The sPHENIX Detector and Physics Program

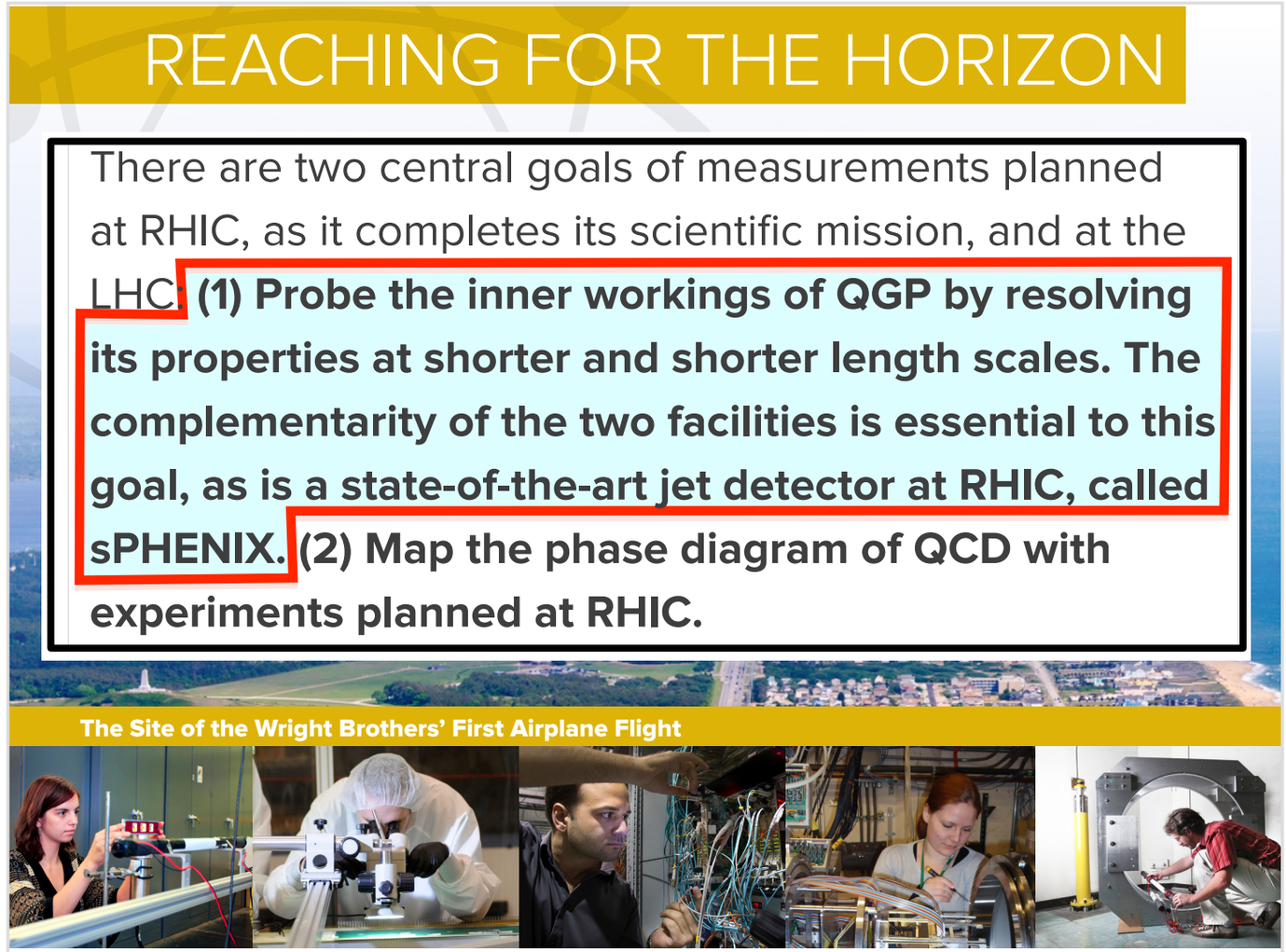
13th Conference on the Intersections of Particle and Nuclear Physics
Palm Springs, CA
June 2, 2018

Ron Soltz (LLNL,WSU)
for the sPHENIX Collaboration

LLNL-PRES-752301

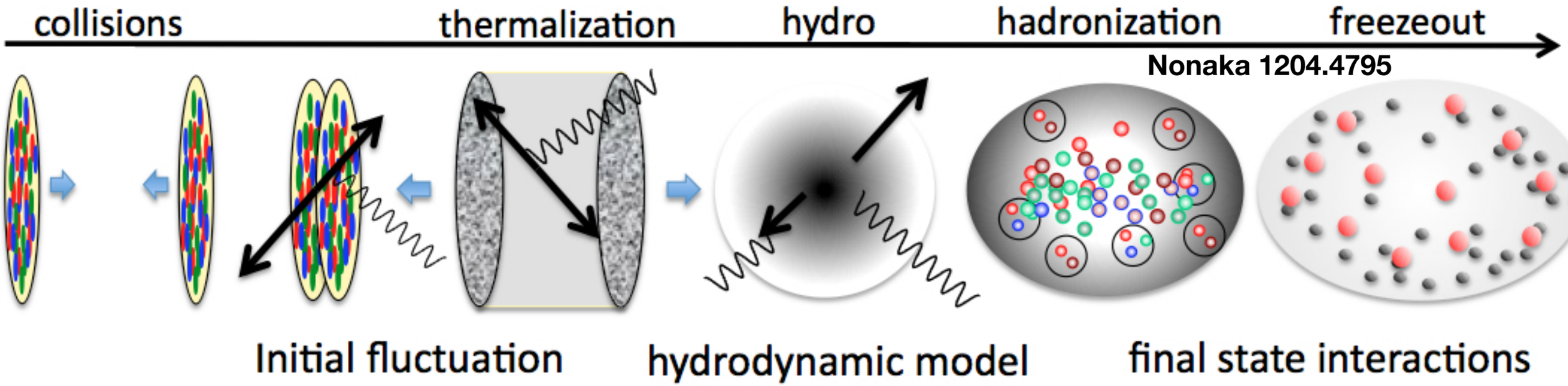
Outline

- Physics Motivation
- Detector Overview
- Schedule & Operations
- Physics Performance ( )



Physics Motivation

- We have quantitative models for bulk properties of the QGP !!!



