

Updates on physics research and detector upgrade in the ATLAS experiment at the LHC (JINR participation)

E. Khramov

22 January 2024

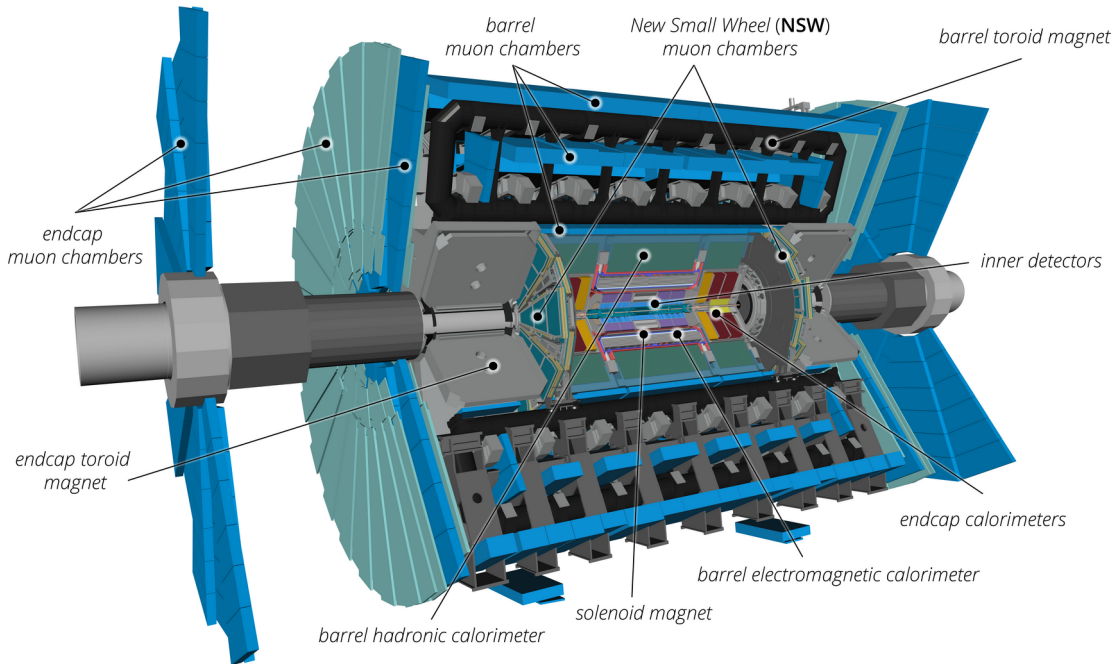
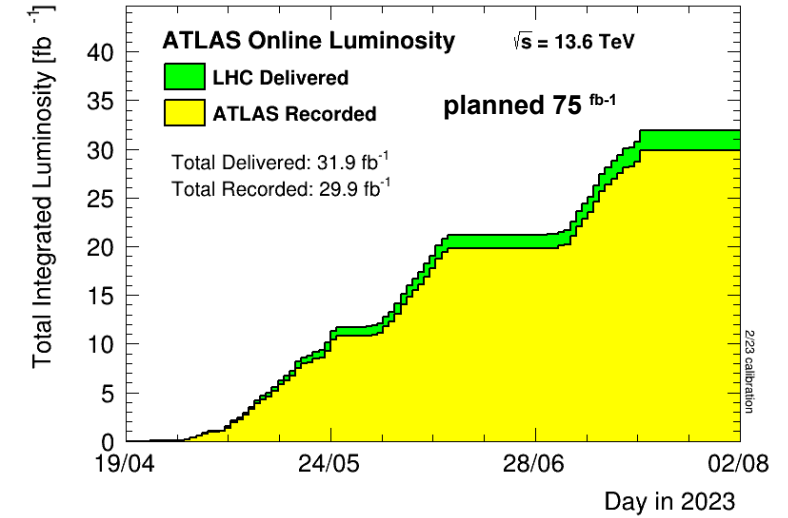
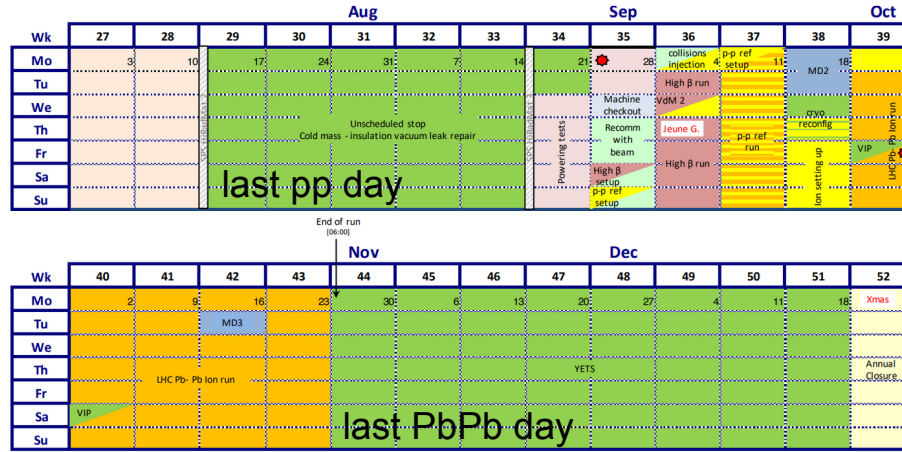
The ATLAS Collaboration

NUMBER OF INSTITUTES: 253

NUMBER OF AUTHORS: 2893

NUMBER OF PARTICIPANTS: ~5900

NUMBER OF COUNTRIES: 42



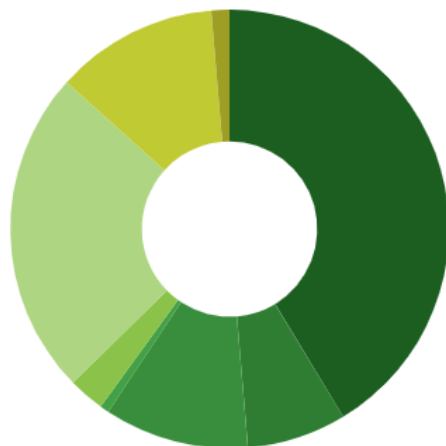
JINR-ATLAS team was deeply involved in designing, construction, tests and assembly of the major systems of ATLAS:

- Inner Detector
- Tile Calorimeter
- Liquid Argon Endcap Calorimeter
- Muon detector
- Common Items:
 - Magnet system
 - Warm Structure, etc.

