Nuclear Data in the NSAC Long Range Plan

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DNP Secretary-Treasurer

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Long Range Plan (LRP) for Nuclear Science

- Every 5-8 years, the funding agencies (DOE and NSF) issue a charge to the Nuclear Science Advisory Committee (NSAC) to produce a Long Range Plan
  - The last previous charge was in 2014
  - The most recent charge was delivered to NSAC in July 2022 and is expected to be completed by October 2023
- The process determines the priorities for US nuclear physics during the next 5-8 year period by agreeing on a number of recommendations and initiatives.
  - USNDP/CSEWG activities are funded under US DOE NP
- Several budgetary considerations: constant or modest (2%) growth is lower bound but upper bound could be new funding from the CHIPS act for the next 5 years if a compelling case is made – great opportunities are possible with a good LRP

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ND = Nuclear Data sub-committee
DNP = DNP chair line
DNP ST = DNP Sec.-Treas.
Town Hall Conveners (2 from each TH)
Today's speakers

LRP subcommittees

- Final outline still to be determined but subcommittees/chapters will include:
  - QCD
  - Fundamental Symmetries
  - Nuclear Structure & Nuclear Astrophysics
  - Workforce Development (includes education and DEI)
  - Applications
  - International Context
  - Crosscutting/interdisciplinary scientific opportunities (e.g., QIS, Accelerator Science, Computing)
  - Impact and synergies with other fields (e.g., High Energy Physics)
  - Budget
  - Theory
- Rollout and communication of the final LRP is very important
- Community needs to come together to produce an equitable, inclusive document in the broadest possible sense -- we need to work together and respect our community

LRP Timeline

- DNP-organized town hall meetings (September – December)
- Working on forming subcommittees
- Closed kickoff meeting Oct. 26 in New Orleans
  - Agencies will talk to committee
  - Presentation about budgets
  - Subcommittees
  - Writing assignments & proposed outline of LRP
  - Agenda and timing of resolution meeting (10-14 July 2023)
- Writing underway with white papers due end of February 2023
- Late spring/summer: 5 - 7 day resolution meeting
  - 1st part will include presentations by people who are not necessarily on the LRP committee
  - 2nd part will be closed and in-person
- Editing LRP document
- October 2023 – draft report ready

DNP Timeline for contributions to LRP

- May/July 2022 DNP chair-line starts organizing and involves Executive Committee
  - Executive Committee
    - Presented with Town Hall topics from DNP chair line
    - Nominates conveners
    - Approves venue selection process
  - DNP Chair contacts conveners
  - Pre-planning for Town Halls
- July 2022
  - General email to the community outlining the process, announcing the Town Meetings, and inviting engagement.
  - NSAC Charge letter
- September-December 2022 Town Meetings conducted
- October 2022 Special LRP Community Update at the DNP Fall meeting (10/27-30/22)
  - Talks by NSAC Chair, DNP Chair on the process, and brief reports from conveners of each Town Meeting.
- January 2023 White papers for each Town Meeting submitted
- October 2023: DNP-JPS Fall Meeting Plenary Session devoted to LRP if DNP Chair approves

Structure of DNP Town Halls

- Three Town Halls Organized:
  - Hot & Cold QCD (23-25 September, MIT) https://indico.mit.edu/event/538/
  - Nuclear Reactions, Structure & Astrophysics (14-16 November, ANL) https://indico.phy.anl.gov/event/22/
  - Fundamental Symmetries, Neutrons and Neutrinos (13-15 December, Chapel Hill NC) https://indico.phy.ornl.gov/event/209/

- Cross Cutting areas in “Discovery Science Delivering for Society”
  - Workforce Development
    - Education
    - Diversity
  - Innovations / Applications
    - Computing
    - Accelerator Science
    - Nuclear Data
    - Isotope Science

Nuclear data initiative for the Long Range Plan (Hot & Cold QCD Town Hall) Seeking community buy in!