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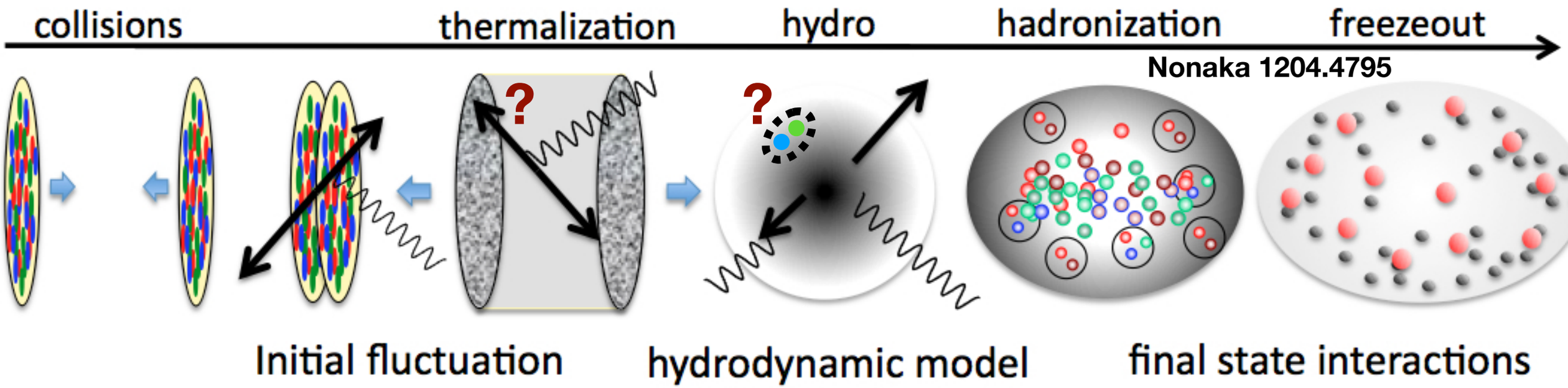
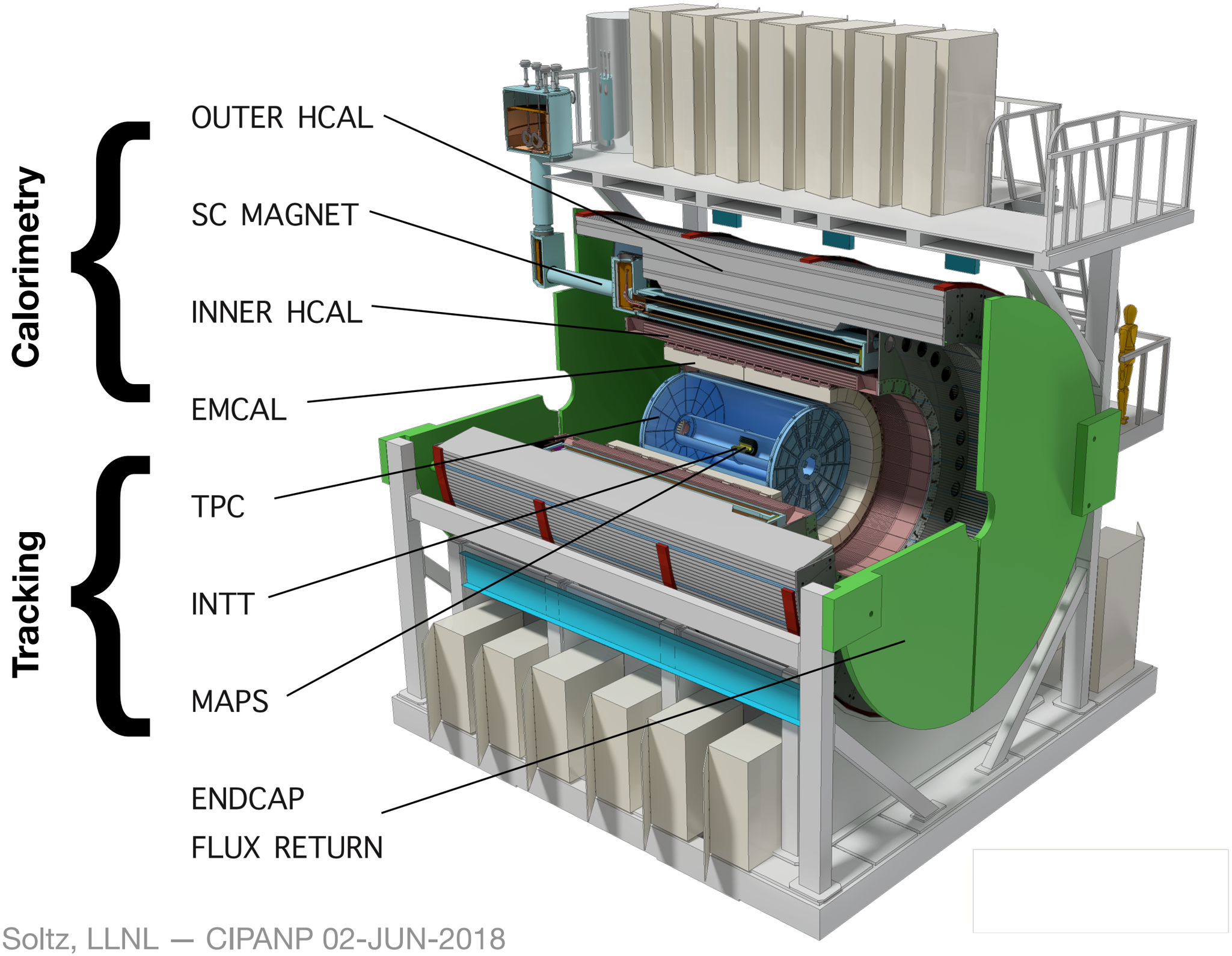
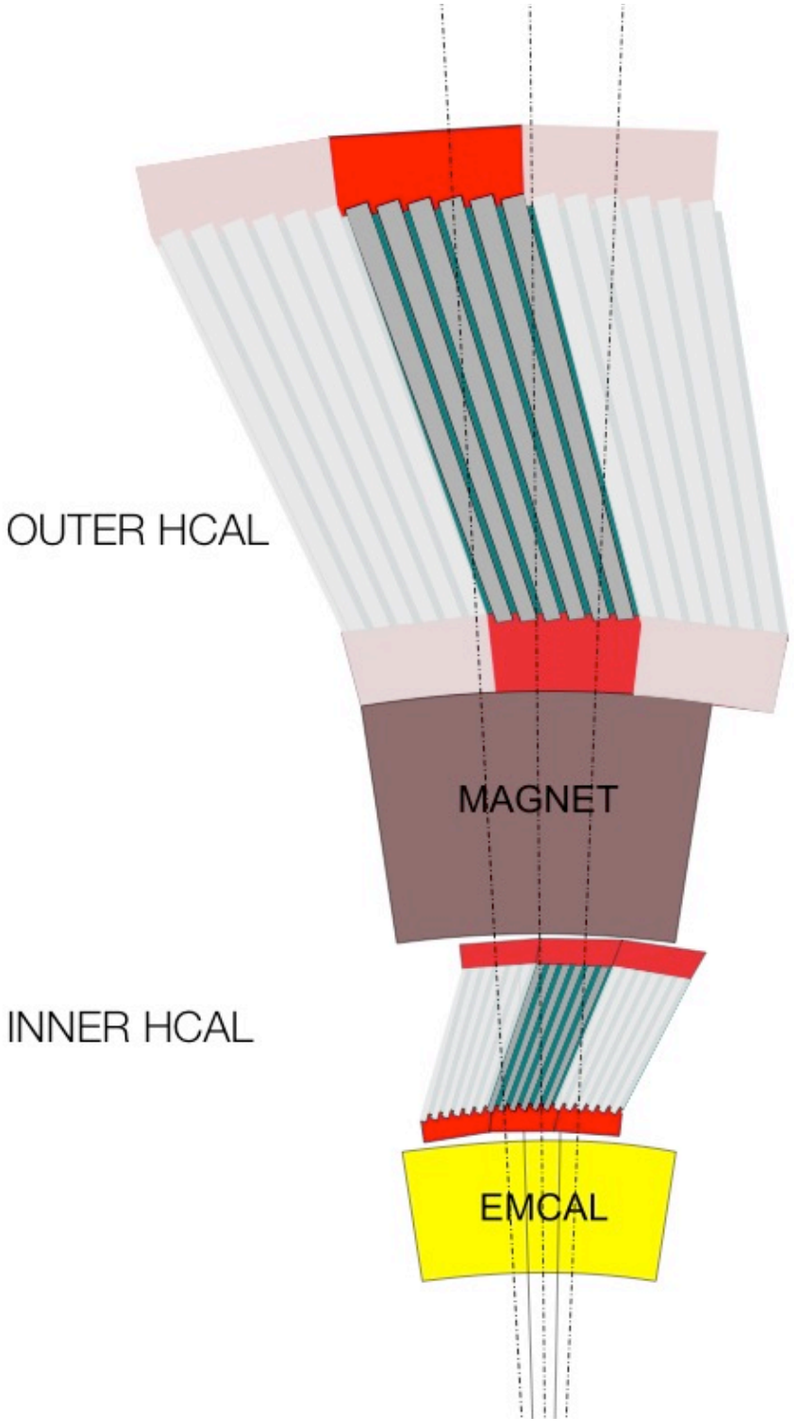


- We don’t yet understand its *femto-scopic structure !*
  - Jet/Parton Transport & Heavy Quark Spectroscopy
  - Coordinated Physics Programs at RHIC and LHC

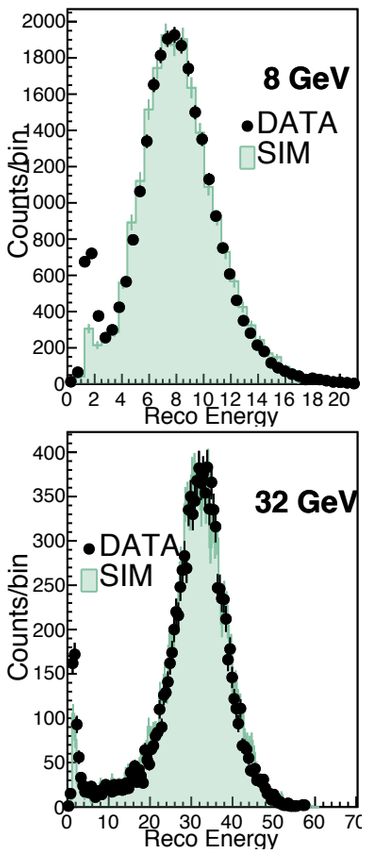
Detector Overview



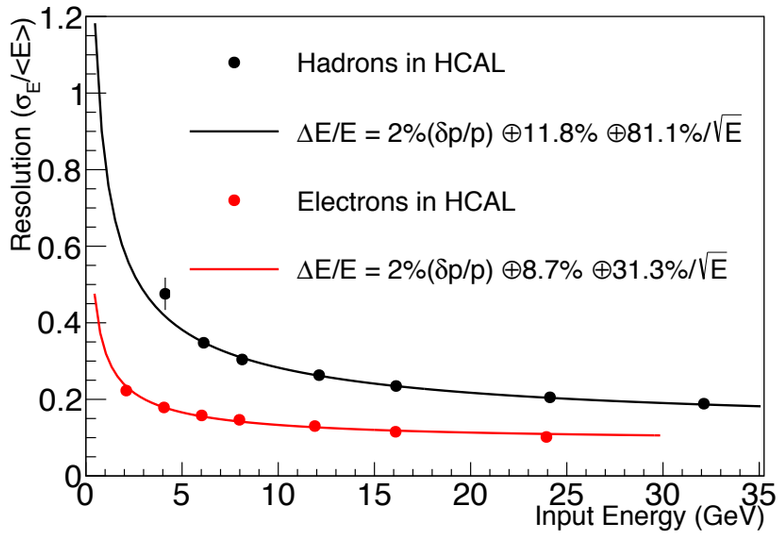
Hadronic Calorimeter



- $|\eta|<1$, $0<\varphi< 2\pi$
- $\Delta\eta$ x $\Delta\varphi \approx 0.1$ x 0.1
- alternating scintillating tiles & steel absorber with SiPM readout
- $\Delta E/E \leq 150\% / \sqrt{E}$ (combined)
- 1,536 readout channels
- Manufactured by UNIPLAST Company, Russia
- Project Contact : J. LaJoie, ISU

