Data 7/06/2024

Letter of Intent
Richiesta di passaggio a sigla di esperimento ePIC da parte della sigla di networking EIC_NET

Gruppi EIC_NET delle seguenti sezioni/laboratori/gruppi collegati (14):

Bari, Bologna, Catania, Cosenza, Ferrara, Genova, Laboratori Nazionali del Sud, Padova, Pavia, Roma 1, Roma Tor Vergata, Salerno, Torino, Trieste

Autore	Verificato da	Approvato da
P. Antonioli	Commissione Scientifca Nazionale 3	R. Nania

Oggetto

Richiesta di passaggio a sigla ePIC da parte della sigla EIC_NET

Storico delle revisioni

Rev.	Data	Descrizione delle modifiche	Autore/Editore
1	7/6/2024	Compilazione documento	P. Antonioli

Sommario (se necessario)

Non necessario

Table of Contents

ACKNOWLEDGMENTS: Inside this document some slides are inserted, they are taken from presentations by P. Antonioli, M. Contalbrigo, J. Lajoie, S. Dalla Torre, R. Preghenella,J. Yeck,

Introduction

The EIC_NET sigla was approved by CSN3 in June 2018 and became operational since January 2019. The initiative was intended to coalesce the INFN community interested to explore a potential engagement of INFN in the activities of the proposed Electron-Ion Collider (EIC). The EIC was at that time a new machine proposed since some years.n 2012 it was published the so called “white paper”, but not yet approved at any level by the US Department of Energy (DOE) and early studies go back to first years of 2000s.

The EIC proposal scope is the investigation of the nucleon structure via Deep Inelastic Scattering (DIS) with an unprecedented precision, with a newly designed collider machine capable to deliver highly polarized beams, at high luminosity, colliding electrons with both protons and nuclei, and a detector able to cope with all the requirements coming from the physics scope and the collider design. Two collider projects were proposed: at the Thomas Jefferson National Acceleration Facility (JLab, VA, USA) and at Brookhaven National Laboratory (BNL, NY, USA). An international community was quickly building up via the EIC User Group (EICUG). In Italy the discussions were followed closely by groups traditionally active at JLab, at CERN SPS (COMPASS experiment), with also interest from groups participating in ALICE. Some INFN groups were already participating to the EIC R&D program of the DOE even before 2019. The EIC User Group is officially organized since 2016 and the EICUG meeting was held for the first time outside Europe in Trieste in 2017. One of the first meetings of the Italian community was organized in Genoa in January 2017.

The first level of approval (the so-called “critical decision 0”, CD-0) was signed by US DOE in December 2019. In January 2020 DOE chose the BNL site. Since then, in the last five years the situation quickly evolved both at international and national level. For sake of brevity, we just summarize the timeline of the project so far. Additional references to the more recent “Consuntivi reports” of the EIC_NET sigla are also provided.

The INFN CSN3 consistently supported the EIC_NET networking initiative since 2019 with growing funds, corresponding to a steady increase of researchers (and FTE) engaged in the project. Given the status of the EIC project and of the ePIC (Electron-Proton/Ion Collider) experiment, and the foreseen timeline of the experiment/machine we believe - as largely anticipated in “Preventivi reports” presented in 2022 and 2023, that it is now - June 2024 - the right time to move this INFN recognized activity (“sigla”) to experiment status (in this phase when R&D is converging towards completion and construction efforts are starting). Already in 2024 the INFN CSN3 has *de-facto* authorized expenses with “apparatus” status (the packaging design of the dRICH ASIC) and in 2025 more construction-directed expenses will be needed to start equip laboratories for qualification and assembly of detector parts/systems, as well as full-fledged core expenses as the ASIC engineering run. The Collaboration is confident to be well prepared, organized and robust enough to fulfill the commitments foreseen in this report. As instructed by the CSN3 chair, more detailed reports will be submitted by July 2024, explaining with greater details the expenses foreseen in 2025

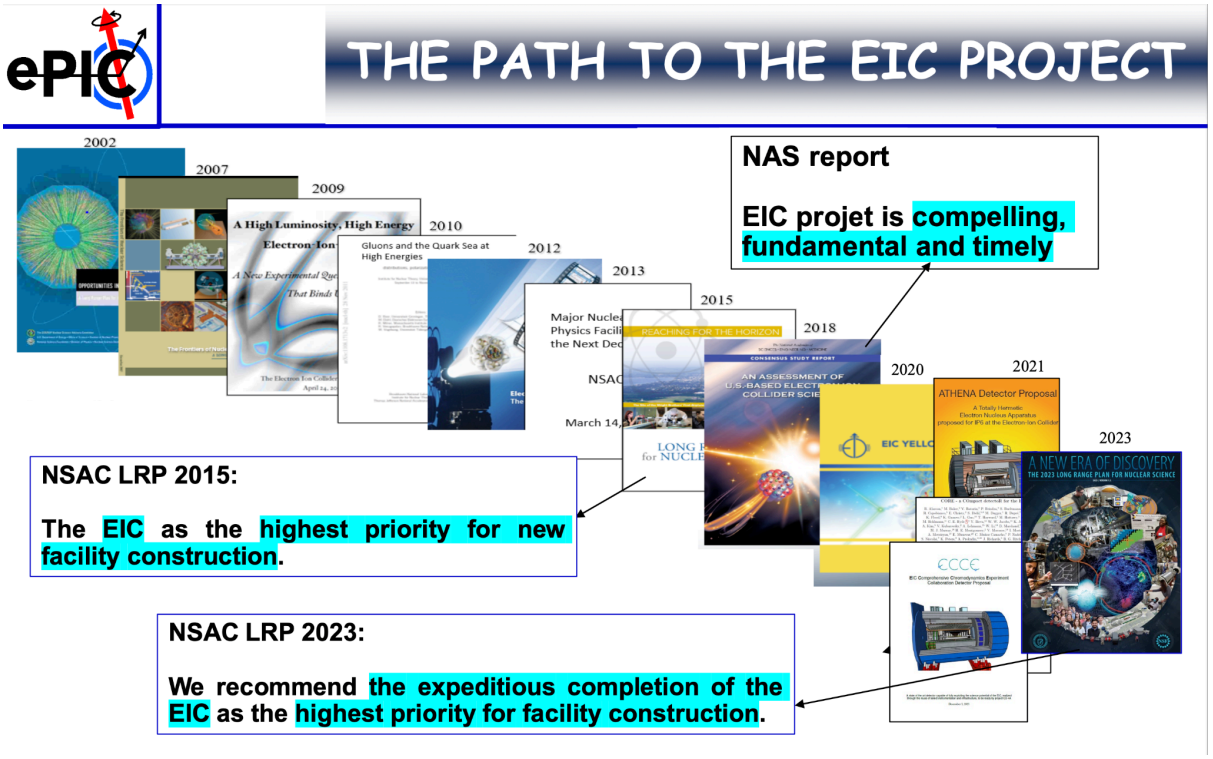
as part of the usual “preventivi” process. This is a high level document describing the foreseen INFN commitments in the ePIC experiment.

Very timely by the end of the year it is expected the signature between INFN and DOE of formal collaboration agreements for the in-kind contributions to the ePIC detector, and the TDR to get CD-2 approval by the DOE will be released in early 2025.

Essential timeline of the EIC project and key INFN steps so far

- 2012 publication of the White Paper “Electron Ion Collider: The Next QCD Frontier - Understanding the glue that binds us all”
- 2017 January, first meeting of interested “EIC Italian community”
- *2019 EIC_NET “sigla di networking” funded by INFN CSN3*
- 2019 December, CD-0 (DOE declares “mission need” for an EIC machine)
- 2020 January, DOE BNL selected by DOE as EIC site
- 2020-2021 preparation of the EIC Yellow Report identifying the EIC detector requirements
- *2020 Expression of interest documents presented by funding agencies PI (not binding) including by INFN*
- 2021 March, EIC Yellow Report released
- 2021 February, EIC Conceptual Design Report submitted
- 2021 June, CD-1 (Conceptual Design Report approved)
- 2021 November, submission of three proposals for the EIC detector from three proto-collaborations: ATHENA, ECCE and CORE
- 2022 March, detector experts panel selects ECCE as baseline proposal
- 2022 July, merging of ECCE and ATHENA, ePIC Collaboration established
- 2023 January, ePIC Charter approved, election of ePIC leadership
- 2023 April, first EIC RRB and approval of RRB Charter
- 2023 March - July: definition of ePIC management structure and organization by detectors
- 2023 October DOE NSAC Long Range Plan approved: implementation of the EIC is one of the three top priorities
- 2023 December, EIC RRB: presentation of International agreements instruments (ICRADA and PPD). *INFN listed among IKC contributor on detector, magnet and material studies for the accelerator*
- 2024 April, CD-3A approved, authorisation to procure long-lead items
- 2024 April, NuPECC draft plan presented: participation of European groups to EIC and ePIC is supported and one of the key recommendations of the plan
- 2024 May, EIC RRB: presentation of maintenance and operation costs scheme for funding agencies

The next important steps in this timeline are the submission of ePIC pre-TDR (for CD-2) and for INFN, the creation of “sigla” ePIC and the signature of INFN-DOE ICRADA for the ePIC detector in-kind contribution.



Miscellanea useful references

- EIC White Paper: “Electron Ion Collider: The Next QCD Frontier - Understanding the glue that binds us all” (2012)
- NSA Report, An assessment of U.S.-Based Electron-Ion Collider (2018)
- EIC Yellow Report, Science Requirements and Detector Concepts for the Electron-Ion Collider: EIC Yellow Report (2021)
- December 2023 Resource Review Board: https://indico.bnl.gov/event/20635/
- May 2024 Resource Review Board: https://indico.bnl.gov/event/22655/
- Expression Of Interest submitted by INFN EIC_NET groups to the EIC project (November 2020) (in agreement with INFN management)
- Last EIC_NET presentation to CSN3 (September 2023)
- EIC_NET Indico main page: https://agenda.infn.it/category/1147/
- Giornate Nazionali EIC_NET: 2019, 2020, 2021, 2022, 2023, 2024
- First European School on the Physics of the EIC (June 2023) organized by INFN
- EIC_NET Consuntivi: 2022, 2023

Status of the EIC project

As of June 2024, the EIC project is firmly established. In April 2024 the project got the approval of CD-3A, i.e. the authorization of the expenses for several long lead procurement items (including - for the detector - the lead tungstate crystals for the Backward EM Calorimeters, SiPM for the Forward Hadronic Calorimetrer, and the Detector Solenoid Magnet Design and Fabrication)..

