EIC, CERN working group, JENAS/JENAA

Ignazio Scimemi

IPARCOS meeting, 16-17/06/2022

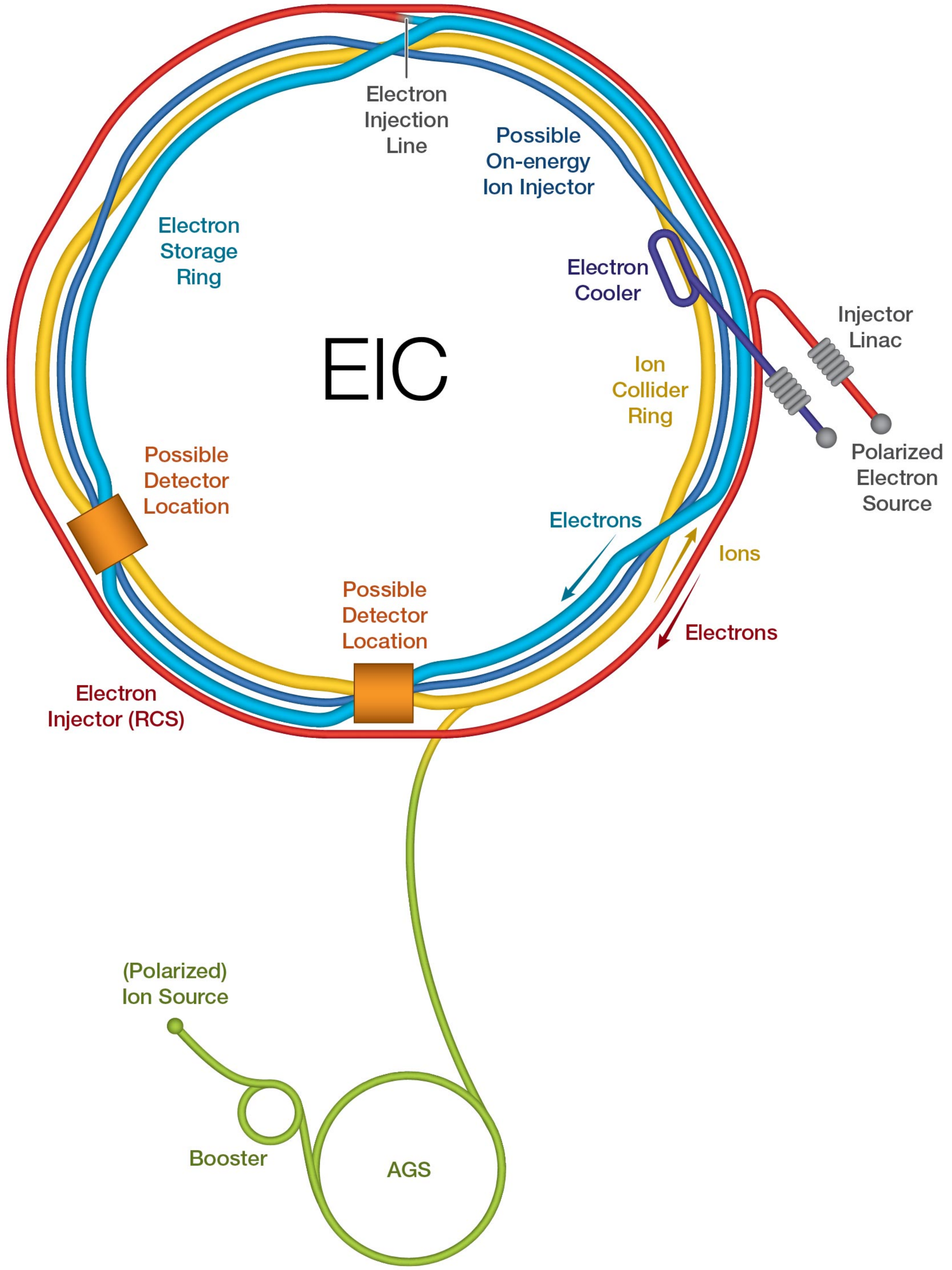
International activity: some examples

