ALICE Commissioning

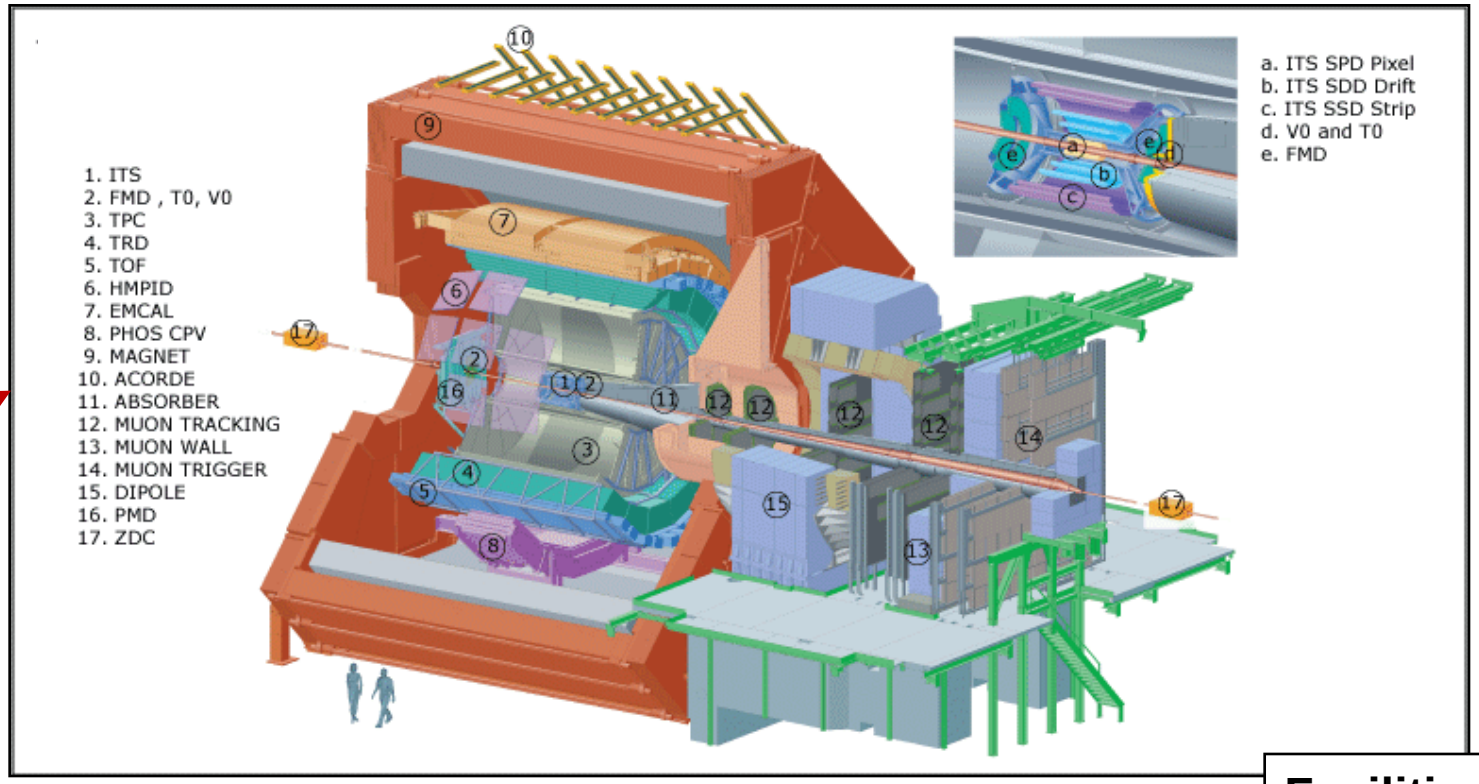
S.Chapeland, for the ALICE collaboration

Physics at LHC - Split - 3/10/2008

Outline

- Experiment layout
- Timeline
- Goals and achievements
- Conclusions

ALICE Experiment components



Facilities

Online systems

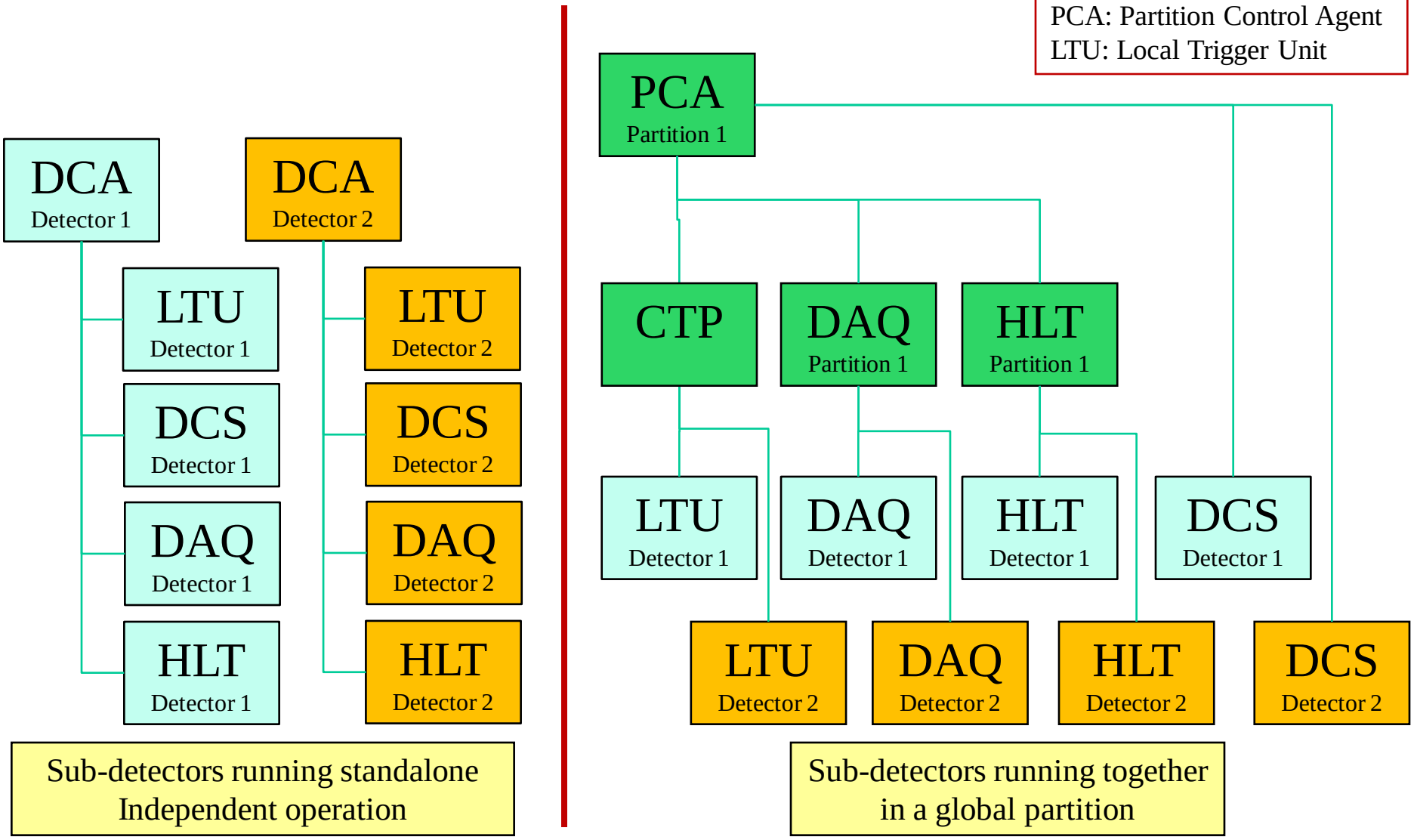
ECS Experiment Control System
DAQ Data Acquisition
DCS Detector Control System
CTP Central Trigger Processor
HLT High-Level Trigger