JINR in the ATLAS Collaboration

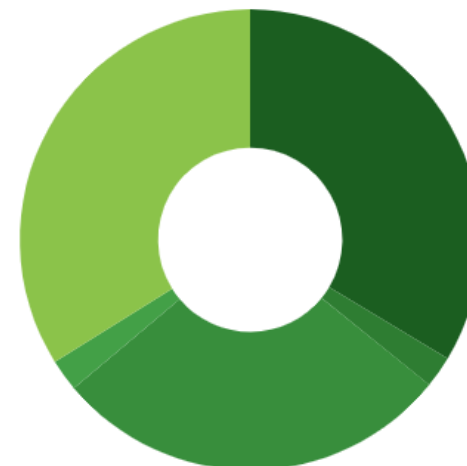
▶ Institutes Active Members - total 150

▶ Professional Status



- ▶ 62 Physicist
- ▶ 11 Physics PhD student
- ▶ 16 Physics masters/diploma student
- ▶ 1 Undergraduate/summer student
- ▶ 4 Engineer with PhD
- ▶ 36 Engineer without PhD
- ▶ 0 Engineering student
- ▶ 18 Technician or equivalent
- ▶ 2 Administrator/other

▶ Lists



- ▶ 30 on Authorlist (A)
- ▶ 2 Signing-Only (a)
- ▶ 25 counted for M&O (M)
- ▶ 2 qualifying members (q)
- ▶ 30.25 for Operation Tasks (O, o)

DLNP: Batusov V., Bednyakov V., Boyko I., ~~Buadze B.~~, ~~Budagov Y.~~, ~~Budtueva Z.~~, Chelkov G., Chizhov M., Chubinidze Z., Dedovich D., Demichev M., Didenko A., Dydyska Y., Elkin V., Ershova A., ~~Gazzaev A. B.~~, Gladilin L., Glagolev V., Gongadze A., ~~Gongadze L.~~, Gostkin M., ~~Gurtsiev R.~~, Huseinov N., Ivanov Y., Kalinovskaja L., Karpov S., Karpova Z., Kharchenko D., Khramov E., ~~Kochergin I.~~, ~~Kokaev D.~~, Kostyukhina I., Koval O., Kruchonak U., Kultchitsky Y., Lyabline M., Lyashko I., Lykasov G., Lyubushkin V., Lyubushkina T., Malyukov S., Minashvili I., Minashvili I.(jr.), Nefedov Y., Plontikova E., Potrap I., Prokhorov A., ~~Prokoshin F.~~, Rusakovich N., ~~Sadykov R.~~, Saponov A., Shiyakova M., Tropina A., Tsiareshka P., ~~Turchikhin S.~~, Yeletskikh I., Zhemchugov A., Shalyugin A., Usov Y., Usubov Z., ~~Vasyukov A.~~, Yermolchuk V

LIT: Alexandrov E., Aleksandrov I., Gromova N., Iakovlev A., Kazymov A., Mineev M., Shigaev V., Zrelov P.

VBLHEP: Ahmadov F., Cheplakov A., Kukhtin V., Ladygin E., Manashova M., Soloshenko A., Zimin N., Fillipov Y., Shaykhatdenov B., Turtuvshin T.

JINR in the ATLAS Human resources

A total number of personnel in the JINR group participating in the ATLAS Physics program is **33** including 5 professors, 14 postdocs and 14 young scientists, students and engineers. Detector maintenance, operation and upgrade team is 28 employees. The whole Team provides 28 FTE.

Besides the participation in the analysis itself members of the ATLAS-JINR Team are also playing managerial roles in the Collaboration. In the recent period we were taking responsibilities of conveners and sub-conveners of the ATLAS Working Groups (WG) as well as technical contacts persons with others Working Groups, such as Standard Model WG, B-Physics sub-group, Trigger Performance etc.

Major part of them is engaged in the project for many years. They have well recognized reputation within the Collaboration and beyond, solid background and necessary skills to fulfill all our obligations.

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JINR in the ATLAS M&O

During the 2023 period JINR has successfully secured all requested OTs of Class 1 and 2 providing:

457 shifts versus 395 shifts requested in 2023

The main task is participation in the ATLAS SLIMOS/TI - Safety shifter, and we would like to continue to cover this kind of shifts in that way.

By the end of the 2023 period the Class 3 shifts were covered at the level of **~73%**.

~ 7.5 FTEs out of 10.3 FTEs requested in 2023

This coverage was mainly due to Detector maintenance, "DAQ/HLT Control & Configuration", BLS Trigger Development and authorship qualification tasks. There are several minor tasks usually provided by JINR Team members in the detector sub-systems

During the 2023 it was published 8 **papers** and 2 **other publications** with significant participation of the JINR staff, 3 **talks different conferences**

Participation in the Physics&Computing Russian Institutes meetings

JINR in the ATLAS Physics during the 2023

1. Study of the applicability of the Standard Model and verification of SM predictions (including interactions of heavy ions), defining the structure of the proton at ultra-high energies (PDFs), tuning and improvement of relevant computer codes and events generators etc.

- 1 prof., 3 postdocs (3.5 FTE, Dydyshka Y, Kalinovskaya L., Saprnov A., Yermolchuck V.)

2. Search for (and study the characteristics of) additional exotic (including chiral Z^* , W^*) bosons in Drell-Yan and two-jet processes.

- 1 prof. (1 FTE, Chizhov M.)

3. Search for (supersymmetric) charged Higgs bosons via their specific decay modes (3 leptons, etc).

- 1 postdoc, 1 master student (2 FTE, Soloshenko A., Turtuvshin T.)

4. BEC

- 1 prof., 2 engineers (3 FTE, Koultchitski Y., Plotnikova E., Tsiareshka P.)

5. Modeling of di- J/ψ , $J/\psi + \psi(2S)$ and $J/\psi + Z (W)$ production

- 1 PhD student (1FTE, A.Prokhorov)

6. BSM $\rightarrow V/H(\rightarrow J)+\gamma$

- 1 postdoc (1 FTE, Khramov E.)

JINR in the ATLAS Physics during the 2023

7. Search for a valence-like nonperturbative component of heavy quarks in the proton (intrinsic heavy quarks) via specific final state topology in the pp-interactions and a study of the gluon structure of the proton, etc.

- 2 prof. (1 FTE, Bednyakov V., Lykasov G.)

9. $VH(\rightarrow bb)$

- 1 postdoc, 1 PhD student (2 FTE, Ahmadov F., Manashova M.)

10. Quantum Black Holes

- 2 postdocs (2 FTE, Karpov S., Karpova Z.)

13. B_c excited states

- 1 prof., 1 postdoc, 1 PhD student (1 FTE, Gladilin L., Lyubushkin V., Lyubushkina T.)

14. Penta-/Tetraquark states

- 1 prof., 1 postdoc, 2 PhD student (2.4 FTE, Gladilin L., Yeletskikh I., Didenko A., Vasyukov A., Yeletskikh I.)

