What is needed to support HIC research

- Funding for experiment

  Good news (as I understood it from talks):
  - continued support for HADES
  - continued development of FAIR/CBM
  - support for EOS @ FRIB experiments
  - other experiments: INDRA-FAZIA, RAON, CEE, ...

- Support for theory
  - realizing the potential of HIC experiments *needs* interpretations of data from transport simulations
  - complex projects to further develop these simulations *need* support for collaborations
  - long-term developments *need* the existence of viable career paths for early career researchers

Who is doing transport research

What is the state of the hadronic transport theory *community*?

Among participants of this meeting:

IN SENIOR POSITIONS:

E. Bratkovskaya
M. Colonna
D. Cozma
H. Elfner
Z.-Q. Feng
N. Ikeno
U. Mosel
P. Napolitani
A. Ono
H. Wolter
J. Xu
Y. Zhang

EARLY CAREER:

H.-G. Cheng
J. Mohs
A. Sorensen
R. Wang

In the US:

IN SENIOR POSITIONS:

P. Danielewicz
C.-M. Ko
V. Koch
B.-A. Li
Z.-W. Lin
J. Lopez
S. Bass

EARLY CAREER:

O. Savchuk
A. Sorensen

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At the “Seattle workshop” (INT-22-84W):

IN SENIOR POSITIONS:

M. Colonna
D. Cozma
P. Danielewicz
N. Ikeno
C.-M. Ko
V. Koch
B.-A. Li
J. Lopez
U. Mosel
Y. Nara
A. Ono
S. Pratt
J. Randrup
J. Steinheimer
H. Wolter

EARLY CAREER:

J. Mohs
A. Motornenko
T. Reichert
O. Savchuk
A. Sorensen
K.-J. Sun

SITIONS:

EARLY CAREER:

O. Savchuk
A. Sorensen

Maintaining the expertise
is needed for
CBM,
FRIB400,
CEE,
…

About the U.S. LRP process = why we wrote the “Seattle” White Paper

White Paper written in response to the U.S. 2023 Long Range Plan (LRP) process

- Community gathers at town hall meetings for 3 (really 4) areas:
  - Hot QCD & Cold QCD
  - Nuclear Structure, Reactions, and Astrophysics
  - Fundamental Symmetries
- Town hall meeting conveners write 3 white papers in their areas = **source material for the LRP**
- Groups within the communities produce more white papers on specific subjects = **what we did**

There are four distinct scientific communities, a **finite** amount of money, and **many** different interesting physics projects (HICs, EIC, $0\nu\beta\beta$, …)

- It’s **not enough** to *say* that your science is “interesting” (*prove* it!)
- It’s **not enough** to convince *your community* to support your science (they’re *already* on your side!)
- You need to convince people who
  - are not really interested in your science
  - are also fighting for survival (= need money)

  Your arguments must be so good that nobody can oppose them in good conscience

The “Seattle” White Paper

A. Sorensen *et al.*, arXiv:2301.13253, to appear in JPPNP

Dense Nuclear Matter Equation of State from Heavy-Ion Collisions *

Agnieszka Sorensen[1], Kshitij Agarwal[2], Kyle W. Brown[3,4], Zbigniew Chajecki[5], Paweł Danielewicz[3,6], Christian Drischler[7], Stefano Gandolfi[8], Jeremy W. Holt[9,10], Matthias Kaminski[11], Che-Ming Ko[9,10], Rohit Kumar[3], Bao-An Li[12], William G. Lynch[3,6], Alan B. McIntosh[10], William G. Newton[12], Scott Pratt[3,6], Oleh Savchuk[3,13], Maria Stefaniak[14], Ingo Tews[8], ManYee Betty Tsang[3,6], Ramona Vogt[15,16], Hermann Wolter[17], Hanna Zbroszczyk[18]

Endorsing authors:

Navid Abbasi[19], Jörg Aichelin[20,21], Anton Andronic[22], Steffen A. Bass[23], Francesco Becattini[24,25], David Blaschke[26,27,28], Marcus Bleicher[29,30], Christoph Blume[31], Elena Bratkovskaya[14,29,30], B. Alex Brown[3,6], David A. Brown[32], Alberto Camaiani[33], Giovanni Casini[25], Katerina Chatziioannou[34,35], Abdelouahad Chbihi[36], Maria Colonna[37], Mircea Dan Cozma[38], Veronica Dexheimer[39], Xin Dong[40], Travis Dore[41], Lipei Du[42], José A. Dueñas[43], Hannah Elfner[14,21,29,30], Wojciech Florkowski[44], Yuki Fujimoto[1], Richard J. Furnstahl[45], Alexandra Gade[3,6], Tetyana Galatyuk[14,46], Charles Gale[42], Frank Geurts[47], Sašo Grozdanov[48,49], Kris Hagel[10], Steven P. Harris[1], Wick Haxton[40,50], Ulrich Heinz[45], Michal P. Heller[51], Or Hen[52], Heiko Hergert[3,6], Norbert Herrmann[53], Huan Zhong Huang[54], Xu-Guang Huang[55,56,57], Natsumi Ikeno[10,58], Gabriele Inghirami[14], Jakub Jankowski[26], Jiangyong Jia[59,60], José C. Jiménez[61], Joseph Kapusta[62], Behruz Kardan[31], Iurii Karpenko[63], Declan Keane[39], Dmitri Kharzeev[60,64], Andrej Kugler[65], Arnaud Le Fèvre[14], Dean Lee[3,6], Hong Liu[66], Michael A. Lisa[45], William J. Llope[67], Ivano Lombardo[68], Manuel Lorenz[31], Tommaso Marchi[69], Larry McLerran[1], Ulrich Mosel[70], Anton Motornenko[21], Berndt Müller[23], Paolo Napolitani[71], Joseph B. Natowitz[10], Witold Nazarewicz[3,6], Jorge Noronha[72], Jacquelyn Noronha-Hostler[72], Grażyna Odyniec[40], Panagiota Papakonstantinou[73], Zuzana Paulínyová[74], Jorge Piekarewicz[75], Robert D. Pisarski[60], Christopher Plumberg[76], Madappa Prakash[7], Jørgen Randrup[40], Claudia Ratti[77], Peter Rau[1], Sanjay Reddy[1], Hans-Rudolf Schmidt[2,14], Paolo Russotto[37], Radoslaw Ryblewski[78], Andreas Schäfer[79], Björn Schenke[60], Srimoyee Sen[80], Peter Senger[81], Richard Seto[82], Chun Shen[67,83], Bradley Sherrill[3,6], Mayank Singh[62], Vladimir Skokov[83,84], Michał Spaliński[85,86], Jan Steinheimer[21], Mikhail Stephanov[87], Joachim Stroth[14,31], Christian Sturm[14], Kai-Jia Sun[88], Aihong Tang[60], Giorgio Torrieri[89,90], Wolfgang Trautmann[14], Giuseppe Verde[91], Volodymyr Vovchenko[77], Ryoichi Wada[10], Fuqiang Wang[92], Gang Wang[54], Klaus Werner[20], Nu Xu[40], Zhangbu Xu[60], Ho-Ung Yee[87], Sherry Yennello[9,10,93], Yi Yin[94]

