

Results from JINR team at ATLAS

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On behalf of the JINR ATLAS team

ATLAS Run II performance

Results from JINR team at ATLAS:

1. Search for heavy resonances, decaying into $Z/W/H + \gamma$;
2. Measurement of vector bosons produced in association with b -jets;
3. Search for pentaquark states in Λ_b decays at ATLAS;
4. Study of $B_c^+(2S)$ state using $B_c^+ \rightarrow J/\psi, \mu^+, \nu$ decays;
5. Measurement of the two-particle Bose-Einstein correlations;
6. Evidence for the $H \rightarrow b\bar{b}$ decay with the ATLAS detector;
7. EventIndex project;
8. Our other activities within ATLAS physics program;

Conclusions

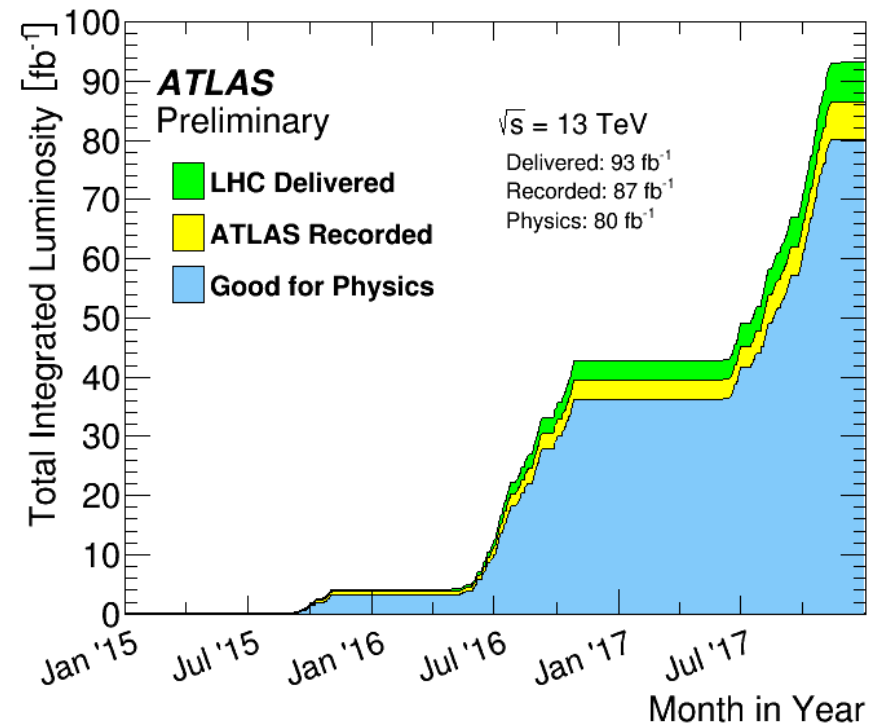
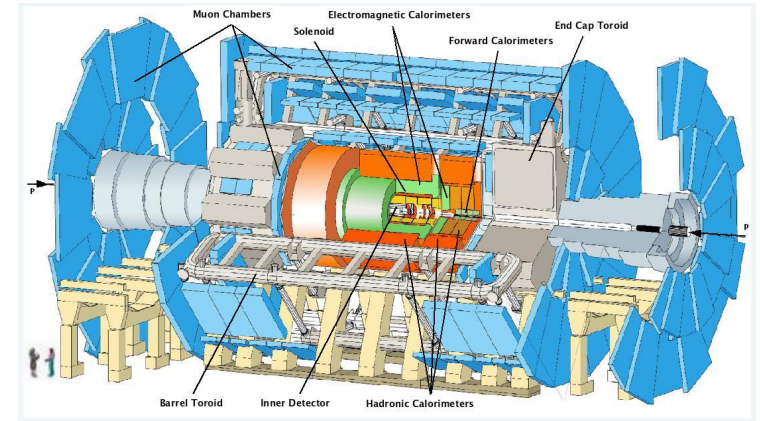
ATLAS performance in 2017

ATLAS showed very good performance in 2017:

- During 2017 ATLAS recorded **47fb⁻¹** of 13TeV pp-collisions data 'good for physics';
- Together with 33fb⁻¹ data recorded in 2016, it makes more than **80fb⁻¹ of 13TeV** data currently available;

ATLAS successfully managed considerably higher loads, compared to 2016:

- LHC Peak Luminosity $1.5 \div 2.0 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$,
~1.5 higher compared to 2016;
- Peak interactions per crossing: $\mu = 40 \div 60$;
~1.5 times higher compared to 2016

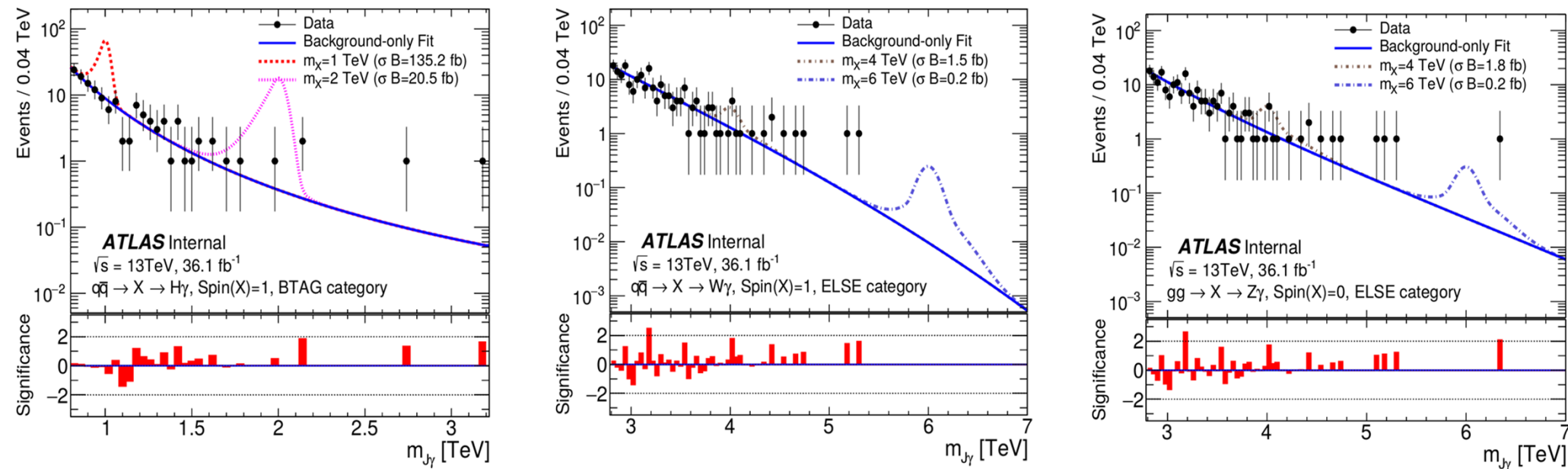


1. Search for heavy resonances, decaying into $Z/W/H + \gamma$

Analysis search target is BSM heavy resonances, decaying into $Z/W/H + \gamma$:

- $X \rightarrow Z(\rightarrow J) + \gamma$, X spin 0 and 2;
- $X \rightarrow W(\rightarrow J) + \gamma$, X spin 1;
- $X \rightarrow H(\rightarrow bb) + \gamma$, X spin 1;

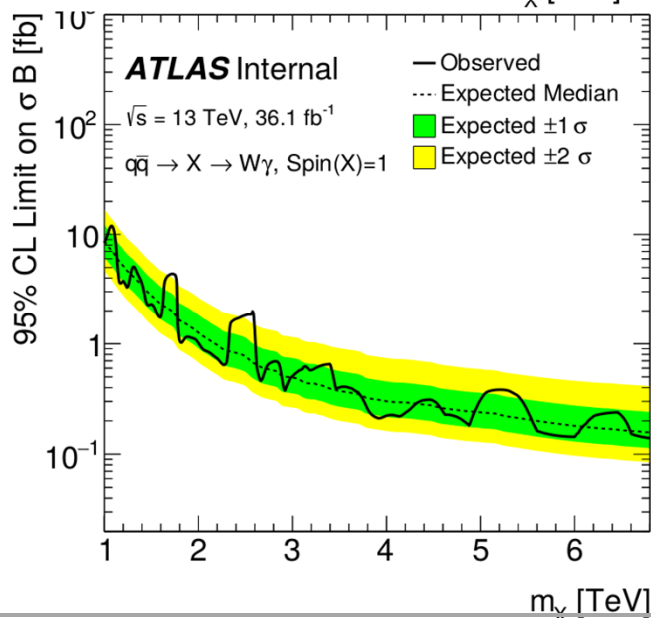
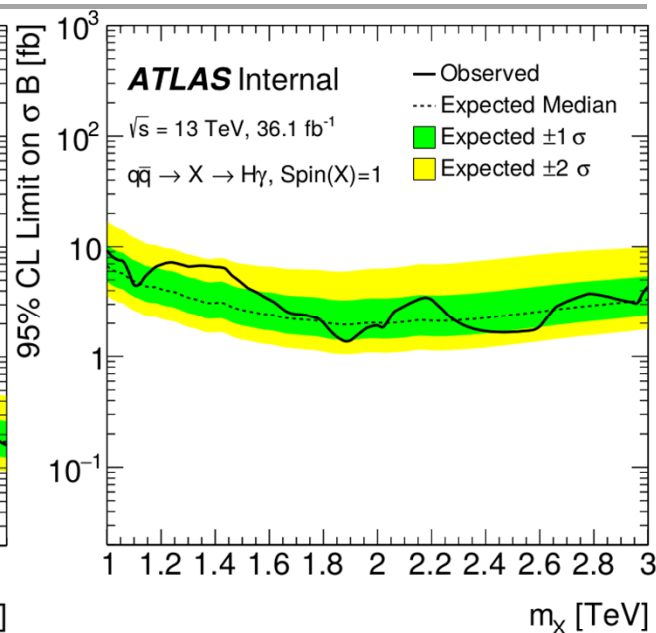
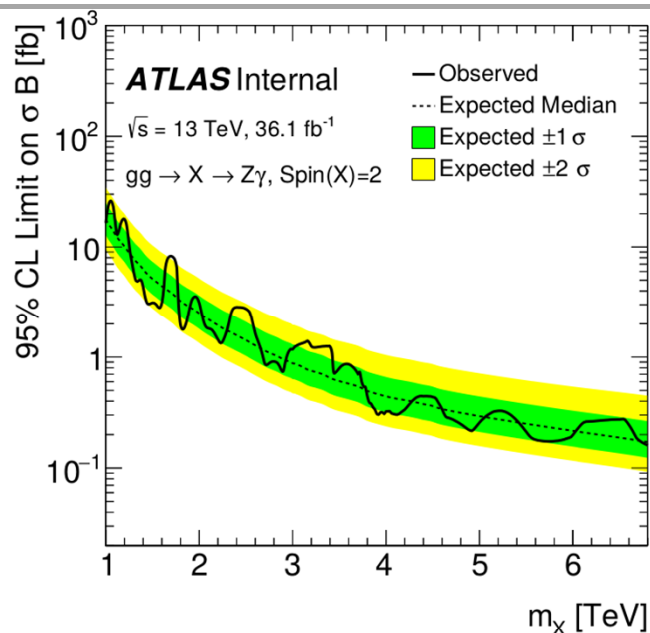
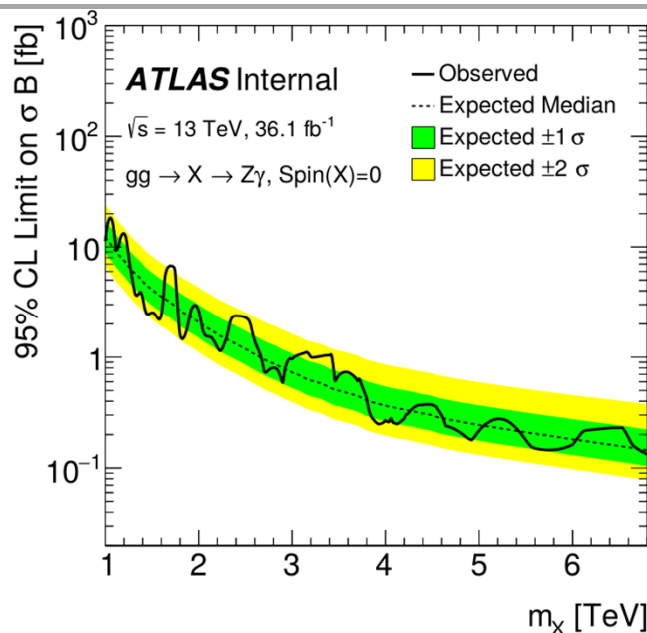
All models use Narrow Width Approximation for X resonances.



Plots show X -candidate mass in data together with background estimation and potential BSM signal shapes.

Khramov E., cds.cern.ch/record/2227222, to be submitted to PRD

1. Search for heavy resonances, decaying into Z/W/H + γ



In the absence of significant signals, the 95%CL upper limits are set on $\sigma \cdot Br$ of the X resonance.

