

EIC_NET 2023 Annual Report Activity plan for 2024

EIC_NET status e introduzione a richieste 2024

P. Antonioli, INFN Bologna

1. EIC, the ePIC Collaboration and EIC_NET

- 1.1 The Electron Ion Collider and the CSN3 EIC_NET initiative
- 1.2 The international project and the ePIC Collaboration
- 1.3 The EIC_NET contribution to the ePIC Collaboration
- 1.4 EIC_NET Collaboration: status and responsibilities
- 1.5 EIC governance and relevant contacts within INFN
- 1.6. EIC_NET Internal Organization, Giornate nazionali 2022 and 2023
1. 7 The First European School on the Physics of the EIC

2. EIC_NET R&D activities (Jan 2022 - June 2023)

- 2.1 Physics and software/computing coordination
 - 2.1.1 Spectroscopy programme at the EIC (GE, RM2)
 - 2.1.2 Exclusive processes: partonic imaging in coordinate space (CS)
 - 2.1.3 Software and computing coordination (BA TS)
- 2.2 Detector simulation (BA SA TS)
- 2.3 Detector R&D: dual RICH activities (BA BO CS CT FE GE LNS RM1 SA TO TS)
 - 2.3.1 dRICH prototype
 - 2.3.2 SiPM studies and readout electronics
 - 2.3.3. The ALCOR ASIC as SiPM front-end
 - 2.3.4 LAPPD studies
 - 2.3.5 High pressure Argon as gaseous radiator
 - 2.3.6 Aerogel studies
- 2.4 Detector R&D: Si-Vertex (BA PD TS)
- 2.5 Detector R&D: streaming readout (CT GE RM2)

3. 2024 Activity planning

- 3.1 Introduction to EIC_NET requests for 2024
- 3.2 Physics, software and simulation studies
 - 3.2.1 Semi-inclusive DIS (PV)
 - 3.2.2 Diffractive physics - Partonic imaging in coordinate space (CS)
 - 3.2.3 ePIC computing (BA CT TS)
 - 3.2.4 Detector simulation (BA FE LNS SA PV TS)
- 3.3 Detector R&D: dRICH (BA BO CS CT FE GE LNS RM1 SA TO TS)
 - 3.3.1 dRICH prototype
 - 3.3.2 SiPM and electronics
 - 3.3.3 ALCOR
 - 3.3.4 LAPPD
 - 3.3.5 Gas radiator
- 3.4 Detector R&D: Si-vertex (BA PD TS PV)
- 3.5 Detector R&D: uRWELL (GE RM2)
- 3.6 Detector R&D: streaming readout (CT GE RM1 RM2)

Appendix A: Synergies with other INFN initiatives

Appendix B: Draft multi-year financial plan

Appendix C: Proposed milestones 2024 (and 2023 update)

Appendix D: Note on missions budgeting

- Don't repeat the report
- What is going in 2023
- What we ask and why

Referee-oriented talk:

- Key news from EIC/ePIC Project (more at CSN3)
 - EIC_NET in 2023/2024
 - Groups & requests overview
 - Missions (ePIC and general meetings only)
 - Draft financial plan toward ePIC sigla
-
- “Minor”: sblocchi s.j. September 2023
 - At the end: milestones check



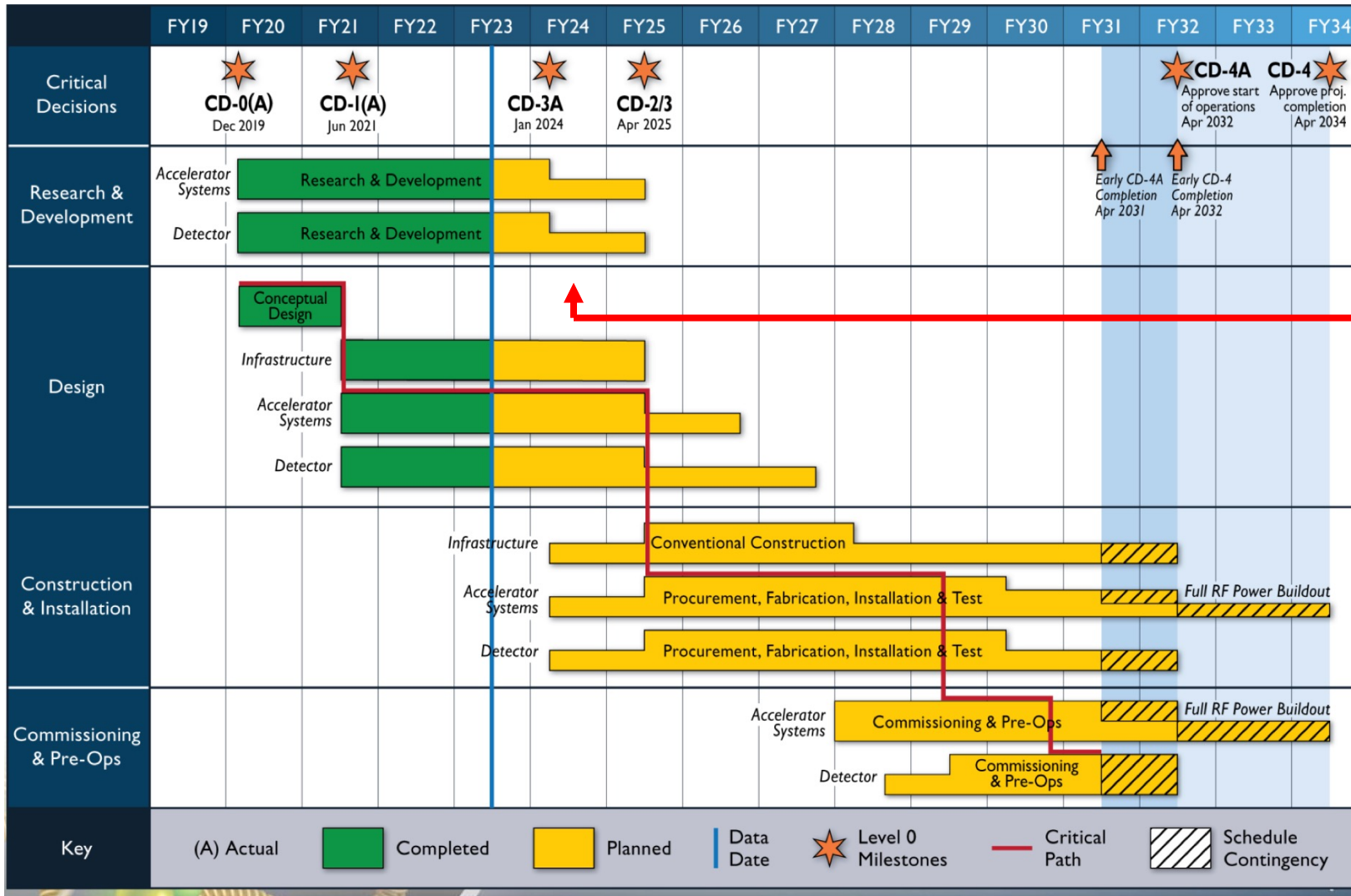
Background links for you:

