

# 25th anniversary of JINR in ATLAS

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## Book of Abstracts



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## Study of WH ( $W \rightarrow l\nu$ , $H \rightarrow b\bar{b}$ ) associated production process in ATLAS

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A search for the decay of a Standard Model Higgs boson into a  $b\bar{b}$  pair when produced in association with a W boson has been performed with the ATLAS detector. Data were collected in proton-proton collisions from Run 2 of the Large Hadron Collider at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of  $13.2 \text{ fb}^{-1}$ . Final state is considered that contain 1 charged lepton (electrons or muons), targeting the decay  $W \rightarrow l\nu$ . For  $m_{\{H\}} = 125 \text{ GeV}$  the ratio of the measured signal strength to the SM expectation is found to be  $\mu = 0.25^{+0.94}_{-0.92}$  and for combination with ZH ( $Z \rightarrow \nu\nu/\ell\ell$ )  $\mu = 0.21^{+0.51}_{-0.50}$ . This corresponds to an observed significance of 0.42 standard deviations compared with an expected sensitivity of 1.94.

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## The requirements of the hadronic calorimetry for the FCC-hh collider and the potential of an ATLAS-Tile concept readout by si-PMTs.

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The particles produced at the future hadron Circular Collider (FCC-hh) with  $\sqrt{s} = 100 \text{ TeV}$  are of unprecedented energies. We present MC simulations that motivate a 11-12  $\lambda$  calorimeter in order to contain at  $\sim 98\%$  level TeV single hadron showers and multi-TeV jets and keep a needed pion energy resolution constant term of few percent, the dominant contribution to the total energy resolution at the TeV energies. The hadronic shower containment and resolution parametrizations shown are based on Geant 4 simulations and are compared with test-beam data from the ATLAS Tile hadronic calorimeter. Other requirements such as the transversal granularity and acceptance improvements with respect to LHC calorimetry are also addressed using FCC physics benchmarks. We also present the potential of the ATLAS-Tile hadron calorimeter mechanics/optics concept read out by silicon photomultipliers for the central barrel and extended barrels, allowing big flexibility to achieve the needed transversal and longitudinal granularity, while keeping the overall good performance, hermeticity, and complexity at reasonable levels. A very preliminary conceptual mechanics layout of the central barrel and extended barrel HCAL cylinders is shown.

### Summary:

This work is done in the framework of the FCC-hh detector working group, including JINR members: Nikolai Topiline and Sergei Kolesnikov

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## Searches for charged Higgs bosons in the ATLAS experiment

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Charged Higgs bosons appear in many models of new physics with an extended Higgs sector. We present an overview of the ATLAS searches for charged Higgs bosons and discuss interpretations of the obtained results within different models. We demonstrate that in the context of the Minimal Supersymmetric Standard Model (MSSM) existing analyses are unable to discover charged Higgs bosons in a wide region of the model parameter space. To alleviate this problem, a new search is proposed - for charged Higgs decays into a chargino-neutralino pair, and we discuss our plans for this new analysis.

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## Search for pentaquark and tetraquark states in B-hadron decays at the ATLAS experiment

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The Lambda-b baryon and B-meson candidates produced in 7-8TeV pp-collisions at ATLAS experiment and decaying into J/psi plus 2 hadrons are analysed. The analysis is focused on studying the decays via tetraquark (X-4200) and pentaquark (Pc-4380, Pc-4450) states previously discovered by LHCb and BELLE experiments. ATLAS Run-I data also suggest hints for the existence of some new multi-quark states in B-hadron decays to be examined in Run-II data.

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## What have we learned over 25 years of ATLAS

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I will discuss the situation in HEP after 7 years of running of the LHC, in particular what has changed after successful run of the LHC, which questions has found their answers and what are the problems left .

