characterisation

- Wafer-level testing
- I-V measurements
- TCT (and e-TCT)
- Irradiation campaigns
- Telescope construction and test beam



Integration

- Lightweight system mechanics (carbon fibre)
- Experience designing different system aspects e.g. powering
- Cooling systems (CO₂, air, helium)
- Component production



Available infrastructure

Cleanroom

- 50 m²
- Up to ISO class 5
- Detector production
- Probe station
- Wirebonder (+ Pull tester)
- TCT setup (Particulars)

IPA Cleanroom



ETH Zurich workshop

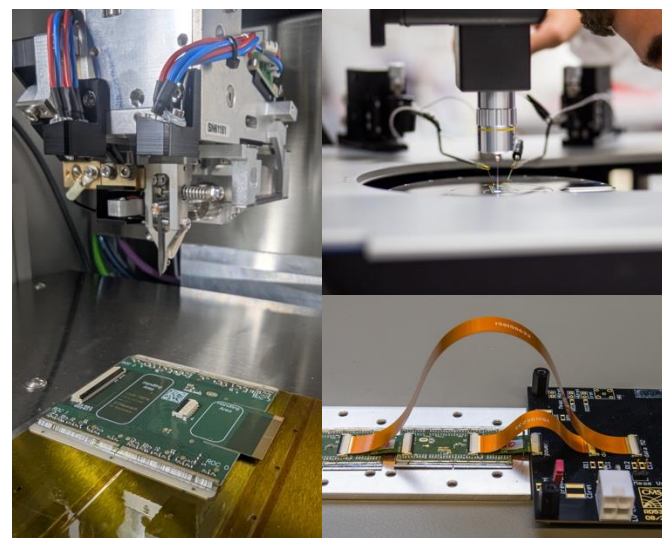


Mechanics

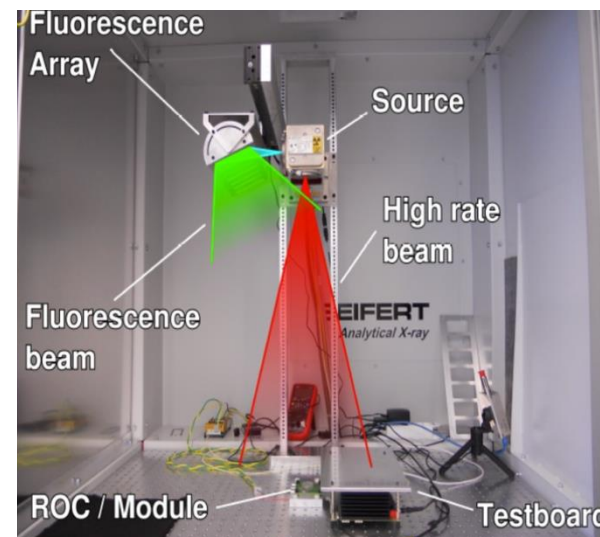
- 3 mechanical engineers for mechanics design
- In-house
 - CNC/conventional milling, turning
 - Laser cutting, welding, engraving

Electronics

- 3 electronics engineers for electronics design
 - Analog and digital electronics
 - FPGA & microcontroller firmware
 - Full readout systems



Wirebonder and probe station



X-ray chamber at ETH

Laboratories

- 6 MV accelerator
- X-ray chamber
- Radioactive sources (Am, Fe, Sr, ...)
- Climate chamber
- Time-Domain Reflectometer

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