EICUG/ePIC meeting ([Warsaw July 2023](#))

Recent ePIC long presentation ([SDT @ EIC School](#)) June 2023

Recent ePIC short presentation ([PA @ HEP-EPS](#)) August 2023

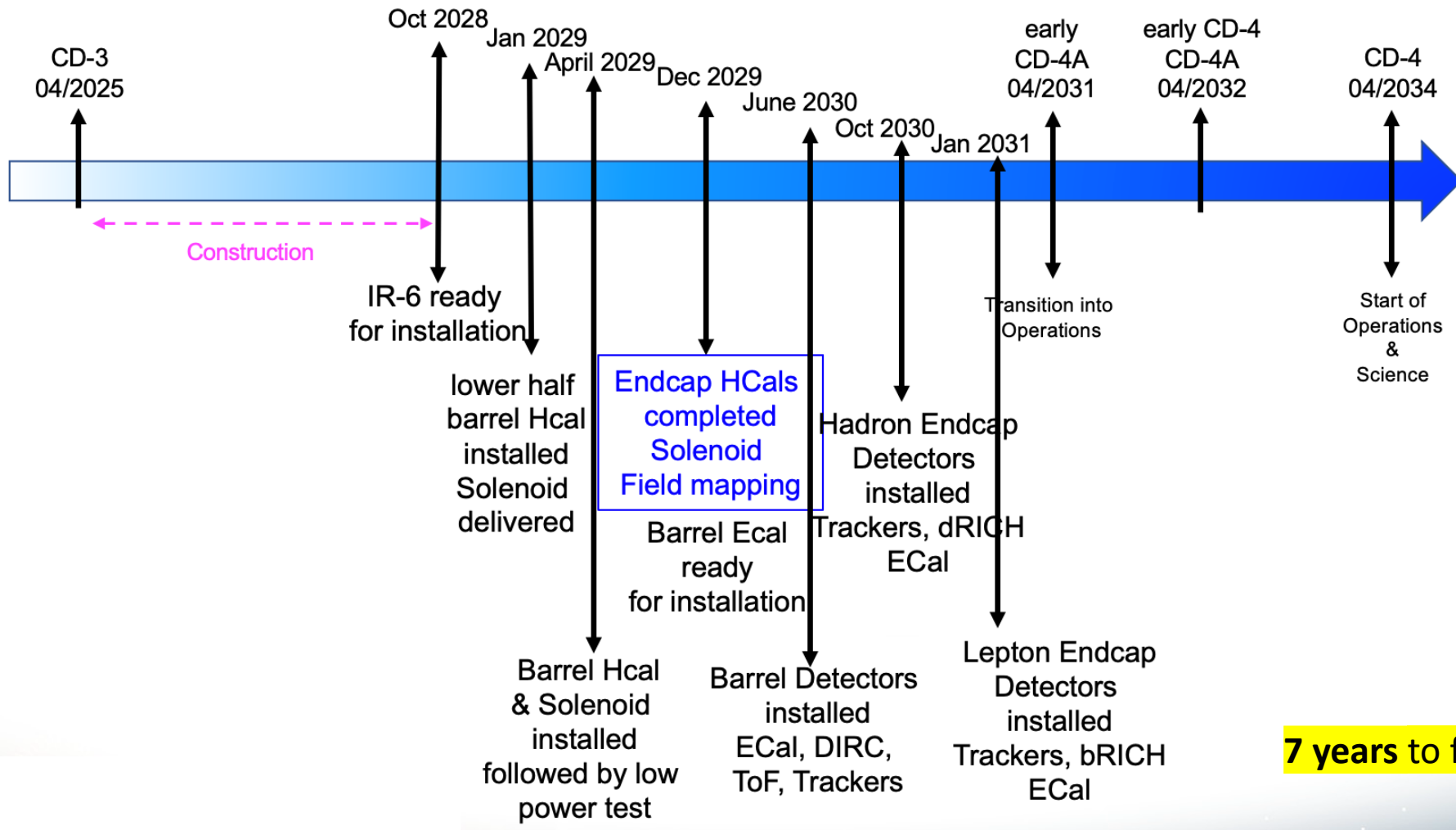
EIC project schedule



October 2024: TDR submission

- construction starts following RHIC shutdown (July 2025)
- **8 years** from operations
- first year (04/31-04/32) for machine commissioning
- 2032-2034 toward full luminosity

ePIC barrel detector installation schedule



- Silicon vertex: **June 2030**
- Gaseous tracker: **June 2030**
- dRICH: **October 2030**

7 years to finalize design, build and install

- Solenoid and Barrel HCal by Jan 2029
- all other subdetectors need to be ready between 06/29 to 06/30

ePIC design (barrel)



Magnet

- New 1.7 T SC solenoid, 2.8 m bore diameter

Tracking

- Si Vertex Tracker MAPS wafer-level stitched sensors (ALICE ITS3)
- Si Tracker MAPS barrel and disks
- Gaseous tracker: MPGDs (μ RWELL, MMG) cylindrical and planar

