

First implementation of Boole for TimePix Velo

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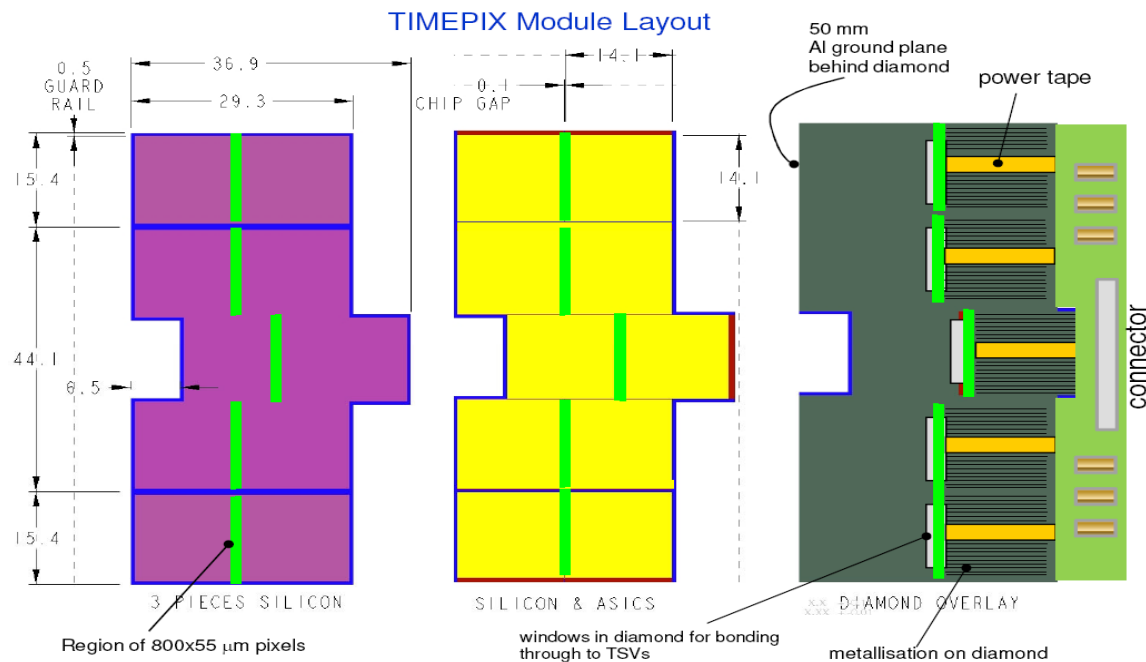
Pixel Velo – MiniPlane TIMEPIX



Geometry simulated in Gauss (*Victor*)

- MiniPlane TIMEPIX (see *Paula's talk at Upgrade Meeting, 15 July*)
- Number of stations and its positions – **THE SAME AS IN THE PRESENT VELO**
- Square pixel cells: **55x55 μm** , thickness: **150 μm**
(also 300 μm to compare with test beam & present Velo)
- RF foil shape taken from existing Velo, **but a factor 2 thinner**

Proposed TIMEPIX module layout



TIMEPIX digitization (Boole)



- VeloPix/VeloPixAlgorithms – *almost ready, not in CVS yet*
 - **make MC charge deposits** (*based on existing Velo solutions, see details on the next slide*)
 - make ToT counts (*linear approximation for now*)
 - **create VeloPix clusters** (*for time being 3x3, maximum charge in central pixel*)
 - create associators: *digit & cluster to MCHit & MCParticle*
- Presented results
 - **MC09 bb inclusive**
 - generated within MiniPlane TIMEPIX geometry (*see previous slide*)
 - **silicon thickness: 150 μm & 300 μm**

MC charge deposits

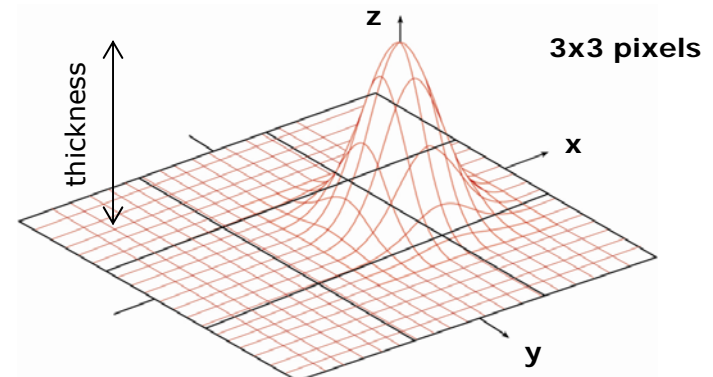
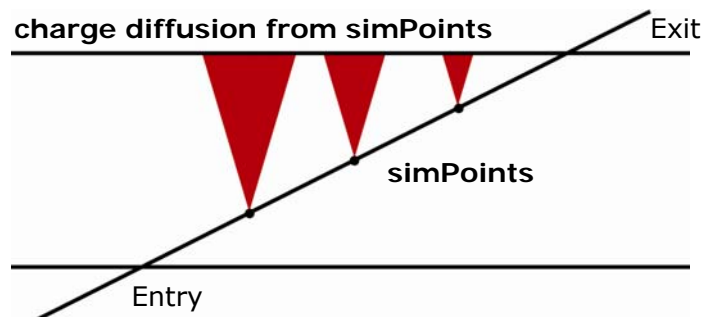


Making MC charge deposits (*adopted from existing Velo code – Chris Parkes*)

