

Status of DETECTOR-1

7/26, 2022

Silvia Dalla Torre, Or Hen, Tanja Horn, John Lajoie, Bernd Surrøw

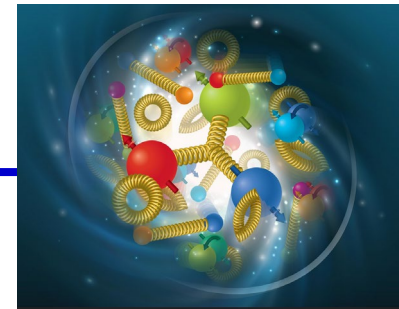
(DETECTOR-1 interim Steering Group, SG)

OUTLOOK

- **INTRODUCTORY CONSIDERATIONS**
- **THE DETECTOR**
- **THE COLLABORATION**



INTRODUCTORY NOTES



- This talk is a short outlook about DETECTOR-1
- All matters related to DETECTOR-1 and the dedicated Collaboration will be discussed in the DETECTOR-1 meeting hosted in dedicated sessions within the EICUG annual meeting

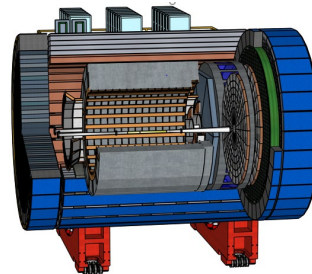
- 7/26 11.00 am – 7/27 evening: sessions of the DETECTOR-1 meeting
- DETECTOR-1 thanks the EICUG for hosting this first meeting in person of the collaboration being formed
- everyone in the EICUG is welcome to attend the DETECTOR-1 meeting (both members of the collaboration being formed and non-members)

THE PATH TO DETECTOR-1

The Proposals

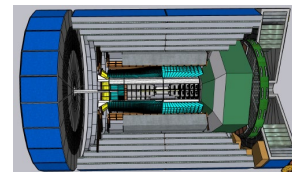
■ ATHENA

- A Totally Hermetic Electron-Nucleus Apparatus
- Concept: General purpose detector inspired by the YR studies based on a new central magnet of up to 3T



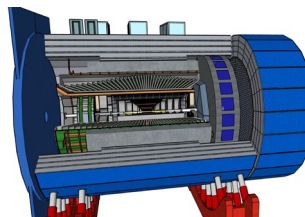
■ CORE

- Compact detector for the EIC
- Concept: Nearly hermetic, general purpose compact detector, 2T baseline



■ ECCE

- EIC Comprehensive Chromodynamics Experiment
- Concept: General purpose detector based on 1.5T BaBar magnet



Call for Collaboration Proposals for Detectors at the Electron-Ion Collider

Brookhaven National Laboratory (BNL) and the Thomas Jefferson National Accelerator Facility (TJAF) are pleased to announce the Call for Collaboration Proposals for Detectors to be built at the Electron-Ion Collider (EIC). The EIC will have the capacity to host two interaction regions, each with a general purpose detector. It is expected that each of these two detectors would be representative of the EIC community.

Detector 1 is within the scope of the EIC project and should be based on the design described by the EIC User Group (EICUG) in the Yellow Report (YR) and included in the EIC Design Report (CDR). This detector must satisfy the requirements of the EIC "mission statement" as defined in the EIC community White Paper and the National Academies of Science (NAS) 2018 report. Detector 1 is expected to support most but not all of the acquisition of Detector 1 science. Detector 1 is located at Interaction Point 6 (IP6) on the Relativistic Heavy-Ion Collider.

Detector 2 could be a complementary detector addressing particular science topics or address science topics beyond those described in the EIC White Paper and the National Academies of Science (NAS) 2018 report. Detector 2 would reside at a different interaction point from Detector 1 and is currently not within the EIC project scope. Routes to a second interaction region possible are being explored.

Collaboration proposals made in response to this call should relate to either Detector 1 or Detector 2. Proposals should consider the design and construction of the detectors described in the CDR. Other options are welcome but proposals that deviate significantly from the CDR need to address the implications to the EIC project. For reference, proposals should be consistent with the CDR, EICUG YR, and the posted Expressions of Interest as background information. The following are the key requirements for proposals.

