CBM DCS
DETECTOR CONTROL SYSTEM
OVERVIEW

PETER ZUMBRUCH, GSI

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Project Lead

- Min Li, IMP CAS
  - Among others Development of Control System of CEE (next talk)
- Peter Zumbruch
  - HADES controls

PURPOSE & OBJECTIVES

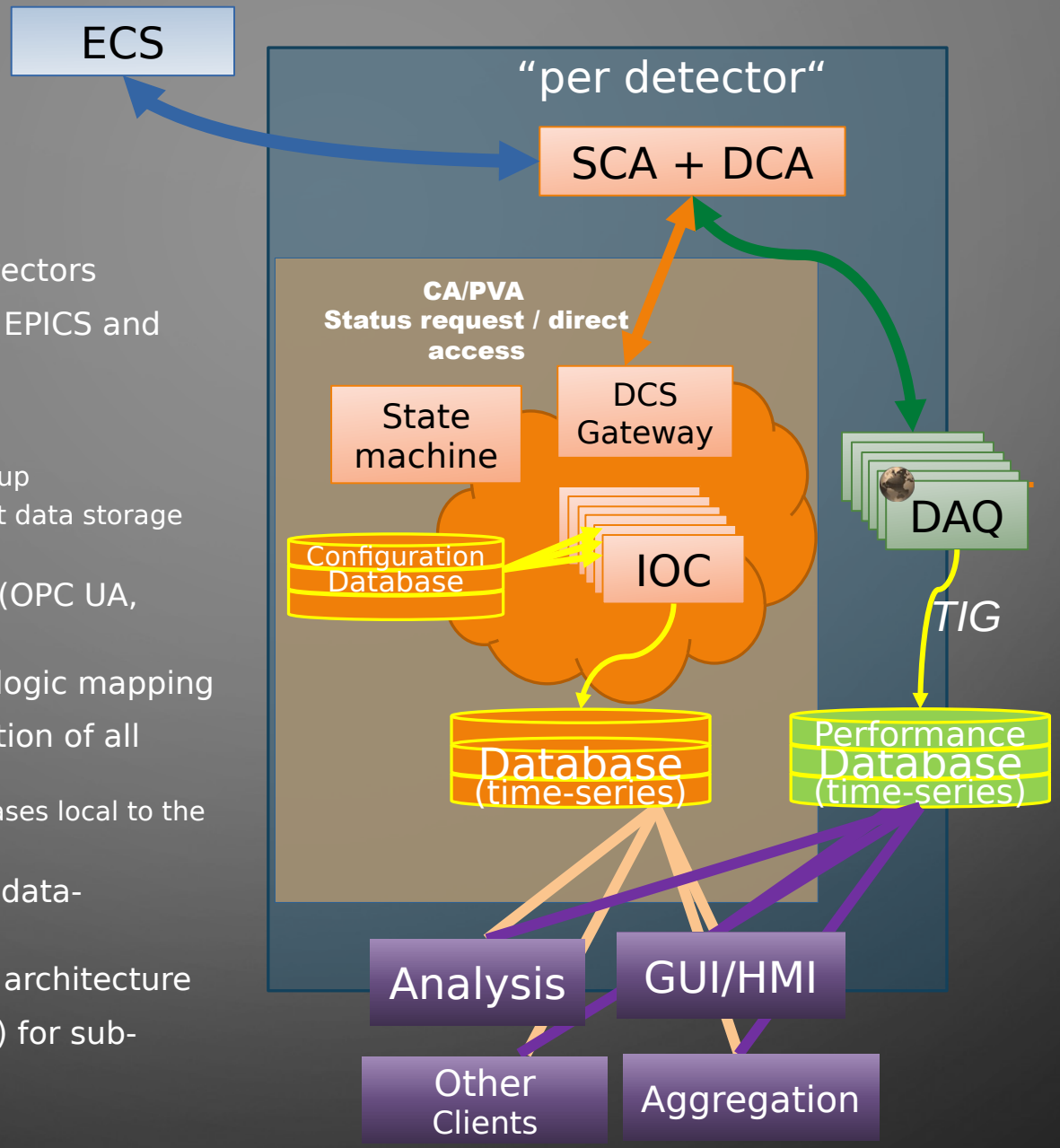
- Ensure the proper and safe operation of the experiment
  - **but** excluding human safety, interlocks, emergency shutdown systems, safety instrumented systems (SIL)
    - Task of DSS Detector Safety System
- Deliver a modular, scalable, distributed, DCS on basis of EPICS, (Experimental Physics and Industrial Control System) across multiple detector units
- Ensure each detector must be able to run stand-alone for testing or fallback, incl. Alarm and Archive
- Each detector's distributed DCS is integrated into the hierarchy of the Experiment Control System (ECS) below the Control Agents, alongside the Readout Controls system
- Replace existing local solutions by common, maintainable solutions
  - If feasible take local solutions into account and integrate
- Leverage and integrate building blocks of the existing external DCS‘s where feasible (e.g. ACC)
- Enable real-time monitoring, control, and data exchange with other industry PLC based systems (Magnet, Cryo, Gas)
- Persistantly store data and thus enable DAQ and Analysis to perform (online) usage of DCS data
- Provide intuitive operator HMIs via EPICS tools and/or web-based Applications
- Maintainability and wide knowledge base via comprehensive documentation, open-source, training, and long-term support