→ VeloPixMCDeposit: *channelID, depositedCharge, reference to MCHit*

→ VeloPixMCDepositCreator algorithm

- generate charge for each MC hit
- calculate how many steps (simPoints) are taken for spreading the charge along the path in silicon
 - **based on MCHit path and silicon thickness**
- allocate charge deposit to each simPoint
 - **split charge equally among the set of simPoints**
 - **add delta rays and Gaussian fluctuations**
- diffuse charge from simPoints to pixels
 - **Gaussian distribution in xy depending on distance to the electrode in z**
 - **distribute charge into the closest neighbour pixels by Gaussian integration**



Digitization & clusterization



- Digitization

- VeloPixMCDigit: *SmartRefVector of MC charge deposits, channelID*

- VeloPixDigit: *4 bit ADC value, 28 bit channelID*

- Clusterization *(for now 3x3 clusters around maximum deposited charge)*

- VeloPixLiteCluster: one 64-bit machine word: summary of cluster information used in trigger and pattern recognition

- VeloPixLiteCluster: *channelID of center of gravity, sum of pulse heights, isLong pixel flag, xFraction position, yFraction position*

- VeloPixCluster: *LiteCluster, vector of channelIDs & corresponding ADC values*

- sort digits by depositedCharge *(descending)*

- take the neighbour pixels

- establish channelID of center of gravity

Lite cluster **(38 bits)**

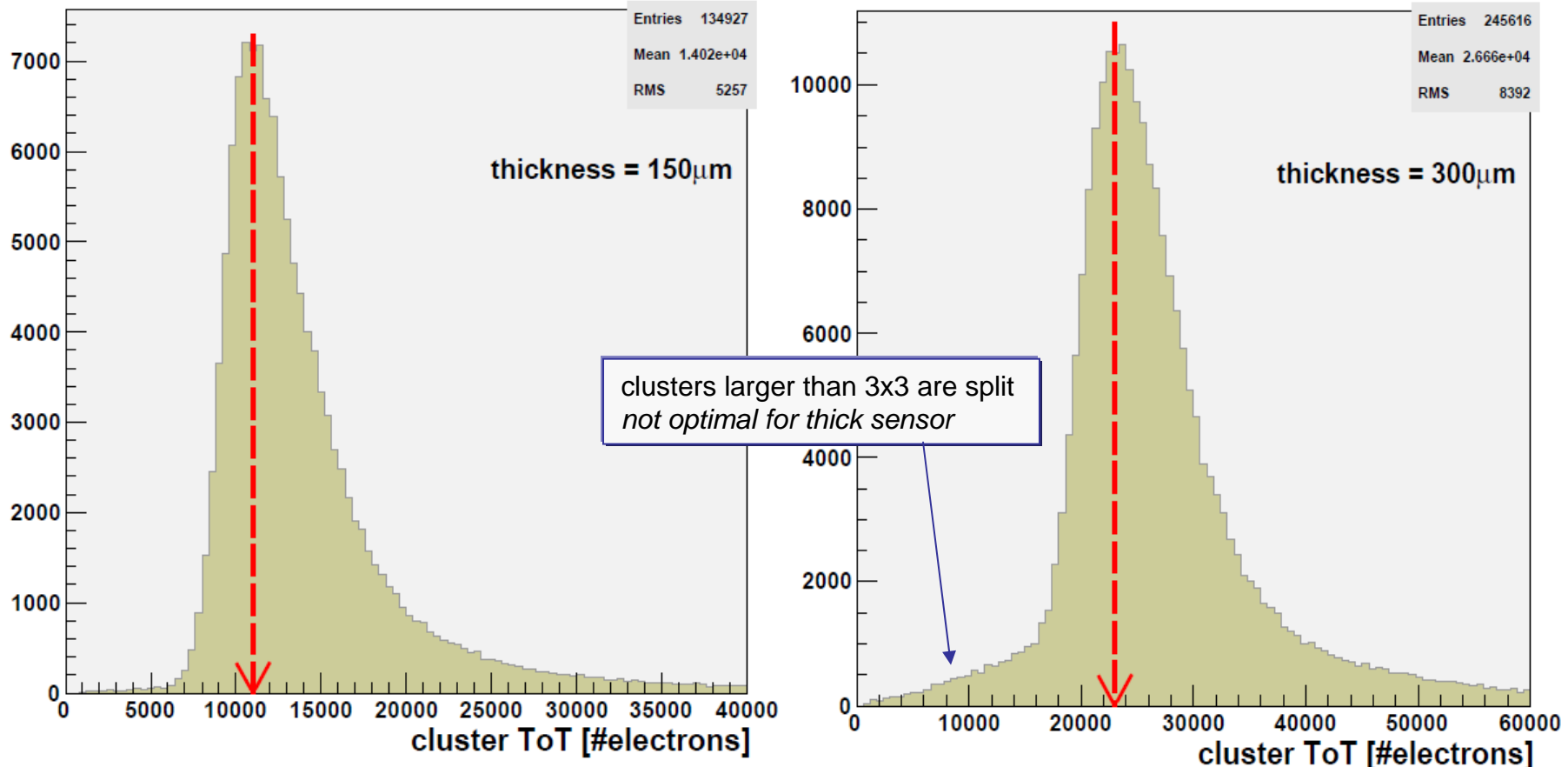
yFraction 3bits	xFraction 3bits	isLong 1bit	sum of pulse heights 3bits	channelID of center fo gravity 28 bits
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Total charge deposited on cluster (I)