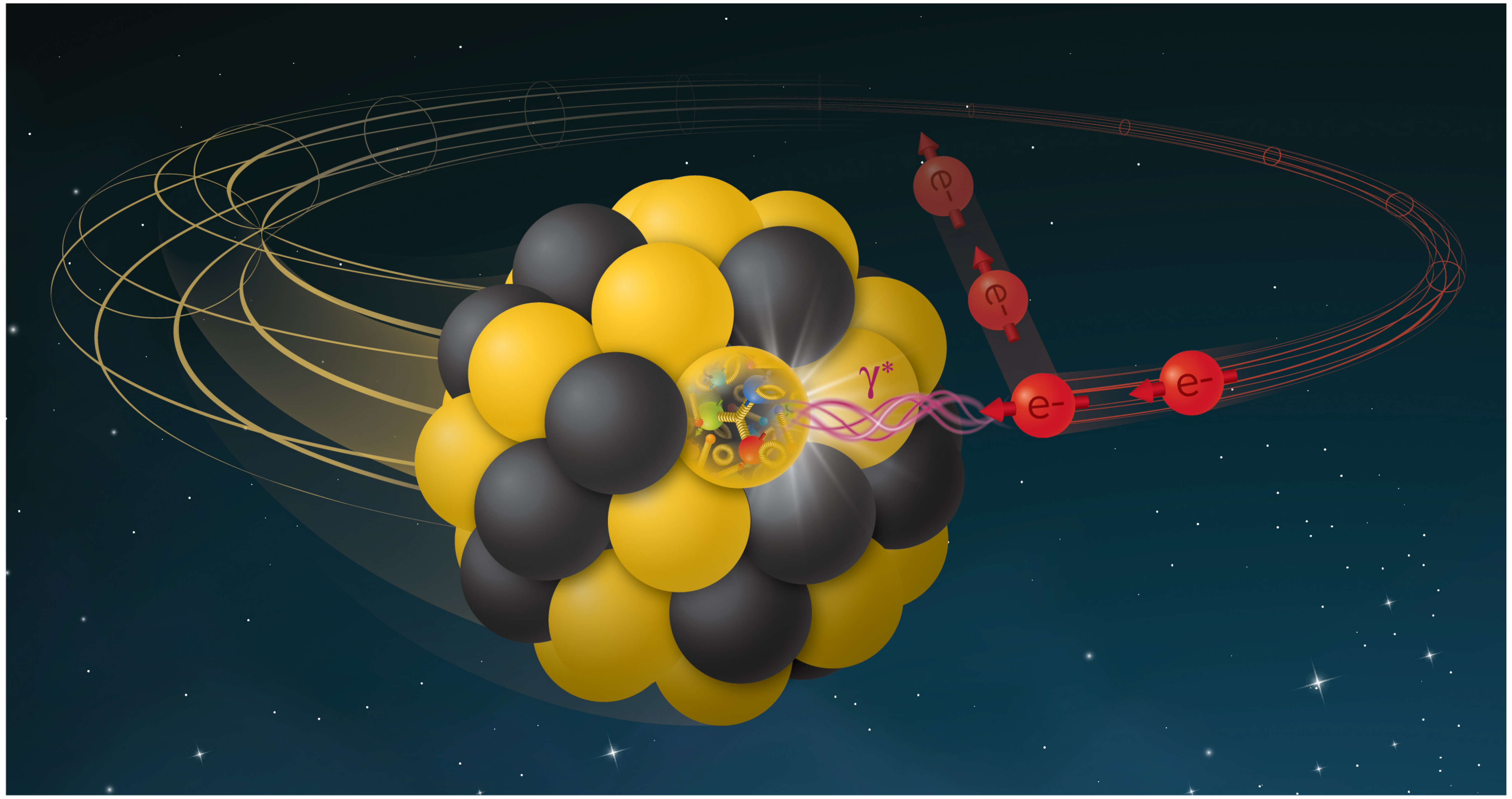
- It is important that IPARCOS participate to international activities as IPARCOS. Up to now we have only single group participations. This can be enlarged.

