BI-WEEKLY MEETING
30 August 2021

Or Hen, Tanja Horn, John Lajoie

Credit to the entire ECCE Team, EIC Project, and all collaborators

ECCE 30 August Meeting Agenda

- Introduction and overview
- The Teams will present their updates
- Next steps: important discussion about the timeline and path forward towards the proposal

12th ECCE Bi-Weekly Meeting

Monday 30 Aug 2021, 16:00 → 21:20 US/Eastern

Description **Connection Information:**

Please click this URL to start or join. https://iastate.zoom.us/j/93573804511?pwd=V0RGRTUvaStNNDcvc3FiYWJqZS9rdz09
Or, go to https://iastate.zoom.us/join and enter meeting ID: 935 7380 4511 and password: 668209

16:00 → 16:30 **ECCE News and Status**
Speaker: Tanja Horn (Cath)

16:30 → 17:00 **Diversity, Equity and Inclusion**

16:30 **DE&I Report**
Speakers: Christine Nattrass (University of Tennessee, Knoxville) , Elena Long (University of New Hampshire) , Marie BOER, simonetta liuti (universoty of virginia)

17:00 → 17:30 **Computing Team**

17:00 **Computing Team Report**
Speakers: Cristiano Fanelli (MIT) , David Lawrence (Jefferson Lab)

17:30 → 18:00 **Physics Benchmark Team**

17:30 **Physics Benchmark Team Report**
Speakers: Carlos Munoz Camacho (IJCLab-Orsay (France)) , Rosi Reed (Lehigh University)

17:45 **Discussion**

18:00 → 18:30 **Detector Team**

18:00 **Detector Team Report**
Speakers: Douglas Higinbotham (Jefferson Lab) , Kenneth Read (Oak Ridge National Laboratory)

18:15 **Discussion**

18:30 → 19:00 **Editorial Team**

18:30 **Editorial Team Report**
Speakers: Peter Steinberg (BNL) , Richard Milner (MIT) , Tom Cormier (ORNL)

ECCE Timeline

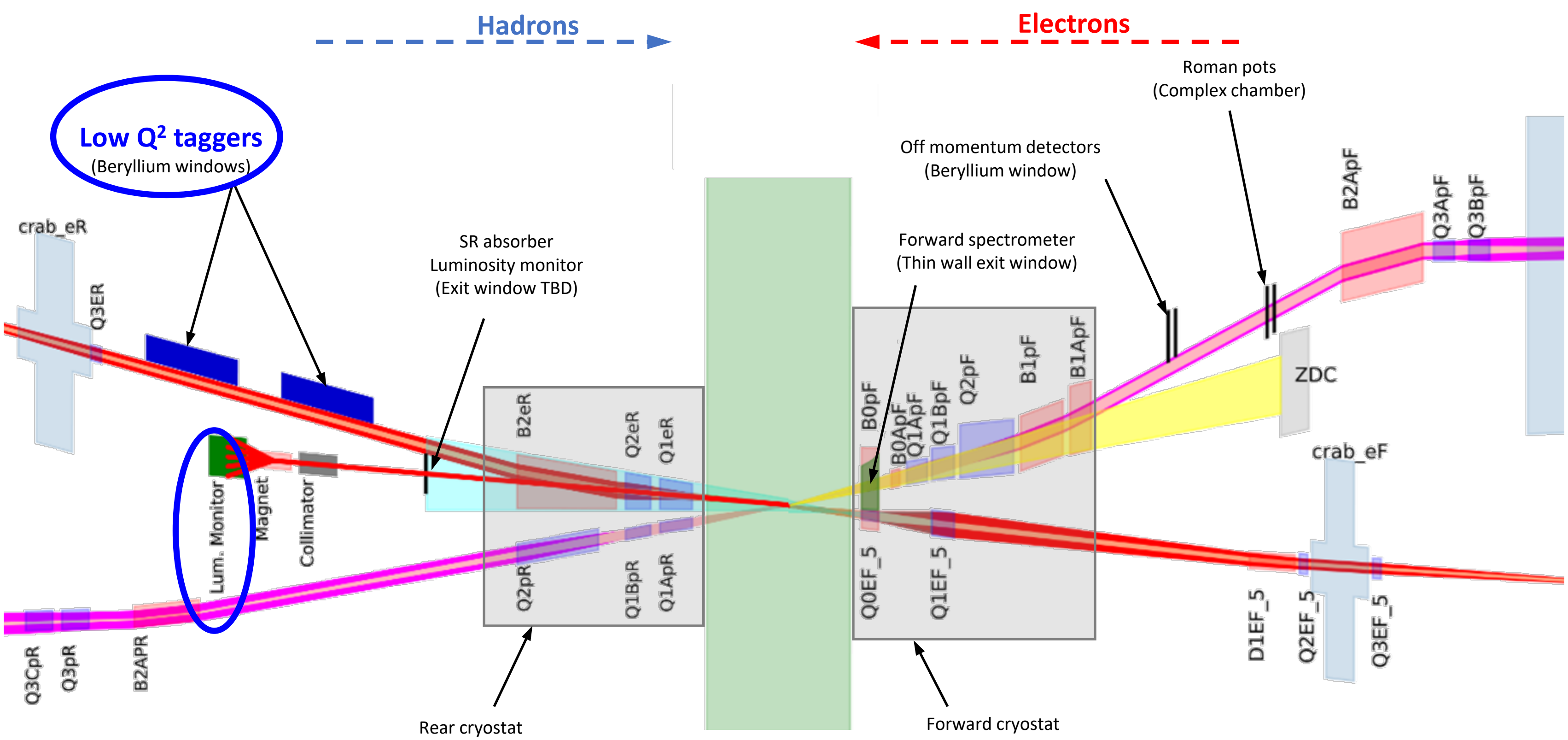
Today, 30 August

Tasks	Duration (months)	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Startup	**1.5**									
Implement ECCE setup in Fun4All										
Agree on technology alternatives to study										
Agree on main physics studies										
Arrange required event generators										
First simulation campain & initial analysis	**1.5**									
Optimize										
Midterm activities	**1**									
Large scale simulations production										
Drafting Collaboration Structure part of the proposal										
Analysis of simulation data	**1.5**									
demonstrate physics extraction										
Start of Proposal Writing	**1.5**									
All physics plots are done										
Agree on technology selection based on physics studies										
Compose narrative around simulation results and selected technologies										
Proposal Review and final edits	**1**									
Review by external colleagues										
Final edits										
Proposal Submission (1 Dec. 2021)										

