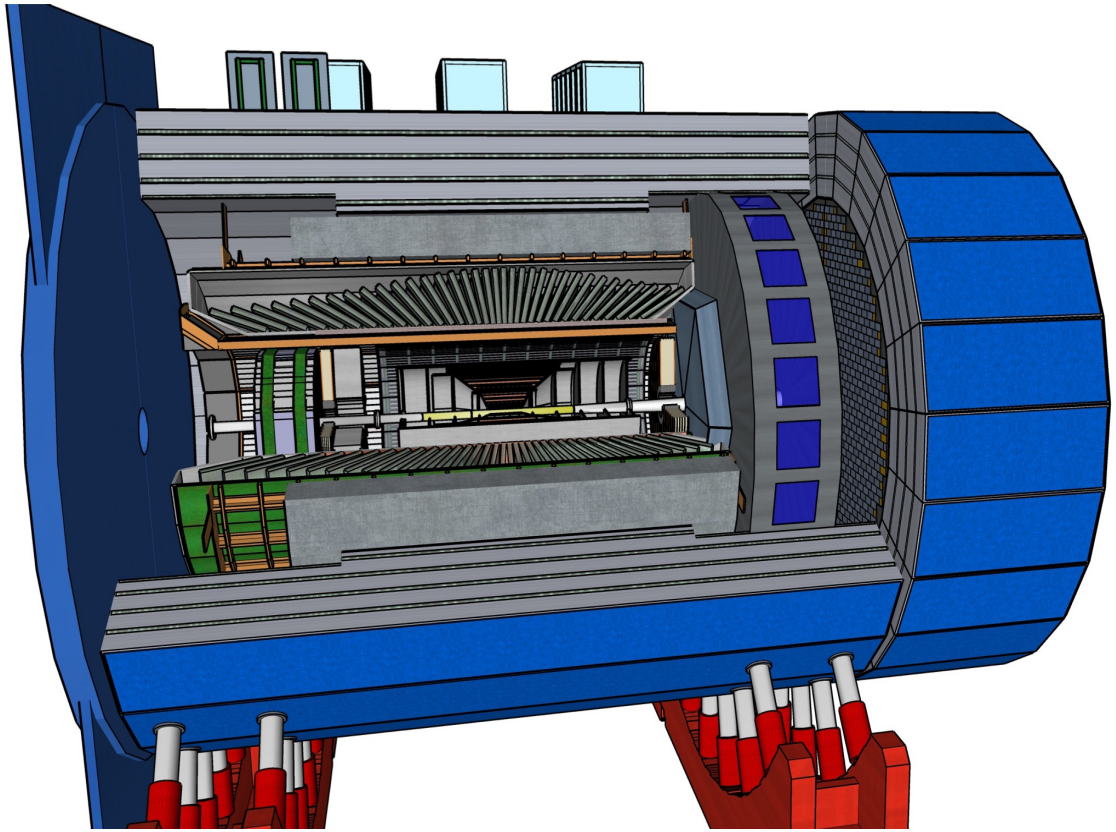
EIC Comprehensive Chromodynamics Experiment



26th Bi-Weekly Meeting

Or Hen, Tanja Horn, John Lajoie

April 25th, 2022

Today's Agenda

10:00 AM → 10:30 AM **ECCE News and Status** — 30m
Speaker: Or Hen (MIT)

10:30 AM → 11:05 AM **Detector Team: Publication Status**
Conveners: Douglas Higinbotham (Jefferson Lab) , Kenneth Read (Oak Ridge National Laboratory)

- 10:30 AM **Introduction, Status of other ECCE detector NIM drafts** — 10m
  Speakers: Douglas Higinbotham (Jefferson Lab) , Kenneth Read (Oak Ridge National Laboratory)
- 10:40 AM **Public Presentation: Design of the ECCE Detector for the Electron Ion Collider** — 20m
  Speakers: Douglas Higinbotham (Jefferson Lab) , Kenneth Read (Oak Ridge National Laboratory)

11:05 AM → 11:55 AM **Physics Team: Publication Status**
Conveners: Carlos Munoz Camacho (IJCLab-Orsay (France)) , Carlos Munoz Camacho (IJCLab, CNRS/IN2P3) , Rosi Reed (Lehigh University)

- 11:05 AM **Introduction** — 5m
  Speakers: Carlos Munoz Camacho (IJCLab-Orsay (France)) , Rosi Reed (Lehigh University)
- 11:10 AM **J/Psi Production** — 20m
  Speakers: Wenliang Li (Stony Brook University CFNS) , xinbai li (USTC)

11:55 AM → 12:25 PM **Computing Team: Publication Status**
Conveners: Cristiano Fanelli (MIT) , David Lawrence (Jefferson Lab)

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- Publications
- Discussion on Det. 1 WGs and overall path forward

Papers

- Great progress promoting tech-notes to publications by WGs.
  - Various of ‘small’ wrinkles from proposal days are getting ironed out.
  - New productions for improved estimates.

