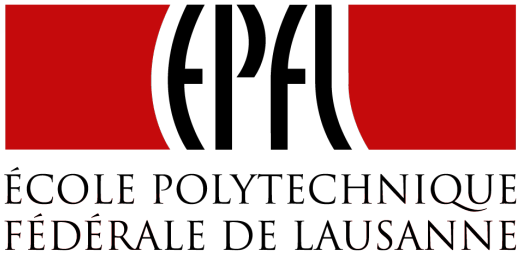
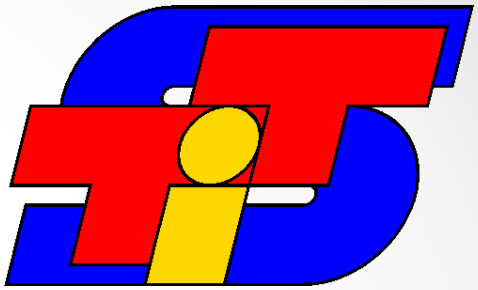




LHCb experiment: ST calibration and performance

CHIPP Winter School (Grindelwald)

22/01/2015

Vincenzo Battista (EPFL)

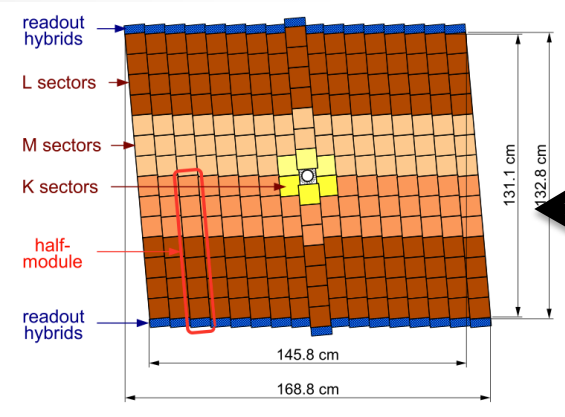
Outline

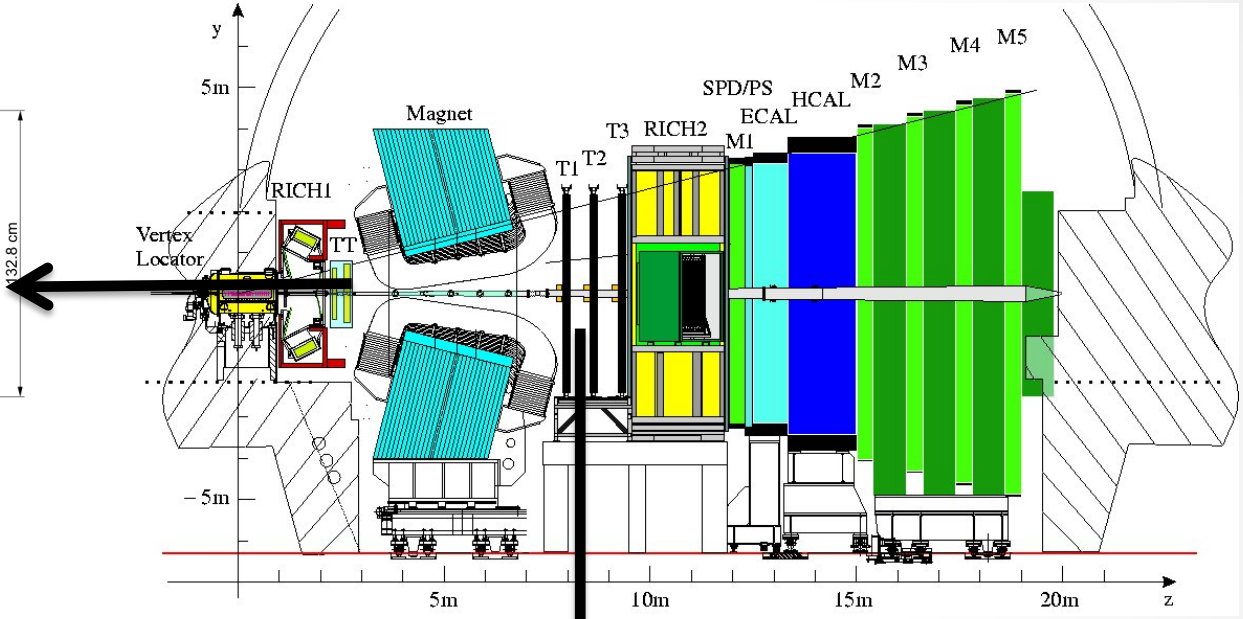
- Introduction
- ST calibration
- ST performance

