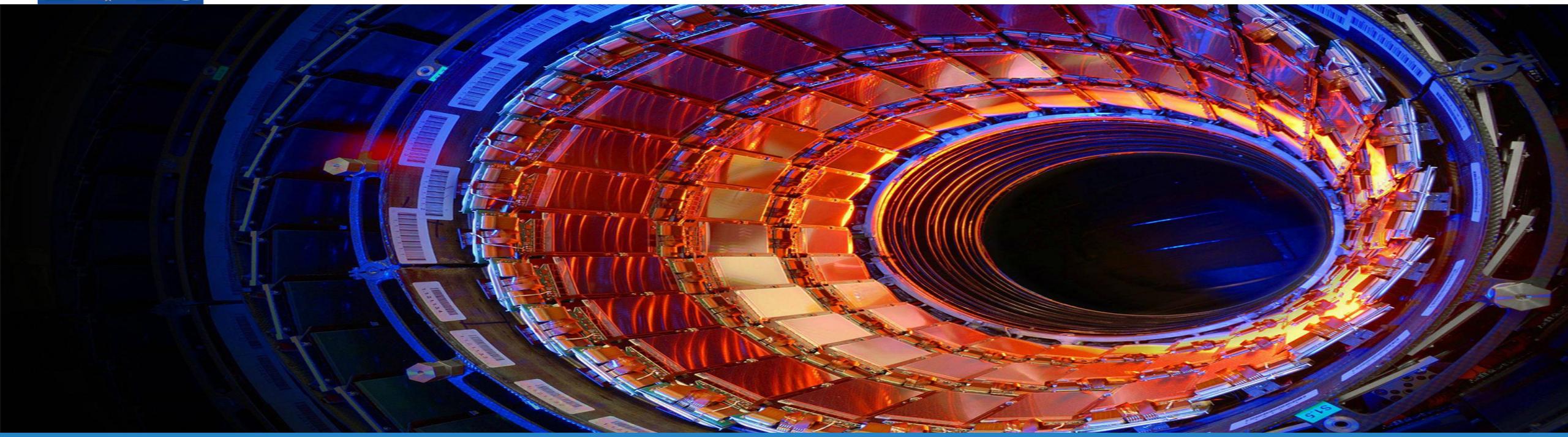


WP16: THEIA: Strange Hadrons and the Equation-of-State of Compact Stars

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824093

Deliverables:

D16.1: Study of A=3 hypernuclei ${}^{3}_{\Lambda}$H and ${}^{3}_{\Lambda}$n — month 36 - report

MS20: First data taking by WASA@GSI/FAIR searching for nnΛ — month 24 $\rightarrow$ 36
tentatively scheduled in February (commissioning) and March (physics run) in 2022

D16.2: Study of antihyperons in nuclei; PANDA software tools — month 30 - demonstrator

MS21: Design report for antihyperons in nuclei ready — month 30

D16.3: Theoretical and experimental studies of bound mesonic systems — month 30 - report

