Helmholtz-Zentrum Dresden-Rossendorf

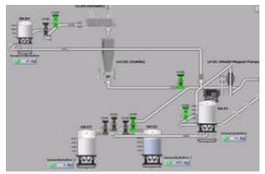
Controlling advanced experiments

Department of research technology

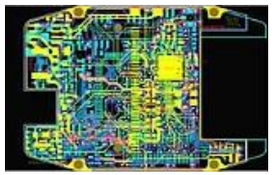
Peter Kaever / Gerald Wedel

Research technology

Instrumentation



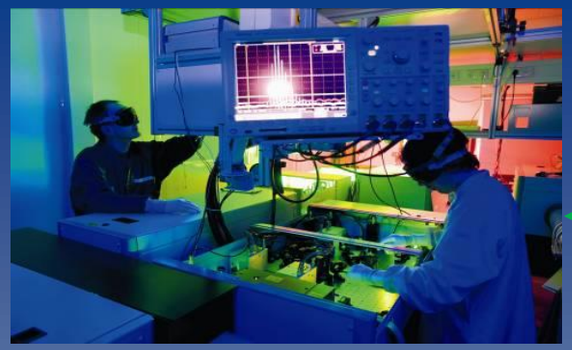
Electronic measurement



mechanical engineering

Manufacturing

Vacuum-Service



Large projects @ HZDR

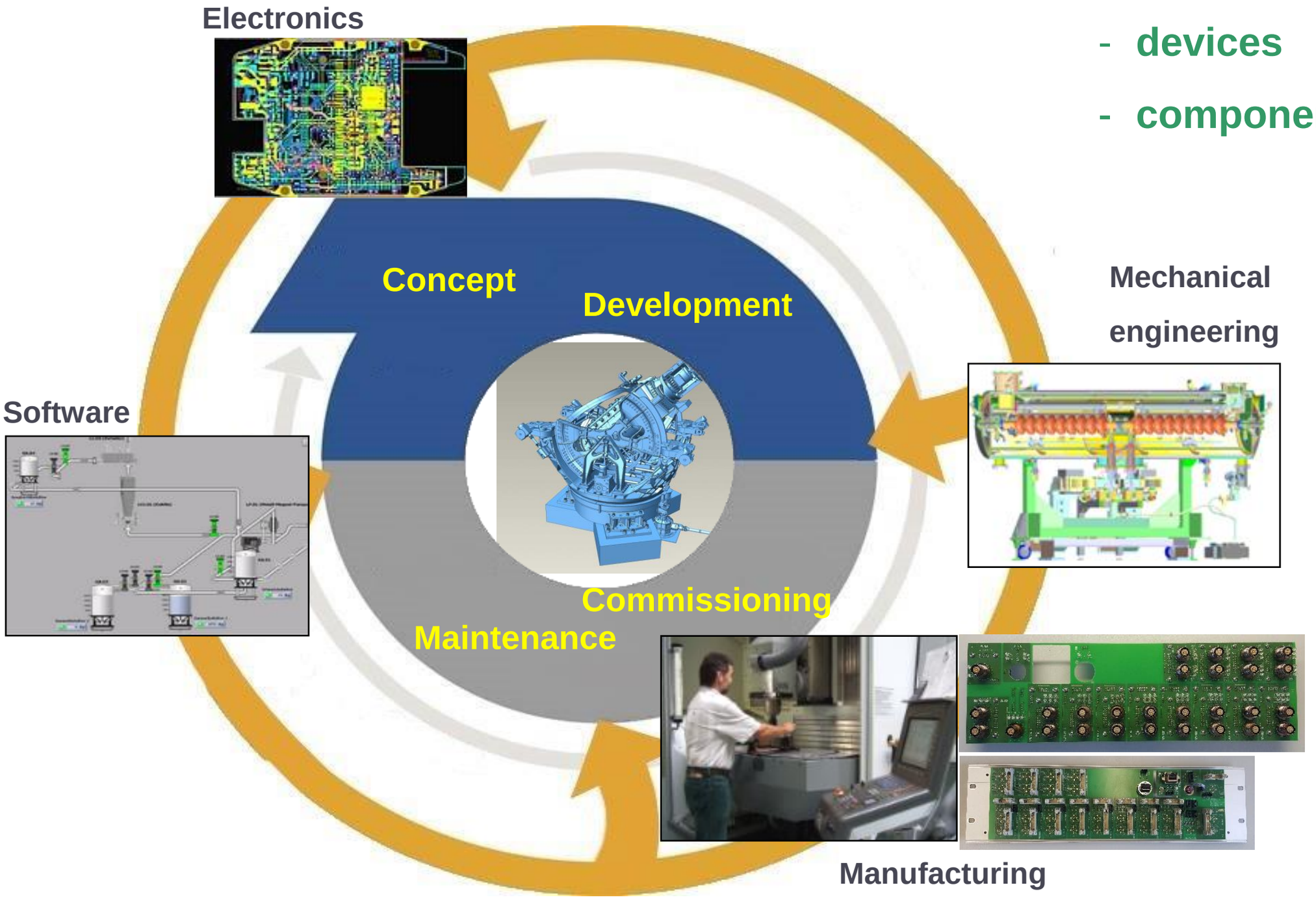
- Center for high power radiation sources
(Petawattlaser + wideband Terahertz-radiation + Coupling of Laser- and electron-beams)
- Extending the High Magnetic field Laboratory
- ZRT – Center for radiopharmaceutical tumor research – Radionuclid-distribution
- DRESDYN - Platform for thermohydraulic and liquid metal experiments (sodium)
- High intensity beamline for extreme Fields @XFEL
- 1MV Accelerator Mass Spectroscopy

Devices:

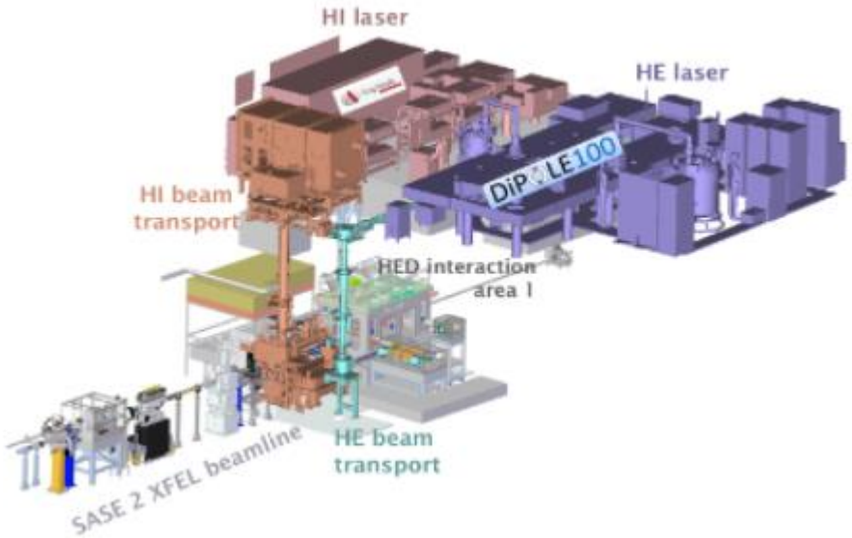
- **Penelope** (High intensity Laser: mechanics, controls)
- **OncoRay** (Cyclotron interface, Beam intensity measurement)
- **IBC** (mechanics, controls, measurement: e.g.10 fA)
- **…**

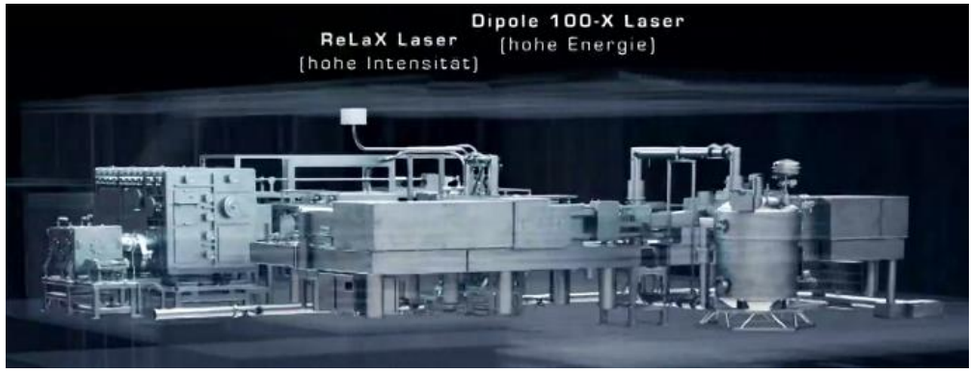
Contributions of Research technology:

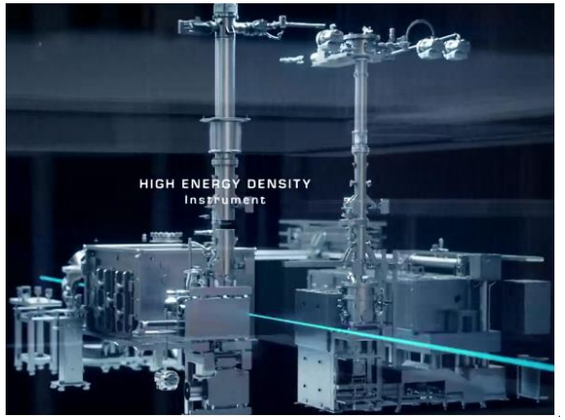
- Facilities
- devices
- components



Advanced experiments: HiBeF
high intensity beamline for extreme fields







Endstation of European XFEL

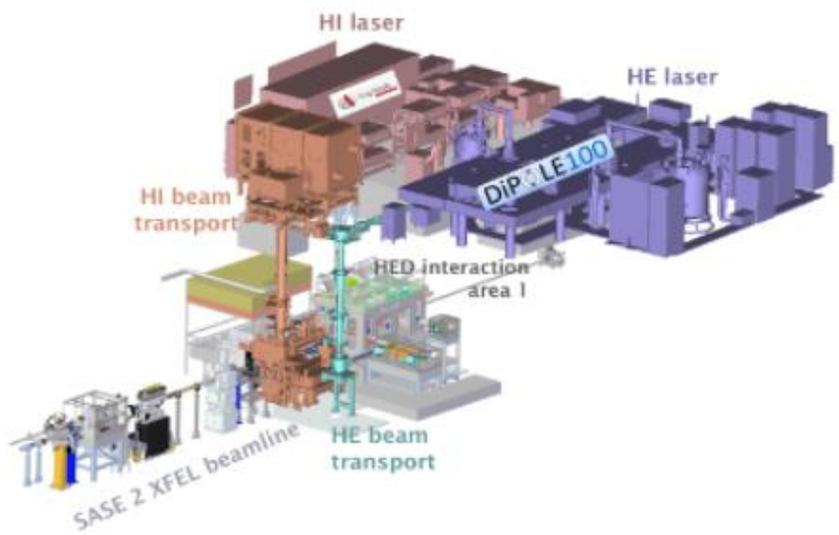
excellent sampling @ 15 fs

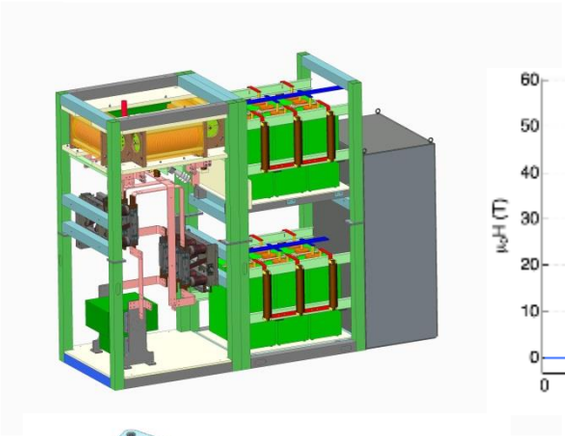
Experiments under extreme Conditions:

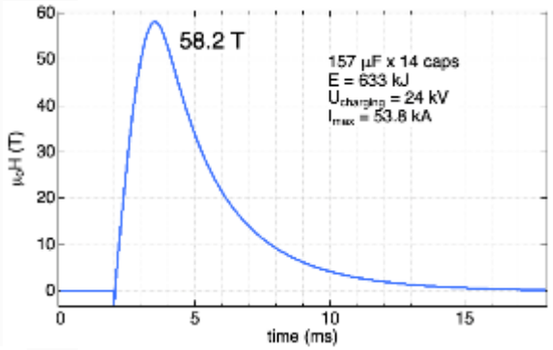
- **High mechanical pressure (3.7 M bar, > 100.000°C)**
- **High magnetic fields (60 T)**
- **High intensity laser light**
  - **1x 300 Terrawatt**
  - **1 x 100 Joule/pulse**

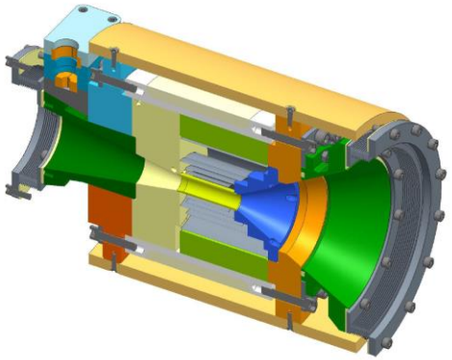
Advanced experiments: HiBeF

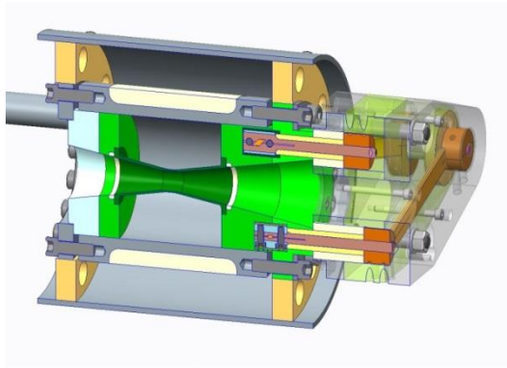
high intensity beamline for extreme fields











Work packages:

- **Beamline chambers**
- **Beamline:**
  design … commissioning
- **Pulsed magnetic fields**
  - **Pulse module 10 MJ**
  - **Pulse Coil**
- **Piezo motor controller**

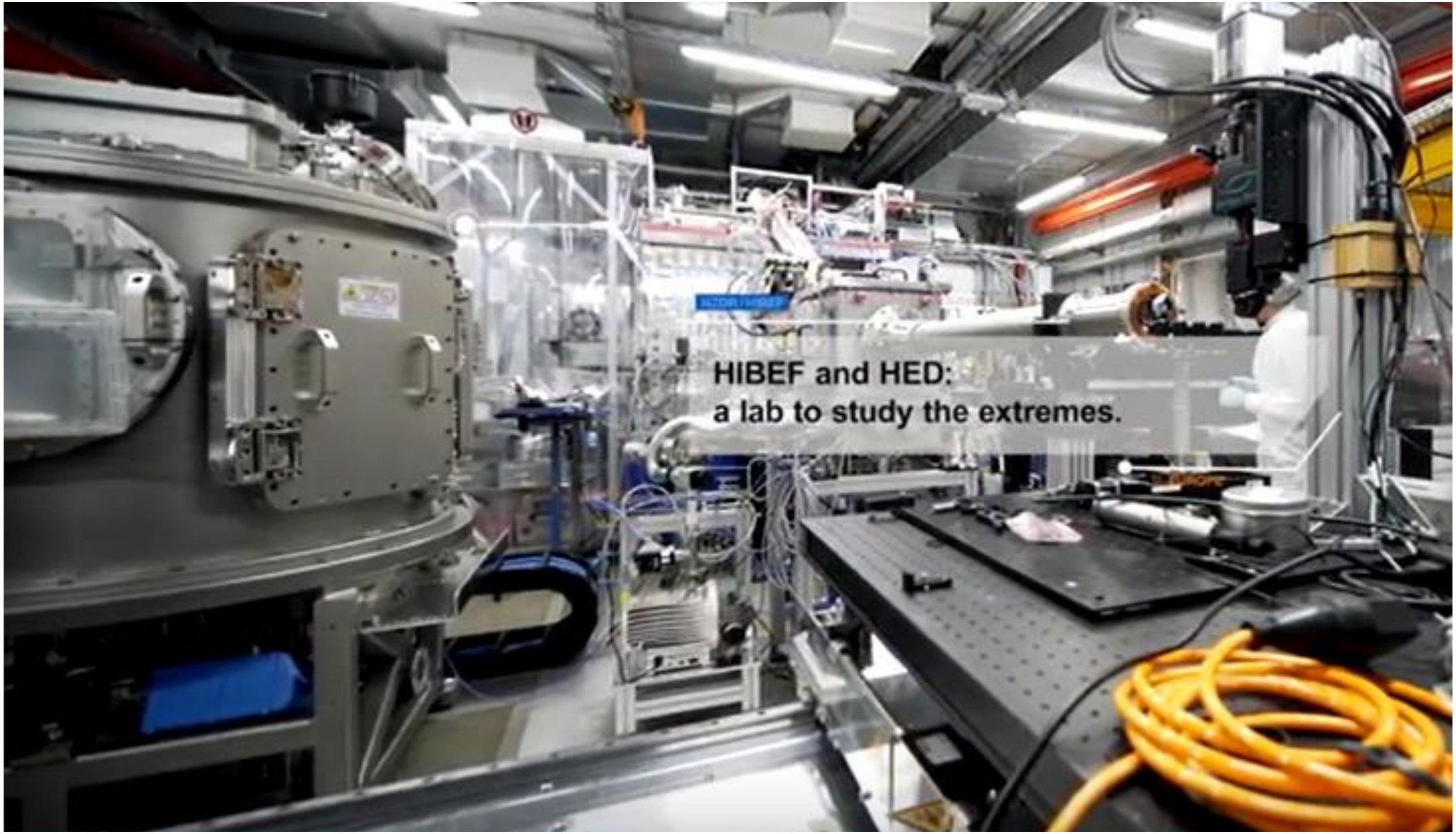
  Adaptive to motor types,
  Compact: 36 motors in 19“, 3 HU