The current timeline foresees in early 2025 the CD-2 approval, and in early 2026 the CD-3 approval, with the start of the construction. In 2025 the RHIC operations will come to an end. During 2025 other two CD-3B and CD-3C are foreseen to continue to authorize funds expenditures (enabling procurement of further long-lead items) before the achievement of the formal CD-3 milestone. In terns of construction of the accelerator the current status is summarized in the following table.

Date	What and commentary
2030, October	Detector to be ready on the floor
2031	Accelerator starts, machine studies only
Late 2032/2033[1]	CD-4A (early CD-4) first stable beams physics run
2033-2034	EIC not working at full luminosity. E-ions runs likely to be exploited first. A rich physics program will be already explored thanks to the unique characteristics of the machine
2034	CD-4 (“project completion”) accelerator at design parameters

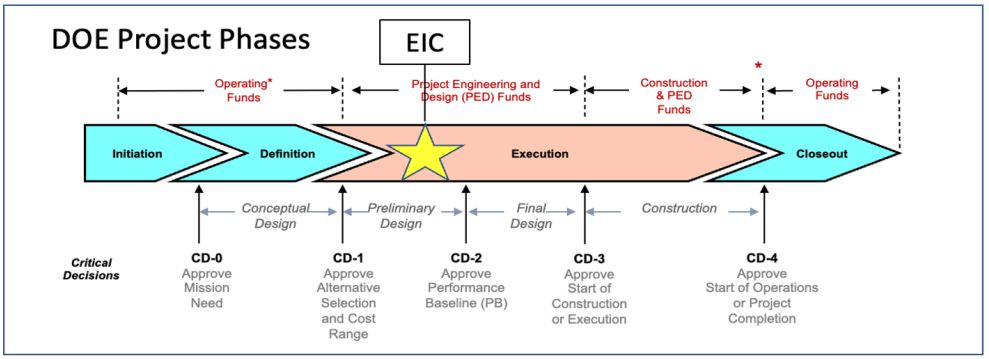
INFN is one of the key international partner funding agencies, together with UK, France and Canada, of the project, contributing already with “divisione acceleratori” and LNF group to the hadron ring (characterisation of pipeline materials to mitigate Secondary Electron Yield). INFN management is also currently negotiating an In-Kind contribution in terms of funding (and responsibility on the procurement) for the new superconducting magnet (MARCO) for the ePIC experiment, designed by CEA.

[1] At the time of writing this letter it is not official if there will be a postponement of the deadline for detector readiness (October 2030 currently), by several months or not, but it is very likely there will be a shift. The start of construction (originally foreseen in July 2025) has been delayed by 6 months for a mix of reasons including the need to collect enough data with the sPHENIX detector, after an unsuccessful year in 2023. The start of operations (machine studies) with the detector installed since end of 2030 remains scheduled for July 2031. The financial plan presented in this letter assumes a 6-month delay which is implicitly stated in the slide shown by J. Yeck at the latest RRB meeting (shown in the next page) where for the first time CD-4A has not been indicated at October 2032 but in 2033.

Some self-explanatory slides taken from the recent (May 2024) EIC RRB meeting about the status of the project provide further details..

EIC Project Critical Decisions and Plans

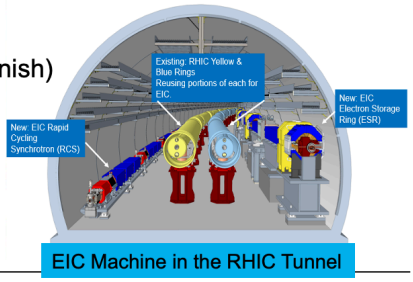
CD-0, Mission Need Approved	December 2019
DOE Site Selection Announced	January 2020
CD-1, Alternative Selection and Cost Range Approved	June 2021
CD-3A, Long-Lead Procurement Approved	**March 2024**
CD-3B, Long-Lead Procurement Planned Approval	**March 2025**
CD-2/3, Performance Baseline/Construction Start Plan	**End 2025**



EIC Project Planning Snapshot

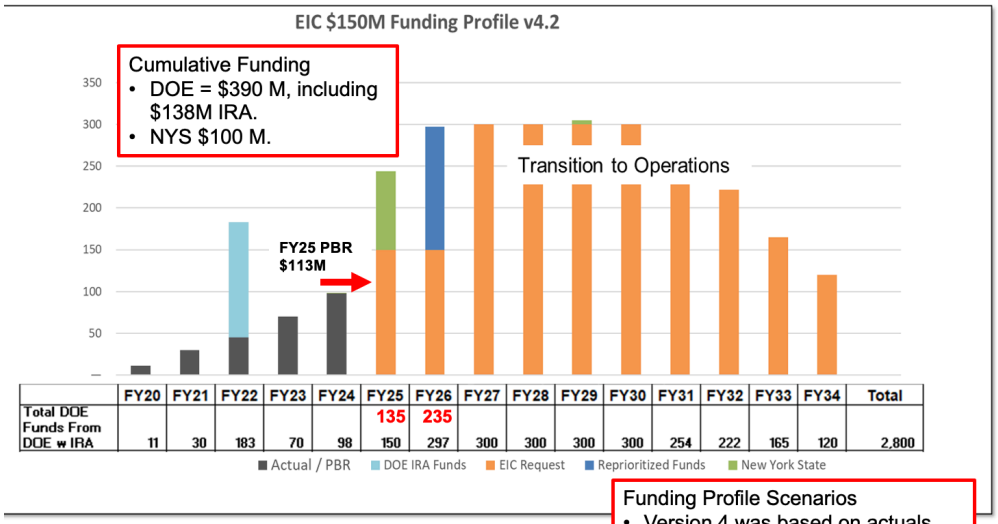
- CD-1 Alternative Selection and Cost Range= $1.7-2.8B
- Current TPC Point Estimate = $2.78B

- Plan for Critical Decision Approval Milestones (*Funding Dependent*)
  - Mar 2025 CD-3B, Long-Lead Procurement (Plan)
  - End 2025 CD-2/3, Performance Baseline/Construction Start (Target)
    - ➢ The goal is CD-2/3 before RHIC concludes in 2025
    - ➢ CD-3A,B,C,...enables procurement, not construction
  - 2026 CD-3 Start of Construction
  - 2033 CD-4 Start of Operations (Early Finish)
  - 2035 CD-4 Start of Operations



EIC Machine in the RHIC Tunnel

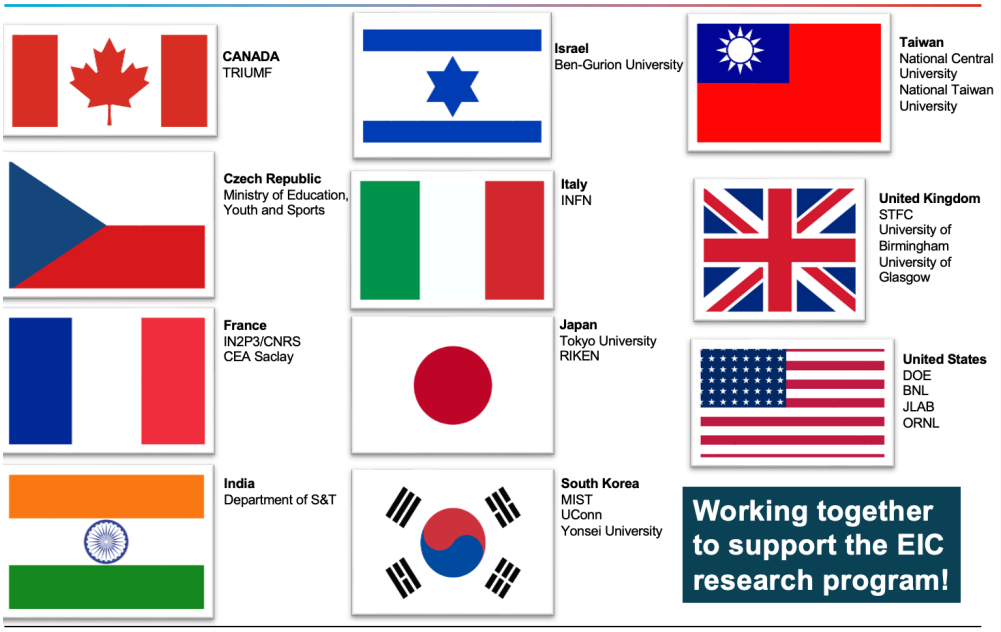
Funding Profile – V4.2



	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	Total
Total DOE Funds From DOE w IRA	11	30	183	70	98	135 150	235 297	300	300	300	300	254	222	165	120	2,800

Funding Profile Scenarios
- Version 4 was based on actuals through FY23 (PBR) and forecasts.
- RHIC ops funding starts to be repurposed to EIC in FY2026.

May 2024 RRB Meeting Participants



Status of the ePIC experiment

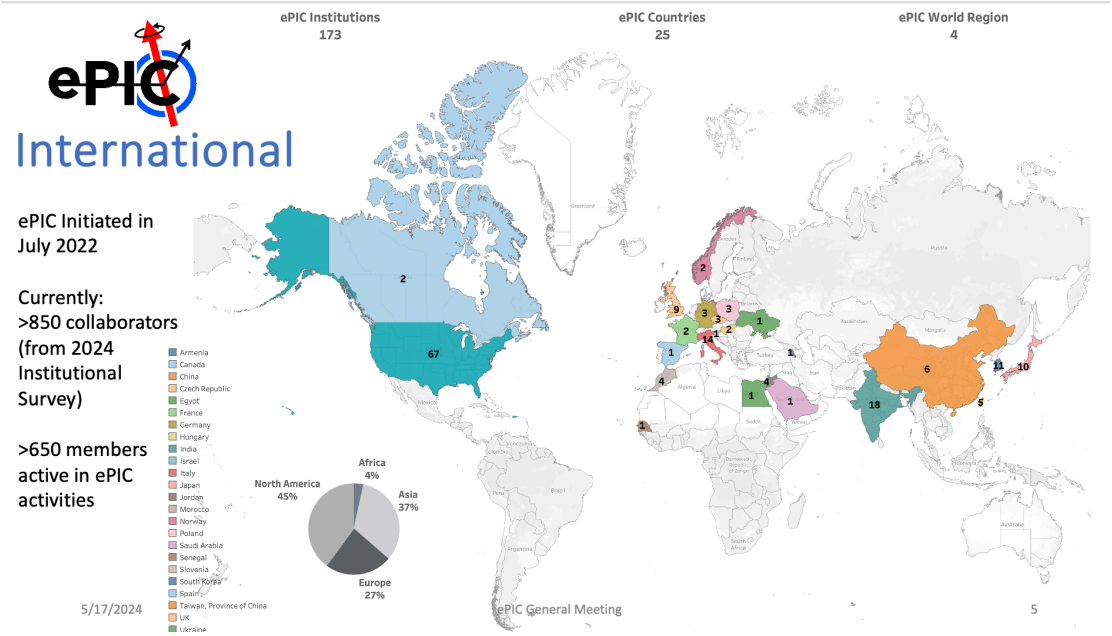
The ePIC Collaboration was officially formed in July 2022, following the “merging” of the main proposals (ATHENA and ECCE) submitted in November 2021 by the EIC community to the EIC project.

