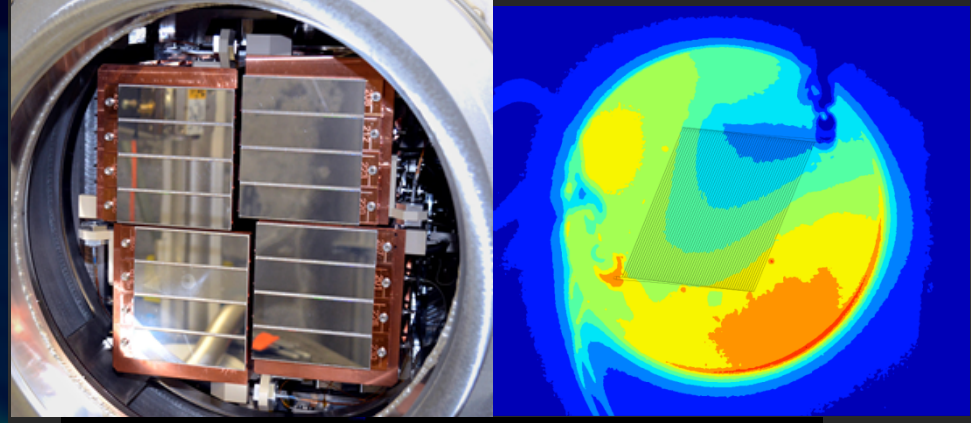
Infrastructures in DTS

Infrastructures and know-how for Detector Development



Helmholtz Program: Matter and Technologies

PoF III Topic: Detector Technologies and Systems

DESY Research Unit: Detector Developments

Doris Eckstein
Center Evaluation DESY, 5 – 9 February 2018

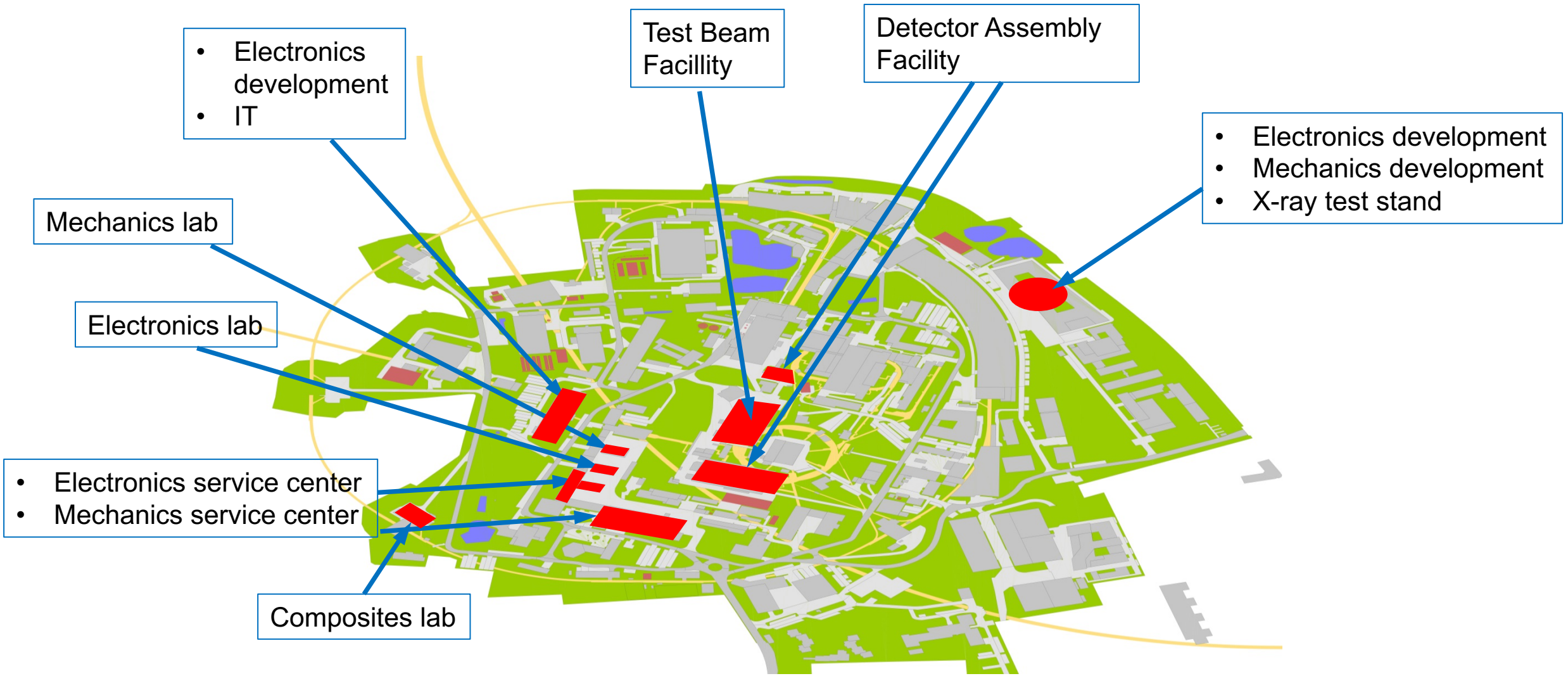
HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

