130th LHCC meeting – Open Session
CERN - 10 May 2017

ALICE Status Report

Livio Bianchi
University of Houston
Detector maintenance and running
Most detectors profited of this long technical stop for maintenance activities

**TRD:**
- Xenon recuperation
- Repair broken optical connections
- Wiener PS firmware upgrade campaign

**TPC:**
- Inspection of TPC inner CO2 volume (guard ring current)
- FEC replacement
- Gas back to neon

**TOF:**
- Displace TOF7 (DC/DC problem)
- Replace DC/DCs and TRMs on several modules

**EMCAL:**
- SRU displacement
- Replace several FEC

**PHOS:**
- Reprogram 5 problematic TRUs, exchange the broken cable for LED and investigate new version of SRU firmware
- Recover 10 FECs in M4

**PMD:**
- Repair several FEC on CPV side (detector in parking position)

**MTG:**
- Change all the 2304 connectors of the FET (Front-End Test) distribution cables on the RPCs

**AD:**
- Shielding to protect ADA from background
- Replace 3 PMTs
- New coax cables ADC
Optimization: TOF calibration

Large/small analogic signals cross FEE threshold at different times
↓
digital signal emitted at different times
↓
time-amplitude correlation (slewing)

**BEFORE**
Parametrization of the time-TimeOverThreshold on a single-chip basis (8 channels)

**NOW**
With higher statistics of Run2 data: channel-by channel residuals estimation

Significant improvement which will lead to smaller systematics!
ALICE detector re-start

Since mid-April: detectors active and ready to take data

Cosmic campaign during LHC re-commissioning phase

Will use cosmic data to align both central detectors and muon spectrometer
ALICE data taking special requests for 2017

- **pp reference run @ 5 TeV**
  - Request: 1000M minimum bias events
    - 128M already collected in 2015
  - Assume 1.5 kHz readout rate → 6.7 days in STABLE BEAM
  - + rare triggers (parasitically)

- **pp data-taking @ 13 TeV with ZDC**
  - Request: 100M minimum bias events with isolated bunches (μ<0.2-0.3%)
    - ~ 2-3 fills
  - ZDC constraints on half total crossing angle:
    - < +85 μrad (< -32 μrad) for positive (negative) crossing

- **pp data-taking @ 13 TeV with reduced B-field (0.2T)**
  - Could be done during the intensity ramp-up phase since solenoid magnetic field has no impact on beam operations
  - ~ 40-45 h data taking

TOP PRIORITY FOR ALICE
Several PbPb and pPb analyses affected by poor 5 TeV pp reference

Supported by LHCC.
ALICE prefers to have it in 2017
Physics results

- Pb-Pb collisions
- p-Pb collisions
- pp collisions
Resonances are powerful tools to probe the hadronic phase after chemical freeze-out
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Resonances in Pb-Pb

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Short-lived resonances exhibit suppression. Suggests elastic scattering dominant mechanism.

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Net particle moments at the LHC

Net particle moments used to measure event-by-event fluctuations on the conserved (on average) charges at the phase boundary:

\[ x = p - \bar{p} \]

\[ \kappa_1(x) = \langle p - \bar{p} \rangle \]

\[ \kappa_2(x) = \langle (p - \bar{p})^2 \rangle - \langle p - \bar{p} \rangle^2 \]

\[ = \kappa_2(p) + \kappa_2(\bar{p}) - 2(\langle p\bar{p} \rangle - \langle p\rangle\langle \bar{p} \rangle) \]

\[ \kappa_2(Skellam) = \kappa_1(p) + \kappa_1(\bar{p}) \]

Correlation term.

Can come from:

- Resonance decay
- Global charge conservation (baryon number, strangeness, ...)

 Difference of two Poisson distributions
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Where does this difference come from?
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Difference of two Poisson distributions

Correlation term. Can come from:

- Resonance decay
- Global charge conservation (baryon number, strangeness, ...)

ALICE Preliminary, Pb-Pb \[ s_{NN} = 2.76 \text{ TeV} \]

\[ 0.6 < p < 1.5 \text{ GeV/c}, |\eta| < 0.8 \]

\[ \kappa_2(p) \neq \kappa_1(p) \]

\[ \kappa_2(\bar{p}) \neq \kappa_1(\bar{p}) \]

Hint for non-Poissonianity of \( p \) and \( \bar{p} \)?
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**Correlation term.** Can come from:

- Resonance decay
- Global charge conservation (baryon number, strangeness, ...)

Model: participants fluctuation (with Poisson input) reproduces \( \kappa_2(p) \), \( \kappa_2(\bar{p}) \), \( \kappa_2(Skellam) \)

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Model arXiv:1612.00702
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Effect of acceptance restriction on deviation from Skellam due to global baryon number conservation.

Correlation observed is due to total baryon conservation.
LHC as a $\gamma$-Pb and $\gamma$-p collider

In ultra peripheral collisions (UPC) hadronic interactions strongly suppressed

High photon flux ($\propto Z^2$)

possible to study photo-induced reactions at highest CM energy ever

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

J/$\psi$ cross-section $\propto$ (gluon density)$^2$ in the target. If target is Pb $\rightarrow$ shadowing
UPC: coherent $J/\psi$ production

Forward-rapidity measurement (muon spectrometer)

100x more statistics than in Run1
Cross-section extracted in 3 $y$-bins.