16. $t\bar{t}H/W$ with multileptonic final states

- 1 postdoc, 1 student (0.6 FTE, Huseynov N., Tropina A.)

17. $tH(bb)$

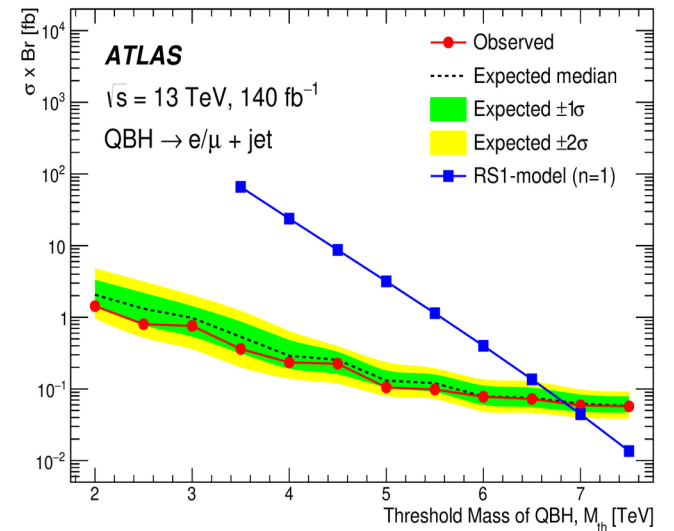
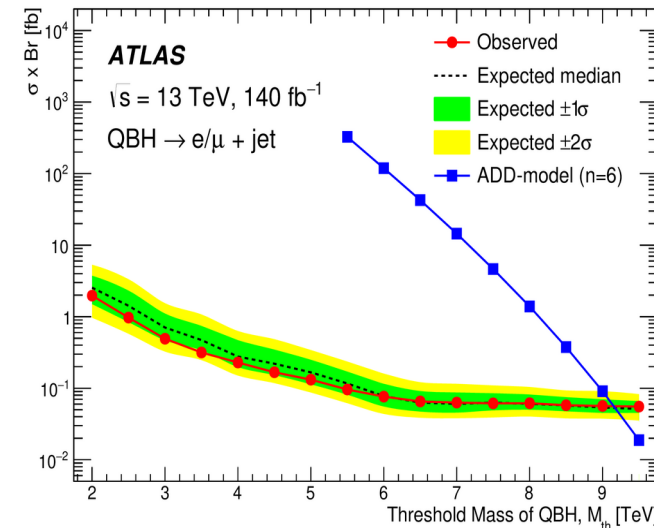
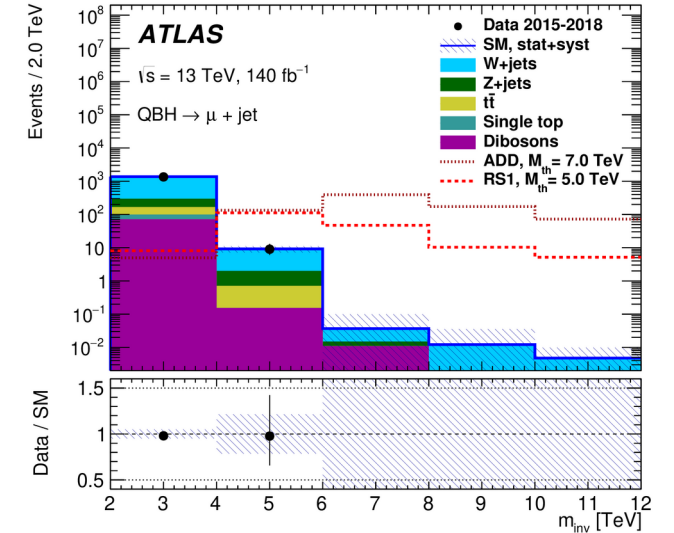
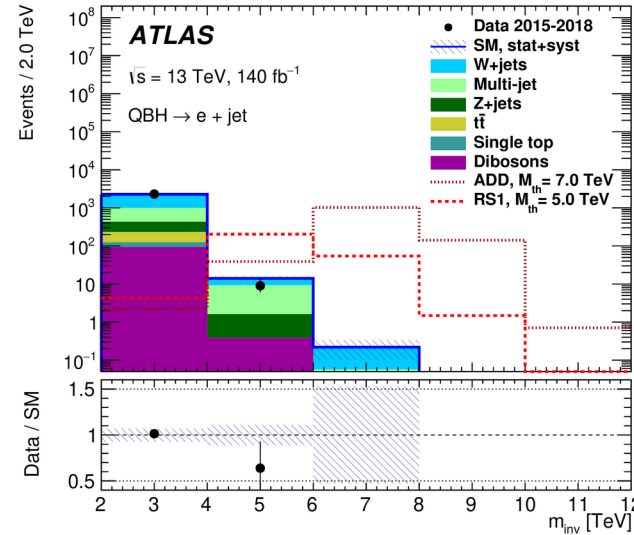
- 4 postdoc, 2 PhD students, 1 m.student (2.6 FTE, Boyko I., Huseynov N., Yeletskikh I., Tropina A., Didenko A., Koval O.)

Search for quantum black hole in lepton+jet final states

- QBH \rightarrow single jet and single lepton (for example ADD and RS models)
- Data collected between 2015 and 2018 by the ATLAS detector, integrated luminosity of 140 fb^{-1}
- $t\bar{t}$ and Z/W+jets backgrounds are estimated via CRs
- Multijets background is derived using the data-driven MM
- The observed invariant mass spectrum is consistent with SM
- The resulting QBH lower mass threshold limit is 9.2 TeV in the ADD model, and 6.8 TeV in the RS model

• [arXiv:2307.14967](https://arxiv.org/abs/2307.14967)