PID

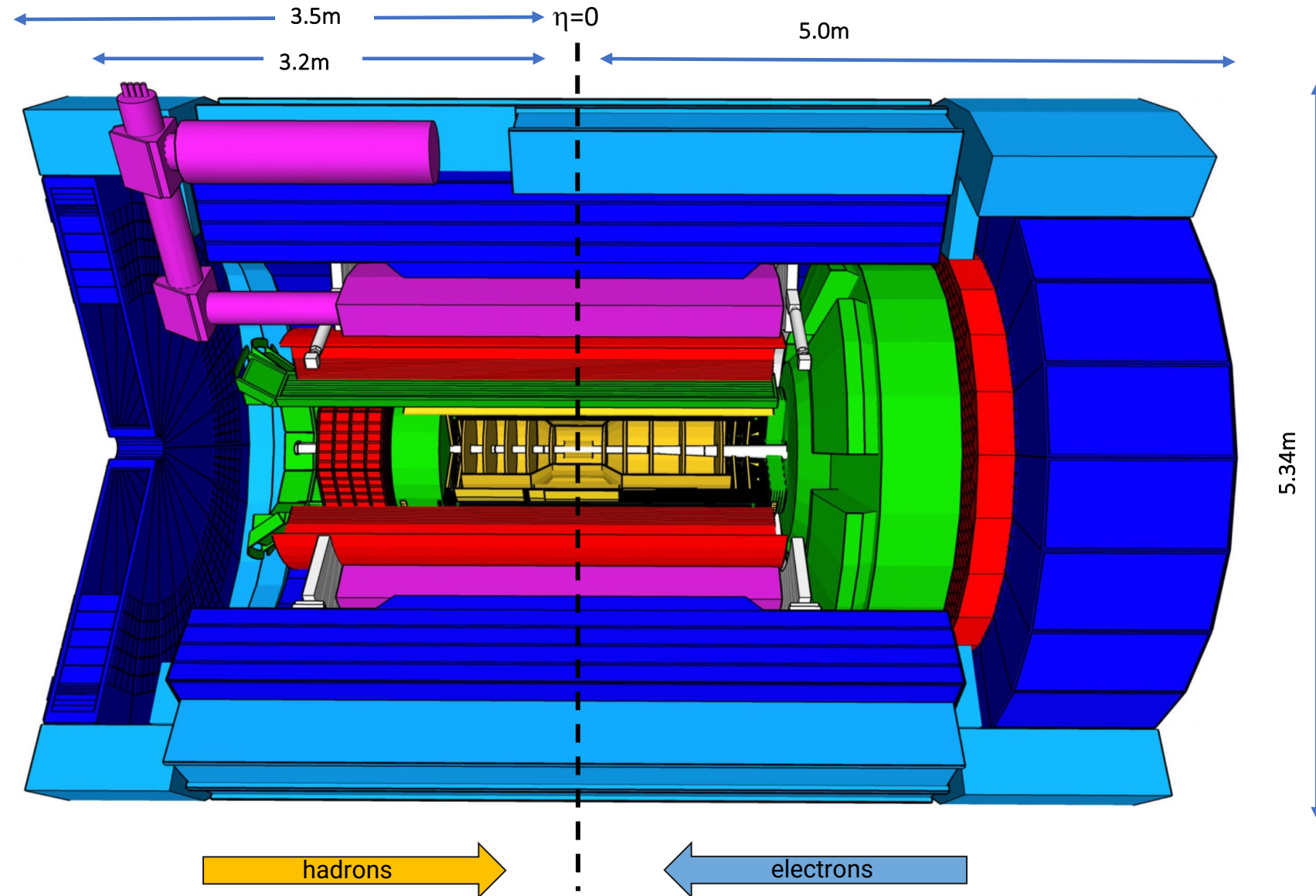
- high performance DIRC (hpDIRC)
- dual RICH (aerogel + gas) (forward)
- proximity focussing RICH (backward)
- ToF using AC-LGAD (barrel+forward)

EM Calorimetry

- imaging EMCal (barrel)
- W-powder/SciFi (forward)
- PbWO_4 crystals (backward)

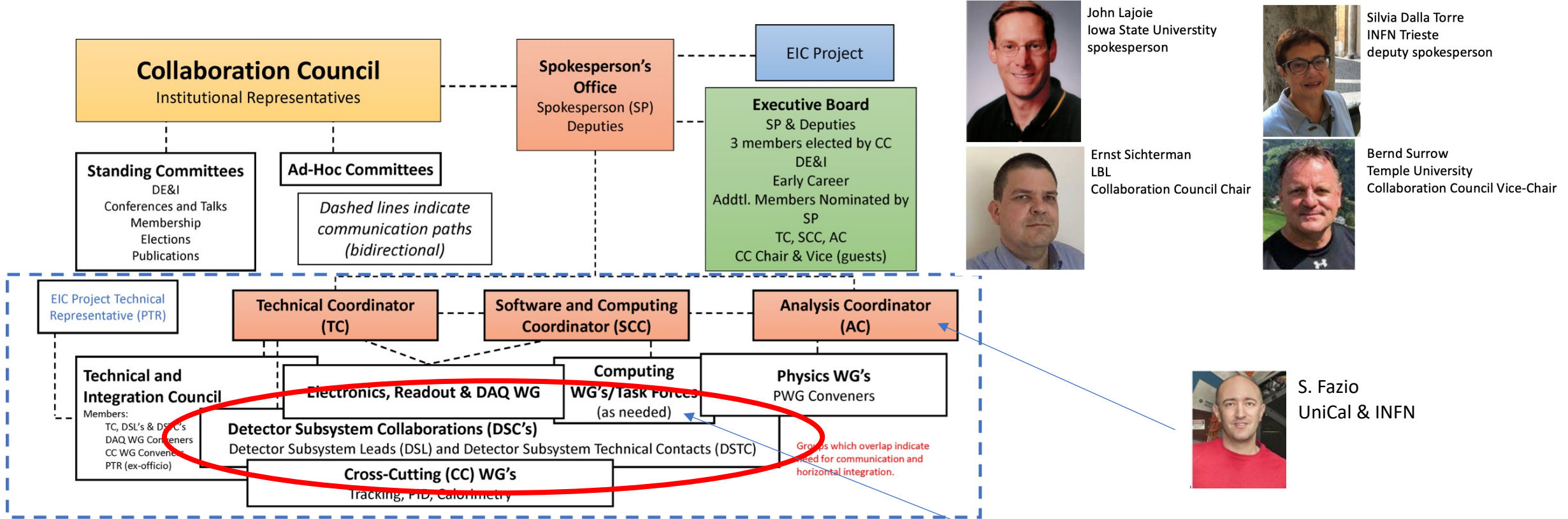
Hadron calorimetry

- FeSc (barrel, re-used from sPHENIX)
- Steel/Scint – W/Scint (backward/forward)



