Эксперимент ALICE в 2013 году

Е. Крышень

Научная сессия ОФВЭ

24 декабря 2013

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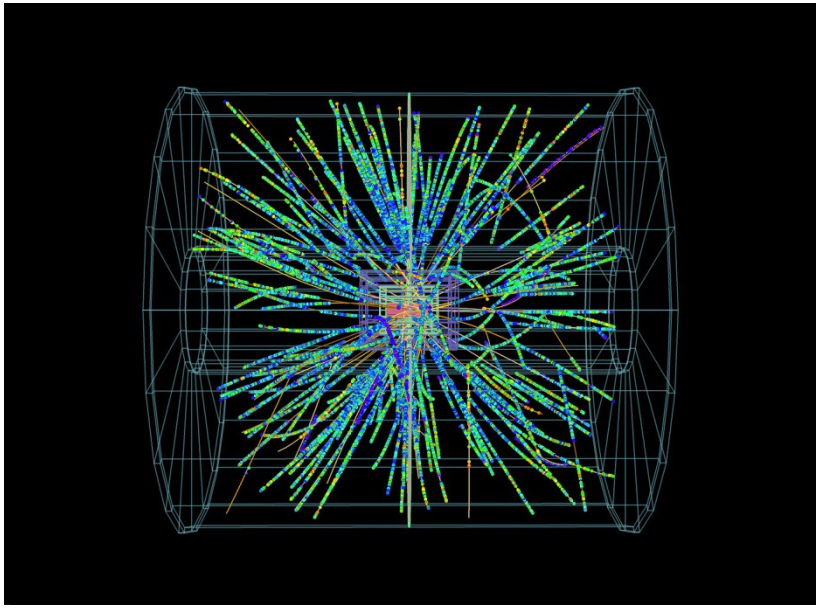
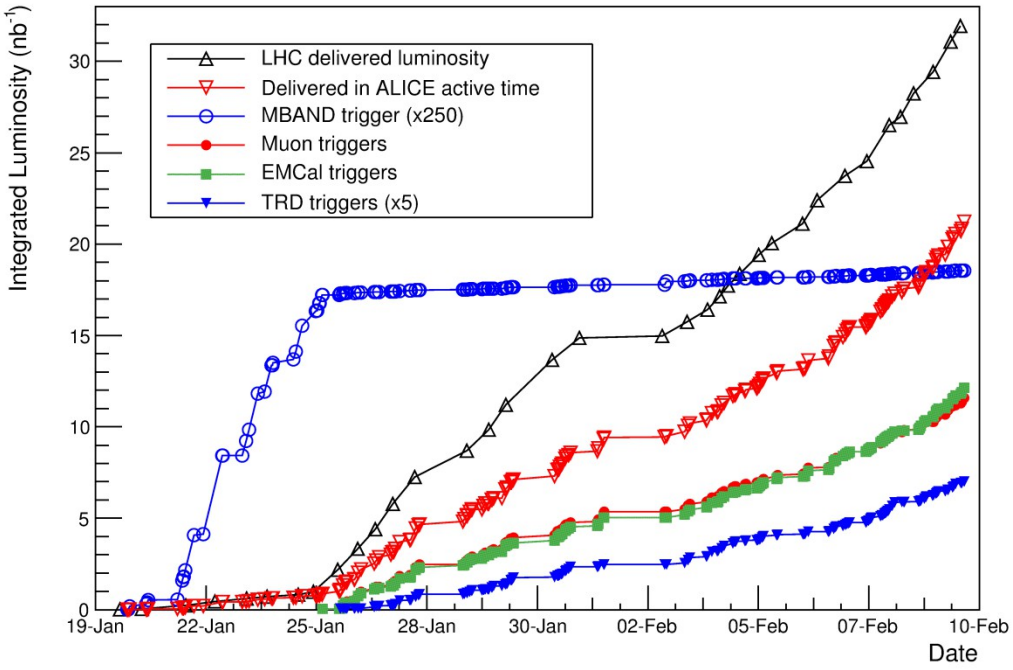
Data taking: pPb collisions

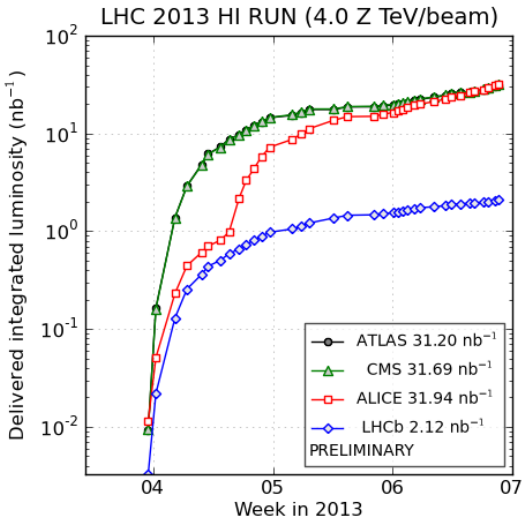
Goals:

- ✓ **108 min. bias events**
- ✓ **30 nb-1 integrated luminosity**
- ✓ **p-Pb and Pb-p switchover**
- ✓ **Magnet polarity change**

Impressive performance of the LHC!







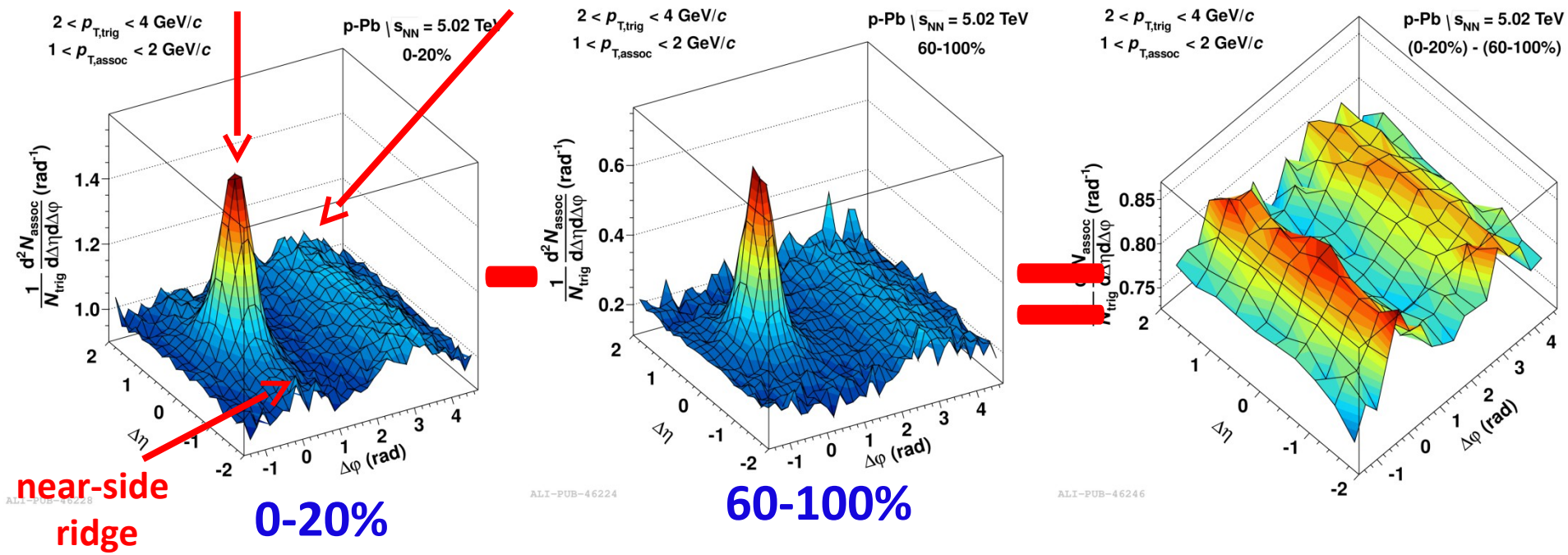
Highlights of ALICE results

Hot topic: double ridge

near-side jet correlations

away-side jet correlations

Phys. Lett. B 719 (2013) 29



near-side ridge

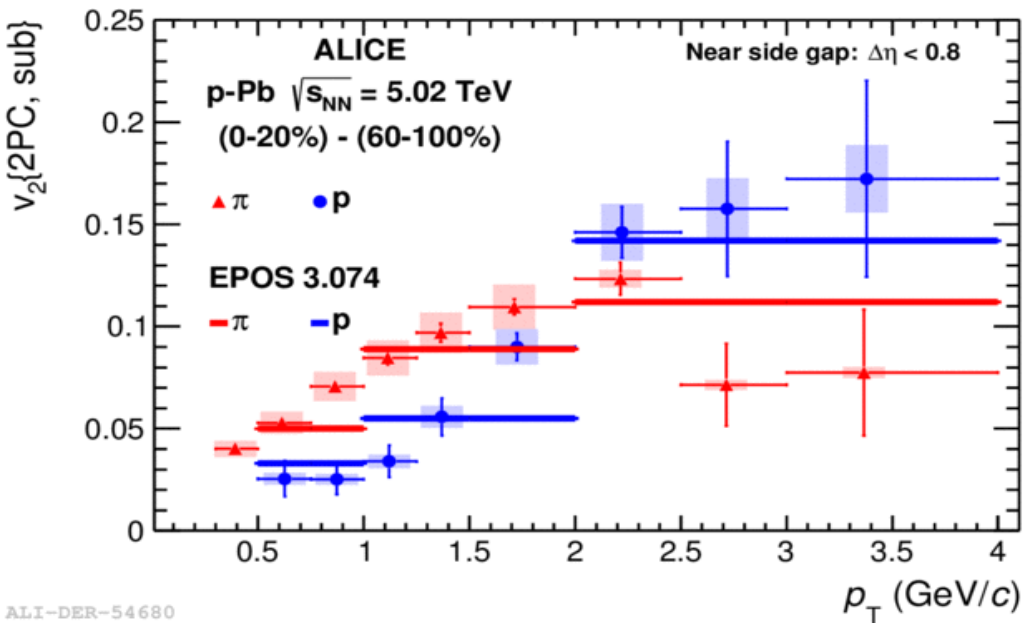
0-20%

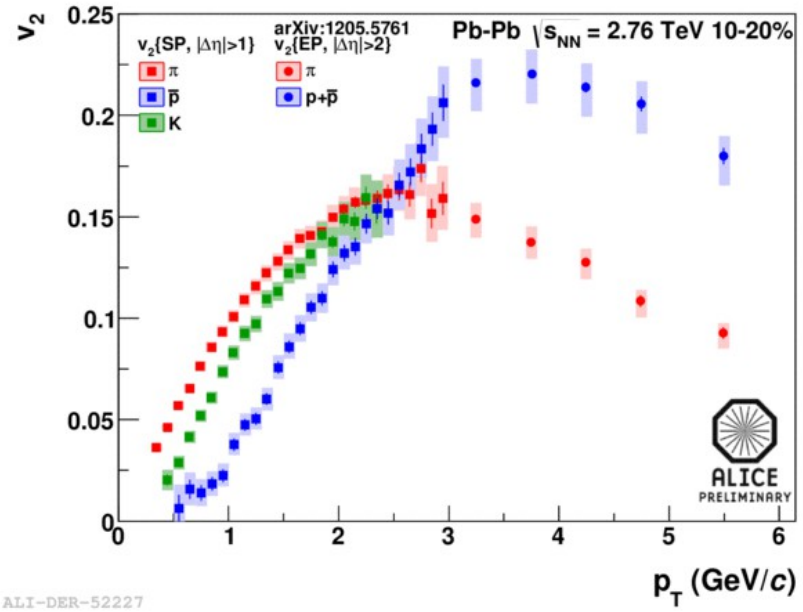
60-100%

- Method: subtract the “pp-like” structure of low-multiplicity p-Pb from the structure of high-multiplicity p-Pb
- Particle correlations described by di-jets + double ridge (nothing more)
- Double ridge:
  - same yield near and away side for all pT and multiplicity classes
  - Resembles the structure attributed to collective flow in Pb-Pb

