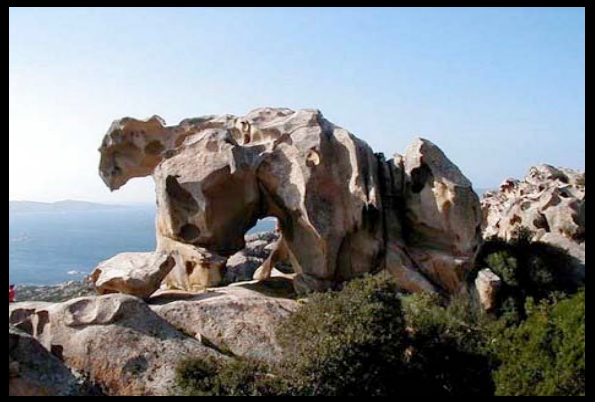
Quarto Convegno Nazionale
sulla Fisica di ALICE

Palau (Sardegna)
28 Settembre - 1 Ottobre 2008



Partenza di ALICE e di LHC

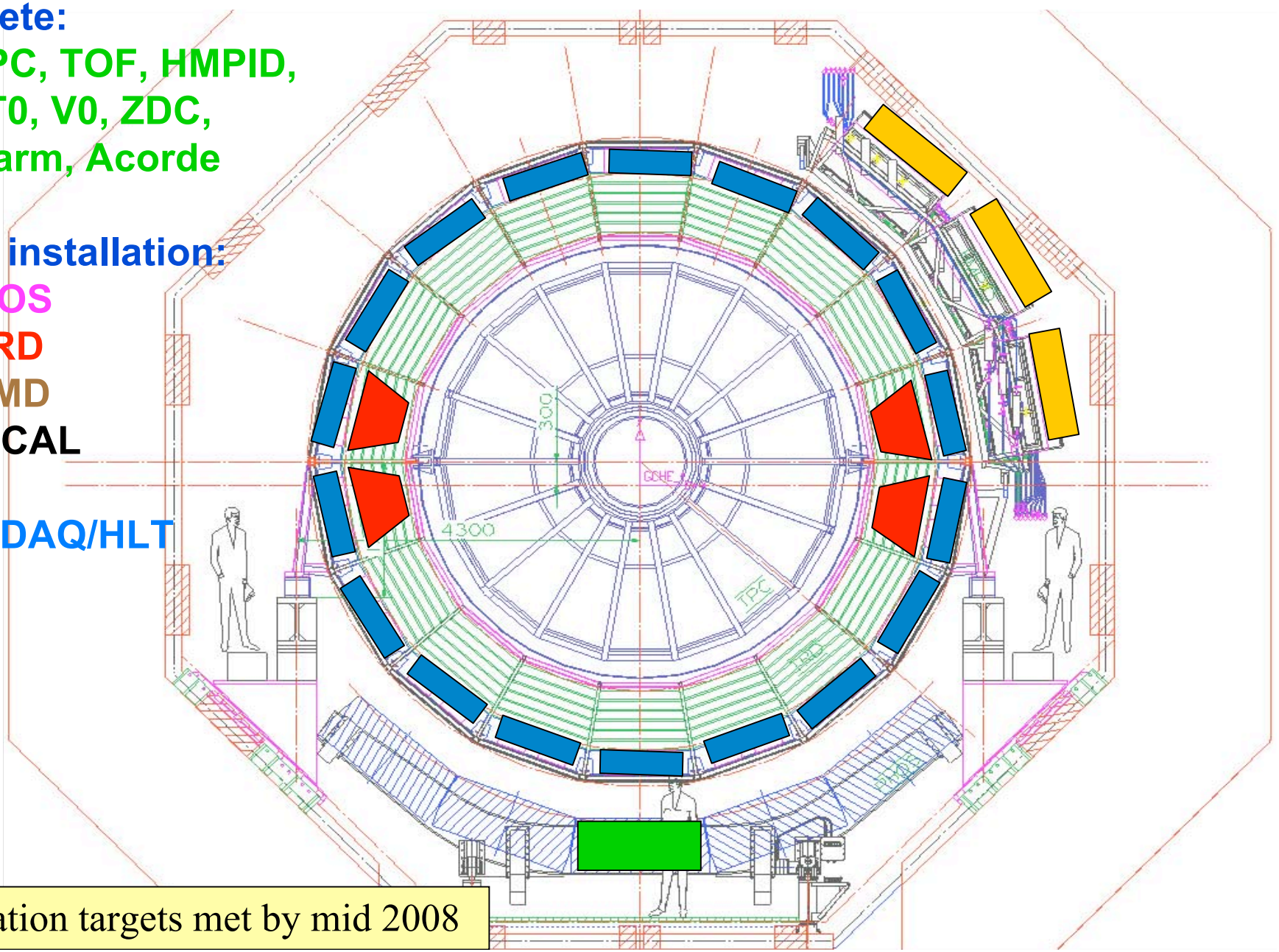
Federico Antinori

ALICE Detector Installation mid 2008

Complete:
ITS, TPC, TOF, HMPID,
FMD, T0, V0, ZDC,
Muon arm, Acorde

Partial installation:
1/5 PHOS
4/18 TRD
9/48 PMD
0/6 EMCAL

~ 40% DAQ/HLT

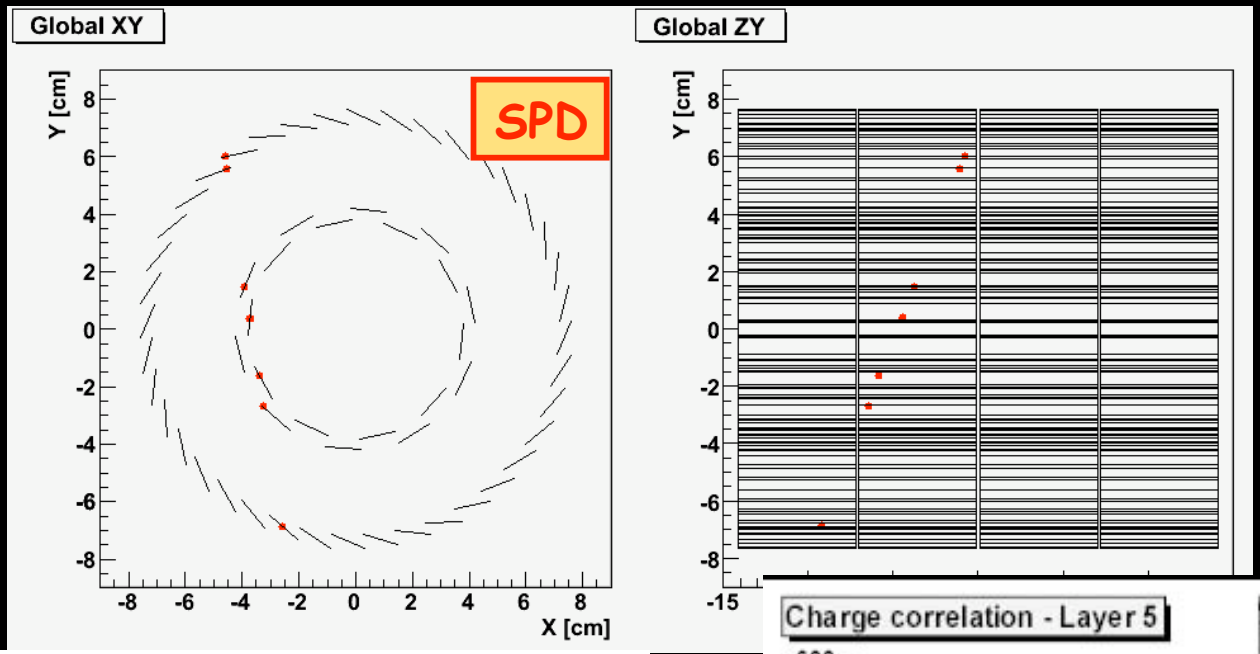


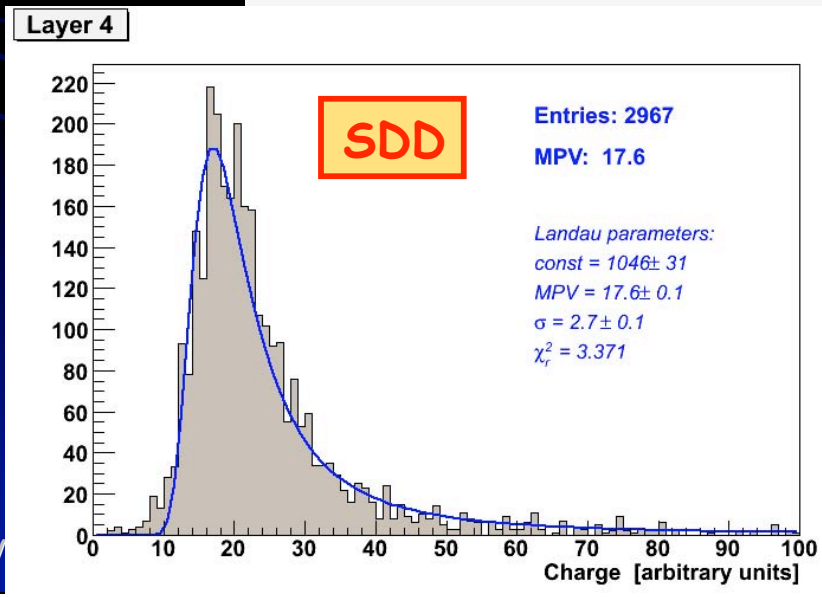
Installation targets met by mid 2008

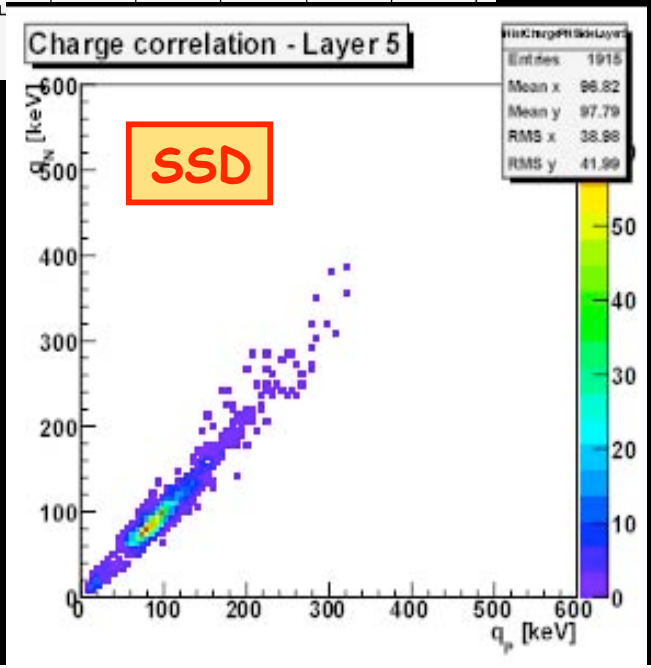
Prese dati

- Global Run I: dicembre 2007 (2 settimane)
  - inizio del commissioning a livello di sistema
- Global Run II: febbraio/marzo 2008 (3 settimane)
  - commissioning globale, commissioning del magnete, cosmici
  - problemi con la TPC: solo una settimana
- Global Run III: da maggio, previsto fino al 12 ottobre
  - commissioning globale, calibrazione e allineamenti con cosmici
  - primi fasci

