ePIC Collaboration Technical Coordinator Report

Silvia Dalla Torre

INFN TRIESTE

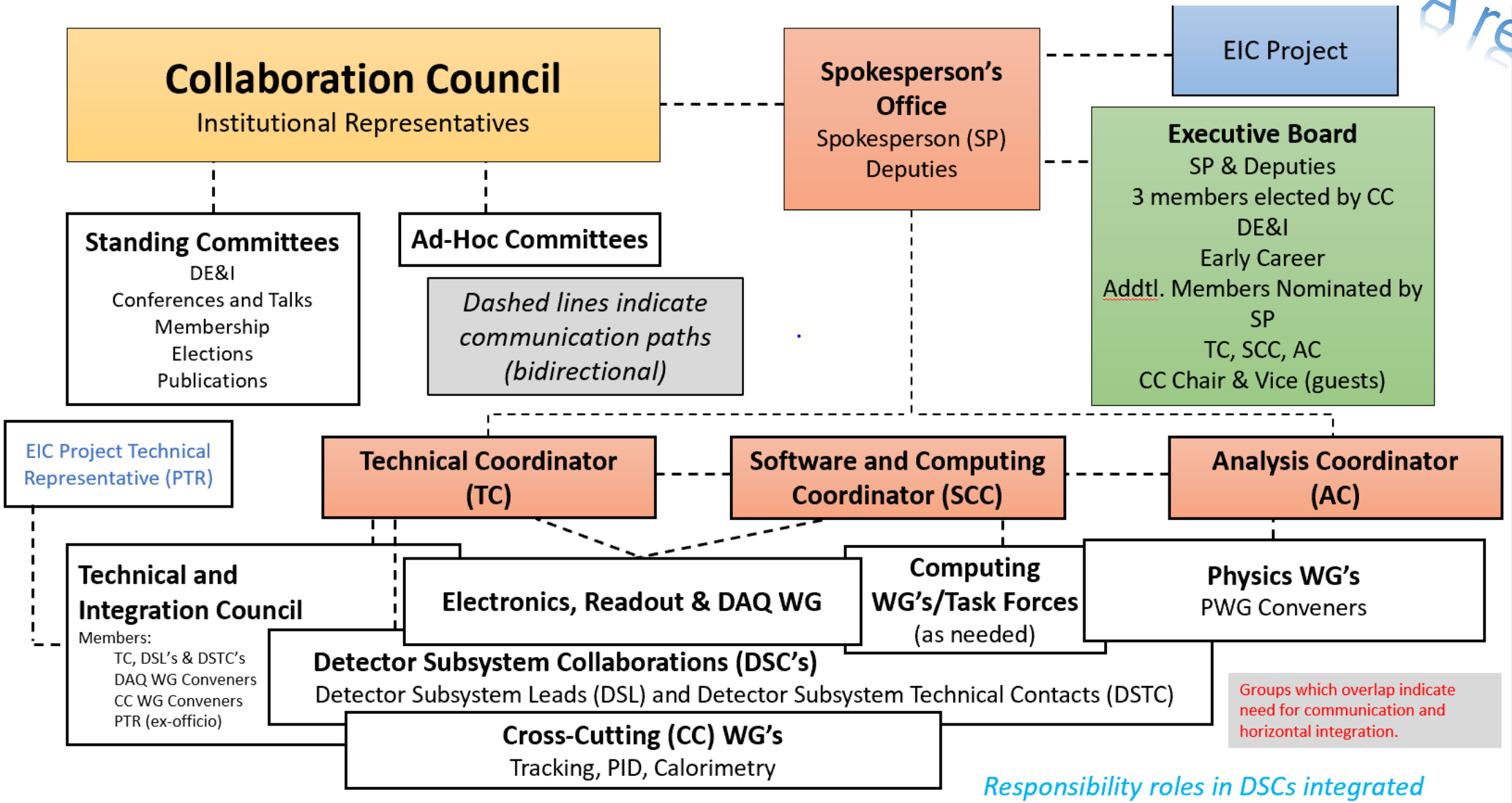
Electron-Ion Collider (EIC) Resource Review Board (RRB) Meeting
2nd EIC RRB meeting, December 7-8, 2023

OUTLOOK

- The ePIC structure to address the detector activity
- The ePIC detector and its optimization/consolidation
- The ePIC collaborative efforts towards the TDR

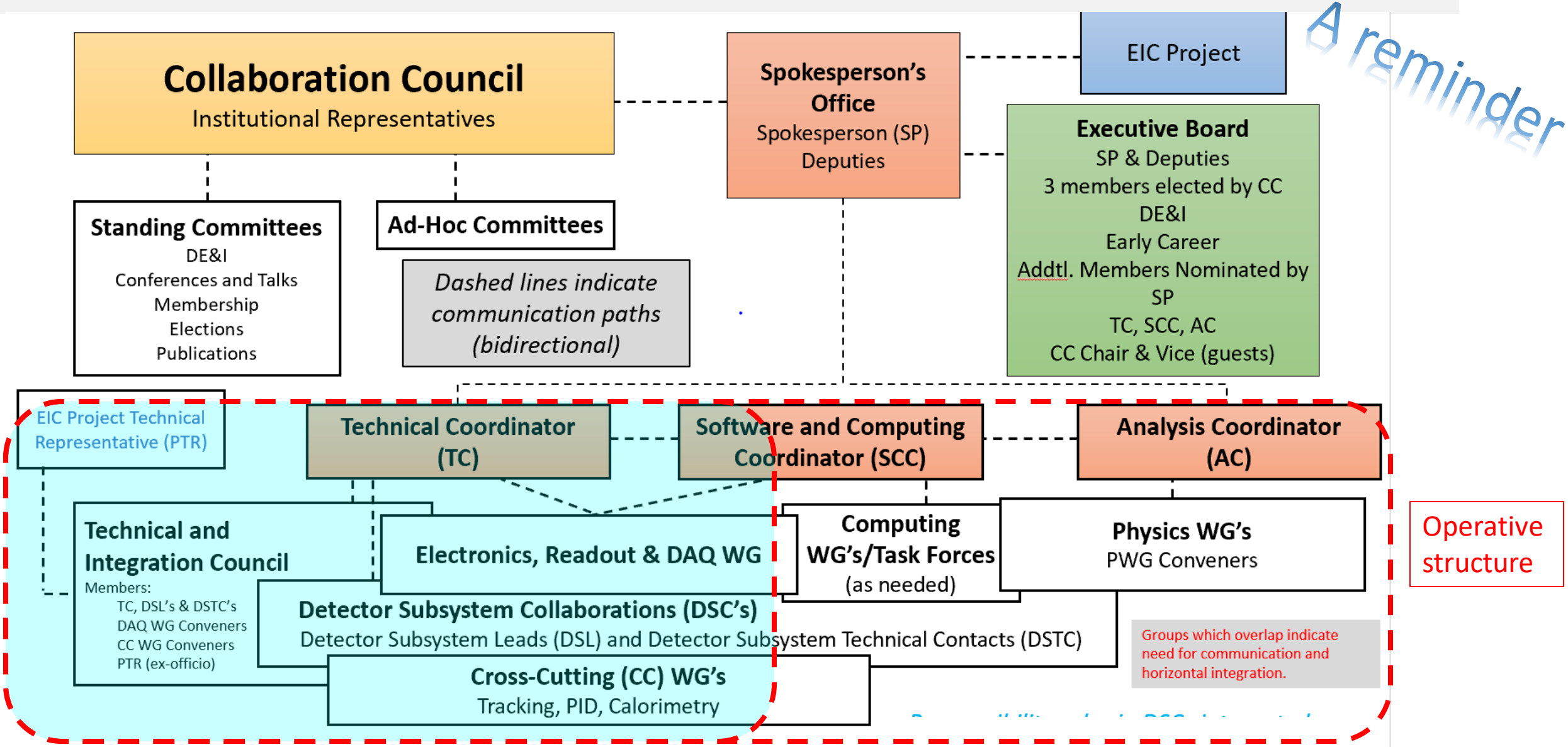
Overall structure of the ePIC Collaboration

A reminder



Responsibility roles in DSCs integrated in the Project at L4/L5 level

Overall structure of the ePIC Collaboration



Focusing on the operative structure

An update to the structure suggested by a deeper analysis of the ePIC collaboration

Technical Coordinator Office (TC-office)

Silvia Dalla Torre
Acting as TC

TC-office members

Prakhar Garg
(Yale)

Oskar Hartbrich
(ORNL)

Matt Posik
(Temple)

EIC Project Technical Representative (PTR)

Technical Coordinator (TC)

Software and Computing Coordinator (SCC)

Analysis Coordinator (AC)

Technical and Integration Council
Members:
- TC, DSL's & DSTC's
- DAQ WG Conveners
- CC WG Conveners
- PTR (ex-officio)

Electronics, Readout & DAQ WG

Computing WG's/Task Forces
(as needed)

Physics WG's
PWG Conveners

Detector Subsystem Collaborations (DSC's)
Detector Subsystem Leads (DSL) and Detector Subsystem Technical Contacts (DSTC)

Cross-Cutting (CC) WG's
Tracking, PID, Calorimetry

Groups which overlap indicate need for communication and horizontal integration.