Flow in pA?

arXiv:1307.3237





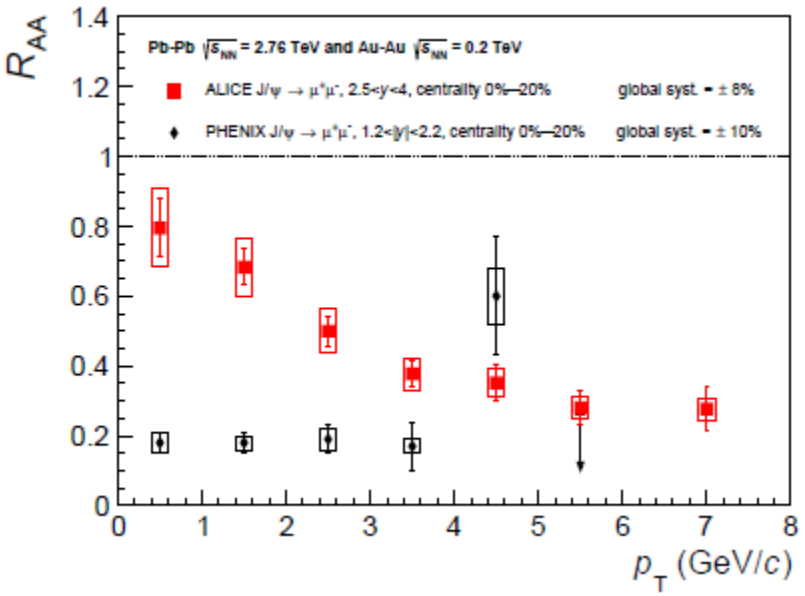
- Clear indication for mass ordering in p-Pb
- Resembles Pb-Pb and supports “flow” picture

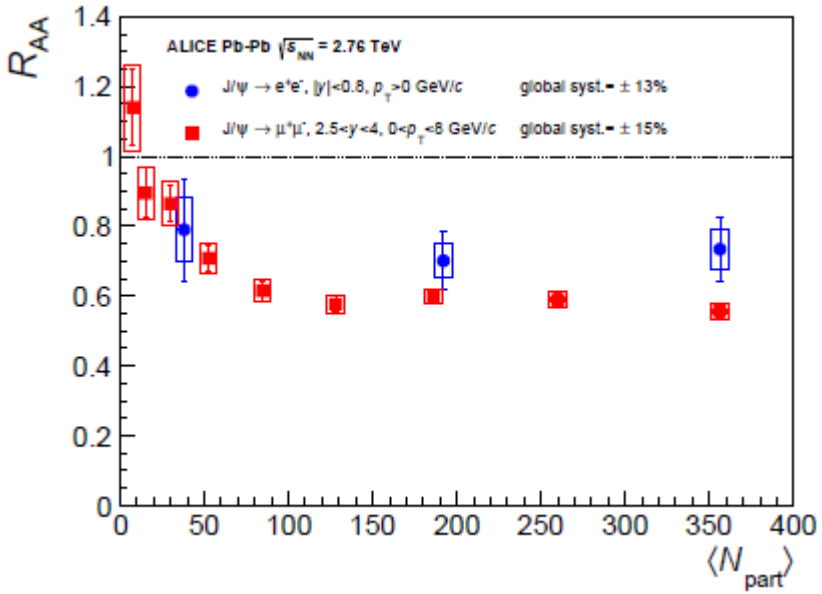
Pb-Pb: mass ordering, interpreted in terms of collective radial and elliptic flow

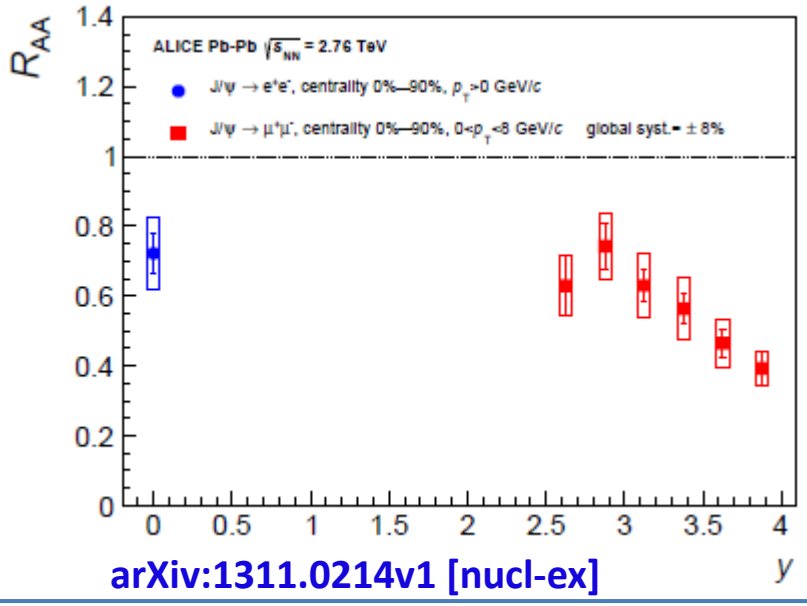
- Models including hydrodynamical expansion can describe the observations (e.g. EPOS)
- Alternative interpretations:
  - CGC: initial-state effect, many-gluon processes can yield correlations
    Dusling, Venugopalan, PRD 87 (2013) 094034
  - Multi-parton interactions and “colour reconnection” can induce flow-like effects,
    e.g. Ortiz et al, PRL 111 (2013) 042001

J/ψ suppression in PbPb collisions at LHC

- J/ψ suppression measured both at forward and central rapidity
- Suppression in central collisions smaller than at RHIC
- Smaller suppression at low pT and at central rapidity in good agreement with J/ψ regeneration scenarios



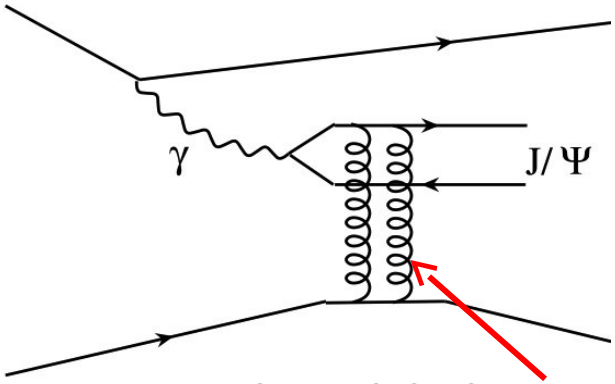




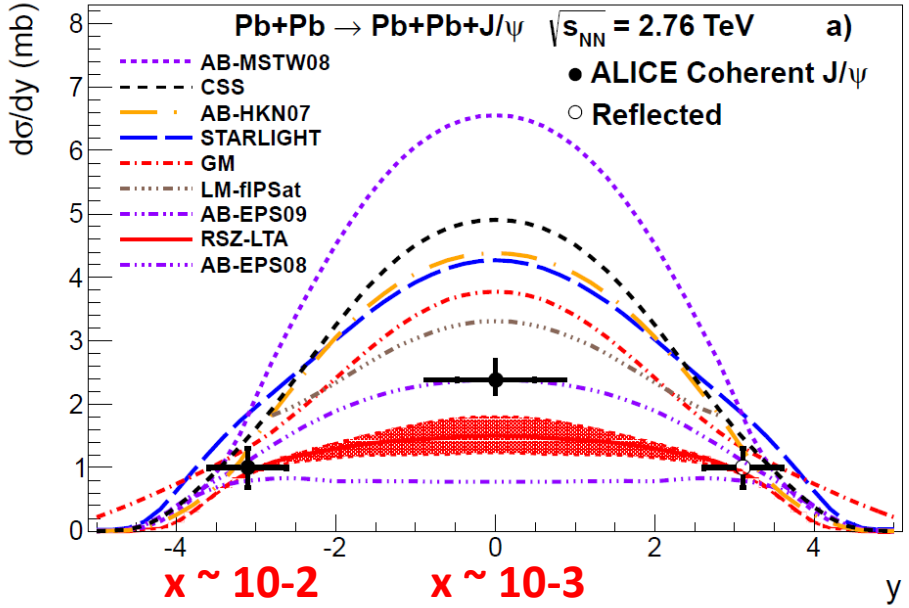
arXiv:1311.0214v1 [nucl-ex]

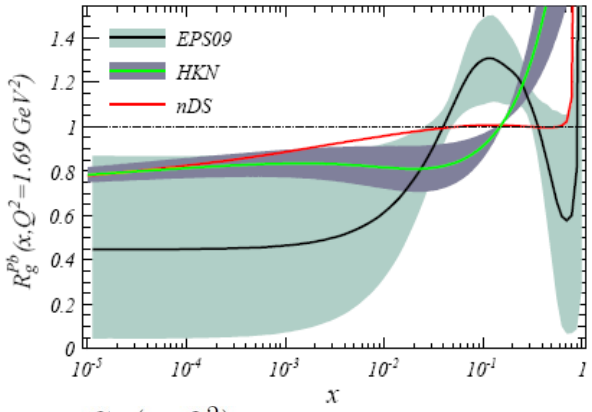
Coherent J/ψ photoproduction in Pb-Pb

Motivation: probe poorly known gluon shadowing effects at low x:



$$\left.\frac{d\sigma_{\gamma A\to J/\psi A}}{dt}\right|_{t=0} = \frac{M_{J/\psi}^3 \Gamma_{ee} \pi^3 \alpha_s^2(Q^2)}{48\alpha_{\rm em} Q^8}\left[xG_A(x,Q^2)\right]^2$$





$$R_g^A(x,Q^2) = \frac{G_A(x,Q^2)}{AG_p(x,Q^2)}$$

Good agreement with models which include nuclear gluon shadowing.
Best agreement with EPS09 shadowing
(shadowing factor ~0.6 at x ~ 10-3, Q2 = 2.4 GeV2)

