Science and the Collaboration

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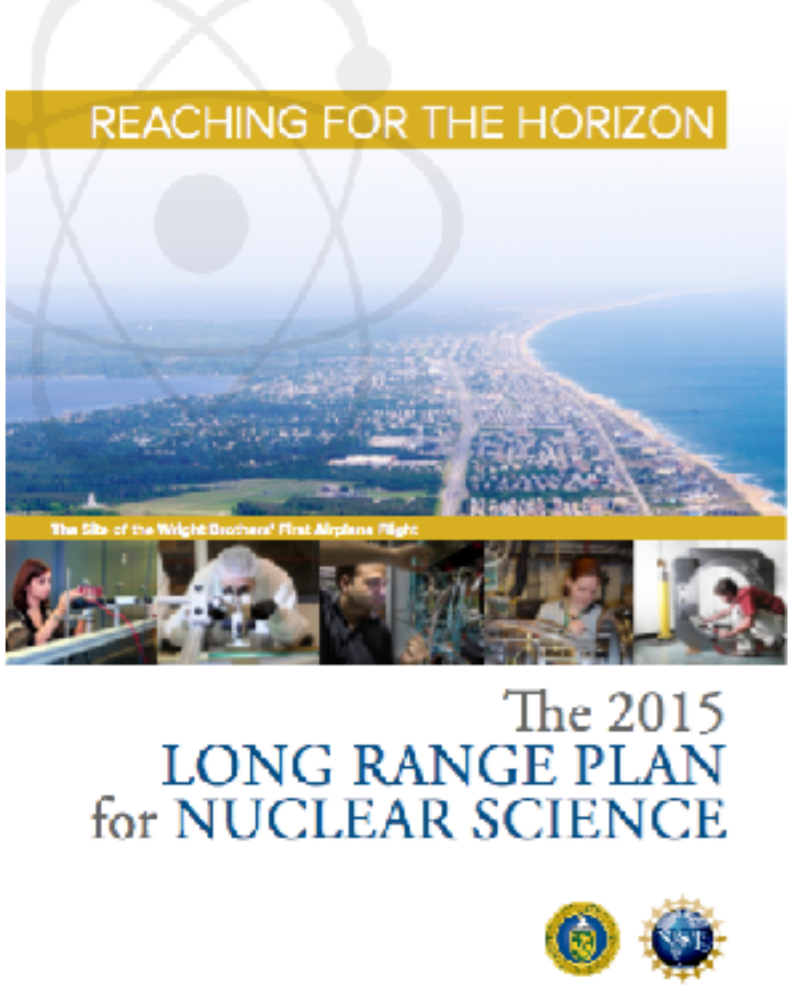
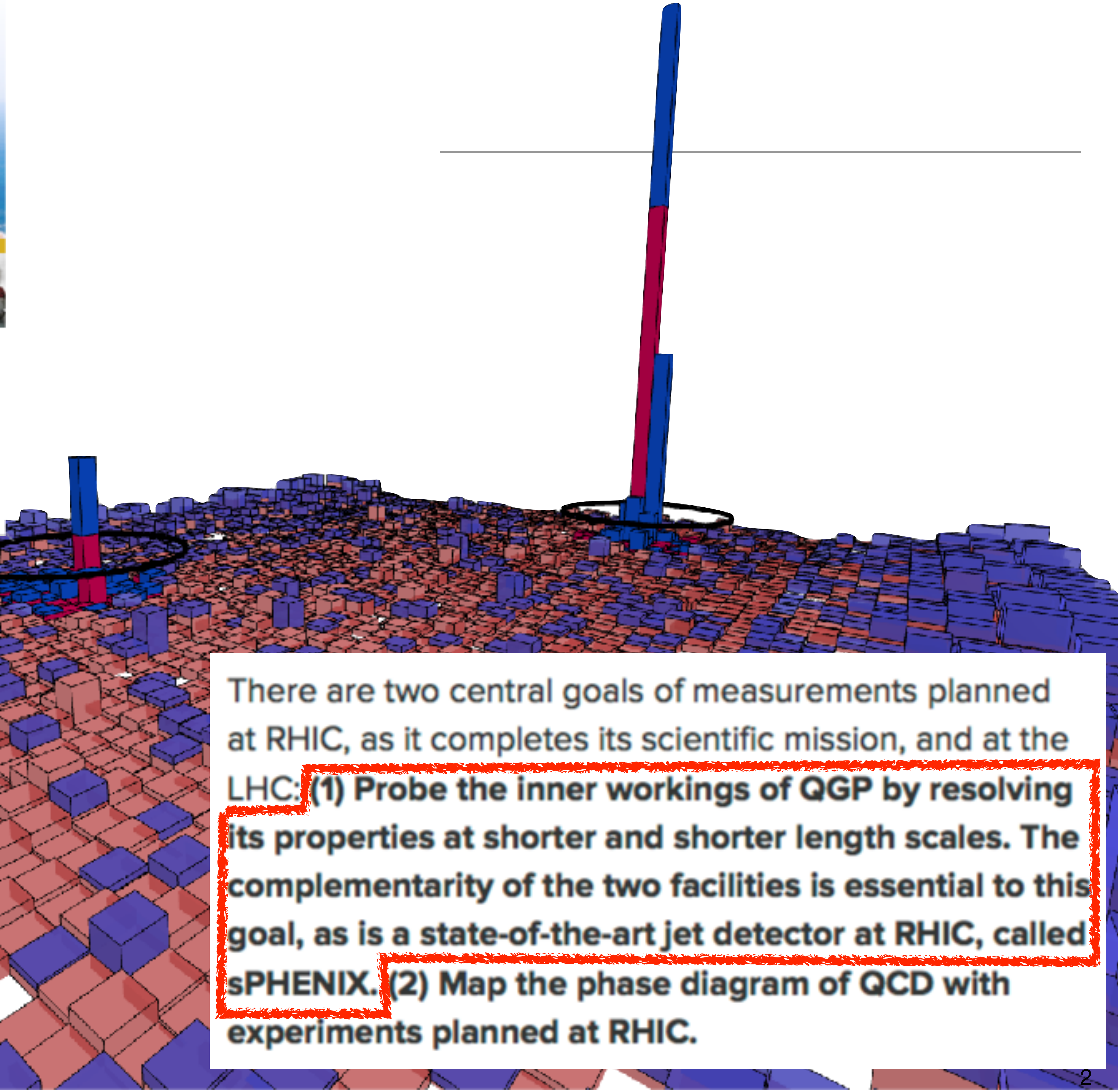
Gunther Roland (MIT)

co-spokespersons

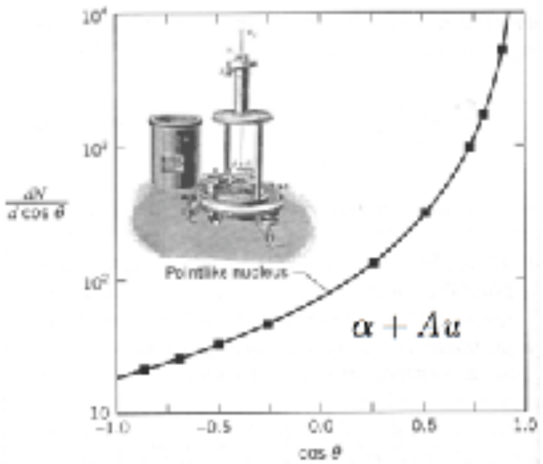




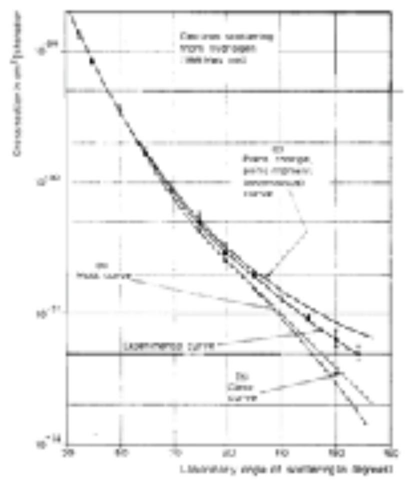
There are two central goals of measurements planned at RHIC, as it completes its scientific mission, and at the LHC: **(1) Probe the inner workings of QGP by resolving its properties at shorter and shorter length scales. The complementarity of the two facilities is essential to this goal, as is a state-of-the-art jet detector at RHIC, called sPHENIX. (2) Map the phase diagram of QCD with experiments planned at RHIC.**