Offline analysis

+ online monitoring and prompt reconstruction

Subdetectors: global partitions and standalone operation

Simplified architecture



All 16 sub-detectors can run standalone in parallel

Up to 6 parallel global partitions running in parallel

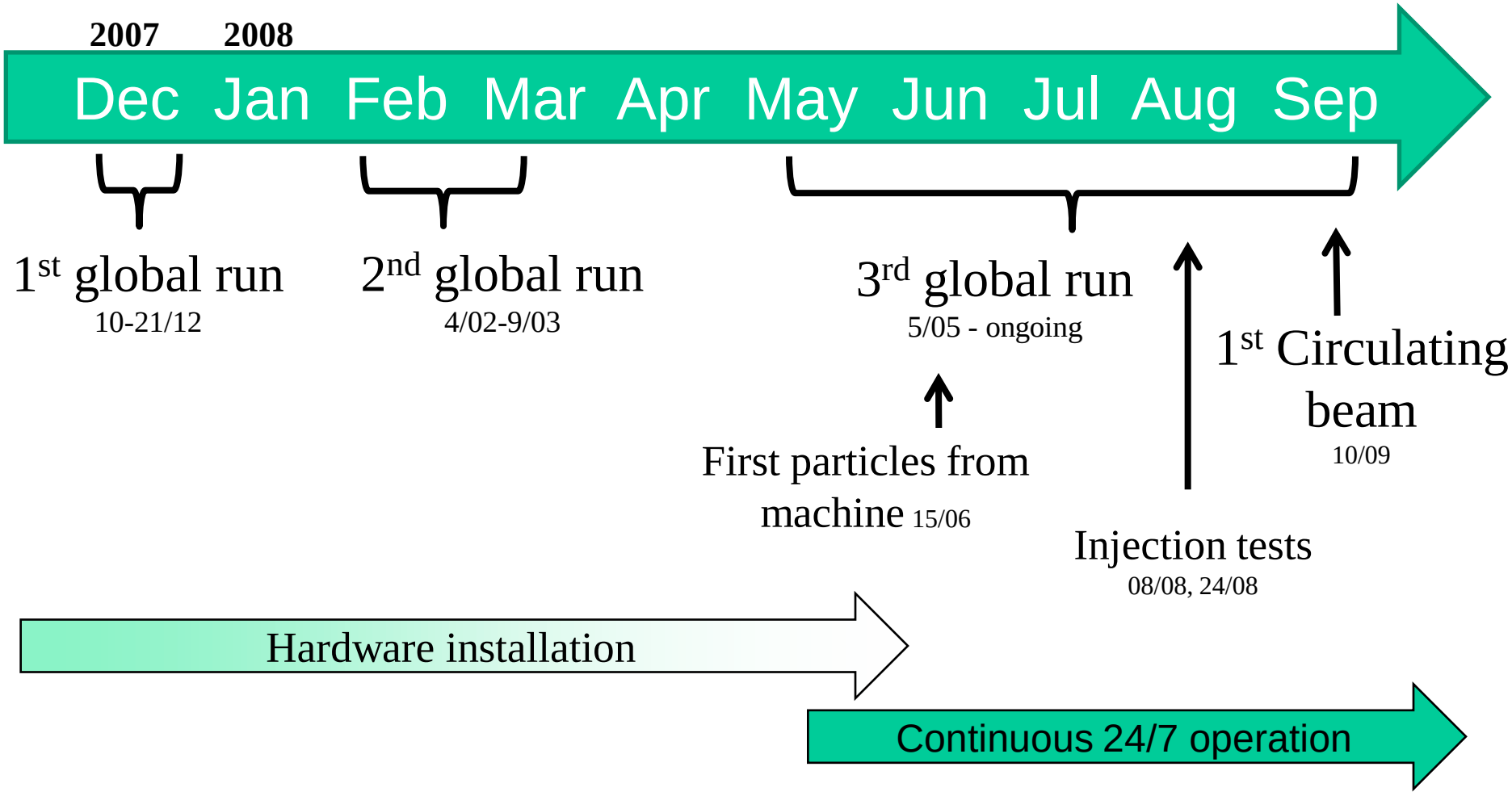
Individual sub-detector commissioning sequence

ALICE currently has 16 sub-detectors

=> ***all of them had to be commissioned***

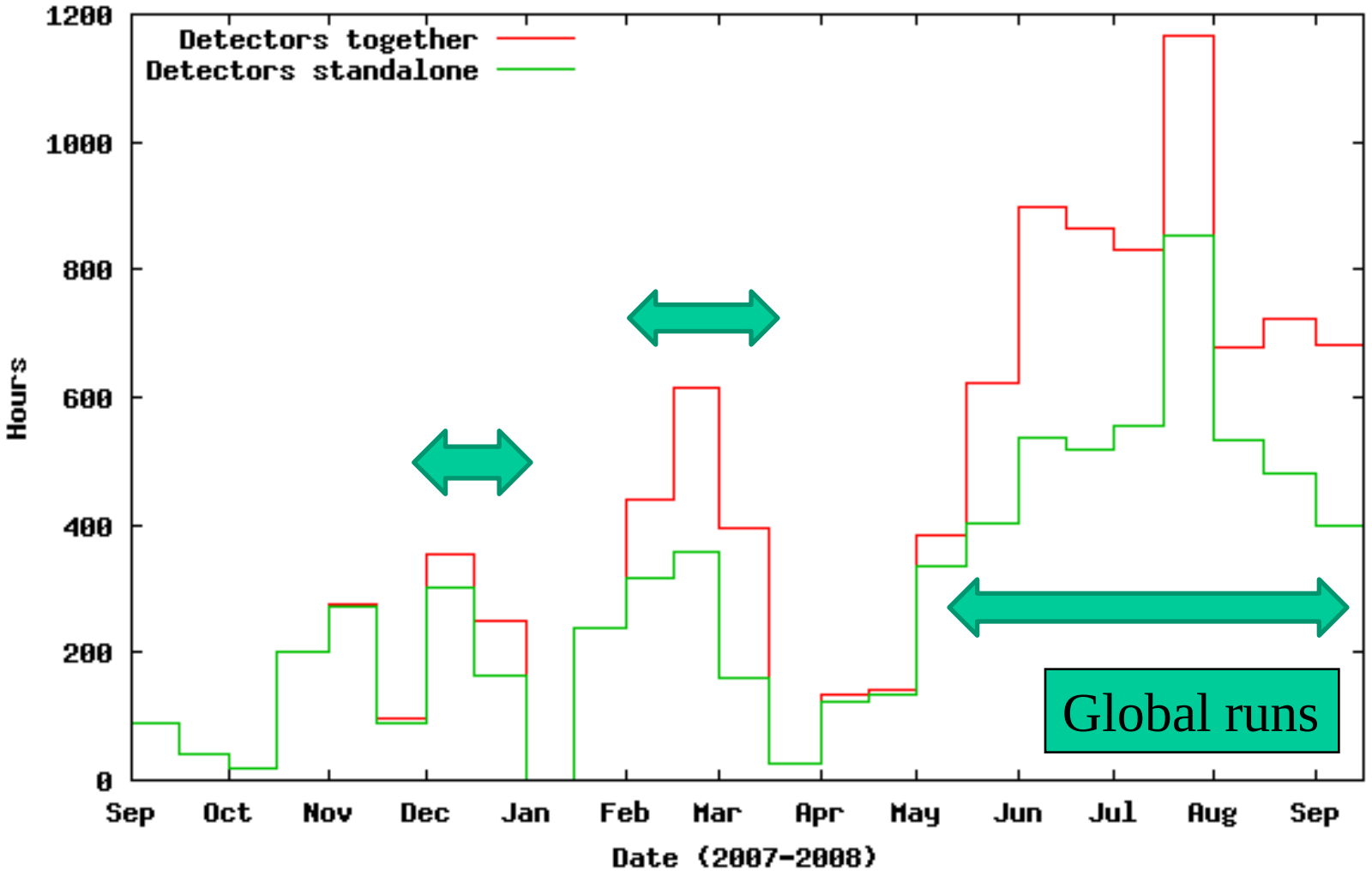
- Hardware & firmware install, check, tune
- Validation of interfaces to online systems
- Standalone data taking stability exercise
  - e.g. pulser trigger up to 40MHz, random triggers, cosmics
- Calibration and control operations
- Integration to global partitions