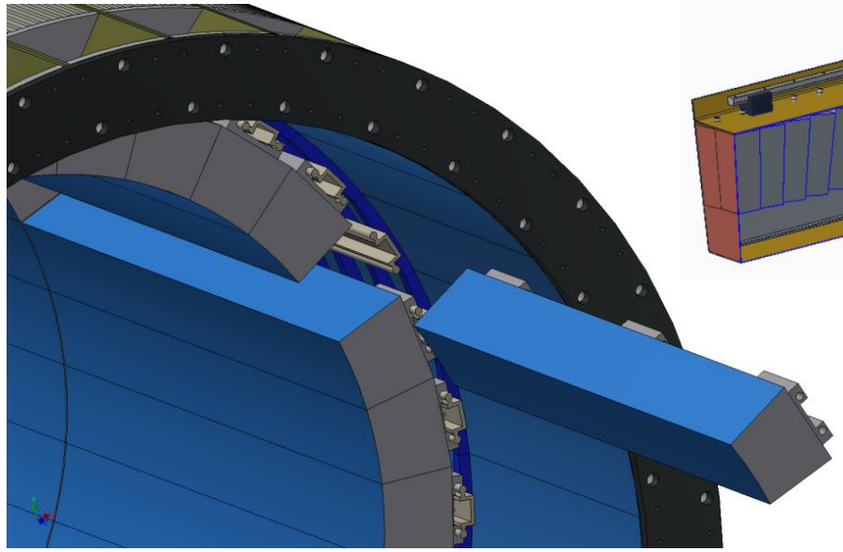


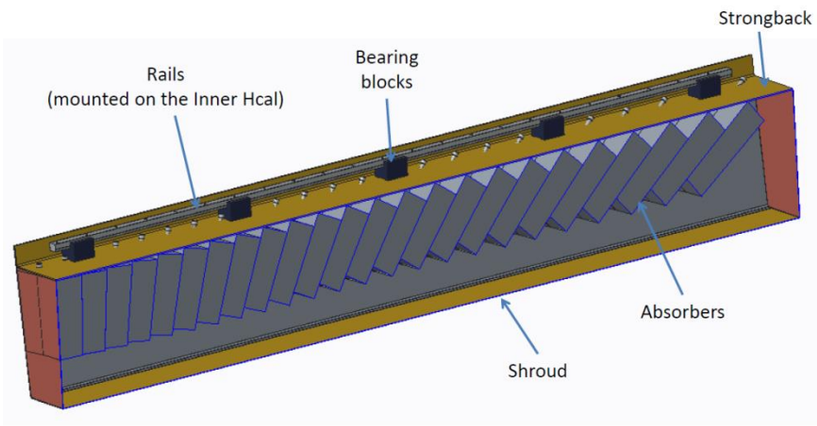
arxiv:1704.01461

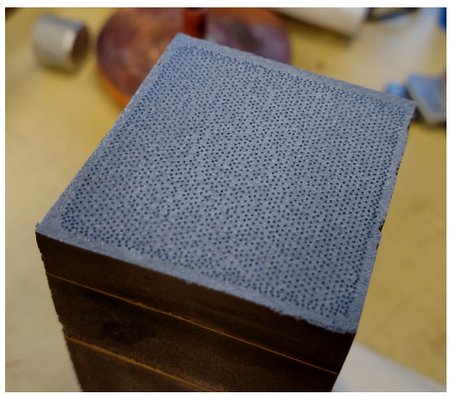


ElectroMagnetic Calorimeter

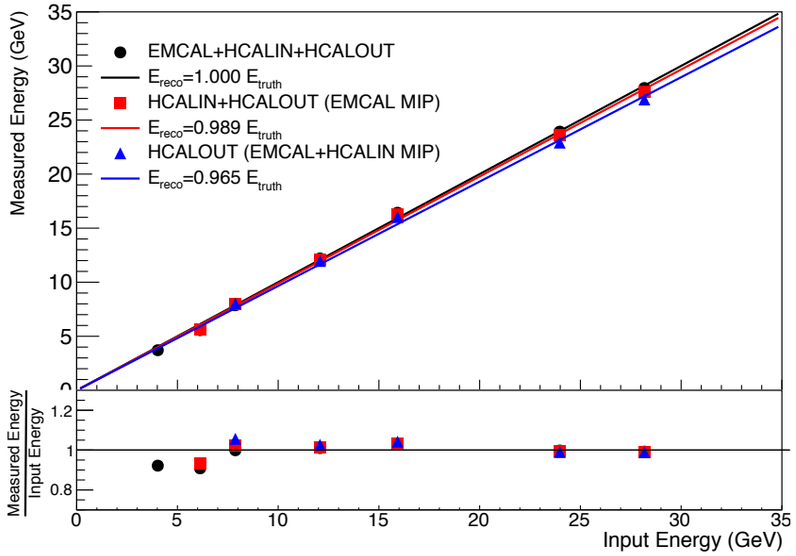
- $|\eta|<0.85$ (may increase), $0<\varphi< 2\pi$
- $\Delta\eta$ x $\Delta\varphi \approx 0.025$ x 0.025
- 2D projective (approximate)
- e/h separation > 100:1
- ΔE/E ≤ 16% E ⊕ 5%
- W/SciFi matrix with SiPM readout
- 2x256=18,432 readout channels
- Manufactured at UIUC
- Project Contact: C. Woody, BNL

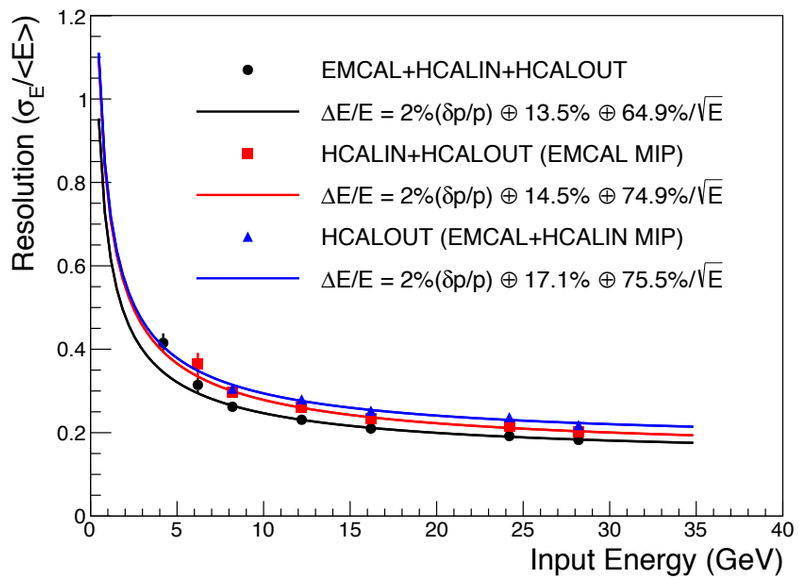






Combined linearity, resolution for testbeam prototype

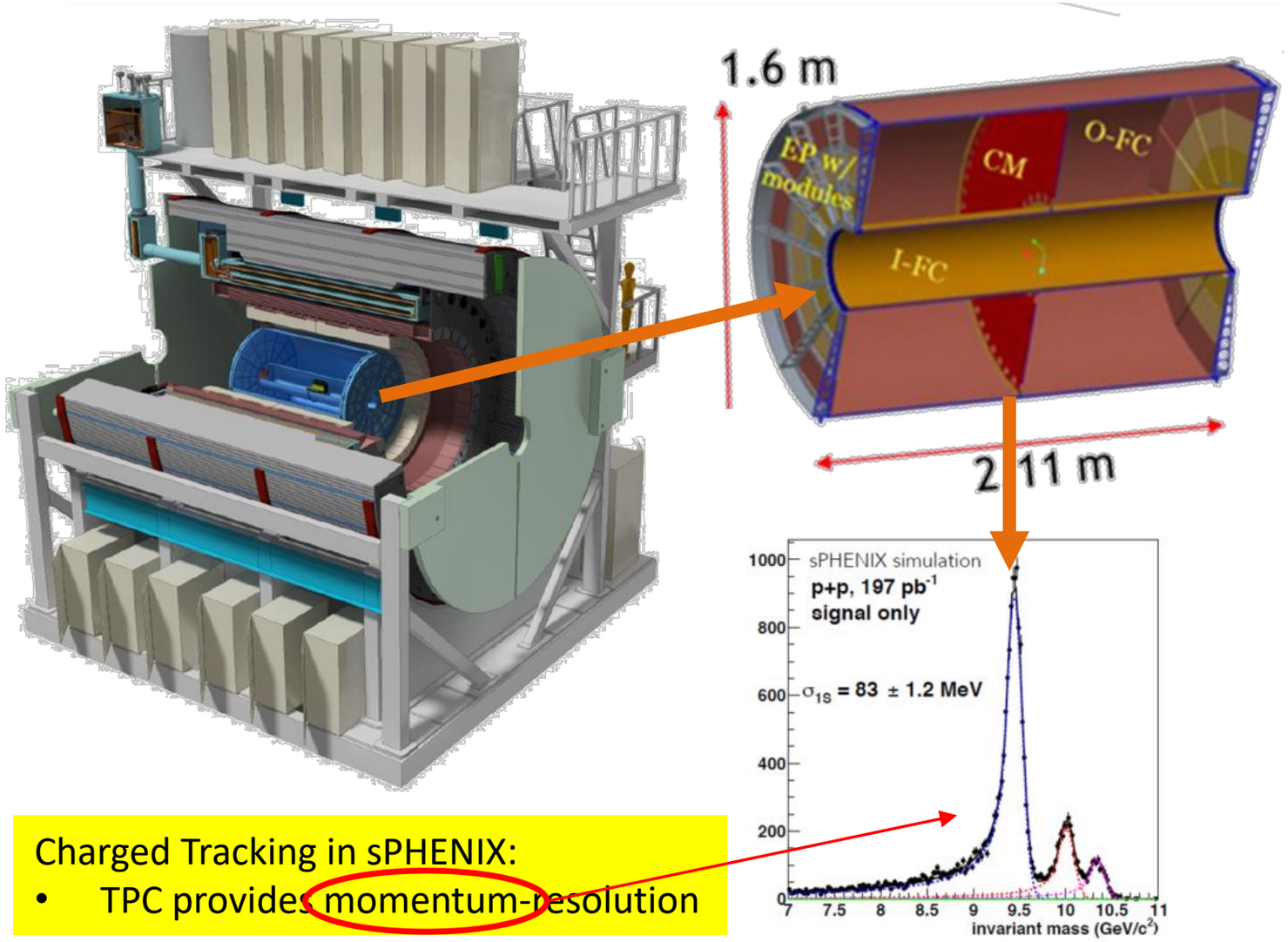




arxiv:1704.01461

Time Projection Chamber

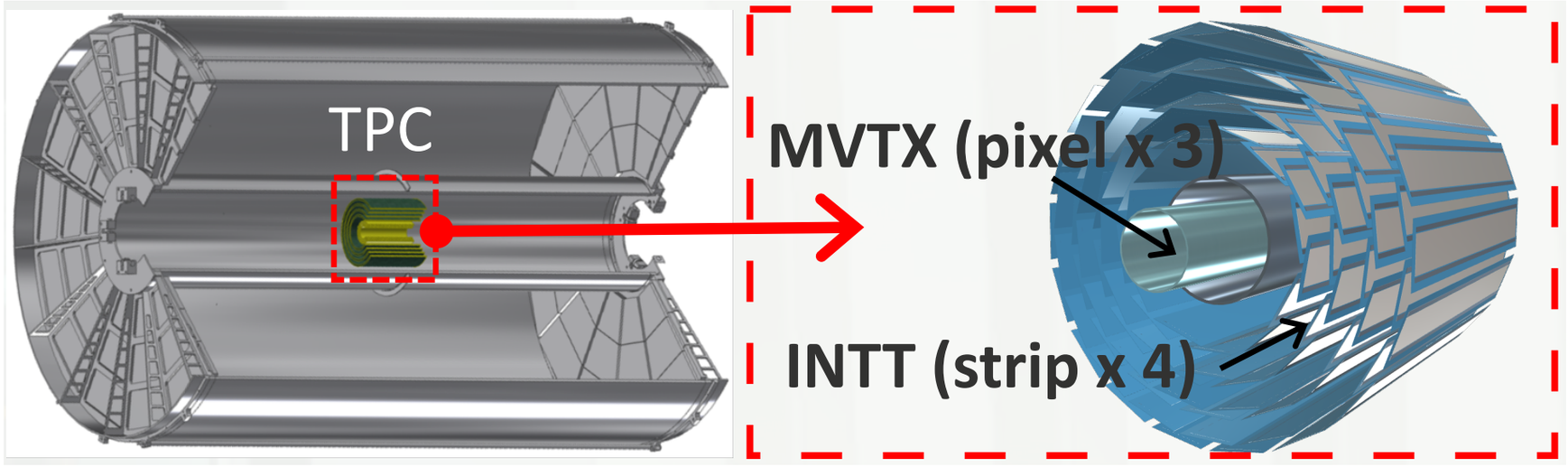
- $|\eta|$<1.1, 0<r<78 cm
- 4-Stage GEM Amplification
- 153,600 channel continuous readout w/ SAMPA chip
- $\Delta p/p \leq 0.2\%$ p
- 400 V/m, Ne:CF_4 90:10
- Project Contact: T. Hemmick, SUNYSB