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## Search for $\chi_{c(2)}$ meson state using partially reconstructed $\chi_{c(2)} \rightarrow J/\psi \mu \nu_{\mu}$ channel with the ATLAS detector

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A search for the excited Bc meson states is performed using 20 fb<sup>-1</sup> of 8 TeV pp collision data collected by ATLAS in 2012. It was done using a partially reconstructed semileptonic Bc decay mode. Having 20 times larger branching ratio, than fully reconstructed hadron Bc decay channel, this mode seems to give an unique ability for searching excited states, using mass difference technique. The structure observed in mass –difference distribution is consistent with previously discovered Bc(2S) state.

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## Search for intrinsic charm at ATLAS experiments

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The hypothesis of the possible existence of valence-like quarks, so called “intrinsic” quarks in proton is shortly reviewed. We show that the careful study of the inclusive production of open charm and the production of  $\gamma/Z/W$  particles accompanied by the heavy jets at large transverse momenta  $p_T$  of these particles or jets can certainly verify this hypothesis. We also focus on the theoretical predictions of observables very sensitive to the intrinsic charm contribution to the PDF, which can be tested at the LHC

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## ATLAS Tile Calorimeter Maintenance

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<sup>1</sup> *JINR, Dubna*

Abstract: Tile Hadron Calorimeter maintenance was started on surface, before detector gone in PIT. Since 2004 till 2007 the commissioning for Front End (FE) end ROD electronics were carried out permanently. From 2009 up today we were performing annual (during the stop of the LHC) TileCal maintenance. As well there were two big FE electronics maintenance campaigns. The first -on 2006-2008, so called FE electronics Refurbishment and second one during LS1, so called Consolidation of all 256 drawers. There are described the problems detected during physics RUNs and ways for solution. Some recomatdations for detector upgrade are given.

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## Measurement of V+HF jet production with ATLAS 13 TeV data

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On-going analysis on measurement of W/Z plus b-jets production in ATLAS using data collected in 2015 and 2016 is presented. Such processes are particularly sensitive to heavy quark component in proton structure function. Event selection, systematics studies, unfolding strategy are outlined. Comparison of data with various Monte Carlo generator predictions at reconstruction level are shown.

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## ASCOT, JINR, and the early days of ATLAS

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The coming into being of ATLAS is recalled, with emphasis on one of its two progenitors, ASCOT, and the important contributions of JINR to that endeavour.

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## ATLAS in Run-2 of the LHC: Status and Perspectives

**Author:** Dave Charlton<sup>1</sup>

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ATLAS has been taking data with high efficiency in Run-2, establishing and measuring the physics landscape in 13 TeV collisions. The current status of ATLAS, and an overview of recent Run-2 results, will be given.

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## CDF achievements

**Author:** Vladimir Glagolev<sup>1</sup>

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The JINR contribution to the CDF experiment and the discoveries along with significant Tevatron results such as discovery of top quark, Bs oscillations, Omega-sub-b ( $\Omega_b$ ) baryon, neutral Xi-sub-b baryon, precise W mass measurement, Higgs search etc will be discussed.

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## Development of large area GaAs:Cr hybrid pixel detectors for imaging applications

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Since 2008 JINR has been cooperating with several institutions in development of GaAs:Cr based detectors for fundamental and applied studies. One of the cooperation venues is the joint German-Russian project GALAPAD-2 aimed at development of tileable modules of large area hybrid pixel detectors to be used at synchrotron light sources, particularly XFEL and PETRA-III, and neutron sources. The current status of the project and its intermediate results will be presented.

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## MCFM & Pythia predictions for Z+heavy flavor jets at ATLAS

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Theoretical calculations for Z boson associated with heavy flavor jets within MCFM & PYTHIA generators are presented. The calculations were done using different PDFs, which include or ignore intrinsic charm component for studying this effect.