MT
MATTER AND TECHNOLOGIES

DESY

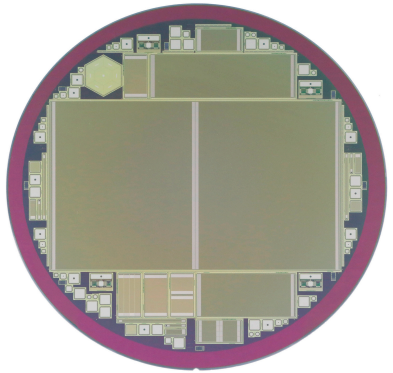
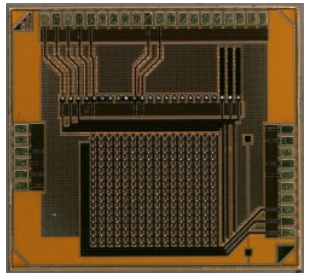
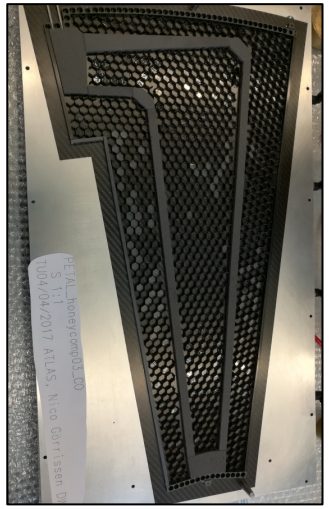
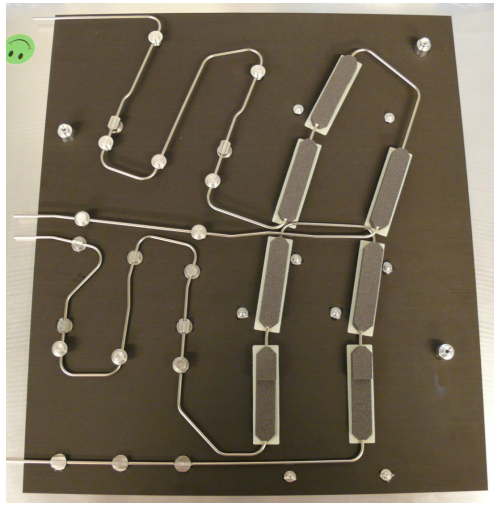
Detector development at DESY

R&D needs infrastructure



Detectors for science applications in MU and MML

Driven by science needs
Embedded in national and international collaborations

Sensors	ASICs	Mechanical structures	Cooling	Service Electronics	Computing
					
Foundries	Electronics groups	Mechanical workshops	Mechanical workshops	Electronics groups	IT

Sensors and Interconnects

Strong collaboration with industry

Sensor production

see talks by C. Wunderer, D. Pennicard

- External foundries
- At DESY:
  - Simulation, prototyping to achieve e.g. radiation hardness
  - **In-house Bump bonding** (see talk by K. Hansen)

    Established for CMS Phase1 Pixel detector

    Extremely useful for R&D

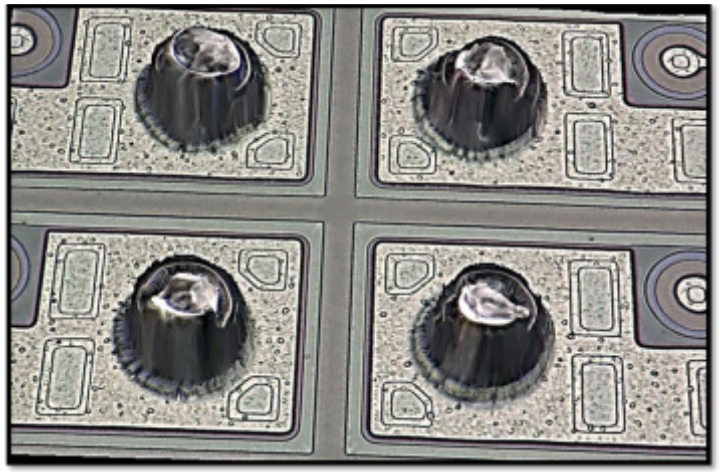
    Allows fast turnaround

    Is used for single chips (not full wafers)