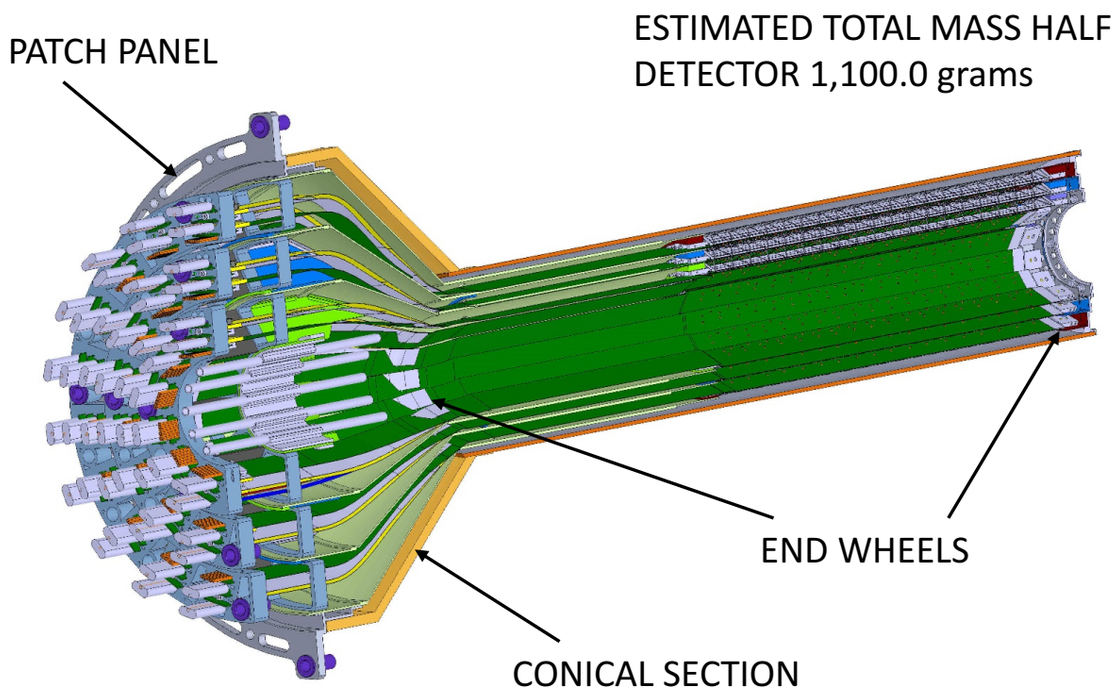


Charged Tracking in sPHENIX:
- TPC provides momentum-resolution

Si Strip Intermediate Tracker (INTT)
MAPS μ-Vertex Detector (MVTX)

- INTT
  - $|\eta|<1.1$, $0<\varphi< 2\pi$
  - 200μm-thick Si sensors, 140/78/78/78 μm strip widths
  - $\sigma_{DCA}<70\mu$m (x-y)
  - Project Contact: Y. Yamaguchi RIKEN
- MVTX
  - Upsilon & Heavy Flavor Tagging
  - $|\eta|<1.1$, $0<\varphi< 2\pi$, $|z|<10$cm
  - $\sigma_{DCA}<70\mu$m at p_T=1GeV
  - Project Contact: M. Liu, LANL





Schedule

Collaboration officially formed	2015
We got CD-0	2016
CD-1 review	**2018**
Installation at BNL	2022
Data taking starts	**2023**

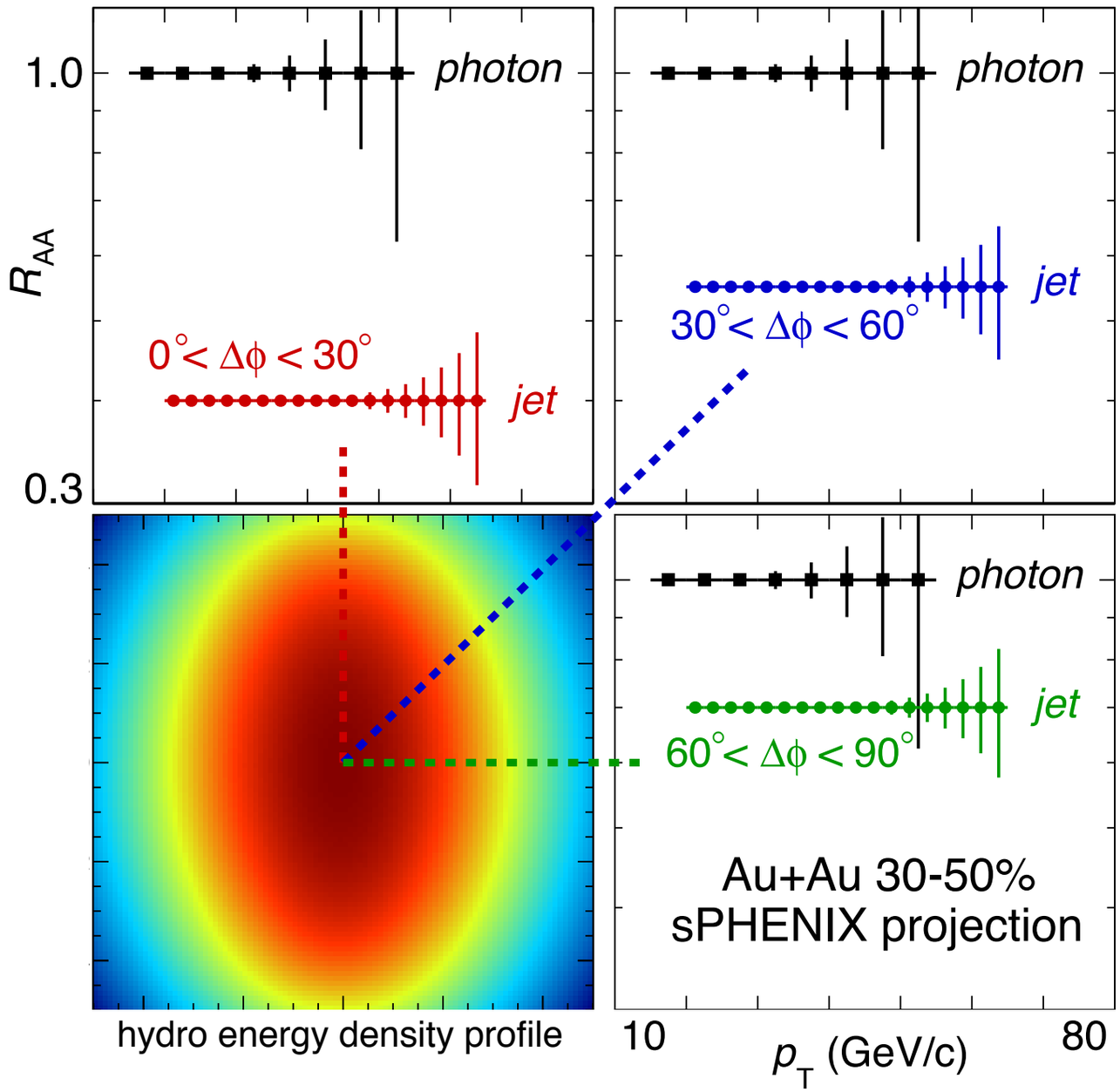
Year	Species	Energy [GeV]	Phys. Wks	Rec. Lum.	Samp. Lum.	Samp. Lum. All-Z
Year-1	Au+Au	200	16.0	7 nb^{-1}	8.7 nb^{-1}	34 nb^{-1}
Year-2	p+p	200	11.5	—	48 pb^{-1}	267 pb^{-1}
Year-2	p+Au	200	11.5	—	0.33 pb^{-1}	1.46 pb^{-1}
Year-3	Au+Au	200	23.5	14 nb^{-1}	26 nb^{-1}	88 nb^{-1}
Year-4	p+p	200	23.5	—	149 pb^{-1}	783 pb^{-1}
Year-5	Au+Au	200	23.5	14 nb^{-1}	48 nb^{-1}	92 nb^{-1}

Au+Au data acquisition at 15kHz for |z| < 10 cm

239B Au+Au MB events for 3 runs

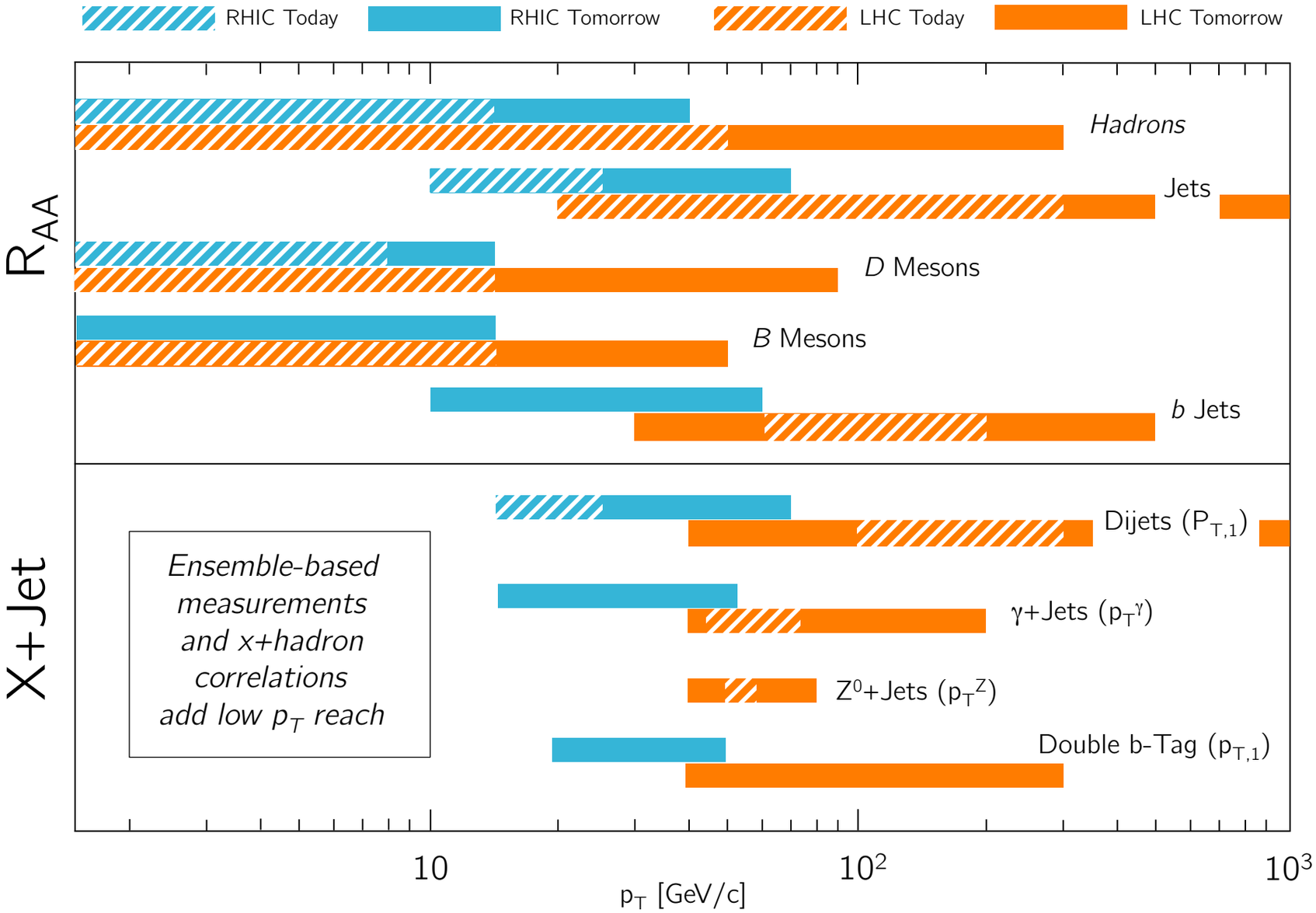
- sPHENIX origin story : began with 2012 PHENIX decadal plan by Morrison & Nagle