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## Micromegas production lines at DLNP JINR. Status and plans

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Presently, two Micromegas chamber production sites have been constructed at the DLNP JINR. The first line will provide production and testing of Micromegas chambers for the outer part (LM2) of large sectors of ATLAS NSW. This line will be used for production of NSW readout planes with the area of 384 m<sup>2</sup> out of the total area of 1200 m<sup>2</sup>. Component materials will be supplied from CERN in a

centralized fashion for all participants of the project.

The second line is aimed at complete cycle of production of Micromegas chambers with the active region width of up to 50 cm. This will obviously give the institute employees an opportunity to take part both in implementation of

different physics experiments and in applied studies more efficiently.

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## Observation of the 2D Earth surface angular deformations by the Moon and Sun with the Precision Laser Inclinometer

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The new data on the two coordinates registration by the Precision Laser Inclinometer of an Earth surface angular oscillations caused by the Moon and Sun are presented.

The new method of the temperature stabilization, of the compensation of noise origin laser ray angular and high precision interferometric calibration new methodic are proposed and realized. The high frequency limit for the measurements by the PLI is determined.

The PLI application for the space location stabilizing of the colliders/accelerators against microseismic angular oscillations of the Earth surface seems to be perspective for the luminosity/intensity increase in particular in the ATLAS location area at the LHC.

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## ATLAS Magnet System Construction, Maintenance and Operations, a long standing succesful ATLAS-JINR cooperation

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The ATLAS Detector Magnet System was constructed and installed in the underground cavern with a significant and long standing contribution of JINR, in particular regarding tooling development, on-site assembly, acceptance testing of the various coils, followed by the installation of the magnet system in the underground cavern. Even after completion and first data taking operations, the collaboration continued and a JINR team is almost continuously present at ATLAS for maintenance and repair works needed for the magnet system and other detector infrastructure. In parallel JINR technicians have participated during the last 10 years to the construction and repair of various other detector magnets handled by the ATLAS Magnet team as well. Highlights of this very successful collaboration will be presented.

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## ATLAS Tile Calorimeter performance in LHC Run-II and upgrades for HL-LHC

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The Tile Calorimeter (TileCal) is the central hadronic calorimeter of the ATLAS experiment at the LHC. It is designed for reconstruction of hadrons, jets, taus and missing transverse energy, and also assists in muon identification. A summary of performance results for TileCal using pp collisions

from the LHC Run-II at 13 TeV will be presented. For the high luminosity upgrade of LHC (HL-LHC) a major upgrade of the TileCal electronics is planned, and the ongoing developments for on- and off-detector systems, together with expected performance characteristics and recent beam tests will be described.

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## **From particle physics to medicine: microCT with GaAs:Cr detectors**

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The development of high resistivity gallium arsenide doped with chromium in Tomsk State University was inspired by the RD8 collaboration while seeking the radiation hard material for ATLAS pixel and strip detectors in 1992. Despite it was not accepted in the final ATLAS design, GaAs:Cr with time became a promising material for X-ray imaging. The first hybrid pixel detector based on GaAs:Cr sensor and a Medipix readout chip was made by the CERN-JINR-TSU collaboration a decade ago. Since then the detectors like these were proven to be an excellent tool not only for tracking in particle physics, but also in the applied fields like microtomography. The report shows a summary of results in computed microtomography using the GaAs:Cr Medipix detector at JINR.

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## **Background and luminosity in ATLAS cavern monitoring system on the base of GaAs:Cr pixel detectors - GaAsPix ATLAS project**

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The main goal of this system is to enhance the performance of the ATLAS-TPX network for real-time measurements of radiation field characteristics inside the ATLAS detector. The proposed enhancement will also improve the system capabilities to measure and monitor the luminosity and the induced radioactivity of the environment online. Comparison of ATLAS-TPX devices data with simulated background (FLUGG / GCALOR) will contribute to better understanding towards future phases of the ATLAS detector upgrade. It will also possibly provide some information on single event effect (SEE) origin.