Phys. Lett. B718 (2013) 1273
Eur. Phys. J. C73 (2013) 2617

Nuclear gluon shadowing from ALICE data

V. Guzei, E. Kryshen, M. Strikman, M. Zhalov. Phys. Lett. B726 (2013) 290

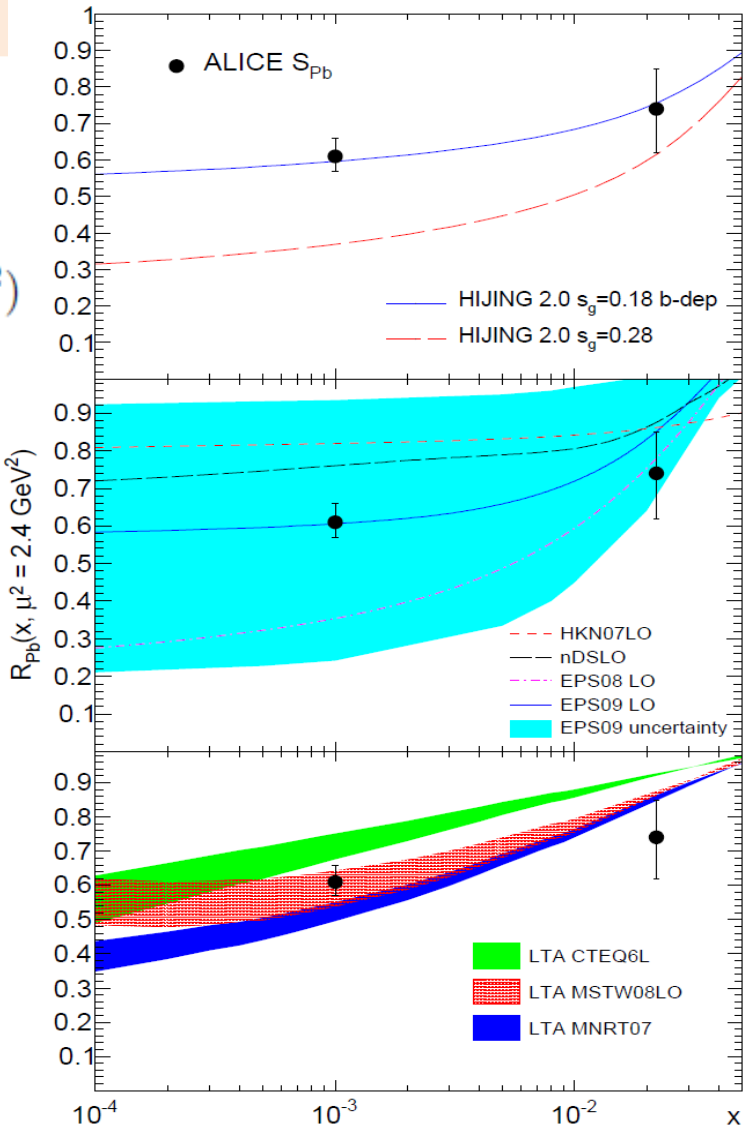
Nuclear suppression factor in J/ψ photoproduction:

ALICE data corrected for photon flux

$$S(W_{\gamma p}) \equiv \left[\frac{\sigma^{\mathrm{exp}}_{\gamma \mathrm{Pb}\to J/\psi \mathrm{Pb}}(W_{\gamma p})}{\sigma^{\mathrm{IA}}_{\gamma \mathrm{Pb}\to J/\psi \mathrm{Pb}}(W_{\gamma p})}\right]^{1/2} \Rightarrow R(x, \mu^2 = 2.4\ \mathrm{GeV}^2)$$

Impulse Approximation: J/ψ photoproduction cross section from HERA corrected for the integral over squared Pb form-factor

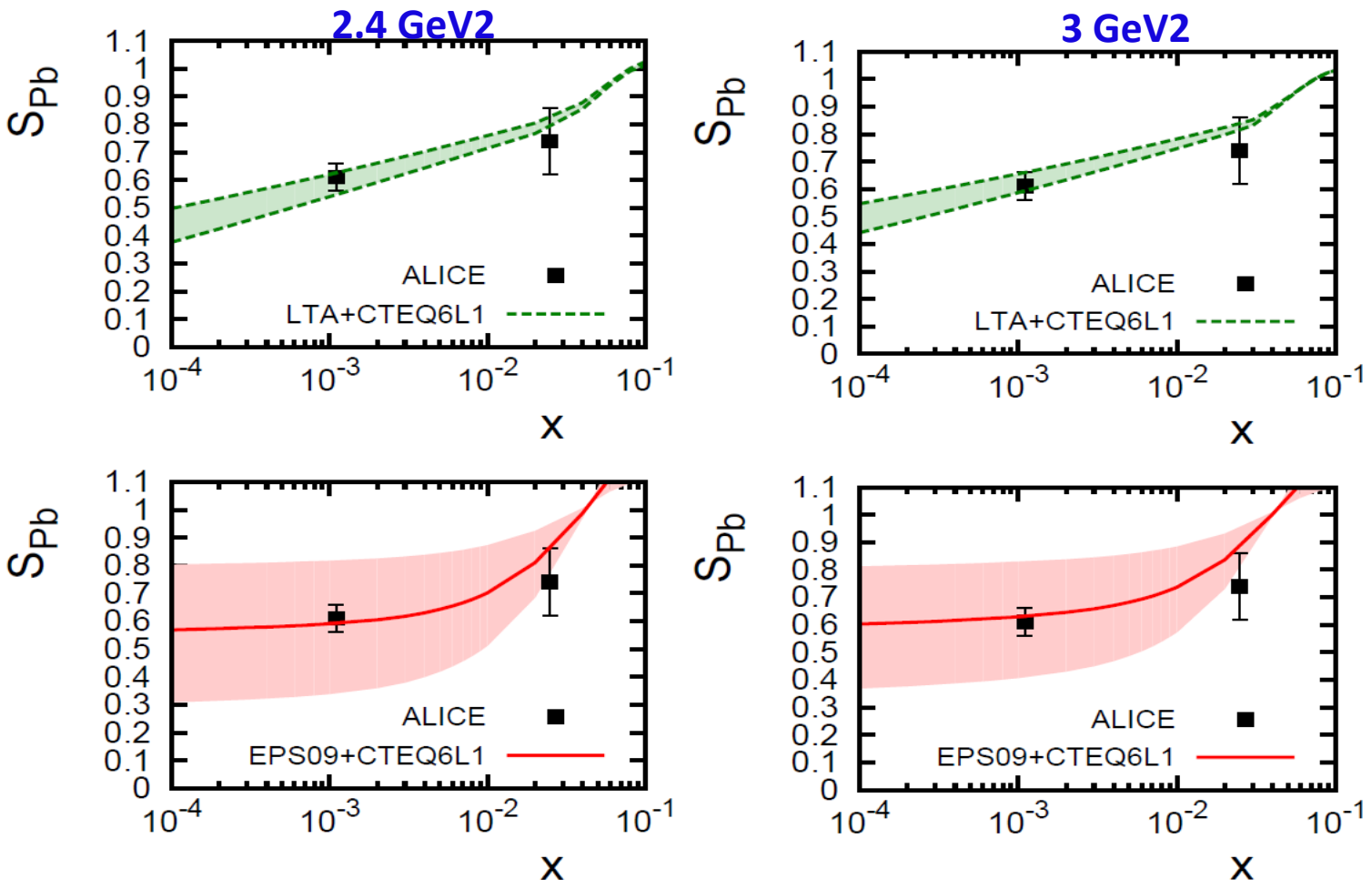
- **Hijing:** scale-independent gluon shadowing, characterized by parameter *sg*
- **Shadowing parametrizations (EPS,nDS,HKN07)** use DIS and Drell-Yan data + π0 data from RHIC (EPS) – gluon shadowing essentially unconstrained at low x
- **Leading twist approximation:** propagation of color dipoles in nuclei via intermediate diffractive states (Gribov-Glauber shadowing theory). Incorporates diffractive parton distributions in proton (from HERA)