sPHENIX γ/jet R_{AA} vs Reaction Plane



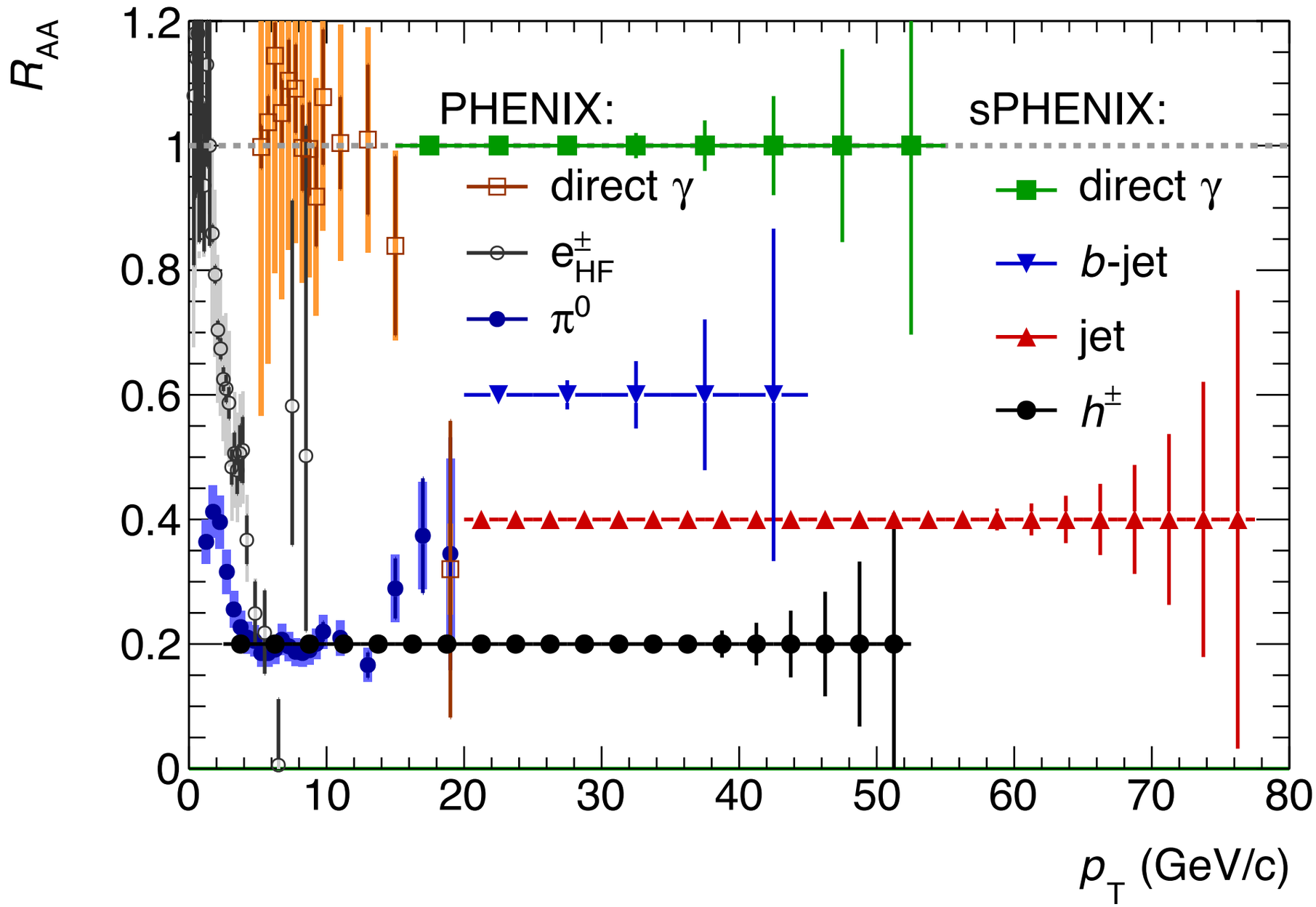
arxiv:1501.06197_fig1.10

sPHENIX pT reach



arxiv:1501.06197_fig1.15 (bot)

