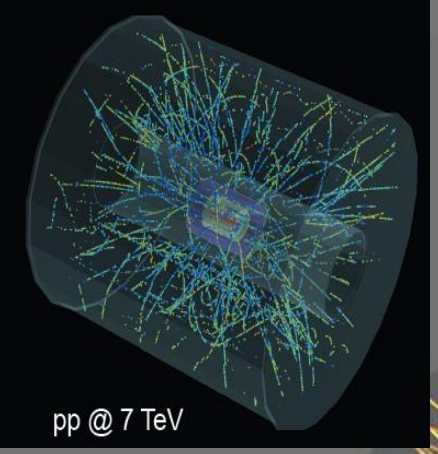
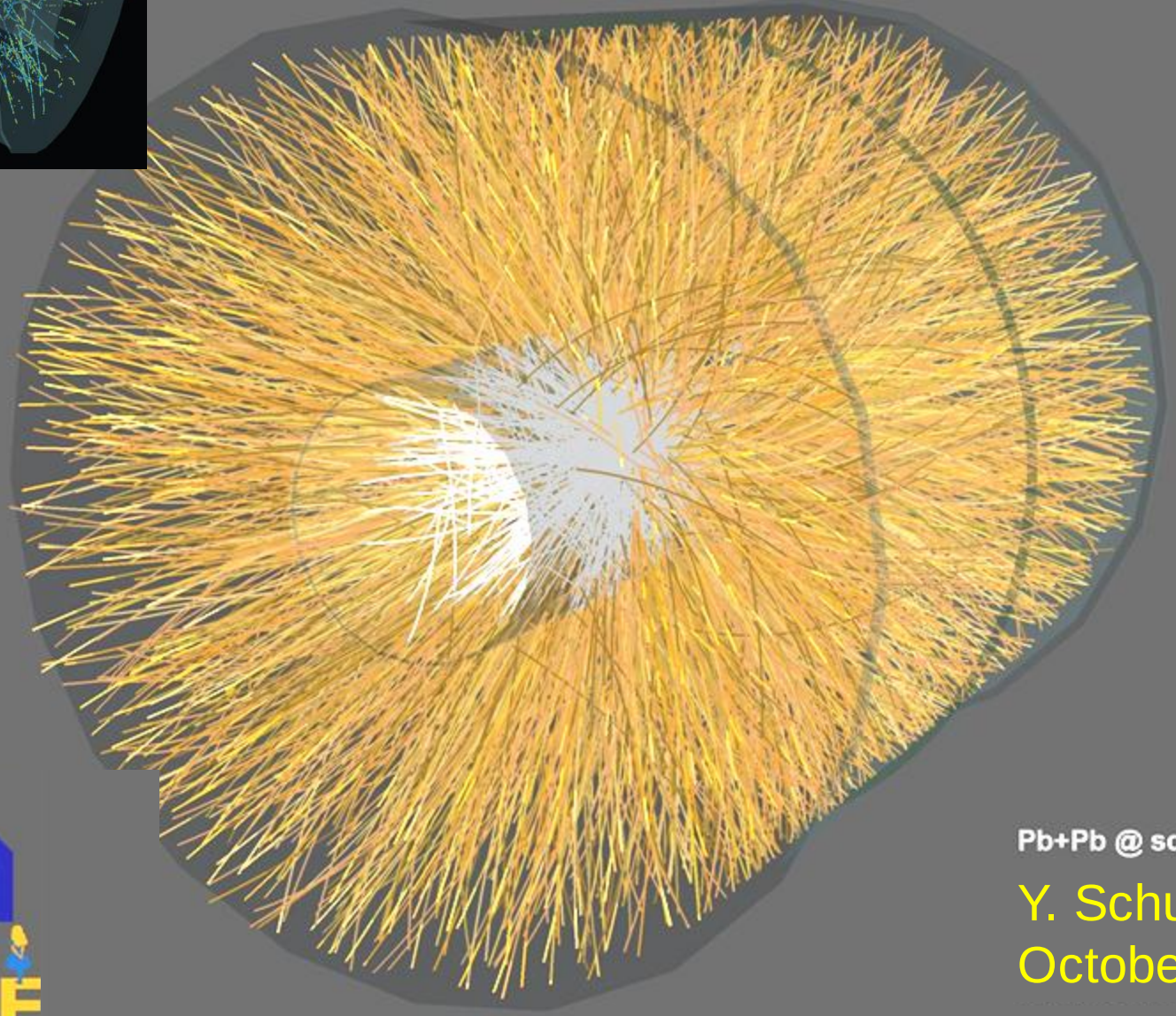


CERN-Korea Meeting
ALICE Status



Y. Schutz

October 17, 2012

ALICE

Collaboration News

Detector and run Status

Physics Results

Outlook

Collaboration News

- **Elections: 2 Management Board Members**
  - R. Nania (Bologna, Italy) and G. Marinez (Nantes, France)
- **New Institutes Applying**
  - **Suranaree University of Technology (SUT)** (Thailand) 'associate member' **Computing / Physics**
  - **Talca University (Chile)** 'associate member' **Computing**
  - **U. Frankfurt Institut fur Informatik,Fachbereich Informatik und Mathematik to replace KIP – Heidelberg** (transfer of group)
- **Ongoing Discussions**
  - **Comsats** (Pakistan): move to full member from associate member **Physics, ITS upgrade**
  - **KISTI** (Korea) : move to full member from associate member **Computing**
  - **Pinstech** (Pakistan) : 'associate member status', **Physics, Computing**
  - **Egypt** (initially via JINR),
- **UK Funding**
  - Just after last RRB new grant to continue participation in ALICE
- **Organization**
  - Physics Board being restructured: PWGs go from 4 to 8, to ensure a more effective steering of the many analysis activities

Korean Participation in ALICE

- Participating Groups:
  - Gangnung-Wonju National University**:**
    - **TOF** assembly & commissioning, **Muon arm** operation, physics
  - **Sejong:**
    - Grid **computing**, physics
  - **Yonsei:**
    - **TRD** assembly and commissioning, physics
  - **Pusan** (replacing Pohang)
    - **HMPID** R&D and operation, physics
  - **Kisti:** (associate member) since Nov 2010
    - ALICE-Korea GRID **computing** center
- Korea is a major player in ALICE!

Activity Report by Prof. In-Kwon Yoo

	number of scie as 1/9/2011	M&O Cat A without energy	Energy in CHF	Energy billed t	Bill FOR 2012 i
CERN	50	429,043	207,478		429,043
Czech Republic	11	94,390	45,645		94,390
Denmark	8	68,647	33,197		68,647
Finland	6	51,485	24,897		51,485
France CEA	7	60,066	29,047		60,066
France IN2P3	48	411,882	199,179		411,882
Germany BMBF	37	317,492	153,534		317,492
Germany GSI	22	188,779	91,290		188,779
Greece	2	17,162	8,299		17,162
Hungary	3	25,743	12,449		25,743
Italy Centro Fermi	6	51,485	24,897		51,485
Italy INFN	107	918,153	444,003		918,153
Netherlands	10	85,809	41,496		85,809
Norway	17	145,875	70,543		145,875
Poland	18	154,456	74,692		154,456
Slovak Republic	10	85,809	41,496		85,809
Spain/Cuba	5	42,904	20,748		42,904
Sweden	3	25,743	12,449		25,743
United Kingdom	7	60,066	29,047		60,066
Armenia	2	17,162	8,299	8,299	25,461
Brazil	6	51,485	24,897	24,897	76,383
China Wuhan CCNU	4	34,323	16,598	16,598	50,922
China Beijing	1	8,581	4,150	4,150	12,730
Croatia	5	42,904	20,748	20,748	63,652
India	31	266,007	128,637	122,694	388,701
Japan	10	85,809	41,496	39,827	125,636
JINR	8	68,647	33,197	33,197	101,843
Mexico	12	102,970	49,795	49,795	152,765
Republic of Korea NRF	10	85,809	41,496	41,496	127,304
Peru	1	8,581	4,150	4,150	12,730
Romania ISS	4	34,323	16,598	16,598	50,922
Romania NIPNE	7	60,066	29,047	29,047	89,113
Russia	40	343,235	165,983	120,973	464,208
South Africa	7	60,066	29,047	29,047	89,113
Ukraine KIPT	1	8,581	4,150	4,150	12,730
Ukraine Kiev	3	25,743	12,449	12,449	38,191
USA DOE	40	343,235	165,983	161,142	504,377
USA NSF	6	51,485	24,897	24,171	75,657
Total	575	4,934,000	2,386,000	763,427	5,697,427

Table 2: Sharing of the 2012 draft budget (in CHF)

2012 M&O Budget for Korea
10 scientists: 127 kCHF

Sharing of the M&O-B 2012 budget in kCHF	ITS Common	ITS-SPD	ITS-SDD	ITS-SSD	TPC	TRD	TOF	HMPID	PHOS	EMCAL-DCAL	FMD	T0	V0 A	V0 C	PMD	ZDC	ACORDE	MUONS TRACKING	MUONS TRIGGER	CENTRAL TRIGGER	Grand Total in kCHF
CERN	25.5	42.8		23.6	23.2			43.4													158.4
Czech Republic	2.4		13.5																		15.9
Denmark					4.6						25.0										29.6
Finland												48.4									48.4
France CEA																		10.0			10.0
France IN2P3	9.1			39.5						8.4			14.0					32.0	40.0		143.0
Germany BMBF						153.1															153.1
Germany GSI					83.4																83.4
Italy INFN	71.0	42.8	206.7	63.0			72.0	101.2		18.4						35.0		27.0	30.0		667.0
Netherlands	9.8			42.4																	52.2
Norway									20.0												20.0
Poland					4.2																4.2
Slovakia	4.4	9.5			2.8																16.7
Sweden					26.0																26.0
United Kingdom																				20.0	20.0
China									10.0	5.6											15.6
Croatia					0.8																0.8
India															29.0			10.0			39.0
Japan									20.0	8.4											28.4
JINR						7.1															7.1
Mexico														11.0			15.0				26.0
Republic of Korea							48.0												5.0		53.0
Romania NIPNE						3.3															3.3
Russia	0.5		2.6	1.8					108.0									4.0			116.9
South Africa																		4.0			4.0
Ukraine	5.2		13.5	12.2																	31.0
United States DOE										36.9											36.9
United States NSF	0.1		0.7																		0.8
Total	128.0	95.0	237.0	182.5	145.0	163.5	120.0	144.5	158.0	77.7	25.0	48.4	14.0	11.0	29.0	35.0	15.0	87.0	75.0	20.0	1810.6

Table 4: Sharing of the 2012 M&O Cat. B draft budget (in kCHF)

Budget scrutinized by the RRB Scrutiny Group, as well as discussed within projects and the Funding Agencies concerned.

TOF: 48K CHF

MUON Trigger: 5K CHF

Detector Status

- In 2010 ALICE took p-p Minimum Bias data at around 15kHz interaction rate (L ~ 2x1029).
- In 2011 we switched to rare triggers and increased rates up to 150kHz (L ~ 2x1030) i.e. >10 pileup events in the TPC. ALICE operation has been remarkably stable at this rate.
- Few issues still open
  - SPD cooling problem that forces us to switch off a significant fraction of the detector.
    - need to wait for the long shutdown for major intervention (being planned and prepared)
  - TPC wire chamber trips and related channel loss.
    - This problem is understood and currently 'cured' by lowering the gas gain and limiting the total rate to 200kHz. This will be fixed in the coming winter shutdown by modifying the HV capacitors which should allow the TPC to operate at nominal gain and significantly higher rates.

ALICE 2011 running

- Short (35 hours) pp run at 2.76 TeV to collect > 50 M events for reference at the same c.m. energy as the Pb runs: collected 74 M minimum bias events and 10 M of rare triggers (Muon, EMCAL: 18 nb^{-1})

✓

Very Successful, great LHC operation: Thanks!

- pp at 7 TeV: add to integrated luminosity for comparison with the ~ 40 μb^{-1} foreseen in the 2010- 2011 Pb runs (*more will be needed* for the comparison of the future High-Luminosity HI runs)
  - Complete original goal of ~ 10^9 events min bias (about half was taken in 2010) at 10 kHz
  - Collect **at least** ~ 2 pb^{-1} for rare triggers (hard processes scale as $N_{coll} \sim A^2$)
    - 10% dead time (100 Hz trig rate)

    → ~ 20 nb^{-1}/day (*daily stat ~ total 2010*)

    → 2 pb^{-1} in 100 days

    → Triggers: dimuon, high-p_T single muon, EMCAL, PHOS, diffractive + small percentage of MB

Ongoing now:
Recorded ~2.2 pb^{-1} with EMCAL trigger, ~2.4 pb^{-1} with unlike sign dimuon trigger

- **Second PbPb run in the fall, with increased luminosity (3 to 5 times 2010)**

- In preparation for the Pb run, validating HLT data reduction (store only reconstructed clusters in the TPC)

Run 2011: Status

Aim: collect at least

- 500 M min bias events to reach the original goal of 10^9 events (double 2010 min bias statistics)
- >10 pb-1 (2011+2012) rare triggers (jets, muons, photons) for the comparison with PbPb

Current status:

- Minimum bias program completed: > 500 M events recorded before the summer
- Rare triggers:
  - > 2.0 pb^{-1} EMCAL, dimuon (opposite sign) (jets, muons, photons)
- PHOS trigger data taking started
- > 5M cosmic events

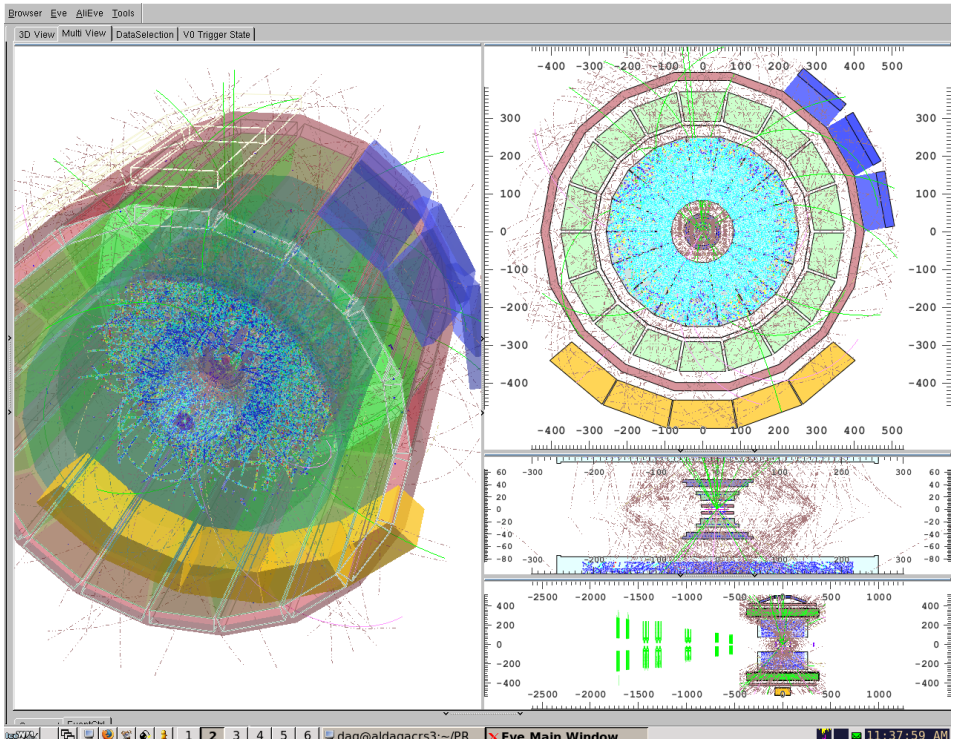
- Background level very high since LHC operation with 1380 bunches, serious impact on the data taking efficiency
- After last technical stop (end of September) worse situation
- Higher beam intensity + reversed ALICE solenoid polarity
- High background correlated with poor vacuum actively investigated by the machine/vacuum group

- Luminosity measurement based on T0 detector in operation (insensitive to background)
- Refined background measurement available in TIMBER

Run 2011: Status

•Plan:

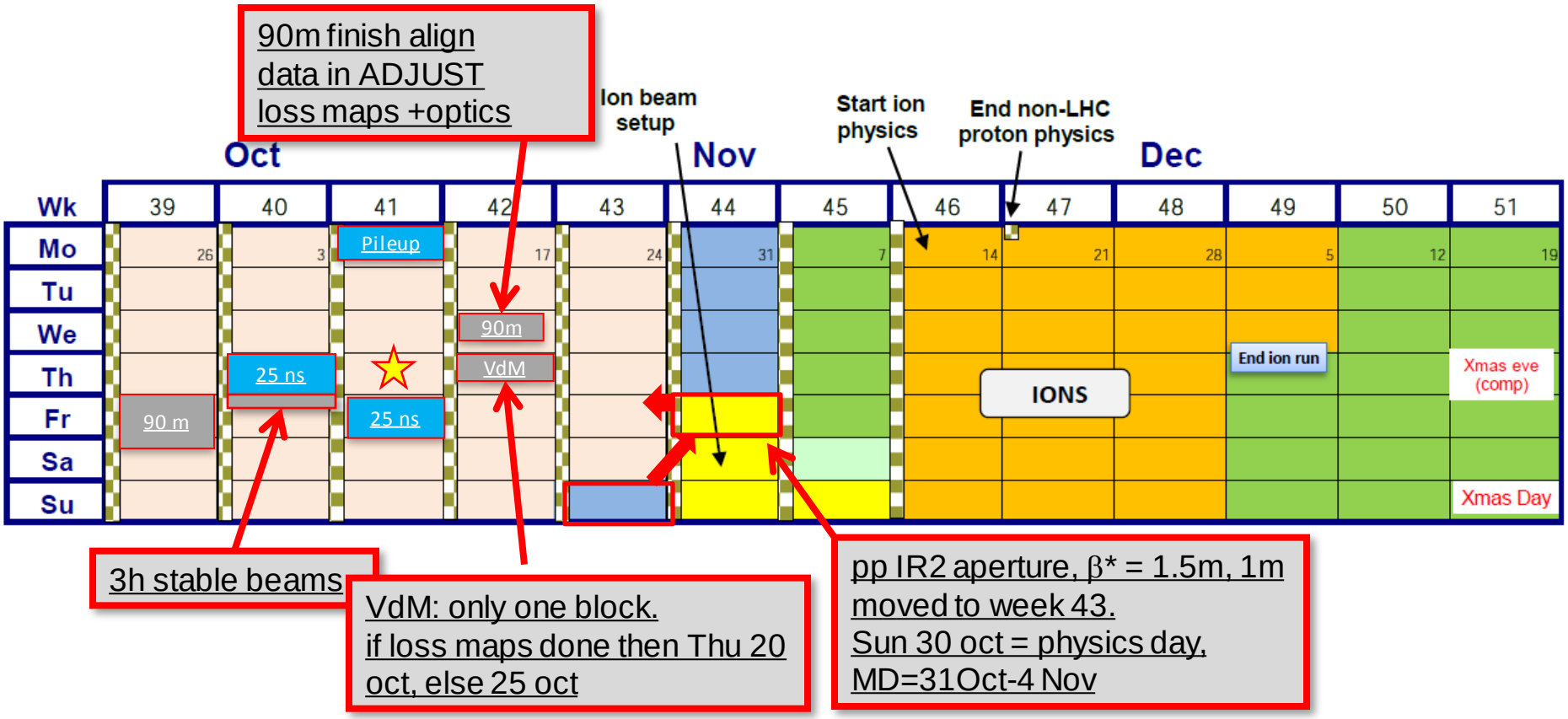
- 15 more days of pp physics
- Increase rare triggers statistics
- Investigate high background



• Prepare experiment for PbPb:

- Complete commissioning of the trigger
- Complete commissioning/validation of HLT
- Stress test of DAQ/HLT with/without beam
- Optimize detector parameters (TPC tail cancellation, MEB, V0 setting, etc.)

Short term: the Heavy Ion Run



Plan for the PbPb run

- 500 – 1000 Hz hadronic rate
- 30 – 60 /μb for rare triggers (~10 – 20 x 2010)
- 10% dead time to centrality triggers → 100 Hz
- 10% dead time to rare triggers

~10 GB/s peak data rate

~ 4 GB/s available bandwidth

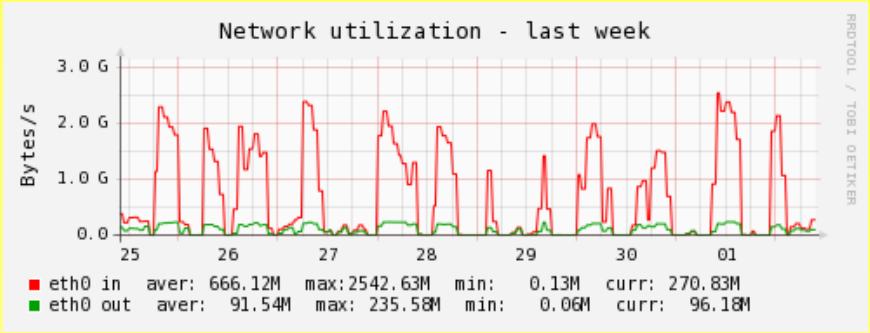
HLT during September Technical Stop:

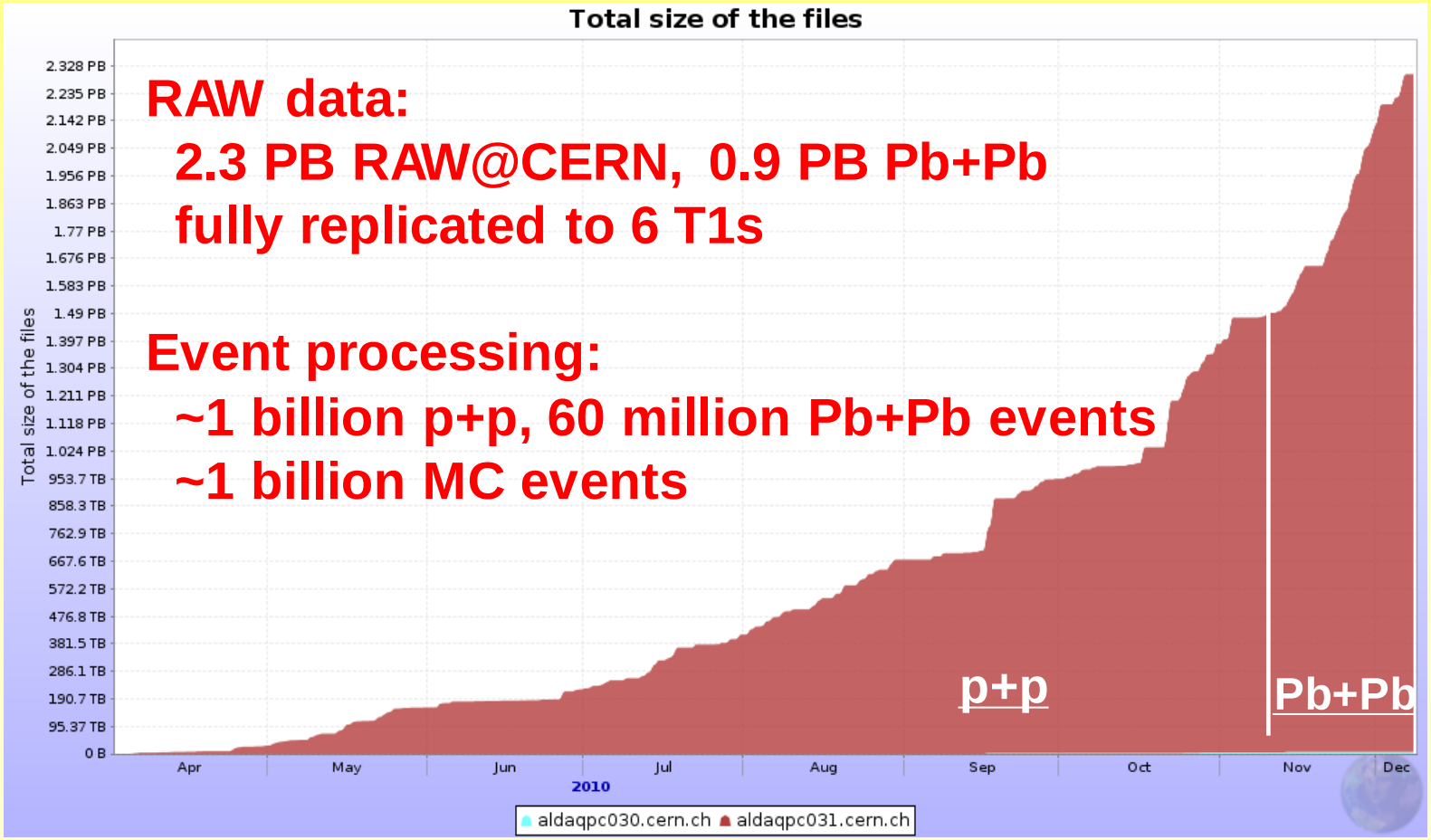
- HW upgrades (increase max rate) 32 → 64 GPU, 10 → 28 DDL
- Final software configuration (commissioned with PbPb 2010 data)
- Will be commissioned with pp events

2010: Data Acquisition and processing

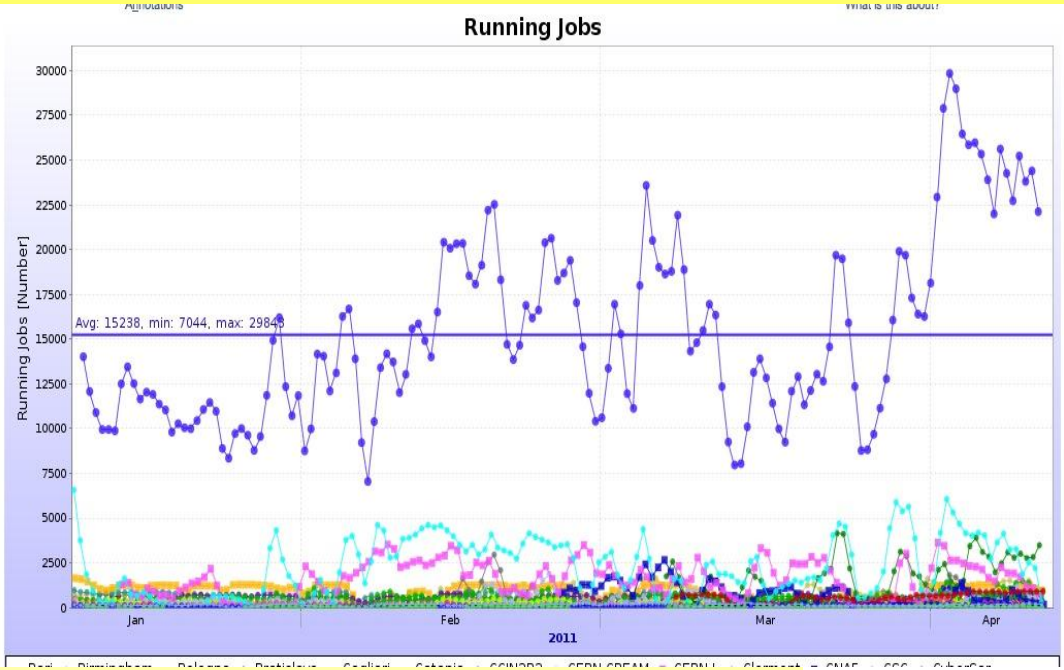
DAQ Performance

Peaks up to 2.5 GB/s





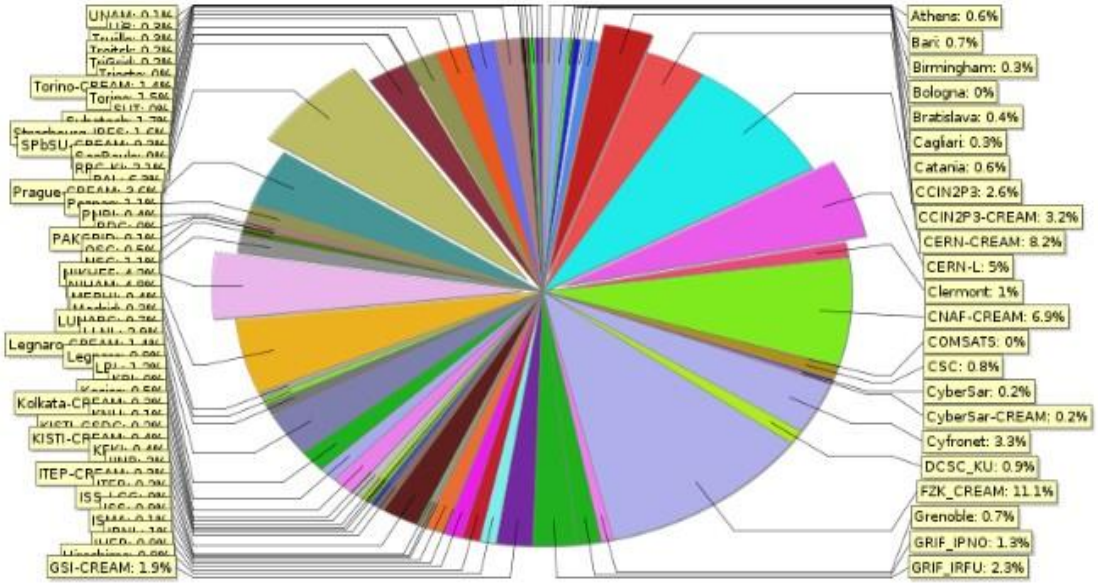
Computing: Resources usage



ALICE has ~ 15-16k job slots, consistent with average use. Excellent stability of the central GRID services. Dips: occasional fluctuations in the workload due to job dependencies and data availability for analysis, and to the fluctuations in the centre's availability. Peaks: opportunistic use of free resources for which our system is particularly efficient.

Grid power – computing centres contribution

62 T2s, 6T1s, 20K CPU cores running in parallel
10PB of disk and tape storage… expanding! (*thanks Funding Agencies..)*

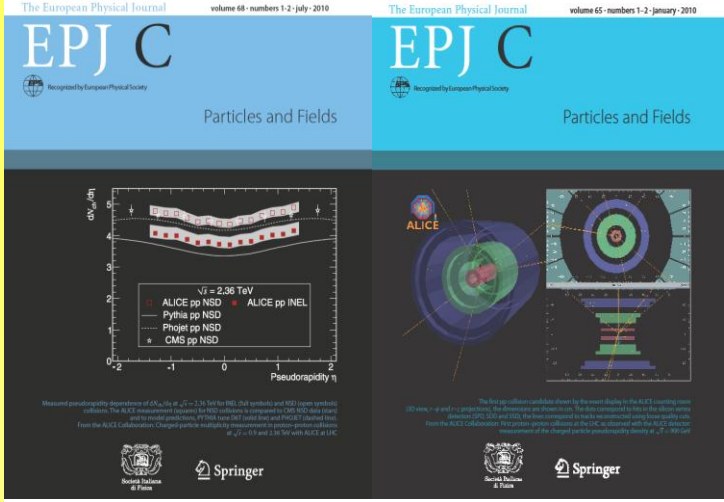


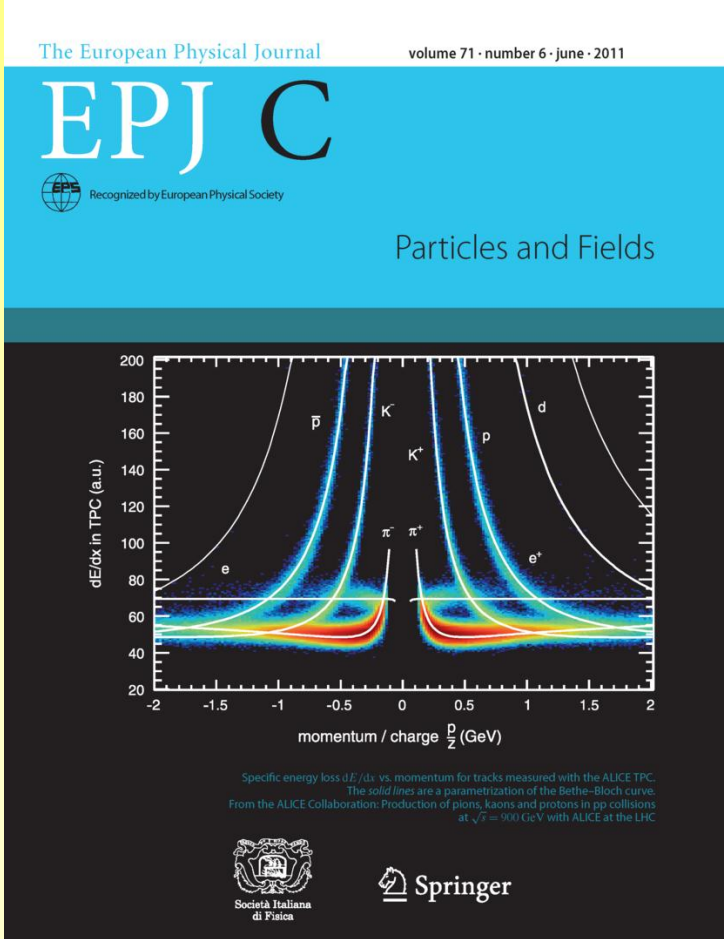
Computing in Korea

- T2@KISTI: 300 CPU + 50 TB (since 3 years)
- T1@KISTI: 1000 CPU + 1 PB (in operation since one month) + mass storage

