PHENIX data analysis and data preservation

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for PHENIX Collaboration

PAC 2021/06/22

PHENIX

Recent highlights
and
publication status

PHENIX

PHENIX papers since June 2020

PRD103,052009	**(2021)**	**π^0 A_N in $p+p$ at 200GeV**
PRD103,032007	**(2021)**	**$A_N(p_T)$ of very forward neutrons**
PRC102,054910	**(2020)**	**direct photon-hadron correlation in dAu, AuAu at 200GeV**
PRD102,092002	**(2020)**	**$b\bar{b}$ production at forward in $p+p$ at 510GeV**
PRD102,072008	**(2020)**	**Polarization and cross section of J/ψ in $p+p$ at 510 GeV**
PRC102,064905	**(2020)**	**π^0, η in U+U at 192GeV**
PRD102,032001	**(2020)**	**Charged pion A_{LL} in pp at 510 GeV**
PRC102,014902	**(2020)**	**Forward and Backwoard J/ψ in pp, pA, ^{3}HeAu at 200GeV**

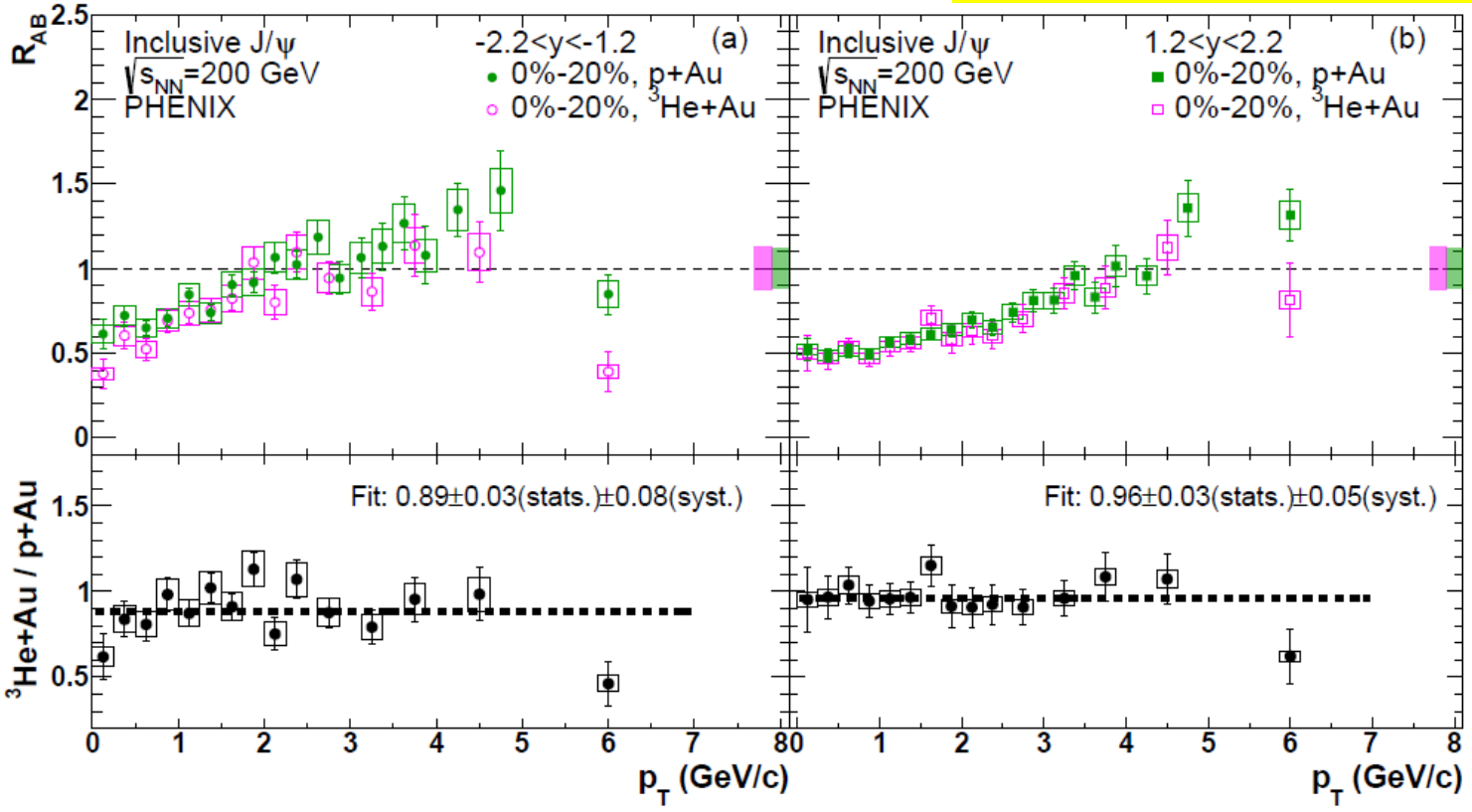
arXiv:2102.13585	A_N of direct photons in $p+p$ at 200 GeV
arXiv:1805.04066	$\mu\mu, e\mu, ee$ correlations in $p+p$ 200 GeV

