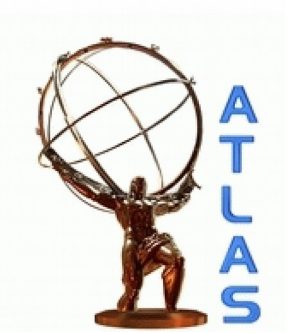
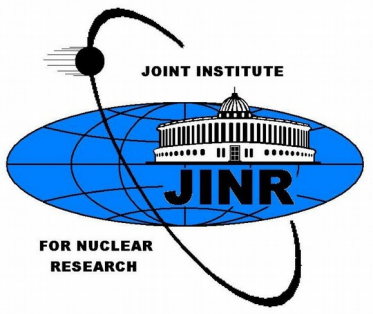




Physics research with ATLAS detector at the LHC Run-III (JINR participation)

1081 theme prolongation for 2020-2024

E. Khramov

4 April 2019

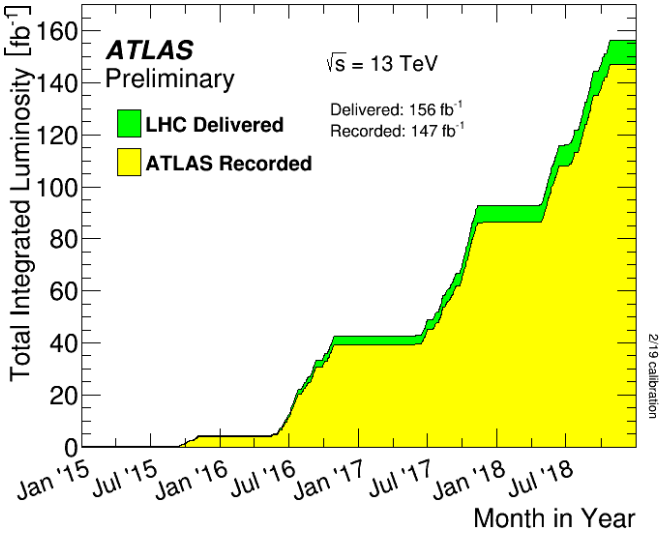
The ATLAS Collaboration

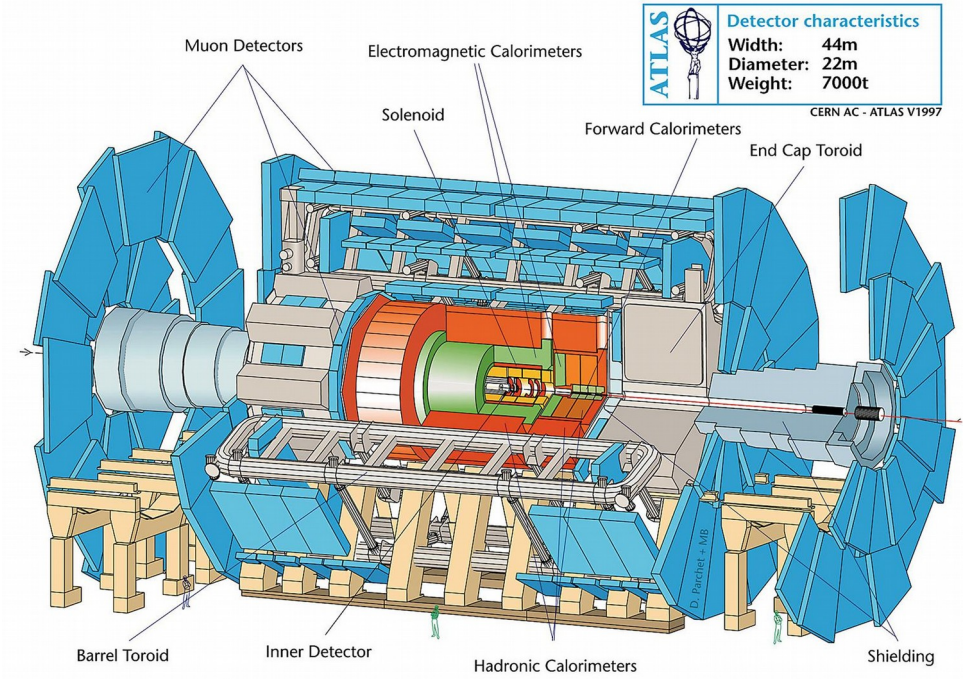
NUMBER OF INSTITUTES: 221

NUMBER OF AUTHORS: 1786

NUMBER OF PARTICIPANTS: 8128

NUMBER OF COUNTRIES: 41





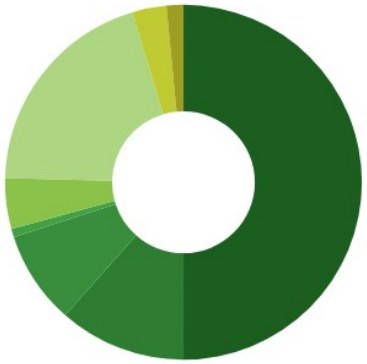
JINR-ATLAS team was deeply involved in designing, construction, tests and assembly of the major systems of ATLAS:

- Inner Detector
- Tile Calorimeter
- Liquid Argon End Cap
- Calorimeter
- Muon detector
- Common Items: Toroid
- Warm Structure, etc.

JINR in the ATLAS Collaboration

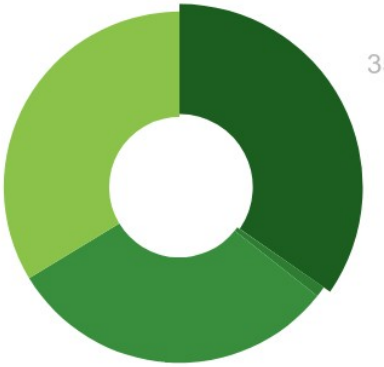
- Institutes Active Members - total: 130

- Professional Status



- **65** Physicist
- **15** Physics PhD student
- **11** Physics masters/diploma student
- **1** Undergraduate/summer student
- **6** Engineer with PhD
- **26** Engineer without PhD
- **0** Engineering student
- **4** Technician or equivalent
- **2** Administrator/other

- Lists



35%

- **35** on Authorlist (A)
- **1** Signing-Only (a)
- **31** counted for M&O (M)
- **0** under qualification (q)
- **34** for Operation Tasks (O, o)

32 participants providing 29 FTE and 16 of them are young scientists

DLNP: Batusov V., Bednyakov V., Boyko I., Budagov Y., Chelkov G., Chizhov M., Dedovich D., Demichev M., Elkin V., Ershova A., Gladilin L., Glagolev V., Gongadze A., Gongadze L., Gostkin M., Huseinov N., Ivanov Y., Kalinovskaja L., Karpov S., Karpova Z., Kharchenko D., Khramov E., Kostyukhina I., Koval O., Kruchonak U., Kultchitsky Y., Lyabline M., Lykasov G., Lyubushkin V., Lyubushkina T., Malyukov S., Minashvili I., Minashvili I. (jr.), Nefedov Y., Plontikova E., Potrap I., Prokoshin F., Rusakovich N., Sadykov R., Sapronov A., Shiyakova M., Tsiareshka P., Turchikhin S., Yeletskikh I., Zhemchugov A., Shalyugin A., Stepenenka Y., Usov Y., Usubov Z.