MS22: SIDDHARTA-2 progress report — month 30

Annual workshops to guarantee effective and fruitful interactions

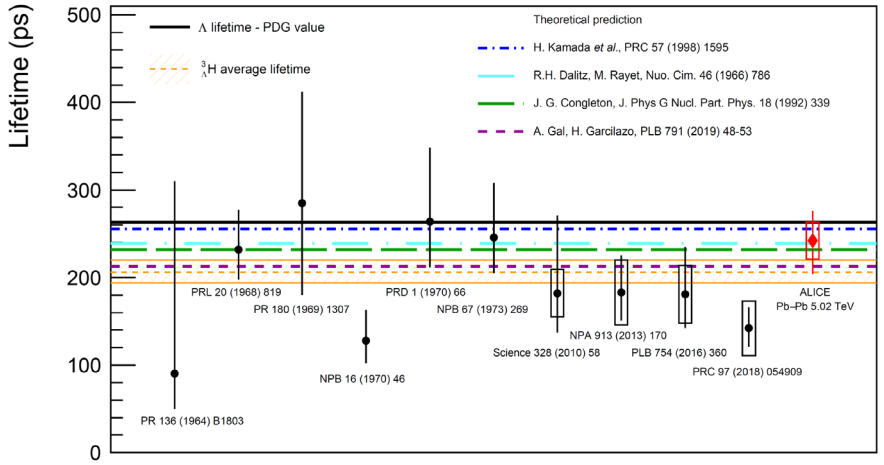
Deliverable 16.1: A=3 hypernuclei

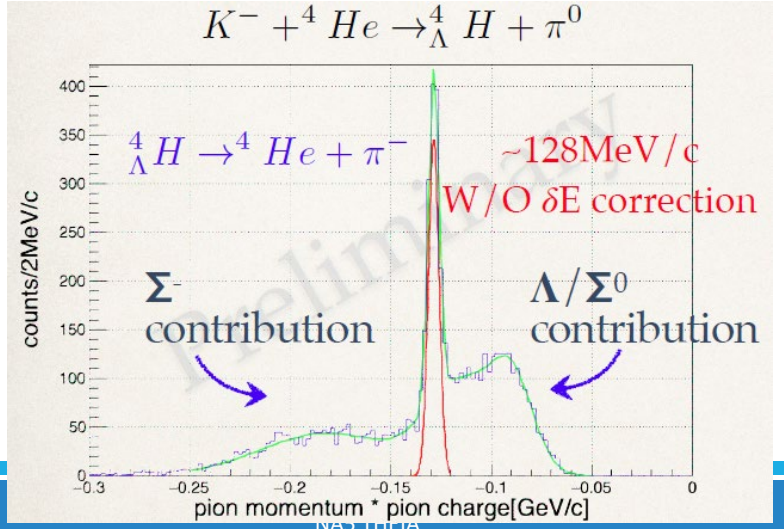
- Hypertriton puzzle: very loosely bound system
  - Expected $\tau({}^{3}_{\Lambda}\mathrm{H}) = \tau(\Lambda)$ $\Leftrightarrow$ observed: $\tau({}^{3}_{\Lambda}\mathrm{H}) < \tau(\Lambda)$

- Does a neutral A=3 hypernucleus nnΛ exist?

Deliverable 16.1: Hypertriton lifetime

- recent ALICE and STAR data show small tension
  - average value still 20% below $\tau(\Lambda)$
- J-PARC P73 successful test with ^{4}He target ($^4_\Lambda$H)
  - world record of $^4_\Lambda$H decays in 3 days test
  - preliminary analysis suggests stat. error for lifetime ~ 10ps
  - stage-1 approval
  - Waiting for ^{3}He run
- Future activities: WASA@GSI; ELPH@TOHOKU

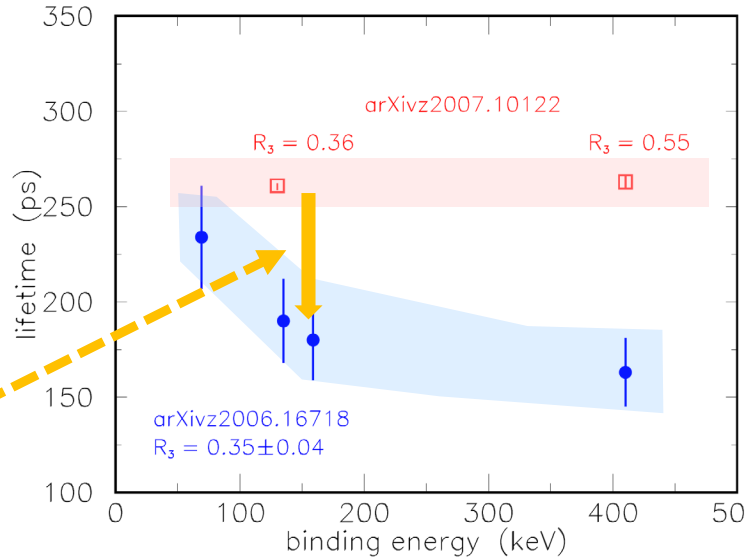




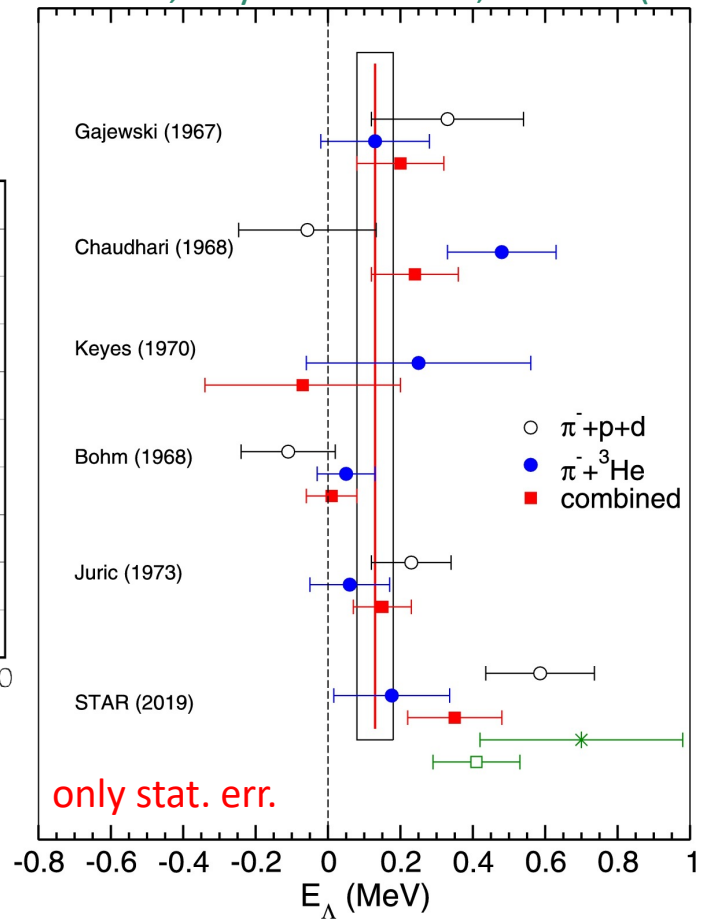
Deliverable 16.1: Hypertriton binding energy

