Svenskt kärnfysikermöte och SFAIR årsmöte 2017

Wednesday, 18 October 2017 - Friday, 20 October 2017

Royal Institute of Technology, KTH

Book of Abstracts

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SFAIR welcome

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Decay spectroscopy of N ~ Z nuclei in the vicinity of 100Sn

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(On behalf of the EURICA collaboration)

The structure of magic nuclei far away from stability provides vital information on modern shell models. In particular, the doubly magic ^{100}Sn and proton-rich nuclei in its vicinity contains many topics of interest: the limit of proton binding in this mass region, the robustness of the $N = Z = 50$ shell closures, and isospin symmetry among many others. Experimental properties of these nuclei are also relevant for precise predictions of the end stages of the rapid proton-capture process of nuclear astrophysics.

A decay spectroscopy experiment on ^{100}Sn and other $N \sim Z \sim 50$ nuclei was performed at RIKEN Nishina Center, where a 345-MeV/u ^{124}Xe beam was fragmented on a ^{9}Be target. The isotopes of interest were identified and implanted on a set of Si detectors, which measured the positrons and protons from subsequent β decays. γ rays emitted from excited states were measured by HPGe detectors placed around the implantation detectors.

A summary of new and more precise experimental results will be presented. Highlights include the discovery of new isotopes, β-decay properties of the heaviest bound $N = Z - 1$ nuclei, an update on the superallowed Gamow-Teller decay of ^{100}Sn, and the structure of ^{96}Cd.

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Extraction of Polarization Parameters from the Proton anti-Proton to Omega anti-Omega Reaction

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The upcoming PANDA experiment will make it possible to study the Proton anti-Proton to Omega anti-Omega reaction for the first time. Previous studies of spin variables in anti-hyperon hyperon production have given very interesting results, but have been restricted to single strangeness hyperons. The triple strangeness Omega hyperon is believed to be a spin 3/2 particle, which therefore carries more polarization parameters than a spin 1/2 particle. The aim of this presentation is to show how one still can retrieve the Omega polarization from the angular distribution of its decay products.

3

De-excitation studies of fragments from the spontaneous fission of 252Cf

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Nuclear fission is a complex process, which –after almost 80 years since its discovery –is still not fully understood. One field of research is for instance studies of the de-excitation process of fission fragments, which in the early stages, i.e. within a few nanoseconds after scission, takes place through the successive emission of prompt neutrons and gamma rays. For nuclear applications, information about the prompt neutrons is crucial for calculating the reactivity in reactors, while precise knowledge about the prompt gamma rays is important for the assessment of the prompt heat released in the reactor core. Concerning the latter we have contributed in the past years with a number of precise measurements of prompt gamma-ray spectra from spontaneous as well as thermal and fast neutron-induced fission of various compound systems. From those we determined average characteristics like multiplicity, mean energy per photon and total gamma-ray energy released in fission.

The obtained results were investigated for their dependences of mass and atomic numbers of the fissioning system as well as the dissipated excitation energy. The purpose of this endeavor was to find a description that allows predicting prompt gamma-ray spectra characteristics for cases that cannot be studied experimentally.

In this work we report on a recent measurement of prompt fission gamma rays from the spontaneous fission of 252Cf, in which we even measured angular correlations between these gamma rays and the fission fragments detected in coincidence. We will present preliminary results and infer what can be learned from the observed angular distribution.

Summary:

In this work we report on a recent measurement of prompt fission gamma rays from the spontaneous fission of 252Cf, in which we even measured angular correlations between these gamma rays and the fission fragments detected in coincidence. We will present preliminary results and infer what can be learned from the observed angular distribution.

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High-precision Measurement of the Proton Radius with Active Target TPC

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One of today's most pressing question in nuclear physics is the understanding of the so-called "proton radius puzzle". The puzzle originates from a striking discrepancy between the electric charge radius of the proton, extracted from the muonic hydrogen Lamb shift, compared to measurements based on electron-proton scattering experiments and atomic transition measurements in electronic hydrogen. Solving this problem requires experiments approaching the problem in new ways. To address this puzzle, we will perform a high-precision measurement of the differential ep-scattering cross section in the region of low momentum transfer in Mainz. To perform this experiment, a new-generation detector, consisting of a Hydrogen Time Projection Chamber (TPC) and Forward Tracking System will be constructed. The experimental setup will allow to measure the energy and angle of the recoil proton with unprecedented accuracy

and with a completely new approach compared to other experiments.
A test measurement with a TPC prototype was conducted at MAMI in August 2017, which served as a basis for the main experiment.