- **8 papers published in the last 1 year**
- **2 papers in journal review**

PHENIX

J/ψ in small systems

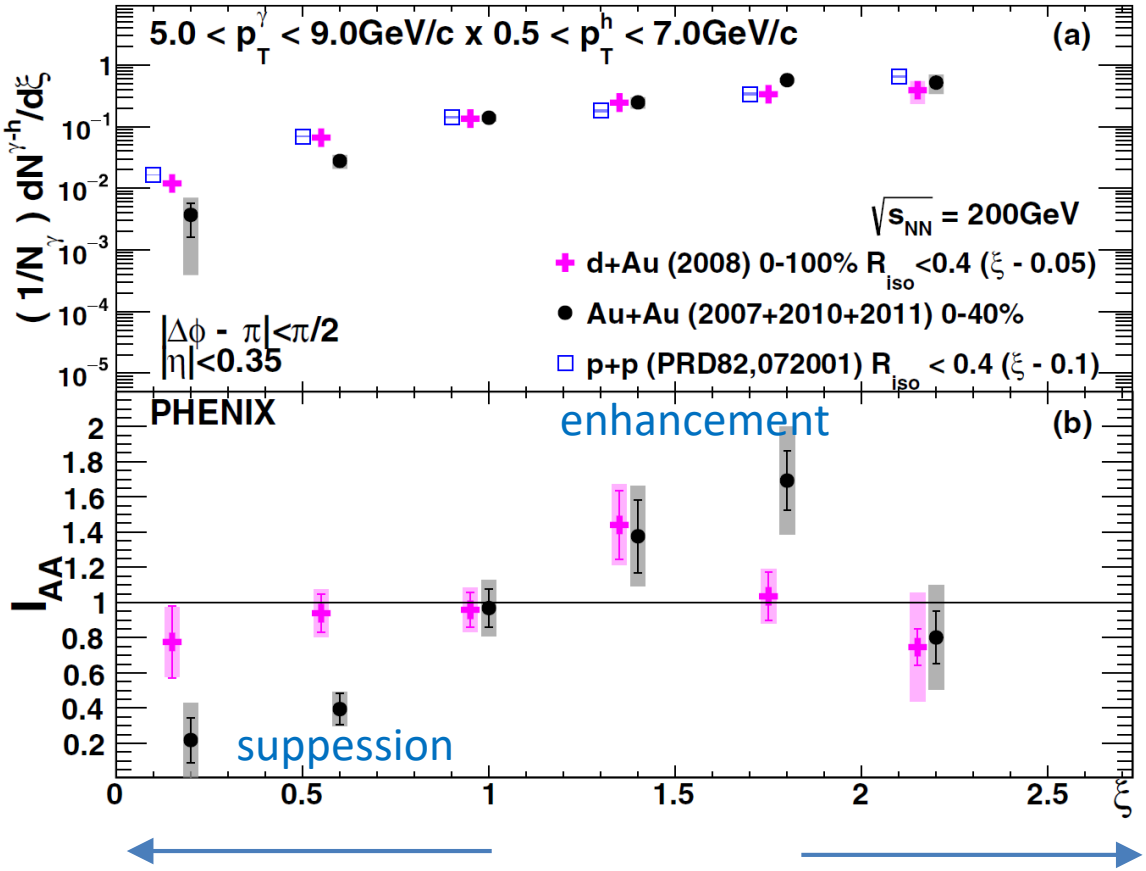
PRC102, 014902 (2020)



- Comprehensive study of J/ψ production in small systems (pAu, dAu, ^{3}HeAu) in forward and backward directions
- Cold Nuclear Matter effects on J/ψ

QGP medium response from direct γ-h correlation

PRC102, 054910 (2020)