ALICE commissioning timeline



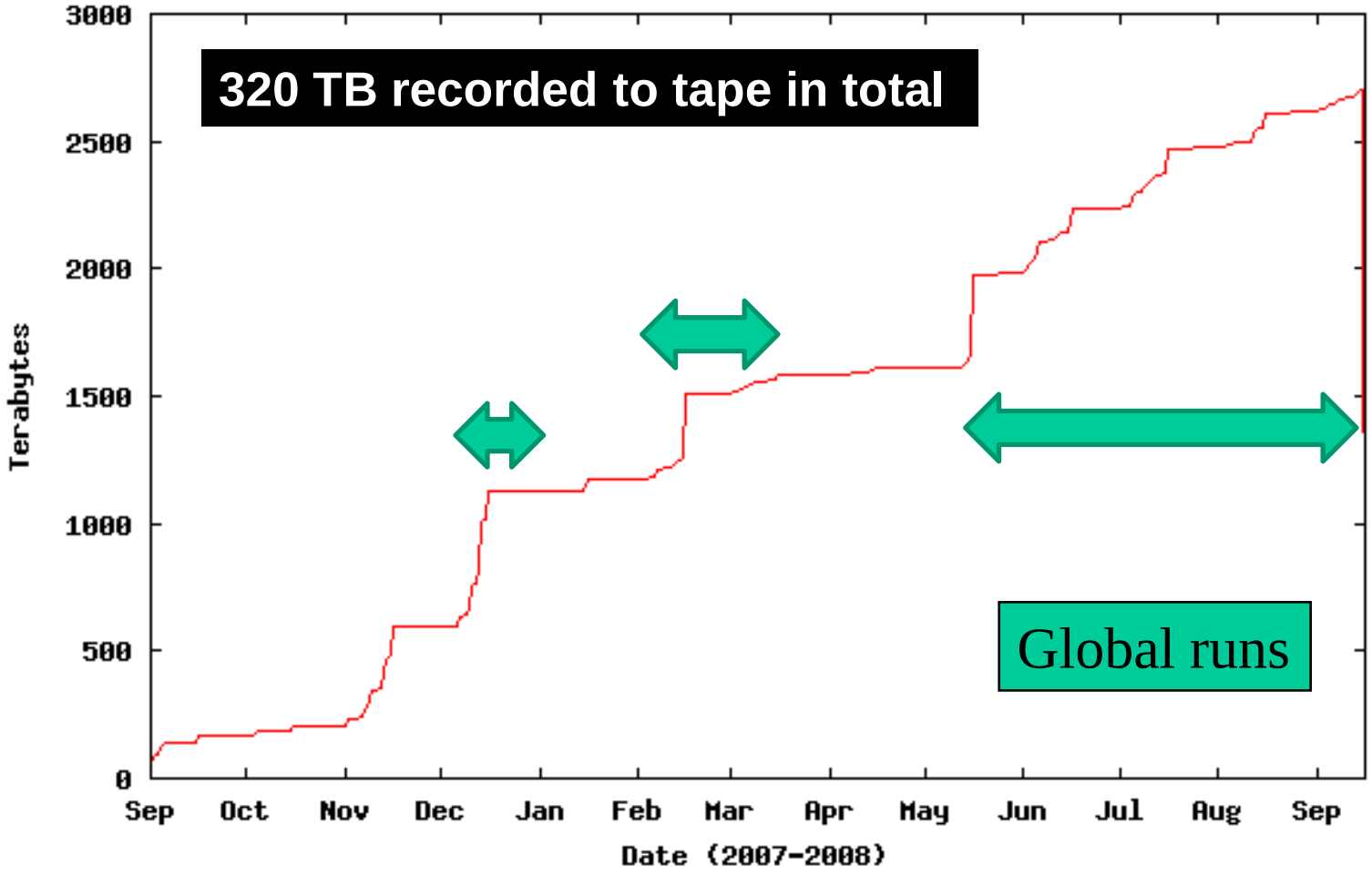
Data taking activity

Data taking time per time interval (15 days)



Data taking activity

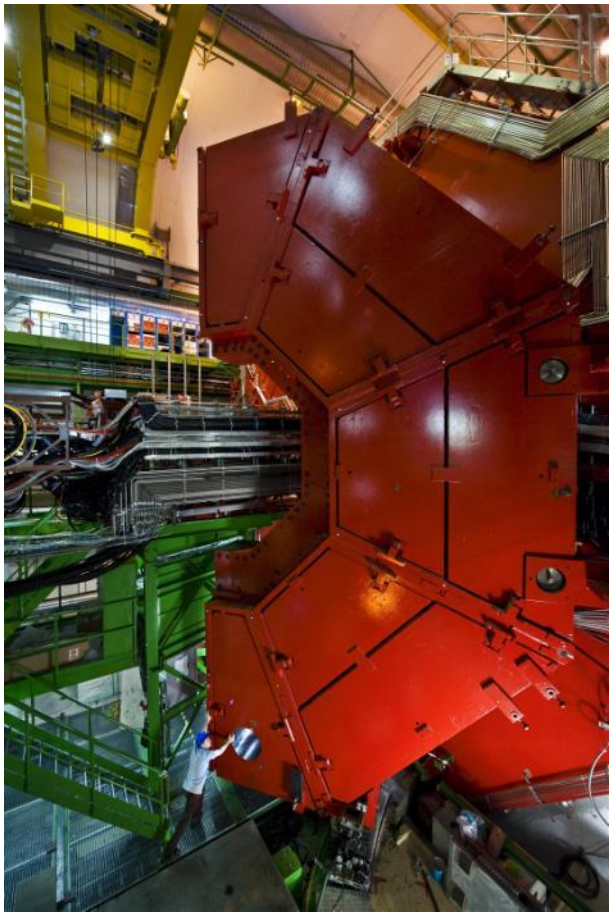
Cumulated amount of data readout



Global runs goals

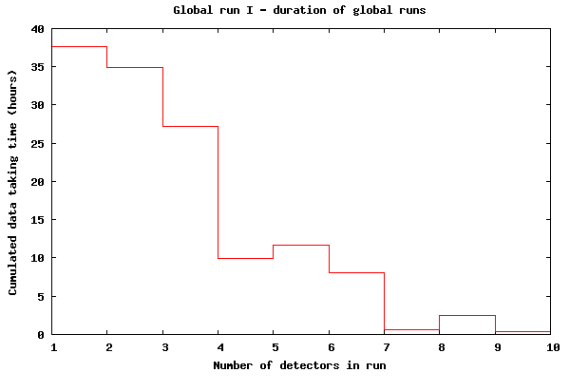
- Exercise performance and stability
  - Subsystems (detectors, services, …)
  - Magnets
  - Controls, trigger and data taking
  - Organization of operations
- Collect data

  (cosmics, lasers, injections, …)
  - Alignment
  - Calibration

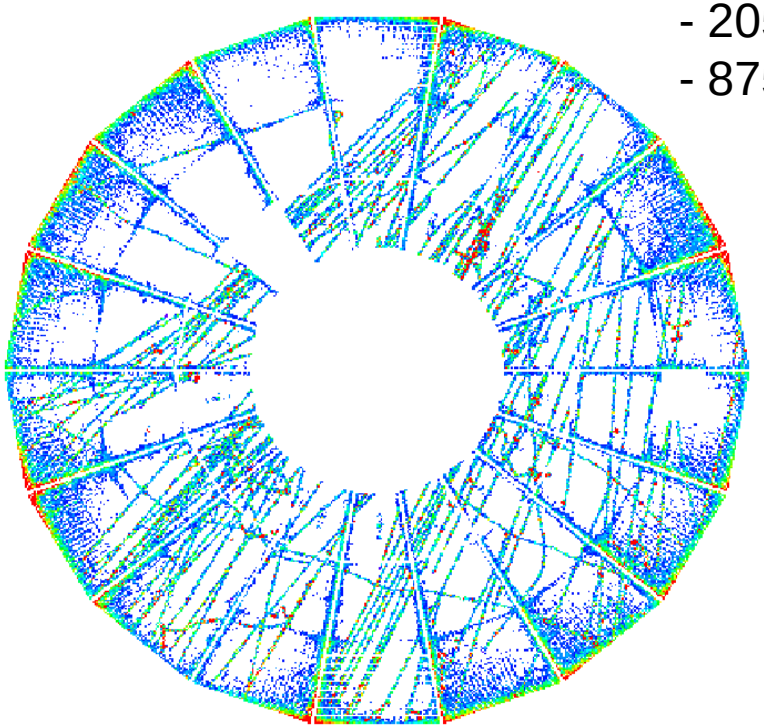


Global runs

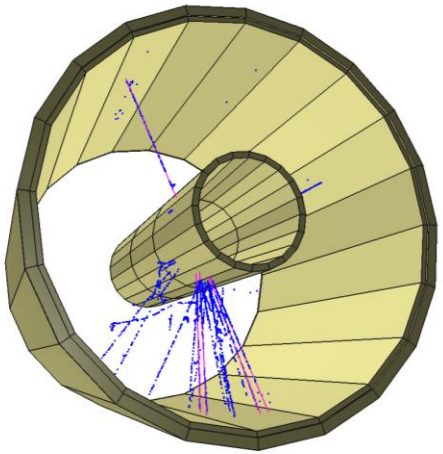
- Global run I (Dec 2007)
  - Data recorded = 17.5 TB average 0.7 GB/file
  - Recording rate = 18 MB/s
  - Detectors running together
  - Continuous operation
    - 12 days of operation
    - 205 persons
    - 875 8-hours shifts