Microscopic structure of matter

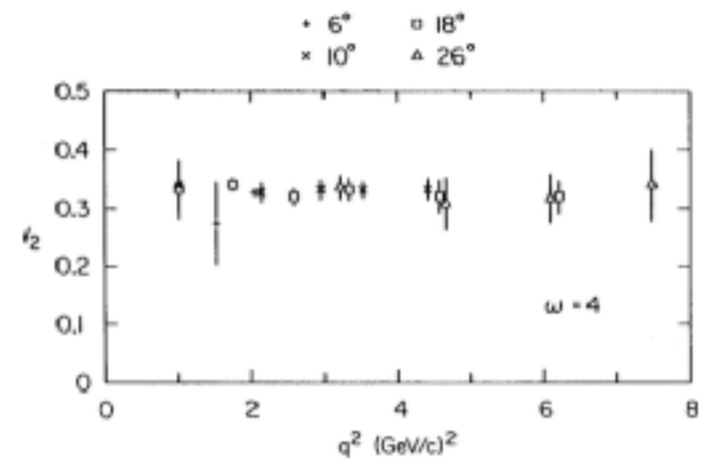
Atoms➔Nuclei

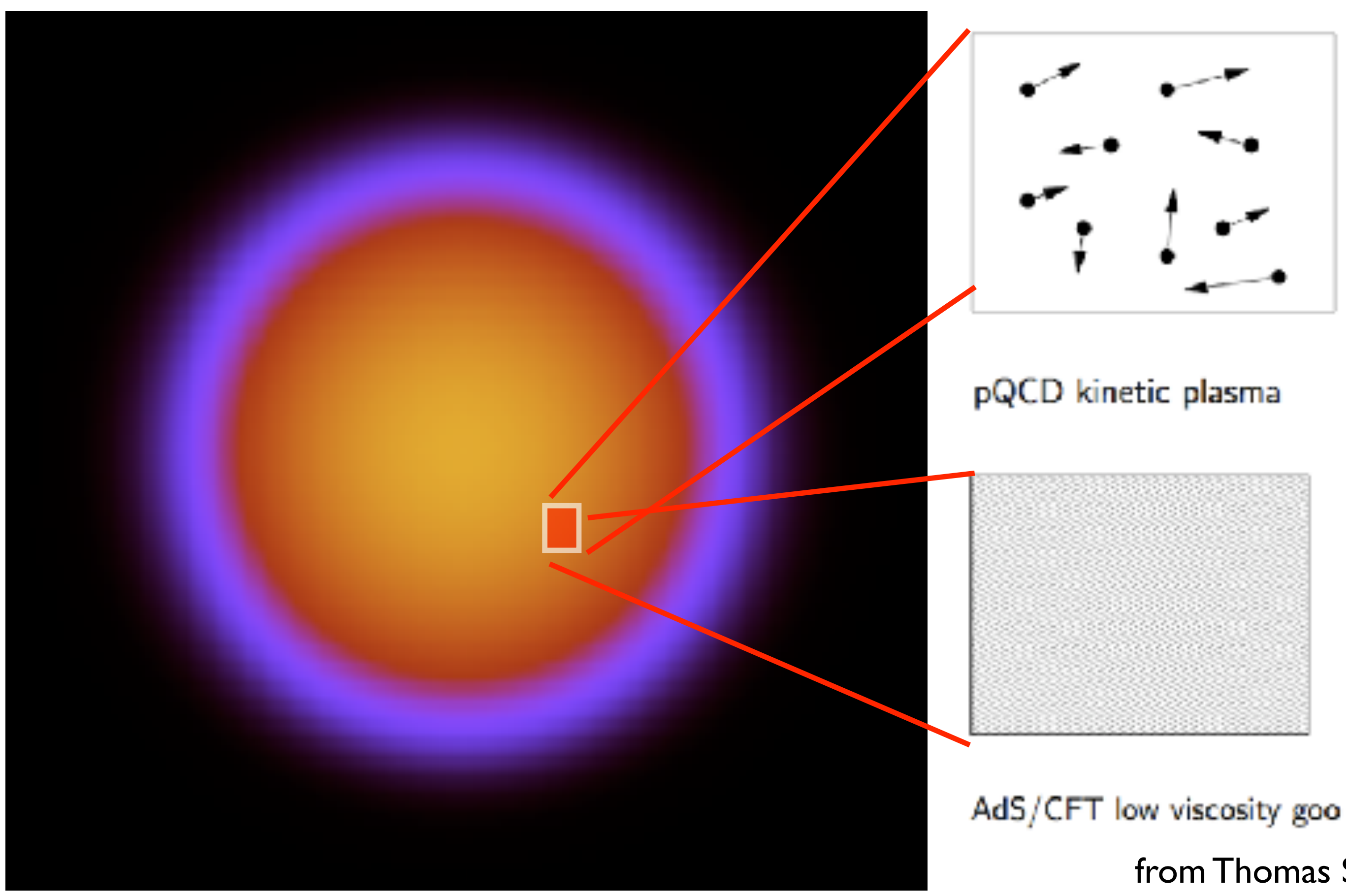


Nuclei➔Nucleons



Nucleons➔Quarks





from Thomas Schafer

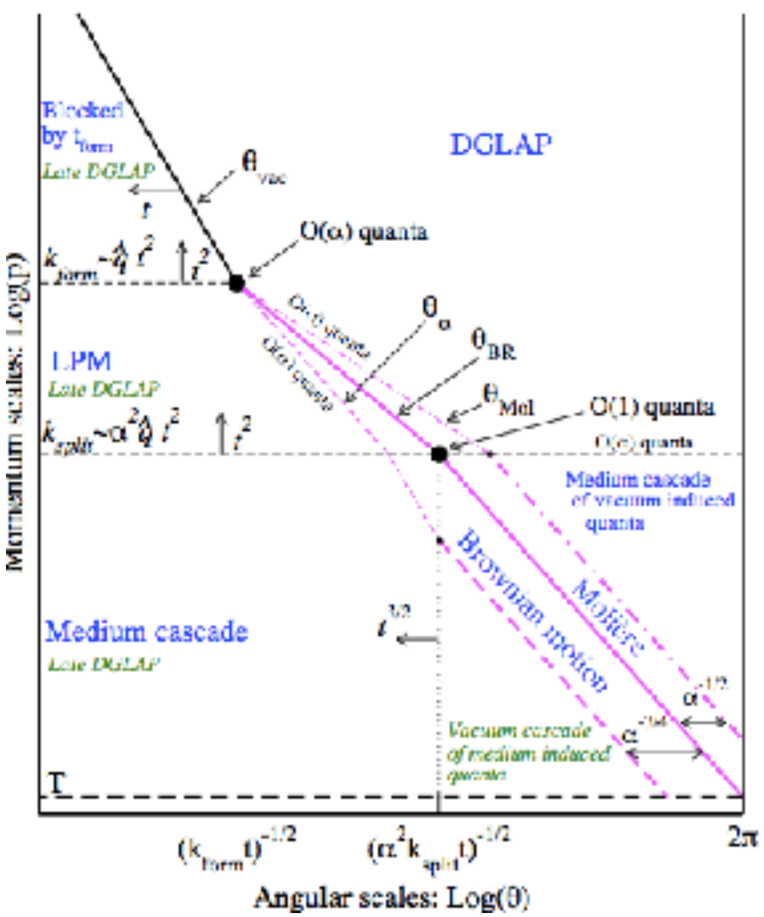
sQGP liquid (?)↔ quasiparticles

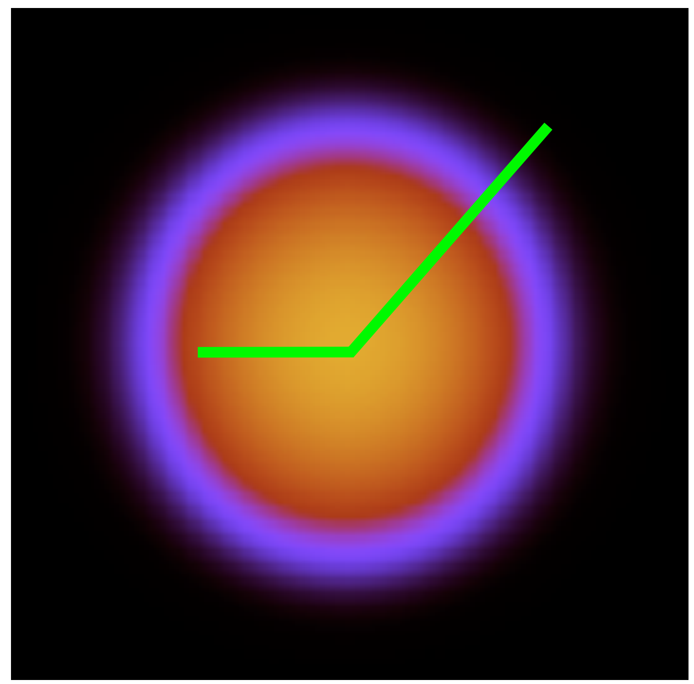
Unavoidable complexity due to strongly interacting nature of QGP probes