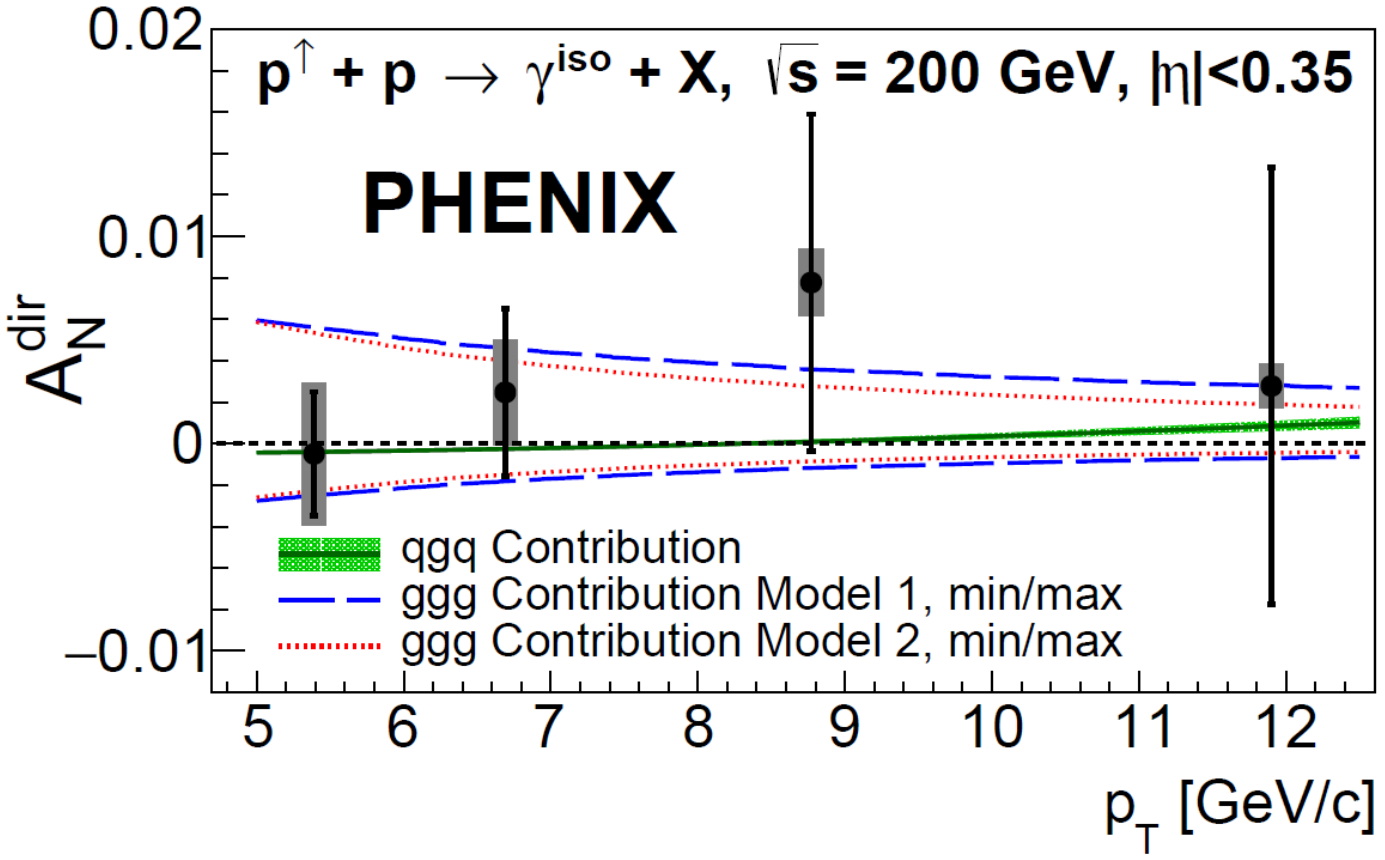
large small

Fractional energy of jet

- Direct-photon and hadron correlation in Au+Au and d+Au are compared
- Medium modification of jet fragmentation in Au+Au is seen
- Hadrons with large jet energy fraction is suppressed
- Low energy hadrons are enhanced as medium response to energy deposited by jets

Direct photon AN

arXiv:2102.13585



- First precision measurement of $A_N(p_T)$ of direct photons
- Direct photons is a very clean probe of proton structure
- The data give constraints on tri-gluon correlation model of A_N

PHENIX publications

- **205 physics papers published**
  - Phys. Rev. Lett. 74
  - Phys. Rev. C 83
  - Phys. Rev. D 42
  - Nature Physics 1
  - Phys. Letter B 4
  - Nucl. Phys. A 1
- **Total citation: ~30000**
- Topcite 1000+ 2
  - 500-1000 7
  - 250-500 21
  - 100-250 52
  - 50-100 46