Data taking duration for given number of detectors running together



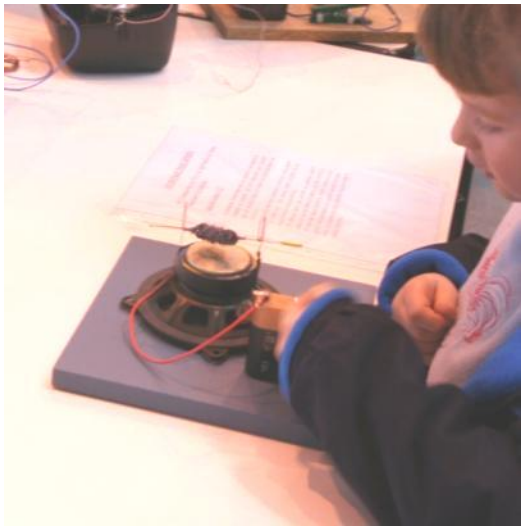
Example TPC event from online monitor



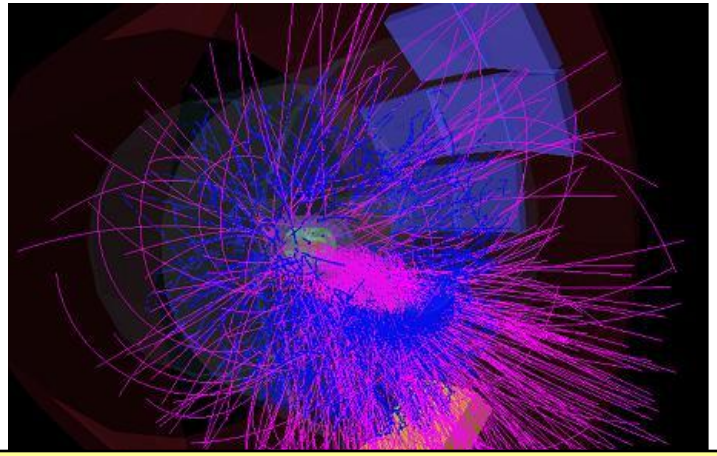
Another TPC event after reconstruction

Global runs

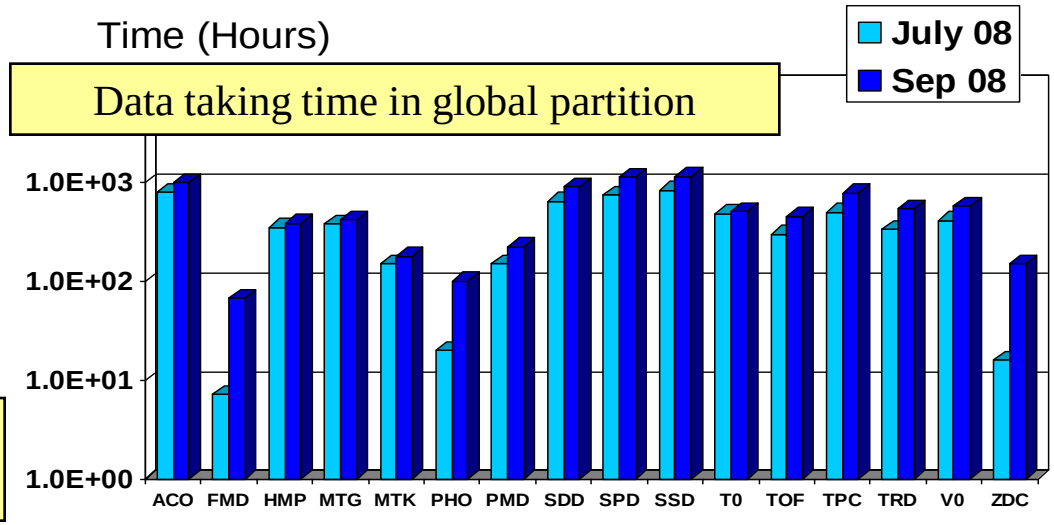
- Global run II (Feb-Mar 2008)
  - L3 & Muon magnets operation
  - More detectors standalone & together
  - Alignment data
- Global run III (May 2008 – ongoing)
  - Calibration and alignment
  - Tuning for operation with LHC beam



Magnet power test @ ALICE
CERN open day Apr 08

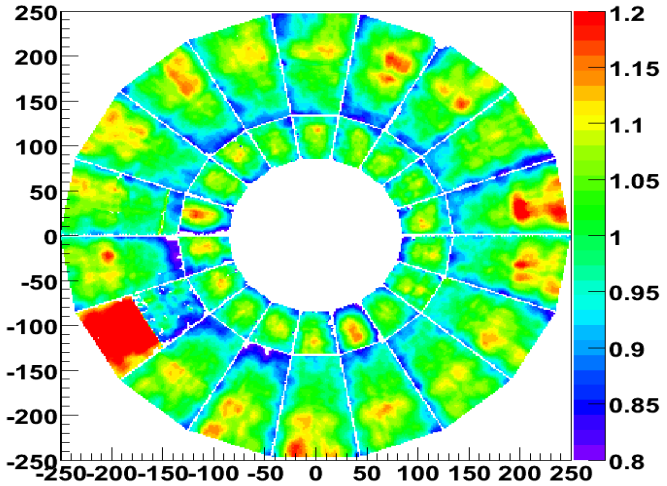


Reconstructed tracks in the ALICE TPC of a cosmic shower event from the muon absorber.

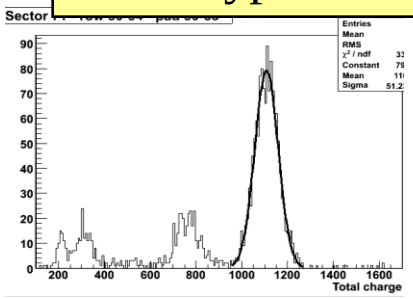


Calibration

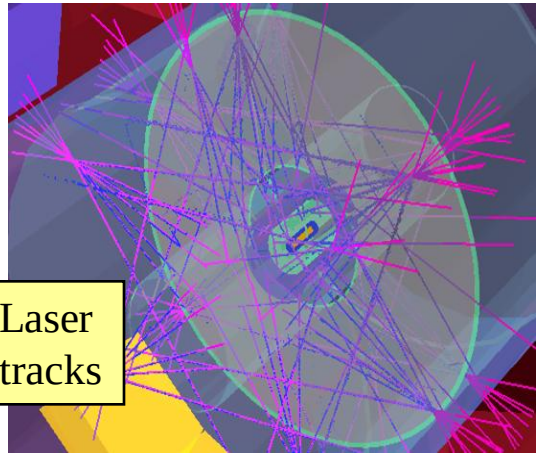
- 35 online detector calibration tasks operational
- Heavy tasks completed offline



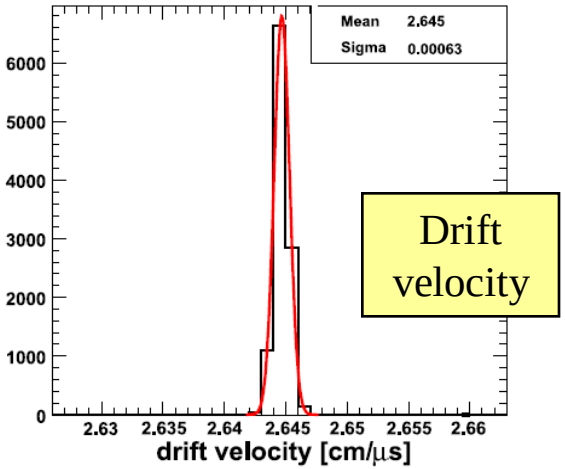
Gain calibration with krypton data



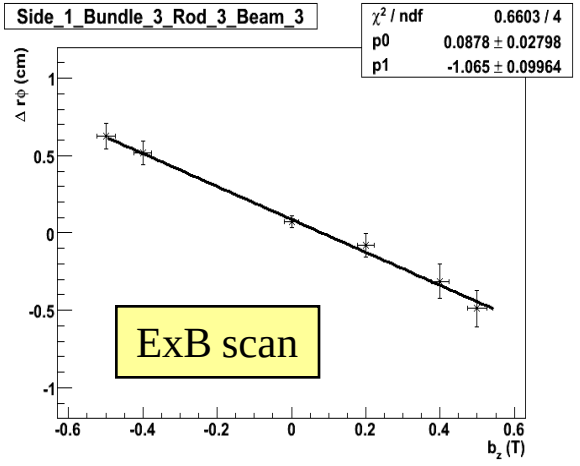
Example calibrations For TPC



Laser tracks

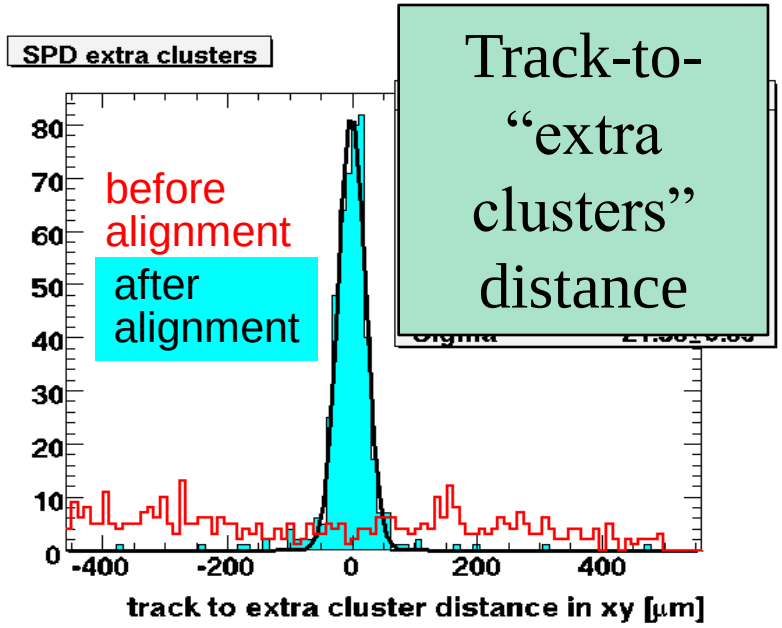


Drift velocity

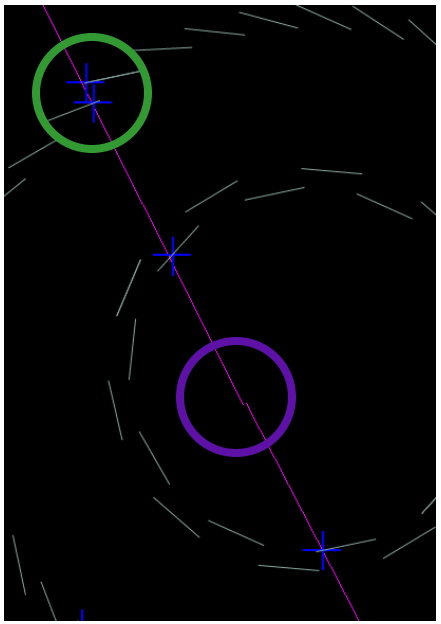


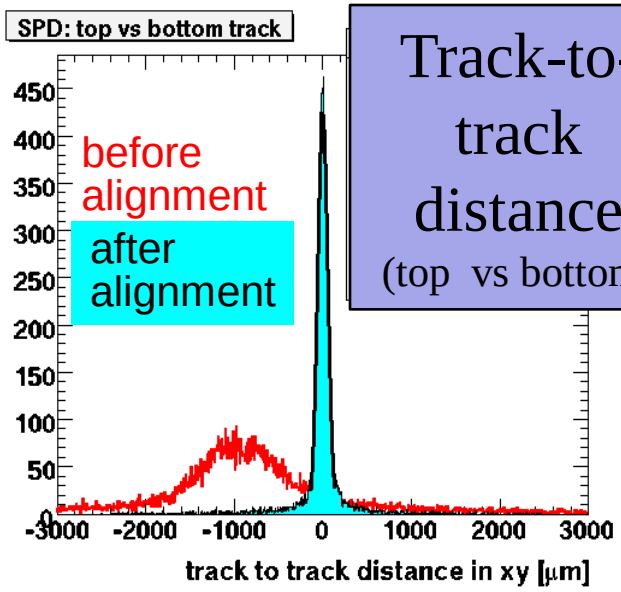
ExB scan

Alignment



Track-to-"extra clusters" distance





Track-to-track distance (top vs bottom)

