RHIC Software Effort

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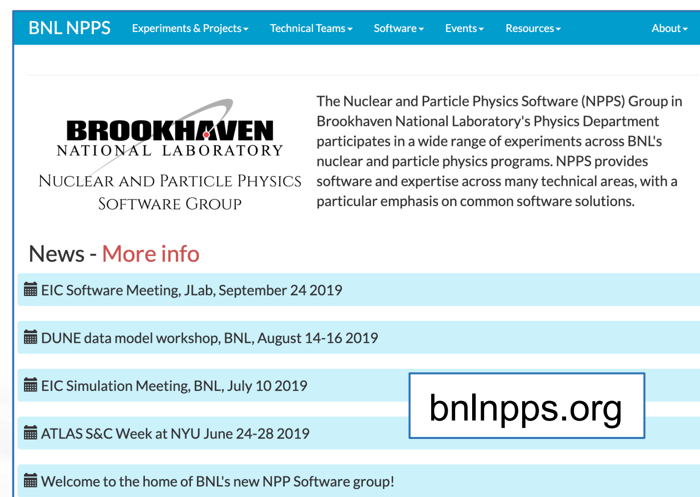
DOE NP RHIC Science & Technology Review
17 – 19 September 2019

Outline

- Nuclear and particle physics software at BNL: Introduction to the new (4 month old) Nuclear and Particle Physics (NPPS) Group
  - Mandate and organization
  - Experiment involvement
  - Technical activity
  - Status
- NPPS RHIC efforts
  - STAR
  - PHENIX
  - sPHENIX
- NPPS EIC efforts
- Community software in NPPS
- Conclusion

Nuclear and Particle Physics Software (NPPS) Group

- In May 2019, discussions on how to consolidate NP and HEP software efforts at BNL converged on a plan to create the NPPS group
- Group resides in the Physics Department
- Initial membership of 19 people
  - 14 from former Physics Applications Software group
  - 4 from STAR
  - 1 shared by STAR/PHENIX
- More information at website
  - In development
- E-list is open to all
  - phys-soft-comp-l@lists.bnl.gov info



NPPS Mandate

BROOKHAVEN NATIONAL LABORATORY
Nuclear and Particle Physics Software Group

The Nuclear and Particle Physics Software (NPPS) Group in Brookhaven National Laboratory's Physics Department participates in a wide range of experiments across BNL's nuclear and particle physics programs. NPPS provides software and expertise across many technical areas, with a particular emphasis on common software solutions.

- Consolidate HEP and NP software efforts into a **consortium of experts on NPP software**, infrastructure, services and tools, sharing knowledge and coordinating efforts
- **Top priority:** serve experiment operational needs, with continuity of support and responsibilities when creating the NPPS group. Don't break things!
  - Strongly emphasized by experiment leads
  - The group is organized to ensure this: put experiments first
  - NPPS members are experiment collaborators reporting along experiment reporting lines
- Propose and lead **development and R&D** with near and long term objectives aligned with the Department's strategic plan and vision
  - Strength in S&C is part of BNL's vision for technical and intellectual leadership in key NPP experiments

NPPS Mandate 2

- Foster the **engagement** of BNL with wider NPP S&C communities & projects
- The group as a consolidation of strong experimental software teams in **both nuclear and particle physics** is unique among US Laboratories
- Seek opportunities to **draw on this strength** and past successes and expand its reach for the benefit of US and international nuclear and particle physics programs
- The focus of the group on **common, cross-cutting projects** will allow it to present a strong case for support in an environment that strongly favors common cross-cutting efforts over ones focused on single experiments
- Be **proactive in seeking funding** via LDRD, program development funds, DOE ASCR, DOE HEP Computing, and DOE NP, with an emphasis on common projects and leveraging the group's cross-cutting scope & expertise

NPPS Membership

- Decided through consultation between Department Chair, experiments, NPPS
- Group structured so that non-members can collaborate fully and effectively
  - Make group boundaries transparent for those working together on projects
- Foster bottom-up organization of working teams
  - Hence the technical team structure of the group

NPPS group members

David Adams
Dmitry Arkhipkin
Johannes Elmsheuser
Amol Jaikar
Alexei Klimentov
Paul Laycock
Tadashi Maeno
Ruslan Mashinistov
Paul Nilsson
Marcin Nowak
Sergey Padolski
Sergey Panitkin
Victor Perevoztchikov
Maxim Potekhin
Dmitri Smirnov
Alex Undrus
Gene Van Buren
Torre Wenaus
Shuwei Ye