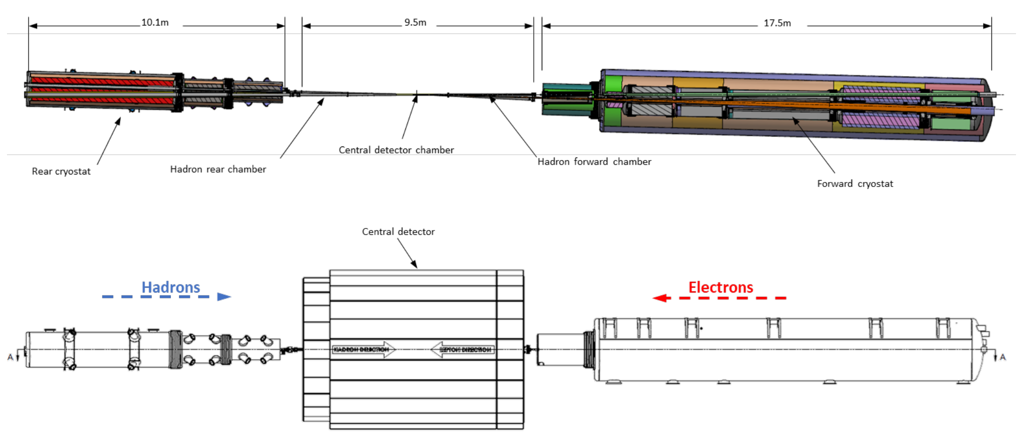
Start to pull things together and start writing