Modular, Scalable, Distributed ...

- Expected no. of Process Variables » 10^5 (HADES) up to O(10^7)
- EPICS, proven at many sites as mature tool,
  - long-term, open-source, large collaboration, big players (e.g. ESS, ITER)
- Containerization / Virtual Machines
- Detector focussed segration of DCS networks
- Configuration Database driven
  - automatic and reproducible, template based
    - IOC setup
  - tag based data-settings

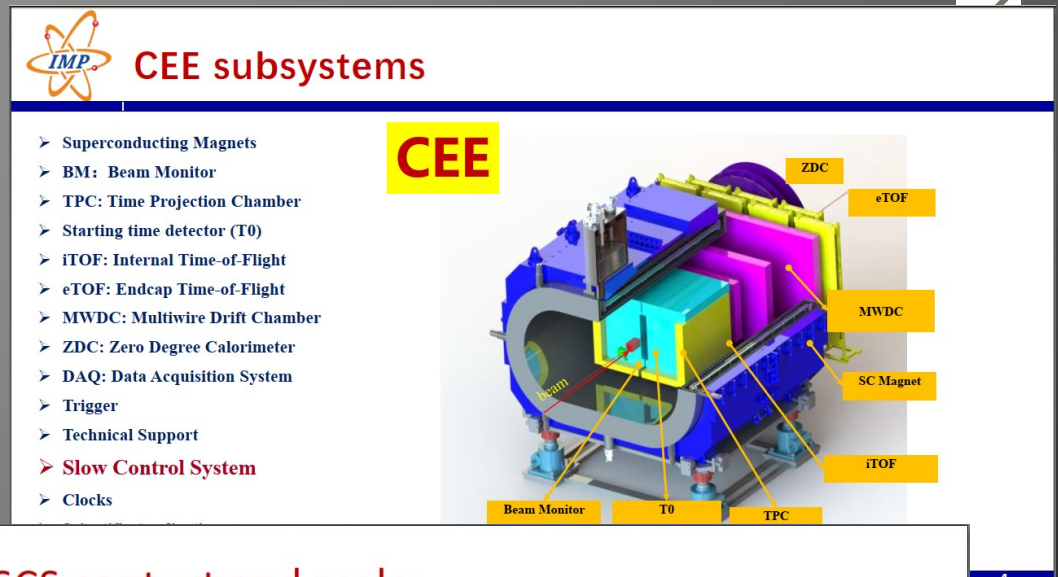
SCOPE

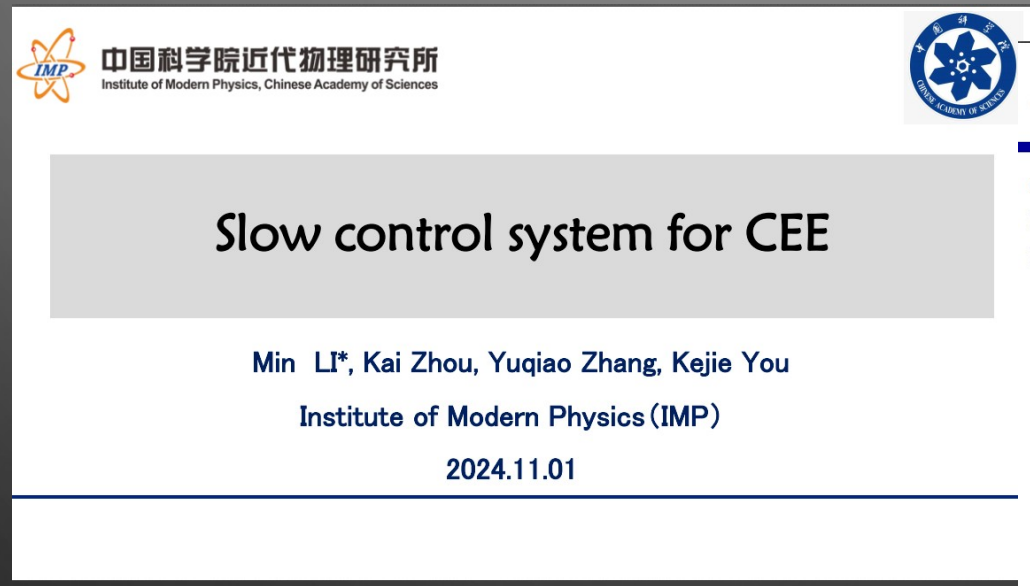
- EPICS IOC development for Detectors
- Integration interfaces between EPICS and higher ECS
  - Sub-detector Status
  - Sub-detector Tasks
  - Automatic configuration & setup
  - database setup for performant data storage (archiver) and retrieval
- Communication layers to PLCs (OPC UA, Modbus, MQTT)
- Task/signal survey and control-logic mapping
- Containerization and orchestration of all services
  - based on configuration databases local to the detector
- Security, archiving, alarm, and data-aggregation subsystems
- Segregated, subdived Network architecture
- HMI/GUI development (support) for sub-detectors

