

eRD17: BeAGLE

A Tool to Refine Detector Requirements for eA

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25-March-2021

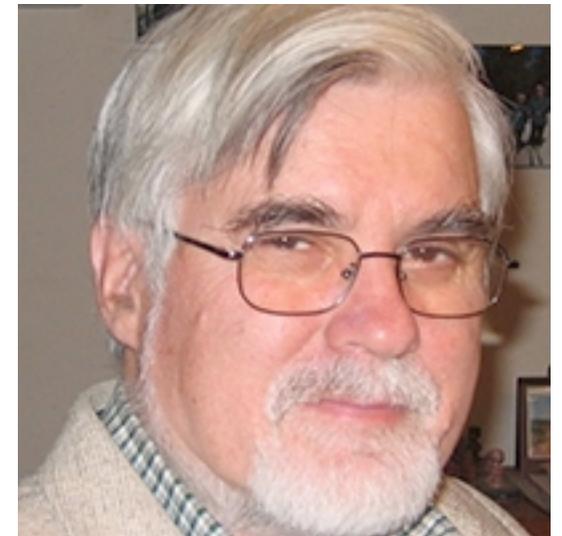
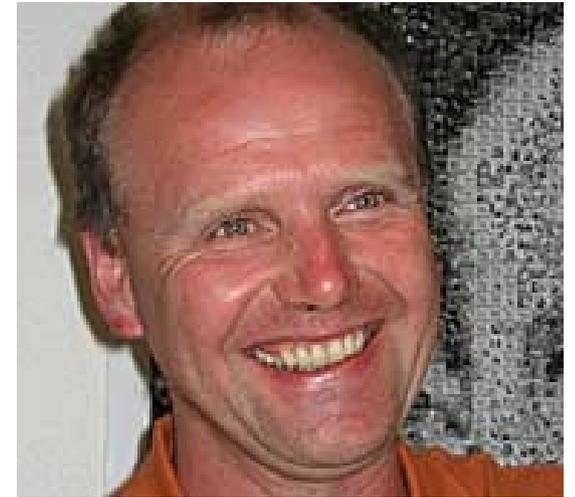
*-co-PIs

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Executive Summary

- The Past (FY2015-now)
 - eRD17 was critical in defining the IR/Detector Requirements for eA @ EIC – as planned!
 - The Yellow Report is the most recent example.
- Immediate future
 - Next BeAGLE workshop talk is this afternoon!
 - Complete 4th benchmark: SRCs for DIS (EMC)
 - Active involvement/support of Detector Proposals
 - Documentation and Publication
- Project completion: 9/30/2021

Thanks for all of the support and advice



eRD17 has had a large impact on the detector/IR design especially for e+A.

Thanks for all of the support and advice



Both support and sharp advice have allowed us to accomplish a lot!