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

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

JINR in the ATLAS Physics 2015-2019

1. Investigation 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.

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

3. Search for manifestations of Supersymmetry (or Beyond-SM physics) mainly in inclusive events with many (more that 4-6) hadron jets accompanied by an energetic lepton and large missing energy.

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

5. 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.

6. Search for new hadrons and baryons containing heavy c- and b-quarks, study the properties.

7. A new comprehensive study of the gluon structure of the proton, etc.

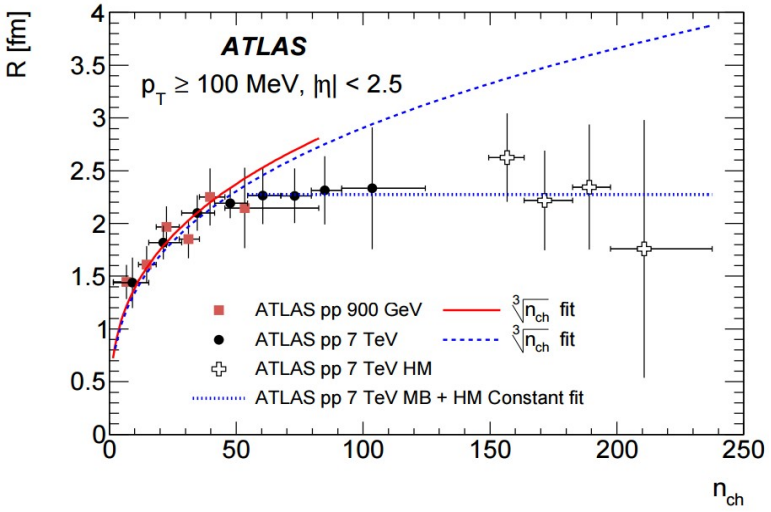
It is important to stress, that almost all of the points (2,3,5,6,7) were proposed for ATLAS at JINR

JINR in the ATLAS Physics 2015-2019

1. Investigation 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.

Eur. Phys. J. C75 (2015) 466

BEC



A decrease of the correlation strength λ along with an increase of the correlation source size parameter R (effective radius parameter) are found with increasing charged-particle multiplicity

Phys. Lett. B 758 (2016) 67

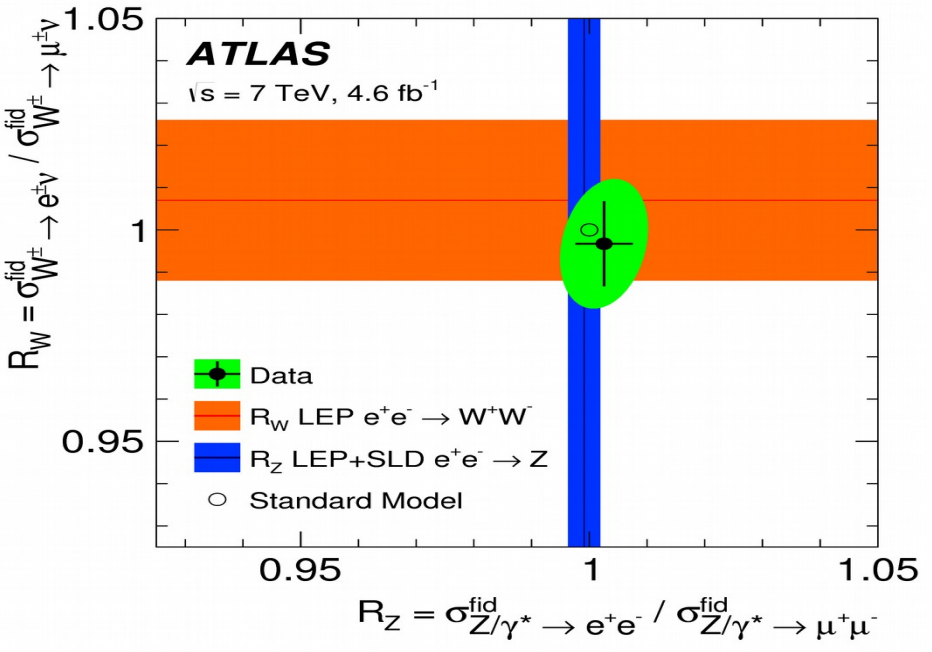
ATLAS-CONF-2015-028

EPJ Web Conf. 192 (2018) 00002

EPJ Web Conf. 120 (2016) 01001

Eur. Phys. J. C 77 (2017) 367

Incl. $W \to \ell\nu$ and $Z/\gamma^* \to \ell\ell$ prod. x-sections



JHEP 12 (2017) 059

Eur.Phys.J. C77 (2017) no.5, 280

JETP Lett. 103 (2016) no.2, 131-136

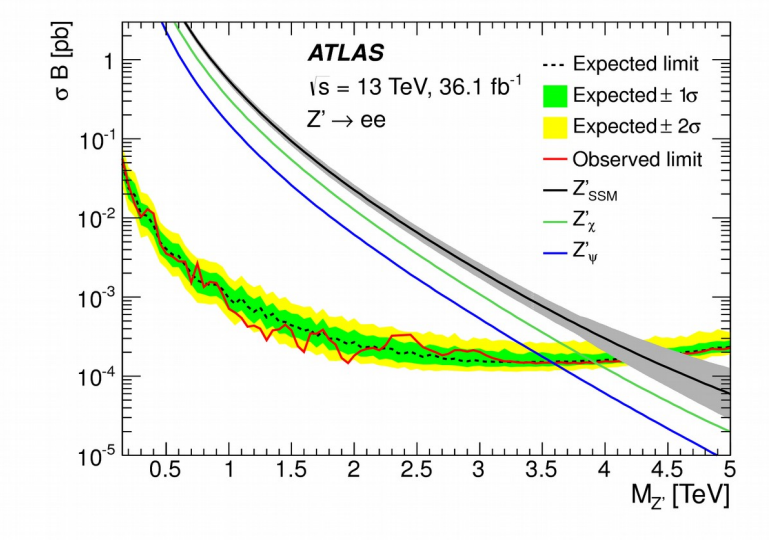
ATLAS-CONF-2018-037

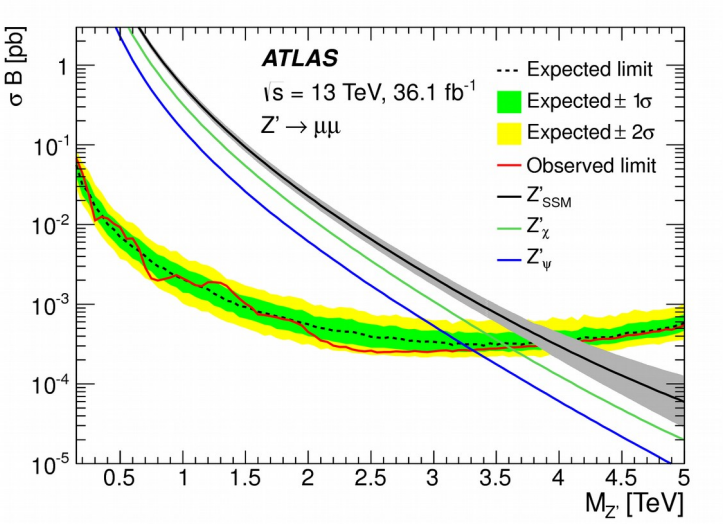
J.Phys.Conf.Ser. 762 (2016) no.1, 012062

JINR in the ATLAS Physics 2015-2019

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

JHEP 10 (2017) 182





No significant deviation from the Standard Model prediction is observed.

