

# ECCE Physics Benchmarks Team IB Meeting Report

June 7<sup>th</sup>, 2021

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# Outline

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- Communications
- Simulation Campaign Update
- Short PWG Updates
- Conclusions/Outlook

# Communication channels

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Wikipedia: [https://wiki.bnl.gov/eicug/index.php/ECCE\\_Physics](https://wiki.bnl.gov/eicug/index.php/ECCE_Physics)

- Open Tasks [https://wiki.bnl.gov/eicug/index.php/Open\\_Tasks](https://wiki.bnl.gov/eicug/index.php/Open_Tasks)

Mailing list: [ecce-eic-phys-l](#)

[Mattermost channels](#): instant messaging

[Discourse](#): forum-style format

Physics Working Group Meetings: <https://indico.bnl.gov/category/346/>

**Physics Team:** Mondays at 9:30 AM & 9:00 PM (All times in EDT)

- **Jets & HF:** Tuesdays at 11:00 AM
- **Exclusive Reactions:** Fridays at 10:00 AM
- **Diffraction & Tagging:** Wednesdays at 12:00 PM
- **SDIS:** Tuesday at 9:00AM
- **BSM & Electroweak:** Tuesdays at 9:30 AM, Wednesdays 9:00 PM
- **Inclusive Reactions:** Monday 2:00PM
- **Simulation Office Hours:** Alternating between Tuesdays 2PM and Mondays 8PM
- Announcements/reminders sent to [ecce-eic-phys-l](#) mailing list

# Recall: Timeline

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- First Simulation Campaign (April 1<sup>st</sup> - May 15<sup>th</sup>)
  - Initial simulation runs using existing implementation
  - Finish implementing ECCE setup
  - Agree on technology, main physics observable and arrange required event generators
- **First Analysis Campaign (May – June 15<sup>th</sup>)**
  - Determine statistics
  - Iterate: simulation  $\leftrightarrow$  analysis
- Full Scale Production (June 15<sup>th</sup> – August)
- Second Simulation Campaign (July 15<sup>th</sup> – September 1<sup>st</sup>)
  - Analysis of simulation data to demonstrate physics extraction
  - Drafts of physics plots
- Proposal Writing (September 1<sup>st</sup> – October 15<sup>th</sup>)
  - All physics 'plots' are done
  - Compose narrative around simulation results and selected technologies
- Proposal Deadline – **December 1<sup>st</sup>**

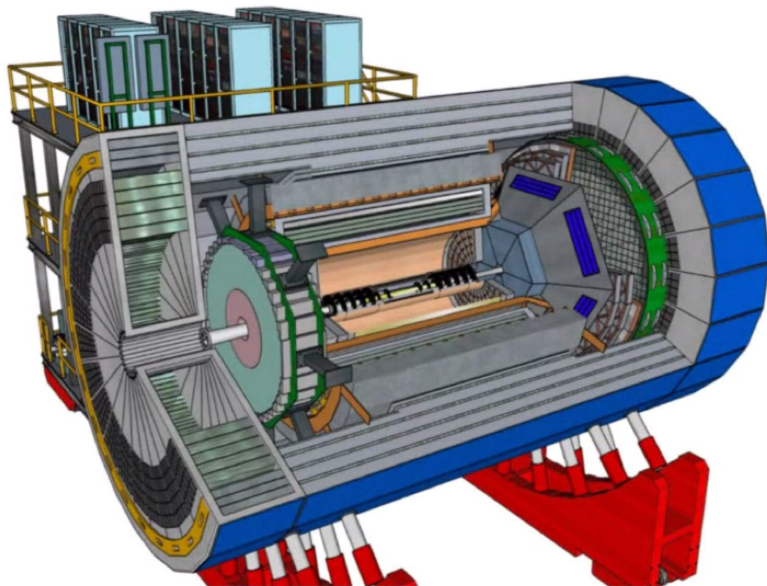


# Recall: General Detector Concept



## ECCE General Detector Concept

The ECCE detector concept is undergoing rapid development



### ECCE ELECTRON ENDCAP STRAWMAN

**Tracking:** MAPS, Micro Pattern Gaseous Detectors (MPGD)

**Electron Detection:** PWO&SciGlass

- Inner part: PWO crystals (reuse some)
- Outer part: SciGlass (backup PbGl)

**h-PID:** mRICH

- From yellow report

**HCAL:** Steel from magnet or Pb/Sc or Fe/Sc

- Not instrumented and only serve as flux return?
- Instrumented \w reduced thickness (lower energies)

### ECCE CENTRAL BARREL STRAWMAN

**Tracking:** Silicon barrel tracker (optional Si/GEM hybrid)

**Electron PID:** SciGlass (backup: W/Sc (Pb/Sc) shashlik)

- SciGlass remains to be demonstrated
- Several backup options – lower resolution though

**h-PID:** hpDIRC & AC-LGAD

- Compact
- AC-LGAD never been shown for barrel configuration
- AC-LGAD backup:  $dE/dx$  (needs more space)

**HCAL:** magnet steel (reuse) - Fe/Sc

### ECCE HADRON ENDCAP STRAWMAN

**Tracking:** MAPS, Micro Pattern Gaseous Detectors (MPGD)

**h-PID:** dRICH&TOF

**e/h separation:** TOF & aerogel

- TRD to separate electrons from high momentum hadrons?