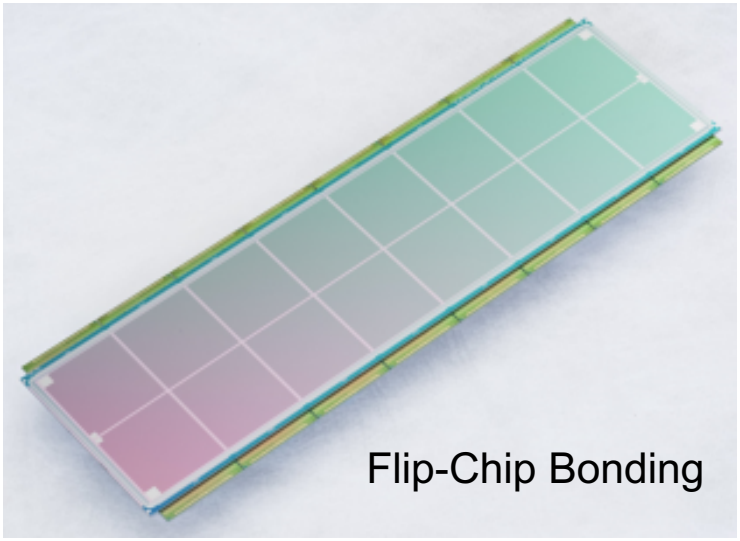
For our R&D

- Need fast turnaround
- Require customization
  - e.g. surface post-processing for thin entrance windows & optimal electric fields

→ **In-house post-processing is desirable**



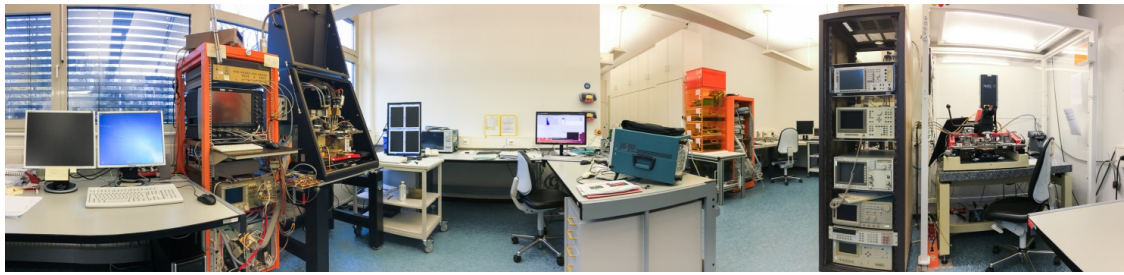
40-µm Solder Bumping



Flip-Chip Bonding

Electronics development

Equipment and know-how

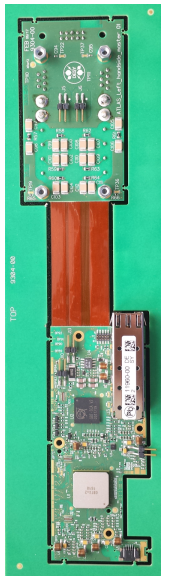


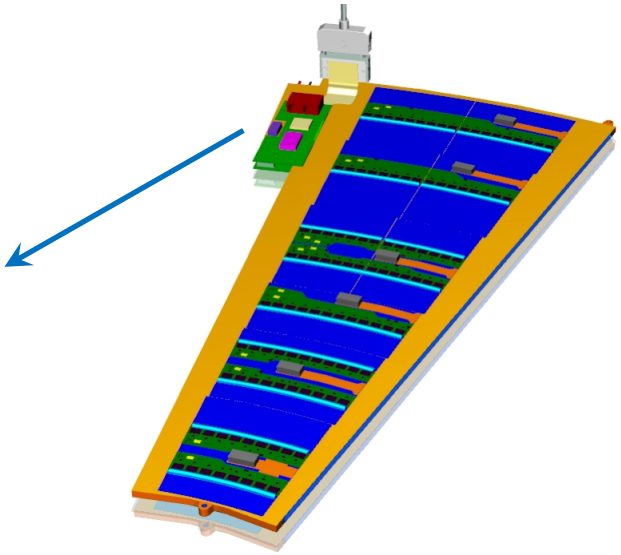
Infrastructure and know-how available

- Research groups developing the detectors for a specific application, i.e. within the HEP and Photon Science communities
- The electronics workshops
- Design, simulations, prototyping, evaluation
- Assembly and production
- Experience

Examples

- DSSC ASIC: Digitizer developed by DESY (see poster by P. Kalavakuru)
- AGIPD ASIC: DESY in collaboration with PSI
- ATLAS End-of-substructure card developed at DESY
  - High-speed and radiation hard
  - Provides common services (power, cooling, signal and data lines) using a Kapton-flex Bus-tape
- Generic development: data concentrator used in AGIPD, Lambda, Percival