Upper limits at 95% credibility level are set on the cross-section times branching ratio for resonances decaying to dileptons, which are converted into lower limits on the resonance mass, ranging between 3.8 TeV and 4.5 TeV, depending on the model.

Phys. Lett. B 761 (2016) 372-392

Phys. Lett. B 762 (2016) 334

Eur. Phys. J. C 78 (2018) 401

ATLAS-CONF-2015-070

ATLAS-CONF-2016-045

ATLAS-CONF-2017-027

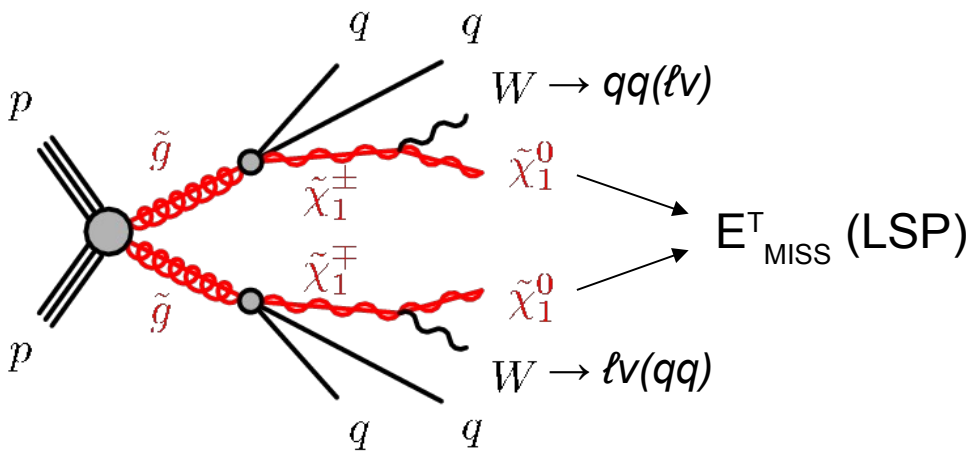
ATLAS-CONF-2015-063

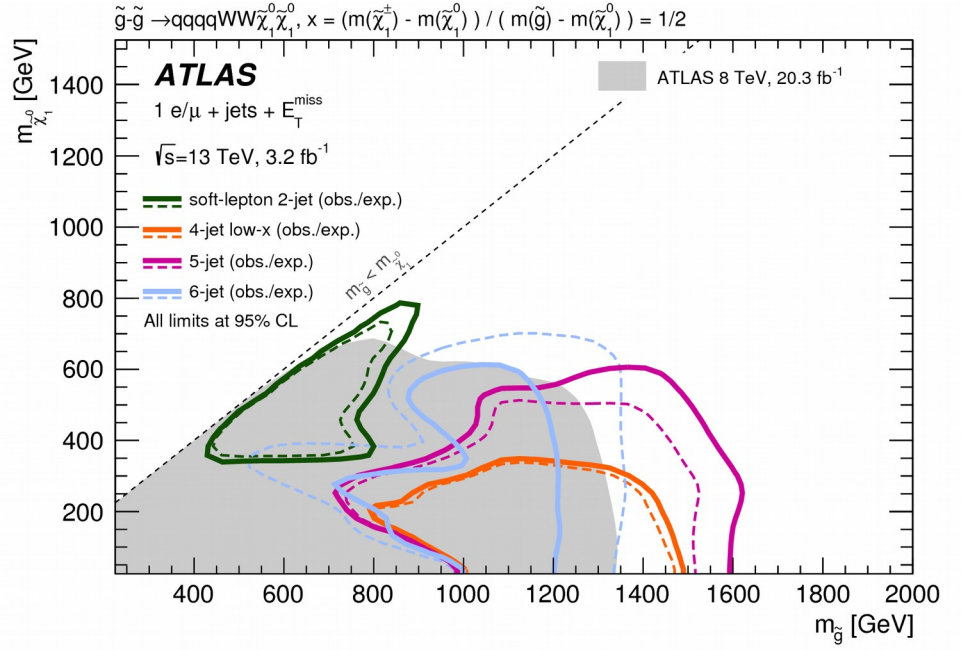
ATLAS-CONF-2017-016

JINR in the ATLAS Physics 2015-2019
Search for SUSY

3. Search for manifestations of Supersymmetry (or Beyond-SM physics) mainly in inclusive events with many (more that 4-6) hadron jets accompanied by an energetic lepton and large missing energy.