Physics Results

- Physics publications:
  - 14 published
  - 1 accepted
  - 2 submitted
  - 4 in final coll review
  - 25 in various review stages
  - many more in preparation..
- Considerable impact!
  - 1 > 100 citations
  - 6 more > 50 citations





The ALICE program

- **Core Business: PbPb**
  - Study the properties of strongly interacting matter under extreme conditions of temperature and density.
    - Understand confinement, by producing and studying in the lab a deconfined plasma of quark and gluons (QGP)
    - Understand evolution of matter from the hot and dense deconfined phase towards ordinary hadrons (analogous to the early Universe evolution)
- **pp**
  - Collect 'comparison data' for heavy ion program
    - many observables measured 'relative' to pp
  - Comprehensive study of MB@LHC
    - tuning of Monte Carlo (background to BSM)
  - Soft & semi-hard QCD
    - very complementary to other LHC experiments
    - address specific issues of QCD
  - Very high multiplicity pp events
    - dN_{ch}/dh comparable to the one in HI => mini-plasma ?
- **pA**

- Essential for the interpretation of PbPb data (shadowing, cold nuclear matter effects)

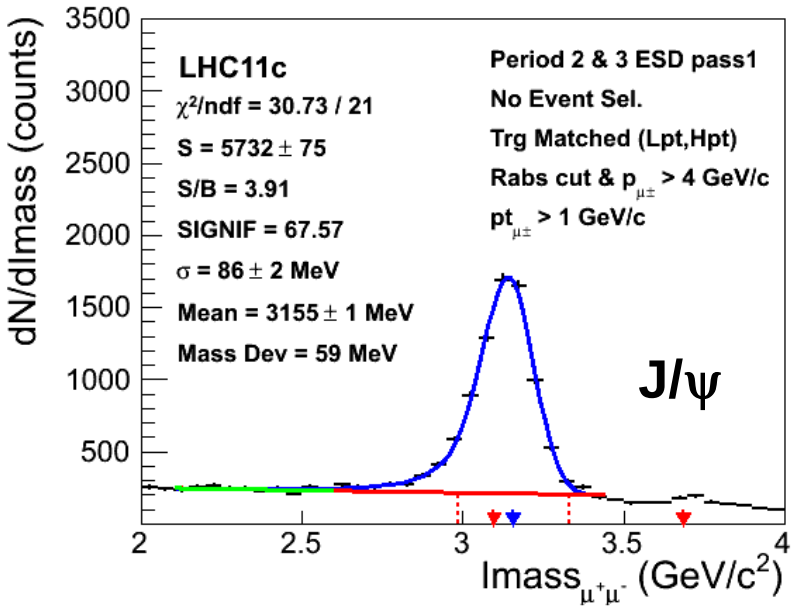
=> a feasibility test will be performed at the beginning of the Pb period this fall, a full run possibly in 2012

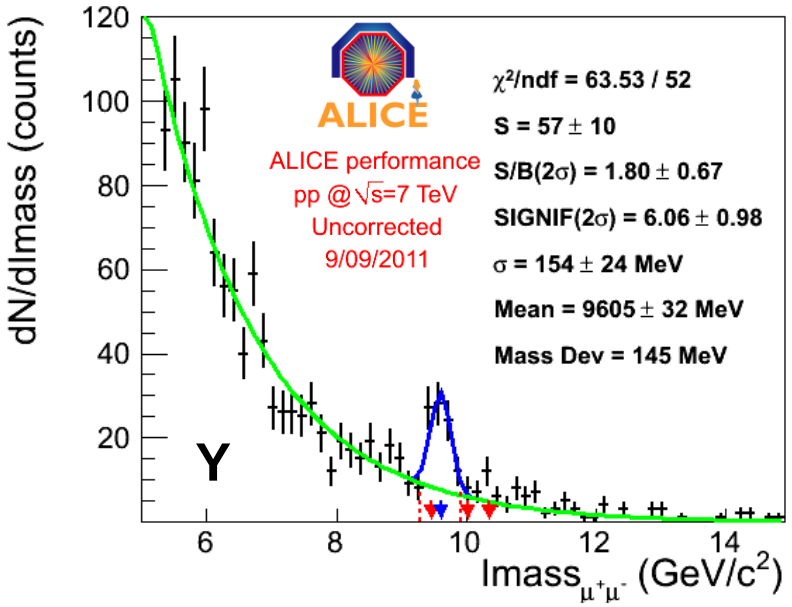
Outlook of ALICE HI runs until 2020

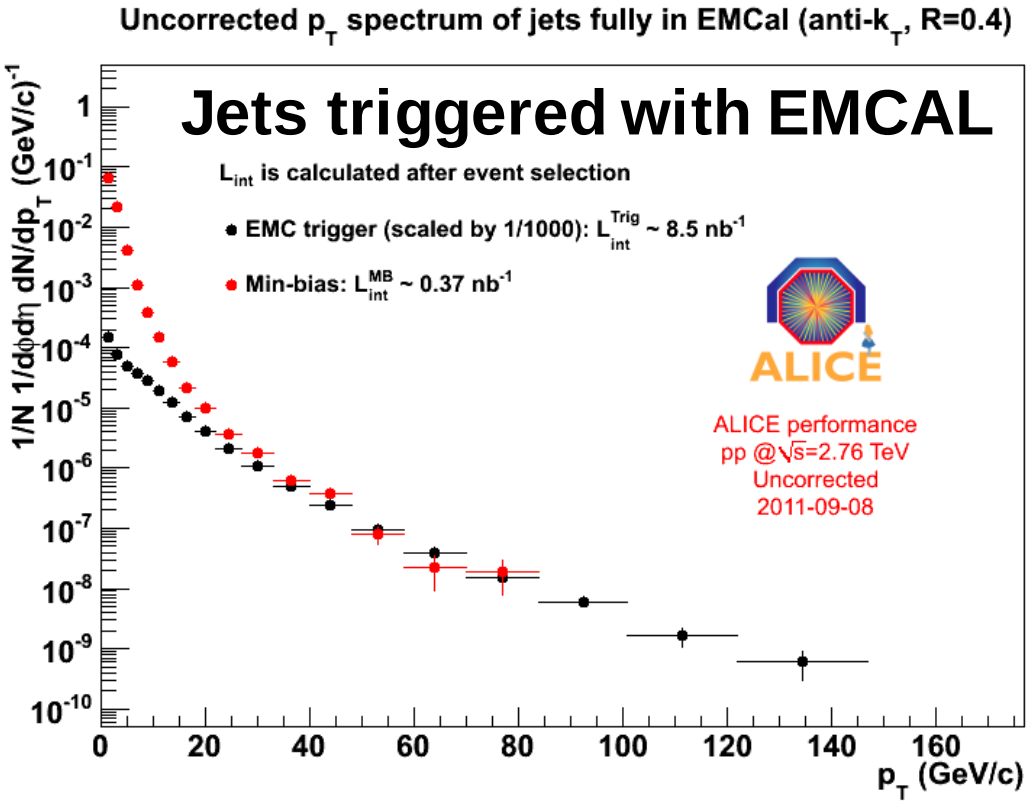
- 2011
  - PbPb at higher luminosity (~1.4x10^{26} cm^{-2}s^{-1}) $\sqrt{s_{NN}}$ = 2.76 TeV
  - Feasibility test for pPb running
- 2012
  - Either pPb/Pbp or further PbPb running
- 2013
  - Shutdown, relocation of collimators
- 2014
  - PbPb at higher luminosity and top energy $\sqrt{s_{NN}}$ = 5.5 TeV
- 2015
  - Continue PbPb at top energy to get to at least 1 nb^{-1}
- 2016
  - Dep. on outcome and integrated lumi of runs in 2014/15 further running of PbPb or pPb
- 2017
  - Shutdown; installation of dispersion suppressor collimator at IP2 (if not done previously)
- 2018
  - PbPb at luminosity >5x10^{26} cm^{-2}s^{-1} at top energy $\sqrt{s_{NN}}$ = 5.5 TeV
- 2019
  - Physics with pPb
- 2020
  - Physics with ArAr at very high luminosity (up to 10^{29} cm^{-2}s^{-1})
- 2021
  - Shutdown
- 2022+ …

Evolving, adapting to changes in overall LHC plan

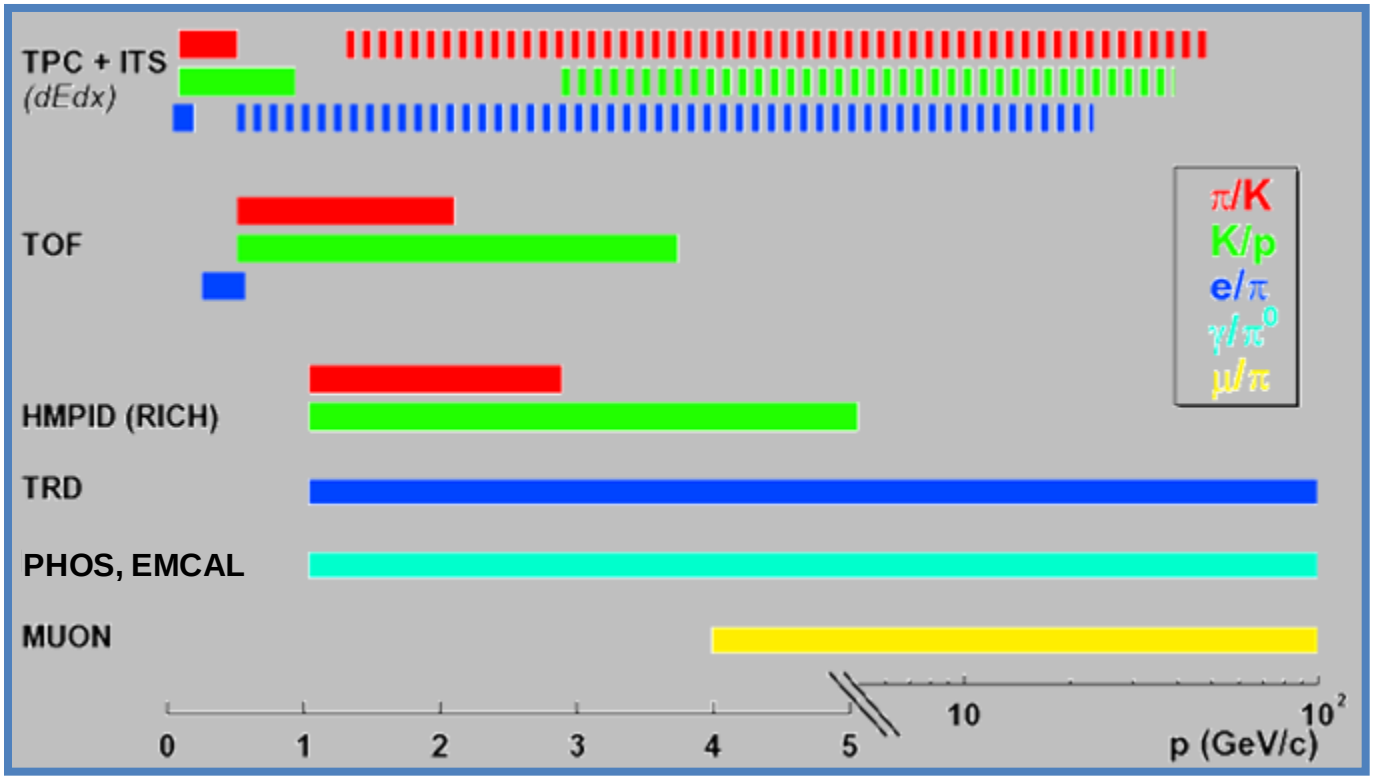
A taste of the ongoing work...





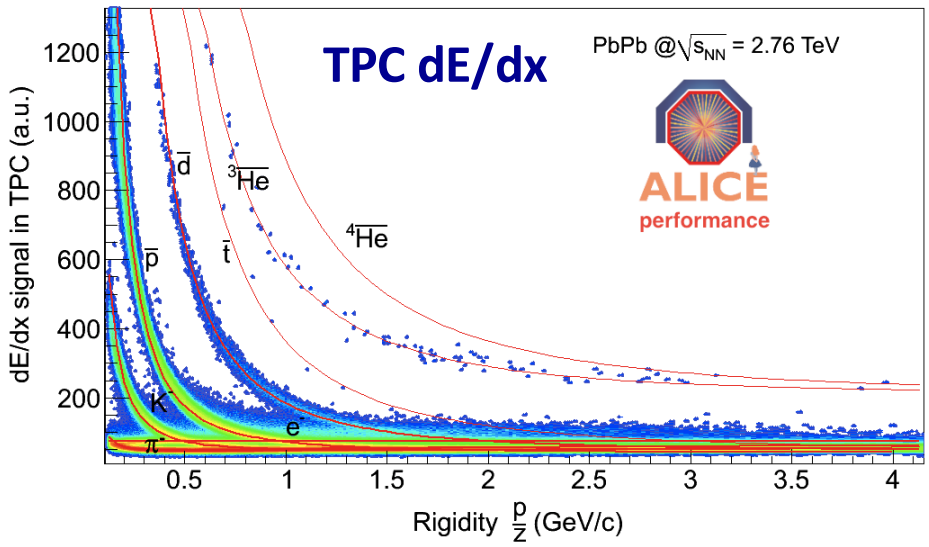


ALICE special: Particle Identification

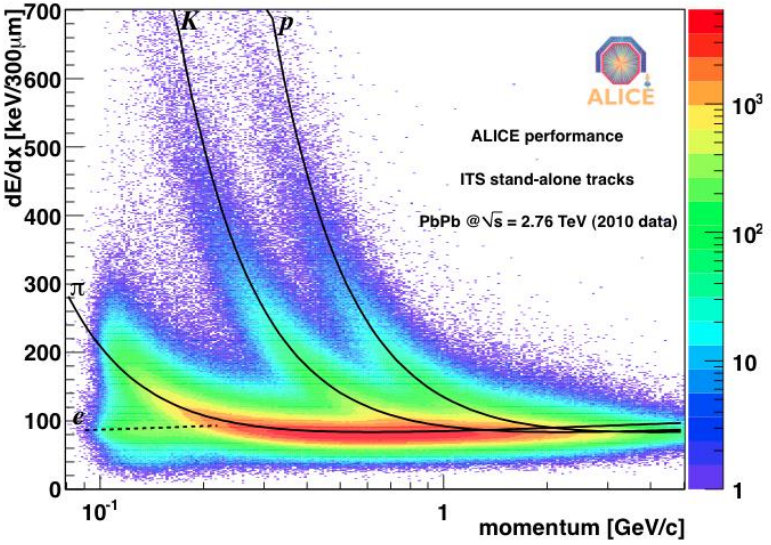


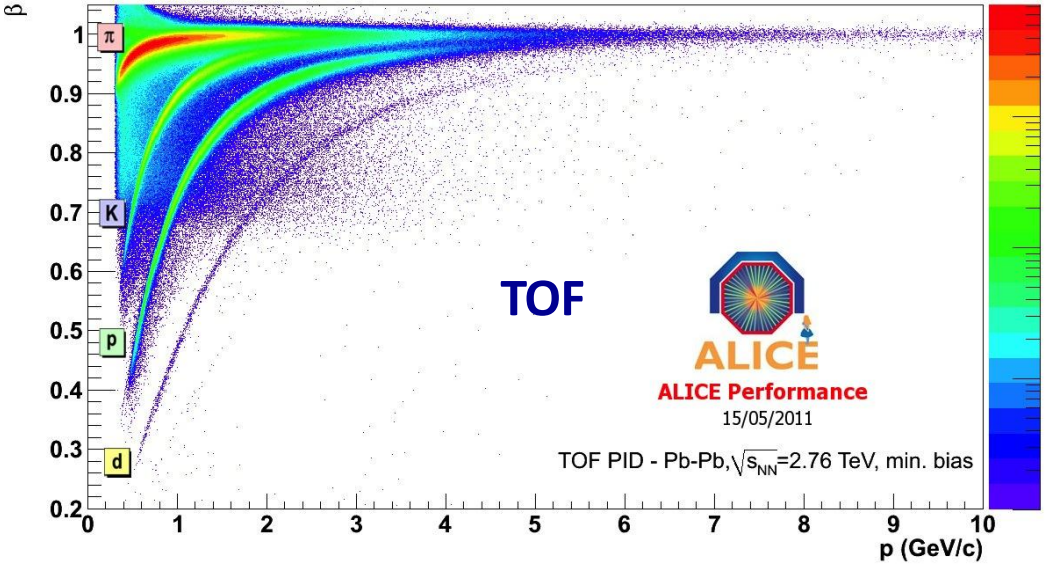
- 'stable' hadrons (π, K, p): 100 MeV/c < p < 5 GeV/c (several 10 GeV/c)
  - dE/dx in silicon (ITS) and gas (TPC) + time-of-flight (TOF) + Cherenkov (HMPID)
- decay topologies (K, Λ, ϕ, Ω, D)
  - K and Λ decays beyond 10 GeV/c
- leptons (e, μ), photons, π^0 η, ω
  - electrons TRD: p > 1 GeV, muons: p > 5 GeV, photons, π^0 in PHOS, EMCAL: 1 < p < 80 GeV