Introduction

LHCb and ST

Tracker Turicensis (TT)

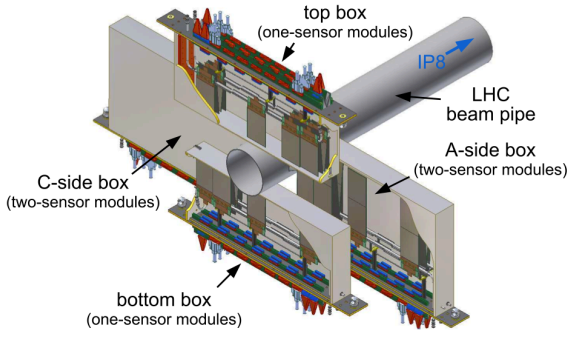




- 4 layers (X,U,V,Y)
- Module: row of 7 silicon sensors (4-3 or 4-2-1)

Single hit resolution: 50μm

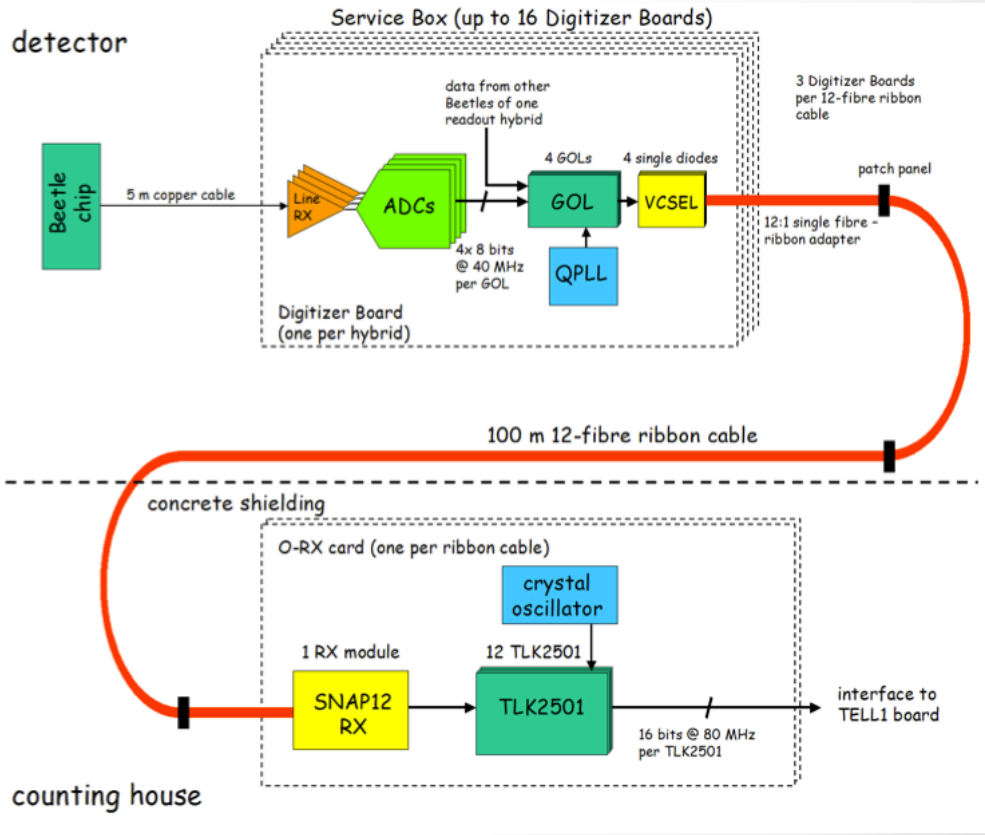
Inner Tracker (IT)



- 3 stations, 4 boxes and 4 layers per station.
- Rows of 7 single-double silicon sensors

