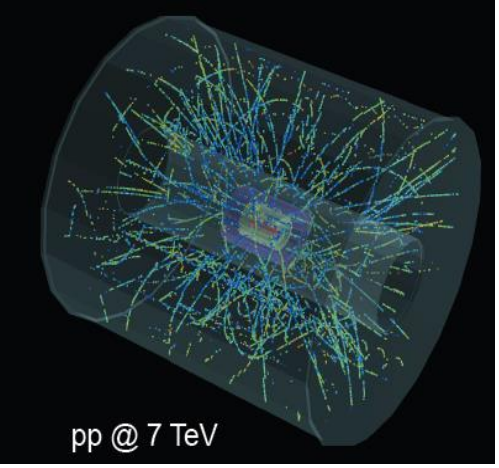
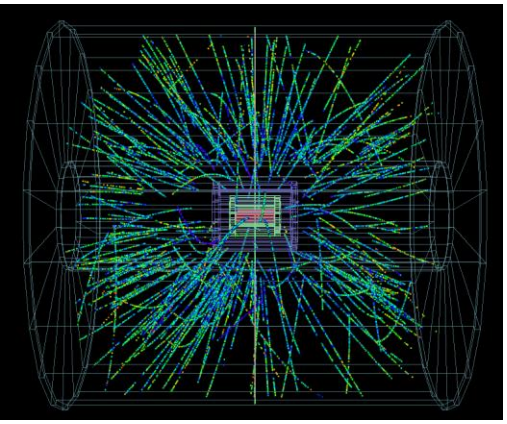
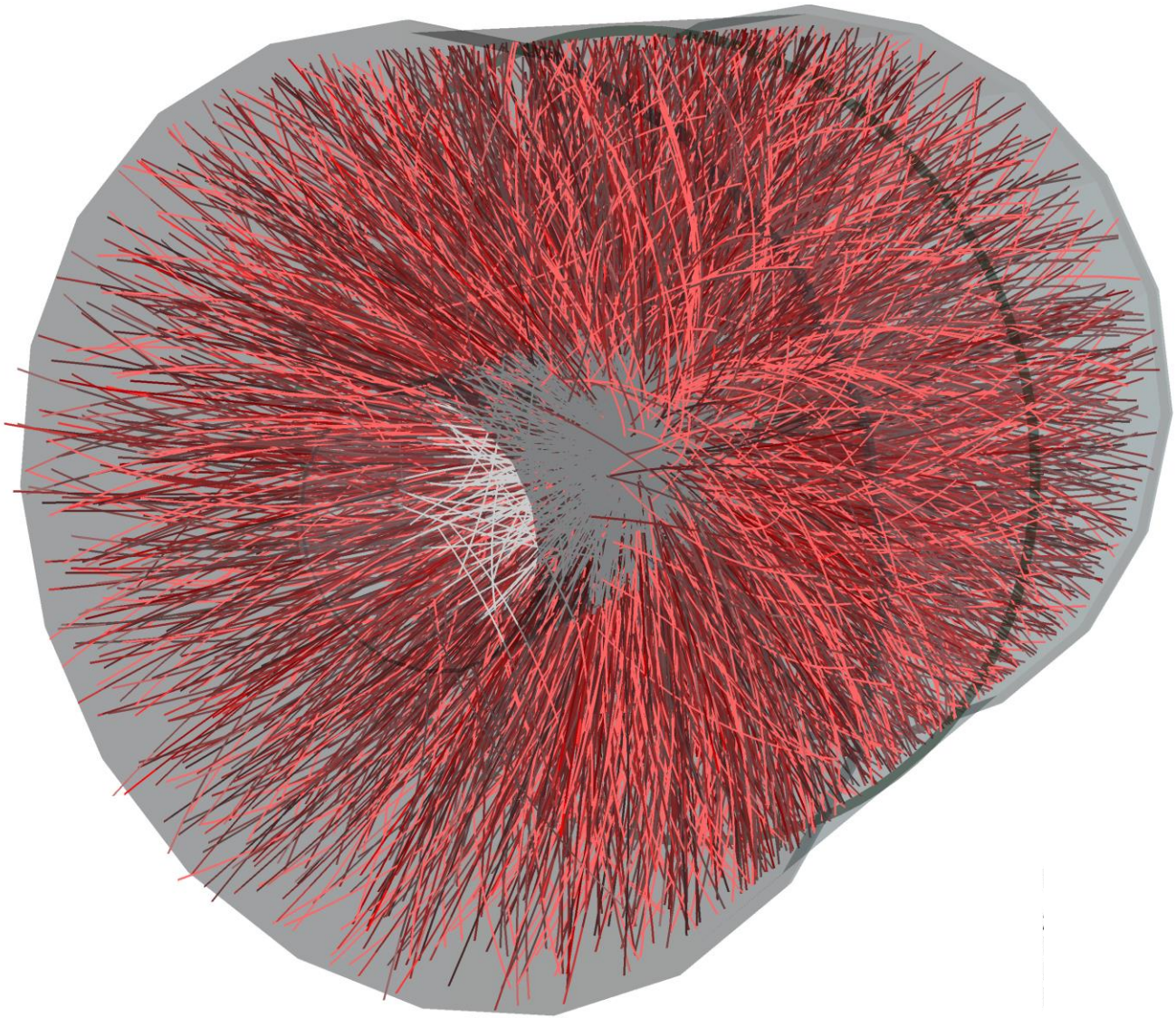
ALICE status





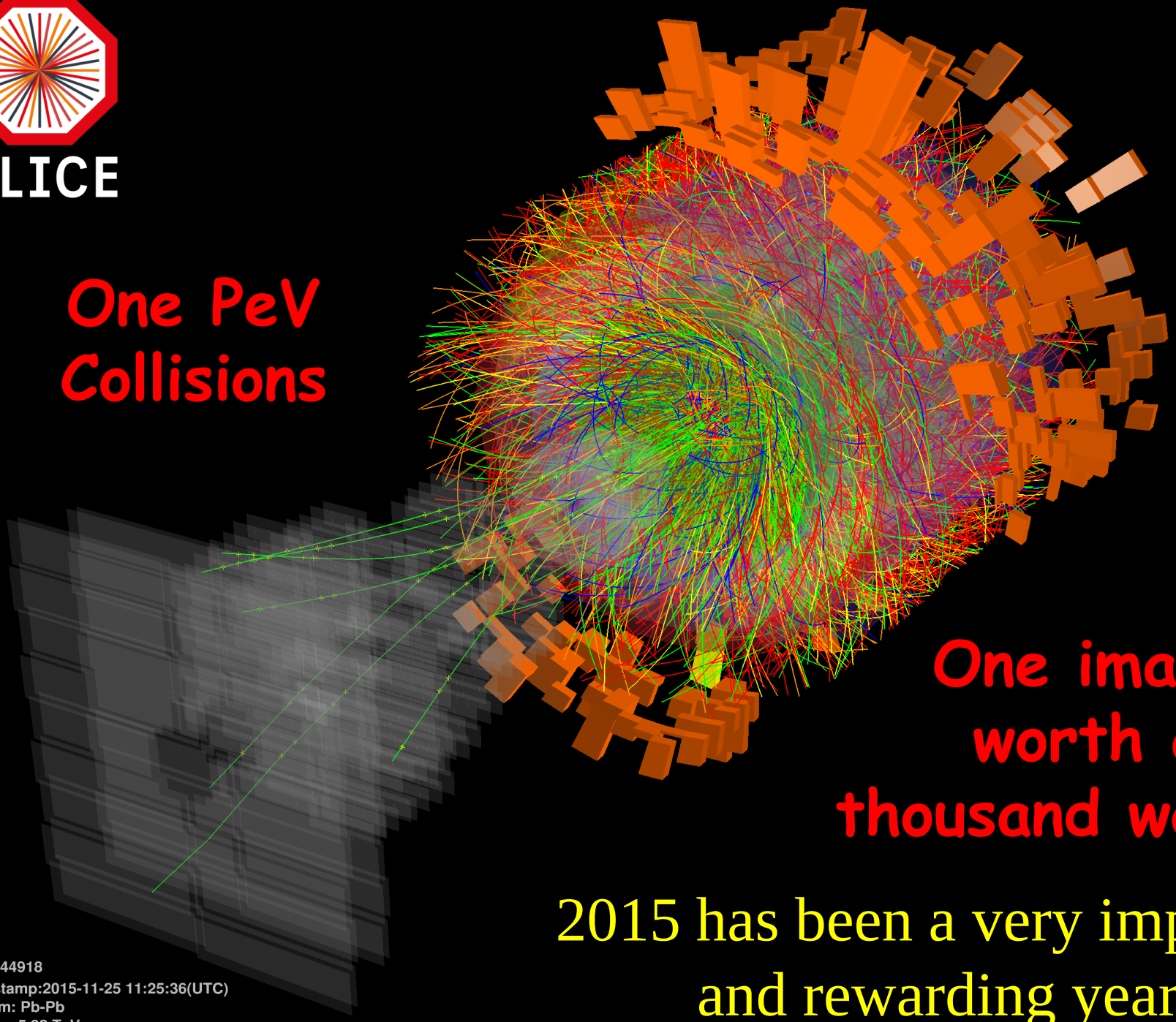


ALICE

ALICE-India Meeting
Kolkata Feb 6, 2016

ALICE

One PeV Collisions



One image worth a thousand words...

2015 has been a very important and rewarding year!

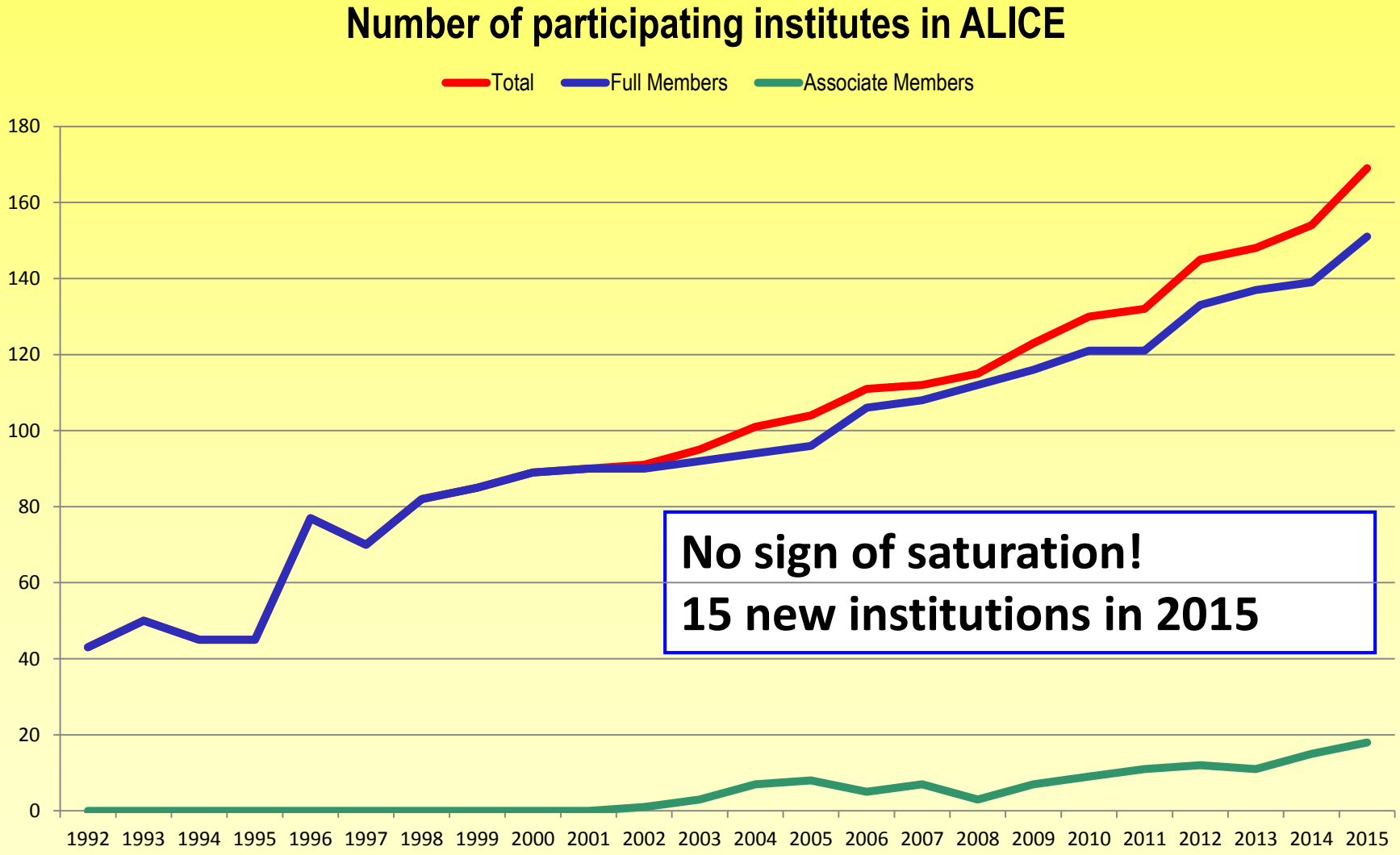
Run:244918
Timestamp:2015-11-25 11:25:36(UTC)
System: Pb-Pb
Energy: 5.02 TeV

ALICE in 2015

- **RUN2**
  - All new detectors and triggers are in operation (just the RCU2 was missing, but installation has been done in the Winter stop)
  - Excellent stability and efficiency, thanks to a LOT of preparation work and continuous care.
  - **Very good pp@13TeV, pp@5Tev and PbPb runs**
- **The Upgrade progresses**
  - **All 5 TDRs have gone through the full approval process**
  - The R&D is progressing very successfully
  - First steps towards production, two key design reviews passed successfully just now (the ITS chip and the TPC chambers)
- **Analysis in full swing**
  - 143 papers at end 2015, already 147 now
  - **Impact** of the publications remains extremely high
  - Strong presence at the 2015 conferences. **29 talks and >50 posters at Quark Matter**
  - **First 13 TeV paper and First PbPb paper submitted, several in preparation**

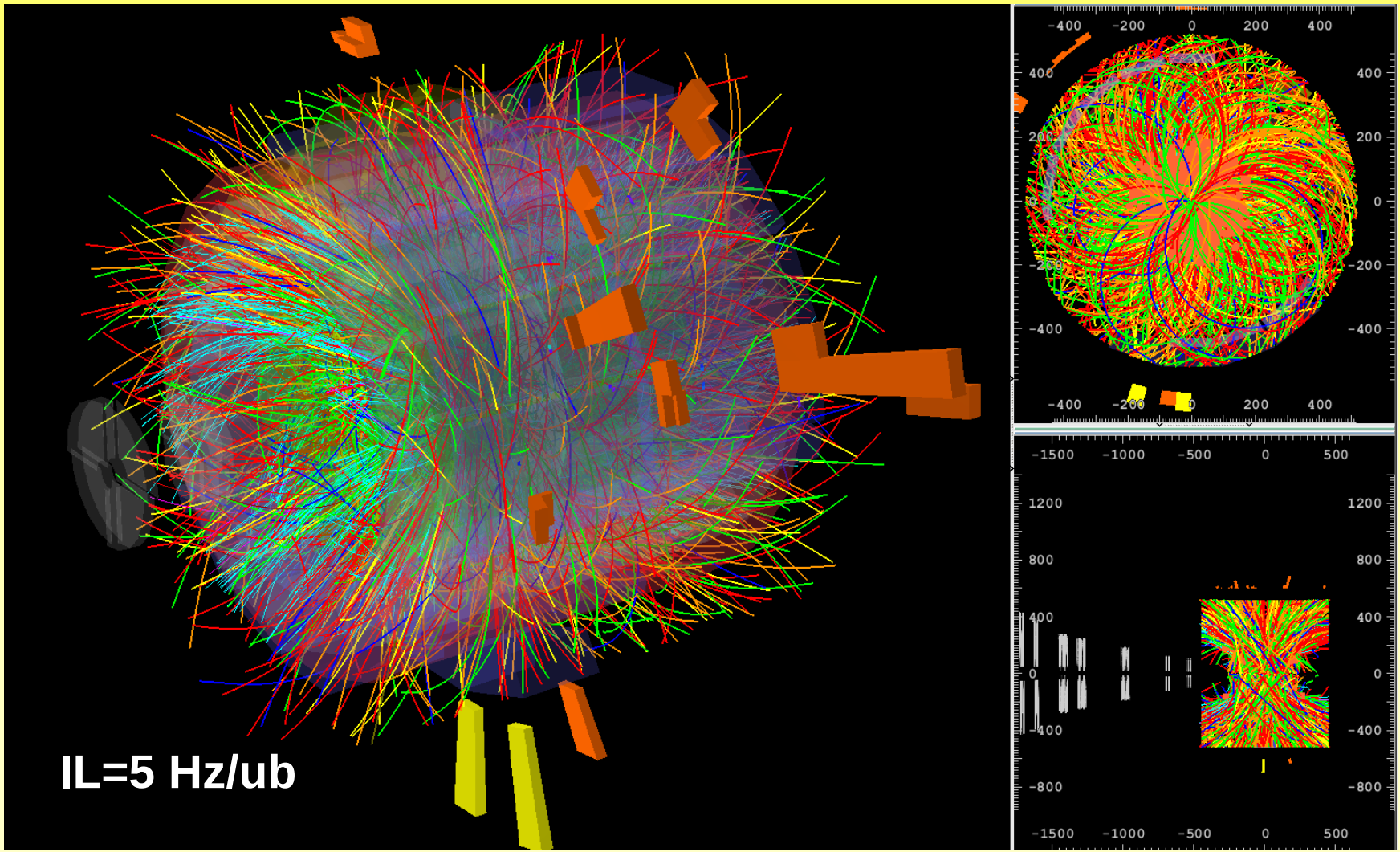
ALICE Continues to grow!