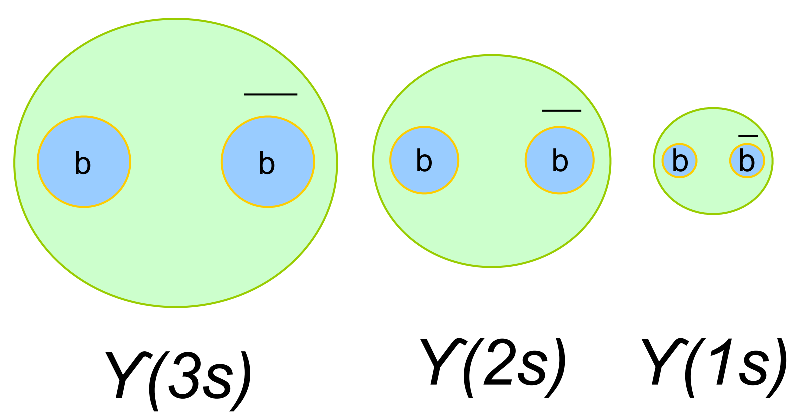
QGP physics with sPHENIX

Three key approaches to study
QGP structure at multiple scales

Jets and jet structure

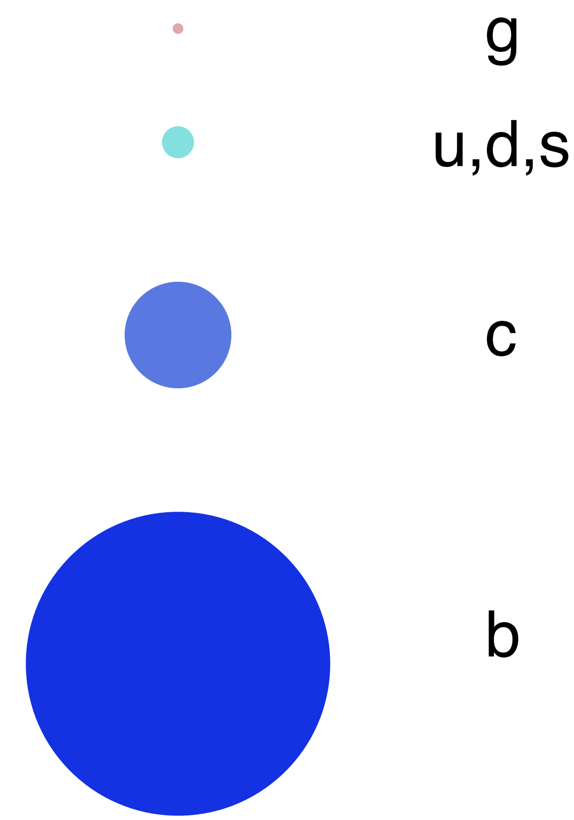




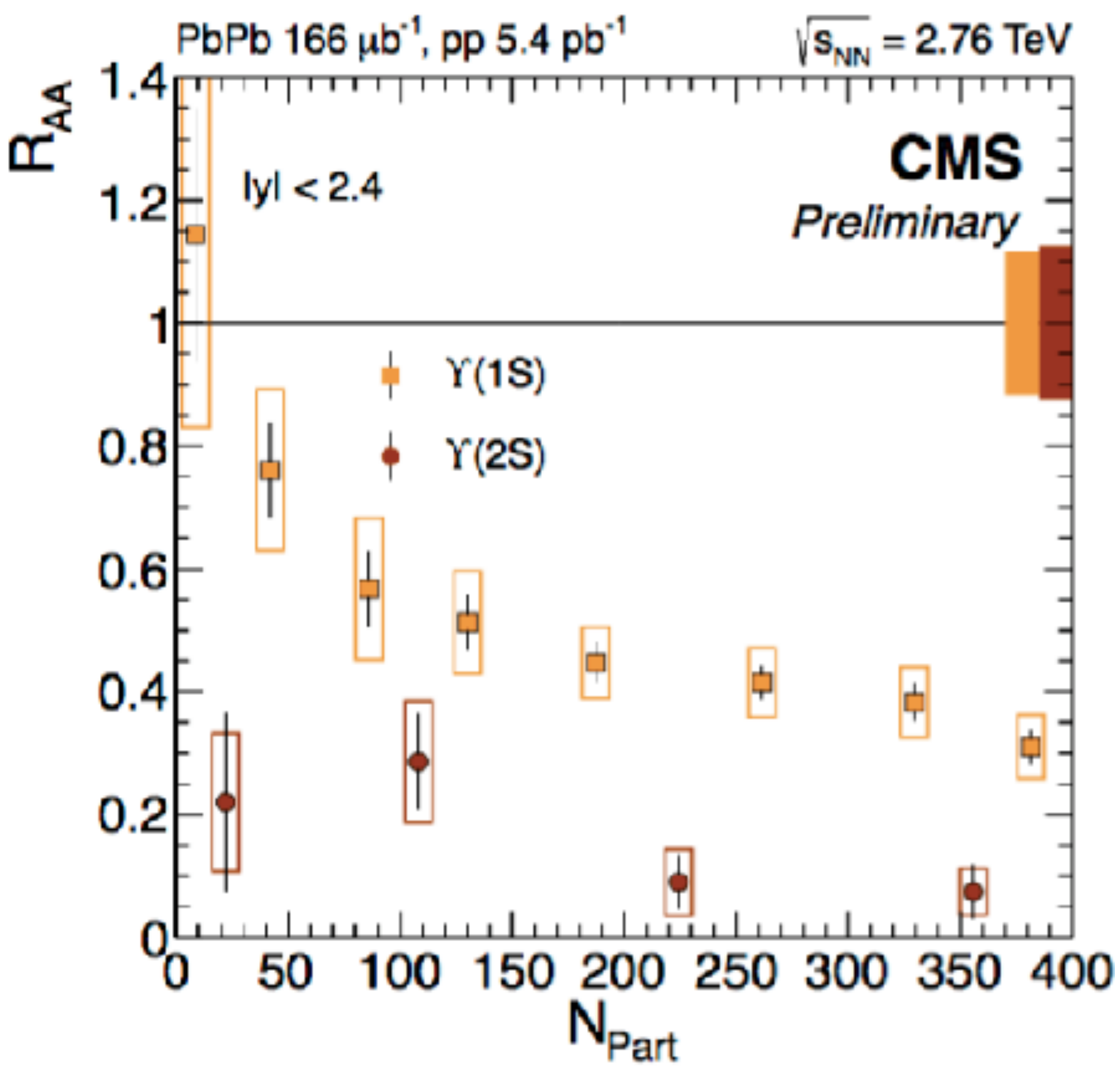


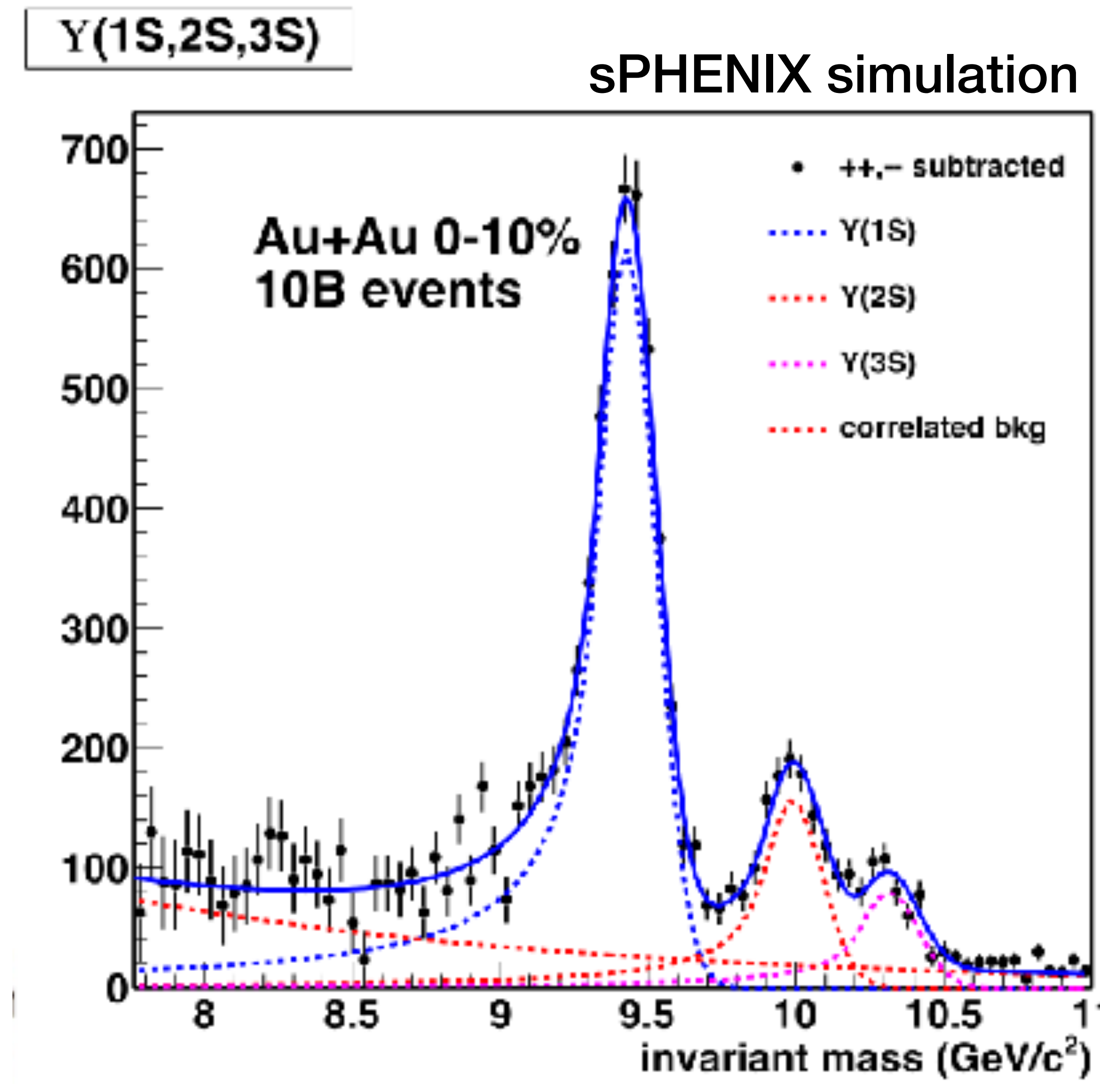
Upsilon spectroscopy

Parton mass/flavor



Physics drives detector requirements: Υ(ns)





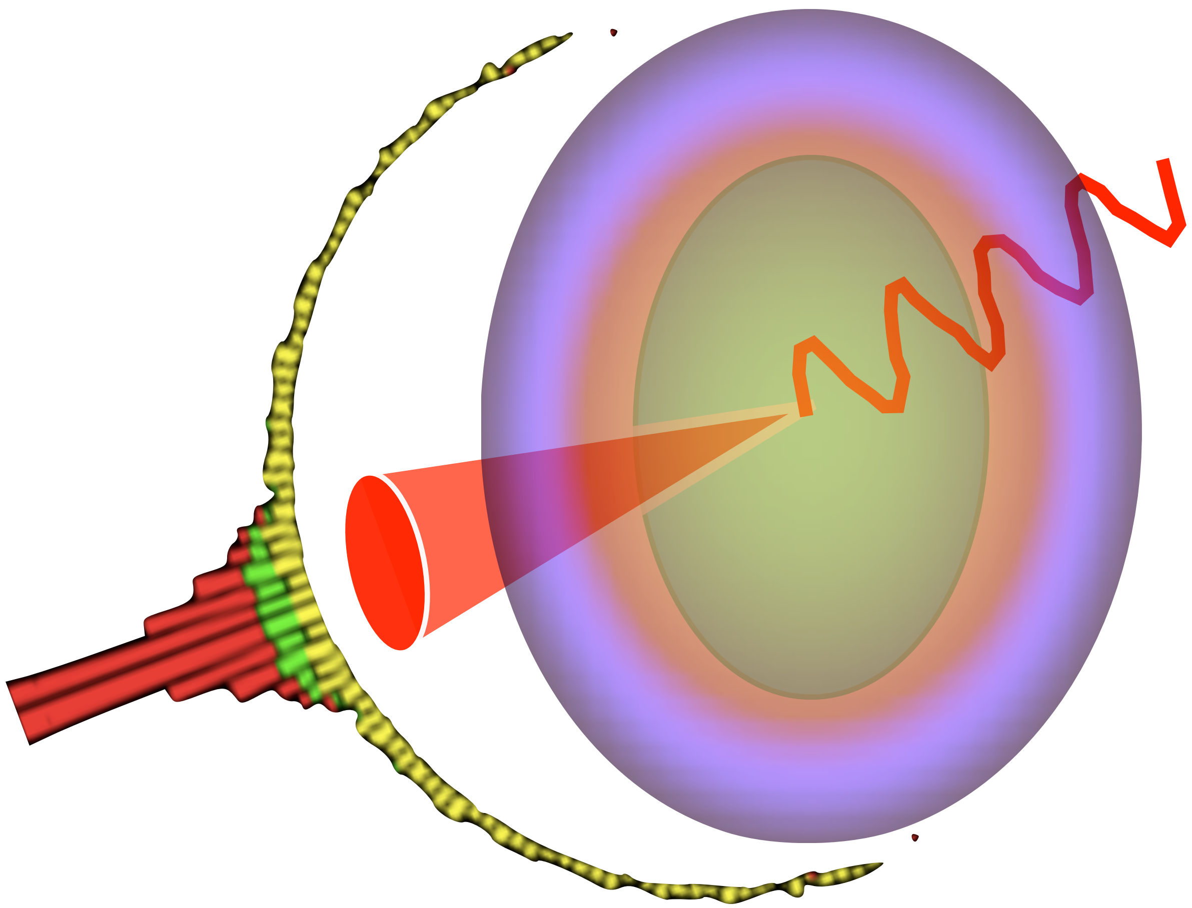
Rapid disappearance of Y(2s), Y(3s) in peripheral events is puzzling ➜
Statistics, statistics, statistics…

Count every Y delivered ➜
high rate, large acceptance

Make every Y count ➜
excellent momentum resolution

Physics drives detector requirements: Jets and HF

Unified approach to jet physics at RHIC and LHC



Use away- and near-side tags to control initial hard system:

- Parton flavor and mass
- Initial momentum
- Path length
- In-medium evolution
- Initial and final state radiation