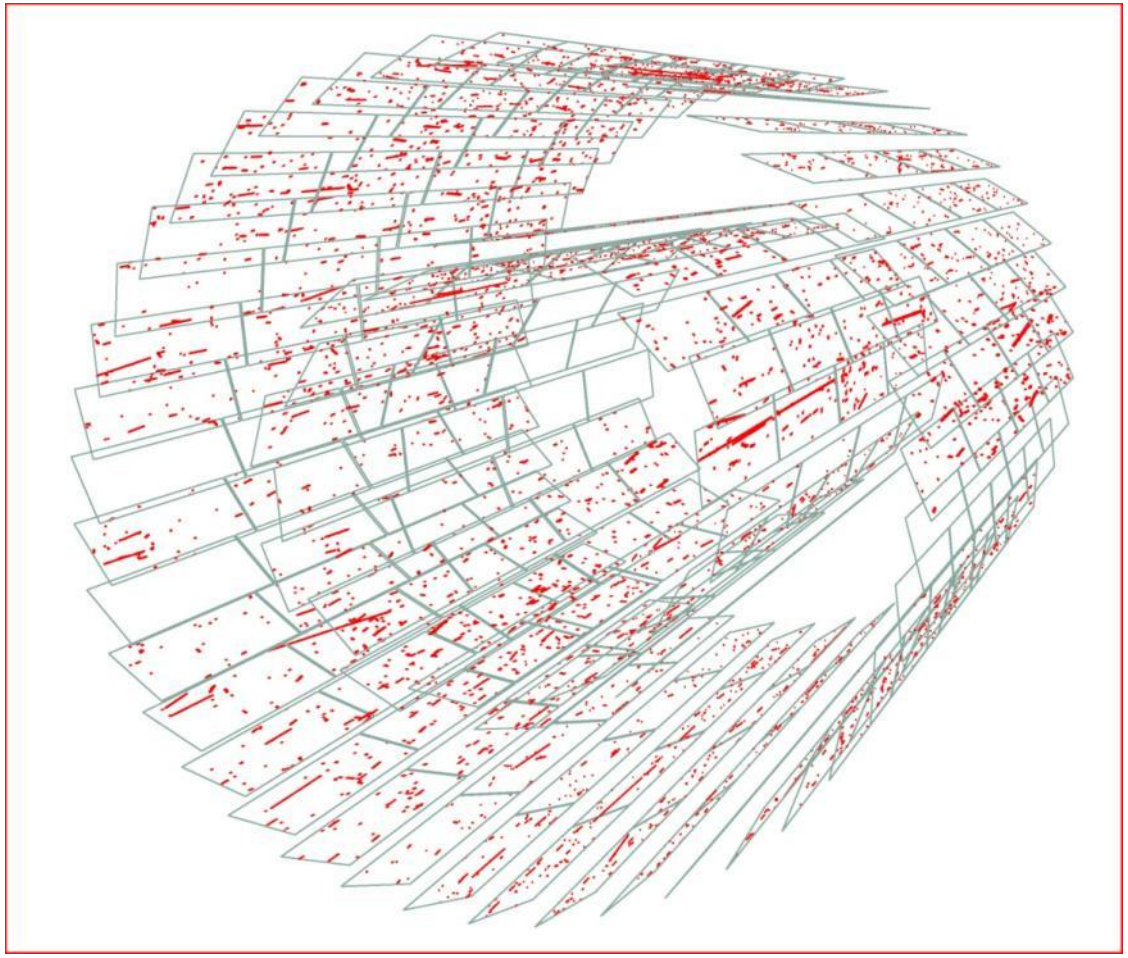
σ = 21 μm
(vs 15 μm in simul. without misalignment)

σ = 55 μm
(vs 40 μm in simul. without misalignment)

- Silicon Pixel Detector: residual misalignment < 10 μm
- Used 55k cosmics muons hits @ 0.1 Hz collected since May

SSD & SDD, ITS/TPC alignment started but not complete yet

First particles from machine

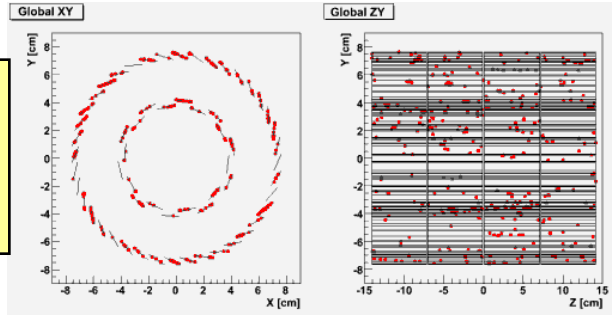


15/06 evening, first tracks at LHC during the first injection test in transfer line TI 2.

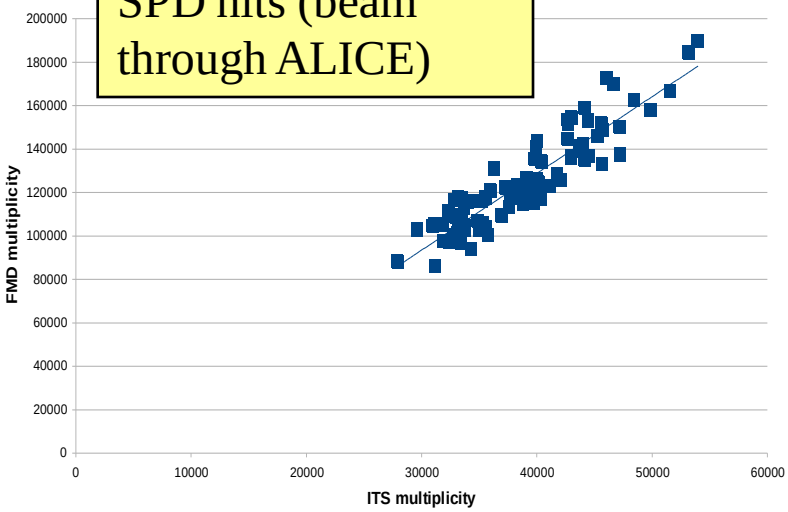
Silicon Pixel detector recorded muon tracks produced in the beam dump near Point 2

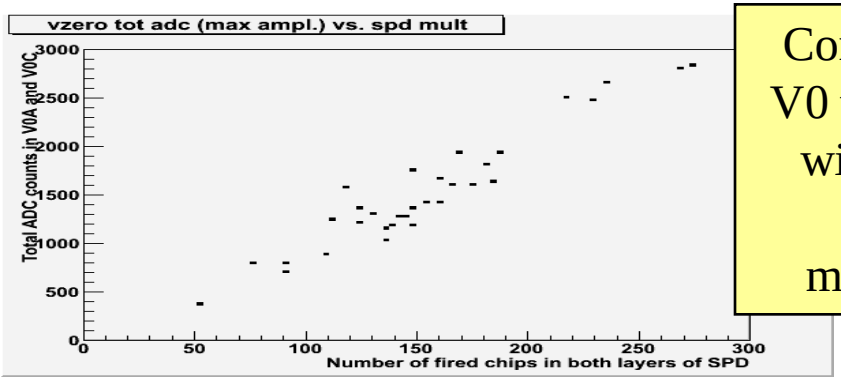
LHC Injection tests August 2008

Example event seen in Silicon Pixel

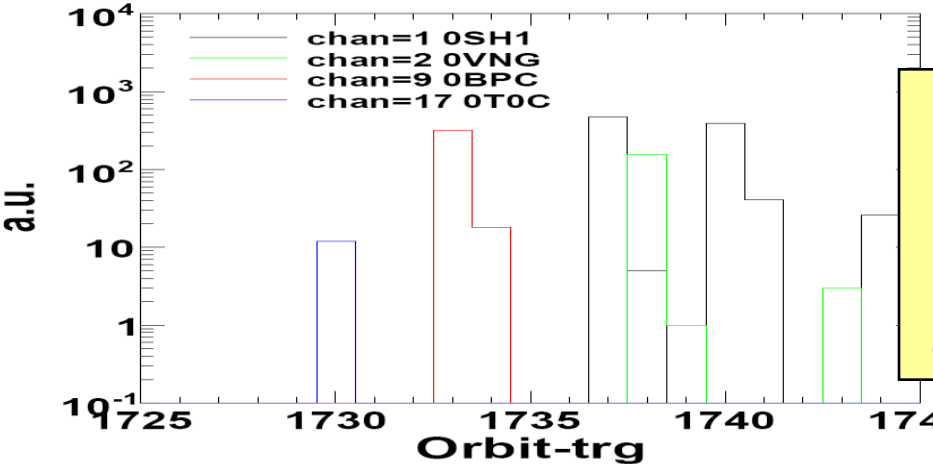


FMD hits versus SPD hits (beam through ALICE)