Now over 1600 members from 169 Institutions in 42 countries



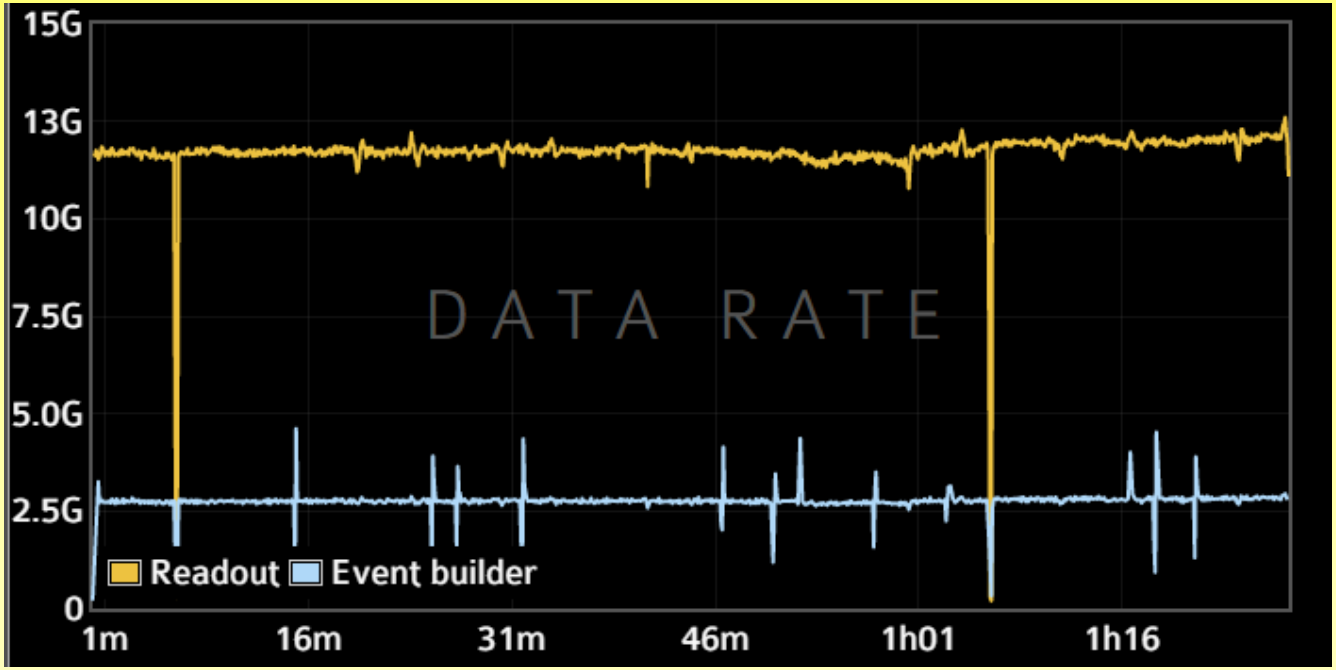
A scientific and technological program with great prospects!

The RUN: pp at 13 TeV



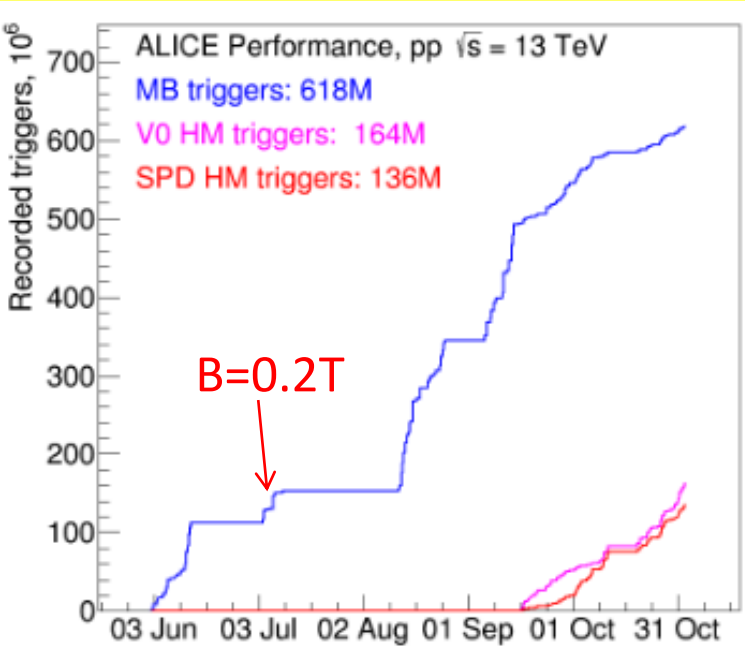
NOTE: Beam induced background x10 better than 2012: took data from the beginning of each fill

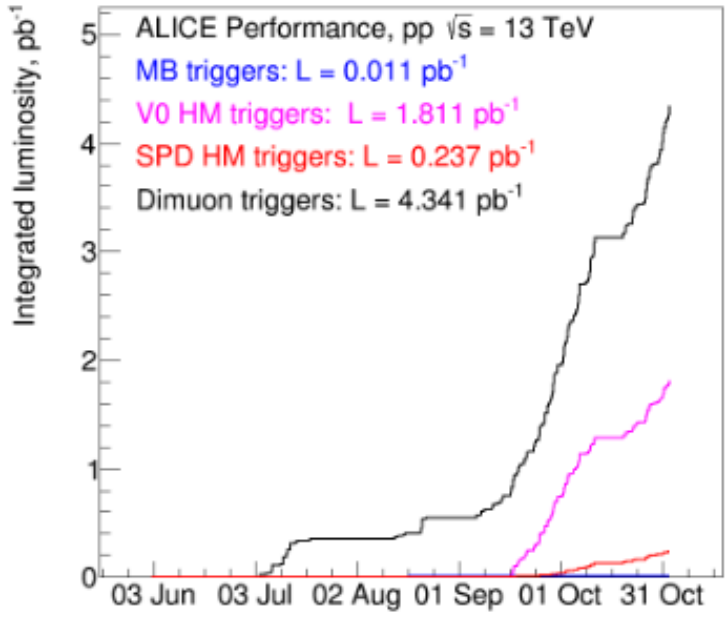
Run 2 pp data taking: Online systems



- Data taking at up to 12.5 GB/s
- Data compression by a factor 5
- Data recorded at up to 2.5 GB/s

ALICE pp run at 13 TeV



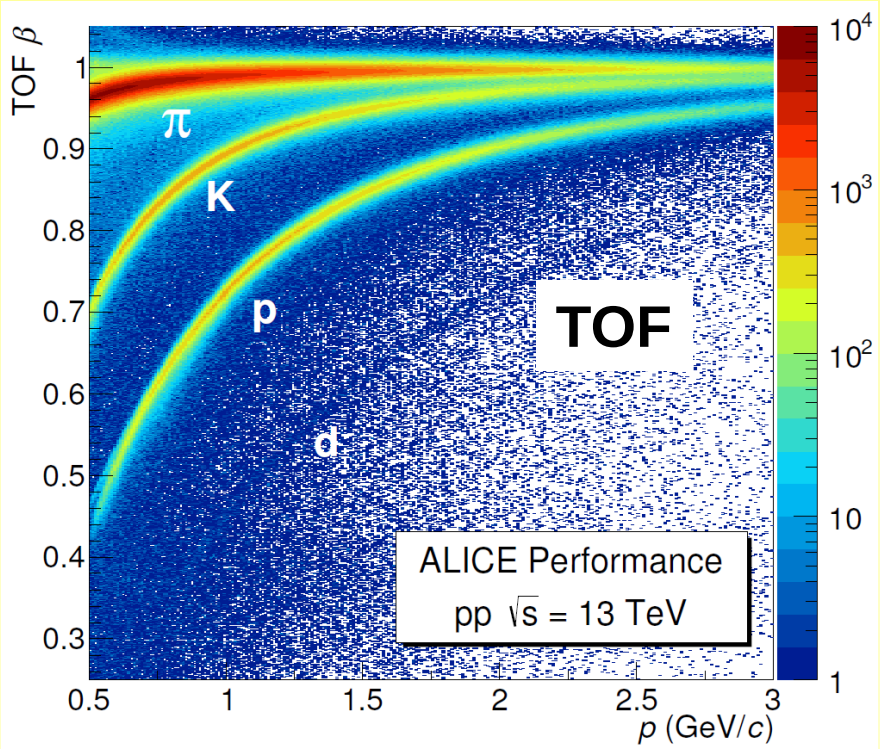


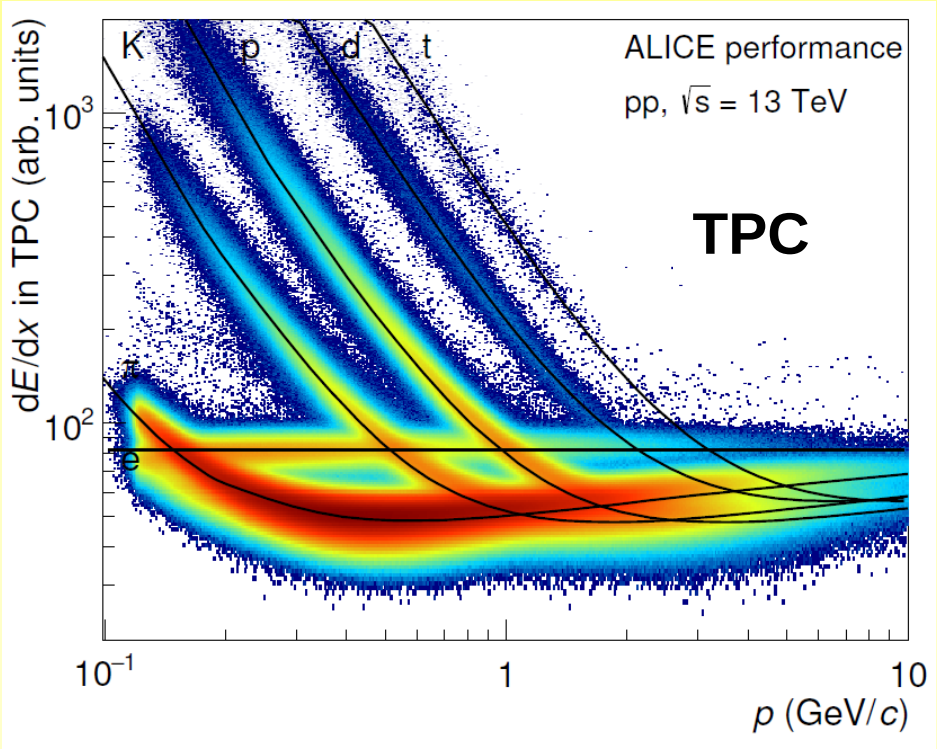
- **LHC restart (Isolated bunches): diffractive data taking with global OR triggers (V0 | AD | ZDC |SPD). Planned 100M, collected 165 M**
- **50ns: muon data taking**
- **90m run: diffractive data taking, collected ~250 nb-1**
- **25ns: data taking at rates up to 5 Hz/ub with rare triggers and minimum bias data taking at low μ**

MB: planned 600M, collected 616M
muon triggers: planned 4pb^{-1} coll. 4.3 pb^{-1}
high mult triggers: planned 2pb^{-1} coll 1.8 pb^{-1}

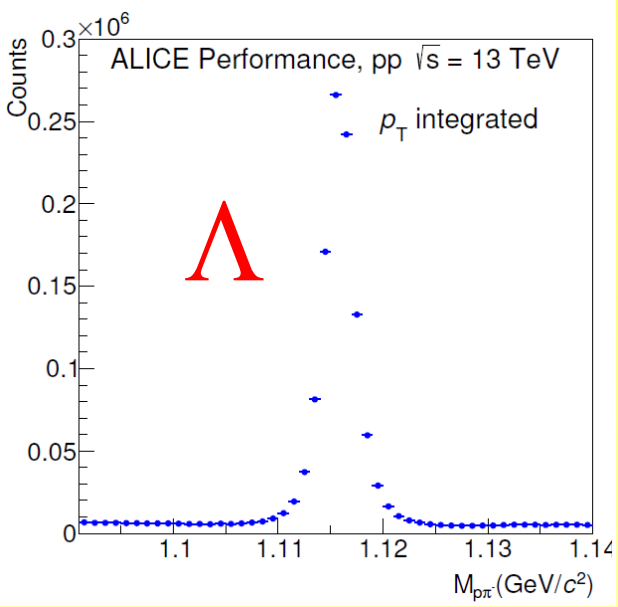
ALICE Detector Performance

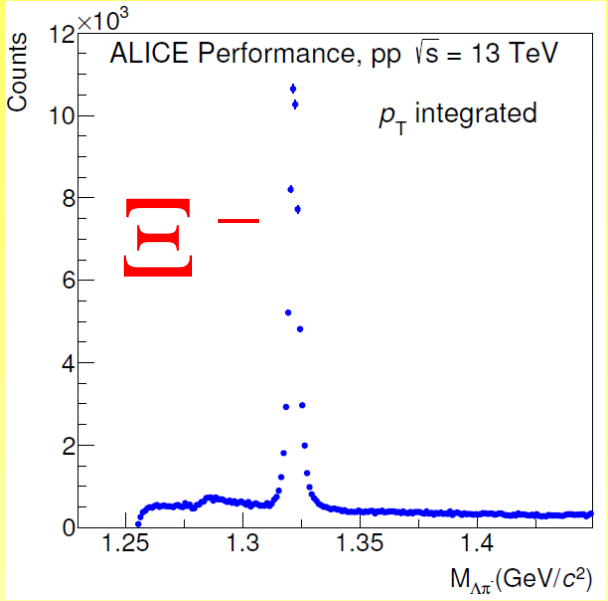
- New detectors (DCAL, AD, CPV) and new triggers (TRD sub-L0, CALO L0 and L1g,jet)
- Good detector stability and running efficiency
- TPC gas mixture changed from $NeCO_2$ (90:10) to $ArCO_2$ (90:10)
- TPC stable response at high fluxes (up to 800 kHz, 14 Hz/μb)
- Muon Chambers tested up to RUN3 rates (2.5 MHz, 42Hz/μb)