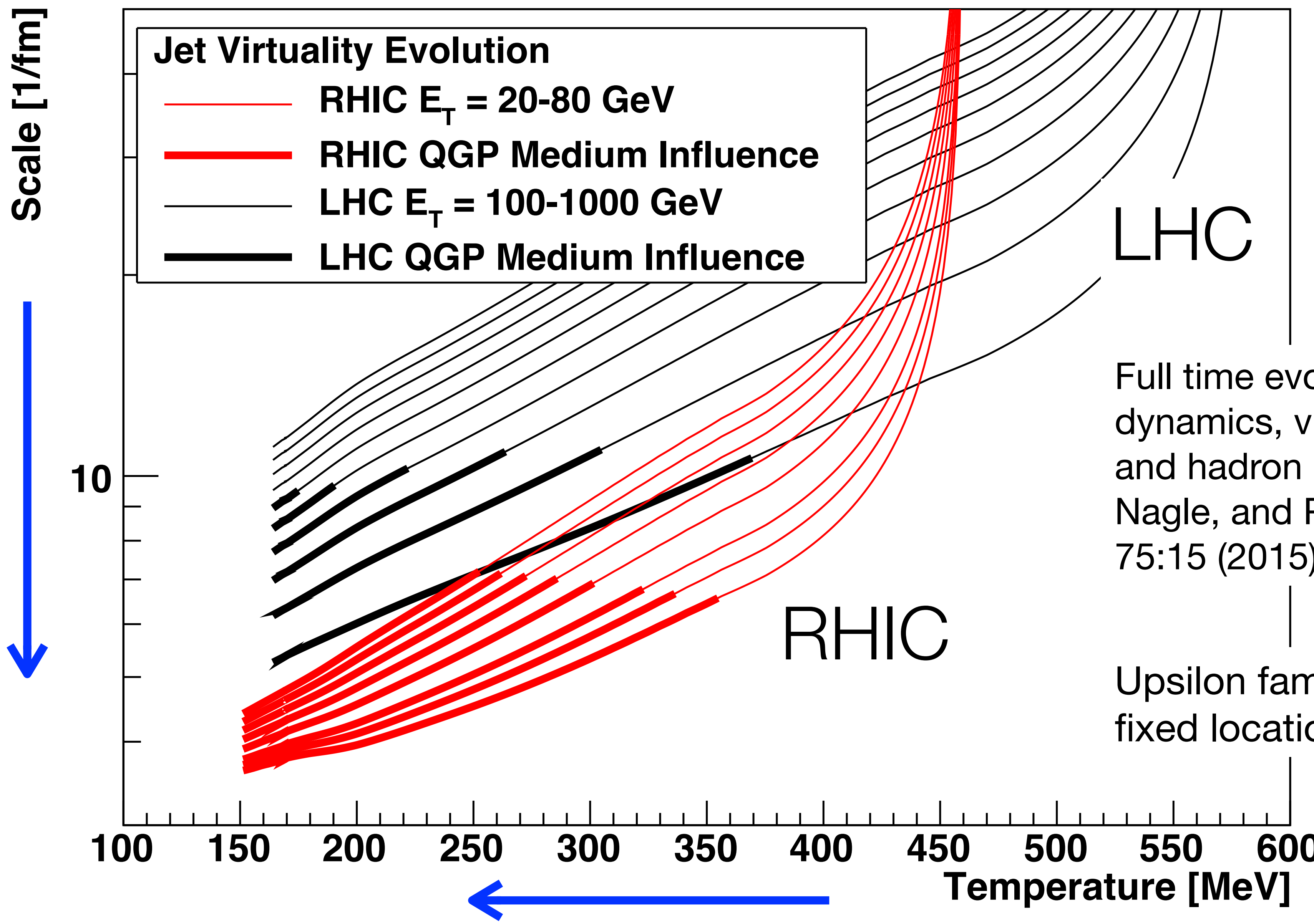
➜

Photon and HF tagging
HF meson reconstruction
High rate
Control over jet energy scale

Fully characterize momentum flow near the jet, both "in-cone" and "out-of-cone"➜
Full azimuthal coverage w/ tracking and calorimetry
Large acceptance in p_T and rapidity
High tracking efficiency, low fake rate

Evolving probes in evolving medium: RHIC ⊕ LHC

Initial hard scattered parton virtuality in units of 1/fm as a function of the local temperature of the QGP medium

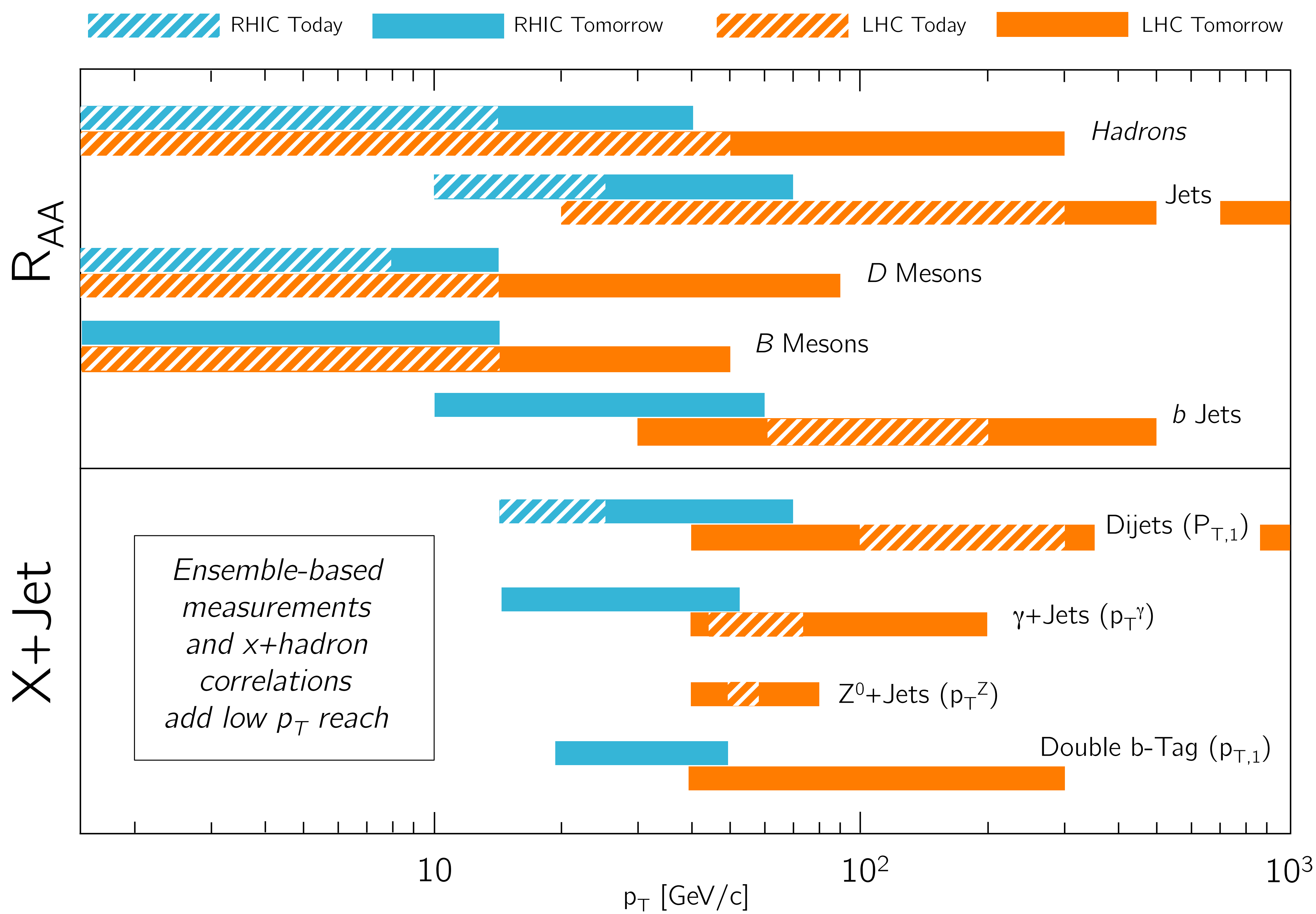


Full time evolution of pre-equilibrium dynamics, viscous hydrodynamics, and hadron cascade M. Habich, J. Nagle, and P. Romatschke, EPJC, 75:15 (2015)