ST Readout chain

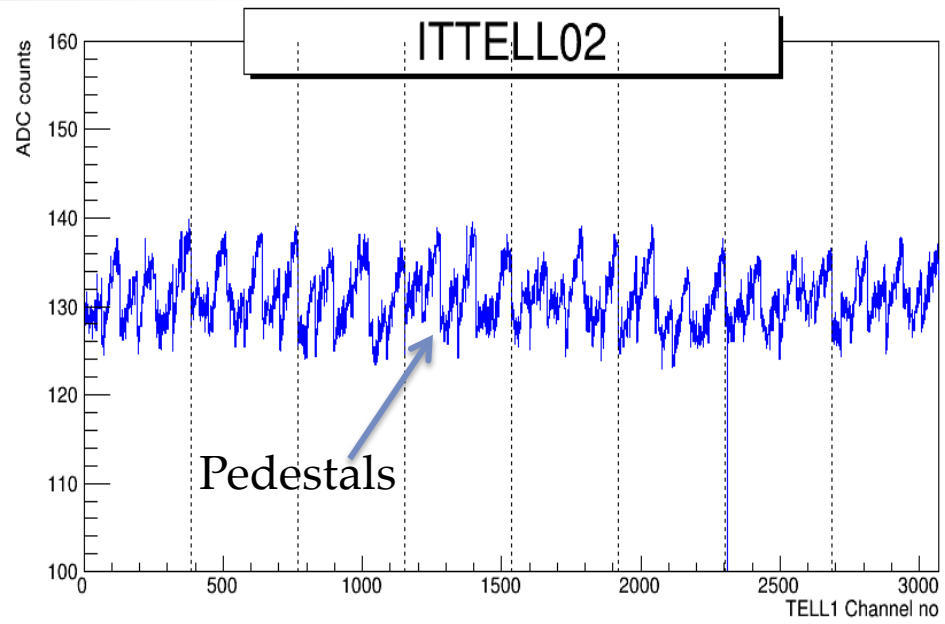
- Beetle chip:
  - Input: 128 channels @ 40 Mhz
  - Output: 4 analogue ports @ 1 Mhz
- Digitizer board:
  - Analogic to Digital Conversion (ADC) of signal amplitude
- TELL1 board:
  - Event synchronization
  - Buffering
  - Data preprocessing (zero suppression, clustering)

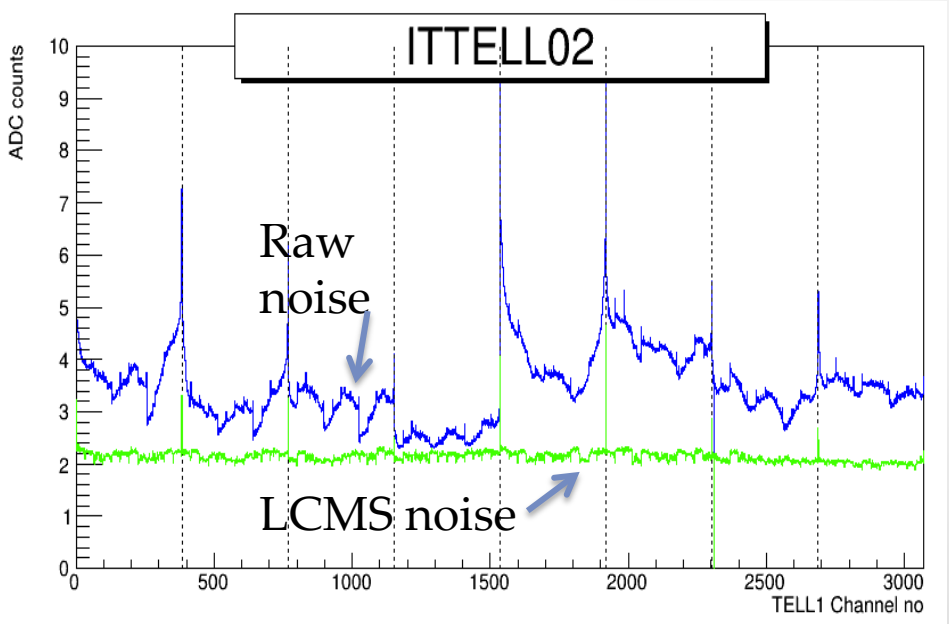


ST Calibration

ST calibration

- TELL1 board processing:
  1. "Header" bit dependent pedestal shift correction
  2. Pedestal subtraction
  3. Linear Common Mode Subtraction (LCMS)
  4. Clusterization