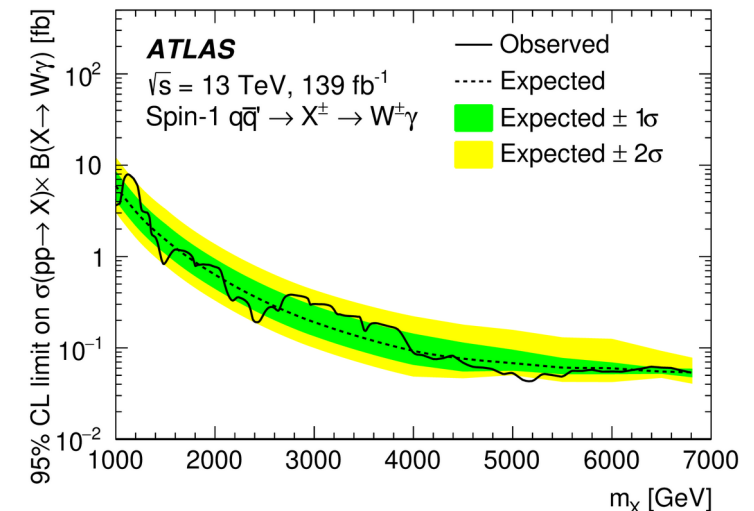
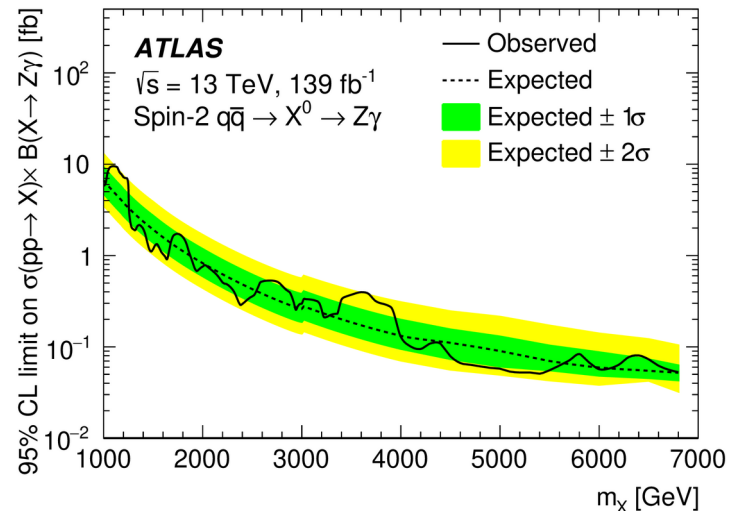
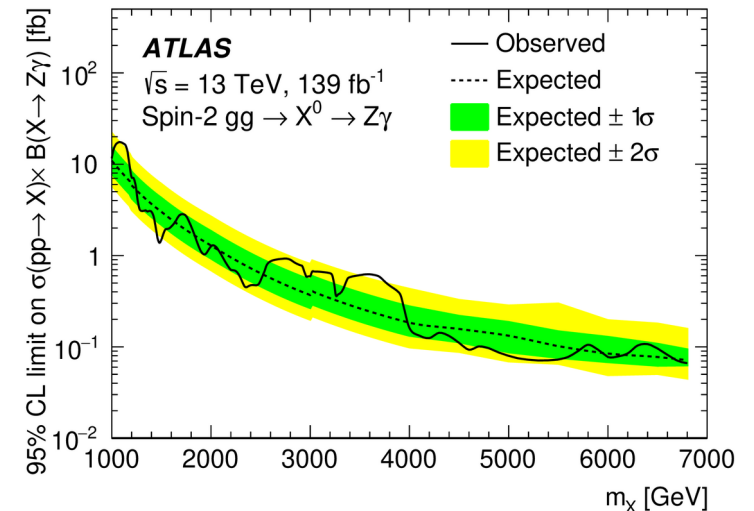
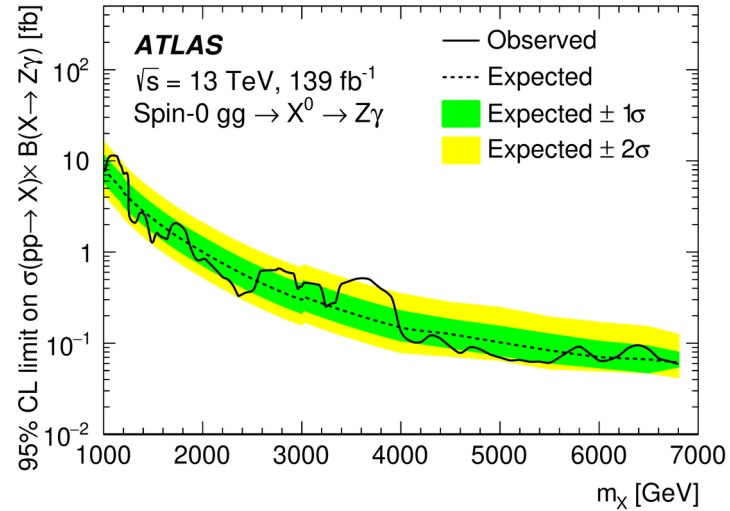
S. Karpov
Z. Karpova



Search for new heavy resonances in $Z\gamma$, $W\gamma$ decays

- Published in **JHEP 07 (2023) 125**
- Data collected between 2015 and 2018 by the ATLAS detector, integrated luminosity of 139 fb^{-1}
- BSM neutral and charged bosons with spin=0, 1 and 2
- V boson is reconstructed via fat jet
- The cross-section measurements are all consistent with the Standard Model expectations
- Upper limits on the $\sigma \times \text{Br}(X \rightarrow V\gamma)$ for different selections are set

E. Khramov



B-physics and Light States Trigger for Run 3

Institutional commitments to B-physics Software maintenance / HLT software

The JINR team is actively involved in the development and support of B-physics trigger software

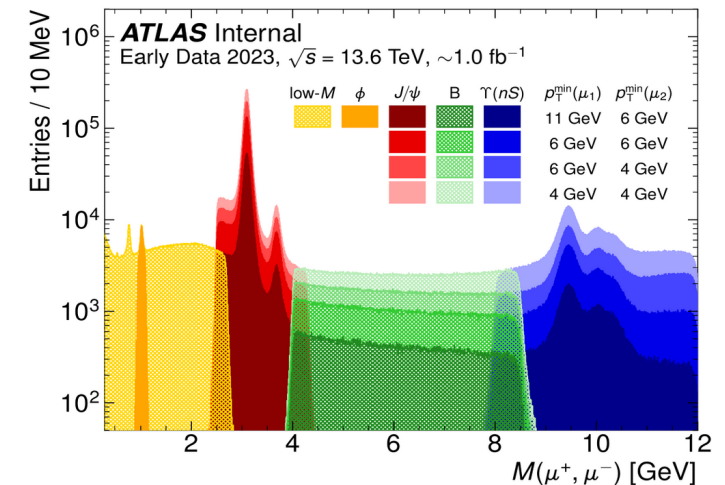
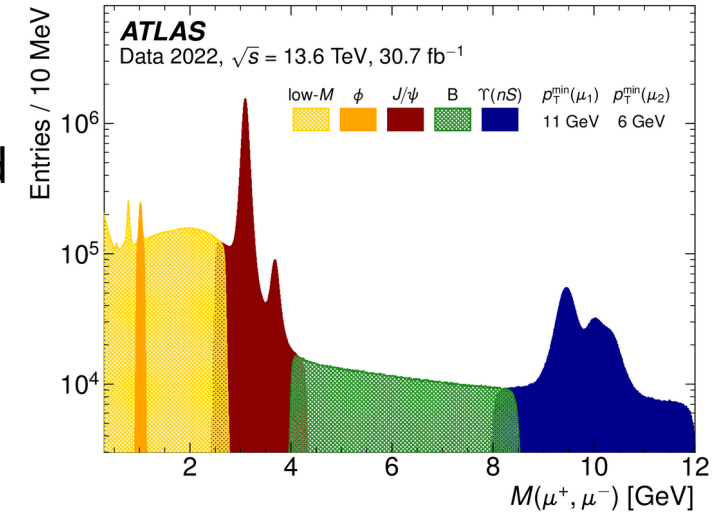
- Updated code for vertexing, new multi-muon chains introduced for B-J/ ψ physics studies
- Di-muon+tracks chains are redesigned to match specific B-meson decay signatures

