Selected results of the JINR team in ATLAS

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on behalf of the JINR ATLAS team

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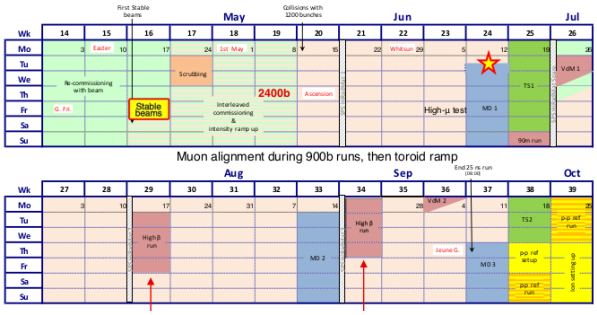
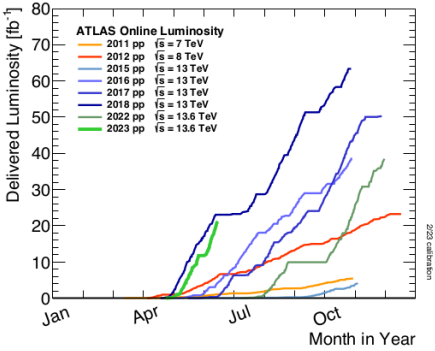
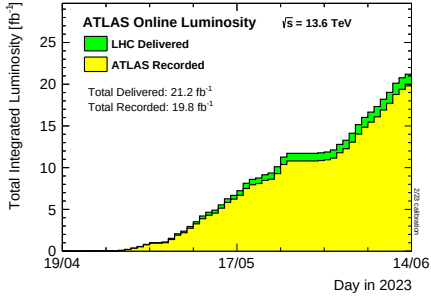
58th meeting of the PAC for Particle Physics
21 June 2023

The ATLAS Collaboration: data taking performance in RUN 3

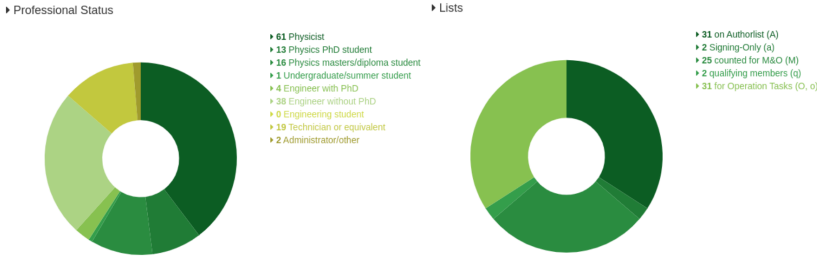




- 2023 data taking was started on April 21st
- 21.2fb^{-1} has been delivered to ATLAS; ATLAS has recorded 19.8fb^{-1} (June 13th)
- Planning for 2023
  - Last day of *pp* physics: September 22nd
  - Start of ion physics on October 2nd
  - Last day of beam: October 30th
  - Expecting 75fb^{-1}



JINR team in ATLAS Collaboration



At the beginning of 2023:

- 6 professors
- 12 postdocs
- 14 young scientists and students
- 27 employees are involved in the work on the ATLAS detector upgrade (14.4 FTE)
- The whole Team provides 43.4 FTE

- 153 Active Employments in Glance
- Dzhelepov Laboratory of Nuclear Problems (DLNP): Batusov V., Bednyakov V., Boyko I., Buadze B., Budtueva Z., Chizhov M., Chubinidze Z., Dedovich D., Demichev M., Didenko A., Dydyshka 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., A. Prokhorov, ~~Prokoshin F.~~, Rusakovich N., ~~Sadykov R.~~, Sapronov A., Shelkov G., Shiyakova M., Tropina A., Tsiareshka P., ~~Turchikhin S.~~, Yeletskikh I., Zhemchugov A., Shalyugin A., Usov Y., Usubov Z., Vasyukov A., Yermolchuk V
- Meshcheryakov Laboratory of Information Technologies (MLIT): Alexandrov E., Aleksandrov I., Gromova N., Iakovlev A., Kazymov A., Mineev M., Shigaev V., Zrelov P.
- Veksler and Baldin Laboratory of High Energy Physics (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 Physics