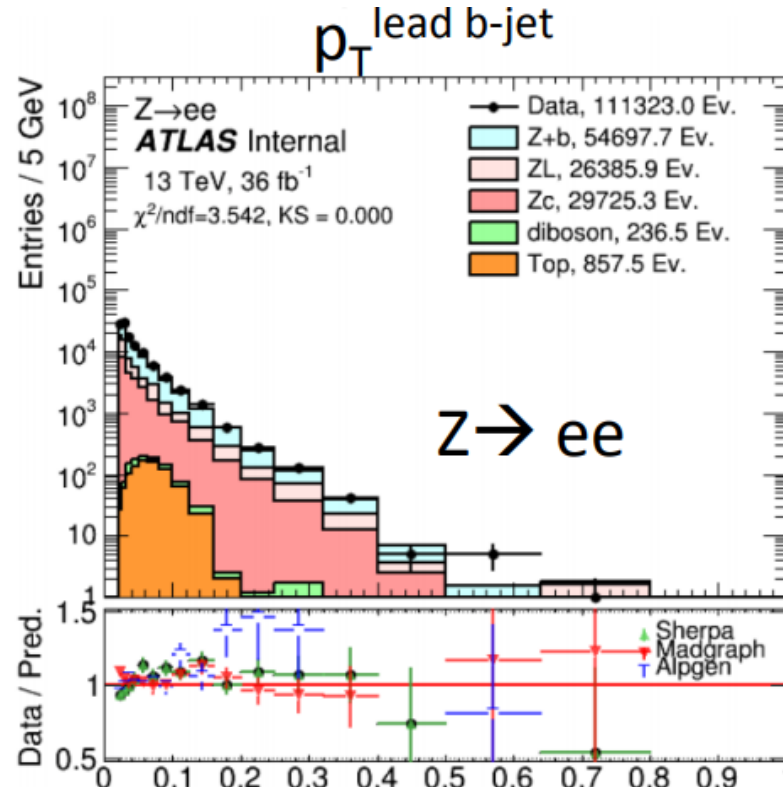
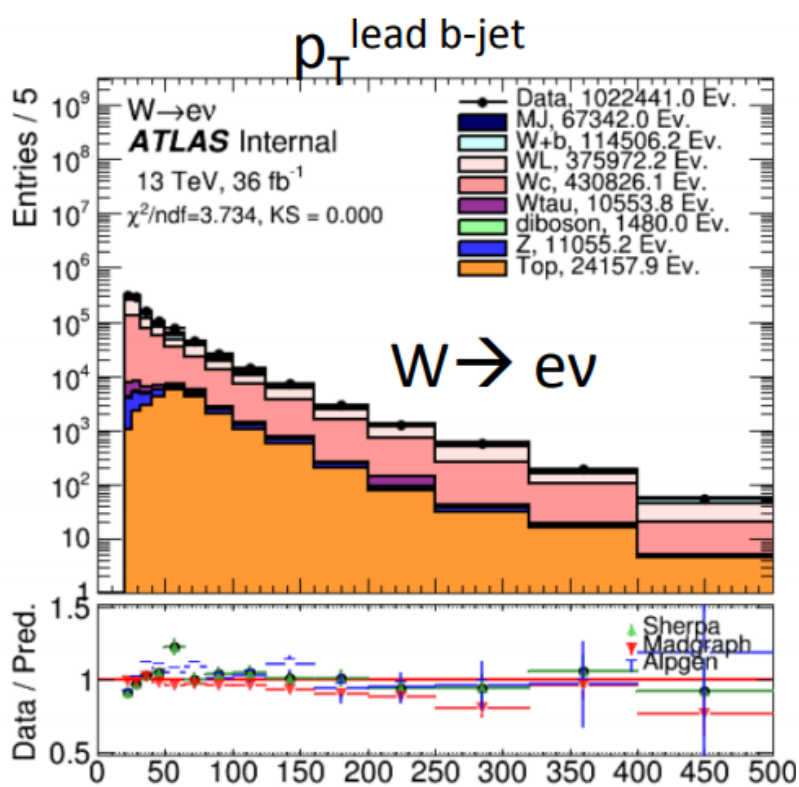
Limits for $Z\gamma$ and $W\gamma$ final states vary from about 10fb to 0.1 fb for masses from 1.0 to 6.8 TeV.

For $H\gamma$ search the limits vary from about 10 to 4 fb for masses between 1.0 and 3.0 TeV.

2. Measurement of vector bosons produced with b-jets

$W/Z+b$ -jets measurements are:

- Important tests of QCD predictions;
- Sensitive to b -flavour content in PDFs;
- Important (large and irriducible) background for Higgs and BSM physics;



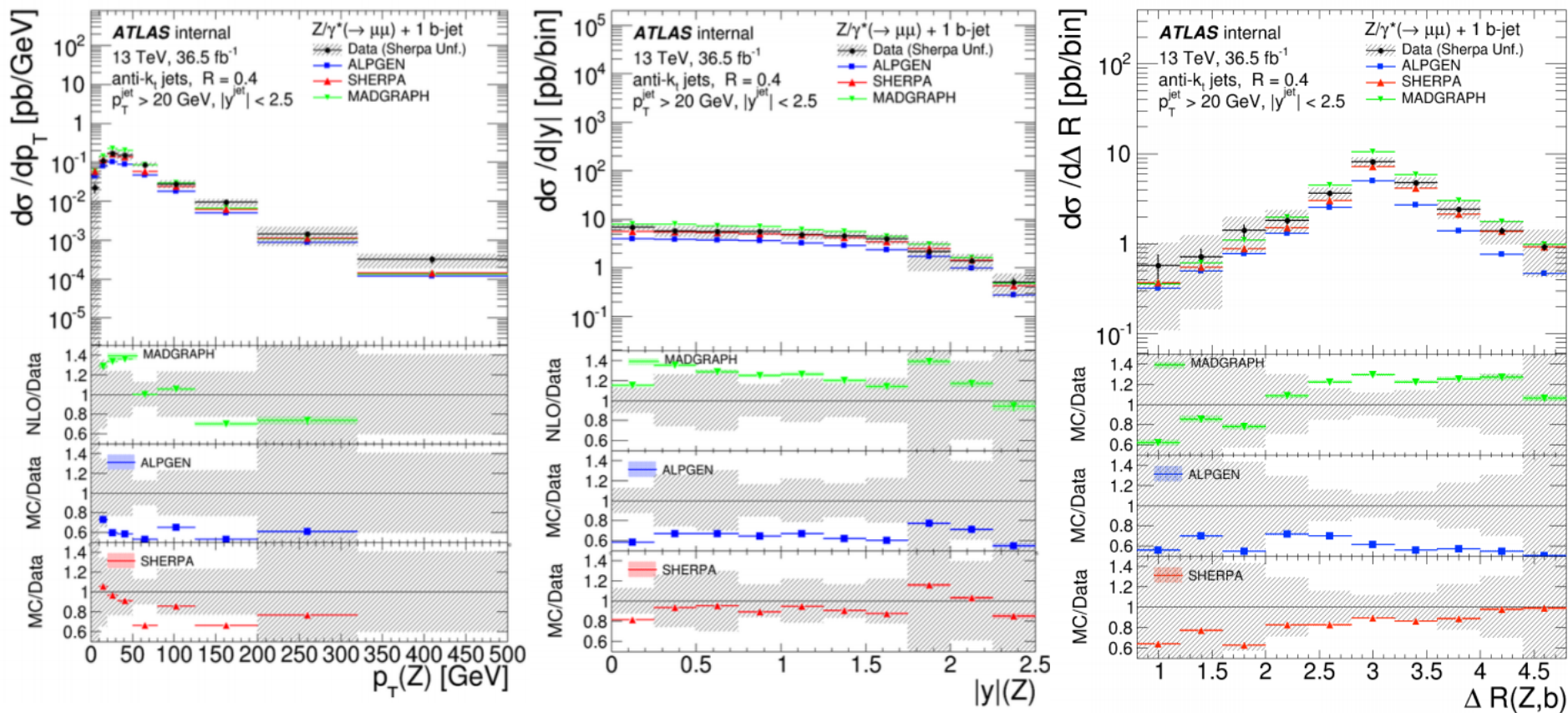
This study is very sensitive and exigent to the quality of background estimation.