Focusing on the operative structure

Weekly TIC meetings:

- The forum where the collaboration is addressing the detector needs to cope the whole EIC physics scope and proposing the path to the ePIC management

September 2023

- 25 Sep TIC meeting - status of RO/DAQ information from DSCs; Feedback from recent DAC reviews
- 18 Sep TIC meeting - Update on MPGD's
- 11 Sep TIC meeting - FEE (non-HGCROC/EICROC), Cooling
- 07 Sep TIC meeting - Backgrounds

August 2023

- 21 Aug TIC meeting - Far Backward Detectors and Integration
- 14 Aug TIC meeting - gaseous trackers
- 07 Aug TIC meeting - ASIC Discussion

December 2023

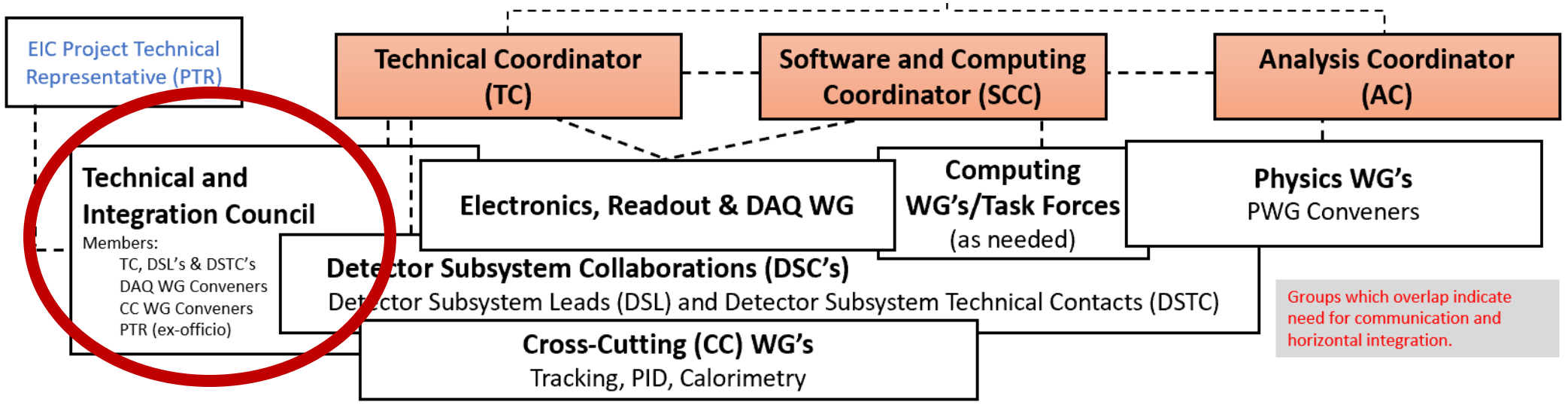
- 18 Dec TIC meeting - ZDC updates, converge towards Design definition
- 11 Dec TIC meeting - integration update from the project engineers; collect information for radhard studies
- 04 Dec TIC meeting - electronics status; photon sensor update for Cherenkov devices

November 2023

- 27 Nov TIC meeting - Update about electronics open points (transceivers, HGCROC)
- 20 Nov TIC meeting - EIC R&D for 2024; ZDC: requirements, radiation dose, updates
- 13 Nov TIC meeting - NO TIC MEETING THIS WEEK
- 06 Nov TIC meeting - photosensors for Cherenkov subsystems and risk mitigation

October 2023

- 30 Oct TIC meeting - Tracking Risk Mitigation Plan
- 23 Oct TIC meeting - Test Beam Needs, Simulation Thresholds
- 16 Oct TIC meeting - detector description in simulations; far backward
- 09 Oct TIC meeting - ZDC
- 02 Oct TIC meeting - barrel ECal

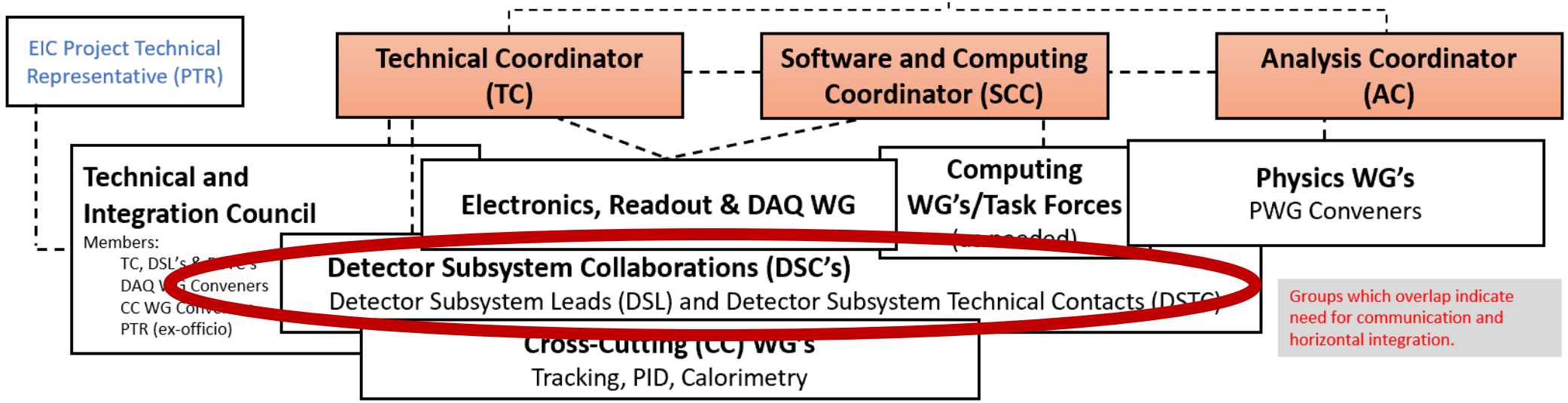


Focusing on the operative structure

The DSCs (Detector Subsystem Collaborations)

- DSC's in ePIC are organized around the **design, R&D and construction of specific subsystems in the ePIC detector**. The collaborations themselves are comprised of the people and institutions committed to realizing a particular subsystem

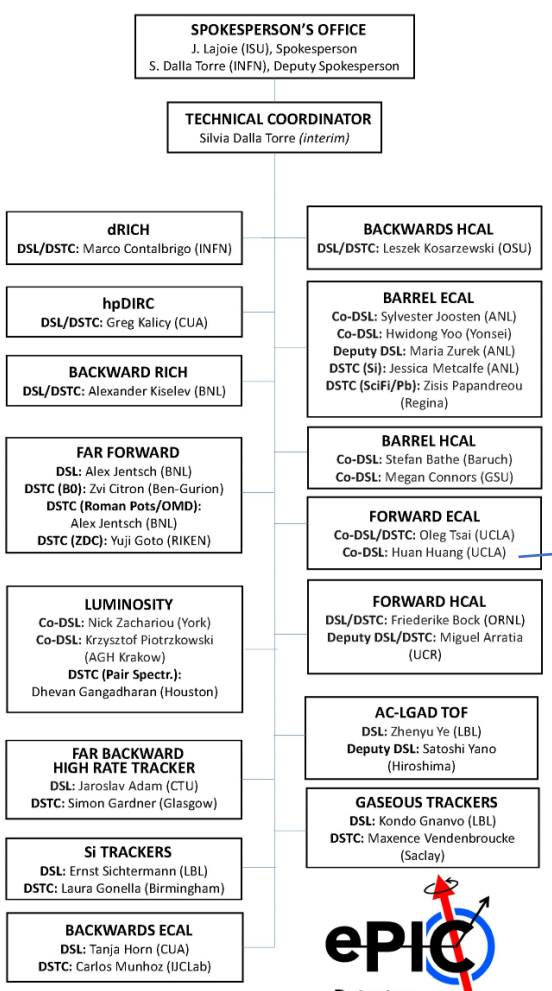
- **DSC activity coherence with EIC Project** ensured integrating key DSC persons in the Project structure: DSC leaders integrated in the project management at level 4, task coordinators in DSCs at level 5

