

Selected results of the JINR team in ATLAS



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On behalf of the JINR ATLAS team

I.Yeletskikh, JINR Program Advisory Committee, 23.01.2023

Professional Status

Lists

- 64 Physicist
 13 Physics PhD student
 16 Physics masters/diploma student
 0 Undergraduate/summer student
 4 Engineer with PhD
 39 Engineer without PhD
 0 Engineering student
 19 Technician or equivalent
 2 Administrator/other
 - 34 on Authorlist (A)
 0 Signing-Only (a)
 29 counted for M&O (M)
 - 2 qualifying members (q)
 - ▶ 34.25 for Operation Tasks (O, o)

- DLNP: Batusov V., Bednyakov V., Boyko I., Buadze B., Budagov Y., 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*.
- 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.

ATLAS physics studies at JINR

| 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 postdoc (1.1 FTE, Bednyakov V., Lykasov G., Turchikhin S.) |
| 5. SM precision measurements (W/Z + b-jet x- section) | 1 postdoc (0.4 FTE, S. Turchikhin) |
| 6. VH(bb) | 1 postdoc, 1 PhD student (2 FTE, Ahmadov F., Manashova M.) |
| 7. Studies of ttH with multileptonic final states | 1 m.student (0.4FTE, Tropina A.) |
| 8. Studies of tH(bb) | 4 postdoc, 2 PhD students, 1 m.student (2.6 FTE, I.Boyko, N.Huseynov, I.Yeletskikh, I.Souslov, A.Tropina, A.Didenko, O.Koval) |

ATLAS physics studies at JINR

| 9. Search for (and study the characteristics of) additional exotic (including chiral Z^* , W^*) bosons in Drell-Yan and two-jet processes | 1 prof., 1 PhD student (2 FTE, Chizhov M., Kochergin I.) |
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| 10. 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.) |
| 11. BSM V/H(J)+gamma | 1 postdoc (1 FTE, Khramov E.) |
| 12. Quantum Black Holes | 2 postdocs (2 FTE, Karpov S., Karpova Z.) |
| 13. Searches for BSM H+ to Wh, h to tautau | 1 postdoc, 1 m.student (0.5FTE, I.Boyko, A.Tropina) |
| 14. <i>B_c</i> , <i>B_c</i> excited states studies | 1 prof., 2 postdocs, 1 engineer (1 FTE, Gladilin L., Lyubushkina T., Turchikhin S., Lyubushkin V.) |
| 15. 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.) |

ATLAS software support by JINR

| 1. 'Event index' database development | 1 postdoc, 1 PhD (1.5FTE, F.Prokoshin, E.Alexandrov) |
|---|---|
| 2. REST API development for database monitoring | 2 PhD students (1.5FTE, A.Gazzaev, D.Kokaev) |
| 3. B-physics trigger software | 3 postdoc, 1PhD student (V. Lyubushkin, A. Sapronov, S. Turchikhin, A. Vasyukov) |

ψ -pair production studies at ATLAS: fully charmed tetraquarks ATLAS-CONF-2022-040

Two degenerate solutions for di-J/ ψ

Studies were motivated by LHCb discovery of resonant-like signal X(6900) in di-J/ψ spectrum.

ATLAS and CMS also studied di-J/ ψ spectrum near production threshold:



I.Yeletskikh, JINR PAC, 23.01.2023

Studies of B_c states at ATLAS



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



ATLAS-CONF-2021-041



Parameters of the BEC function have been derived from ATLAS data at 13 TeV up to track multiplicity ~300. Results are compared to those obtained at 0.9TeV and 7TeV. Track p_T thresholds of 100MeV and 500MeV are used. At high multiplicities a plateau is observed in $R(m_{ch})$ dependence, confirming results obtained with 7TeV collisions. • Probing the proton structure with associated vector boson and heavy flavor jet production at the LHC

A.Lipatov, G.Lykasov, M.Malyshev, S.Turchikhin Phys.Rev.D 106 (2022) 5, 054017, e-Print: 2203.07741

Kinematics of Z+c events are predicted for different scenarios of intrinsic charm contribution to proton pdf



• Towards the global fit of the TMD gluon density in the proton from the LHC data