Plots show some of the selected events distributions: p_T of the leading b-jet in W and Z electron decay channels;

Turchihin S., Lykasov G., cds.cern.ch/record/2293067/

2. Measurement of vector bosons produced with b-jets

Analysis aims at measurement of differential cross sections w.r.t. main kinematic variables:
 $p_T(Z/W)$, $p_T(jet)$, $|y|(Z/W)$, $|y|(jet)$, $\Delta R(Z/W, b)$, $\Delta y(b, b)$:



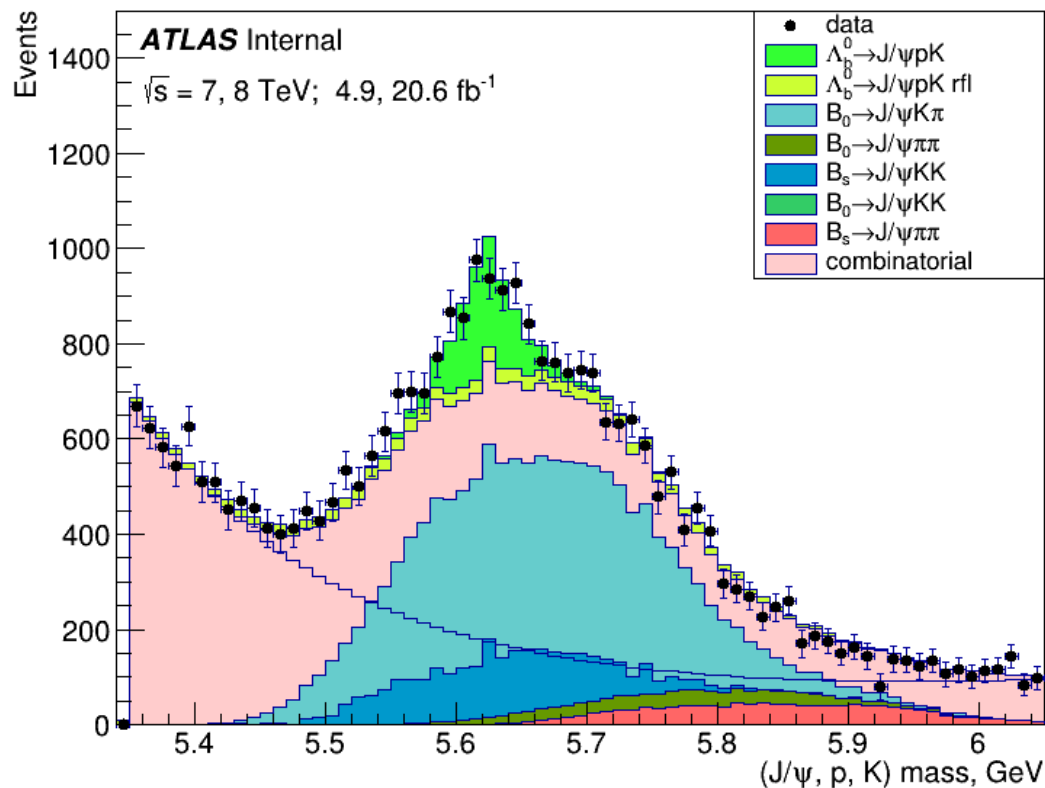
Work in progress... timescale for release – few months;

3. Search for pentaquark states in Λ_b decays at ATLAS

Study is motivated by the discovery of pentaquark-consistent signals (LHCb, 2015) as intermediate states in $\Lambda_b \rightarrow J/\psi, p, K$ decays;

In the absence of hadron track ID, we have to analyze simultaneously different Λ_b , B_d and B_s decays.

Plot shows reconstructed mass of the selected $\Lambda_b \rightarrow J/\psi, p, K$ candidates together with background estimation from multidimensional fits:

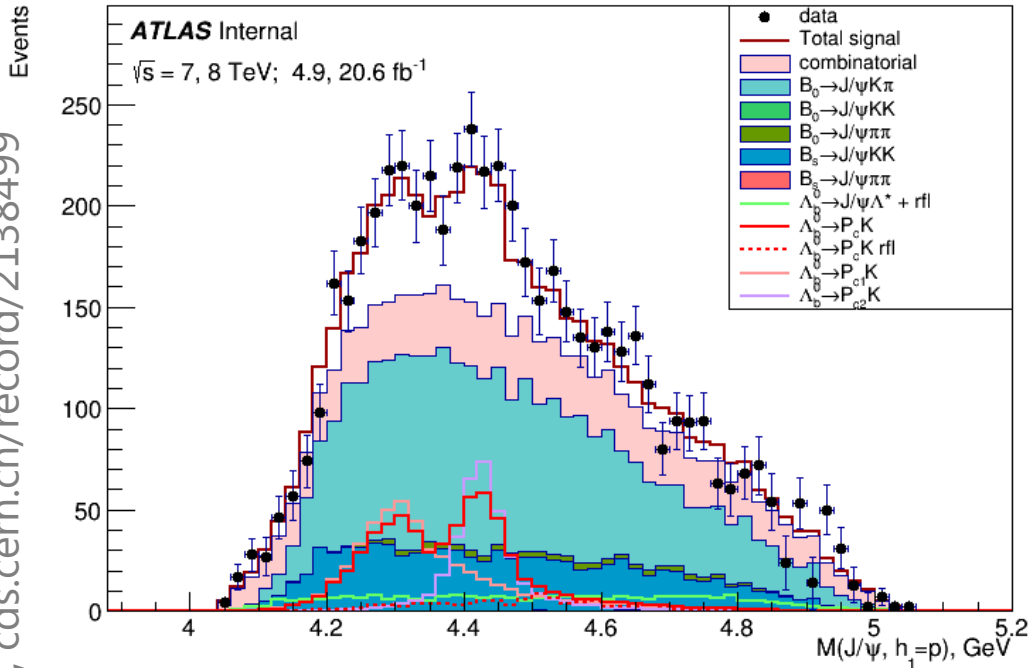


	Events	Stat. error	Sys. error (preliminary)
$\Lambda_b \rightarrow J/\psi, p, K$	2540	250	130
Λ_b direct in signal region	1060	100	50
$B_d \rightarrow J/\psi, K, \pi$	10500	300	400
$B_d \rightarrow J/\psi, \pi, \pi$	840	100	30
$B_s \rightarrow J/\psi, K, K$	2500	310	170
$B_s \rightarrow J/\psi, \pi, \pi$	1200	80	80