Advanced experiments: HiBeF

high intensity beamline for extreme fields

Advanced experiments: HiBeF

high intensity beamline for extreme fields



Advanced experiments: HiBeF

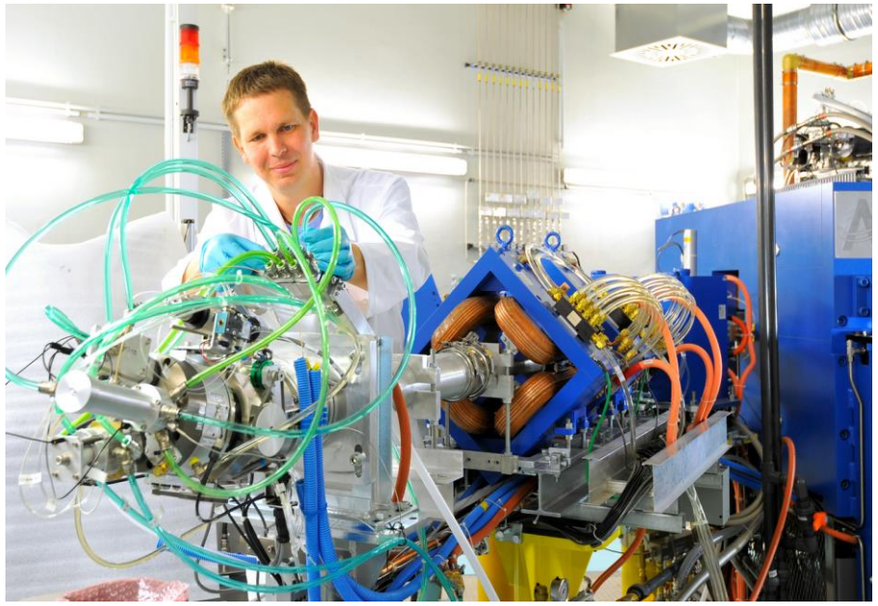
high intensity beamline for extreme fields

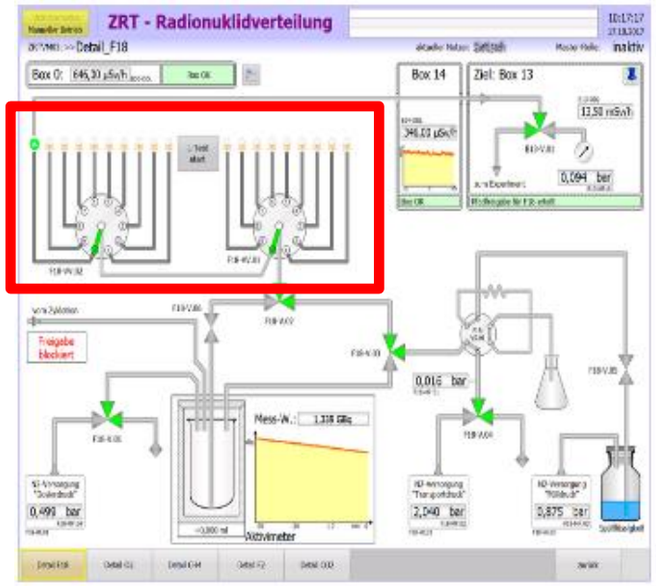
Advanced experiments: ZRT

center for radiopharmaceutical tumor research: pharmaceutical manufacturing

Production of a large range of isotopes under GMP-standards for diagnostics and therapy

Acitivities at Gigabequerel





Safe distribution of gaseous, liquid and solid activity

Advanced experiments: ZRT

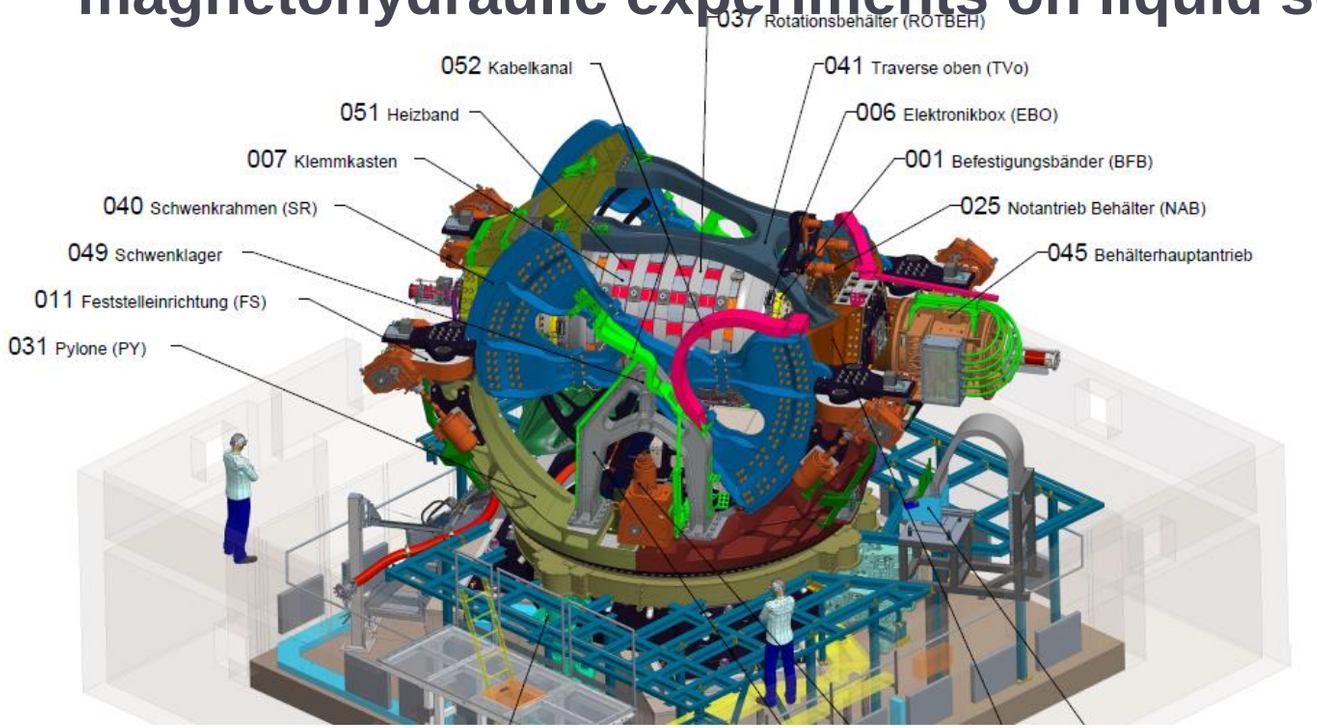
center for radiopharmaceutical tumor research