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## GaAs:Cr pixel detectors

**Author:** Petr Smolyanskiy<sup>1</sup>

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High resistivity gallium arsenide compensated by chromium fabricated by Tomsk State University has demonstrated a good suitability as sensor material for hybrid pixel detectors used in X-ray imaging systems with photon energies up to 60 keV. The material is available with thickness up to 1 mm and thanks to its Z number and fully active volume of the sensor high absorption efficiency in this energy region is provided.

Some results of works aimed at studying of the Timepix detectors hybridized with GaAs:Cr sensors of various thickness will be presented. The energy and spatial resolution, mu-tau charge carrier distribution over sensor area have been determined. By means of scanning the detector with pencil photon beam generated by synchrotron facility the geometrical mapping of pixel sensitivity is obtained as well as the energy resolution of a single pixel. The long-term stability of the detector has been evaluated based on the measurements performed over one year. Also radiation hardness of GaAs:Cr sensors was investigated by means of irradiation with 20 MeV electrons and some results will be presented. Current status of ATLAS-GaAsPix network based on Timepix detectors with GaAs:Cr sensors will be reported.

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## On Higgs signal weighting

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A potentially important subtlety of the maximum likelihood fit of the Higgs signal strength from the data in many 'event categories', and the presentation of the Higgs signal, is discussed.

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## ATLAS Tilecal mechanics: Rememberings of eye-witnesses

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Anniversary report contains historical scenario of the ATLAS tilecal barrels assembly in facts, figures and how authors remember it.

In the second part of report presented virtual bridge between two grands Projects: ATLAS (CERN) and NICA (JINR).

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## Search for Quantum Black Holes in 1 lepton + 1 jet channel at 13 TeV with the ATLAS

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Search for quantum black holes (QBHs) was performed with the proton-proton collision data collected by the ATLAS detector at the LHC in 2015-2016 at a center-of-mass energy 13 TeV with the integrated luminosity of 36.1 fb<sup>-1</sup>. The QBH is assumed to decay into a final state with one lepton (electron or muon) and one jet with high transverse momentum of both. Finding of excess of events with high invariant mass of lepton-jet pair can indicate to quantum gravity effects with the QBH production. If not, the QBH mass value and upper limit on the QBH production cross sections can be constrained for several models.

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## The brief theoretic view on search for Quantum Black Holes at the ATLAS

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The brief theoretic view on the possibility of observations of Quantum Black Holes at the LHC is considered. The search assumes the sensitivity of ATLAS to the TeV scale gravity and to quantum black holes in final states with leptons and jets. In this case mass range of the multidimensional mass MD is equal or less of the 10 TeV. According to the ADD models with large extra dimensions the discovery reach is expected to be able due to the large increase of the LHC luminosity of 36.1 fb<sup>-1</sup> and due to the proton-proton-collisions energy at the centre-of-mass equal to 13 TeV.

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## Upgrade of the forward calorimetry. Behind the scene.

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After a short “historical” introduction I will present the Dubna group contribution to the development of the most optimal scenario for upgrade of the ATLAS forward calorimetry.

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## Intrinsic Charm: Monte Carlo Study

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Intrinsic Charm is an idea of long living heavy flavor quarks inside of the proton. It states that apart of usual state  $|\text{uud}\rangle$  proton also contains small fraction of other states. Most dominant is believed to be state  $|\text{uud}\bar{c}\rangle$ , which fraction is not more than few percent (1-2 %). We investigate such proposal using Monte Carlo samples which contain 1 or 2 % of intrinsic charm contribution.