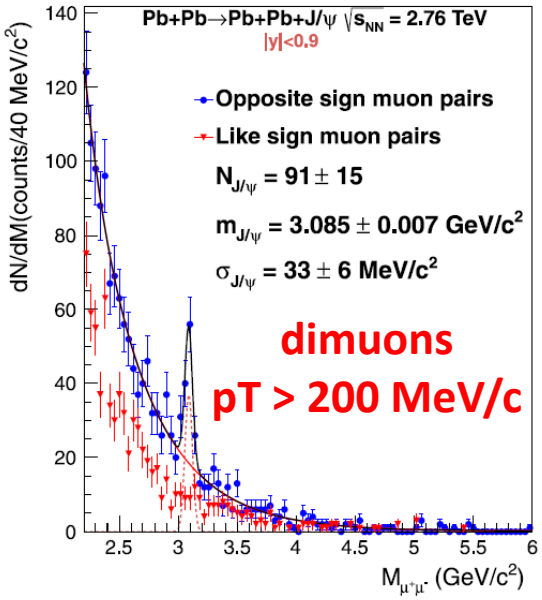
ranges of x probed by ALICE

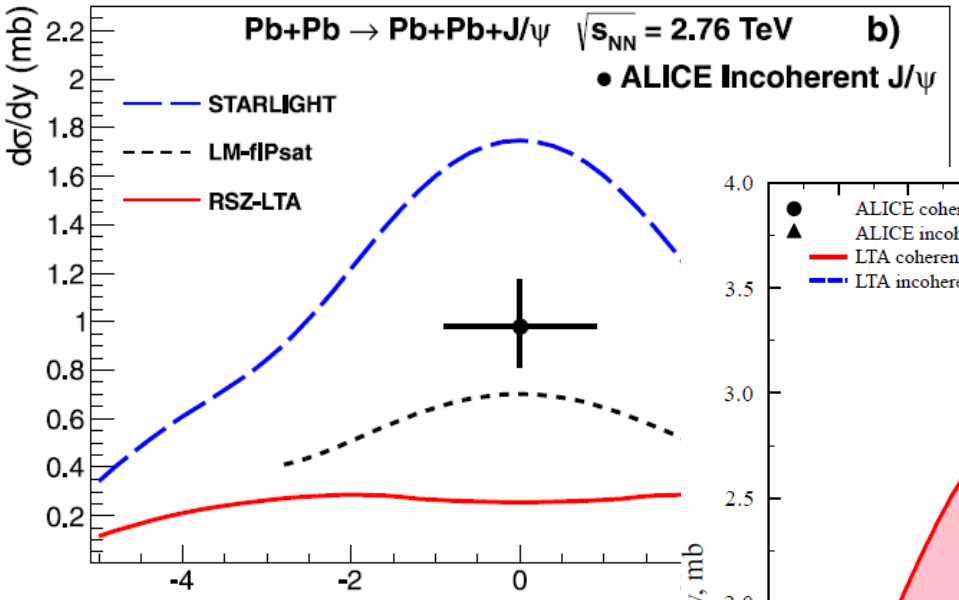
Scale dependence

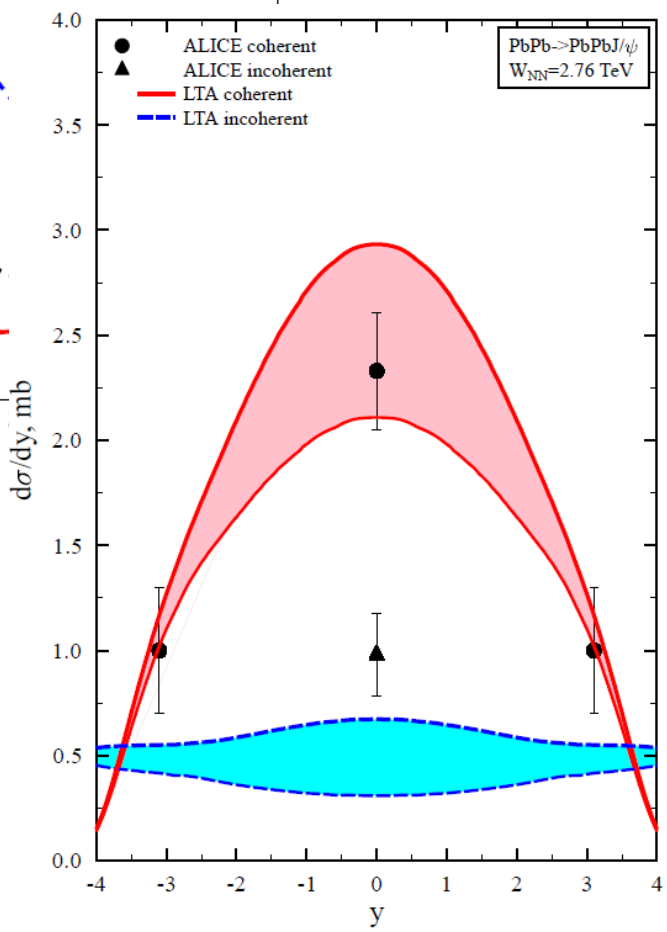
- Studied in detail in Guzey, Zhalov: JHEP 1310 (2013) 207.
- Scale of 3 GeV2 found to be most appropriate for the description of J/ψ photoproduction data



Incoherent J/ψ at central rapidity





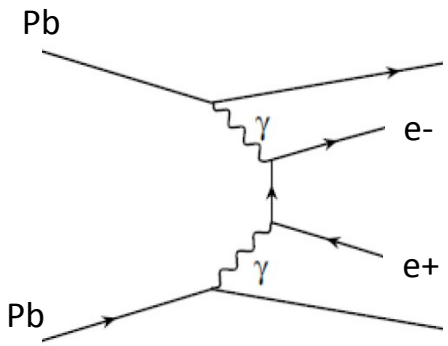


- Almost one order of magnitude difference in the predicted cross sections
- ALICE sets strong constraints

Eur. Phys. J. C73 (2013) 2617

Guzey, Strikman, Zhalov, hep-ph:

γγ⟶e+e- in central barrel



Standard QED:

- Born cross sections obtained by Landau & Lifshitz in 1934

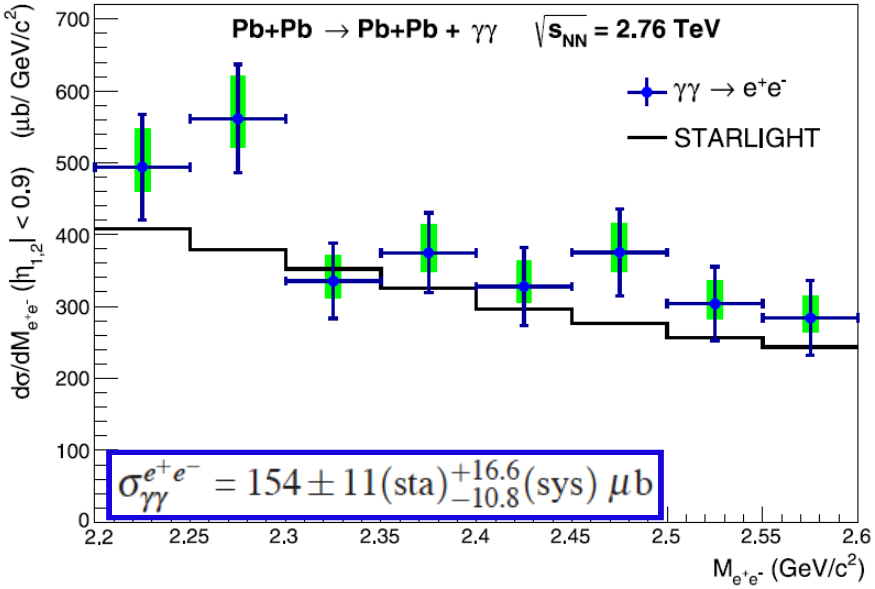
But caveats due to

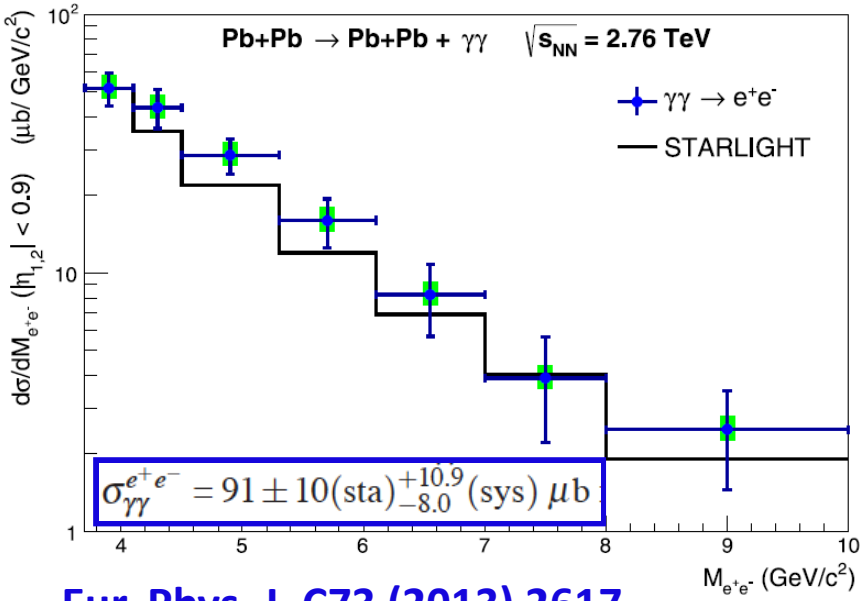
- Uncertainty in higher order terms due to coupling $Z\sqrt{\alpha}$
- Uncertainty on minimum momentum transfer and nuclear form factor

Different models predict a reduction of the LO cross section up to 30%

ALICE:

- Data slightly above LO prediction
- 12% and 16% precision in two mass ranges
- ALICE data sets stringent limits on the contribution from high order terms





Eur. Phys. J. C73 (2013) 2617

J/ψ photoproduction in p-Pb

Data collected in 2013:

p-Pb: p towards muon spectrometer

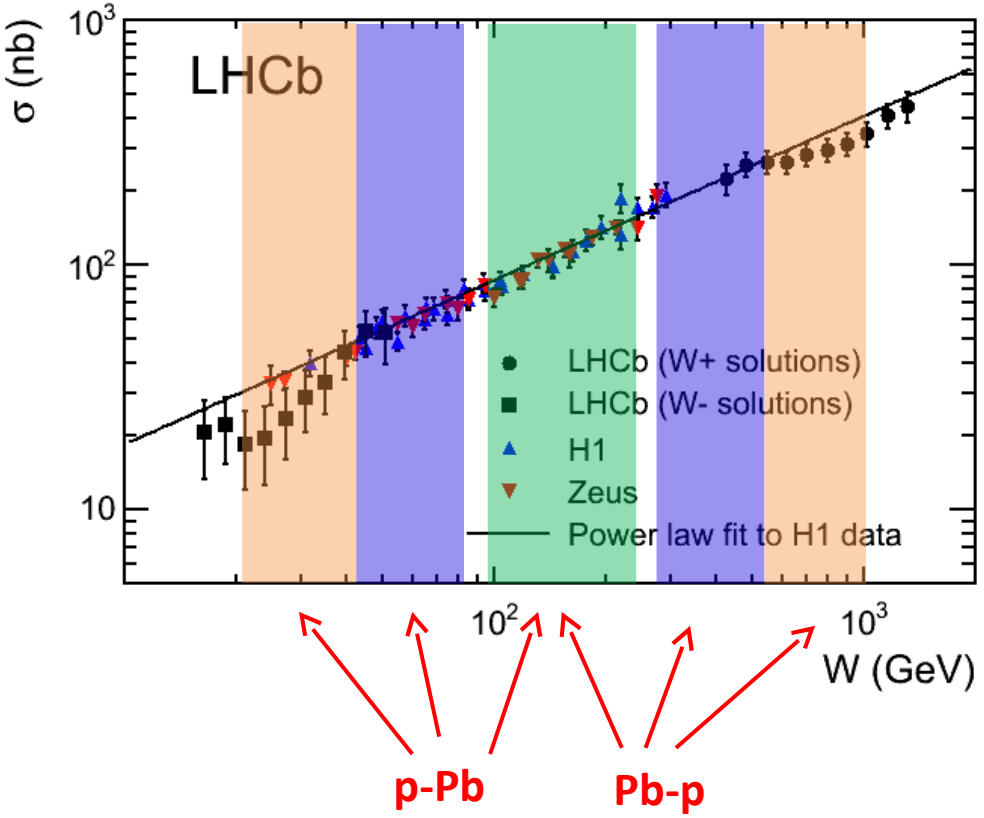
Pb-p: Pb towards muon spectrometer

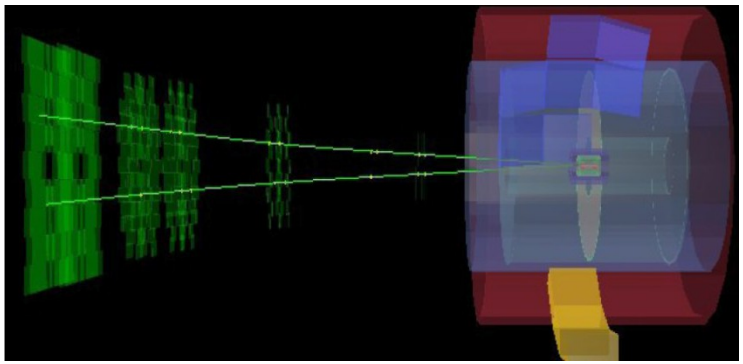
Three UPC trigger options in ALICE:

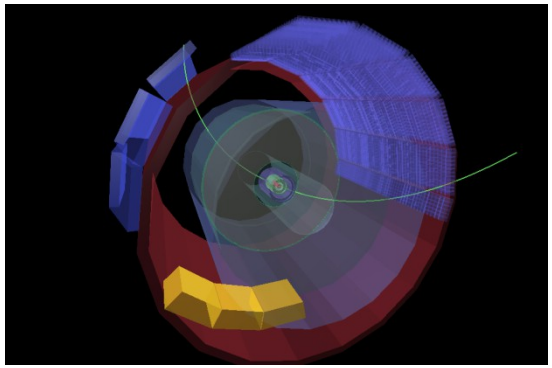
- Forward: both muons in the muon arm
- Central: both leptons in the barrel
- Semi-forward: one muon in the muon arm, second in the barrel

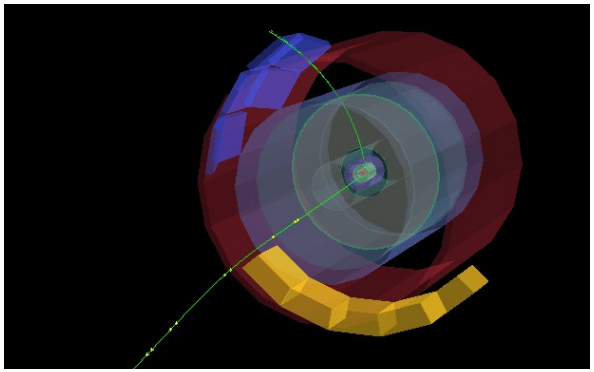
→ wide gamma-proton CM energy coverage up to W ~ 1 TeV!