- Extremely important, especially as ECCE is the formal reference design

  ➔ Our papers are the main technical documents we’re making available to the NP / HEP communities.

  ➔ Need to be mindful of what’s shown and how it’s presented and explained.

  (we do not want our papers to cause confusion)

- Some papers present a larger challenge in terms of their structure and in how studies and results should be best presented and explained.

  ➔ Everyone are encouraged to help the review process.

EIC Comprehensive Chromodynamics Experiment

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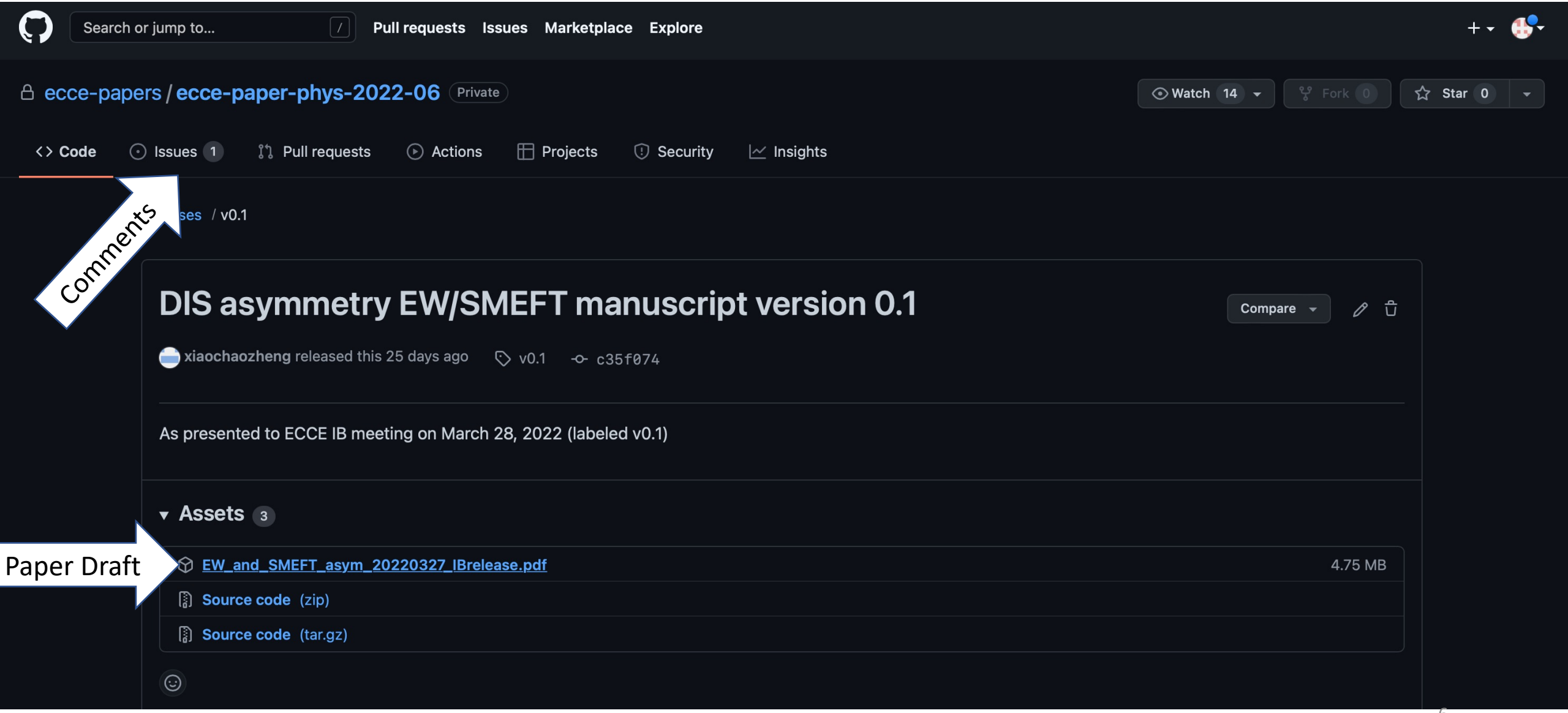
ECCE Publications Database

The GitHub and Overleaf repositories listed in the database are protected. For access please contact Peter Steinberg <peter.steinberg@bnl.gov>.