Raggi cosmici nell'ITS

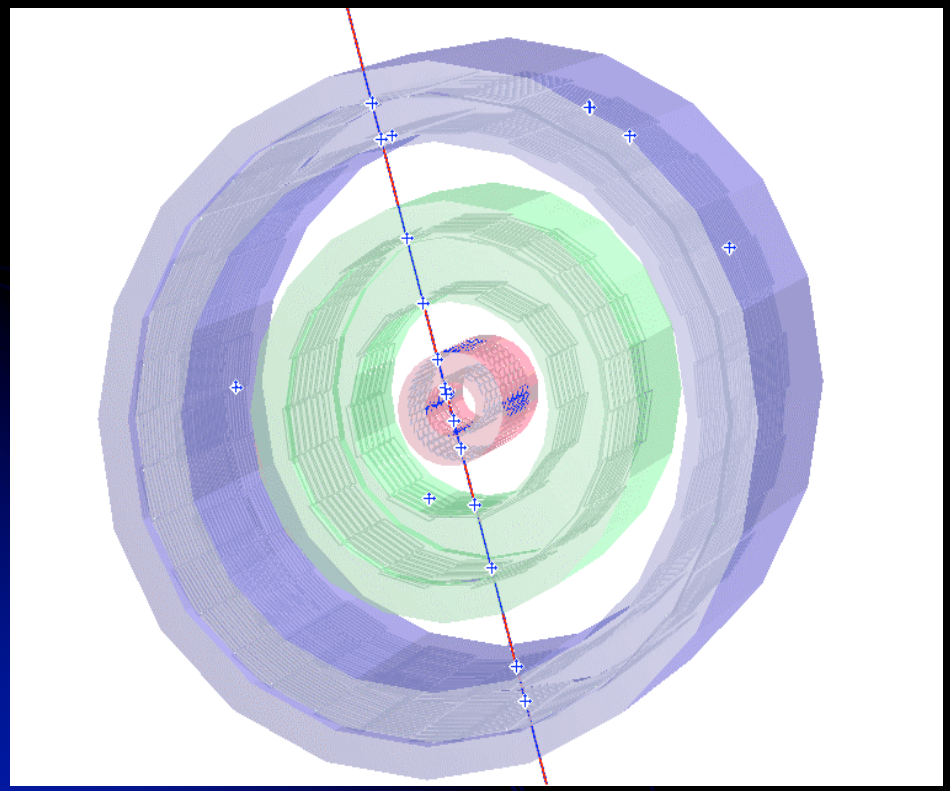




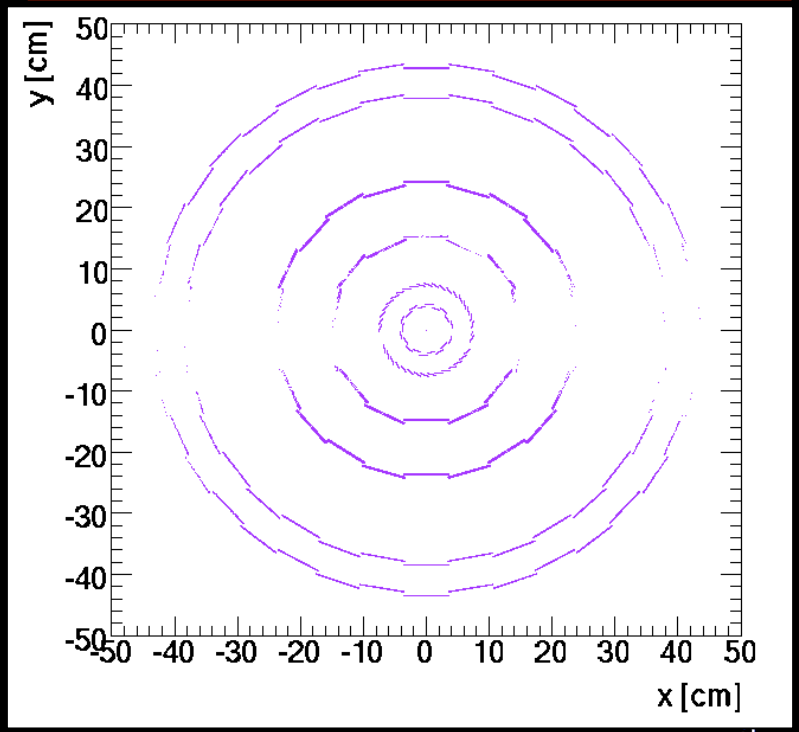


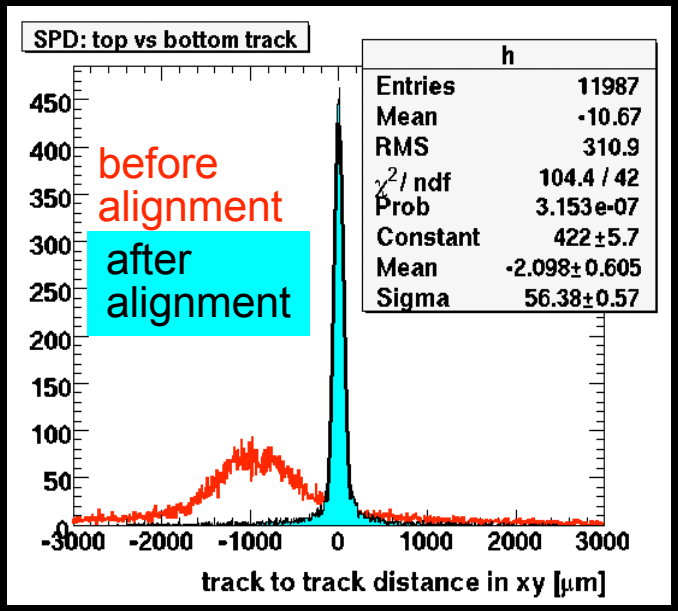
Allineamento dell'ITS

- 2200 volumi allineabili → 13200 gradi di libertà!
  - Millepede, allineamento "gerarchico"
- ~ 50 k eventi cosmici raccolti col trigger SPD (~ 0.1 Hz)

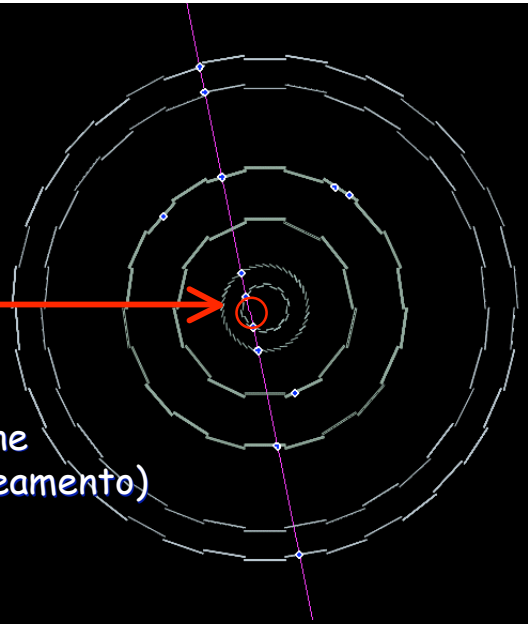


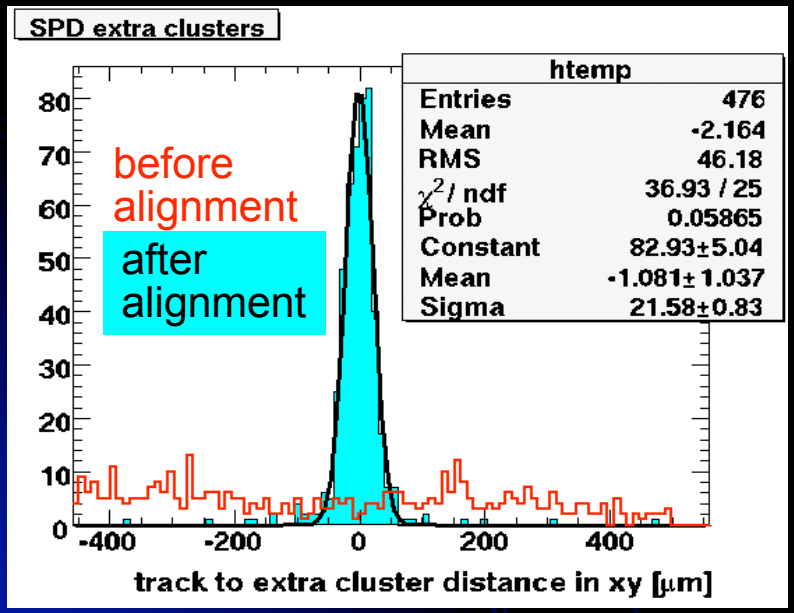
Distribuzione dei cluster nei 6 strati dell'ITS



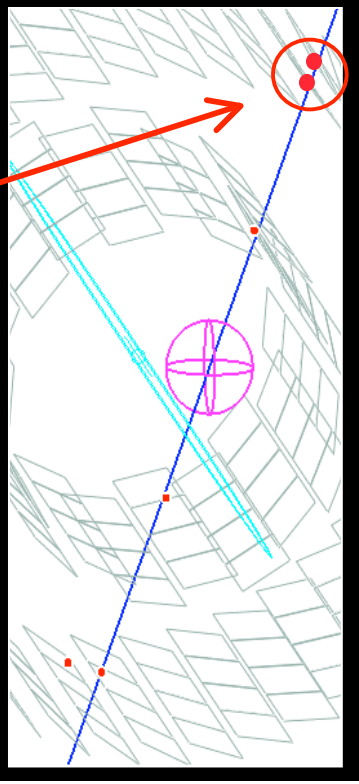


- Distanza tra traccia superiore e traccia inferiore
  - σ = 56 μm
  - (40 μm in simulazione senza alcun disallineamento)

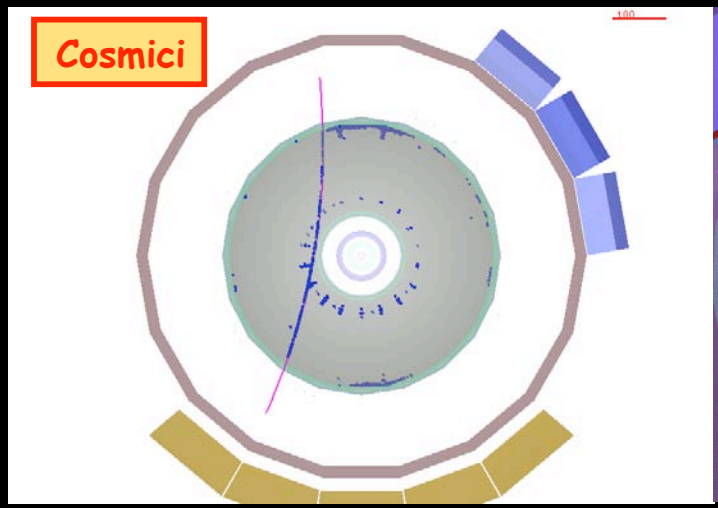


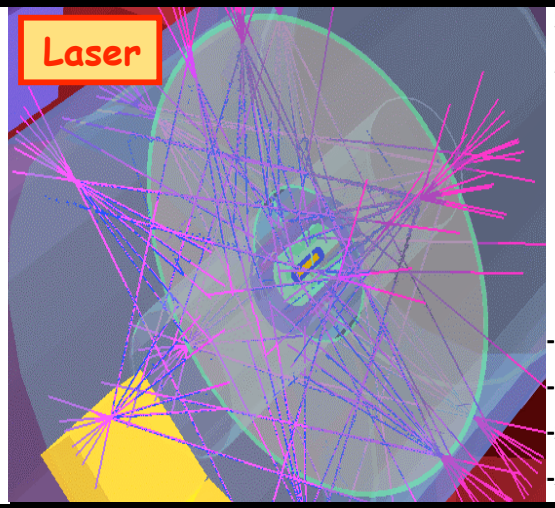


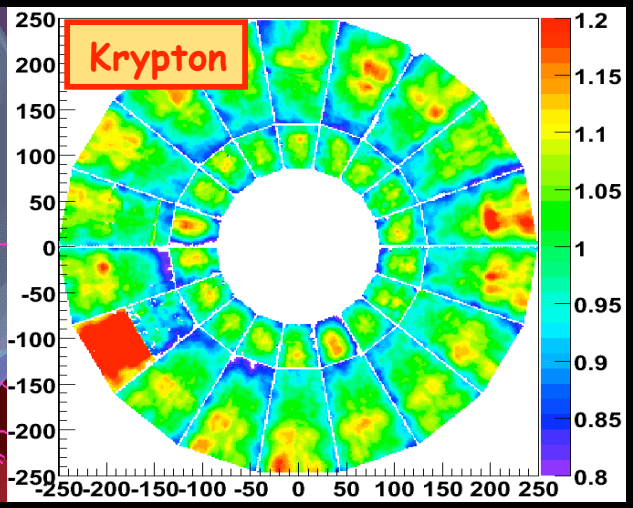
- Distanza tra traccia e hit nella regione di overlap
  - σ = 22μm
  - (15 μm in simulazione senza alcun disallineamento)