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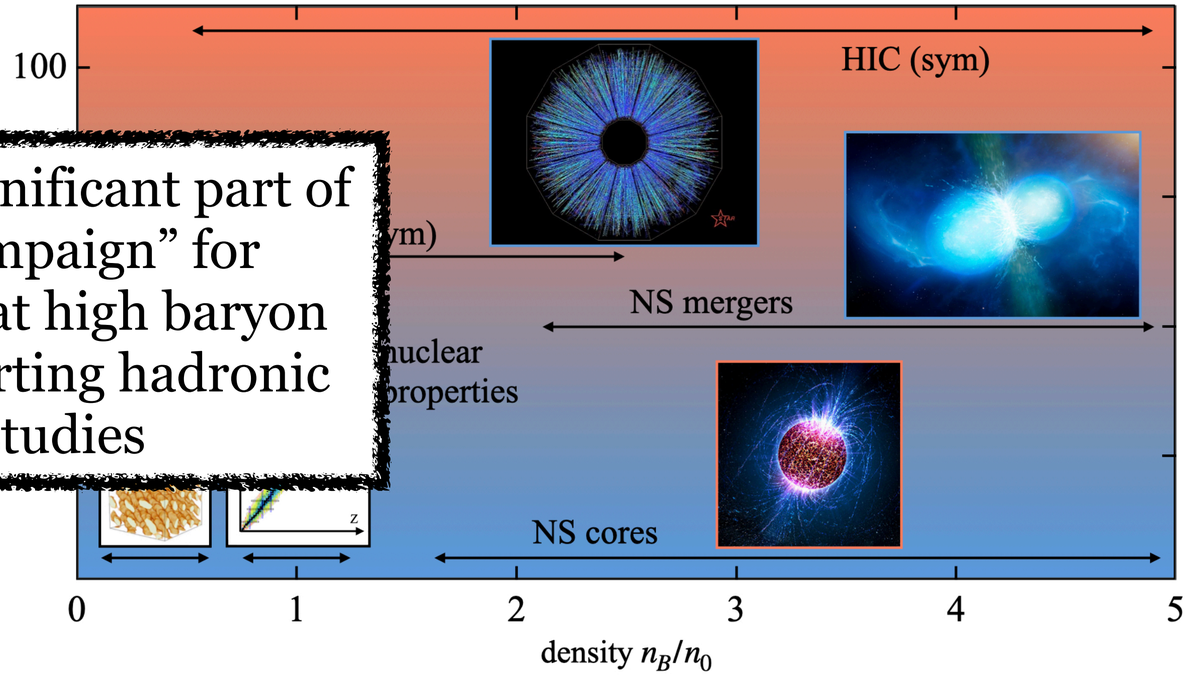
The paper was a significant part of a larger “PR campaign” for exploring physics at high baryon density and supporting hadronic transport studies

Hot QCD

Cold QCD

Nucl. reactions + astro

Fundamental sym.



Exploring synergies between communities:

- exposure to varied scientific ideas, approaches
- increased support for EOS physics

Outcomes of the “Seattle” White Paper and the “PR campaign”

The U.S. 2023 Long Range Plan hasn’t been released yet = no certainty of impact, but…

- Initiative for “[exploring] US participation in international facilities at the high baryon density” (=CBM) after a failure in the first vote, passed the second vote at the Hot & Cold QCD town hall meeting

  Survey: Yes 92 / No 113 / No Answer 50

  (Yes: 157; No: 129; No Answer: 56)

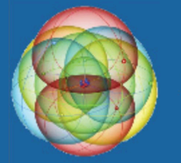
  (the wording @ 1st vote implied RHIC BES wouldn’t succeed; differences @ 2nd vote: make the case without implying that RHIC BES had failed, advocate for building on their results and further progress, make connections to astrophysics)

- Multiple significant mentions of hadronic transport, the EOS at high baryon density, and TMEP in the Hot & Cold QCD *and* Nuclear Structure, Reactions, and Astrophysics white papers

The Present and Future of QCD

QCD Town Meeting White Paper – An Input to the 2023 NSAC Long Range Plan

P. Achenbach[1], D. Adhikari[2], A. Afanasev[3], F. Afzal[4], C.A. Aidala[5], A. Al-bataineh[6,7], D.K. Almaalol[8], M. Amaryan[9], D. Androić[10], W.R. Armstrong[11], M. Arratia[12,1], J. Arrington[13], A. Asaturyan[14,15], E.C. Aschenauer[16], H. Atac[17]



WHITE PAPER ON NUCLEAR STRUCTURE, REACTIONS, AND ASTROPHYSICS

- Section of an upcoming white paper on “Motivations for Early High-Profile FRIB Experiments” devoted to the high-density EOS extraction from HICs, transport simulations, χEFT, …

What is needed to support HIC research

- Funding for experiment

  Good news:
  - continued support for HADES
  - continued development of FAIR/CBM
  - support for EOS @ FRIB experiments
  - other experiments: INDRA-FAZIA, RAON, CEE,...