Work packages:

- **Controls @ Clean room Radionuclide distribution**
  - **Solids, liquids, gaseous**
  - **Motor controller for feedback control of distribution valves**
  - **Safety functions**
  - **Documentation**
- **Cyclotron interface for iodine**

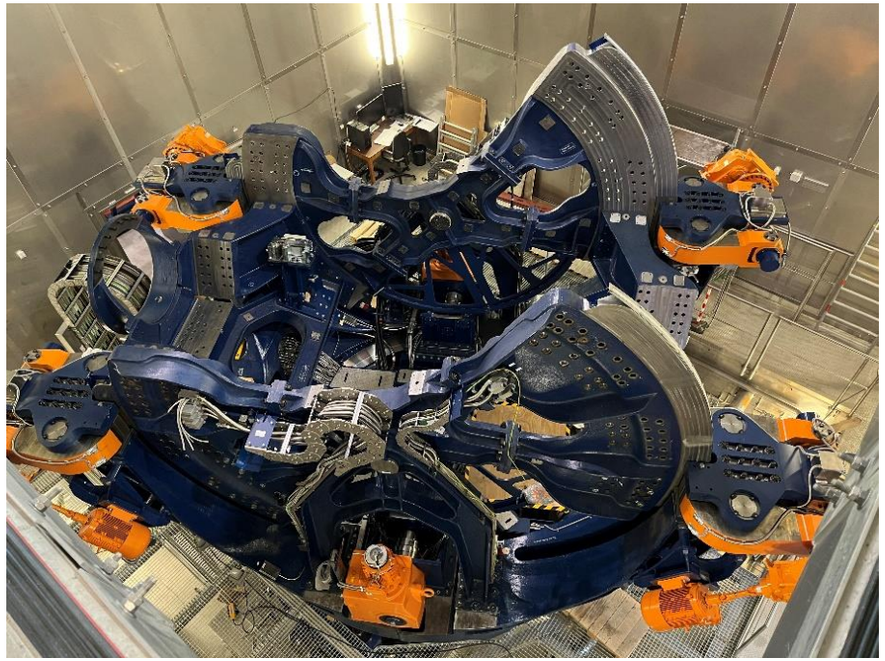
Advanced experiments: DRESDYN

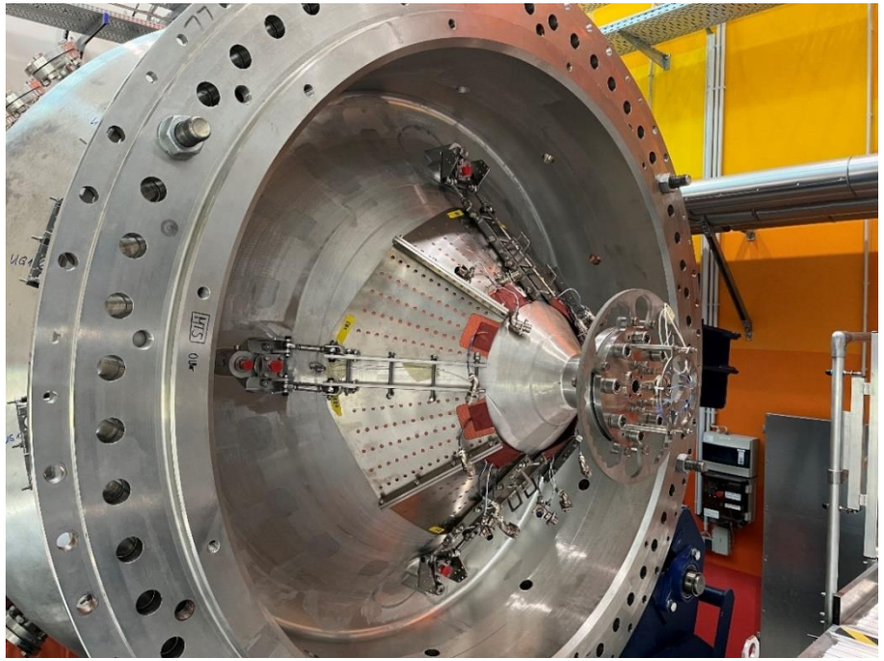
magnetohydraulic experiments on liquid sodium



Parameters & functions:

- **130 tons weight**
- **10 Hz vessel rotation**
- **500 g +- 80 g acceleration**
- **Motion control**
- **Measurement system**
- **Machine safety**





Advanced experiments: DRESDYN

Motion control cockpit

Done:

- **personal safety system**
- **design of electronics @600 g**
- **DAQ – system software**

  (device test … diagnostics)
- **motion control**

Work in progress:

- **PLC control of subsystems**
- **Live view**
- **Machine supervision**
- **Data logging**
- **Documentation, risk assessment**