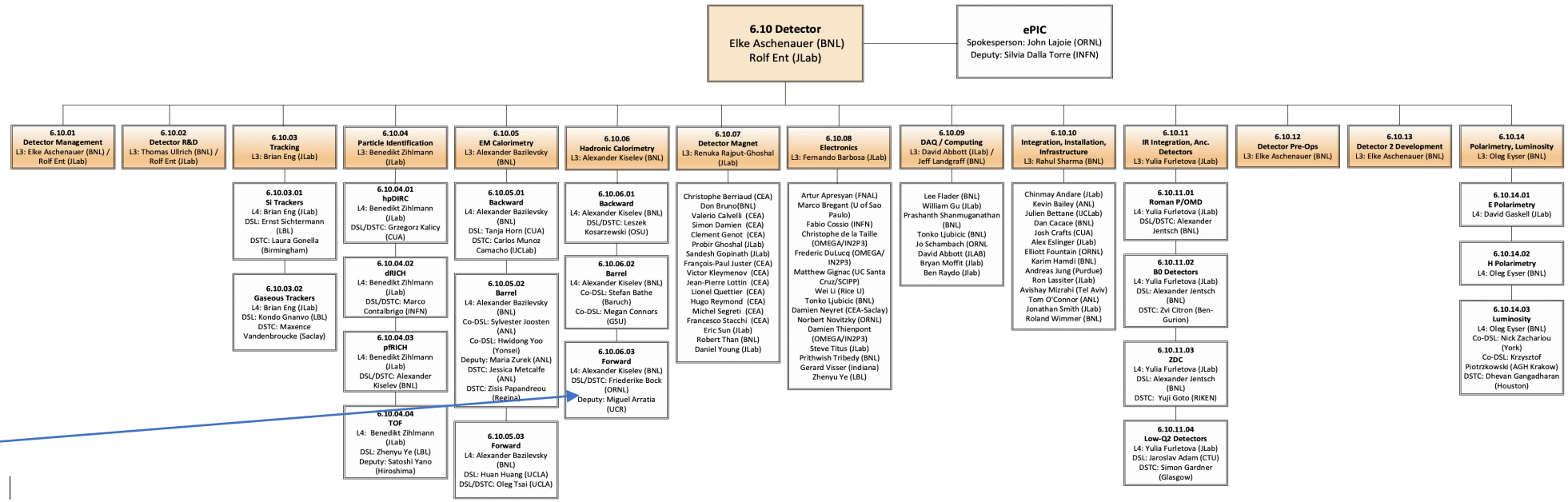


Detector Subsystem Collaborations, a panorama

DSCs in ePIC

Management responsibilities in EIC Project

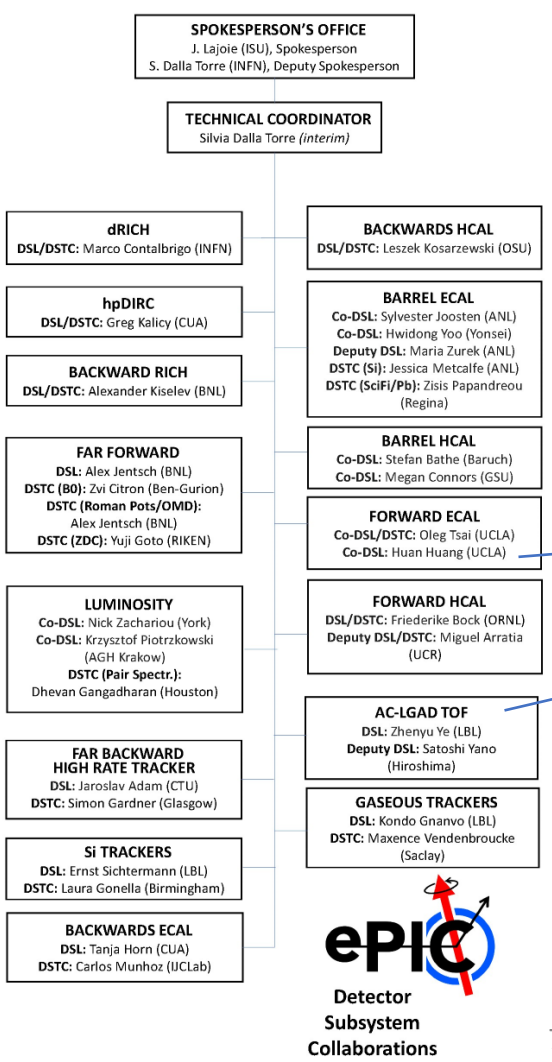


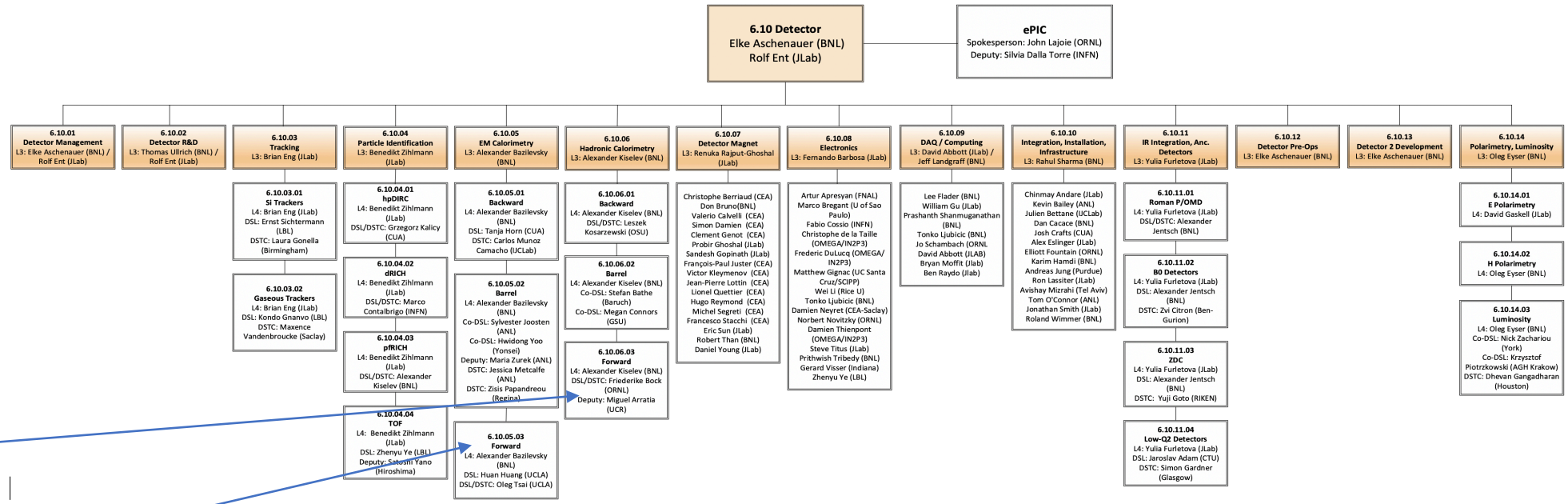


Detector Subsystem Collaborations, a panorama

DSCs in ePIC

Management responsibilities in EIC Project

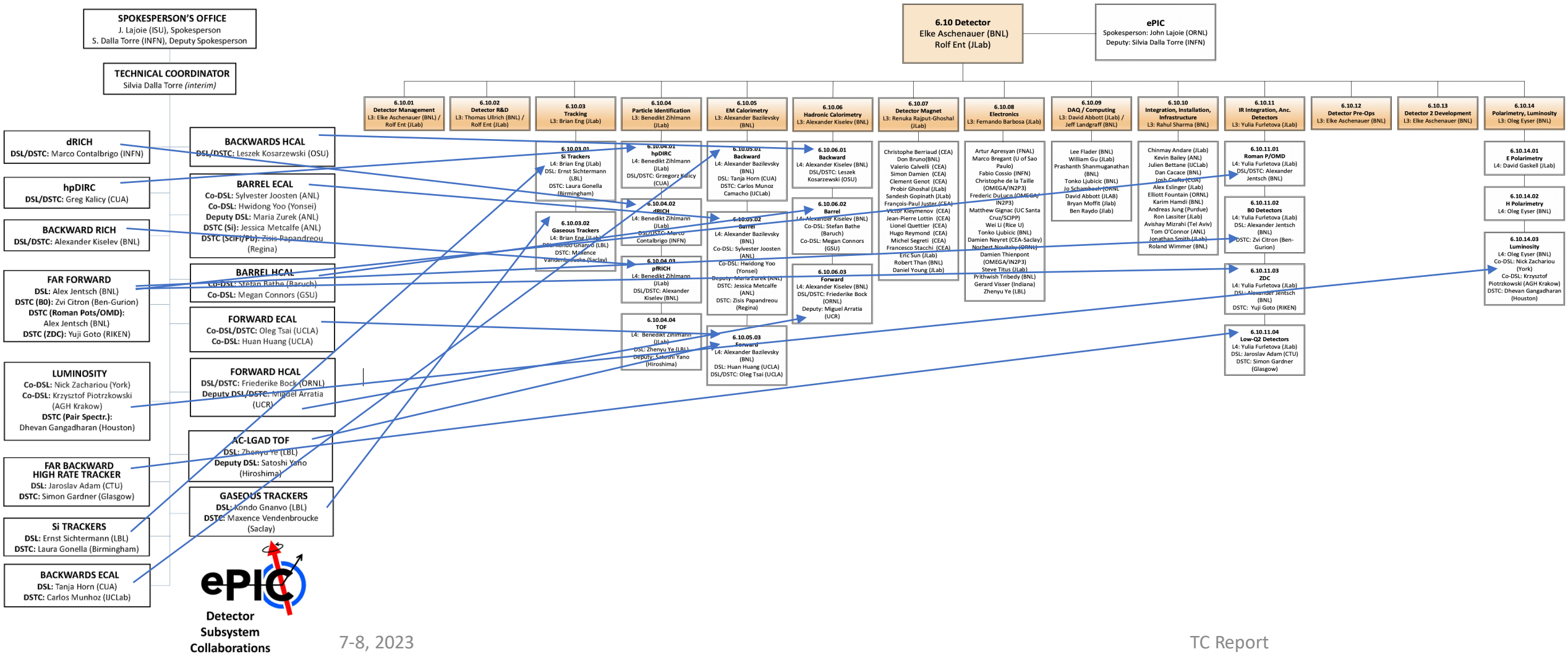




Detector Subsystem Collaborations, a panorama

DSCs in ePIC

Management responsibilities in EIC Project

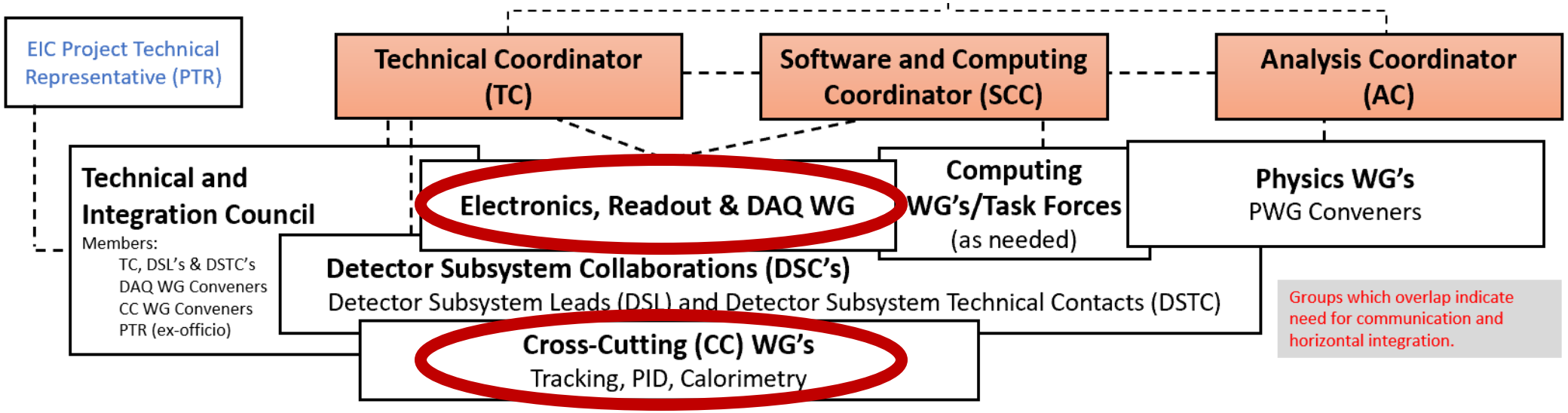


Focusing on the operative structure

The Working Groups

- ***Electronics, readout & DAQ:***
  where the whole read-out chain is designed, up to the streaming r-o DAQ making the bridge with data analysis (SCC's report)