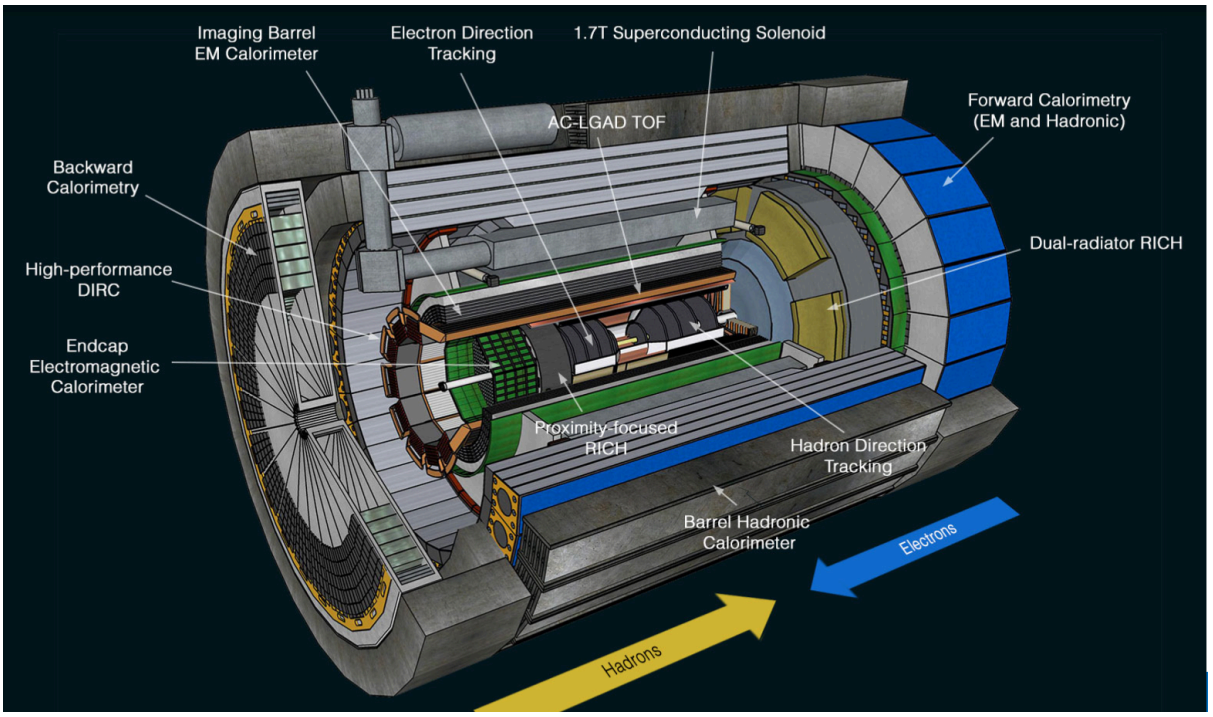
John Lajoie (ORNL) is the current spokesperson of the ePIC experiment. INFN is holding since the beginning several leadership positions in the Collaboration (see sub-section The INFN contribution to the ePIC experiment).

In the following few self-explanatory slides reporting the composition of the Collaboration, its organization, the experiment sub-systems (DS - “detector subsystems” is the acronym used by ePIC). The group of institutions contributing to a specific detector are named as DSC - Detector Subsystem Collaboration.

A detailed status of the ePIC experiment design, on-going R&D activities and physics reach was recently presented in a CERN Seminar last 24 May 2024 by Silvia Dalla Torre (TS), in her capacity as ePIC deputy spokesperson and ePIC Technical Coordinator.

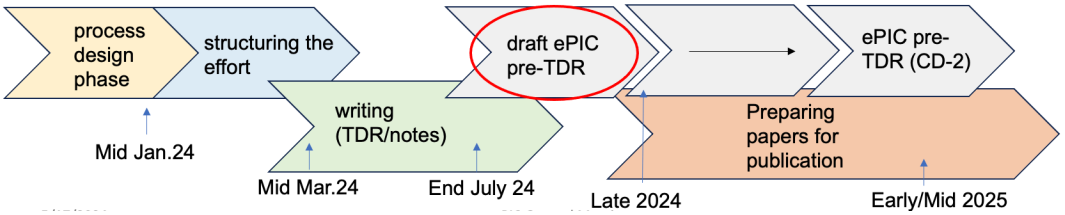
The design of the ePIC experiment, building on the requirements elaborated for the EIC detector during the preparation of the Yellow Report in 2020/2021, is in advanced stage and the corresponding TDR preparation is currently on-going. The TDR for CD-2 level (pre-TDR in DOE language) will be submitted to the DOE by the end of 2024. The TDR for CD-3 (final TDR) must be ready by the end of 2025.





TDR Strategy and Publications

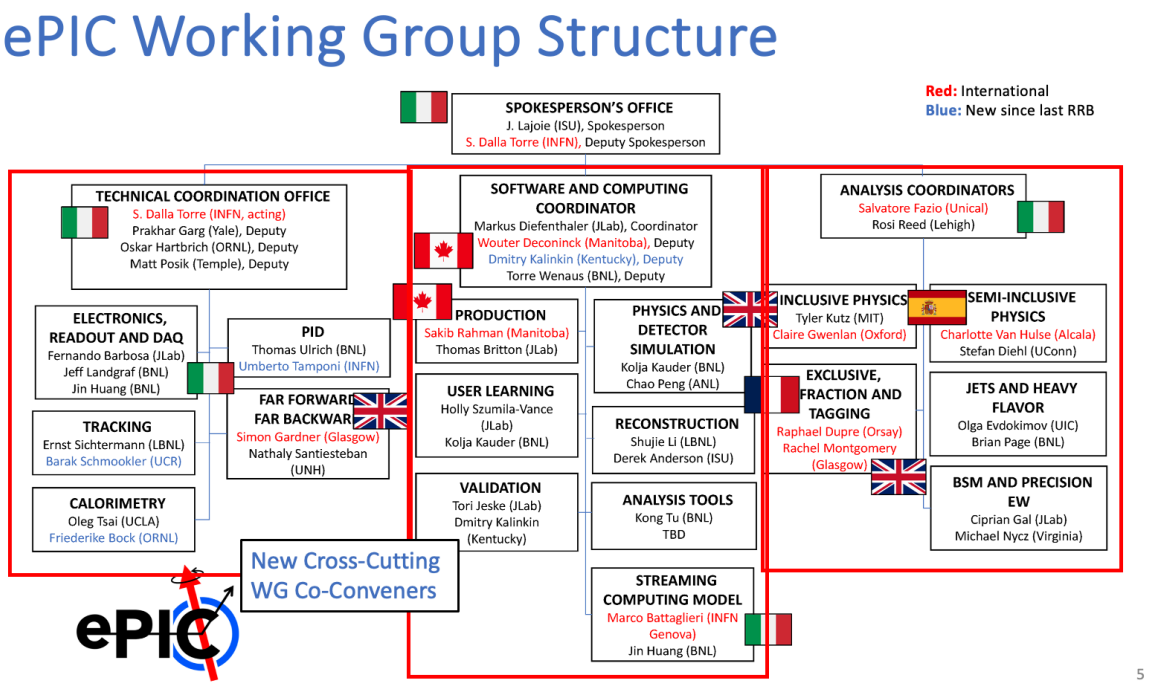
- In 2024 the ePIC collaboration will produce:
  - The ePIC contributions to the EIC TDR
    - The EIC TDR is the top priority
      - Chapters on *Physics Goals and Requirements* and *Experimental Systems*
      - Not just the document, but the simulations and detector R&D that form the basis
      - Requires close cooperation between the collaboration and the project!
- An ePIC Detector Design paper:
  - Derived and expanded from the *Experimental Systems* TDR chapter
- An ePIC Physics Performance paper:
  - Derived and expanded from the *Physics Goals and Requirements* TDR chapter
- Both to be published in a scientific journal (such as NIMA, JINST, or PRC)
- These publications will serve as a focus in developing the ePIC Membership and Publication policies.