PHENIX White Paper: 3055 cites

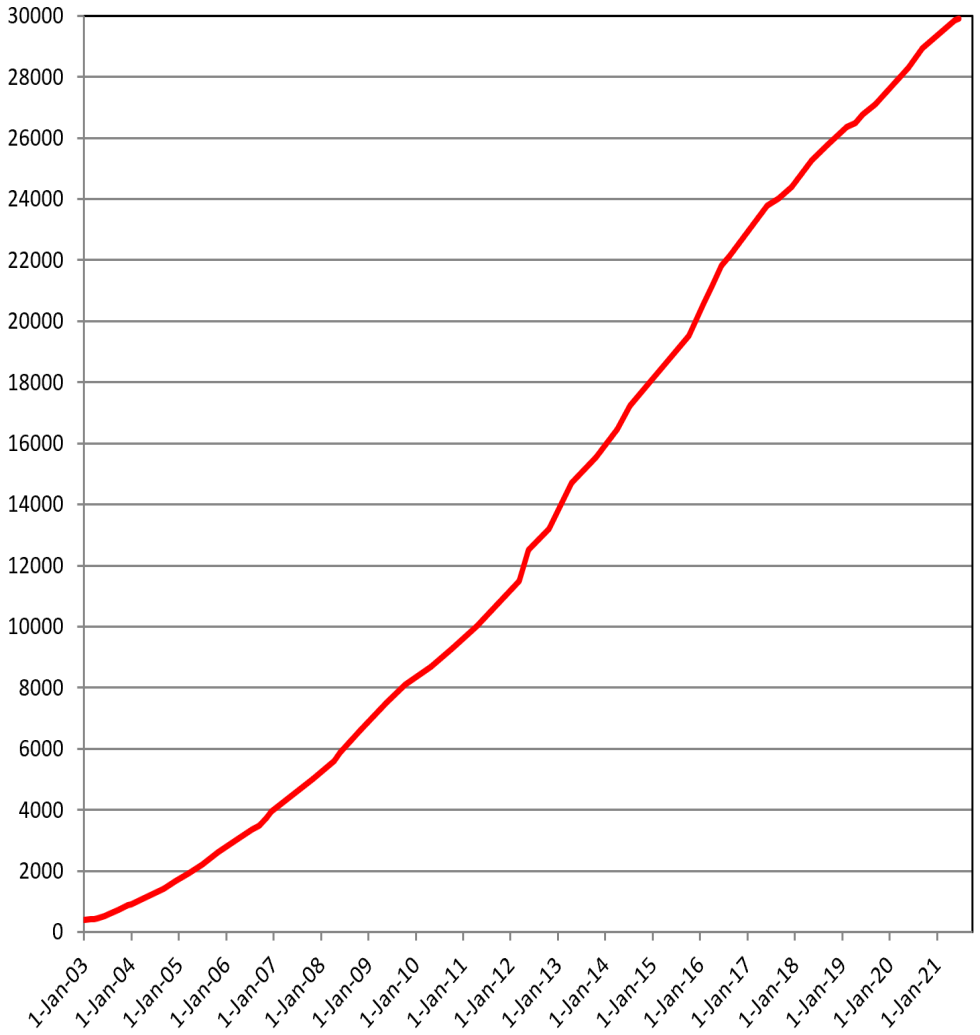
Jet quenching discovery: 1112 cites

Nature P paper: 154 citations

128 physics papers in topcite 50+

(149 if proceedings and detector papers are included)