NPPS Organization: Leadership Team

- Group is managed by a **leadership team** consisting of
- **Group leader** answerable to the Department Chair
  - Works in close collaboration with the rest of the leadership team in all aspects of planning and managing the group's activities and overseeing its personnel
- Leadership team **members representing the principal experiments** and scientific activity areas of the group
  - ATLAS - Alexei Klimentov
  - Belle II - Paul Laycock
  - DUNE - Brett Viren
  - EIC - Alexander Kiselev
  - sPHENIX - Chris Pinkenburg
  - STAR - Gene Van Buren

Experiments and programs with existing or aspiring NPPS involvement

- Nuclear physics
  - STAR
    - 5 members on reconstruction, calibration, simulation, software infrastructure, production
  - PHENIX
    - 1 member on simulation
  - sPHENIX
    - sPHENIX review this month identified 5 FTEs of tasks for NPPS
  - Electron Ion Collider
    - 2 members on sw infrastructure, collaborative tools, sw coordination
  - Lattice QCD
    - 1 member on HPC workload management and utilization
- High energy physics
  - ATLAS
    - 9 members on distributed sw, core sw, sw infrastructure, …
  - Belle II
    - 3 members on data management, conditions database
  - DUNE
    - 1 member on protoDUNE software development, support, analysis
    - Exploring other possible contributions
  - LSST
    - Past work on distributed sw, exploring documentation/development work

Experiments

NPPS members participate in many of BNL's nuclear and particle physics experiments and programs, working as members of experiment software teams. We also participate in community projects such as the HSF.

ATLAS at the LHC (CERN)

Belle II at SuperKEKB (KEK)

DUNE Long Baseline Neutrino Facility (FNAL & Sanford)

Electron Ion Collider (EIC)

HEP Software Foundation (HSF)

Lattice QCD

Large Synoptic Survey Telescope (LSST)

PHENIX at RHIC (BNL)

sPHENIX at RHIC (BNL)

STAR at RHIC (BNL)

NPPS Experiment Teams

The teams will take material shape around new common projects as they are established

Teams made up of NPPS members and non-members

Group Leader
Wenaus

Leadership Team
Experiment reps: ATLAS, Belle II, DUNE, EIC, sPHENIX, STAR
Klimentov, Laycock, Viren, Kiselev, Pinkenburg, Van Buren