The separate guidelines for proposals follows:

- **Detector 1 Collaboration:** Experiments must address the EIC White Paper and NAS Report science case. The collaboration should propose a system that meets the performance requirements described in the EIC CDR and EICUG YR. The design should be compatible with that of the accelerator and interaction region layout of the CDR. Completion of detector construction must be achieved by Critical Decision (CD)-4A, the start of EIC accelerator operations.

THE PATH TO DETECTOR-1

DPAP RECOMMENDATIONS
& PROJECT DECISION

- **DPAP - EIC Detector Proposal Advisory Panel**
 - Report released on 21 March 2022
- **Project – assumed the DPAP recommendations:**

*“The EIC Project recognizes that the panel recommended ECCE as the Project Detector. As described in the panel report, we will urge the proto-collaboration to: (1) **integrate new collaborators** in a manner that enables them to make contributions that impact the capabilities and success of the experiment in significant ways, including new collaborating individuals and groups into positions of responsibility and leadership; and (2) **integrate new experimental concepts** and technologies that improve physics capabilities without introducing inappropriate risk. **ECCE is the reference design for this optimization and consolidation so that the Project Detector can advance to CD2/3a in a timely way**” – email communication from the EIC Project Team on 13 March 2022.*

- **In this context, some statements in the DPAP report are key:**
 - “The managements and collaborations of **both ATHENA and ECCE are capable of becoming a solid basis for the full development and implementation of a successful Detector 1.**
 - ... the proto-collaborations are not yet at the strength necessary to prepare a **detector for Day 1 of the EIC.**”

THE PATH TO DETECTOR-1

■ DPAP - EIC Detector Proposal Advice

- Report released on 21 March 2022

■ Project

In spite of **initial difficulties** created by a competitive process done almost entirely without opportunities for in-person interactions

the **ECCE and ATHENA proto-collaborations** came together to move forward towards:

- The formation of a **new scientific collaboration**
- Consolidate and optimize, **evolving the reference detector to an advanced detector concept**

HOW?

- Interim SC from representatives in both proto-collaborations
- Forming joint WGs
- Organizing detector consolidation and optimization
- Steps for establishing the new collaboration

in the DPAP report are key:

... and collaborations of **both ATHENA and ECCE** are capable of providing a **solid basis for the full development and implementation of a successful Detector 1.**

- ... the **proto-collaborations** are not yet at the strength necessary to prepare a **detector for Day 1 of the EIC.** “

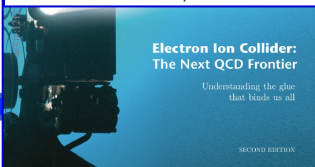
LEGACY FROM THE PREVIOUS ACTIVITY

DETECTOR HISTORICAL BACKGROUND

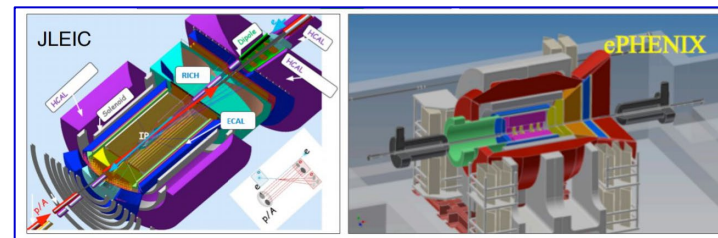
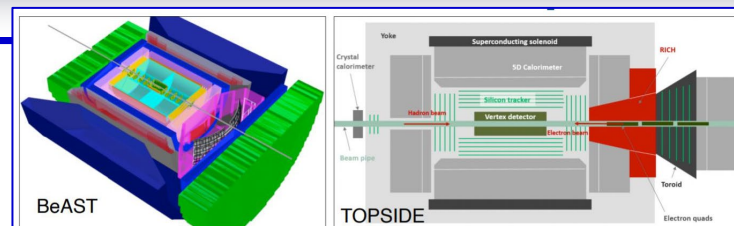
- White paper (2012, 2014)