5

Prospects of nuclear astrophysics at storage rings

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Most of the time, stars gain their energy from fusion of the very light left-overs of the Big Bang into heavier elements over long periods of time. The observation of radioactive isotopes in different regions of the Universe is an indicator of this ongoing nucleosynthesis. In addition, short-lived nuclei are often intermediate steps during the nucleosynthesis in stars.

A quantitative analysis of these relations requires a precise knowledge of reaction cross sections involving unstable nuclei. The corresponding measurements are very demanding and the applied techniques therefore manifold. The reward, however, is surprisingly huge. It is possible to constrain basic parameters as the age of the Universe, temperature and convection times in stars, or neutron densities during explosions.

Ion storage rings offer unprecedented possibilities to investigate radioactive isotopes of astrophysical importance. I will present recent experiments and ideas for future setups. The experiments cover neutron- and proton-induced reactions as well as beta decays. The astrophysical scenarios range from small, compact objects like neutron stars to huge Red Giants.

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Detection of special nuclear material for the purpose of nuclear safeguards

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Efficient and reliable detection of special nuclear material, such as ^{233}U, ^{235}U, ^{240}Pu and ^{239}Pu, is crucial for safeguards and for preventing illegal spreading of nuclear materials.
The spontaneous fission of ^{239}Pu results in the creation of several prompt photons and neutrons with known energy distributions. Time correlations between the detection of these particles can then be used to identify such fissions. For this reason, passive detection of neutrons and photons from Plutonium was performed at the JRC facility in Ispra, Italy. The use of organic scintillators (EJ309) allowed for particle discrimination. Various PuO and PuGa samples with up to 6.2 grams of ^{239}Pu were investigated.
The reconstruction of fission events was performed using coincidence detection of prompt neutrons and γ-photons. The short coincidence time of around 10 ns resulted in a very low background and a clean signal.
Preliminary results of the analysis and a comparison with MCNP simulations will be presented.

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Normal ordered three-body forces for the no-core-shell model

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To be submitted

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Nucleon spin physics: present and near future

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In the talk the following subjects will be tackled: basics of the spin-dependent deep inelastic scattering; status of spin-dependent parton distribution measurements and of tomographic imaging of the nucleon; need of higher energies and higher luminosities; features of the planned Electron-Ion Collider and its detectors; possible new phenomena in the now-unexplored kinematic regime reached by EIC.

Electron-Ion Collider, a planned new machine to be located in the USA (BNL or JLab), will start operation about 2028.Collision centre-of-mass energy will be of the order of that at HERA but polarisation of electron, proton and light-ion beams, wide variety of heavy-ion beams, up to 1000 times increase in luminosity and wide energy variability will greatly exceed the capabilities of HERA.

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Search for unbound states in 30Ne

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I will present my ongoing work where I look for unbound states in 30Ne.

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Projectile fragmentation experiments in PreSPEC – AGATA's S429

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In the years 2012–2014 the pan-European Advanced GAmma-ray Tracking Array (AGATA) was placed at the German accelerator research centre GSI Darmstadt. Within the PreSPEC collaboration, AGATA was used to perform high-resolution γ-ray spectroscopy of relativistic radioactive ions to obtain unique nuclear structure information of exotic nuclei far away from the line of stability.

This contribution focuses on an experiment where the fragmentation of a ^{208}Pb primary beam was used to populate even-mass nuclei around ^{208}Pb. The principal aim was to study the aforementioned neutron-rich even-mass nuclei via Coulomb excitation. Prior to that, however, measurements with stopped beams were necessary for two reasons: firstly, when measuring $E2$ transition strengths it is mandatory to determine the isomeric composition of the beam via isomeric ratios. Secondly, isomeric ratios are the main ingredient for understanding the population of excited states in nuclei produced via relativistic fragmentation reactions.