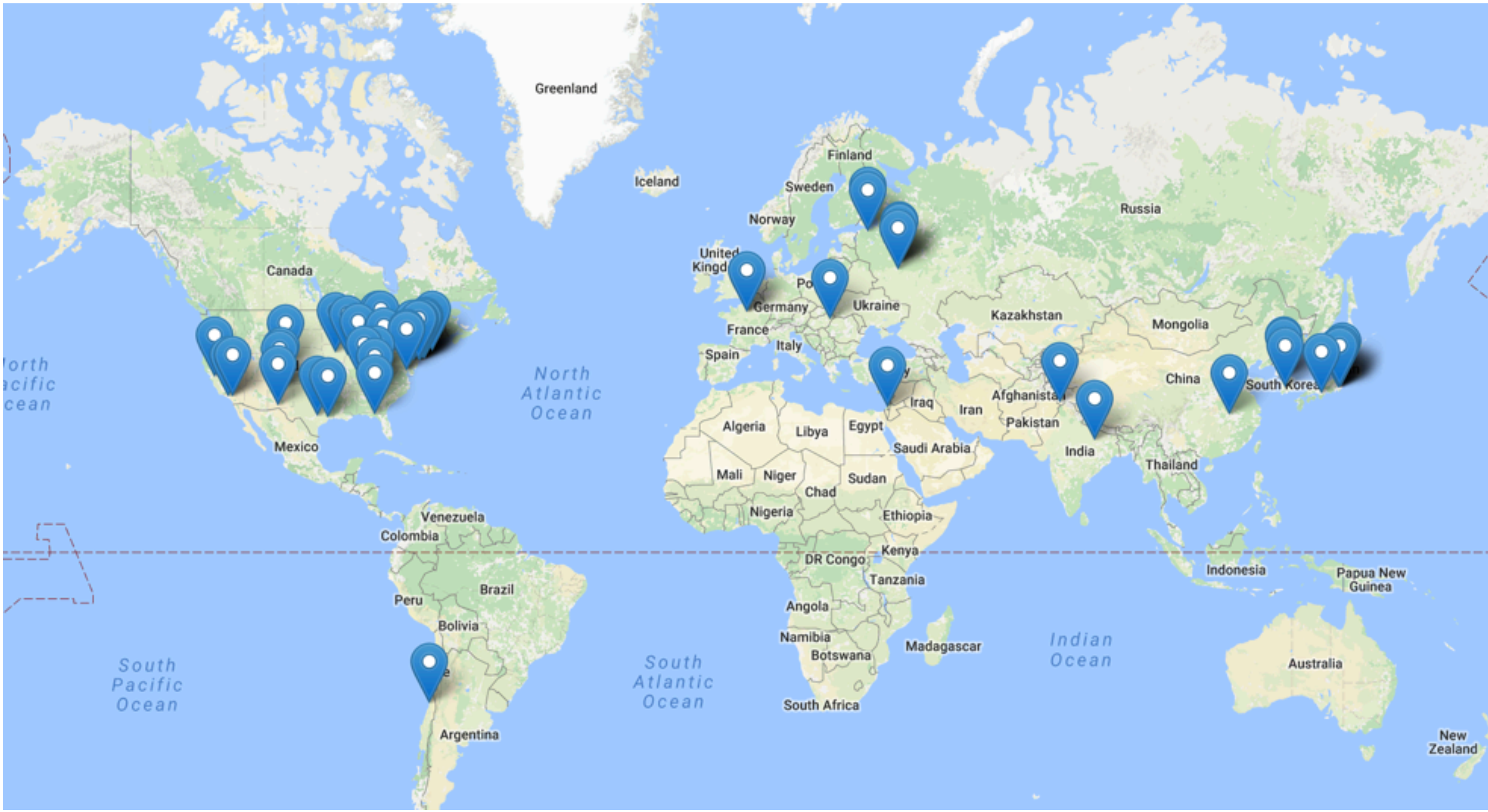
Upsilon family 1S, 2S, 3S establish fixed locations in this space

Vacuum virtuality evolution initially, with medium influence becoming significant as virtuality of parton shower and medium become comparable

Physics drives detector requirements: RHIC ⊕ LHC



A worldwide collaboration



Six new institutions have joined since CD-0

PURDUE UNIVERSITY

Berkeley UNIVERSITY OF CALIFORNIA

cea

TEMPLE UNIVERSITY

CENTRAL CHINA NORMAL UNIVERSITY

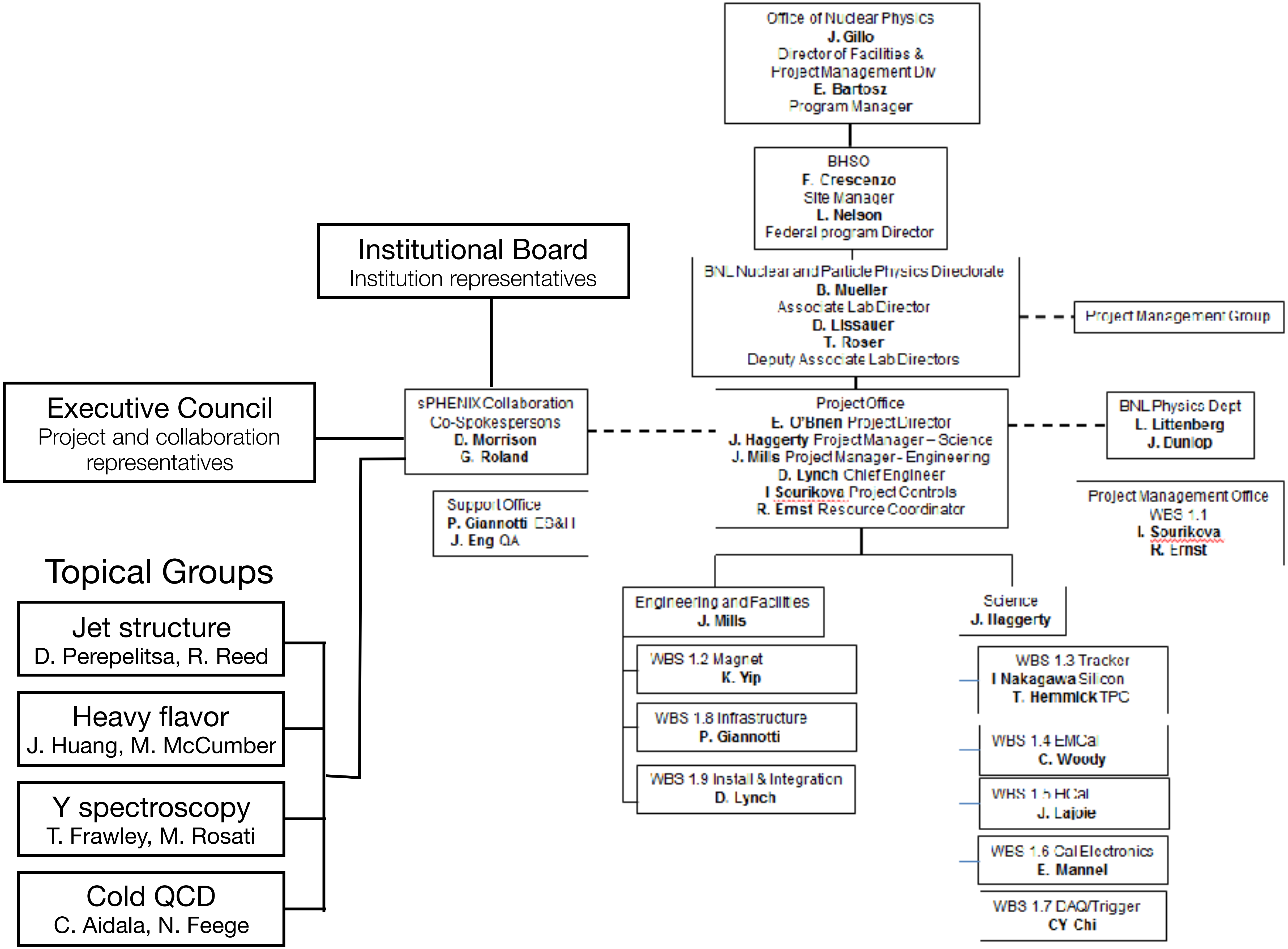
BERKELEY LAB Lawrence Berkeley National Laboratory