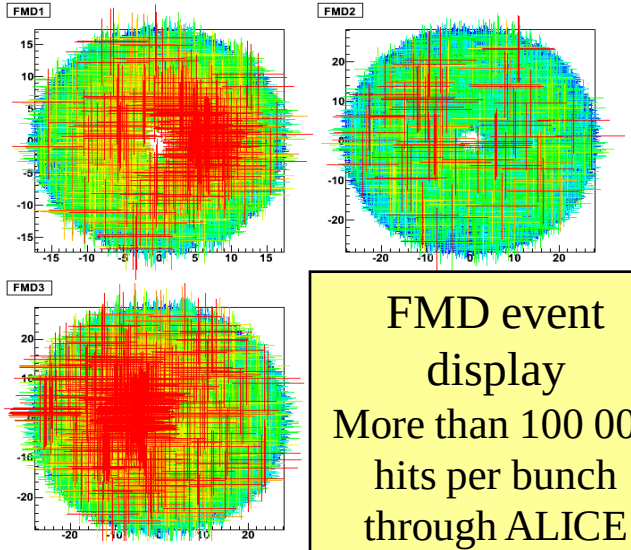




Correlation of V0 total charge with Silicon Pixel multiplicity

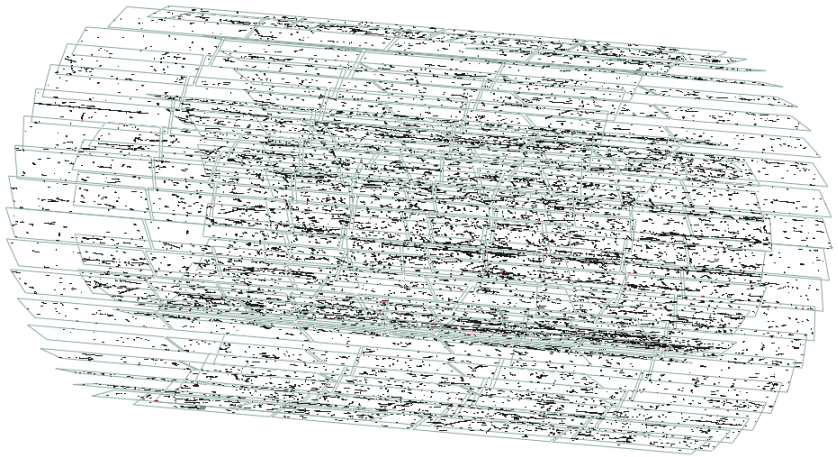


Trigger input signals before alignment



FMD event display
More than 100 000 hits per bunch through ALICE

1st circulating beam



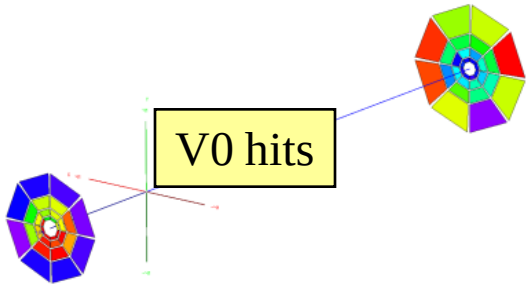
High multiplicity from Pixel detector on 10/09 during beam circulation

Very high particle fluxes measured in August during dumps and even during injection through ALICE (10's to 1000's particles/cm^2) with beam screens in LHC and/or TI2.

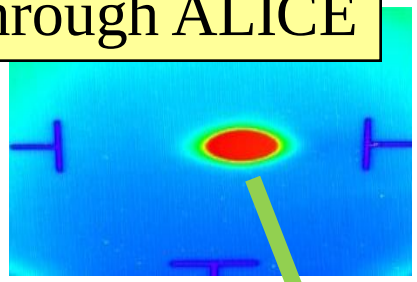
=> decided to switch off all sensitive detectors during injection

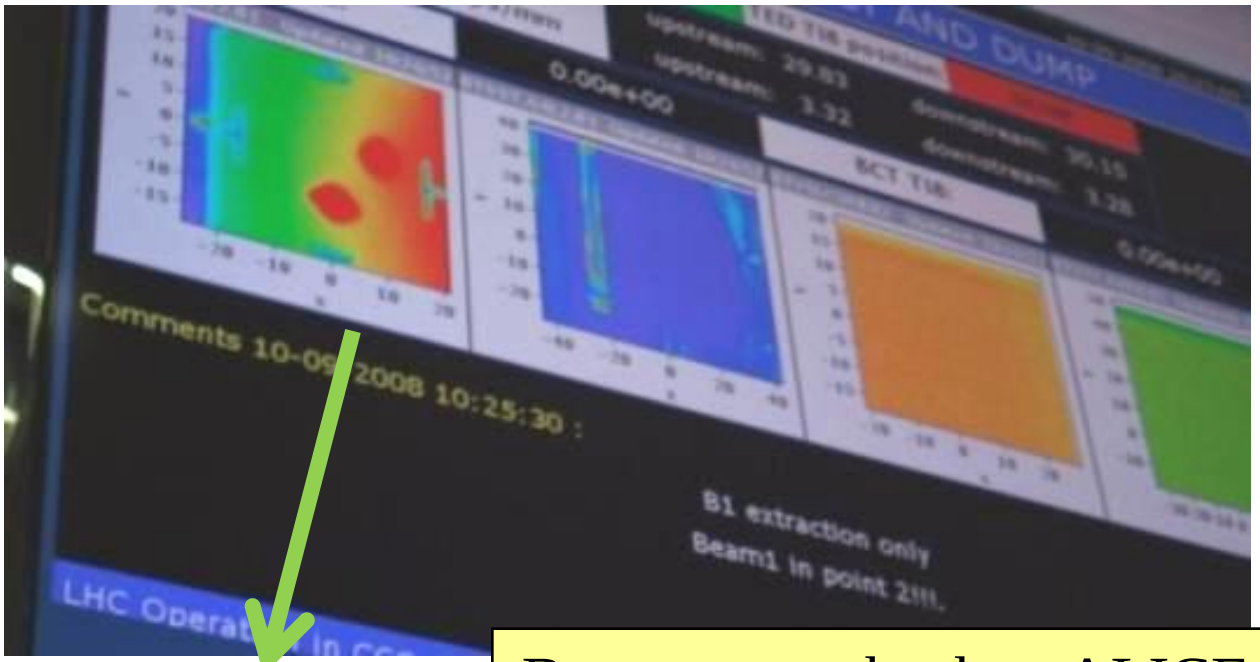
1st Beam data available only for limited set of detectors:
SPD, V0 always on (trigger), SSD, SDD, FMD, T0 occasionally