Nuclear data play an essential role in all facets of nuclear physics. Access to accurate, reliable nuclear data is crucial to the success of important missions such as nonproliferation and defense, nuclear forensics, homeland security, space exploration, and clean energy generation, in addition to the basic scientific research underpinning the enterprise. These data are also key to innovations leading to new medicines, automated industrial controls, energy exploration, energy security, nuclear reactor design, and isotope production. It is thus crucial to maintain effective US stewardship of nuclear data.

- We recommend identifying and prioritizing opportunities to enhance and advance stewardship of nuclear data and maximize the impact of these opportunities.

- We recommend building and sustaining the nuclear data community by recruiting, training, and retaining a diverse, equitable and inclusive workforce.

- We recommend identifying crosscutting opportunities for nuclear data with other programs, both domestically and internationally, in particular with regard to facilities and instrumentation.

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Nuclear Data Initiative

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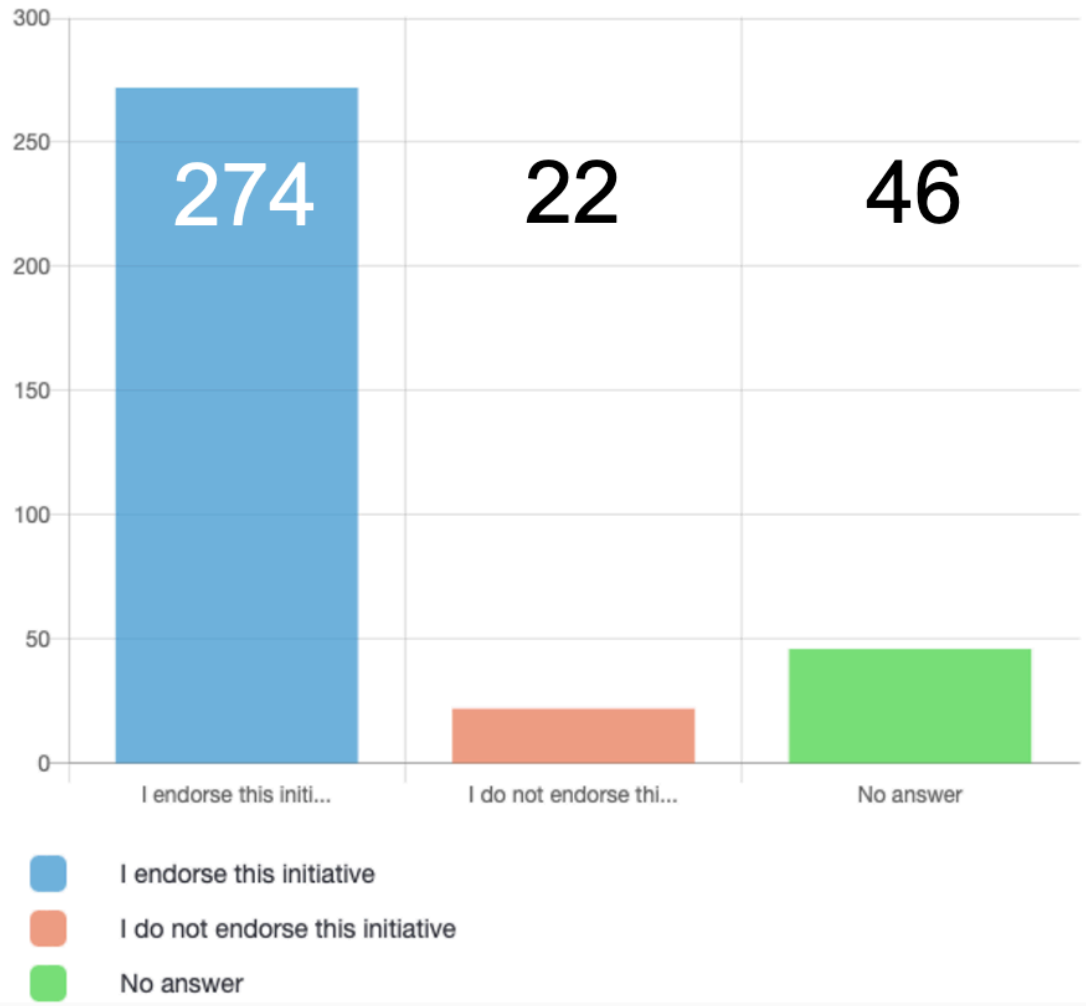
Final Town Hall survey results: Strong community support