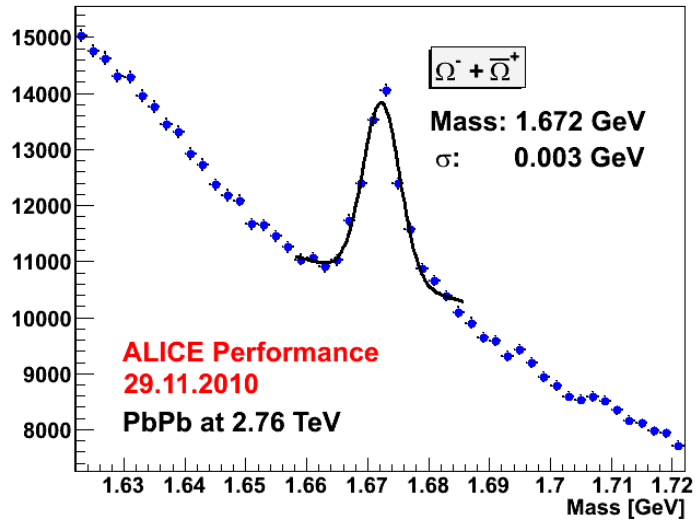
A few examples…



ITS Silicon Drift/Strip dE/dx





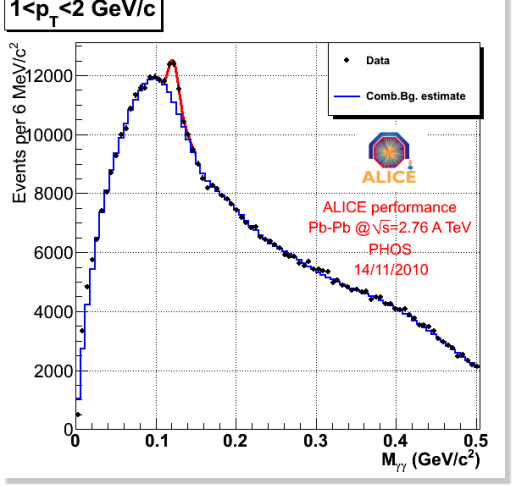


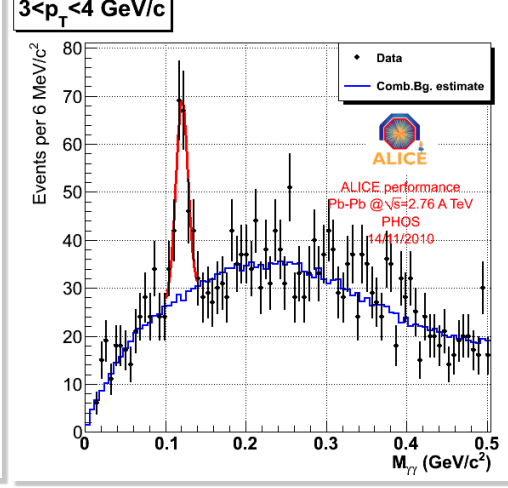
π^0 reconstruction in Pb-Pb

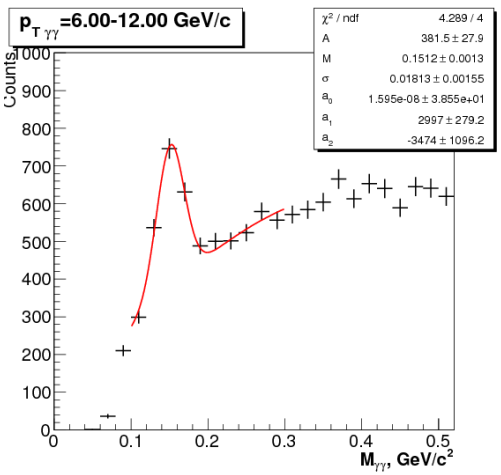
$\pi^0 \rightarrow \gamma\gamma$ in PHOS:

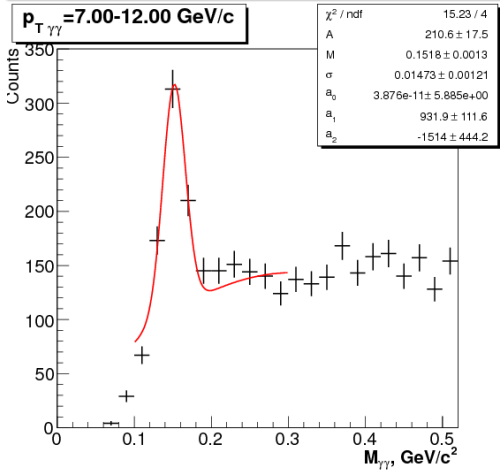
$\pi^0 \rightarrow \gamma\gamma$ in EMCAL:

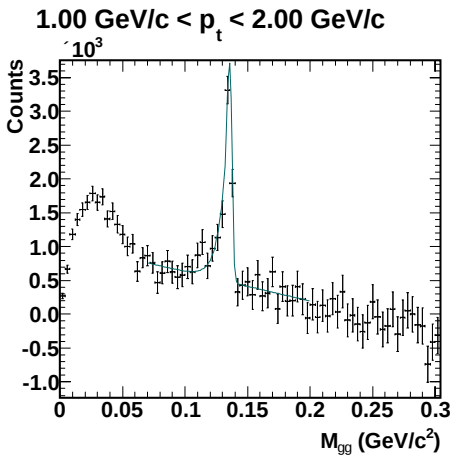
$\pi^0 \rightarrow \gamma\gamma$ -> e^+e^- e^+e^- TPC:

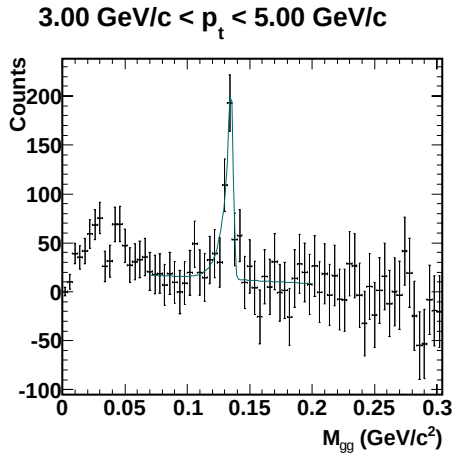








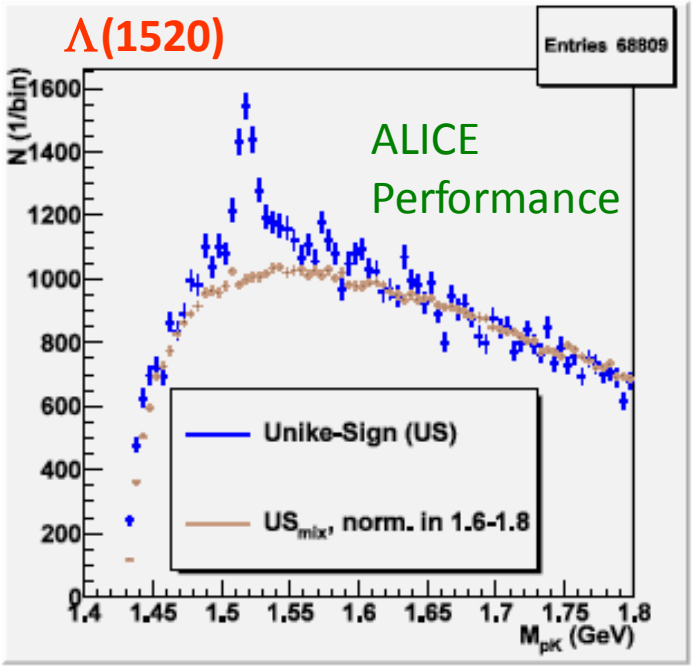




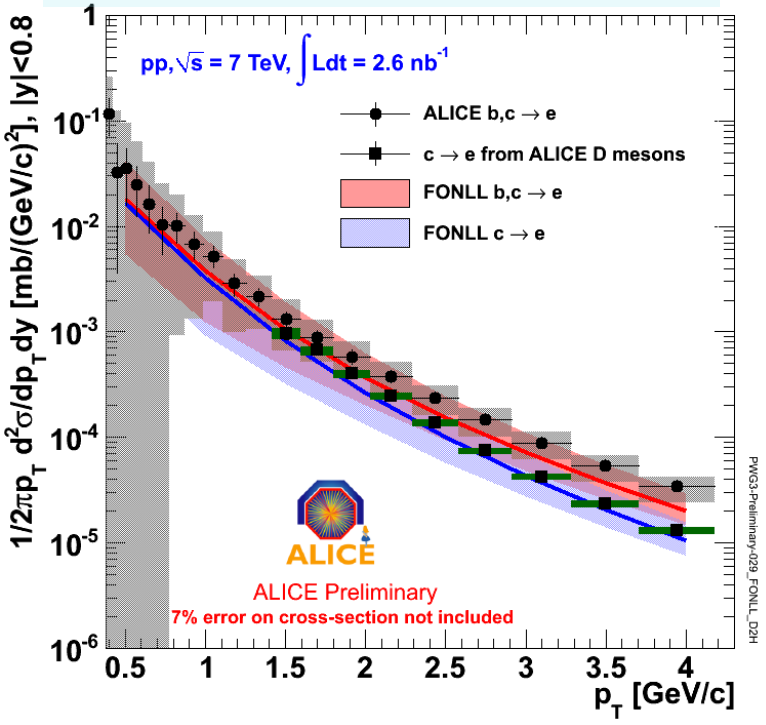
pp analysis

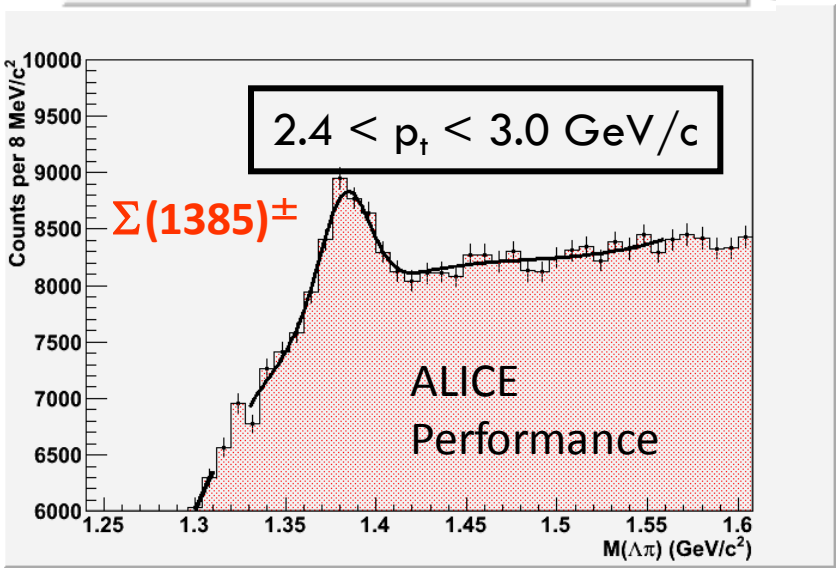
- progress continues (Open Charm, J/ψ polarization, J/ψ vs. multiplicity, event shape, multistrange baryon and several more papers are being finalized)
- A few examples…

Particle production… After
$\phi \rightarrow K^+K^-$, $\Sigma^* \rightarrow \Lambda\pi$,
$\Omega \rightarrow \Lambda K$, $K^* \rightarrow K\pi$, $\Xi \rightarrow \Lambda\pi$