EIC Yellow Report

http://www.eicug.org/web/sites/default/files/Yellow_Report_v1.1.pdf

SCIENCE REQUIREMENTS
AND DETECTOR
CONCEPTS FOR THE
ELECTRON-ION COLLIDER

EIC Yellow Report

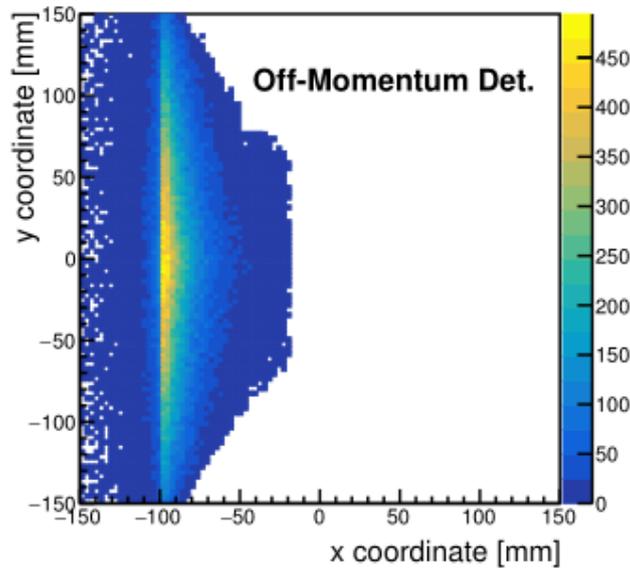
CHAPTER 4. OPPORTUNITIES FOR DETECTOR TECHNOLOGY AND COMPUTING

tors, with Fresnel lens focalization in the former and with gas and aerogel radiators in the latter. New coating materials like nano-diamonds to replace Cesium-Iodide (CsI) for RICH photo sensors are also under investigation. Time-of-Flight detectors, as well as Roman Pots for forward proton detection, require highly segmented AC-coupled Low-Gas Avalanche Detector (AC-LGAD) sensors whose development has just started to get support from the program. Besides hardware R&D the

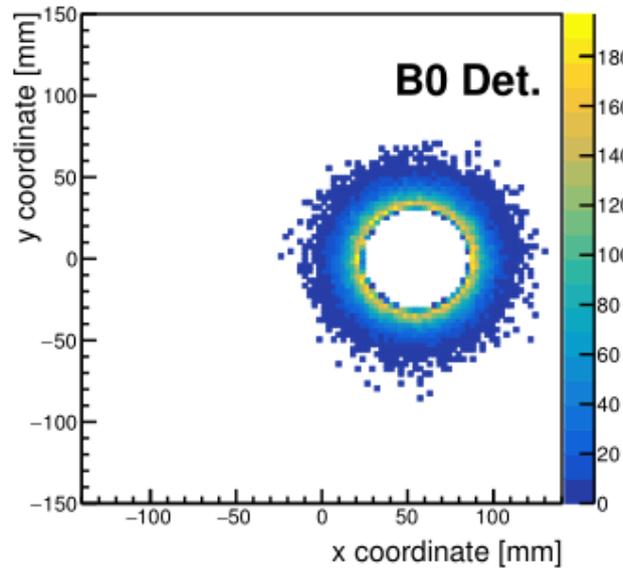
[generic EIC-related R&D] program has supported various vital projects such as machine background studies and simulation software developments to enable more accurate definition of the physics' requirements. Sartre and Beagle are two examples of Monte-Carlo event generators whose development was substantially boosted by the program. Both were extensively used in the context of this report.