Support structures

Mechanics developments

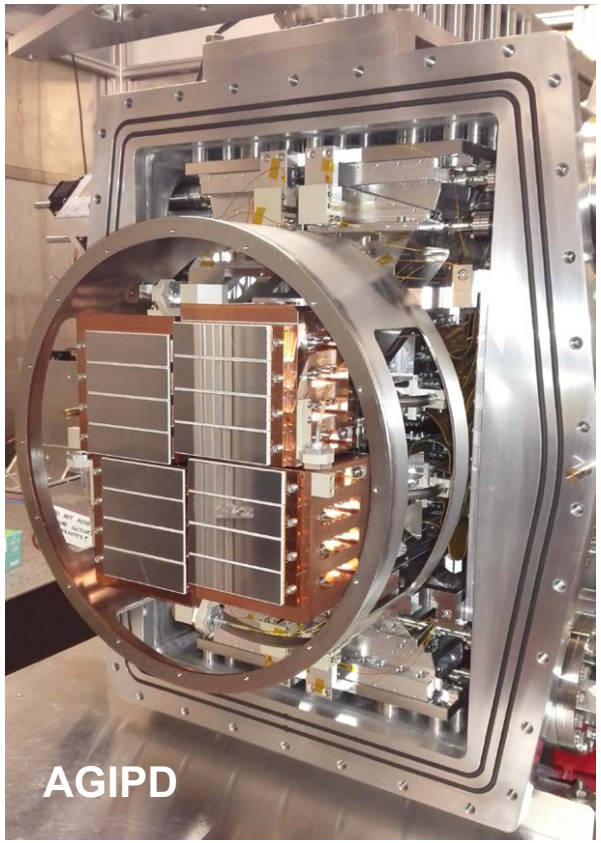

Mechanical workshop

Infrastructure and know-how available in

- The groups developing the detectors for a specific application
- The mechanical workshops
  - Design and FEA
  - Workshop space and machines
  - Provides machining and personnel capacities for prototyping and smaller series productions
  - Provides know-how and contacts
  - Quality assurance

Demands depend on application see talk by A. Mussgiller

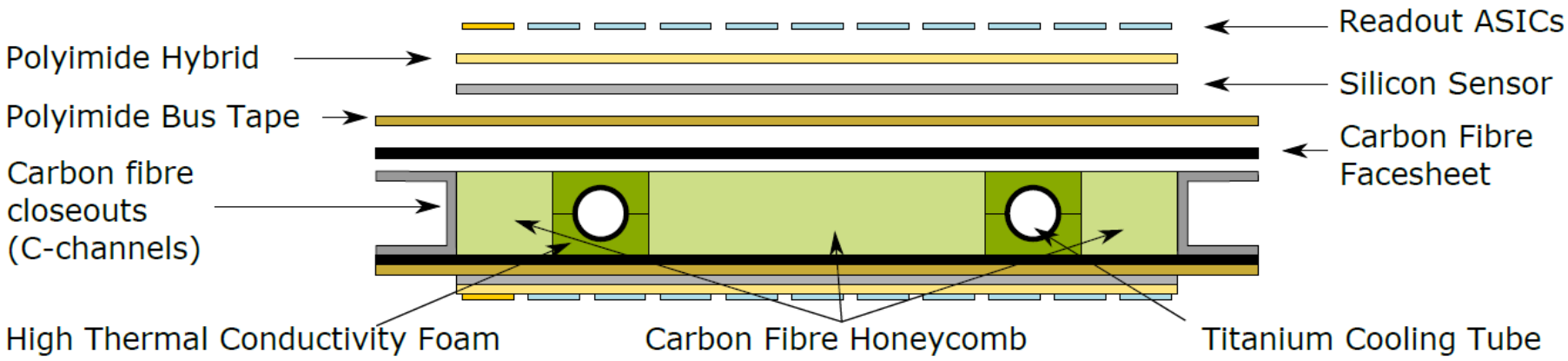
- Low mass for HEP
- Highly integrated (support, positioning and cooling)
- In vacuum for photon science
  - E.g. AGIPD