Refine ECCE detector technology selection

Extended ECCE detector integrated in IR



ECCE Far
Backward Scope



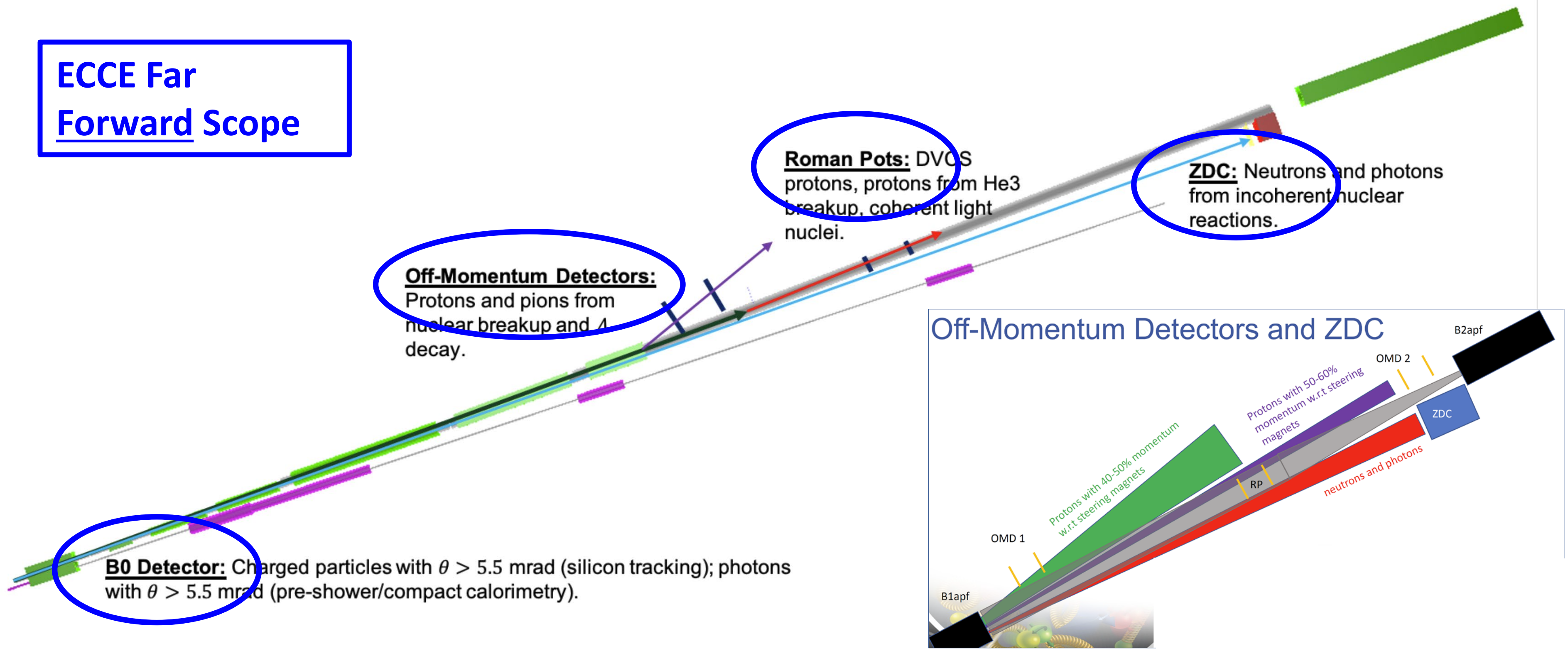
Extended ECCE detector integrated in IR

Concept is common with other detector proposals – technology choices may differ

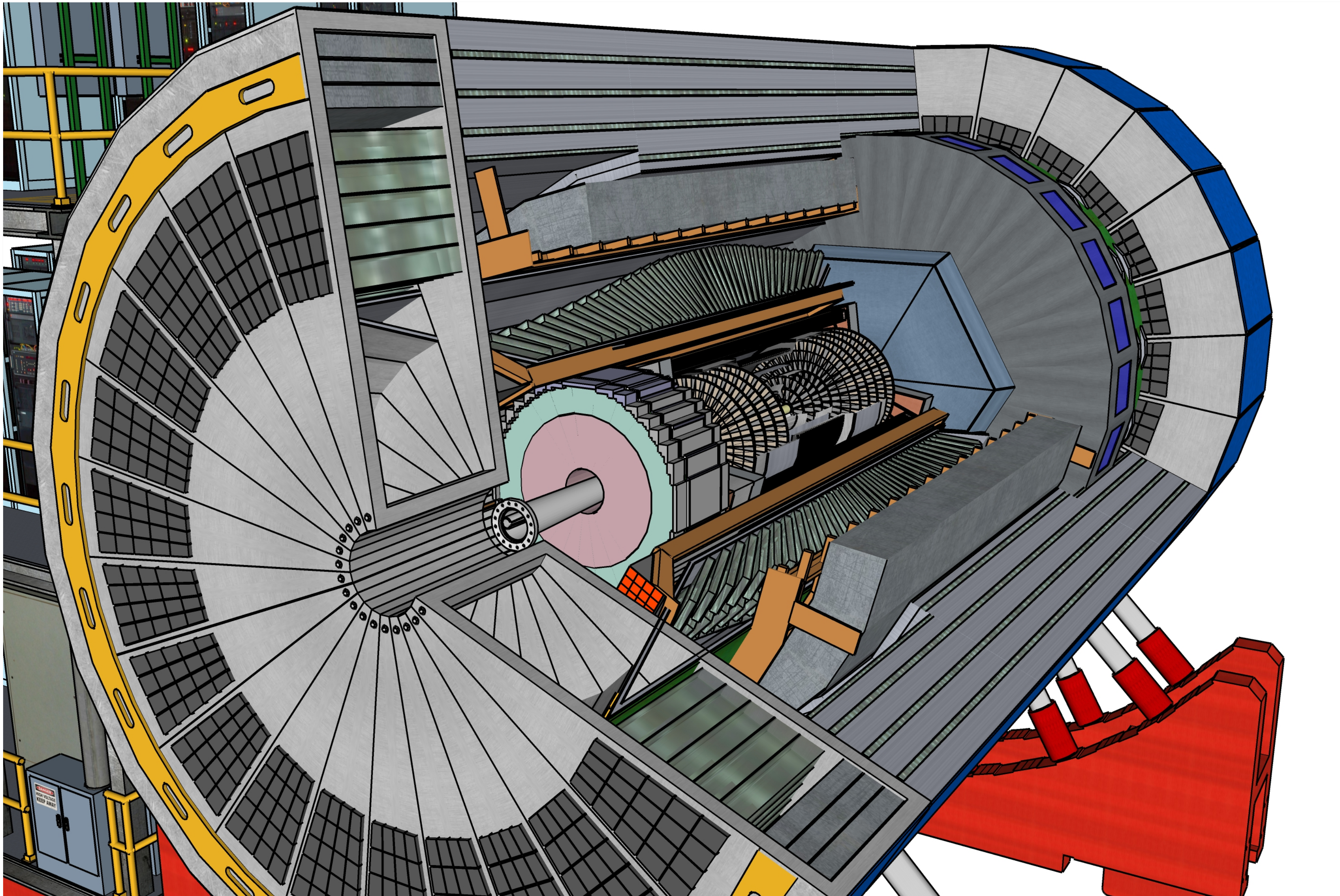
Process	Theta range (at top energy)	xL range	Detector (in IP6)
e+p DVCS	$0 < \theta < 5$ mrad	0.9 – 1.0	Roman Pots
e+d diffractive (spectator proton)	$0 < \theta < 5$ mrad (mostly up to 2 mrad)	0.45– 0.55	Roman Pots; OMD
e+d diffractive (struck proton)	$0 < \theta < 10$ mrad (up to 15 for the tails)	0.2 – 0.6 (sometimes higher)	OMD; B0 det.
e+He3 (spectator protons)	$0 < \theta < 10$ mrad	0.6 – 0.7	Roman Pots
e+Au	$0 < \theta < 10$ mrad	0.35 - 0.55	All three

From A. Jentsch at EIC PM+Proposal meetings (spring 2021)

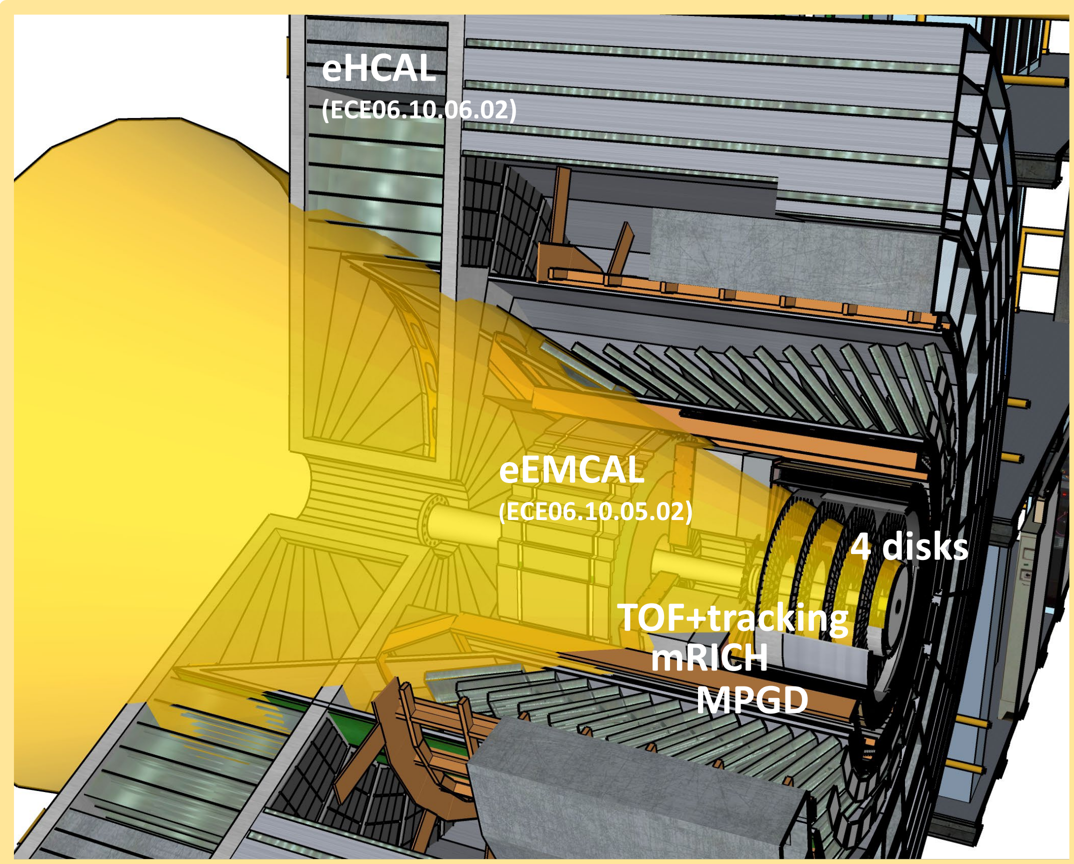
ECCE Far Forward Scope



ECCE Central Detector Concept



ECCE Central Detector Concept



Changes since initial ECCE concept:

- hpDIRC readout in backward region
- Extend projective barrel EMCal
- Move backward EMCal more inward, reduce number of Si disks from 5 to 4