  - **Electron Ion Collider (A. Vladimirov, I.S.)**
  - **CERN working group (A. Vladimirov, I.S.)**
  - **JENAS/JENAA (L. M. Fraile (+I.S.))**

Electron Ion Collider at BNL

https://www.bnl.gov/eic/





EIC Detector Proposals

- **ATHENA Detector Proposal - A Totally Hermetic Electron Nucleus Apparatus (December 2021)**
- **CORE - a COmpact detectoR for the EIC (December 2021)**
- **ECCE - EIC Comprehensive Chromodynamics Experiment (December 2021)**
-

SCIENCE REQUIREMENTS AND DETECTOR CONCEPTS FOR THE ELECTRON-ION COLLIDER

EIC Yellow Report

https://arxiv.org/pdf/2103.05419

Science:

3D hadron imaging
Gluon saturation
Hadron Spectroscopy
Jets
New Physics

EIC User Group at IPARCOS:
Alexey Vladimirov
Ignazio Scimemi

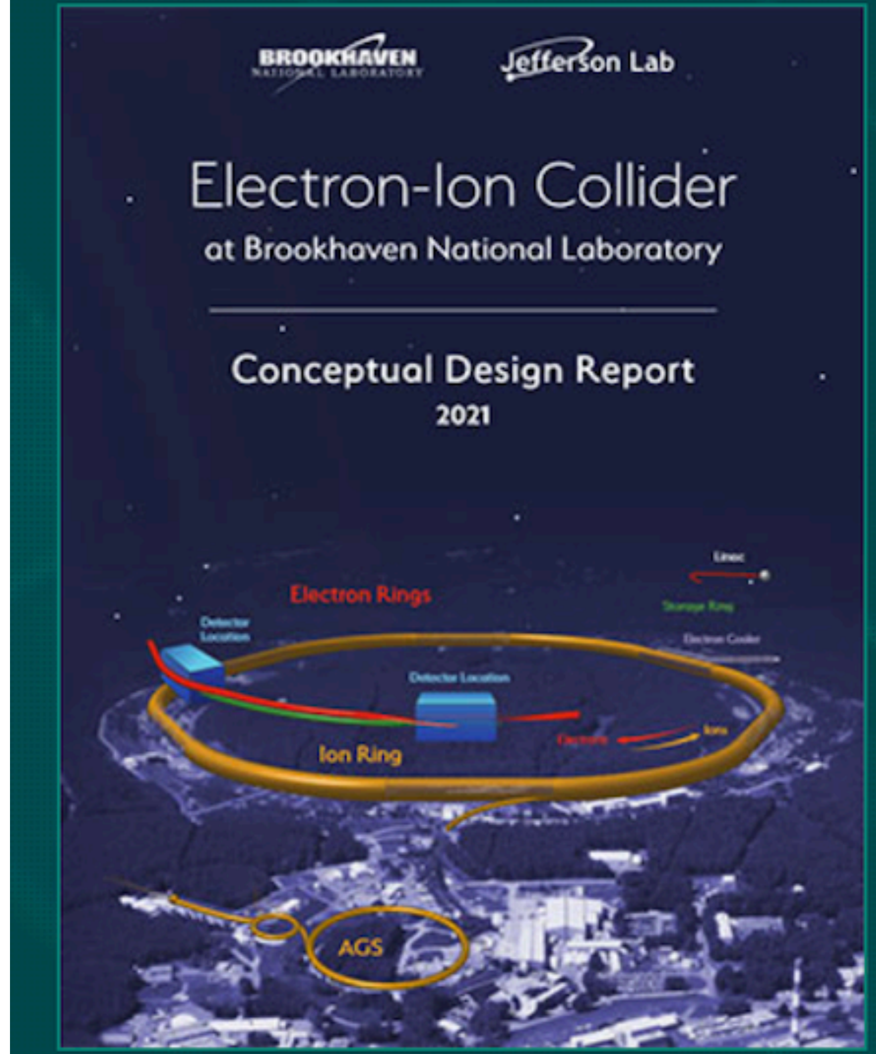
Species	p	e	p	e	p	e	p	e	p	e
Beam energy [GeV]	275	18	275	10	100	10	100	5	41	5
$\sqrt{s}$ [GeV]	140.7		104.9		63.2		44.7		28.6	
No. of bunches	290		1160		1160		1160		1160	
	High divergence configuration									
RMS $\Delta\theta$, h/v [μrad]	150/150	202/187	119/119	211/152	220/220	145/105	206/206	160/160	220/380	101/129
RMS $\Delta p/p$ [10^{-4}]	6.8	10.9	6.8	5.8	9.7	5.8	9.7	6.8	10.3	6.8
Luminosity [10^{33}cm^{-2}s^{-1}]	1.54		10.00		4.48		3.68		0.44	
	High acceptance configuration									
RMS $\Delta\theta$, h/v [μrad]	65/65	89/82	65/65	116/84	180/180	118/86	180/180	140/140	220/380	101/129
RMS $\Delta p/p$ [10^{-4}]	6.8	10.9	6.8	5.8	9.7	5.8	9.7	6.8	10.3	6.8
Luminosity [10^{33}cm^{-2}s^{-1}]	0.32		3.14		3.14		2.92		0.44	