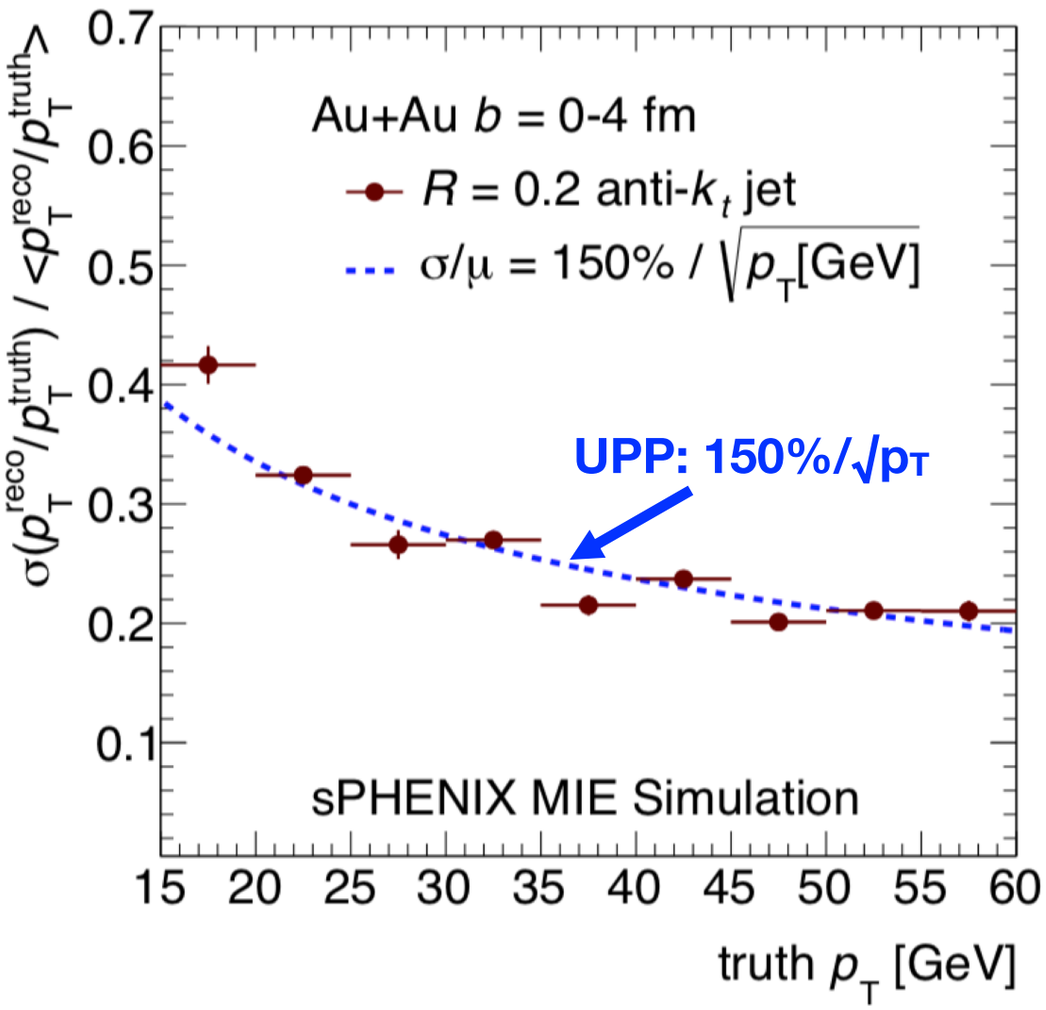
sPHENIX PID



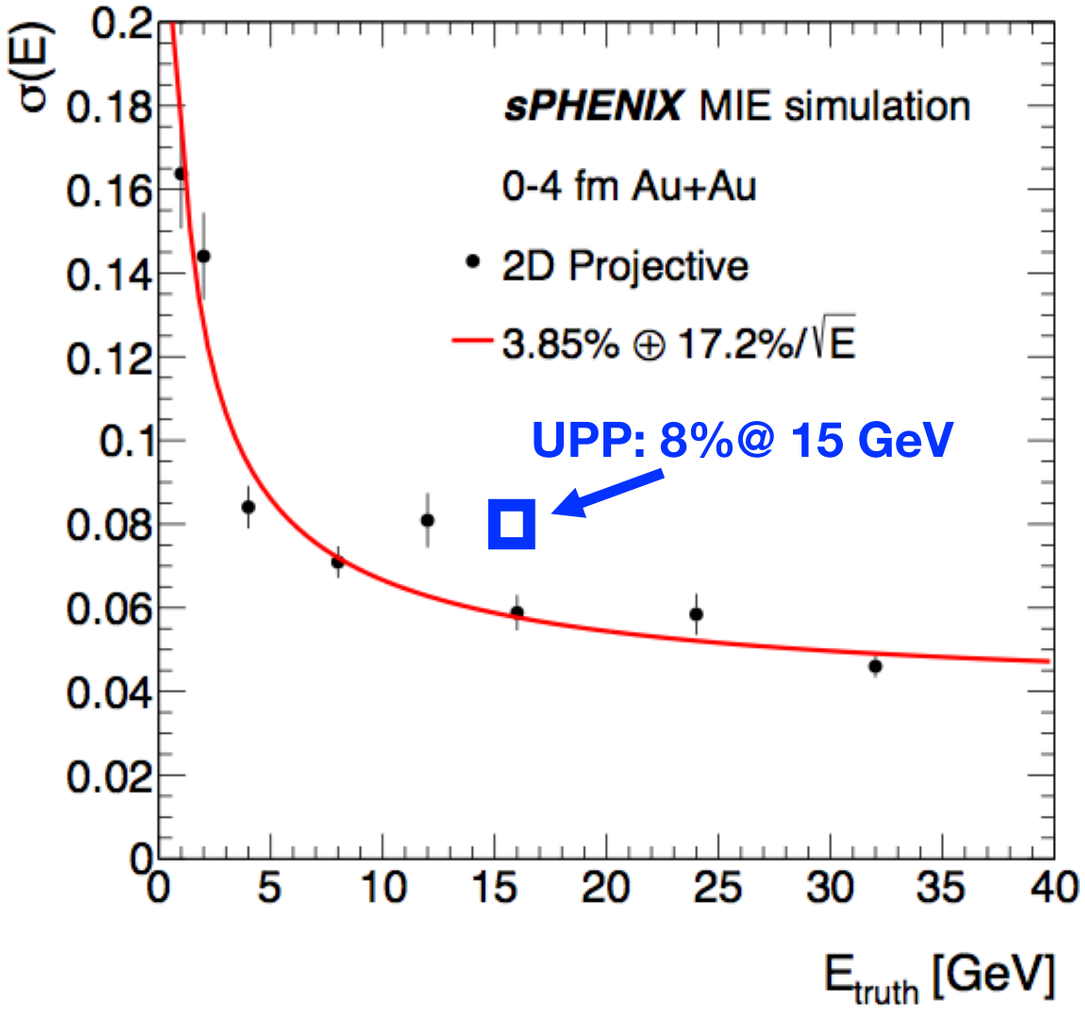
arxiv:1501.06197_fig1.15 (top)

sPHENIX single jet/photon resolution

Single jet resolution (central Au+Au)



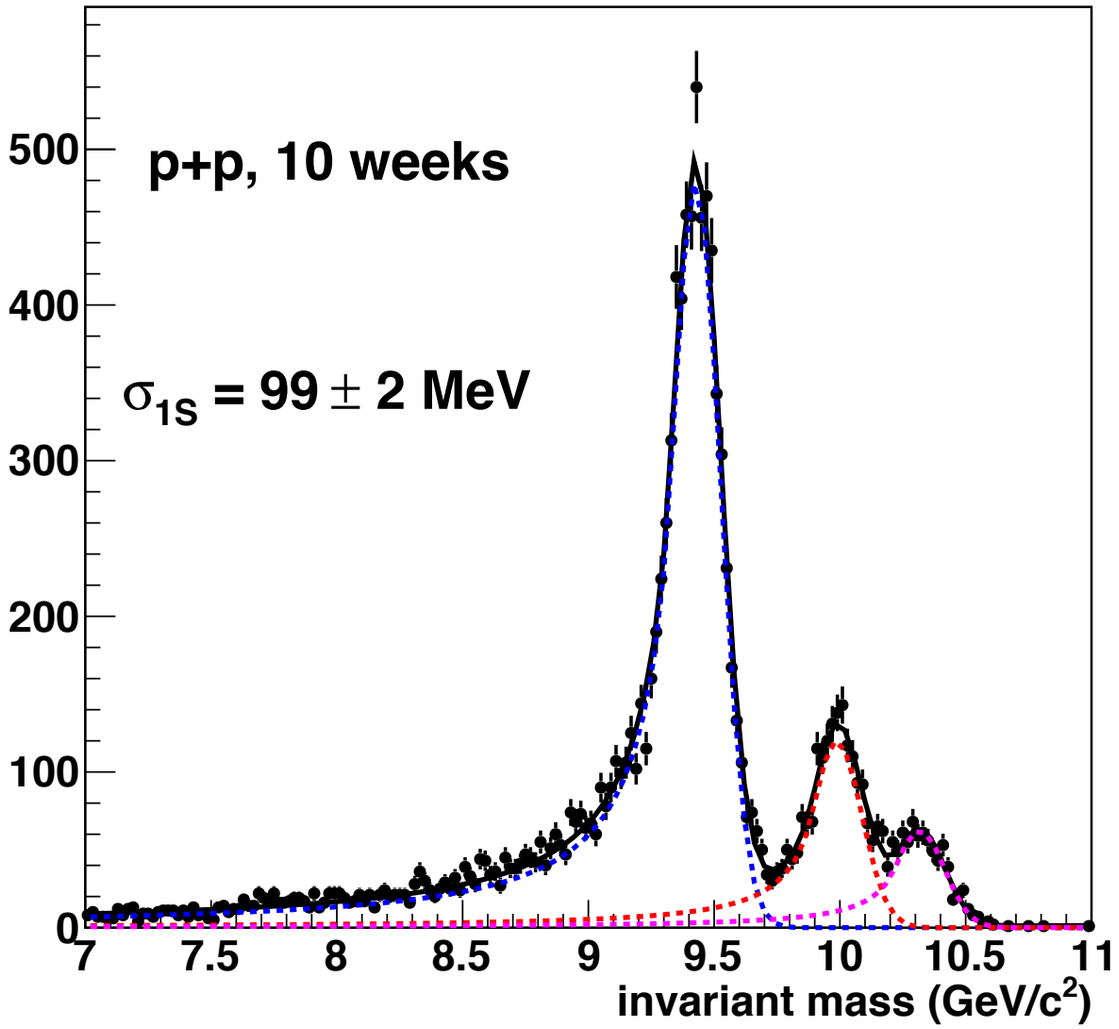
Single photon resolution (central Au+Au)