→ wide x coverage: 10-2 -10-5

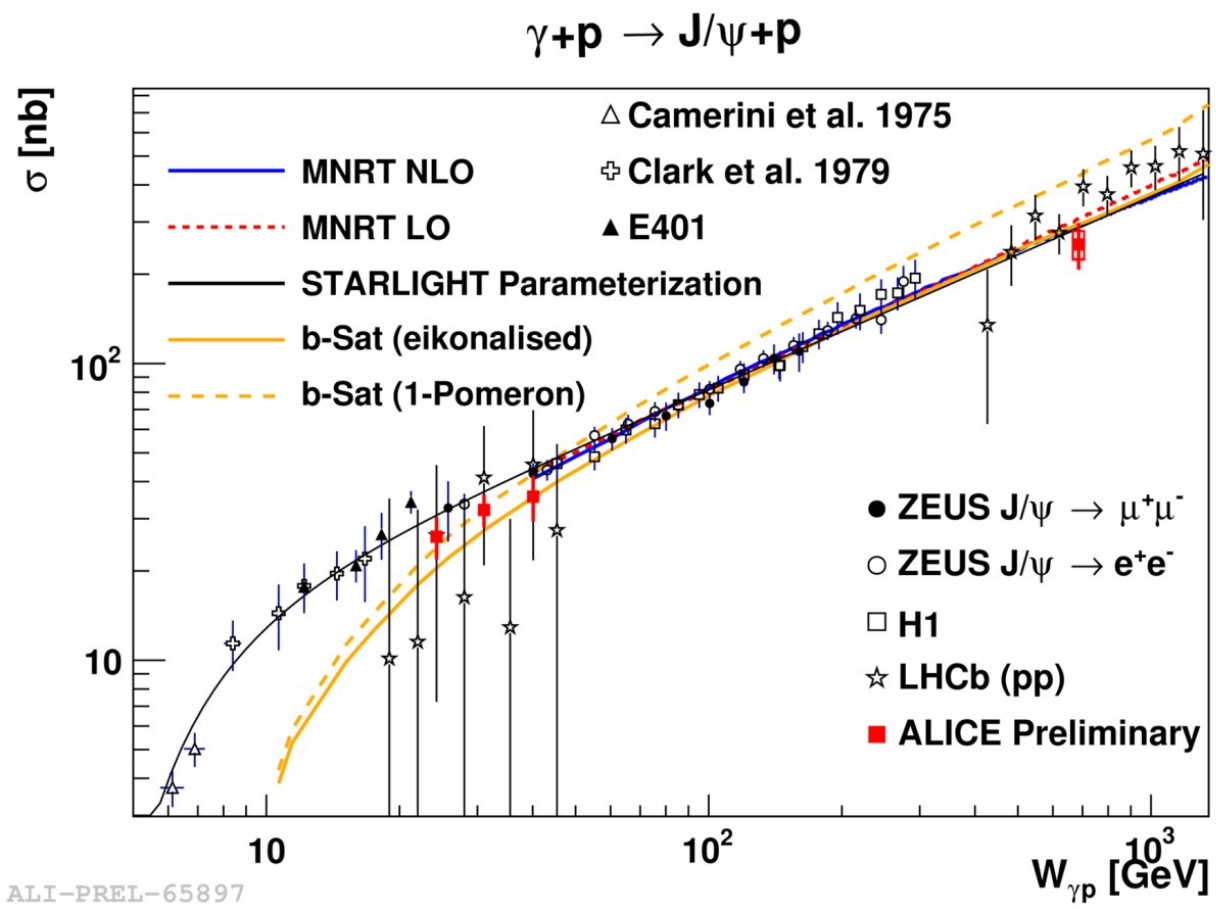


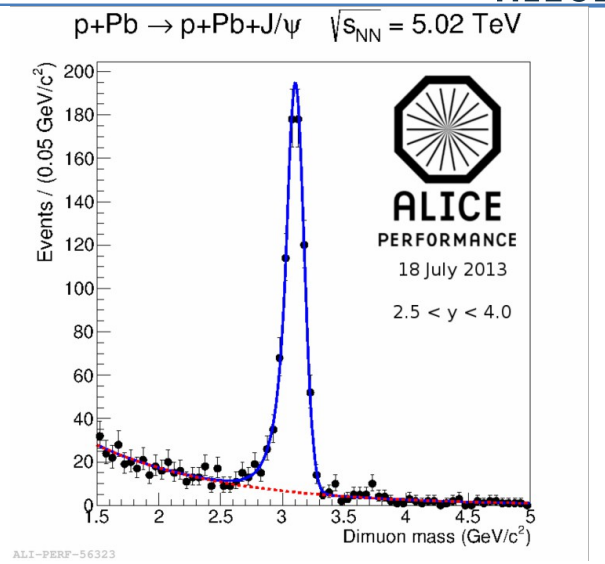


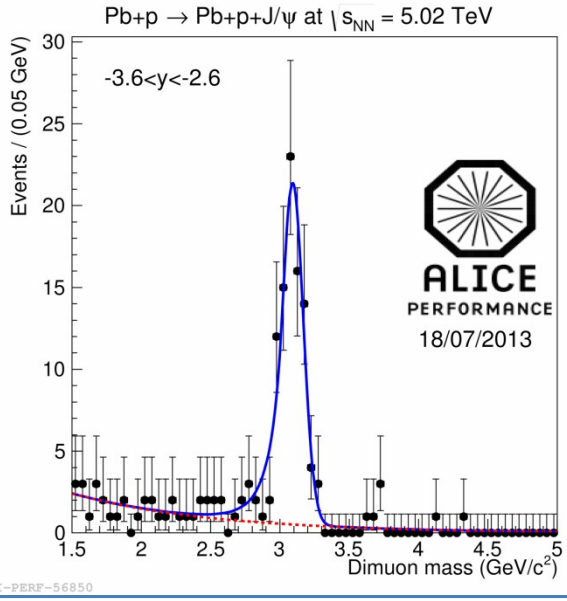




Preliminary results in forward pA

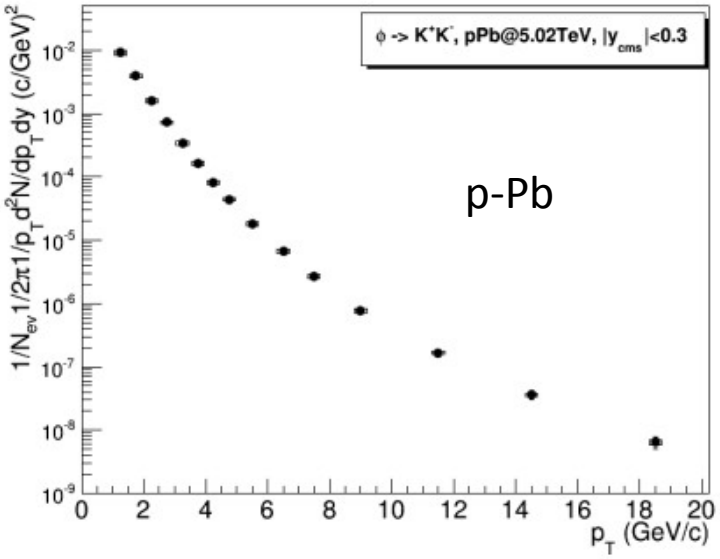






- Cross sections measured at forward rapidity
- Semiforward and central barrel – work in progress

ϕ→KK in pPb: pT spectra and RpA



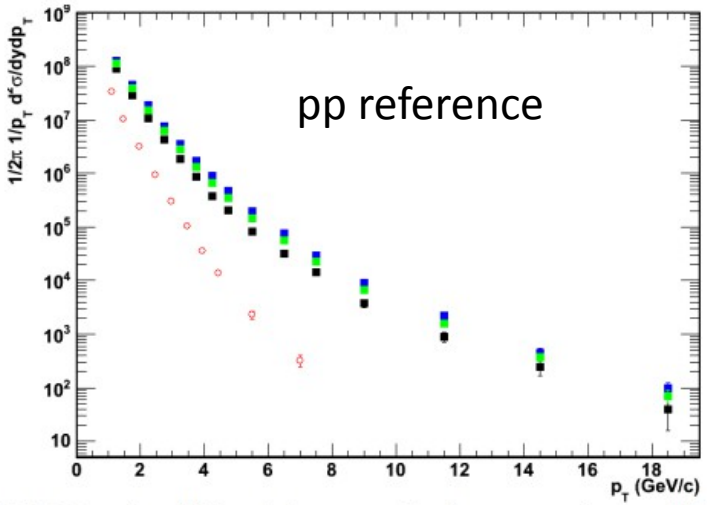


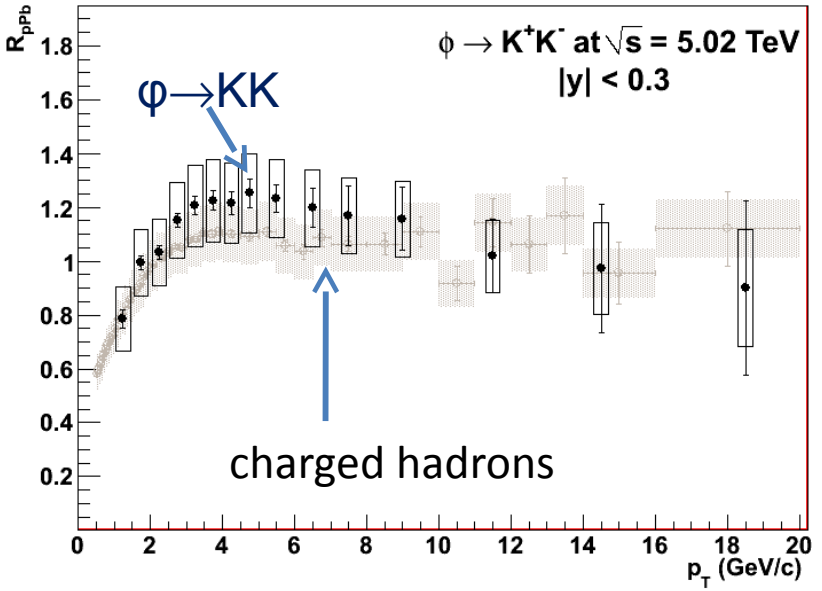
Fig. 5.2.1.2 Invariant differential cross section for φ meson in pp collisions at √s = 0.2 (red), 2.76 (black), 5.02 (green) and 7 (blue) TeV. Only statistical errors are shown.