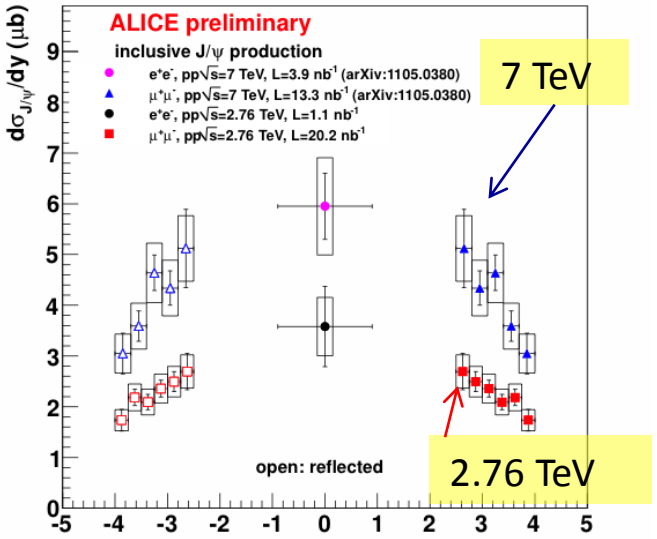


Heavy flavor production via semi-leptonic decays

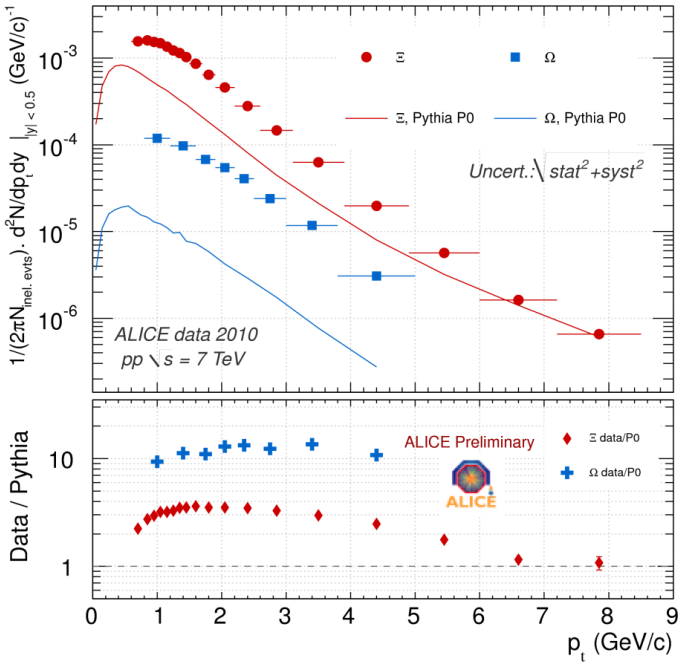




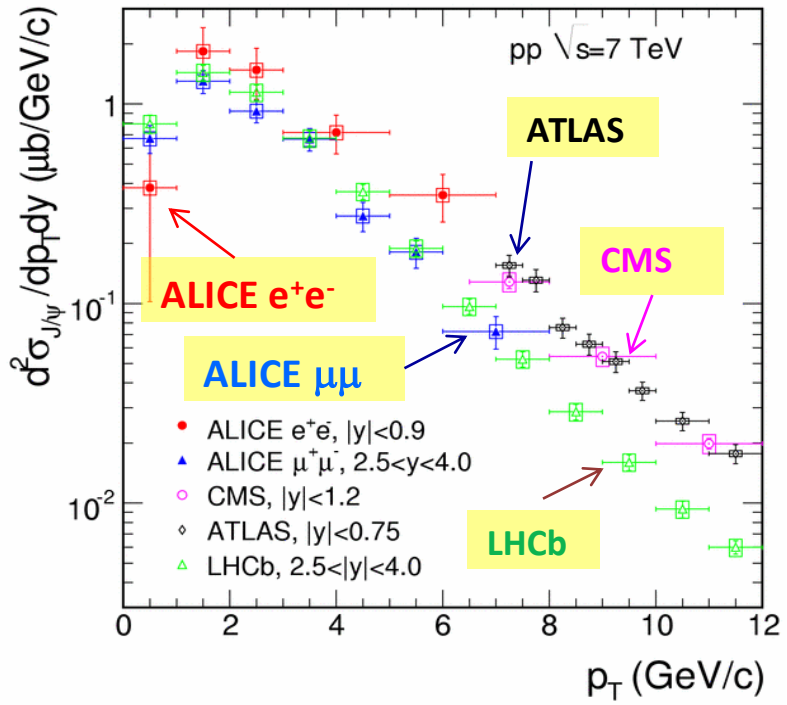
J/ψ rapidity distribution



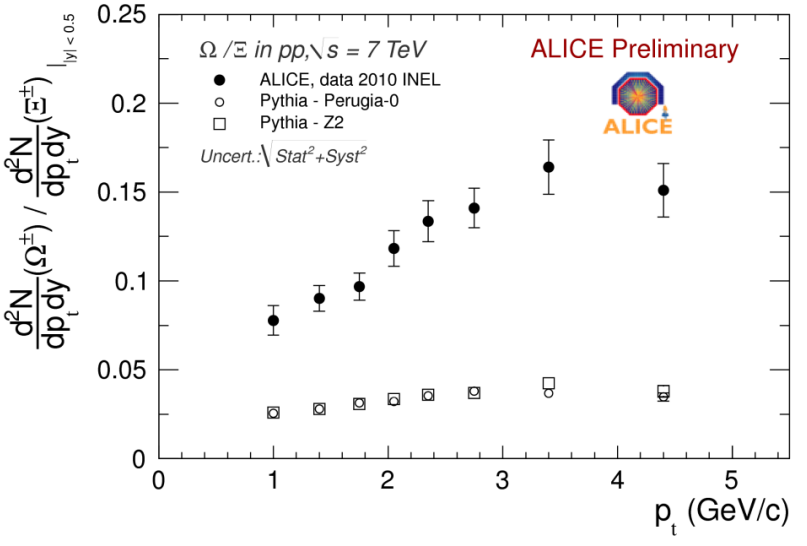
Selected pp results at 7 and 2.76 TeV



J/ψ 4 LHC experiments

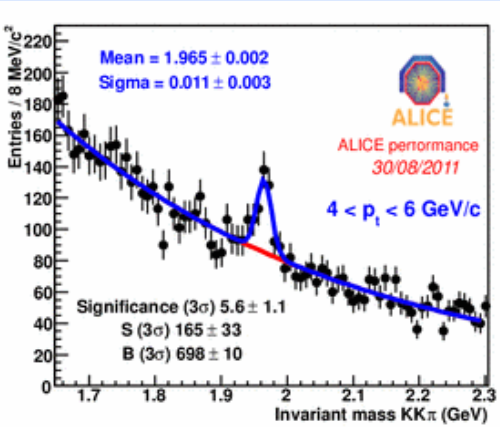


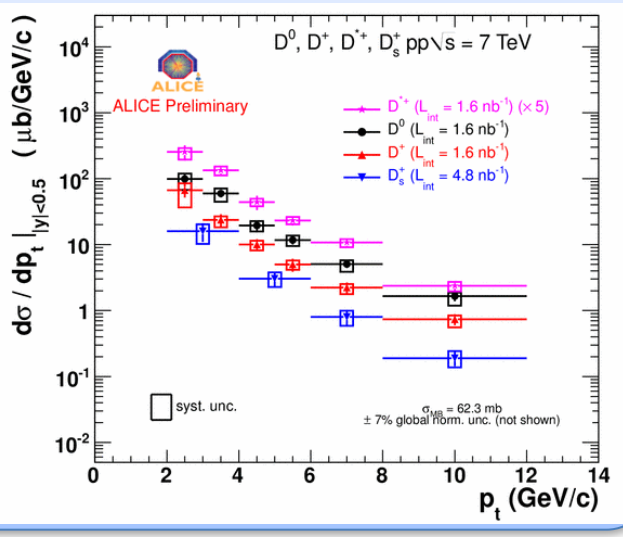
Multi strange particle production



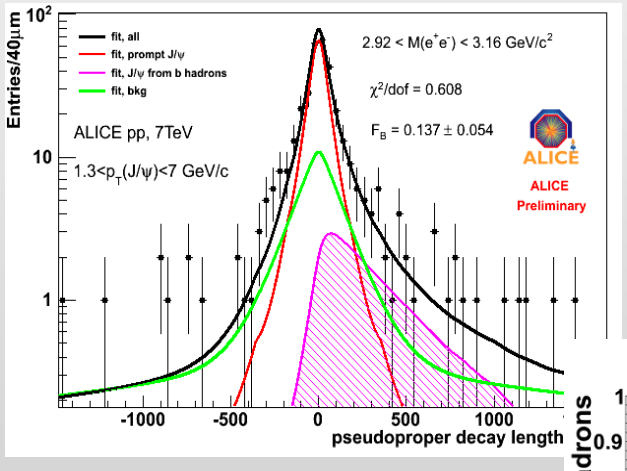
Some of the latest (since June SPC) pp results

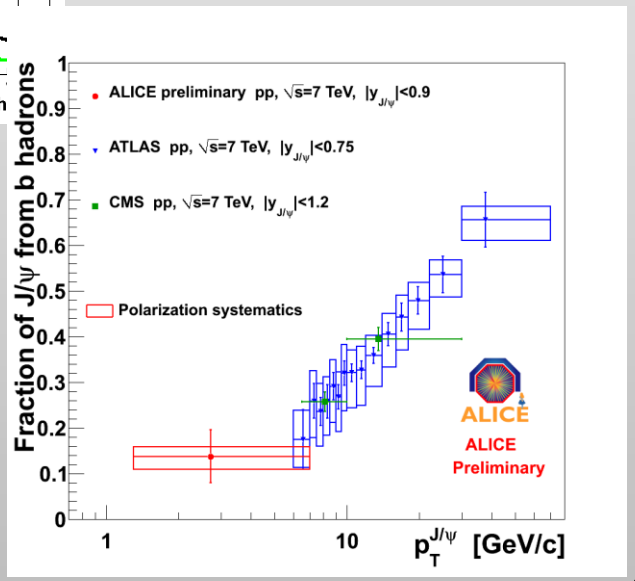
D_s cross section joins D^0, D^+, D^*





$B \rightarrow J/\psi \rightarrow ee$ at $|y|<0.9$





Unique measurement
down to 1.3 GeV/c
at y=0 at LHC

ALICE PbPb results

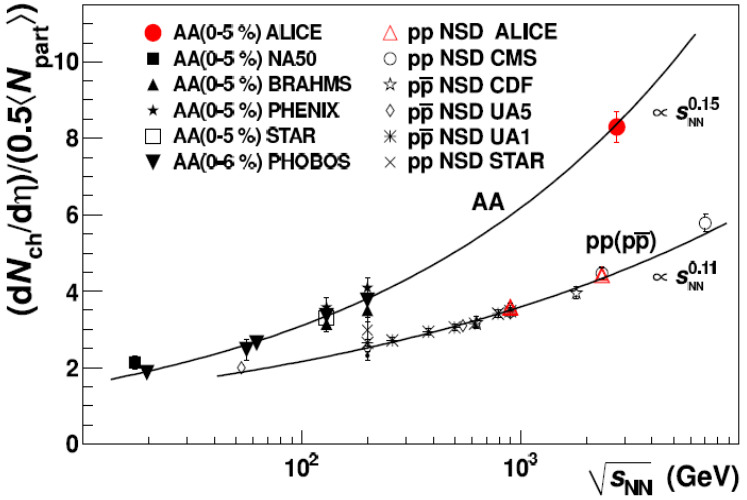
1. Five papers submitted before Christmas (have already collected 320 citations) establishing the general features of the high-density strongly interacting matter created at the LHC

2. Quark Matter (end of May, reference conference for Heavy-Ion Physics): **41 presentations**, over 70 posters. First overview of results. Raised very strong interest

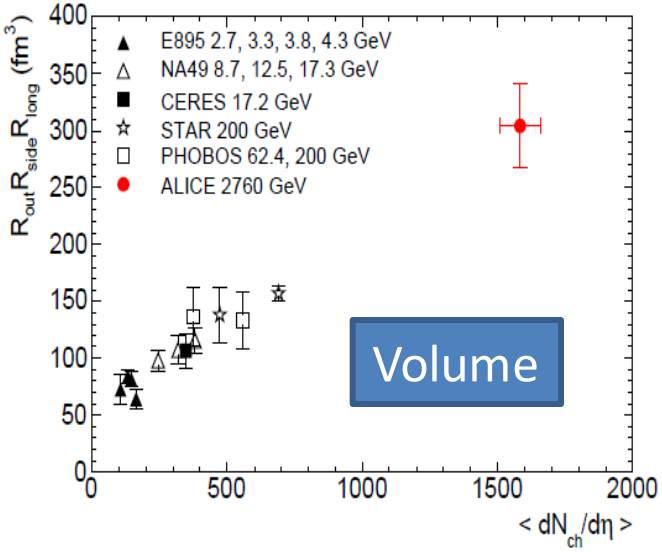
3. **Now:** going to details, and working on transforming the preliminary results shown at QM into final ones and publish in journals. Ongoing process, one paper published (higher harmonics of anisotropic flow), two will be submitted this week, many more in preparation

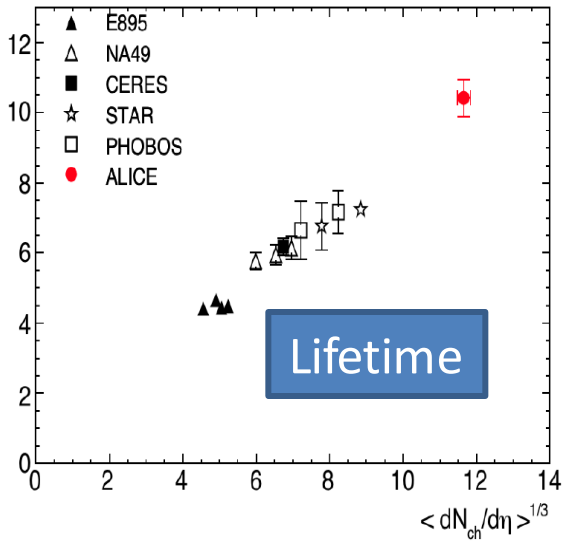
Characteristics of Central Pb+Pb Collisions at 2.76 TeV

- **Energy density from $dN_{ch}/d\eta$**
  - $dN_{ch}/d\eta = 1599 \pm 4$ (stat.) $\pm$ 80 (syst.)
  - constrains / rules out models
  - 100 times cold nuclear matter density
  - 3 times the density reached at RHIC ($\varepsilon \approx 15$ GeV/fm^3)



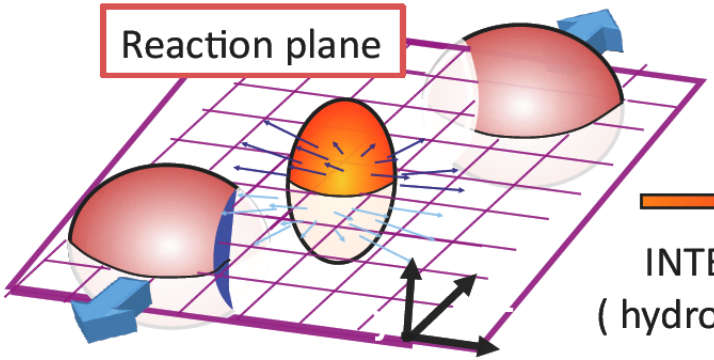
- **Volume and lifetime from HBT interferometry**



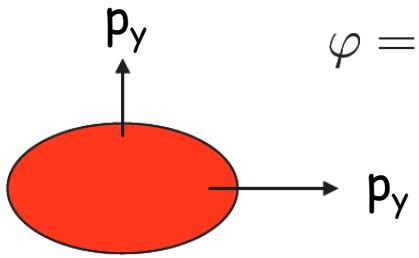


- Freeze-out volume 300 fm^3
- 2 times the volume measured at RHIC (AuAu@200 GeV)
- Lifetime until freeze-out 10 fm/c

Anisotropic Transverse Flow



INTERATIONS
(hydrodynamics?)



$$\varphi = \arctan\frac{p_y}{px}$$

$$v_2 = \frac{\langle p_y^2\rangle - \langle p_x^2\rangle}{\langle p_y^2\rangle + \langle p_x^2\rangle}$$

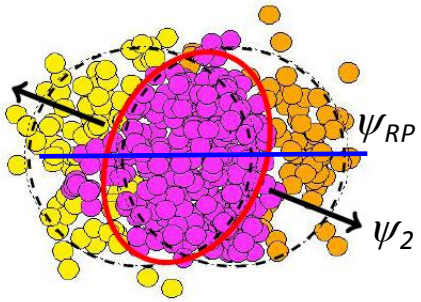
(elliptic flow)

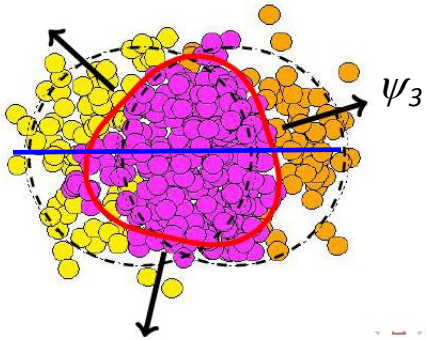
$$\varepsilon = \frac{\langle y^2\rangle - \langle x^2\rangle}{\langle y^2\rangle + \langle x^2\rangle}$$

Initial spatial anisotropy → **Final momentum anisotropy reflected in azimuthal distribution**

$$\frac{dN}{d(\varphi-\psi_n)} \propto 1 + 2\sum_{n=1} v_n \cos(n[\varphi-\psi_n])$$

$$v_n = \langle \cos(n[\varphi-\psi_n])\rangle$$





✧ Smooth matter distribution in the colliding nuclei

- $\Psi_n = \Psi_{RP}$
- $v_{2n+1} = 0$ by symmetry

✧ **Fluctuations in the matter distribution**

→ event by event fluctuations of the plane of symmetry around Ψ_{RP}

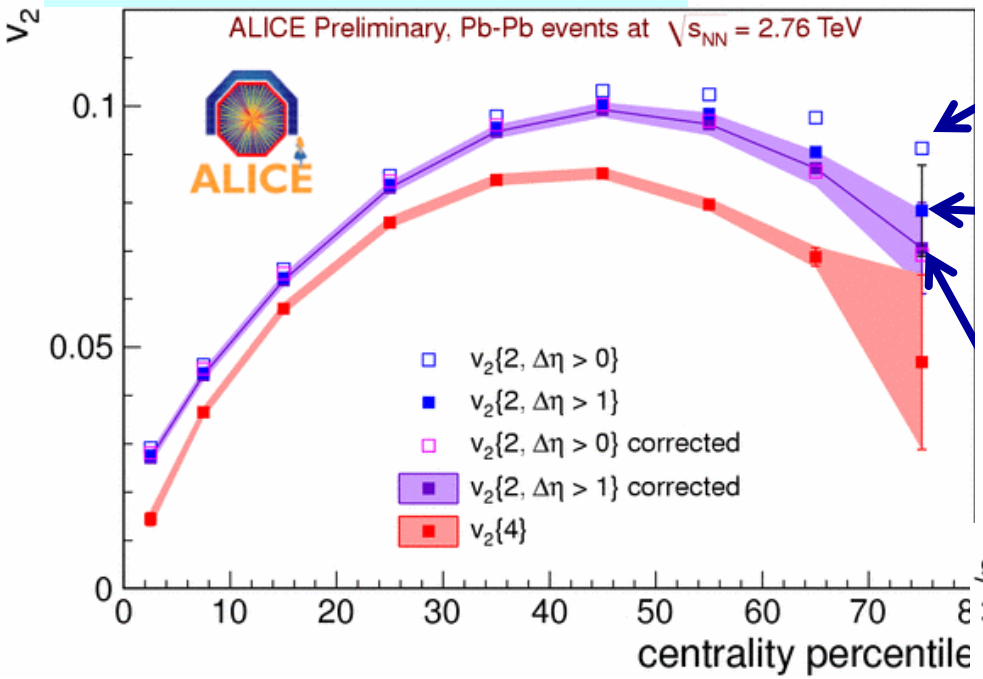
→ **non negligible odd harmonics**

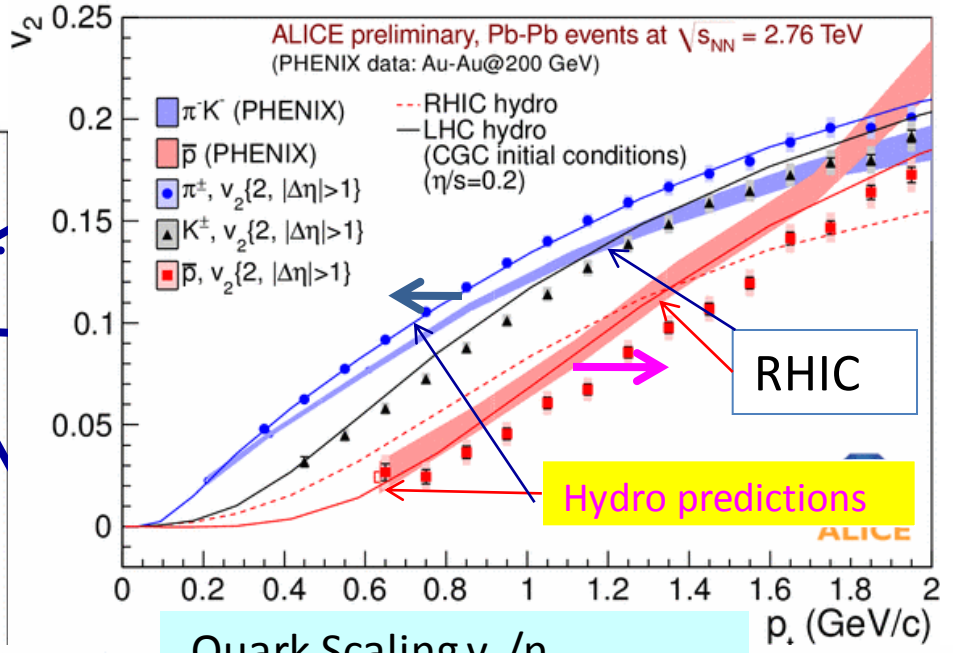
✧ **v_3,v_5,..** magnitude regulated by shear viscosity to entropy density ratio (η/s)