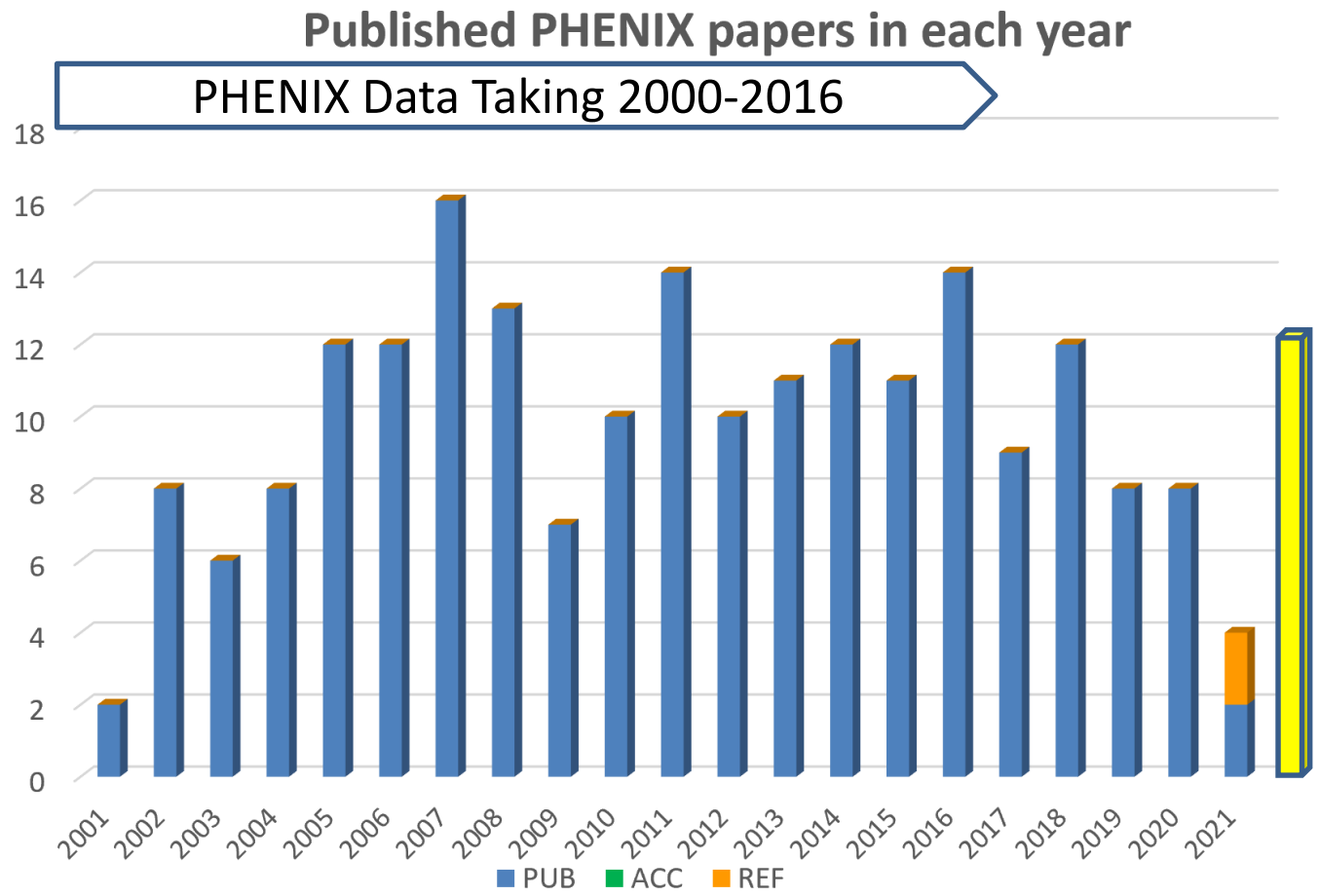
Cumulative Citations of PHENIX papers



PHENIX

PHENIX publications

- 8 papers published in 2020, 2 papers published in 2021 so far.
- Keep the scientific productivity with reduced collaboration
- Complete publication of major results by 2023 (sPHENIX start)
- Working on the data and analysis preservation



~12 papers in preparation.
2 papers are in internal reveiw

On going analyses

- $A_N(p_T)$ of very forward neutron in $p + A$
- Direct photons cross sections and A_{LL}
- $A_N(p_T)$ of heavy-flavor decay electrons
- Direct photons in RUN14 Au+Au
- flow in small systems
- R_{AA} of $b \to e$ and $c \to e$
- v_2 of $b \to e$ and $c \to e$
- Jets in Cu+Au
- J/ψ and $\psi(2S)$ in small systems
- π^0 in $p + A$ and ^{3}He+Au
- $\pi^{\pm}, \bar{p}$ in p +Au
- $\pi^{\pm}, K^{\pm}, \bar{p}$ in p +Al
- $\pi^{\pm}, K^{\pm}, p, \bar{p}$ in ^{3}He+Au
- ϕ in in $p + A$ and ^{3}He+Au
- K^*in p +Au

PPG (paper preparation group) is formed most of these analyses.