**Electron PID:** W/ScFi, Pb/Sc or W/Sc shashlik

**HCAL:** Pb/Sc or Fe/Sc

- Alternative for improved resolution: dual readout, high-granularity

# Detector Strawman – Electron Endcap

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**Tracking:** MAPS, Micro Pattern Gaseous Detectors (MPGD) ✓

**Electron Detection:** **PWO&SciGlass**

- Inner part: **PWO crystals** ✓
- Outer part: SciGlass

**h-PID:** **mRICH**

- From yellow report ✓

**HCAL:** Steel from magnet or Pb/Sc or Fe/Sc ✓

## Concerns

- mRICH – Detailed simulation ready in Fun4All, need to validate integration. Ongoing development of full reconstruction.
- HCAL – Currently no HCal in the e-going direction

# Detector Strawman – Hadron Endcap

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Tracking: MAPS, Micro Pattern Gaseous Detectors (MPGD) 

h-PID: dRICH&TOF 

e/h separation: TOF & aerogel 

Electron PID: W/ScFi, Pb/Sc or W/Sc shashlik 

HCAL: Pb/Sc or Fe/Sc 

## Concerns

- dRICH – Working but not currently in the framework – perhaps should be simulated as a gas volume
- e/h via TRD – Not in the framework, need material distribution

# Detector Strawman – Central Barrel

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Tracking: Silicon barrel tracker



Electron PID: SciGlass (backup: W/Sc (Pb/Sc) shashlik)



h-PID: hpDIRC & AC-LGAD

- AC-LGAD never been shown for barrel configuration
- AC-LGAD backup: dE/dx (needs more space)



HCAL: magnet steel (**reuse**) - Fe/Sc




## Concerns

- hpDIRC – Work on full simulation will not be completed by June 14<sup>th</sup>
- ePID - fast geometry for SciGlass but full (blocked) geometry is in development and will take time.





# Detector Strawman – Far Forward/Backward

## FAR BACKWARD DETECTORS

- low-Q2 tagger 
- Lumi-detector - Project
- Lepton polarimetry - Project
- hadron polarimetry - Project

## FAR FORWARD DETECTORS

- ZDC 
- Roman Pots
- Off-momentum det. 
- B0-trackers
- Lepton polarimetry - Project
- hadron polarimetry - Project

## Concerns

- ZDC – Needs to be validated
- Work on other detectors is ongoing
- Far Forward/Background Regions placed in vacuum with parameterization of beampipe

# Immediate Timeline

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## **No Show Stoppers** for Simulation Campaign!

- Strategy - mix of full detector/fast geometry approximations → allows production to start for PWG while DWG can still develop subsystems

All DWGs asked to have their subsystems in fun4all by June 14<sup>th</sup>

- Most are in the EIC Build but not yet in the ECCE Configuration
- Groups need to validate geometry (no overlaps, etc)
- Thursday DWG Meeting: <https://indico.bnl.gov/event/12079/>

June 14<sup>th</sup> – June 21<sup>st</sup> Strawman Detector Validation

- Check that all detector modules compile
- Check Geometry (holes vs overlap)
- Integration Meeting TBD (June 17<sup>th</sup>?)

First Simulation will be ~10M Events with Particle Gun

- Verify Resolution and Efficiency for Tracking and Calorimeter Detectors <sup>10</sup>

# Simulation Update

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- Many Patches on Software due to rapidly evolving detector configuration
- Working on eA Simulations
- Beam crossing angle (25 mR) in by default
  - Need help in validating results
  - Once IP8 (35 mR) option is mature will develop a switch for the two geometries
    - This is not trivial – detectors need to move, etc.
- Creating top level production scripts for simulation campaign
- Meta data for tagging configurations is in process

# PWG Update (1/2)

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- Inclusive:
  - Electron resolution and PID studies nearly completed
  - Neutral current files produced with Djangoh for EW working group
  - Need to generate charged current files
  - Working closely with EW/BSM group
- SDIS
  - Ready for simulation campaign, will look at selections of  $Q^2$  and  $x$  and then extrapolate
- Jets/HF
  - Jet analyses are already in fun4all – work being done on ensuring all necessary information is in the event evaluator
  - HF studies done w/fast sim, soon for full – KF Particle is already incorporated into fun4all