Elliptic Flow v_2:

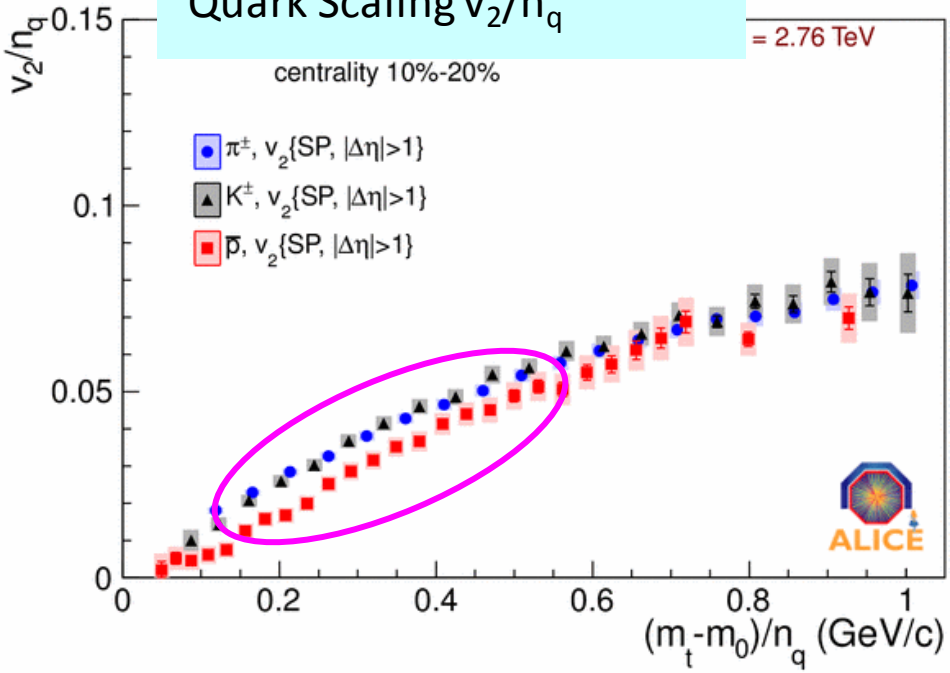
Flow of identified particles :π/K/p v_2

Non-Flow corrections





Quark Scaling v_2/n_q

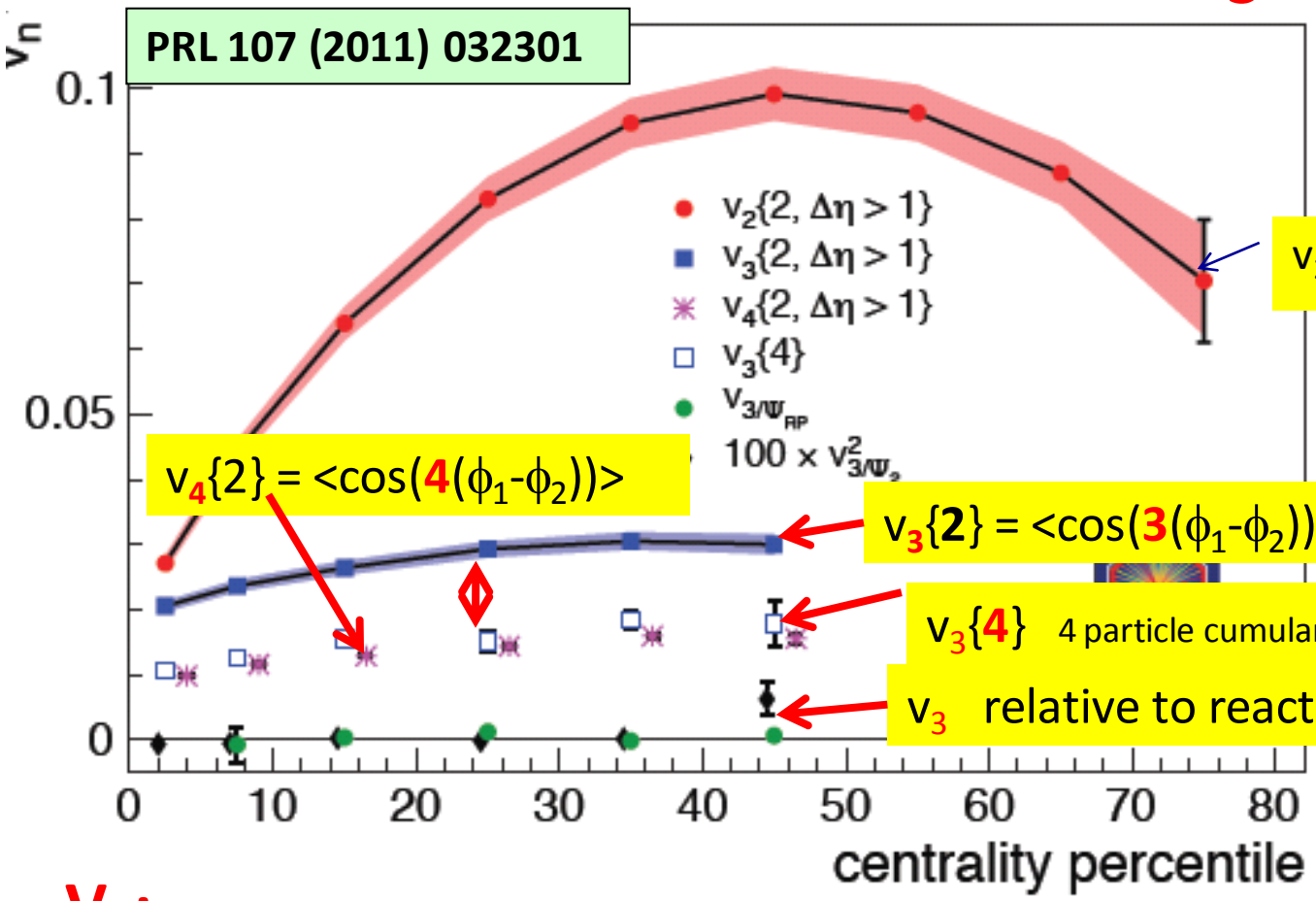


Several methods to assess (and correct for) non-flow

PID flow:

- p and p are 'pushed' further compared to RHIC ≈ expected from hydro, but even stronger radial flow (see spectra)
- quark scaling no longer holds at lower p_T (hadrons flow!)

Higher Order Flow v_3,v_4,..



v_2

$$v_n\{2\} \cong v_n^2 + \sigma_n^2 + \delta$$
$$v_n\{4\} \cong v_n^2 - \sigma_n^2$$

$v_4\{2\} = \langle\cos(4(\phi_1-\phi_2))\rangle$

$v_3\{2\} = \langle\cos(3(\phi_1-\phi_2))\rangle$

$v_3\{4\}$ 4 particle cumulant

v_3 relative to reaction & participant planes

V_3:

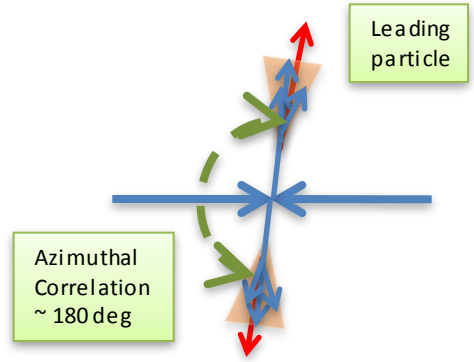
small dependence on centrality

$v_3\{4\} > 0$ => not non-flow

$v_3\{4\} < v_3\{2\}$ => geometry fluctuations !

$v_3\{\Psi_{RP}\} \approx 0$ => Ψ_3 indep. fluctuations w.r.t. Ψ_{RP}

Di-Hadron Correlations



Two-particle correlations

- conditional [per-trigger] yields

$$\frac{1}{N_{trig}}\frac{dN_{assoc}}{d\Delta\varphi} \quad \text{and} \quad \frac{1}{N_{trig}}\frac{d^2N_{assoc}}{d\Delta\varphi d\Delta\eta}$$

At Low-p_T:

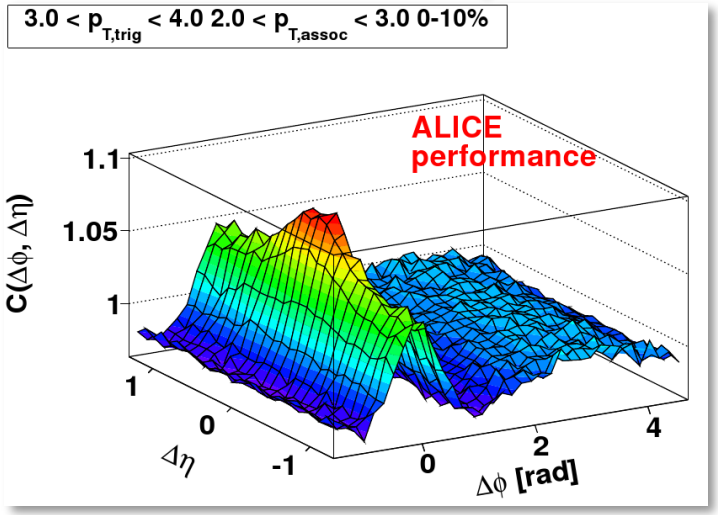
Ridge

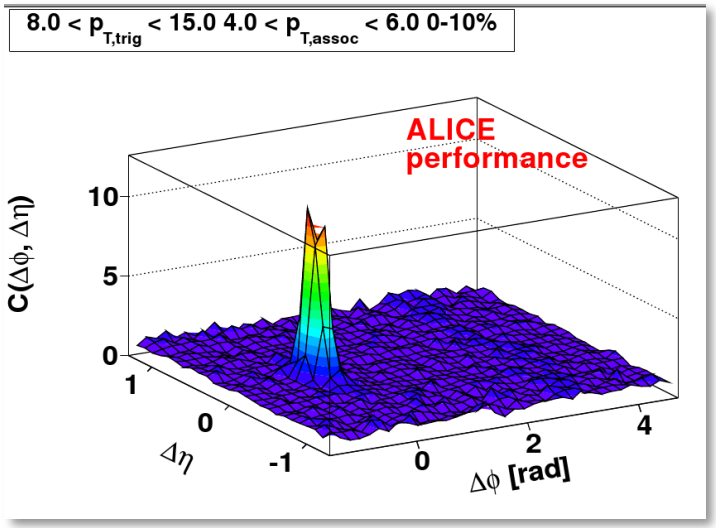
Hydrodynamics, flow

At High-p_T:

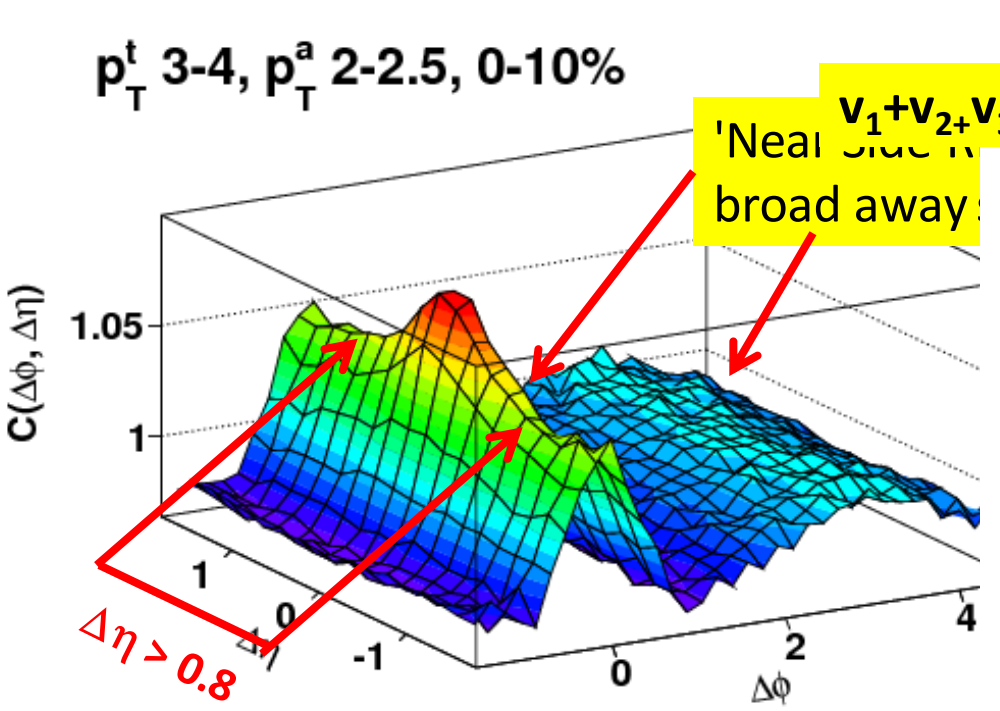
Quenching/suppression, broadening

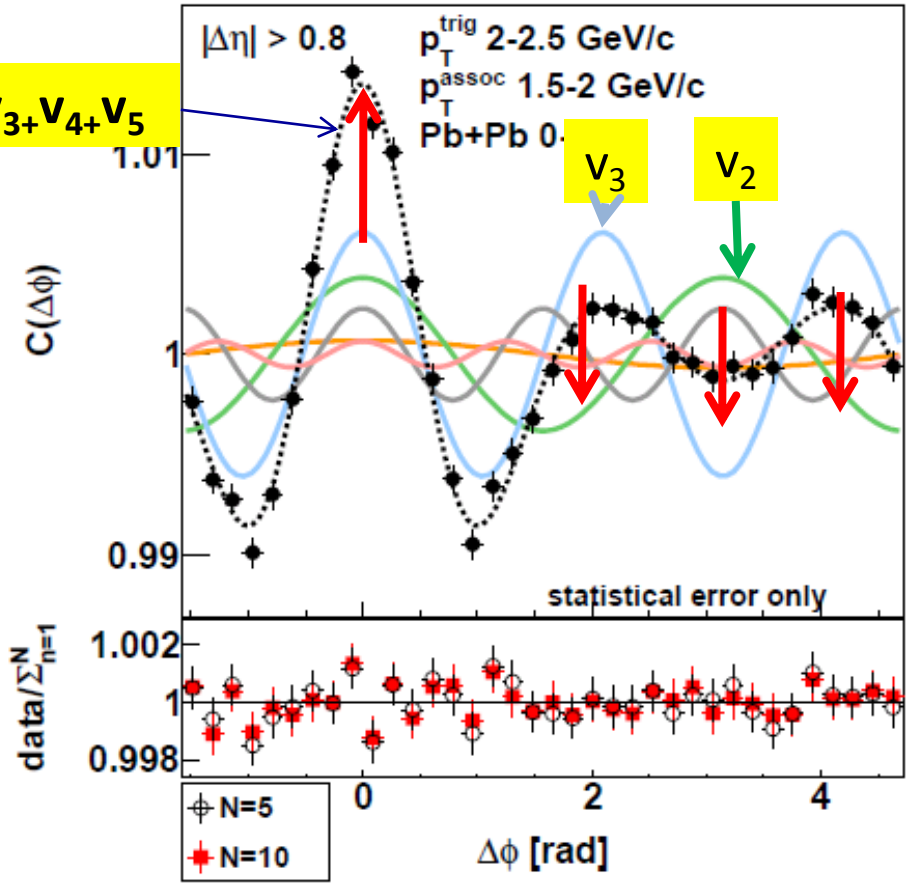
Powerful instrument to study system characteristics, including Jet Quenching (recoil jet suppression)





Flow & 2 Particle Correlations





Projection on Δφ for **Δη > 0.8**

Clean double hump (aka 'Mach Cone') appears for ultra-central

(without any flow subtraction !)