- ***Tracking, Calorimetry, PID, Far Forward/Far Backword CC WGs:***
  a forum for synergies among subsystems with communalities

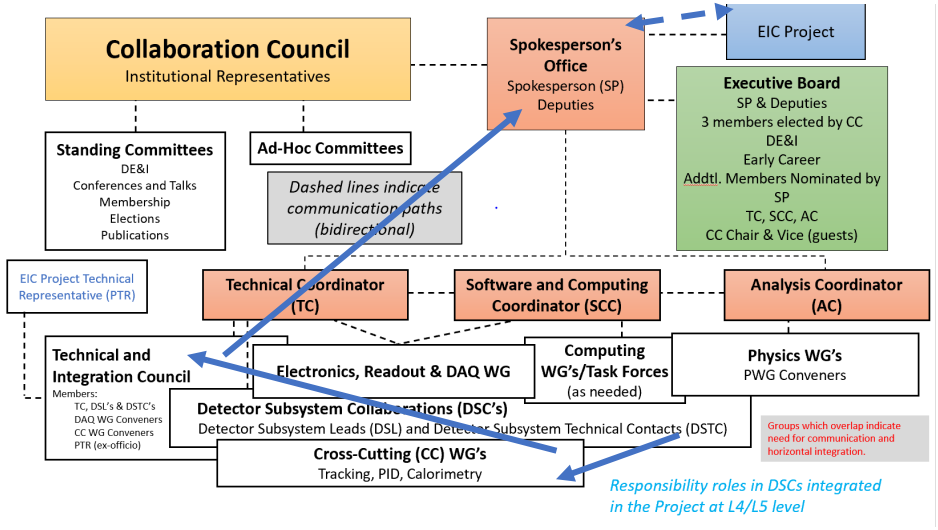


An effective structure for detector consolidation/optimization

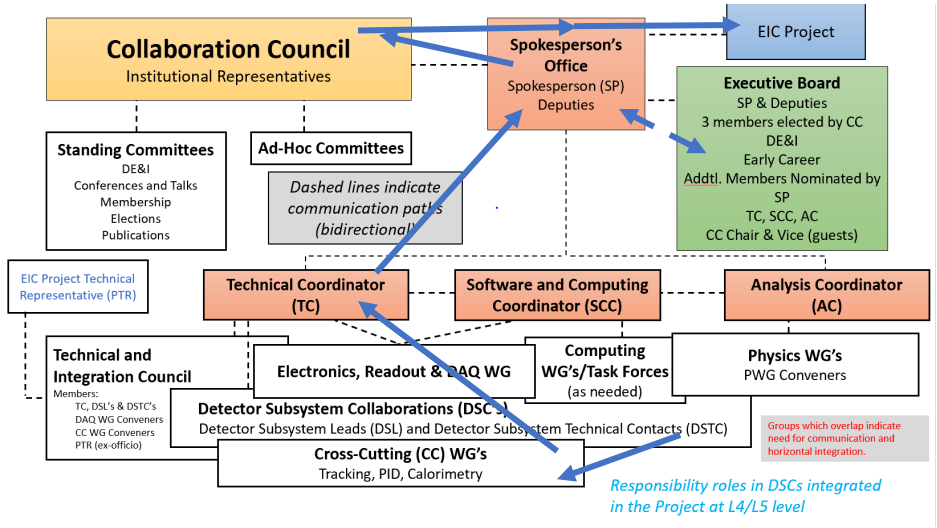
Decision flow

1. Proposed steps for detector consolidation/optimization initially **elaborated within DSCs**
2. Discussed within **the pertinent Cross-Cutting Working Group**
3. Presented and discussed at **TIC meetings** (iterating when improved proposal maturity may be beneficial) → **TIC MEETING RECOMMENDATION**
4. **Different paths** according to the modification entity:

- *Modest modifications:*
  - SP-office approval, in consultation with the Project Management feedback



- *Substantial modifications:*
  - SP-office collects Executive Board feedback and submits to Collaboration Council for decision
  - SP-office requests to Project management to start a **Change Control Process**

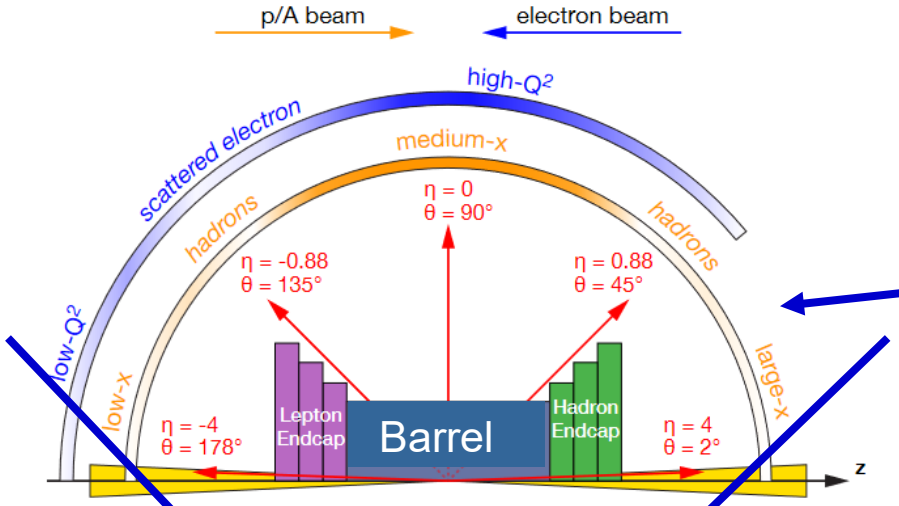


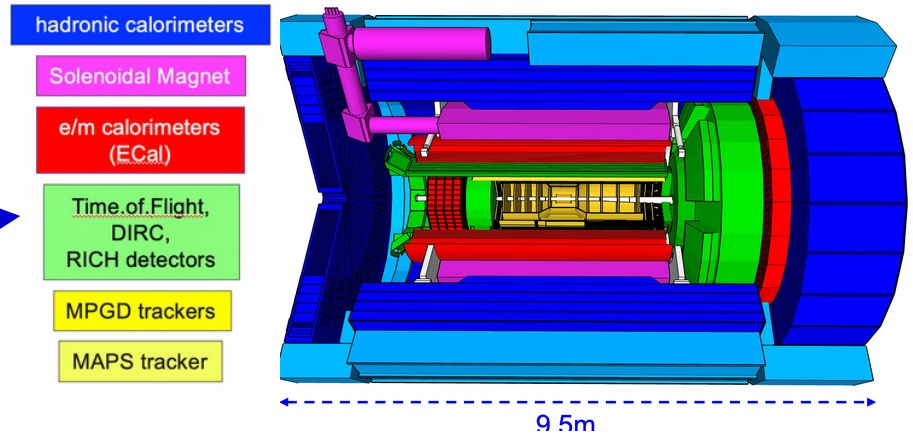
OUTLOOK

- The ePIC structure to address the detector activity
- The ePIC detector and its optimization/consolidation
- The ePIC collaborative efforts towards the TDR