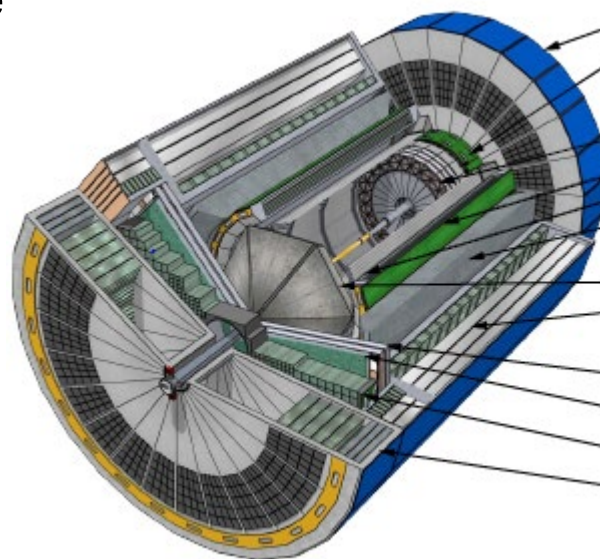
A. Accardi et al., Electron-Ion Collider: The next QCD frontier, Eur. Phys. J. A52 (2016) 268.



- The initial concepts in the 2010's



- The Yellow Report reference detector (2020)
 - A global effort of the EIC-User Group



LEGACY FROM THE PREVIOUS ACTIVITY

The program of Generic Detector R&D for EIC

- The development of detector technologies for the EIC detector(s) supported in years 2011-2021 by a robust R&D program with US and international participation
- An (incomplete) flavour:

Project	Topic
eRD1	WSciFi and SciGlass electromagnetic calorimetry
eRD3	MMG, GEM, and μ RWell MPGD technologies
eRD6	Lightweight GEM tracker miniTPC* for PID in barrel through dE/dx MMG, GEM, and μ RWell MPGD
eRD12	Auxiliary detectors: low- Q^2 tagger, far forward tracker (Roman Pots), luminosity measurement
eRD14	DIRC, dRICH, Photosensors, LAPPDs
eRD16	Forward and backward MAPS tracker disks

Tracking

PID

Calorimetry

Simulations

DAQ/Electronics

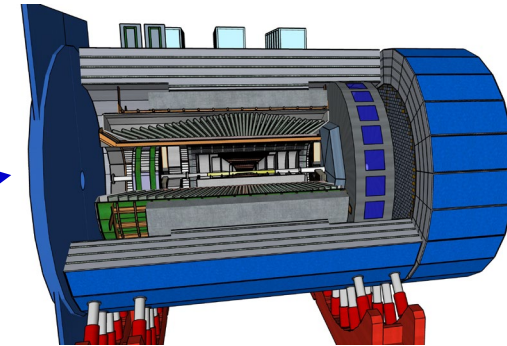
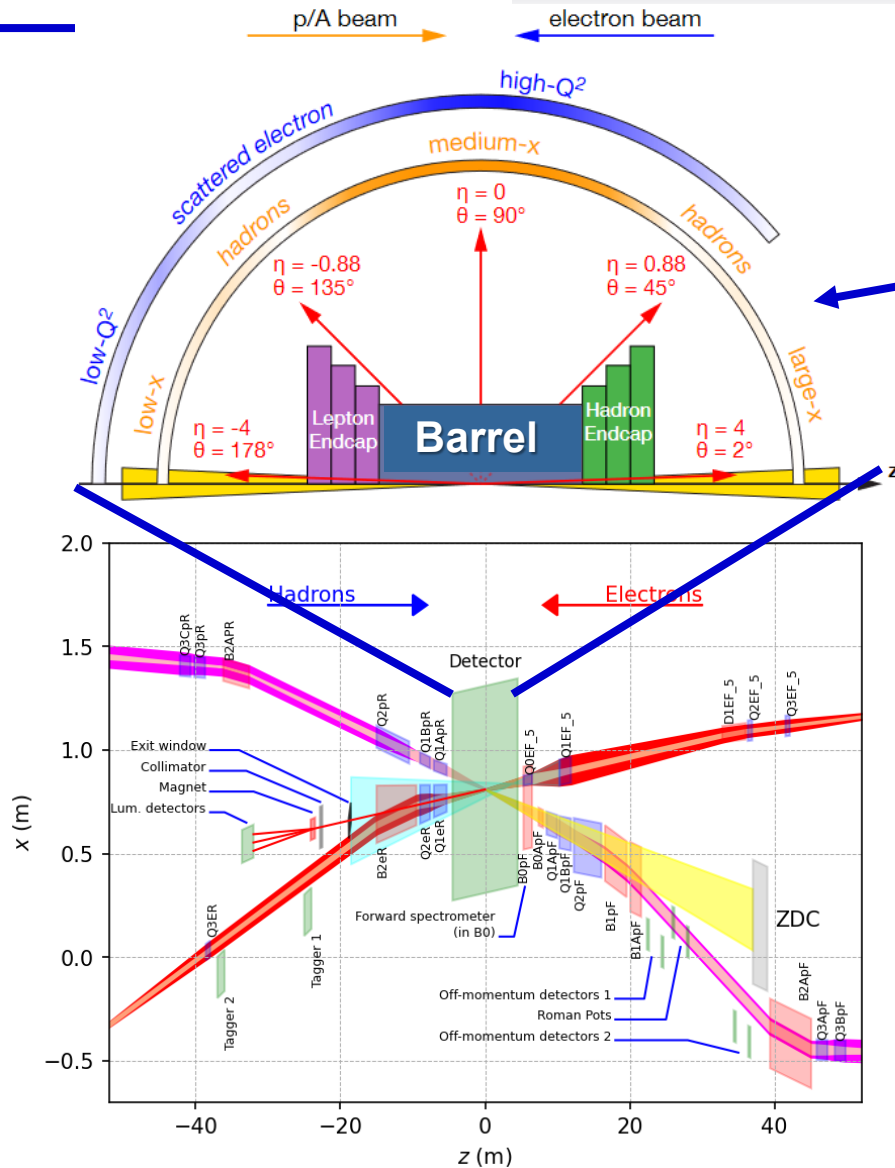
Project	Topic
eRD18	Barrel: main and vertex MAPS tracker
eRD22	TRD in forward region for enhanced e/h
eRD23	Streaming DAQ
eRD24	AC-LGAD sensors for Roman Pots and B0
eRD25	Merger of eRD16 and eRD18 covering Si tracker
eRD27	High Resolution ZDC
eRD29	AC-LGAD barrel ToF for enhanced PID

