Instructions for moderators

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ALICE measurement: Looking for strange particles in ALICE

Topic of the measurement

- Identify strange particles (V0s : Ks, Λ, anti-Λ) from their decay pattern, combined with calculation of their invariant mass.
- Find number of Ks, Λ, anti-Λ for different centrality regions for lead-lead data
- Calculate yields for Ks, Λ, anti-Λ and strangeness enhancement factors by comparing to proton-proton data
- Optional: particle ratios as input to thermal model to estimate temperature

What the students do in each institute

Visual analysis

Using a simplified version of the ALICE event display based on ROOT, they identify and classify strange particles (V0s : Ks, Λ, anti-Λ) from their decay pattern, combined with invariant mass calculation. Each group of 2 or 3 students looks at 15 events.

At the end of this first part, the tutor merges the results of all groups and produces invariant mass plots for Ks, Λ, anti-Λ.

They can give the mass values and width of the peaks.

Large scale analysis - Find V0s in different centrality regions in PbPb collisions

Students analyse large datasets, by running a programme that selects V0s, calculates the invariant mass and produces an invariant mass plot; each group of 2 or 3 students is assigned a centrality region and they have to find the number of K_s, Λ, anti-Λ in this region. To do this, they have to fit curves to the combinatorial background and the peak and subtract.

Calculation of particle yields and strangeness enhancement factors

Each group reports the number of K_s, Λ, anti-Λ they found in the centrality class that they have analysed. The results for the whole class are entered in a spreadsheet as the following

centrality	<Npart>	Nevents	NKs	efficiency Ks	yield Ks	Ks enhancem
0-10	360	213	4816	0.26	86.963	1.933
10--20	260	290	4638	0.26	61.512	1.893
20-30	186	302	3750	0.29	42.818	1.842
30-40	129	310	2610	0.29	29.032	1.800
40-50	85	302	1493	0.29	17.047	1.604
50-60	52	300	777	0.29	8.931	1.374
60-70	30	315	409	0.35	3.710	0.989
70-80	16	350	149	0.26	1.637	0.819

The number of events in each centrality region is given in the spreadsheet.

The number of participating nucleons in the collision, N_{part}, which is correlated with the centrality, is also given in the table for each centrality class.

The number of particles measured is less than the number of particles produced; to find the latter we need to take into account the efficiency; efficiency values, for K_s, Λ and anti-Λ, have been estimated and are given in the table.

In the spreadsheet, there are embedded formulas to calculate:

Yield : the number of particles (of a certain type) produced per interaction = Nparticles(produced)/Nevents = Nparticles(measured)/(efficiency x Nevents)

Strangeness enhancement: the particle yield normalised by the number of participating nucleons in the collision, and properly normalised by the yield in proton-proton collisions at the same collision energy.

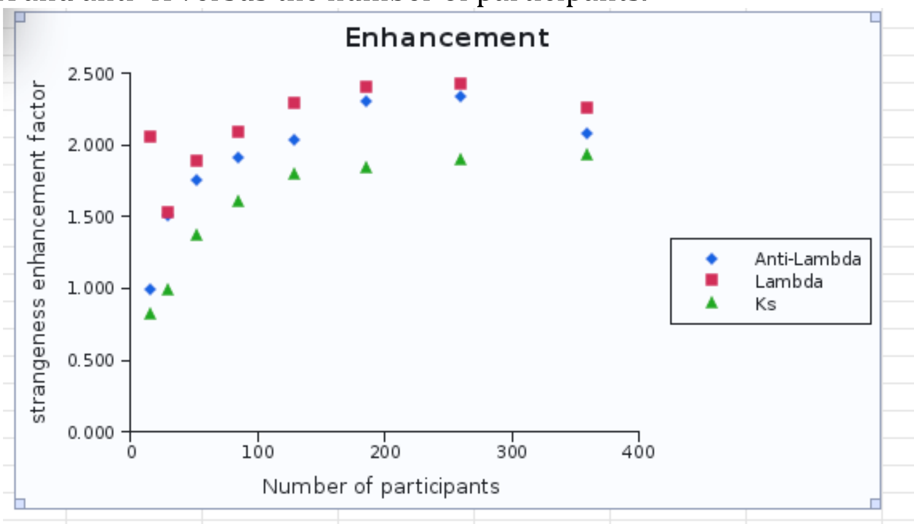
Ks-Yield(pp) = 0.25 /interaction
Λ-Yield(pp) = 0.0615 /interaction ; the same for anti-Λ
<Npart> = 2 for pp

NOTE: the above yields for Ks and Λ refer to proton-proton collisions at 2.76 TeV (same energy as for Pb-Pb collisions, 2.76 TeV per nucleon pair); they have been calculated by interpolation, between measured K_s and Λ yields at 900 GeV and 7 TeV [internal ALICE notes].