Key advances in detector design (choices made for backward RICH, Emcal barrel calorimeter, trackers)

ePIC organization

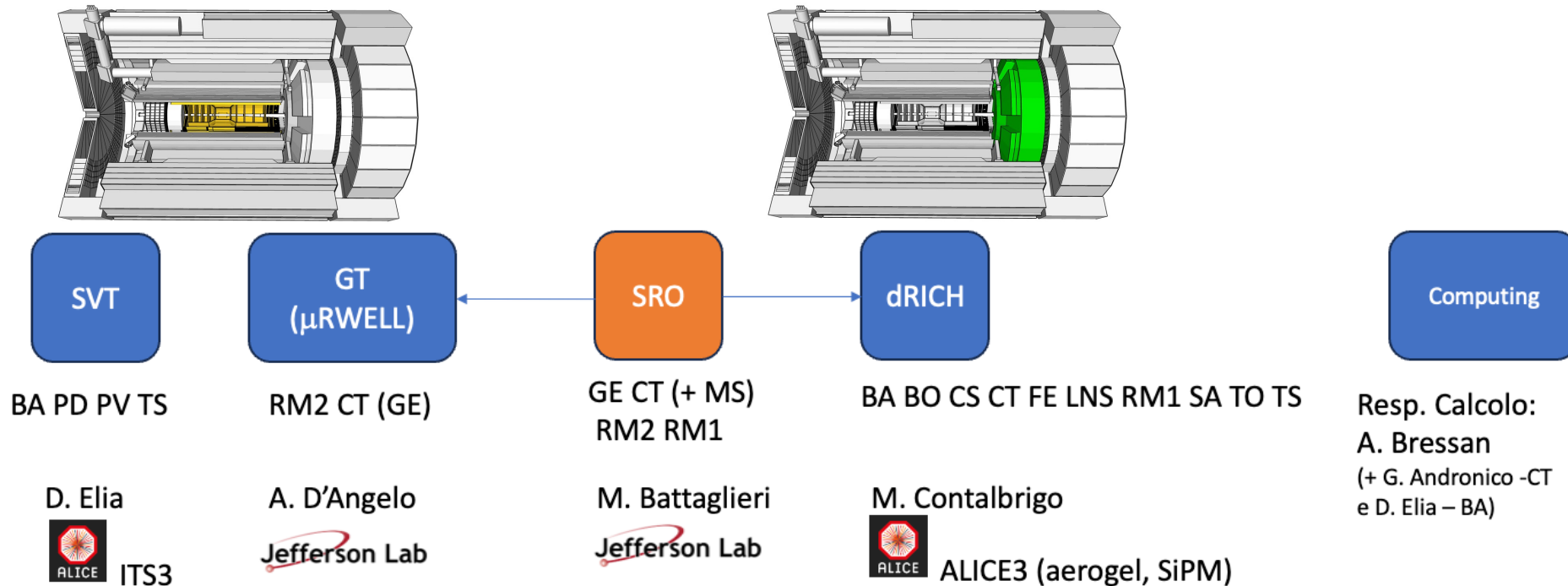


- Transition from detector working groups to Detector Subsystems (DSS)
- Creation of DSS Collaboration
- Identification of DSS Leadership