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THE COMPLETE DETECTOR



Central Detector (CD)

Total size detector: ~75m

Central detector: ~10m

Backward electron detection: ~35m

Forward hadron spectrometer: ~40m

Auxiliary detectors needed to tag particles with very small scattering angles both in the **outgoing lepton** and **hadron beam** direction (B0-Taggers, Off-momentum taggers, Roman Pots, Zero-degree Calorimeter and low Q2-tagger).

FAR FOR/BACKWARD

Far Forward

Far Backward

Figure: Low- Q^2 taggers

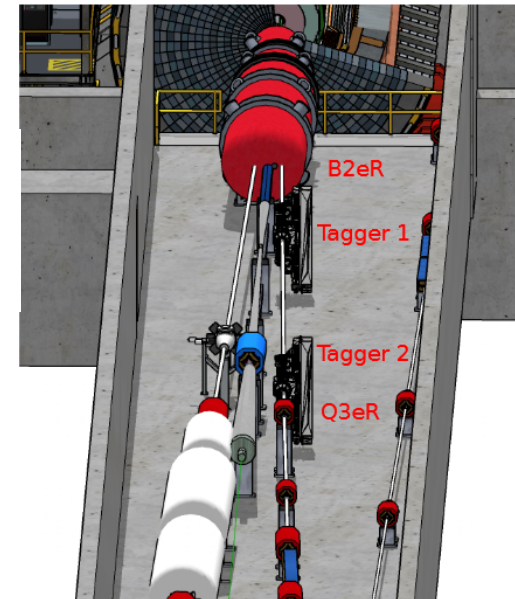
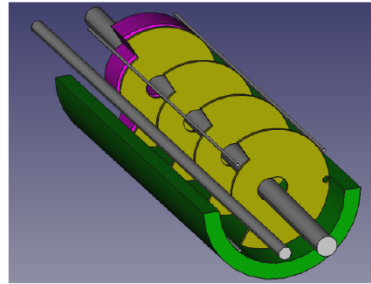
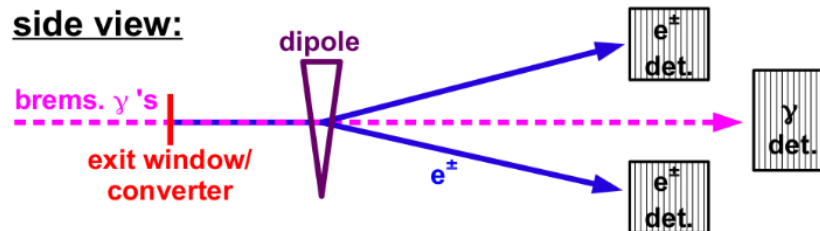