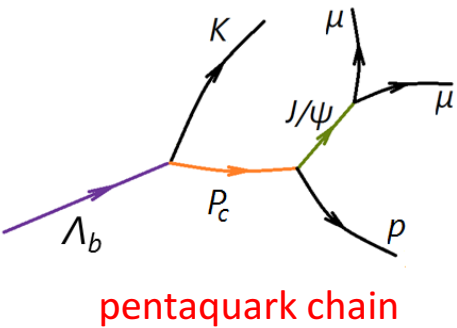
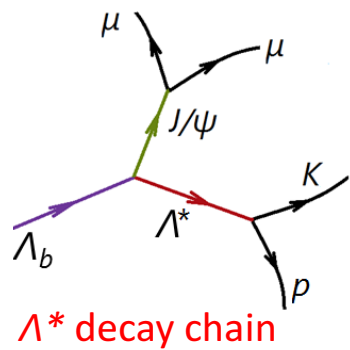
Yeletsikh I., Gladilin L.,
cds.cern.ch/record/2138499

3. Search for pentaquark states in Λ_b decays at ATLAS

Yeletskikh I., Gladilin L., cds.cern.ch/record/2138499



Invariant mass of $J/\psi, p$ shows presence of new structures, inconsistent with conventional $\Lambda_b \rightarrow J/\psi, \Lambda^*$ decay chains:



Fit to data using 2 pentaquarks model shows results close to LHCb numbers

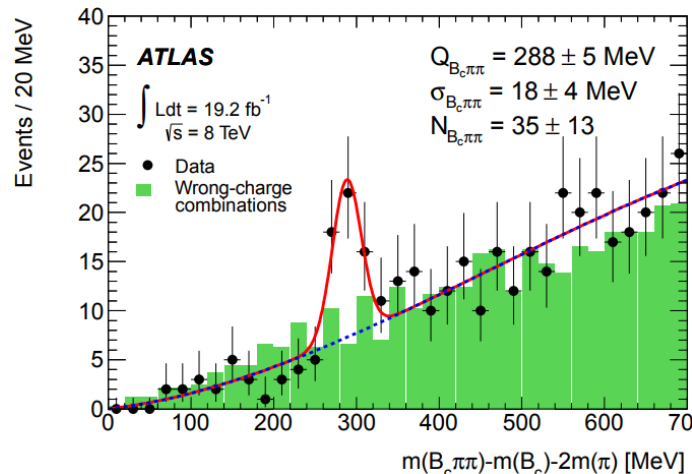
parameter	value
P_{c1} mass, GeV	4.296
P_{c1} width, MeV	143
P_{c2} mass, GeV	4.423
P_{c2} width, MeV	53.2

	Events
Λ_b total events in signal region	1059
Λ^* events (direct + reflected)	305
P_{c1} direct events	496
P_{c2} direct events	348

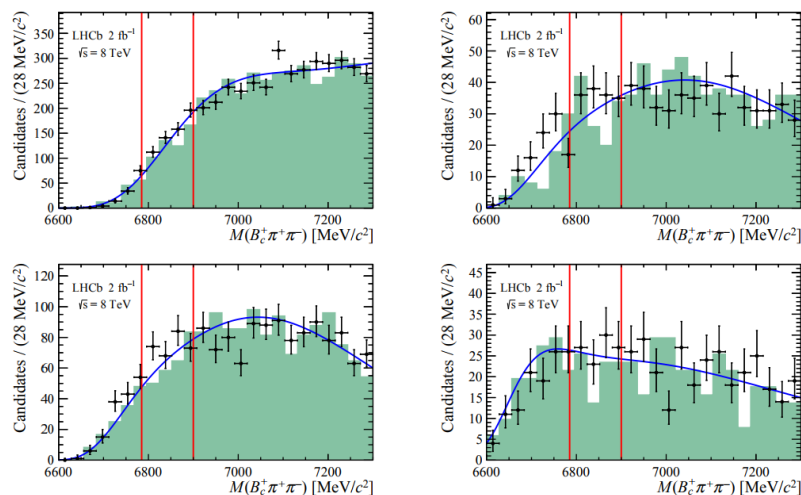
Work in progress... timescale for release – few months;

4. Study of $B_c^+(2S)$ state using $B_c^+ \rightarrow J/\psi, \mu^+, \nu$ decays

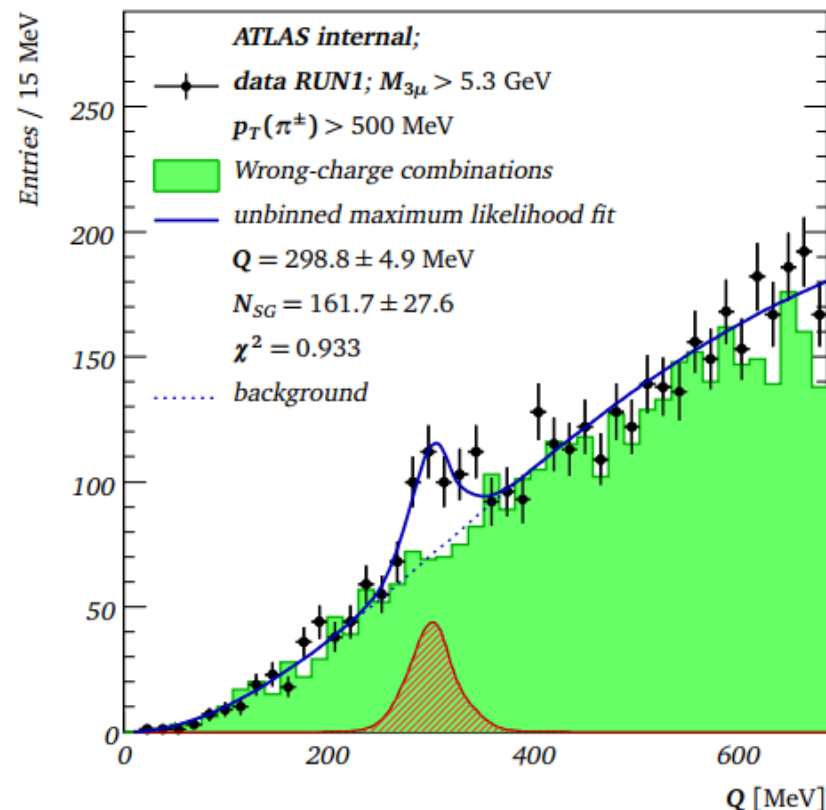
ATLAS sees signal in $B_c^+ \pi^+ \pi^-$ states with $B_c^+ \rightarrow J/\psi, \pi^+$ decays in 7-8 TeV data:



LHCb claims no evidence for same state with Run I data:



Similar search using $B_c^+ \rightarrow J/\psi, \mu^+, \nu$ decays is in progress, aiming at confirmation of previous ATLAS results:



Signal is seen with parameters, consistent with $B_c^+ \rightarrow J/\psi, \pi^+$ channel result.