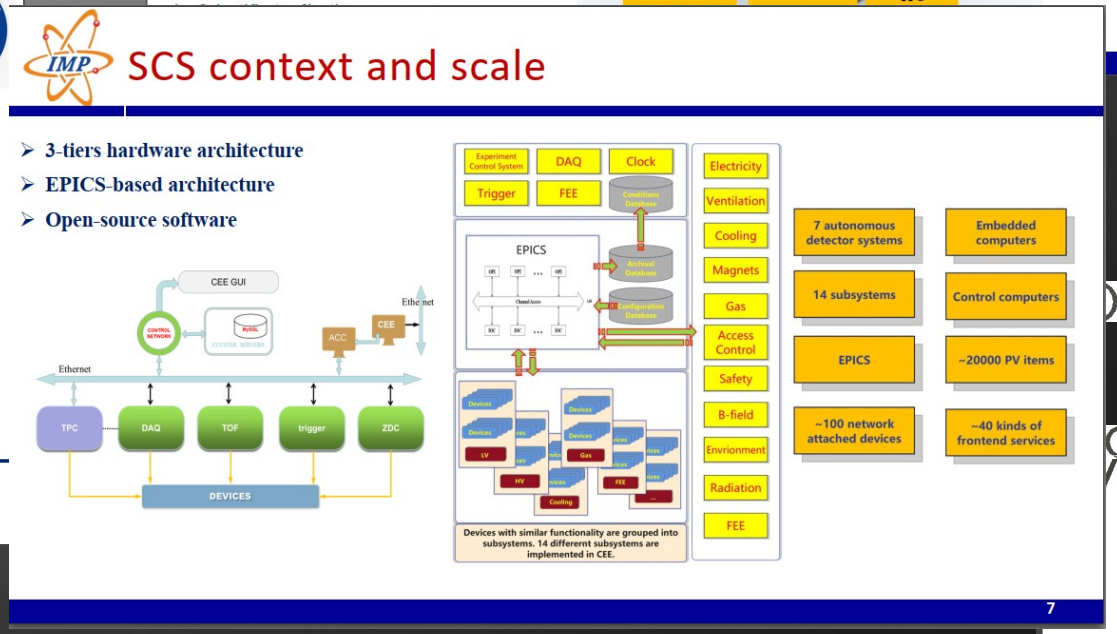


make use of experience at CEE ...

- See next Talk:
  - *DCS CEE*, M.Li, IMP
    - https://indico.gsi.de/event/20881/contributions/93864/







(Slides from previous presentation 2024)

CEE …
evaluate what can be used, adopted

- After
  - getting the status quo and needs of the detector systems
    - during CBM DCS Workshop April 2025
    - Detailed survey
- But not forgetting/ignoring the existing local built-up expertise and work

Status quo
The survey

- Stakeholder contacts
- DCS Workshop April 2025
- Survey

STAKEHOLDERS

- Project Leader:
  - Min Li (IMP, CAS)
  - Peter Zumbruch (GSI)
- Subproject Contact Persons
  - BMON – J.Pietraszko, GSI
  - Target – NN (P.Dahm,?)
  - Magnet – NN (P.Senger,?)
  - MVD – C.Müntz, IKF
  - STS – D.Gutierrez Menendez
  - RICH – C.Pauly (Wuppertal), F.Hollfoth (Gießen)
  - MUCH
    - GEM – NN (A.Dubey)
    - Straw - NN
  - TOF – E.Rubio, Heidelberg
  - TRD – D.Schledt, Münster
  - DAQ/FLES (DAQ coordinator)
  - FSD – NN (P.Chaloupka, ?)

- External DCS Provider:
  - GSI Accelerator
  - CBM ECS System
- PLC Vendors:
  - Magnet Control System
  - Gas Control Systems (Mladen, GSI ACC)
- End Users/Operators:
  - CBM groups
  - CBM Analysis
  - DAQ/Fles
- Hardware / IT support
  - CBM / GSI IT Hardware experts
    - e.g. D.Emschermann as contact ?

Status quo
The survey

- Sent to known contacts
- Quite complicated to fill out
- Next to evaluate and combine with detector system reports from DCS Workshop

TIMELINE & MILESTONES

- Project Kickoff
  - assign leaders
  - define scope
- Contacts, Task & Signal Survey
  - Ongoing, send out,
- Survey evaluation including timing request
  - Until CM 2025/Lanzhou