2023 data taking campaign: BLS triggers are in place with improved reconstruction performance

- Better yields than 2022 – which lost data from bad calibration maps

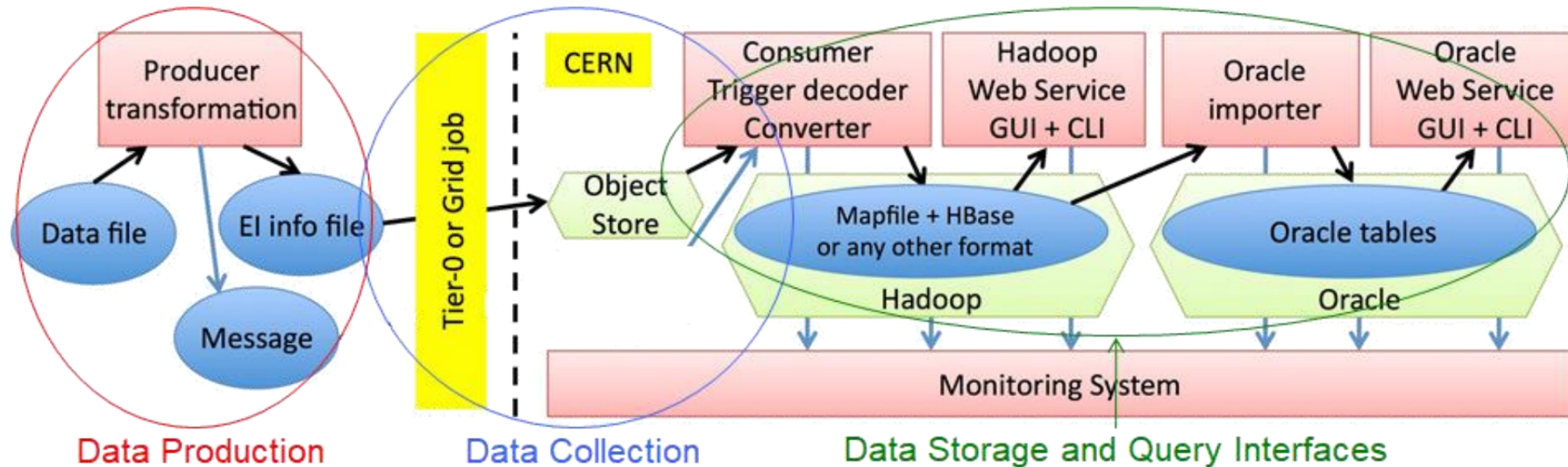
Team: V. Lyubushkin, A. Saprnov, A. Vasyukov, I. Yeletskikh

[See poster for details](#)



Events Indexing

EventIndex is a system to index the data or Monte Carlo events in the ATLAS experiment



Application:

- Event picking
- Event selection or counting based on trigger decisions
- Checking data consistency
- Producing trigger chain overlapping matrices
- Producing data stream overlapping matrices
- Quick assessment of datasets content

DLNP: Budtueva Z., Gazzaev A.-B., Gurtsiev R., Kokaev D., Prokoshin F.,

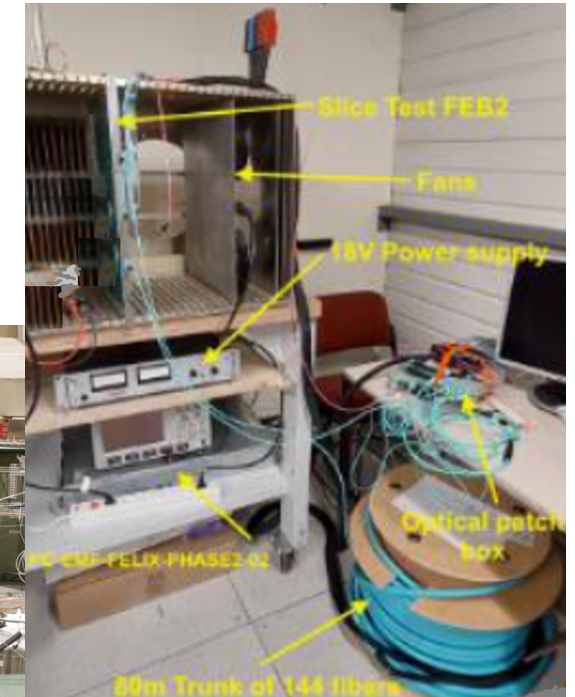
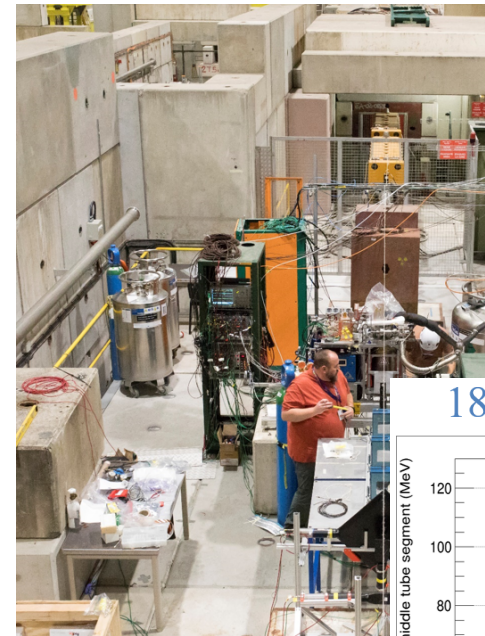
LIT: Alexandrov E., Aleksandrov I., Iakovlev A., Kazymov A., Mineev M.