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)
   - 1 prof., 2 postdocs (2.5 FTE, Kalinovskaya L., Sadykov R., Sapronov A.)
2. Modeling of di-J/ψ and $J/\psi + Z(W)$ production
   - 1 PhD student (1FTE, A.Prokhorov)
3. Studies of Bose-Einstein correlations
   - 1 prof., 2 engineers (3 FTE, Koultchitski Y., Plotnikova E., Tsiareshka P.)
4. Search for intrinsic heavy quarks in proton, studies of the gluon structure of the proton
   - 2 prof. (1.0 FTE, Bednyakov V., Lykasov)
5. VH(bb)
   - 1 postdoc, 1 PhD student (2 FTE, Ahmadov F., Manashova M.)
6. Studies of ttH with multileptonic final states
   - 1 m.student (0.4FTE, Tropina A.)
7. Studies of tH(bb)
   - 4 postdoc, 2 PhD students, 1 m.student (2.6 FTE, I.Boyko, N.Huseynov, I.Yeletskikh, A.Tropina, A.Didenko, O.Koval)

JINR in the ATLAS Physics

8. 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.)
9. Search for (supersymmetric) charged Higgs bosons via their specific decay modes (3 leptons, etc)
   - 1 postdoc, 1 m.student (2 FTE, Soloshenko A., Turtuvshin T.)
10. BSM $V/H(J) + \gamma$
    - 1 postdoc (1 FTE, Khramov E.)
11. Quantum Black Holes
    - 2 postdocs (2 FTE, Karpov S., Karpova Z.)
12. Searches for BSM $H^+ \to Wh$, $h \to \tau\tau$
    - 1 postdoc, 1 m.student (0.5 FTE, I.Boyko, A.Tropina)
13. B_c^+ excited states studies
    - 1 prof., 1 postdocs, 1 PhD student (1.1 FTE, Gladilin L., Lyubushkin V., Lyubushkina T.)
14. Penta-/Tetraquark states in B-hadron decays, fully charmed tetraquarks
    - 1 prof., 1 postdoc, 2 PhD students (2.4 FTE, Gladilin L., Yeletskikh I., Vasyukov A., Didenko A.)

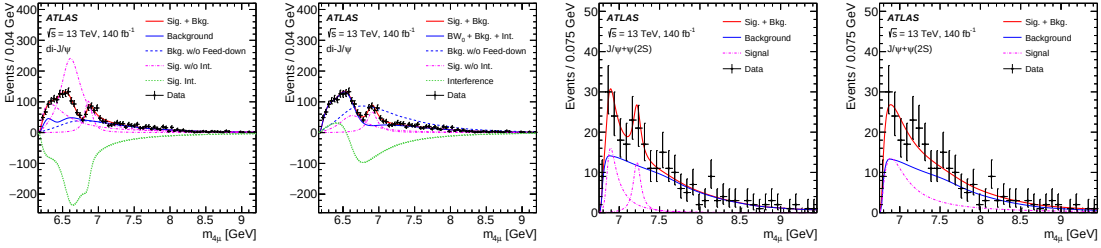
Observation of an excess of di-charmonium events in the 4μ final state

submitted to Phys. Rev. Lett.

by Alisa Didenko & Ivan Yeletskikh

- Studies were motivated by LHCb observation of a new X(6900) structure in $pp \to J/\psi J/\psi \to 4\mu$ mass spectrum
- Di-J/ψ spectrum fit with a model with 3 interferring resonances
  - X(6900) parameters consistent with LHCb, significance above 5σ
- ATLAS studies of $J/\psi + \psi(2S)$ spectrum shows hint on the additional signal at 7.2GeV (significance is 3σ)