Figure: Luminosity detector



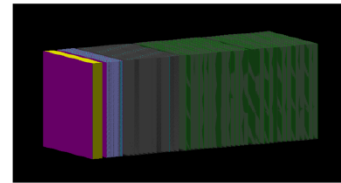
Roman Pots

ZDC

Off Momentum

Hadron Beam after IP

ZDC



B1apf Dipole

B1pf Dipole

Q2bpf quadrupole

Q1pf quadrupole

Q1apf quadrupole

B0apf Diople

B0pf Diople

(Joint) Working Groups

Key role in the consolidation/optimization process

	WG	Conveners			
Transversal WGs	Global Detector Optimization	Richard Milner	Jin Huang	Thomas Ullrich	Silvia Dalla Torre
	Simulation production and QA	Joe Osborn	Wenliang (Bill) Li	Zhoudunming (Kong) Tu	Wouter Deconinck
	Computing and Software	Cristiano Fanelli	David Lawrence	Sylvester Joosten	Andrea Bressan
	DAQ / Electronics / Readout	Chris Cuevas	Jo Schambach	Alexandre Camsonne	Landgraf Jeff
Detector WGs	Tracking	Xuan Li	Kondo Gnanvo	Laura Gonella	Francesco Bossu
	Calorimetry	Friederike Bock	Carlos Munoz Camacho	Oleg Tsai	Paul Reimer
	PID Cherenkov	Xiaochun He	Grzegorz Kalicy	Tom Hemmick	Roberto Preghenella
	PID ToF	Wei Li	Constantin Loizides	Franck Geurts	Zhenyu Ye
	Far Forward	Michael Murray	Yuji Goto	Jentsch Alex	John Arrington
	Far Backward	Igor Korover	Nick Zachariou	Krzysztof Piotrkowski	Adam Jaroslav
Physics WGs	Inclusive Physics	Tyler Kutz	Claire Gwenlan	Barak Schmookler	Paul Newman
	Jets and Heavy Flavor	Cheuk-Ping Wong	Wangmei Zha	Miguel Arratia	Page Brian
	Exclusive, Diffraction, & Tagging	Axel Schmidt	Rachel Montgomery	Spencer Klein	Daria Sokhan
	Semi-Inclusive Physics	Ralf Seidl	Charlotte Van Hulse	Anselm Vossen	Marco Radici
	BSM & precision EW	Xiaochao Zheng	Sonny Mantry	Furletova Yulia	Ciprian Gal

Hot items in consolidation/optimization

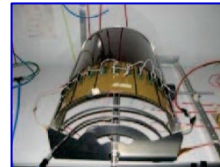
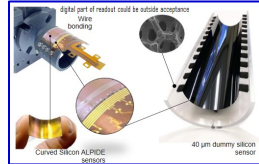
An introductory list (much more during the DETECTOR-1 meeting)

- ❑ Optimization of barrel tracking
 - Achieve a realistic, low-mass design with good performance
 - MPGD selection (μ RWell / MM)
- ❑ Reference design did not include backward HCAL
 - Is there a strong physics justification?
- ❑ The two barrel EMCal solution imply a different physics emphasis
- ❑ AC-LGADs are new, unproven technology
 - Potential for risk-reduction
- ❑ PID in backward region (two competing technologies)
- *This process must be driven by the physics performance based on a holistic approach*
- *Integration aspects also to be considered*
- *Iterative process toward optimization*

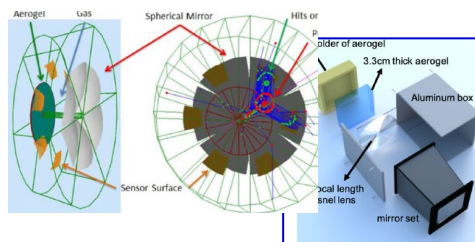
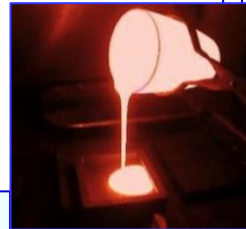
R&D NEEDS

A SUMMARY

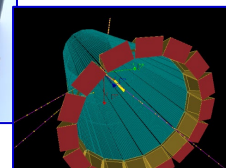
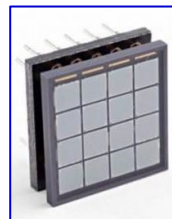
- MAPS, ITS3
- MAPS, ITS3 stich sensor version
- 2-D read-out of MPGDs
- Cylindrical μ RWELL