Phys. J. C (2016) 76: 565





JHEP 10 (2015) 054

ATLAS-CONF-2015-076

ATLAS-CONF-2016-010

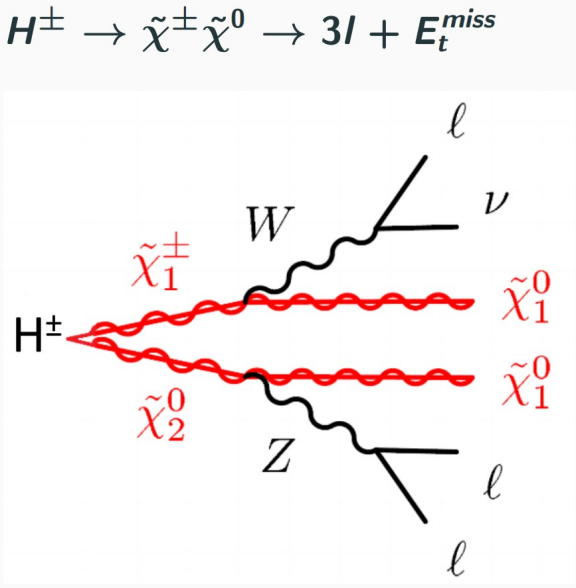
ATLAS-CONF-2016-054

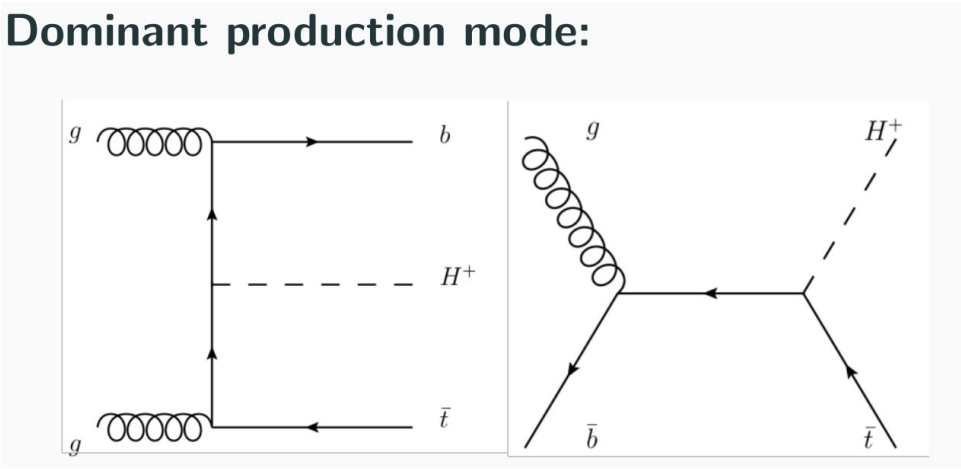
ATL-PHYS-PUB-2015-029

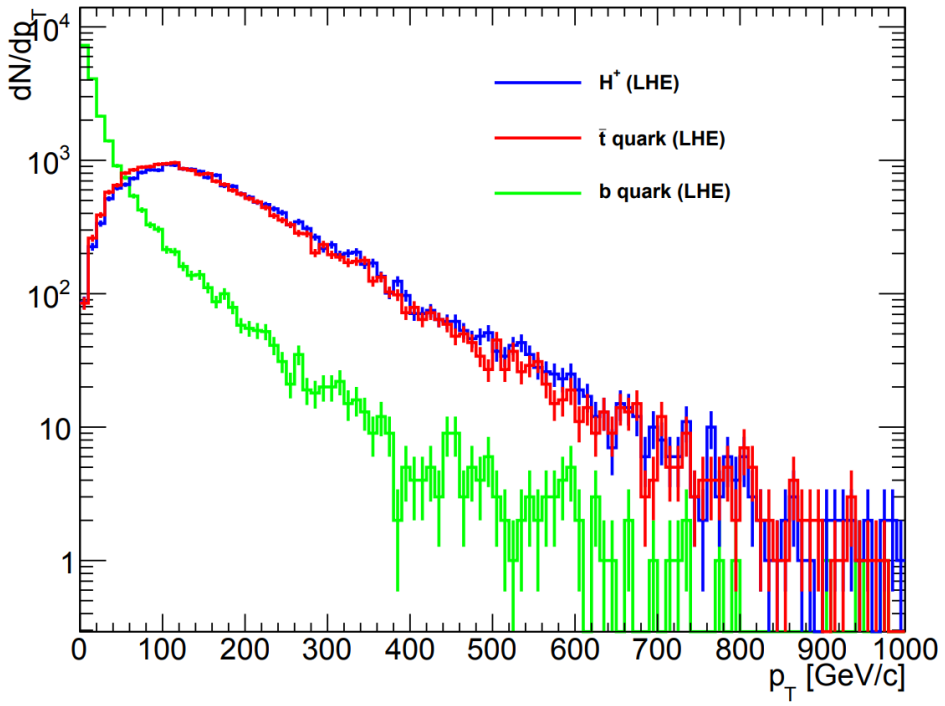
Six signal selections are defined that best exploit the signal characteristics.
The data agree with the SM background expectation in all six signal selections, and the largest deviation is a 2.1 sigma.
The results are interpreted in a simplified model where pair-produced gluinos decay via the lightest chargino to the lightest neutralino. In this model, gluinos are excluded up to masses of approximately 1.6 TeV depending on the mass spectrum of the simplified model.

JINR in the ATLAS Physics 2015-2019

4. Search for (supersymmetric) charged Higgs bosons (2HDM) via their specific decay modes (3 leptons, etc).







Late start of this task due to the qualification works

Long discussions with theoreticians

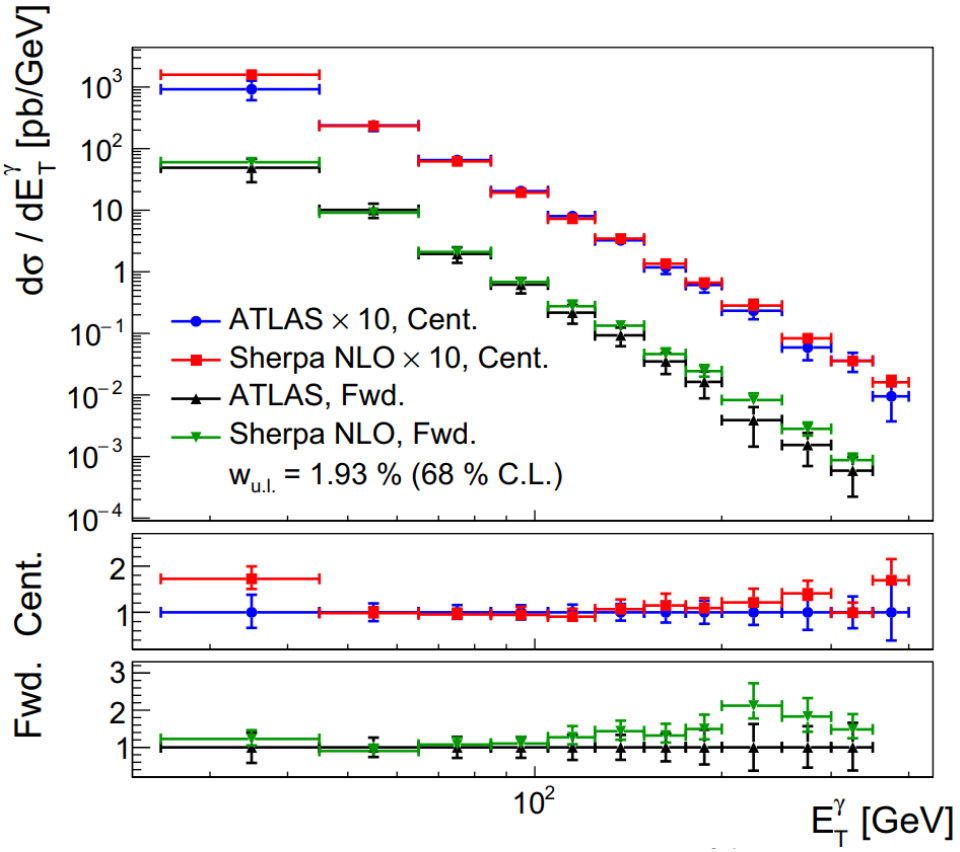
Model is implemented in MadGraph5

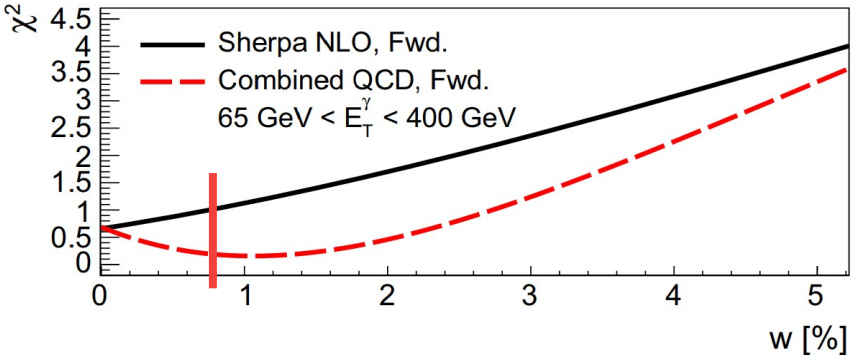
JINR in the ATLAS Physics 2015-2019

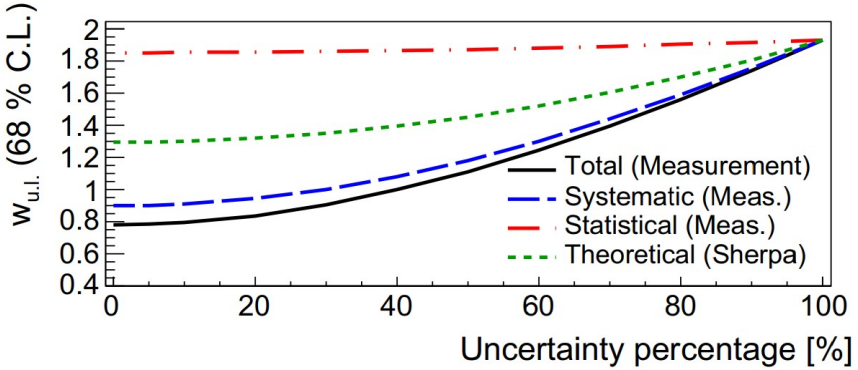
5. Search for a valence-like nonperturbative component of heavy quarks in the proton (intrinsic heavy quarks) via specific final state topology in the pp-interactions.