Table 10.1: Beam parameters for e+p collisions for the available center-of-mass energies $\sqrt{s}$ with strong hadron cooling. Luminosities and beam effects depend on the configuration. Values for high divergence and high acceptance configurations are shown.

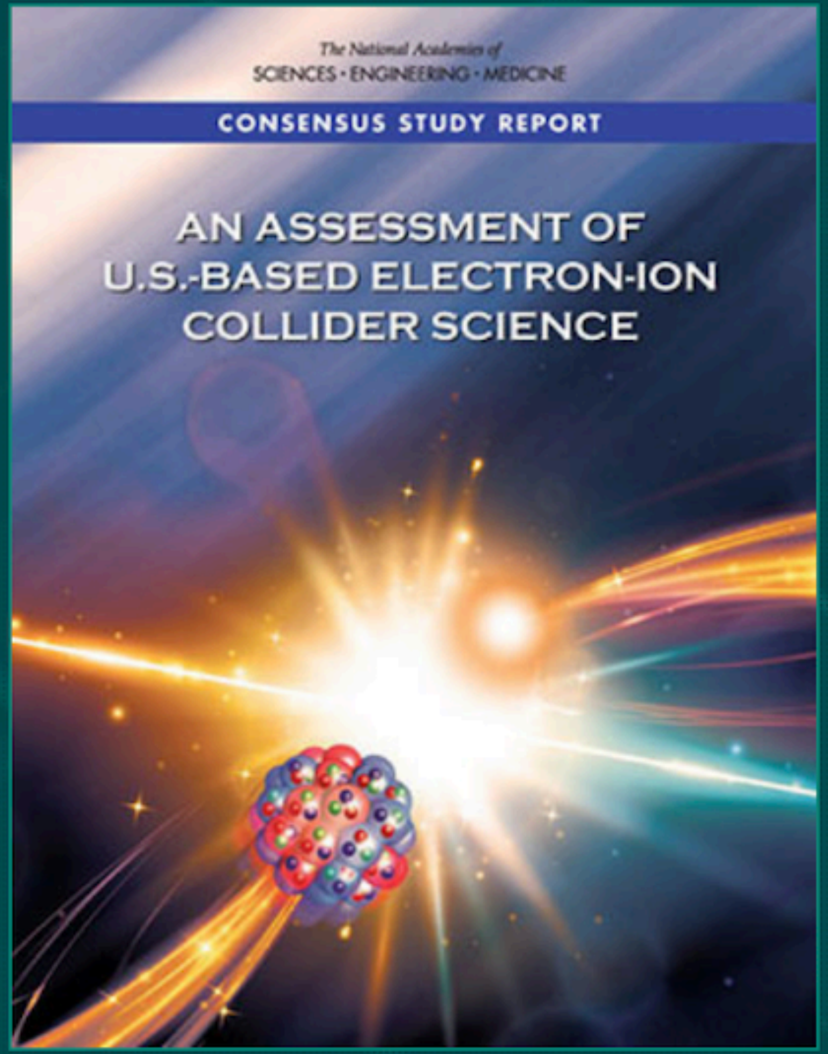
Species	Au	e	Au	e	Au	e	Au	e
Beam energy [GeV]	110	18	110	10	110	5	41	5
$\sqrt{s}$ [GeV]	89.0		66.3		46.9		28.6	
No. of bunches	290		1160		1160		1160	
	Strong hadron cooling							
RMS $\Delta\theta$, h/v [μrad]	218/379	101/37	216/274	102/92	215/275	102/185	275/377	81/136
RMS $\Delta p/p$ [10^{-4}]	6.2	10.9	6.2	5.8	6.2	6.8	10	6.8
Luminosity [10^{33}cm^{-2}s^{-1}]	0.59		4.76		4.77		1.67	
	Stochastic cooling							
RMS $\Delta\theta$, h/v [μrad]	77/380	109/38	136/376	161/116	108/380	127/144	174/302	77/77
RMS $\Delta p/p$ [10^{-4}]	10	10.9	10	5.8	10	6.8	13	6.8
Luminosity [10^{33}cm^{-2}s^{-1}]	0.14		2.06		1.27		0.31	