DST production status

Golden datasets of PHENIX

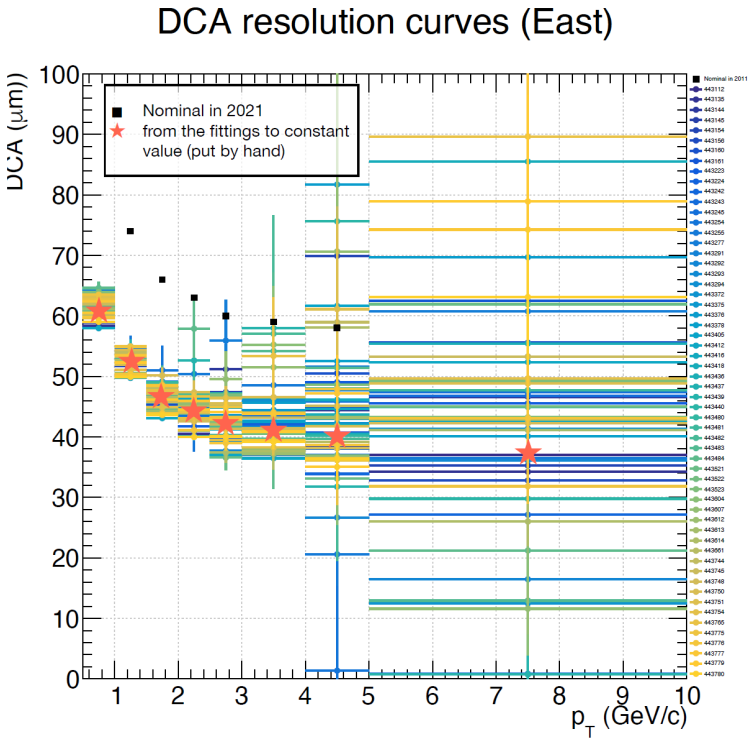
year	Beam, E(GeV)	Recorded data (pp equiv)	upgrade	Physics
2016	AuAu 200 dAu 200 dAu 62,39,20	2.3/nb (90/pb) **15B events** 1G & 73/nb (29/pb) 0.6G 0.1G, 8M	VTX,FVTX MPC-EX	Heavy Flavor Gluon nPDF Small QGP
2015	pp 200 pAu 200 pAl 200	23/pb 80/nb (16/pb) 275/nb (7.4/pb)	VTX, FVTX	Heavy Flavor Transverse spin CNM, small QGP
2014	AuAu 200, 15 ^{3}HeAu 200	2.3/nb (90/pb) **15 B events** 25/nb (15/pb)	VTX, FVTX	Heavy Flavor Small QGP
2013	pp 510	240/pb	W-trigger	Anti-quark spin Gluon spin
2012	pp 510 pp 200 CuAu 200 UU 193	50/pb 4/pb 5/nb (60/pb) 0.17/nb (10/pb)	W-trigger VTX, FVTX	Anti-quark spin Transverse spin Heavy flavor Geometry
2011	pp 510 AuAu 200 AuAu 19, 27	28/pb 0.8/nb (32/pb)	W-trigger VTX	Anti-quark spin Heavy flavor BES-I
2010	AuAu 200 AuAu 62,39,7	1.1/nb (44/pb)	HBD	Low mass ee BES-I

Many physics topics with variety of high statistics datasets

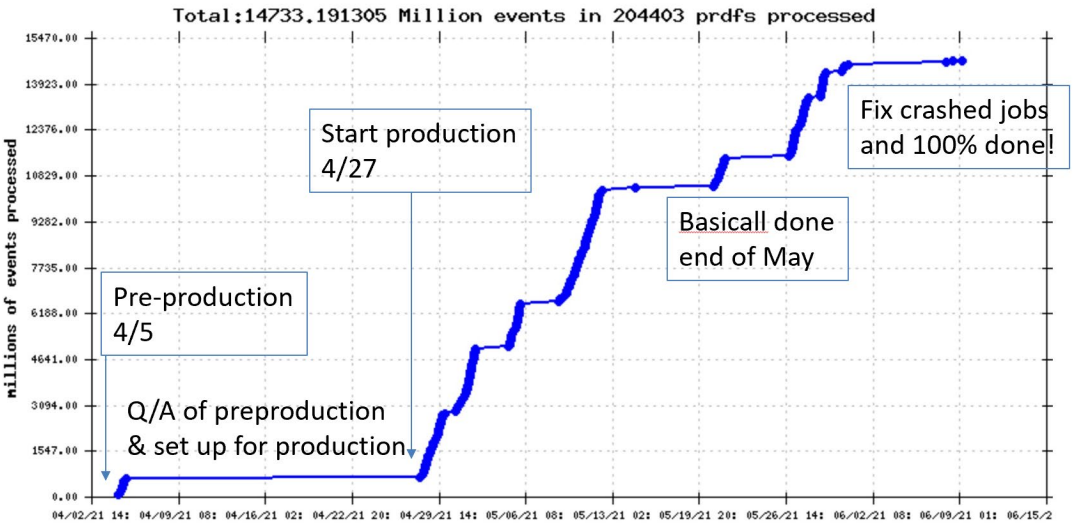
Data Production Status

RUN	beam	VTX/FVTX/Muon (heavy flavor)	Central Arm flow	Central Arm EM (γ, e)
16	Au+Au 200	VTX: DONE FVTX: starting	DONE	DONE
	d+Au BES	DONE	DONE	DONE
15	p+p 200	DONE	DONE	DONE
	p+Au 200	DONE	DONE	DONE
	p+Al 200	N/A	DONE	DONE
14	Au+Au 200	DONE	DONE	DONE
	3He+Au 200	2019	DONE	DONE