Eur.Phys.J. C79 (2019) no.2, 92,

γ + c-jet production







Phys.Rev. D97 (2018) no.11, 114019

Prog.Part.Nucl.Phys. 93 (2017) 108

Phys.Rev. D94 (2016) no.5, 053011

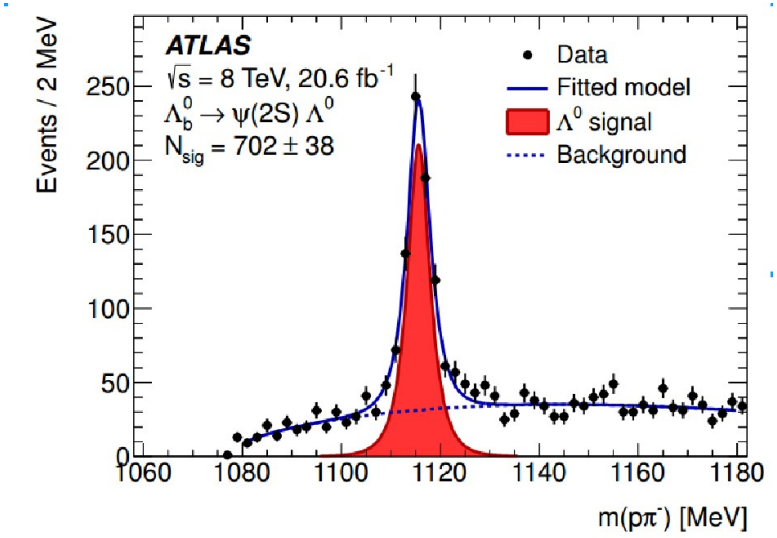
PoS DIS2017 (2018) 033

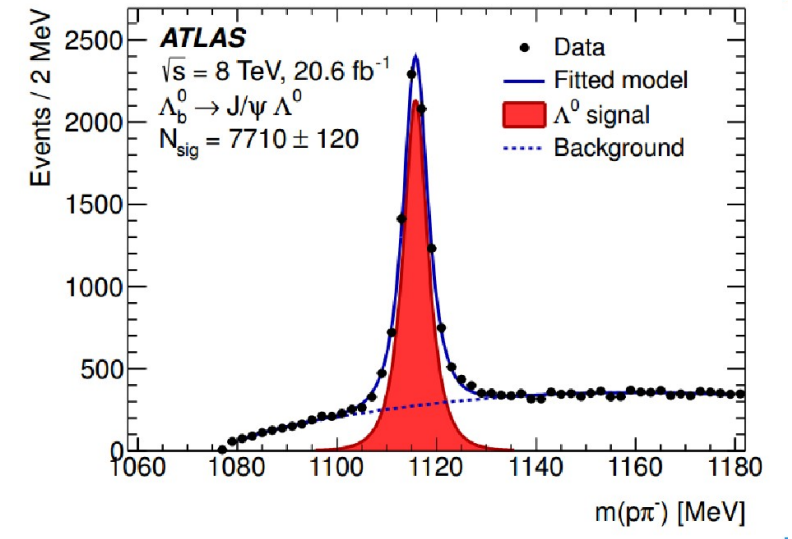
DESY-PROC-2016-04

JINR in the ATLAS Physics 2015-2019

6. Search for new hadrons and baryons containing heavy c- and b-quarks, study the properties.

Physics Letters B 751 (2015) 63-80





$$\frac{\Gamma(\Lambda_b^0 \to \psi(2S)\Lambda^0)}{\Gamma(\Lambda_b^0 \to J/\psi\,\Lambda^0)} = 0.501 \pm 0.033(\text{stat}) \pm 0.016(\text{syst}) \pm 0.011(\mathcal{B})$$

The only available theoretical expectation for the branching ratio of the two Λ^0_b decays (0.8 ± 0.1) exceeds the measured value.

Eur. Phys. J. C 76 (2016) 513

JHEP 10 (2018) 047

Eur. Phys. J. C, 76(1), 1-24 (2016)

ATLAS-CONF-2017-023

CONF-BPHY-2018-06

EPJ Web Conf. 202 (2019) 05001

PoS BEAUTY2018 (2018) 048

EPJ Web Conf. 158 (2017) 02001

Phys.Part.Nucl. 48 (2017) no.5, 801-803

PoS BEAUTY2016 (2016) 009

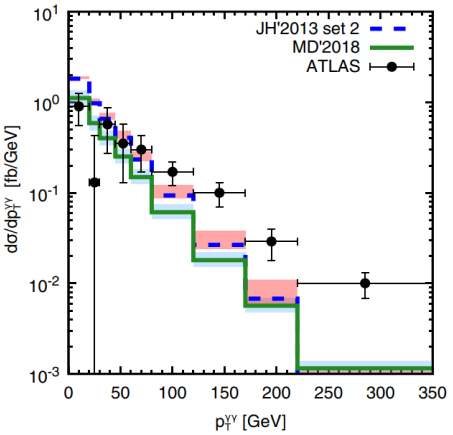
JINR in the ATLAS Physics 2015-2019

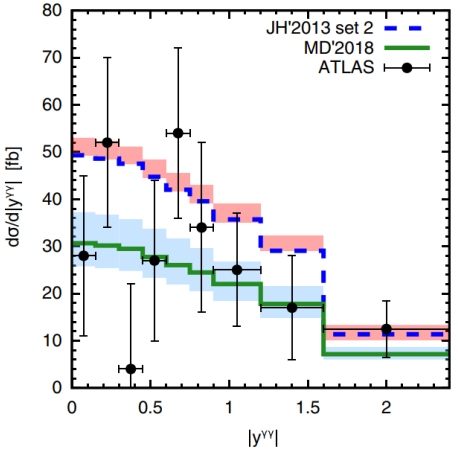
7. A new comprehensive study of the gluon structure of the proton, etc.