In the course of the analysis, we used all AGATA-tailored algorithms relying on the characterisation and an established consolidated treatment of the data. Projectile-like fragments were selected and identified with the FRagment Separator. They were then implanted in a passive stopper so that these implantation events could be correlated with delayed γ rays. From their yields, isomeric ratios are derived. These findings were compared with theoretical predictions and provide a valuable input for nuclear reaction theories.
Recent results from another AGATA-PreSPEC experiment report that the reaction mechanism responsible for population of an isomeric state can involve Δ resonances, especially when only few nucleons are removed. We suggest a similar approach to be utilized in the interpretation of the production of excited states when removing few nucleons from the ^{208}Pb primary beam.

Besides the experiment presented here, such a systematic assessment of isomeric decays is viable for both other experiments within the campaign with a primary ^{238}U beam as well as the upcoming PreSPEC stopped-beam campaign.

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DyTER: A framework for Dynamic Track and Event Reconstruction for PANDA at FAIR

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The upcoming next-generation antiproton experiment PANDA at FAIR in Darmstadt, Germany will be an accelerator-based experiment where the data selection relies entirely on a software filter. This paradigm shift is driven by the likeness of signal and background as well as the multitude of investigated physics channels, requiring full and precise information from all detectors in order to perform a reliable data selection.
Such a scheme will also be adopted by other cutting-edge experiments in the future. The software trigger in our experiment will need to cope with incoming event rates of up to 20 MHz, corresponding to a raw data rate of up to 200 GB/s.

Of particular interest for Uppsala are hyperon reactions. Hyperons are baryons, in which one or several of the light quarks have been replaced with heavier ones. Due to their relatively long-lived nature, their decay vertices can be separated from the beam-target interaction point by up to several metres. This poses a particular challenge for the track and event reconstruction. In order to filter interesting data, Uppsala is, in collaboration with other international groups, developing a framework for Dynamic Track and Event Reconstruction (DyTER). DyTER draws upon a variety of reconstruction algorithms, such as a cellular automaton and pattern matching. This presentation will give an overview of the general concept as well as showcase the current development.

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Difference Predicted Trace Compression on FPGAs

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A compression scheme for trace data, the output of sampling ADCs, which is suitable for implementation on front-end FPGAs will be presented.

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Results from particle-induced fission yield measurements at IGISOL-4

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The yield of fission products is an important nuclear physics quantity. For applications, quantification of the amount of fission products in the fuel is at the basis of accurate reactor kinetics calculations. For fundamental research, fission yields and isomeric yield ratios (i.e., the fraction of a product populating a metastable state) shed light on the properties of the compound nucleus at scission and on the nascent fragments.
At JYFL-ACCLAB (University of Jyväsklyä Accelerator Laboratory), the Ion Guide and Isotope Separator On-Line (IGISOL) technique was used, in conjunction with gamma spectroscopy and mass identification with the JYFLTRAP Penning trap, to extract independent, cumulative and isomeric yields of various fissioning systems.
Yields from high-energy neutron induced fission of ^{nat}U will be presented for Sn and Sb, in the mass-range between A=128 and A = 133. Also 5 isomeric yield ratios have been measured in the same experimental campaign with gamma-spectroscopy.
Isomeric Yield Ratios from 25 MeV proton-induced fission of ²³²Th and ^{nat}U, obtained with JYFLTRAP for 6 nuclides, will also be shown.

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Experimental measurements of neutron-induced reactions at the GANIL-NFS facility

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Experimental measurements of neutron-induced reactions at the GANIL-NFS facility

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Despite long efforts on experimental and theoretical studies of nuclear reactions, it is still not possible to predict the cross sections of most reactions from the first principles, and therefore accurate measurements are still necessary in order to improve evaluated nuclear data files and to benchmark nuclear model codes. In particular, studies of neutron-induced reactions in medium-energy range are demanded by both fundamental research and applications.

For that purpose, a new facility called Neutrons For Science (NFS) is being built at GANIL (Caen, France). It will provide quasi-mono-energetic and white neutron beams with energies up to 40 MeV.

Our research group at Uppsala University is preparing two kinds of experiments to be performed at the NFS facility: one is devoted to improve neutron cross section standards, by doing a simultaneous measurement of 235U(n,f) and 238U(n,f) relative to neutron-proton elastic scattering; the other is aiming at measuring double-differential cross-sections of light-ion production in different materials, starting with a measurement on Carbon, that has been already approved by the GANIL Program Advisory Committee.