ELECTRON ENDCAP

Tracking: MPGD (large area μRWell)
Electron Detection:
- reference: PbWO4 crystals (reuse some)
- VE: replace outer rings with SciGlass (backup PbGl)

h-PID: mRICH & TOF
HCAL: Fe/Sc (STAR re-use)

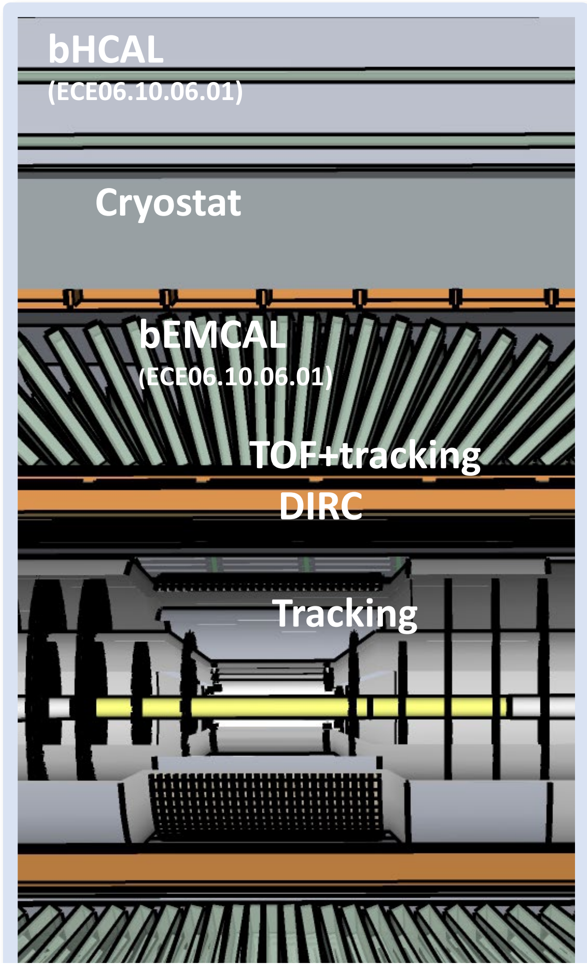
CENTRAL BARREL

Tracking: MAPS Si for vertexing and endcaps (design to be optimized)
Electron PID: SciGlass (alt: PbGl or W(Pb)/Sc shashlik) (plus instrumented frame)
h-PID: hpDIRC & TOF
HCAL: Fe/Sc (sPHENIX re-use)

HADRON ENDCAP

Tracking: MPGD (large area μRWELL)
PID: dual-RICH & TOF
Calorimetry:
- reference: standard W/ScFi shashlik (PHENIX re-use) for EMCal and long. sep. HCAL
- Alternative: dual readout

ECCE Central Detector Concept



Changes since initial ECCE concept:

- Tracking layers defined (2-3 Si vertex, 2 Si sagitta layer, GEM µRwell outer)
- ~5 cm for TOF (or upgrade option for AC-LGAD or LYSO/TOF) between hpDIRC and bEMCAL

ELECTRON ENDCAP

Tracking: MPGD (large area µRWell)
Electron Detection:
- reference: PbWO4 crystals (reuse some)
- VE: replace outer rings with SciGlass (backup PbGl)

h-PID: mRICH & TOF
HCAL: Fe/Sc (STAR re-use)

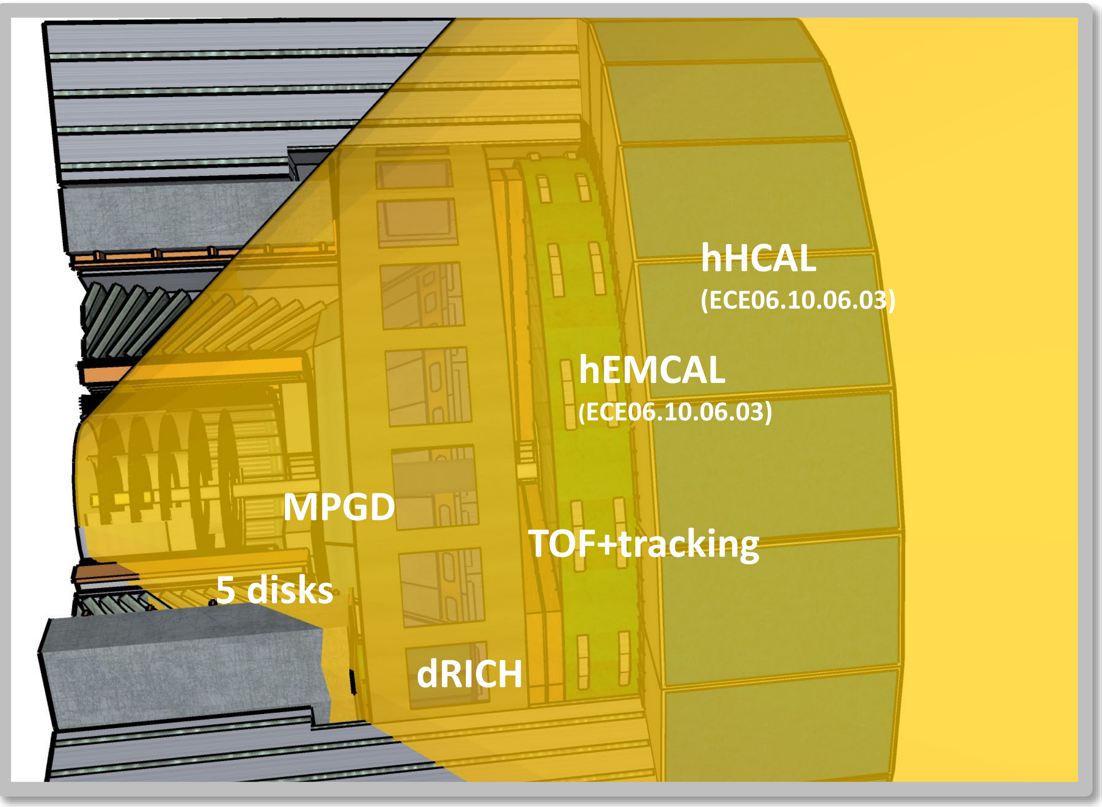
CENTRAL BARREL

Tracking: ITS3 based MAPS Si for vertexing, sagitta, and endcaps (optimization underway)
Electron PID: SciGlass (alt: PbGl or W(Pb)/Sc shashlik)
(plus instrumented frame)
h-PID: hpDIRC & TOF
HCAL: Fe/Sc (sPHENIX re-use)