Lyubushkina T., Gladilin L., Turchihin S.

5. Two-particle Bose-Einstein correlations in pp -collisions at 13TeV

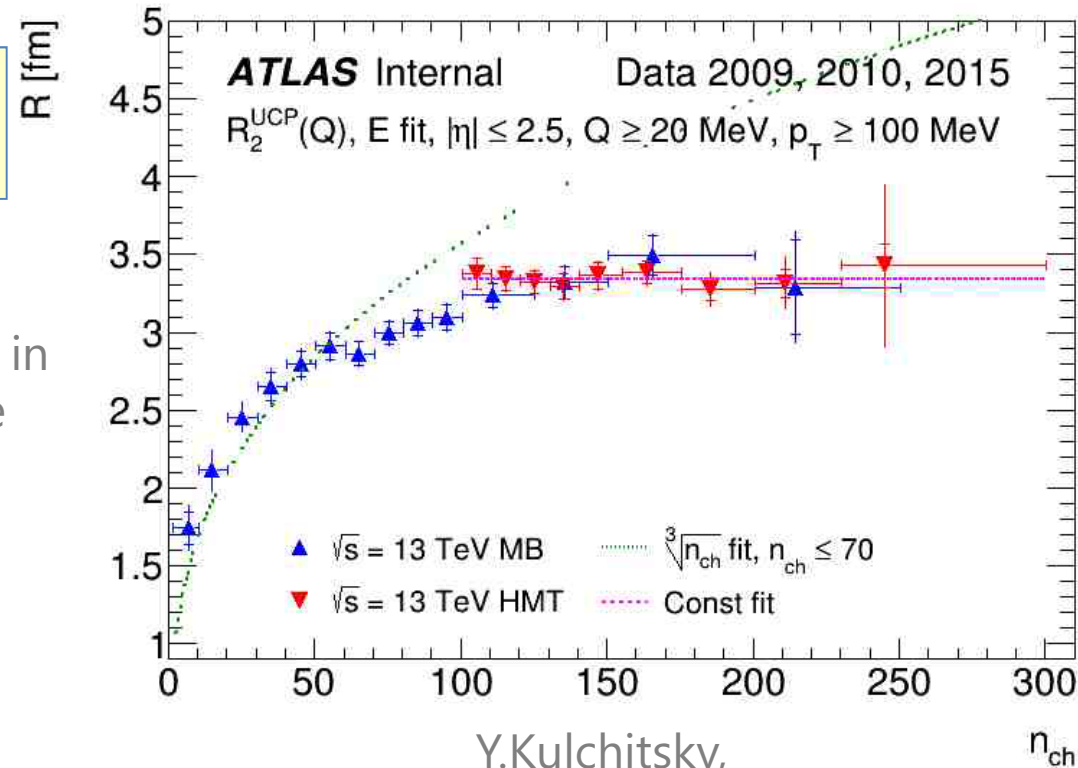
Bose-Einstein correlations (BEC) correspond to an enhancement in two identical boson correlation when two particles are near in phase space;
BEC represent a unique probe of the hadronization region and allow determination of the size and shape of the source from where particles are emitted.

Correlation function C_2 is a ratio of probabilities:

$$C_2(Q) = \frac{\rho(p_1, p_2)}{\rho_0(p_1, p_2)} = C_0(1 + \Omega(\lambda, RQ)) \cdot (1 + Q\varepsilon),$$

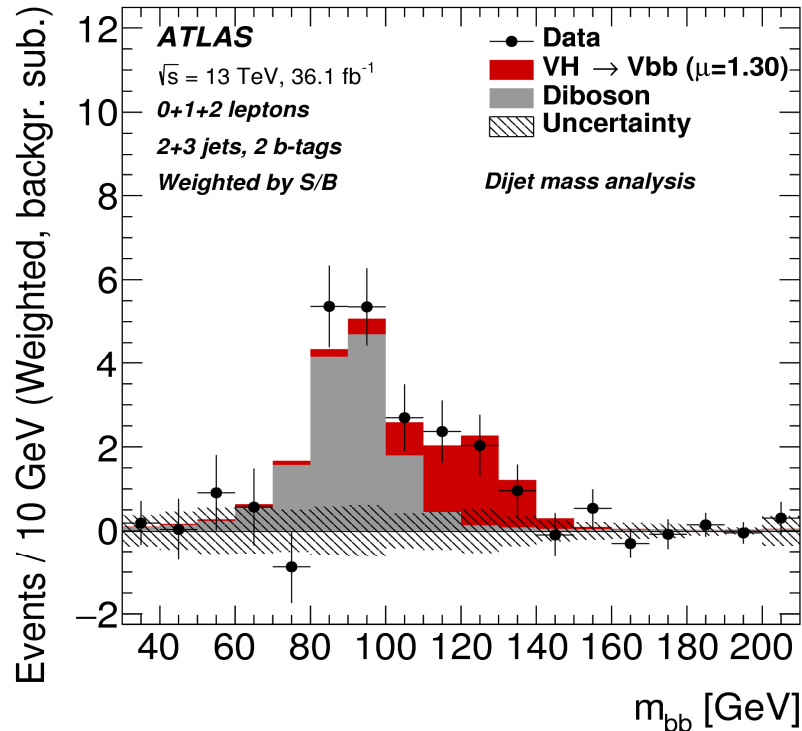
R is the source radius parameter, λ – effect strength, ε – long range effect parameter;
Plot shows R dependence on the multiplicity in the event; the multiplicity dependence of the BEC parameters are investigated for multiplicities of up to **very-high number of charged-particles, $n_{ch} \approx 300$** .