THE COMPLETE ePIC DETECTOR

A reminder



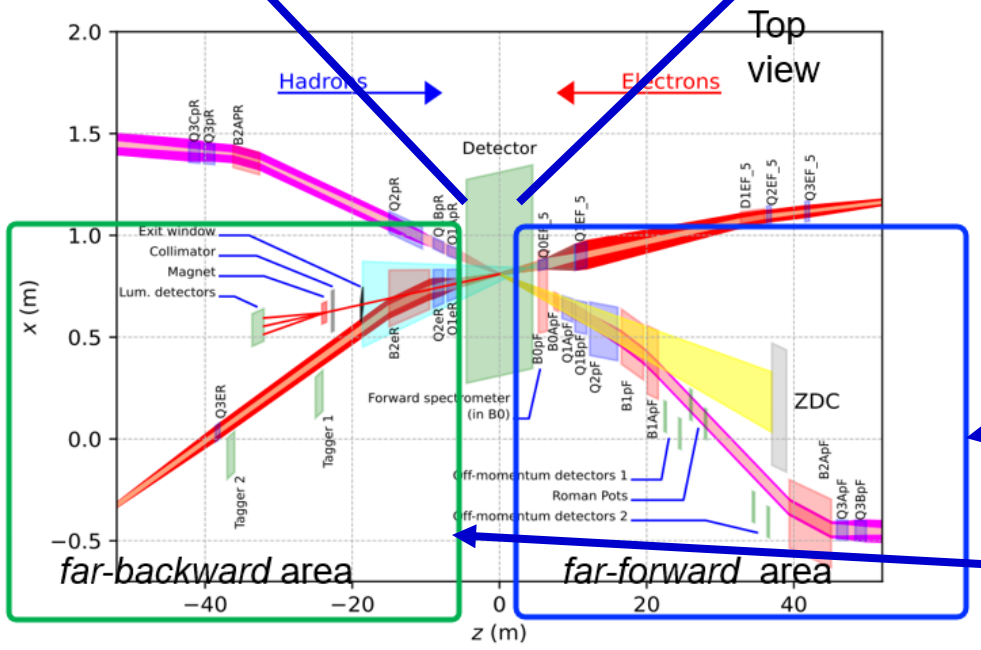


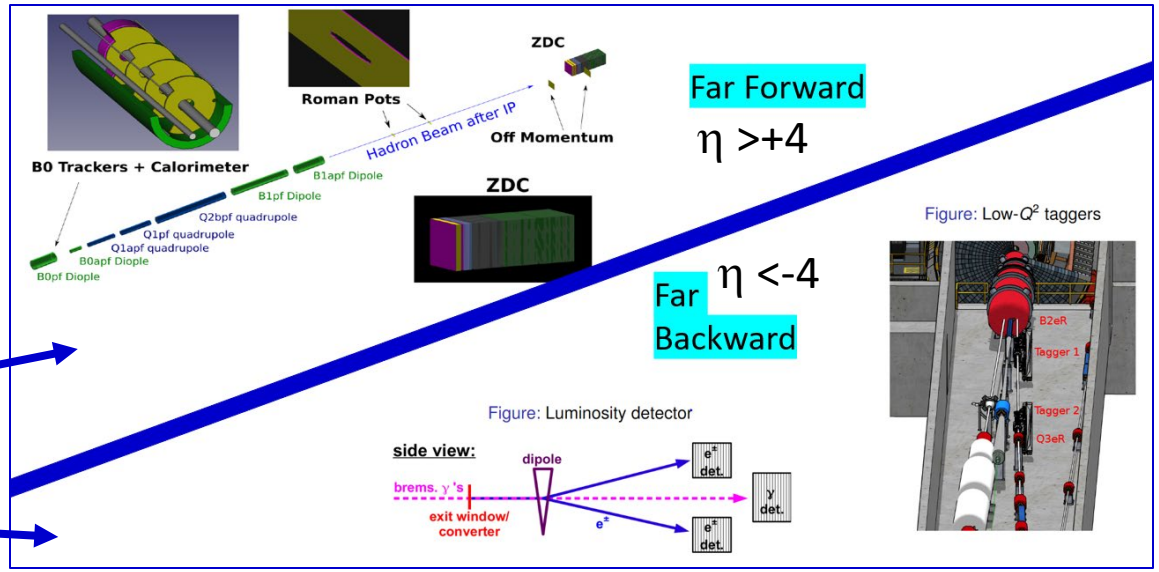
Central Detector (CD):

$-4 < \eta < +4$

Formed by:

- Backward endcap
- Barrel
- Forward endcap



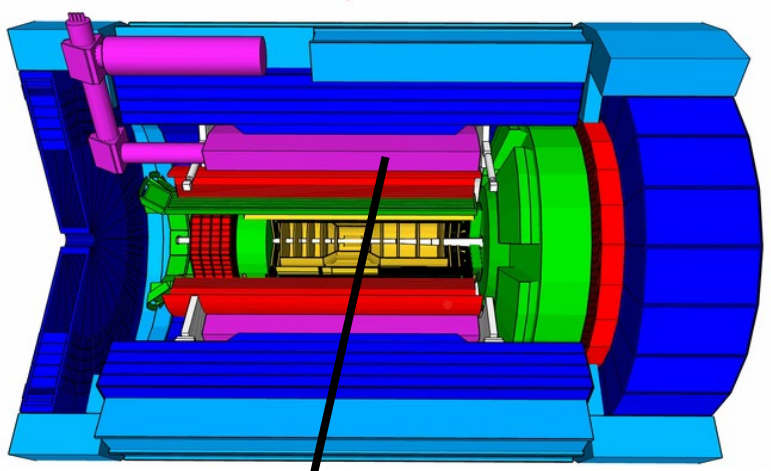


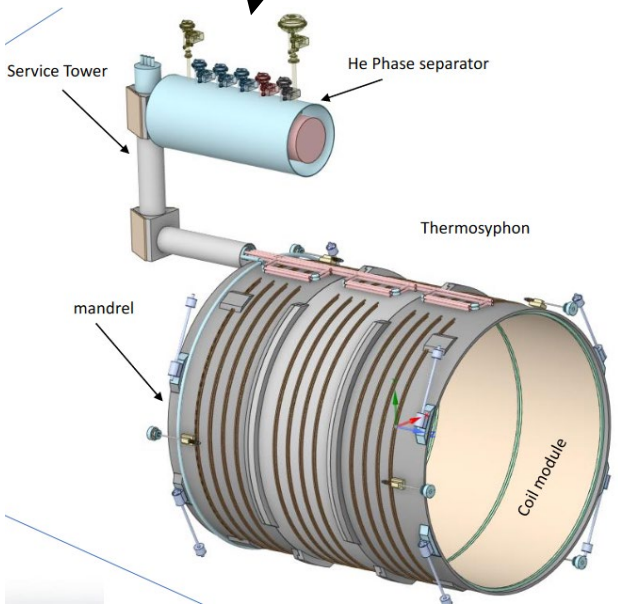
THE ePIC DETECTOR

In the following, the detector with a selection of highlights, underlining the collaborators contributing to the detector subsystems

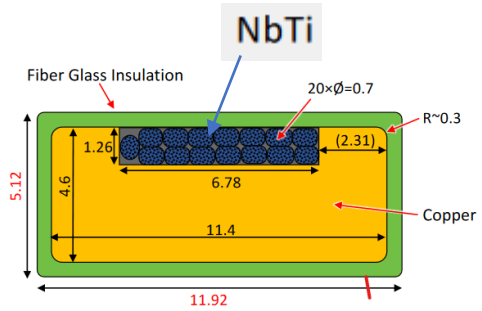
Collaborator contributions to detector subsystem efforts
do not always imply established in-kind contributions

THE SOLENOID





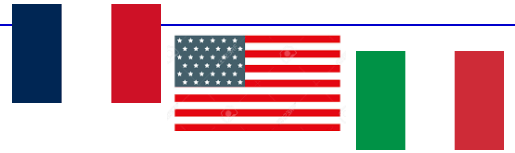
Conductor Design



Parameter	Value	Comment
Central Field B_0	2.0 T	
Lowest operating field	0.5 T	
Field Uniformity in FFA	12.5 % ± 100 cm around center 80 cm radius	**Magnetic Field Properties**
Projectivity in RICH Area	< 0.1 (mrad@30GeV/c) < 10 T/A/mm² From Z = 180 cm to 280 cm	

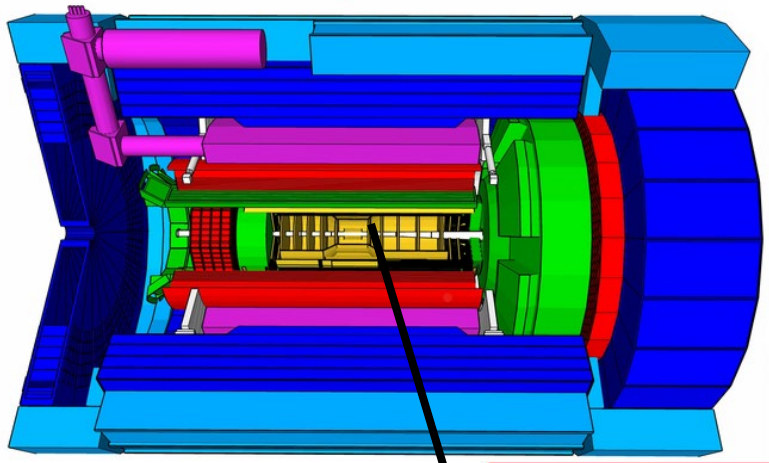
Reference field value: 1.7 T

- **A newly designed solenoid satisfying the detector design requirement**
- **90% readiness review successfully passed in Fall 2023**
- **Design: a combined effort Saclay – JLab – BNL**
- **Realization : interest from Italy under investigation**



TRACKING

Tracking



Complementary tracking technologies characterized by leight materials

Si trackers based on ALICE ITS3 65 nm MAPS sensors

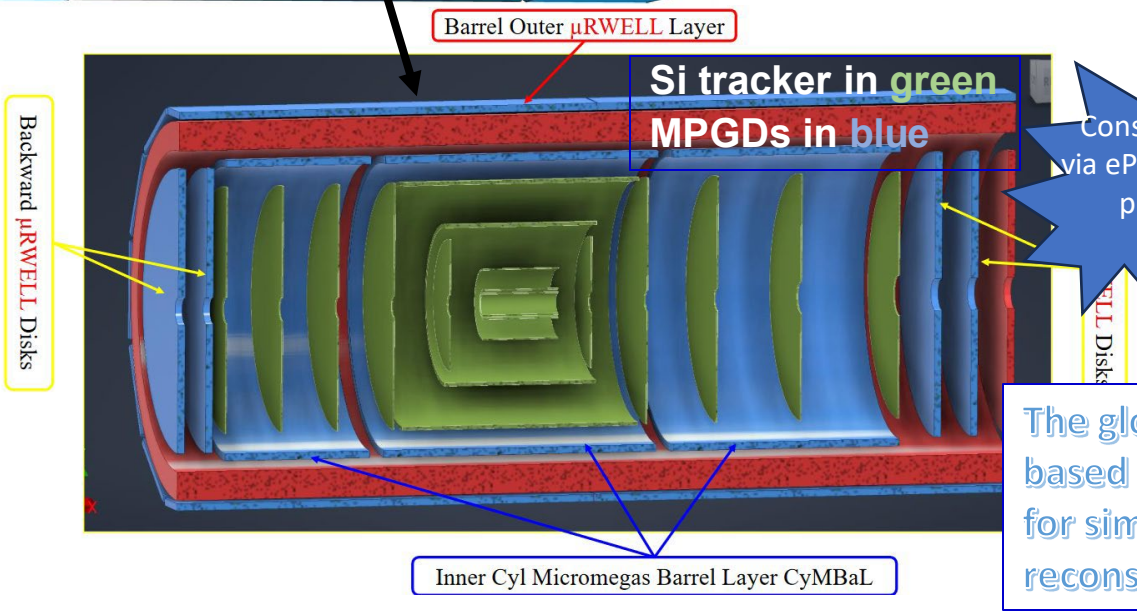
- Five layers in the barrel and in the endcaps

MPGD trackers

- Cylindrical MICROMEGAS
- Planar μR-WELL

Novel technology with co-contributions to its development by ePIC. Main players within ePIC: Groups from UK, US, Italy

Following the experience at CLAS12, never so extended an MM cylindrical system An effort by Saclay group in ePIC



Consolidation via ePIC decision process

A novel MPGD technology to be used in experiments in the coming years.
Possible at ePIC thanks to years of R&D, now moving to design finalization, by US groups with the addition of an INFN group