HADRON ENDCAP

Tracking: MPGD (large area µRWELL)
PID: dual-RICH & TOF
Calorimetry:
- reference: standard W/ScFi shashlik (PHENIX re-use) for EMCal and long. sep. HCAL
- Alternative: dual readout

ECCE Central Detector Concept



<u>Changes since initial ECCE concept:</u>
- MPGD to aid tracking
- dRICH shape changed
- TOF: mRPC
- Longitudinal-segmented hHCAL

<u>ELECTRON ENDCAP</u>

Tracking: MPGD (large area μRWell)
Electron Detection:
- reference: PbWO4 crystals (reuse some)
- VE: replace outer rings with SciGlass (backup PbGl)

h-PID: mRICH & TOF
HCAL: Fe/Sc (STAR re-use)

<u>CENTRAL BARREL</u>

Tracking: MAPS Si for vertexing and endcaps (design to be optimized)
Electron PID: SciGlass (alt: PbGl or W(Pb)/Sc shashlik) (plus instrumented frame)
h-PID: hpDIRC & TOF
HCAL: Fe/Sc (sPHENIX re-use)

<u>**HADRON ENDCAP**</u>

Tracking: MPGD (**l**arge area μRWELL)
PID: dual-RICH & TOF
Calorimetry:
- reference: standard W/ScFi shashlik (PHENIX re-use) for EMCal and long. sep. HCAL
- Upgrade path: dual readout

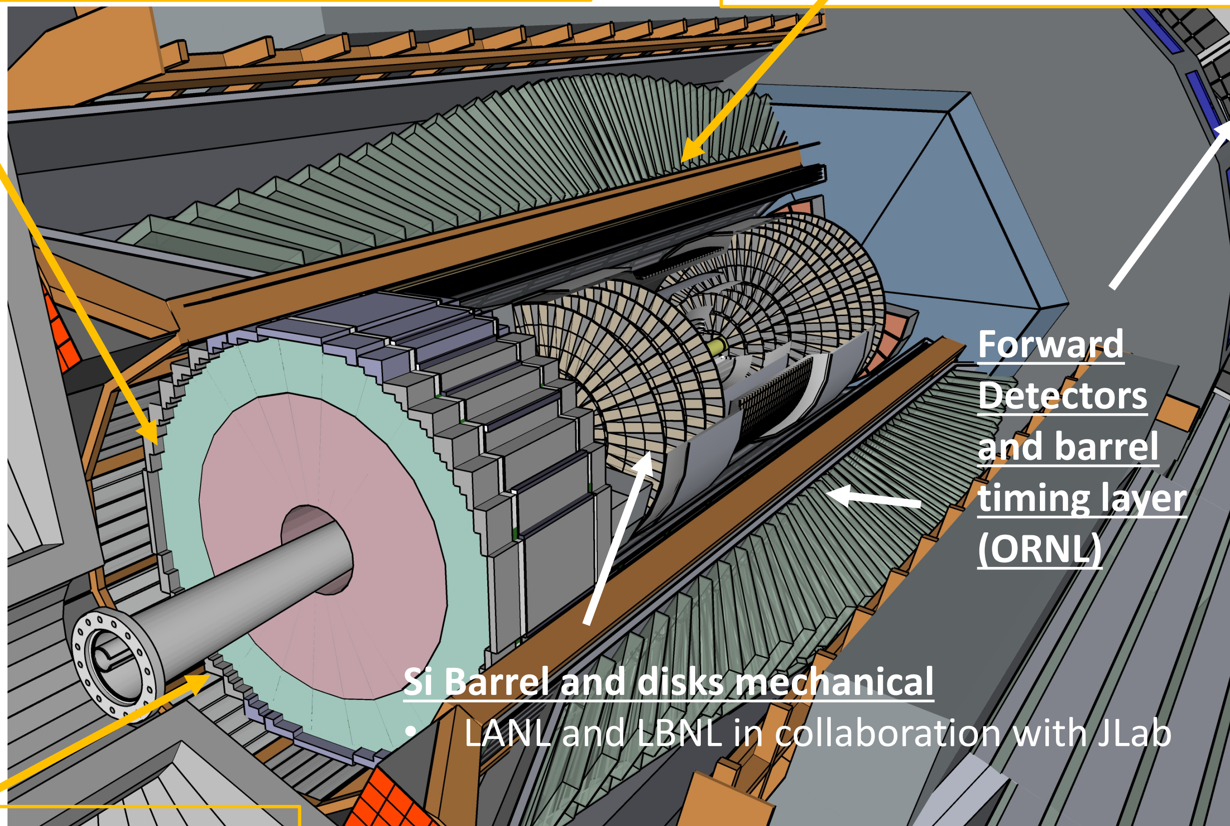
ECCE Last Remaining Issues to be Decided This Week

- ❑ 2-3 Si Vertex Layers
- ❑ Choice of TOF

Design/Engineering Activities and Integration

Electron Endcap EMCal
- Initial concept (Josh Crafts, CUA)
- Frame and cooling system (IJCLab-Orsay)

Barrel EMCal Support
- Various options EMCal (Josh Crafts, CUA)
- Impact on support structure and frame (MIT)



Evaluate available space and detector placement and supports

Next: integrate MPGD between Si and DIRC (work starting)

DIRC
- Re-use concept (CUA, GSI)
- Support structure (GSI)

EIC Project :
- Support for barrel EMCal and a universal frame that holds the DIRC and detectors "within" (backward EMCAl, mRICH, etc.)
- support of forward Hadron Calorimeter, and how to split it for maintenance mode, looking at similar for the backward HCal side.