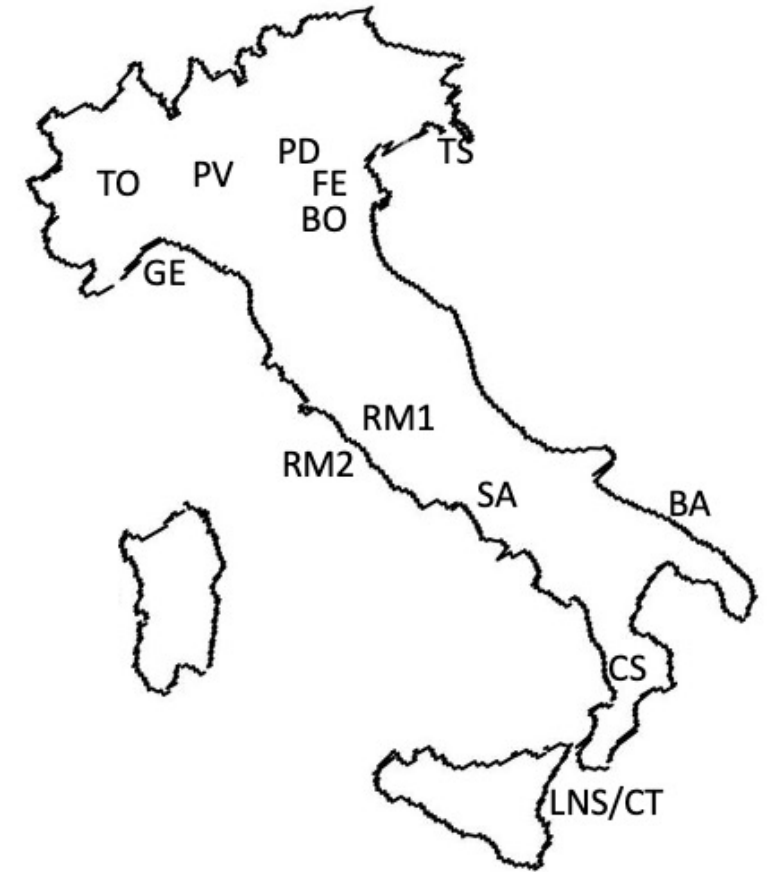
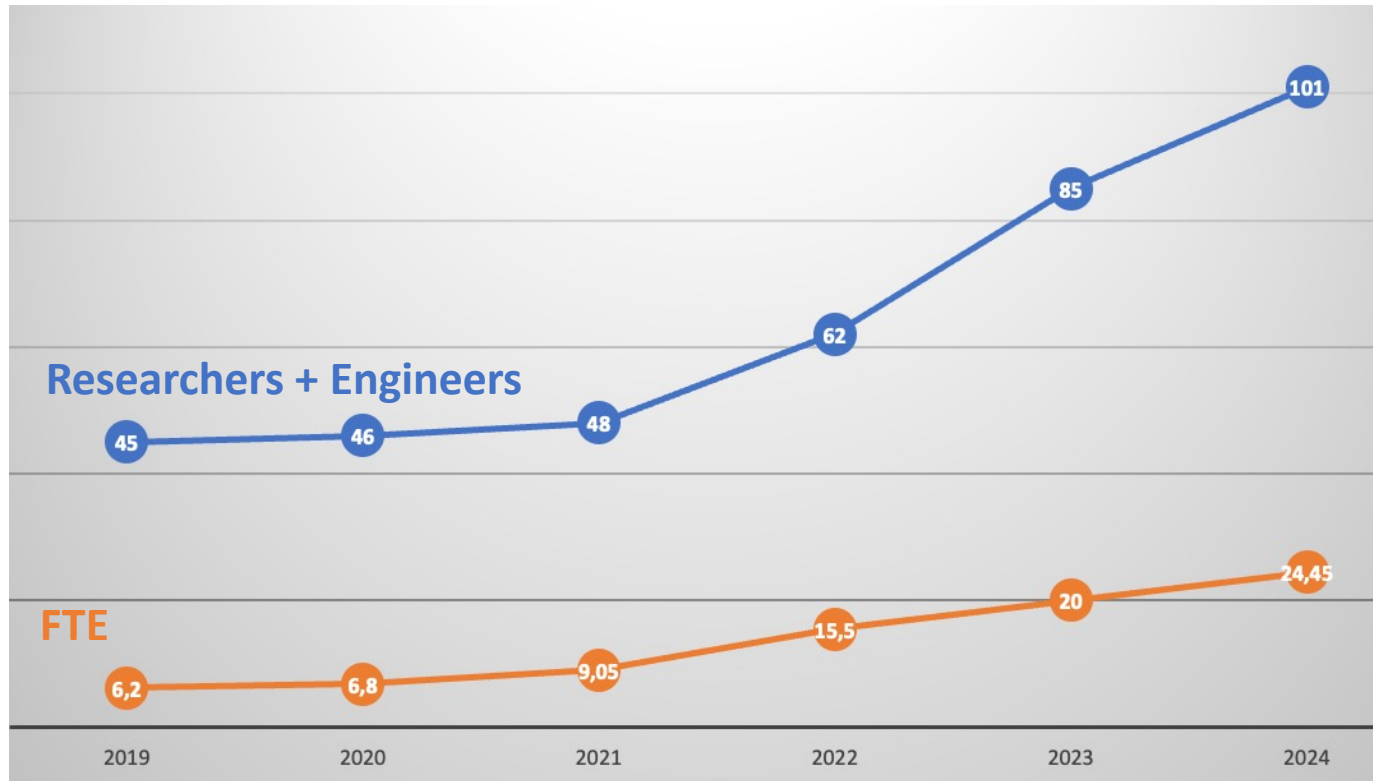
EICUG steering committee: members from INFN: M. Radici (chair), M. Ruspa

ePIC organization and EIC_NET

- dRICH team leaders (all INFN + Duke + Niser) indicated **Marco Contalbrigo** as DSSL (I acted as facilitator/some how convener in the process) (TO GE TS FE BO BA RM1 RM2 CT LNS CS SA are members of dRICH DSSC)
- EIC Silicon Consortium morphed in Silicon Vertex Tracker DSC → **Ernst Sichtermann** as DSSL (LBNL) (PD BA TS PV are members of SVT DSSC)
- Gaseous Trackers (MPGD) → **Kondo Gnavno** (JLab) is DSSL (RM2 + GE/CT)



- Responsabile nazionale role is changing: less “coalescence” work, more “pure INFN coordination” work
- Today: detector oriented presentations by DSSC



- RM1 is back with large group
- PV has now also joined experimental part
- CS, CT passed 1.0 FTE threshold (include involvement of MS)
- LNF left

Large number of people interested, ratio FTE/personnel to increase when we will move to sigla/construction
But note CSN3 requirements for “sigle in costruzione”

Requests overview



| struttura | missioni | missioni_sj | consumo | consumo_sj | altri_cons | trasporti | inventario | apparati | apparati_sj | licenze-SW | spservizi | spservizi_sj | totali | totali_sj |
|-----------|----------|-------------|---------|------------|------------|-----------|------------|----------|-------------|------------|-----------|--------------|--------|-----------|
| BA | 20 | | 46 | | | | | | | | | | 66 | |
| BO | 71.5 | 6 | 86 | 18 | | | 51.5 | | | | 7.5 | | 216.5 | 24 |
| CS | 14 | | | | 3 | | 5.5 | | | | | | 22.5 | |
| CT | 8.5 | 3 | | | | | 5 | | | | | | 13.5 | 3 |
| FE | 13 | 6 | 38 | | | 2 | 9 | | | | | | 62 | 6 |
| GE | 11 | | 21 | | | | 6 | | | | | | 38 | |
| LNS | 17 | | | | | 3 | | | | 9 | | | 29 | |
| PD | 6 | | | | | | 10 | | | | | | 16 | |
| PV | 4.5 | | | | | | | | | | | | 4.5 | |
| ROMA1 | 5 | 2.5 | 1 | | | | 22 | | | | | | 28 | 2.5 |
| ROMA2 | 6 | | 1 | | | | | 4 | | | | | 11 | |
| SA | 10 | | | | | | | | | | | | 10 | |
| TO | 12 | 4 | 8 | 75 | | | | | 100 | | | | 20 | 179 |
| TS | 40.5 | | 35 | | | | 15.5 | | | | | | 91 | |
| Totale | 239 | 21.5 | 236 | 93 | 3 | 5 | 124.5 | 4 | 100 | 9 | 7.5 | | 628 | 214.5 |

