# Technical Design Concept and First Steps in the Development of the New Accelerator Control System for PETRAIV

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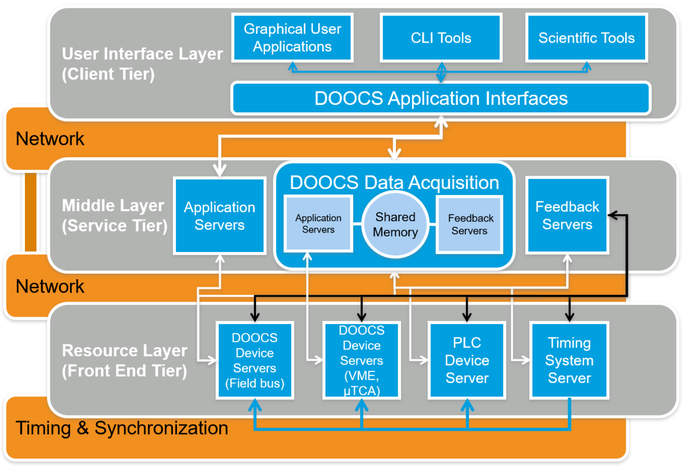
## PETRA III → PETRA IV

- 2300-metre-long storage ring feeding 24 user beamlines
- Operated either in brightness mode (480 equally distributed bunches, 120 mA stored beam) or in timing mode (40 equally distributed bunches, 100 mA stored beam)
- Research groups from all over the world use the particularly brilliant, intense X-ray light for a variety of experiments - from medical to materials research

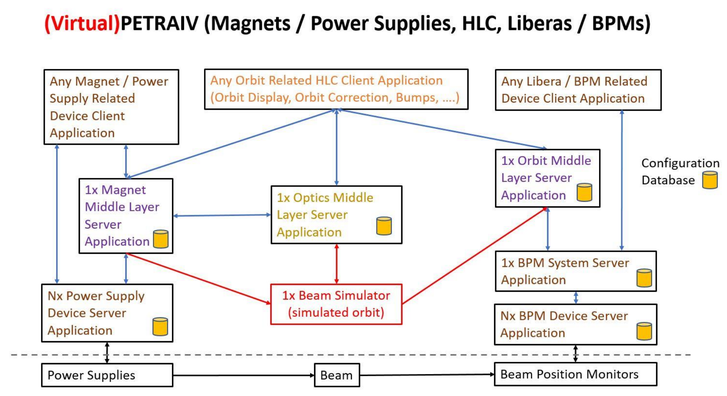
- High-resolution 3D X-ray microscope for chemical and physical processes
- Will extend the X-ray view to all length scales, from the atom to millimetres
- Offers outstanding possibilities and optimal experimental conditions for industry
- Will replace PETRA III, but keeping the existing experimental halls
- An additional experimental hall will provide space for additional 18 user beamlines
- New booster synchrotron DESY IV

## Control System Framework




Three-layer architecture of the Distributed Object-Oriented Control System (DOOCS)

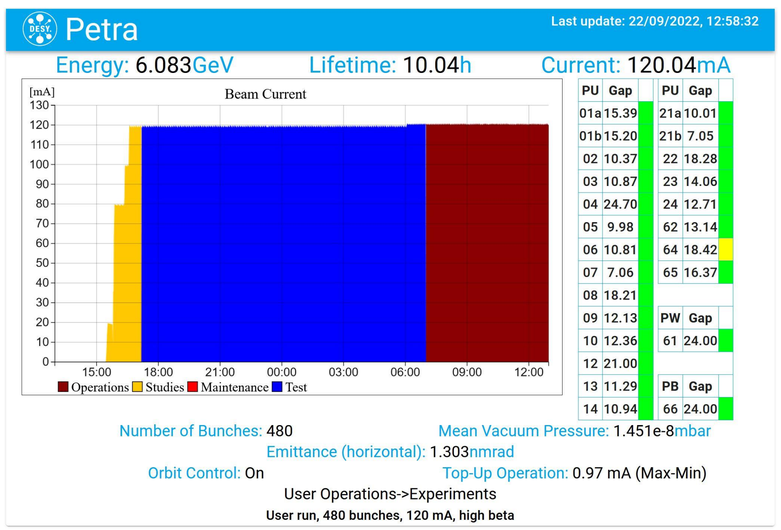
- Distributed Object-Oriented Control System (DOOCS)
  - Architecture: Three-layer, distributed client-server
  - Transportation layer: Industrial RPC protocol, ZeroMQ (being implemented)
  - Implementation:
    - Server: C++
    - Client: C++, Java, Python, MATLAB
  - Device interface: Variety of fieldbus and hardware interfaces
  - Integrated data acquisition service (DOOCS DAQ)
  - Interoperability: Client API provides access to
    - EPICS (facility control system at DESY)
    - TANGO (beamline control system at PETRA)
  - Development and Simulation Environment (Virtual PETRA)




Real PETRA ↔ Virtual PETRA
(Example: Orbit control)

## Graphical User Interfaces

- Java DOOCS Data Display (JDDD):
  - Tool of choice for the standard beam operation as well as operating technical accelerator devices and systems
  - Thin-client approach with a functional and rich set of widgets
- Python and MATLAB:
  - Tool of choice for rapid prototyping and visualization of scientific procedures and data
- Progressive Web Apps (PWA):
  - Tool of choice for dashboard-like applications
  - Based on React JavaScript framework




PETRAIII operational overview implemented as Progressive Web App using React framework

## Device Interfaces

- Interfaces for triggered, high-performance applications:
  - Compliant with MicroTCA.4 technology
  - Linux
  - Remotely manageable
  - Specific modules, e.g. Timing, ADC, Digital I/O processing
- Interfaces for conventional slow-control applications:
  - Compliant with industrial process control standards
  - Generic bridge server available for, e.g.:
    - OPC UA servers
    - Beckhoff controller
    - PLC

## Acquisition and Archiving of Operational Data

- Data:
  - Time series data:
    - Number of devices: ~ 10.000
    - Acquisition rate / duration of storage:
      - Typically: 10 Hz / unlimited, max. 100 Hz / limited
      - In rare cases: 10kHz (→ DOOCS DAQ)
  - Snapshot data: Event triggered
- Database:
  - Timescale (extension of PostgreSQL)
    - Mature, robust technology
    - Variety of data types (including arrays)
    - Good scaling behaviour
    - Can be operated as a distributed cluster
    - Large number of specific processing functions
  - Ongoing prototype development (performance exploration, data pipeline, data reduction strategies, local data buffering)

## Management of Configuration Data

- Configuration data:
  - Include:
    - Hardware-related data: e.g. calibration constants
    - Software-related data: e.g. control system addresses
  - Not include:
    - State-dependent operational setpoint data (→ Save&Restore tool)
    - Different versions of software applications (→ GitLab)
- Change management:
  - Formalized change workflow
  - Through control system (but monitored against references)
- Database:
  - Relational
  - Ongoing prototype development (table structure, change history, unique identifier / temporal validity scheme)