A.Lipatov, G.Lykasov, M.Malyshev e-Print: 2211.03727

A new analytical expression for the Transverse Momentum Dependent (TMD, or unintegrated) gluon density in the proton is proposed



 AtlFast3: the next generation of fast simulation in ATLAS I.Yeletskikh, ATLAS Collaboration

Computing and Software for Big Science, volume 6, Article number: 7 (2022), e-Print: 2109.02551

Trigger menu for Run3

Å 5000

Entries /

3000

2000

1000

12

ATLAS Preliminary Data 2022, $\sqrt{s} = 13.6$ TeV, 6.8 fb

- New trigger software has been actively developed during LS2 with substantial JINR contribution
- Dimuon and Multimuon chains for Run3: updated code for vertexing, new multi-muon chains introduced for $B-J/\psi$ physics studies

 $\Upsilon(nS) \quad p_{T}^{\min}(\mu_1) \quad p_{T}^{\min}(\mu_2)$

10

 $M(\mu^{+},\mu^{-})$ [GeV]

11 GeV 6 GeV

Dielectron triggers for $B \rightarrow e^+e^-X$ decays

low- $M \phi$

 J/ψ

6

В

8

ATLAS Internal

Data 2022, $\sqrt{s} = 13.6 \text{ TeV}$, 37.8 fb⁻¹



- Dimuon+tracks chains are redesigned to match specific *B*-meson decay signatures
- Validation with Run3 data is completed

Δ

2

Entries / 10 MeV

10⁵

10⁴

Muon Spectrometer – NSW project:

- Infrastructure development
- Production of large Micromegas quadruplets
- NSW assembly and commissioning

Factor 4 reduction in the rate of fake μ -triggers

Liquid Argon Calorimetry:

- Design of baseplane and preshaper
- Radiation tests and
- Simulation of signal degradation

TILE scintillator calorimeter:

- Min.bias trigger modules
- Development of new electronics for the readout Demonstrator







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

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 LAr

Preamp-Shaper and HEC Preshaper ASICs - *HEC input stage design and testing;*

Optical Link Components - *Production and testing of optical pigtails* (*MES+Lebedev*);

FEB2 - Develop analog circuit and testing;

Front-End Power Distribution System - Procurement of parts (MES);

LAr Signal Processor Hardware - Procurement of parts;

TILE

LV services: New Auxillary control boards, cables MUON

RPC chambers and FE electronics - *RPC Singlet assembly and testing; Strip panels production and testing;*

Gas System - Gas system design, production, installation;

Power System - *Power distribution design, distribution, production and installation;*

Surface commissioning, installation and commissioning HGTD

LGAD sensors, electronics – *Sensors pre-production & production, DC converters, crates*

DCS and Control, Mechanics – DCS, network, assembly tools Installation and commissioning, testbeam

RPC prototypes production already started!





3 RPC strip panels are made with good quality (thickness tests)

- During 2022 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 LS2 more attention were paid to the software projects
- We kept contribution to detector maintenance: Class 1, 2 (1.51 FTE 457%) and 3 (6.93FTE – 73%) shifts
- 5 papers, 5 ATLAS Conference talks, several scientific schools, workshops and student conferences reports
- All JINR commitments w.r.t. Phase-I upgrade are successfully accomplished
- Currently it's difficult to plan long-term activities: software support, PhD terms for students, etc.

BACKUP

ICPPA-2022 <u>6th International Conference on Particle Physics and Astrophysics</u> *T.Lyubushkina ATLAS results on B_c production and decays*

LHC Days 2022 <u>LHC Days in Split 2022</u> I.Yeletskikh B-physics in ATLAS and CMS

ICNFP 2022 <u>11th International Conference on New Frontiers in Physics</u> I.Yeletskikh ATLAS results on exotic hadronic resonances

ICPPA-2022 <u>6th International Conference on Particle Physics and Astrophysics</u> Y. Koultchitski Standard Model measurements by ATLAS and CMS

ICPPA-2022 <u>6th International Conference on Particle Physics and Astrophysics</u> L.Gladilin *Recent Heavy Flavour results from ATLAS and CMS*