- Emulsion data suggest very small binding energy ~130keV
- New data from STAR show stronger binding ~410keV

- Hildebrand & Hammer, EFT, arXiv:2007.10122
  - Exp. $R_3 \approx 0.35$ favors small BE
- Obiol et al., EFT, arXiv:2006.16718
  - π distorted waves and
  - ΣNN admixture important
  - $\Rightarrow$ strong relation between BE and τ

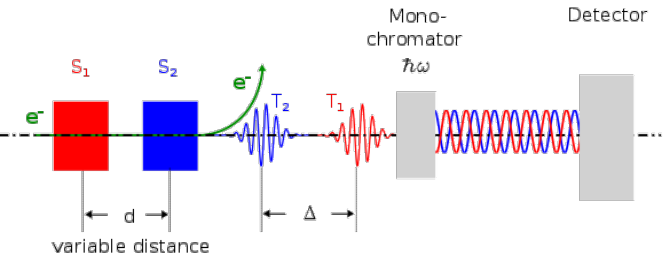


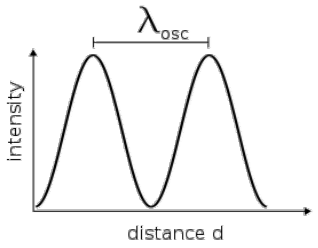
Le *et al.*, Phys. Lett. B 801, 135189 (2020)