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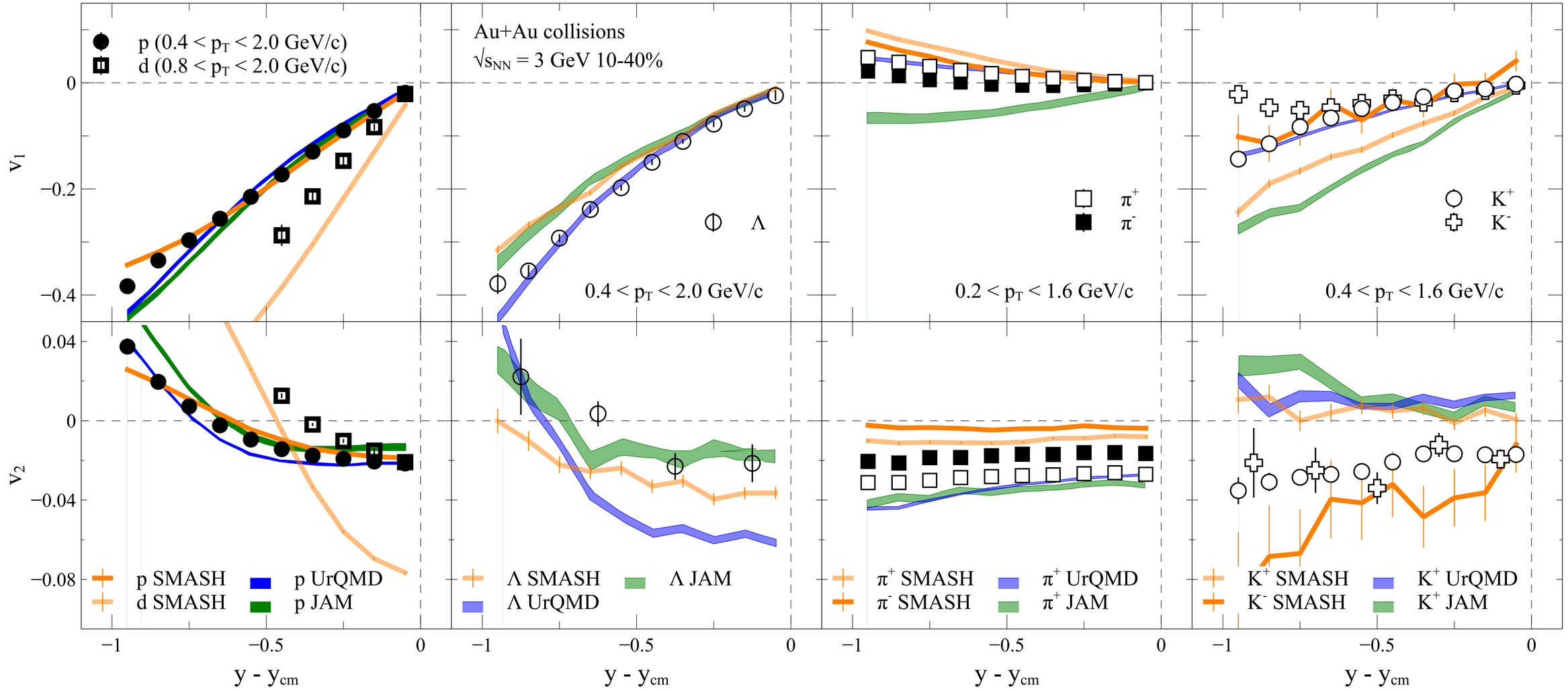
  - realizing the potential of HIC experiments *needs* interpretations of data from transport simulations
  - complex projects to further develop these simulations *need* support for collaborations
  - long-term developments *need* the existence of viable career paths for early career researchers

to support the upper two points:

- Engagement with other nuclear physics communities = not only increased visibility (PR), but also:
  - exchange of ideas
  - finding common goals
  - influx of talent
  - ...