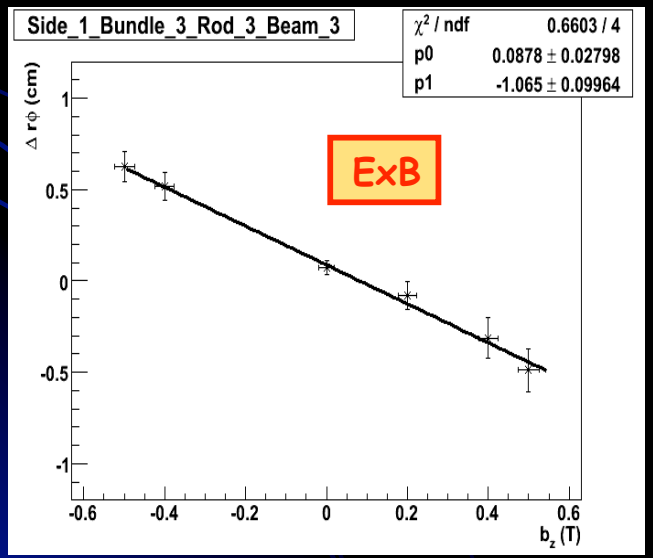


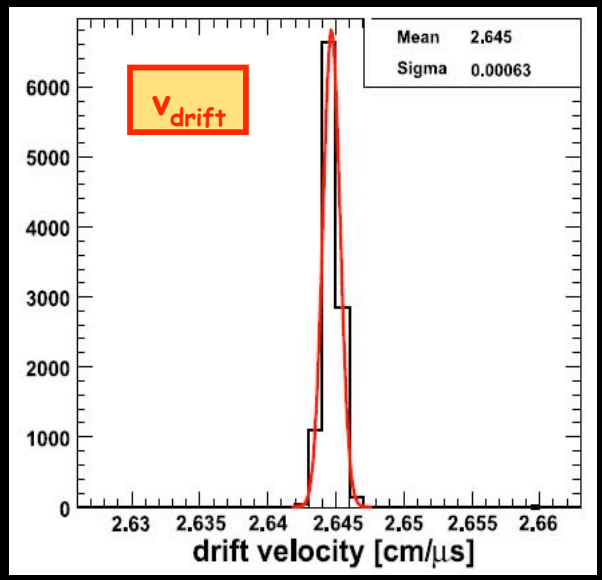
TPC


Cosmici

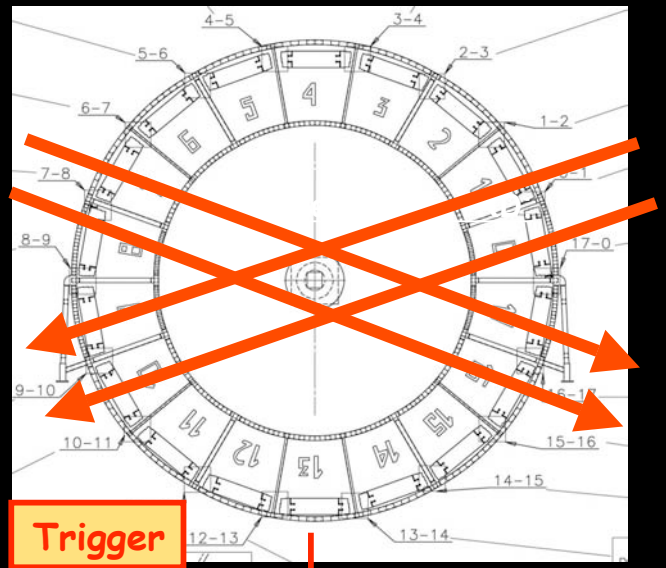

Laser

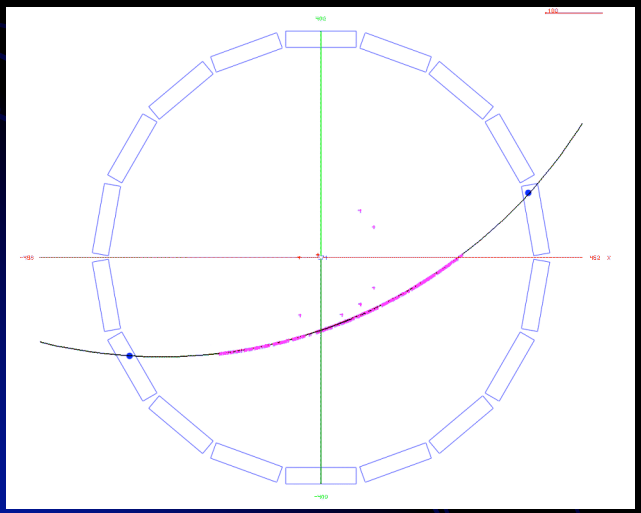

Krypton
250
200
150
100
50
0
-50
-100
-150
-200
-250
-250-200-150-100 -50 0 50 100 150 200 250
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8

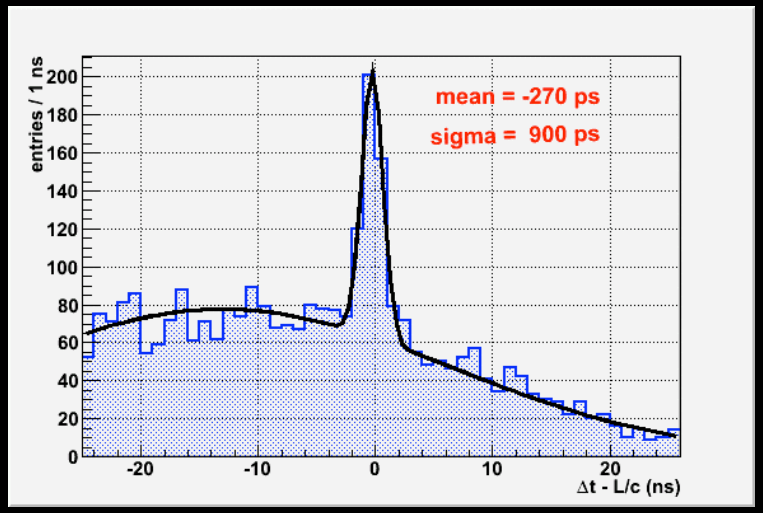

Side_1_Bundle_3_Rod_3_Beam_3
χ² / ndf 0.6603 / 4
p0 0.0878 ± 0.02798
p1 -1.065 ± 0.09964
ExB
Δ rφ (cm)
1
0.5
0
-0.5
-1
-0.6 -0.4 -0.2 0 0.2 0.4 0.6
b_z (T)


Mean 2.645
Sigma 0.00063
v_drift
6000
5000
4000
3000
2000
1000
0
2.63 2.635 2.64 2.645 2.65 2.655 2.66
drift velocity [cm/μs]

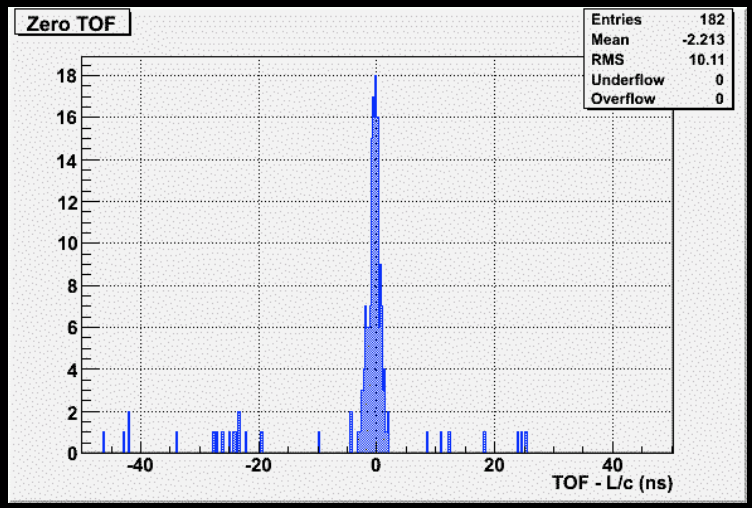
TOF





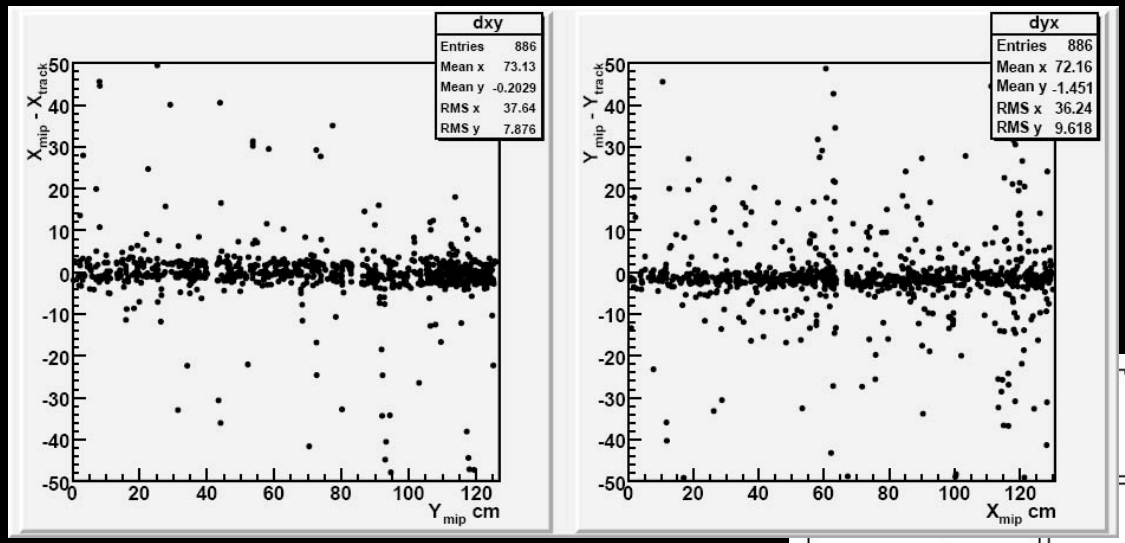


- senza correzioni (tracking, time slewing, pad timewalk, …)



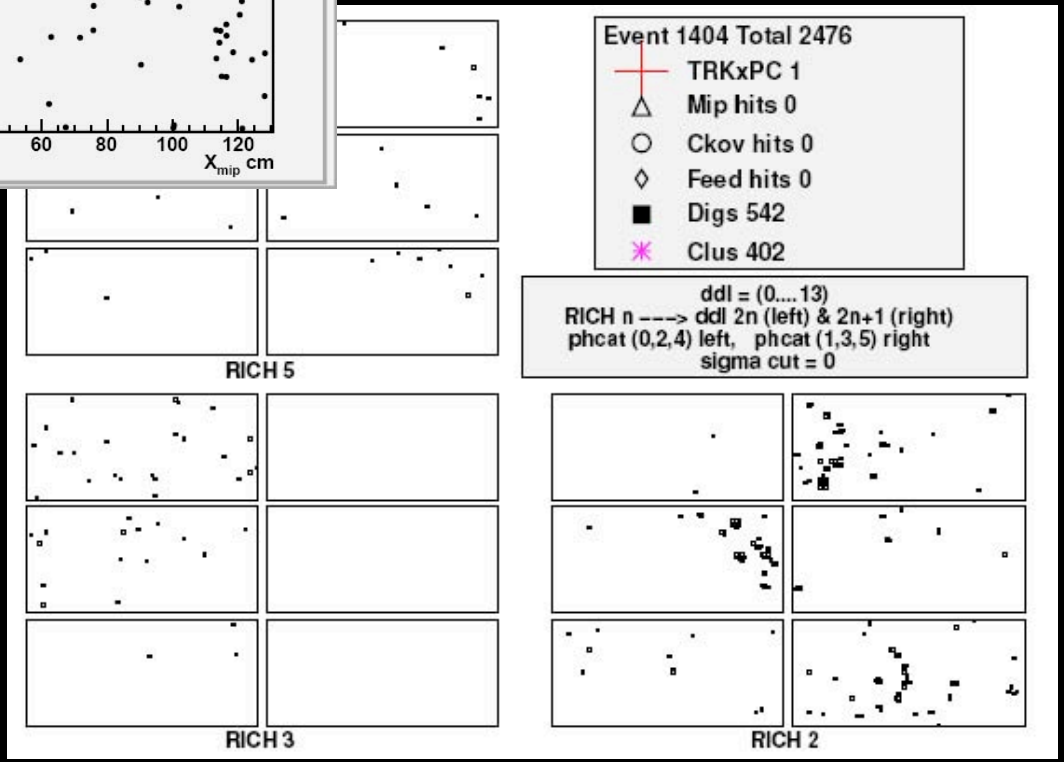
- conferma a L1 (TRD) → praticamente senza fondo!

HMPID

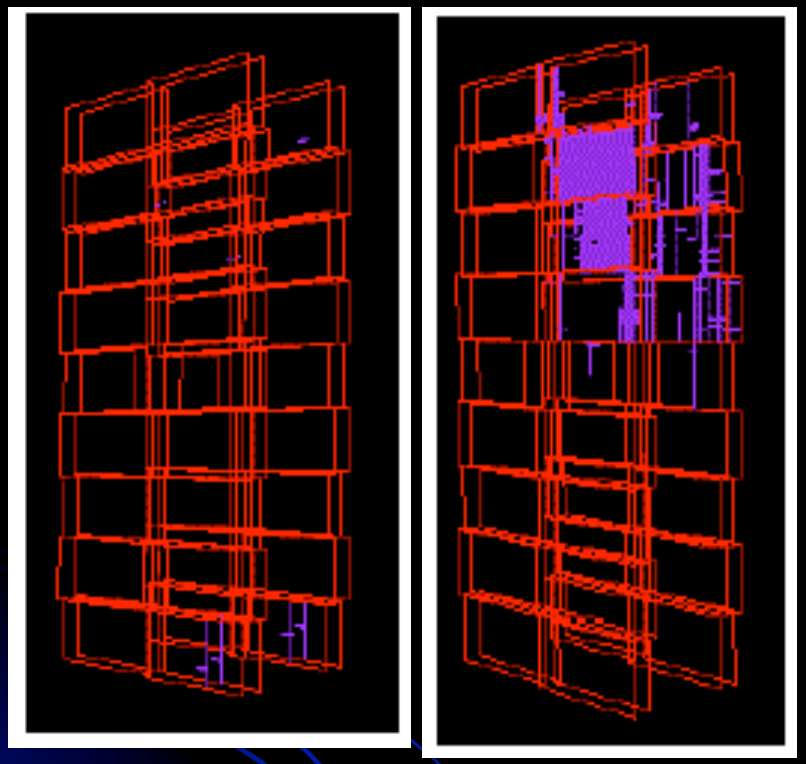


- track matching HMPID – TPC
  - raw data, senza riallineamenti

- anelli!