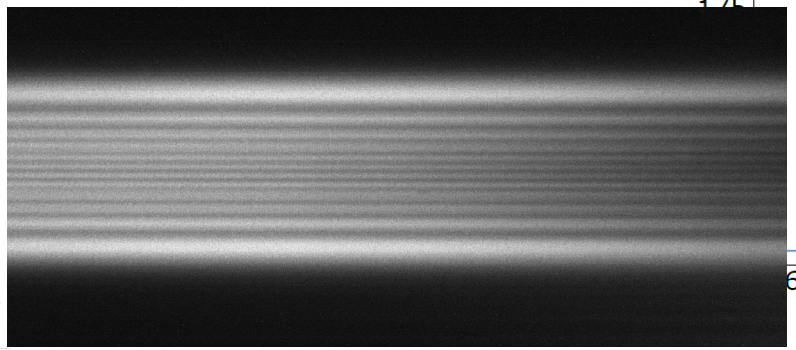


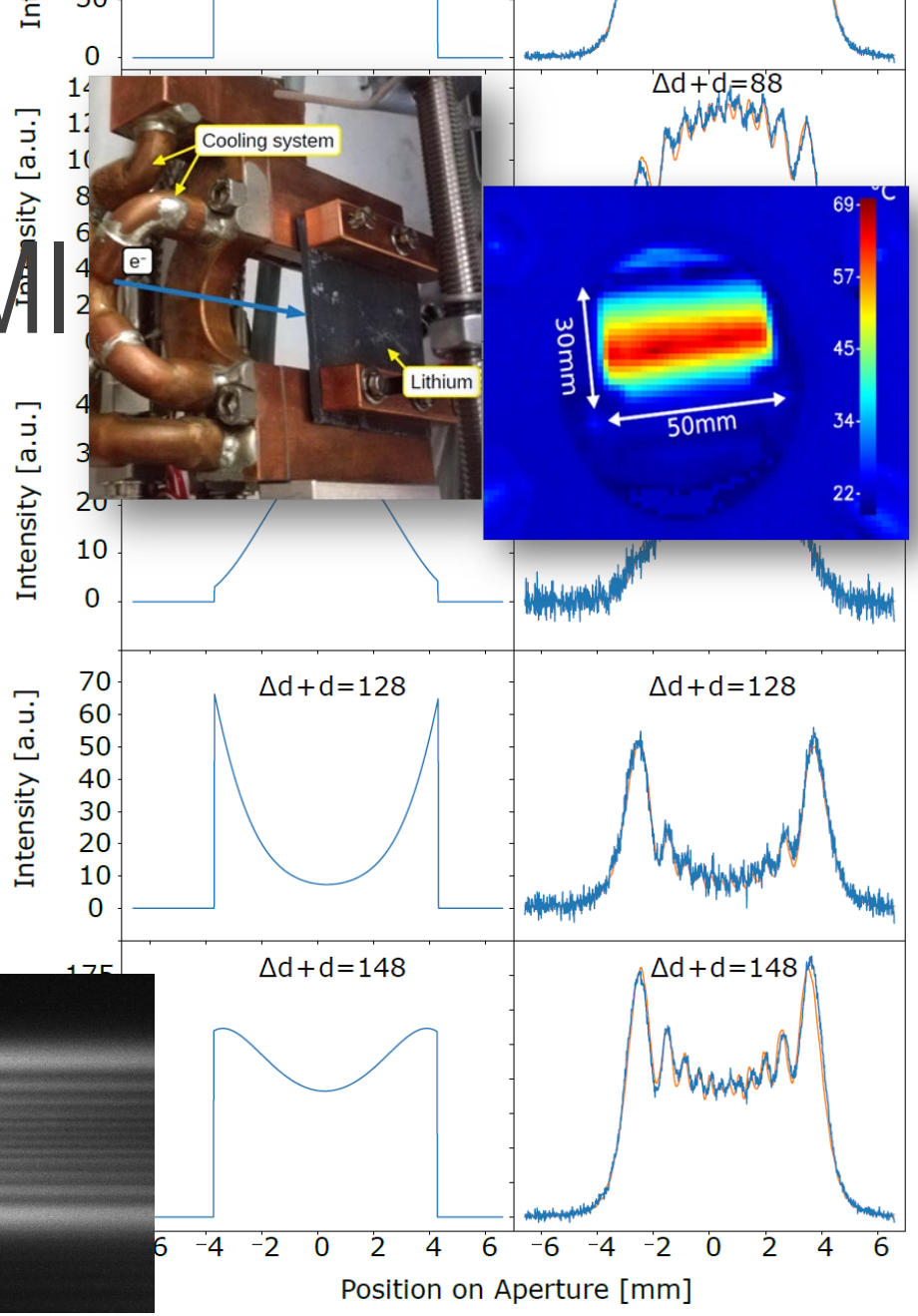
Deliverable 16.1: BE at MAMI

- Measure mass via two-body pionic decay $^{3}_{\Lambda}H \rightarrow \pi^{-} + {}^{3}He$
  - decay at rest $\Rightarrow$ momoenergetic pions
- MAMI has pioneered the π- decay spectroscopy method for $^{4}_{\Lambda}H$. For $^{3}_{\Lambda}H$
  - higher luminosity required $\Rightarrow$ 5cm Li target@10μA
  - precise absolute calibration of spectrometers $\Rightarrow$ interference of undulator radiation
  - Waiting for beam in 2021









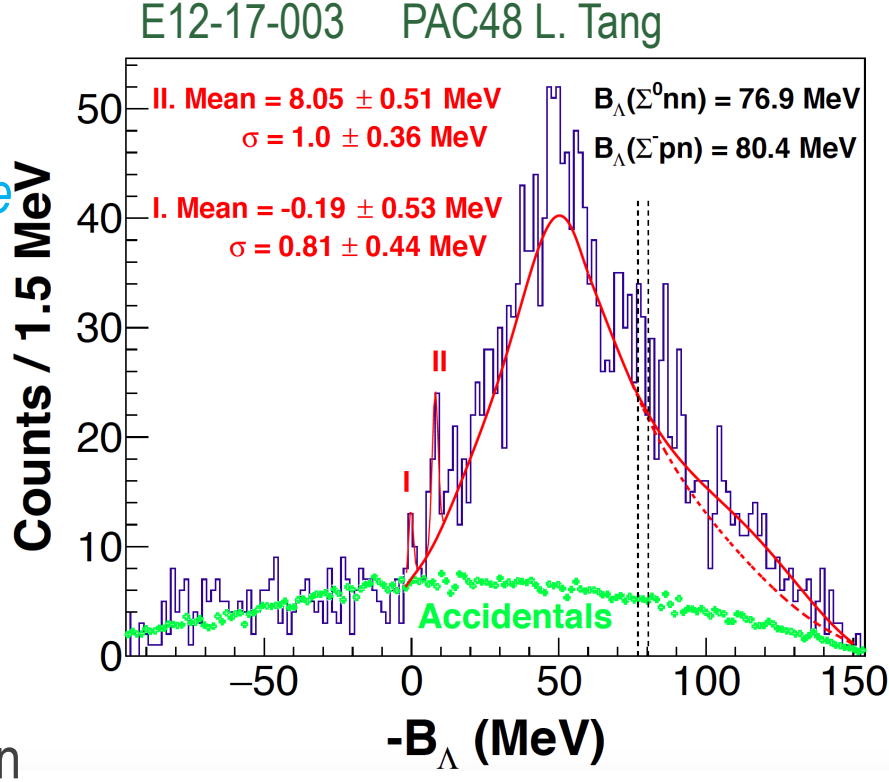
Deliverable 16.1: Status of nnΛ – JLab

- Experiment successfully performed at Jlab using a tritium target
  - The analysis of the JLab experiment is basically completed:

  "Two possible Λnn resonance states and a bound ΣNN state were observed for with an energy resolution of better than 1.6 MeV (FWHM), although greater statistics are needed to make definitive identifications.