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## JINR's participation in computing for the ATLAS experiment: history and current status

**Author:** Vladimir Korenkov<sup>1</sup>

**Co-authors:** Artem Petrosyan<sup>1</sup>; Danila Oleynik<sup>2</sup>; Igor Alexandrov<sup>1</sup>; Petr Zrelov<sup>3</sup>; Sergey Belov<sup>4</sup>

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The report is dedicated to the retrospective of the JINR's participation in the ATLAS experiment during more than 25 years in the tasks related to computing. A wide range of performed tasks is considered - beginning from the creation of the data acquisition systems, remote access and data management and ending distributed computing in the Grid environment. Considerable attention is paid to the activities in frames of the Russian node of the Grid network, in which JINR plays a role of one of the centers for modeling and analysis of the data of the ATLAS experiment. The involvement of JINR in the ATLAS TDAQ and Data Quality Monitoring Framework is under consideration, the history of the creation at JINR of a remote access system (Remote Control Room). Described is the development (in the field of Distributed Data Management) of the service of deleting unnecessary or damaged data (Data Deletion Service) on the sites Tier0-Tier1-Tier2 which ensures the integrity of storing information in a geographically distributed environment. Attention is paid to the creation of grid-nodes of the Tier3 level for a physical analysis on the local resources. Described is a participation in work on the monitoring systems Tier3-monitoring, Global Transfer Monitoring, ATLAS dashboard. The issues of the participation in the activities on the creation of the data management system (Workload Management System - WMS) - Panda, intelligent networking and HPC integration are also discussed.

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## Higgs boson couplings from the LHC

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<sup>1</sup> *University of the Witwatersrand*

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Following the discovery of a Higgs boson at the Large Hadron Collider, the experiments are reporting significant progress in understanding the coupling of this particle to other particles in the Standard Model. In this talk results from the ATLAS and CMS experiment will be reviewed. This includes results on the magnitude and structure of various couplings.

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## Scintillators radiation hardness study

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Scintillator detectors in the ATLAS will sustain a significant amount of radiation damage during the HL-LHC run time, so study of radiation hardness of scintillators is required. In this report JINR, Wits University and ISMA groups present some preliminary results of radiation hardness tests of commercially available plastic scintillators as well as new scintillators.

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## X-RAY COMPUTED TOMOGRAPHY ANALYSIS OF GEOMATERIALS

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ABSTRACT. X-ray CT analysis is an express non-destructive nuclear physical method for fast estimation of internal texture and structure characteristics of mineral and technogenic raw materials investigation, allows to obtain direct visual picture, and reconstruct the 3-D image of the sample internal structure. Since 1990 we study geomaterials with X-ray CT technique for morphostructural peculiarities and phase composition as the basic characteristics when forecasting quality and technological data –minerals and rocks, ferrous, ferromanganese and polymetallic ores, ocean ore formations, coal, diamonds, oil and gas collectors, metallurgical slags, organogenous matter, unique objects et. [Khozyainov M. et al. Geoinformatics. 1992. №1. PP. 42-50], We used “Geotom”BT-50- 1 unit, that combines the high resolution X-ray radiography and CT system and was specially constructed for geological tasks by PROMINTRO Ltd., Russia. Technical parameters: tube accelerating voltage 100 kV; thickness of the measured slice 3 μm; max cross-section 15 mm; space resolution ~5 μm. The results of X-ray CT implementation in the modern complex of analysis techniques for testing various geomaterials are presented. The obtained experience enabled us to elaborate some new approaches in X-ray CT images analysis, original method of phase identification with using standard sample. The latter operates the experimental entrance parameters for analysis characteristics used in technological and mineralogical studies, quantities calculations and histograms. Today developing new innovative processing technologies challenge complete and comprehensive information of the mineral composition and phases’ morphometric features that certainly determine technological characteristics because of the raw matter complicated composition, its poor quality, possible presence toxic and harmful impurities as an environmental problem. The method has proved to be a reliable tool to obtain direct, fast information for the quality and technological properties of raw

materials express  
forecasting.

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## **OPENING TALK**

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## **The Long Journey Together to the Higgs Discovery**

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## **The Long Journey Together to the Higgs Discovery**

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## **ASCOT, JINR, and the early days of ATLAS**

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## **ATLAS in Run-2 of the LHC: Status and Perspectives**

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