Partly tasca RN

Potentially already under "in-kind" (without this request total similar to 2023 requests)

Remember synergies with ALICE/NA60+ (ITS3/ALICE3 (aerogel/SiPM)) and JLab (MPGD)

Largest requests for dRICH, "limited" requests for SVT, GT and SRO

Two ePIC meetings in 2024 in US:

- 9-13 January Argonne National Laboratory (close to Chicago)
- “July”: EICUG+ePIC meeting Lehigh University (close to Philadelphia)

ATTENDANCE CRITICAL IN A TDR YEAR

Requests:

- 2.5 kEU for each US meeting
- inserted locally where there are coordinating responsibilities in ePIC or within DSS (12 persons) + EICUG (2: 1 meeting only)
- + 16 trips asked → ~ 20 persons/meeting in tasca RN

EIC_NET Giornate Nazionali: 0.5 EU/person 2 per group or more

RN: some mobility in Italy + RRB meeting (1)

Special → support for Silvia Dalla Torre (deputy spokesperson) under TS (1 RRB meeting + 3 additional meetings)

“the big picture” (1)

TABLE 1 – Labor and investment for R&D and construction in period 2021-2029.

| Years | Labor, scientists | Labor, technical personnel | In-kind investment R&D | In-kind investment constructions | Travelling | Manpower | Investment, TOTAL |
|------------------------------------|-------------------|----------------------------|------------------------|----------------------------------|------------|-------------|-------------------|
| | (FTE) | (FTE) | (USD) | (USD) | (USD) | (USD) | (USD) |
| 2021 | 10 | | minimal | | minimal | 0.4 M | 0.4 M |
| 2022-2023 | 10 | | 1 M | | 0.3 M | 1.6 M | 2.9 M |
| 2024 | 20 | | | | | | |
| 2025-2029 | 50 | 10 | | 7-8 M | 0.7 M | 12 M | 19.7 - 20.7 M |
| Investment 2021-2029, TOTAL | | | 1 M | 7-8 M | 1 M | 14 M | 23-24 M |

From 2020 EoI + EoI 2021/ATHENA

In 2024 24.45 FTE, in 2025 likely we enter as ePIC with 30 FTE (0.3 FTE/person) then we grow... [INFN rules allowing...]
INFN investment in R&D (all sums given to EIC_NET excluding missions up to 2023 is **496,5 kEU**)
 Key role of **synergies** to make investment sustainable (ALICE ITS3 the main one, but new ones since this year (JLAB12, TEXTAROSSA, IBIS_NEXT, ...). Full list in backup.

“the big picture” (2)

| ePIC | INFN R&D | | | Total R&D |
|--------------------------------------|----------|-------|-------|-----------|
| Year | tracking | dRICH | other | |
| 2019 | 0 | 19 | 5,5 | 24,5 |
| 2020 | 0 | 33,5 | 6,5 | 40 |
| 2021 | 0 | 72 | 6 | 78 |
| 2022 | 0 | 149,5 | 0 | 149,5 |
| 2023 | 0 | 198,5 | 6 | 204,5 |
| 2024 | 40 | 333 | 16 | 389 |
| 2025 | 60 | 200 | | |
| 2026 | 60 | 100 | | |
| 2027 | | | | |
| 2028 | | | | |
| 2029 | | | | |
| 2030 | | | | |
| Total INFN R&D up to 2023 | | | | 496,5 |
| Total INFN R&D up to 2024 | | | | 885,5 |
| Eol Target (up to 2024) | | | | 1000 |

INFN R&D= funds given - mission costs

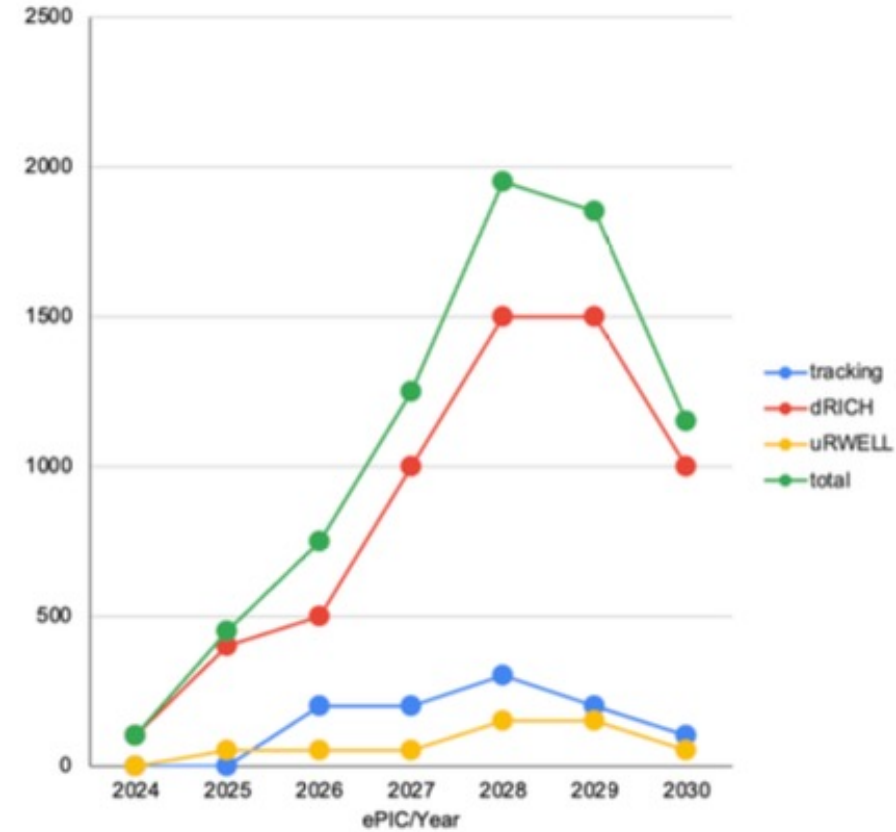
Note tracking almost zero so far (→ ITS3 synergy!)