With all this information a spreadsheet like the following is produced with the information for K_s, Λ and anti-Λ.

centrality	<Npart>	Nevents	NKs	efficiency Ks	yield Ks	Ks enhancem	Nlambda	efficiency L	Yield Lambda	Lambda enh	Nantilambda	effic antiL	yield antiLam	antiL enha
0-10	360	213	4816	0.26	86.963	1.933	1066	0.2	25.023	2.253	980	0.2	23.005	2.071
10--20	260	290	4638	0.26	61.512	1.893	1185	0.21	19.458	2.426	1142	0.21	18.752	2.338
20-30	186	302	3750	0.29	42.818	1.842	917	0.22	13.802	2.405	875	0.22	13.170	2.295
30-40	129	310	2610	0.29	29.032	1.800	621	0.22	9.106	2.288	550	0.22	8.065	2.026
40-50	85	302	1493	0.29	17.047	1.604	363	0.22	5.464	2.084	332	0.22	4.997	1.906
50-60	52	300	777	0.29	8.931	1.374	182	0.2	3.033	1.891	169	0.2	2.817	1.756
60-70	30	315	409	0.35	3.710	0.989	89	0.2	1.413	1.526	88	0.2	1.397	1.509
70-80	16	350	149	0.26	1.637	0.819	71	0.2	1.014	2.055	34	0.2	0.486	0.984

Embedded in the spreadsheet is a scatter plot, showing the enhancement factors for K_s, Λ and anti- Λ versus the number of participants.



These results can be produced as follows:
Go to www.editgrid.com and login as

User alice-masterclass
Password alice

The example spreadsheet is
http://www.editgrid.com/user/alice-masterclass/centr-results-example.csv

Each institute can fill in a spreadsheet
http://www.editgrid.com/user/alice-masterclass/centr-results_inst_name.csv
(inst_name will be the name of the institute, e.g. CERN, Nantes, Heidelberg…)

DISCLAIMER : The results in this example – and the results produced by this analysis – are based on a small dataset selected for this measurement and on a number of assumptions and simplifications; therefore they may differ from official ALICE results.

Institutes' report and comments

The institutes must prepare one of the students to report the results during the videoconference.

He/she could report on the visual analysis first: they could say that they analysed xxx number of events, found y1, y2, y3 number of Ks, Lambda and antiLambda and the values of the mass (peak of the distribution) were as expected.

They should then report on the large scale analysis in centrality regions.

By logging in at the site www.editgrid.com as in the previous section, the moderator should bring to the screen and show the spreadsheet with the institute's results, including scatter plot.