Nuclear Data at Hot and Cold QCD Town Hall

- Hot QCD parallel sessions:
  - Fixed target @ STAR for space radiation – Daniel Cebra (UC Davis)
  - Nuclear Data and its relation to QCD -- Dave Brown (BNL NNDC)

- Plenary Session: Intersections of QCD and Nuclear Data – RV (LLNL & UC Davis)

- Some (slightly modified) slides from the plenary session are shown in the following slides

How is nuclear data related to QCD? Detector development

- Transport/interaction of particles in detector material is of paramount importance in all physics experiments and also in accelerators, medical applications
  - Experiment design: material budget, energy loss/stopping power, energy and position resolution, radiation levels, tolerances
  - Monte Carlo corrections to data: material budget, particle tracking (multiple scattering, momentum resolution), energy loss, conversion
- Most commonly used packages: Geant3, Geant4, FLUKA utilize information taken directly from Nuclear Data libraries

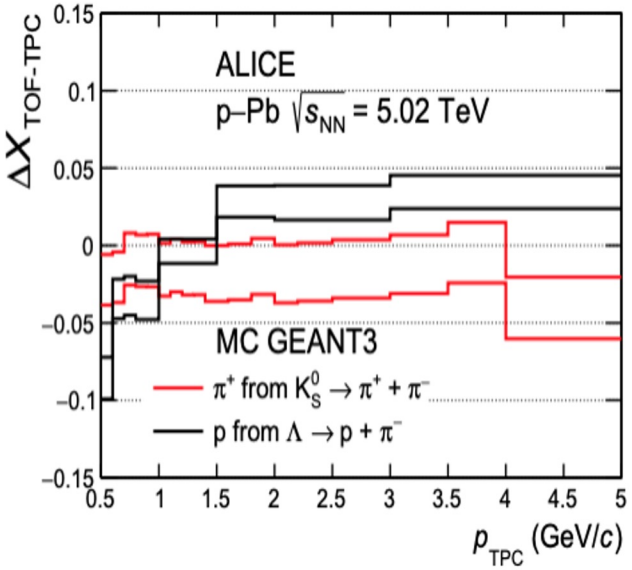
Detector simulations involve particle transport through matter

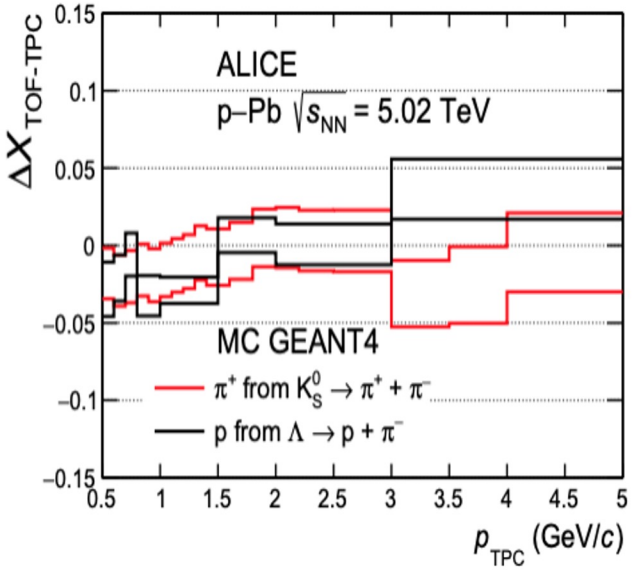
GEANT4 for HEP (https://geant4.web.cern.ch/support/data_files_citations) needs nuclear data:

- Nuclide properties derived from ENSDF
- Radioactive decay and photon evaporation data from ENSDF
- Shell effects: ground state deformations; shell corrections from FRLDM for a spherical ground state; default masses for A, Z nuclei
- Data evaluated from SAID database for p, n, π inelastic, elastic, and charge exchange cross sections for nucleons < 3 GeV
- Livermore Evaluated Atomic Data Library