ATLAS
Elmsheuser, Klimentov, Maeno, Nilsson, Nowak, Padolski, Undrus, Wenaus, Ye

Belle II
Laycock, Mashinistov, Padolski

DUNE
Adams, Klimentov, Laycock, Viren, Wenaus

EIC
Arkhipkin, Kiselev, Pinkenburg, Potekhin, Wenaus

sPHENIX
Pinkenburg

STAR
Arkhipkin, Jaikar, Perevoztchikov, Smirnov, Van Buren

PHENIX
Jaikar, Pinkenburg, Potekhin

LSST
Wenaus

NP Theory LQCD
Panitkin

	NPPS members	From group	Based at	Experiment(s)	(Some of) people's activities	FTE%
1	David Adams	PAS	BNL	(Proto)DUNE	dunetpc sw, protoDUNE analysis	100% DUNE
2	Dmitry Arkhipkin	STAR	BNL	STAR	All things database	100% STAR
3	Johannes Elmsheuser	PAS	CERN	ATLAS	Distributed computing, jet/MET software	100% ATLAS
4	Amol Jaikar	PHENIX, STAR	BNL	(s)PHENIX, STAR	Production	50/50 STAR/PHENIX
5	Alexei Klimentov	PAS	CERN	ATLAS	Distributed computing, PanDA, HPCs	90% ATLAS, 10% DUNE
6	Paul Laycock	PAS	BNL	Belle II	Data management, conditions DB	90% Belle II, 10% DUNE
7	Tadashi Maeno	PAS	CERN	ATLAS	Distributed computing, PanDA core	100% ATLAS
8	Ruslan Mashinistov	PAS	BNL	Belle II	Data management, conditions DB	100% Belle II
9	Paul Nilsson	PAS	CERN	ATLAS	Distributed computing, PanDA pilot	100% ATLAS
10	Marcin Nowak	PAS	CERN	ATLAS	I/O software, ROOT I/O integration	100% ATLAS
11	Sergey Padolski	PAS	BNL	ATLAS, Belle II	Monitoring systems, data management	80% ATLAS, 20% Belle II
12	Sergey Panitkin	PAS	BNL	LQCD	PanDA for LQCD, HPCs	100% LQCD (depart 9/19)
13	Victor Perevoztchikov	STAR	BNL	STAR	Reconstruction, tracking	100% STAR
14	Maxim Potekhin	PAS	BNL	(Proto)DUNE, Belle II	Data quality, conditions DB	50% PHENIX, 50% EIC
15	Dmitri Smirnov	STAR	BNL	STAR	Reconstruction, tracking	100% STAR
16	Alex Undrus	PAS	BNL	ATLAS	Software infrastructure, testing	100% ATLAS
17	Gene Van Buren	STAR	BNL	STAR	TPC calibration, tracking	100% STAR
18	Torre Wenaus	PAS	BNL	ATLAS, LSST	Distributed computing	40% ATLAS, other 10%s
19	Shuwei Ye	Omega	BNL	ATLAS	Analysis support, software infrastructure	100% ATLAS

NPPS Organization: Technical Activities

- NPPS members are experiment collaborators reporting along experiment reporting lines
- NPPS inherited the experiment responsibilities of its members, as defined and overseen by the experiments
- Consequently the primary technical organization and reporting lines for NPPS members are in their experiments
  - Overseen within NPPS by Group Leader and Leadership Team rep for the experiment
- But NPPS was created to cultivate and grow cross-cutting common projects and common software
- Hence the Technical Teams

NPPS Technical Teams

- NPPS technical teams gather experts on a technical topic from across experiments to catalyze, establish and carry out common efforts
- Match experiment needs to capabilities, software and expertise within the group and the Department
- Draw support for new R&D and development work building on expertise and delivering for multiple experiments
- Tech teams begin as discussion forums, and extend to real common efforts when projects and manpower are identified

Technical Teams

Beyond experiment-specific work, NPPS members and collaborators make up technical teams spanning the group's many areas of expertise. Teams may be actively engaged in cross-experiment projects or may act as technical forums sharing expertise and exploring common project opportunities.

Analysis tools

Collaborative tools, documentation and training

Core software & advanced algorithms

Databases

Data and analysis preservation

Distributed data management

High performance computing

Real-time analysis

Reconstruction

Simulation

Software infrastructure and support

User interfaces, monitoring and analytics

Workflow and workload management

NPPS Technical Teams

The teams will take material shape around new common projects as they are established

Teams made up of NPPS members and non-members

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Wenaus

Leadership Team
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Klimentov, Laycock, Viren, Kiselev, Pinkenburg, Van Buren

Analysis tools	*Elmsheuser, Laycock, Maeno*
Collaborative tools	*Arkhipkin, Padolski, Potekhin, Wenaus*
Core software	*Adams, Kiselev, Nowak, Perevoztchikov, Pinkenburg, Viren*
Databases	*Arkhipkin, Laycock, Maeno, Mashinistov*
Data preservation	*Potekhin*
Data management	*Elmsheuser, Klimentov, Laycock, Maeno, Mashinistov, Nilsson, Padolski*
HPC	*Klimentov, Maeno, Nilsson, Panitkin, Wenaus*
Real time analysis	*Viren*
Reconstruction	*Adams, Elmsheuser, Kiselev, Perevoztechikov, Pinkenburg, Smirnov, Van Buren, Viren*
Simulation	*Kiselev, Perevoztchikov, Pinkenburg, Potekhin, Van Buren, Viren, Wenaus*
SW Infrastructure	*Adams, Jaikar, Smirnov, Undrus, Ye*
Monitoring & Analytics	*Elmsheuser, Jaikar, Padolski, Undrus*
Workflow/workload management	*Elmsheuser, Klimentov, Laycock, Maeno, Nilsson, Padolski, Panitkin, Wenaus*