Example: diffractive $e+D \rightarrow e'+p+n+J/\psi$

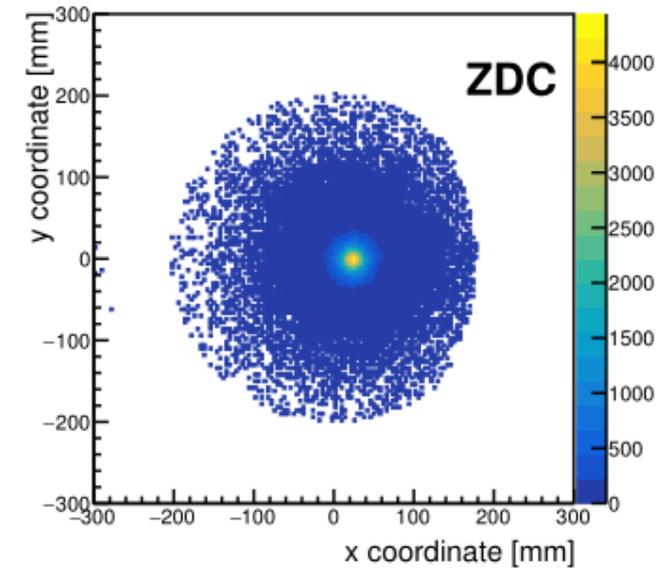
Active proton hits



Active proton hits



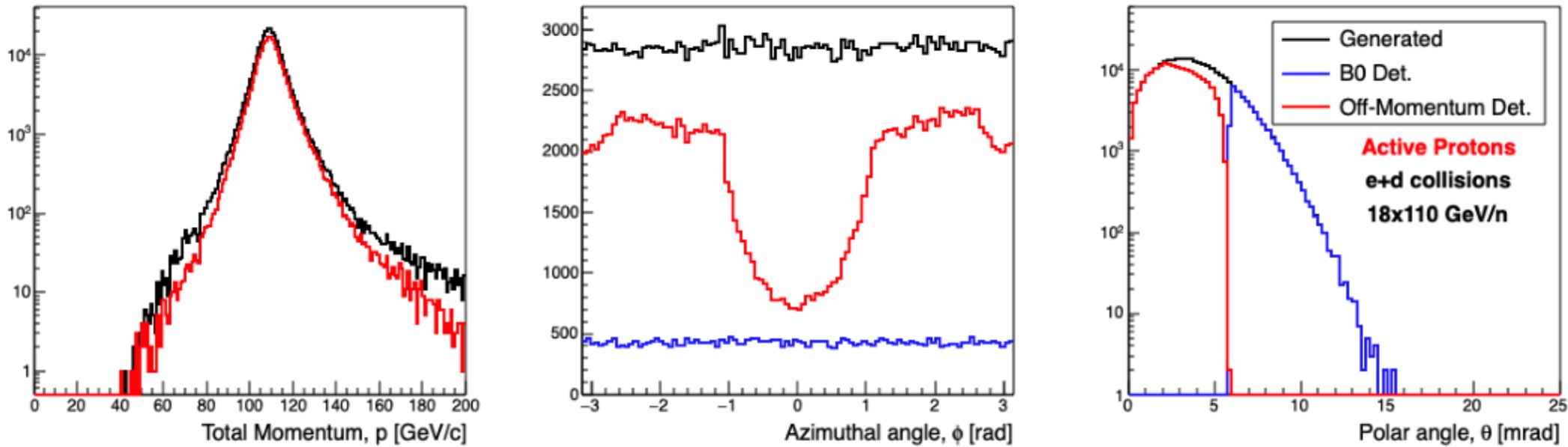
Spectator neutron hits



Yellow Report Figure 11.100
BeAGLE + GEANT

http://www.eicug.org/web/sites/default/files/Yellow_Report_v1.1.pdf

Example: diffractive $e+D \rightarrow e'+p+n+J/\psi$



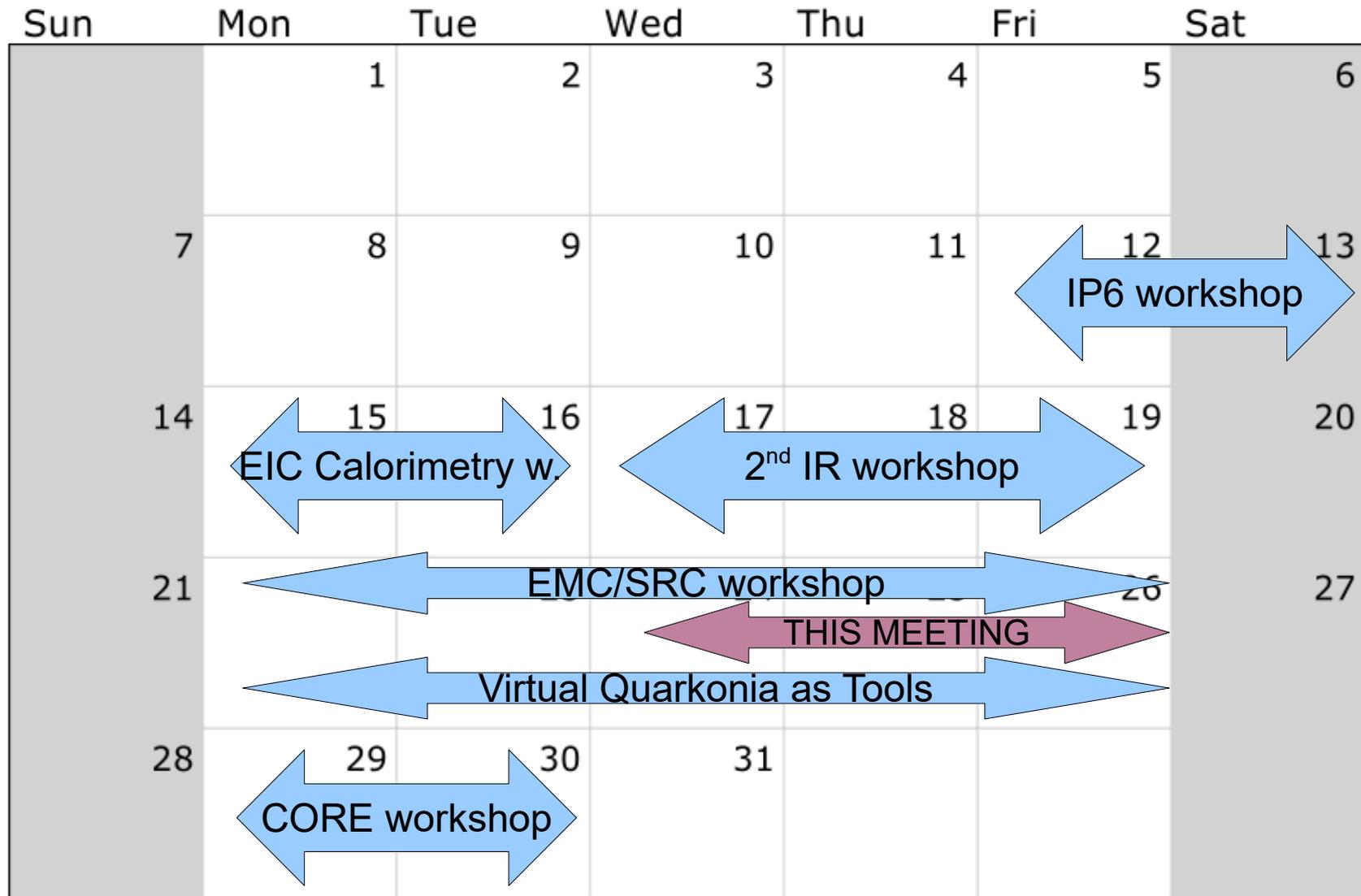
Yellow Report Figure 11.103
BeAGLE + GEANT

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"EIC on Steroids" (to quote Thomas...)

Or the other March Madness!

March 2021



A week in the life...



3rd Workshop on Quantitative Challenges in EMC and SRC Research

This afternoon!

15:00	GCF and the BeAGLE simulation code (20+5)	<i>Mark Baker</i>	14:50 - 15:15
	Tritium (e,e')	<i>Shujie Li</i>	15:15 - 15:40
	Tagging with Tensor Polarized Deuteron (20+5)	<i>Wim Cosyn</i>	15:40 - 16:05
16:00	FLASH TALK: Extraction of Nuclear Properties from Semi-Inclusive Data using GCF (10+2) (Alex Kiral)		16:05 - 16:15
	Discussion		16:15 - 16:40

A week in the life...

virtual Quarkonia As Tools 2021

22-26 March 2021

Virtual

Europe/Brussels timezone

This afternoon!

16:00	Event activity dependence of heavy flavor and quarkonium production in small collision systems <i>Kazuhiro Watanabe</i> 	16:00 - 16:15
	<i>Virtual</i>	
	Quarkonium production in proton-nucleus collisions at the LHC <i>Luca Micheletti</i>	16:20 - 16:35
	<i>Virtual</i>	
	Quarkonium measurements in small systems at LHCb <i>Qiuchan Lu</i>	16:40 - 16:55
	<i>Virtual</i>	
17:00	Overview of DPS theory <i>Riccardo Nagar</i>	17:00 - 17:15
	<i>Virtual</i>	
	Transverse proton structure via double parton scattering in photon-induced interactions <i>Matteo Rinaldi</i>	17:20 - 17:35
	<i>Virtual</i>	
	Investigations of coherent $J/\psi/\psi(2S)$ production background and eA collision geometry using forward particles at the EIC <i>Wan Chang</i>	