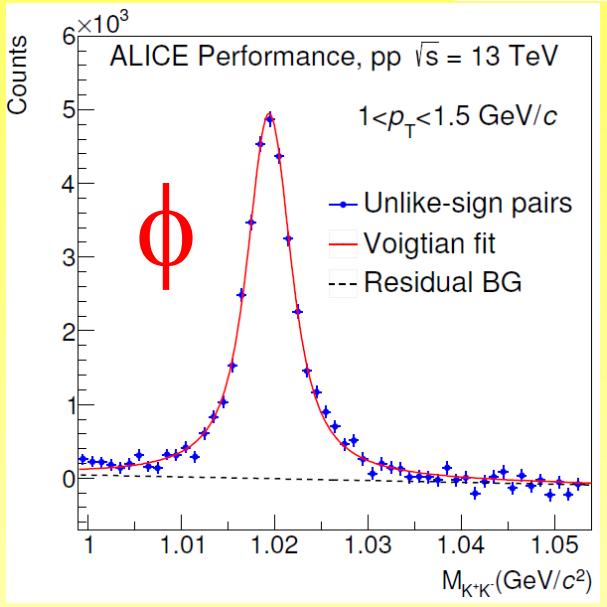


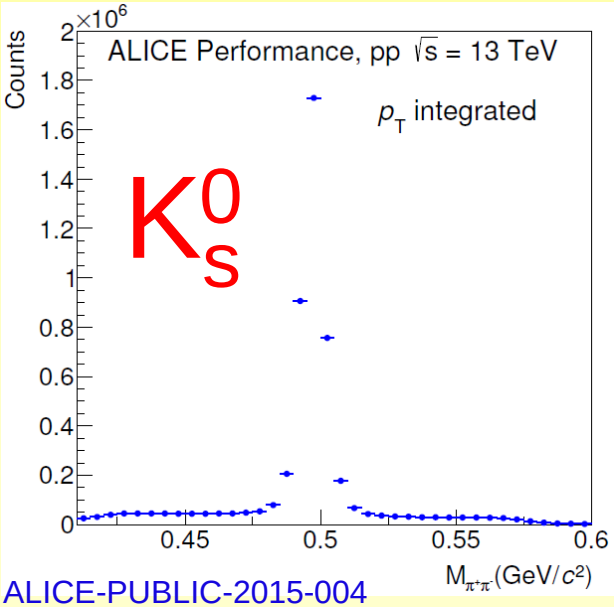


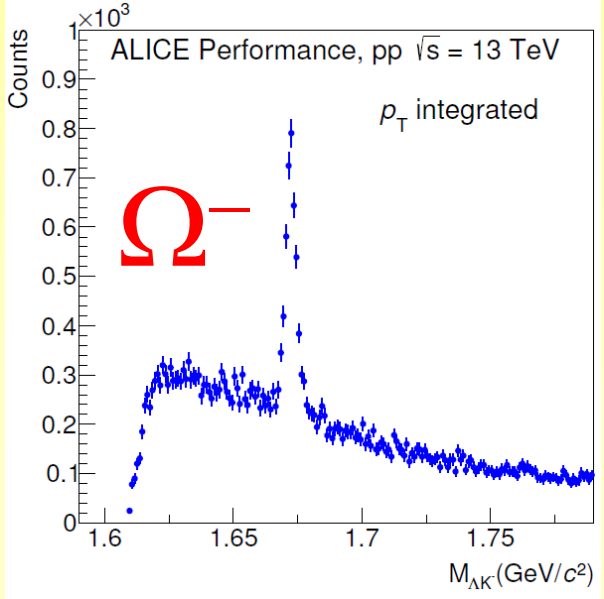
The Particle Zoo: strangeness…

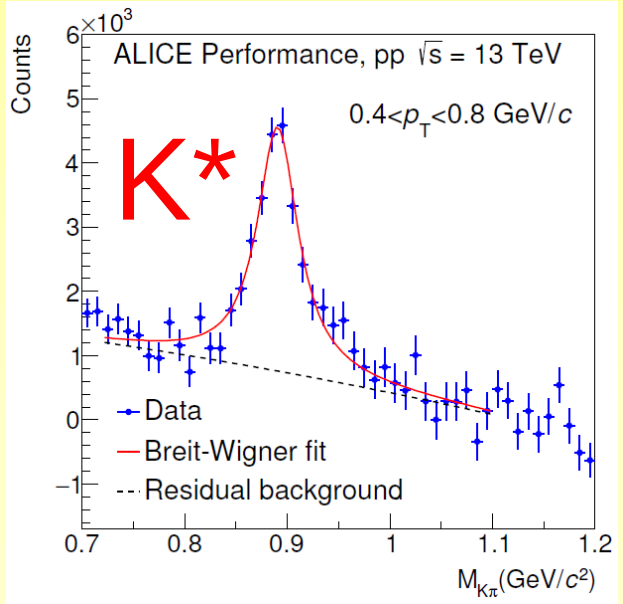






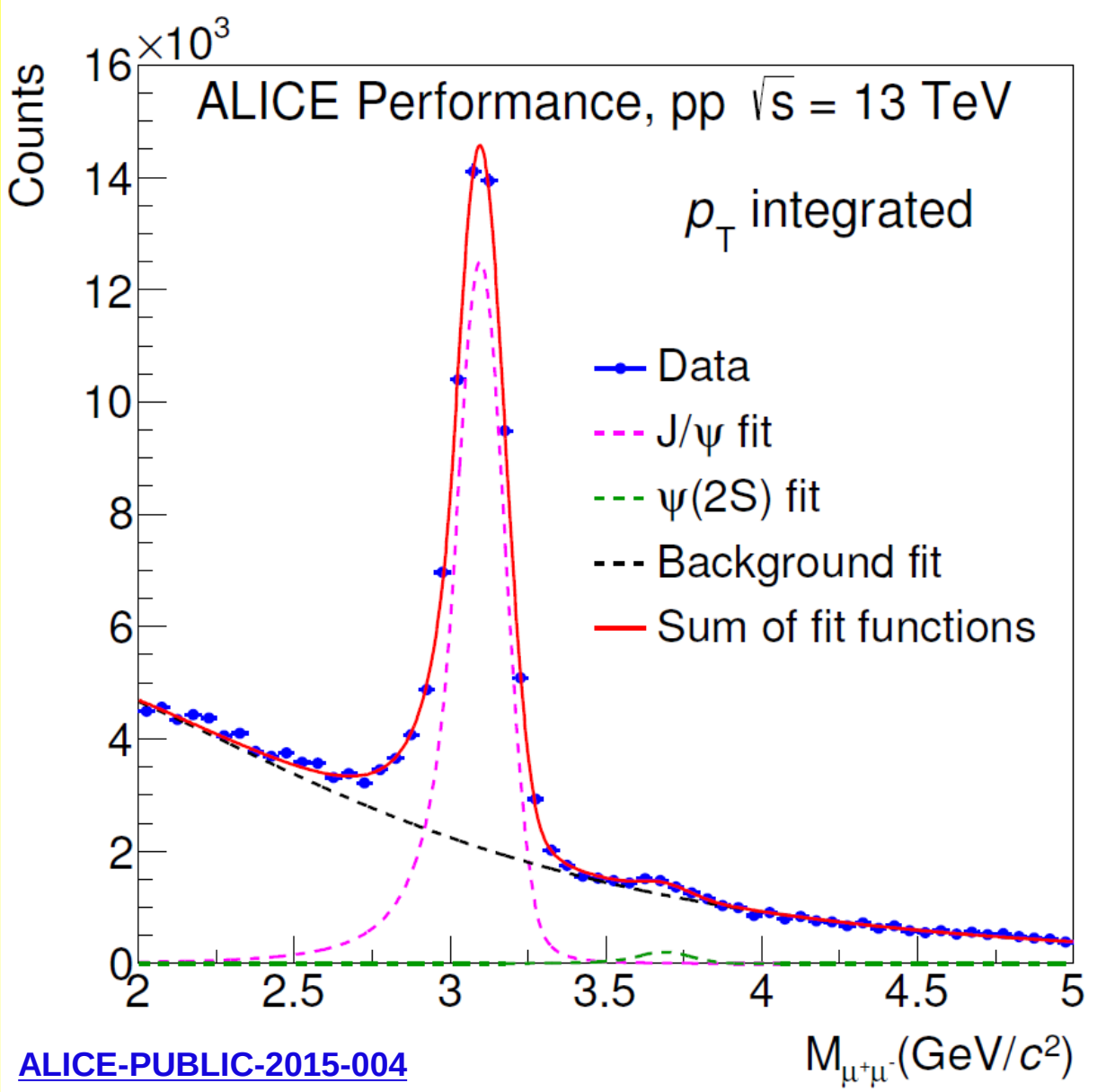




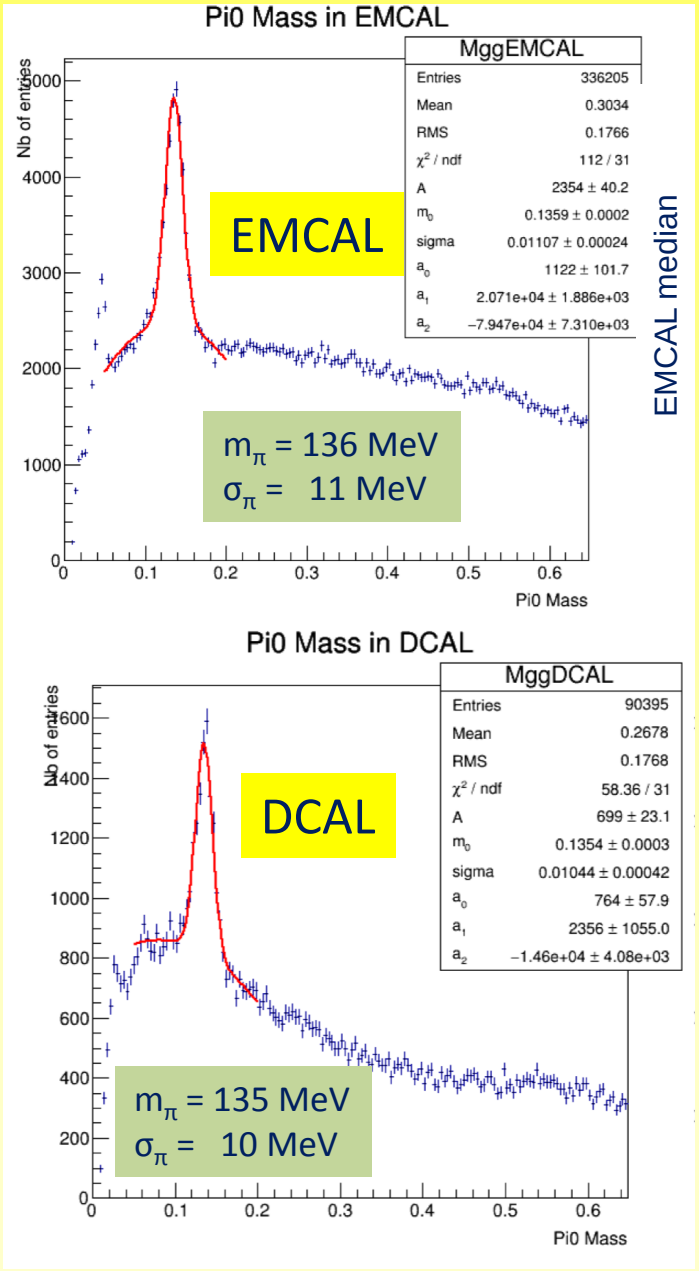


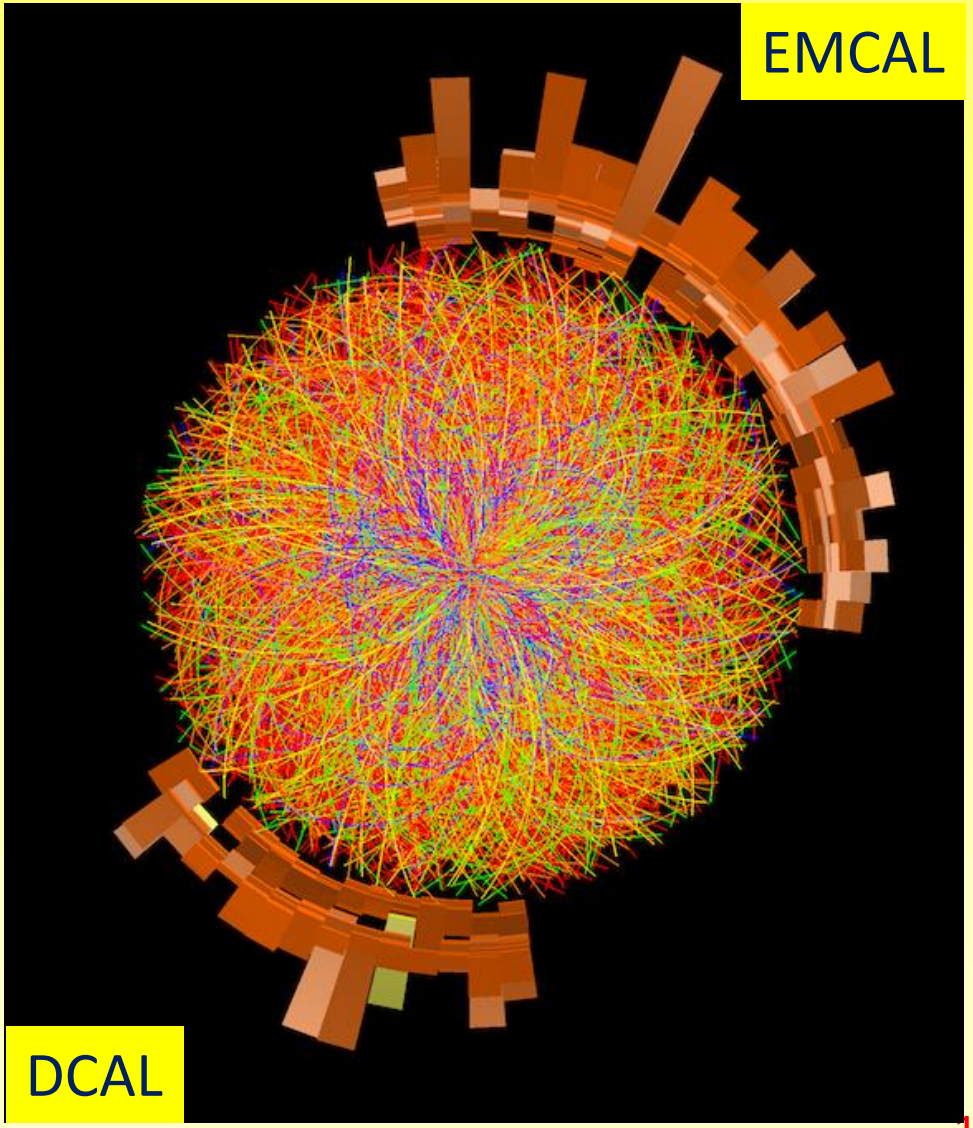
ALICE-PUBLIC-2015-004

… and charm

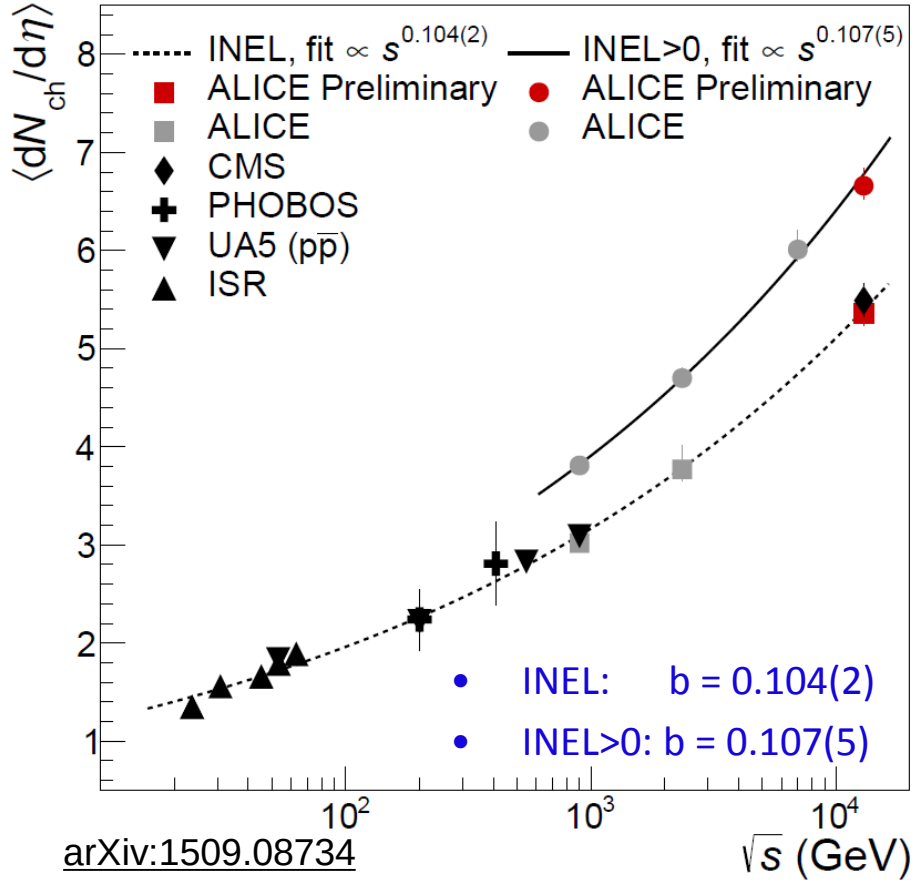

ALICE Performance, pp $\sqrt{s}$ = 13 TeV
p_T integrated
Data
J/ψ fit
ψ(2S) fit
Background fit
Sum of fit functions
Counts
$\times 10^3$
$M_{\mu^+\mu^-}$ (GeV/c^2)
ALICE-PUBLIC-2015-004

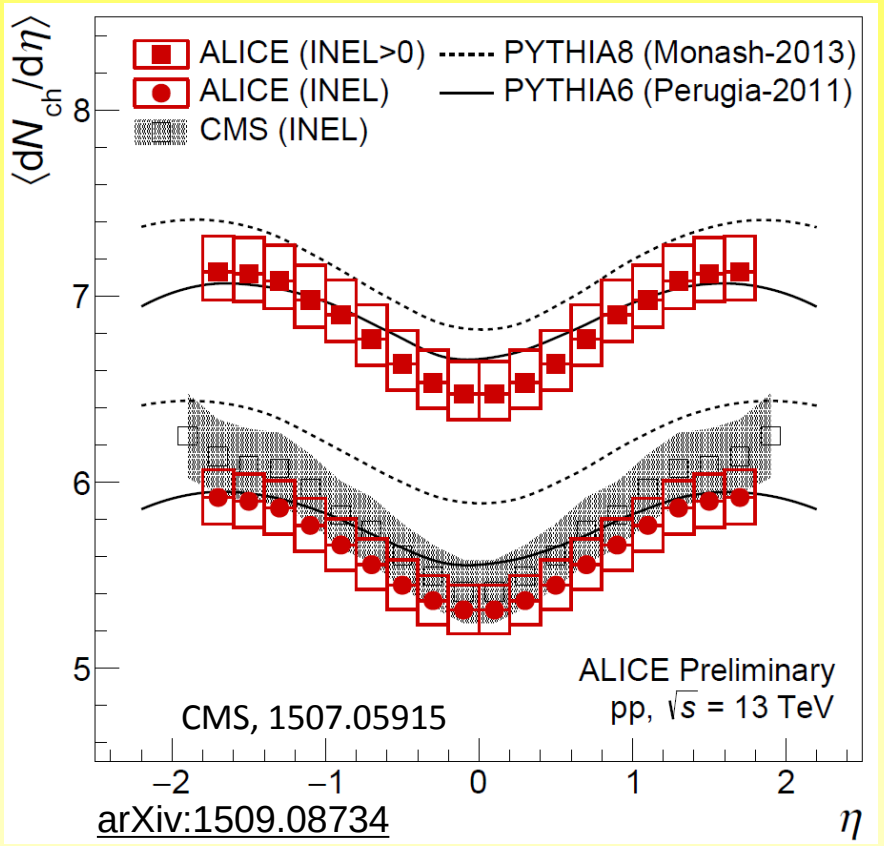
Detector Performance: EMCAL/DCAL





Charged-particle density at 13 TeV





INEL: $\langle dN/d\eta \rangle$ in $|\eta|<0.5$

INEL>0: $\langle dN/d\eta \rangle$ in $|\eta|<1.0$

Energy dependence fitted with power-low function as^b

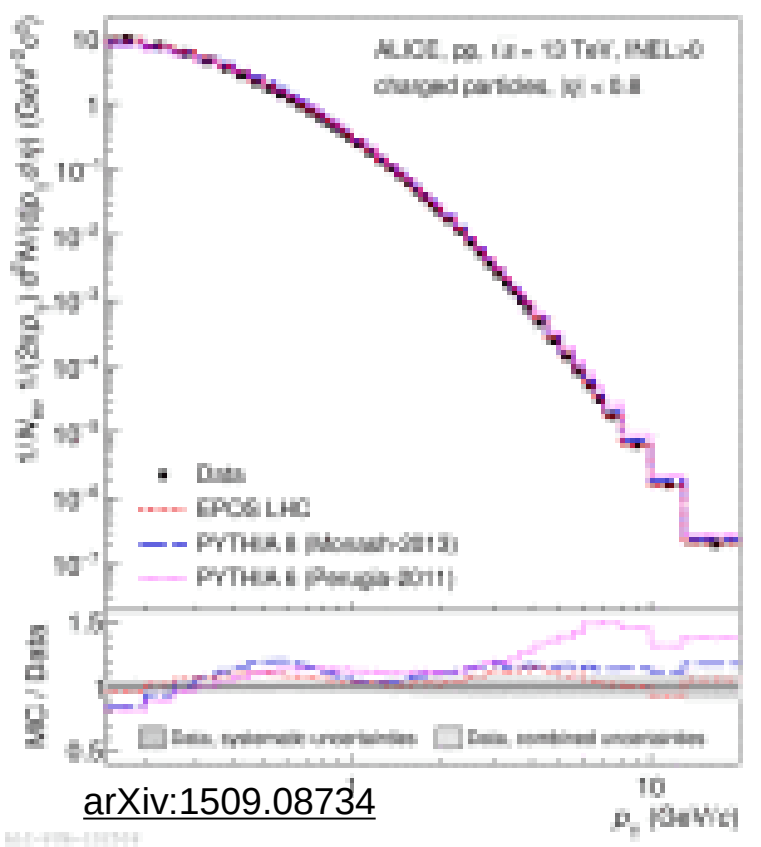
Energy dependence in fair agreement with expectations from low energy extrapolations

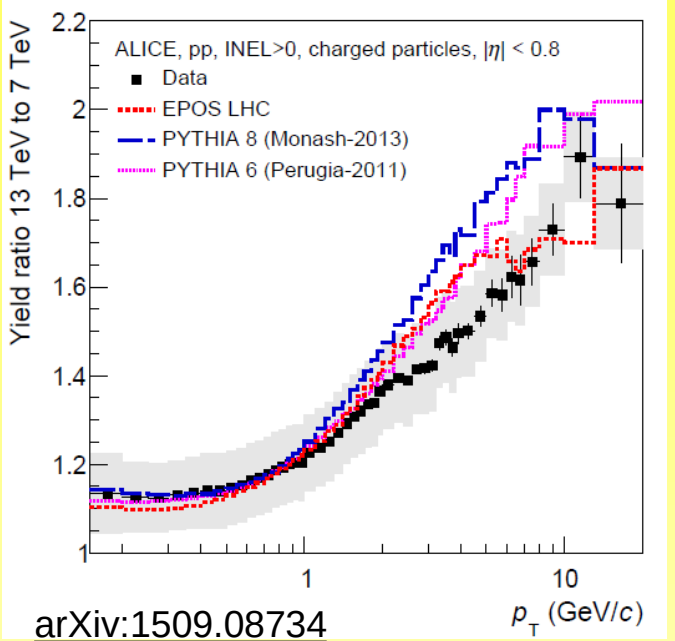
dN/dη measured for two normalisation classes:

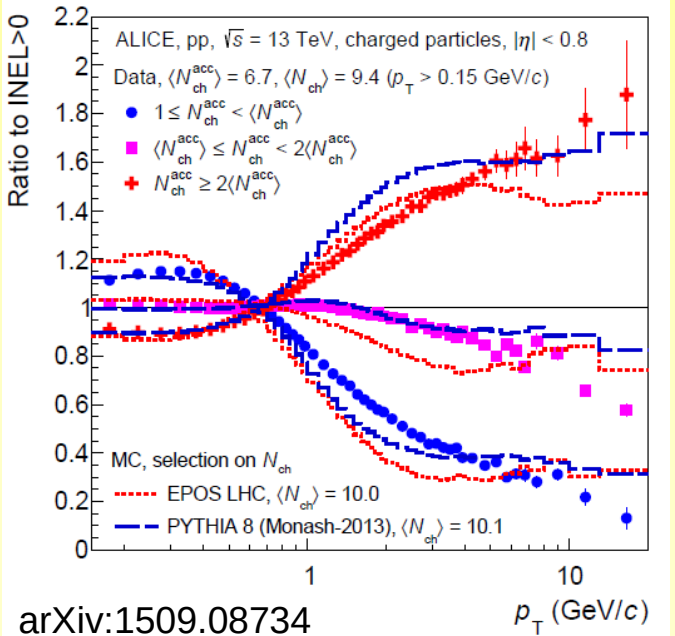
INEL: inelastic events

INEL>0: events having at least one charged particle in $|\eta|<1$

P_T distributions at 13 TeV



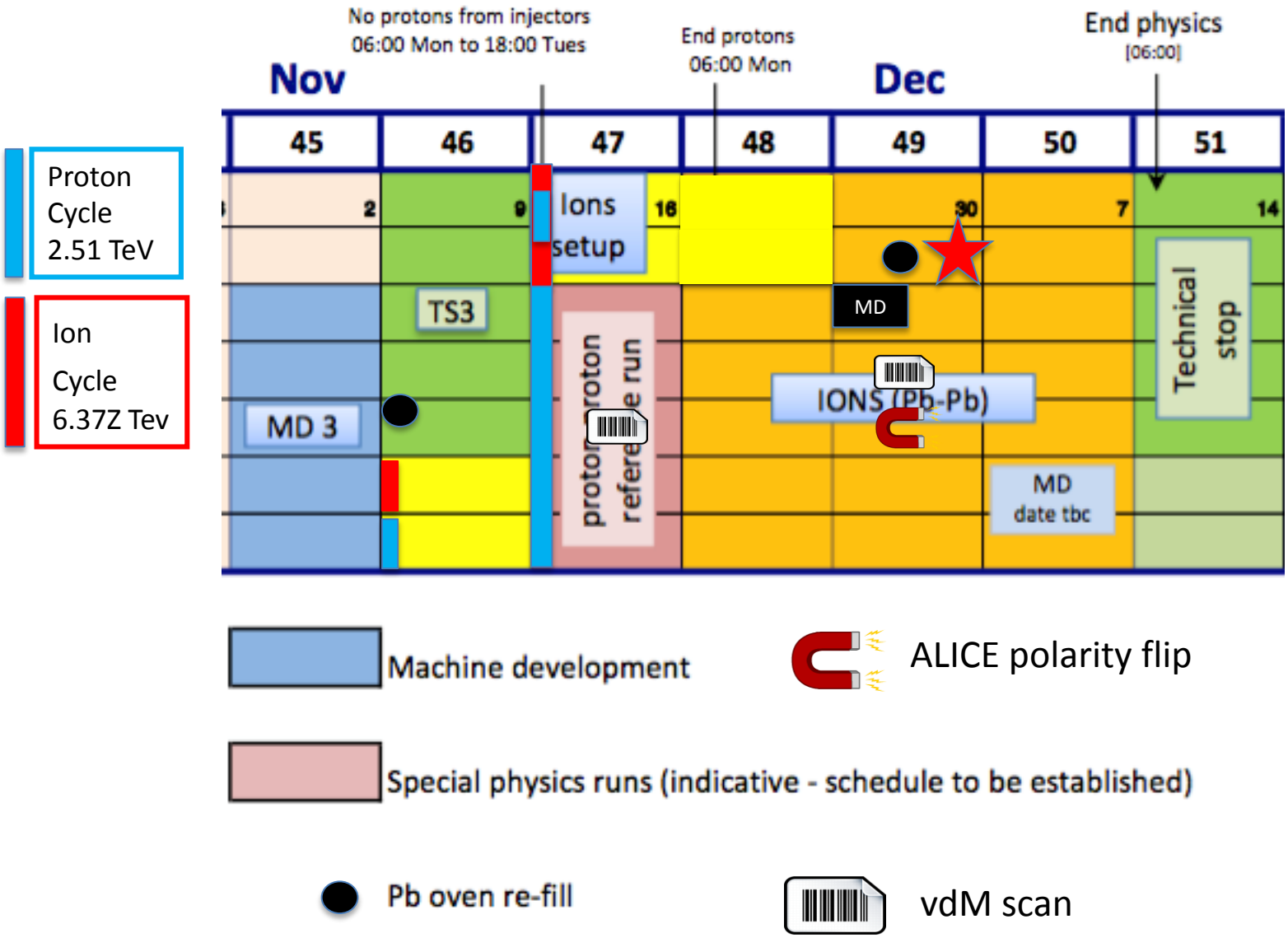




- Spectrum significantly harder than at 7 TeV
- shapes depend strongly on charged-particle multiplicity
- in fair agreement with event generators.

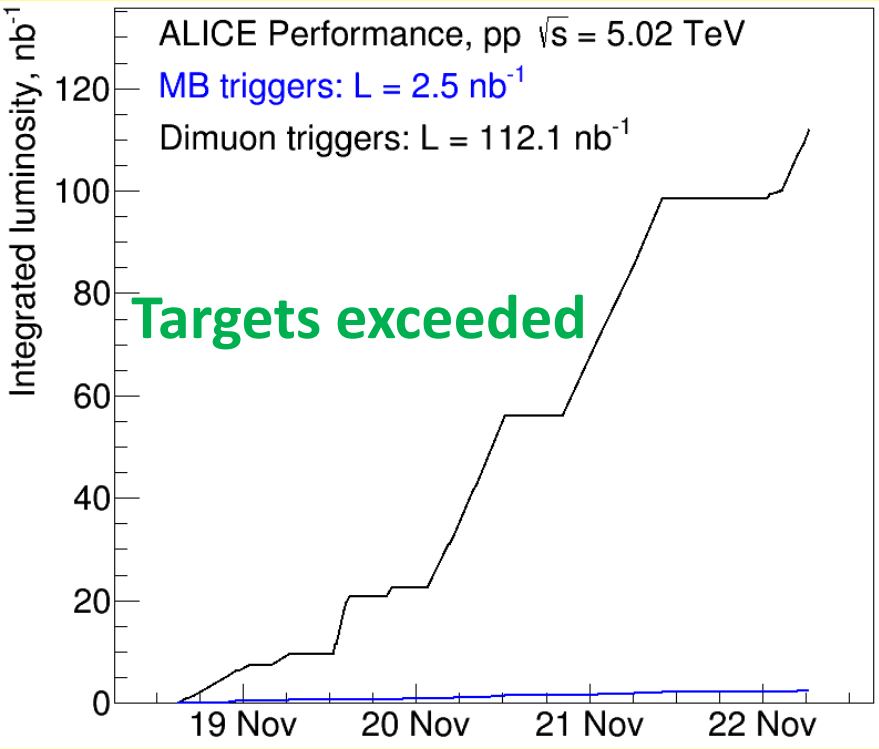
HI 2015: Tight Schedule

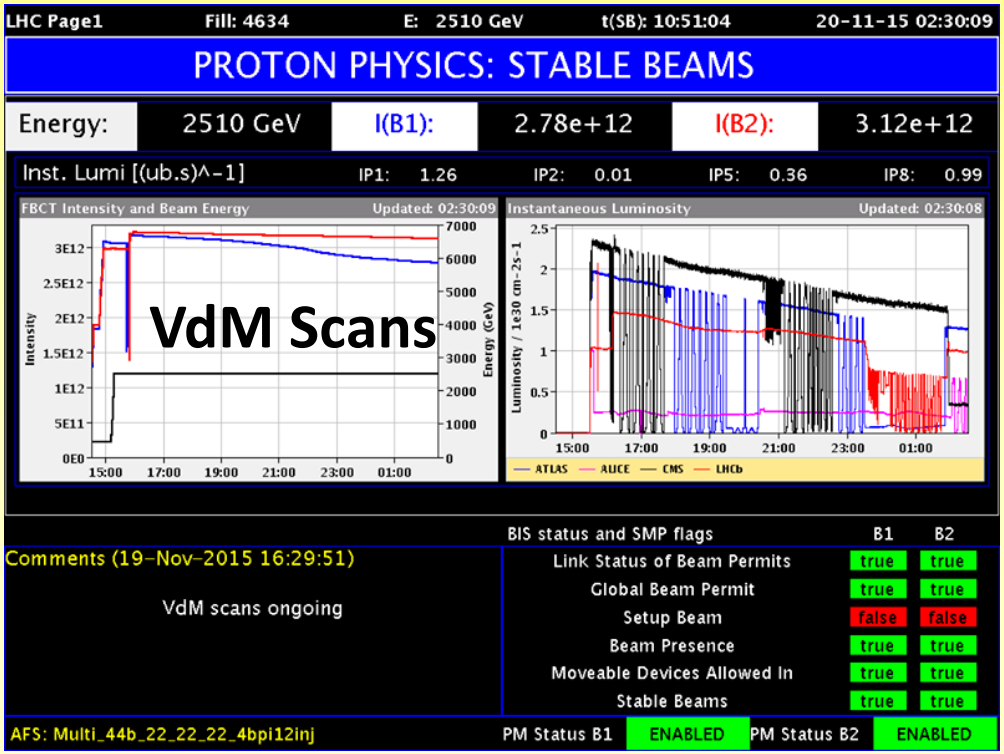
A Large Ion Collider Experiment



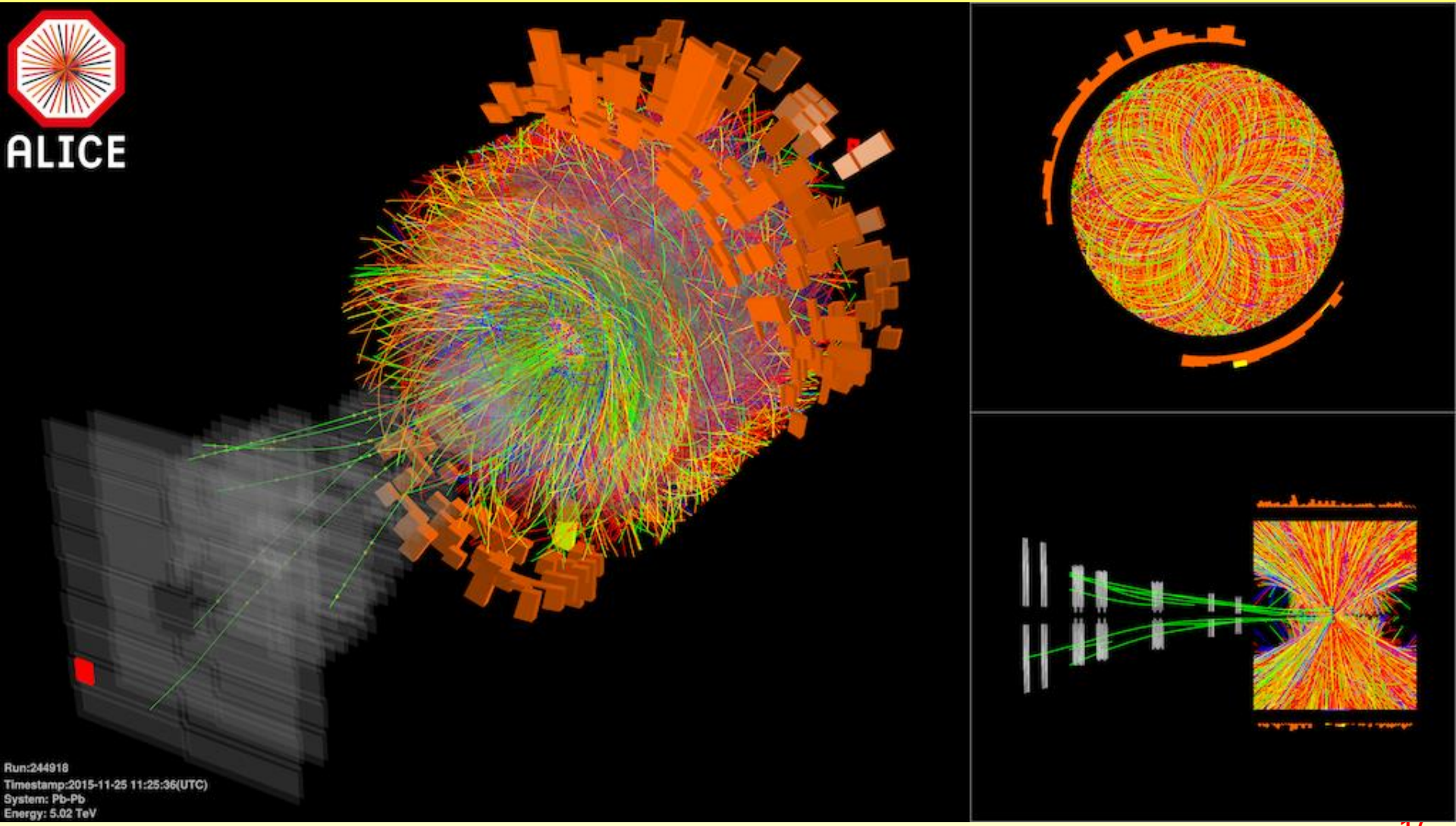
pp Reference Run at 5.02 TeV

- Precious reference data for PbPb 2015 and pPb 2013
- Complex operations: short setup time, little contingency
  - LHC moved from ion to proton cycles several times.
  - vdM + PHYSICS scan
  - High ALICE data taking and operational efficiency





PbPb!


ALICE
Run:244918
Timestamp:2015-11-25 11:25:36(UTC)
System: Pb-Pb
Energy: 5.02 TeV

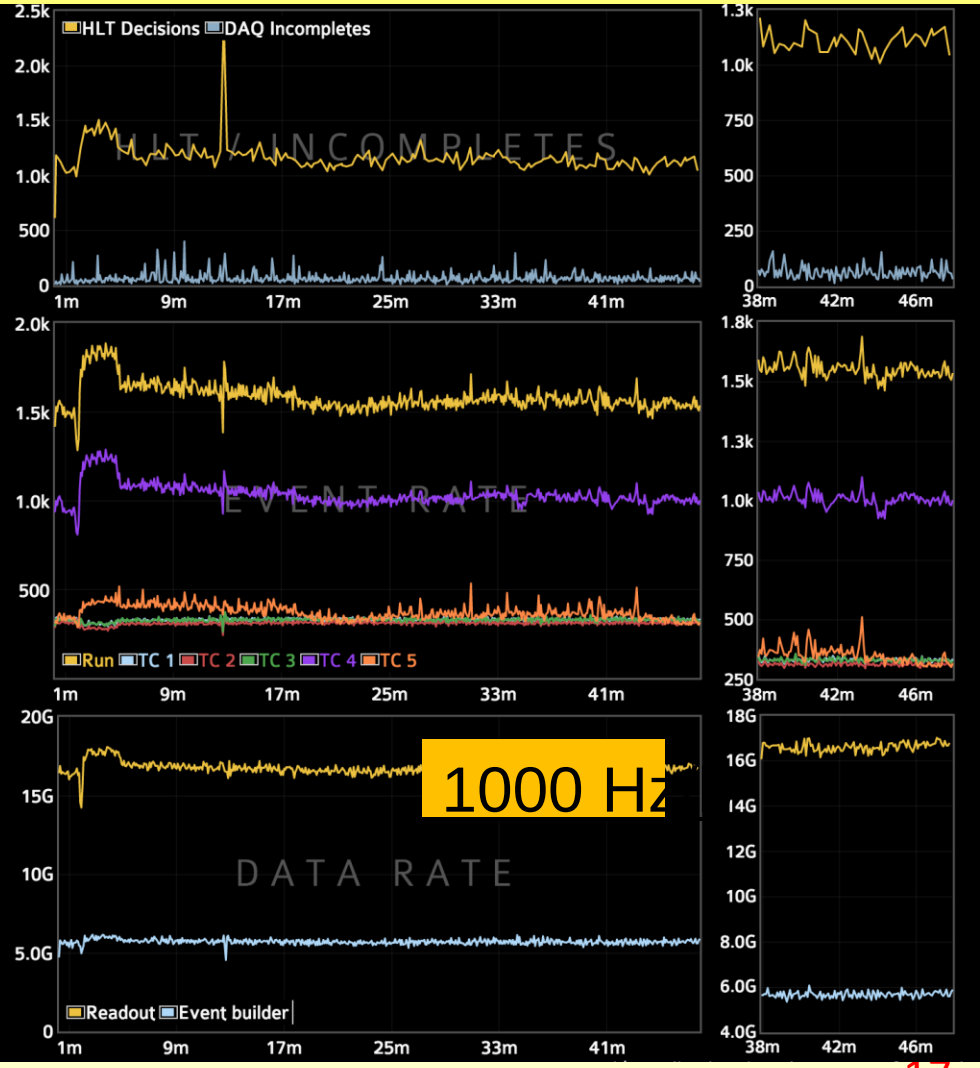
PbPb data taking

1000 Hz/b → 16 GB/s readout, 6 GB/s on disk after HLT compression

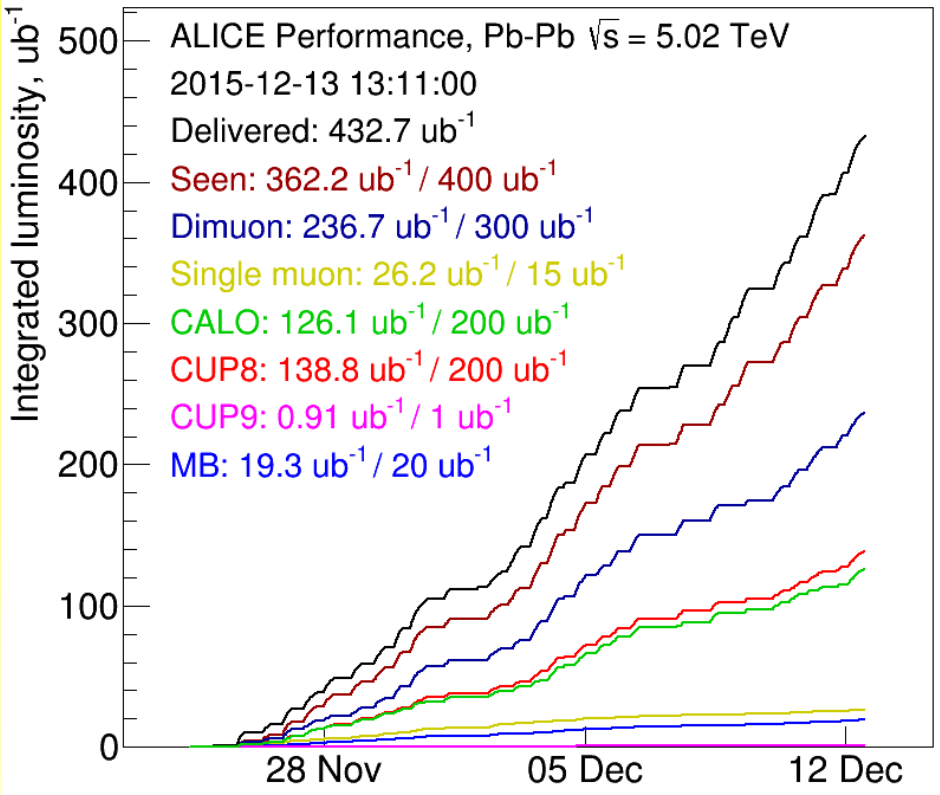
Run	Beam	Partition	Run type	HLT	Rec	Duration	Events
245683	Y	PHYSICS_1	PHYSICS	C	Y	00:48:05	4.5M