Analysis of 2013 data (5.02 TeV):

- pT spectra in pPb up to 21 GeV/c
- pT spectra in pp @ 2.76 and 7 TeV, determination of the reference @ 5.02 TeV bin-by-bin assuming power low dependence of the cross section on √s
- RpPb up to 21 GeV/c

Analysis notes:

- pp@ 5.02: M. Malaev, V. Riabov, Yu. Riabov, https://aliceinfo.cern.ch/Notes/node/209
- pPb@5.02: M. Malaev, V. Riabov, Yu. Riabov, https://aliceinfo.cern.ch/Notes/node/214

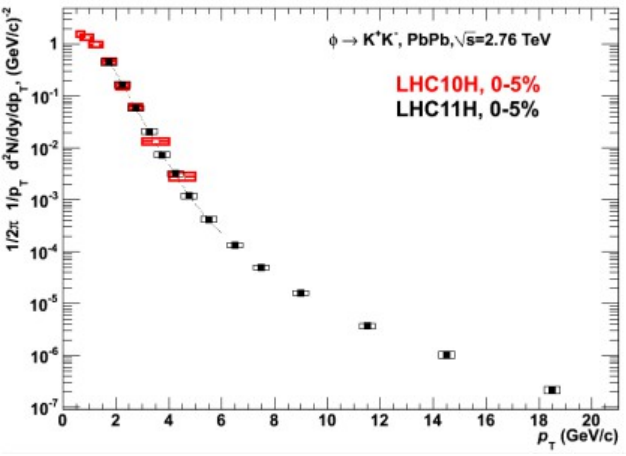


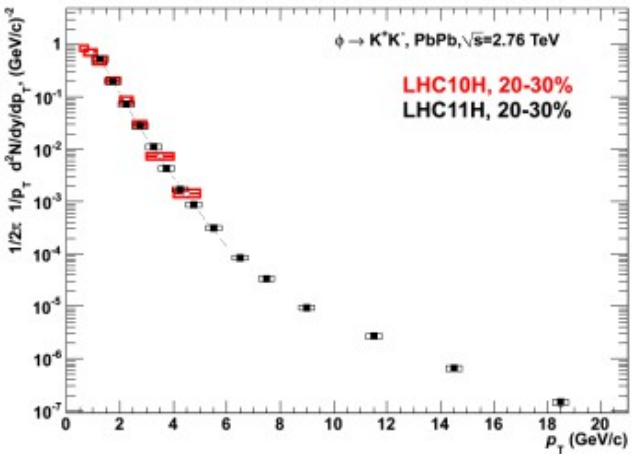
ϕ→KK in Pb-Pb: pT spectra and RAA

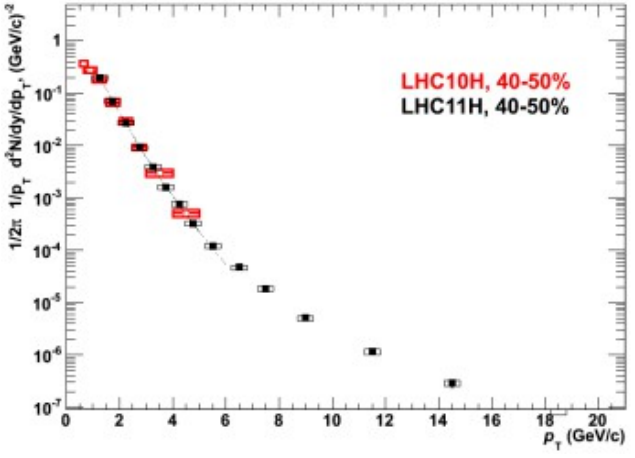
Motivation:

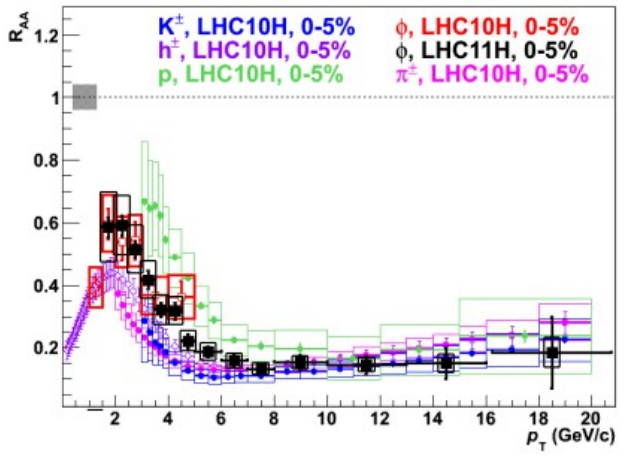
- ✓ species dependence of particle suppression at high pT
- ✓ mass and/or quark content dependence of the “baryon puzzle” at intermediate pT

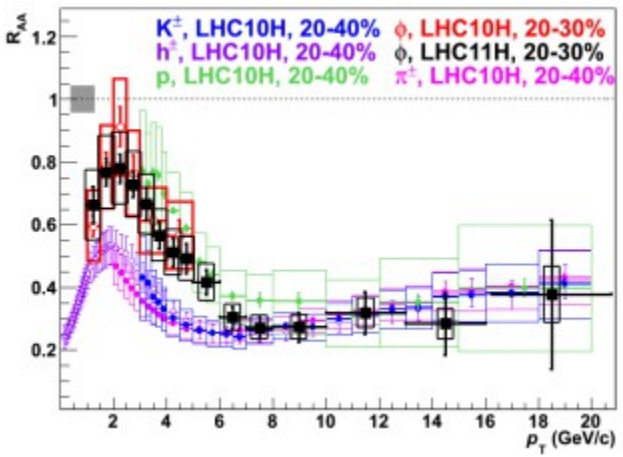
Results: production spectra at 1 GeV/c < pT < 21 GeV/c + RAA(pT) at different centralities
Analysis note: PbPb@2.76: M. Malaev, V. Riabov, Yu. Riabov, https://aliceinfo.cern.ch/Notes/node/256