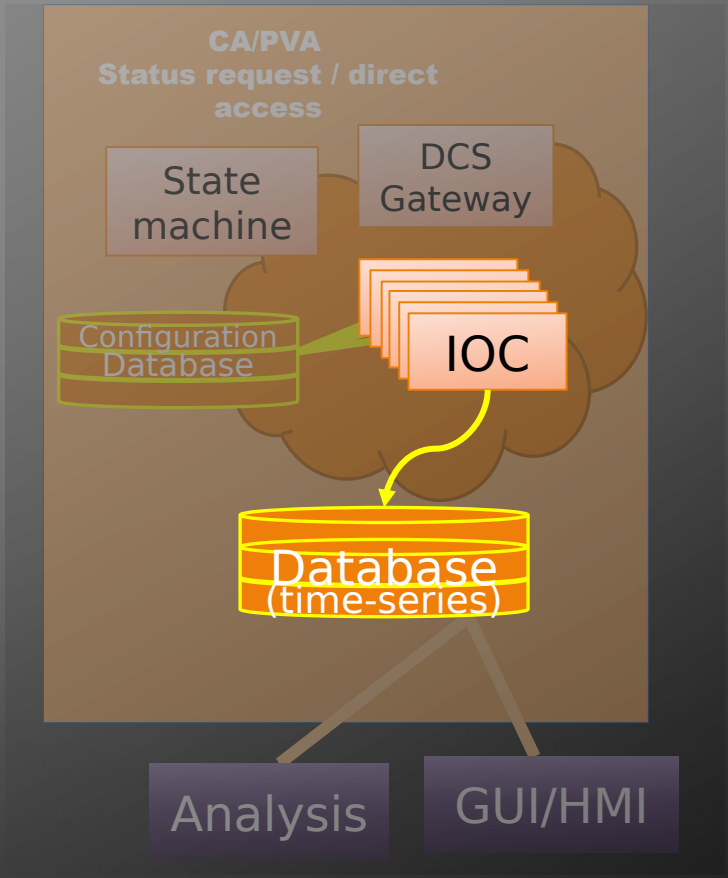
- Existing CEE DCS Evaluation
- Design consideration of data sources/sinks
  - e.g. Archiver Data Base / DAQ resources / grafana
- Choice of Pilot detector
  - small and/or mature
- EPICS Architecture & Interface Design Consolidation
- Code Infrastructure setup (gitlab)
- Hardware platforms choice & procurement
- Hardware setup
  - including network hierarchy

- parallel per System, continously integrating
  - IOC Development/Configuration per Unit
  - HMI/GUI Development
  - System Integration & Testing
  - Documentation & Training
  - Final Deployment
  - Post-Deployment Review
- Interface consolidation to external Users/ECS/DCS/CS

Database

First Project (M.Li et al.)

- setup timebased high-performance database prototype



DCS Working Group Session

- Going into Details …
- Getting in contact with the IMP Team
- Status, Feedback, plans, ...
- Wednesday 15:00 – 18:00
  - https://indico.gsi.de/event/20881/contributions/93946/
  - 666 Meeting Room, 6th floor, No. 6 Building, IMP

Upcoming talks

- IMP
  - Introduction to DCS of CEE
  - Related Activities of IMP Group
- STS
  - Needs on Controls

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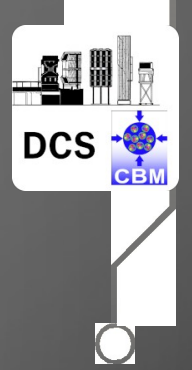
Thank you.


DCS
CBM

ADDENDUM

DELIVERABLES

- EPICS-based control system per unit
- External DCS interface
- PLC communication layer
- Operator HMIs (CSS/Phoebus)
- Task/signal survey docs
- Training materials & manuals
- Aggregated status reports to higher ECS tiers
- keyword triggered automatic configuration setup
- persistant database (configuration and archive)
  - efficient data retrieval for HMI, Clients, DAQ and Analysis

- Access control
- Network segregation via EPICS gateways, per Detector system
- Data archiving
- Alarm handling
- Data aggregation
- Stand-alone operation capability
- Containerization (e.g., podman, singularity)
- Orchestration (e.g., Kubernetes)

RISKS & MITIGATION

Risk	Mitigation
Incompatibility with external DCSs	Early evaluation & prototyping
PLC communication delays	Proven protocol bridges & rigorous testing
Resource bottlenecks per unit	Dedicated subproject leaders
Scalability challenges	Container orchestration & auto-scaling policies
Data volume overload	Shared and modularized archiving backend & optimized queries

SUCCESS CRITERIA

- Reliable, real-time control across all units
- Seamless integration with external DCS and PLCs
- Operator satisfaction with HMIs & alarms
- Independent operation of each detector
- Stable performance with 10 million+ PV load
- Complete documentation, training, maintainability plan