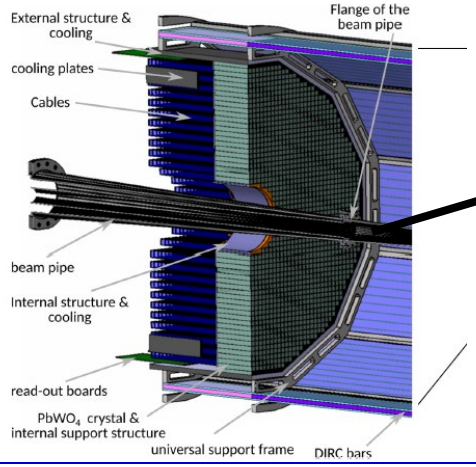
The global tracking layout is based an ePIC software effort for simulation and track reconstruction

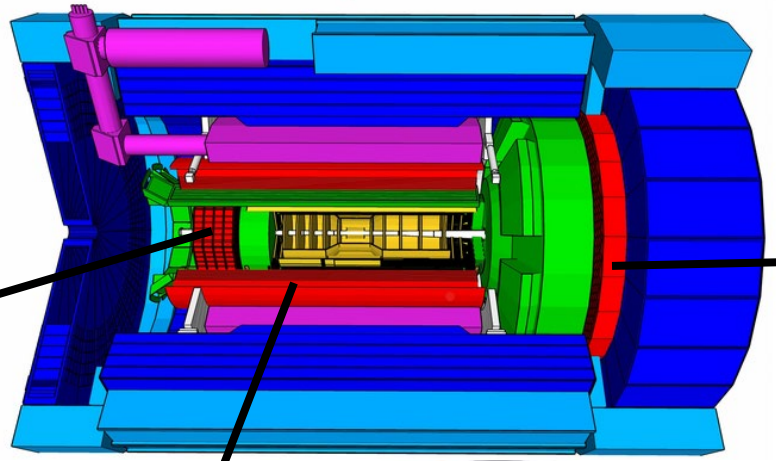
ELECTROMAGNETIC CALORIMETRY

SiPM sensors for all Calorimeters

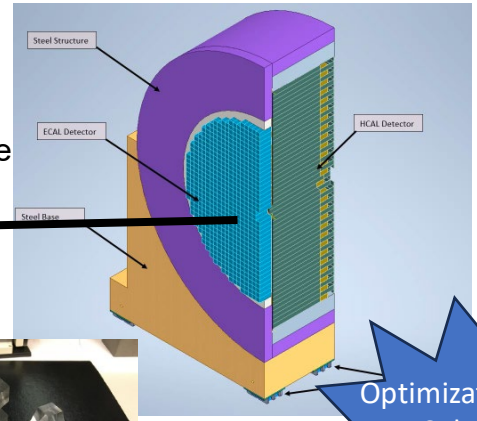
An effective option consolidated by sPHENIX experience, optimized also for operation in duet with HCal, by US and Chinese groups

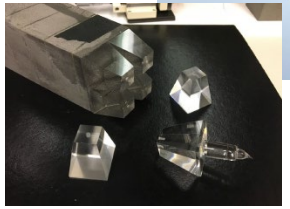
Backwards EMCal
PbW04 crystals, fine granularity





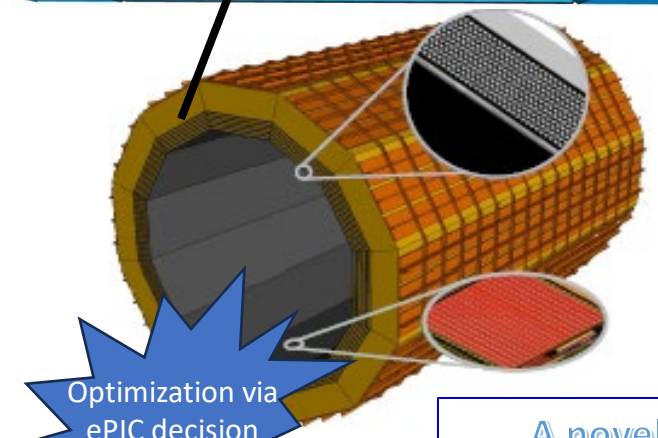
WSciFi is a unique technology allowing to achieve e/h ~1 (response to hadrons)





Optimization via ePIC decision process

A consolidated technique demanding a major effort to achieve the finest resolution by a strong collaboration including US institutions, CNRS, groups from Czech R. and Armenia

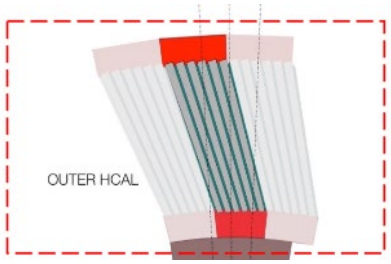


Optimization via ePIC decision process

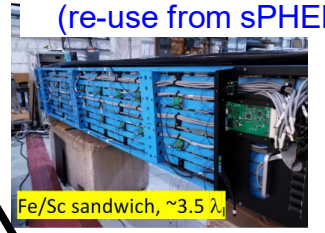
4 (6) layers of imaging calorimetry by Astropix MAPS,
and sampling calorimetry by Pb/SciFi
both in between Astropix layers and in the pure sampling section

A novel hybrid approach inspired by imaging calorimetry at CERN and sampling calorimetry at GlueX by a strong collaboration including US, Canada, Korea and Germany groups

HADRONIC CALORIMETRY

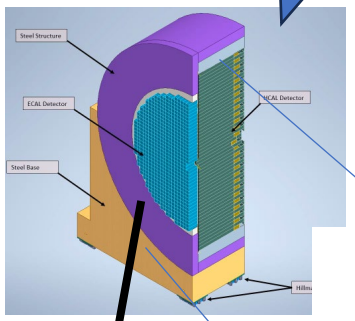


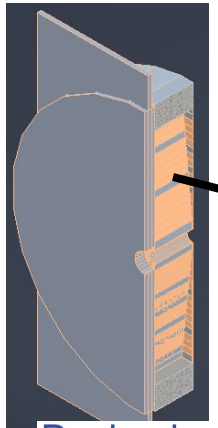
Barrel Hcal
(re-use from sPHENIX)



Optimization via ePIC decision process

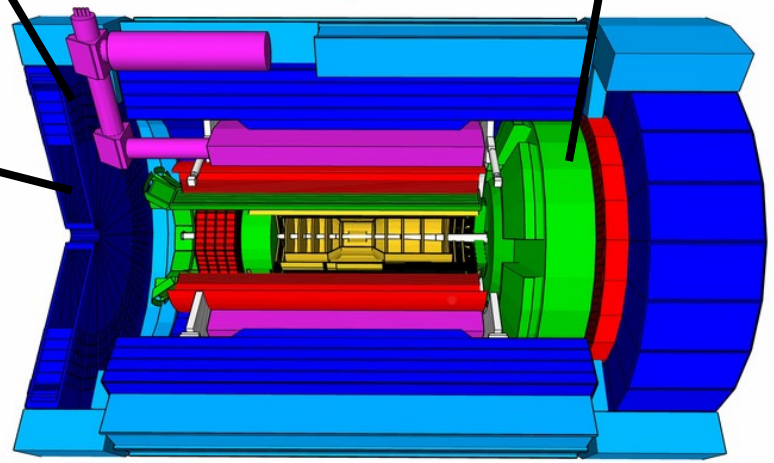
An original innovative design inspired by CALICE developments adopted by ePIC by a strong US collaboration

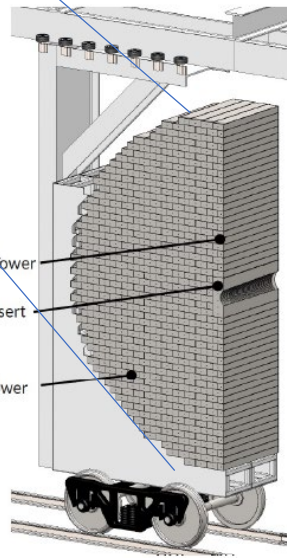




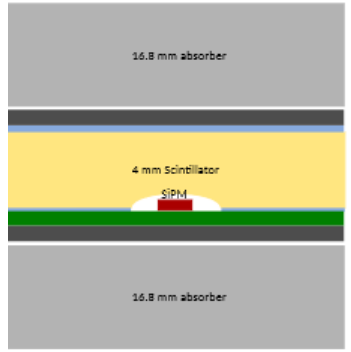
Backwards HCal
Steel/Sc Sandwich
tail catcher

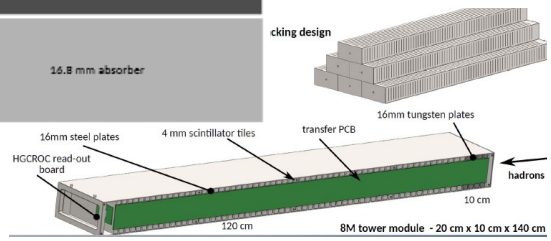
Design based on STAR megatiles





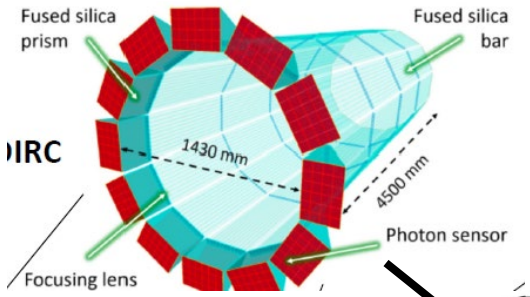
Forward Hcal
SiPM on tile





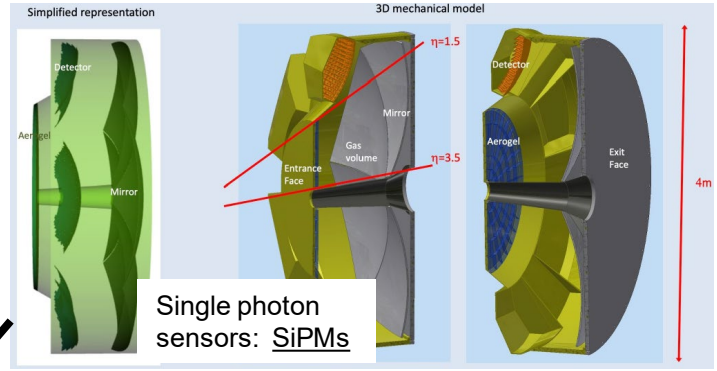
PARTICLE IDENTIFICATION

High-Performance DIRC

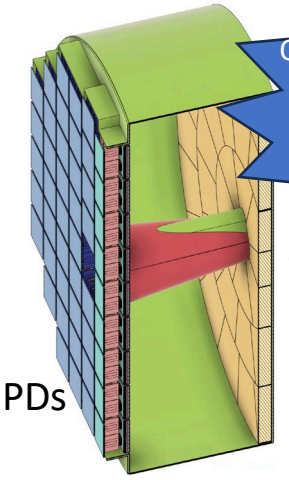


ePIC bringing J. Va'vra's concept of focusing DIRC to fully maturity thanks to the effort of US and German Collaborators