Coherent contribution extracted in $p_T<0.25$ GeV/c.
Correction for incoherent part estimated with templates from STARLIGHT
UPC: coherent $J/\psi$ production

Will extend this study:
- at central rapidity
- Measuring $J/\psi$ polarization

Stringent constraint on the models
Physics results

- Pb-Pb collisions
- p-Pb collisions
- pp collisions
J/$\psi$ VS multiplicity - p-Pb at 5.02 TeV

ALICE p-Pb $\sqrt{s_{NN}} = 5.02$ TeV

Inclusive J/$\psi$

- 2.03 < $y_{\text{cms}}$ < 3.53, p-going direction
- -4.46 < $y_{\text{cms}}$ < -2.96, Pb-going direction
- -1.37 < $y_{\text{cms}}$ < 0.43

± 3.1% normalisation unc. not shown

Increase different when going from forward to backward rapidity

arXiv:1704.00274
J/ψ VS multiplicity - p-Pb at 5.02 TeV

At central rapidity the trend is similar to the one measured for D mesons:

Increase different when going from forward to backward rapidity
J/ψ VS multiplicity - p-Pb at 5.02 TeV

At central rapidity the trend is similar to the one measured for D mesons:

Theoretical models can now be tested across a very wide dN_{ch}/dη regime

Increase different when going from forward to backward rapidity

The precision of this measurement will improve significantly making use of Run-2 data!

arXiv:1704.00274
Physics results

- Pb-Pb collisions
- p-Pb collisions
- pp collisions
D-jets cross section in pp @ 7 TeV

Study of D-tagged jets in pp collisions: useful to constrain QCD-based models for charm production.

Important for ongoing measurements in p-Pb and Pb-Pb

ALICE Preliminary
pp, √s = 7 TeV
Charged Jets, Anti-k_T, R = 0.4, |η_jet| < 0.5
with D^0, p_T,D > 3 GeV/c

Data are described by POWHEG+PYTHIA within uncertainties

doi:10.1103/PhysRevD.85.052005

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Strangeness production in pp

Transverse momentum spectra of $K^0_S$, $\Lambda$, $\Xi$ and $\Omega$ measured in pp at 7 TeV as a function of charged particle multiplicity at central rapidity.

Total yields:
integrate measured spectra +
add extrapolation to $p_T = 0$

Nature Physics (2017) doi:10.1038/nphys4111
Strangeness enhancement in high multiplicity pp collisions

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Strangeness enhancement in high multiplicity pp collisions

- Strangeness-related: $p/\pi$ and $\Lambda/K^0_S$ unaffected
- Commonly-used event generators at LHC do not reproduce the observed behavior
  (strangeness increase $\Leftrightarrow p/\pi$ increase)
Strangeness enhancement in pp

Strangeness enhancement in high multiplicity pp collisions

- Strangeness-related: \( p/\pi \) and \( \Lambda/K^0_S \) unaffected
- Commonly-used event generators at LHC do not reproduce the observed behavior
- Increase \( \propto \) to \( s \)-content. Hint of QGP in high multiplicity pp and p-Pb collisions?

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Strangeness enhancement in pp

Strangeness enhancement in high multiplicity pp collisions

• Strangeness-related: $p/\pi$ and $\Omega/K_0$ unaffected
• Commonly used event generators at LHC do not reproduce the observed behavior
• Increase $\propto s$-content. Hint of QGP in high multiplicity pp and $p-Pb$ collisions?

Nature Physics (2017) doi:10.1038/nphys4111
Strangeness enhancement: energy dependence?

Strangeness enhancement does not depend on $\sqrt{s}$

Will complement this with high multiplicity triggers at 13 TeV (should reach $\sim dN_{ch}/d\eta = 50$)
Detector upgrade
High precision measurements of rare probes:
- Heavy flavour and quarkonia
- Low mass dileptons
- Jets
- Heavy nuclear states

Target **Pb-Pb luminosity:**
13 nb$^{-1}$ (10x increase in luminosity)

Continuous read-out of all minimum bias Pb-Pb interactions at a rate of 50 kHz

**Online data reconstruction** and compression
**ITS upgrade**

**Pixel Sensor Chips:**
- Mass production started
- PRR Nov.2016
- Production: Jan.2017-Jan.2018

**HIC/Stave:**
- Series production about to start
- PRR: 27 Apr 2017
- Production: Jun.2017 – Aug.2018

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**Pointing Resolution**

- ALICE
  - Current ITS, Z (Pb-Pb data, 2011)
  - Upgraded ITS, Z
  - Current ITS, r (Pb-Pb data, 2011)
  - Upgraded ITS, r

**Tracking efficiency**

- ALICE
  - Current ITS
  - Upgraded ITS

- IB: X/X₀ = 0.3% ; OB: X/X₀ = 0.8%

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**Total weight**

1.4 grams
TPC upgrade with GEMs

Operate at the 50 kHz rate
↓
no gating grid
↓
need to minimize Ion Back Flow to keep space charge distortions at a tolerable level
↓
Replace wire-chambers with GEMs
↓
New readout electronics

ROC + GEM PRR on March 10, 2017:
• Full qualification of pre-production ROCs
• Performance within design specifications
• All production sites ready
• Mass production of 40+40 ROCs started

SAMPA + FEC performance tests ongoing
Summary
Conclusions and Outlook

ALICE is delivering very high quality physics results using Run-1 and Run-2 data. Many new results in preparation for summer conferences.

The detector is back running. A cosmic campaign is ongoing while waiting for beam.

The very ambitious upgrade program for Run 3+4 is on track and is passing important milestones.

Thank you.
Hints for QGP in small systems

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