More details on the ongoing work on these projects at Uppsala University will be presented in this contribution. The main characteristics of the NFS facility will be shown, as well as an overview of some of the other projects that will be making use of the NFS.

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Fission dynamics with microscopic level-densities

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Presentation of fission dynamics in the recently developed framework where microscopic level densities are combined with the Metropolis walk method. This method is used to describe neutron induced fission and predict how the resulting fission fragment mass distributions depend on the energy of the incoming neutron. The method is extended to allow predictions of how the available excitation energy is shared between heavy and light fragments. From the excitation energy distributions one can deduce how many new neutrons that will be emitted following fission.

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Excited states and gamma ray analysis of neutron rich nucleus 111Mo

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Theoretical calculations based on different approaches predict that, ground state prolate to oblate shape transitions can coexist in N= 70 neutron rich region in nuclear chart. To investigate the phenomena, we study the excited states and lowest lying yrast states of neutron rich ^{111}Mo nucleus. The experiment (SEASTAR2 campaign) was done using the unique setup in Radioactive Ion Beam factory (RIBF) with the BigRips, Zero Degree spectrometers and DALI2, MINOS detectors in RIKEN. This nucleus was populated in (p,p') and knockout reactions involving the primary U238 beam at 345 MeV/u and secondary BigRIPS beam which is centered in ^{111}Nb at 228 Mev/u. As a results of the analysis 4 transitions observed first time for ^{111}Mo nucleus and the construction of the level scheme will be studied.

Summary:

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Lifetime Measurements of high-spin states in ^{94}Ru using DSAM

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Co-authors: Alberto Boso [9]; Alejandro Algora [10]; Andrea Gottardo [11]; Andres Gadea [10]; Ayse Nyberg [1]; Baki Akkus [12]; Caterina Michelagnoli [5]; Costel M. Petrache [11]; D. M. Debenham [7]; Eiji Ideguchi [13]; Emmanuel Clement [5]; Farnaz Ghazi Moradi [1]; Francesco Recchia [9]; Giacomo de Angelis [6]; Harith Al-Azri [7]; Hongjie Li [1]; Janos Timar [14]; Johan Nyberg [15]; Jose Javier Valiente-Dobon [6]; Marcin Palacz [16]; Marco Siciliano [4]; Mikael Sandzelius [17]; Sefa Ertürk [18]; Tayfun Hüyük [10]; Torbjörn Bäck [1]; Victor Modamio [4]; Zhigang Xiao [19]; Zsolt Dombradi [2]

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The lifetimes of the high-spin states in the semi-magic (N=50) nucleus ^{94}Ru have been determined using the Doppler Shift Attenuation Method (DSAM). Excited states in ^{94}Ru nucleus were populated via ^{58}Ni(^{40}Ca, $4p$)^{94}Ru* fusion-evaporation reaction at the GANIL accelerator complex. DSAM lifetime analysis was performed on the Doppler broadened line shapes in energy spectra obtained from the emission of γ-rays while the residual nuclei were slowing down in the thick ($6\ mg/cm^2$) metallic ^{58}Ni target. The lifetime results have been validated with respect to the previous measurements and totally eight excited-state lifetimes have been obtained. Large-scale shell model calculations have been carried out and compared with experimental results.

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One quasi-particle states with low angular momentum in neutron-rich nuclei

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We have added a weakly repulsive external potential to the self-consistent mean field in Hartree-Fock-bogoliubov calculations in order to see the responses of the low angular momentum orbitals to a shallowing potential. It is seen that the bound state nature of the d5/2 and s1/2 quasi-particle states in neutron-rich Ni isotopes are very sensitive to the form of the pairing interaction employed and to the depth of the mean field. When the system gets less bound, the odd-even staggering in the charge radii as well as the effect of the tensor force on the shell gap are expected to be reduced.

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Gamma-Ray Tracking and the GRETINA Physics Program

Author: Augusto Macchiavelli[None]

The structure of nuclei far from the stability line is a central theme of research in nuclear physics. Key to this program has been the worldwide development of radioactive beam facilities and novel detector systems, which provide the tools needed to produce and study these exotic nuclei.