- Sum of charges deposited in 3x3 cluster (*averaged over all tracks*)
 - silicon thickness = 150 μm \Rightarrow *expected peak: ~11000 electrons*
 - silicon thickness = 300 μm \Rightarrow *expected peak: ~22000 electrons*

MC 09 bb inclusive

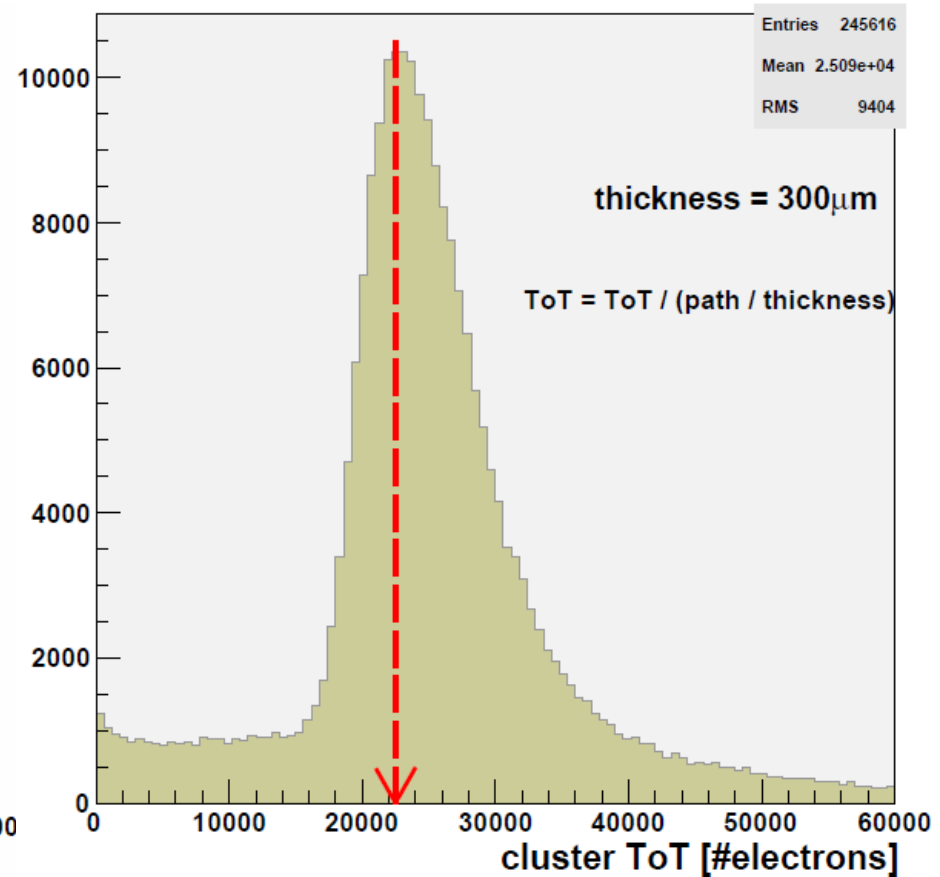
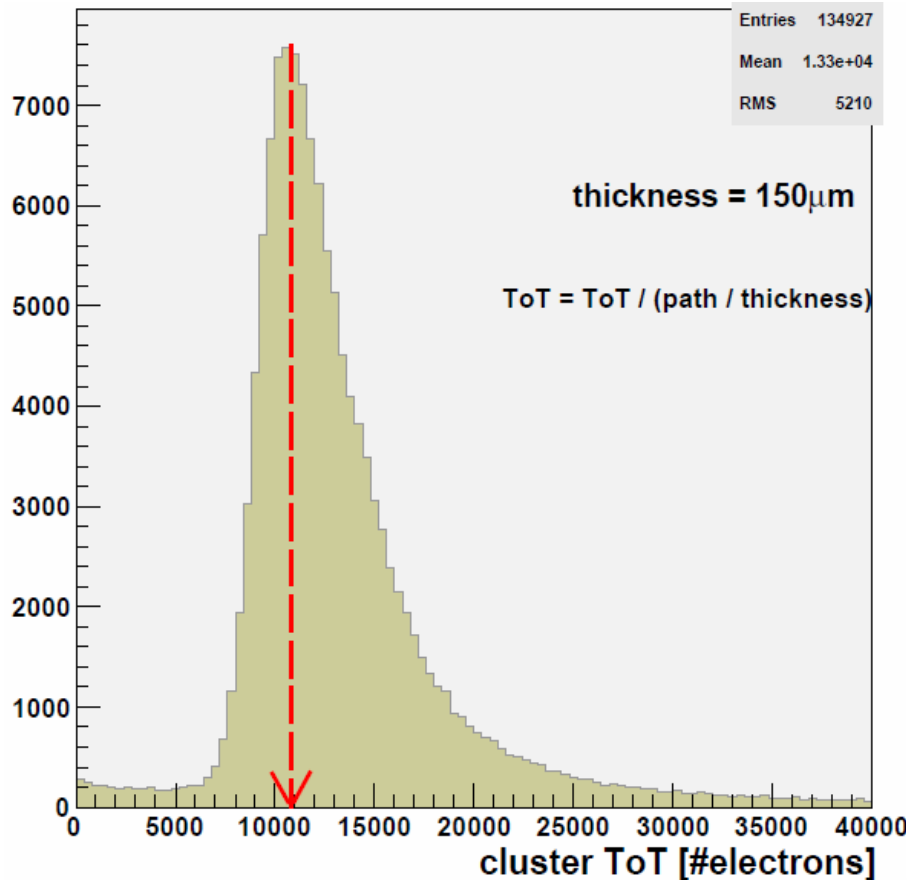