The INFN contribution to the ePIC experiment

Roles in the Collaboration

Silvia Dalla Torre (TS) was elected deputy-spokesperson in January 2023. She also holds the role of Technical Coordinator. Salvatore Fazio (CS) is one of the two Analysis Coordinator (i.e. Physics Coordinator). Pietro Antonioli (BO) was a member of the Charter Committee who drafted the ePIC Charter then approved in January 2023, and he is the deputy chair of the Membership Committee. Annalisa Mastroserio (BA) is the deputy chair of the Publications Committee. Michela Chiosso (TO), Nicola Rubini (BO) and Domenico Elia (BA) are members respectively of the Publications Committee, Conference Committee and Elections Committee. Additional roles (discussed later in this document) held by INFN personnel or INFN associates involve responsibilities in the following detectors: dRICH (forward dual-RICH) with Marco Contalbrigo (FE) as DS Leader, forward disks μRWELL-based MPGD with Annalisa D'Angelo (RM-TV) as coordinator, SVT (Silicon Vertex Tracker) with Domenico Elia (BA) as coordinator for the inner layers, Streaming Computing Model and PID with Marco Battaglieri (GE) and Umberto Tamponi (TO) as co-convener of the corresponding working groups respectively. Previously, until April 2023, Roberto Preghenella (BO) and Marco Radici (PV) had also WG convenership roles (PID and SIDIS respectively).



ePIC DSC Structure

Red: International
Blue: New since last RRB

SPOKESPERSON'S OFFICE
J. Lajoie (ORNL), Spokesperson
S. Dalla Torre (INFN), Deputy Spokesperson

TECHNICAL COORDINATION OFFICE
Silvia Dalla Torre (INFN, acting)
Prakhar Garg (Yale), Deputy
Oskar Hartbrich (ORNL), Deputy
Matt Posik (Temple), Deputy

Detector Subsystem Collaborations

Particle Identification

dRICH
DSL/DSTC: Marco Contalbrigo (INFN)

hpDIRC
DSL/DSTC: Greg Kalicy (CUA)

BACKWARD RICH
DSL/DSTC: Alexander Kiselev (BNL)
Deputy DSL: Brian Page (BNL)

AC-LGAD TOF
DSL: Zhangbu Xu (Kent State)
Deputy DSL: Satoshi Yano (Hiroshima)

Calorimetry

BARREL ECAL
Co-DSL: Sylvester Joosten (ANL)
Co-DSL: Hwidong Yoo (Yonsei)
Deputy DSL: Maria Zurek (ANL)
DSTC (SI): Jessica Metcalfe (ANL)
DSTC (SciFi/Pb): Zisis Papandreou (Regina)

BARREL HCAL
Co-DSL: Stefan Bathe (Baruch)
Co-DSL: Megan Connors (GSU)

FORWARD ECAL
Co-DSL/DSTC: Oleg Tsai (UCLA)
Co-DSL: Huan Huang (UCLA)

BACKWARDS HCAL
DSL/DSTC: Leszek Kosarzewski (OSU)

FORWARD HCAL
DSL/DSTC: Friederike Bock (ORNL)
Deputy DSL/DSTC: Miguel Arratia (UCR)

BACKWARDS ECAL
DSL: Tanja Horn (CUA)
DSTC: Carlos Munhoz Camacho (IJCLab)

Far-Forward Far-Backward

FAR FORWARD
DSL: Alex Jentsch (BNL)
DSTC (B0): Zvi Citron (Ben-Gurion)
DSTC (Roman Pots/OMD): Alex Jentsch (BNL)
Co-DSTC (ZDC): Yuji Goto (RIKEN)
Co-DSTC (ZDC): Miguel Arratia (UCR)

FAR BACKWARD HIGH RATE TRACKER
DSL: Jaroslav Adam (CTU)
DSTC: Simon Gardner (Glasgow)

LUMINOSITY
Co-DSL: Nick Zachariou (York)
Co-DSL: Krzysztof Piotrzkowski (AGH Krakow)
DSTC (Pair Spectr.): Dhevan Gangadharan (Houston)

Tracking

Si TRACKERS
DSL: Ernst Sichtermann (LBL)
DSTC: Laura Gonella (Birmingham)

GASEOUS TRACKERS
DSL: Kondo Gnanvo (JLab)
DSTC: Maxence Vendenbroucke (Saclay)

6

ePIC Committees

Collaboration Council
Institutional Representatives

Standing Committees
DE&I
Conferences and Talks
Membership
Elections
Publications

Ad-Hoc Committees

DE&I Committee:
Chair: Megan Connors (GSU)
Vice-Chair: Christine Nattrass (UTK)
Francesco Bossù (CEA-Saclay), Wouter Deconinck (University of Manitoba), Narbe Kalantarians (Virginia Union University) , Iris Ponce Pinto (Yale University) , Maya Shimomura (Nara Women's University) , Allison Zec (University of New Hampshire)

Conferences and Talks:
Chair: Maria Zurek (ANL)
Vice-Chair: Brian Page (BNL)
Barbara Jacak (Berkeley), Daniel Brandenburg (OSU), Dmitry Kalinkin (Kentucky), Nick Zachariou (York), Xuan Li (LANL), Nicola Rubini (Bologna), Wouter Deconinck (Manitoba)

Membership Committee:
Chair: Peter Steinberg (BNL)
Vice-Chair: Pietro Antonioli (INFN-Bologna)
Friederike Bock (ORNL), Helen Caines (Yale), Doug Higinbotham (JLab), Bedhangas Moharty (NISER), Silvia Niccolai (IJCLAB), Marzia Rosati (ISU)

Publications Committee:
Chair: Rene Bellwied (U. Houston)
Vice –Chair: Annalisa Mastroserio (INFN Bari)
Lokesh Kumar (Panjab U.), Michela Chiosso (Torino), Prithwish Tribedy (BNL), Markus Diefenthaler (JLab), Sevil Salur (Rutgers),
ex-officio w. Conferences and Talks Committee:
Daniel Brandenburg (OSU)

Elections Committee:
Chair: Helen Caines (Yale)
Vice-Chair: Ken Barish (UCR)
Past-Chair: John Arrington (LBNL)
Maria Stefaniak (OSU), Domenico Elia (INFN)

5/6/2024 3rd EIC Resource Review Board

Key interests on EIC physics

The interests of INFN groups in the rich EIC science program and in the ePIC experiment partially reflect previous work of the current members, area of expertise, etc. A non-exhaustive list includes:

- Study of Semi-Inclusive Deep Inelastic Scattering (SIDIS) process for determination of the Transverse-Momentum Dependent (TMD) distribution functions
- Partonic imaging in coordinate space via exclusive processes
- Spectroscopy
- Heavy-flavour tagging for study of PDFs
- Inclusive diffraction for studies of dPDFs
- Hadronization in the nuclei

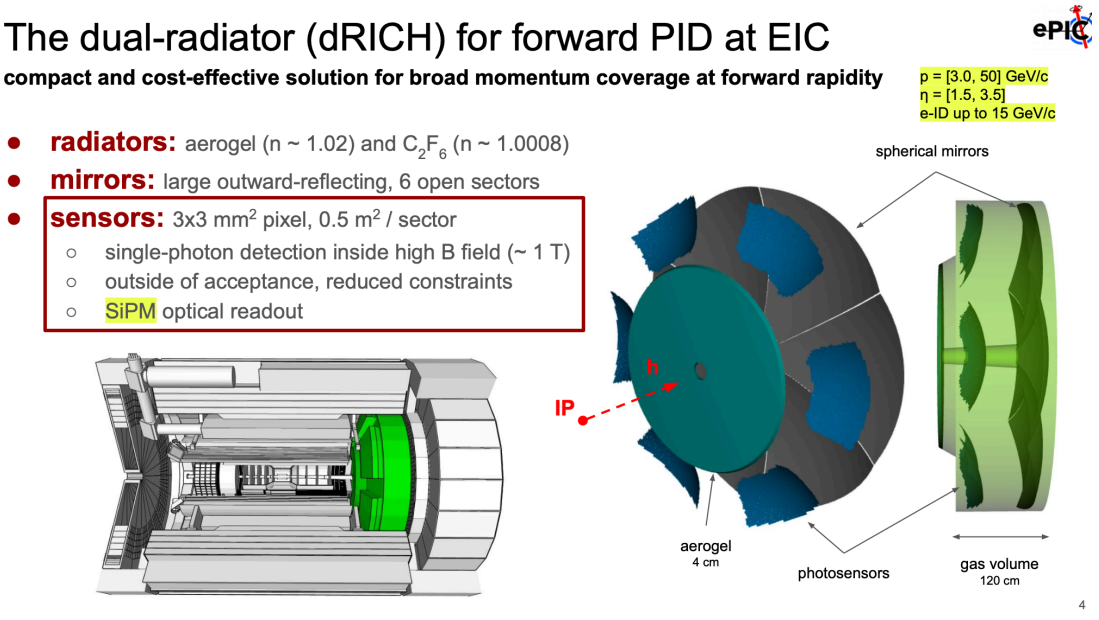
Unsurprisingly many of these interests are well aligned with the detectors where INFN is investing: hadron-PID in the forward region (obtained via the dRICH) is key for HF-tagging and SIDIS studies. Secondary vertex identification is also key for HF studies, spectroscopy and hadronization studies. The forward disks of the MPGD tracker is a key addition to the tracking capabilities of ePIC in the forward region within the acceptance covered by the dRICH.

Taking advantage of the leadership of S. Fazio (CS) as Analysis Coordinator several groups (BA BO CS PV LNS SA TO) are gradually engaging in physics performance analysis preparing for the TDR.

Direct contributions to ePIC detectors: dRICH, GEM-μRWELL, SVT

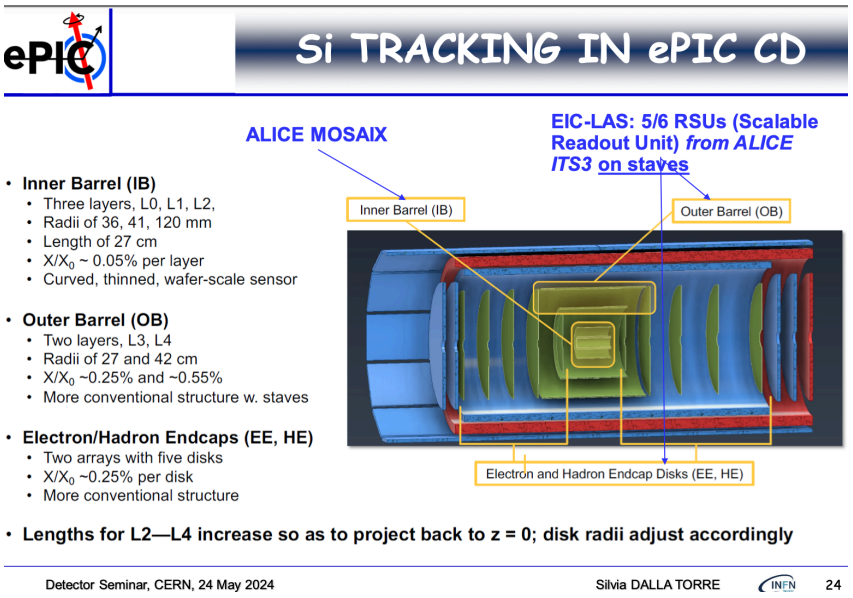
As detailed in sub-section The INFN In-Kind Contribution (IKC), the interest of INFN groups involved in ePIC is focused on three of the detector subsystems: the forward dual-radiator RICH (dRICH) for particle identification, the Silicon Vertex Tracker (SVT) and the MicroPattern Gaseous Tracker (MPGD). A full description of these detectors in references provided. Here a short description is given with main INFN responsibilities together with self-explanatory slides.