NPPS Technical Teams 1

- Analysis tools
  - We co-coordinate the HEP Software Foundation's analysis tools working group
- Collaborative tools, documentation and training
  - Ensure experimental needs are met by provided services
- Core software and advanced algorithms
  - Particular focus: software, I/O and algorithms/techniques (e.g. ML) for leveraging HPCs and accelerators
- Databases
  - Wide variety of DB based tools and services, e.g. conditions DB
- Data and analysis preservation
  - Of immediate importance for PHENIX, down the road for STAR, sPHENIX (and all the rest)
- Data management
  - Core capability particularly with the community-standard Rucio
- High performance computing
  - Core capability via long-time HPC investment in ATLAS, realized in PanDA workload manager capabilities

NPPS Technical Teams 2

- Real time analysis
  - TDAQ/online is outside NPPS scope but much online/offline commonality in software; discussion forum across the many experiments pursuing this (including STAR, sPHENIX, EIC)
- Reconstruction
  - TPC/tracking expertise, sPHENIX interest in ATLAS tracking common project ACTS
- Simulation
  - Full/fast simulation for EIC, PHENIX, sPHENIX, STAR, ATLAS
- Software infrastructure and support
  - Continuous integration, development & testing tools, containers
- User interfaces, monitoring and analytics
  - Common web-based monitoring and analytics tools
- Workflow and workload management
  - Deep expertise as developers of workload and workflow systems for ATLAS and others

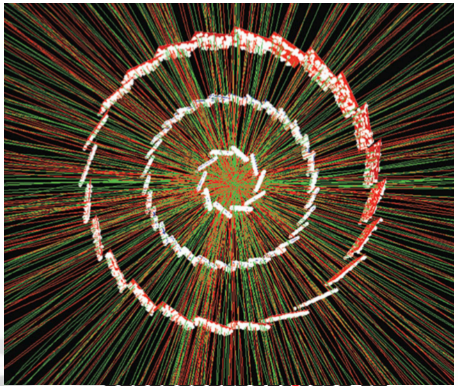
NPPS status, four months in

- As requested, nothing broken! Non-interfering impedance match to prior activities
- Identified initial priorities for new activity: sPHENIX, EIC, DUNE
- LDRD proposals for sPHENIX+EIC and DUNE (not successful)
- Program Development proposal for all three under one ‘Strategic Software’ submission
  - Proposal description is in the supplemental slides
  - 2 FTEs x 3 years for sPHENIX transitioning to EIC
  - 2 FTEs x 3 years for DUNE
  - Waiting on the outcome
- Two job postings out thanks to Physics Department support
  - Belle II / ATLAS / DUNE data management expert
  - sPHENIX software postdoc
- Worked with EIC Users Group and JLab to increase BNL’s participation and presence in EIC software
- Surveying software status & needs in all involved experiments, and the expertise & activities of members
- Participating in rapidly evolving S&C plans for forthcoming experiments: sPHENIX, EIC, DUNE
  - Substantial NPPS requests from sPHENIX review
  - Potential DUNE interest in NPPS capabilities (workload management, data management, conditions DB)
- Next: as effort becomes available, ramp up tech teams on common activity
  - Early priorities: collaborative tools, reconstruction, databases, data/analysis preservation, simulation, software infrastructure, workload management
- Coming slides: NPPS activities and plans across BNL’s NP software efforts
  - In all these, NPPS is a contributor within a larger effort both at BNL and in the wider experiment/program

STAR

- Generally NPPS people contribute part of these efforts, not all (true of all NPPS activities). Many other contributors are in BNL STAR, wider STAR
- 5 STAR S&C people are in NPPS; a similar number remain in STAR group
- Databases (DA)
  - Online and offline conditions DBs, run log, geometry, file catalog, …
- Calibration (GVB)
  - Initial calibrations performed within ~1 week of new collision conditions
  - Full calibrations in a few months after datataking completes
  - TPC calibrations expose unique issues for study almost every year
- Reconstruction (VP, DS)
  - Tracking via cellular automata + Kalman
  - CA a collaboration with ALICE, CBM (GSI)
  - Handling of non-uniform magnetic fields and forward tracking for coming upgrades
- Software infrastructure (AJ, DA, DS)
  - ~5M lines of code, 60% C++, 35% Fortran
  - Comprehensive nightly test suite
  - Code QA via peer review, cppcheck, coverity, ...
- Production (AJ)
  - Highly efficient: 99% job success on first attempt
- Development and R&D continues
  - STAR Forward Upgrade
    - New tracking and calorimeter systems