Total charge deposited on cluster (II)



- Normalised to the path length
→ *low cluster ToT region affected by 3x3 clustering*

MC 09 bb inclusive



Number of pixels per cluster

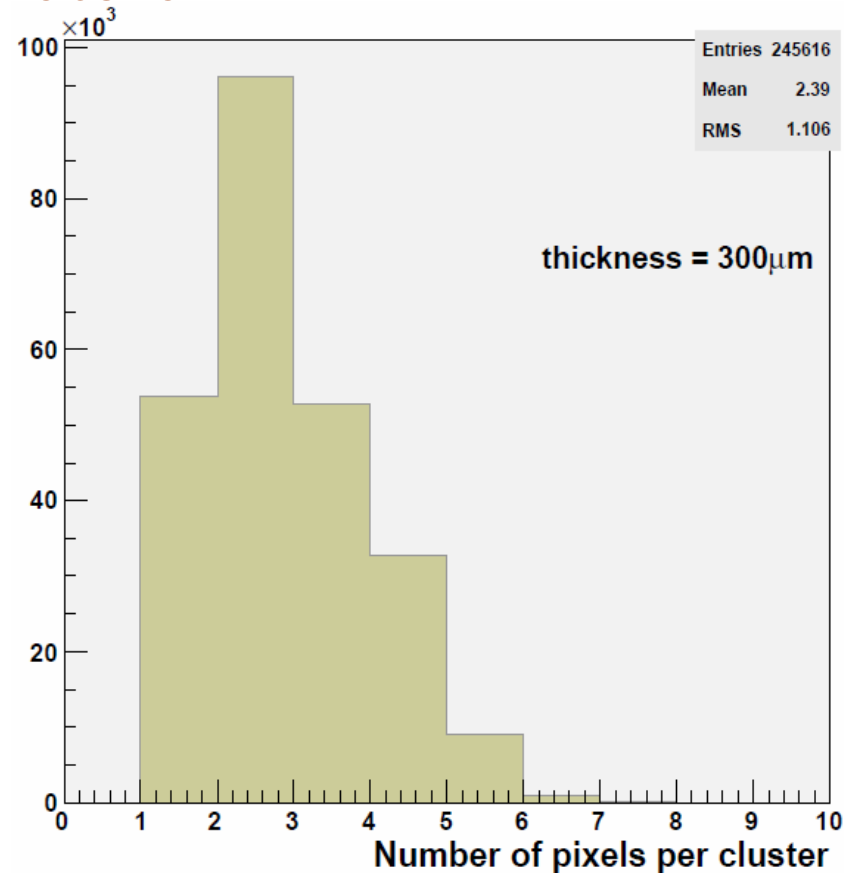
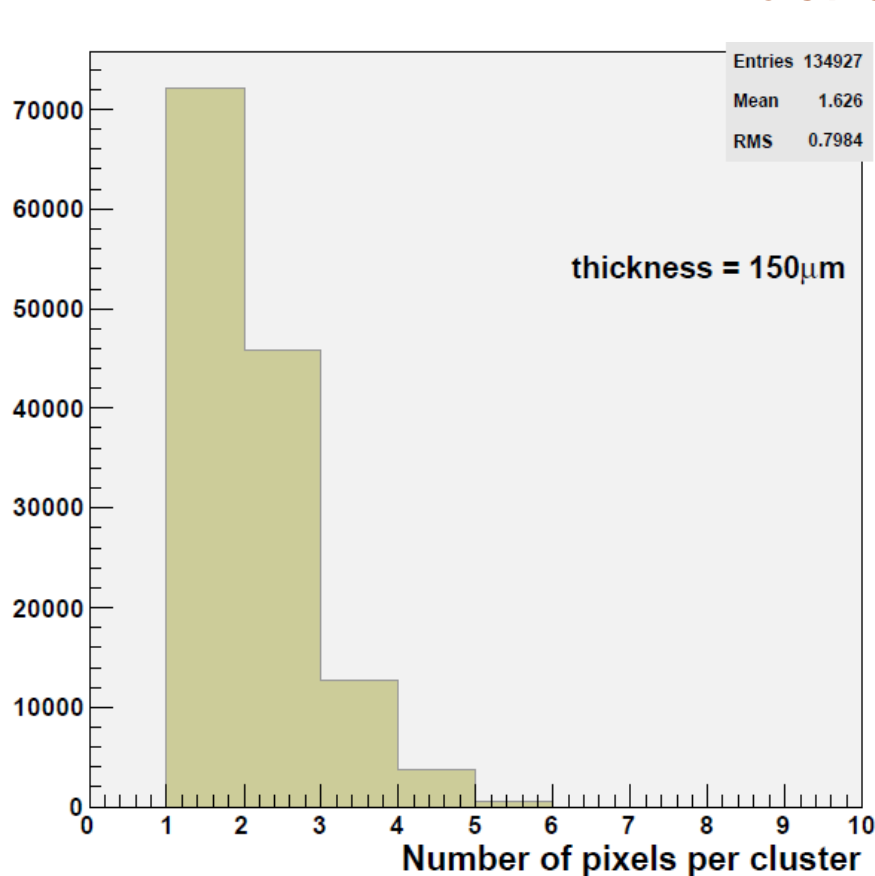