- SciGlass, large blocks



- dRICH
- mRICH
- hpDIRC



- SiPMs
- LAPPDs



The new EIC R&D program (2022)

ID	Subject	Funding
eRD101	mRICH	yes
eRD102	dRICH	yes
eRD103	hpDIRC	yes
eRD104	Service reduction MAPS	yes
eRD105	SciGlass	yes
eRD106	Forward EMCAL	no/delayed
eRD107	Forward HCAL	no/delayed
eRD108	Cylindrical & Planar MPGD	yes
eRD109	ASICs/Electronics	no/delayed
eRD110	Photosensors	yes
eRD111	Si-Tracker/no sensors	yes
eRD112	AC-LGAD	yes

Put on hold, until technology choices become clearer

Put on hold, not enough details to start ASIC development yet

OUTLOOK

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THE FIRST STEP TOWARDS A NEW COLLABORATION

An interim body established by the PM: the SC

About us: Fully conscious that we are merely a temporary body

- **YES, we come from different background and detector concepts**
- **We are completely united in the goal to realize the EIC detector and the EIC science program at BEST**
 - We have succeeded (with some initial effort) in building-up an effective, working relationship that is based on mutual trust and respect
- The progress in the Collaboration formation process and related timelines are testifying the above

*→ We ask you to trust in **our dedication to the goal** and to work with us till (in a few months, as shown by timelines) you Collaborators will be guided by your (our) elected representatives*

COLLABORATION STEP & TIMELINES



Vision of Collaboration Forming Process

17

□ Vision for a collaboration forming process:

- Institutional Survey: Next slide!
- Formation of a ~~prelim. IB~~ (inst. representatives)
- Nomination & Formation of Bylaws/Charter Committee
- Formulation & Adoption of Bylaws/Charter
- Nomination & Election Process of Detector 1 Leadership

Elected
at the
same
time!

- Finalization of IB and Election of IB Chair
- Election of Spokesperson(s)

EIC Detector 1 Institutional Survey Form

Timescale:

Done

ASAP

Now -> JULY

EICUG Meeting
Discussion
(approval following
mtg)

Set by adoption of
bylaws – perhaps
Sept/Oct?