The dual-radiator Ring Imaging Cerenkov (dRICH) detector provides full hadron identification from 3 GeV/c up to 50 GeV/c in the ion-side endcap. It also offers a remarkable electron and positron identification up to about 15 GeV/c. In addition to the extended momentum coverage, dRICH needs to operate single-photon detection inside the foreseen strong magnetic field (about 1 T at dRICH photosensor location) and optimise optics in the limited space available at ePIC. Members of the dRICH DSC are almost all INFN groups (with the exception of PV and PD), Duke University, JLab, Ramaiah University (India) and NISER (India). Via the ePIC RICH consortium (putting together pfRICH and dRICH) Temple University, BNL and Stony Brook support dRICH effort. INFN has the leadership of the project, with Marco Contalbrigo (FE) as Detector Subsystem Leader.

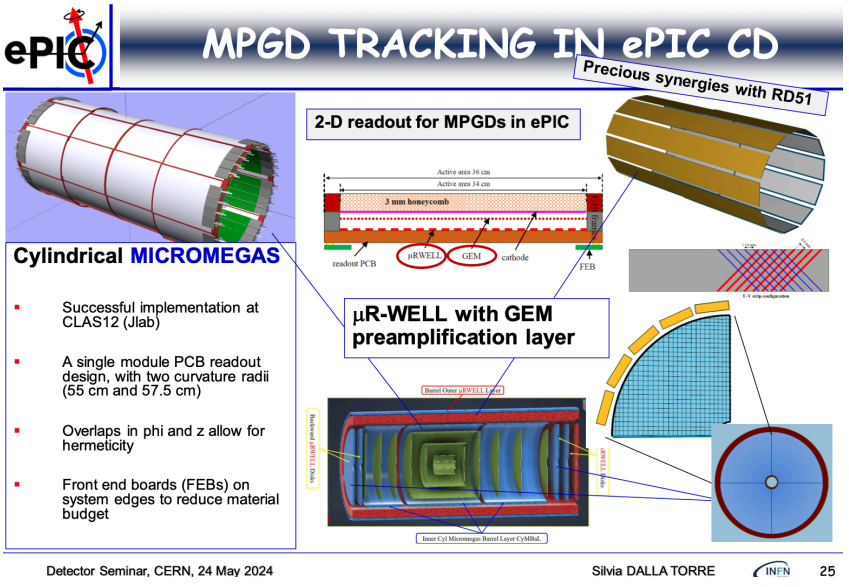


The ePIC SVT has to provide a large acceptance tracking and vertexing system with high spatial resolution and low mass that exceeds the current capabilities of any existing highly granular pixel detectors. The Monolithic Active Pixel Sensors (MAPS) in 65 nm CMOS technology has been identified as the only sensor technology that can meet in the available time frame the particular requirements the EIC imposes on pixelation, power consumption, and material budget. Members of the SVT DSC include INFN groups (Bari, Padova, Pavia

and Trieste)), UK groups (Birmingham, Liverpool, London, Oxford, STFC), Berkeley University, BNL, LANL, LBNL, MIT, JLAB, ORNL, Purdue University, UIC, CTU Prague. INFN is co-convener of the SVT WP4 (Layers and Disks), with overall responsibility on the three inner layers with Domenico Elia (BA).



Monte Carlo simulations showed that the tracking configuration in the endcap regions of the ePIC detector will not provide enough hit points in the $|\eta| > 2$ regions to perform good pattern recognition. Two planar MPGD trackers in each endcap of the ePIC baseline tracker design have been added, to increase the number of hit points available for pattern recognition, and complement the slower Si hits with fast hit points (MPGD timing resolution is of the order of ~ 10 ns, helping in background rejection). Members of the MPGD DSC (for the disks) include INFN (3 groups), Temple University and JLab (IN2P3 and CEA are instead contributing to the cylindrical barrel MPGD). INFN has coordination responsibility on the MPGD GEM- μRWELL disks with Annalisa D'Angelo (RM-TV).



Streaming readout (GE CT)

Under the leadership of GE group, the INFN community has always been at the forefront of the definition of the “streaming readout” (SRO: i.e. triggerless) paradigm, then chosen by EIC and ePIC. Such a choice, nowadays already adopted by ALICE and LHCb at the LHC since Run3,- is increasingly becoming a standard choice in HEP and Nuclear Physics. The INFN groups provided seminal work about these concepts and they were able to attract external funds (from MAECI and from DOE) along the years.

The GE group (and more recently the CT group) tested on the field the concept at JLab supporting the readout of calorimeters. Despite the significant flexibility offered by the SRO, the absence of a trigger that defines a readout window imposes a careful definition of sparsification thresholds, in conjunction with acceptable rates to the back-end. Any implementation needs to be tested in a realistic on-beam configuration, in order to demonstrate that results are superior to conventional triggered solutions. Italian groups' activities were devoted to perform on-beam tests to make a quantitative assessment of the back-end software performances.

M. Battaglieri (GE) is one of the co-conveners of the WG “ePIC Streaming Computer Model” and during the years of final R&D and construction the INFN groups involved are expected to maintain a key role in this matter, with an evident synergy with respect to activities carried out at JLab (CLAS12 is moving to SRO as well as other proposed experiments as BDX).

This activity is not the subject of a specific INFN IKC to ePIC and it is expected to be maintained with a limited amount of funds (few labs equipment, missions to JLab in the immediate future for some tests). Nevertheless this work remains well appreciated in the ePIC Collaboration and it proved to be capable of attracting external funds. Besides the traditional role of Genoa group, Mariangela Bondì (CT) - previously as junior scientist at Genoa and Rome2 - is now INFN staff at Catania and she is coalescing several students (including from Messina University) on this activity.

Computing

The most recent RRB discussions showed that agreement on computing matters (and its governance structure) still needs debate among the stakeholders. A four-layer structure (labelled as “Echelon” instead of “Tier” used in the WLCG “language”) for the computing infrastructure is foreseen, with L0 being the online resources at BNL, and L1 the shared computing center between JLab and BNL. L0 and L1 will be funded entirely by DOE.

Large computing resources in national computing centers (as INFN CNAF and possibly WLCG Tier-2s) will be labelled as L2. L3 corresponds instead to resources eventually available at local universities. The discussion about how to account for pledged resources at L2 level and how to use them in the ePIC computing model is still in its initial stages. A computing resources accounting similar to that for the LHC experiments is under discussion

(including the possibility of ePIC to be part of WLCG). The EIC_NET groups in consultation with INFN management expressed the intention to pledge resources at the level of 10% of INFN pledged resources for LHC (this corresponds roughly to 40 FTE). it is also possible that will be accounted. Giunta Esecutiva appointed Giancarlo Carlino, in his role of chair of INFN computing steering committee (C3SN) to follow this negotiation at high level on behalf of INFN. A. Bressan (TS) is serving as EIC_NET computing coordinator.

Involvement of the Italian theoretical community

From the very beginning, the EIC_NET initiative established, and is still keeping a strong connection with the INFN theoretical community in Hadron Physics, mainly organized in the NINPHA initiative of INFN-CSN4. The management group made by the RN and local responsibles includes also an observer from the theoretical community (M. Radici - PV).

Moreover, M. Radici is also a member of the ePIC Collaboration Council representing INFN-PV and, together with a NINPHA-PV postdoc (F. Delcarro) has a fraction of his FTE in EIC_NET. The plan is to foster a continuative engagement in the experiment, from which the entire ePIC community will benefit. Experimental groups working on the physics performance of ePIC are already working side by side with theoretical colleagues. The framework created by the EIC Users Group, with the ad-hoc Theory Working Group and the Annual EICUG meeting, provide an additional occasion for this type of collaboration.

Finally, the NINPHA-PV group significantly contributed to the First European School on the EIC Physics, that was held in Corigliano-Rossano in June 2023, both at the organization level and by delivering lectures on the theory of TMDs and a hands-on session on how to extract them from experimental data. This kind of collaboration could be replicated in the future, e.g. with ePIC Ph.D. or post-doc training events, setting the basis for a vibrant INFN contribution to the future of the ePIC Collaboration and, more generally, of the EIC project.

Beyond ePIC: the INFN contribution to the EIC User Group

The INFN community is contributing actively also to the EIC User Group. The EICUG was the initial engine promoting the EIC project and coalescing the community now committed to build and operate the ePIC experiment. For example, the preparation of the EIC Yellow Report (on detector requirements) was coordinated under the EICUG umbrella; it involved several members of both the experimental and theoretical Italian community in Hadronic Physics as conveners of specific chapters and/or simple contributors.

In fact, the EICUG scope goes beyond the ePIC experiment. First it convenes also a vibrant theoretical community, and promotes several key activities (such as effectively lobbying in the process preparing the NSAC Nuclear Physics Long Range Plan and NuPECC Long Range Plan, seminal work on Monte Carlo Generators, and use of AI in EIC science and so on). On the other hand, some of its initial seminal work has been / is going to be naturally

subsumed by the ePIC experiment (quarterly meetings were abolished and there is now just an annual meeting, etc.).

Several INFN members served as members of the EICUG Steering Committee. The current chair of this key stakeholder group is Marco Radici (PV). Marta Ruspa (TO) is also serving as a member of the Committee.

The INFN In-Kind Contribution (IKC)

The global amount of INFN financial committment follows what was mentioned, back in 2020, when the EIC project asked PI of the detector parts of the different funding agencies (INFN Responsabile Nazionale) to frame what could have been the interest and the financial investment. The proposed numbers were agreed with CSN3 chair (R. Nania) and INFN-Giunta Esecutiva (D. Bettoni) making clear it was not a binding committment at that time. The amount of money exposed (last time in an *in-camera* meeting between DOE and INFN management in December 2023) has been always maintained at the level of 8 M$ (UE budget).

The proposed financial committment and evolution of FTE was summarized in the following table.

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**

General remarks about this table:

- In the following we apply an exchange currency ratio of 0.9 € = 1 $
- The manpower cost exposed is related to the personnel salaries engaged in the construction (this is just for US accounting purposes to then expose the total of INFN IKC in International Collaboration Agreement (ICRADA) see section International Cooperation Agreement and Project Planning Document (ICRADA and PPD)
- The cost of travelling covered by INFN refers only to the expenses during the construction (installation and commissioning at BNL)
- The actual INFN investment in R&D (“no missioni”) in the years 2021-2024 has been of 0.9 M€, perfectly in line with what submitted to DOE in the EOI (October 2020)

- About the FTE levels, see section INFN ePIC groups: organization and FTE.