2024 (in red): requests

2019-2023: assignments

“the big picture (3)”

| ePIC | INFN R&D | | | Total R&D | INFN in-kind | | |
|--------------------------------------|----------|-------|-------|-----------|---------------------------|-------|------|
| | tracking | dRICH | other | | SVT | dRICH | MPGD |
| 2019 | 0 | 19 | 5,5 | 24,5 | | | |
| 2020 | 0 | 33,5 | 6,5 | 40 | | | |
| 2021 | 0 | 72 | 6 | 78 | | | |
| 2022 | 0 | 149,5 | 0 | 149,5 | | | |
| 2023 | 0 | 198,5 | 6 | 204,5 | | | |
| 2024 | 40 | 333 | 16 | 389 | 0 | 100 | 0 |
| 2025 | 60 | 200 | | | 0 | 400 | 50 |
| 2026 | 60 | 100 | | | 200 | 500 | 50 |
| 2027 | | | | | 200 | 1000 | 50 |
| 2028 | | | | | 300 | 1500 | 150 |
| 2029 | | | | | 200 | 1500 | 150 |
| 2030 | | | | | 100 | 1000 | 50 |
| Total INFN R&D up to 2023 | | | | 496,5 | 1000 | 6000 | 500 |
| Total INFN R&D up to 2024 | | | | 885,5 | 1000 | 6500 | 500 |
| Eol Target (up to 2024) | | | | 1000 | Eol Target (total) | | 8000 |



- **First draft** of how we could request in-kind to INFN (data entered in db for 2025/2026) + plot in the report
- DSSC at work: to be finalized for 2025 preventivi, passaggio a sigla and TDR preparation

“the big picture (4)”

| ePIC | INFN R&D | | | Total R&D | INFN in-kind | | | INFN in-kind exposed to DoE | | | DoE funds (USD) | | | Other in-kind |
|--------------------------------------|----------|-------|-------|-----------|---------------------------|-------|------|-----------------------------|-------|------|-----------------|-------|--------------|---------------|
| | tracking | dRICH | other | | SVT | dRICH | MPGD | SVT | dRICH | MPGD | eRD | PED | Construction | |
| 2019 | 0 | 19 | 5,5 | 24,5 | | | | | | | 0 | 0 | | |
| 2020 | 0 | 33,5 | 6,5 | 40 | | | | | | | 0 | 0 | | |
| 2021 | 0 | 72 | 6 | 78 | | | | | | | 0 | 0 | | |
| 2022 | 0 | 149,5 | 0 | 149,5 | | | | | | 245 | 0 | 0 | | |
| 2023 | 0 | 198,5 | 6 | 204,5 | | | | | | 360 | 45,5 | 0 | | |
| 2024 | 40 | 333 | 16 | 389 | 0 | 100 | 0 | 0 | 300 | 0 | 400 | 60 | 0 | |
| 2025 | 60 | 200 | | | 0 | 400 | 50 | 0 | 1200 | 150 | | | | |
| 2026 | 60 | 100 | | | 200 | 500 | 50 | 600 | 1500 | 150 | | | | |
| 2027 | | | | | 200 | 1000 | 50 | 600 | 3000 | 150 | | | | |
| 2028 | | | | | 300 | 1500 | 150 | 900 | 4500 | 450 | | | | |
| 2029 | | | | | 200 | 1500 | 150 | 600 | 4500 | 450 | | | | |
| 2030 | | | | | 100 | 1000 | 50 | 300 | 3000 | 150 | | | | |
| Total INFN R&D up to 2023 | | | | 496,5 | 1000 | 6000 | 500 | | | | 1005 | 105,5 | 0 | |
| Total INFN R&D up to 2024 | | | | 885,5 | 1000 | 6500 | 500 | | | | | | | |
| Eol Target (up to 2024) | | | | 1000 | Eol Target (total) | | 8000 | | | | | | | |

- INFN Giunta esecutiva recommends to multiply by 3 in-kind investment to expose it to DoE (US budgeting) → MoU in 2024
- How to treat USD/EUR currency ratio to be clarified
- eRD funds: 2024 are requests, mainly used for personnel but not only (some travels + some hardware)
- About eRD funds: a truly win/win operation for INFN: R&D investment “matched” by external funds
- Other in-kind are for accelerators + possibly magnet

20 (+ 3 kEU : vessel dRICH LNS → request (see MarcoC presentation)

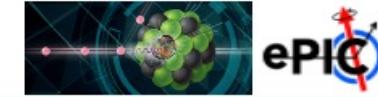
3 kEU (consumo BO): costo irraggiamento a LENA → restituzione

1.5 kEU (missioni GE): test in campo magnetico CERN / LAPPD → restituzione

--> entro prox. settimana faremo valutazione per missioni

Just a flash about what is going on in 2023

Our best investment for the future



- nice mix of experimental and theoretical communities
- 28 participants: 2 from India (+1), 1 from Poland, 1 from Germany, 3 "from fisica applicata + chemistry", **the rest (22) from INFN** at large (participants: 33%F – 67%M, lecturers: 40%F – 60%M, organizers: 45%F – 55%M) – 3 undergraduates
- excellent synergies among Universities and groups, good sponsorships, a superthank to Abhay and CFNS



| Data | Descrizione |
|-------------|--|
| 30 lug 2024 | Organizzazione giornate nazionali |
| 29 set 2024 | Finalizzazione disegno ALCOR a 64 canali |
| 31 dic 2024 | Realizzazione prototipo RDO |
| 31 dic 2024 | Caratterizzazione versione finale HRPPD |
| 31 dic 2024 | realizzazione disegno readout due dischi basati su tecnologia uRWELL per ePIC endcap |
| 31 dic 2024 | Sviluppo procedure di curvatura e interconnessione per prototipizzazione ePIC vertex layer |

DSSC oriented: 3 dRICH, 1 SVT, 1 GT

1 “networking”

Evitiamo milestones connessa a programmazione EIC project (no TDR pero' contribuiremo!!)