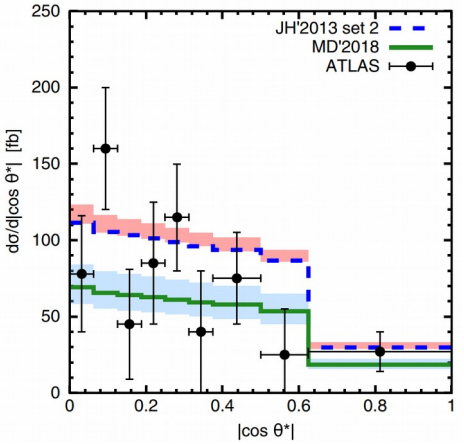
The Catani-Ciafaloni-Fiorani-Marchesini evolution equation to extend the obtained transverse momentum dependent (TMD) gluon density to the whole kinematical region is applied

Phys.Rev. D98 (2018) no.5, 054010

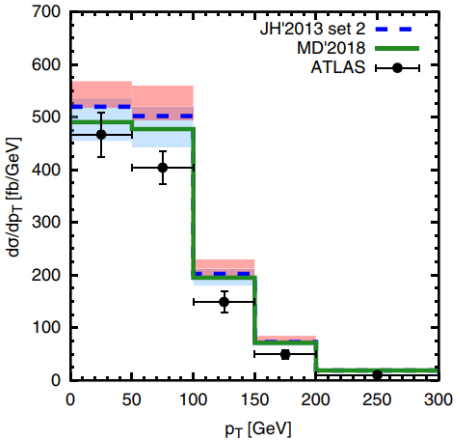
Incl. t-channel H→γγ prod. at √s = 8 TeV

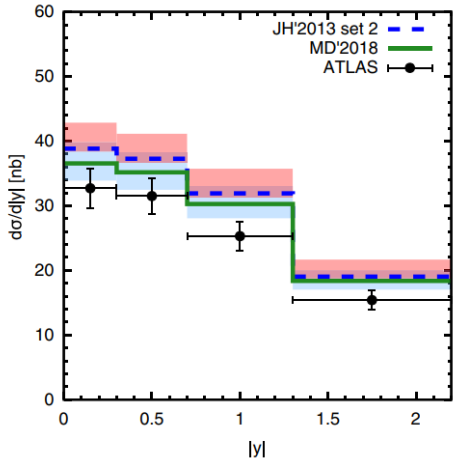






Incl. t-channel single top prod. at √s = 8 TeV





Eur.Phys.J. A54 (2018) no.11, 187

Phys.Rev. D93 (2016) no.1, 014035

PoS DIS2016 (2016) 038

Int.J.Mod.Phys.Conf.Ser. 39 (2015) 1560115

Additional activities

Observation of H→bb decays and VH production with the ATLAS detector

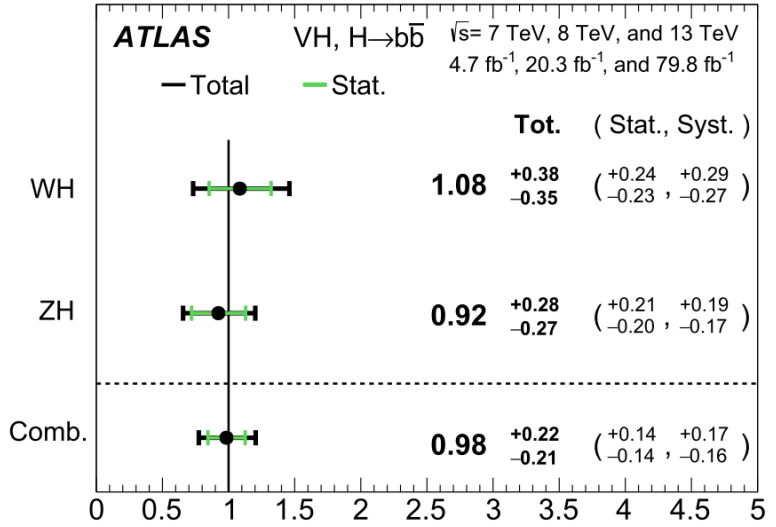
Phys. Lett. B 786 (2018) 59

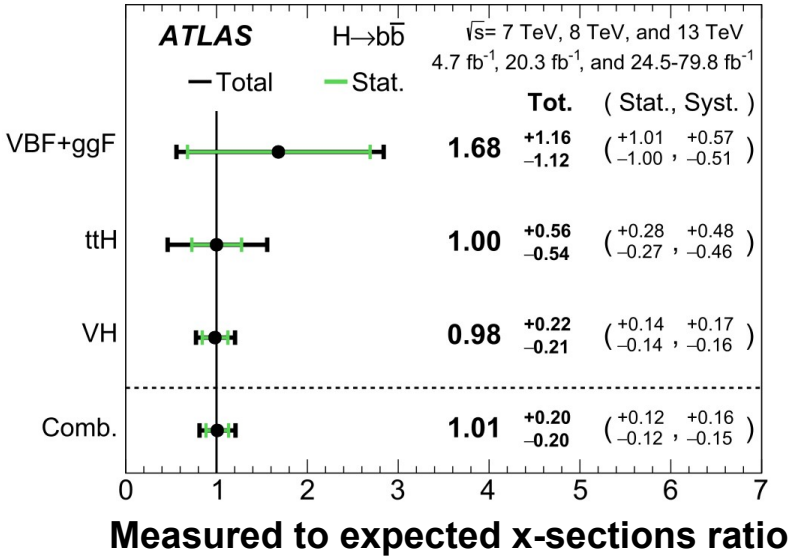
0-lepton channel to search for $ZH \to \nu\nu b\bar{b}$

1-lepton channel to search for $WH \to \ell\nu b\bar{b}$

2-lepton channel to search for $ZH \to \ell\ell b\bar{b}$

Higgs boson produced in association with a vector boson yields an observed significance of 5.3 standard deviations





JHEP01(2015)069

JHEP 12 (2017) 024

Phys. Lett. B 786 (2018) 59

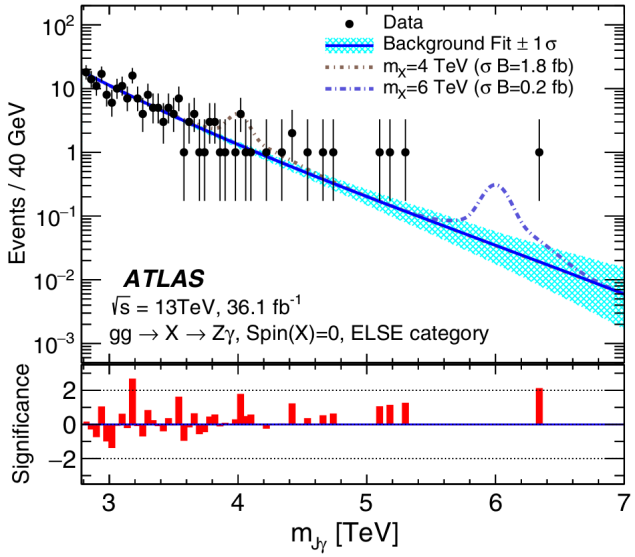
arXiv:1903.04618 (submitted to JHEP)