RUN16 VTX DST production completed

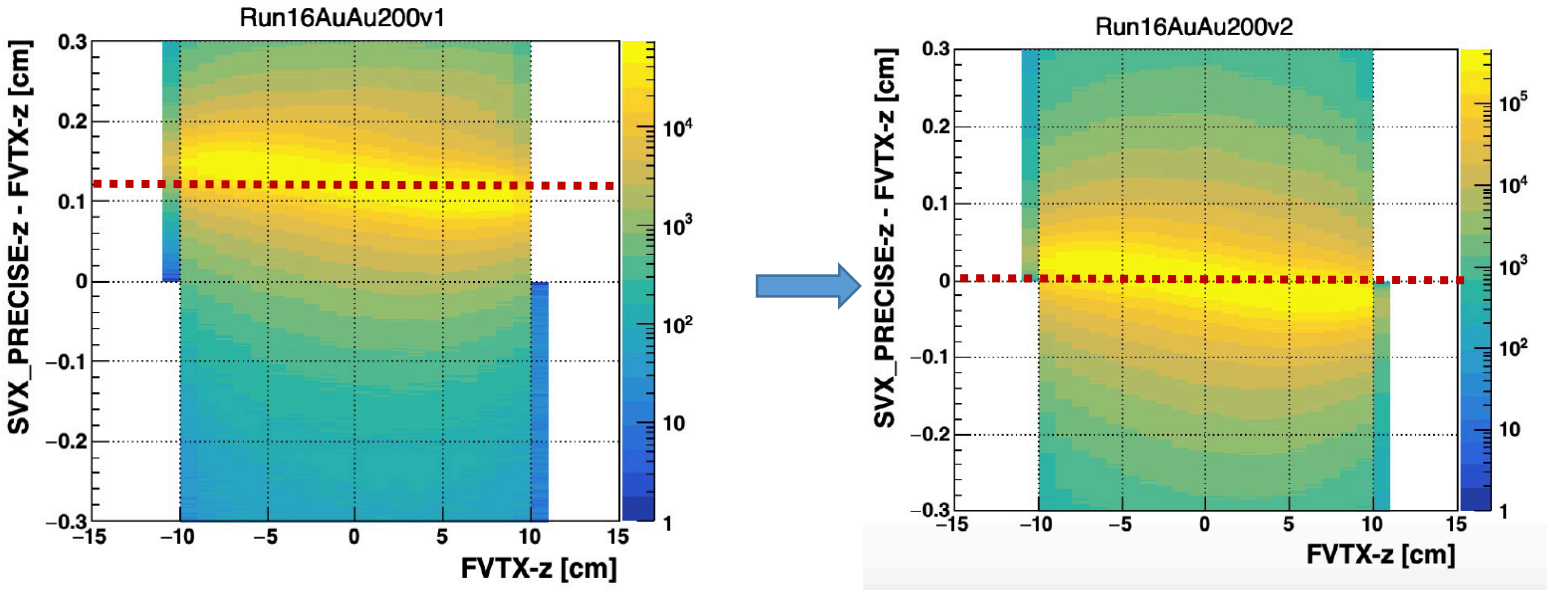


Total: 14.7 Billion event



- DST production of RUN16 VTX dataset was delayed as geometry calibration was lost by beam accident in 2015
- Geometry calibration is done and much improved DCA resolution is achieved.
- RUN16 vtx DST production is completed and this doubled the dataset for Heavy Flavor analysis at mid-rapidity

FVTX dst production status



- A small misalignment of VTX and FVTX in Z is found from a mini-production of ~100M events → corrected
- FVTX team is now working to correct small misalignment in X, Y. This will be done in a few weeks.
- After correction, full production will start
- Full production will be completed in a few months.

Data and Analysis Preservation

PHENIX Data analysis and Preservation page

Experiment Results Detectors Software Analysis About

and the PHENIX Collaboration is now analyzing large data samples previously collected, prioritizing those with a unique physics reach.

This website has been created by the Collaboration to support its Data and Analysis Preservation effort. Materials are collected from legacy web resources, curated and systematized for placement on this site. New content is created with the specific purpose of aiding in the long-term analysis preservation. This effort leverages best practices and tools developed in the High Energy and Nuclear Physics communities such as Zenodo, HEPData and Open Data portals.

