

VELO software

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Lite clusters in Kalman fit

- The VELO clusters are available both as a lite and “full” version
 - Two consecutive blocks in the banks written by the TELL1 hardware:
 - First just strip number , size (1,many) and centroid to $1/8^{\text{th}}$ of a strip
 - Second includes the exact cluster size and ADC values for each strip
 - Pattern recognition uses just the first half
 - Decoding is much faster to a LiteClusterContainer
 - See if the trigger can work with just the lite clusters in the fit

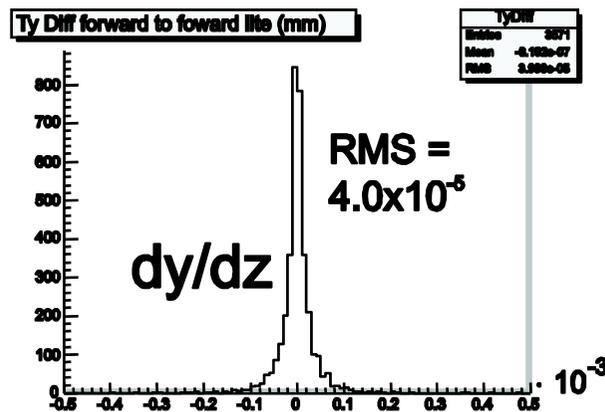
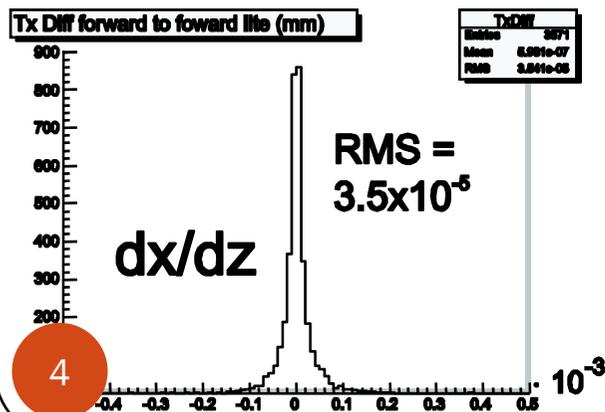
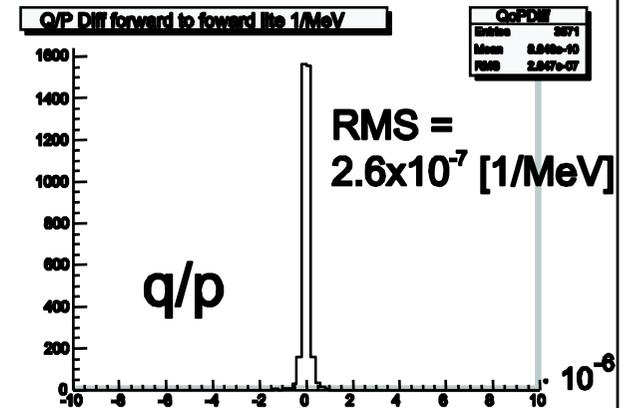
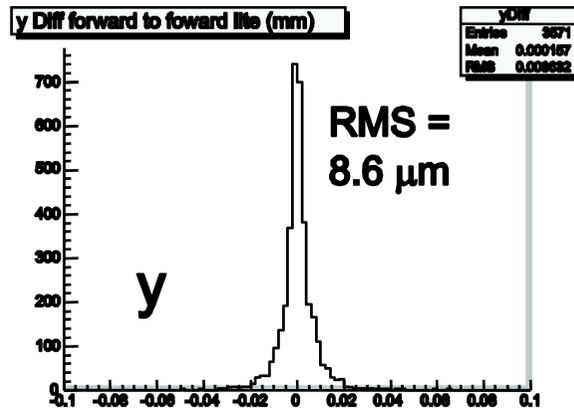
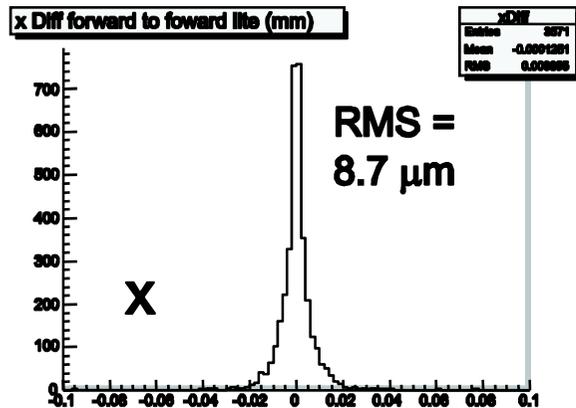
Changes required

- FastClusterContainer needed direct access by key to elements
 - **Health warning** : assumes container sorted
- Added sort to lite cluster decoding
 - Not needed in MC, may be needed in real data
- Measurements with Lite Clusters to be made
 - Adding a measurement type breaks a lot of code as many places have hard coded TypeName \leftrightarrow enum
 - Make a `std::map` of this mapping automatically generated in GOD from the XML?
- Trajectories from lite clusters etc.
- At some point need to add VELO pixels for upgrade studies too...