Dmitry Arkhipkin
Amol Jaikar
Victor Perevoztchikov
Dmitri Smirnov
Gene Van Buren



PHENIX

Amol Jaikar
Maxim Potekhin

- Simulation (MP)
  - Coordinating the PHENIX simulation effort
  - Helping analyzers to run their simulations
  - Developing common and documented simulation macros and templates for tasks such as embedding
  - Optimizing schemes to embed MC particles into raw data
  - Prepare MC track samples for efficiency studies
  - Investigating handling of and access to conditions data, dead channel maps towards improved reproducibility
- Data and analysis preservation (MP)
  - Developed together with PHENIX management and experts a proposal for data and analysis preservation
  - Identifies particular PHENIX constraints (e.g. tight coupling to RACF), enabling technologies (containers), needed effort
  - Next: NPPS work with STAR and PHENIX to generalize the proposal to also meet coming STAR (and sPHENIX…) needs
  - Common approach, common effort as much as possible
  - Couple to and leverage wider community efforts
- Production (AJ)
  - Production operations effort shared with STAR over the last year

Data and analysis preservation

- Some comments in light of the discussion yesterday
- Meaningful preservation requires addressing the whole problem: the data itself, conditions and metadata, analysis software and workflows, reproducibility, MC must be included, …
- Experiments (like mine, ATLAS) have begun seriously addressing this in recent years
  - ATLAS produced a (DESY led) internal report in 2017
    - Focus of the recommendations is to use the CERN Analysis Portal (CAP); we should look at it
  - Analysis preservation was made part of the mandate of the newly created Data Characterization and Curation group
- A persistent problem has been getting support for putting people to work on it, both within experiments and in the wider community -- easily falls down the priority list
- But there are recent factors pushing progress nonetheless
  - **Containers**. This is a key enabling technology that is also a powerful analysis tool: developing and sharing reproducible, portable analyses
    - We have jumped on containers for analysis and are making progress on analysis preservation almost as a byproduct
  - **Open data**. Not only is it good for outreach and collaboration but it's increasingly mandated. Addressing open data confronts data/analysis preservation issues.
    - Experiments are increasingly realizing its importance. CMS went further than ATLAS in releasing a Run-1 data sample in AOD form together with the tools to use it, with the result that the CMS data sample is widely used in the community, e.g. for the Higgs ML challenge
    - ML in itself is a big driver for more attention to open data; ATLAS receives a steady stream of requests from its members to give data access to non-ATLAS collaborators on ML projects
  - **Metadata recording and reproducibility**. Large experiments are increasingly sophisticated in recording metadata and conditions with sufficient completeness for reproducibility
    - ie an essential ingredient for analysis preservation – one very difficult to retrofit – is increasingly seriously addressed
    - New/young experiments have the opportunity to address this up front and so avoid a big retrofit challenge
- Bottom line: meaningfully achieving data and analysis preservation is regarded as a real and realistic goal
  - But it takes real effort and support

sPHENIX

No active NPPS members yet

- A priority for new NPPS effort
  - "It's in BNL's vital interest to ensure sPHENIX software is developed successfully on schedule, enabling timely analysis and scientific output, and is subsequently well supported."
- sPHENIX has just undergone an ambitious and productive software & computing planning cycle
  - sPHENIX Computing Plan, Aug 29 2019
    - A comprehensive 36pp plan covering online, offline, resource and effort needs
  - sPHENIX software & computing review, Sep 5-6 2019
    - Charge: Assess understanding of resources required for data transmission and storage, processing and analysis; software development plan
- Planning/review process identified several areas in which sPHENIX would like to see NPPS effort (so would we!), leveraging NPPS expertise
  - Track reconstruction, meeting speedup requirements, investigating applicability of ATLAS-originated ACTS common tracking software
  - Challenging and critical TPC distortion corrections, building on ALICE work
  - Databases, data management, record keeping, drawing on much existing software and community-standard Rucio
  - Software releases and QA, leveraging support for other experiments
  - Simulation
  - Distributed workflows, leveraging group expertise, tools such as PanDA
  - GPU acceleration, leveraging work in NPPS HEP, collaboration with CSI

sPHENIX: Requested NPPS contributions

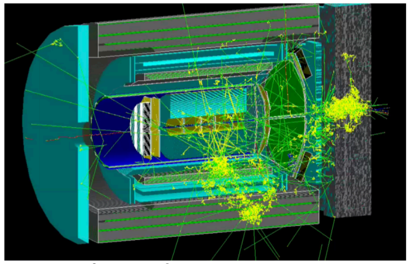
Prioritized effort, existing and needed, presented to the reviewers