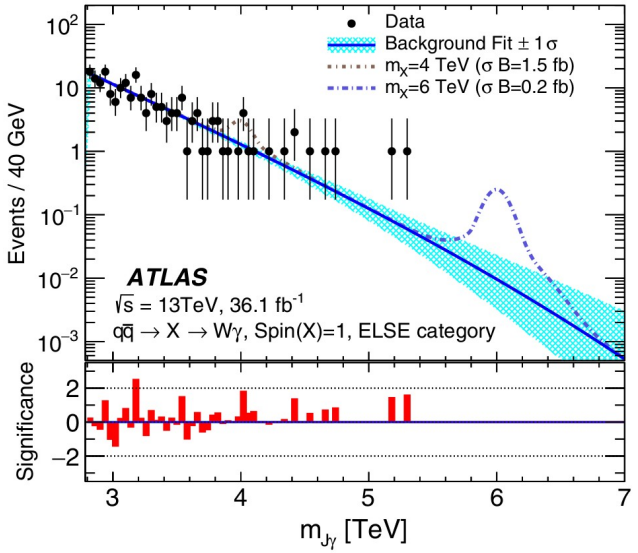
ATLAS-CONF-2017-041

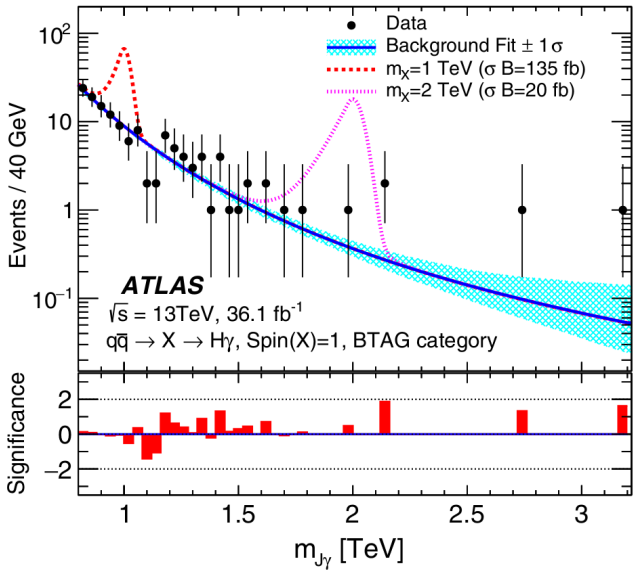
ATLAS-CONF-2018-036

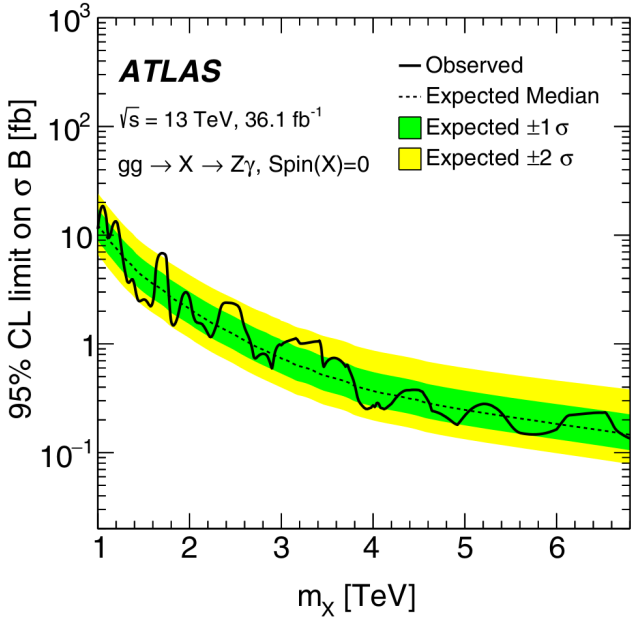
ATLAS-CONF-2018-053

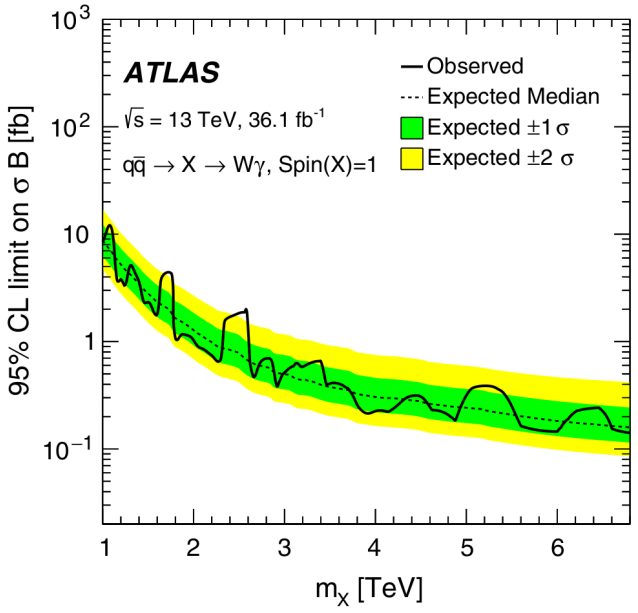
Search for heavy resonances decaying to a photon and a Z/W/H(→J) boson











Phys. Lett. B 764 (2017) 11

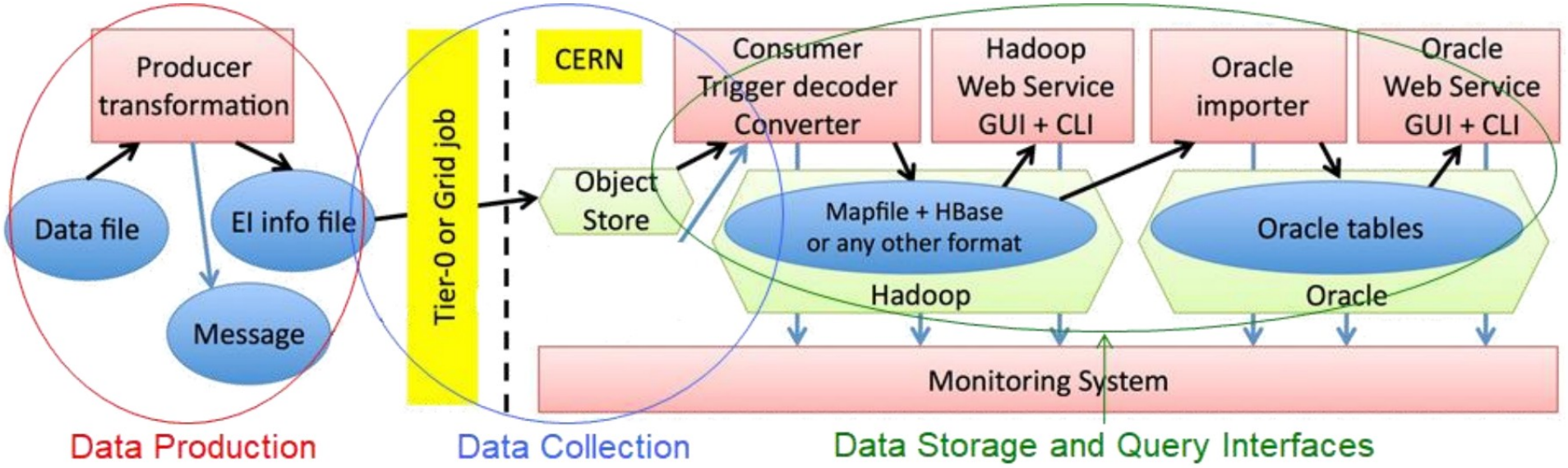
Phys. Rev. D 98 (2018) 032015

ATLAS-CONF-2016-010

The data are found to be consistent with the expected background in the entire mass range investigated and upper limits are set on the production cross section times decay branching ratio to W/Z/H + γ of a narrow scalar boson with mass between 1 TeV and 6.8 TeV