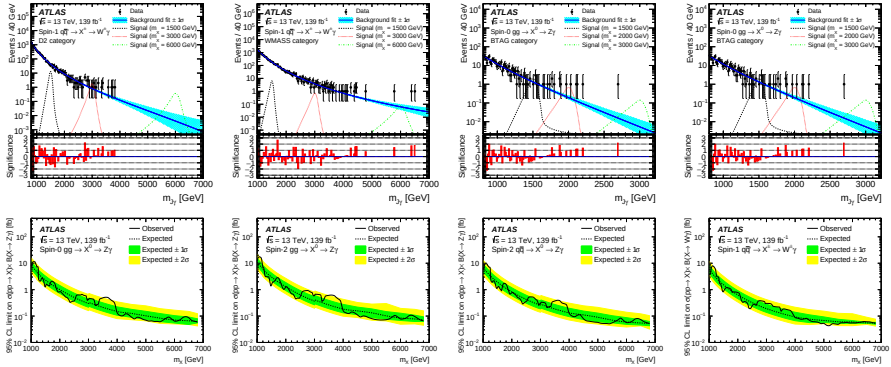
di-J/ψ	model A	model B
m_0	$6.41 \pm 0.08^{+0.08}_{-0.03}$	$6.65 \pm 0.02^{+0.03}_{-0.02}$
Γ_0	$0.59 \pm 0.35^{+0.12}_{-0.20}$	$0.44 \pm 0.05^{+0.06}_{-0.05}$
m_1	$6.63 \pm 0.05^{+0.08}_{-0.01}$	—
Γ_1	$0.35 \pm 0.11^{+0.11}_{-0.04}$	
m_2	$6.86 \pm 0.03^{+0.01}_{-0.02}$	$6.91 \pm 0.01 \pm 0.01$
Γ_2	$0.11 \pm 0.05^{+0.02}_{-0.01}$	$0.15 \pm 0.03 \pm 0.01$
$\Delta s/s$	$\pm 5.1\%^{+8.1\%}_{-8.9\%}$	—
J/ψ+ψ(2S)	model α	model β
m_3 or m	$7.22 \pm 0.03^{+0.01}_{-0.03}$	$6.96 \pm 0.05 \pm 0.03$
Γ_3 or Γ	$0.09 \pm 0.06^{+0.06}_{-0.03}$	$0.51 \pm 0.17^{+0.11}_{-0.10}$
$\Delta s/s$	$\pm 21\% \pm 14\%$	$\pm 20\% \pm 12\%$



Search for new heavy resonances in $Z\gamma$, $W\gamma$ spectrum submitted to JHEP

by Evgeniy Khramov

- Search for BSM resonances decaying to $Z/W/H + \gamma$
- $Z/W/H$ identified in their hadronic decays via fat jets
- Upper limits set on the $\sigma(X) \times \mathcal{B}(X \to W/Z/H + \gamma)$

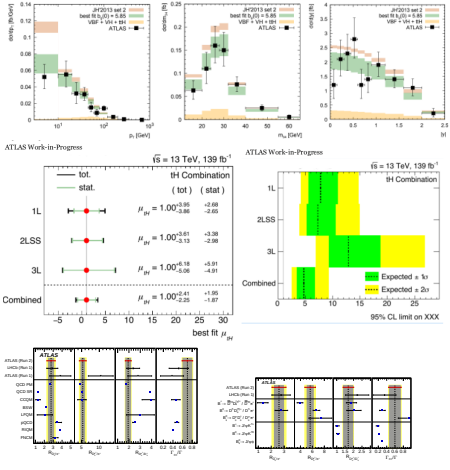


The data consistent with the expected background

Other results from 2023

1. Toward the global fit of the TMD gluon density in the proton from the LHC data (Phys.Rev.D 107 (2023) 1, 014022, 2211.03727 [hep-ph])
   - A.V. Lipatov, G.I. Lykasov, M.A. Malyshev
2. Study of the Higgs boson production with a single top quark in ATLAS experiment (accepted by PEPAN Letters)
   - I. Boyko, N. Huseynov, O. Koval, A. Tropina, I. Yeletskikh
3. ATLAS results on B_c^+ production and decays (accepted by Nucl. Phys)
   - T. Lyubushkina

- +2 ATLAS Conference talks (by Y. Koultchitski)