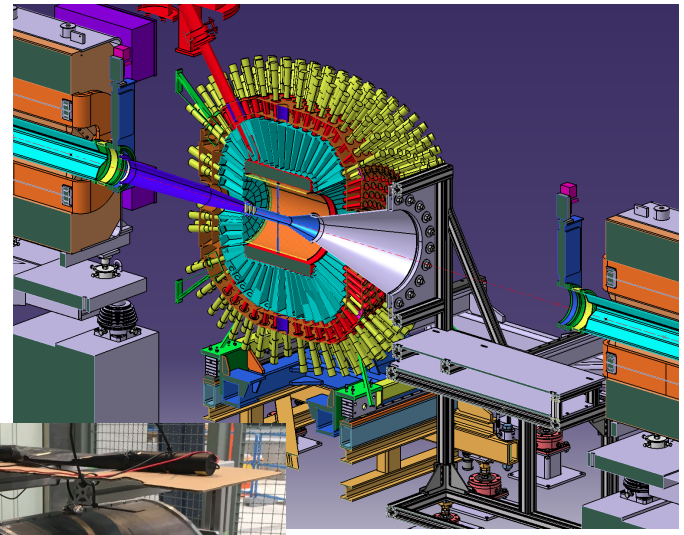
  Due to low statistics and accidental background, the statistical significance is only at level of 2.3, neither solidly confirm nor rule out these observed states."

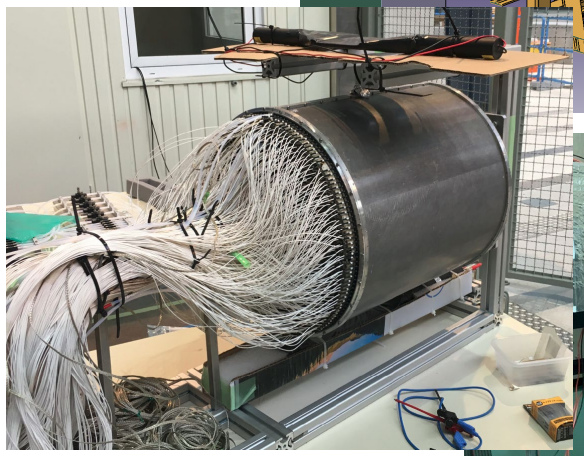
- The collaboration proposed to redo this experiment with the optimized HKS-HRS system so that the 20 times more statistics can be reached while the accidental background can be fully avoided.
  The proposal is currently conditionally approved.

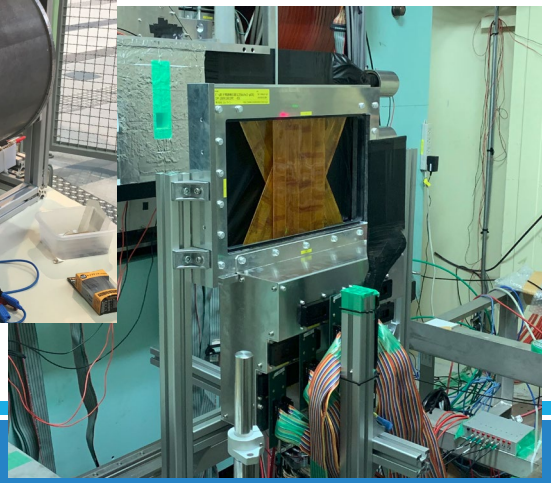


Deliverable 16.1: Status of nnΛ – WASA

- Experiment at FAIR Phase 0 with the WASA-FRS detector under preparation; beamtime re-approved by GPAC
  - Commissioning of Mini drift chamber: DONE
  - Superconducting magnet: already ay 4 K
  - Upgrading of Time-of-Flight Barrel: in progress, by end of 2020
  - Large Scintillating fiber detectors commissioning in progress
  - Mini fiber detector inside the iron yoke: in production
  - Electronics for fiber detectors: in progress, by end of 2020
- Experiment is tentatively scheduled in February (commissioning) and March (physics run) in 2022. (note: MS20: month 36!)