- Number of pixels per cluster

→ silicon thickness = 150 μm \Rightarrow *mean*: ~ 1.6

→ silicon thickness = 300 μm \Rightarrow *mean*: ~ 2.4

MC 09 bb inclusive

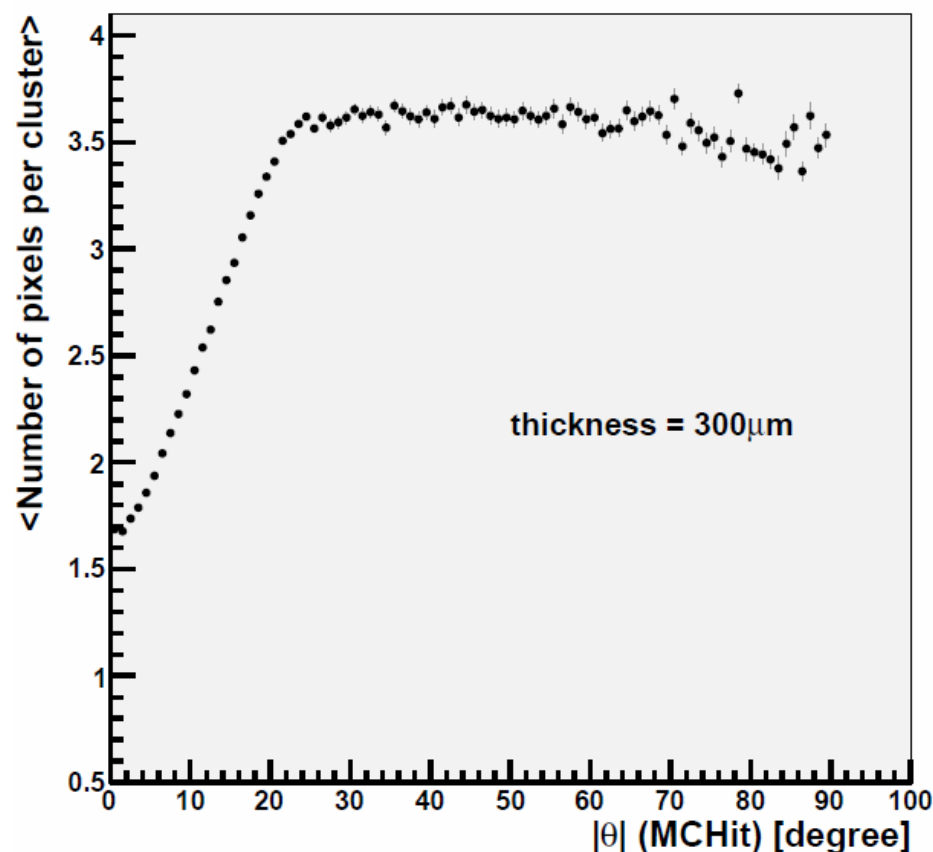
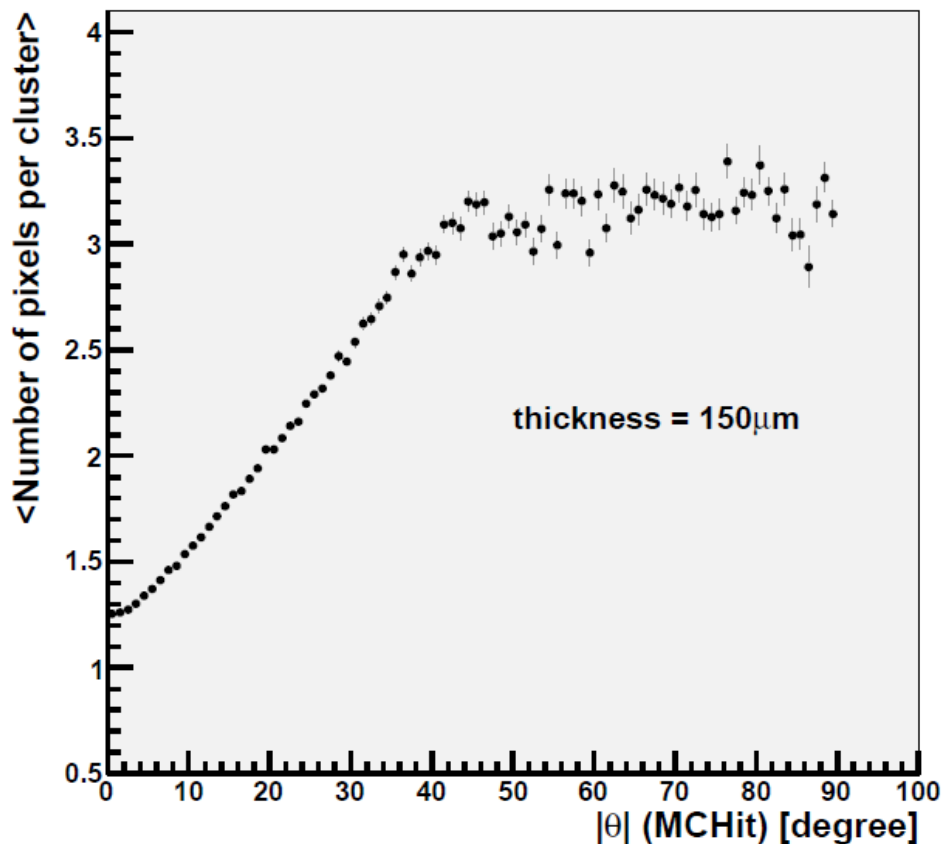