# PWG Update (2/2)

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- Exclusive:
  - DVCS → Run for ep @MIT
  - DVMP → Look at generating events
  - $J/\psi$  studies – also straddles the D&T working group
- Diffractive and Tagging
  - Implemented realistic ZDC into fun4all
  - Coordinating/establishing preliminary positions of far forward detectors (kick-off meeting was last week!)
  - Testing JLab resources and documenting how-tos
- BSM/EW
  - Electron smearing studies completed
  - Investigating unfolding studies currently

# Conclusions/Outlook

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- Full simulation campaign will soon be underway
  - Mix of full/fast sim to efficiently start production while allowing subsystem development to continue
  - Validation will be required
  - Stay tune for additional physics/detector/integration meetings!
  - Start with IP6 design due to its maturity
- Top physics priorities mapped observables  $\leftrightarrow$  physics topics
- PWG confirming evaluators have all necessary information
  - Can allow multiple PWG-specific trees from same generated DSTs for efficient work flow
- Finalizing PWG list of generators and number of events needed for campaign

Back-Up

# Physics Priorities

Physics group is working on the outline of the proposal **requires prioritization**

Some discussion can be found at: <https://indico.bnl.gov/event/11937/>

Table from Yellow Report – Map observables to main physics topics

Processes Topics	Inclusive	Semi-Inclusive	Jets, Heavy Quarks	Exclusive	Diffraction, Forward Tagging
Global properties & parton structure	<b>incl. SF</b>	<b>h, hh</b>	<b>jet, Q</b>	<b>excl. <math>Q\bar{Q}</math></b>	<b>incl. diffraction, tagged DIS on D/He</b>
Multidimensional Imaging		<b>h</b>	jet, di-jet, jet+h, Q, $Q\bar{Q}$	<b>DVCS, DVMP,</b> elast. scattering	
Nucleus	<b>incl. SF</b>	<b>h, hh</b>	jet, di-jet, Q, $Q\bar{Q}$	<b>coh. VM, di-jet, h, hh, D/He FF</b>	<b>diff. SF, incoh. VM, di-jet, h, hh, nucl. fragments</b>
Hadronization		<b>h, hh, jet+h</b>	jet, Q, $Q\bar{Q}$		
Other fields	incl. SF with $e^+$ , $\sigma_{\gamma A}^{\text{tot}}$	charged curr. DIS, $\sigma_{\gamma A \rightarrow hX}$		$\sigma_{\gamma A}^{\text{elast}}$	$\sigma_{\gamma A}^{\text{diff}}$



# Physics Priorities

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Simulation assumption will be a luminosity of  $10 \text{ fb}^{-1}$

- Imaging and parity  $\rightarrow 100 \text{ fb}^{-1}$

Early science (first results) under assumptions:

- $10 \times 250 \text{ GeV}$ ,  $\sim 5 \text{ fb}^{-1}$  polarized e-p (g1 at low x) and  $\sim 2.5 \text{ fb}^{-1}$  e-A (% diffraction)

Focus on physics topics, as oppose to processes:

- **Mass**
- **Imaging** (Momentum and Spatial)
- **Spin & Flavor**
- **Saturation**
- **Emergent properties**
- **Hadronization**
- **BSM**

# Top Physics Priorities

## Inclusive

- F2A @ low-x [Saturation, nuclei]
- A1p vs. x [Spin & Flavor, nucleon]
- A1n vs. x [Spin & Flavor, nucleon]
- Twist-3 gTq vs. x [Spin & Flavor]

## SIDIS

- Quark Sivers function [Momentum imaging, nucleon]
- Sea quark helicities via SIDIS A1 A<sub>LL</sub> measurements [Spin & Flavor, nucleon]

## Electroweak and BSM

- Parity violating asymmetries
- Charged Lepton Flavor Violation

## Heavy Flavors and Jets

- In medium correction for heavy flavor [Hadronization, nuclei]
- Di-hadron correlations [Saturation, nuclei]

## Exclusive

- DVCS ep [Position Imaging, nucleon]
- DVCS eA [Position Imaging, nuclei]
- J/ψ production in ep [Position Imaging, nucleon]

## Diffraction & Tagging

- A1n from double tagged <sup>3</sup>He [Spin & Flavor]
- Diffractive meson (J/ψ) production [Saturation]
- Pion structure [Mass]
- Kaon FF [Mass]

In addition there are lower priorities – these may change as simulations progress

# Summary & Outlook

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- Much work is being done with all physics working groups meeting regularly
  - <https://indico.bnl.gov/category/339/calendar>
- Second Simulation Tutorial with details at:
  - <https://indico.bnl.gov/event/11719/>
- Observables need to be mapped to physics topics for the proposal
  - Span physics of the NAS Report and WP, based on observables from YR
- Next Physics Meeting will be right after the IB Meeting!
  - <https://indico.bnl.gov/event/11611/>