NOW

End
JULY

End
AUG

End SEP
/15 OCT

INSTITUTIONAL SURVEY

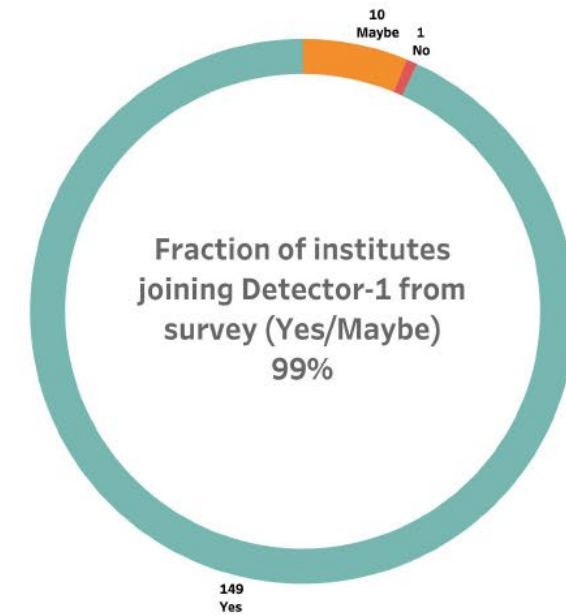
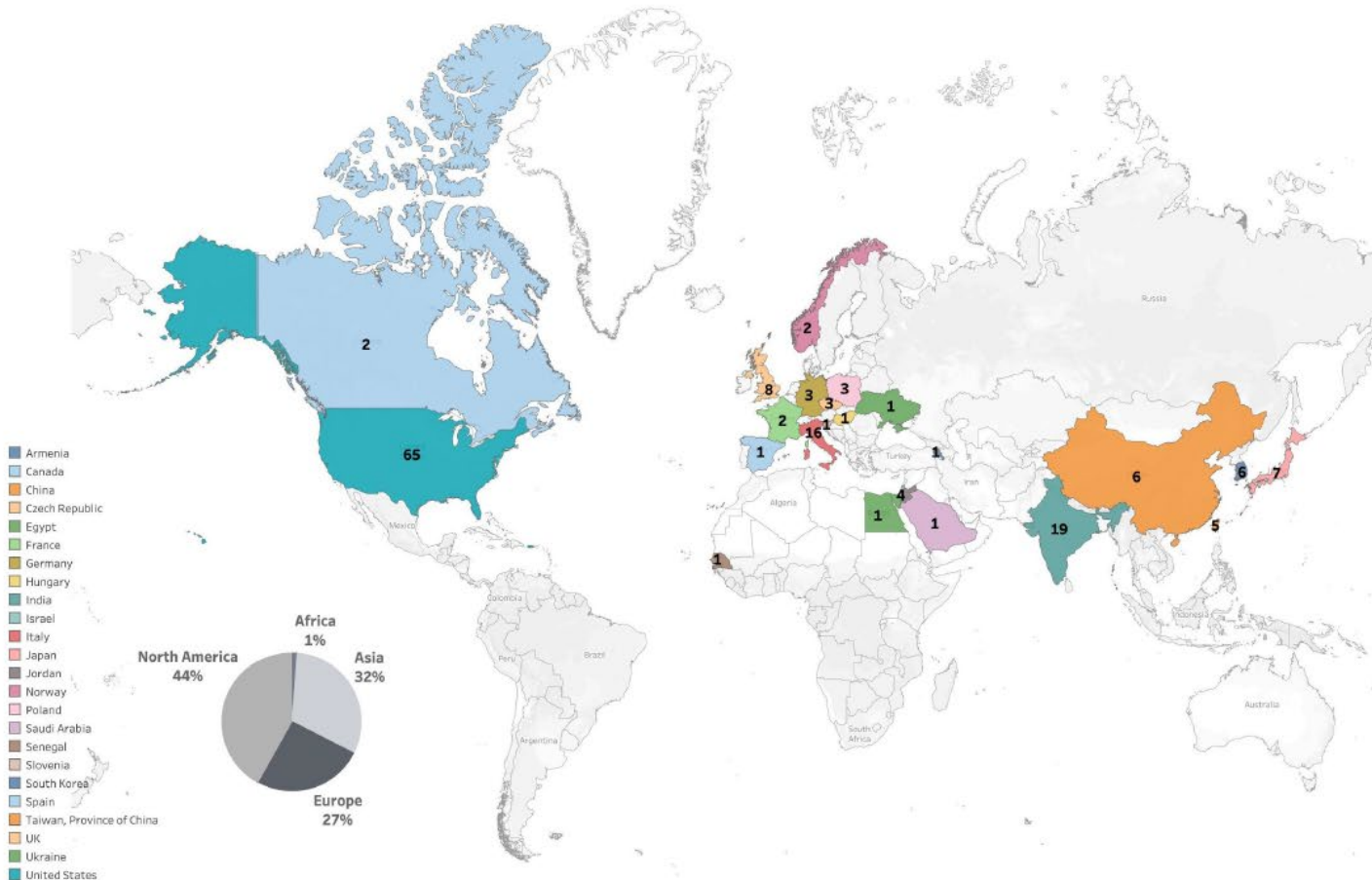
Some hints (much more during the DETECTOR-1 meeting)