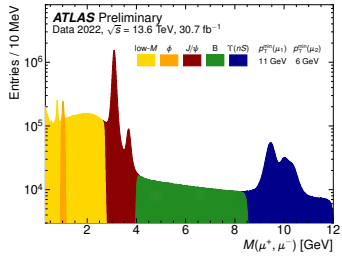


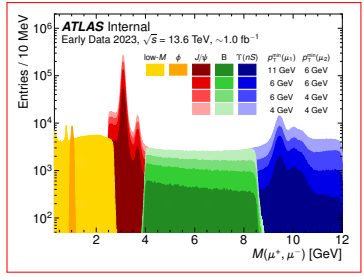
JINR in the ATLAS M&O

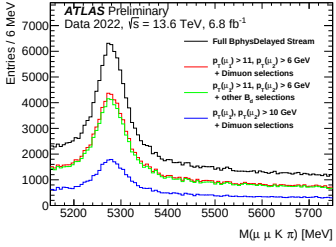
- We kept contribution to detector maintenance:
  - Class 1: Central and Detector Shifts in ATLAS Control Room at Point-1
  - Class 2: Other shifts - Additional shifts, including shifts in satellite control rooms, computing shifts, remote shifts, on-call shifts
  - 395 shifts is requested
- Class 3: Expert operation tasks - Operation tasks involving experts on systems, data preparation, computing, software.
  - The 2023 Class 3 OTP requirement is 10.31 FTE
  - ATLAS software support by JINR:
    1. Event index database development
    2. TDAQ system, development of the operational monitoring systems and networks monitoring
    3. B-physics trigger software
- QT:
  - Artem Vasyukov has completed his analysis of L1Topo selections qualified for authorship
  - Anastasiia Tropina: the studies of the longitudinal development profile of hadronic shower using hadrons beams at different energies inning at 90 degree and comparison with G4 models
  - Alisa Didenko: the studies of the transverse development shapes of hadronic shower using hadrons beams at different energies impinging at 20 degree and comparison with G4 models

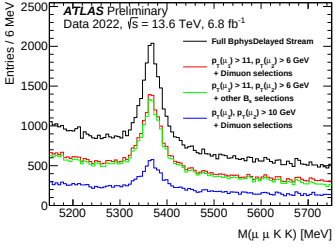
B-physics and Light States Trigger for Run 3

- 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
  - Dimuon+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



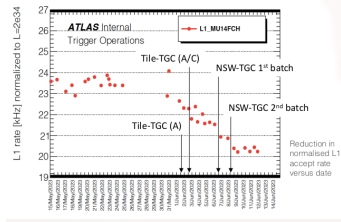


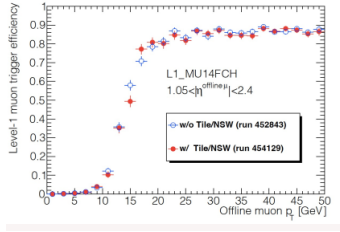




JINR group participation in the ATLAS Phase-I upgrade program (2013-2022)

1. Muon Spectrometer – New Small Wheel project:
   - Infrastructure development
   - Production of large Micromegas quadruplets
   - NSW assembly and commissioning
   - NSW partly (14→29 out of 144 sectors) included in trigger selection, good results
2. Liquid Argon Calorimetry:
   - Design of baseplane for the new readout crate
   - Development several prototypes of the preshaper for the analog part of the LAr Trigger Digitizer Board
   - Radiation tests and Simulation of signal degradation
3. TILE scintillator calorimeter:
   - The radiation hard scintillators for replacement of Min.bias trigger modules in the transition area between the barrel and endcap cryostats.
   - Development of new electronics for the readout Demonstrator



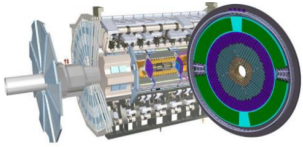


L1Muon turn on

JINR group participation in the ATLAS Phase-II upgrade program (2023-2027)

1. Trigger and Data Acquisition (TDAQ)
   - Readout - FELIX I/O card. Procurement of components and testing
   - Hardware Track Trigger (HTT) Pattern Recognition Mezzanine - Procurement of components and testing
   - HTT ATCA Infrastructure - Procurement, installation and commissioning
   - HTT Track Trigger Interface - Procurement of components and testing
2. Liquid argon calorimeter (LAr)
   - Optical link components (production) - common work with Lebedev Inst.
   - Data processing (procurement)
3. Tile calorimeter
   - LV services: New Auxillary control boards, cables
4. Muon
   - Production site (NSW) for RPC strip panel is ready to start
   - 3 BIL-RPC panels are made, good quality is demonstrated
5. Highly granular time detector (HGTD)
   - The design was determined, materials were prepared and an important step in the preparation of DCS - SPR (Specification Preliminary Review) was completed.
   - Half-disk instrumentation stand (production)

RPC prototypes production already started!



Conclusions 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
- During the 1st part of 2023 it was published 3 papers with significant participation of the JINR staff; 2 conference proceedings were accepted by journals
- Currently it's difficult to plan long-term activities: software support, PhD terms for students, etc.

Backup slides

ATLAS detector