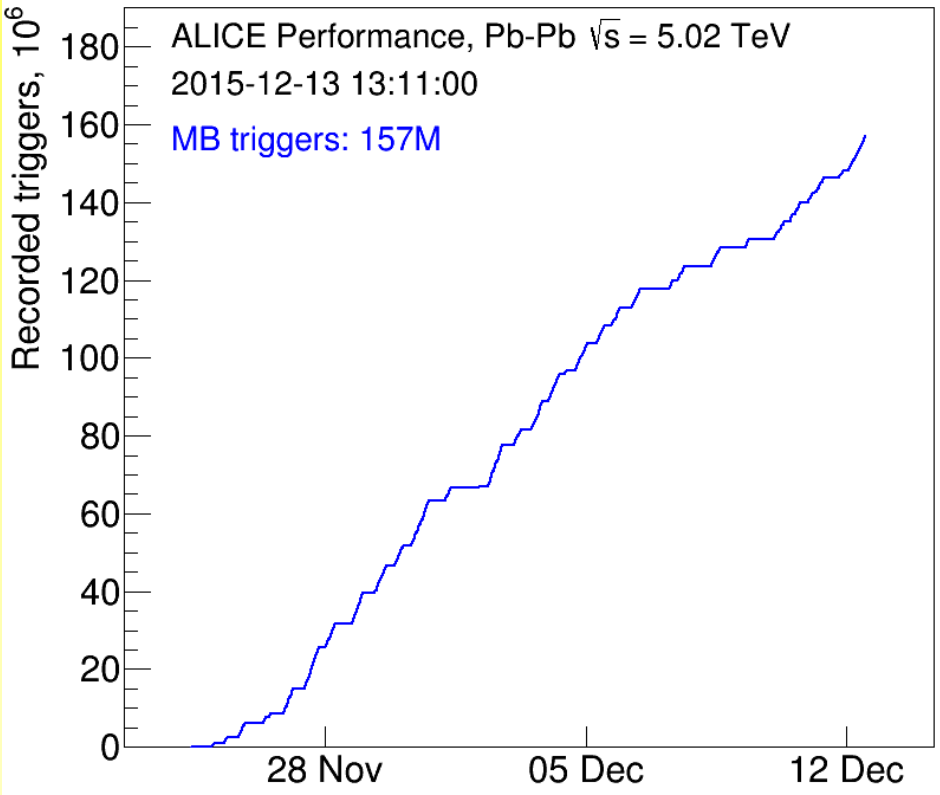
CTP Config: PbPb2015 (v39)

Calib	Bsy	Bck	Name	RUN	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	TC 8
	-	-	-	4.5M	940k	884k	938k	3m	1.1m	-	-	-
	-	-	ACO	-	-	-	-	-	-	-	-	-
21:23 PED	-	○	AD0	✓	✓	✓	✓	✓	✓	-	-	-
21:45 PED	-	○	CPV	✓	✓	✓	✓	-	-	-	-	-
	-	○	EMC	✓	✓	✓	✓	-	-	-	-	-
	-	○	FMD	✓	✓	✓	✓	-	-	-	-	-
21:24 CAL	-	○	HMP	✓	✓	✓	✓	-	-	-	-	-
16:33 CAL	-	○	MTR	✓	-	-	-	✓	○	-	-	-
21:52 PED	-	○	MCH	✓	-	-	-	✓	-	-	-	-
	-	○	PHS	✓	✓	✓	✓	-	-	-	-	-
21:44 PED	-	-	PMD	-	-	-	-	-	-	-	-	-
21:51 INJ	-	○	SDD	✓	✓	✓	✓	-	-	-	-	-
	-	○	SPD	✓	✓	✓	✓	✓	✓	-	-	-
21:26 PED	-	○	SSD	✓	✓	✓	✓	-	-	-	-	-
	-	○	T00	✓	✓	✓	✓	✓	✓	-	-	-
21:23 NOI	-	○	TOF	✓	✓	✓	✓	-	✓	-	-	-
19:19 LAS	-	○	TPC	✓	✓	✓	✓	-	-	-	-	-
	-	○	TRD	✓	✓	✓	-	-	-	-	-	-
	-	○	TRI	✓	✓	✓	✓	✓	✓	-	-	-
	-	-	TST	-	-	-	-	-	-	-	-	-
	-	○	V00	✓	✓	✓	✓	✓	✓	-	-	-
21:27 SPE	-	○	ZDC	✓	✓	✓	✓	✓	✓	-	-	-
	-	○	HLT									



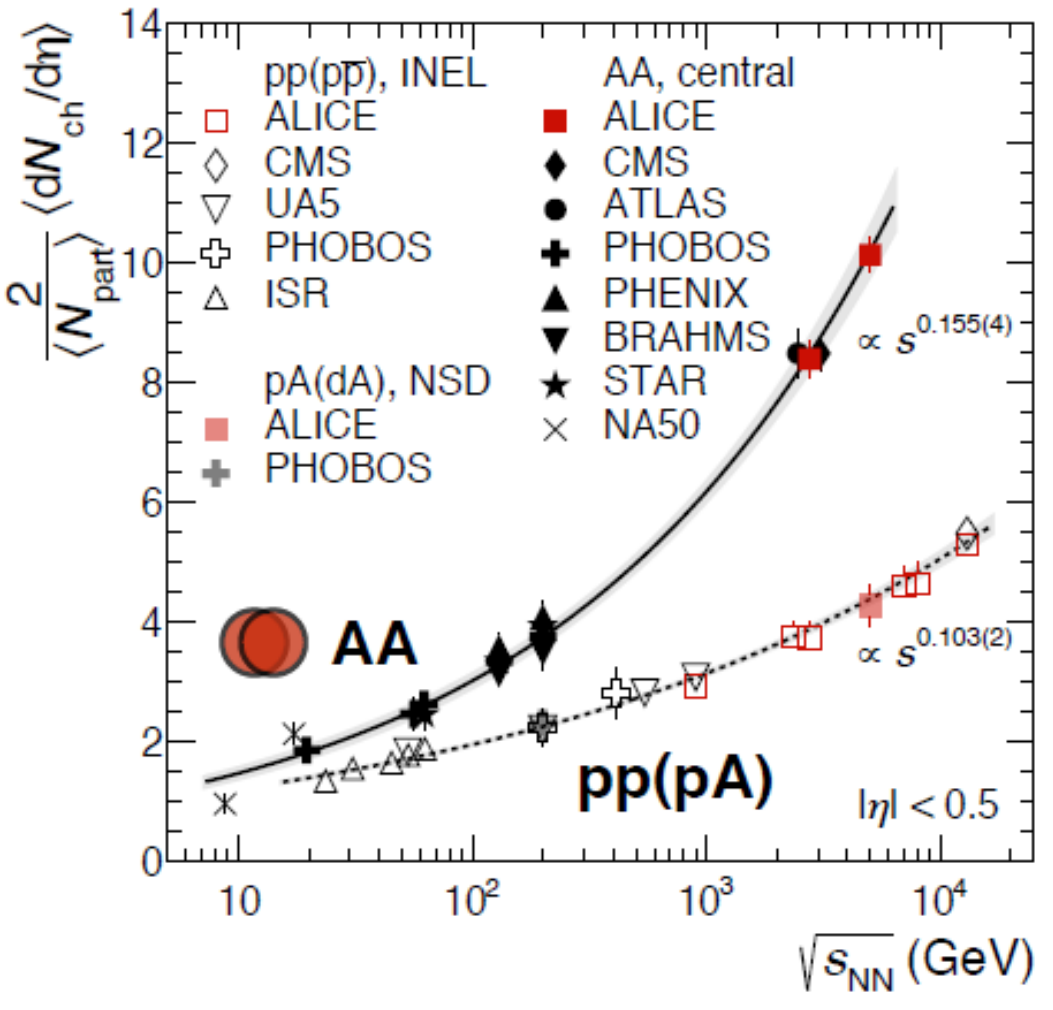
PbPb Run at 5.02 TeV





- Statistics reasonably close to our goals (especially for MB)
- Should insist for the future not to take the pp reference run out of the HI time

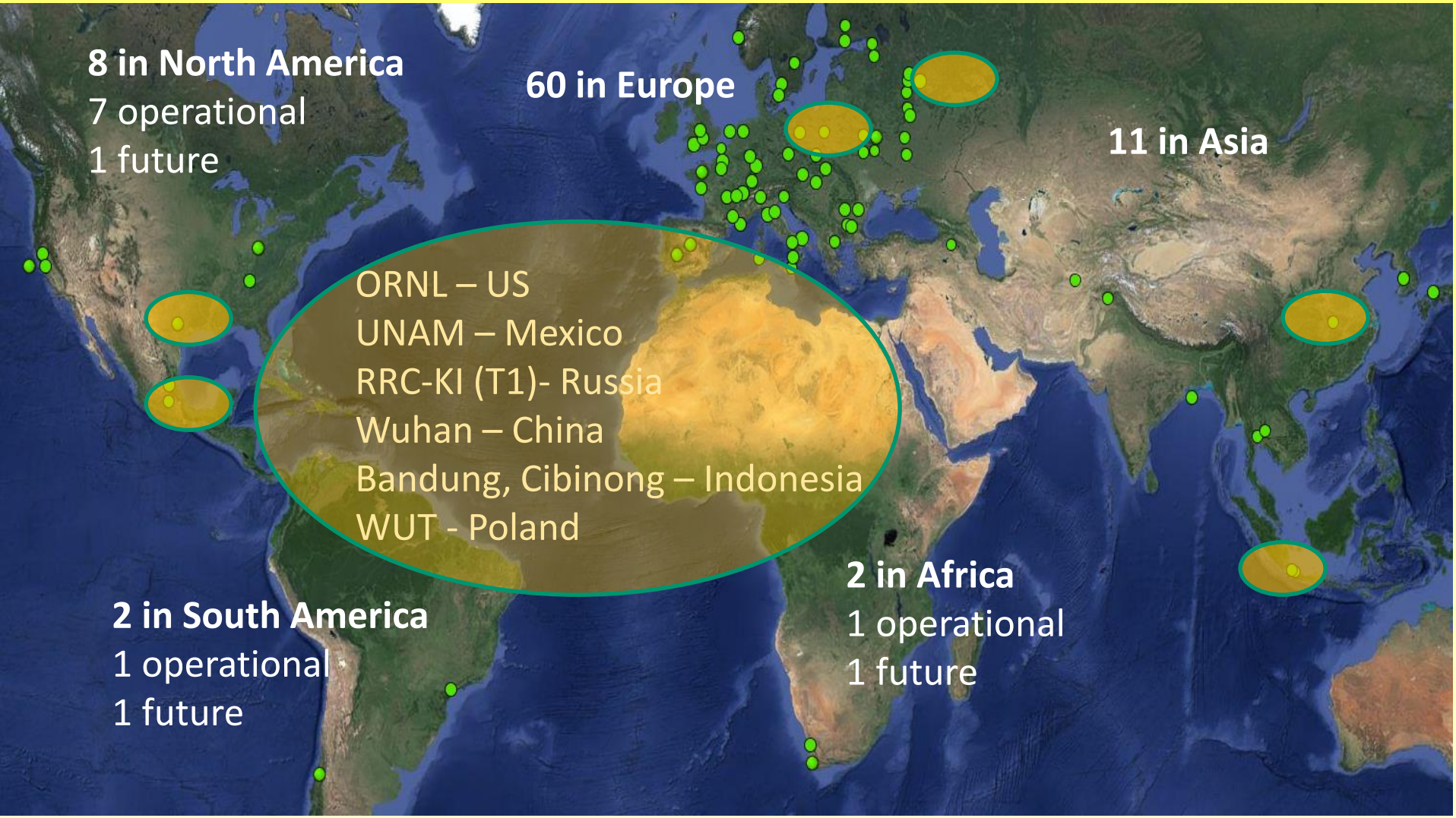
Charged particles in Pb-Pb@5.02 TeV



- **charged-particle multiplicity density**
  - at mid-rapidity, $|\eta| < 0.5$ reaches a value of 1943 ± 56 in most central collisions
- **much stronger √s dependence than pp**
  - 2.4x larger charged-particle multiplicity than p-Pb at same energy scaled by the average number of participating nucleon pairs ⟨*N*part⟩/2

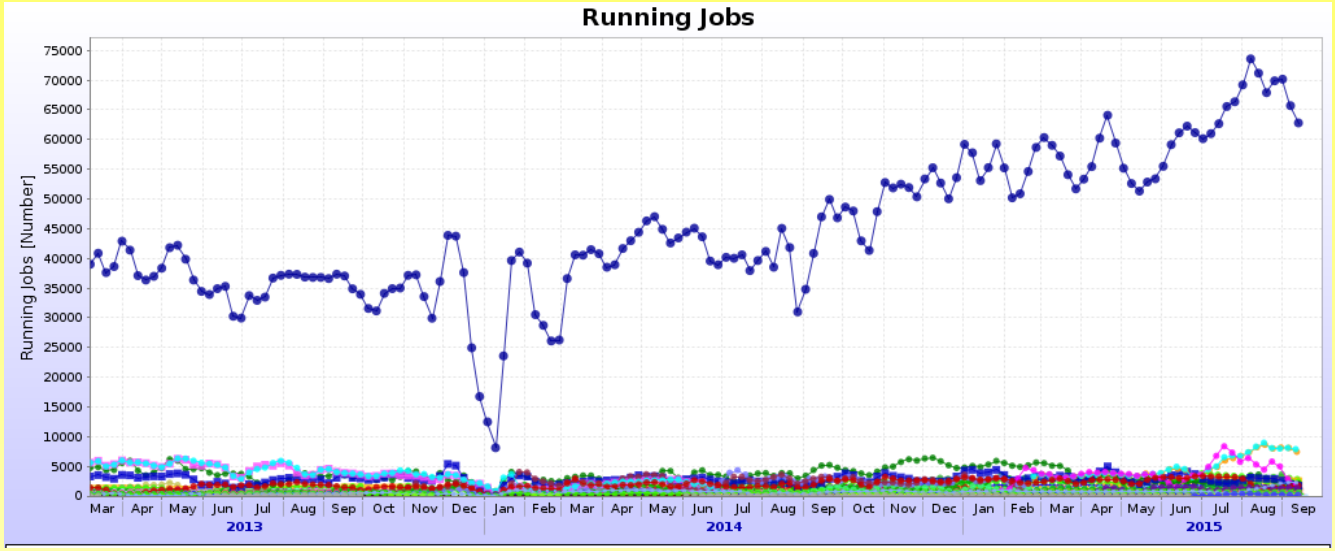
- Submitted dec 18th : *CERN-PH-EP-2015-324*

The ALICE Grid keeps growing



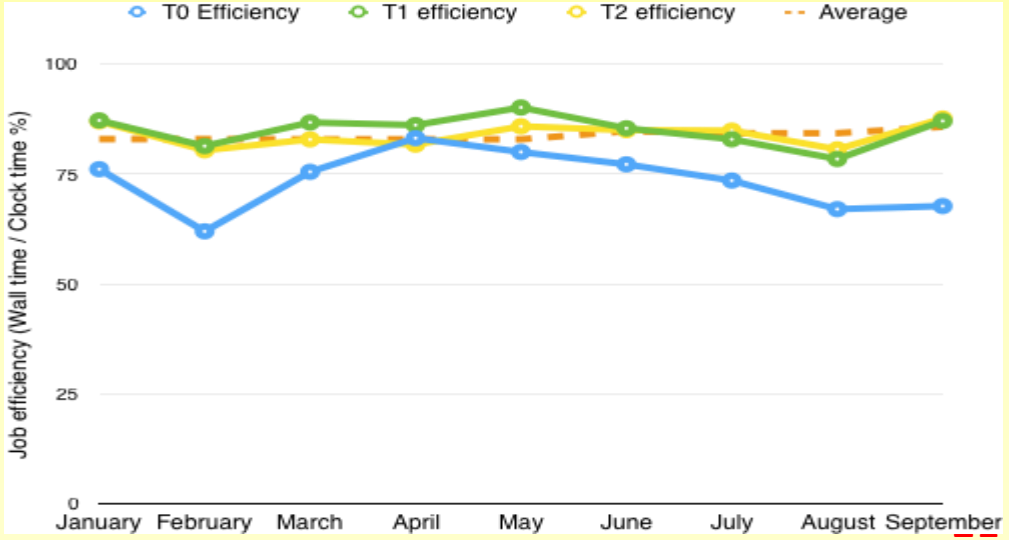
10 Gbs line from KISTI TIer1 operational

Grid utilization since end of RUN1



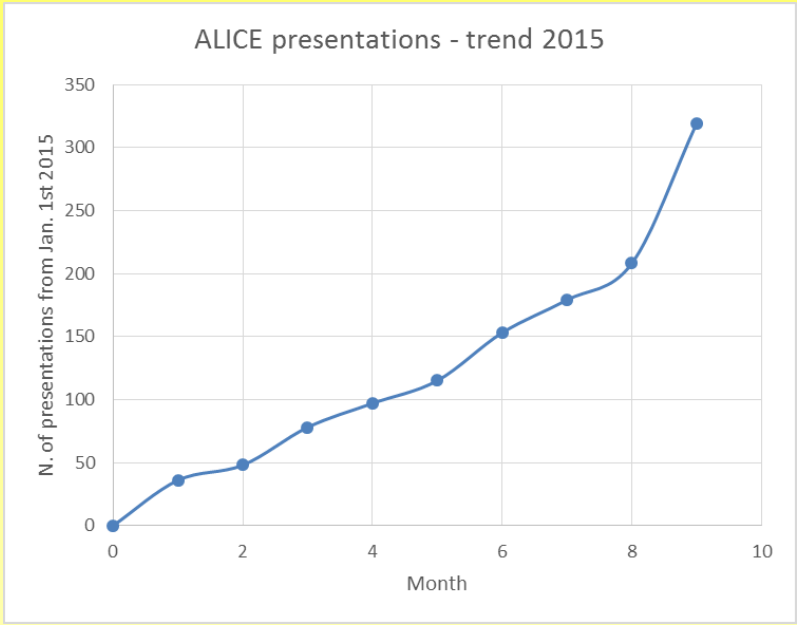
- Reaching new highs
- **96K parallel jobs**