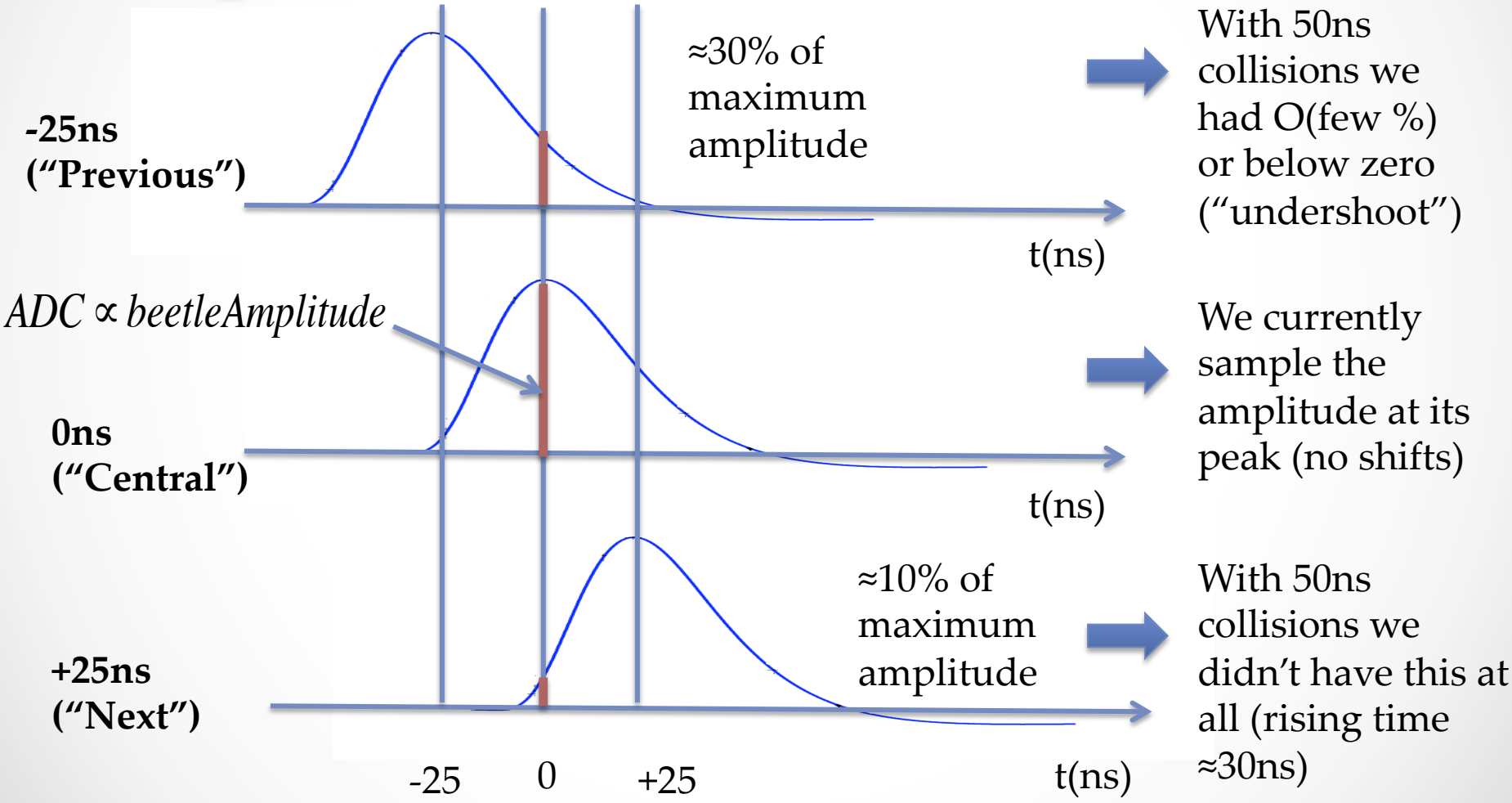


ST calibration

- Clusterization:
  1. Seeding: hits with ADC>2.5 LCMS noise are accepted
  2. Clustering: neighboring strips (up to 4) with total ADC>5 LCMS noise are accepted
  3. Spillover or high threshold flag: clusters with total ADC>10 LCMS noise are flagged as "good"
- Calibration: use dedicated LHCb global runs (no beam) @ 1Mhz (trigger) to check calibration parameters and update them (if necessary):
  - Masks of good/bad channels/beetles/ports/optical links
  - Pedestal (1 per channel)
  - Noise (1 per channel)
  - Header shifts (48 per Beetle port)
- The database is used for:
  - Build TELL1 recipes
  - Perform Montecarlo simulations.