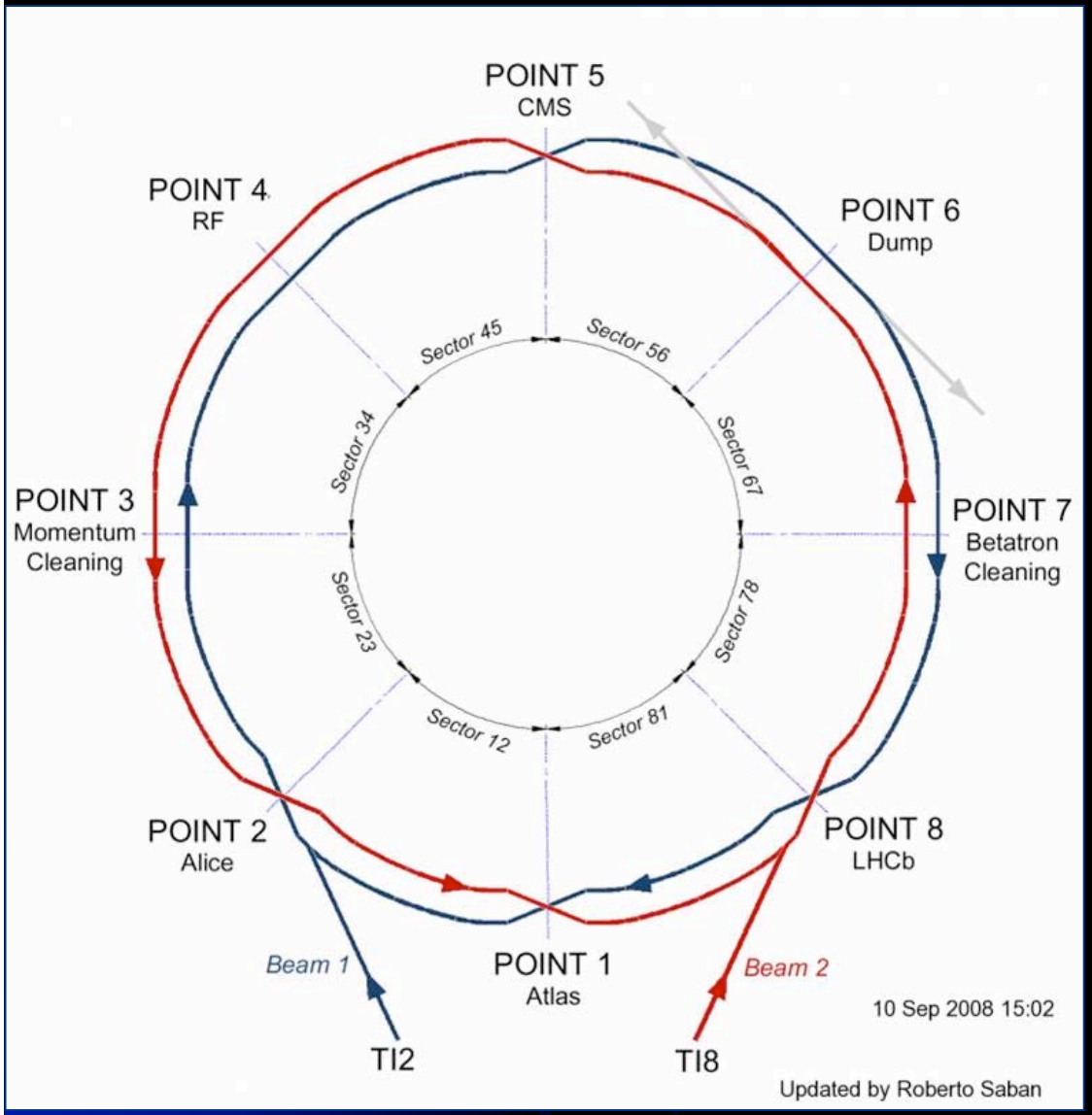


Muon Trigger



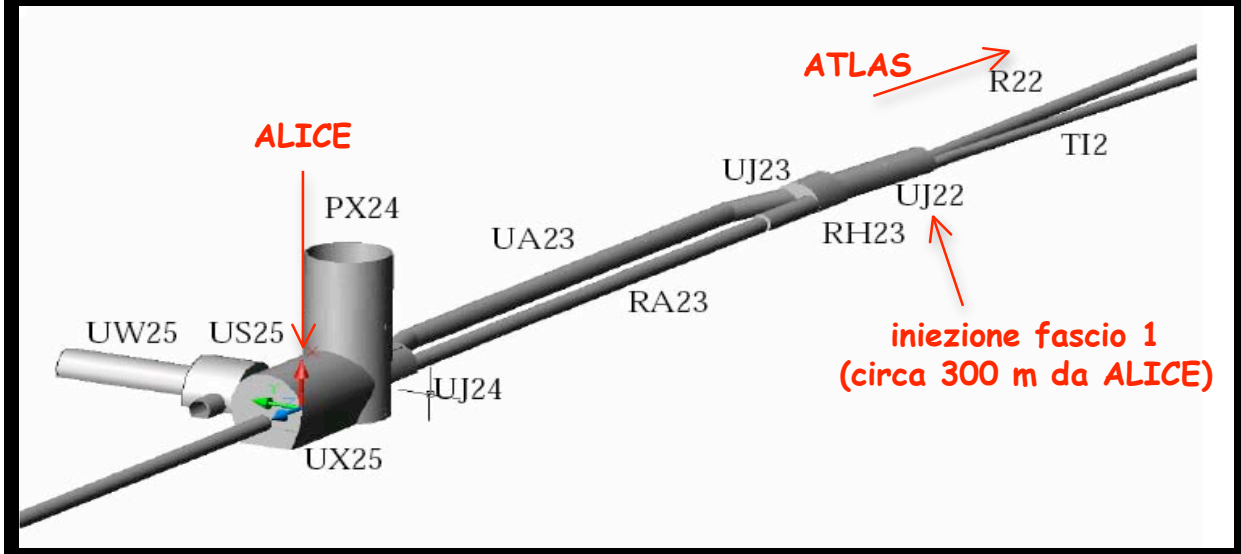
- ~ 160 ore di presa dati con cosmici
- Rate ~ 0.15 Hz
  - muoni + sciami
- accettanza solo per tracce ~ orizzontali

Particelle in LHC !

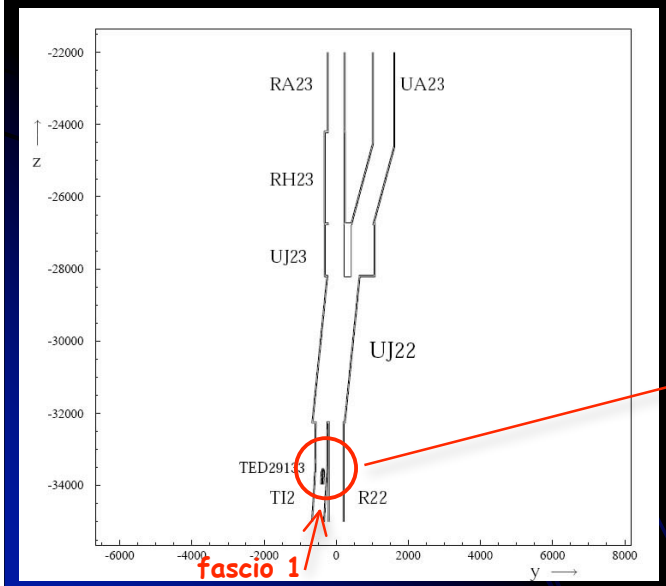


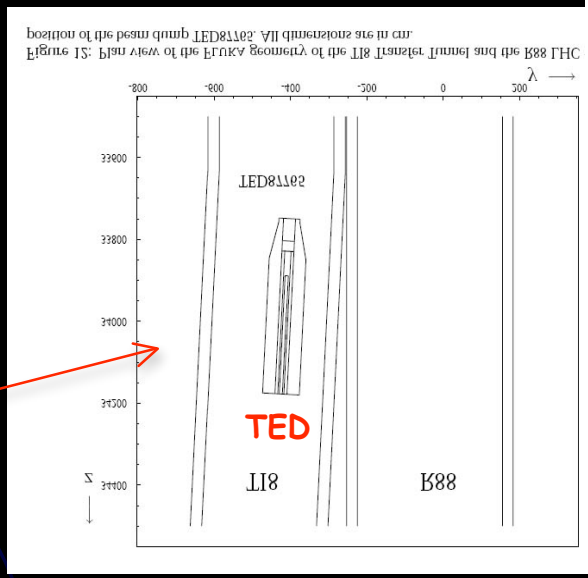
- primi segni di vita…
  - 14-15 giugno
  - estrazione in TI2 e dump sul TED
- test di iniezione
  1) 8-11 agosto
     - prima iniezione in LHC (fascio 1)
  2) 22-24 agosto
     - prima iniezione fascio 2
  3) 5-7 settembre
- fasci circolanti
  - 10-12 settembre