The financial plan presented foresees therefore an INFN IKC equal to 7.2 M€. An additional decreasing amount of R&D - engineering expenses will be requested in 2025-2027 using as much as possible synergies (including work on ECFA DRD). It is worth to note that the EIC_NET INFN groups attracted so far during the R&D effort from DOE additional external funds for the INFN for 1.3 M€ (2019-2024), making the operation very attractive financially. Via PED (Project and Engineering Design) and Construction Funds it is expected support from DOE to the INFN groups construction effort.

The indicative division of investment in the three detectors is as follows:

- dRICH: 5.8 M€
- SVT: 0.9 M€
- μRWELL: 0.5 M€

While the budgeting is prepared under this assumption, we remain flexible on the exact allocation among the three detectors, depending on opportunities, savings, etc. The ICRADA will report only the global IKC investment, not the share among the detectors.

dRICH (BA BO CS CT FE GE LNS RM1 RM-TV SA TO TS)

The INFN groups involved intend to design, produce and assemble the dRICH detector with an overall responsibility on the detector, acknowledged by the ePIC Collaboration with the expression of the DSL (Marco Contalbrigo FE). The IKC contribution will not cover, however, the entirety of the cost of the dRICH. The INFN IKC will highlight the coordination role of INFN and capitalize the competence of the involved INFN groups, in particular regarding the unprecedented photodetector with dedicated straming readout, the complex and demanding dual-radiator system, and the consequent challenging mechanics structure.

The INFN IKC will cover the design, production and quality assurance cost of the SiPM photodetector, of front-end ASIC (ALCOR), of the front-end board (FEB), of the readout boards (RDO) as well as the assembly of the above components in a compact Photo Detector Unit (PDU), including the cooling circuitry and related mechanics. It will cover the cost of the realization of the six detector boxes (containing the PDU of each sector) with the control panels and the electronic services attached (for HV/LV/daq links routing). It will contribute to the design and realization of the main vessel, the monitoring systems, the data filtering in streaming mode, and to the design of the radiator gas system. It will also cover the cost of the aerogel radiator, after concluding the on-going R&D. Finally, it will overview the definition of specifications and quality assurance of all the other components and services (i.e. cooling plants, HV and LV systems, etc.). The INFN IKC will not include the cost of the gas, of the mirrors, of the cooling, gas and power plants, and of the FELIX cards receiving the data from the RDO.

- FE: is coordinating the dRICH Italy groups and the whole DSC and is leading the mechanical design. The group will lead the design and productions of the vessel and of

the detector boxes for the 6 sectors and produce the control panels. The assembly of the detector boxes is expected to happen in its laboratories.

- BO: the group is leading the activity on the SiPM-based photodetector (SiPM) and on the data-acquisition. It will be responsible for the procurement of SiPM sensors, design and production of the SiPM PCB carrier boards, design and production of the readout boards (RDO) and will coordinate the integration of the various elements of the PDU. The PDU will be assembled in BO, tested and validated before being moved to FE for the installation in the detector boxes.
- BA: the group is leading the aerogel activity. It will coordinate the mass production and the quality assurance (expected to be operated in the US at Temple University and BNL).
- CS - SA - CT: this cluster of units in the South of Italy will work on SiPM and front-end boards quality assurance prior to the PDU assembling. They will equip test stations in SA and CS for this purpose.
- GE: is carrying out a feasibility study of an interaction tagger to filter the dRICH data stream. Possible options being discussed are the use of the information from other detectors (AC-LGAD TOF plane, hadron calorimeters) or a scintillating fiber plane. The group will coordinate with RM1 and BO groups in this respect.
- LNS: the group will contribute to the mechanical design effort.
- RM1/RM-TV: the RM1 group (and one staff person of RM-TV) has extensive experience on AI algorithms for PID running on FPGA. RM1 and RM-TV will develop the algorithm for pattern recognition and data reduction on FELIX cards. RICH expertise available in the RM1 group will continue to support the implementation and testing activities.
- TO: the group is leading on the design, test and production of the front-end ASIC ALCOR. The group will produce the chips and the front-end cards (FEB) mounting the ALCOR, and coordinate the quality assurance tests of the chip and FEB (expected to happen in Italy).
- TS: the group is leading the radiator gas activity. It will lead the design of the gas system and develop a continuous monitor system (critical to maintain a good chromaticity). It will also develop a test station of SiPM (with smaller capacity with respect to the CS-SA-CT cluster).

In the units where a larger effort is foreseen during production (BA-BO-CS-FE-SA-TO-TS) the support of respective INFN directors has been agreed regarding space granted, access to shared resources/facilties with different degrees of committments proportional to the activity foreseen.

All the groups have committed staff personnel resources to the project. A non exhaustive list (only researchers and engineers) more involved in the hardware activities include: M. Contalbrigo, A. Saputi (FE), G. Volpe (BA), P. Antonioli, D. Falchieri, A. Paladino, R. Preghenella, L. Rignanese (BO), S. Fazio (CS), C. Tuve' (CT), M. Battaglieri, M. Osipenko (GE) D. De Gruttola, N. Funiciello (SA), F. Noto (LNS), A. Lonardo, P. Vicini (RM1), R. Ammendola (RM-TV), M. Chiosso, F. Cossio, G. Della Casa, M. Ruspa (TO), S. Dalla Torre (senior association) and F. Tessarotto (TS). The core team involves experienced staff in

photosensors, RICH detectors, front-end electronics, DAQ systems etc. building on experience got in HERMES, CLAS12, COMPASS/AMBER, ALICE, DARKSIDE, JUNO and EIC R&D during last years.

GEM-μRWELL (CT GE RM-TV)

The involved INFN groups intend to design, produce and assemble the two GEM-μRWELL forward disks, which are a component of the MPGD endcap tracker system in the hadron direction. The RM-TV group is getting a growing experience on this kind of detector, thanks also to a consolidated collaboration with the group of Gianni Bencivenni in LNF, the inventor of μRWELL detector technology. It is important to note that, while INFN IKC will produce the two forward μRWELL disks, Annalisa D'Angelo (RM-TV) within the MPGD DSC is responsible within the ePIC Collaboration of the whole MPGD endcap tracker system, including the GEM-μRWELL backward disks on the electron direction. JLab and Temple University are the other institutions involved in the MPGD DSC for the MPGD endcap trackers.

The synergy with scientific activity at JLab is particularly promising for this IKC because in addition to the high luminosity program at JLab where chambers are being prepared, a new proposal for a tracker in an experiment using a polarized target is being discussed. The ePIC group in RM-TV will benefit from existing INFN infrastructures procured within the JLab12 experiment, such as gas bottles housing, gas handling system, oven, DAQ based on APV25 chip and HV supply.

The forward endcap MPGDs have an outer radius of 500 mm and a center hole of 90 mm radius. The detector foresees a stack of uRWELL plus a GEM to provide an amplification stage of the signal. A two-dimensional read-out scheme for a half-circular geometry poses significant challenges on GEM-μRWELL detectors and 2024 R&D is aiming to define the best arrangement choice (see Activity Plan 2024).

The INFN IKC will cover the cost of the GEM-μRWELL sensors, of the chambers (mechanics), of the Front-End Board (FEB), equipped with the SALSA chip and designed with a special form factor for optimized integration in the GEM-μRWELL detector mechanics. It will also include the cost of the HV/LV power supplies. The SALSA ASIC will be provided by CEA (France) as IKC. The amount of funds for the construction of the μRWELL forward disks is expected to be 500 KEU.

The responsibilities of the INFN groups are as follows:

- RM-TV: it will lead Italian MGPD groups. Support from the relevant services (electronic and mechanical workshops) has been agreed with the INFN Rome Tor Vergata director. The FEB design is well supported by the digital electronics workshop at RM-TV. It has been also agreed access to the RM-TV clean room. The sensors will be produced at CERN. The assembly of the disks will happen in RM-TV.

- GE: an experienced electronic engineer, head of the electronics workshop of the GE INFN unit has agreed to serve as senior supervisor member for the design and production of the FEB, based on the SALSA ASIC.
- CT: the group is coordinating the Monte Carlo simulation studies (for detector design optimization)

Staff personnel in RM-TV is led by Annalisa D'Angelo and include: Roberto Ammendola, Alessia Fantini, Roberto Ammendola, Rachele Di Salvo and Lucilla Lanza. Paolo Musico (GE) and Mariangela Bondì (CT) complement the core group in RM-TV with the responsibilities highlighted above.

SVT (BA PD PV TS)

The INFN groups involved in the ePIC SVT intend to produce and assemble the two innermost layers of the IB (Inner Barrel). They are all involved in the ALICE ITS3 project where they have gained experience and are currently actively participating in the development of a new truly-cylindrical low-mass silicon detector based on MAPS in 65 nm technology. Domenico Elia (BA) within the SVT DSC is co-convener of the WP4 (layers and disks). It is important to underline that, while the INFN IKC will produce two of the three inner layers, INFN maintains via the leadership of the WP4 an overall coordination responsibility over the whole IB (three layers).

The INFN IKC will cover the costs of the sensors, their characterization and test, the assembly procedure of the two innermost layers with high precision, and the development of the Flexible Printed Circuit (FPC, special connection of the sensors to the readout electronics). The amount of funds for the construction is expected to be 900 KEU.

The responsibilities of the groups are as follows:

- BA: leading of the SVT Italy group and main assembly centre of the two innermost layers.
- TS: qualification, test and production of the SVT IB FPC
- PD: development and production of the global SVT IB mechanics and backup assembly/production centre for the two innermost layers
- PV: test of the special gluing of the sensors with support structure (using the climatic chamber available), development of dedicated transport boxes and shipping/handling to BNL.

These INFN units have extensive experience in the respective activities from contribution to previous projects and that for the upcoming ITS3 construction. Staff personnel with previous experience (from ALICE) on these detectors is available in all the four INFN units, with leading roles covered by G. Contin (TS), D. Elia (BA), D. Colella (BA), S. Costanza (PV), R. Turrisi (PD), P. Giubilato (PD). Availability of spaces and possibilities to use related INFN services / facilities have been agreed with the corresponding INFN unit directors. All the four groups have attracted DOE external funds thanks to the work done over the last 2-3 years.