AGIPD

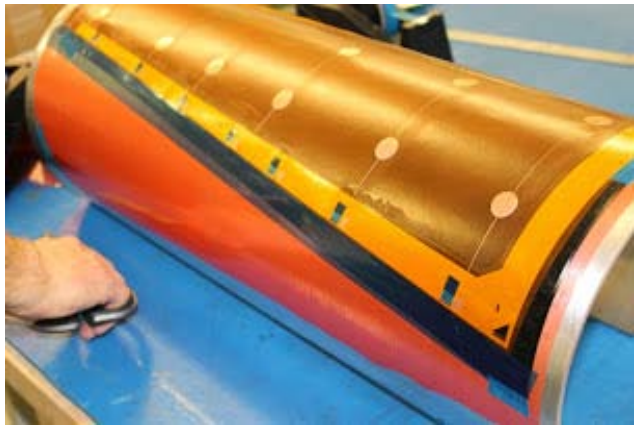
Highly integrated support structures

Example: ATLAS Petal

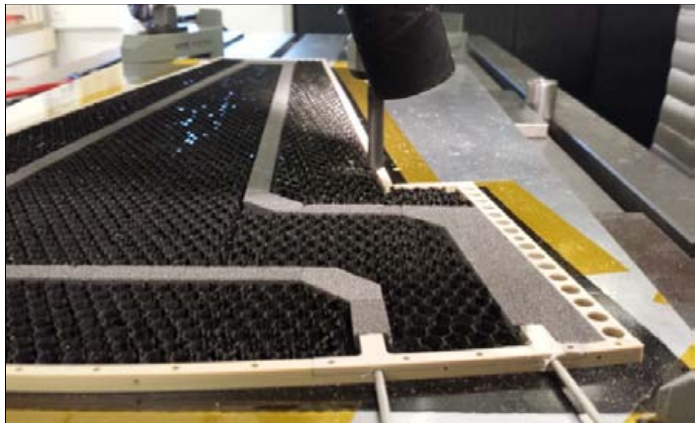
Highly complex structure



Co-curing Kapton flex + Carbon fiber facings in autoclave



Carbon Honeycomb, foam, cooling pipe



Diagnostics, QA

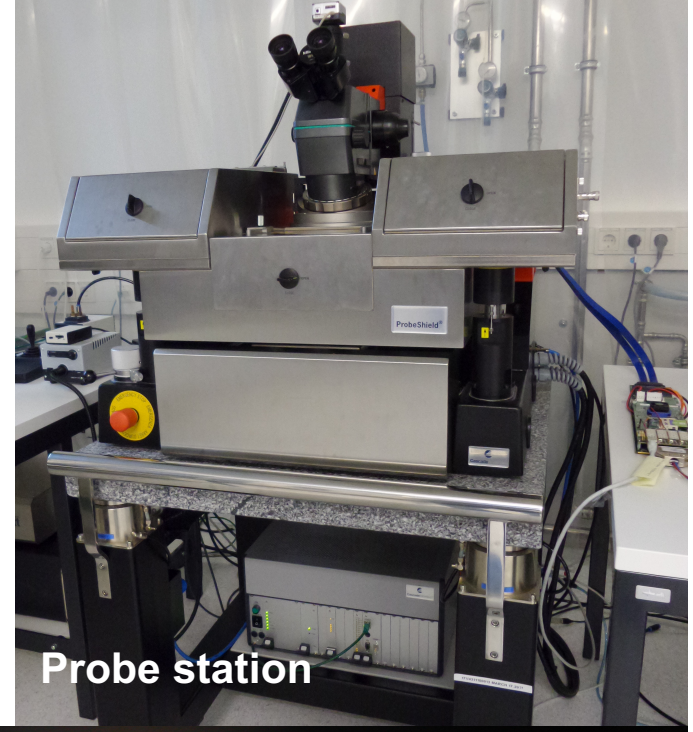
Tooling and expertise

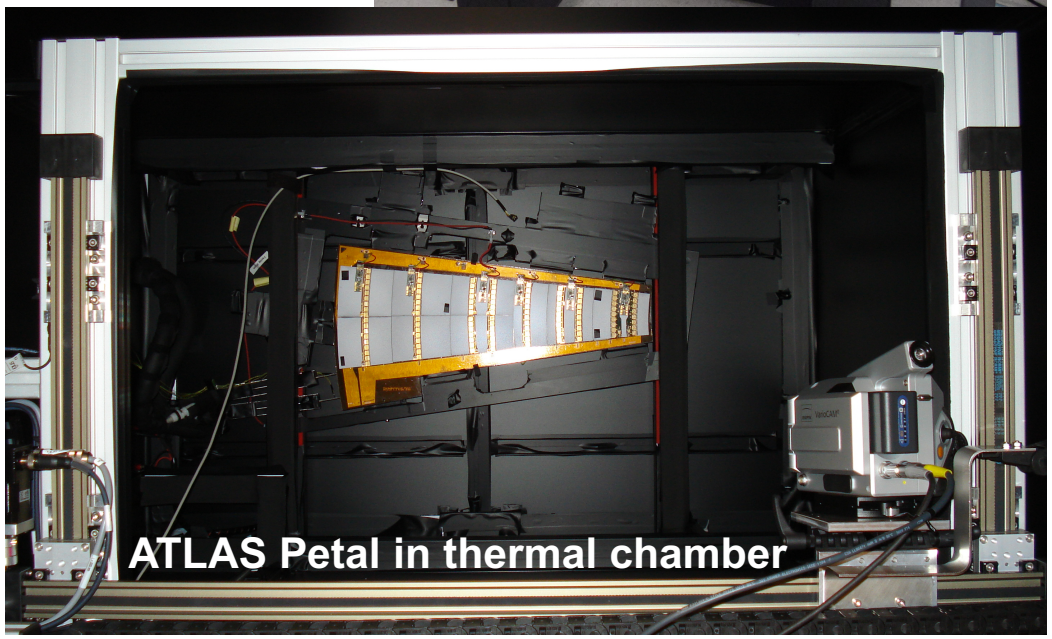
Diagnostic tools essential for R&D and for production