La linea TI2 e il TED



pilot bunch (5 10^9 p) sul TED
→ ~ 10 μ / cm² in ALICE





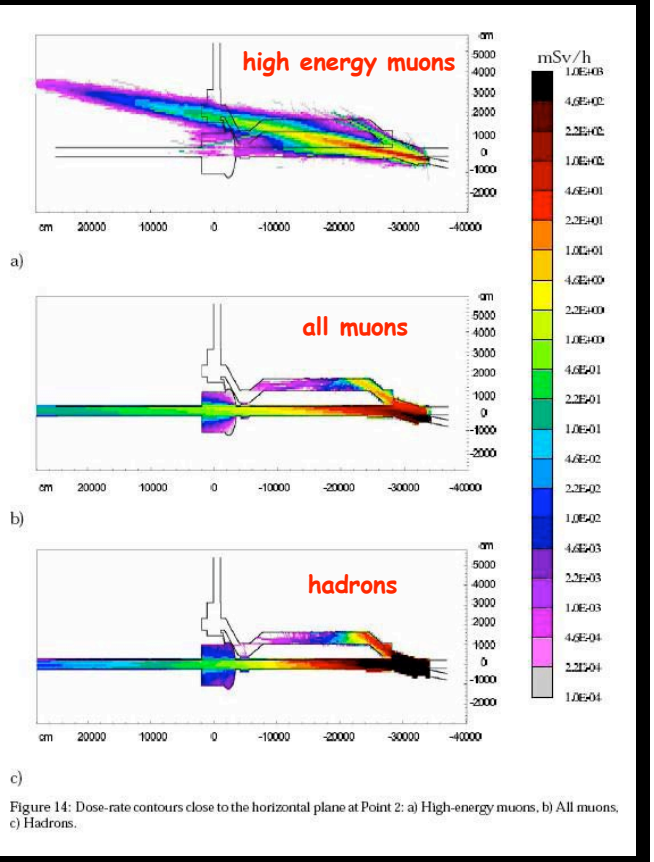
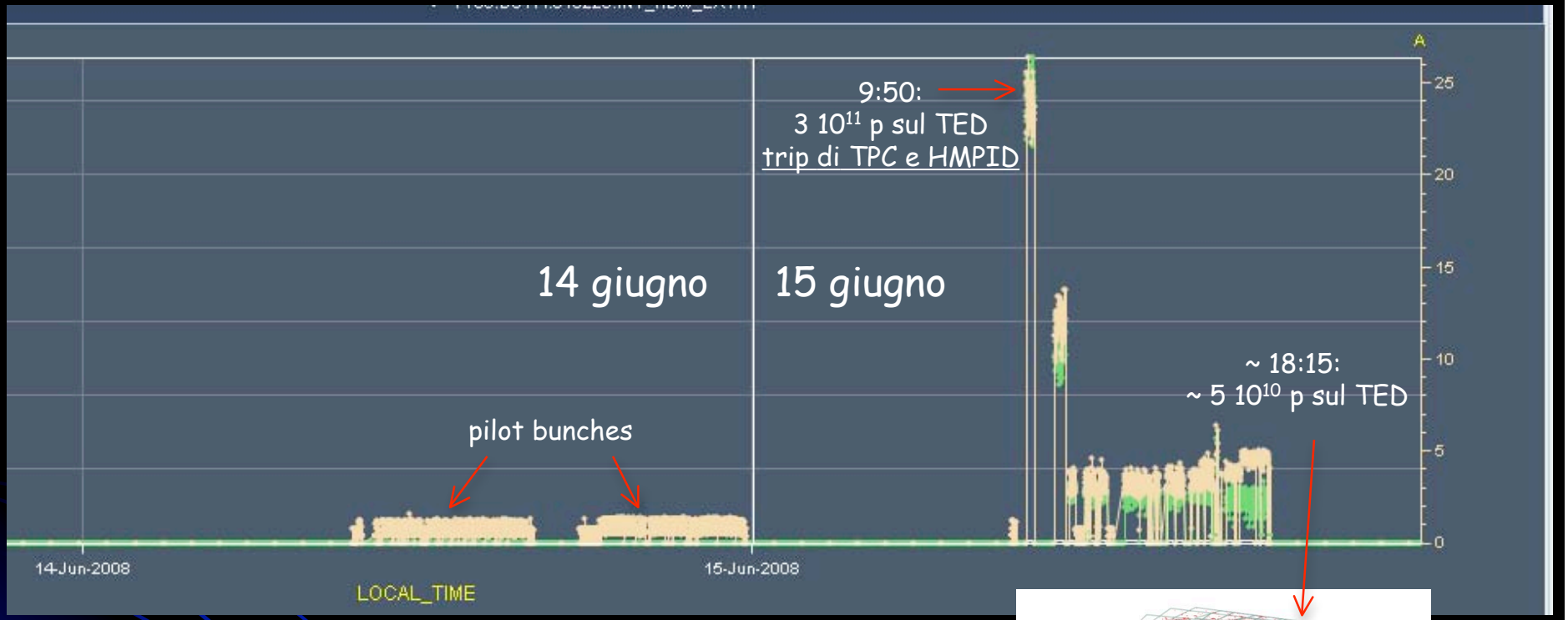
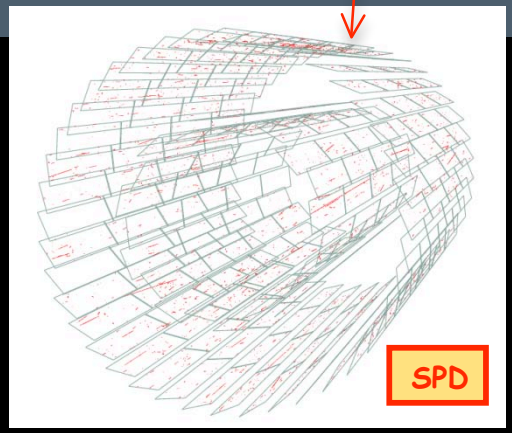


Figure 14: Dose-rate contours close to the horizontal plane at Point 2: a) High-energy muons, b) All muons, c) Hadrons.

Test di estrazione 14-15 giugno





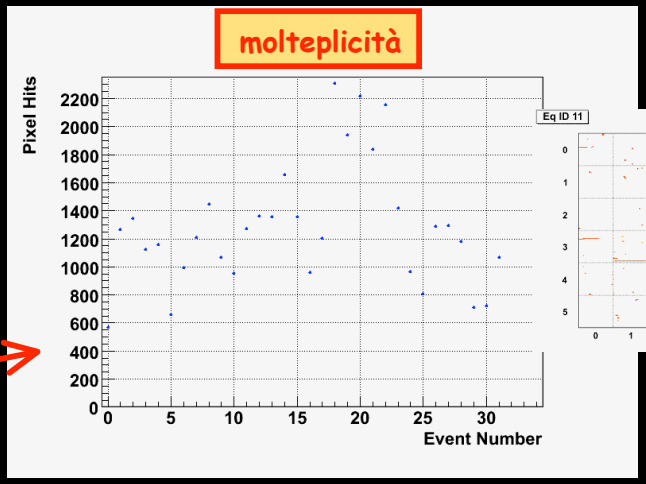
Prima iniezione in LHC!

- 8 agosto
- rivelatori spenti, salvo SPD e V0 accesi durante la prima fase (dump sul TED)
  - pilot bunches: ~ 5 10^9 protoni
- Trigger: ≥ 10 hit sul layer 2
- 32 eventi acquisiti
  - Run 51403 (16:53 to 18:05)

- molteplicità SPD: $O(10^3)$
  - → il 15 giugno, con ~ 5 10^{10} protoni sul TED, multeplicità SPD fino a ~ 2 10^4

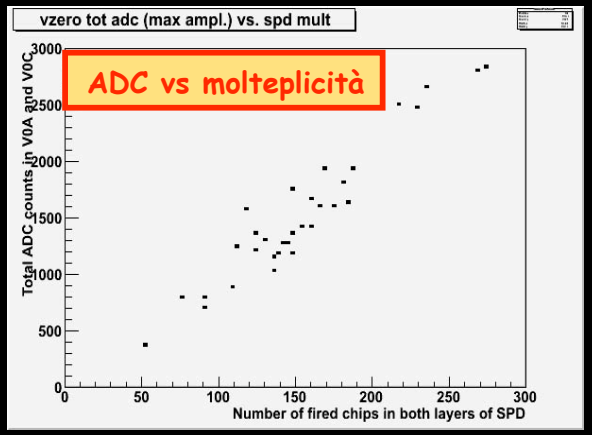
- 18:30: SPD spento, fascio sul TDI

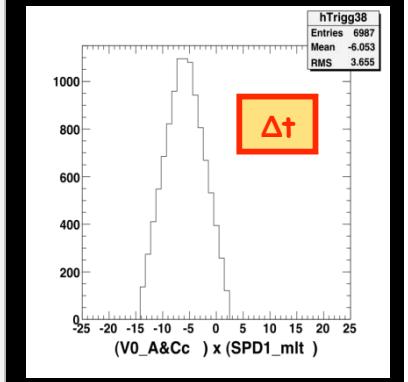
- SPD

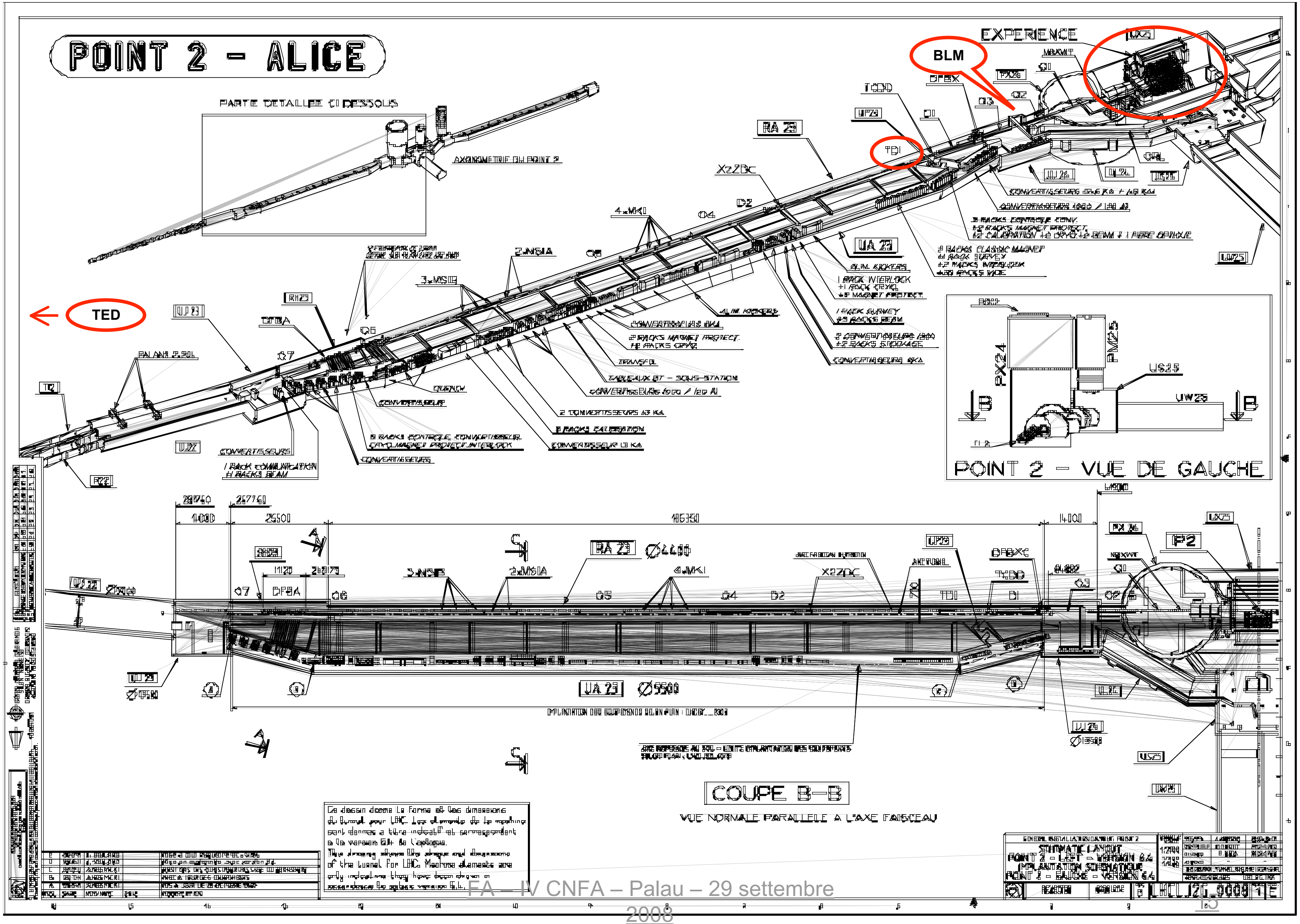


"display" (1 settore)

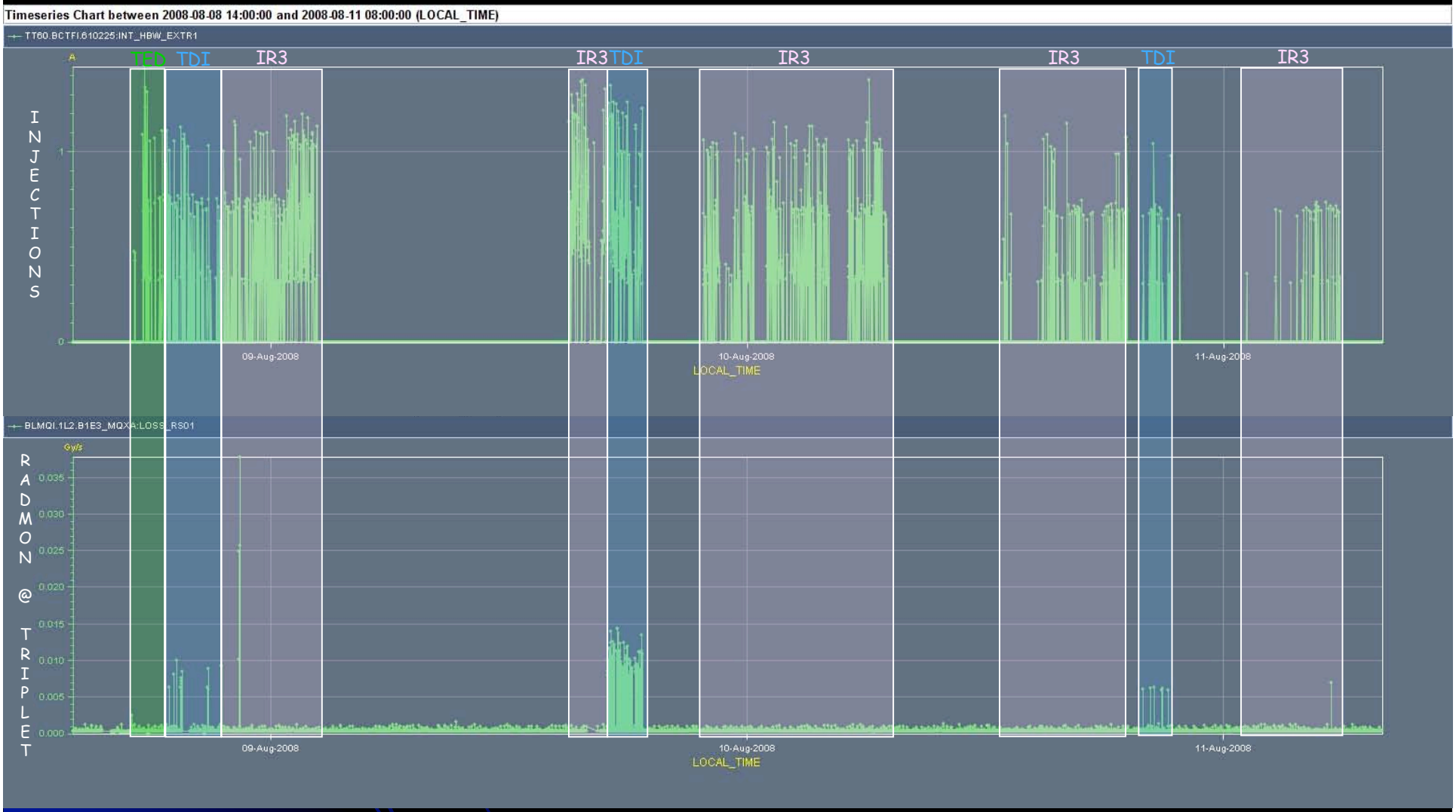
- V0 vs SPD






POINT 2 - ALICE
PARTIE DETAILLEE CI DESSOUS
AXONOMETRIE DU POINT 2
EXPERIENCE
BLM
TDI
TED
RA 23
UA 23
X2ZDC
D2
Q4
Q5
Q6
Q7
DFBA
DFBX
4.MKI
2.MSIA
3.MSIB
POINT 2 - VUE DE GAUCHE
PX24
PM25
US25
UW25
COUPE B-B
VUE NORMALE PARALLELE A L'AXE FAISCEAU
LHCLJ2G_0008