The links below connect to the GitHub site used for comments on paper drafts during the ECCE internal review process. In order to comment, you must first have a GitHub account and request access to the GitHub site from Peter Steinberg <peter.steinberg@bnl.gov>. Following the instructions for posting review comments from the Wiki here.

Draft Publications for Collaboration Review

- Neutral-Current Electroweak Physics and SMEFT Studies at the EIC - posted for review 3/31/2022, closed 4/7/2022
- ECCE Computing Plan - posted 4/1/2022, closed 4/8/2022
- ECCE Calorimetry Paper - posted 4/11/2022, review closes 4/25/2022 (two week review period)
- AI-assisted Optimization of the ECCE Tracking System - posted 4/17/2022, review closes 4/24/2022
- Open Heavy Flavor Studies for the ECCE Detector at the Electron Ion Collider - posted 4/19/2022, review closes 4/26/2022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As presented to ECCE IB meeting on March 28, 2022 (labeled v0.1)
Assets 3
Paper Draft
EW_and_SMEFT_asym_20220327_IBrelease.pdf
4.75 MB
Source code (zip)
Source code (tar.gz)

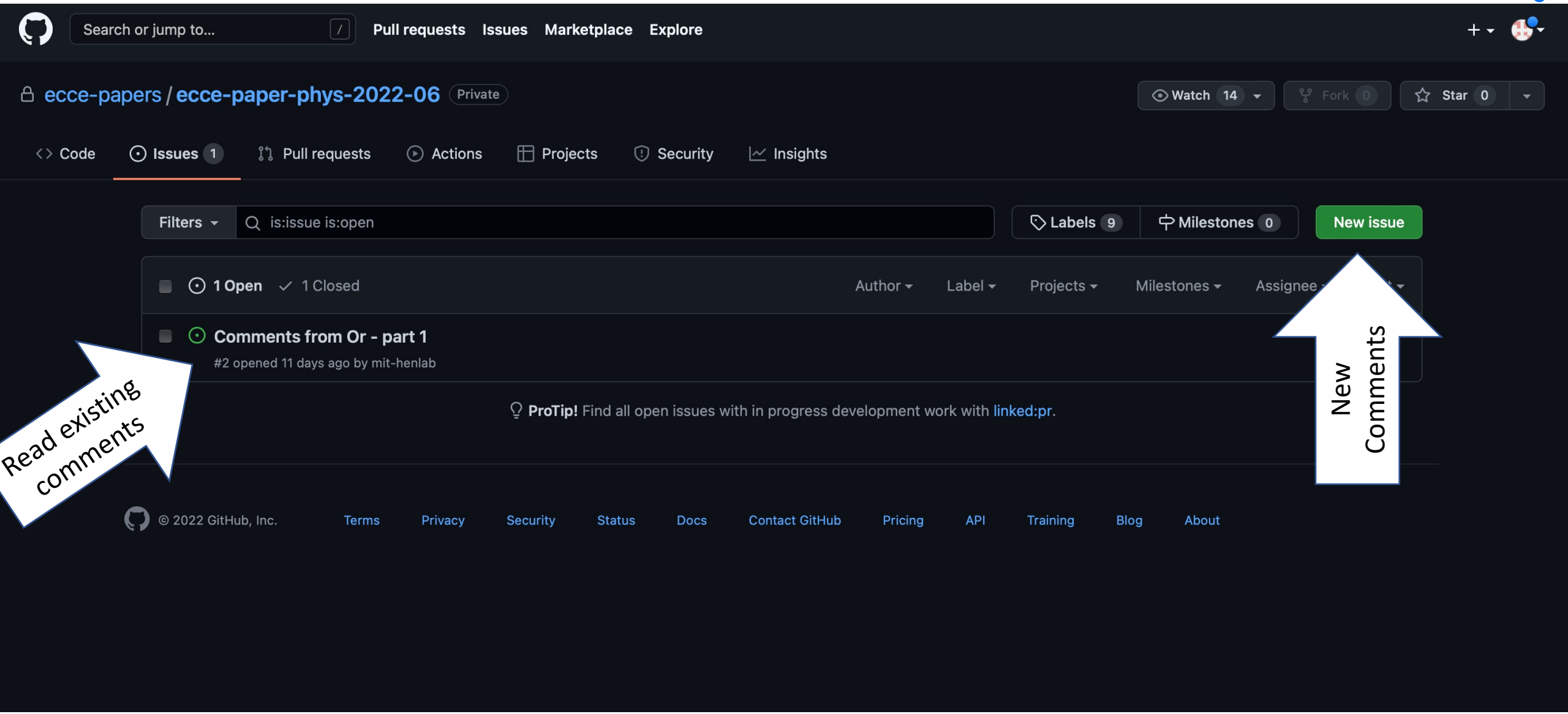
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Table 1: might want to explicitly say in the caption what the 'c's are (the ones with 1, -1, 0). You give the equation but still a few words about them defining the operator's chiral and flavor structure would be good.