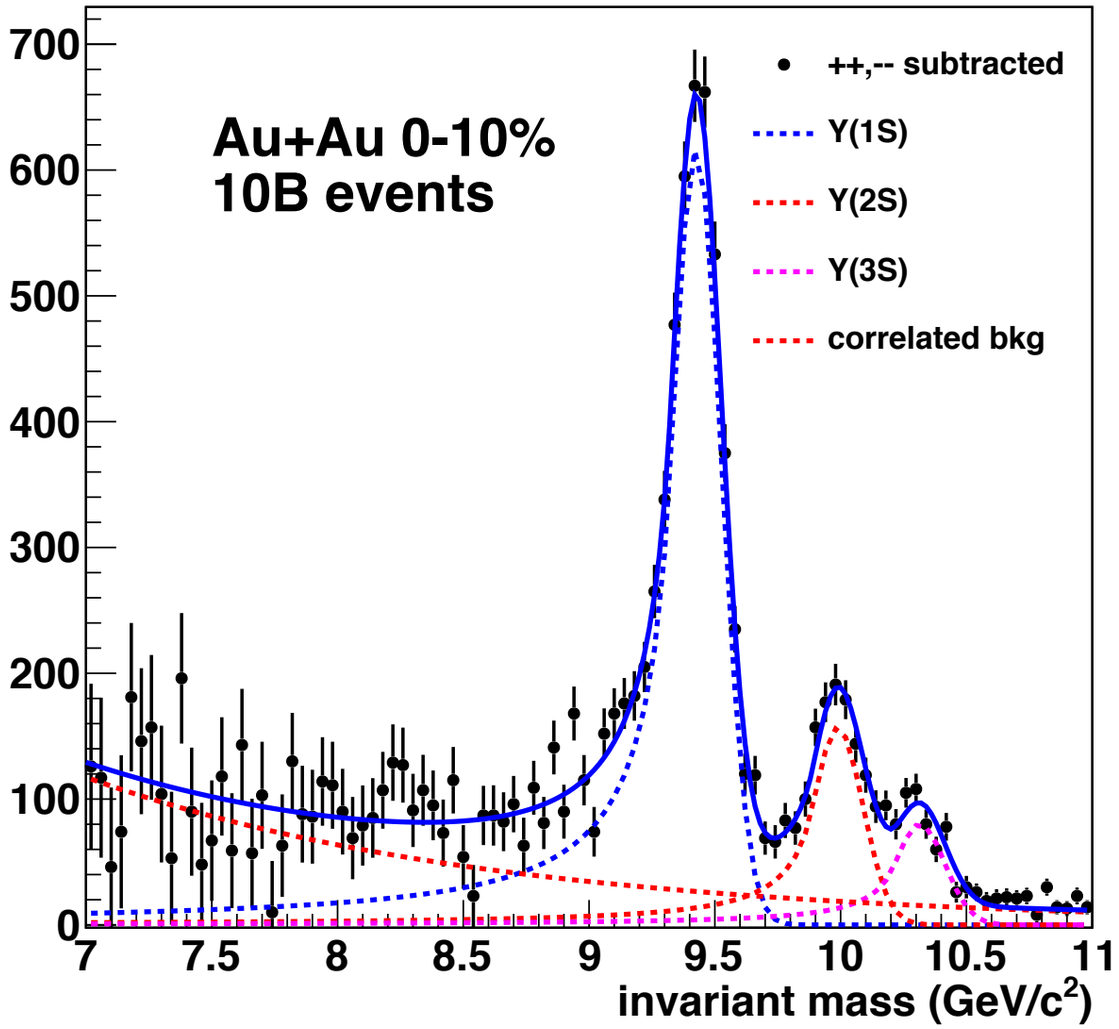
sPHENIX CDR

sPHENIX Upsilon

$\Upsilon(1S,2S,3S) \rightarrow e^+e^-$



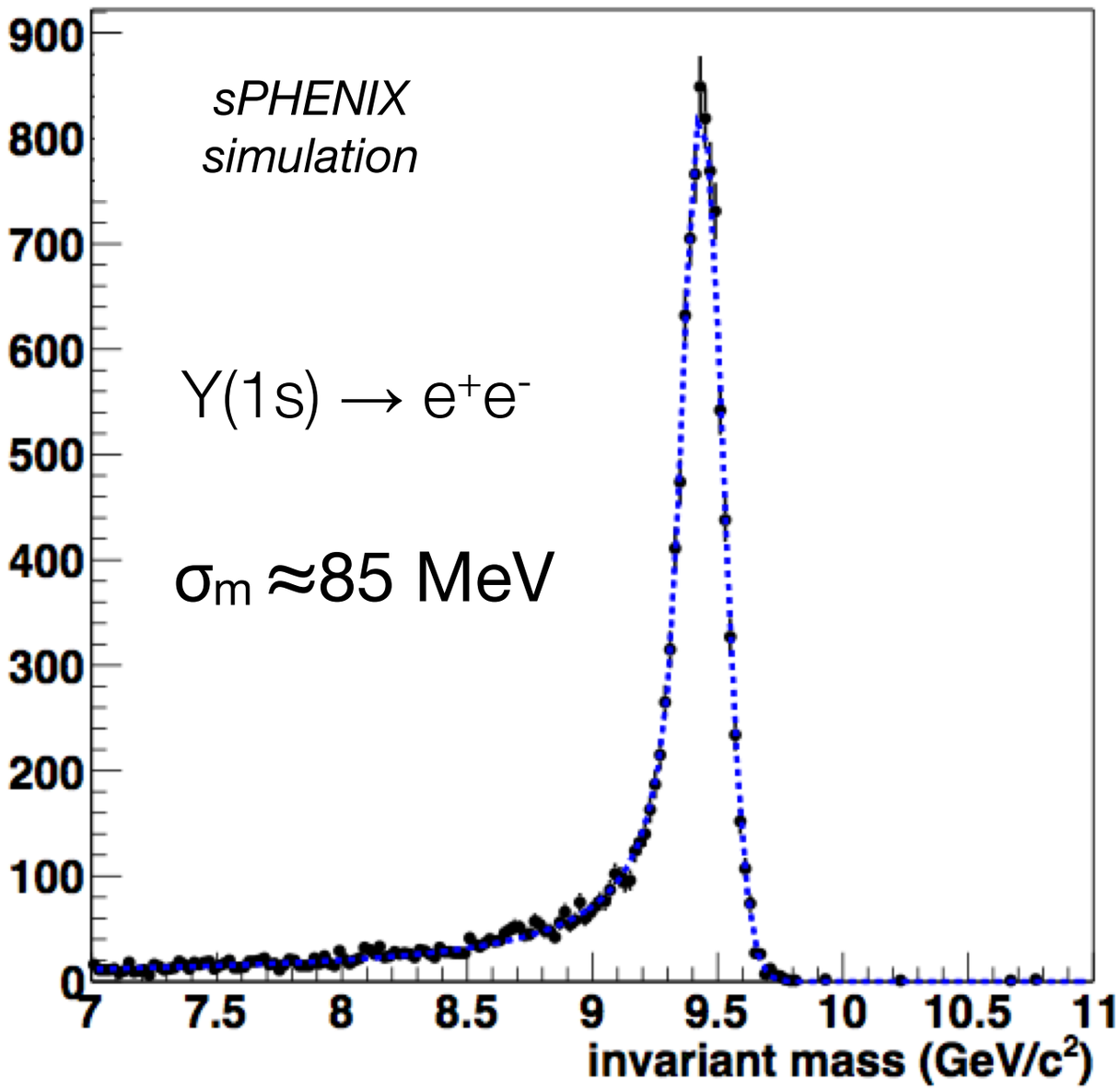
$\Upsilon(1S,2S,3S)$



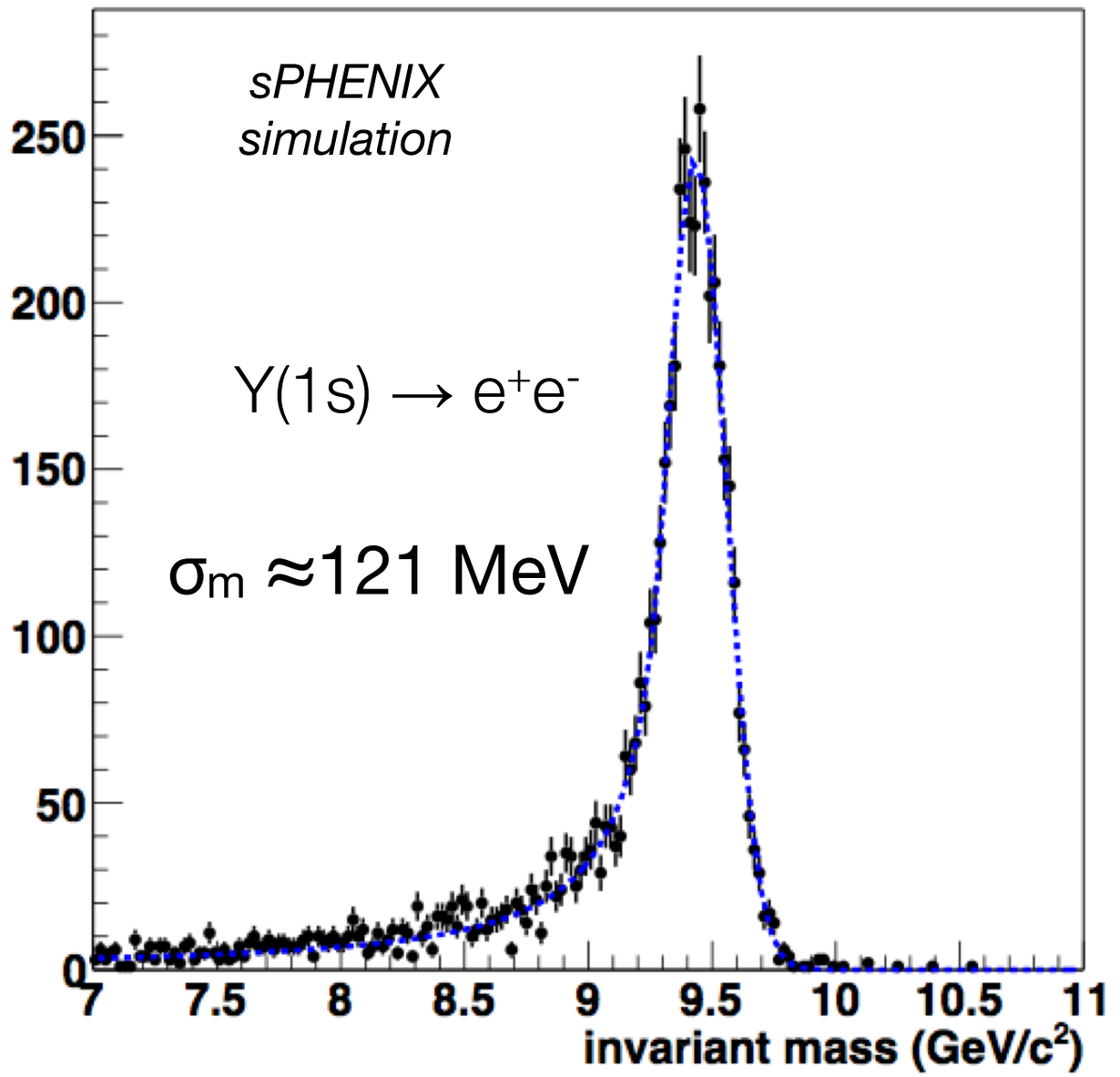
arxiv:1501.06197

sPHENIX Upsilon (1S) Resolution

p+p √s = 200GeV



Au+Au + TPC pileup √s = 200GeV

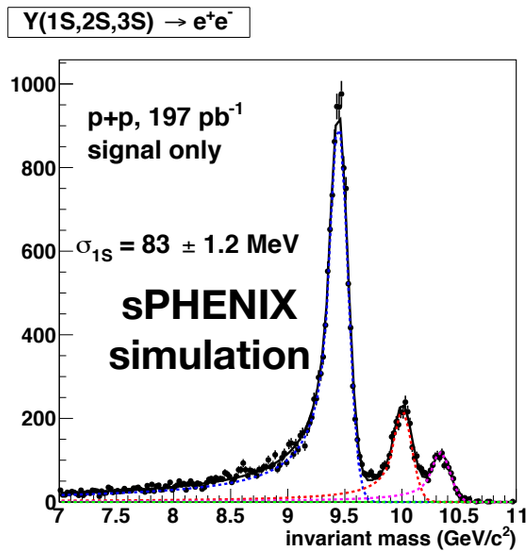


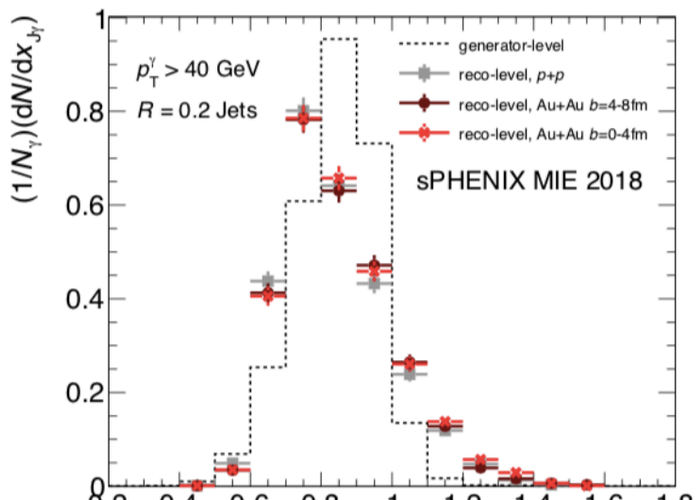
sPHENIX CDR

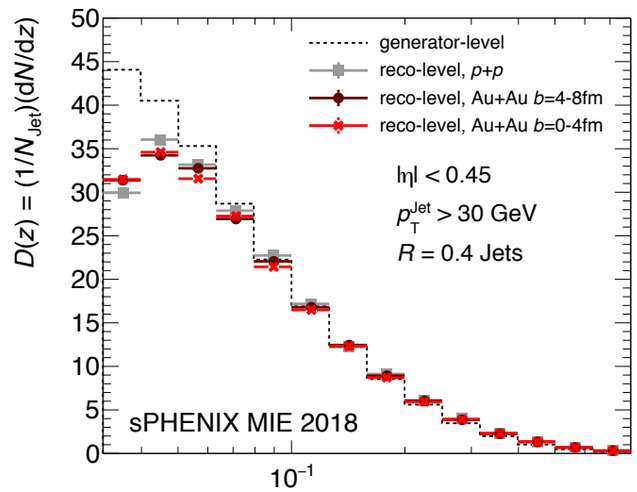
sPHENIX — LHC Comparison

Youngsun Kim, QM2018

sPHENIX

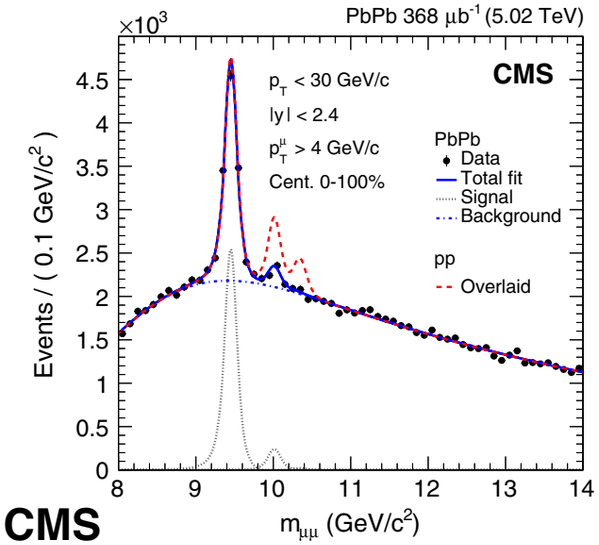






LHC

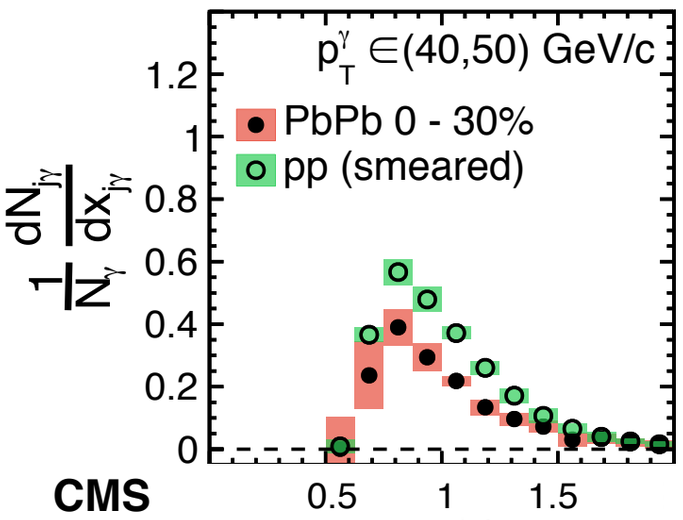
Resolution of Υ states



CMS

PRL 120 142301 (2018)

Photon-jet correlation

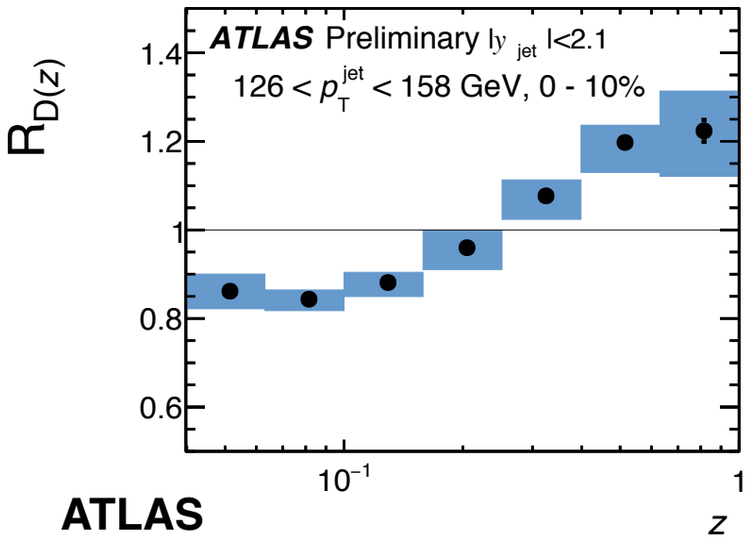


CMS

1711.09738

$x_{j\gamma} = p_T^{jet}/p_T^{\gamma}$

Jet fragmentation function



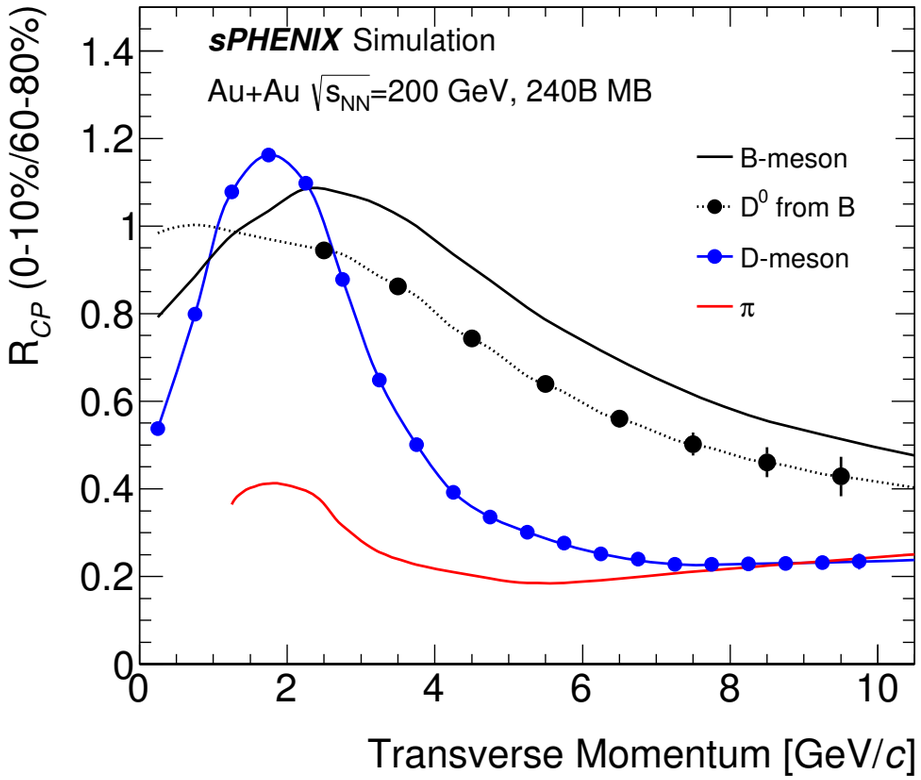
ATLAS

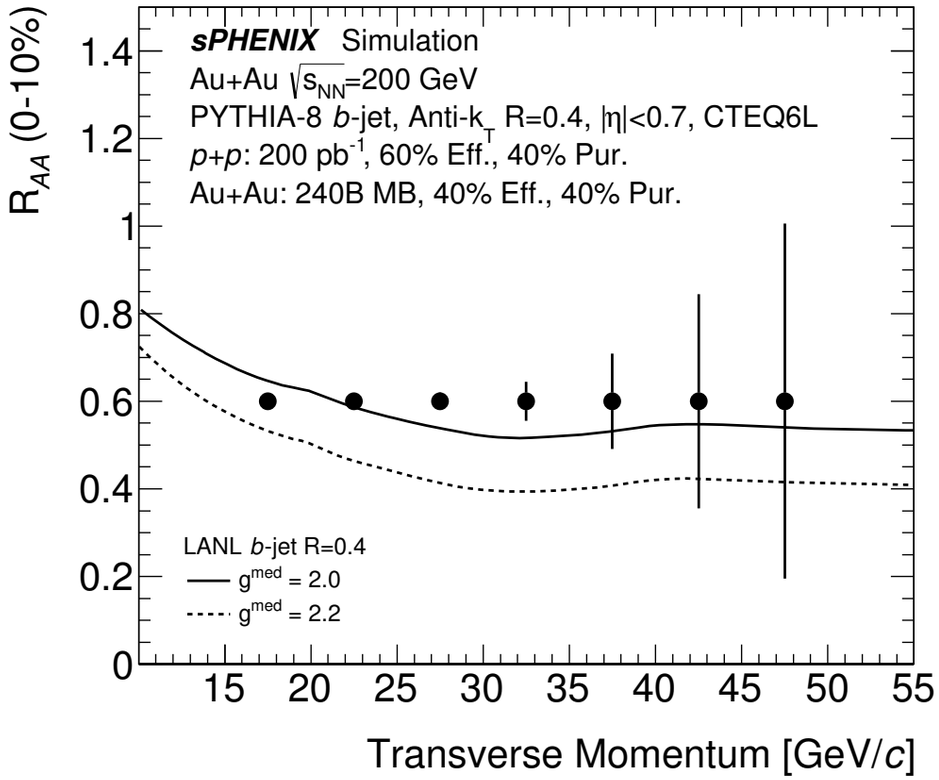
CONF-2017-005

Heavy Flavor with MVTX

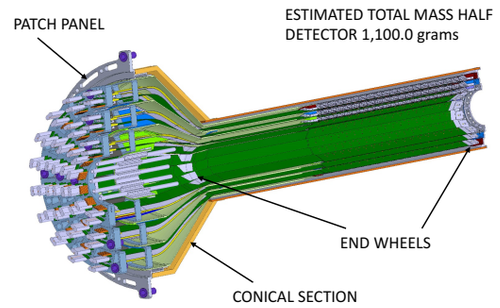
Heavy flavor physics in sPHENIX

Youngsun Kim, QM2018





sPHENIX can also resolve the flavor of jets using the MVTX



sPHENIX Collaboration

Spokespersons: Dave Morrison & Gunther Roland

70 Institutions

Augustana University, Banaras Hindu University, Baruch College, CUNY Brookhaven National Laboratory CEA Saclay, Central China Normal University Chonbuk National University Columbia University, Eötvös University, Florida State University, Georgia State University, Howard University, Hungarian