A week in the life...

virtual Quarkonia As Tools 2021

22-26 March 2021
Virtual
Europe/Brussels timezone

Tuesday

	Virtual Coffee break on Wonder	Virtual	15:45 - 16:00
16:00	Quarkonium production at GlueX	Virtual	Lawrence Ng  16:00 - 16:15
	Study of Short-Range nuclear Correlations in light nuclei using BeAGLE event generator	Virtual	Zhoudunming Tu  16:20 - 16:35
	Accessing GTMDs through pair production of jets, Quarkonia and open heavy flavours	Virtual	Farid Salazar  16:40 - 16:55
17:00	Discussion on a add-on on quarkonia to the EIC YR	Virtual	17:00 - 18:00

Impact of Reduced Funding - FY2021

FY2021 Funding	Total Funding (incl. carryover)	%Funding	Baker FTE	Result
\$93,000	\$121,500	100%	0.45 FTE	Project goals completed
\$74,400	\$102,900	80%	0.38 FTE	Goals may slip
\$55,800	\$ 84,300	60%	0.31 FTE	Unlikely to finish in FY2021

Table 3: Impact of Reduced Funding in FY2021

Despite committee recommendation for full funding, only \$71,300 was available.

77% of requested new funding.

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FY2021 Milestones (full funding)

- November 21, 2020: BeAGLE results at YR meeting.
- January 2021: Benchmark channels in good enough shape to be used in YR (possibly in preliminary form).
- May 2021: BeAGLE improved as needed for the baselining.
- Sept. 2021: BeAGLE tuned as well as possible & uncertainties quantified.

FY2021 Milestones (adjusted)

- November 21, 2020: BeAGLE results at YR meeting.
- January 2021: Benchmark channels in good enough shape to be used in YR.
One channel (SRC/EMC) postponed to 3/31.
- May 2021: BeAGLE improved as needed for the baselining.
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FY2021 Milestones status

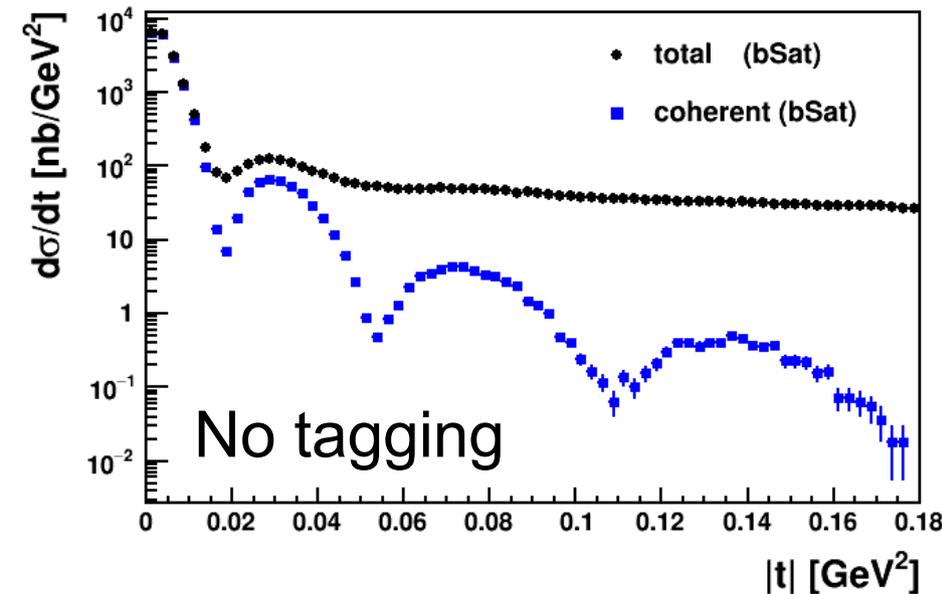
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Documentation and Publications