ECCE Proposal – path forward

Contents

Starting point: collect information on key topics - AND think about ways to convey the information in a clear and concise way (and not a lot of text)

Example 1: ECCE Detector Requirements (DRAFT)

Topic	Issue	ECCE solution	Comment
Barrel PID – e/π separation: up to 10^{-2}-10^{-4} down to 0.2 GeV	Need good EMcal resolution; need additional e/π below 2GeV	Use SciGlass with 55 cm space as option with good precision; use hpDIRC as π veto down to p = 0.3 GeV/c	Below 0.3 GeV/c can also augment with TOF. Leave 5-10cm for MRPC.
Barrel PID – π/K/p separation down to 0.2 GeV	hpDIRC covers down to 0.6 GeV, need to augment PID below this	Cover 0.2 < p < 0.6 GeV/c with TOF option	Leave 5-10 cm space for this (in region up to forward/backward TOF). Can be MRPC but allows upgrade options (AC-LGAD or LYSO-based TOF)
Hermetic coverage of e- detection	Leave no gaps in e- detection while also folding in PID/hpDIRC need.	hpDIRC readout in backwards region; Moved backward EMCal 15 cm inwards; extended barrel EMCal	Good coverage for negative rapidity needs; performance needs to be verified with simulations.
Backward e- determination, e/π separation up to 10^{-4}	Need highest precision EM calorimetry	Assume all $PbWO_4$	Partial coverage with SciGlass can be scope contingency
Momentum resolution in barrel	Assume 1.5 T field	AI Optimization; base choice is 3 Si vertex layers and 2 intermediate Si outer layer μRwell	Need to work out how to stage such that early beam commissioning starts without Si.
Momentum resolution in forward/backward regions at high η	Assume 1.5 T field	Five disks forward, four disks backward to move EMCal in. Additional MPGD tracking behind dRICH and mRICH	Upgrade options: TRD for PID; AC-LGAD for tracking
Forward Hadronic calorimetry	Forward hadronic calorimetry resolution < 50%/√(E)	Longitudinally separated calorimeter to meet needs in high-η region	Upgrade Option: Dual calorimeter (or can fold in earlier in region of highest need)
Forward Particle Identification	Constrained space in forward region	dRICH based on C4F10; make use of recirculation and gas recovery systems	Recirculation and gas recovery systems for environmentally unfriendly gas use

Example 2: ECCE Detector Scope DRAFT

List of Assumptions
1) The accelerator/cryogenics scope will provide a cryogenic distribution can in the experimental Hall at IP6. The remaining scope in the Hall is included in the detector magnet.
2) The IR and vacuum (IR magnets, beam pipes, pumps, valves, windows, etc.) are part of the accelerator/IR scope.
3) The luminosity detector is included in this detector proposal and includes anything that comes behind the conversion/exit window. Up to that window is assumed to be accelerator scope.
4) The polarimetry scope is not included in this detector proposal as it is handled external to the proposals through the across proto-collaborations polarimetry working group.*
5) Any required IP-6 de-installation costs are assumed to be covered as regular laboratory operations costs.
6) ….

**Note that for the CD-1 EIC Project cost estimates the polarimetry and luminosity detector scope was still covered under accelerator/IR scope.*

Example 3: ECCE Detector R&D Needs DRAFT

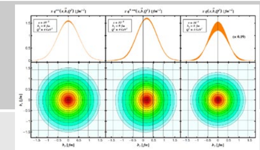
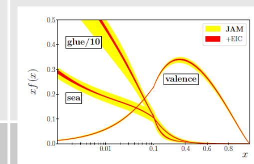
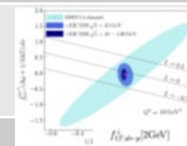
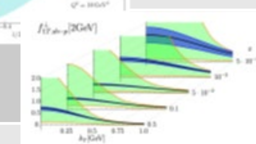
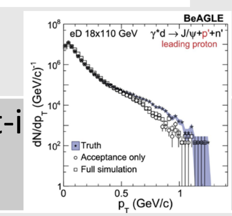
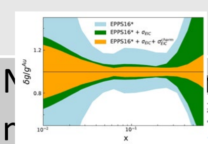
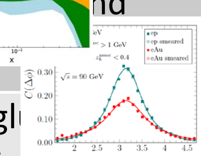
ECCE

Plus a GANTT chart visualization with milestones

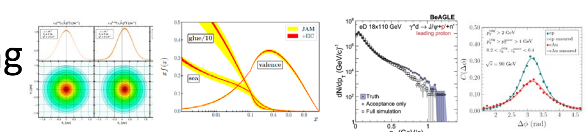
Topic	What R&D is needed to realize the ECCE Detector	What are the milestones to validate R&D for the ECCE Detector
mRICH (eRD101)		
dRICH (eRD102)		
hpDIRC (eRD103)		
Si Service (eRD104)		
SciGlass (eRD105)	Prove that SciGlass is a viable cost-effective solution	Beam test with small prototype (2021) Scale-up from 20 cm to 45 cm (2021/22) Test different geometries (2022)
Forward Calorimeter (eRD106/eRD107)		
MPGD (eRD108)	Prove that μRwell with capacitive readout works	
ASICS (eRD109)		
Si-Vertex (eRD111)		
AC-LGAD (eRD112)		

Example 4: Key Physics Drivers and Connection to EIC WP/YR and NAS Study DRAFT

"Experiments must address the EIC White Paper and NAS Report science case"

NAS Report Topics	NAS Report Sub-topics	ECCE Measurements	Yellow Report enhancement
Origin of Mass	Tomographic Imaging Quarks and Gluons		
	Heavy-quarkonia exclusive production at threshold (check NAS report)		π/K structure 
	(mention) 3D Imaging in Momentum Space		
Origin of Spin	Gluon spin and orbital motion		
	Transverse motion in polarized nucleons		
Dense Systems of Gluons	Propagation of energetic quarks through matter		D/D* reconstruction and heavy-flavor in jets. 
	Properties of Nuclei in QCD	N… nd r… 	Light-i…
	Diffraction	Dense gl… saturatio… 	

Science to check performance in IP8: p/K Structure, Light-Ion tagging

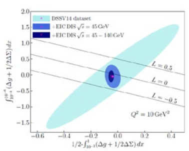


Physics Studies Focus: a first look

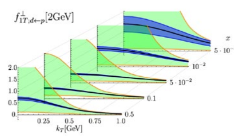
Plots to demonstrate EIC NAS Study, White Paper	Plots to show unique ECCE strengths

Plots to demonstrate EIC NAS Study, White Paper

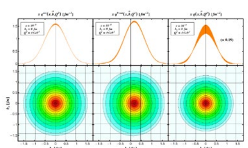
- Origin of Nucleon Spin



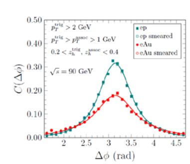
- Confined motion of partons



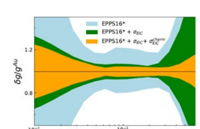
- 3D imaging quarks and gluons



- Nucleon mass
- High gluon densities in nuclei

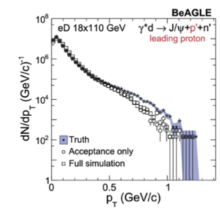


- Quarks and gluons in the nucleus

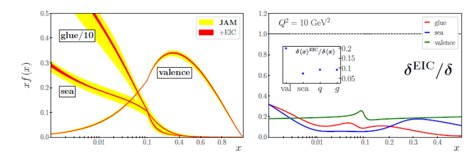


Plots to show unique ECCE strengths

- Light-ion tagging



- Pion/Kaon structure



- Diffractive jets?
- nuclear modifications and in-medium evolution
  - D/D* reconstruction and heavy-flavor in jets.
  - showcasing ECCE lower pT-cutoff due to the 1.5T field