Expertise in relevant physics, MPGDs, silicon, TPCs. Discussions with University Sao Paulo and contacts with other international institutions

64 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

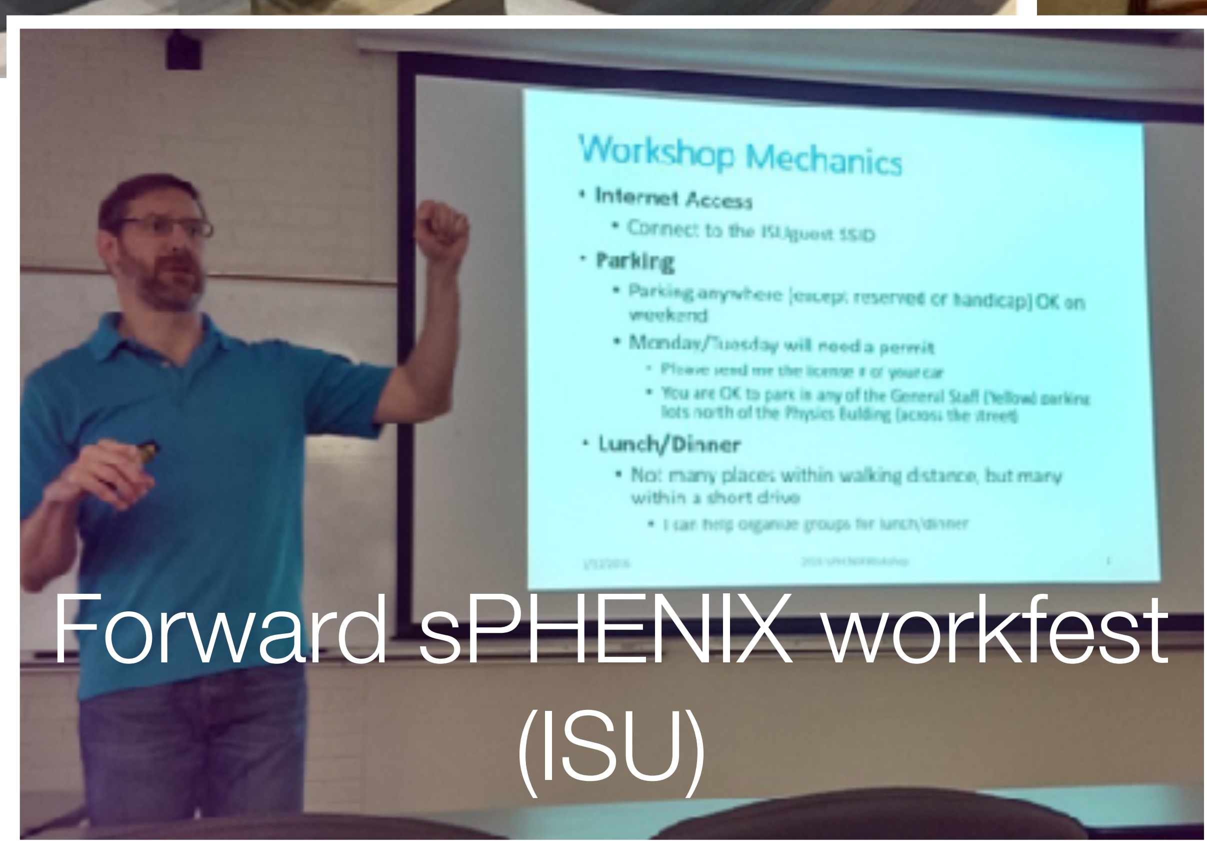
June 13-14 sPHENIX Collaboration Meeting


Office of Nuclear Physics
J. Gillo
Director of Facilities & Project Management Div
E. Bartosz
Program Manager
BHSO
F. Crescenzo
Site Manager
L. Nelson
Federal program Director
Institutional Board
Institution representatives
BNL Nuclear and Particle Physics Directorate
B. Mueller
Associate Lab Director
D. Lissauer
T. Roser
Deputy Associate Lab Directors
Project Management Group
Executive Council
Project and collaboration representatives
sPHENIX Collaboration
Co-Spokespersons
D. Morrison
G. Roland
Project Office
E. O'Brien Project Director
J. Haggerty Project Manager – Science
J. Mills Project Manager - Engineering
D. Lynch Chief Engineer
I. Sourikova Project Controls
R. Ernst Resource Coordinator
BNL Physics Dept
L. Littenberg
J. Dunlop
Support Office
P. Giannotti ES&H
J. Eng QA
Project Management Office
WBS 1.1
I. Sourikova
R. Ernst
Topical Groups
Jet structure
D. Perepelitsa, R. Reed
Heavy flavor
J. Huang, M. McCumber
Y spectroscopy
T. Frawley, M. Rosati
Cold QCD
C. Aidala, N. Feege
Engineering and Facilities
J. Mills
WBS 1.2 Magnet
K. Yip
WBS 1.8 Infrastructure
P. Giannotti
WBS 1.9 Install & Integration
D. Lynch
Science
J. Haggerty
WBS 1.3 Tracker
I Nakagawa Silicon
T. Hemmick TPC
WBS 1.4 EMCal
C. Woody
WBS 1.5 HCal
J. Lajoie
WBS 1.6 Cal Electronics
E. Mannel
WBS 1.7 DAQ/Trigger
CY Chi

Close connection of collaboration and project: PHENIX-style workfests


MAPS cost and schedule workfest (LANL)


HF tagged jets workfest (BNL)



Forward sPHENIX workfest (ISU)

- Continues practice that was very productive in developing sPHENIX proposals
- Invite outside experts when appropriate – e.g., discussion with ALICE & STAR experts on space charge distortion in TPC
- Recent activities: two-day EMCal workfest in August, two-day test beam paper writing workshop, discussion with ALICE to gauge needs of sPHENIX TPC readout