Areas for potential cooperation: Software and electronics

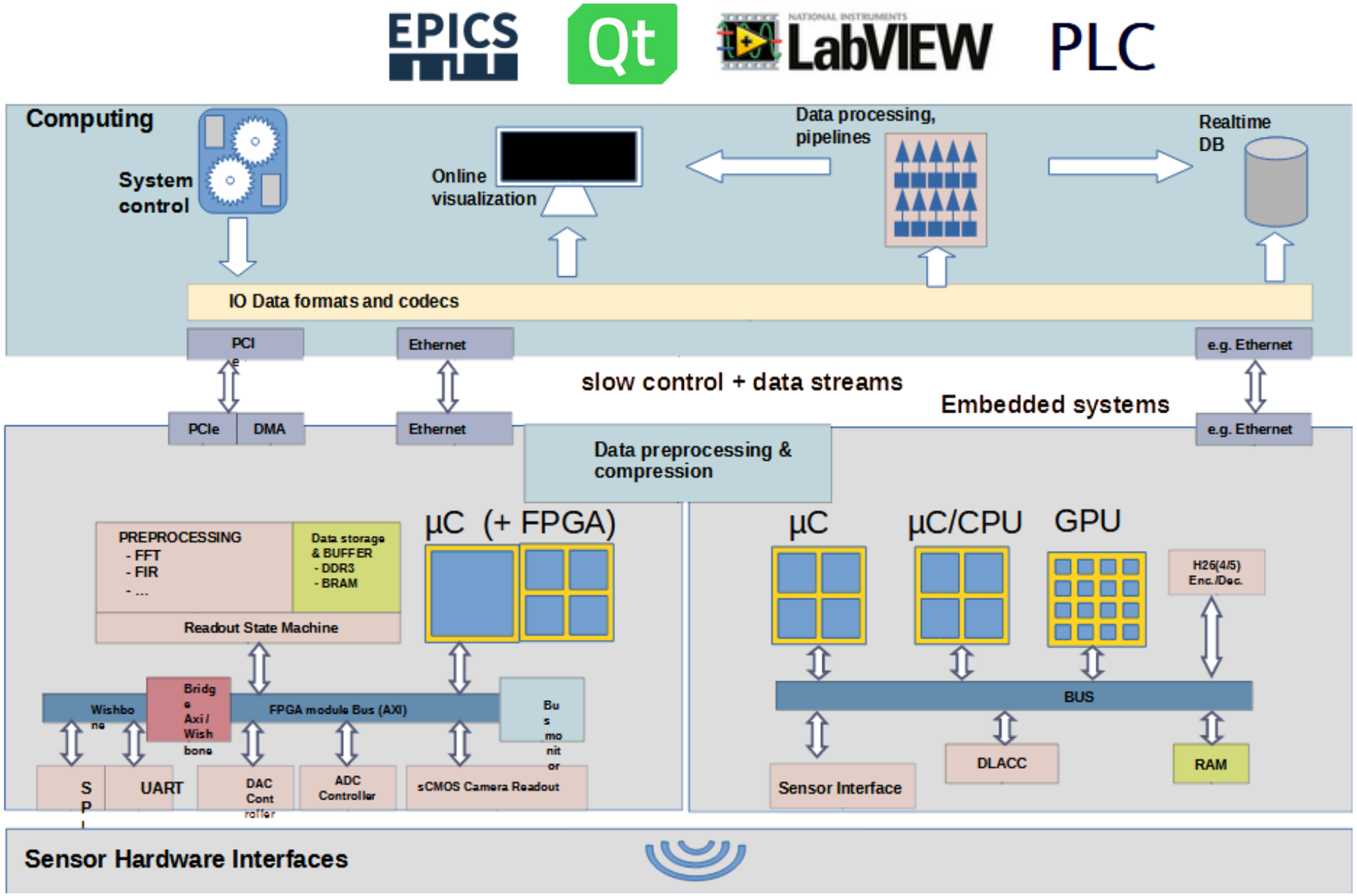
numerous application areas

Control Systems

Electronics

Embedded Device Firmware

Sensors



Candidates for Cooperation:

Inexpensive Hardware, extensive KnowHow

Range: Realtime systems … to GUI

Control systems :

- Qt based, EPICS, Labview, PLC, …

Software development:

- Image processing & Artificial Intelligence (Lab @HTW Dresden)

=> Camera parameterization and Data acquisition

=> PC – based flexible processing pipeline

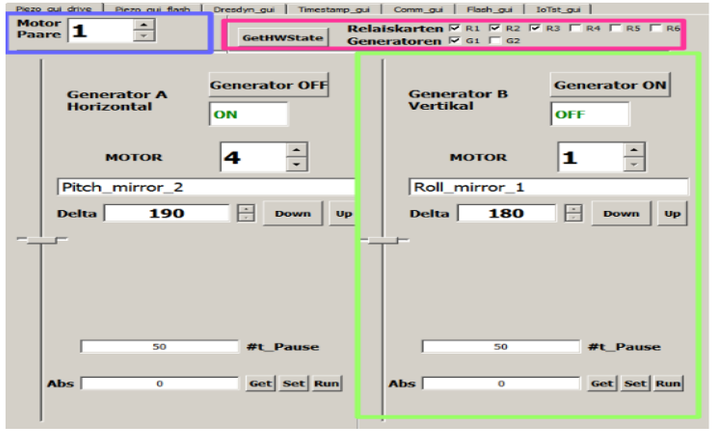
Electronics / Embedded System Platforms:

- Embedded GPU programming
- Raspberry PI devices
- Microcontroller firmware
- FPGA firmware

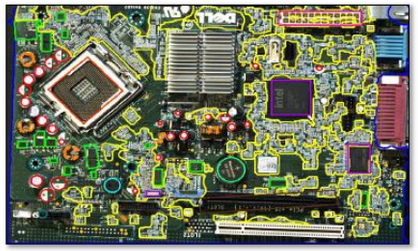
Motion Controllers: Motor types: stepper, BLDC, DC, Piezo

Detector systems: Parameters and Data streams

precise synchronisation of distributed devices



Saxony 5: Co-Creation Lab Künstliche Intelligenz
Anwendungsprojekt an der HTW Dresden



SEVVBWG: Systeme zur Erfassung, Verarbeitung und Visualisierung von Bilddaten in wissenschaftlichen Großgeräten