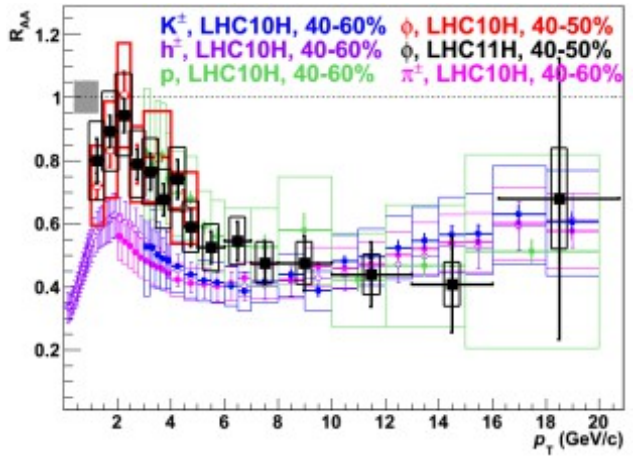






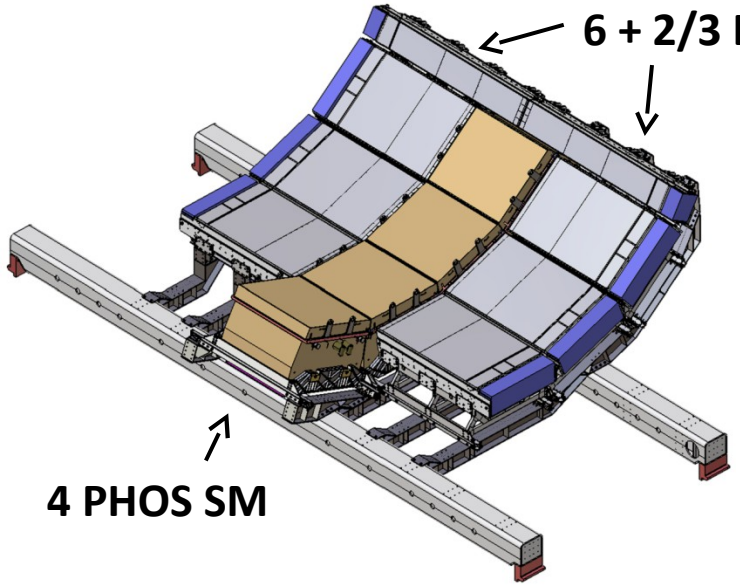


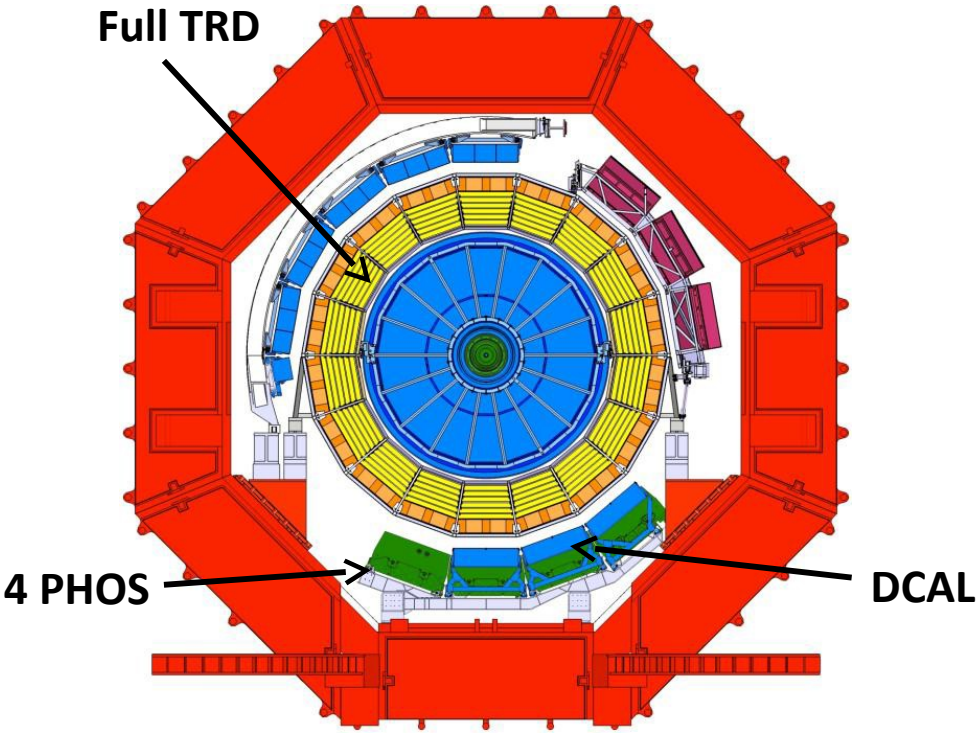




ALICE LS1 upgrade

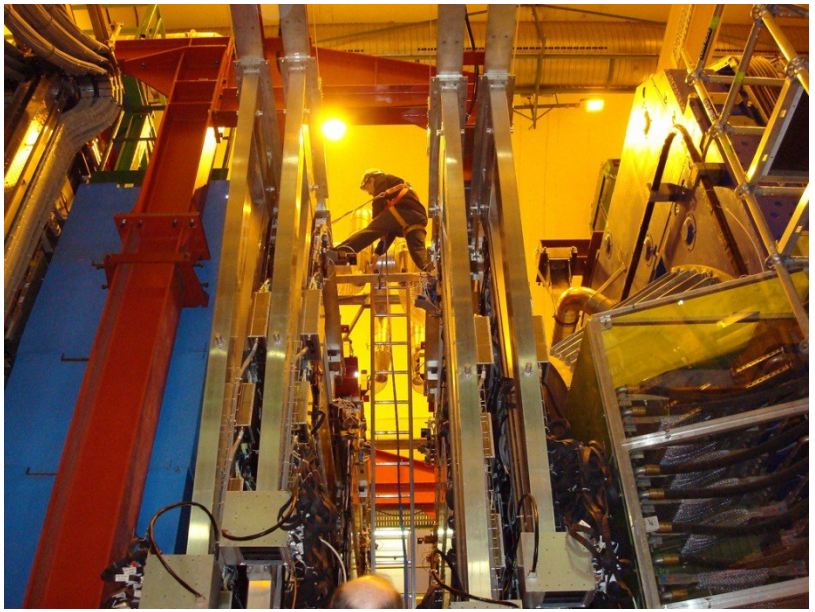
- complete **PHOS** (PWO)
- complete **TRD**
- consolidate jet capability by introducing **EMCal (DCAL)** at opposite position to the current EMCal





Ремонт трековых камер

Диагностика работоспособности мюонных камер, устранение появившихся в них за предыдущий период работы БАК неисправностей и подготовке мюонного детектора к последующей работе в эксперименте.



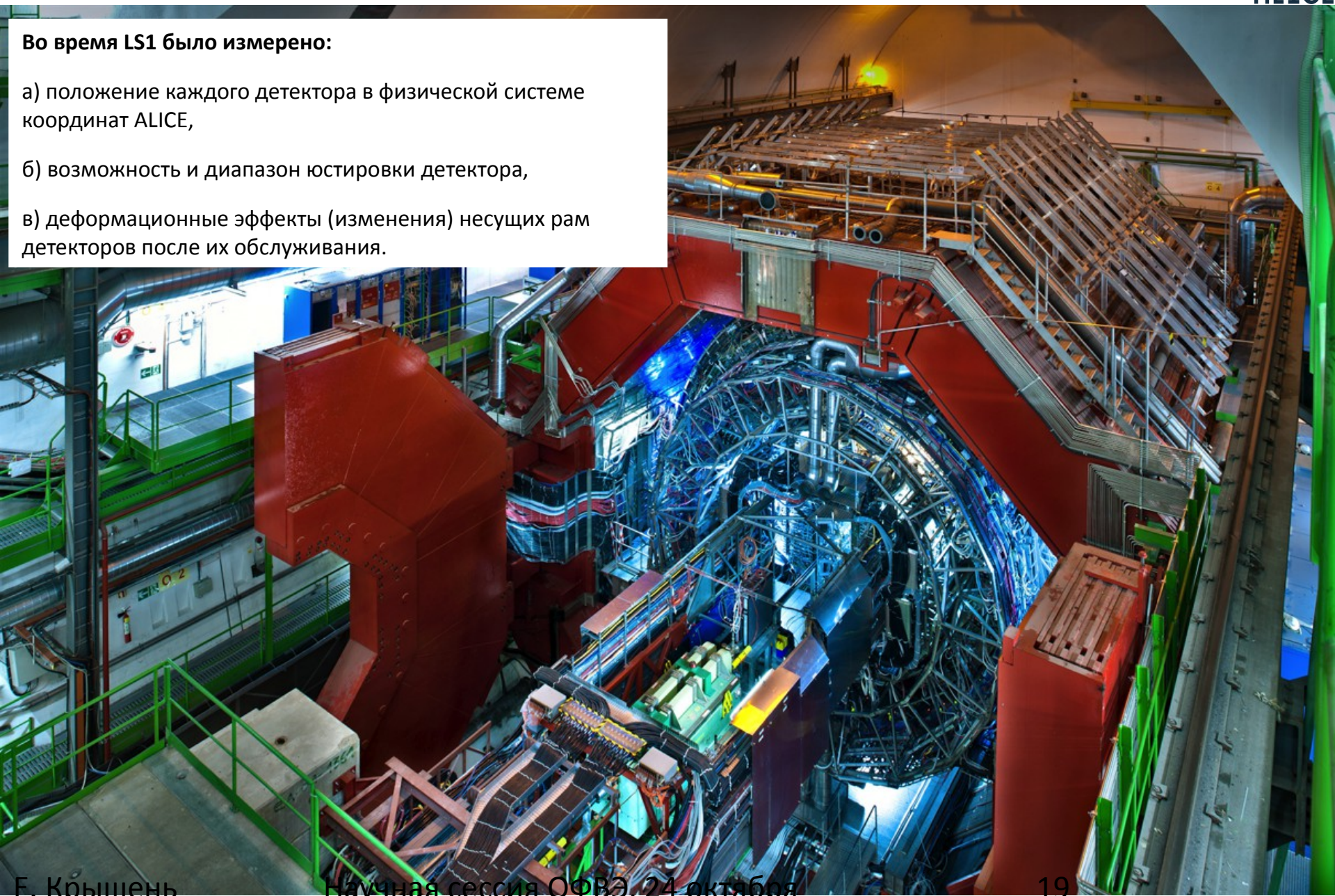
Метрологическое обеспечение

Во время LS1 было измерено:

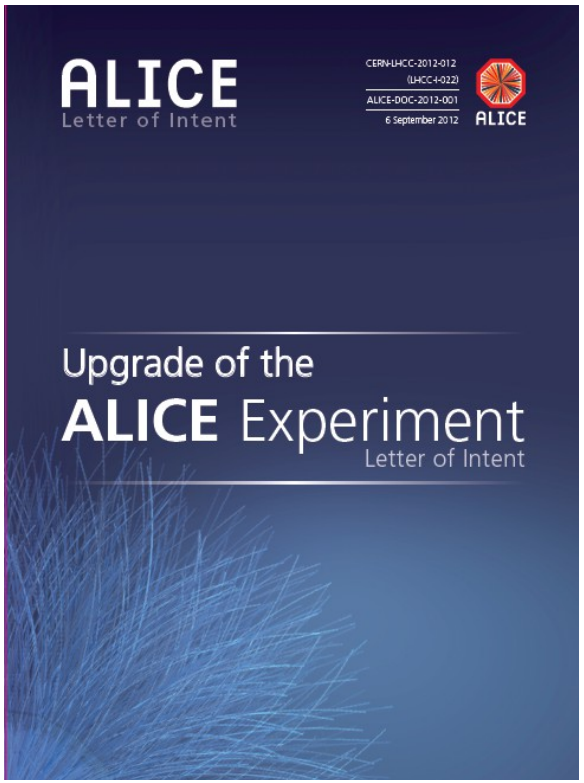
а) положение каждого детектора в физической системе координат ALICE,

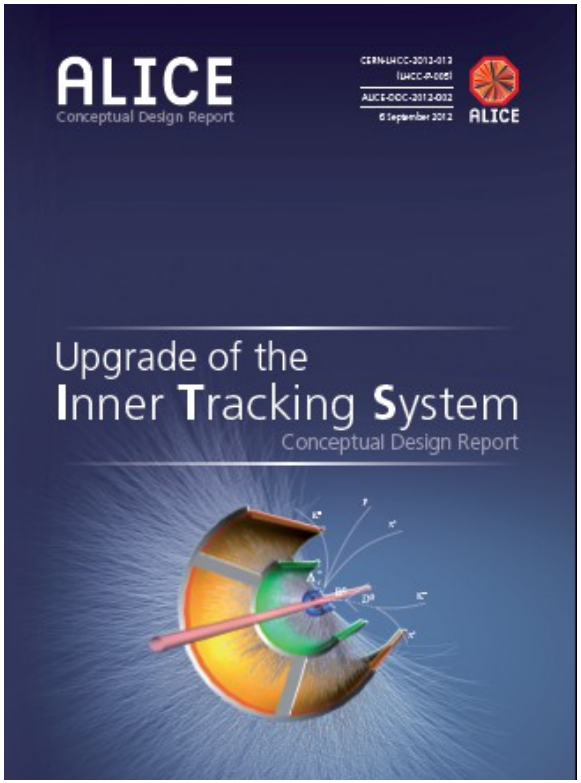
б) возможность и диапазон юстировки детектора,

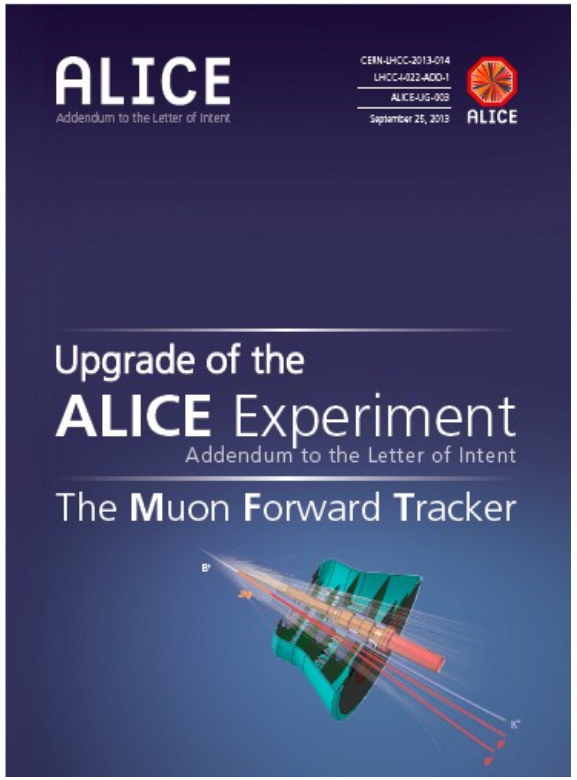
в) деформационные эффекты (изменения) несущих рам детекторов после их обслуживания.