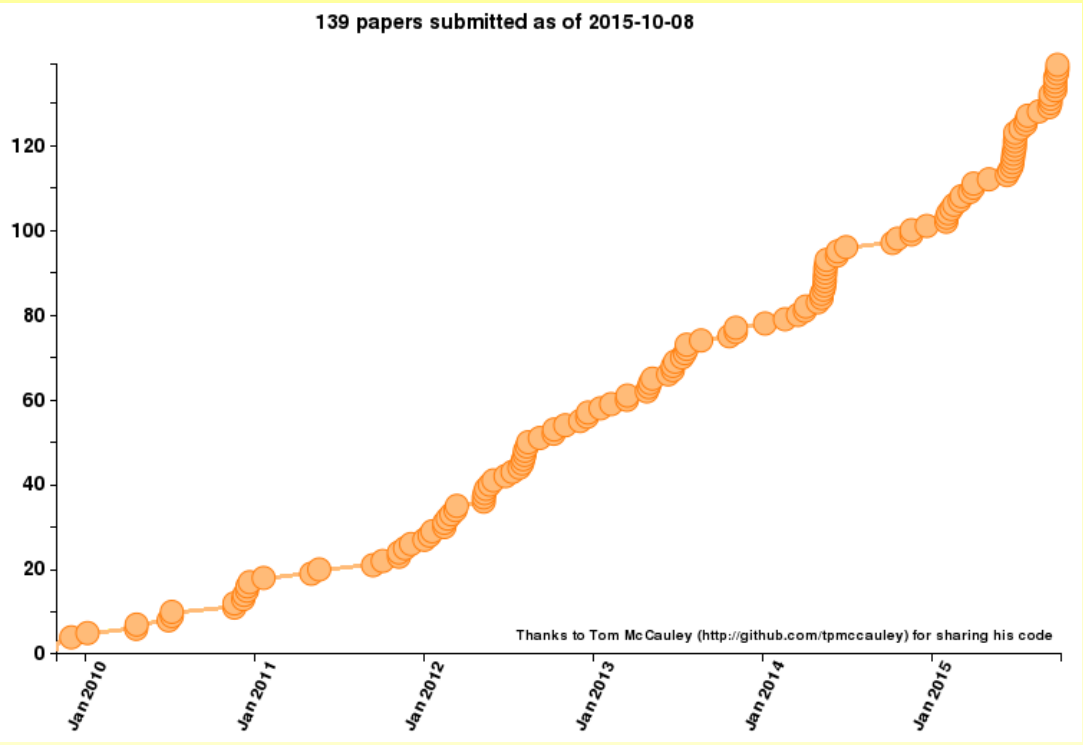
- Consistent and very good efficiency in all computing centres

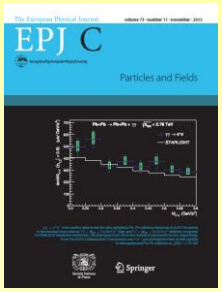


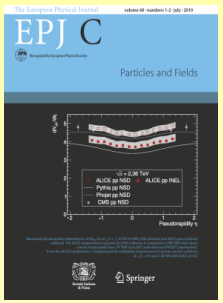
An impressive Physics output

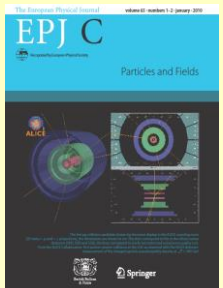
- A huge scientific output
  - **147 ALICE papers on arXiv** (already 4 since the beginning of 2016!)
  - **High impact papers:** average of over 75 citations
  - **Several hundred** presentations at international conferences *each year:* **29 talks and ~50 posters just at QM**

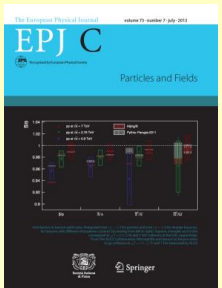


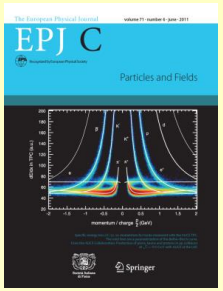












LHC physics publications by number of citations

Use the checkboxes to remove individual items from this Citation Report

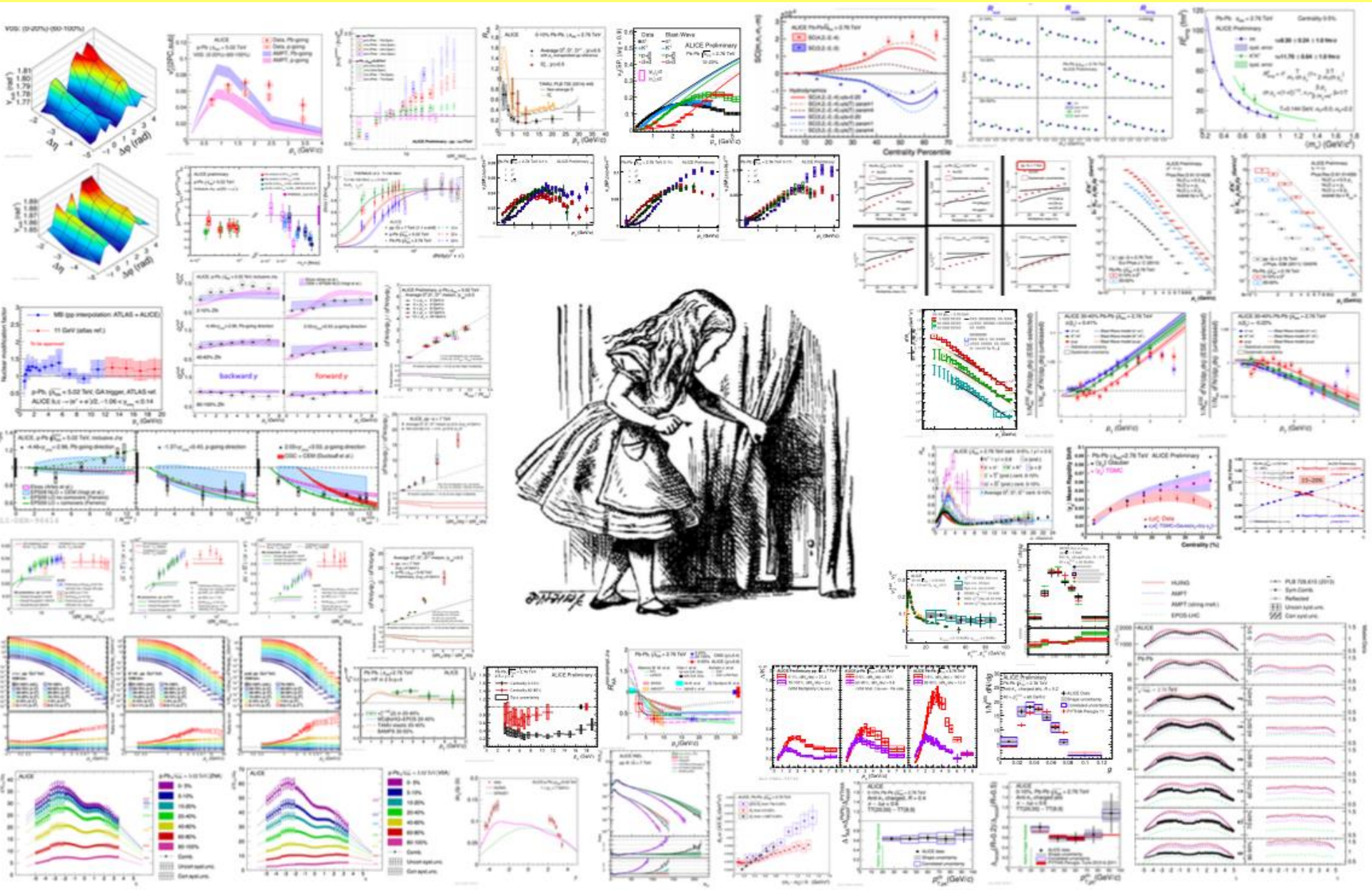
or restrict to items published between 2010 and 2015 Go

		2011	2012	2013	2014	2015	Total	Average Citations per Year
		2037	5827	7773	8780	5522	30071	5011.83
1.	**Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC** By: Aad, G.; Abajyan, T.; Abbott, B.; et al. Group Author(s): ATLAS Collaboration PHYSICS LETTERS B Volume: 716 Issue: 1 Pages: 1-29 Published: SEP 17 2012	0	138	1042	1007	549	2736	684.00
2.	**Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC** By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al. Group Author(s): CMS Collaboration PHYSICS LETTERS B Volume: 716 Issue: 1 Pages: 30-61 Published: SEP 17 2012	0	124	992	934	535	2585	646.25
3.	**Combined results of searches for the standard model Higgs boson in pp collisions at root s=7 TeV** By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al. Group Author(s): CMS Collaboration PHYSICS LETTERS B Volume: 710 Issue: 1 Pages: 26-48 Published: MAR 29 2012	0	221	98	49	25	393	98.25
4.	**Combined search for the Standard Model Higgs boson using up to 4.9 fb(-1) of pp collision data at root s=7 TeV with the ATLAS detector at the LHC** By: Aad, G.; Abbott, B.; Abdallah, J.; et al. Group Author(s): ATLAS Collaboration PHYSICS LETTERS B Volume: 710 Issue: 1 Pages: 49-66 Published: MAR 29 2012	0	223	79	29	21	352	88.00
5.	**Elliptic Flow of Charged Particles in Pb-Pb Collisions at root s(NN)=2.76 TeV** By: Aamodt, K.; Abelev, B.; Abrahantes Quintana, A.; et al. Group Author(s): ALICE Collaboration PHYSICAL REVIEW LETTERS Volume: 105 Issue: 25 Article Number: 252302 Published: DEC 13 2010	48	82	78	67	27	302	50.33
6.	**Observation of a Centrality-Dependent Dijet Asymmetry in Lead-Lead Collisions at root s(NN)=2.76 TeV with the ATLAS Detector at the LHC** By: Aad, G.; Abbott, B.; Abdallah, J.; et al. Group Author(s): ATLAS Collaboration PHYSICAL REVIEW LETTERS Volume: 105 Issue: 25 Article Number: 252303 Published: DEC 13 2010	44	80	86	61	30	301	50.17
7.	**Suppression of charged particle production at large transverse momentum in central Pb-Pb collisions at root s(NN)=2.76 TeV** By: Aamodt, K.; Abrahantes Quintana, A.; Adamova, D.; et al. Group Author(s): ALICE Collaboration PHYSICS LETTERS B Volume: 696 Issue: 1-2 Pages: 30-39 Published: JAN 24 2011	66	80	71	48	27	292	58.40
8.	**Higher Harmonic Anisotropic Flow Measurements of Charged Particles in Pb-Pb Collisions at root s(NN)=2.76 TeV** By: Aamodt, K.; Abelev, B.; Abrahantes Quintana, A.; et al. Group Author(s): ALICE Collaboration PHYSICAL REVIEW LETTERS Volume: 107 Issue: 3 Article Number: 032301 Published: JUL 11 2011	11	78	84	77	37	287	57.40
9.	**Transverse-Momentum and Pseudorapidity Distributions of Charged Hadrons in pp Collisions at root s=7 TeV** By: Khachatryan, V.; Sirunyan, A. M.; Tumasyan, A.; et al. Group Author(s): CMS Collaboration PHYSICAL REVIEW LETTERS Volume: 105 Issue: 2 Article Number: 022002 Published: JUL 6 2010	69	54	48	33	30	246	41.00
10.	**First Evidence for the Decay B-s(0) -> mu(+) mu(-)** By: Aaij, R.; Abellan Beteta, C.; Adametz, A.; et al. Group Author(s): LHCb Collaboration PHYSICAL REVIEW LETTERS Volume: 110 Issue: 2 Article Number: 021801 Published: JAN 7 2013	0	0	119	59	18	196	65.33

11. **Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC** By: Aad, G.; Abajyan, T.; Abbott, B.; et al. Group Author(s): ATLAS Collaboration PHYSICS LETTERS B Volume: 726 Issue: 1-3 Pages: 88-119 Published: OCT 2013	0	0	18	127	50	195	65.00
12. **Centrality dependence of dihadron correlations and azimuthal anisotropy harmonics in PbPb collisions at root s(NN)=2.76 TeV** By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al. Group Author(s): CMS Collaboration EUROPEAN PHYSICAL JOURNAL C Volume: 72 Issue: 5 Article Number: 2012 Published: MAY 2012	0	4	33	71	76	184	46.00
13. **Long-range angular correlations on the near and away side in p-Pb collisions at root S-NN=5.02 TeV** By: Abelev, Betty; Adam, Jaroslav; Adamova, Dagmar; et al. Group Author(s): ALICE Collaboration PHYSICS LETTERS B Volume: 719 Issue: 1-3 Pages: 29-41 Published: FEB 12 2013	0	0	33	102	46	181	60.33
14. **Search for Supersymmetry at the LHC in Events with Jets and Missing Transverse Energy** By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al. Group Author(s): CMS Collaboration PHYSICAL REVIEW LETTERS Volume: 107 Issue: 22 Article Number: 221804 Published: NOV 21 2011	0	118	41	9	6	174	34.80
15. **Observation of long-range, near-side angular correlations in pPb collisions at the LHC** By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al. Group Author(s): CMS Collaboration PHYSICS LETTERS B Volume: 718 Issue: 3 Pages: 795-814 Published: JAN 8 2013						62	54.00
16. **Search for the Standard Model Higgs Boson in the Diphoton Dec... root s=7 TeV with ATLAS** By: Aad, G.; Abbott, B.; Abdallah, J.; et al. Group Author(s): ATLAS Collabo... PHYSICAL REVIEW LETT...	0	82	48	25	0	155	38.75
17. **Study of the Mass and S... Decays to Z Boson Pairs** By: Chatrchyan, S.; Khachat... Group Author(s): CMS Collab... PHYSICAL REVIEW LETTER... ...10 Issue: 8 Article Number: 081803 Published: FEB 21 2013	0	0	44	78	31	153	51.00
18. **Charged-Particle Multiplicity Density at Midrapidity in Central Pb-Pb Collisions at root s(NN)=2.76 TeV** By: Aamodt, K.; Abelev, B.; Abrahantes Quintana, A.; et al. Group Author(s): ALICE Collaboration PHYSICAL REVIEW LETTERS Volume: 105 Issue: 25 Article Number: 252301 Published: DEC 13 2010	49	38	28	27	11	153	25.50
19. **Evidence for the spin-0 nature of the Higgs boson using ATLAS data** By: Aad, G.; Abajyan, T.; Abbott, B.; et al. Group Author(s): ATLAS Collaboration PHYSICS LETTERS B Volume: 726 Issue: 1-3 Pages: 120-144 Published: OCT 2013	0	0	7	95	47	149	49.67
20. **Charged-particle multiplicity measurement in proton-proton collisions at root s=0.9 and 2.36 TeV with ALICE at LHC** By: Aamodt, K.; Abel, N.; Abeysekara, U.; et al. Group Author(s): ALICE Collaboration EUROPEAN PHYSICAL JOURNAL C Volume: 68 Issue: 1-2 Pages: 89-108 Published: JUL 2010	50	32	34	12	5	146	24.33

30% of the top cited scientific production at the LHC is from ALICE

ALICE @ Quark Matter 2015



The LS2 ALICE upgrades

ALICE

New Inner Tracking System (ITS)
- improved pointing precision
- less material -> thinnest tracker at the LHC

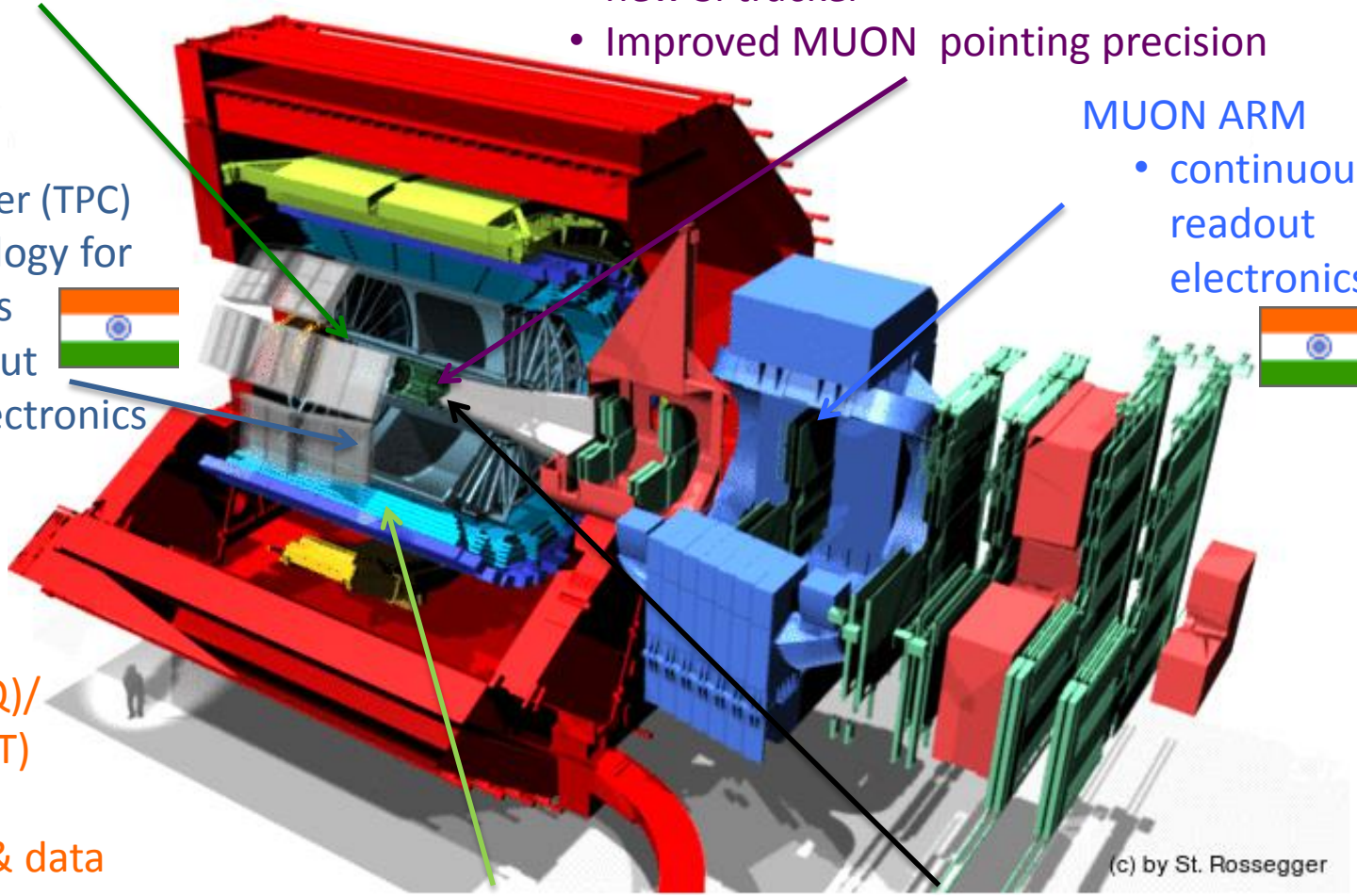
Muon Forward Tracker (MFT)
- new Si tracker
- Improved MUON pointing precision