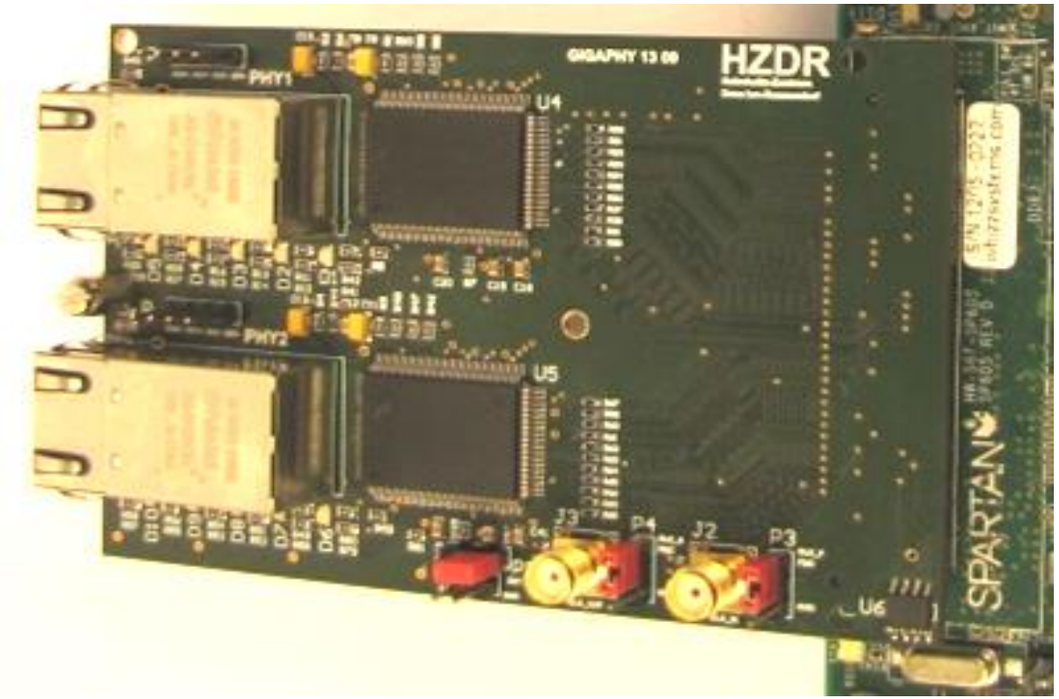
Die HTWD führt innovative Entwicklungen auf dem Gebiet der Gewinnung und Verarbeitung visueller Daten bis zu wissenschaftlich-technischen Auswertungen dieser durch und betreibt dazu ein mit moderner Hardware und Software ausgestattetes Labor. Das HZDR entwickelt im Rahmen des wissenschaftlichen Gerätebaues Automatisierungssysteme und sorgt für die Auslese, Verarbeitung und Analyse der dabei anfallenden Sensordaten in unterschiedlichen Experimentieranlagen. Im Rahmen der Zusammenarbeit kombinieren beide Partner ihr Knowhow auf den Gebieten Computergrafik, Bildverarbeitung, Datenvisualisierung, Wissensverarbeitung und Lernverfahren einerseits und Automatisierung, Sensorik, Aktuatorik, Erkundung, Modellierung und Simulation andererseits. Wichtige Anwendungen ergeben sich dabei aus geologischen und ressourcentechnologischen Problemstellungen.

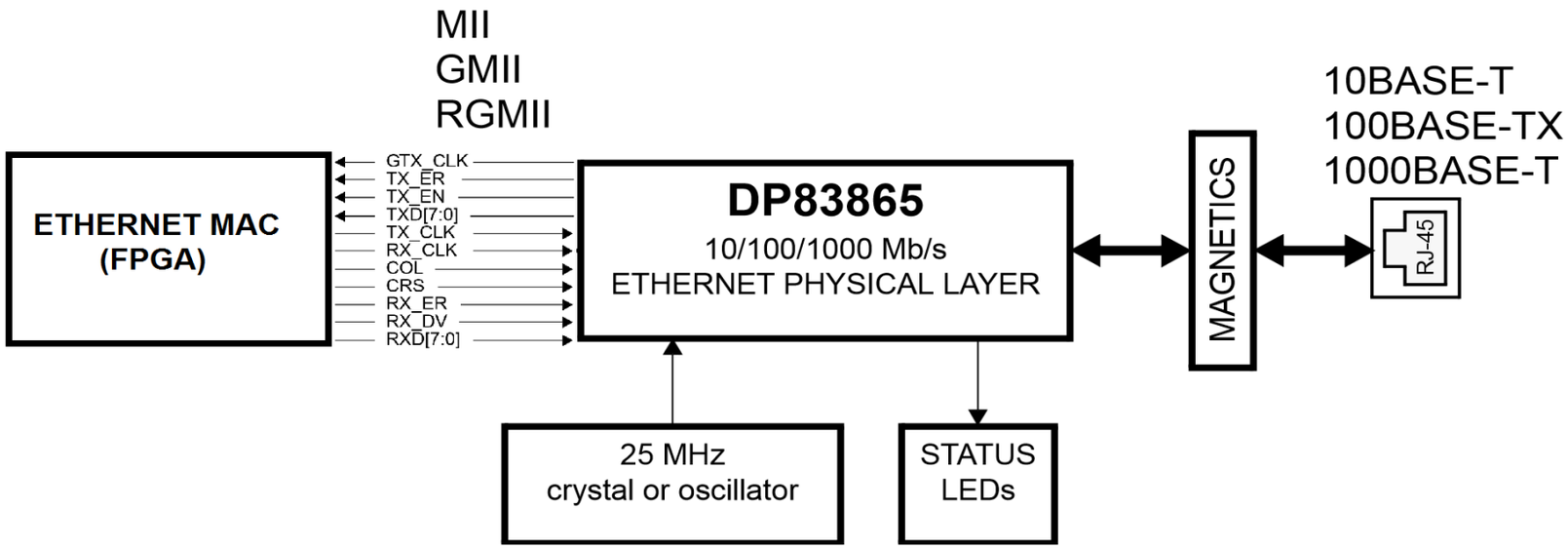
Projektlaufzeit: 01/2021 – 12/2022
Kooperation: Hochschule für Technik und Wirtschaft Dresden (HTWD) und Helmholtz-Zentrum Dresden-Rossendorf (HZDR)
Bearbeiter: Prof. Wolfgang Oertel und Prof. Peter Kaever