And back to science: *What* do we need to do to describe all flows?



STAR, Phys. Lett. B **827**, 137003 (2022) arXiv:2108.00908

D. Oliinychenko, **A. Sorensen**, V. Koch, L. McLerran, Phys. Rev. C **108**, 3, 034908 (2023), arXiv:2208.11996

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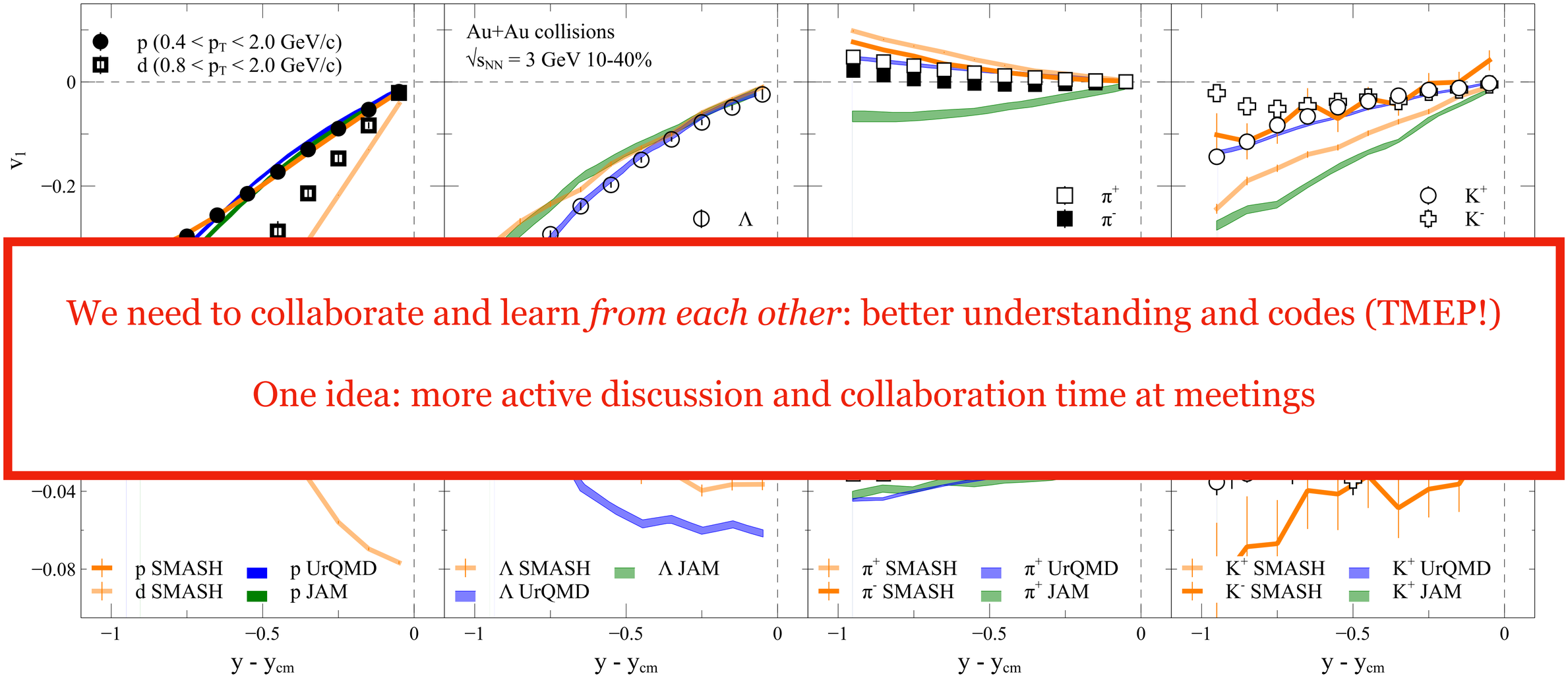

We need to collaborate and learn *from each other*: better understanding and codes (TMEP!)

One idea: more active discussion and collaboration time at meetings

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