212, 227: should it not be x instead or r indexes to be consistent with the notations of Eq. 10? Its also in other paces in the text so probably simpler to change x to r in eq. 10?

247: g_4^j, should the j not be an i? If not, might want to say what j is in the text.

302: "where ij = " you don't use ij in the equation above so this is confusing. You might want to move it to after the first time you use the ij notation in the next line for discussing L (i.e. write: L^ij stand for .... where ij = ...)

Section III.A. I think it would be appropriate to have a few lines with references on ECCE here. You mention ECCE in the intro but it would be good for the reader to repeat some of it (shortly) here. See also my comment on Fig. 2 - the text should really make this point about the resolutions very clear.

Section III.B. Not sure but you might want to mention that work is ongoing to increase electron calorimeter acceptance to lower negative eta (close to -4?) which will give more phase-space for the analysis.

376: I would say "of the EIC Yellow Report" to give some context to it. Not sure you need the '-' after [6].

I stopped in part III.D for this part of my comments.

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For EW NC physics studied in this work, we focus on the detection and identification of inclusive scattered electrons, provided by ECCE's tracking system~\cite{ecce-note-det-2021-03} combined with electromagnetic calorimetry~\cite{ecce-note-det-2021-02} in a nearly hermetic coverage. ECCE features a hybrid tracking detector design using three state-of-the-art technologies to achieve high precision primary and decay vertex determination, fine tracking momentum, and distance of closest approach resolution in the $\vert\eta\vert\leqslant 3.5$ region with full azimuth coverage. The ECCE tracking detector consists of the Monolithic Active Pixel Sensor (MAPS) based silicon vertex/tracking subsystem, the µRWELL tracking subsystem and the AC-LGAD outer tracker, which also serves as the time-of-flight detector, and all optimized by artificial intelligence. In terms of electromagnetic calorimeter, the system employed by ECCE consists of the PbWO$_4$-based Electron Endcap EM Calorimeter (EEMC) for the region $-3.7<\eta<-1.8$, the SciGlass-based barrel ECal for the region $-1.7<\eta<1.3$, and the Pb-Scintillator shashlik type forward ECal (FEMC, hadron beam direction) that covers roughly $1.3<\eta<4$. For the inclusive DIS kinematics determination, we used single-electron simulations in the full detector to characterize the measurement of the electron's momentum and trajectory in the so-called fast-smearing method, described in the next section, that yielded all physics projections provided in this work. On the other hand, other methods that can be used to identify DIS kinematics, such as by detecting all hadrons in the final state, or by detecting both the scattered electron and all hadrons, are not investigated here.

> The plots in figure 2 are ECCE performance plots, so they should be labeled "ECCE Preliminary" or "EIC/ECCE Preliminary"
> "EIC/ECCE Preliminary" added

> (2) lines 375-377 - This confused me until I went and looked up the table in the YR. It makes it sounds like you are assuming 10x the YR integrated luminosity, but I think what your are saying is you take the instantaneous luminosity x 1e7s to get the numbers you use for the integrated lumi. This is, in fact, much closer to being a reasonable estimate for the integrated luminosity for standard EIC running. This should be explained for clearly to the reader - it gets even more confusing when you talk about a 10x lumi upgrade later in the paper and it's not clear what factor of 10 is what?

Indeed, you are so right! I have revised this part to the following and combined your suggested texts from the end here:

To account for realistic running conditions, the annual luminosity -- the `high divergence configuration'' value as shown in Table 10.1 of the Yellow Report (YR)~\cite{AbdulKhalek:2021gbh}, multiplied by $10^7$~s -- were used. These values are shown in Table~\ref{tab:expconfig} and will be referred to as` Nominal Luminosity (NL)'' hereafter. As a comparison with the weak mixing angle extraction presented in the YR, we also carried out projections for 100~fb^{-1} 18×275~GeV ep and 10fb^{-1} 18×137~GeV eD collision as the `YR reference point''. We abbreviate the ep pseudo data sets as P1, P2, P3, P4, P5 and the eD pseudo-data sets as D1, D2, D3, D4, D5, see Table~\ref{tab:expconfig}. The YR reference point is denoted P6. Simulated pseudo-data sets with polarized hadrons are indicated as ΔD1--5 and ΔP1--6, while positron data sets are referred to as LD1--5 and LP1--6 (with` L'' for Lepton charge).