Multi-year run plan scenario for sPHENIX

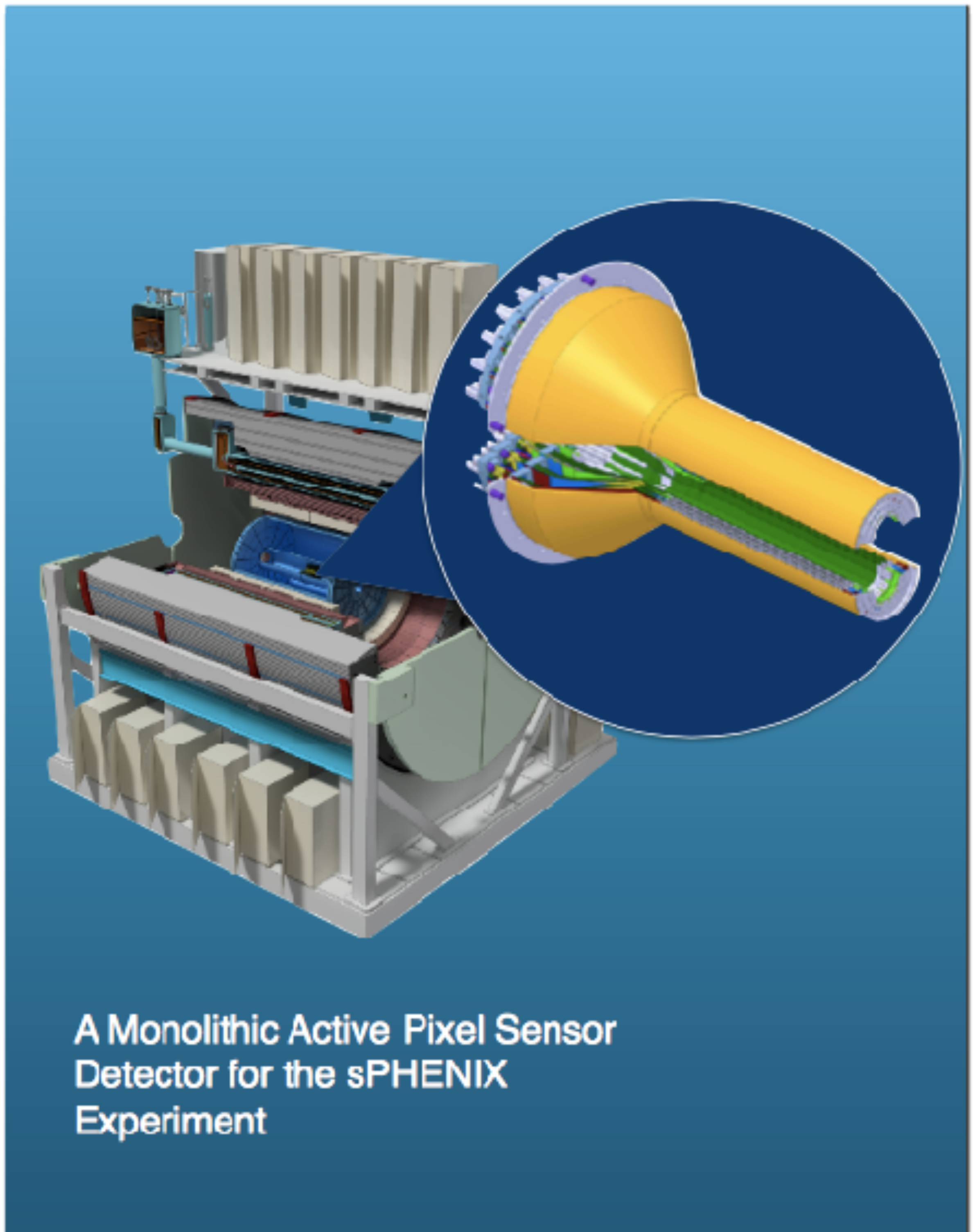
Year	Species	Energy [GeV]	Phys. Wks	Rec. Lum.	Samp. Lum.	Samp. Lum. All-Z
2022	Au+Au	200	16.0	7 nb^{-1}	8.7 nb^{-1}	34 nb^{-1}
2023	p+p	200	11.5	—	48 pb^{-1}	267 pb^{-1}
2023	p+Au	200	11.5	—	0.33 pb^{-1}	1.46 pb^{-1}
2024	Au+Au	200	23.5	14 nb^{-1}	26 nb^{-1}	88 nb^{-1}
2025	p+p	200	23.5	—	149 pb^{-1}	783 pb^{-1}
2026	Au+Au	200	23.5	14 nb^{-1}	48 nb^{-1}	92 nb^{-1}

- Guidance from ALD to think in terms of a multi-year run plan
- Consistent with language in DOE CD-0 “mission need” document
- Incorporates updated C-AD guidance now officially documented
- Run plan relates to capabilities of full barrel detector
- Incorporates commissioning time in first year

Minimum bias Au+Au at 15 kHz for |z| < 10 cm:
47 billion (2022) + **96 billion** (2024) + **96 billion** (2026) = Total **239 billion events**

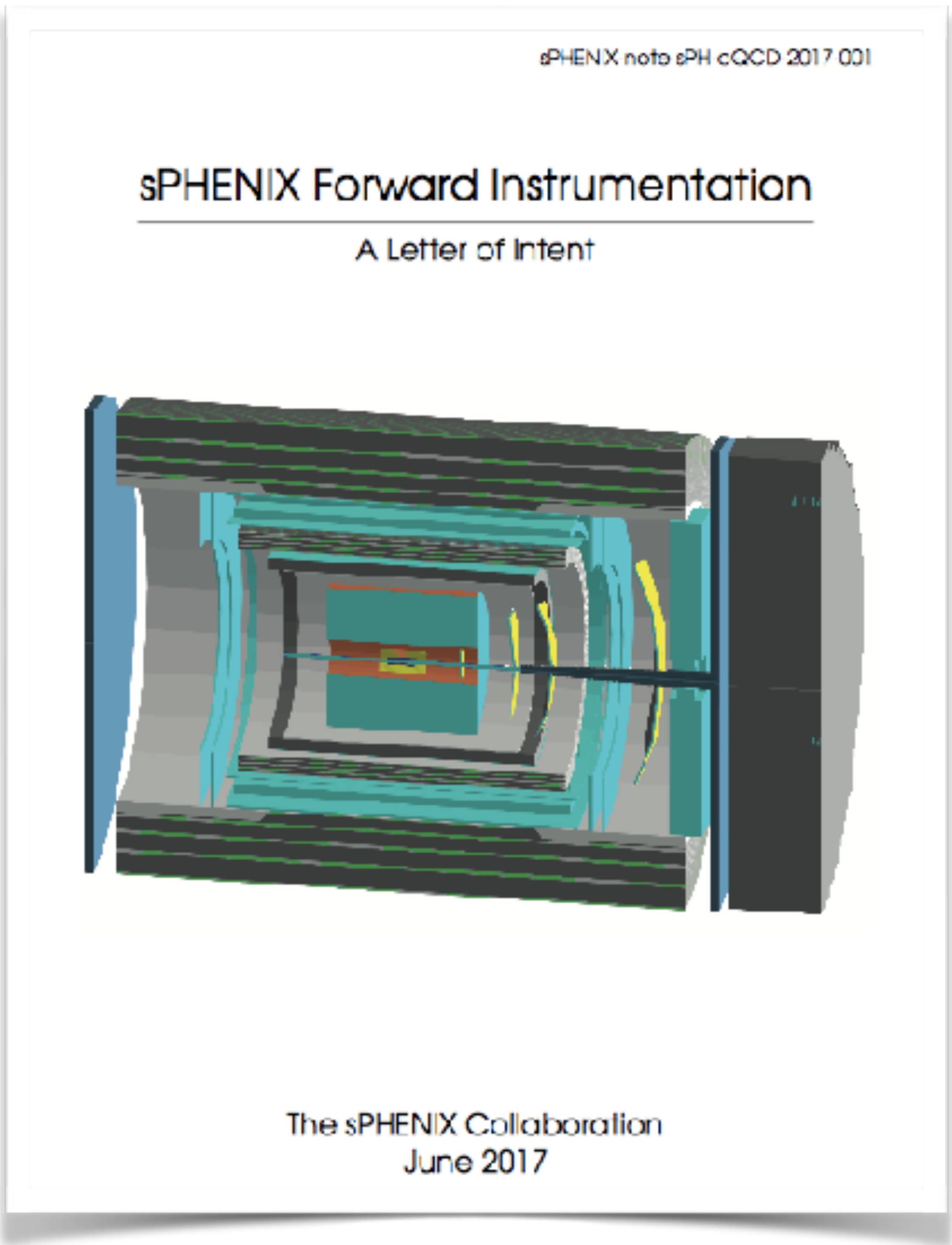
For topics with Level-1 selective trigger (e.g. high p_T photons), one can sample within |z| < 10 cm a total of 550 billion events. One could consider sampling events over a wider z-vertex for calorimeter only measurements, 1.5 trillion events.

MVTX pre-proposal and beyond



- MVTX as separate project outside of, but pursued in parallel to, baseline MIE detector
- Enables open HF and HF-tagged jet addition to physics program of baseline detector
- MVTX consortium developed MVTX pre-proposal, with Director's review at BNL on July 10-12, 2017

Modest Forward Upgrade LOI



- Invitation by ALD to STAR and sPHENIX on February 22. Submitted to ALD on June 3
- Contributions across collaboration, led by cold QCD topical group.
- In addition to p+p and p+A program, collaboration excited by strengthening of core sPHENIX program by adding forward instrumentation to high-rate, deep calorimetry, high resolution tracking, precise vertexing of barrel.
    - E.g., dijets and (central-forward) gamma+jet over extended rapidity range $-1 < \eta < 4$

Outlook

- sPHENIX scientific collaboration in full swing working towards start of physics in early 2020s
- Ongoing efforts to strengthen collaboration:
  - discussions with additional (strong) groups about joining sPHENIX
  - ongoing effort to strengthen workforce from member institutions
  - discussion on hardware collaboration (e.g. w/ ALICE reg. MAPS) with non-member groups
- Collaboration is committed to building a world-class experiment with the capabilities needed to deliver the full suite of sPHENIX physics