LoI and ITS CDR endorsed by LHCC in Sep 2012
MFT as addendum to LOI endorsed by LHCC in Sep 2013



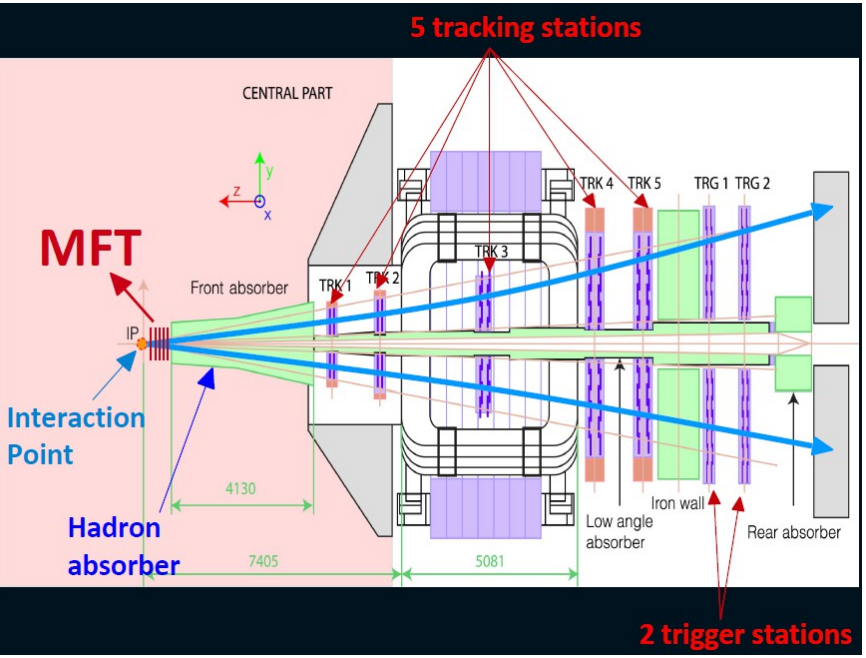


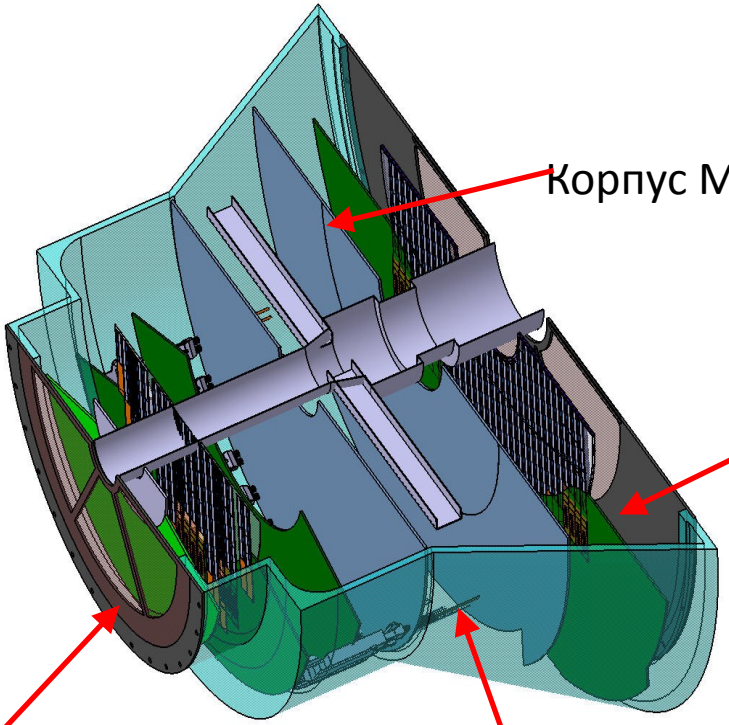


– **LOI Approved by Research Board** Nov 28th 2012

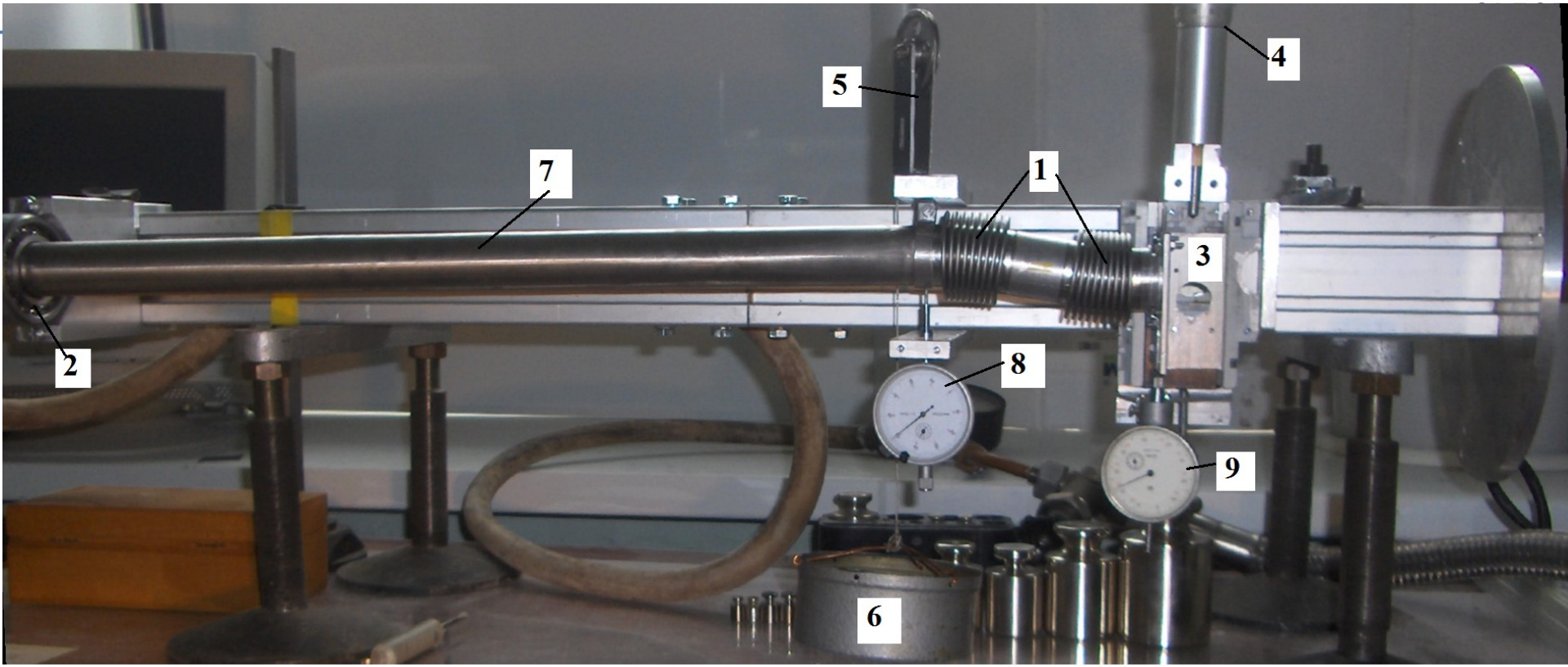
*"**The Research Board approved the upgrade of ALICE for the physics case that has been made in the LoI,** based on up to 10 nb-1 of data taken with lead ions, implying that **the experiment will continue to run beyond 2018**. The CERN accelerator departments should assess the feasibility of delivering the requested integrated luminosity"*

MFT: вершинный детектор мюонного плеча





Участие ПИЯФ в проекте МФТ: подвес пучковой трубы



1: Сильфоны; 2: Узел фиксации; 3: “Фланец абсорбера”; 4: узел смещения фланца; 5: блок; 6: вес, прилагаемый к точке поддержки; 7: пучковая труба под вакуумом; 8: индикатор смещения точки подвески; 9: индикатор смещения фланца.

Основная неопределенность в моделировании системы поддержки

пучковой трубы проистекает из неясности строения сильфонов.

На стенде было продемонстрировано согласие результатов измерений

с ожидаемыми значениями в модели сильфона постоянной толщины

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Conferences, publications, proceedings…

Доклады на конференциях:

- V. Guzey. Exclusive processes with nuclei at the EIC. POETIC workshop. Jyväskylä, 2nd-5th September 2013
- E. Kryshen. Recent ALICE results on Pb-Pb and p-Pb ultraperipheral collisions. CERN LHC Seminar, (CERN, France, December 17, 2013)
- E. Kryshen. ALICE status and perspectives on photoproduction and diffractive processes in pA and AA collisions. SaporeGravis workshop, (Nantes, France, December 2, 2013)
- E. Kryshen. Overview of ALICE results. International conference: "New trends in High Energy Physics 2013" (Alushta, Ukraine, September 23-29, 2013)
- E. Kryshen. Diffraction and ultra-peripheral collisions at ALICE. International conference: "Rencontres de Moriond: QCD and High Energy Interactions" (La Thuile, Italy, 9--16 March, 2013). Proceedings: arXiv:1306.1072
- E. Kryshen. Ultra-peripheral collisions with ALICE. International workshop ''Results and prospects of forward physics at the LHC`` (CERN, Switzerland, 11--13 February, 2013).

Proceedings:

- E.L. Kryshen for the collaboration. Diffraction and ultraperipheral collisions at ALICE. arXiv:1306.1072 [nucl-ex].
- E.L. Kryshen for the collaboration. ALICE status and plans. arXiv:1305.2804 [nucl-ex]. PoS IHEP-LHC-2012 (2012) 002.
- E.L. Kryshen for the collaboration. Overview of ALICE results. arXiv:1310.5819 [nucl-ex]

Papers:

- 34 papers by ALICE collaboration +
- V. Guzey, M. Zhalov. Exclusive J/ψ production in ultraperipheral collisions at the LHC: constrains on the gluon distributions in the proton and nuclei. JHEP 1310 (2013) 207
- V. Guzey, E. Kryshen, M. Strikman, M. Zhalov. Evidence for nuclear gluon shadowing from the ALICE measurements of PbPb ultraperipheral exclusive J/ψ production. arXiv:1305.1724 [hep-ph]. Phys.Lett. B726 (2013) 290-295
- V. Guzey, M. Zhalov. Rapidity and momentum transfer distributions of coherent J/ψ photoproduction in ultraperipheral pPb collisions at the LHC. arXiv:1307.6689 [hep-ph]
- Научно-технические ведомости СПбГПУ, Физико-математические науки, #3(177) 2013, стр 106-114

Conclusions

- **Successful and fruitful p-Pb run in the beginning of 2013**
- **LS1 consolidation and upgrade ongoing**
- **PNPI team in ALICE data analysis:**
  - Analysis of J/ψ and dimuon pair photoproduction in Pb-Pb UPC finished, 2 papers published, results reported in several conferences
  - Theoretical interpretation of obtained results
  - Analysis of J/ψ photoproduction in p-Pb UPC ongoing
  - $\varphi \rightarrow KK$ production in pp, p-Pb and PbPb: 3 analysis notes issued, preliminary status expected in January 2014, results to be included in two upcoming papers