Different versions of Geant with different nuclear data sets predict different uncertainties in detector material and response – can mean the difference between making the measurement and not doing so

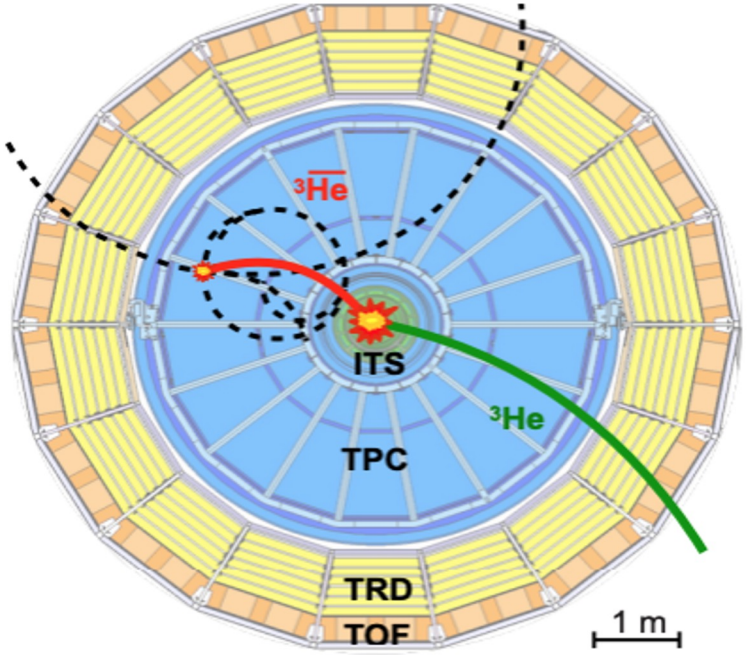
ALICE detector simulations (1σ uncertainty)