- Available centrally in mechanics and electronics labs, service centers
- Custom and local tools

Examples

- Metrology systems
- Surface diagnostics
- Temperature chambers
- Wafer probing
- X-Ray test stand
- Custom thermal chamber with IR camera
- Thermal deflection measurements
- Ultrasonic inspection





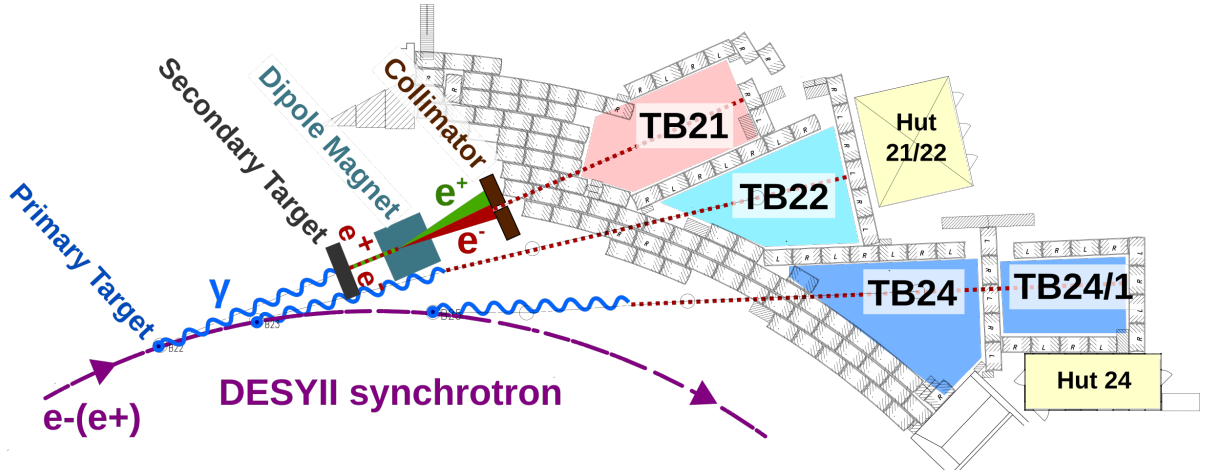
Testbeam infrastructure

R&D and system tests

Poster J. Dreyling-Eschweiler and P. Schütze

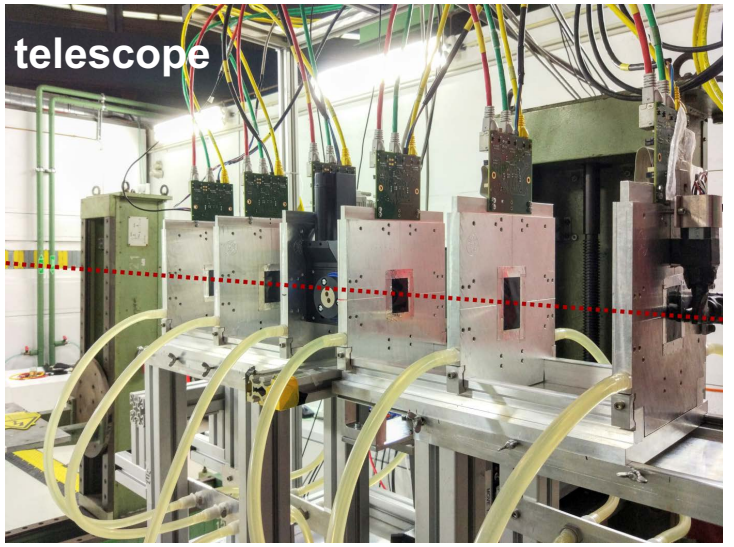
DESY Testbeam – a User Facility

- Up to 6 GeV electrons/positrons
- Beam telescopes with possible point resolution 2 to3 μm
- Magnets: 1.3 T dipole and 1.0 T solenoid



Essential for Detector R&D

- Tests of sensors, electronics, system prototypes
- Used by users worldwide
- Unique within Helmholtz