In particular, gamma-ray spectroscopy plays a vital and ubiquitous role in these studies.
The ɣ-ray tracking technique marks a major advance in the development of ɣ-ray detector systems and can provide order-of-magnitude gains in sensitivity compared to existing arrays. It uses highly-segmented hyper-pure germanium crystals together with advanced signal processing techniques to determine the location and energy of individual ɣ-ray interactions, which are then combined to reconstruct the incident ɣ-ray in a process called tracking.

A 4π tracking-array will be a powerful instrument needed in a broad range of experiments addressing the intellectual challenges of low-energy nuclear science. Developments of these instruments are underway both in the US (GRETINA/GRETA) and Europe (AGATA).

Following a short overview of the concept of gamma-ray tracking and its technical requirements, I will discuss GRETINA, a first implementation of a tracking array, and present selected examples

from its physics campaigns at ATLAS/ANL and NSCL/MSU. Future plans for the full array, GRETA, will also be discussed.

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DAQ-in-a-box

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A new data acquisition system is under development, and is one contender for use as 'data pump' at NUSTAR. Focus is on ease-of-use (yes - command-line is easy and suitable!), while maintaining or improving performance and keeping compatibility with existing systems.

A short preview will be given.

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Ground state phase transition in the Nilsson mean-field plus pairing model

Author: Xin Guan[1]

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Nuclear pairing correlation, as an important part of the residual interactions necessary to augment any nuclear mean-field theory, represents one of the main and longstanding pillars of current understanding of nuclear structure. Particularly, the pairing interaction in the nuclear shell model plays a key role to reproduce ground state properties of nuclei, such as binding energies, two-neutron (proton) separation energies, odd-even effects, and excitation spectra, etc. In this presentation, I will briefly review the exact solutions of mean-field plus pairing models which works well for the ground states of spherical nuclei as well as well-deformed heavy nuclei. They are also successfully applied to describe the ground state phase transitions in some isotopes. The results may provide a microscopic insight of the ground state phase transitional behaviors in which the competition between the Nilsson mean-field and the pairing interaction may be the driven force based on the present model.

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Study of Discrete Symmetries in eta' Meson Decays with BESIII

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Study of Discrete Symmetries in η' Meson Decays with BESIII

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Towards Hyperon Physics with PANDA at FAIR

Author: Jenny Regina[1]

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The upcoming PANDA (anti-Proton ANnihilation at DArmstadt) experiment at the future FAIR (Facility for Anti-proton and Ion Research) offers unique possibilities for performing hyperon physics experiments. The almost full 4π coverage of the detector will offer the possibility of reconstructing both hyperon and antihyperon which will be created together in proton-antiproton collisions. Due to their relatively long-lived nature, the displaced decay vertices of hyperons impose a particular challenge on the track reconstruction.

This talk will address the hyperon channels of special interest for PANDA, what makes them special and why these are interesting to study. The interesting hyperons are the single strange Λ, the doubly strange Ξ^- and the triple strange Ω^- with the production channels $p\bar{p} \to \Lambda\bar{\Lambda}$, $p\bar{p} \to \Xi^-\bar{\Xi}^+$ and $p\bar{p} \to \Omega^-\bar{\Omega}^+$. The challenges regarding the tracking and reconstruction of hyperons at PANDA will also be discussed.

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Simulation study of Sigma hyperon production with BES III

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Simulation study of Sigma hyperon production with BES III.

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Welcome

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PANDA @ FAIR

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Hyperon-photon physics at FAIR

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Detector activities in Lund

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DyTER: A framework for Dynamic Track and Event Reconstruction for PANDA at FAIR

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Energy resolution of a PANDA 3x3 - Prototype for Energies below 100 MeV

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Status of FAIR

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Sampling ADC's for the PANDA EMC

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Polarization Parameters from the Proton anti-Proton to Omega anti-Omega Reaction

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Difference Predicted Trace Compression on FPGAs

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DEGAS status report

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Measurements and Simulations of Single-Event Upsets in the PANDA sADC

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Any other business

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Annual meeting of the Nuclear Physics division of the Swedish Physical Society

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What Marie Curie, Irène Joliot-Curie and Maria Goeppert-Mayer had, and what is needed for a career in Physics

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Emergency Preparedness and Response work at the Swedish Radiation Safety Authority

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News from VR-NT

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