Description	*Effort*	*Names*	*Risk if not realized*
Develop/Maintain online computing tools	1.0	M. Purschke	Operational risk to data taking
Develop/Maintain offline framework	1.0	C. Pinkenburg	Operational risk of data quality, speed of analysis
Develop/Maintain simulation tools	1.0	J. Huang	Suboptimal detector refinements, configuration
TPC distortion calibration	**1.0**	**NPPS**	**Failure to reconstruct tracks, meet Upsilon mass req.**
Achieve 5 sec/event track reco	**1.0**	**NPPS**	**Larger CPU needs**
Track reconstruction and calibration	1.0	C. Roland	Larger CPU needs
Fast ADC / Clustering	0.5		Larger CPU needs
Calorimeter Calibration	0.5	U. Colorado/LLNL	Fail to meet JES/JER req., trigger rejections in pp, pA
Jet-calibration (with TPC)	0.5		Failure on core physics aim of sPHENIX
Trigger rates, adjustments	0.2	U. Colorado	Failure to meet trigger rejections in pp, pA
Database, data moving, record keeping	**0.5**	**NPPS**	**Operational risk to data taking, production**
Release and QA	**1.0**	**NPPS**	**Operational risk to data QA, readiness for analysis**
Vertex Finding	1.0	A. Frawley	Risk to HF program
0.2 FTE per subsystem	1.0		
0.2 FTE per substystem (excluding TPC)	1.0		
Simulation/Verification	**0.5**	**NPPS**	**Suboptimal detector refinements, configuration**
Integration	0.5		
Distributed workflows	**0.5**	**NPPS**	**Suboptimal**
Fast Simulators	0.5		
GPU-acceleration	**0.5**	**NPPS**	**Inability to use some HPC resources, also Lab focus**
	14.7	**(5 NPPS)**	

NPPS effort request: 3.5 high priority FTEs (red), 1.5 lower priority (blue)
NPPS acting on these requests requires adding effort
- Both to provide incremental effort needed and to backfill existing experts

EIC

Fun4All
EIC simu



Charged Current DIS

Dmitry Arkhipkin
Alexander Kiselev
Chris Pinkenburg
Maxim Potekhin
Torre Wenaus

- A priority for new NPPS effort
  - "BNL involvement and expertise in EIC software feeds directly into BNL leadership in detector development and ultimately EIC science, with dedicated effort needed now to secure central roles for BNL"
- EIC software coordination (TW)
  - The EIC Users Group established last year a Software Working Group tasked with delivering the software needed by the EIC community
  - TW co-coordinates with M. Diefenthaler (JLab), A. Bressan (INFN Trieste)
    - EIC Software WG report at BNL, July 2019
- EIC simulation (EIC, sPHENIX; no NPPS at present)
  - Strong EIC software focus at present is on simulation, with EIC UG mandate for common tools: a user with a (sub)detector model should be able to try it in all detector concepts
  - BNL developed and supports several of the principal EIC simulation tools
    - eic-smear fast simulation, EicROOT, Fun4All
  - NPPS focus has been on usability of the tools, following the UG mandate, in collaboration with (in particular) Jlab
- Collaborative tools and software infrastructure
  - NPPS supports and develops EIC community tools including website/wiki, e-lists/google groups, phonebook, common software stack
  - Supported by EIC Users Group and best-effort

The EICUG Software Working Group's initial focus will be on **simulations of physics processes and detector response** to enable quantitative assessment of measurement capabilities and their physics impact. This will be pursued in a manner that is accessible, consistent, and reproducible to the EICUG as a whole.