Table 10.2: Beam parameters for e+Au collisions for the available center-of-mass energies $\sqrt{s}$. Luminosities and beam effects depend on the cooling technique. Values for strong hadronic and stochastic cooling are shown.

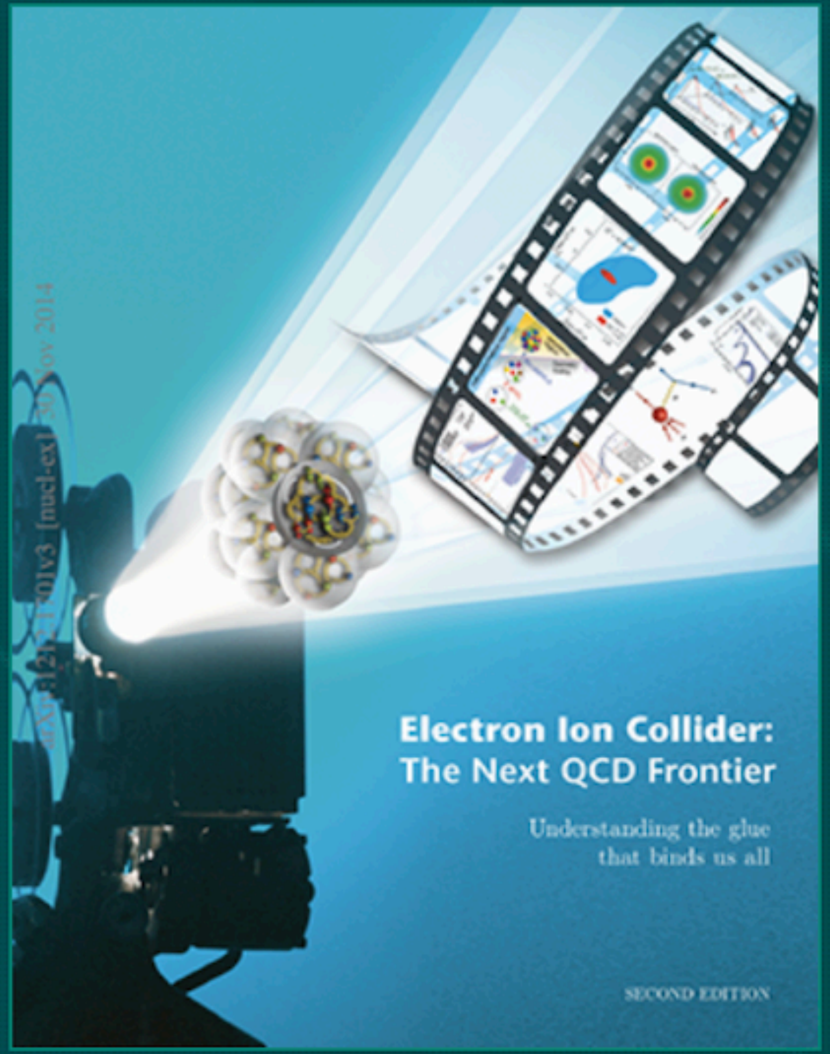
EIC Studies and Reports



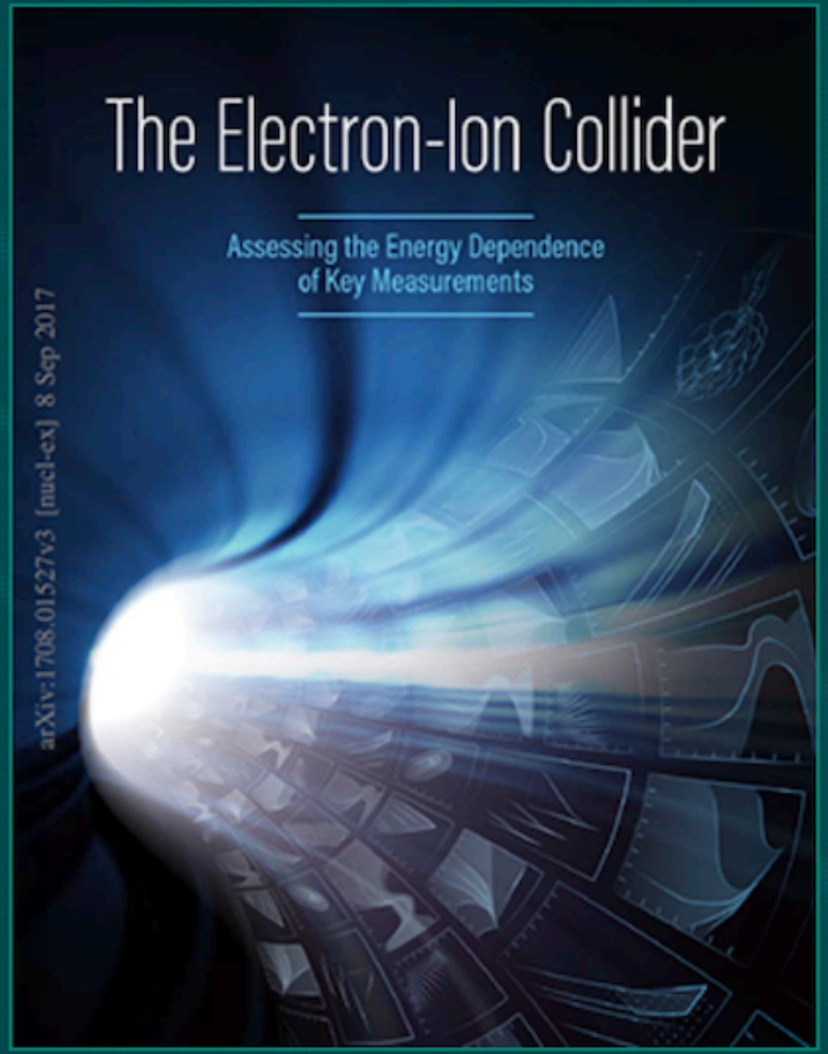
Conceptual Design Report for the Electron-Ion Collider (PDF, 170 Mb)



An Assessment of U.S.-Based Electron-Ion Collider Science



Electron-Ion Collider: The Next QCD Frontier (PDF)



The Electron-Ion Collider: Assessing the Energy Dependence of Key Measurements (PDF)

Benefits Beyond Physics

Beyond sparking scientific discoveries in a new frontier of fundamental physics, building the EIC will also trigger broader benefits for society. Research on the technologies needed to make the EIC a reality is already pushing the evolution of magnets and other particle accelerator components. Some of these advances could lead to energy-efficient accelerators, thereby dramatically shrinking the size and operating costs of future accelerators used across science and industry to:

- Make and test computer chips
- Attack cancer cells
- Design solar cells, batteries, catalysts
- Develop drugs and medical treatments
- Produce radioisotopes for diagnosis and treatment

LHC-EW working group

- The objective is to perform a benchmark of different group for the Z-boson production transverse momentum distributions.

- The Z-boson spectrum precise analysis is essential for the extraction of the W-mass at percent precision. This parameter is used for BSM searches