The funds have been used and are being used mainly for recruitment of post-doc or PhD positions. In addition it is worth to point out that L. Gonella (currently at Birmingham, and Technical Coordinator of the SVT) has been recruited by the University of Trieste. She will start her new role in TS effective September 3rd 2024 and she is expected to increase the capacity of the TS group for what concerns the SVT part.

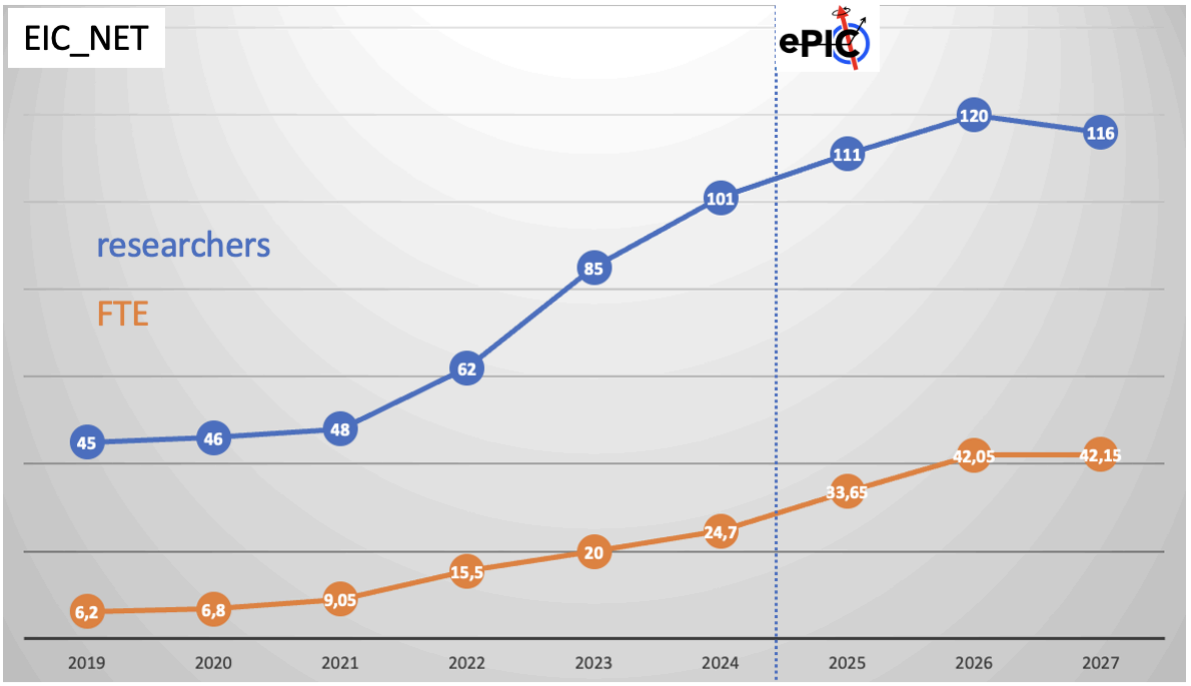
INFN ePIC groups: organization and FTE

Since 2023, EIC_NET is already operating as an “experiment sigla”. This is because in 2023 the ePIC Collaboration started to have a management structure linked to the Detector Subsystems. While the usual INFN hierarchy is and will be in place (i.e. a responsabile nazionale and responsabili locali), as standard in collaboration with multiple detectors, the RN is expected to work closely with the three detector coordinators (at Italian level) where the IKC investment is done.

P. Antonioli (BO) is serving as Responsabile Nazionale since 1st November 2021. He will end his three-year term on the next 30th October 2024. To ensure an orderly handover, the Comitato EIC_NET Italia (CEI, the assembly of the EIC_NET responsabili locali plus the responsabile nazionale and the theoretical observer) has already elected the new responsabile nazionale who is Domenico Elia (BA). Marco Contalbrigo (FE), Domenico Elia (BA) and Annalisa D’Angelo (RM-TV) are the Italian coordinators for the dRICH, the SVT and the GEM-μRWELL, respectively.

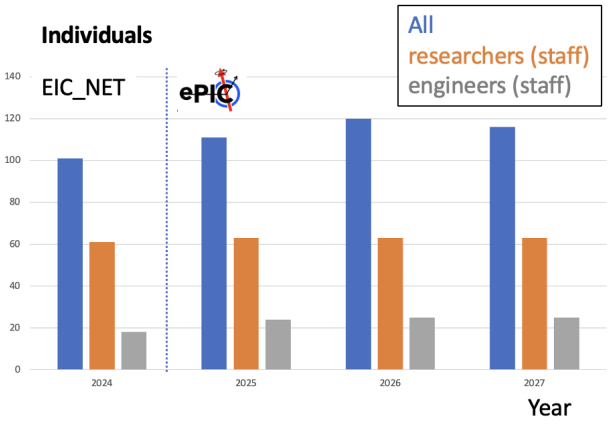
To prepare for the transition to experiment the community made a detailed planning of the expected increase of the FTE for the next three years, shared with INFN CSN3 referees. Here we report and discuss some data. Data from 2019 to 2024 are actual, since 2025 the forecast. Only secured contracts are shown up to 2027.

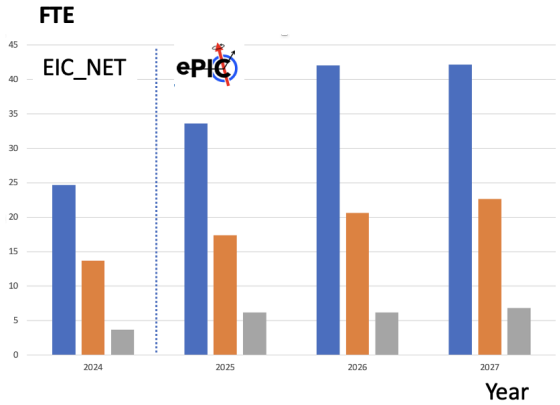
The growth in persons and FTE is clear since 2019.



The total number of persons involved in ePIC is expected to remain substantially constant during next three years (around 115 ± 5 individuals) but the number of FTE will increase from the value of 25 recorded in 2024 to an expectation of more than 40 in 2027. And we will be at that point still at 5-6 years from the start of the physics data taking and at 4-5 years from the start of operations/detector ready.

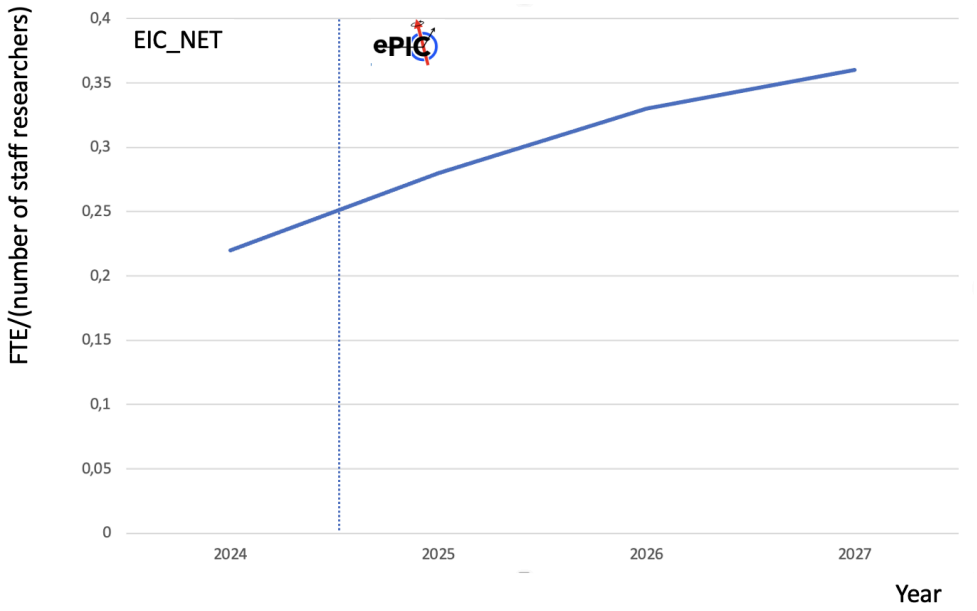
Moreover the INFN CSN3 referees advised to check the FTE fraction of staff (“personale strutturato”) in the coming years. This is discussed in the following plots.



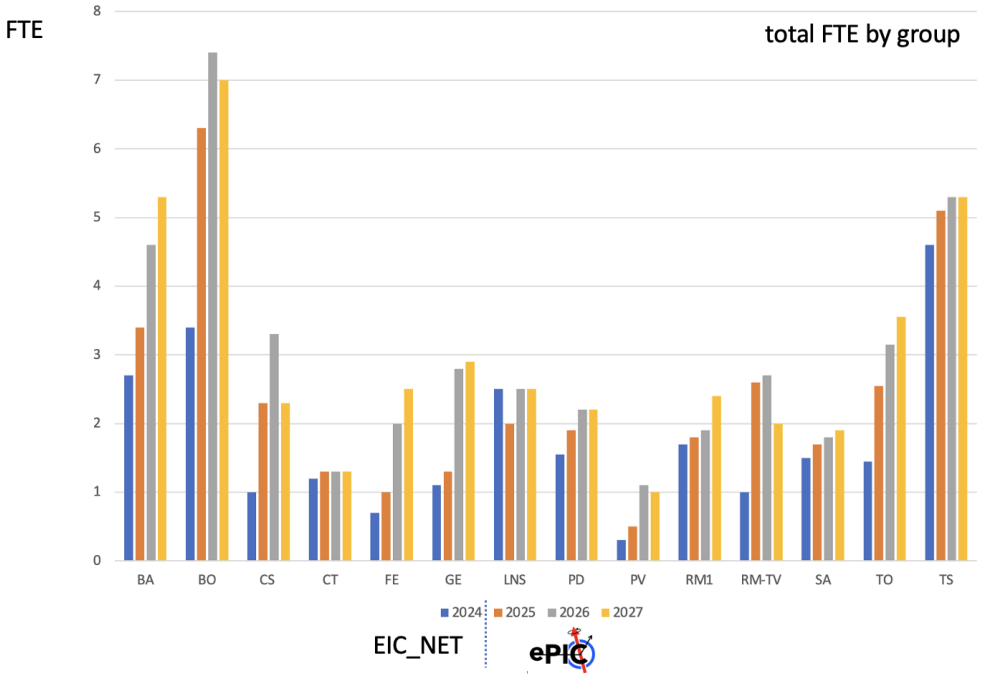


In fact it is visible in the figure above the steady increase of FTE of permanent staff (orange, right plot). Note that within “personale strutturato”, senior associations (i.e. retired personnel) were not included in the FTE forecast (even if for two years since retirement they contribute with FTE in the INFN accounting). It is worth to point out that, while it is impossible to have certainties about how many of the current PhD and post-doc personnel will become permanent staff during the upcoming years, we have reasonable expectations that some of the young PhD and post-doc people working for the Italian ePIC effort will.