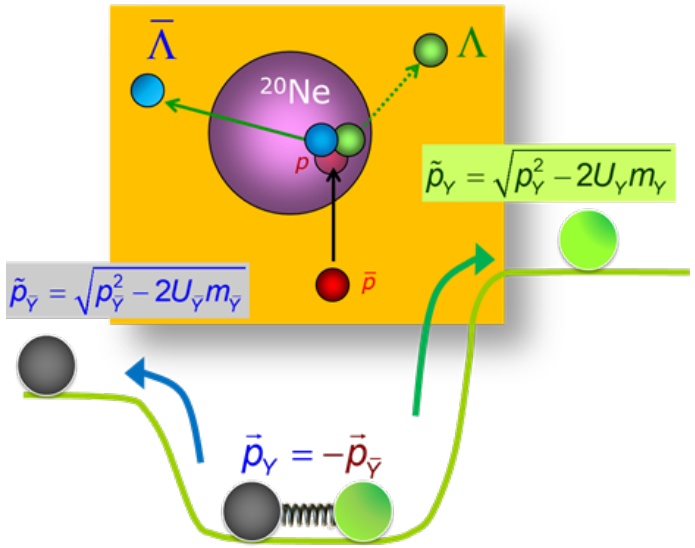
Deliverable 16.1: Hypernucleus Database

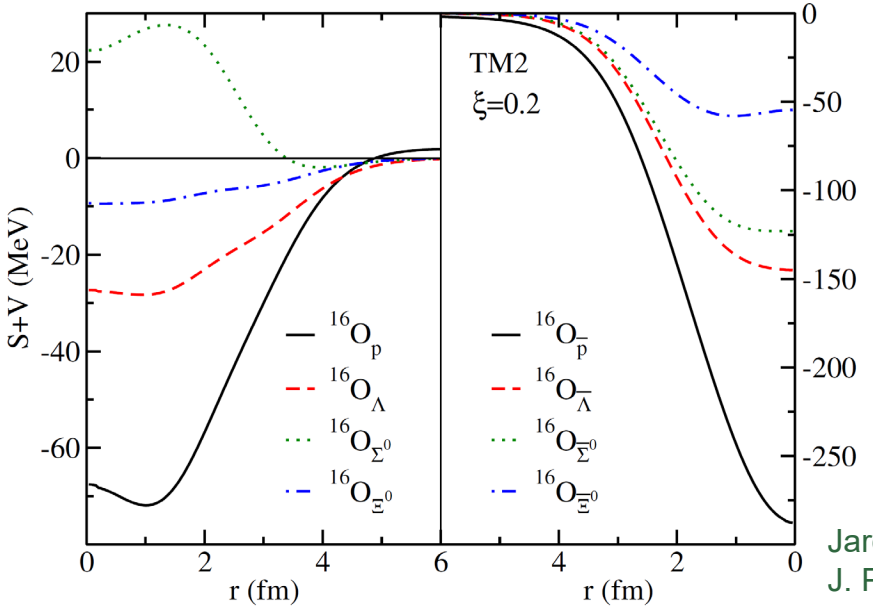
- a hypernucleus database is being built at Mainz
  https://hypernuclei.kph.uni-mainz.de/page.html
  - goal: provides complete overview of existing data
    including additional information (e.g. references, bibtex entries etc.)
    - PDG style and rules
    - summary plots, errors etc generated automatically
    - export data and plots to files possible
    - frame has been set up; *only filled with test data*
    - presently access still restricted
      (user: scooter; pw: hyperhyper)
    - DB will continuously updated with new data

D16.1 will be delivered in time and MS21 will probably be reached

Deliverable 16.2: Antihyperons in Nuclei

- Baryon-antibaryon interactions can be studied by two-particle correlation functions in HI
- PANDA will measure the effective potential of Λ hyperons by the exclusive $^{20}Ne(\bar{p},\bar{\Lambda}\Lambda)$ reaction during PHASE-1 of PANDA