ST performance

Spillover in ST @ $25ns^{-1}$



Montecarlo simulation

- Beetle response is seen at the following time (assuming the Beetle peak @ 0ns):

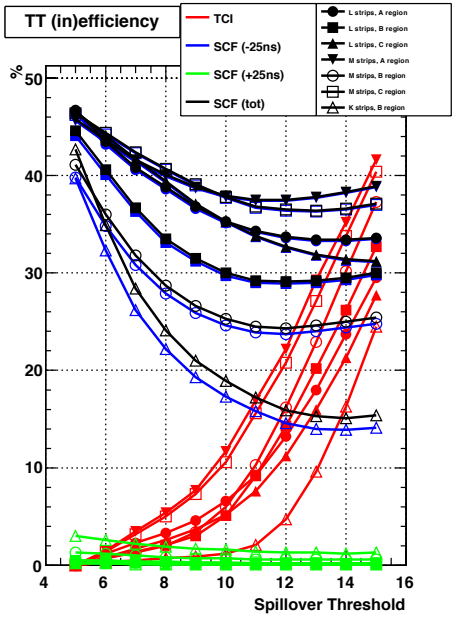
$$time = TOF - hitTime - spillTime + samplingTime \cong samplingTime$$

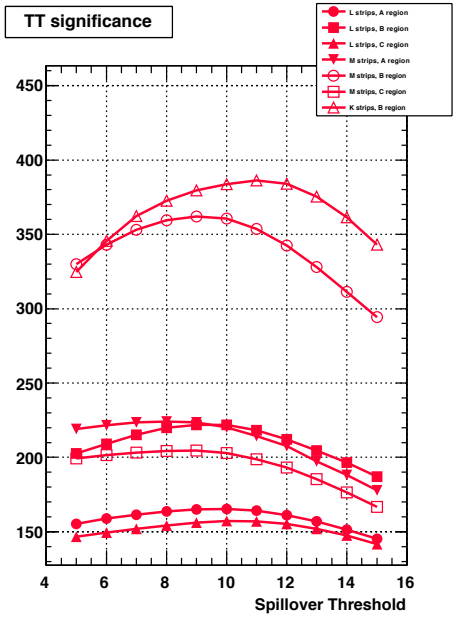
≈ 0 ns — Default =0 ns (central spill) — Default = 0 ns (amplitude peak)

- Montecarlo; three digitizations at three sampling times:
  - -25ns ➔ Beetle raising tail ("Next" clusters)
  - 0ns ➔ Beetle peak ("Central" clusters)
  - +25ns➔ Beetle upper tail ("Previous" clusters)
- Generation and simulation:
  - "Minimum bias" events (pp->??)
  - Full simulation of particle/matter interaction and detector response
  - 2015 data taking conditions: 6.5 GeV beams, magnet up/down, bunch crossing rate @ 25 ns^{-1}
  - Spillover threshold scanning in [5,15] range (Run I default=10)