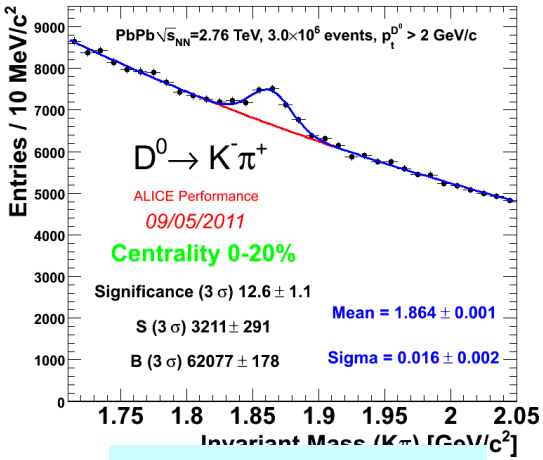
Full correlation structure described by Fourier Coefficients v_1,**v_2, v_3**, v_4,v_5 **(for |η|>0.8)**

v3 very visible, indeed, v3 ≈ v2 for very central

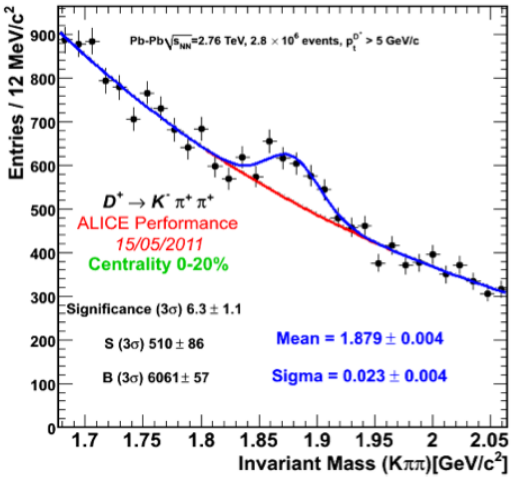
'Mach Cone' & 'Near Side Ridge' shapes evolve smooth with magnitude of v_2 and v_3

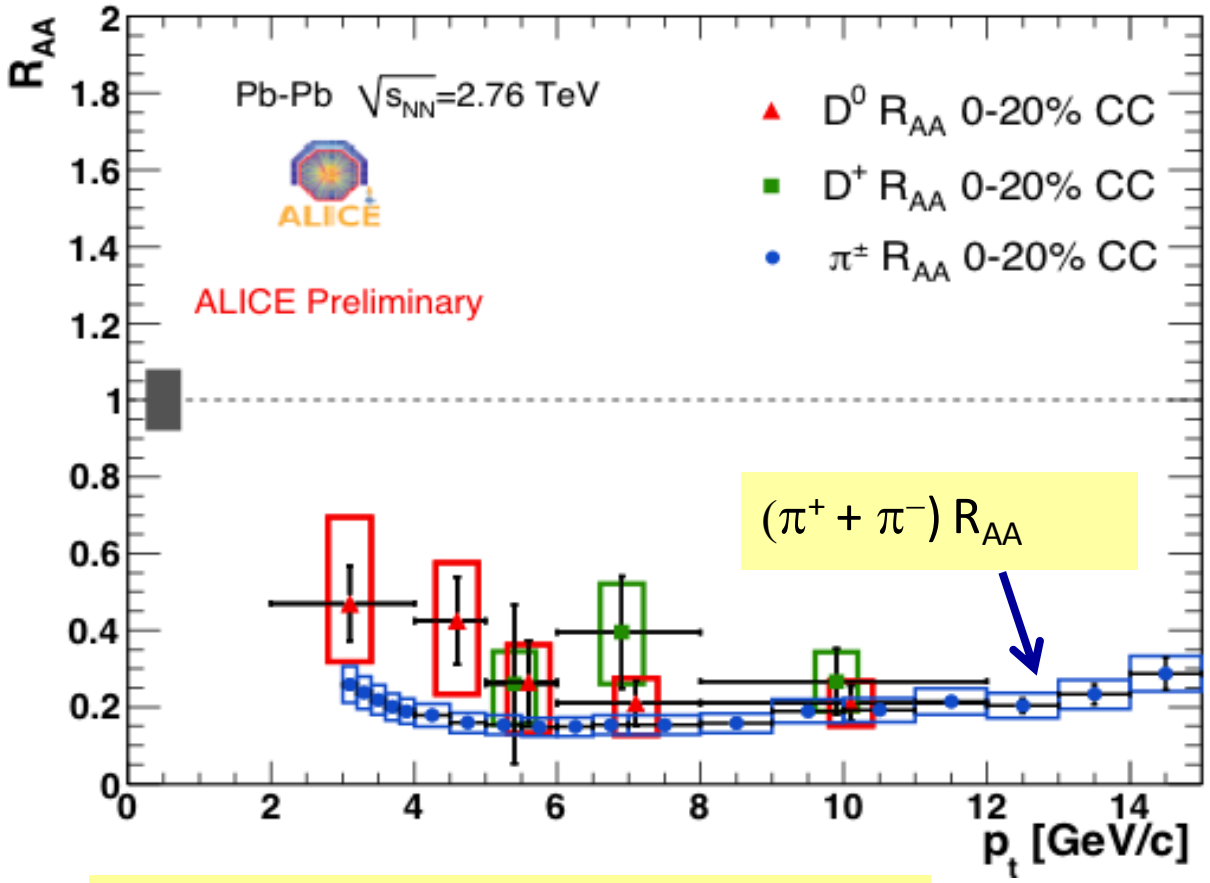
Charm R_{AA}: Strong Suppression

$D^0 \rightarrow K\,\pi$



$D^+ \rightarrow K\,\pi\pi$





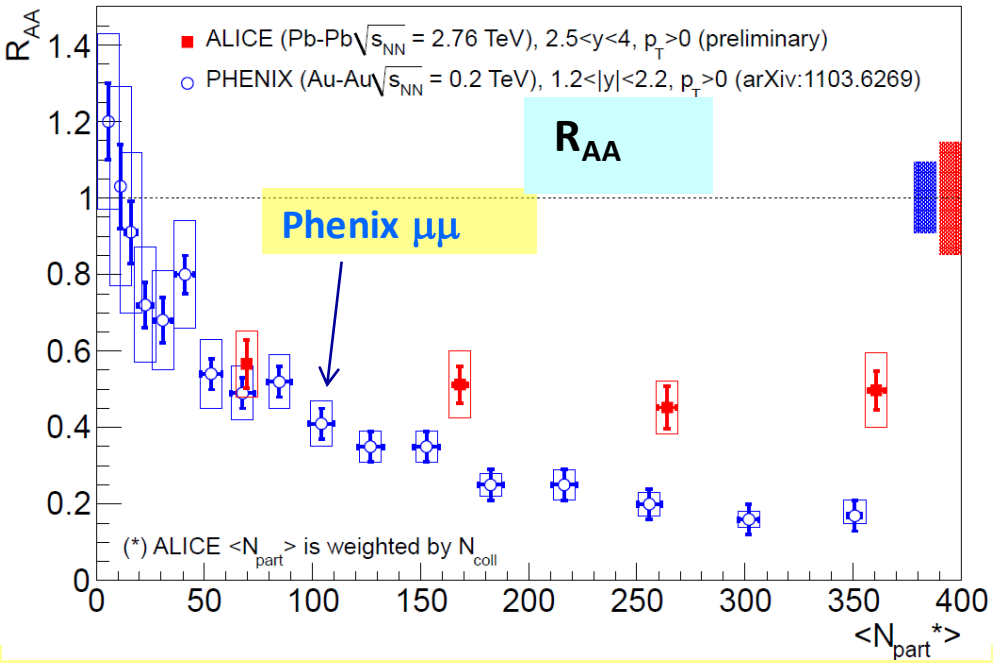
- **R_{AA} prompt charm ≈ R_{AA} pions**
- Hint of R_{AA} charm > R_{AA} π for p_T < 5 GeV/c ?

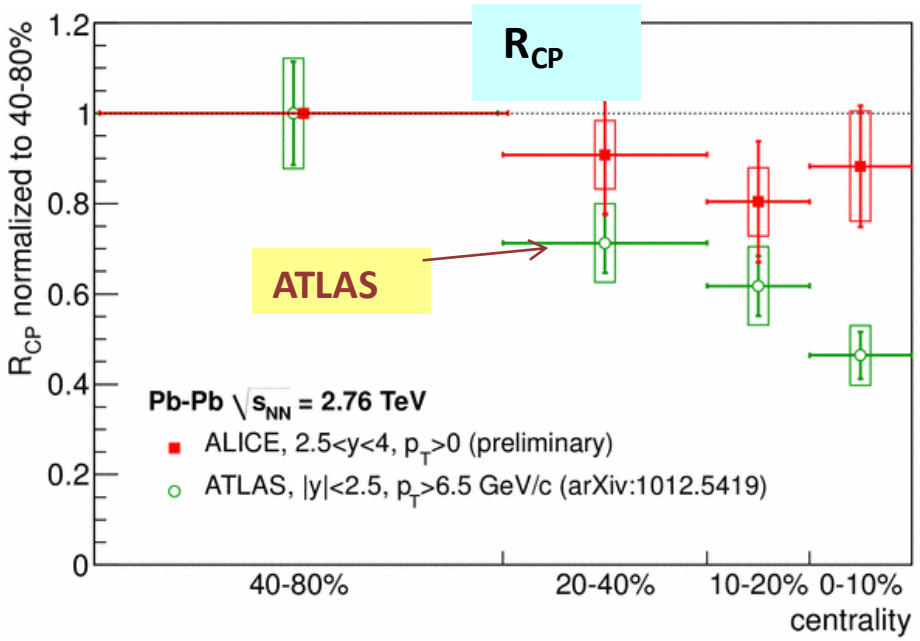
Qualitative expectation: R_{AA} Charm > R_{AA} Mesons

- ΔE gluon > ΔE quark (**Casimir factor**)
- ΔE massless parton > ΔE massive quark (**'dead cone'**)

Needs quantitative comparison with quenching calculations

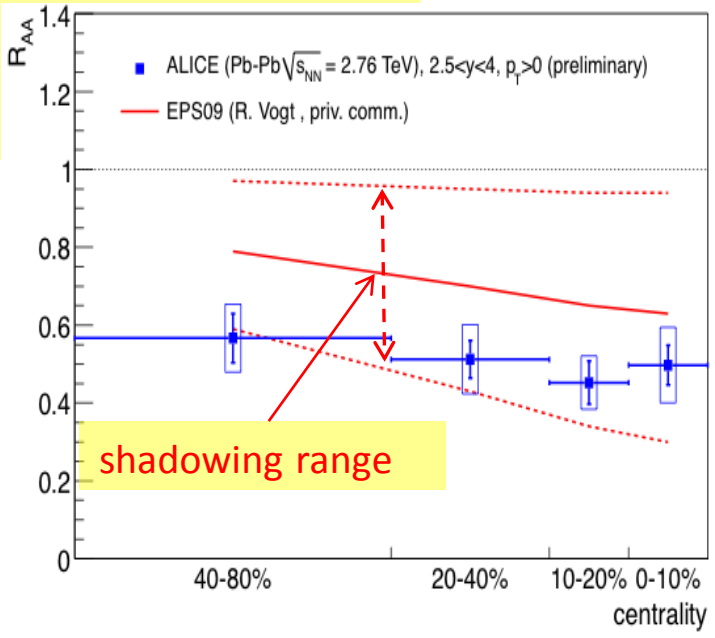
J/ψ Suppression





Surprisingly (?) : less suppression than RHIC !

R_{CP}(ALICE/ATLAS): suppression stronger at high p_T ??



Caveats:

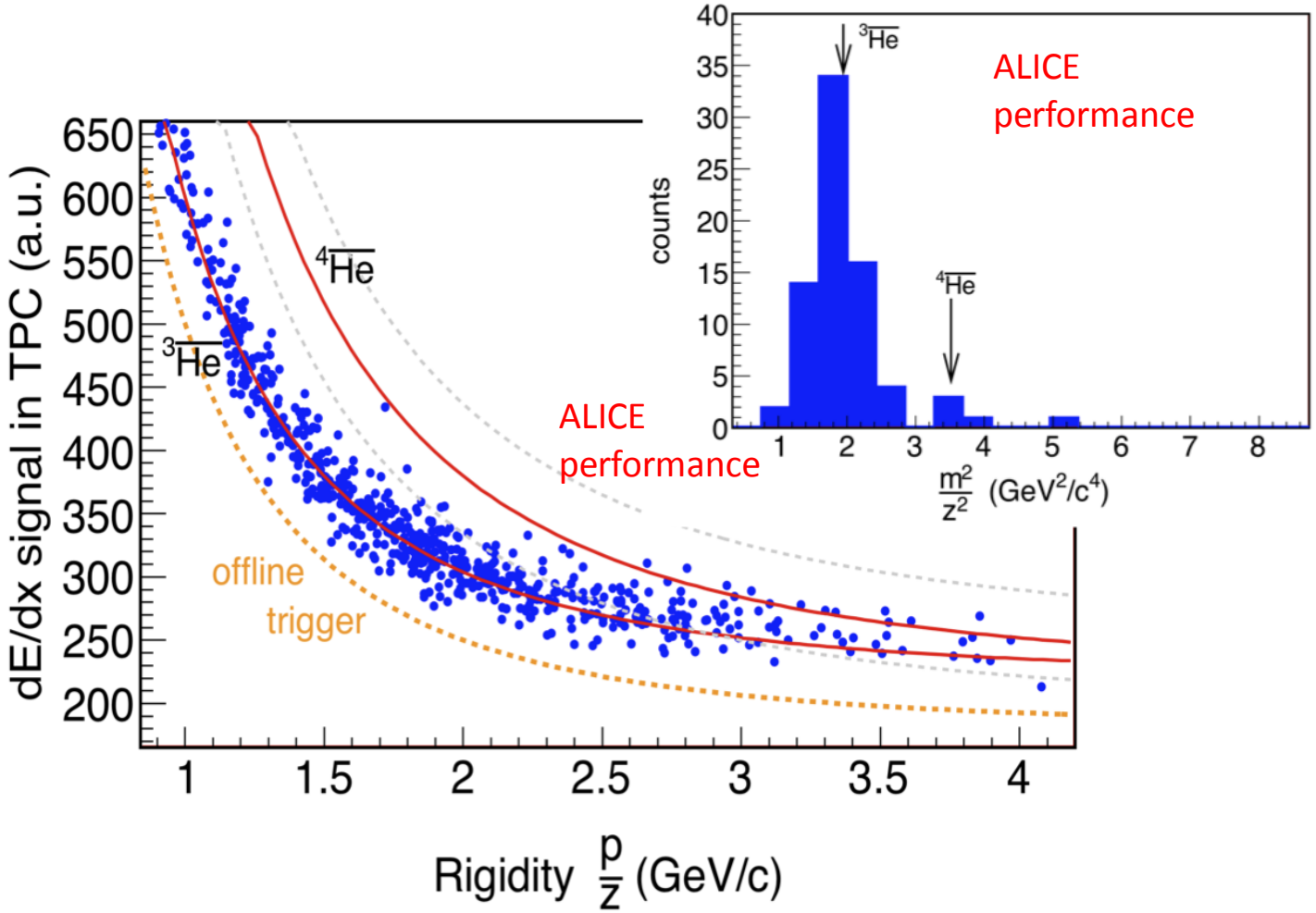
- **J/ψ (B) ≈ 10%** (LHCb) => R_{AA}(prompt) lower by ≈ 0.05
- compare to Phenix e^+e^- ? => less difference, still significant
- shadowing(LHC) > shadowing(RHIC) ? => R_{AA} goes up ?
- cold nuclear matter suppression ?