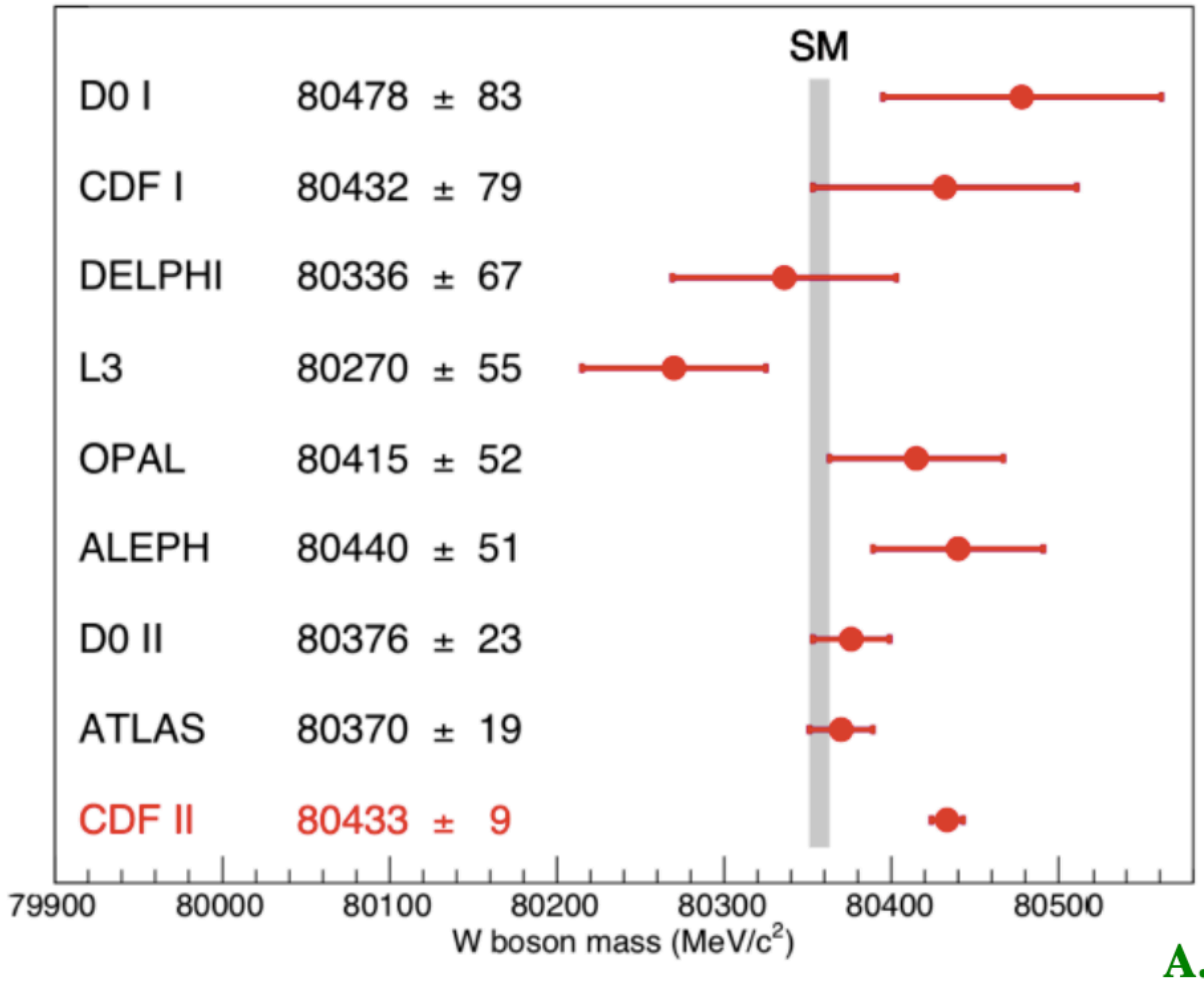


Fig. 5

A. Kotwal

A. Kotwal

SM expectation: $M_W = 80{,}357 \pm 4_{inputs} \pm 4_{theory}$ (PDG 2020)

LHCb measurement : $M_W = 80{,}354 \pm 23_{stat} \pm 10_{exp} \pm 17_{theory} \pm 9_{PDF}$ [*JHEP* **2022**, 36 (2022)]

LHC-EW working group

Resummation benchmarking

- Different approaches to resummation
- Benchmarking to understand their differences, uncertainties, and accuracy
  - Had never been done before!

- q_T resummation
  - DYRes/DYTURBO — Camarda et al., '19
  - reSolve — Coradeschi, T.C., '17
- TMD
  - NangaParbat — Bacchetta et al., '19
  - arTeMiDe — Scimemi, Vladimirov, '17
- SCET
  - SCETLib — Ebert et al. '17
  - (CuTe) — Becher et al. '11,'20
- Parton Shower-like/Branching
  - RadISH — Monni et al. '16,'17
  - (PB-TMD) — Martinez et al. '20

Many groups, well spread across the several different approaches.

https://indico.cern.ch/event/941711/contributions/4045710/attachments/2118956/3565814/Resummation_Status_report.pdf