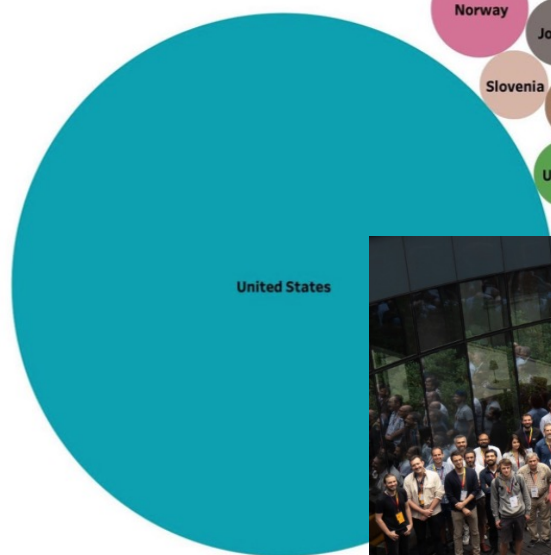
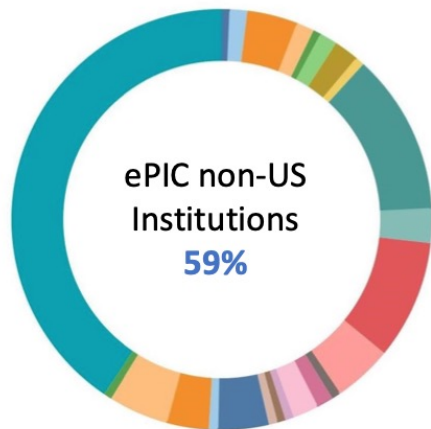
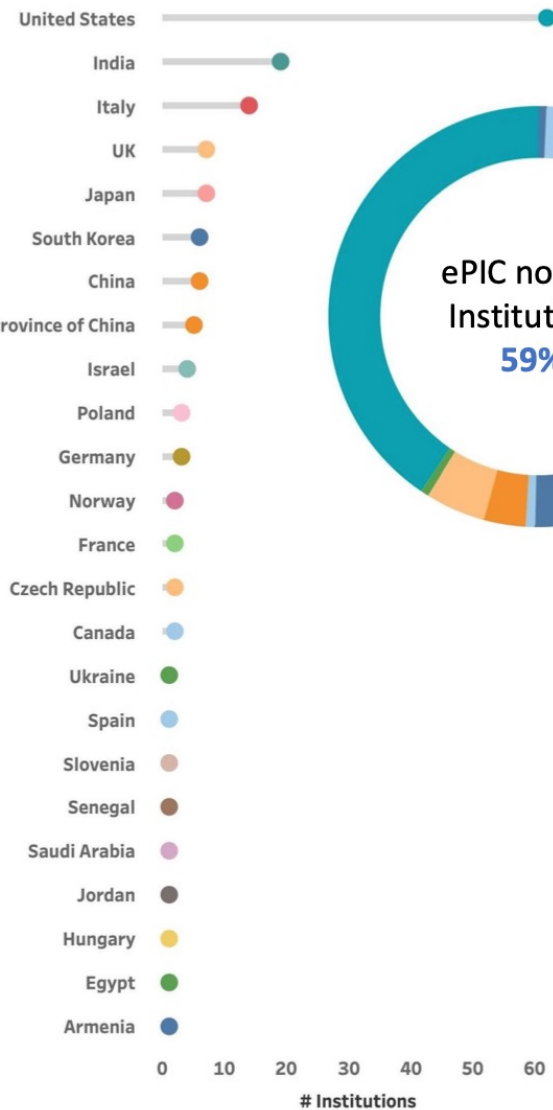
The ePIC Collaboration



171 institutions
24 countries

500+ participants

*A truly global pursuit for
a new experiment at the
EIC!*



Appendix A: Synergies with other INFN initiatives

We details the synergies with other INFN initiatives for 2024 (and where funding is requested directly through EIC_NET requests)

| EIC_NET R&D | EIC_NET groups | Synergistic to | Supported within |
|--------------------------|-------------------|---------------------------|------------------------|
| MAPSs 65 nm technology | BA PD PV TS | ALICE ITS3 / NA60+ (CSN3) | ALICE |
| Aerogel studies | BA FE | ALICE3 RICH (CSN3) | EIC_NET |
| SiPM for Cherenkov app. | BO CT CS FE SA TO | ALICE3 RICH (CSN3) | EIC_NET |
| Rad. tolerant SiPM | BO TO | IBIS_NEXT (CSN5) | EIC_NET and IBIS_NEXT |
| ALCOR | TO | PRIN about ALCOR | EIC_NET and PRIN |
| LAPPD | GE TS | AMBER (CSN1) | EIC_NET and AMBER |
| Pressurized gaseous RICH | FE LNS TS | AMBER (CSN1) | EIC_NET |
| Streaming readout | GE CT RM2 | JLAB12 (BDX) (CSN3) | EIC_NET |
| Data algorithms on FPGAs | RM1 | TEXTAROSSA (CSN5) | EIC_NET and TEXTAROSSA |
| uRWELL | CT RM2 | JLAB12 CLAS12 (CSN3) | JLAB12 |

Table A.1. Synergies in place with other INFN initiatives

A document describing the **synergistic activities** among three CSN3 sigle: **ALICE, EIC_NET and NA60+** was finalized in June 2022 and circulated to CSN3, referees and GE (D. Bettoni) (<https://cernbox.cern.ch/index.php/s/C7QUuny57ibvmxJ>). A total of 300 kEU/year for three years were granted to the CSN3 budget as additional funds following this submission. The additional funds are being used to cover mainly the cost of 65 nm test structures and aerogel studies.

A document describing the **synergistic activities** among two CSN3 sigle: **JLAB12 and EIC_NET** was finalized in July 2023 and circulated to CSN3, referees and GE (D. Bettoni) (<https://cernbox.cern.ch/index.php/s/bvfOQK7xrStMPSi>).