Dual-Radiator RICH (dRICH)



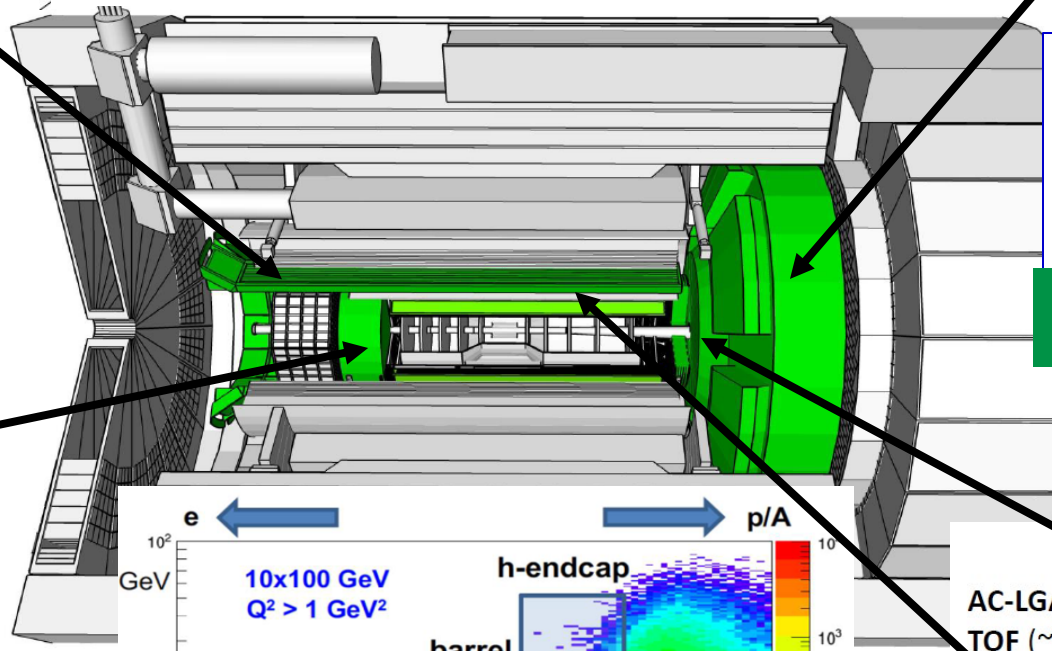
Single photon sensors: SiPMs



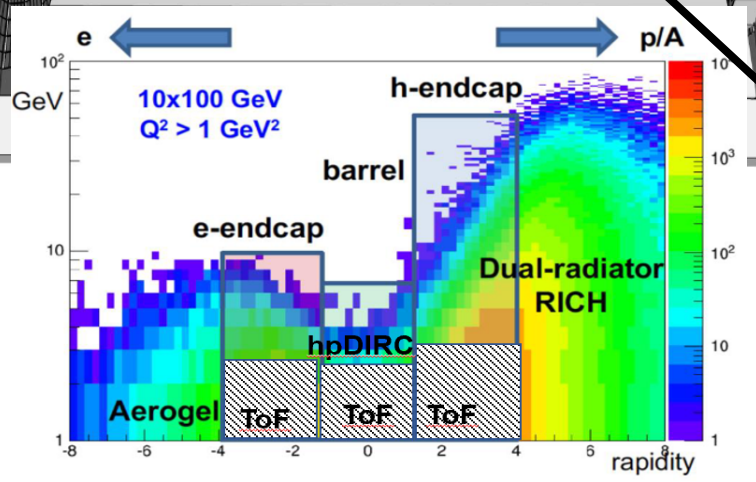
Optimization via ePIC decision process

aerogel

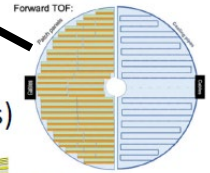
HRPPDs



3Rd world-wide example of dual radiator RICH by ePIC (following HERMES, LHCb) developed over more than 10y by 10 INFN groups with recent addition of US and India institutions



AC-LGAD TOF (~30ps)



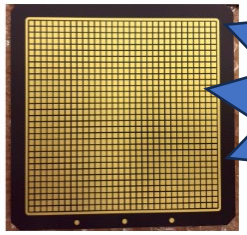
A major time-of-flight system by Si from the joint effort of groups from Japan, Korea, Taiwan and US

An original evolution of the focusing RICH approach by ePIC groups in US, Italy and Japan

ePIC PAVING THE WAY TO THE NEW ERA OF SINGLE PHOTON SENSORS FOR CHERENKOV IMAGING

HRPPDs: Large-size MCP-PMTs by INCOM

- Engineering contribution by ePIC
- 10 x 10 cm^2
- DC-DC coupled
- Being established within ePIC



Optimization via ePIC decision process

DC-coupled HRPPDs by Incom Inc.

SiPMs as single photon detectors

- Never used so far for RICHes in experiments due to the dark-count rates increasing with radiation dose
- Robust R&D with ePIC:
  - Thermal annealing (also in situ) demonstrated also in repeated cycles
  - SiPMs usage in RICHes in now an open path

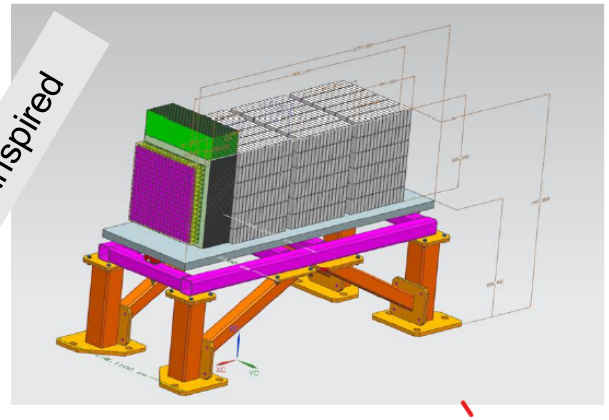
Establishing LAPPDs/HRPPDs as devices for RICHes and, at the same time, as adequate for ToF measurements, as well as and cooperating with industry for the correct engineering of the sensors is by US and Italy groups

Bringing to fully maturity the concept of SiPMs as sensors for Cherenkov imaging devices is entirely by the R&D of 5 INFN groups

THE ZERO DEGREE CALORIMETER FOR THE FAR FORWARD DETECTOR

ZDC layout

ALICE FOCAL inspired



Optimization via ePIC decision process: **ONGOING**

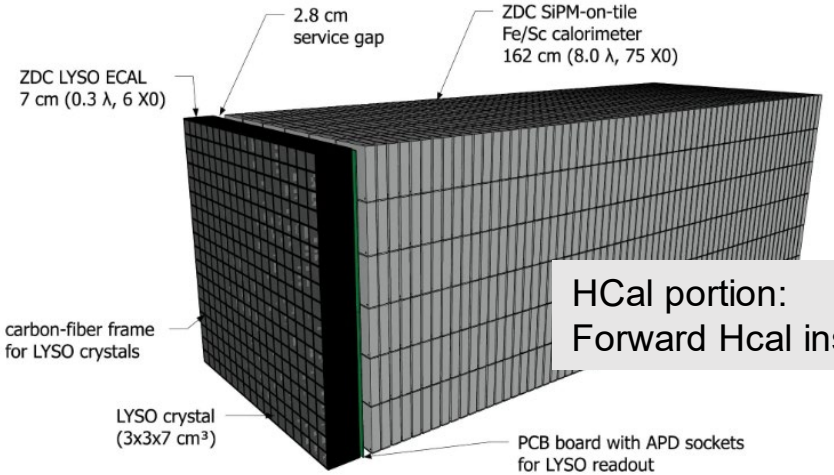
Technology (*)
VETO: Si -layer in front for charged particle veto
EMCAL :
- PbWO4 crystals blocks
- W/Si sampling calorimeter (imaging calorimeter)

HCAL:
- Pb/Sci. sampling calorimeter.