LHC-EW Benchmark

	Sudakov/ Resummation	Non-Sudakov	Matching	Non-perturbative
arTeMiDe	Q	μ_{OPE}	No level 3	f_{NP}
Cute-MCFM	μ, μ_h, r	μ_R, μ_F (?)	Parameters of damping func. (?)	-
DYTURBO	Q	μ_R, μ_F	Parameters of Damping func.	f_{NP} (?)
NangaParbat	Q, μ_b	μ_R, μ_F	Still none (damping func.)	f_{NP}
RadISH	Q	μ_R, μ_F	Parameters of Damping func.	f_{NP} (?)
ResBos	C_1, C_2, C_3	μ_R, μ_F (?)	Parameters of damping func. (?)	f_{NP} (?)
Resolve	μ_S	μ_R, μ_F	No level 3 (?)	f_{NP} (?)
SCETlib	Δ_{resum}	Δ_{FO}	Profile scales Δ_{match}	(Cutoff variations) Δ_{Λ}

- This categorisation should help us produce comparisons for uncertainties:
  - at low q_{T} for level 2 (*e.g.* $q_{\mathrm{T}} < 40$ GeV),
  - over the full range ($q_{\mathrm{T}} < 100$ GeV) for level 3.

JENAA

Joint ECFA-NuPECC-APPEC Activities

JENAS Expressions of Interest

List of submitted EoI:

1. Dark Matter - iDMEu (https://indico.cern.ch/event/869195/overview)
2. Gravitational Waves for fundamental physics (https://agenda.infn.it/event/22947/overview)
3. Machine-Learning Optimized Design of Experiments - MODE (https://userswww.pd.infn.it/~dorigo/MODE.html)
4. Nuclear Physics at the LHC (https://indico.ph.tum.de/event/4492/)
5. Storage Rings for the Search of Charged-Particle Electric Dipole Moments (EDM) (https://indico.ph.tum.de/event/4482/overview)
6. Synergies between the Electron-Ion Collider and the Large Hadron Collider experiments (https://indico.ph.tum.de/event/7004/)

EoIs in the form of a brief letter are to be submitted to the chairs of the committees/consortia. In the letter you can elaborate on the synergy topic, the objectives, the initial thoughts and the potential communities involved. This letter is not the end of the process, but potentially the start of further communications on the expressed interest.

Recognition Working Group

The aim of this ECFA-NuPECC-APPEC working group is to find ways to improve the recognition of individual achievements in large collaborations.

- Key objectives of this working group:
  - create awareness,
  - initiate discussions inside collaborations,
  - exchange and discuss best practices among all three communities, and reflect on alternative or additional procedures,
  - potentially perform a second survey in 2020-2021 to monitor the progress on the topic,
  - however, the group will not be an ombuds-committee for individual problems.
- Report back to ECFA-NuPECC-APPEC
- The collaborations remain themselves responsible for the actions of the working group and to implement (or not) recommendations

The working group was installed in July 2019 in Ghent. It continues previous work by ECFA, which among other activities performed a community-wide survey in 2018.

List of participating collaborations

The WG contacted large collaborations (> 40 authors) and received feedback from the following collaborations:

- **ECFA (14)**

  Atlas, BelleII, Calice, Cast, Cloud, Dune, CMS, Compass, Dirac, LHCb, NA61/SHINE, NA62, Solid, T2K

- **NuPECC (21)**

  ACTAR-TPC, AGATHA, ALICE, BM@N, CBM, CLAS, CRIS, Mass measurement program at GSI/FAIR, Galileo, HADES, HISPEC/DESPEC, IDS, Isolde, JEDI, MATS/Laspec, Miniball, MPD, nTOF, NUMEN, NUSTAR, PANDA, R3B

- **APPEC (34)**

  AMS, Antares, Auger, Baikal GVD, Borexino, CALET, CTA, CUORE, DAMIC, DarkSide, Darwin, DEAP, Edelweiss, ET, EUCLID, Fermi-LAT, Gerda, IceCube, Juno, Katrin, Km3NeT, Legend, LIGO, LISA, LSST, MAGIC, Pamela, SNO+, Virgo, XENON, HESS, HAWC, JEM-EUSO, LHAASO

...Eppur si muove....

Galileo Galilei