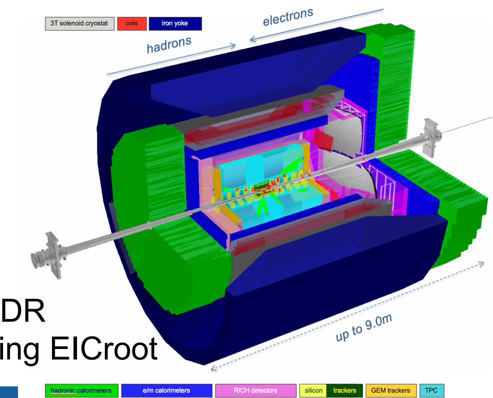
EIC simulation

ANL TOPSiDE detector concept (ILC software variant)

BNL BeAST detector concept: EICroot (FairRoot variant)

BNL ePHENIX detector concept (Fun4All)

JLAB JLEIC detector concept (GEMC → eJANA)



eRHIC pCDR studies using EICroot

- EIC Software meeting at BNL in July focused on addressing community need for commonality and ease of use in simulation
- Established a set of agreements that when implemented will deliver the requested commonality, and will fully enfranchise BNL software
  - eRHIC studies using EICroot ongoing
  - ePHENIX studies based on Fun4All ongoing
- Followup meeting Sep 24 at JLab will address implementing the agreements (standards and conventions for Geant4 detector model descriptions, geometries, response)
- Deliver documented standards this fall, and implemented commonality this year
- Our current focus is consistent with a long term strategy: concentrate on priority community needs, leveraging BNL and wider community work, and collaborating closely with JLab and others
  - Launching a joint BNL-JLab 'software roundtable' monthly community meeting, previously run by JLab

EIC Software Meeting on Detector and Physics Simulations

Wednesday 10 Jul 2019, 09:00 → 15:00 US/Eastern

2-160 (BNL Physics)

Andrea Bressan (Trieste), Markus Diefenthaler (Jefferson Lab), Torre Wenaus (BNL)

35 participants

Why we urgently need a
- common (EIC-wide)
- easy to use*
- capable

detector simulation software

EIC Software Meeting on Detector and Physics Simulations

Wednesday Jul 10, 2019, BNL

Thomas Ullrich (BNL)

EIC User Group
- preparation of EIC collaborations
- request for common software tools and documentation

Request from EIC Generic Detector R&D program:
- in most cases only GEANT simulations are needed:
  - no need for sophisticated framework
  - no need for elaborate tracking
- a simple *lite setup* with a well defined geometry description standard might get them a long way as long if it is EIC wide and easy to use

Goals
- meet requirements by EIC community fully
- meet requirements by EIC community by end of 2019

Approach
- common repository for detector R&D for tEIC
- common detector description in Geant4 (C++)
- common detector naming convention for EIC
- common definition of parameters and their management
- common API/class design for sensitive detector stepping action
- possible common hits output structure
- concise document and template on how to implement and integrate subdetector in the detector concepts for the EIC

Community software in NPPS: highlights

- ROOT
  - Long time STAR expertise/contributions to ROOT core, graphics, schema evolution
  - NPPS responsible for ROOT I/O in ATLAS
- Conditions database
  - Belle II conditions DB, a realization of the community concept documented by the BNL-led HEP Software Foundation (HSF) working group
- PanDA workload manager
  - With its ancillaries (pilot, Harvester resource provisioning, monitoring, event service/iDDS) a uniquely scalable and capable (e.g. on LCF HPCs) workload manager originating in ATLAS
    - Experiment-agnostic ancillary projects iDDS and Harvester via the HSF
- Rucio data manager
  - Originated in ATLAS, tightly coupled to PanDA, becoming a de facto community standard (adopted by CMS, DUNE, Belle II, many others; considered by sPHENIX and others)
- ACTS tracking software
  - ATLAS originated common project for LHC Run-3, Run-4

Software

NPPS members and collaborators have developed and/or have expertise on many software products and projects, many of which are (or could be) multi-experiment **common software**.

ACTS

Athena

Conditions database

DIRAC

dunetpc

EicRoot

eic-smear

ATLAS event service

Fun4All

Harvester

HEP software knowledge base

Intelligent data delivery system (iDDS)

LXR code browser

PanDA workload management system

PanDA monitoring system

PanDA pilot

ATLAS production system

ROOT

Rucio

Conclusion

- The RHIC software effort is consolidating in the new NPPS group to maximize commonality and crosscutting expertise (HEP and NP)
  - STAR core effort, entrusting NPPS with major responsibilities and deliverables
  - PHENIX support for ongoing analysis, preservation
  - sPHENIX plan to confer major responsibilities on NPPS
  - Strong emphasis on growing BNL’s presence and visibility in EIC software
  - All leveraging wider NPPS capabilities and expertise: currently 14 HEP people across 4 experiments
- Uniquely among US labs, NPPS leverages under one roof strong software programs in NP and HEP
- Beginning to exploit that with proposals targeted at priority BNL programs where software is strong and/or can bring new strengths through leverage
  - sPHENIX, EIC, DUNE
- *Early* indications are that NP (and HEP) programs aren’t being hurt by the reorganization and are being helped by it
  - The leverage is real, and the clarity of one software group helps planning the future