Moved to the NICA project

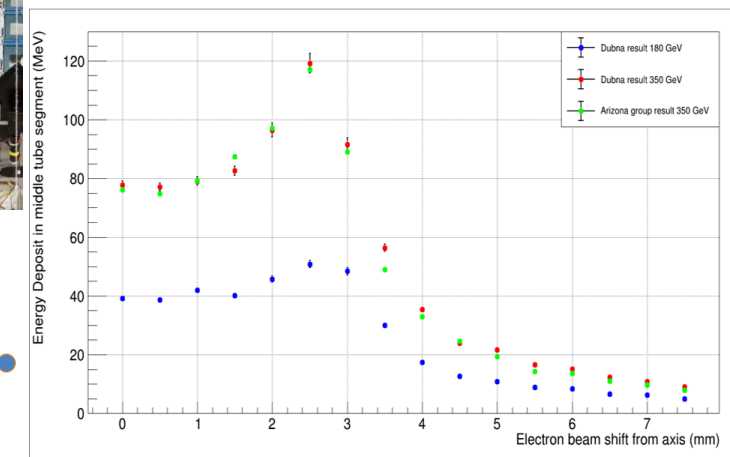
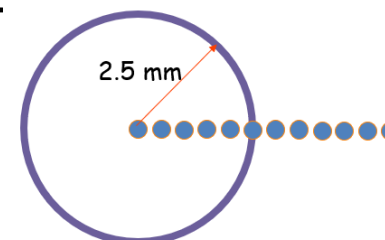
EM LAr Phase 2 upgrade

Liquid argon calorimetry:

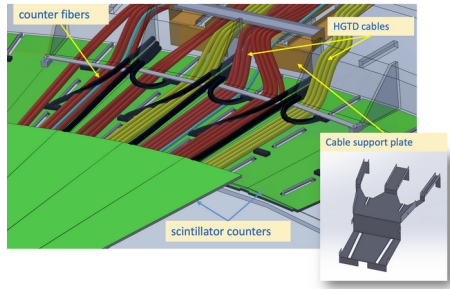
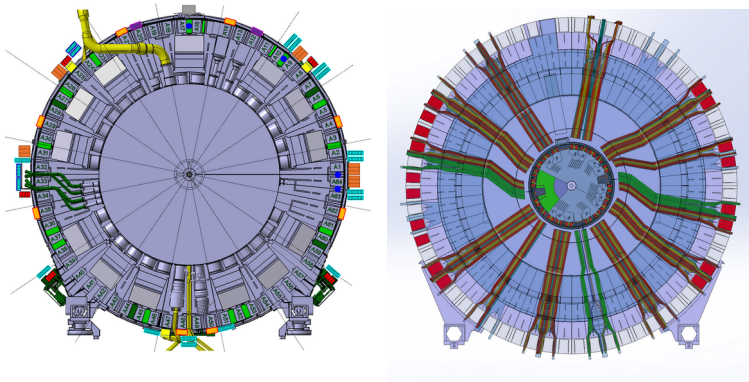
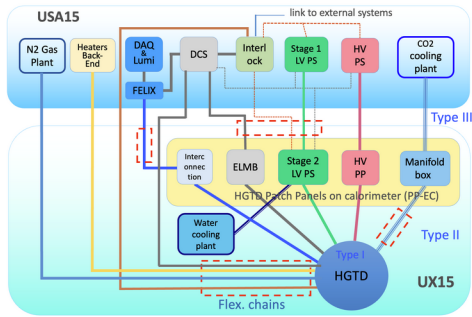
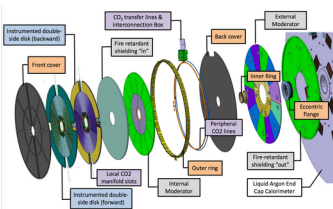
- ❑ Development of the Electronics Maintenance Facility (EMF) at CERN:
 - Half Crate Test for the final version of the readout electronics in 2024
 - JINR supplied optical cables and patch-cords (about 20kUSD CORE contribution)
- ❑ Participation in the FCalPulse project aimed at the signal study in the LAr Forward calorimeter in HL-LHC era
 - GEANT4 simulation of the testbeam setup'2022
 - Study of the LAr contamination by O_2



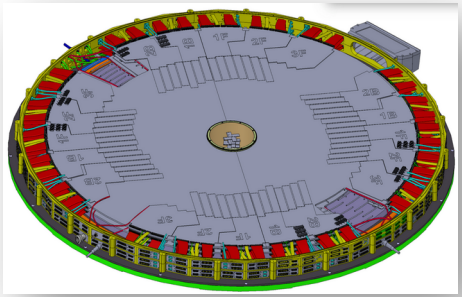
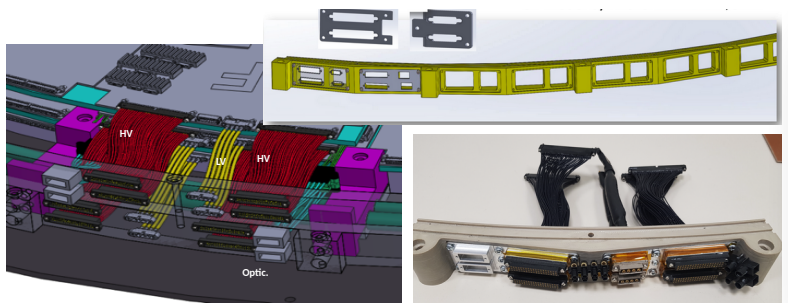
180 GeV, 350 GeV electron shower



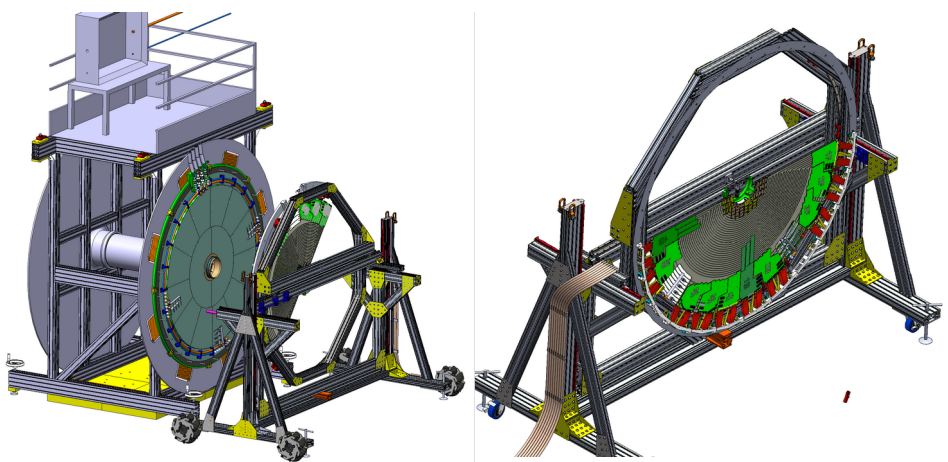
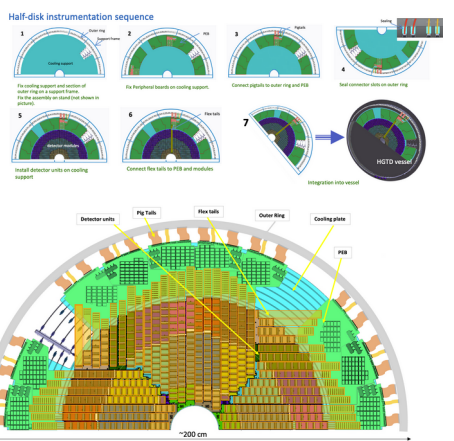
High Granularity Timing Detector for Phase 2 upgrade



Project of HGTD services has been developed. Cable and fiber services, patch panels and power supplies integrated into ATLAS configuration. 3D model created for services on calorimeter end caps. The model was validated using a mockup in 1:1 scale.