1st circulating beam 10/09/08

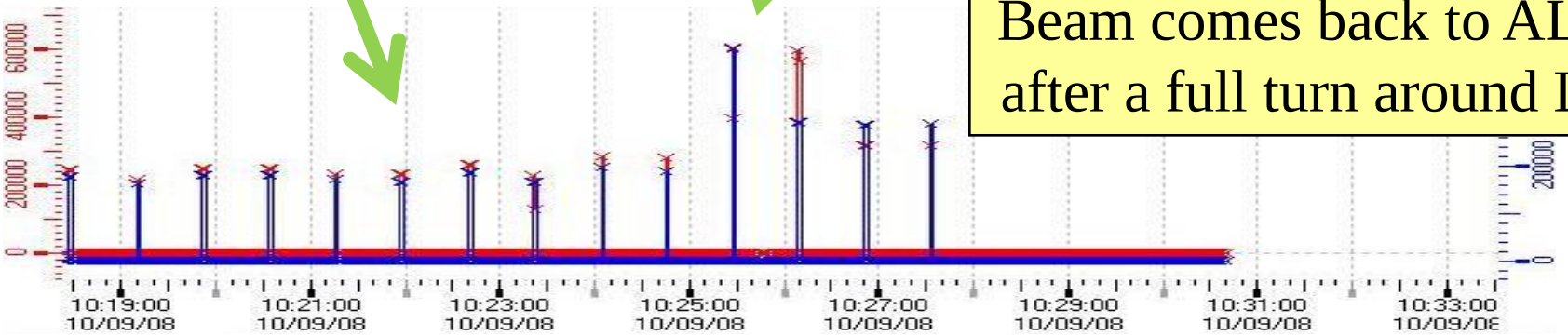


Single beam through ALICE



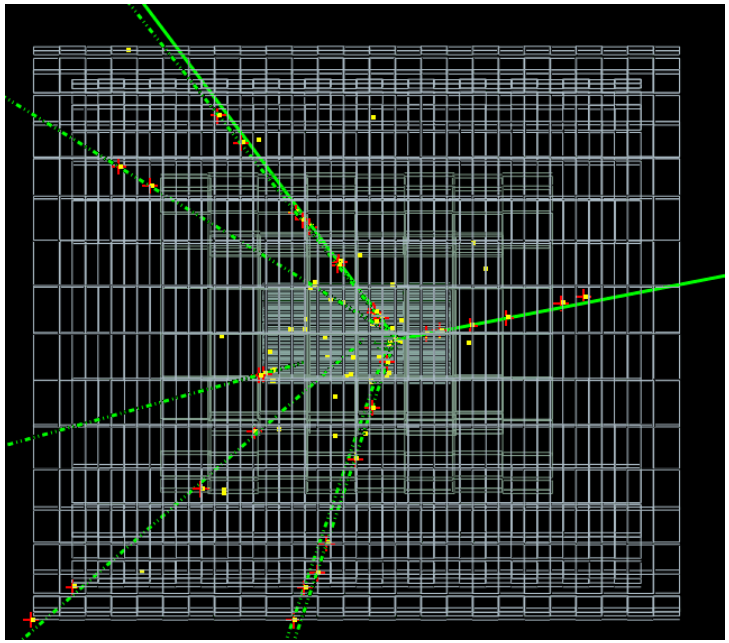


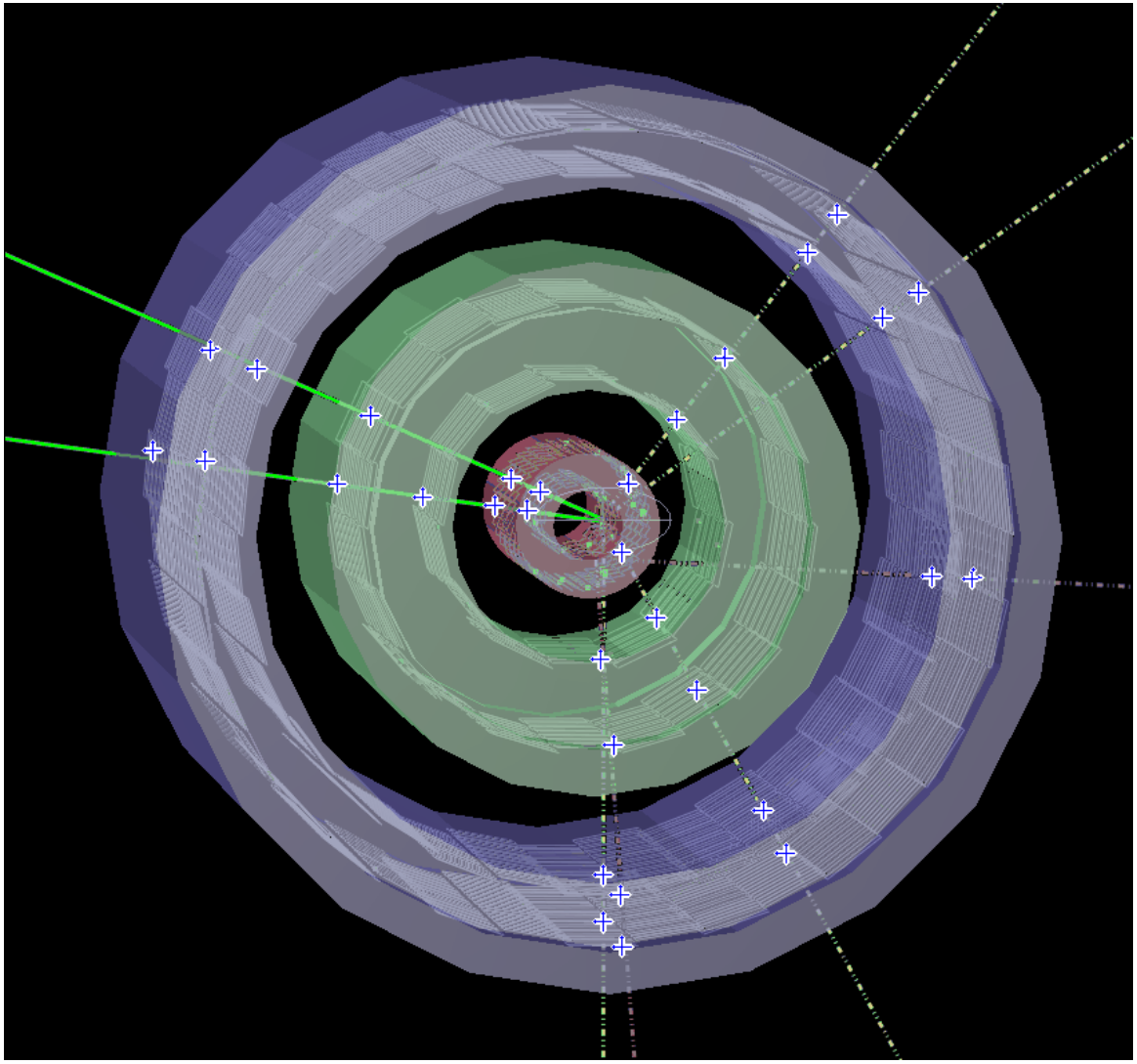
Beam comes back to ALICE after a full turn around LHC



V0 luminosity monitor

1st circulating beam





Collision in silicon pixel detector on 11/09, reconstructed tracks

Control

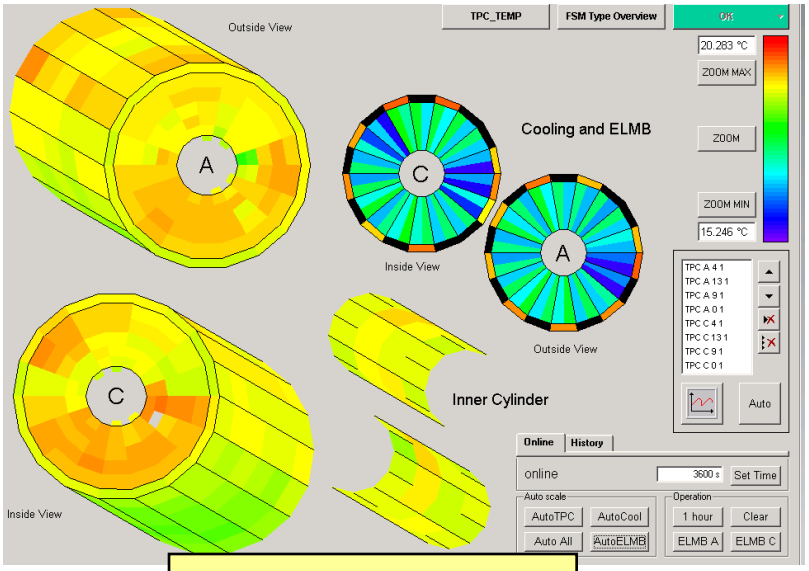
Detector Control System

- Safe and reliable operation of the hardware
- Device configuration, control and monitoring

  Powering on-off, Front End Electronics configuration, Beam-tuning states, interlocks
- 1600 servers publishing 150000 services,

  10^8 registers, 1200 network attached devices,

  Sustained db archiving rate of 1000 updates per sec



TPC temperature

Experiment Control System

– Synchronization of online systems

execution of ordered tasks at start / end of run

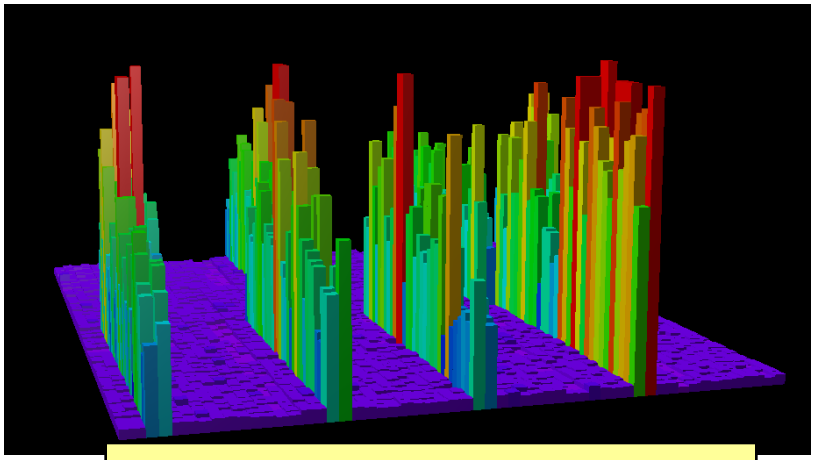
– Operations depend on run type

more than 30 run types exercised

Control workstation

Trigger

- Central Trigger Processor
  - Tested with realistic configurations
    - simulated random and cosmics triggers
    - Parallel detector clusters
    - Parallel triggers classes
  - Timing of trigger inputs
  - Synchronization with LHC signals



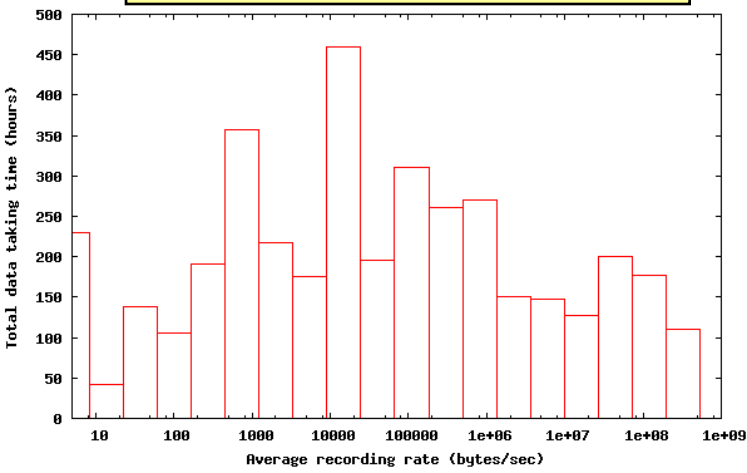
HLT online display
For a PHOS LED pulser run