- We are developing PHENIX Data analysis and preservation web site
- “reference manual” for PHENIX data analysis
- Aim to preserve full analysis chain of one of key analyses in future

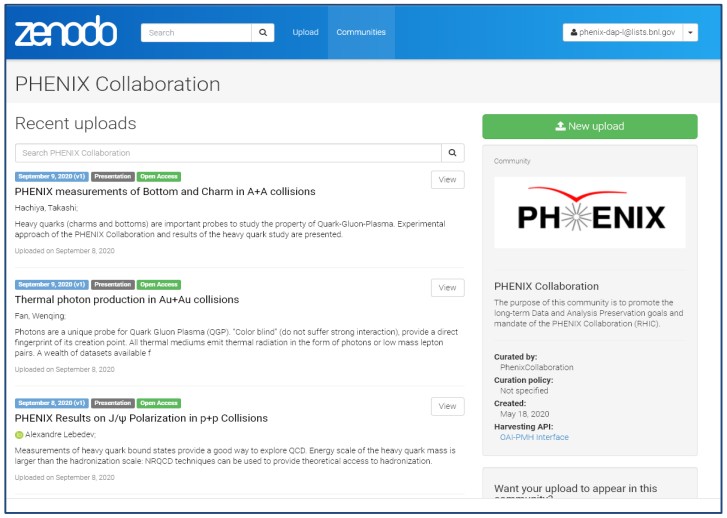
PHENIX DAP page

- In new DAP page, we preserve knowledge of how to analyze PHENIX data. It includes
  - Data set summary
  - How to access data in RCF and to run analysis jobs
  - Reference manual of analysis software
  - Reference manual for simulation and embedding
  - Analysis tutorials and example
- Short term goal of the DAP page is to help current analyzers and new analyzers
- It will take another > 6 months to complete the page
- Long term goal is to preserve an entire analysis chain of one of key analysis

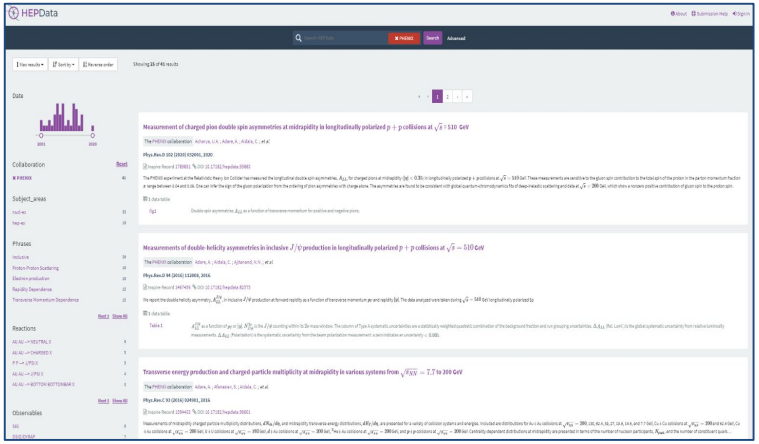
Data and Analysis Preservation

- Growing collection of materials in Zenodo
  - ~400 documents/data uploaded
- Publish final data in HEPData
  - Requirement for new papers
  - Data of ~50 published papers uploaded.
    - More effort is needed
- Experimenting with Docker and REANA to preserve analysis
  - Custom Docker Image for PHENIX data analysis being developed
  - More support is needed here

Zenodo



HEPData



PHENIX School 2021
Open Day

Monday, June 21, 2021

Agenda*

8:00 - PHENIX History and Welcome (20')	Yasuyuki Akiba (BNL/RIKEN)
8:20 - General Introduction to QCD (40')	Dmitri Kharzeev (SBU)
9:00 - Spin Physics with Avenues to EIC (30')	Ralf Seidl (RIKEN)
9:30 - Heavy Ion Physics with Avenues to sPHENIX (30')	Thomas Hemmick (SBU)
10:00 - Break (10')	
10:10 - Acceleration and Collisions at RHIC (30')	Vincent Schoefer (BNL)
10:40 - Overview of PHENIX Detector (30')	Gabor David (BNL/SBU)
11:10 - Overview of PHENIX Spin Results (20')	Sanghwa Park (SBU)
11:30 - Overview of PHENIX Heavy Ion Results (20')	Megan Connors (GSU)
11:50 - Overview of Remaining PHENIX Analyses (30')	Axel Drees (SBU)

- Since 2017, we organize a PHENIX school for new students and postdocs to teach RHIC physics and PHENIX data analysis.
- PHENIX School 2021 is from 6/21 to 6/23.
  - 6/21: Lectures
  - 6/22: PHENIX data analysis
  - 6/23: Data and analysis preservation

Summary

- PHENIX completed its data taking in RUN16
- Publication status
  - PHENIX continues to produce high impact results
  - We will complete publication of major results by 2023, when sPHENIX starts
- Towards completion of Data analysis and preservation
  - RUN16 VTX DST production done. FVTX production will be completed in a few months
  - New DAP page
    - Preserving the knowledge of PHENIX data analysis
  - PHENIX School