sPHENIX Consortium, Insititut de physique nucléaire d'Orsay, Institute for High Energy Physics Protvino, Institute of Nuclear Research, Russian Academy of Sciences, Moscow, Institute of Physics University of Tsukuba, Iowa State University, Japan Atomic Energy Agency, Joint Czech Group, Korea University, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory Lehigh University, Los Alamos National Laboratory, Massachusetts Institute of Technology, Muhlenberg College, Nara Women's University, National Research Centre "Kurchatov Institute", National Research Nuclear University "MEPhI", New Mexico State University, Oak Ridge National Laboratory, Ohio University, Petersburg Nuclear Physics Institute, Purdue University, Rice University, RIKEN , RIKEN BNL Research Center, Rikkyo University, Rutgers University, Saint-Petersburg Polytechnic University, Stony Brook University , Temple University, Tokyo Institute of Technology, Universidad Técnica Federico Santa María, University of California Berkeley, University of California Los Angeles, University of California Riverside, University of Colorado Boulder, University of Debrecen, University of Houston, University of Illinois Urbana-Champaign University of Jammu, University of Maryland, University of Michigan, University of New Mexico, University of Tennessee Knoxville, University of Texas Austin, University of Tokyo, Vanderbilt University, Wayne State University, Weizmann Institute, Yale University, Yonsei University