- Data taking with High Level Trigger
  - online reconstruction & data reduction
  - All operation modes, including with event reject
  - Reconstruction of main detectors (TPC,TRD,PHOS,MUON), online compression (SDD)

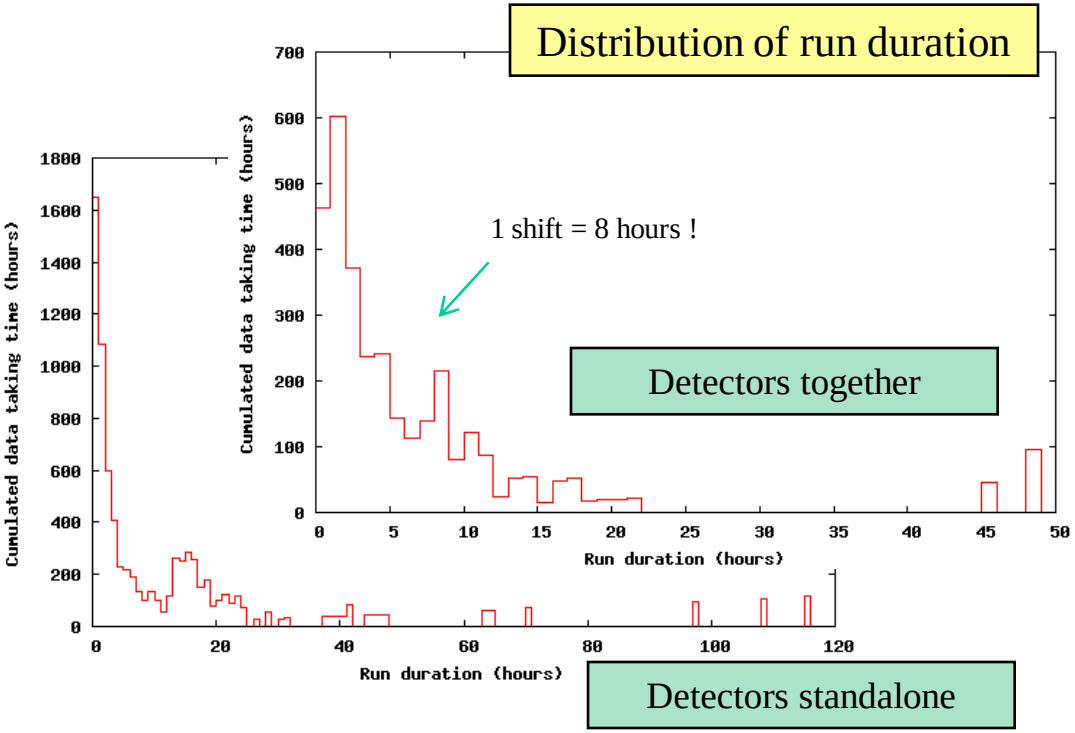
Data Acquisition

- Sustained recording at high data rate, adequate for p-p collisions
  - Up to 400 MB/s sustained, 1.3GB/s for short periods
- Wide range of operating conditions
- Concurrent detectors activity
- Flexible configuration

Distribution of average recording speed



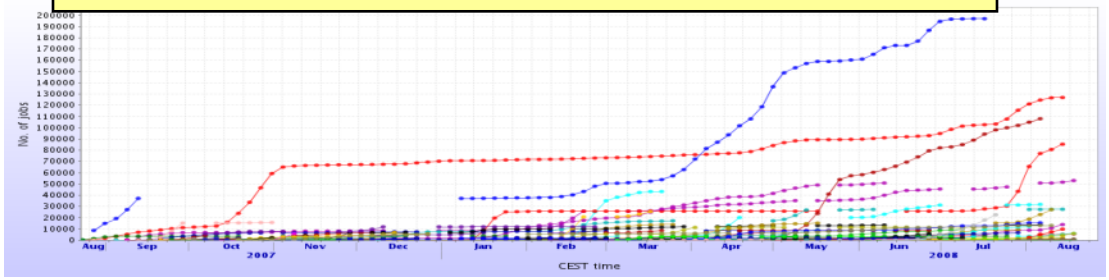
Distribution of run duration

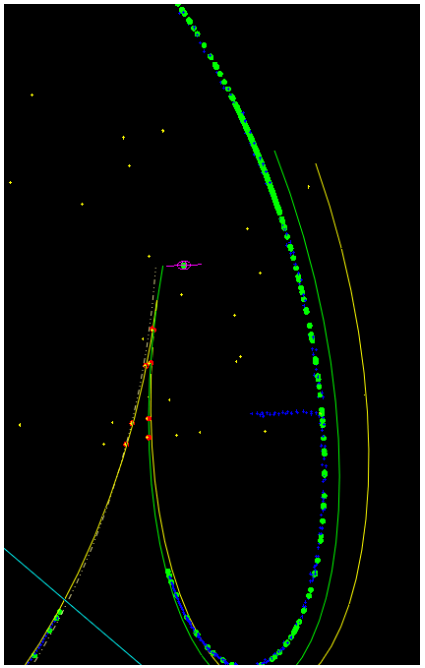


Offline

- GRID used with success
  - RAW data registration/replication, workload management, storage
  - Reconstruction chain for RAW and Event Summary Data (T0, T1s and T2s)
- Dedicated clusters for Time-critical data analysis (CAF, GSIAF)
- Test of reconstruction algorithms on cosmics events, injections, lasers
- Alignment, efficiencies, calibration

~1M user jobs, 2.7K/day
~130 active users on the Grid/CAF

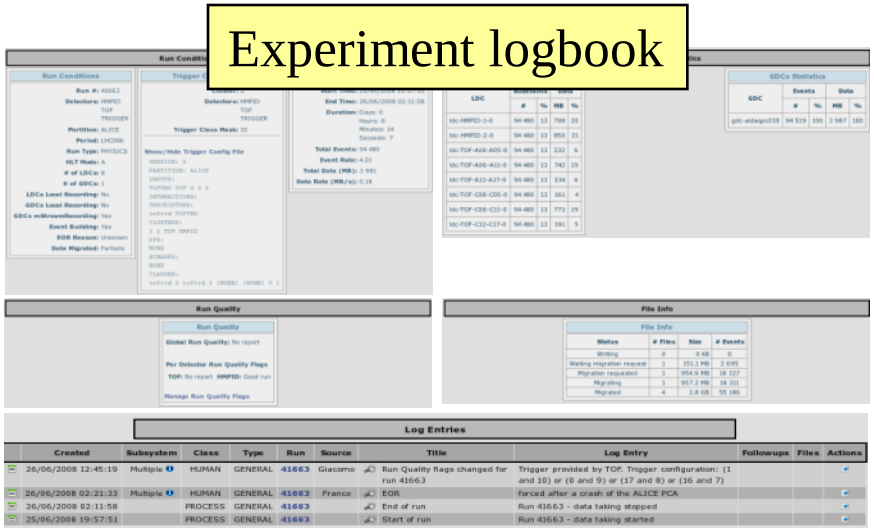


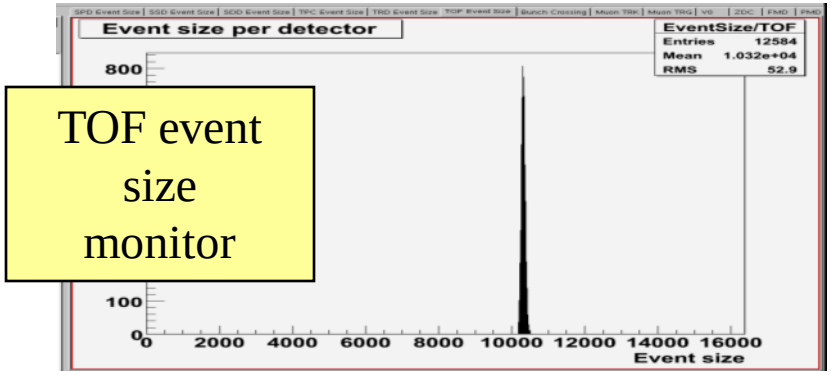


Experiment operation

- 24/7 operation in global runs
  - >4300 shifts Dec. 07 – Aug. 08
- Strict remote access policy
  - isolated network
  - constraints worth the effort
- Logbook
  - Report and operation analysis
- Online monitoring and

Data Quality monitoring tools





Achievements were not effortless

- Services issues: cooling, power supplies
- Much work on detectors firmware and noise issues
- Control scalability: had to distribute and isolate some systems
- Data formatting: CPU needed higher than anticipated (price to pay for allowing single pass offline analysis)
- Geographical mapping of data links required some iterations
- Test of all (complex!) trigger configurations is time consuming
- Fix for spurious triggers
- Problems grow with number of detectors involved 0.99^16=0.85
  - Starting run rakes time
- Detector state machines and complex sequence control still under development, not yet fully automated

Conclusions

- Commissioning was a long and tricky way
  - Issues found and fixed
- Completed with success and in time
- System fully operational
  - Will continue to gather alignment / calibration data
- Ready to provide high quality physics
  - when all experts around…

- Let's have some collisions !