For the first time, a **saturation effect** in the multiplicity dependence of the correlation source-size parameter is observed at 7TeV and 13 TeV



Y.Kulchitsky,
ATL-COM-PHYS-2016-1621

6. Evidence for the $H \rightarrow b\bar{b}$ decay with the ATLAS detector

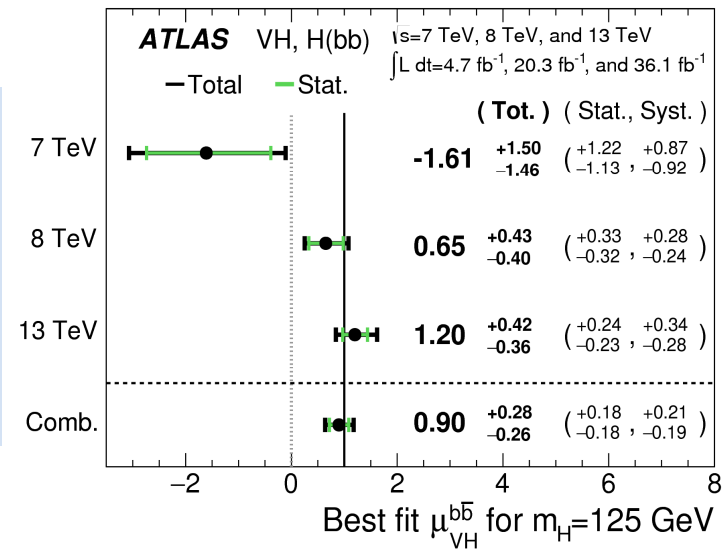


Plot shows the distribution of $m_{b\bar{b}}$ in data after subtraction of all backgrounds except for the WZ - and ZZ - diboson processes. Observed (expected) excess is 3.5σ (3.0σ), whereas the ratio μ of the measured signal to the one expected in the Standard Model $\mu = 1.20^{+0.24}_{-0.23}(\text{stat})^{+0.34}_{-0.28}(\text{sys})$.

Search for the Standard Model Higgs boson decaying into the pair of b -quarks produced in association with the W/Z -boson is an important test of the SM Higgs physics.

The multi-dimensional MVA method of the analysis was applied to the experimental data to select signal candidate events;

Run-2 data combined with Run-1 data showed signal with significance of 3.6σ compared to an expectation of 4.0σ .



The cross section measurement is well consistent with the value of the Yukawa coupling to bottom quarks in the Standard Model. Analysis will continue with the full dataset of Run II.

A.Cheplakov, F.Ahmadv, JHEP 12 (2017) 024

7. EventIndex project

Event Index — ATLAS data and MC index on the event level, which can be used by ATLAS physicists;

For each event, the index contains:

- Run/event numbers
- Trigger decisions
- Bunch number, LumiBlock, etc.

Data indexing is performed 'on the fly'— during process of data taking;

EventIndex information is available through the web interface;

For LHC Run III, on the EventIndex platform, the new system – Event White Board will be created, having extended functionality;

Event index team:

E. Alexandrov (LIT,JINR),
M. Mineev (LIT,JINR),
A. Yakovlev (LIT, JINR),
I. Alexandrov (LIT, JINR),
F. Prokoshin (UTFSM, Chile)

We are grateful for their
significant contribution to
ATLAS TDAQ to LIT people:
E.Alexandrov, M.Mineev,
I.Alexandrov, A.Kazymov

JINR team takes part in the development of the SANC MC generator.

Photon induced processes are important background for many analyses using pp-collisions data.

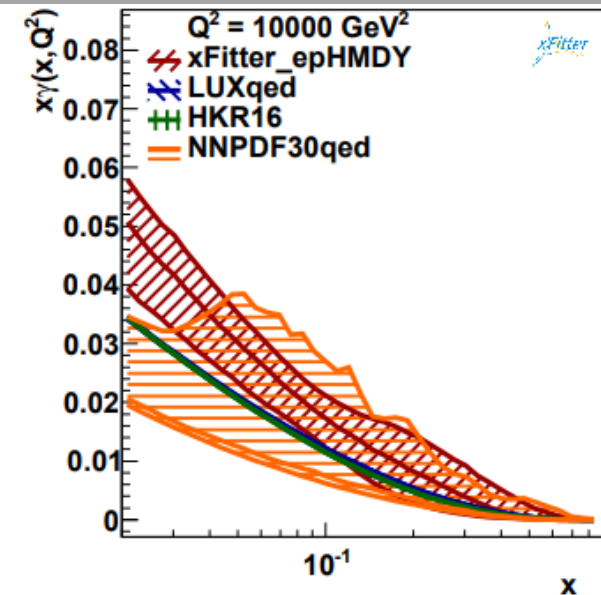
Recently, JINR team (in collab. with PNPI) implemented $\gamma\gamma \rightarrow ZZ$ process in SANC generator at the one loop level. The derived one-loop scalar form factors can be used for any cross channel after an appropriate permutation of their arguments – Mandelstam variables s, t, u . An extensive comparison of derived analytical and numerical results is made with those existing in the literature (L.Kalinovskaya, et al.).

The photon PDF determination within the xFitter framework

JINR team takes part in the development of the xFitter analysis framework.

Determination of the photon PDF from fits to recent ATLAS measurements of high-mass Drell-Yan dilepton production at $\sqrt{s} = 8$ TeV using xFitter framework has been performed.

(L.Kalinovskaya, et al.)

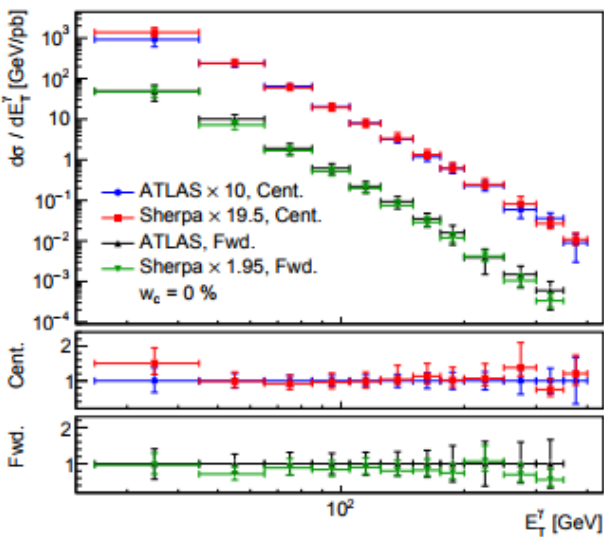


Constraints on the intrinsic charm (IC) probability in the proton are obtained for the first time from LHC measurements. ATLAS data for the production of prompt photons, accompanied by a charm-quark jet in pp -collisions at 8 TeV are used.

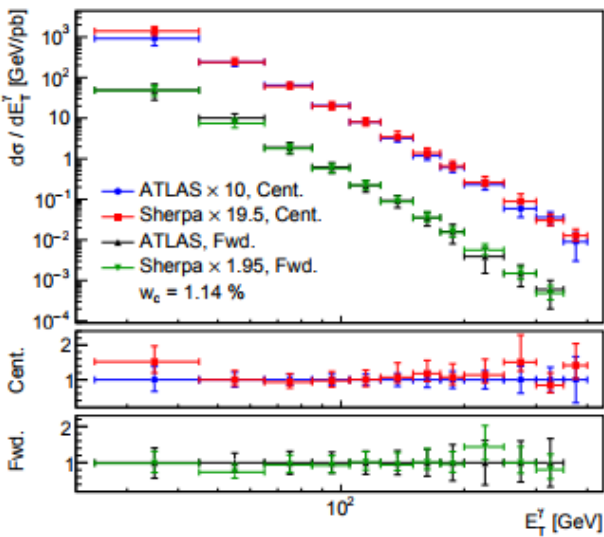
Fits to the ATLAS data result in a central estimate for a IC probability: $w = 1.14\%$. Upper limit: $w < 4.32\%$ is obtained at the 95% C.L.