Compare “full” and “lite” fit tracks

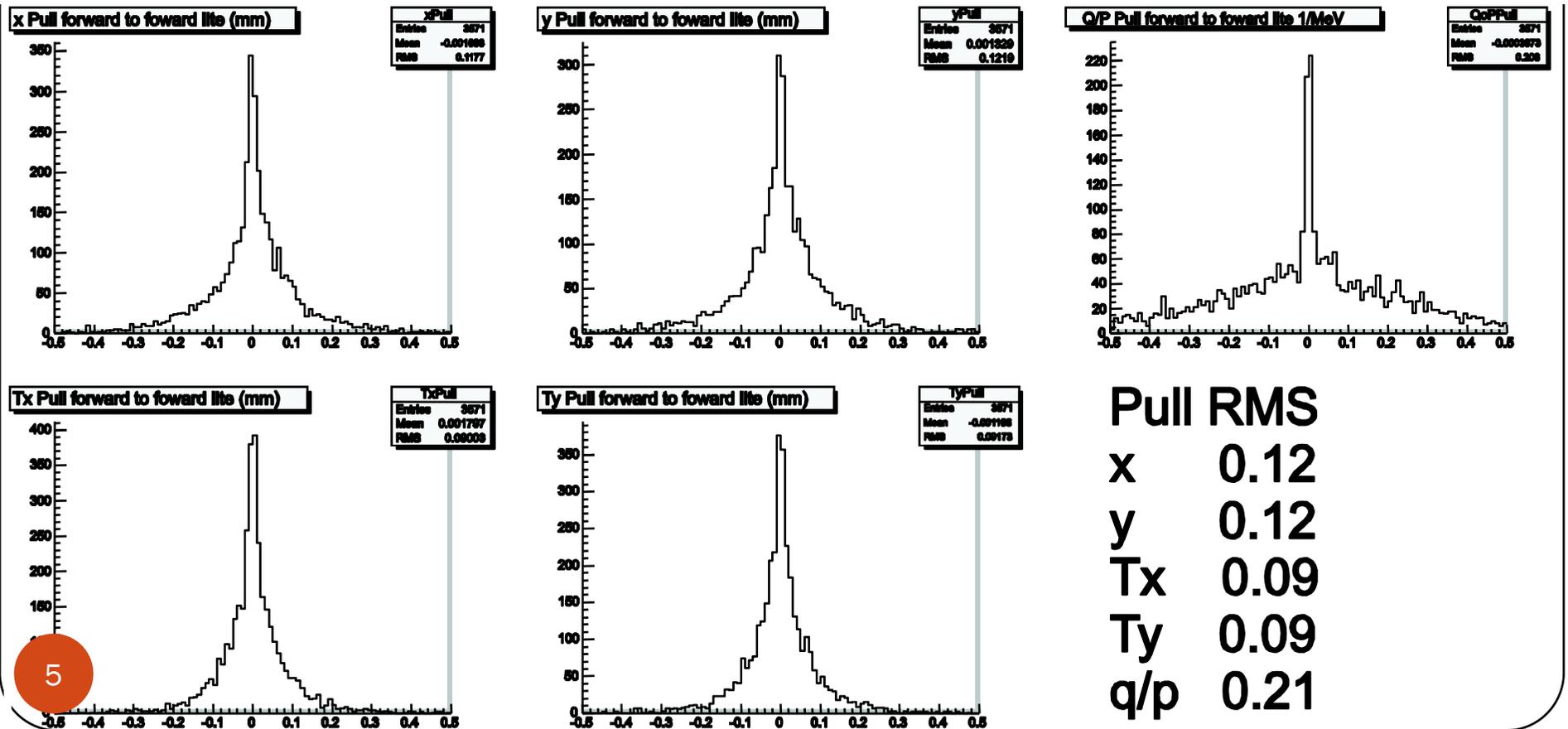
Fit comparison of “full cluster” tracks and “lite cluster” forward tracks after a Kalman fit