Detector-1 - A **global** pursuit for a new EIC experiment at IP6 at BNL

Detector-1 Institutions
160

Detector-1 Countries
24

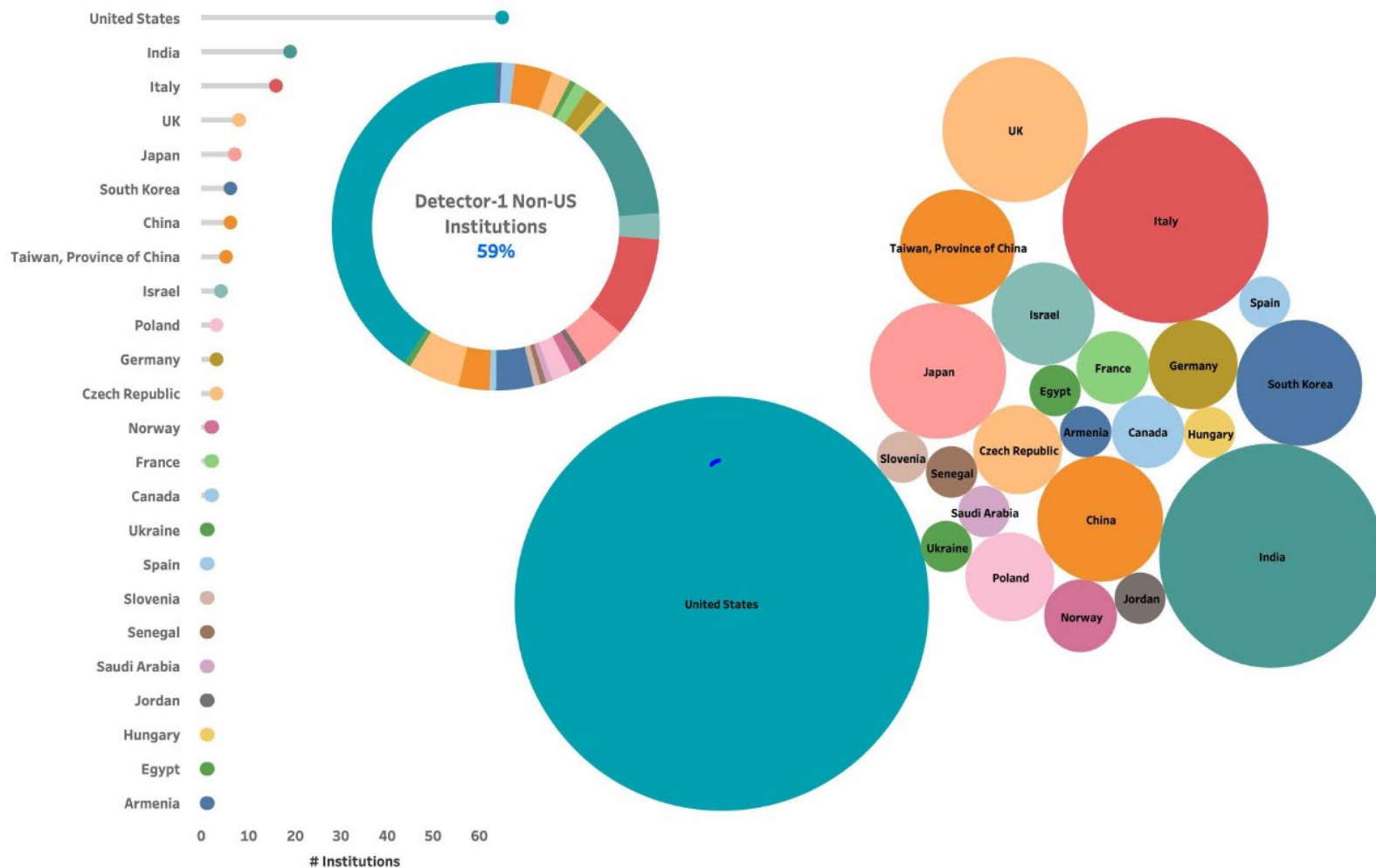
Detector-1 World Region
4



INSTITUTIONAL SURVEY

Some hints (much more during the DETECTOR-1 meeting)

Detector-1 - A **global** pursuit for a new EIC experiment at IP6 at BNL



MORE TOWARDS STRUCTURING THE COLLABORATION

Some hints (much more during the DETECTOR-1 meeting)

Selection of the collaboration name

- *More news later today !*

First meeting of the Institutional Representatives on July 18

- *A representative per Institution for all the Institutions which submitted the survey form*

Goals:

- *Prepare the formation of the collaboration Bylaws/Charter*
- *Prepare and conduct the Bylaws/Charter approval process*

IMPORTANT:

- *the SC will in no way steer the IRs: it is a green field on which the IRs themselves will build-up*
- *2 experienced Colleagues have kindly accepted to facilitate the organization of the IR meetings:*

Victoria Greene (Vanderbilt U.)
Franck Sabatié (CEA/Saclay)

THANK YOU !



SUMMARIZING

- The “Detector-1” Collaboration effort has kicked-off:
 - Ongoing WG meetings focused on consolidation and developing technical design for CD-2/3A
 - EIC detectors are an enormous undertaking that will require participation and expertise from both the RHIC and Jlab communities, the US academia as well as key international contributions!
 - In parallel, a new Collaboration being formed and structured
- *It is NOW the right time to join
the effort and get involved !*
- *Have exciting perspectives with us designing
and building DETECTOR-1*



THANK YOU