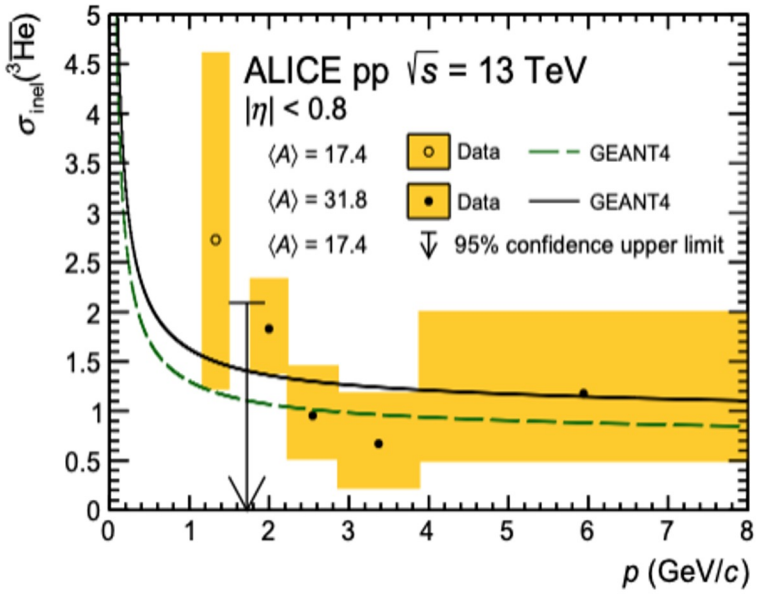


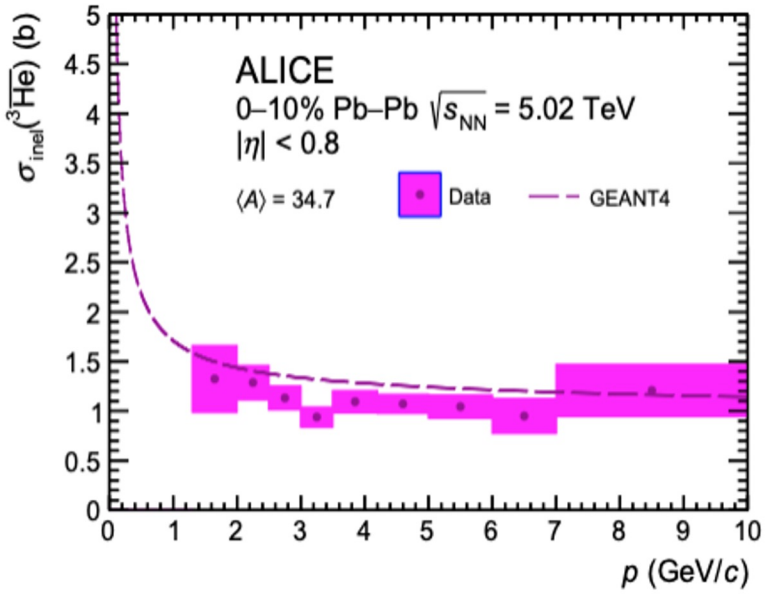


Light (anti)-nuclei from high-energy heavy-ion collisions

First measurement of absorption of anti-nuclei (^{3}He) in matter (arXiv:2202.01549 [nucl-ex]): different parts of the ALICE detector (TPC, TRD, TOF) serve as absorbers with different average *A* values to determine the anti-^{3}He cross section – measurement impossible without reliable nuclear data