An original proposal by ePIC

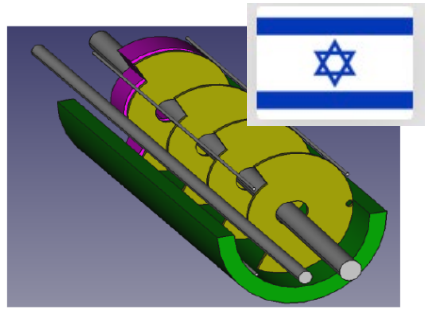
Under evaluation:

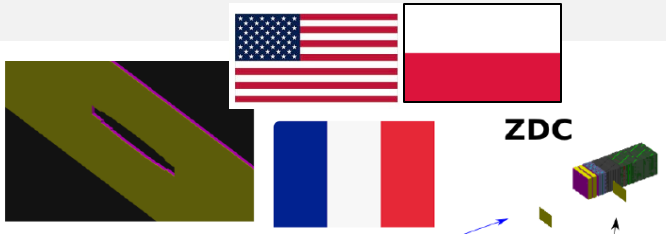
A different technology to reduce cost and risks while preserving performance, and increase synergies with other subsystems:
- Hadron section by SiPM-on-tile (the technology for the insert of the forward HCAL)
- short ECal section by Lyso crystals

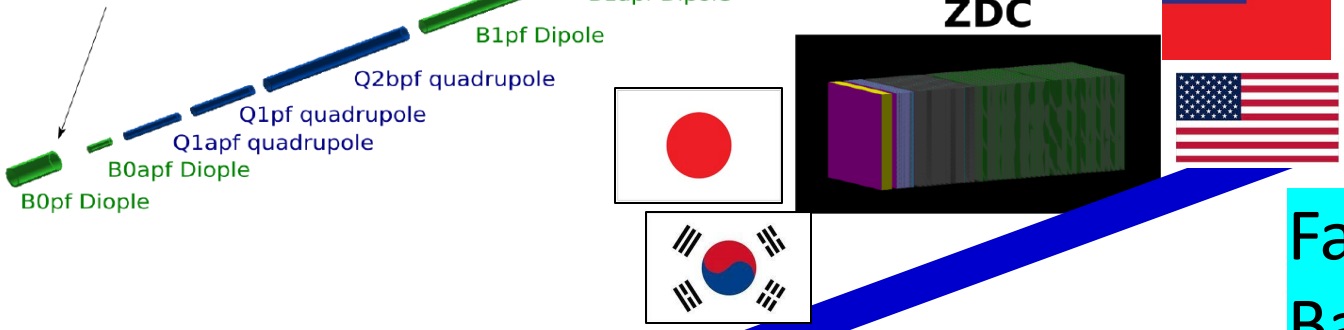


HCal portion:
Forward Hcal insert technology

THE FAR FORWARD AND FAR BACKWARD DETECTORS

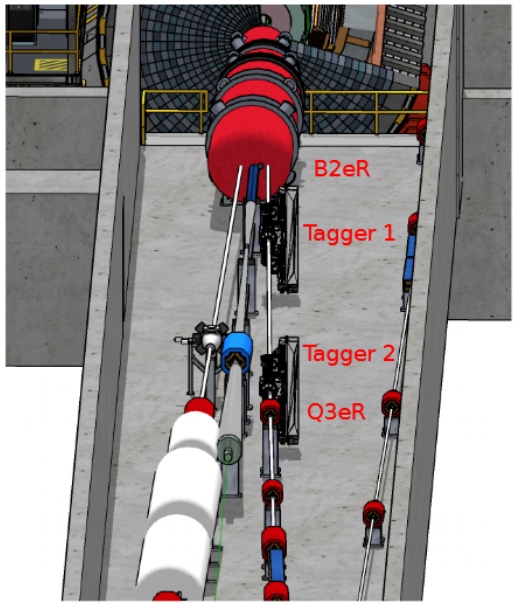






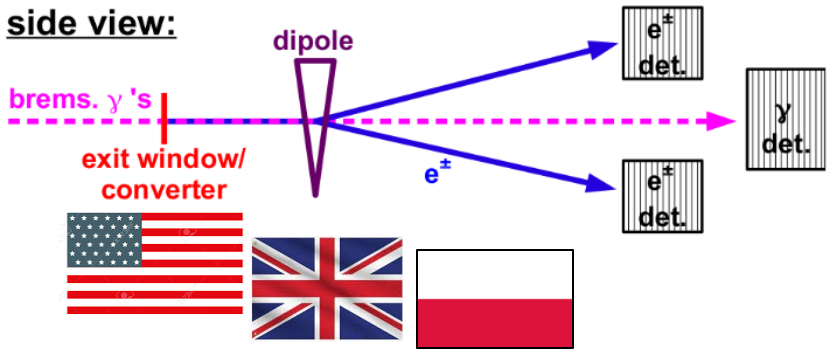
Far Forward

Figure: Low-Q^2 taggers



Far Backward

Figure: Luminosity detector



OUTLOOK

- The ePIC structure to address the detector activity
- The ePIC detector and its optimization/consolidation
- The ePIC collaborative efforts towards the TDR

Technical Design Report (TDR) – Detector, the needs

From the Project Management talk, ePIC Meeting, Warsaw, July 2023

Chapter 2: Physics Goals and Requirements *(should be short, < 50 pages)*

- 2.1 EIC Context and History (like CDR 2.2 or YR section 1)
- 2.2 The Science Goals of the EIC and the Machine Parameters (like CDR 2.3)
- 2.3 The EIC Science (follow YR structure)
- 2.4 Scientific Requirements

Chapter 3: Interaction Region 6 Overview (Elke/Rolf contributing)

Chapter 8: Experimental Systems *(can be long such that we can use as standalone detector TDR)*

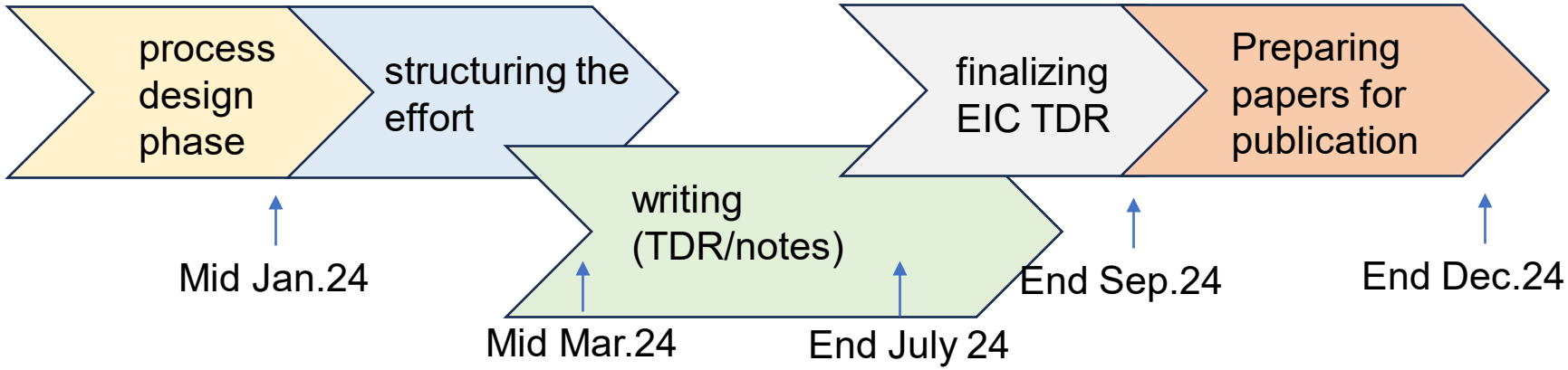
- 8.1 Experimental Equipment Requirements Summary (like CDR 8.2)
- 8.2 General Detector Considerations and Operations Challenges (YR 10, CDR 8.3)
- 8.3 EIC Detector
- 8.4 Detector R&D Summary
- 8.5 Detector Integration
- 8.6 Detector Commissioning and Pre-Operations

Chapter 11: Commissioning (Elke/Rolf contributing)

Appendix-B: Integration of a Second Experiment (mainly emphasizing feasibility, luminosity sharing, polarization with two experiments, and first-order checks of magnets/acceptance)

TDR – the ePIC goals and timelines

- The ePIC contributions to the EIC TDR (Chapters 2,8)
  - The EIC TDR is the top priority
  - Precise timescale driven by EIC project requirements
- Scientific production/dissemination
  - An extended version of the ePIC detector section from the EIC TDR with appropriate front matter, published in a scientific journal (such as NIMA, JINST, PRC, …)
    - *Derived from TDR Chapter 8*
  - An ePIC Physics Performance long paper published in a scientific journal (such as NIMA, JINST, PRC, …)
    - *Derived and expanded from TDR Chapter 2 (Section 2.3)*



TDR – structuring the effort

TDR

- **PM Serves as the "managing editors" for the ePIC Contributions to the EIC TDR**

- **TDR Chapter 2**
  - ***Holistic detector performance*** (short form)
    - The TC Office acts as "editor"
    - Organized/supervised by CC WG conveners
  - ***Physics performance and science reach*** (short form)
    - The ACs acting as "editors"
    - The Physics WGs as subgroups for text drafting

- **TDR Chapter 8**
  - ***Detector description and basic performance***
    - Project CAMs/Collab. DSL's acting as "co-editors" for their sections
    - The DSCs provide studies, material, text, etc.
  - ***Software, Analysis and Data Preservation***
    - Project CAMs and SCCs acting as "editors"
    - The electronics/DAQ CC WG and the software WGs

ePIC publications

- **ePIC SP-Office serves as the "managing editors" for the ePIC publications**

- **ePIC Physics Performance Publication:**
  - ***Holistic detector performance*** (extended text)
    - The TC Office acts as "editor"
    - Organized/supervised by CC WG conveners
  - ***Physics performance and science reach*** (extended text)
    - The ACs acting as "editors"
    - The Physics WGs as subgroups for text drafting

- **ePIC Detector Publication**
  - ***Detector description and basic performance***
    - DSL's acting as "editors" for their sections
    - The DSCs provide studies, material, text, etc.
  - ***Software, Analysis and Data Preservation***
    - SCCs acting as "editors"
    - The electronics/DAQ CC WG and the software WGs for text drafting

summarizing

- ePIC has built-up a **solid structure to address the detector activity**; goals:
  - to complete detector R&D and design for the TDR
  - to be ready for the construction phase in 2025
- The ePIC **detector design**
  - Via its structure, ePIC has effectively addressed optimization/consolidation items assuming key decisions, then made effective in the cooperation with the Project Management
- The **ePIC collaborative efforts towards the TDR**
  - ePIC is ready for a constructive engagement in contributing to the TDR
  - this effort is also an opportunity for the production of scientific documentation by the Collaboration, a goal that will focus the effort and support the engagement of the collaborators: a common goal towards scientific production at short term will increase the coherence within ePIC

Thank you

Backup