Number of pixels per cluster vs theta



- Number of pixels per cluster vs theta determined for MC Hit
 - silicon thickness = 150 μm
 - silicon thickness = 300 μm
- **Plateaus because of 3x3 clustering** (*need more realistic clustering algorithm to fix it*)

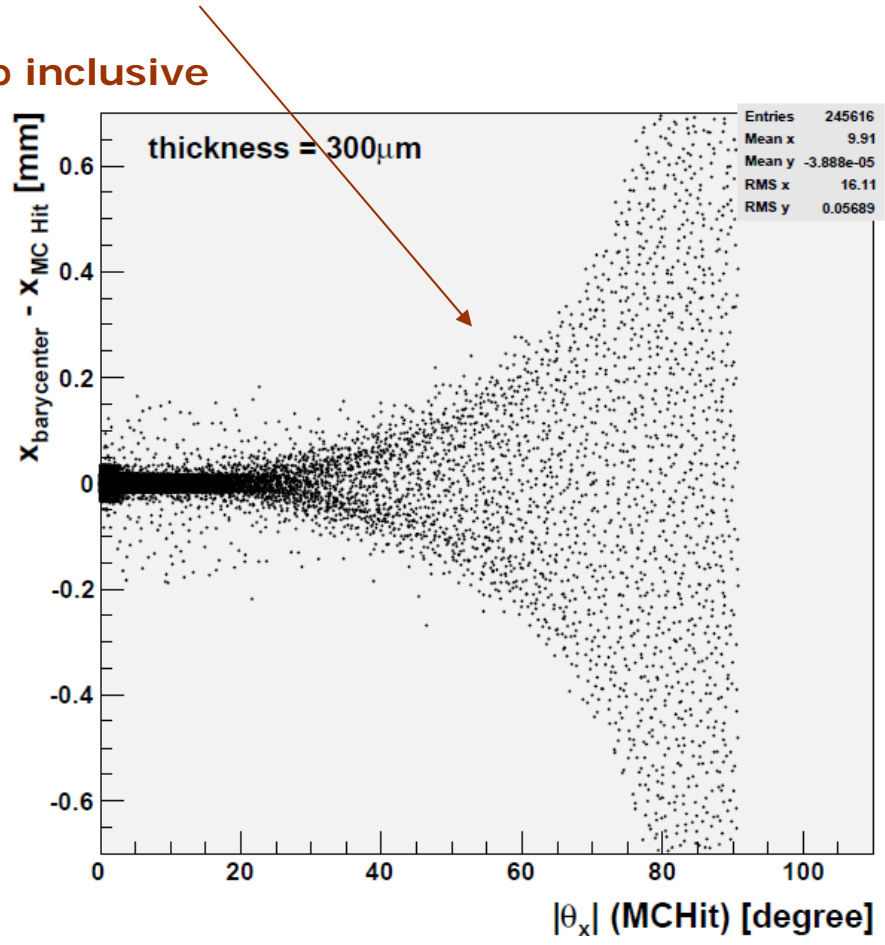
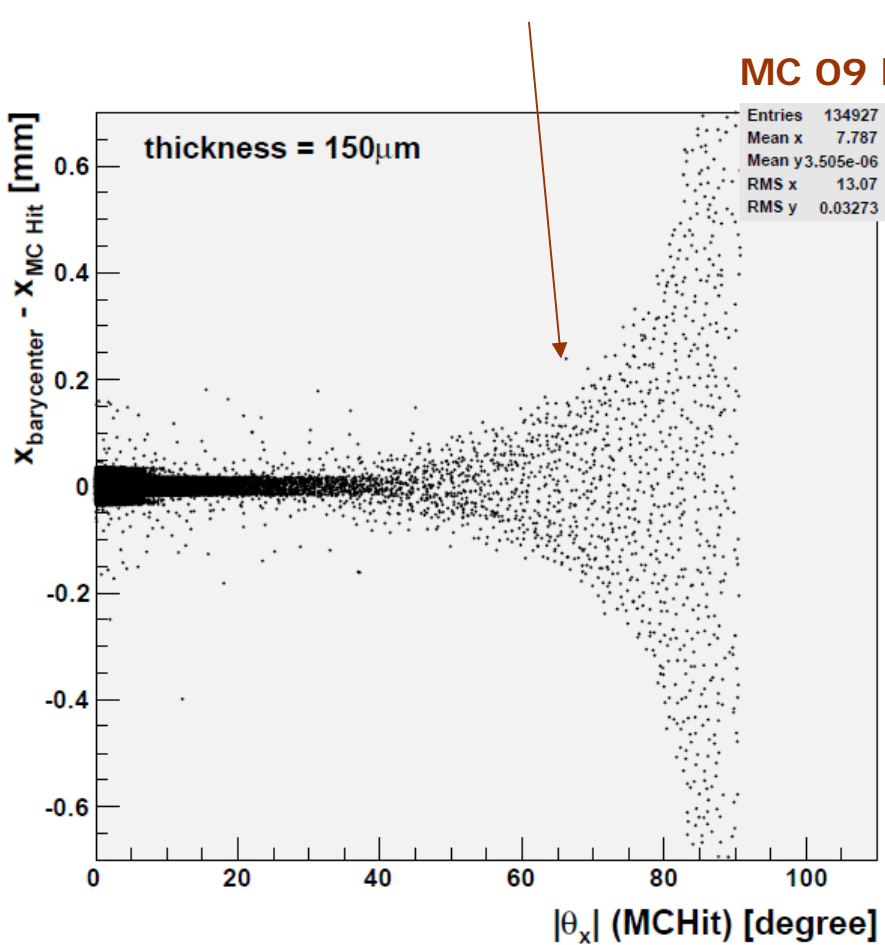
MC 09 bb inclusive