MUON ARM
- continuous readout electronics

Time Projection Chamber (TPC)
- new GEM technology for readout chambers
- continuous readout
- faster readout electronics

New Central Trigger Processor

Data Acquisition (DAQ)/ High Level Trigger (HLT)
- new architecture
- on line tracking & data compression
- 50kHz Pbb event rate



TOF, TRD, ZDC
- Faster readout

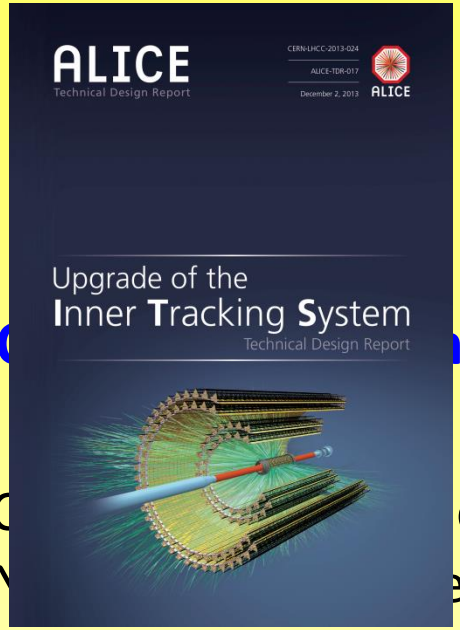
New Trigger Detectors (FIT)

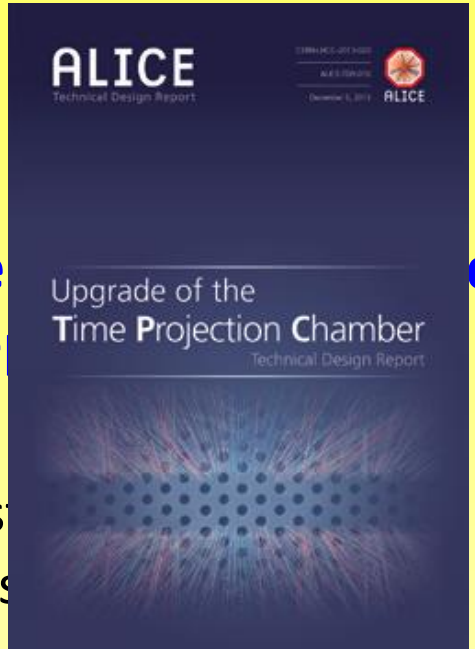
The ALICE Upgrade: status

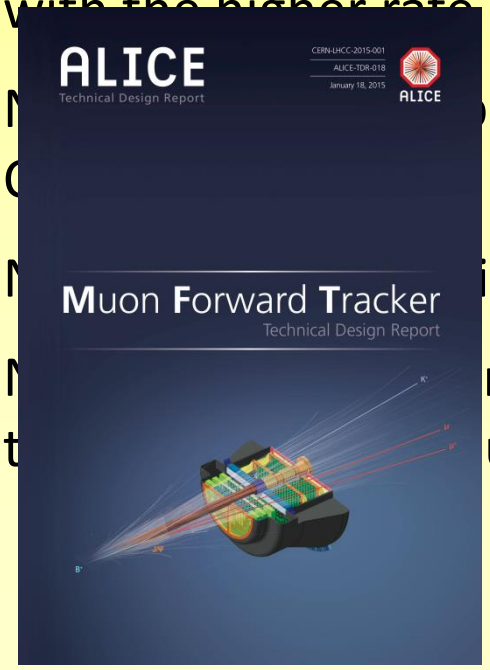
- **Five Pillars (each in a Technical Design Report), all approved by LHCC, UCG and RB, the latest this past September:**
  - Completely new Silicon Inner Tracking System
  - New or upgraded readout for all detectors to cope with the higher rate, new CTP and Trigger Detectors
  - New readout chambers for the Time Projection Chamber
  - New Silicon Tracker in front of Muon Absorber
  - New Data Acquisition System and High Level Trigger to handle the continuous readout, new Offline

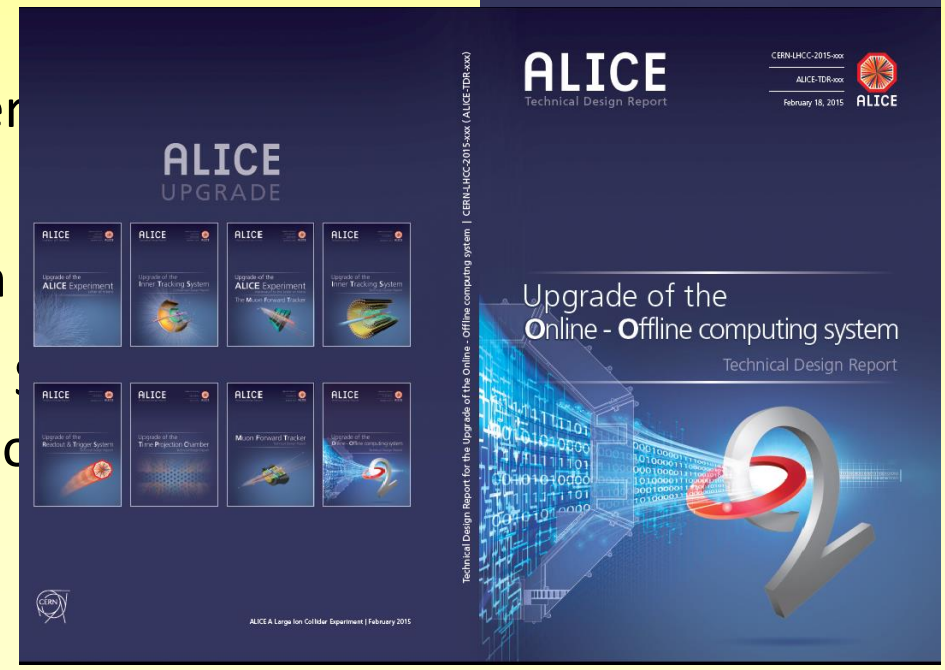
The ALICE Upgrade: status

- **Five Te d by LHC**





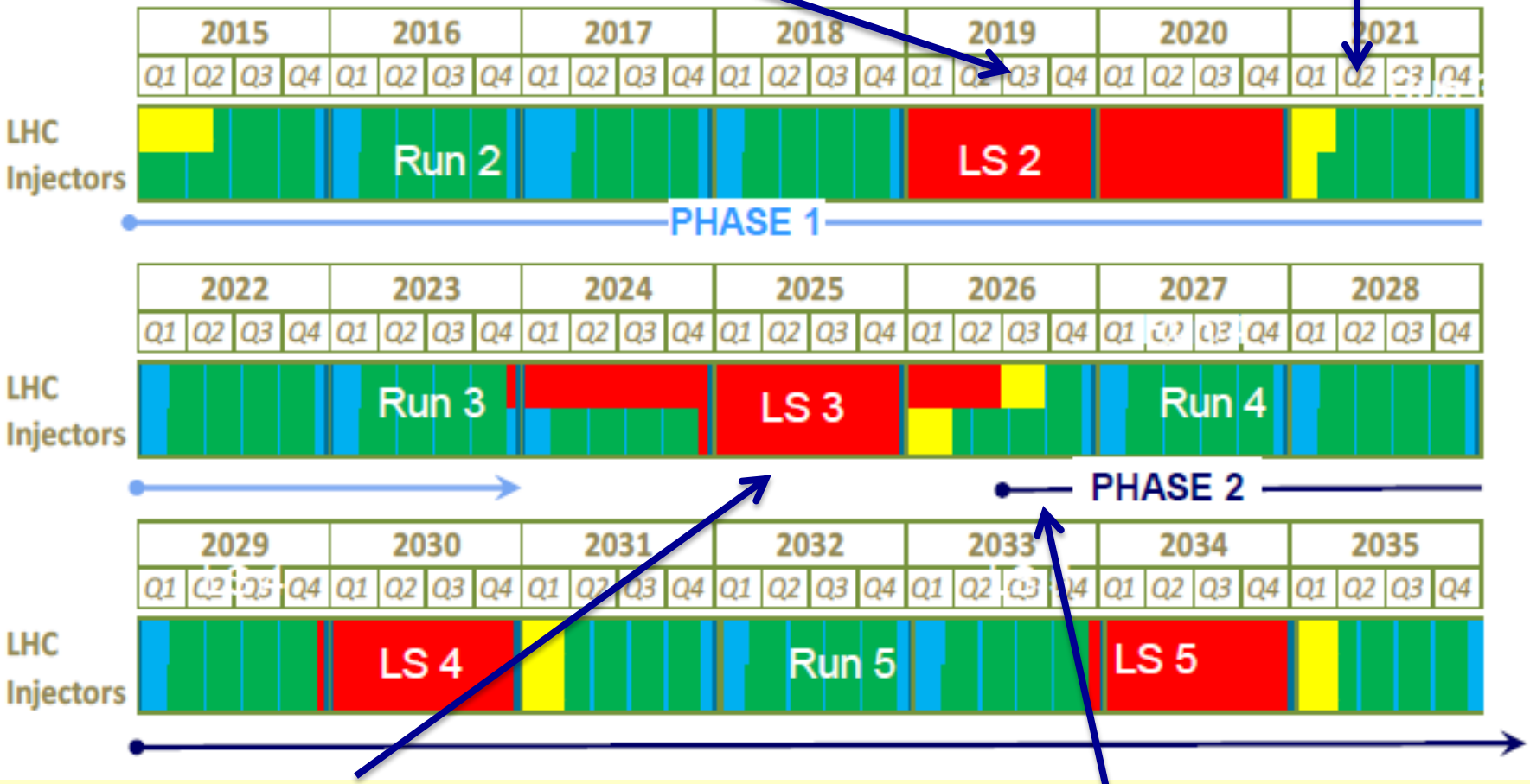




LHC Schedule

PHASE I Upgrade
ALICE, LHCb major upgrade
ATLAS, CMS ‚minor' upgrade

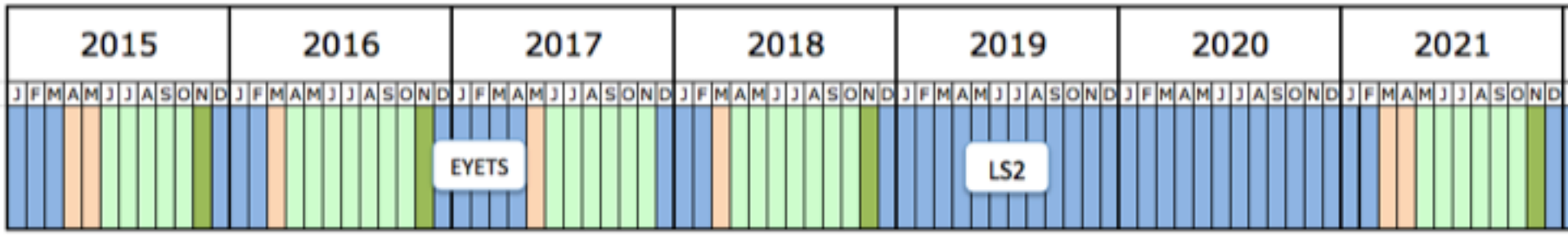
Heavy Ion Luminosity
from 10^{27} to 7 x10^{27}



PHASE II Upgrade
ATLAS, CMS major upgrade

HL-LHC, pp luminosity
from 10^{34} (peak) to 5 x10^{34} (levelled)

Upgrade milestones



EYETS: O^2 EL and CV infrastructure in place

Nov-2017: ITS IB assembled

Dec-2015: SAMPA final prototype submission

Aug-2018: ITS OB assembled

Q3-2018: O^2 installed

19 Oct 2015: ITS pixel chip EDR - ***done***

4 Nov 2015: TPC GEM and chamber EDR → start of production

Nov 2015: ITS stave EDR

Aug-Dec 2020: ALICE re-commissioning

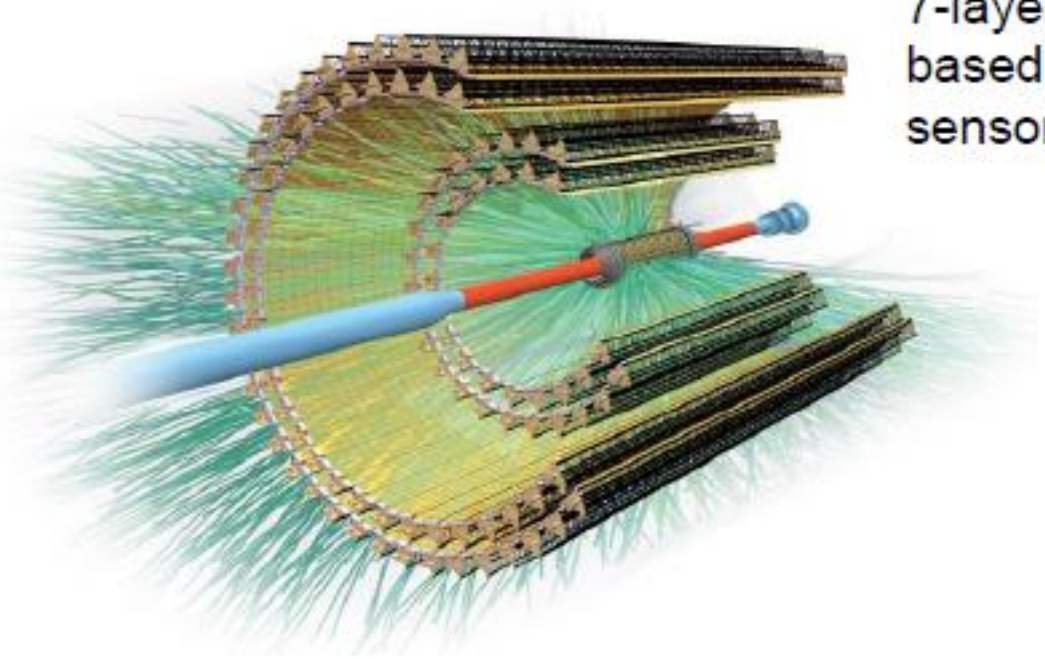
Nov 2019-Jul 2020: install TPC/new ITS/MFT/FIT beampipe + close experiment

Mar-Oct 2019: TPC upgrade in cleanroom

Jan-Feb 2019: open experiment + remove TPC/ITS/beampipe

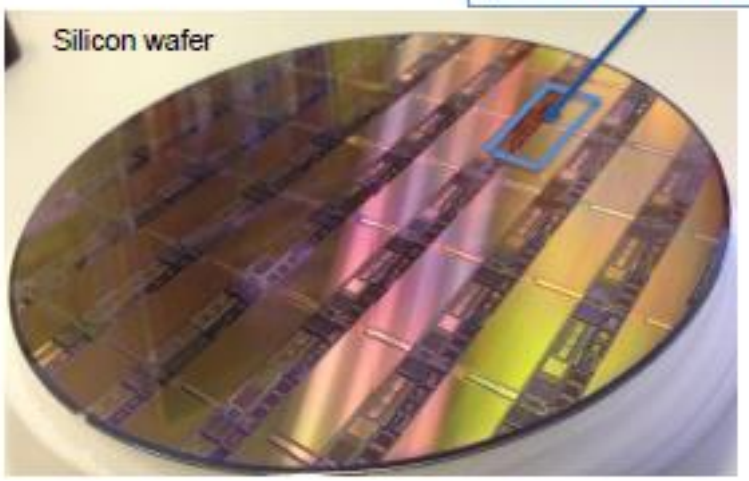
Dec-2018: TPC chamber production finished

Upgrade of the ALICE Inner Tracking System



7-layer pixel detector based on CMOS sensors

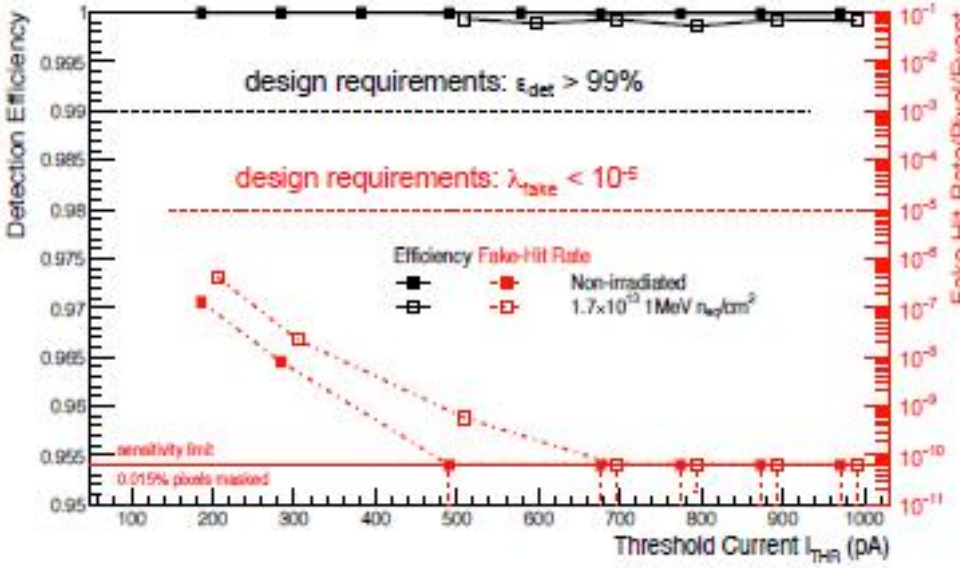
ALPIDE (~15 x 30 mm²)