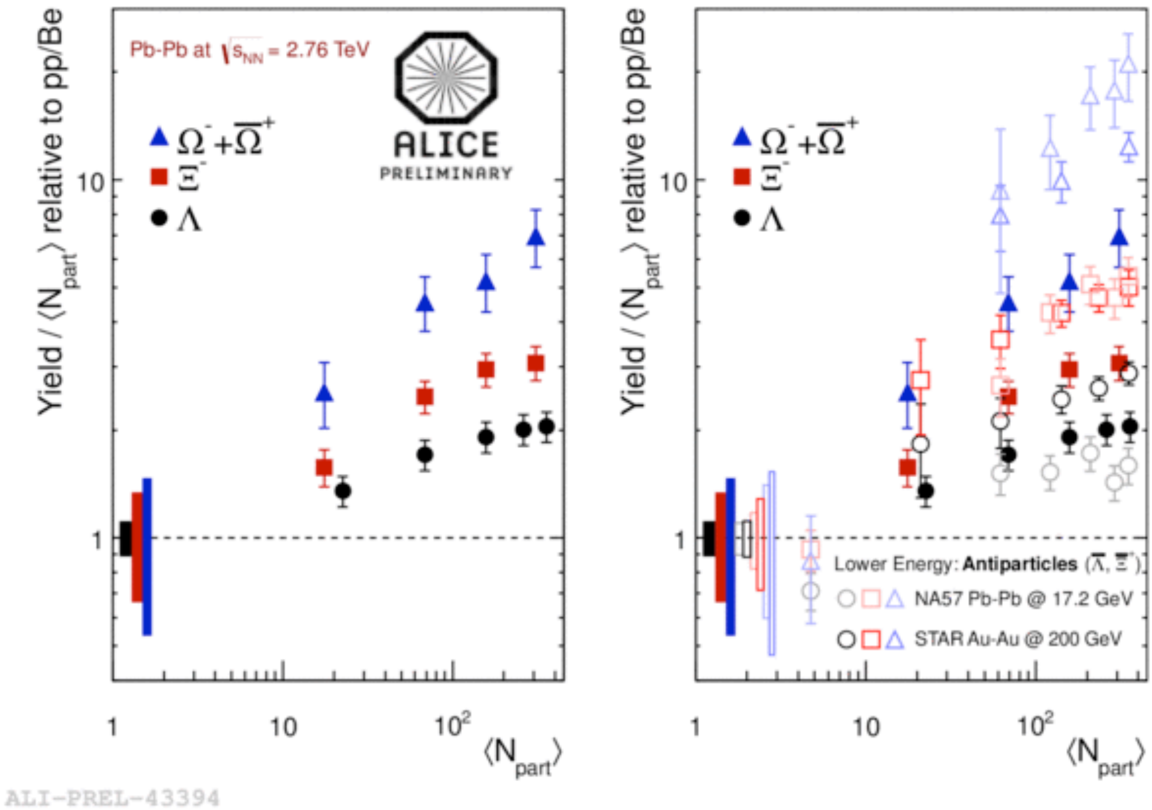
Once all institutes have presented their results, comparisons can be made.
If there is enough time, the moderators can fill online a summary spread sheet.
For example, for Lambdas, the spread sheet :
http://www.editgrid.com/user/alice-masterclass/ centr-results-lambda-all.csv

Possible comments :

The number of Ks, Lambda and antiLambda (and the calculated yield) is higher for more central collisions. This is normal since, in the most central ones, up to ~400 nuclei in total interact, which results in thousands of particles produced per collision.

Strangeness enhancement is observed (ratio >1). Ratio=1 would mean that there is no difference between collisions of nucleons of the lead nuclei and collisions of protons.

Show ALICE preliminary results



The students have only measured Λ (1 strange quark); Their measurement is in agreement with the ALICE preliminary results, within errors. (In addition, assumptions were made about the efficiency – real life analysis takes much longer – things were simplified here to complete the measurement).

The other particles shown on the plot have higher content of s-quarks: the Ξ has 2, the Ω 3. Strangeness enhancement increases with the number of strange quarks in the baryon.
The right-hand plot shows preliminary results of ALICE and for comparison results from lower energy heavy ion collisions. (NA57 and RHIC)

Note

If there is a problem with accessing editgrid, the institutes can use excel spreadsheets with embedded scatter plots, or extract the necessary data from the excel file and create a text file which is read by a root macro and thus produce plots. They can then show them by screen sharing.

Additional information can be found at the URL

http://aliceinfo.cern.ch/public/MasterCL/MasterClassWebpage.html

the text describing the measurement
also

“Instructions to the Institutes”
http://aliceinfo.cern.ch/public/MasterCL/InstituteInstructions2013.pdf

Temperature Calculation

An additional comment can be made by the moderators on the calculation of temperature from particle ratios, see above document “Instructions to the Institutes”, along the lines:

Based on the measured particle yields, particle ratios can be calculated, i.e. K0s/pions, Λ/pions etc. These, together with many other particle ratios, are used by a model which can estimate the temperature of the created matter. This is found to be of the order of 200 000 times higher than at the centre of the sun. Normal matter cannot exist at such temperatures. Furthermore, this temperature is compatible with the one expected if a quark-gluon plasma is created.