$\Delta x(y)$ vs $\theta_{x(y)}$



- $\Delta x(y) = x(y)_{\text{barycenter}} - x(y)_{\text{MC Hit}}$
→ barycenter: **linear weighed average**
- larger angle region affected by 3x3 clustering



Resolution vs θ

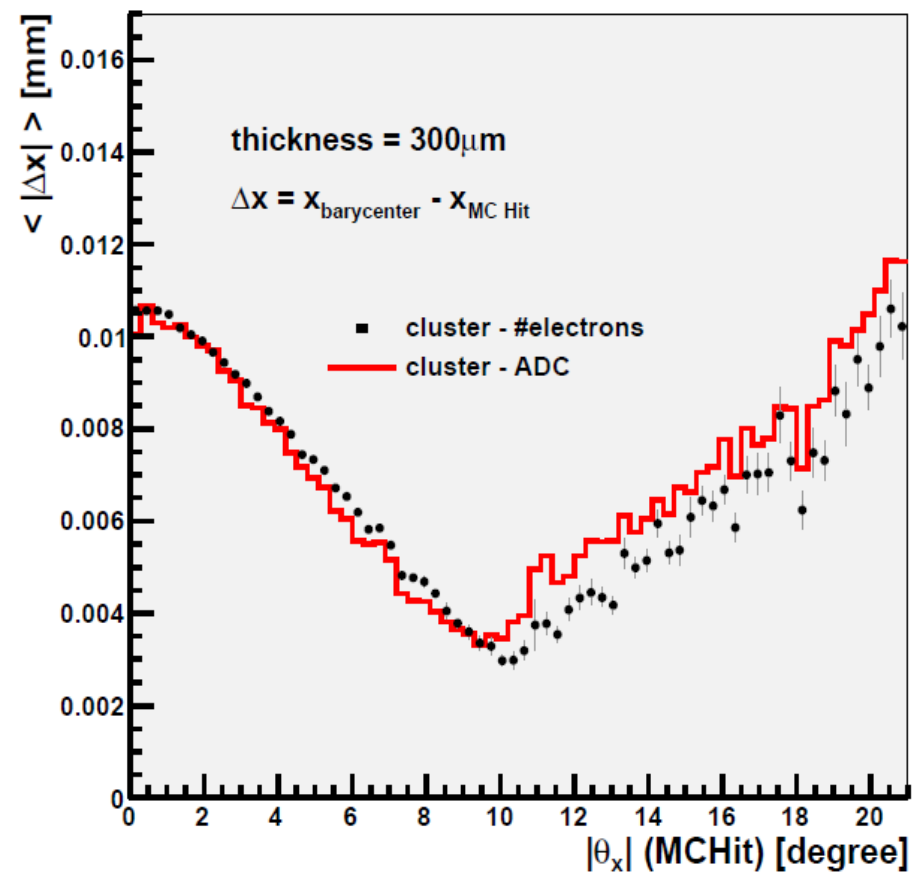
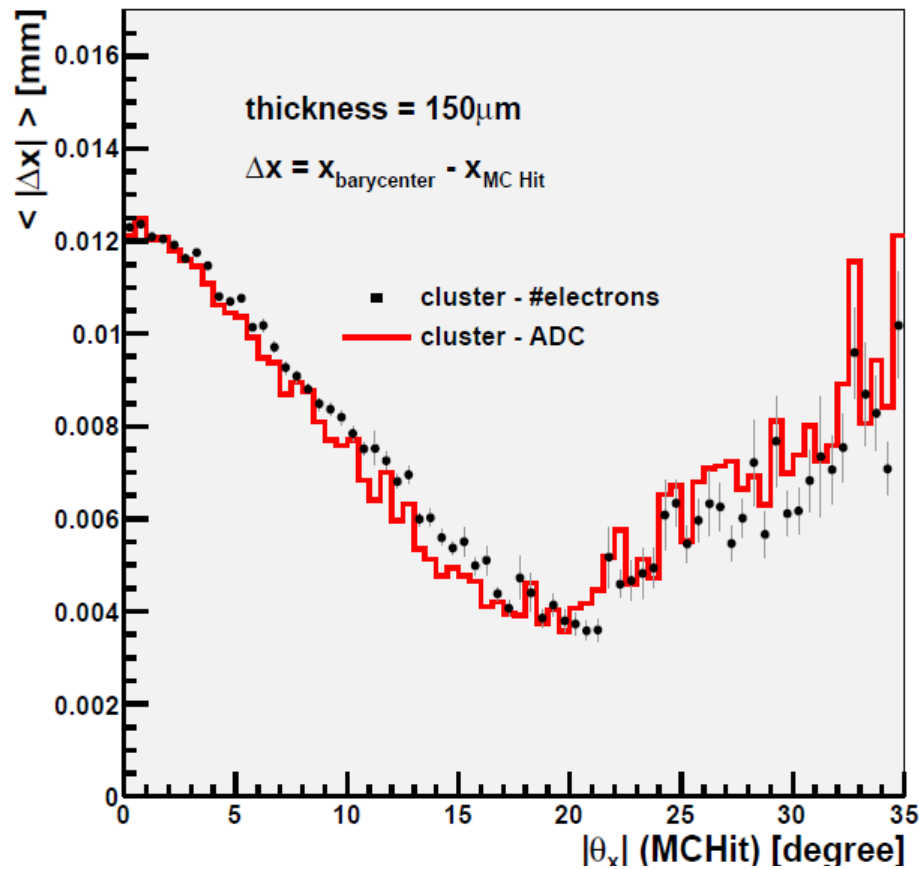