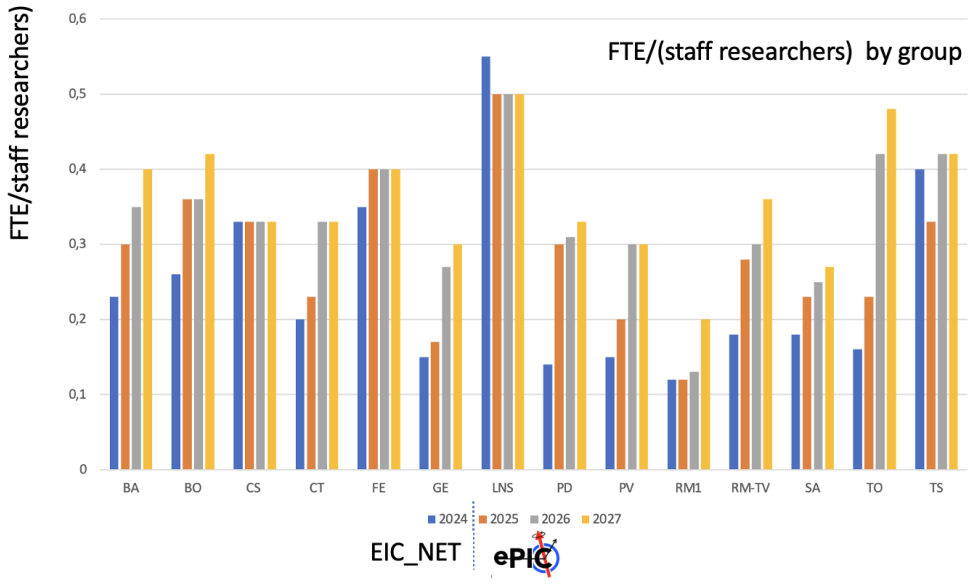
The DOE funds will continue to be used to sustain the recruitment of non permanent positions (PhD and assegni di ricerca) at this particular juncture. Currently 6 positions are in place (RM-TV, TO, BO, FE, TS, PD) and other recruitments are planned (TS BA PD TO BO CS).



The ratio FTE/(staff researchers) will increase on average from 0.22 to 0.36. Moving to an analysis by group, the large majority of responsabili locali will move to 50% since 2025 (this is beyond what is asked by CSN3 rules for “esperimenti in R&D e costruzione”), with others to follow in 2026. With the exception of one group, all groups will have more than one FTE since 2025 (PV will pass that threshold in 2026). The distribution of FTE by group is reported in the figure below.



Many groups will grow their FTE by 100% (with respect to 2024) in the next two years (in some groups there is a slight decrease in 2027 due to the end of fixed-term contracts (as PhD or post-doc) over a 3-year span. We inserted numbers only for positions already assigned or under recruitment (“bando pubblicato”). So in some groups if a PhD student will end his/her enrollment in 2026 there is a decrease in 2027. But It could be well the case he/she will have then a post-doc in 2027 or a new PhD will start etc.



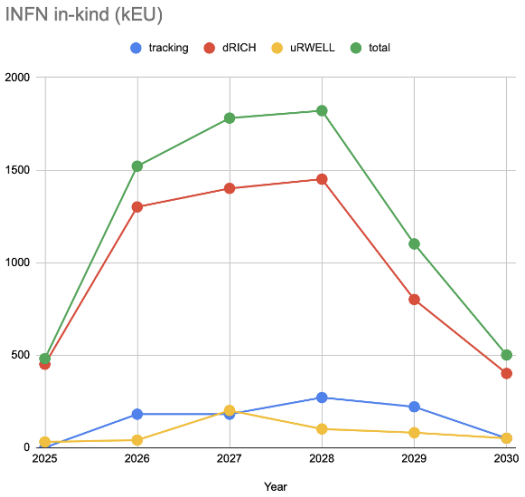
The increase of the engagement of staff researchers by group is represented above. Obviously there are differences reflecting the different group composition (and engagement in other experiments) but the commitment is clear. The lowest percentage of the ratio are in RM1 group, which is somehow special with a large and highly-qualified group in AI algorithms deployed on FPGA for the NA62 experiment at CERN and a small component critically engaged in JLab. Other factors that have an influence in these numbers are: the effect of being in full-fledged experiment and belonging to relatively small groups (this is the case for ePIC group members in JLab, ATLAS, CMS and AMBER) and the presence of theoretician in PV (which obviously stay with a small percentage in ePIC).

With the end of LHC Run 3 and current AMBER data taking we expect additional FTE will move to ePIC. We recommend special care to CSN3 referees for JLab groups (who are moving FTE from JLab to ePIC) to guarantee them the required missions to cover the shifts of data taking in these years and maintain authorship. Within ALICE Italy a constructive discussion was held about the need to relax the current internal ALICE Italy rule (which exceeds CSN3 rules) of reserving a minimum of 70% FTE for having authorship on ALICE publications, especially for members moving to synergistic experiments such as ePIC and NA60+. Seven members of ALICE and EIC_NET have asked the Comitato ALICE Italia to move the percentage to 50% for ALICE (reserving the remaining 50% to ePIC) starting from 2025, others will follow. Finally, it is also interesting to note the ePIC sigla in CSN3 will bring FTE from CSN1 to CSN3 (from AMBER, ATLAS, BELLE and CMS).

Financial plan

The total financial envelope of 7.2 M€ introduced before is proposed to be spent with the following spending profile.

	INFN In-Kind (kEU)			
Year	SVT	dRICH	uRWELL	TOT
2025	0	450	30	480
2026	180	1300	40	1520
2027	180	1400	200	1780
2028	270	1450	100	1820
2029	220	800	80	1100
2030	50	400	50	500
	900	5800	500	7200
	Total IKC (EU)		7200	



Detailed management plans are in preparation and sequencing of expenses for the different items is being discussed in more detail with INFN CSN3 referees. As a general comment, where possible, the cost has been leveled over the next 6 years, with, however, an unavoidable larger effort expected between 2026, 2027 and 2028, which corresponds to procurements of SiPM and the electronics for the dRICH and of the uRWELL. Modifications in the EIC schedule might impact on the current plan that will be adjusted year-by-year via CSN3 annual budgeting cycle accordingly.

Key synergies with other INFN projects: ALICE and JLab

In 2022 and 2023 the EIC_NET Collaboration submitted to INFN referees, CSN3 chair and INFN Giunta Esecutiva two documents highlighting the synergies of the on-going and proposed activities at the EIC with two main programs funded by INFN CSN3: ALICE and JLab.

The document describing the synergistic activities among three CSN3 sigle: ALICE, EIC_NET and NA60+ was prepared in June 2022, with focus on silicon tracking, aerogel, LAPPD and SiPM. The document about synergies with activities with JLAB12 was prepared in July 2023 [focus: μRWELL and streaming readout, and benefit from CLAS12 RICH expertise] and shared with referees, CSN3 chair and GE.

This is clearly paying. For example, given the synergy with ALICE - ITS3, no R&D costs were budgeted to EIC_NET for the R&D efforts for the SVT in 2019-2023 (and R&D requests ePIC specific in 2024-2027 will be minor). A similar situation is now happening for the R&D aerogel costs (budgeted under EIC_NET and used also by ALICE groups preparing proposal for ALICE3). Other synergies in place for the μRWELL will benefit JLab (GEM-μRWELL for high luminosity and for a proposed experiment on polarized target).

Additional synergies are or were in place with several CSN1 (AMBER) and CSN5 sigle (IDEA, IBIS_NEXT, APEIRON) or UE projects (AIDA Innova, STRONG2020, TEXTAROSSA) or PRIN and PNRR projects.

Since preventivi 2025 synergies with the ECFA-led “DRD” collaboration will be also highlighted. INFN ePIC groups members from BA BO FE PD RM2 TS are members of DRD1 (CMOS sensors and μRWELL), DRD3 (solid state detectors and vacuum technologies), DRD4 (photosensors)

International Cooperation Agreement (ICRADA) and Project Planning Document (PPD)

In the 2023 December RRB the DOE presented the strategy of non-binding and binding agreement schemes that will be formally signed, behind the INFN committment to the ePIC detector.

There are two documents being negotiated:

- the ICRADA, which is a “high-level” document, with first 8 pages absolutely standard, and signed by the INFN president and one of the two directors of the laboratories involved. Formally the ICRADA will be signed with JLab (not with BNL). The ICRADA indicates the scope of the collaboration and the whole financial envelope (which is 8 M$ re-evaluated under US budgeting rules, i.e. a varying factor between 2 (usual for nuclear physics) and 3 (usual for high energy physics). A draft ICRADA for the detector part is being discussed and several details were discussed in a side-meeting during the last RRB by the EIC_NET RN, INFN GE, INFN CSN3 chairs and EIC leadership. The current schedule foresees (similarly to UK and France) to have the ICRADA signed by the end of 2024.
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- a Project Planning Document, again signed by the INFN president, where then the single items of the IKC envelope is detailed, together with the planned delivery schedule, description of procedure of quality assurances, deliverables etc. The PPD has been discussed so far by EIC_NET RN and BNL administrative staff and detector leads started to work on this document. The PPD will be prepared alongside the preparation of the ePIC TDR and detailed definition of the schedule. There are also interconnections with the DOE project management tool (Primavera, so-called P6) for the numbering of milestones. It seems a reasonable target having the PPD signed by the first quarter of 2025.

Both ICRADA and PPD are standard documents used in Collaboration agreements between INFN and DOE.

Advanced draft version of the ICRADA being negotiated in coordination with INFN Giunta Esecutiva and template files of the PPD have been shared with INFN CSN3 referees.