Characterization of pixel chip full-scale prototype (ALPIDE)

➔ large margin over design requirements

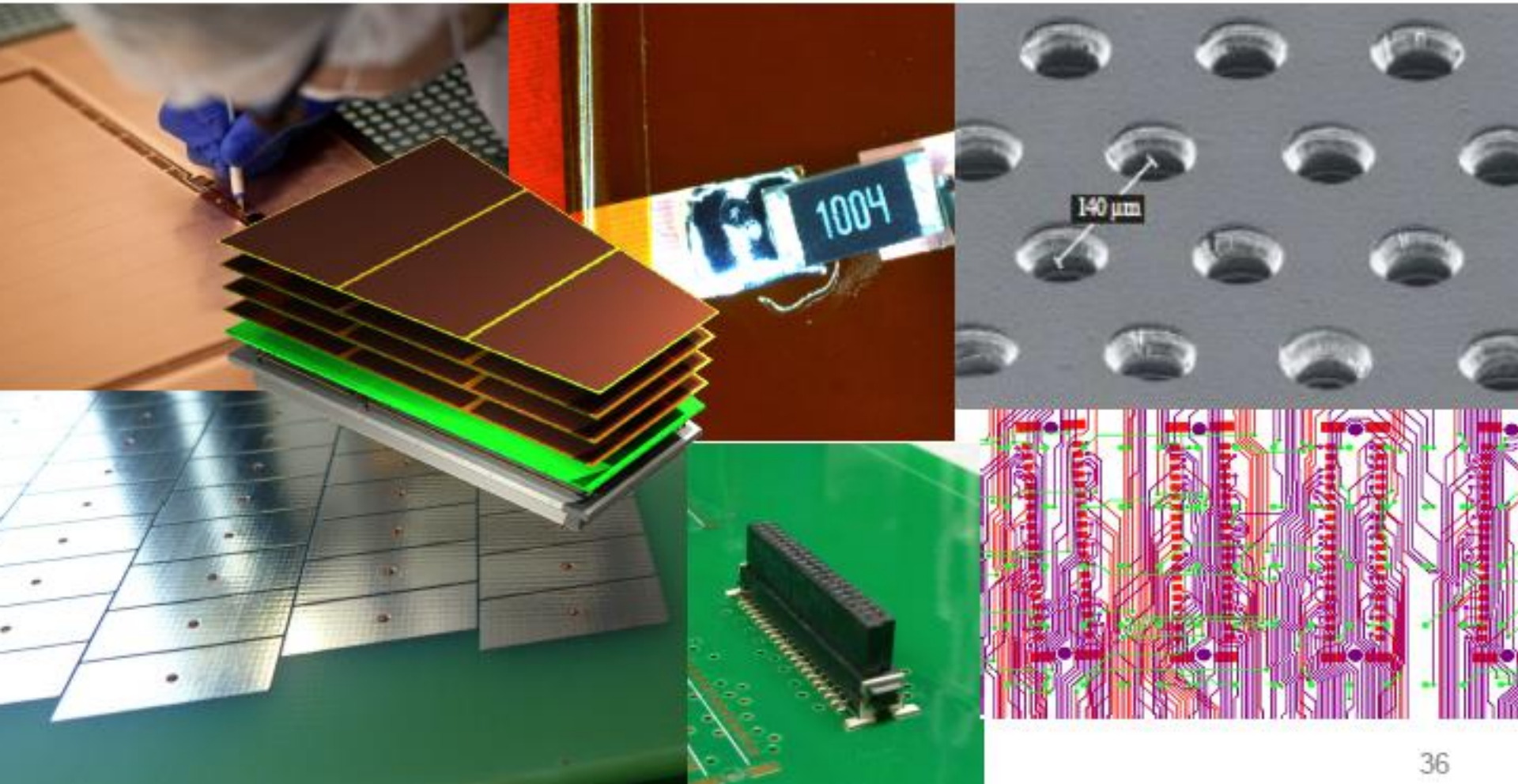
- Engineering Design Review: Oct. 2015
- Pre-series production: Feb. 16
- Mass production: Sep. 16 – Jul. 17



Upgrade of the ALICE Time-Projection Chamber

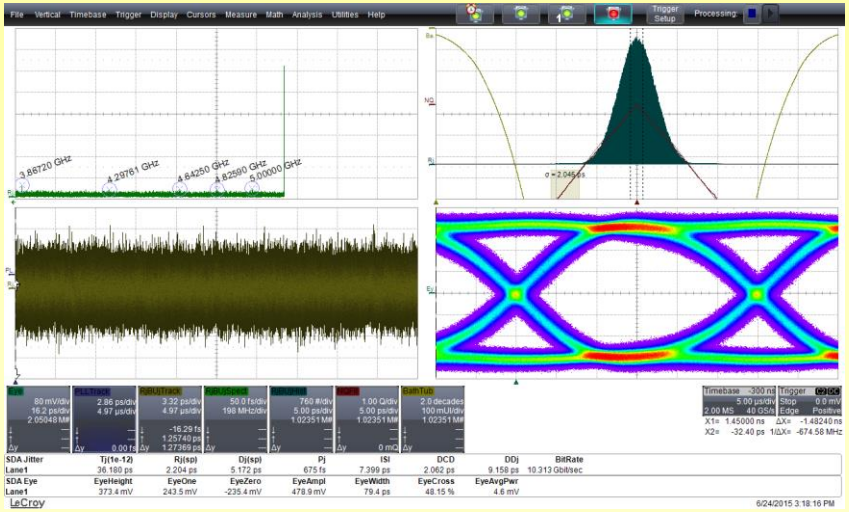
Design for new GEM-based Readout Chambers is finalised

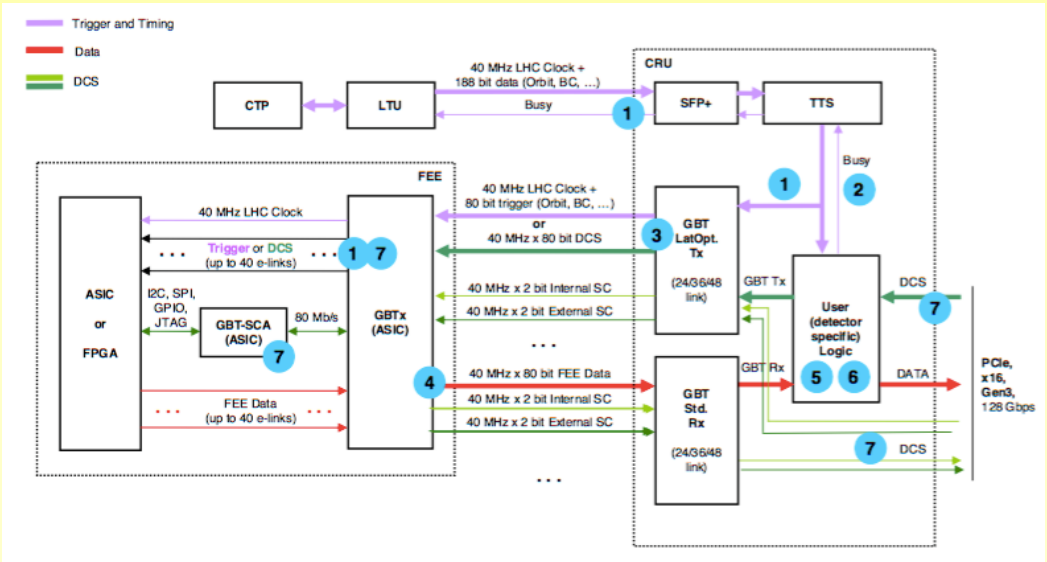
- Engineering Design Review: Nov. 2015
- Pre-production started
- Production Readiness Review: Mar. 2016



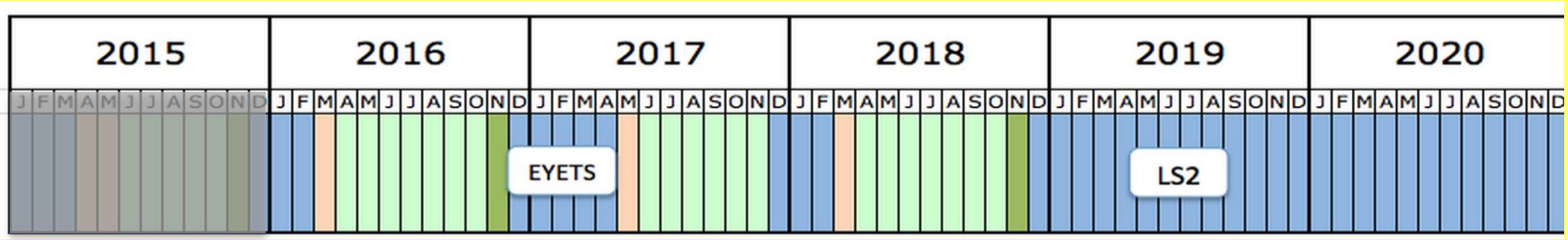
The CRU: Common Readout Unit

- Will be used for the readout of all main ALICE detectors
  - Key element of the overall project
- CRU (PCI based), prototype tested, pre-series production to be started
- Detector specific firmware specifications defined





What Next? RUN2 Overview



Year	System	E [TeV]	Lumi [$cm^{-2}s^{-1}$]	Rate [kHz]	Time
2015	pp	13	$5x10^{30}$	300	7w
	PbPb	5.02	$1x10^{27}$	8	3w
	pp-ref	5.02	$5x10^{30}$	300	4d
2016	**pp**	**13**	**$5x10^{30}$**	**300**	**28w**
	pPb	**5.02**	**$1x10^{29}$**	**200(rare)**	**2w**
			$1x10^{28}$	**20(min.bias)**	**2w**
	pp-ref	**5.02**	**$5x10^{30}$**	**300**	**7d**
2017	pp	13	$5x10^{30}$	300	24w
2018	pp	13	$5x10^{30}$	300	28w
	PbPb	5.02	$1x10^{27}$	8	4w
	pp-ref	5.02	$5x10^{30}$	300	7d

For RUN2, ALICE is not interested any other ion species than Pb

Run plan for 2016

pp operations:

- At full energy: Inst. lumi: 5E30 Hz/cm2, target delivered: 16 pb-1
- pp reference at 5.02 TeV:
  - 3 weeks over the whole RUN2 (1E9 MB events, collected 128 M)
  - 1 week (including setup and vdM scan) in 2016
  - not taken from the planned 4 weeks of HI time
  - not necessarily attached/close to the HI block
    (ALICE supports the scenario where the pp-ref is taken during the 25 ns yearly intensity ramp up, with mu of the order of 1-5%)

HI 2016

- pPb:
- Energy preference for 5 TeV => reference at same energy as PbPb

- ALICE interested in parasitic participation to high B runs
  (IP2 B 10 m, small crossing angles for ZDC operation)
- vdM scans and 1 polarity flip needed (in each operation period)

Plan for pPb in 2016

- Relevant part of the trigger scenario is minimum bias (wall clock driven) at lumi leveled around 20 kHz (1E28 Hz/cm2, TBC)
- ALICE wishes to integrate pPb ~30 nb-1 (TBC) at high lumi (rare triggers): 200 kHz (1E29 Hz/cm2)
- Energy preference for 5 TeV as physics-wise pPb is seen as reference data
  - ALICE desires to have data for all collision systems at the same energy (i.e. pp, pPb, PbPb at 5.02 TeV)
  - The other experiments prefer 8 TeV (maximum energy)
  - A possible compromise would be to have the Min Bias running at 5 TeV and the High Lumi one at 8 TeV
- ALICE needs to collect consistent data samples of pPb and Pbp
- 1 vdM scan and 1 polarity flip

Startup in 2016

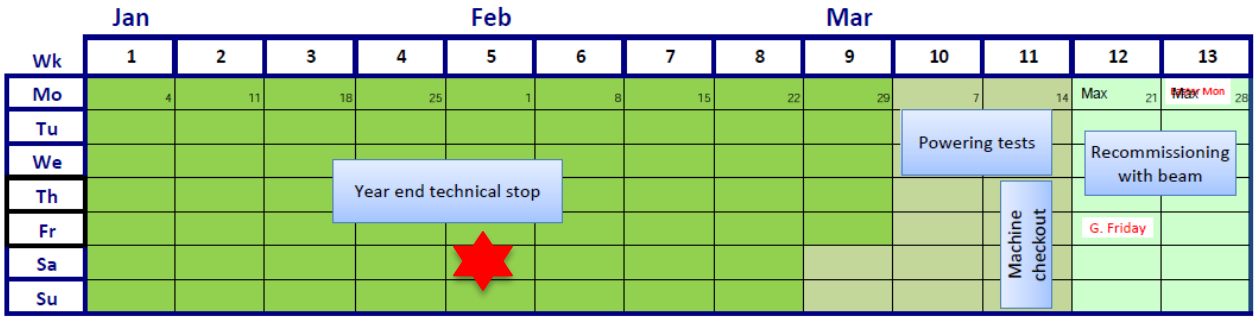
A Large Ion Collider Experiment

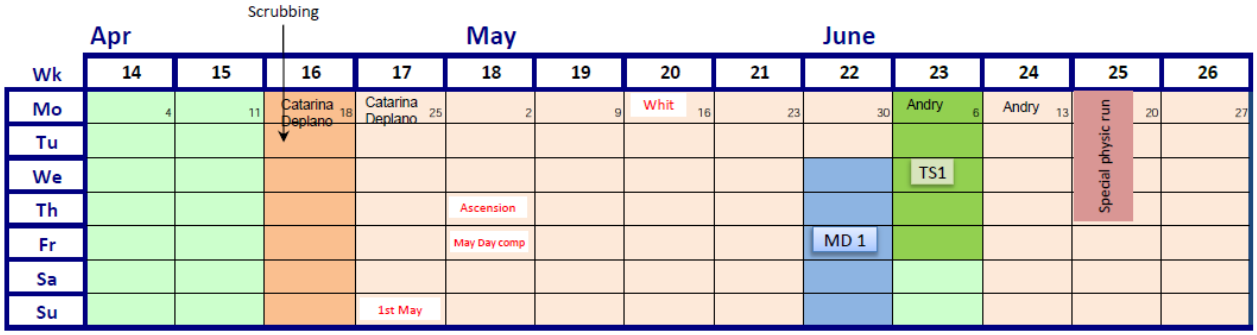
ML

December 12, 2015
V1.0

LHC Schedule 2016

Approved by the Research Board, December 2015





Week 7 to 8: Detector Commissioning with Cosmics

Week 9 to 11: Cosmics

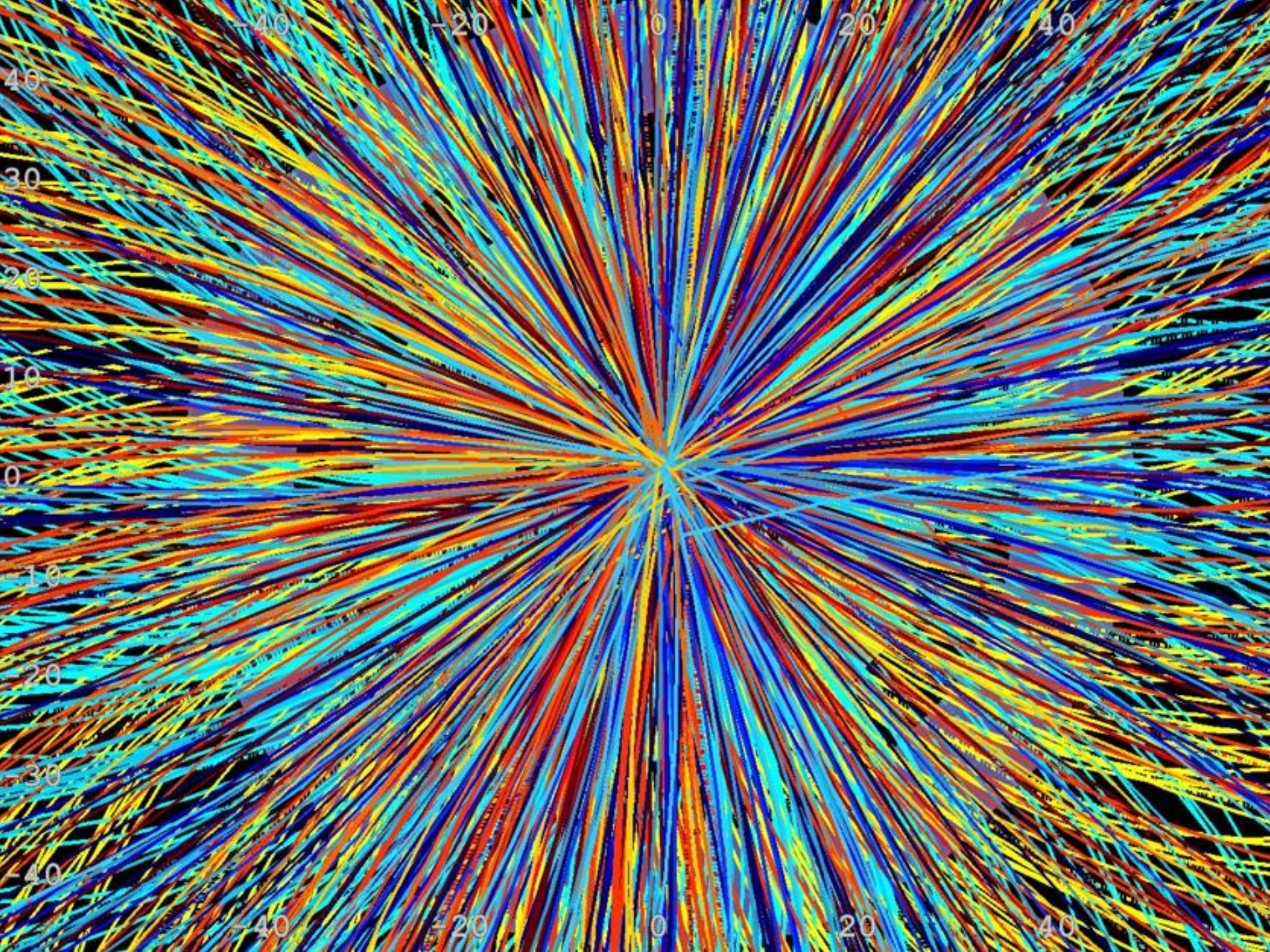
16 March: Closure of Cavern

Week 12: Resume full Running Conditions

SUMMARY

- 2015 has been a challenging yet very rewarding year for ALICE
- RUN1 has started well for the ALICE detector, the LS1 work is paying off
- Important data samples collected in pp at 13 and 5 TeV and in PbPb
  - First results already published and many more coming
- In the meantime
  - The harvest of RUN1 Physics results continues
  - The upgrade for LS2 progresses steadily

2016 promises to be as rich and interesting!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