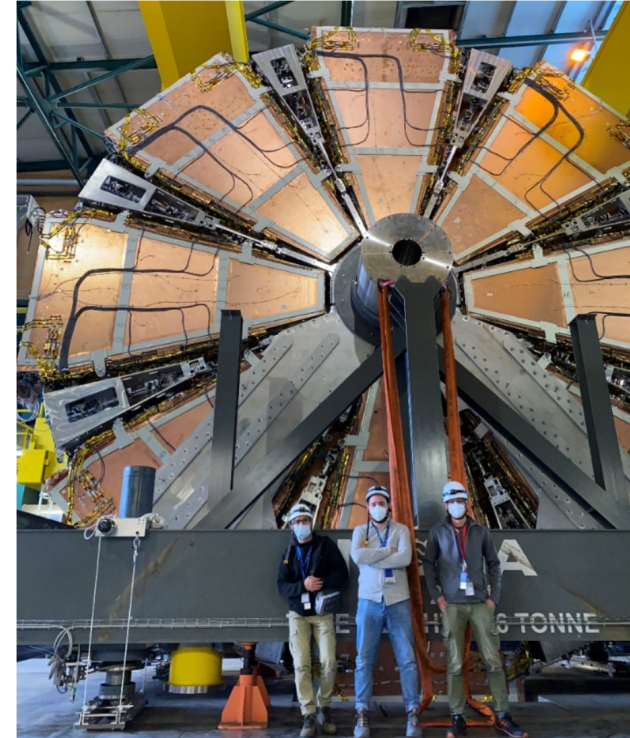
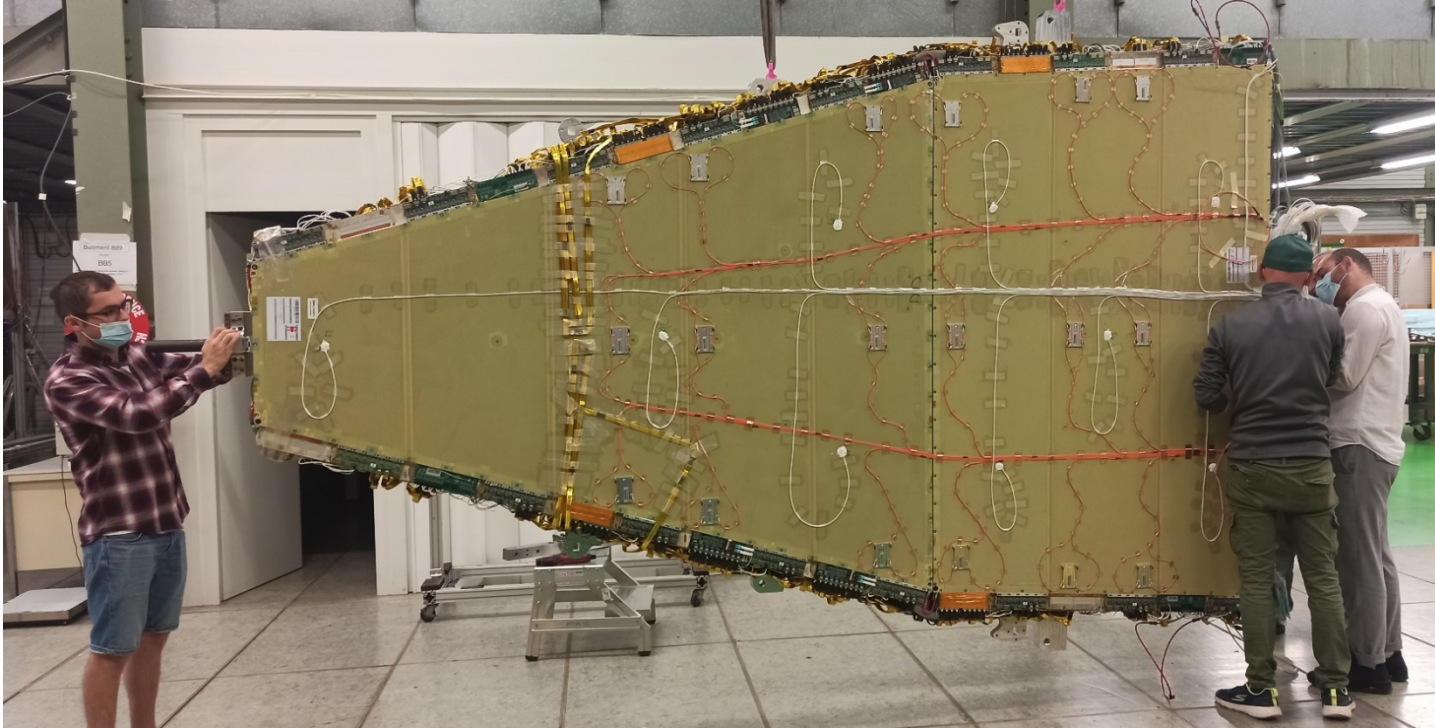
Proposed and developed the concept of outer ring, which is part of HGTD vessel and also serves as services interface. It allows for complete assembly and testing of the detector in a clean room outside experimental cavern, and for integration of the HGTD detector into ATLAS installation in a closed, hermetically sealed housing. Optical and cable services were designed inside detector vessel. A prototype of outer ring segment including services was manufactured and tested. A mock-up was created to validate the design and dimensions of services



Methods for assembling active components (the so-called active half-disks) of the HGTD detector, as well as for integrating instrumental half-disks into the detector vessel were developed. Design of a stand for instrumentation of half-disks was completed. Materials were purchased to assemble a prototype stand in 2024.

A series of reviews for validations of detector systems and infrastructure was conducted. Detailed plans were developed for the assembly, installation and testing of the HGTD detector. Work progress is regularly monitored. Results of the work done were regularly presented at seminars and workshops of the HGTD collaboration.