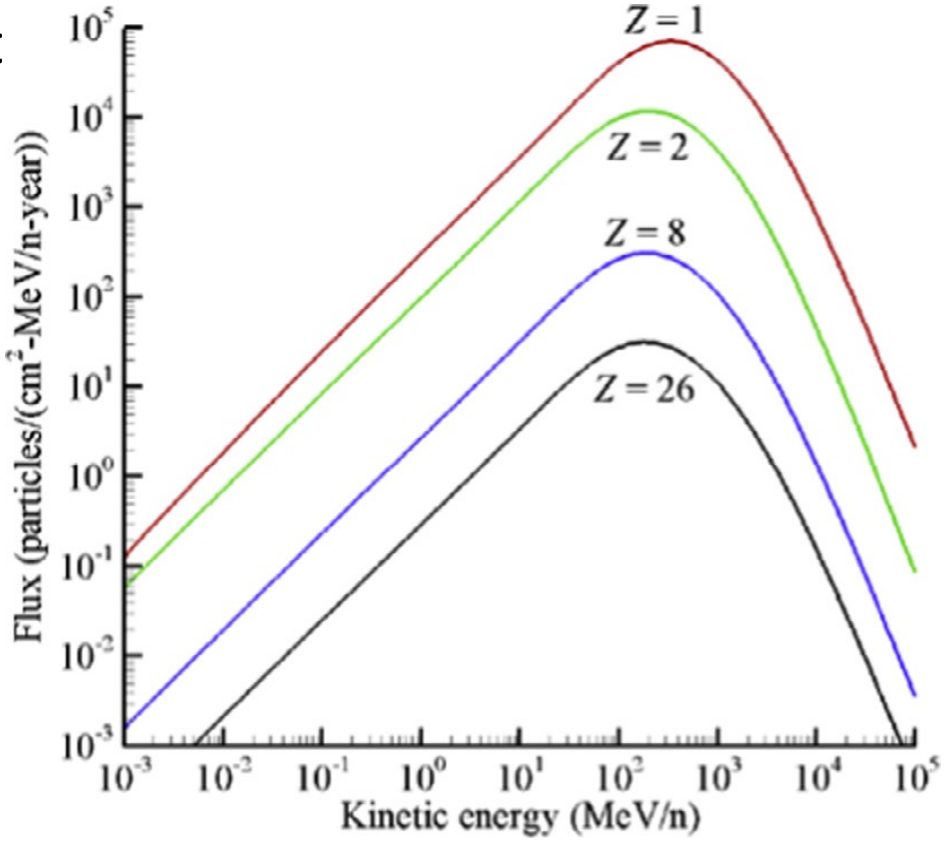






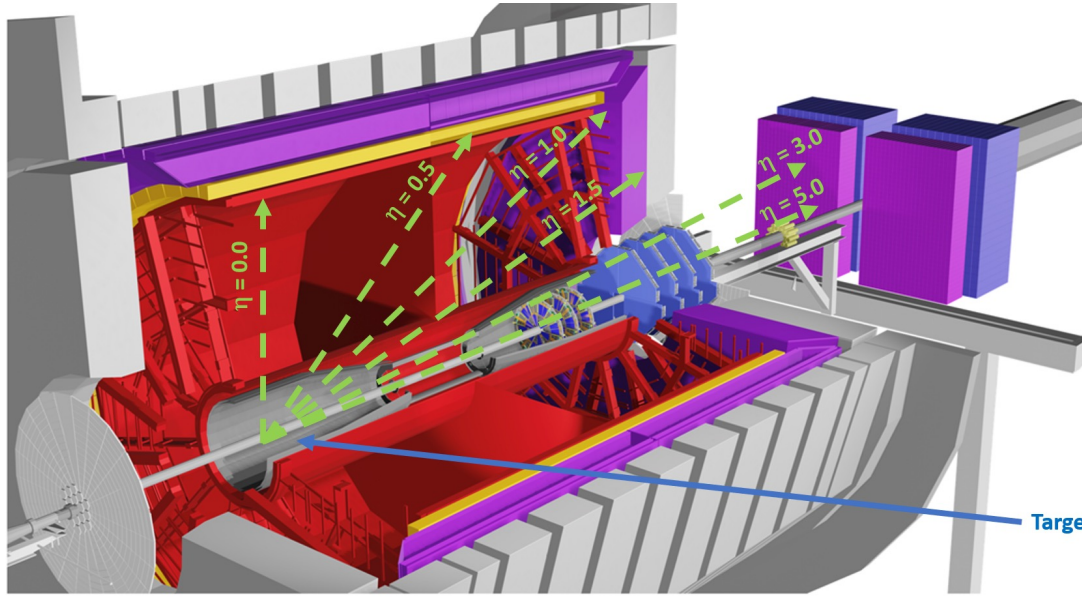
STAR measurements at RHIC could provide damage cross sections

- Radiation damage proportional to Z^2: ions are important
- Damage from secondary production of p, d, t, ^{3}He, and ^{4}He is significant but no data exist for 3-50 GeV/n
- STAR 2023-2025 Beam Use Request: light fragment yields from C, Al, and Fe on C, Al, and Fe targets with beam energies from 5 to 50 GeV to fill gaps in high energy data



T.C. Slaba et al., Life Sciences in Space Research 12 (2017) 1–15

STAR detector in fixed-target mode



Peak is at few hundred MeV but tail extends to GeV and beyond, can cause significant damage

Plans for Nuclear Data at the Town Hall on Nuclear Structure, Reactions and Astrophysics at ANL

- The second day of the meeting will be devoted to parallel working group sessions
- There are 12 working groups covering:
  - core physics topics (nuclear structure and reaction theory; nuclear structure and reaction experiments; nuclear astrophysics – modeling/theory; connecting nuclei to the cosmos; and facilities, instruments and upgrades);
  - the intersection of low-energy nuclear physics and fundamental symmetries;
  - cross-cutting areas (accelerator science, applications and broader impacts; computing (HPC, quantum, AI/ML); diversity, equity, inclusion and belonging; education; isotope science; and nuclear data).
- The nuclear data working group organizers are: Christian Illiadis, John Kelley, Filip Kondev (POC), Libby McCutchan, Matt Mumpower, Artemis Spyrou

Plans for Nuclear Data at the Town Hall on Fundamental Symmetries, Neutrons and Neutrinos

- Still in the formative stage
  - RV had a discussion with the conveners
  - Calvin Howell from the NSAC-ND subcommittee has been added to the program committee

- Conveners appreciate that no ton scale double beta decay experiment can be designed or built without nuclear data

- Last town hall, longest time to organize, least time to write

We need your support!

- Participate in the town halls
- Give your input to the ND subcommittee and the LRP writing committee
- Support the plan developed by the whole community
- Nuclear data will be an integral part of the LRP for the first time – this is a BIG DEAL!
- We have a great opportunity to expand and grow nuclear data in new directions
- We need to show that the data community is strong, inclusive, and ready to take on and meet new challenges