Ethernet Integration of detectors

- Timestamps < 1 ns
- Jitter 45 ps
- Synchronity in distributed systems

- Standard components
- SyncE, Gigabit Ethernet





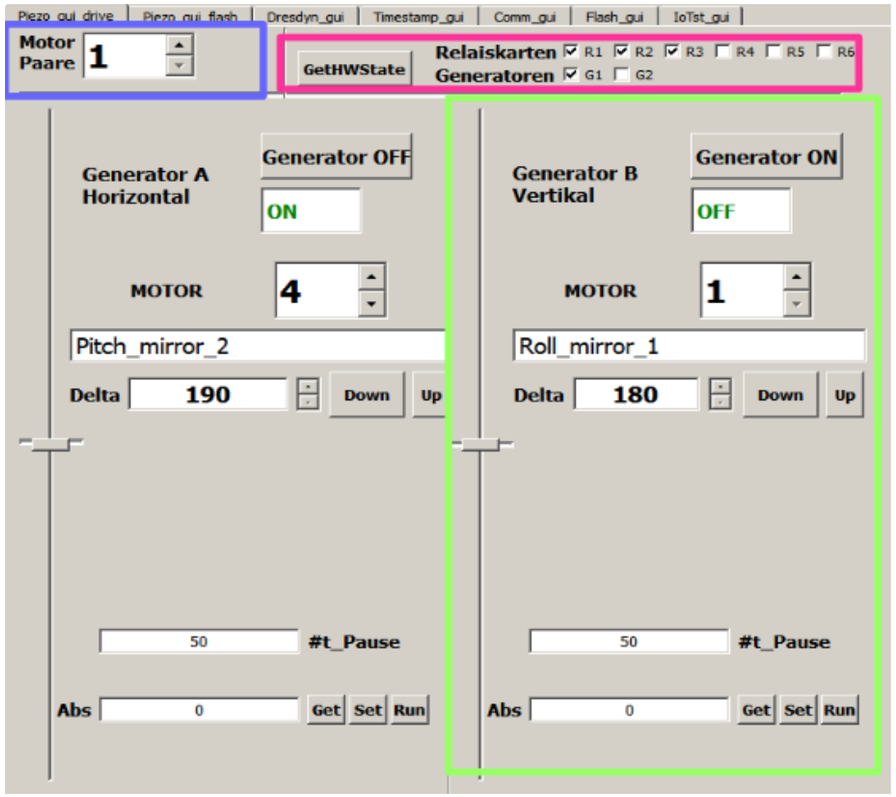
PHYTER® is a registered trademark of National Semiconductor Corporation

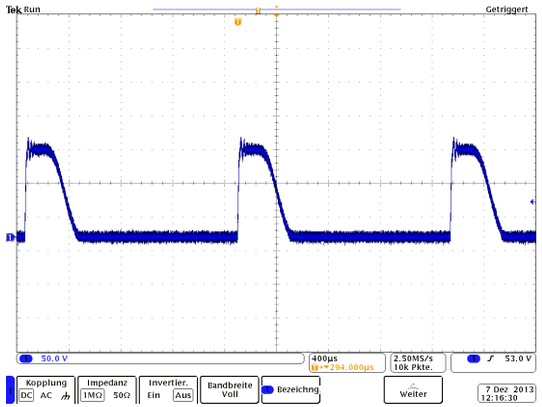
Rack Systems:
Stepper controller

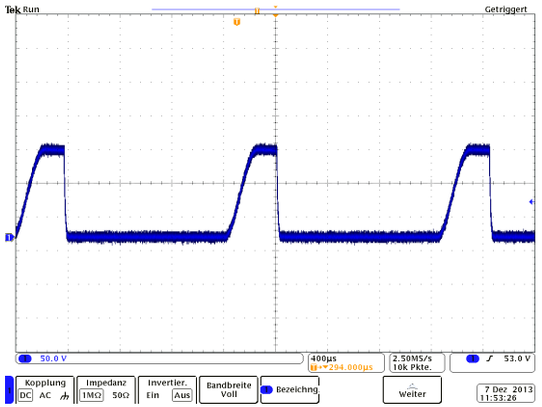
- 12 steppers
- absolut Encoder interface @process
- Motion control
- Integration into Control systems

Piezocontroller:

- 36 Piezomotors; 2 parallel simultaneously
- Motor parameters adaptable to various suppliers
- automatic detection of output states
- PC-GUI for easy operation

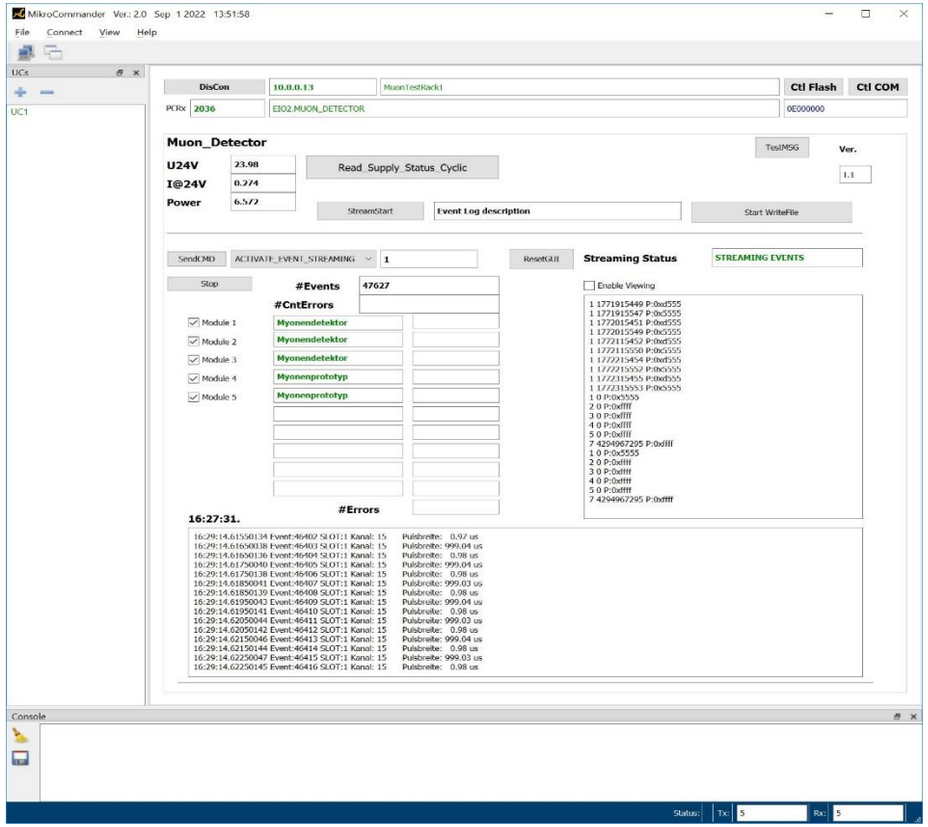






Rack Systems: Muon detector – digital processing

- 160 / 80 channels / rack (stackable)
- 10 ns timestamp resolution
- 50 k Events / s / rack
- 10 € / channel => 1.700 € / rack
- Integration into Control system via Ethernet



Outlook:

- timestamps < 1 ns
- inherent synchronization via ethernet
- increased event rate