Thank you

- Thank you to the NPPS Leadership Team and all group members and participants for contributions to this talk and the program it describes

References

- NPPS website and links therein
- sPHENIX Computing Plan, Aug 29 2019
- sPHENIX S&C review, Sep 5-6 2019
  - Charge
- EIC UG software working group report, Paris EIC UG meeting, July 2019
- EIC software website, google group
- EIC software WG repository https://gitlab.com/eic

Supplemental

NPPS Strategic Software proposal description

- **In sPHENIX software, it's in BNL's vital interest to ensure the software is developed successfully on schedule, enabling timely analysis and scientific output, and is subsequently well supported.** The 2018 sPHENIX S&C review concluded that sPHENIX needs a core software team at BNL. The effort funded by this proposal will nucleate this core team, complementing the overextended high level experts BNL now has on sPHENIX with expertise throughout the software stack (Fun4All framework, simulation, reconstruction/tracking, event building, I/O, conditions, analysis workflow, containerized software, test beam support, …). Our experts will be able to direct and train this core team, ensuring progress and datataking readiness, and making it possible to leverage other NPPS expertise important to sPHENIX (TPC software, data management, distributed processing, conditions database, computing model development, …). sPHENIX postdocs will complement the BNL core software effort when they arrive closer to datataking, with the BNL team ensuring continuity of software support. Close coupling to the EIC software effort will ensure shared expertise and knowledge transfer.

- **In EIC software, BNL involvement and expertise in software feeds directly into BNL leadership in detector development and ultimately EIC science, with dedicated effort needed now to secure central roles for BNL.** EIC software responsibilities are currently being competitively apportioned among those putting forward effort (JLab, BNL, ANL, LBNL, …). BNL's scientists are leaders in practical, needs-driven EIC software, but fully leveraging BNL's strengths requires dedicated effort to develop and deliver software to the community under the guidance of our experts, thus leveraging our expertise into visible influential leadership in EIC software. BNL provides much of the working EIC software, in particular the tools and capabilities the EIC community has been asking for. These include eic-smear fast simulation, full Geant4 based EIC detector simulations, and mature simu/reco frameworks (EicRoot, Fun4all). Others, in particular JLab, are investing and asserting leadership; we need to do the same. Our strategy is to share effort with sPHENIX with as much synergy as possible, with focus transitioning from sPHENIX to EIC over time.

- **In DUNE software, the software needs of DUNE -- a strategic priority for US HEP and BNL -- coincide with BNL strengths and present the opportunity for BNL to secure central software roles early, if we invest now.** Software responsibilities are being apportioned now, and decisions on computing model and technologies are being made. This is the moment for BNL to invest proactively in securing responsibilities that leverage and grow our strengths. We have an opportunity for BNL to secure central software roles early, if we invest now, with support transitioning later to US DUNE operations. The DOE wants BNL involved, and DUNE and Fermilab are supportive. BNL's unique strengths in software areas important to DUNE include data management (DUNE has adopted ATLAS's Rucio, and BNL has more Rucio expertise than anywhere outside CERN), workload management (BNL has world leading expertise, having developed ATLAS's PanDA), conditions database (BNL has in the Belle II CDB a system readily applicable to DUNE), software solutions to exploit DOE HPC and Exascale facilities, and longstanding expertise in computing model development at the most challenging scales. We are leading DIRAC-Rucio integration on Belle II which is particularly relevant for DUNE as that could well be the combination of WMS+DDM that DUNE will use.

- These new strategic investments will leverage experts and expertise in established programs including ATLAS, Belle II, PHENIX, and STAR. They will also leverage collaboration with SDCC (e.g. Rucio and conditions database expertise and services) and CSI (e.g. accelerator and HPC readiness). The supported effort will include both existing personnel and new hires. New hires will be used both to provide direct effort and to backfill existing experts contributing their expertise to these new ventures. The NPP Software Group was created to enable exactly this.