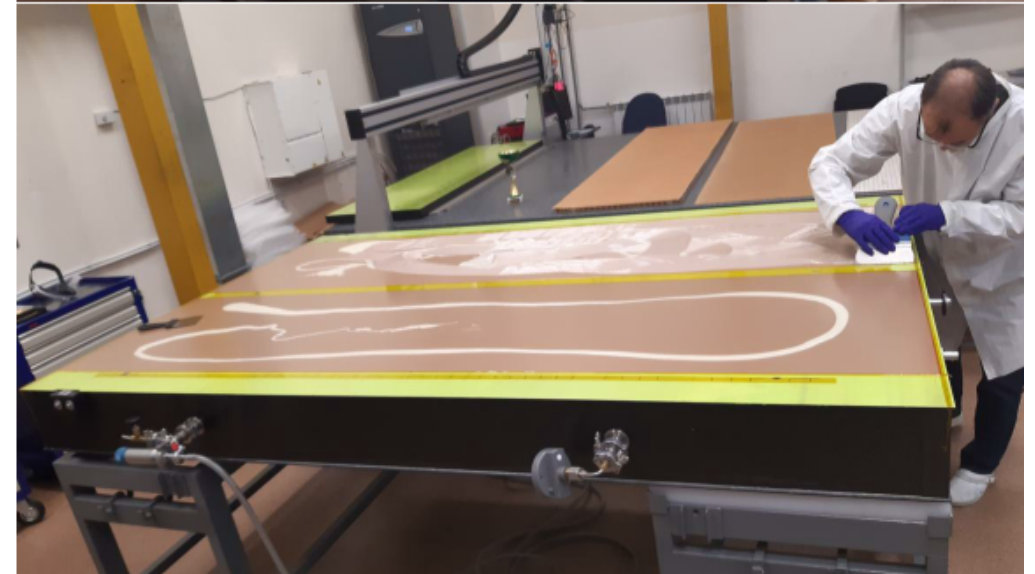
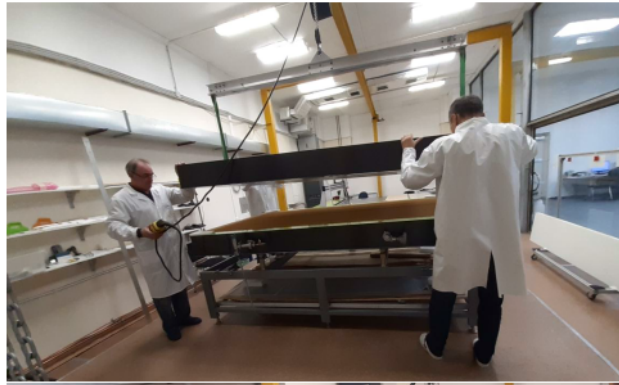
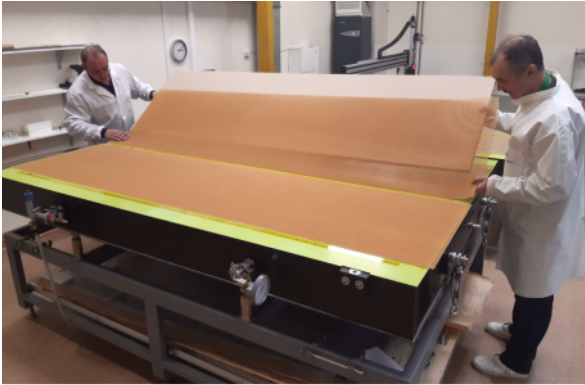
ATLAS Phase 1 – New small Wheel (NSW)



On-site detector maintenance and service enhancements

ATLAS Phase 2 – Resistive Plate Chambers (RPC)

- 1) RPC production and testing site was done
- 2) 3 BIL-type test panels were produced. The tests showed high, exceeding the requirement of the collaboration panel quality
- 3) The scheme for sending the detectors was worked out!
- 4) The detectors were delivered to CERN.



Acknowledgments from ATLAS to RPC team



GENÈVE, SUISSE
GENEVA, SWITZERLAND

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Geneva 6/12/2023

Prof G. Trubnikov
Director of JINR
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141980 Dubna
Moscow region
Russia

Dear Grigory Evgeny and Vadim,

I would like to thank you very much for allowing your JINR engineers and technicians to participate to the ATLAS activities and to give an invaluable support for the completion of the foreseen works for ATLAS during the End of the Year Technical Stop. Their stay at CERN will be covered by the ATLAS collaboration with standard COLA (cost of living allowance).

In particular I would like to thank very much U. Kruchonak, D. Kharchenko and I. Troeglazov who were fundamental for the maintenance and the repairs of the RPC chambers which play a central role in the Muon trigger. Their hard and competent work allowed to advance very much in this activity which will be needed for many other years due to the fragility of these detectors.

The competencies acquired by your specialists over the past few years are outstanding, and I can easily say that better people for this job cannot be found in the whole world.

I really hope that we can continue to count on these very competent and hardworking specialists also in the future for the continuation of ATLAS.

Finally, I have to greatly thank Nikolai Zimine, whose extremely efficient leadership and knowledge of all the CERN mechanism, allows all requests regarding reparations and maintenance of the Toroid Magnets and other ATLAS detector subsystems to be responded positively and swiftly.

With my best regards,

Sincerely yours,

Ludovico Pontecorvo (ATLAS Technical Coordinator)

A handwritten signature in blue ink, appearing to read "Ludovico Pontecorvo".

Conclusion and plans

- During the 2023 we were continuing our successful participation in the ATLAS Physics program and realization of attractive ideas in the ATLAS research program proposed by ATLAS at JINR
- ATLAS-JINR team participates in many ATLAS Physics Working Groups
- We actively involved in the Detector upgrade
- We kept contribution to detector maintenance: Class 1, 2 (116%) and 3 (73%) shifts
- We plan to maintain participation in Class 3 shifts by 1-2 FTEs this year
- 8 papers and 2 other publications, 3 talks at conferences
- We will keep going to support our analysis activity

Backup slides

HGTD DCS activities in 2023 and plan for 2024

- Activities on 2023:
 - PDR on DCS and Interlock took place on 18.01.2023
 - Was performed test of Pt10k temperature sensors, selected connection scheme, design of crate for ELMB and condition board for Pt10k sensors started
 - The dew point sensor was connected to WinCC and a test was performed in the climate chamber
 - A prototype of a high-voltage power supply has arrived at CERN, and work has begun on it
 - The writing of the program code for a low-voltage power supply has begun
- Plans for 2024:
 - Final testing of the dew point sensor under conditions of controlled humidity changes at low temperature and radiation test
 - Continued works with high and low voltage power supplies
 - Implementation of monitoring of HGTD via FELIX-IpGBT