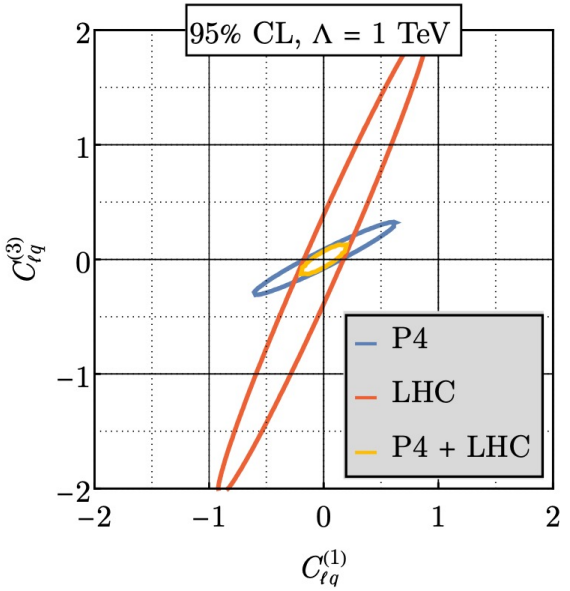
As an exercise, we consider the additional statistical power that could be obtained by a high-luminosity upgrade to the EIC (HL-EIC) that delivers a ten-fold increase in the integrated luminosity ($10\times$ higher than those in Table~\ref{tab:expconfig}) for these measurements. As the EIC is not yet built, there is no technical basis to assume that such an upgrade is possible. We choose the factor of $10\times$ luminosity increase as the minimum that would justify such an upgrade in order to explore the sensitivity of the measurements we study in this paper, without comment as to the feasibility of such an upgrade. These projections will be denoted with an ``High Luminosity (HL)'' label.

This system is great for tracking changes!

Neutral-Current Electroweak Physics and SMEFT Studies at the EIC

Radja Boughezal[1], Alexander Emmert[2], Tyler Kutz[3], Sonny Mantry[4], Michael Nycz[2], Frank Petriello[1,5], Kağan Şimşek[5], Daniel Wiegand[5], Xiaochao Zheng[2]

[1] *Argonne National Laboratory, Lemont, IL, USA*
[2] *University of Virginia, Charlottesville, VA, USA*
[3] *Massachusetts Institute of Technology, Cambridge, MA, USA*
[4] *University of North Georgia, Dahlonega, GA, USA*
[5] *Northwestern University, Evanston, IL, USA*



We study the potential for precision electroweak (EW) measurements and beyond-the-Standard Model (BSM) searches using cross-section asymmetries in neutral-current (NC) deep inelastic scattering at the electron-ion collider (EIC). Our analysis uses a complete and realistic accounting of systematic errors from both theory and experiment and considers the potential of both proton and deuteron beams for a wide range of energies and luminosities. We also consider what can be learned from a possible future positron beam and a potential ten-fold luminosity upgrade of the EIC beyond its initial decade of running. We use the SM effective field theory (SMEFT) framework to parameterize BSM effects and focus on semi-leptonic four-fermion operators, whereas for our precision EW study, we determine how well the EIC can measure the weak mixing angle. New features of our study include the use of an up-to-date detector design of EIC Comprehensive Chromodynamics Experiment (ECCE) and accurate running conditions of the EIC, the simultaneous fitting of beam polarization uncertainties and Wilson coefficients to improve the sensitivity to SMEFT operators, and the inclusion of the weak mixing angle running in our fit template. We find that the EIC can probe BSM operators at scales competitive with and in many cases exceeding LHC Drell-Yan bounds while simultaneously not suffering from degeneracies between Wilson coefficients.

https://arxiv.org/pdf/2204.07557.pdf

Det. 1 WGs and overall path forward

- First Detector-1 meeting this Friday. (https://indico.bnl.gov/event/15371/)

- Will not preview now, what will be discussed there (sorry). Please do your best to attend!

- General path forward:
  - Work must always progress ➔ established joint working groups to keep us moving productively towards CD2.

    (+ expect joint work to break any remining ECCE/ATHENA barriers)
  - Need to form a collaboration. EICUG meeting in late July seems like a good time to make significant progress.