Anti Nuclei: Anti-Alpha Candidates in Pb-Pb

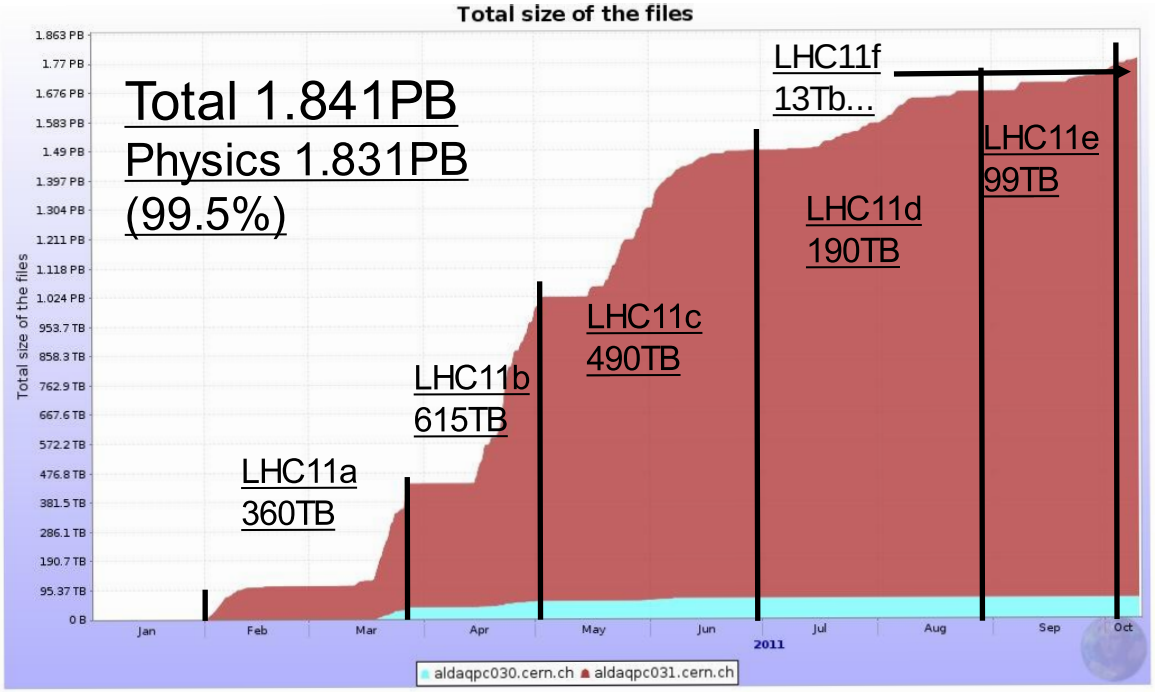
Time of flight (sensitive to m/z-ratio):

$$m = \frac{z \cdot R}{\sqrt{\gamma^2 - 1}}$$

$$< \frac{dE}{dx} >= \frac{4\pi N e^4}{mc^2} \frac{z^2}{\beta^2} \left(\frac{1}{2} \ln \frac{2mc^2 E_{max} \beta^2 \gamma^2}{I^2} - \frac{\beta^2}{2} - \frac{\delta(\beta)}{2} \right)$$



Three candidates unambiguously confirmed by TOF analysis



Data taking According to schedule

RAW data processing proceeds successfully

LHC11a – Pass1

2.76TeV – Pass3

LHC11b – Pass1

LHC11c – Pass1

LHC11d – Pass1

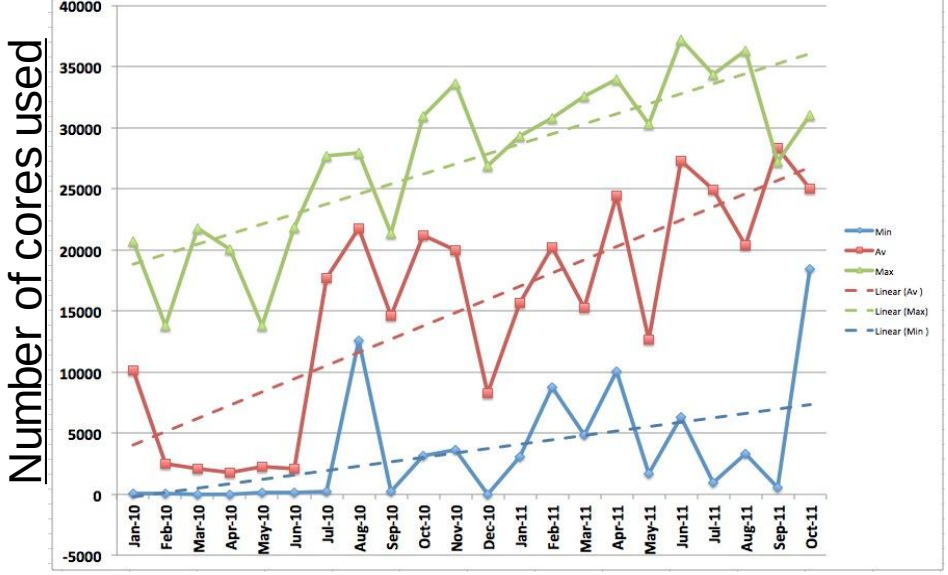
LHC11e - Pass1

LHC11f - Pass1 (current period)

LHC10b – Pass3

LHC10c – Pass3

TOTAL	122,347/129,527	94.5%	381,799,429	216 jobs	
TOTAL	32,760/32,997	99.3%	95,398,974	24 jobs	
53,519/59,901	89.3%	320,585,734	168 jobs	0 err	
97,683/116,621	83.8%	147,595,998	222 jobs	0 err	
39,378/39,978	98.5%	42,441,853	163 jobs	0 err	
TOTAL	37,281/55,164	67.6%	67,565,213	166 jobs	
TOTAL	13,039/13,641	95.6%	13,209,621	54 jobs	
13,729/14,541	94.4%	82,094,065	125 jobs	0 err	
25,679/28,540	90%	200,958,921	94 jobs	0 err	

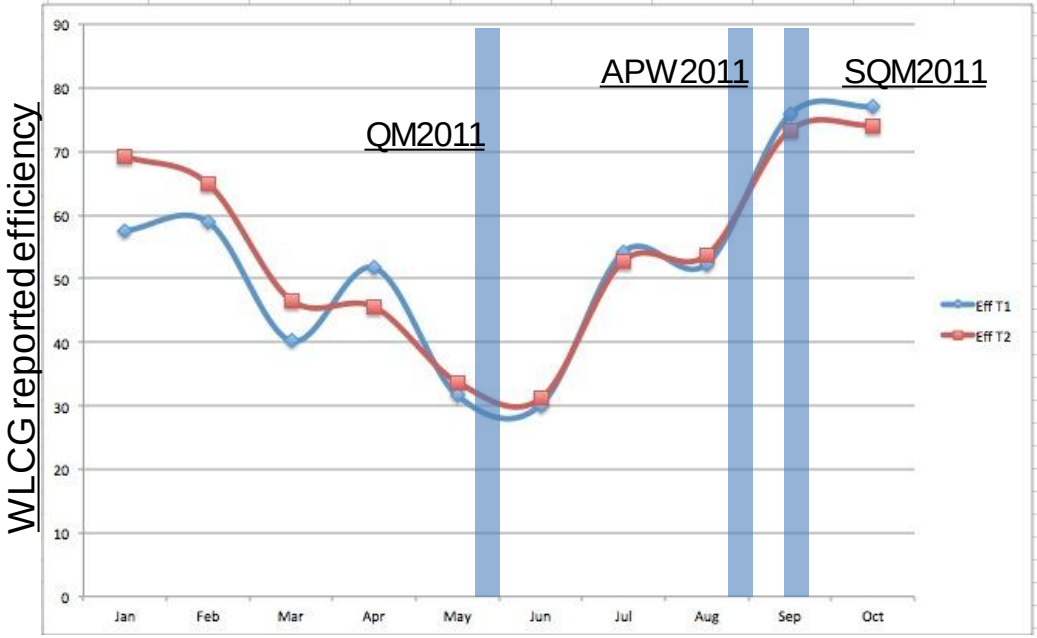


Very good usage of opportunistic resources

ALICE Grid is used by all ALICE users even for tests or short jobs garantees uniformity and reproducibility of results.

GRID jobs efficiency:

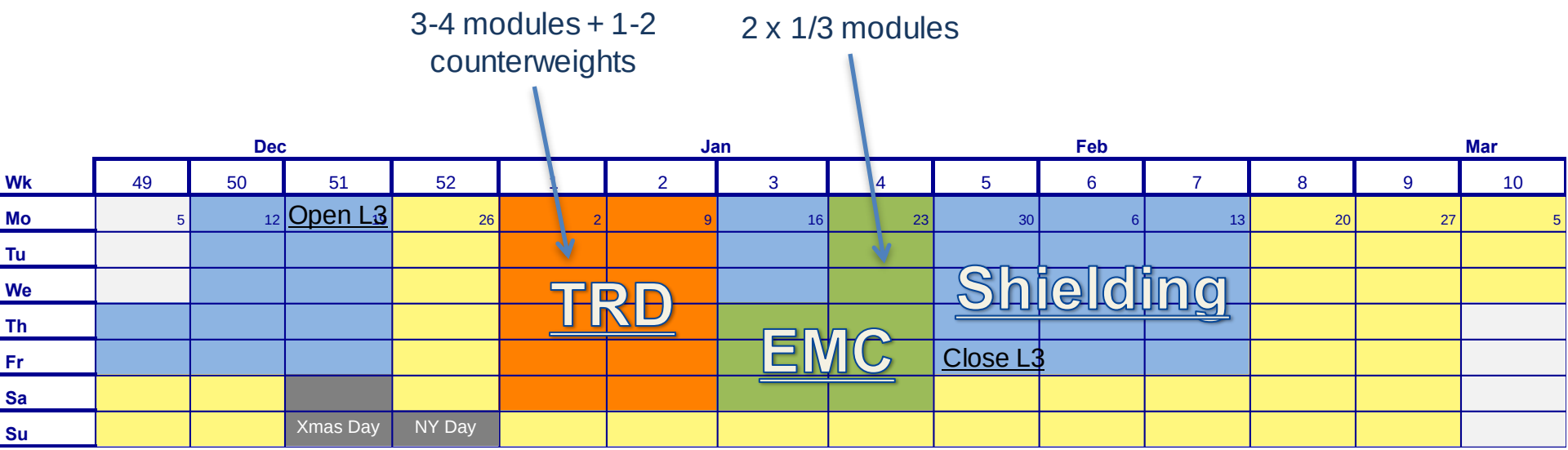
- Nominal GRID efficiency for central productions (Reconstruction passes, Analysis Trains and MC productions)
- User jobs are below nominal efficiency on average



OUTLOOK

Detailed plan for HI

The Winter shutdown



Legend

- Open/close Experiment
- TRD
- EMCal
- Contingency

13 weeks (11 last year):

- 3 to 4 TRD modules
- 2 1/3 EMCal modules

+, on the machine side, modification of the beam pipe in the ZDC area and relocation of collimators

ALICE Upgrades

- ALICE has evolved considerably from its Technical Proposal, in particular:
  - the **TRD** has been approved much later than the other central detectors
    - 7/18 installed
    - 3 more in winter 2010/2011
    - complete by 2012
  - a new **EMCAL** calorimeter (very important for jet-quenching) has been added recently
    - US project, with French and Italian (+ China and Japan for DCAL) involvement.
    - 4 SM installed in 2009 out of 11
    - Complete in winter shutdown 2010/2011
    - Further 6 SM on opposite side in phi (DCAL) approved in 2010
    - DCAL Complete by 2012, installed in 2013
- These additions have been handled through specific MoU addenda with the proponents of the projects

Upgrade projects

Detector Upgrades for >= 2013. ***Objectives:***

Extend the Physics reach (independent on $\mathscr{L}$)

Improve the rate capability (in view of higher AA $\mathscr{L}$)

- High rate upgrade:
  - increase rate capability of TPC (faster gas, increased R/O speed)
  - → rare hard probes (Υ, γ-jet, …)
- DAQ, TRIGGER & HLT upgrades:
  - → more bandwidth, more sophisticated and selective triggers
- Particle ID upgrade:
  - extend to p_T range for track-by-track identification to O(20) GeV/c
  - → new physics interest, based on RHIC results
- Forward upgrades (probably to be split into 2 phases):
  - new detectors for forward physics (tracking & calorimetry)
  - → low-x in pA, AA
  - → Extend ALICE coverage for diffractive Physics
- Inner Tracking upgrade:
  - 2nd generation vertex detector (closer to beams, extended acceptance, capabilities)
  - → heavy flavour baryons, fully reconstructed B, …

Upgrade Timeline

- approved detector upgrades
  - EMCal (jet-quenching, *completed*), TRD (electron ID for heavy flavor, *to be completed by 2012*), DCAL (di-jets, *to be completed in 2013*)
- upgrade of rate capabilities (*≥ 2012*)
  - TPC (faster gas, readout), DAQ/trigger/HLT (increase bandwidth)
- major projects: ITS, MFT, VHMPID, FoCal (Phase 1)
  - diffraction, PHOS, other EMCal upgrades?

Upgrade Timeline (contd.)

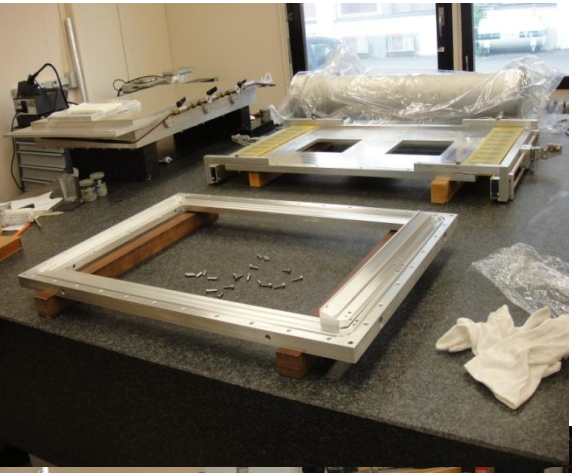
- phase 1 upgrades (*to be installed in LS 2017/18*):
  - **ITS**: improve sec. vertex resolution, topological trigger
  - **MFT**: sec. vertex for muon arm
  - **VHMPID**: hadron PID to ≈20 GeV/c
  - **FoCal**: large rapidity/small x physics (Phase 1)
  - diffraction, PHOS, more calorimeters (to be defined?)
- phase II upgrades (*to be installed in later shutdown*)
  - FoCal (Phase 2)

Detector Upgrade Projects

- major projects: ITS, MFT, VHMPID, FoCal (Phase 1)
  - Expressions of Interest received
  - Physics Potential confirmed in Physics Workshop in July
  - Call for Letter of Intent (ALICE internal)
  - IRC's installed – review process started
  - goal: ALICE decision on approval in ALICE mini week January 2012
- other proposals being considered: diffraction, PHOS, other EMCal upgrades?

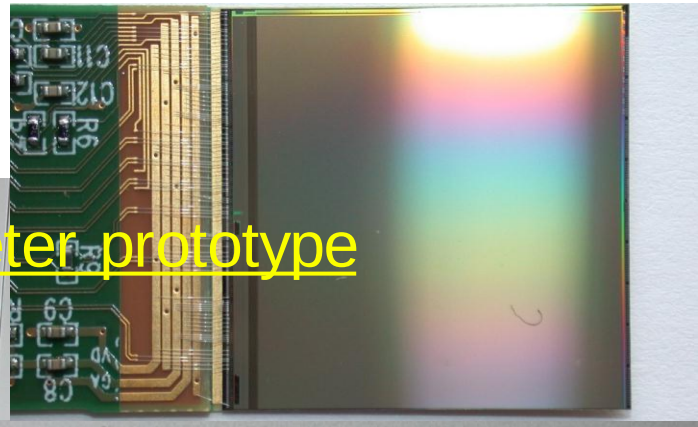
R&D activities ongoing

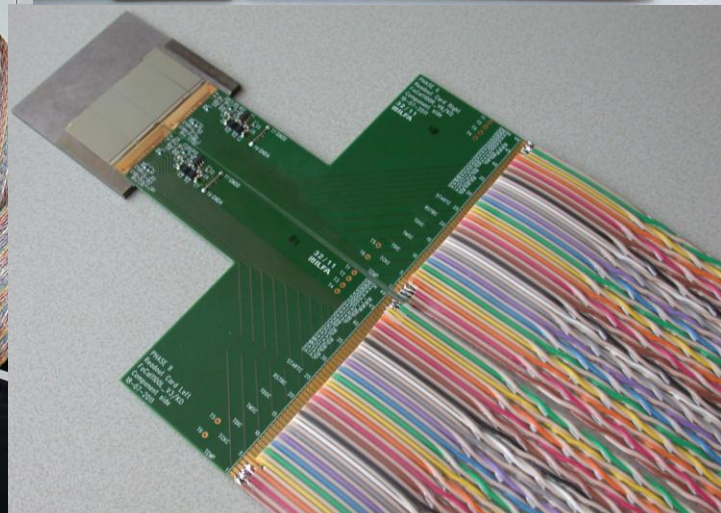
- already supported by a number of funding agencies
- crucial R&D issues to be solved: need further support!



VHMPID:

FoCal: SiW calorimeter prototype





Summary

- ALICE is now harvesting after 20 years of preparation!
  - 14 papers, some already with considerable impact
  - 18 more in advanced preparation stage
  - Many more to come
- The Detector continues to provide excellent performance, and ALICE as a whole confirms its readiness and commitment
- More challenges ahead!

We count on your continued support…

THANK YOU!