Plots show the transverse photon energy in ATLAS data compared to MC simulations with and without IC contribution.

	SHERPA [%]	Comb. QCD [%]
w_c	1.14	1.00
$w_{u.l.} \text{ (68\% C.L.)}$	2.74	3.69
$w_{u.l.} \text{ (90\% C.L.)}$	3.77	6.36
$w_{u.l.} \text{ (95\% C.L.)}$	4.32	> 7.5



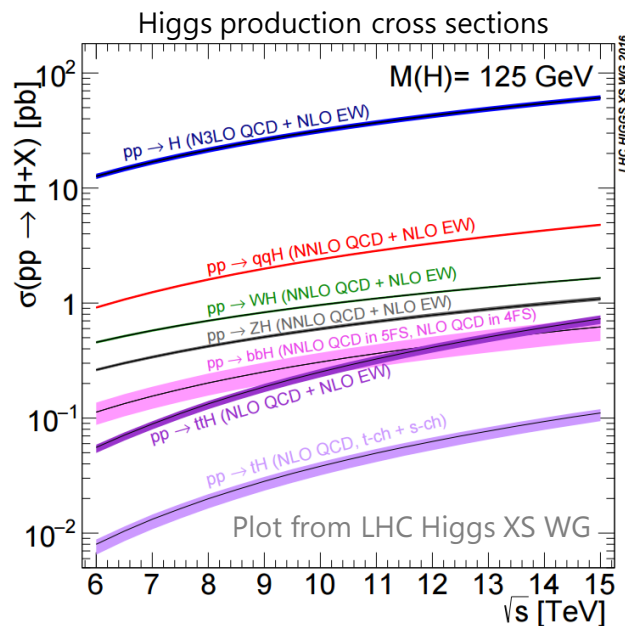
(a) $w_c = 0\%$



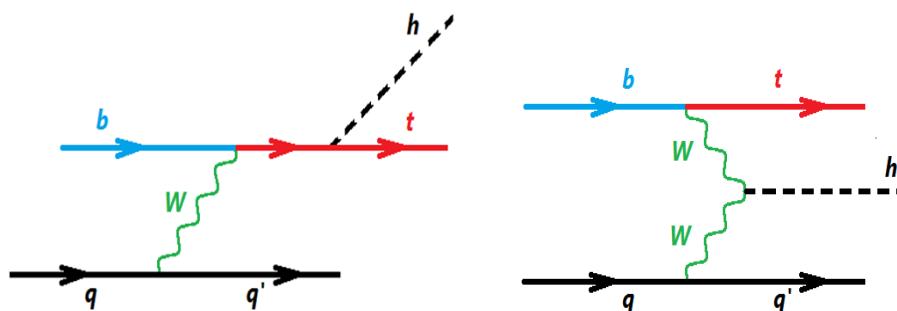
(b) $w_c = 1.14\%$

V.Bednyakov, G.Lykasov, A.Lipatov, J.Smiesko, et al.

Search for Higgs production in association with single top-quark



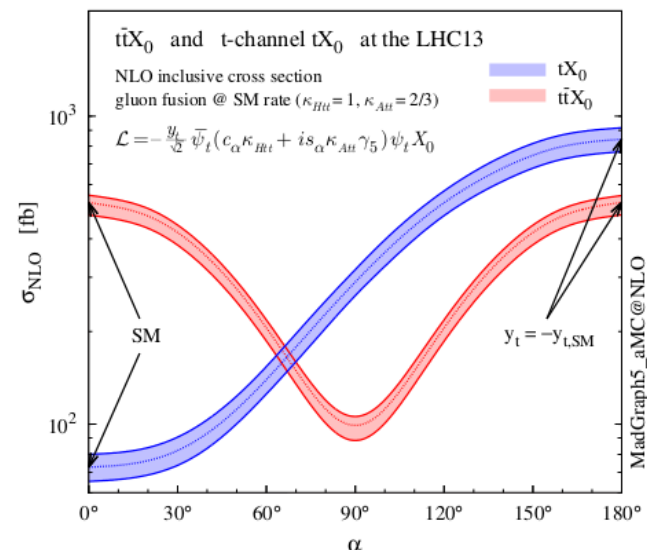
Higgs boson production in association with a single top-quark is suppressed in the SM by the strong destructive interference between Htt and HWW interaction vertices:



Current experimental data do not forbid the opposite sign of Higgs coupling to top-quark, in which case this interference would be constructive.

$H+t$ production is one of the processes most sensitive to Htt vertex sign. Moreover, this process is sensitive to various BSM physics. Right plot show $H+t$ production cross section depending on the phase of Htt coupling.

JINR team searches for the signal of $H+t$ production and possible signals of BSM physics in this channel (Boyko, Guseynov, et al.).



Conclusions

1. JINR team takes active part in all of the main directions of ATLAS physics program:
 - Higgs physics;
 - BSM Exotics;
 - B-physics;
 - Standard model;
2. A set of topical results are obtained by JINR ATLAS group, several interesting studies are ongoing... and we are always tempted to further extend our involvement in ATLAS physics program!
3. Our 2017 publications:
 - Evidence for the $H \rightarrow b\bar{b}$ decay with the ATLAS detector, JHEP 12 (2017) 024, F. Ahmadov;
 - Search for heavy resonances, decaying into $Z/W/H + \gamma$, EXOT-2016-30 (to be submitted to PRD), E.Khramov;
 - Measurement of vector bosons produced in association with b-jets, ATLAS-CONF-2017-023, S.Turchihin;
4. 2017 conferences and meetings:
 - Organization and participation in the Conference "25th Anniversary of JINR at ATLAS", 25-29.04.2017, Budva;
 - Organization and participation in the "Russian Institutes Physics&Computing Meetings", 24.01.2017 (MSU), 19-20.09.2017 (LNP, JINR);
 - We reported results obtained by JINR ATLAS team at: QFTHEP-2017, Hadron-2017, International Session-Conference of the Nuclear Physics Department of RAS, etc.

THANK YOU!

5. Other activities (ref. backup slides)

1. ATLAS physics analysis software development (L.Kalinovskaya, et al.):
 - Development of the *xFitter* framework and it's application to photon PDF determination from ATLAS data;
 - Development of *SANC* MC generator: implementation of $\gamma\gamma \rightarrow ZZ$ processes;
2. Measurements and search for BSM physics in processes with Higgs boson production in association with top-quark pairs and single top-quark (I.Boyko, N.Guseynov, et al.);
3. Constraints on the intrinsic charm contribution to PDF from ATLAS data (G.Lykasov, V.Bednyakov, et al.);