Detector 1 working groups

Detector WG's	Conveners
Tracking	Xuan Li, Kondo Gnanvo, Laura Gonella, Francesco Bossu
Calorimetry	Friederike Bock, Carlos Munoz Camacho, Oleg Tsai, Paul Reimer
Chereknov PID	Xiaochun He, Grzegorz Kalicy, Tom Hemmick, Roberto Preghenella
TOF PID	Wei Li, Constantin Loizides, Franck Geurts, Zhenyu Ye
Far Forward	Michael Murray, Yuji Goto, Alex Jentsch, John Arrington
Far Backward	Igor Korover, Nick Zachariou, Krzyzstof Piotrzkowski, Jaroslaw Adam
DAQ/Electronics/ Readout	Chris Cuevas, Jo Schambach, Alexandre Camsonne, Jeff Landgraf
Computing and Software	Cristiano Fanelli, David Lawrence, Sylvester Joosten, Andrea Bressan
Global Detector/ Integration	Richard Milner, Jin Huang, Thomas Ullrich, Silvia Dalla Torre

Physics WG's	Conveners
Simulation production and QA	Joe Osborn, Wenliang (Bill) Li, Zhoudunming (Kong) Tu, Wouter Deconinck
Inclusive	Tyler Kutz, Claire Gwenlan, Barak Schmookler , Paul Newman
Semi-inclusive	Ralf Seidl, Charlotte Van Hulse, Anselm Vossen, Marco Radici
Exclusive, Diffraction, & Tagging	Axel Schmidt, Rachel Montgomery, Spencer Klein, Daria Sokhan
Jets & Heavy Flavor	Cheuk-Ping Wong, Wangmei Zha, Miguel Arratia <miguela@ucr.edu>, Brian Page
BSM & precision EW	Xiaochao Zheng, Sonny Mantry, 2xTBD

Global charges are defined

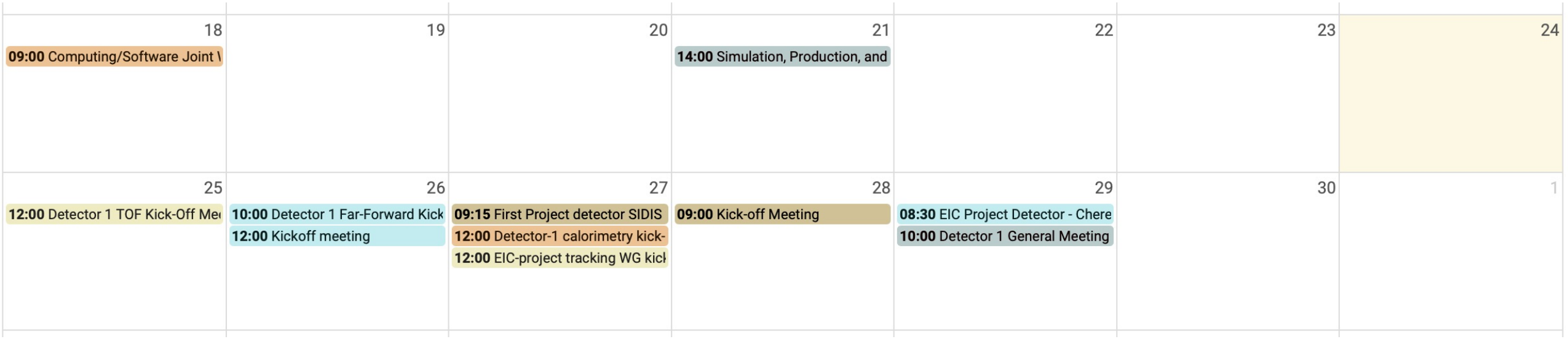
Detector WG's:

- The overall goal of the detector WG's is to optimize the ECCE reference design towards a technical design within the constraints listed above. In working towards this goal, the DWG's should collaborate with existing detector consortia (EICSC, EEEMCAL, MPGD, DIRC, DRICH, AC-LGADs, etc.), all detector R&D efforts relevant for Detector-1, and any additional efforts within the EIC scientific community.
- All working groups will work closely with the Global detector / integration working group and the EIC project towards a technical design that optimizes the global detector performance, taking into account global integration and physics performance.
- Each joint WG should hold at least one kickoff meeting where the designs of each proposal are presented in detail. It is critically important that WG members understand the scientific and technical reasoning behind different design choices before engaging in optimization discussions.
- The WG conveners will lead a discussion to identify any non-trivial differences and/or aspects in need of further optimization.
- For each non-trivial difference working groups will then work to prepare a pro/con list accounting for technical performance, risk and cost. The resolution of non-trivial differences should be discussed in close consultation with the Global detector/integration WG, physics working groups, the EIC project, relevant detector consortia and R&D efforts.