ECCE Detector Costing

(note that this a simplified version; labor is included)

WBS	EIC Ref Project $M	EIC Ref In-Kind $M	EIC Ref Total $M	ECCE Project $M	ECCE In-Kind $M	ECCE Total $M
Detector management			7.4			
Detector R&D			12.1			
Tracking			31.1			
PID			26.5			
EM Calorimetry • Backward • Barrel • Forward			36.2	5.0	4.0	9.0
Hadronic Calorimetry			33.1			
Magnet			29.7	3.0	6.0	9.0
Electronics			17.1			
DAQ Computing			8.7			
Detector Infrastructure			26.4			
IR Integration & Auxiliary Detectors			8.1			
Detector Pre-Ops & Commissioning			8.7			
TOTAL	**153.1**	**92.0**	**245.1**			

Collection of cost estimates ongoing with teams and ORNL

In-Kind Contributions – Example EEEMCAL

Electron Endcap Electromagnetic Calorimeter – the consortium plans to pursue:

- the reuse of existing $PbWO_4$ and lead glass **(~$0.5)** and pursue purchase 200-250 crystals through Charles U./Prague **($0.4-$0.5Million)**
- further develop glass radiator, to be provided at reduced cost.
- Labor (design, Q&A, assembly, etc.) contributed through continuing university grants (**~$2Million**)
- The Science Committee of Armenia (Research and instrumentation) could contribute and AANL could contribute labor, pending further discussions
- IN2P3/France (**~<$1Million**) could contribute, pending further discussions.
- In addition, the Consortium plans to pursue several external funding sources for procurement of additional crystals

WBS	ECCE Project $M	ECCE In-Kind $M	ECCE Total $M
ECE06.10.05.02	5.0	4.0	9.0

In-Kind Contributions – International Interest

Ongoing discussions about intent to pursue funding and collection of information

CENTRAL DETECTOR

Tracking:

- Silicon: Japan, Czech Republic; LANL LDRD

Calorimetry

- PWO and SciGlass: Czech Republic, Armenia, France
- Forward Calorimeter: Japan, South Korea

Particle ID

- DIRC: GSI/Germany contribution
- mRPC/crystals: China

FAR FORWARD – FAR BACKWARD

- Roman pots: France
- Off momentum: Israel
- ZDC: Japan
- Luminosity monitors: Israel
- Low Q2 tagger: UK

ECCE Detector – Risk Items DRAFT

Start of a list:

CENTRAL

Magnet

- Reuse presents moderate risk (according to 2020 Jlab Engineering Risk Assessment, engineer: R. Fair); ECCE strategy: minimal changes, check functionality during sPHENIX, carry through E&D as schedule risk mitigation (– see Doug/Ken talk)

Tracking

- MAPS ITS3 risk similar as Si Consortium
- GEM μRwell with capacitive couplig – ongoing JLab/CLAS12 and EIC R&D

Calorimetry

- SciGlass – validation of large-scale glass, part of ongoing project R&D
- Forward Dual Readout Calorimeter – technical risk;

Particle ID

- hpDIRC
- mRICH
- dRICH – no expertise in collaboration → increasing expertise in ECCE

FAR FORWARD – FAR BACKWARD

- AC-LGAD – technical risk, part of project R&D
- No further obvious risks in FF/FB detectors

Risk and In-Kind – Example Magnet

Assume *re-use* of Babar magnet

- Risk: Babar solenoid develops operational issues
- Mitigation: Monitor sPHENIX high field test in June 2022 and first run (starts February 2023) to make decision if refurbishment or a replacement solenoid is needed
- Mitigation: Carry through Engineering&Design Labor for replacement magnet as schedule risk mitigation **($1Million**)
- Need replacement valve box, cryoflex line, and possibly a trim coil **($1-2Million**)
- In-Kind: existing 1.5T magnet estimated at $9Million – minus the cost to use it for EIC operations **($6Million**)

WBS	ECCE Project $M	ECCE In-Kind $M	ECCE Total $M
ECE06.10.05.02	3.0	6.0	9.0

ECCE Consortium

1. AANL/Armenia
2. AUGIE
3. BGU/Israel
4. BNL
5. Brunel University/UK
6. Canisius College
7. CCNU/China
8. Charles U./Prague
9. CIAE/China
10. CNU
11. Columbia
12. CUA
13. Czech. Tech. Univ./CZ
14. Duquesne U.
15. Duke
16. FIU
17. Georgia State
18. Glasgow/Scotland
19. GSI/Germany
20. GWU
21. Hampton
22. HUJI/Israel
23. IJCLab-Orsay/France
24. IMP/China
25. Iowa State
26. IPAS/Taiwan
27. JLab
28. Kyungpook Natl. U./K.
29. LANL
30. LBNL/Berkeley
31. Lehigh University
32. LLNL
33. Morehead State
34. MIT
35. MSU
36. NCKU/Taiwan
37. NCU/Taiwan
38. NMSU
39. NRNU MEPhI/Russia
40. NTHU/Taiwan
41. NTU/Taiwan
42. ODU
43. Ohio U
44. ORNL
45. PNNL
46. Pusan Natl. Univ./Kor.
47. Rice
48. RIKEN/Japan
49. Rutgers
50. Saha/India
51. SBU
52. SCNU/China
53. Sejong U./Korea
54. TAU/Israel
55. Tsinghua U./China
56. Tsukuba U./Japan
57. CU Boulder
58. UCAD/Senegal
59. UConn
60. UH
61. UIUC
62. UKY
63. U. Ljubljana/Slovenia
64. UNH
65. U. Regina/Canada
66. USTC/China
67. UT Austin
68. UTK
69. UTSM/Chile
70. UVA
71. Vanderbilt
72. Virginia Tech
73. Virginia Union
74. Wayne State
75. WI/Israel
76. WM
77. Yonsei Univ./Korea
78. York/UK
79. Zagreb U./Croatia

ECCE Consortium Structure

EIC Project POC
Rolf Ent (JLab)

ECCE Steering Committee
Or Hen (MIT)
Tanja Horn (CUA)
John Lajoie (ISU)

Institutional Board

Computing Team
Cristiano Fanelli (MIT)
David Lawrence (JLab)

Diversity, Equity and Inclusion
Narbe Kalantarians (VUU, co-chair)
Christine Nattrass (UTK, co-chair)
Simonetta Liuti (UVA)
Elena Long (UNH)

Computing Working Groups:

- Artificial Intelligence
  William Phelps (CNU/JLab)
- Computing and Software
  Joe Osborn (ORNL)

Detector Team
Doug Higinbotham (JLab)
Ken Read (ORNL)

Physics Benchmarks Team
Carlos Munoz-Camacho (IJCLab-Orsay)
Rosi Reed (Lehigh U.)