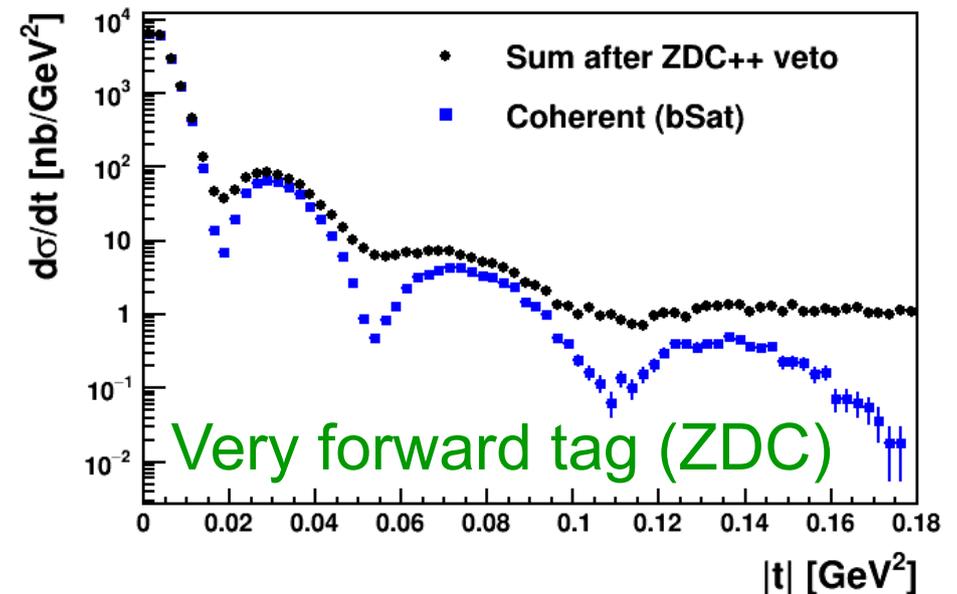
- Updating documentation and creating examples.
- Publications:
 - Z. Tu, A. Jentsch, M. Baker, L. Zheng, J.-H. Lee, R. Venugopalan, O. Hen, D. Higinbotham, E.-C. Aschenauer, and T. Ullrich, "Probing short-range correlations in the deuteron via incoherent diffractive J/ψ production with spectator tagging at the EIC," *Physics Letters B* 811 (2020) 135877.
 - More on the way from Yellow Report figures & newer studies.

Veto tagging incoherent diffraction

Sartre 10x40 e+Pb->J/ψ+X (smeared)



Sartre 10x40 e+Pb->J/ψ+X (smeared), BeAGLE $\tau_0=7$ fm



Note: plot from 2019 for illustration...

- Veto tagging is essential to measure coherent diffraction (& the spatial gluon distribution in the nucleus).
- ZDC neutron tag alone is questionable.
- Currently we are studying the effect of beampipe design on forward photon detection. **More GEANT than BeAGLE!**

Future of BeAGLE development – FY2022+

- Looking to identify specific, short, targeted projects for support by the labs driven by new theoretical and/or experimental results.
- Some examples
 - Improve the description of multinucleon shadowing and or partonic saturation in BeAGLE w/ theorists.
 - Compare and tune the BeAGLE+GCF SRC process with intranuclear cascade to JLAB12 data.
 - Valuable for describing active data.
 - Can validate the BeAGLE/DPMJET Intranuclear Cascade which we have been relying upon for EIC.

Future of BeAGLE development – FY2022+

- EIC Upgrades (and generic R&D) will also likely be driven by new "beyond the Yellow Report" theoretical and experimental results.
- Targeted BeAGLE development to address these new questions may be needed in the future as well, particularly as we try to improve the forward physics / eA capability of the detectors.

Conclusion

- The Past (FY2015-now)
 - eRD17 was critical in defining the IR/Detector Requirements for eA @ EIC – as planned!
- Immediate future – plenty to do!
- Project completion: 9/30/2021
- BeAGLE after eRD17
 - Targeted shorter projects may arise.
 - For continuity purposes, it may be valuable to support a low level of continuous development and maintenance.