In photon science beam time at synchrotrons and FEL's used

Dedicated photon test beam is desirable

X-Ray tests

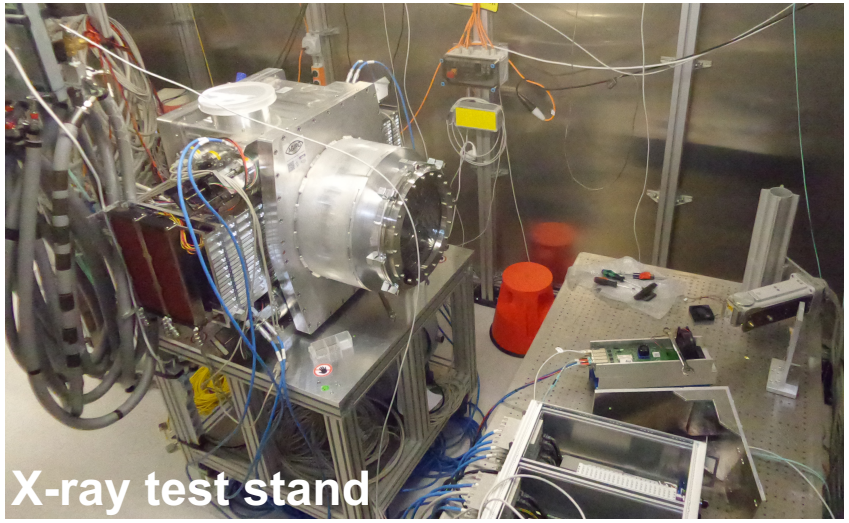
Test and calibration

X-ray test stand

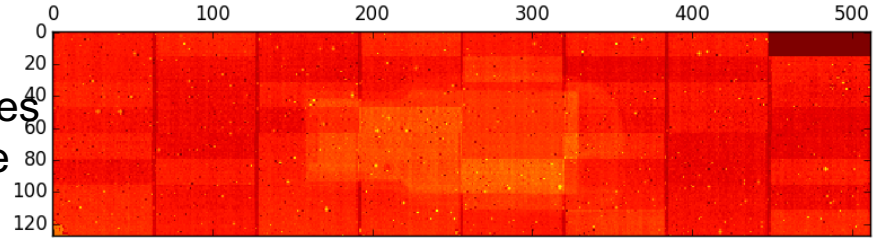
- Test and calibrate e.g. AGIPD and LAMBDA detectors
- X-Ray generator, optical table

Example:

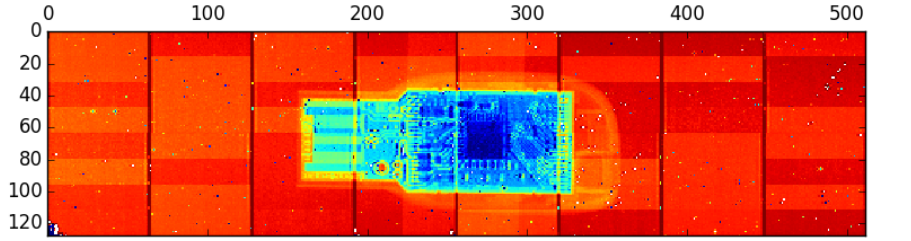
- USB Pendrive picture taken with AGIPD single module
- Data and calibration taken in test stand



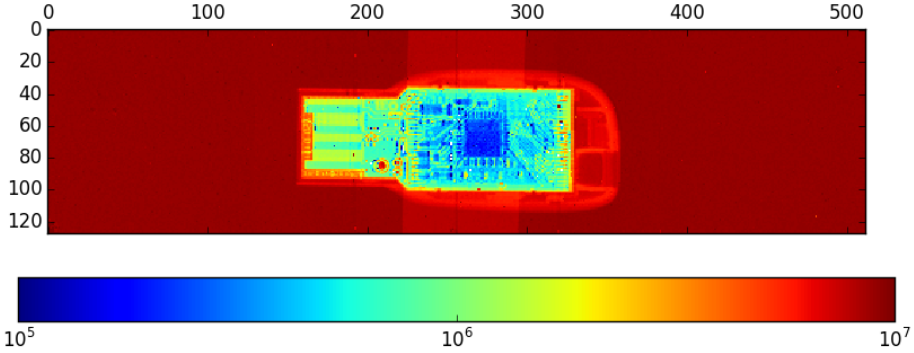
Raw data
Mean of 30000 frames
50µs integration time per frame