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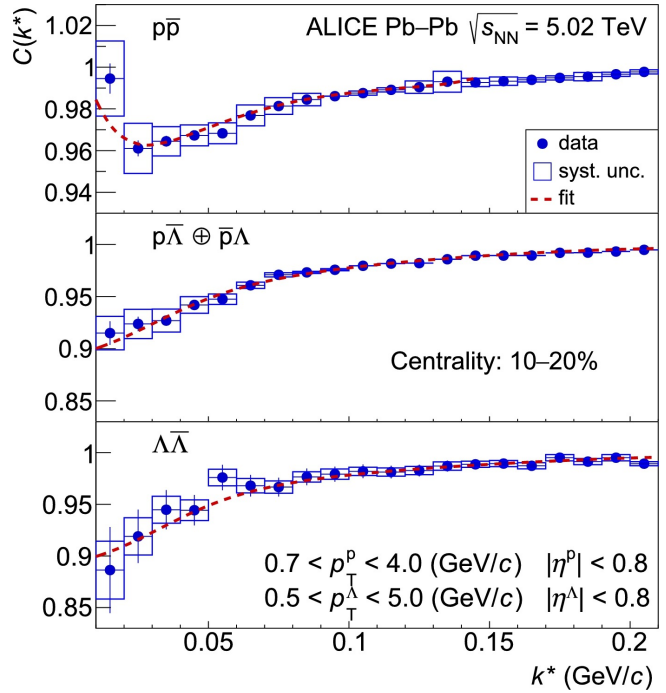
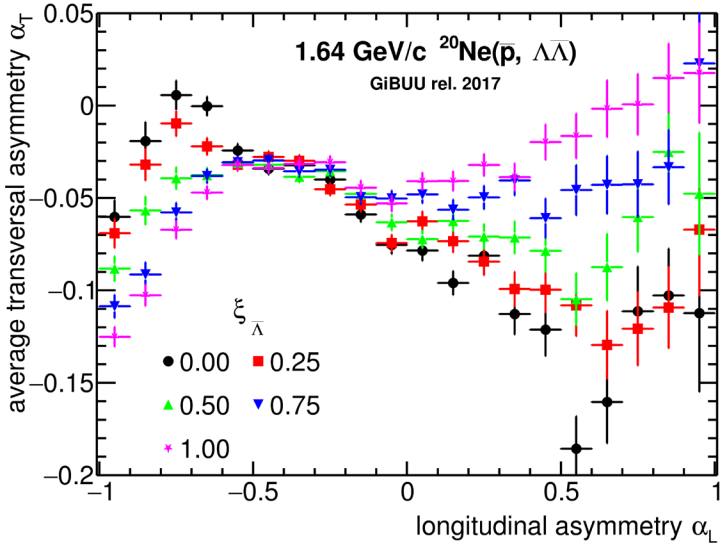
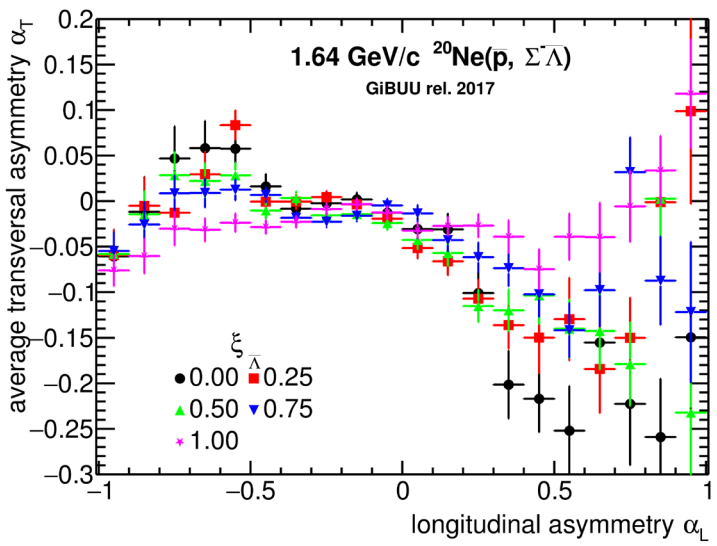


Jaroslava Hrtánková and Jirí Mareš
J. Phys.: Conf. Ser. 599 012007

Deliverable 16.2: Antihyperons in Nuclei

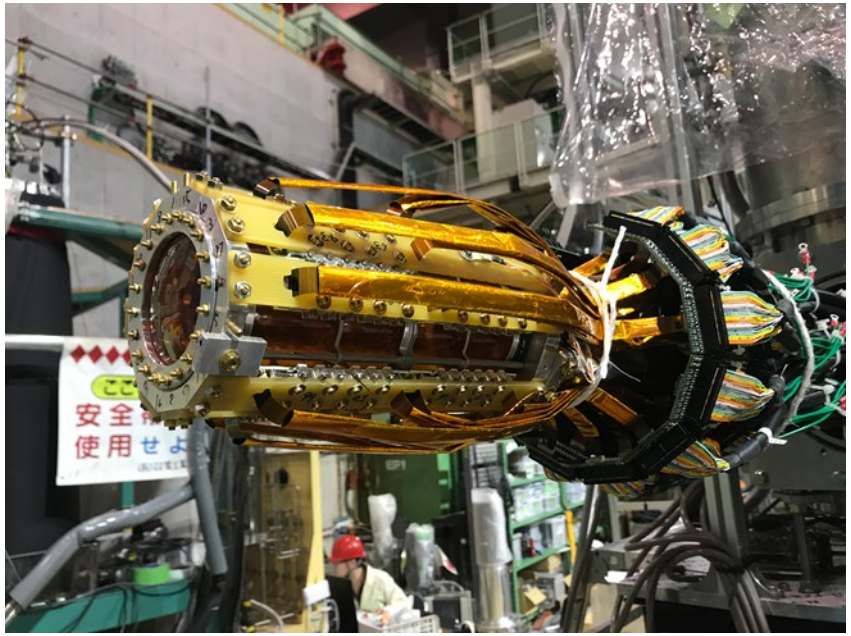
- High statistics event samples generated with GiBUU
  - being continued at HPC in Mainz
- Integration in PANDA reconstruction software (time based analysis)
  - Slowed down by COVID-19; continuous progress
- PANDA Phase One paper under final internal review by collaboration
- *D16.2 will be delivered in time and MS21 will be reached*