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

J.Phys.Conf.Ser. 898 (2017) no.3, 032016
J.Phys.Conf.Ser. 1085 (2018) no.3, 032052

Other JINR-ATLAS Team achievements

Ongoing analyses:

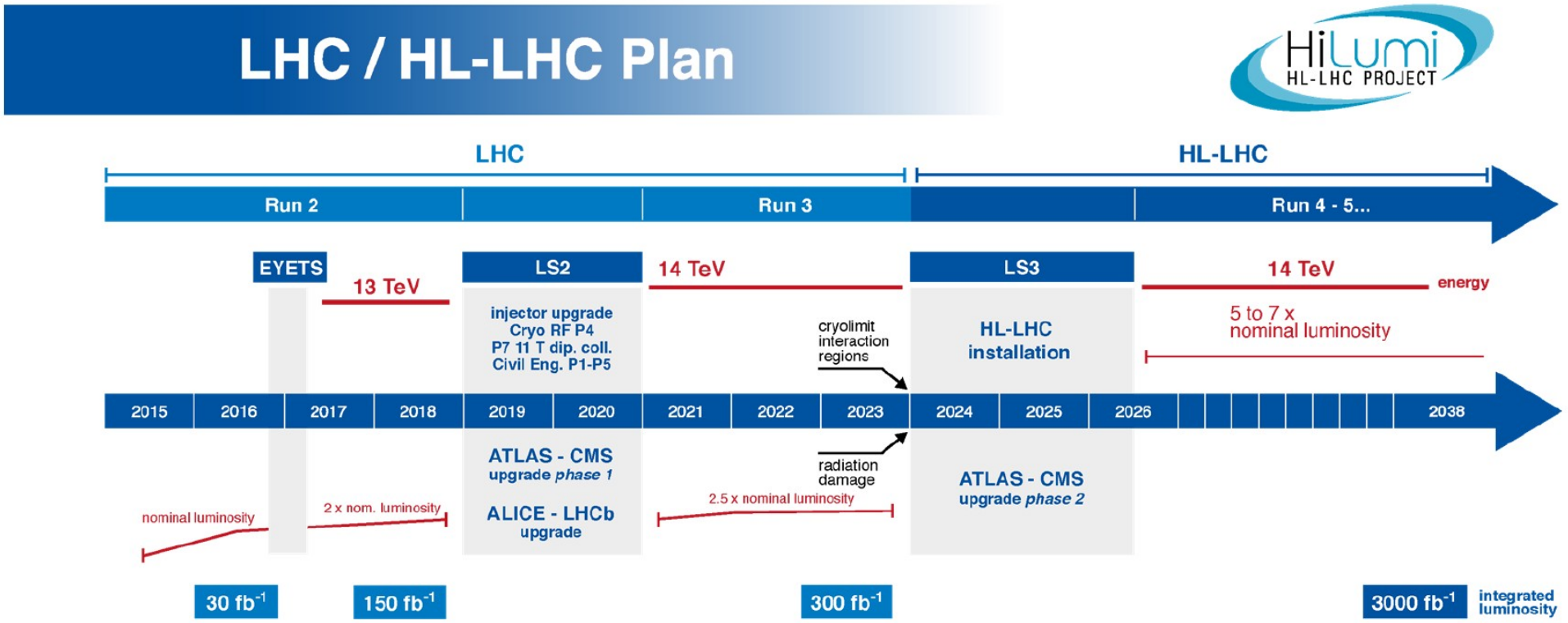
- Quantum Black Holes
- SM precision measurements (W /Z + b-jet x-section)
- Bc excited states
- Pentaquark
- ttH
- tH

During the 2015 – 2019 period of the current project it was published 28 papers with significant participation of the JINR staff, more than 20 talks at different conferences and meeting excluding working meeting within the Collaboration

Organization and participation in the Physics&Computing Russian Institutes meeting

Organization and participation in the “25th anniversary of JINR in ATLAS” on 24-29 April 2017

LHC and ATLAS upgrade programme



Expect after LS2: $\mathcal{L} = 2.2 \cdot 10^{34}\,\mathrm{cm}^{-2} \cdot \mathrm{s}^{-1}$, 25 ns bunch spacing, $\langle \mu \rangle = 60$

Phase-1 includes

- additional chambers in the forward muon spectrometer
- upgrade of the calorimeter trigger electronics
- new Level-1 trigger processors
- new Level-1 topological trigger processor
- fast track trigger (FTK)

Plans for 2020–2024 period

1) Investigation 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.

2) Search for the chiral Z*/W* bosons in the two-jet decays as well as in process with more complex topology of their associative production including heavy b and t quarks.

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

4) Analyses on associated productions of the SM Higgs withpair and search for production with single top.

5) 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.

6) Search for new hadrons and *baryons containing heavy c- and b-quarks*, study the properties.

7) Measurement of the Drell-Yan triple-differential cross section and effective leptonic weak mixing angle in Z-boson decay

8) A new comprehensive study of the *gluon* structure of the proton, etc.

9) Search for quantum black holes in lepton+jet channel at 13 TeV.

10) Participation in the event triggers indexing infrastructure development.

11) Maintenance and development of the TDAQ system.

Requested project budget

Наименование статей затрат	Полная стоимость	1 год 2020	2 год 2021	3 год 2022	4 год 2023	5 год 2024
Компьютерная связь, GRID	50 k$	10 k$	10 k$	10 k$	10 k$	10 k$
Материалы и оборудование, обслуживание детектора	1500 k$	300 k$	300 k$	300 k$	300 k$	300 k$
Оплата НИР, выполняемых по договорам	250 k$	50 k$	50 k$	50 k$	50 k$	50 k$
Командировочные расходы: а) в страны нерублевой зоны б) в города рублевой зоны в) по протоколам	1150 k$ 1000 k$ 150 k$	230 k$ 200 k$ 30 k$	230 k$ 200 k$ 30 k$	230 k$ 200 k$ 30 k$	230 k$ 200 k$ 30 k$	230 k$ 200 k$ 30 k$
Итого по прямым расходам:	2950 k$	590 k$	590 k$	590 k$	590 k$	590 k$
Внебюджетные источники	ЦЕРН, Госпрограммы РФ, Гранты РФФИ и др.					

Replies to comments

D.I. Kazakov: “The other important issue is the involvement of new young members in the JINR group. My impression is that JINR ATLAS group should pay more attention to this problem, recruiting students and PhD students, arranging their education and involvement in research at early stages.”

→ “Sure, we are working with Russian institutes and universities. Always reply to requests for manpower from the UC JINR. Currently we have ~50% of young participants.”

A.V. Kulikov: “It is not clear from the text, how many JINR scientists are involved in physics analysis. For some reason it is indicated the number of persons participating in the ATLAS upgrade program, but the upgrade is not the subject of this very project and is not discussed here at all.”

→ “It was a mistypo in the “Human Resources” chapter. Corrected to the ATLAS Physics program”

“For completeness, it would also be desirable to compare the physics program of the current project with the program of the CMS project in JINR, which is another general purpose detector at LHC: what are the differences (if any) or peculiarities.”

→ “Agree, this would be very useful for complete understanding. But to keep the report of the readable size it was decided to leave this part aside”