Editorial Team
Tom Cormier (ORNL)
Richard Milner (MIT)
Peter Steinberg (BNL)

Detector Working Groups:

- IP8/Equipment Re-use
  John Haggerty (BNL)
- Far Forward/Far Backward*
  Michael Murray (KU), Yuji Goto (RIKEN), Igor Korover (MIT)
- Tracking
  Xuan Li (LANL), Nilanga Liyanage (UVA)
- Calorimetry
  Friederike Bock (ORNL), Yongsun Kim (Sejong U.)
- Particle ID
  Greg Kalicy (CUA), Xiaochun He (GSU)
- Magnetic Field
  Paul Brindza (JLab), Renuka Rajput-Ghoshal (JLab)
- DAQ/Electronics/Readout
  Chris Cuevas (JLab), Martin Purschke (BNL)

***Alex Jentsch, Yulia Furletova** (far-forward/backward POC)

Physics Working Groups:

- Simulations
  Cameron Dean (LANL), Jin Huang (BNL)
- Inclusive Processes
  Tyler Kutz (MIT), Claire Gwenlan (Oxford)
- Semi-Inclusive
  Ralf Seidl (RIKEN), Charlotte Van Hulse (Orsay)
- Exclusive
  Rachel Montgomery (Glasgow), Julie Roche (OU)
- Diffractive and Tagging
  Wenliang Li (W&M), Axel Schmidt (GWU)
- Jets and Heavy Flavor
  Cheuk-Ping Wong (LANL), Wangmei Zha (USTC)
- BSM and Precision Electroweak
  Sonny Mantry (UNG), Xiaochao Zheng (UVa)

Editorial Working Groups:

- Proposal Editing, Verification and Version Control
- Costing and Management

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- ecce-eic-det-l
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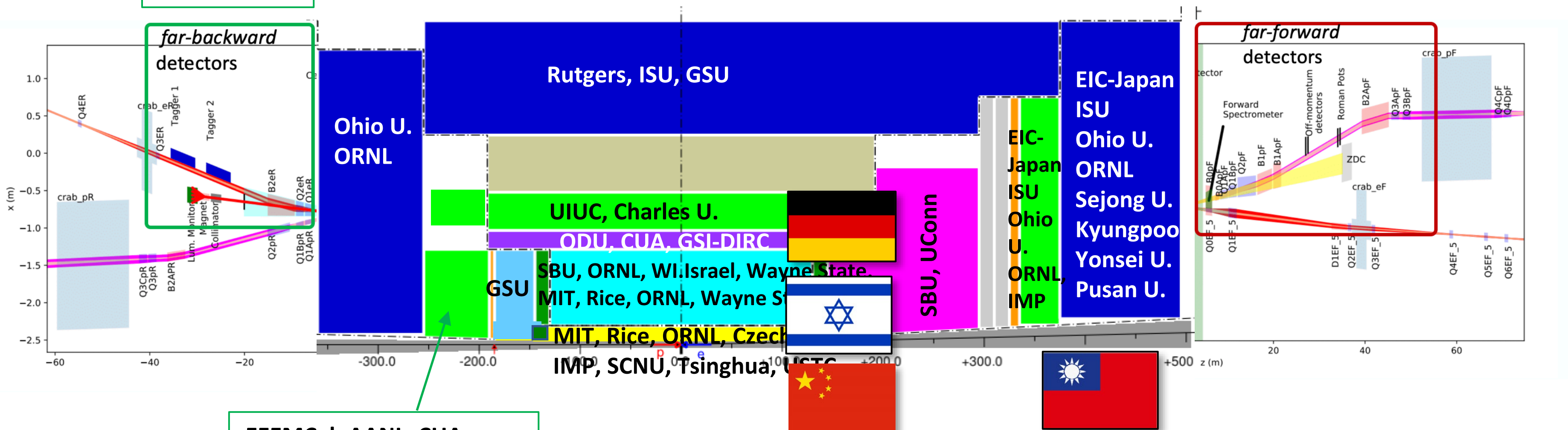
- ecce-eic-prop-l

ECCE Consortium and Technology Interest

Glasgow U., ODU, UCAD

BGU/Israel, MIT, ORNL, UIUC, IJCLab-Orsay, EIC-Japan, TAU/Israel, UVA, GWU, MIT-BATES, HUIJ/Israel



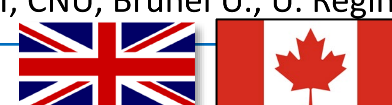
EEEMCal: AANL, CUA, Charles U., FIU, IJCLab, MIT, Lehigh U., UKY, JMU

Polarized Beam and polarimetry: MIT, UNH, SBU

Electronics: Columbia, ORNL

DAQ/Trigger: ISU, CU Boulder, OU, ORNL, SBU, UConn, LLNL

Artificial Intelligence: MIT, CNU, Brunel U., U. Regina



Announcements

Godparents

- Origin of Mass: Jianwei Qiu (reader)
- Spin: Ralf Seidl
- Tomography: Carlos Munoz Camacho
- Dense Gluons: TBA
- EW & BSM: Xiaochao Zheng and Christoph Paus

Upcoming Events

- AI4EIC-exp Workshop (7 – 10 Sept)
- Sardinian Workshop on Spin Studies and related Issues (6 – 8 Sept)
- DNP and ECCE meeting (11 – 14 Oct)
- Artificial Intelligence for Nuclear Technology and Applications (25 – 29 Oct)

IB Vote on the Code of Conduct

- An email will be sent out after this meeting. Vote closes on Tuesday Sept 7th at noon. If you haven't received your voting email by EOD 8/31 please contact us. Requires majority of IB votes cast to pass.