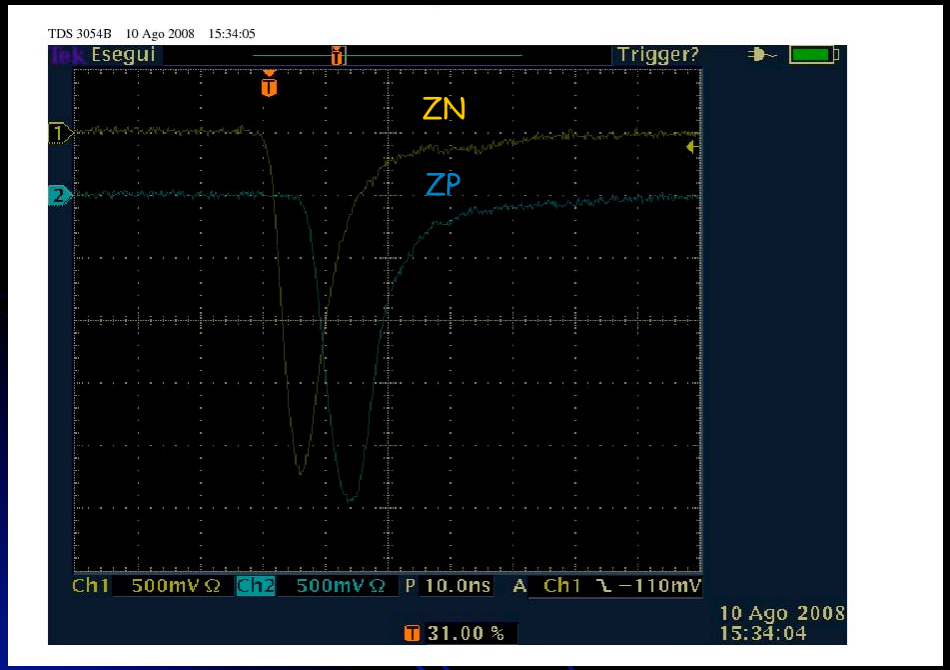
Iniezioni in TI2 8-11 agosto

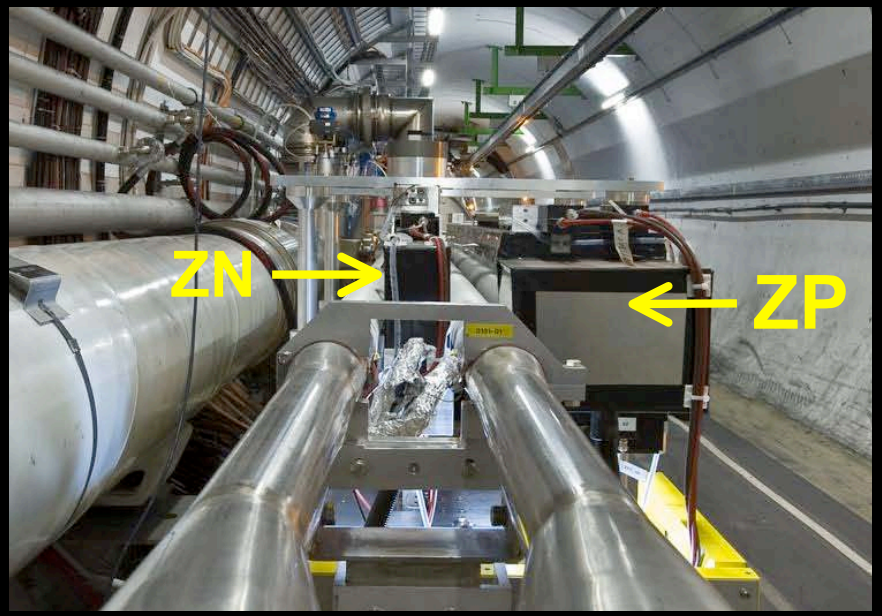


- dump sul TDI: attività nei monitor di radiazione; ~ $O(10^3)$ MIP / cm^2 al tripletto interno

Segnali nello ZDC

- 10 agosto, fascio passante, lo ZDC viene acceso
  - ~ 15 cm sotto la posizione nominale
  - segnali ad ogni iniezione!

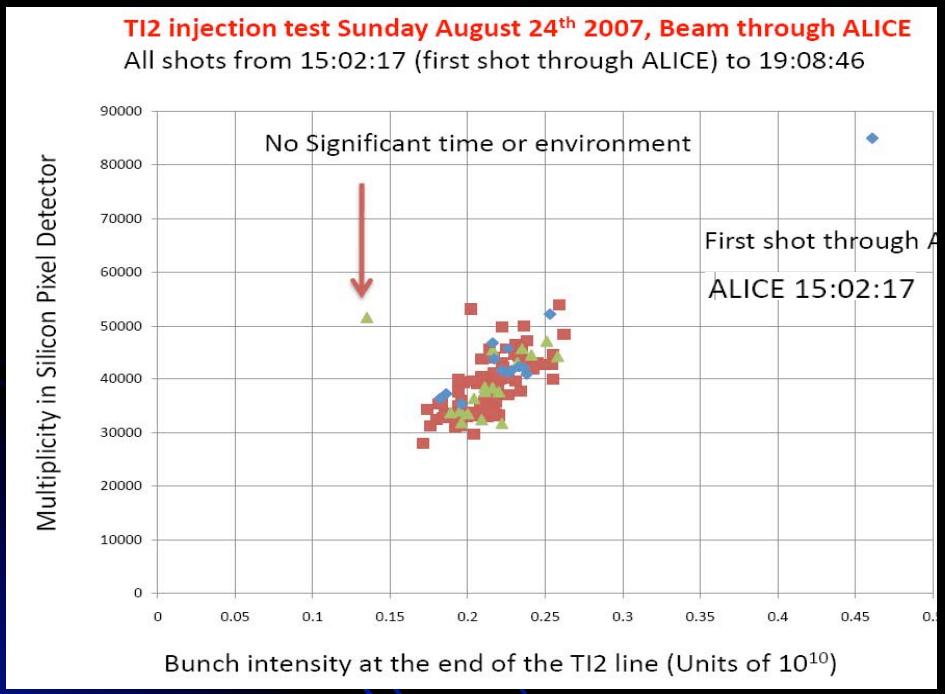


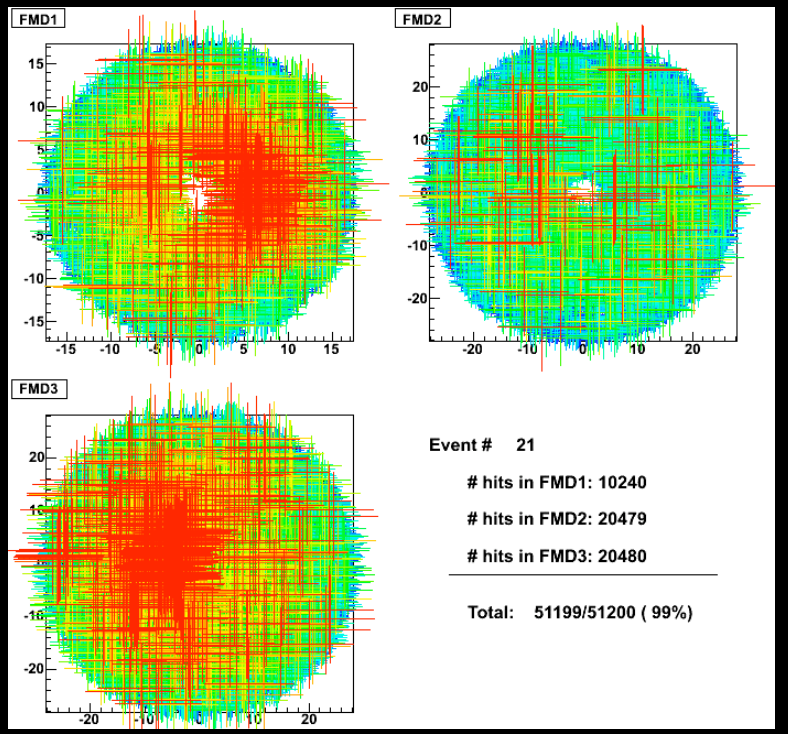


Fascio passante

- seconda serie di iniezioni in TI2 (24 agosto) ~ 2 10^9 protoni per bunch

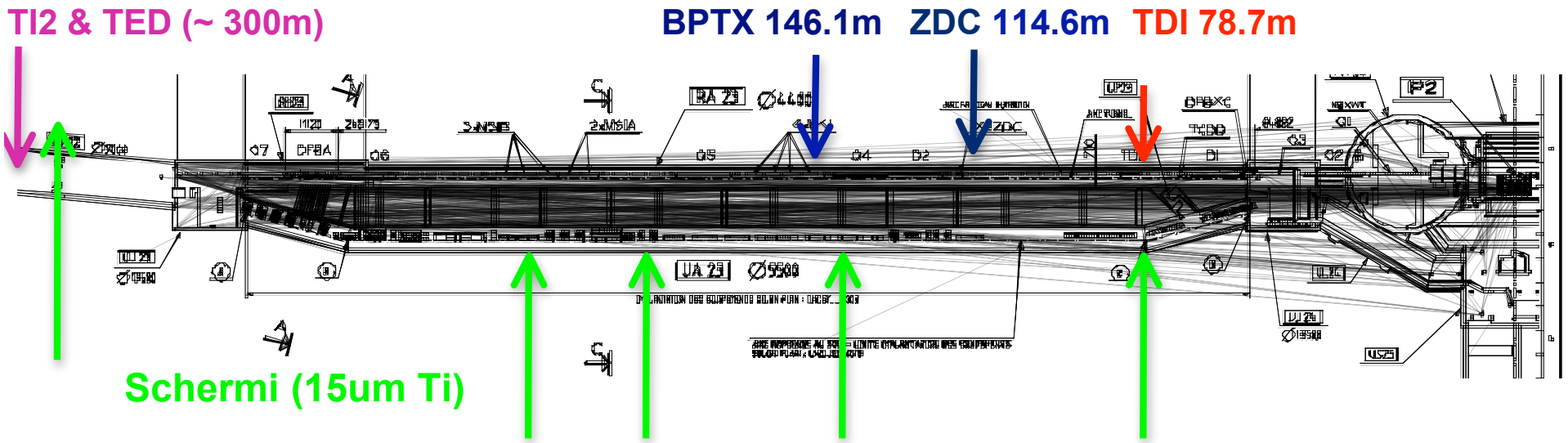
→ misura fondi con fascio attraverso ALICE