Physics WGs:

- Work with the Detector Working Groups to perform constant validation of the performances for physics observables. Emphasis should be placed on studies of key physics processes in the NAS report, the EIC whitepaper, Yellow Report, and detector proposals.
- When alternative technological solutions are examined, work with the detector groups to provide quantitative information on the physics performance of the proposed solutions.
- In collaboration with the Computing/Software and Simulations WGs, further develop simulation and data analysis tools. Organize workshops as needed to provide training in the use of these tools for collaborators.
- Over time, extend the existing scope of physics processes being studied, with an emphasis on those processes called out by the DPAP as being significant for the science program and yet not studied by the proto-collaborations.

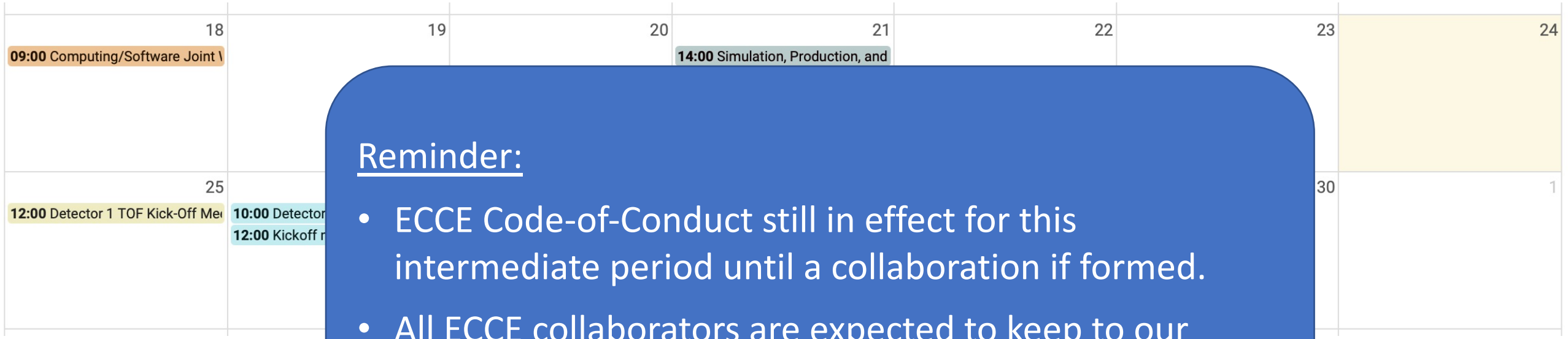
Detector 1 calendar starting to fill up ☺



- WGs scheduling ‘standing’ meeting times and working to resolve overlaps (to 1st order, we cannot have overlaps).
- We ask for all meetings to have an indico page & use informative names (‘kickoff meeting’ isn’t one ;)
- Also ‘private’ meetings for WG conveners only should be noted on the calendar and marked as private

https://indico.bnl.gov/category/402/calendar

Detector 1 calendar starting to fill up ☺



Reminder:

- ECCE Code-of-Conduct still in effect for this intermediate period until a collaboration if formed.
- All ECCE collaborators are expected to keep to our Code-of-Conduct in the new Detector-1 working groups

- WGs scheduling
  resolve overlaps
- We ask for all meetings to have an indico page & use informative names (‘kickoff meeting’ isn’t one ;)
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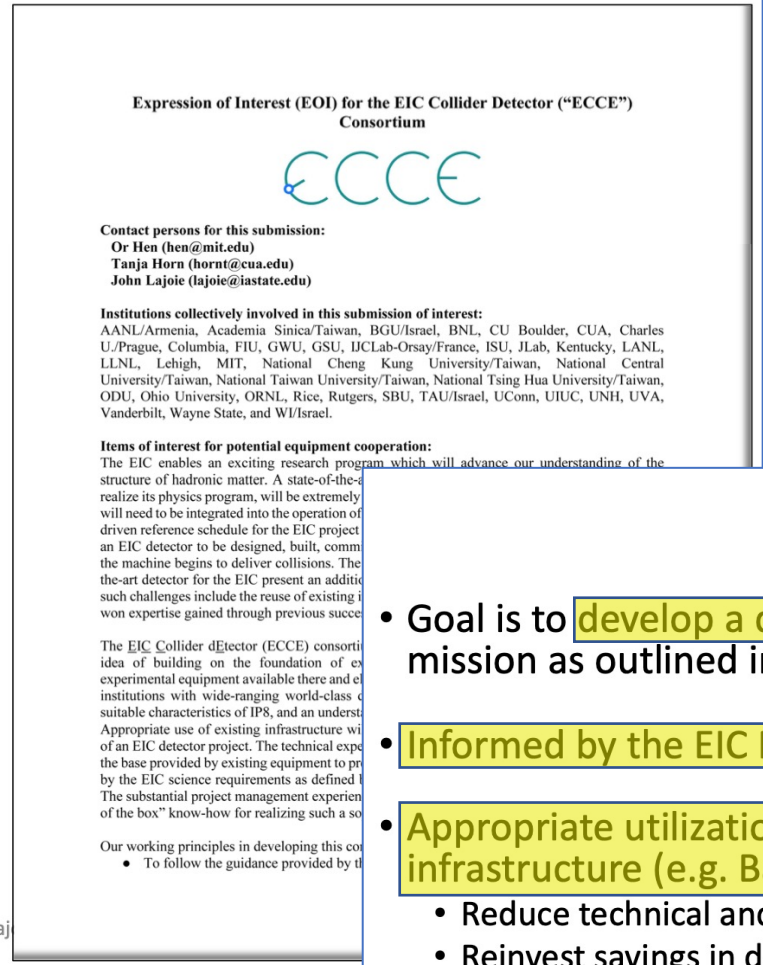
ECCE perspective