After dark field correction

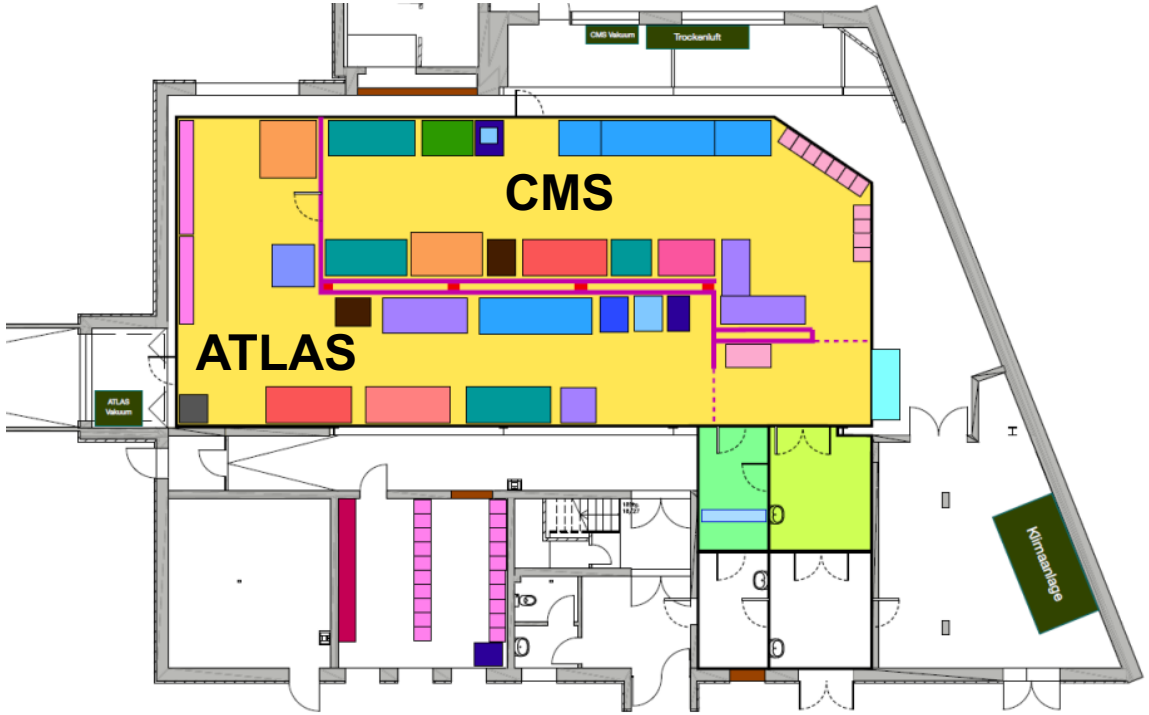


After flat field correction



Outlook

Sharing of experience and infrastructure



Detector Assembly Facility

- New clean room infrastructure for production of ATLAS and CMS tracker modules and endcaps
- Includes equipment (wire bonders, probe stations, glue dispensers etc.)
- Will become common infrastructure

Distributed Detector Lab building upon and extending current expertise

- 3D and Post Processing Center
  - Expertise, 3D design support, Diagnostics, Post-Processing
- Advanced Materials Center
  - Calculation, simulation, fabrication, diagnostics & analysis
- Test Beam Facilities
  - Extension of test beam facility with 4th beam line
  - Instrumentation/detector testbeam at PETRA

Summary

- We have a well equipped and established infrastructure available for detector development
- It enables us to play a major role in several aspects of detector R&D, in prototyping, testing and production
- The infrastructure is our solid basis to be a hub for detector integration

- In future, we will
  - Extend and strengthen the cooperation between the departments
  - Shape our expertise by establishing a Distributed Detector Lab with the focus on
    - 3D and post processing
    - Advanced materials
    - Test beam facilities

Backup

IT services for Photon Science

Compute, storage, services and developments

Compute: The Maxwell HPC cluster: The platform to serve all Photon Science computations

- >200 Server, several equipped with GPUs
- Login and batch servers
- Dedicated fast interconnect (InfiniBand)
- CentOS 7 (Singularity/Docker for differing environments)
- >600 users, more than 400 active users/month

Storage for Photon Science

- >10 PB fast storage for data taking and analysis (4x IBM GPFS instances), fast interconnect to analysis cluster
- Sustained ingest rate 12-20 Gbyte/s per instance
- dCache for sustained long-term data storage and access (includes tape copy)
- Remote data access: Gamma Portal and FTP service

Services delivered by DESY-IT

- Support for a wide spectrum of scientific applications
- Support for compilation, debugging, profiling, tuning …
- Data management tools
- Adapting to new developments and requirements (Compute, Storage, Network, Tools)

(Selected) Developments

- Container integration & orchestration
- HiDRA (next gen) for high performance data multiplexing
- Integrating EUCALL Simulation framework SIMEX

Projects involved

- See Volker Guelzow's presentation for general projects
- Additionally, several IT projects specifically aimed at Photon Science: NOVA, PaNdata, PNI-HDRI