Deliverable 16.3: Bound Mesonic Systems

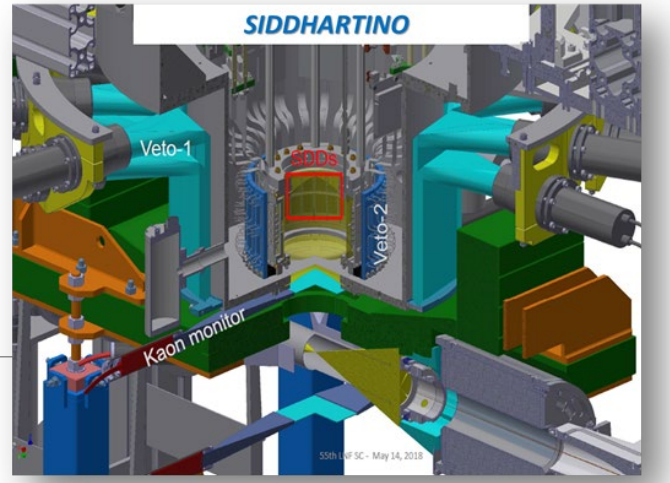
- E57 @ J-PARC: “ Measurement of the strong interaction induced shift and width of the 1*s* state of kaonic deuterium at J-PARC”
  - Test beam time Feb. and April 2019 for total 4 days
  - Goal: Due to a measurement of kaonic hydrogen to proof that the apparatus is ready for the kaonic deuterium measurement.
  - Problem: kaonic hydrogen X-ray lines observed, but K□ X-ray efficiency about a factor 3 less than expected.
  - Outlook: improving MC simulation using obtained data set; design of a short kaon beam line to increase number of kaons; working on an active deuterium target, detector within gas volume without windows.



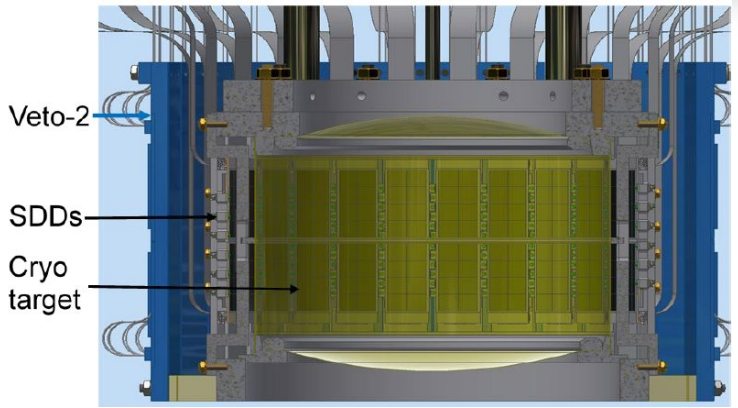
Cryogenic target and detector system for beam time Feb. and April 2019

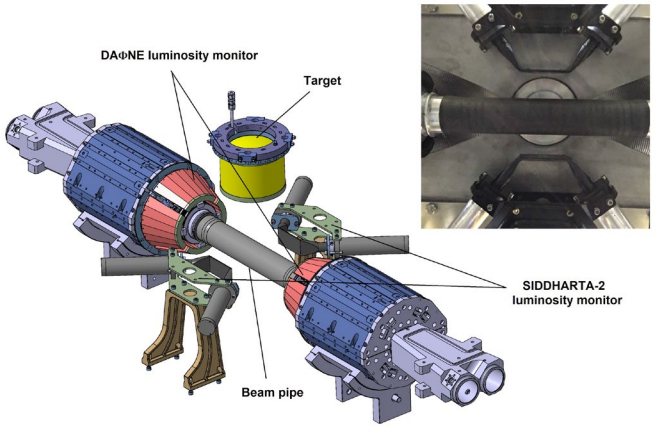
Deliverable 16.3: SIDDHARTA-2

See TA3 Talk of C. Curceanu



- Goal: study of kaonic deuterium with drastically increased signal-to-background ratio, by gaining in solid angle, by taking advantage of the new SDDs with improved timing resolution and by implementing additional veto systems.
- measurements with SIDDHARTINO (PHASE 1) will determine and contribute to optimize the level of the background and the Signal/Background optimized working conditions for SIDDHARTA-2.
- Timeline
  - SIDDHARTINO: start November 2020 - end probably February 2021
  - SIDDHARTA-2 - start spring 2021 and go on at least till end 2021





Workshops

First workshop in Speyer Nov. 2019

https://indico.gsi.de/event/8950/

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Second workshop planned in Crete Oct 2020
⇒ replaced by web-seminar

https://indico.gsi.de/category/513/

weekly meeting each Wednesday

Usually 2 talks

First talk 7.10.2020:
69+x participants

Summary

All delivarables and milestone will very likely be achieved

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Annual workshops will be resumed if COVID-19 situation allows