- $\Delta x(y) = x(y)_{\text{barycenter}} - x(y)_{\text{MC Hit}}$
 - pixel charges in #electrons
 - pixel charges digitized in 4 bits

(points)

(red curves)

MC 09 bb inclusive



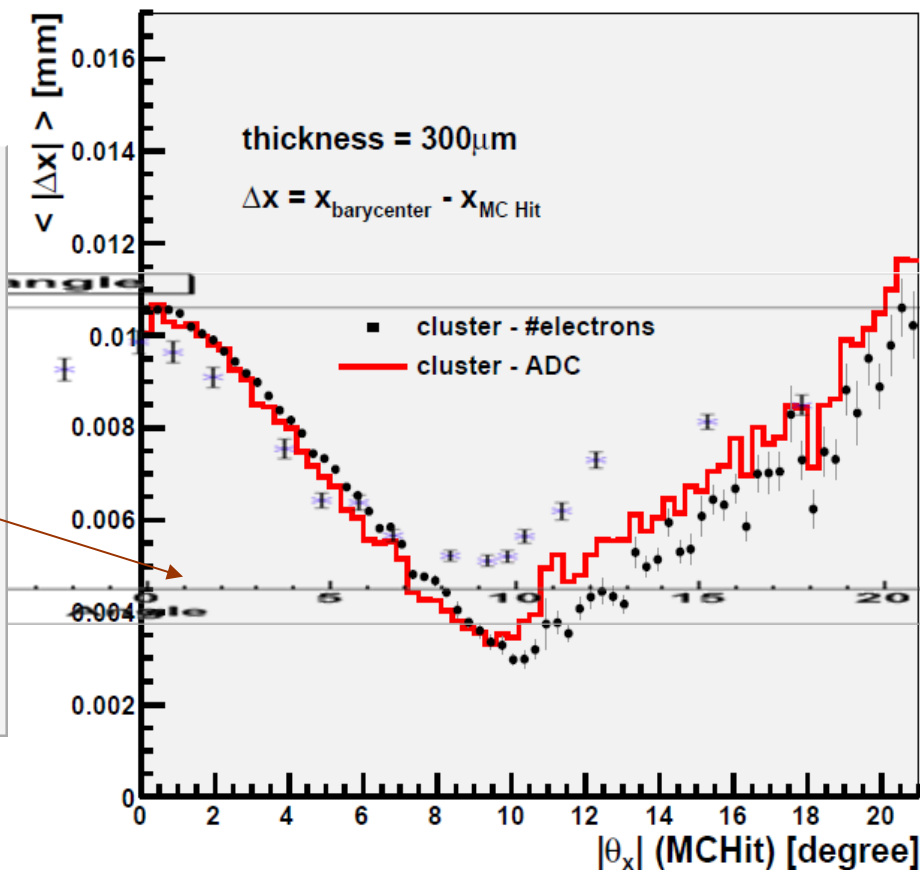
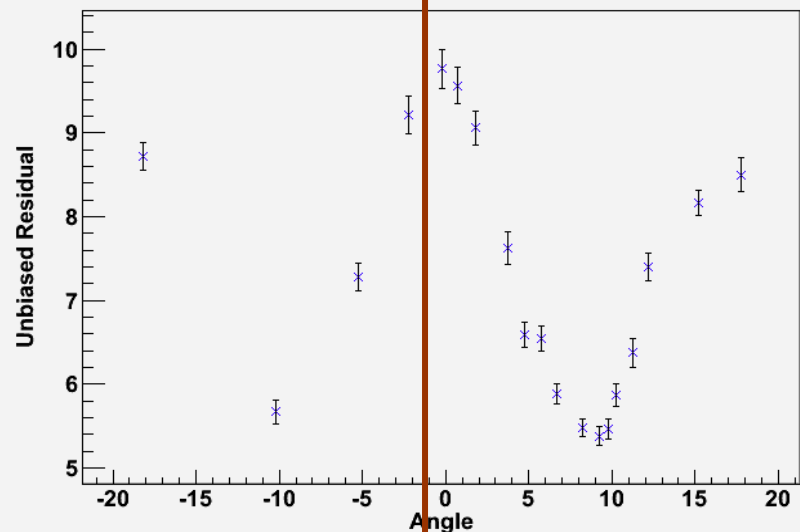
Resolution vs $\theta \rightarrow$ test beam



- Jan's presentation at Velo Upgrade meeting 09/09/09
 - thickness tested: 300 μm
 - **average number of pixels per cluster: ~ 2.6**

Jan

Resolution as a function of angle



Conclusions



Digitization / clusterization package for TIMEPIX almost ready

- charge deposits algorithm based on existing Velo solutions
- naïve model of digitization
- simplest clusterization for now
- need to add model of raw data
- need to properly integrate with official Boole configurable
- package in CVS soon