Sorgenti di fondo

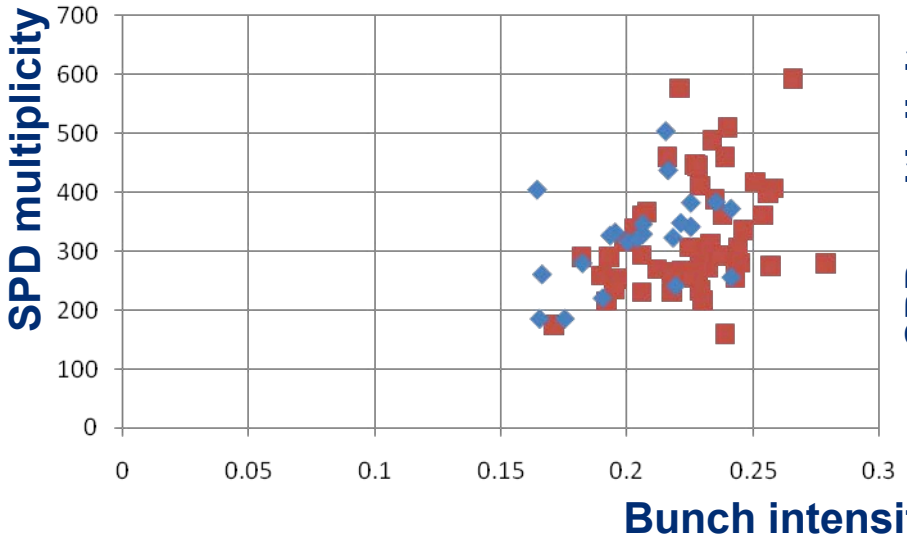
- TED: beam dump alla fine della linea di iniezione TI2
- TDI: collimatore usato come dump nella sezione dritta
- Schermi: usati per ottenere immagini del fascio
  - 4 nella sezione dritta (retratti in condizioni normali)
  - 9 in TI2 (sul fascio in condizioni normali)



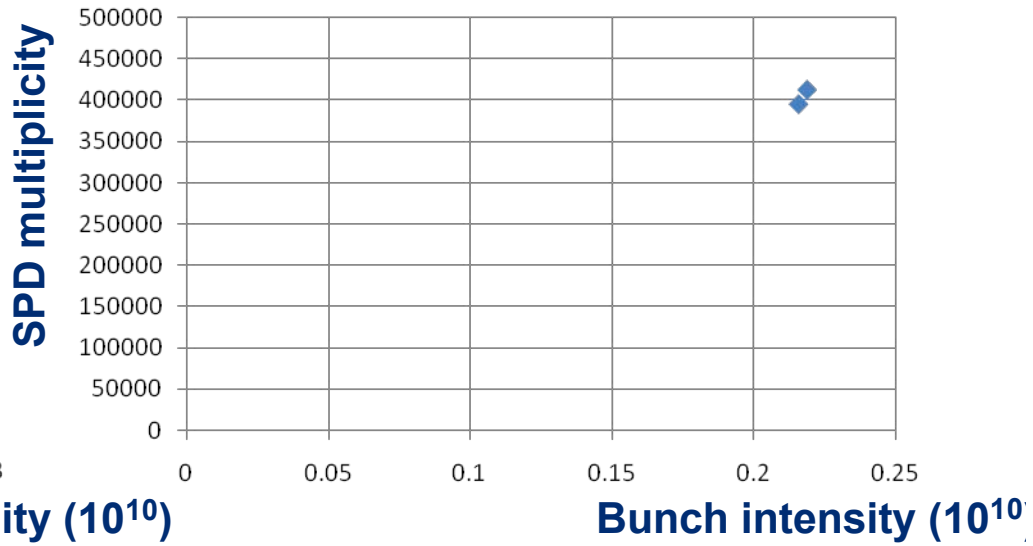
Misure di fondo

- programma di misure il 7 settembre
  - iniezioni dedicate in TI2 (bunch da ~ 2 10^9 protoni)

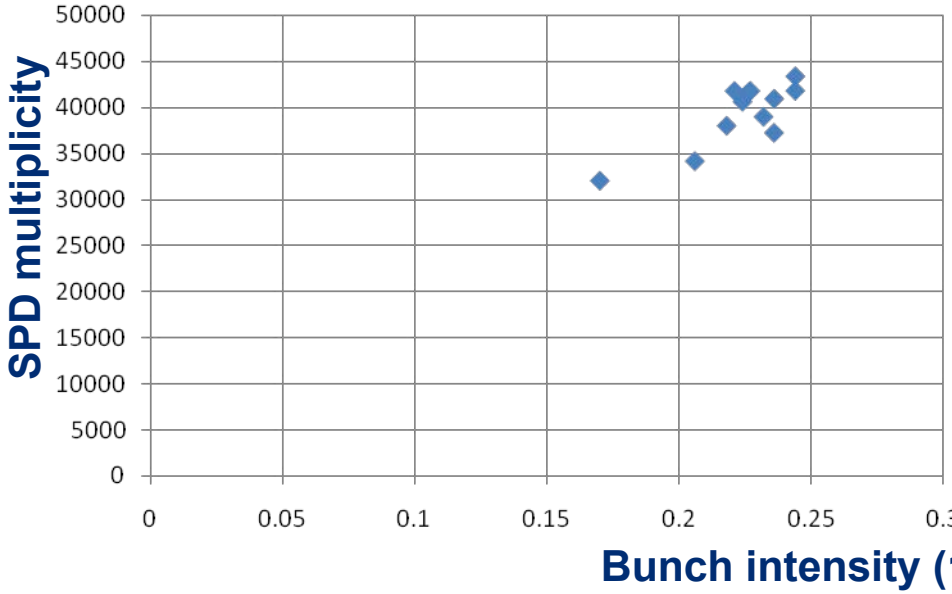
Beam on TED: 300



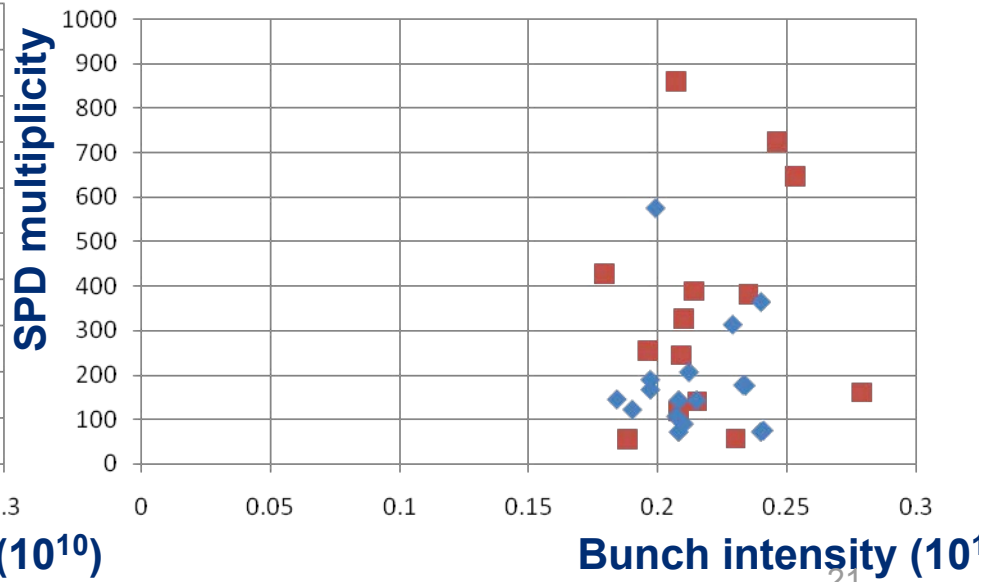
Beam on TDI: >400 000



Beam Through ALICE,
LHC screens IN & TI2 screens IN: 40 000



Beam through ALICE,
LHC screens out, TI2 screens IN: 300



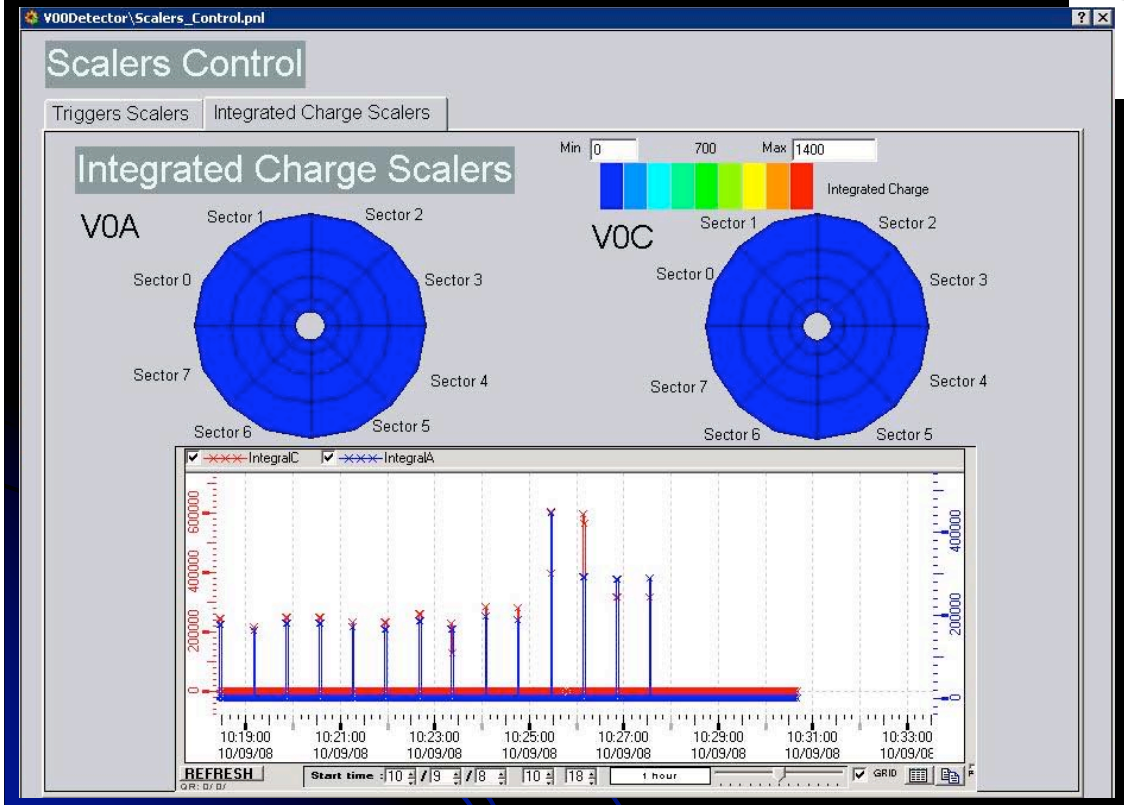
With all screens OUT: No measureable signal, only cosmics

Misure di fondo

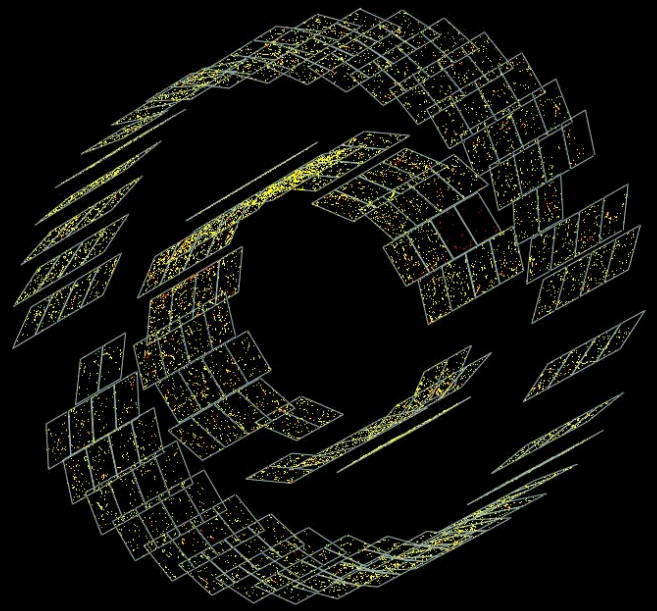
- programma di misure il 7 settembre
  - iniezioni dedicate in TI2 per ALICE (bunch da ~ 2 10^9 protoni)
- risultati (per bunch da 2 10^9 protoni)
  - bunch su TED (~ 350 m da ALICE) → 2-5 particelle per cm^2
  - bunch su TDI (~ 80 m da ALICE) → ~ 1000 particelle per cm^2 (in zona ITS)
  - bunch passante, schermi dentro → ~ 100 particelle per cm^2 (in zona ITS)
  - bunch passante, schermi LHC fuori, schermi TI2 dentro → 1-2 part. per cm^2
  - bunch passante, schermi fuori → niente (trigger SPD: solo cosmici)
  - bunch circolante , fascio 2 (vedi dopo) → trigger SPD: qualche Hz

