Data taking 2018

nominal running conditions for pp, rich trigger menu

preparations for the end-of-year Pb-Pb campaign fully underway
aiming for 1 nb\(^{-1}\), running at 1 Hz mb\(^{-1}\)
Submitted papers


2) "Medium modification of the shape of small-radius jets in central Pb-Pb collisions at √s_{NN} = 2.76 TeV", submitted to JHEP, https://arxiv.org/abs/1807.06854


5) "Charged jet cross section and fragmentation in proton-proton collisions at √s = 7 TeV", https://arxiv.org/abs/1809.03232

6) "Energy dependence of exclusive J/ψ photoproduction off protons in ultra-peripheral p-Pb collisions at √s_{NN} = 5.02 TeV", https://arxiv.org/abs/1809.03235
light flavor physics, flow and femtoscopy

ALICE - physics news
Multiplicity dependence of light-flavor hadron production at 7 TeV pp

<table>
<thead>
<tr>
<th>Multiplicity class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma/\sigma_{\text{inel}}$</td>
<td>0-0.95%</td>
<td>0.95-4.7%</td>
<td>4.7-9.5%</td>
<td>9.5-14%</td>
<td>14-19%</td>
</tr>
<tr>
<td>$(dN_{th}/d\eta)$</td>
<td>$21.3 \pm 0.6$</td>
<td>$16.5 \pm 0.5$</td>
<td>$13.5 \pm 0.4$</td>
<td>$11.5 \pm 0.3$</td>
<td>$10.1 \pm 0.3$</td>
</tr>
<tr>
<td>Multiplicity class</td>
<td>VI</td>
<td>VII</td>
<td>VIII</td>
<td>IX</td>
<td>X</td>
</tr>
<tr>
<td>$\sigma/\sigma_{\text{inel}}$</td>
<td>19.28%</td>
<td>28.38%</td>
<td>38.48%</td>
<td>48.68%</td>
<td>68-100%</td>
</tr>
<tr>
<td>$(dN_{th}/d\eta)$</td>
<td>$8.45 \pm 0.25$</td>
<td>$6.72 \pm 0.21$</td>
<td>$5.40 \pm 0.17$</td>
<td>$3.90 \pm 0.14$</td>
<td>$2.26 \pm 0.12$</td>
</tr>
</tbody>
</table>

Forward multiplicity estimator probing the evolution of base physics observables with multiplicity
Particle ratios in pp, p-Pb, Pb-Pb collisions

$p/\pi \sim \text{constant}$

$K^*$ rescatters

$\Lambda, \Xi, \Omega/\pi$ suggests strangeness enhancement

**new** $\phi/\pi$ hidden strangeness ($s\bar{s}$), doesn't follow $\Lambda, \Xi, \Omega/\pi$ ratio

Smooth evolution of yields across systems and energies

Same production mechanism?
Particle ratios in pp, p-Pb, Pb-Pb collisions

more results in preparation

smooth evolution of yields across systems and energies

same production mechanism?

\[ \frac{p}{\pi} \sim \text{constant} \]

\[ \text{K}^* \text{ rescatters} \]

\[ \Lambda, \Xi, \Omega/\pi \text{ suggests strangeness enhancement} \]

\[ \text{new } \phi/\pi \text{ hidden strangeness (s}\bar{s}) \text{, doesn't follow } \Lambda, \Xi, \Omega/\pi \text{ ratio} \]

smooth evolution with \[ \langle dN_{ch}/d\eta \rangle \]
$v_n$ - continuing the path of high precision

High precision measurements of ratios of $v_n$ at different energies constrain viscosities $\eta/s(T)$, $\zeta/s(T)$.
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$\rho_T$ differential shapes sensitive to $\eta/s(T)$, $\zeta/s(T)$, initial conditions.
$v_n$ - continuing the path of high precision

$v_n$ of identified particles in p-Pb show similar features as Pb-Pb (mass ordering, baryon/meson splitting)

Evolution of collectivity with multiplicity
Constraining hyperon-nucleon potentials

exploiting femtoscopy to study unknown correlations among hyperon-nucleon pairs

\[ C(k^*) = \int S(r) |\Psi(k^*, \vec{r})|^2 \, d\vec{r} \]

Emission source: Two-particle wave function

pp benchmark: correlation well described

\( pp \)

ΛΛ shallow attractive interaction favored

\( \Lambda \Lambda \)
Constraining hyperon-nucleon potentials

exploiting femtoscopy to study unknown correlations among hyperon-nucleon pairs

\[ C(k^*) = \int S(r)|\Psi(k^*, r)|^2 \, d^3r \]

Emission source Two-particle wave function

ΛΛ-interaction: strong constraints on the scattering parameter phase space in terms of effective range \( d_0 \) and scattering length \( f_0 \) described

pp benchmark: correlation well described

ΛΛ shallow attractive interaction favored

pPb: strong attractive potential for pΞ, in line with calculations by HAL QCD collaboration
hard probes - parton energy loss and jet substructure

ALICE - physics news
In-medium energy loss using $\pi^0$ spectra

$$R_{AA} = \frac{dN_{AA}/dp_T}{N_{coll}dN_{pp}/dp_T}$$

$\pi^0$ spectra measured with high precision up to $p_T = 30$ GeV/c

significant improvement of uncertainties w.r.t. 2.76 TeV

strong centrality dependence in $R_{AA}$

constrains the role of in-medium path length of energy loss
Medium modification of jets

Jet girth in PbPb shifted toward lower values w.r.t. pp/PYTHIA indicates harder and more collimated (quark-like) fragmentation in Pb-Pb than in vacuum.
Exploring the phase space of jet splittings

Intra-jet splittings studied by declustering:

Re-wind last clustering step and evaluate

\[ z = \frac{\min(p_{T,1}, p_{T,2})}{p_{T,1} + p_{T,2}} \]

Define hard splitting when

\[ z > z_{\text{cut}} \]
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Possible to repeat on hardest prong to find \( n_{SD} \) splittings
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Possible to repeat on hardest prong to find \( n_{\text{SD}} \) splittings

no difference in \( n_{\text{SD}} \) between PbPb and vacuum
Exploring the phase space of jet splittings

first splitting at **small** angles: no difference between Pb-Pb jets and vacuum reference

first splitting at **large** angles: overall suppression in tagged Pb-Pb jets, steeper $z_g$ distribution
di-electrons and quarkonia

ALICE - physics news
Dielectron production in pp, Pb-Pb

ALICE

pp: $p_{T,e} > 0.2$ GeV/c, $|\eta| < 0.8$

Pb-Pb: $p_{T,e} > 0.4$ GeV/c, $|\eta| < 0.8$

$B = 0.5$ T

Light meson decays
c$ \rightarrow e^+ e^-$

bb $\rightarrow \gamma \gamma$

Total cocktail

No significant low-mass enhancement from $\rho$ modification in central Pb-Pb collisions but limited by statistics and cocktail uncertainty

12/9/2018
Dielectron production in pp, Pb-Pb

No significant low-mass enhancement from $\rho$ modification in central Pb-Pb collisions but limited by statistics and cocktail uncertainty

Zooming in: data are consistent with expanding fireball model and parton-hadron-string dynamics transport approach that worked well at RHIC&SPS
sensitivity to nuclear modification (\(R_{ppPb}\) and \(Q_{pPb}\)) increased with luminosity via reduced uncertainties and increased range
Forward $Y$ and $J/\Psi$ production at 8 TeV p-Pb

Both CGC and gluon nPDF's describe the observed $J/\Psi$ suppression.

For $Y(1S)$:
- $\eta > 0$: suppression with weak $p_T$ dependence
- $\eta < 0$: suppression not reproduced by shadowing in nPDF
Forward $Y$ and $J/\Psi$ production at 8 TeV $p$-Pb

No difference between $Y(1S)$ and $Y(2S)$ suppression within uncertainties

for $Y(1S)$

- $\eta > 0$: suppression with weak $p_T$ dependence

$\eta < 0$: suppression not reproduced by shadowing in nPDF

for $Y(1S)$
upgrades

preparing ALICE for RUN 3 and RUN 4
Upgrade strategy

goal: high precision measurements of rare probes at low $p_T$, cannot be triggered

target at recorded Pb-Pb luminosity $\geq 10 \text{ nb}^{-1}$ (8x10^{10} collisions) gain factor 100 in statistics over RUN 1 + RUN 2 program

significantly improve vertexing and tracking

detector requirements:

read out all Pb-Pb interactions at a maximum rate of 50kHz (i.e. $L=6\times10^{27} \text{ cm}^{-1}\text{s}^{-1}$) continuously or upon minimum bias trigger

perform online data reconstruction based on reconstruction of clusters and tracks

improve vertexing and tracking at low $p_T$ with new Inner Tracking System (ITS)
Upgrades

Time Projection Chamber (TPC)
- New readout chambers using GEM technology
- New electronics for continuous readout (SAMPA)

MUON ARM
- New electronics for Muon Chambers (SAMPA)
- New electronics for Muon Trigger

New Trigger Detectors (FIT)
New Central Trigger Processor (CTP)
TOF, TRD new readout electronics
PHOS, EMCAL, CPV, HMPID improvement of readout rate with existing electronics

Common Projects:
Common Readout Unit (CRU) for all detectors (PCI card)
SAMPA common FE chip for TPC and Muon arm

Online Offline (O2) system
- New computing facility
- On-line tracking & data compression
- 50kHz PbPb event rate
New Inner Tracking System (ITS)
• Improved pointing precision
• Monolithic CMOS sensors (ALPIDE) with very small material budget
• Smaller beampipe, 1st layer closer

Muon Forward Tracker (MFT)
• New tracker based on ALPIDE
• Improved MUON pointing precision, prompt vs. decay muons
Detailed description of what will be installed: EDMS 1890533

- 5km INOX cooling pipes (MFT, ITS)
- 45km copper cables (ITS, TPC, MFT, FIT, MCH, CPV and ZDC)
- 4.5km of 300mm² LV cables (TPC/TRD/TOF)
- 20km optical cables (28k links) and 4600 patch cords

Close collaboration with EN-EA and EN-EL

90% of the material ordered, partly already delivered at P2
Services and infrastructure

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O2 computing facility infrastructure on its way

Acoustic noise measurement and simulation complete

Civil engineering work complete

Cooling and Electrical infrastructure installation ongoing

Power module delivered September 11th

Site Acceptance Test in October/November

2nd batch (2 IT) September 2019
Inner barrel reconstruction (CERN)

Time to assemble one layer ≈ 2 hours

⇒ Inner Barrel nearly completed. Last layer will be assembled by mid September
Inner barrel reconstruction (CERN)

Production of outer structural shell and service barrel (Berkeley)
TPC upgrade for continuous readout

80 new GEM-based Readout Chambers
- 40 Inner (IROC) and 40 Outer (OROC)
- Status: 61 assembled, 49 delivered to CERN
- Production finishes in October 2018

3670 new Frontend-Cards
- Design phase finished
- Ready for mass production
- All cards available in March 2019

ROC storage at CERN P2
data taking in nominal conditions ongoing, preparing for Pb-Pb run
many new physics results from Run II
upgrades on track for LS2
backup
Fig. 4 $\Lambda-\Lambda$ interaction potentials as a function of the relative distance $r$. The parametrization in Eq. (10) is taken from [70].