ECCE EOI Principles

- Develop a detector capable of delivering the full EIC science mission
  - As outlined in the Yellow Report (see talks by Or Hen and Tanja Horn)
- Appropriate utilization and/or upgrades of existing detectors and infrastructure
  - Reduce technical and schedule risks
  - Reinvest savings in detectors
- ECCE seeks to be ready for the start of EIC operations



Expression of Interest (EOI) for the EIC Collider Detector ("ECCE") Consortium

Contact persons for this submission:
Or Hen (hen@mit.edu)
Tanja Horn (hornt@cua.edu)
John Lajoie (lajoie@iastate.edu)

Institutions collectively involved in this submission of interest:
AANL/Armenia, Academia Sinica/Taiwan, BGU/Israel, BNL, CU Boulder, CUA, Charles U./Prague, Columbia, FIU, GWU, GSU, IJCLab-Orsay/France, ISU, JLab, Kentucky, LANL, LLNL, Lehigh, MIT, National Cheng Kung University/Taiwan, National Central University/Taiwan, National Taiwan University/Taiwan, National Tsing Hua University/Taiwan, ODU, Ohio University, ORNL, Rice, Rutgers, SBU, TAU/Israel, UConn, UIUC, UNH, UVA, Vanderbilt, Wayne State, and WI/Israel.

Items of interest for potential equipment cooperation:
The EIC enables an exciting research program which will advance our understanding of the structure of hadronic matter. A state-of-the-a
realize its physics program, will be extremely
will need to be integrated into the operation of
driven reference schedule for the EIC project
an EIC detector to be designed, built, comm
the machine begins to deliver collisions. The
the-art detector for the EIC present an additi
such challenges include the reuse of existing i
won expertise gained through previous succe

The EIC Collider dEtector (ECCE) consorti
idea of building on the foundation of e
experimental equipment available there and e
institutions with wide-ranging world-class
suitable characteristics of IP8, and an underst
Appropriate use of existing infrastructure wi
of an EIC detector project. The technical expe
the base provided by existing equipment to pr
by the EIC science requirements as defined
The substantial project management experien
of the box" know-how for realizing such a s

Our working principles in developing this co
- To follow the guidance provided by t

1st ECCE workshop (Feb. 11th 2021)

1st ECCE IB Meeting (Feb. 26th 2021)

ECCE 101

- Goal is to develop a detector capable of delivering the full EIC science mission as outlined in the Yellow Report / White paper / NAS study.
- Informed by the EIC Reference detector layout in Yellow Report and CDR.
- Appropriate utilization and/or upgrades of existing detectors and infrastructure (e.g. BaBar Solenoid).
  - Reduce technical and schedule risks
  - Reinvest savings in detectors
- Seeks to be ready for the start of EIC operations.
- Preference for IP8 but ok with IP6 if defined as the "reference detector IP"

ECCE perspective

With ECCE defined as the reference design and joint working groups going, the consortium seems to have achieved everything we setout to do.

So… what is the consortium role moving forward?

Proto-collaboration moving Forward?

- Do we want to ramp down ECCE meetings as we ramp up on Detector 1 meetings?
- What message are we sending if we keep meeting as proto-collaborations in parallel to working on Detector 1 as a united community?
- At the same time, we need to continue working on converging the ECCE papers, independently of Detector 1 activities.

Discussion time