Fasci circolanti

- 10 settembre, "media day"
  - fascio 1: 1° giro ~ 10:30



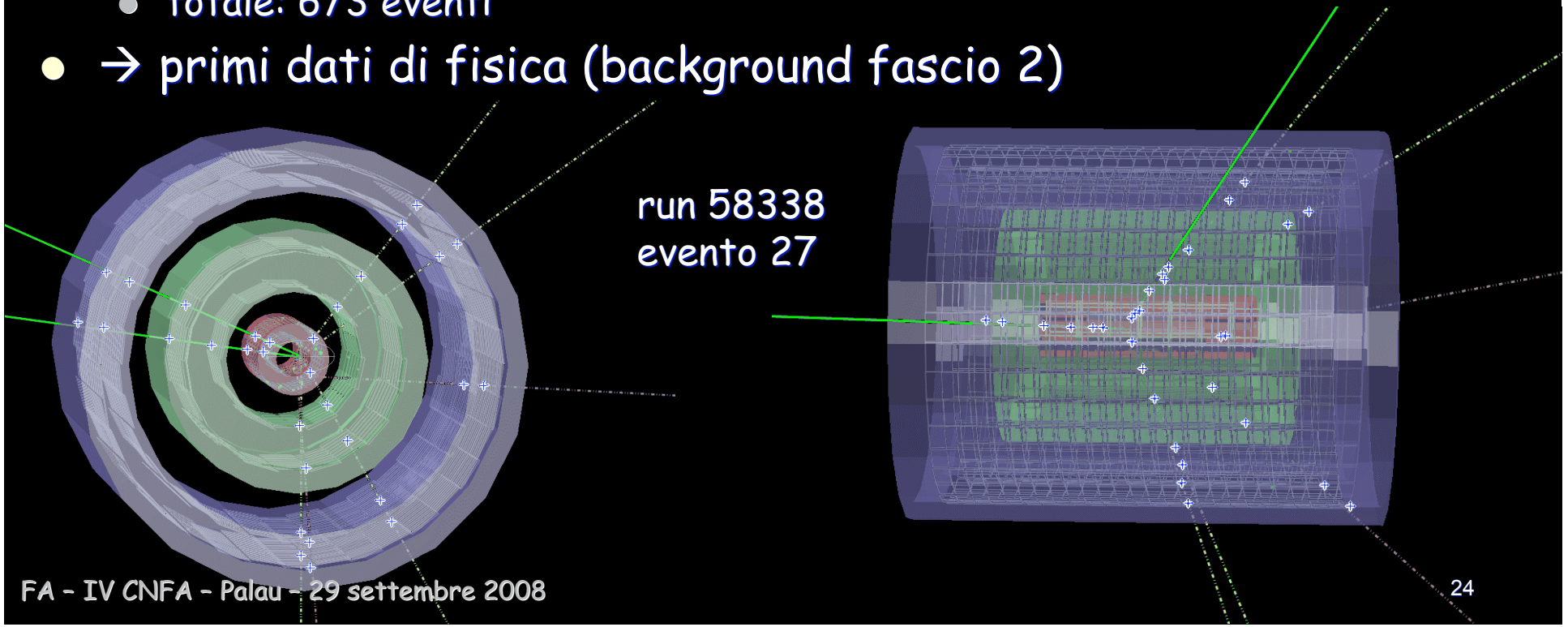
- ALICE è il primo esperimento a vedere segnali



- fascio 2: 1° giro ~ 15:00

Cattura RF: primi dati di fisica!

- 11 settembre, ~ 22:35 prima cattura
  - fascio 2 in orbita per più di 10 minuti!
  - run 58334: 22:37 – 22:56, 16 eventi
- durante la notte 11-12 sett.: serie di iniezioni con cattura RF
  - run 58334, 58338, 58343, 58376, 58378, 58394
  - totale: 673 eventi
- → primi dati di fisica (background fascio 2)



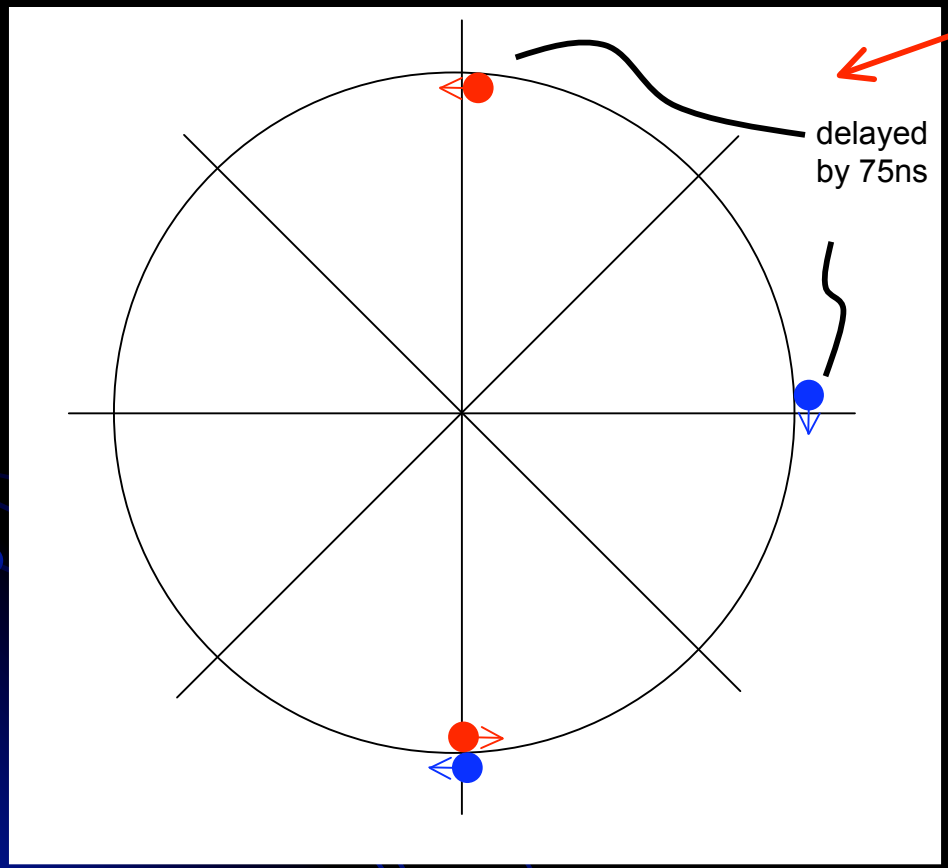
run 58338
evento 27

Problemi LHC

- 12 settembre: problema con trasformatore Punto 8
- 19 settembre: quench nelsettore 3-4…
- Niente più fasci prima dello shutdown invernale
- Ripresa programmata per "early spring"

Prime collisioni nel 2009: esempio

- e.g.: 2 × 2 con un bunch ritardato per fascio:



situazione a bc 0:

- bc 445.5 → fasci 1 e 2
- bc 1339.5 → fascio 1
- bc 3118.5 → fascio 2

→ 3 fasi diverse per il trigger SPD (clock di 4 bc):

- 445 mod 4 = 1
- 1339 mod 4 = 3
- 3118 mod 4 = 2

Condizioni sperimentali: esempi

- First collisions @ 900 GeV
  - # bunches colliding @ P2 = 1 (2)
  - β^* = 10 m
  - beam size = 280 μm (σ)
  - L ~ 9 10^{27} cm^{-2} s^{-1}
  - rate per bc ~ 3 %
  - MB rate ~ 350 Hz
- First collisions @ 10 TeV
  - # bunches colliding @ P2 = 1 (2)
  - β^* = 10 m
  - beam size = 84 μm (σ)
  - L ~ 2 10^{28} cm^{-2} s^{-1}
  - rate per bc ~ 14 %
  - MB rate ~ 1.4 kHz
- 43 bunches
  - # bunches colliding @ P2 = 4
  - β^* = 10 m
  - beam size = 84 μm (σ)
  - L ~ 8 10^{28} cm^{-2} s^{-1}
  - rate per bc ~ 14 %
  - MB rate ~ 5.7 kHz
- 156 bunches ?
  - # bunches colliding @ P2 = 16
  - β^* = 10 m
  - beam size = 84 μm (σ)
  - L ~ 3.3 10^{29} cm^{-2} s^{-1}
  - rate per bc ~ 14 %
  - MB rate ~ 23 kHz

Alta luminosità per ATLAS e CMS

- Current, "brute force" scheme

→ ~ as many bunches collide @ P2 as @ P1, P5

- 75 ns operation
  - # bunches colliding @ P2 ~ 936
  - β^* = 10 m
    - beam size = 71 μm (σ)
    - L ~ 2.6 10^{31} cm^{-2} s^{-1}
    - rate per bc ~ 17 %
    - MB rate ~ 1.8 MHz (sic!)
      - ~ 180 events in TPC
  - β^* = 30 m (current estimate of max value @ P2)
    - beam size = 123 μm (σ)
    - L ~ 8.5 10^{30} cm^{-2} s^{-1}
    - rate per bc ~ 6 %
    - MB rate ~ 600 kHz
      - ~ 60 events in TPC
- 25 ns operation
  - you don't want to know...

- The "magic" 50 ns scheme

→ allows freedom in configuring the collision pattern

- e.g.: # bunches colliding @ P2 = 2
  - β^* = 10 m
    - beam size = 71 μm (σ)
    - L ~ 5 10^{28} cm^{-2} s^{-1}
    - rate per bc ~ 17 %
    - MB rate ~ 3.8 kHz (0.4 evts in TPC)
  - β^* = 2 m
    - beam size = 32 μm (σ) → Heavy Flavour!
    - L ~ 2.7 10^{29} cm^{-2} s^{-1}
    - rate per bc ~ 85 %
    - MB rate ~ 19 kHz (2 evts in TPC)
- e.g.: # bunches colliding @ P2 = 72
  - β^* = 10 m
    - beam size = 71 μm (σ)
    - L ~ 2.0 10^{30} cm^{-2} s^{-1}
    - rate per bc ~ 17 %
    - MB rate ~ 140 kHz (14 evts in TPC)

→ very interesting! (also for other reasons)

→ currently under study (injectors)

Trigger per fase a 1 bunch crossing (i)

"one bc mix", as an example:

- MB [f(V0A, V0C, SPD)]
  - read central detector
- muon
  - read muon arm, SPD
  - live time for trigger determined by DT(SPD)/DT(central)
- rare (e.g. 20% live time)
  - test high mult'y trigger
  - → read central detector
  - + central detector with muon trigger?
- bc downscaled
- test triggers (+ detector triggers) (say, 1% live time)
- cosmics?
- MB, muon with beam from A, beam from C (for beam-gas subtraction)

Rough rate estimates:

e.g.: high mult: > 4 × mean
(PYTHIA mult'y distribution)

~ 600 Hz MB

~ 5 Hz muon (single, low p_T)

~ 25 Hz high mult'y

- ~ 12 Hz "good"
  - i.e.: no pile-up, ε > 50%
- enrichment wrt MB ~ 1

Trigger per fase a 1 bunch crossing (ii)

"low β" run?

→ with one bc, we could in principle stand β–squeezed luminosity!
- if detector OK
- if machine OK…
- if, if, if…

→ e.g.: 2 m squeeze
- transverse size: ~ 70 μm → ~ 30 μm
- L ~ 2 10^{29} cm^{-2} s^{-1}, MB ~ 15 kHz, ~ 1.4 int/bc (no high mult'y…)

→ full live time to non-rare
- MB (or bunch crossing…)
- muon
  - read muon arm, SPD
  - live time for trigger determined by DT(SPD)/DT(central)
- MB, muon on beam from A, beam from C

Rough rate estimates:

~ 950 Hz MB

→ ~ 3 10^7 evt/day

→ pilot hf sample in best vertexing conditions; low p_T

~ 25 Hz muon (single, low p_T)

Trigger per fase a bc multipli (i)

e.g.: 30 bc, $\beta^* = 10$ m, L = 1.3 10^{30}
MB ~ 90 kHz, 0.2 int/bc

example "multiple bc mix":

- MB
- muon
- rare (e.g. 50% live time)
  - high multiplicity
  - → past-future protection may be needed
  - + others
    - e.g.: dimuon w central det, PHOS…
- bc downscaled
- test triggers (+ detector triggers) (say, 1% live time)
- MB, muon with beam from A, beam from C (for beam-gas subtraction)

Rough rate estimates:

e.g.: high mult: > 7 × mean
(PYTHIA mult'y distribution)

~ 500 Hz MB

~ 70 Hz muon (single, low p_T)

~ 20 Hz highest mult'y
(+ "bridge" thresholds)

- ~ 0.4 Hz "good"

i.e.: no pile-up, ε > 50%

→ ~ 15 k /day; 300 k in 20 days

- enrichment wrt MB ~ 15

→ × ½ if past-future protection

Trigger per fase a bc multipli (ii)

Here, too, we may want to consider a special machine configuration:

High β setting?

→ special configuration for high mult'y trigger

- lower pileup
  - → cleaner, higher mult'y trigger?
- but lower luminosity…
  - → compensate with more bunches?
- feasible? to be studied…

Conclusioni

- Run 2008:
  - messa in opera dei rivelatori
  - commissioning DAQ, DCS, trigger,
  - organizzazione operazioni
  - calibrazioni, allineamenti
  - studio delle condizioni di fondo in LHC
  - commissioning dell'organizzazione delle operazioni

→ esperimento pronto per le prime collisioni

- Shutdown 2008-2009 "lungo" → intervento sul miniframe

- Preparativi per la presa dati 2009 in corso
  - configurazioni collisioni a Punto 2
  - strategie di trigger