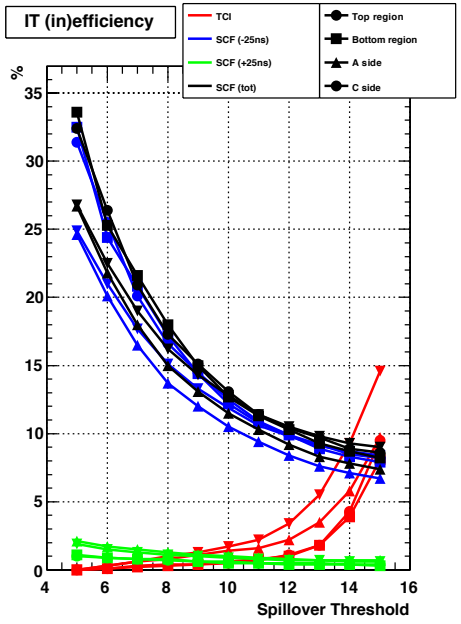
Signal significance and efficiency

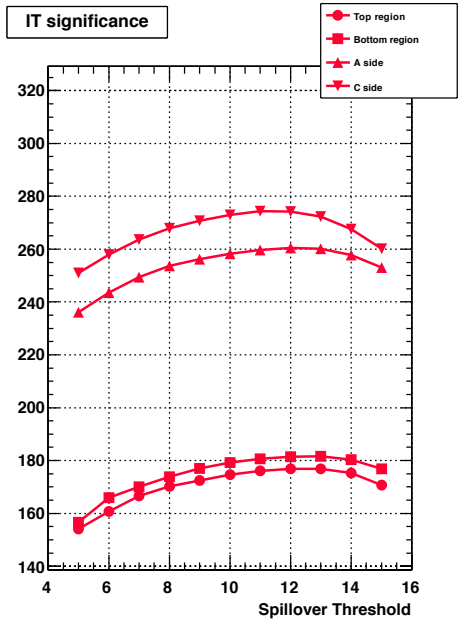
TT



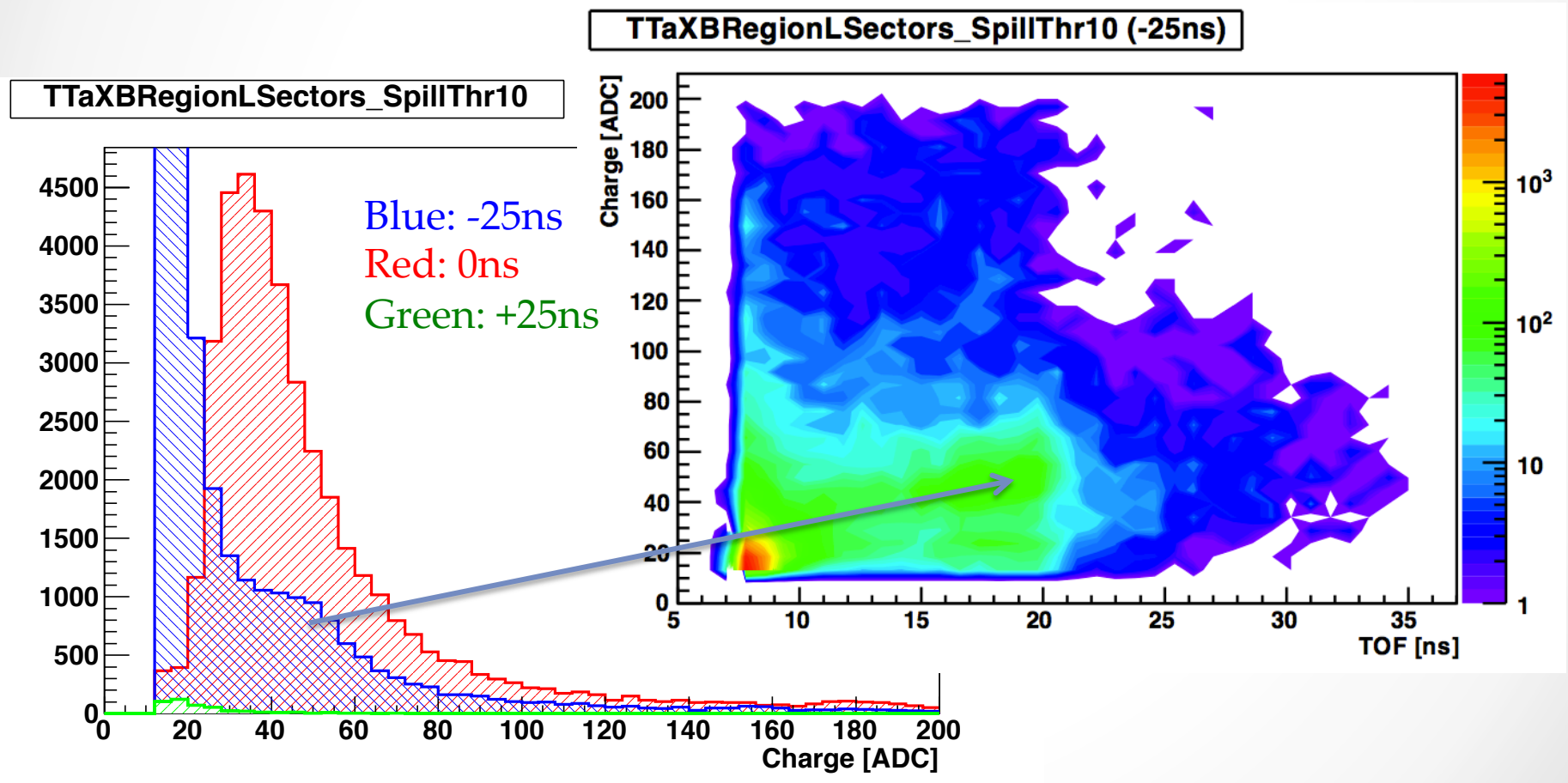


IT





Charge distribution

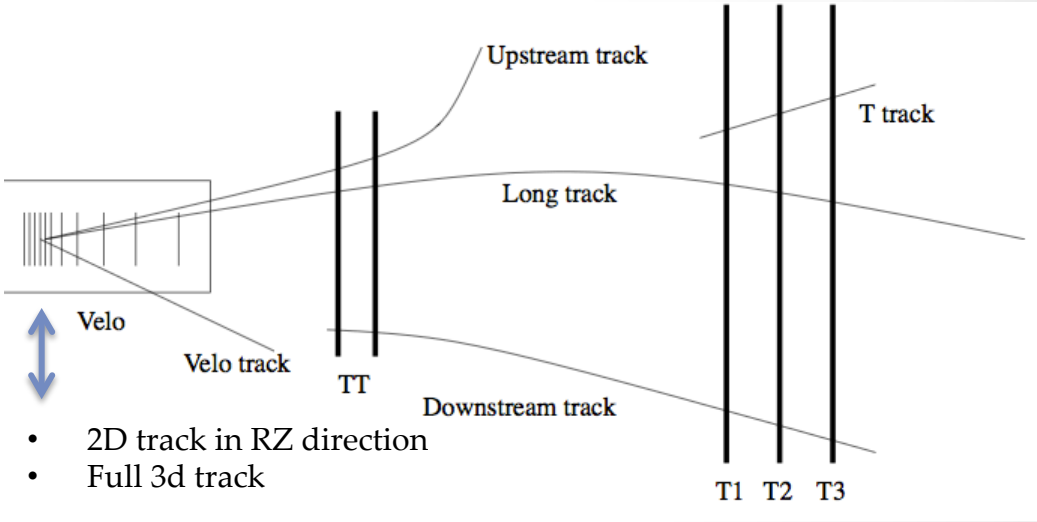


Tracking

- 6 different track types.
- Many concurrent tracking methods and algorithms exist in order to build tracks.
- To analyze spillover is ST, the following algorithms are important:
  - T Seeding: build T tracks out of T hits. Requires:

    $ITHighThresholdHits > 3$
  - Downstream Tracking: build downstream by matching T tracks with TT hits. Requires:

    $TTHighThresholdHits > 2$



- 2D track in RZ direction
- Full 3d track

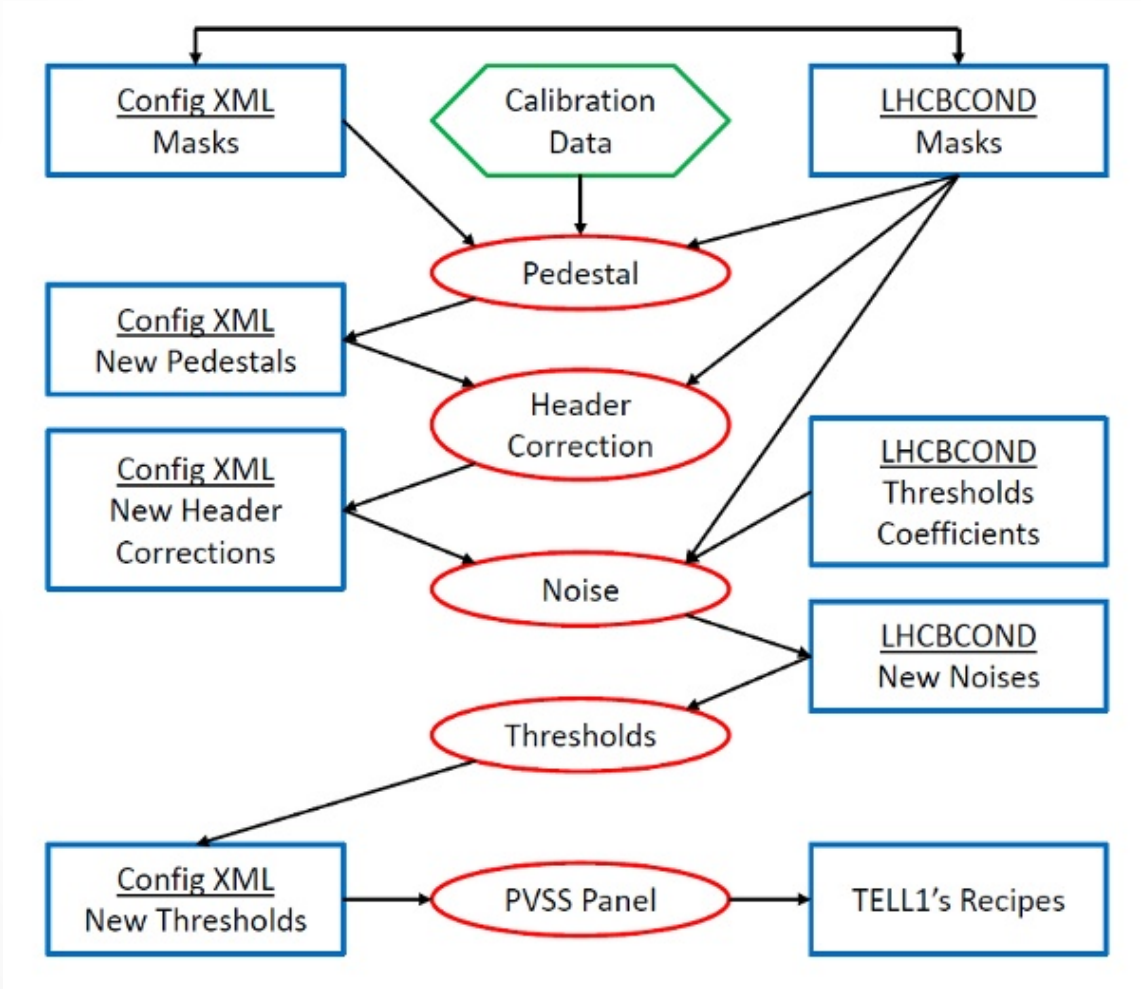
Required numbers of high threshold hits have to be checked and (eventually) tuned to optimize:

- Hit efficiency
- Ghost rate

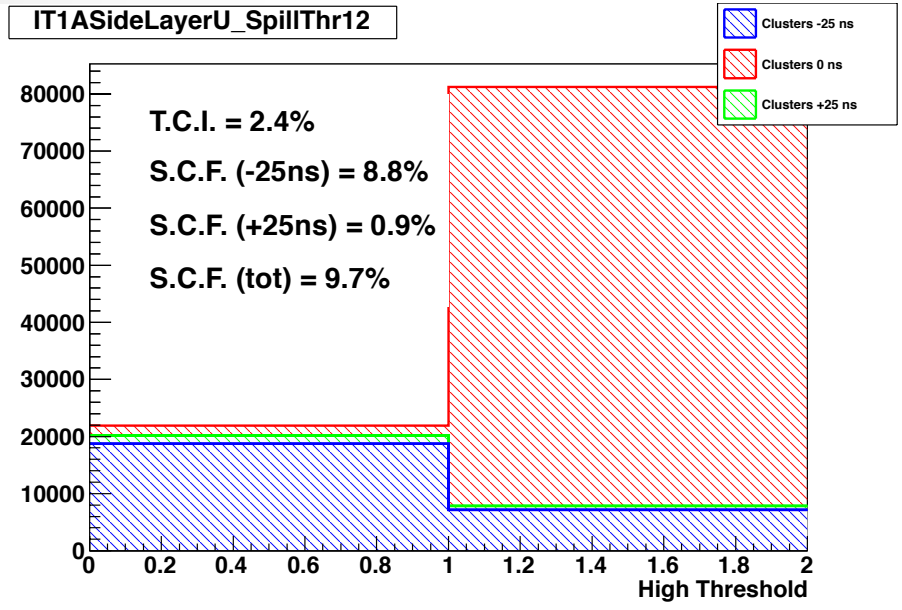
Thank you

Backup

TELL1 Calibration scheme



F.O.M. for ST spillover analysis



$$TrueClusterInefficiency(TCI) = \frac{True(0)}{True(0) + True(1)}$$

$$SpilloverClusterFraction(SCF)_t = \frac{Fake(1)_t}{True(1) + Fake(1)}$$

$$Significance = \frac{True(1)}{\sqrt{True(1) + Fake(1)}}$$