Difference Full - Lite Kalman fits



Compare “full” and “lite” fit tracks: pulls

Fit comparison of “full cluster” tracks and “lite cluster” forward tracks after a Kalman fit



Timing

- Tried fitting both with full fit and lite fit in the same events (using Johannes' changes)

(millisec)	<user>	<clock>	entries	total (s)
DecodeVeloRawBuffer	0.224	0.163	98	0.016
...				
DecodeVeloClusters	1.581	1.626	98	0.159
...				
PatForward	26.924	27.435	98	2.689
CopyForwardForLite	0.224	0.215	98	0.021
PreFitForward	117.339	121.006	98	11.859
FitForward	21.946	22.505	98	2.206
PreFitForwardLite	103.280	105.829	98	10.371
FitForwardLite	27.945	28.350	98	2.778

- The “lite” fit is 19ms slower if run first! 8ms faster if run second (shown above).
- May need more detailed profiling to check timing

VELO energy deposits

- New version of GEANT shows different energy deposition characteristics
- Retuned VELO simulation to better match 2006 testbeam data and lab test data on TELL1 / ARX / Beetle configurations

Check “linearity” of simulation

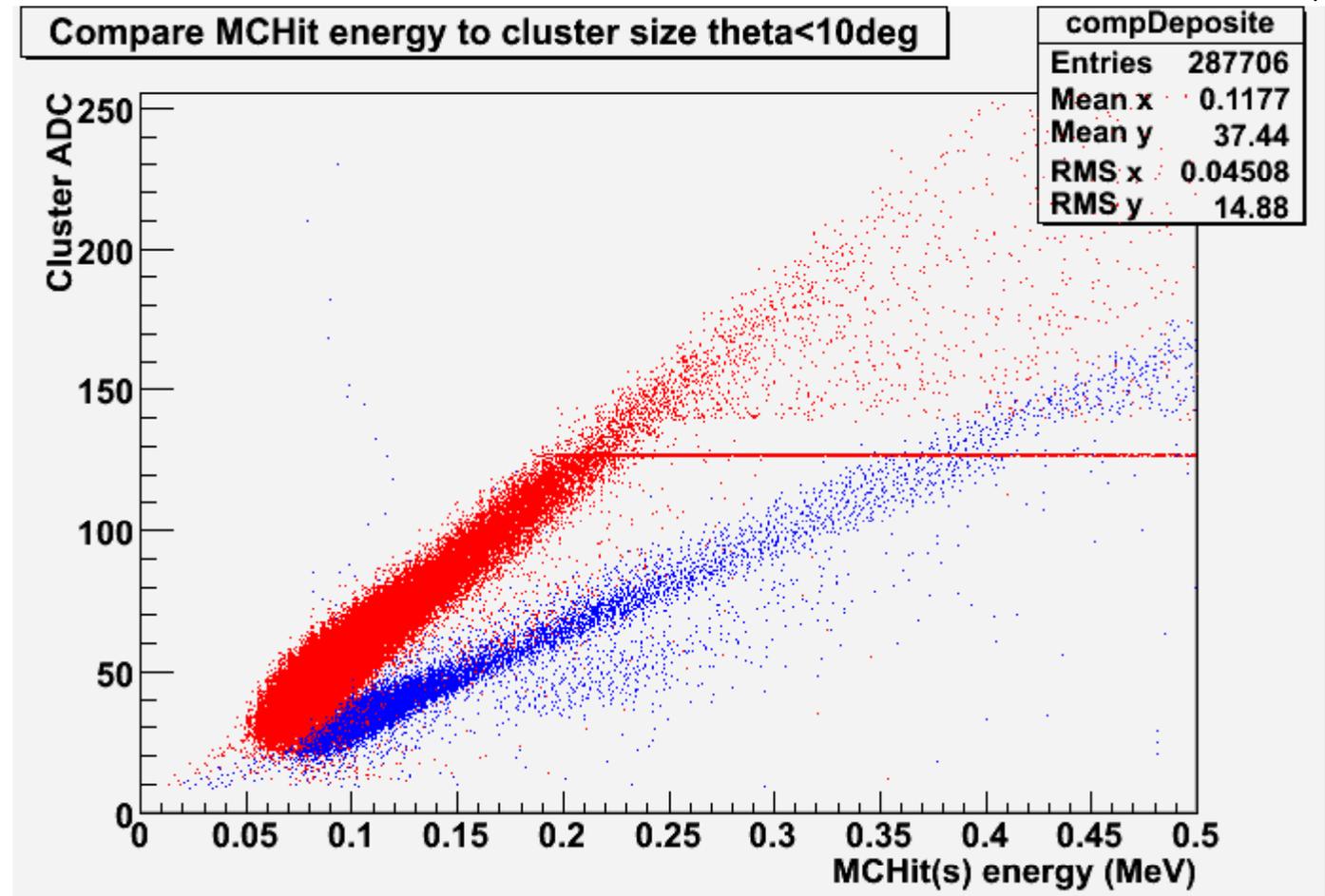
Red '08

Blue '06

Gain is higher

Absolute noise is a little bigger, relative noise a big smaller

Saturation is more significant due to higher simulated gain



GEANT

Red '08 GEANT

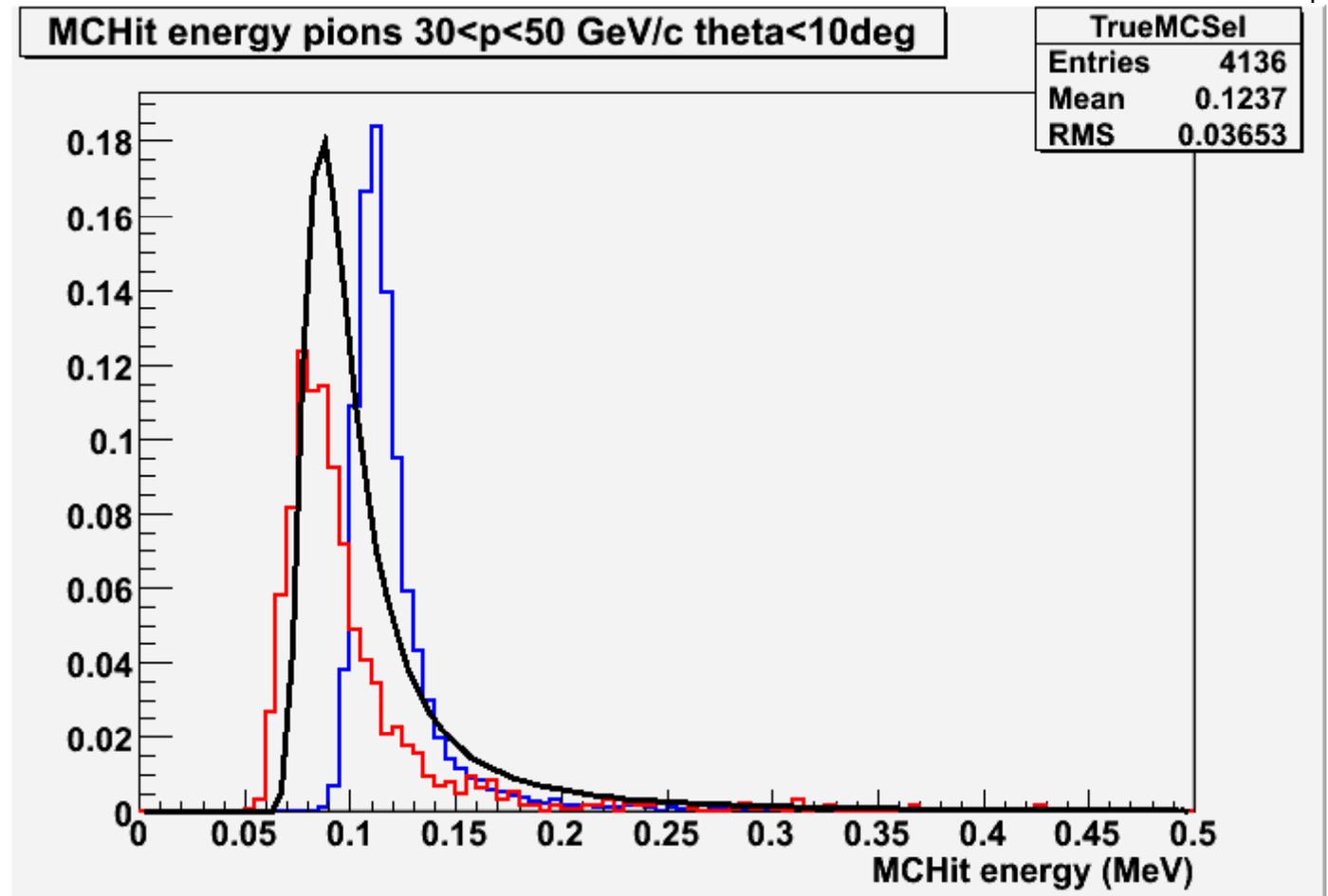
Blue '06 GEANT

Black line is a landau
with

MPV = 88 keV

FWHM = 30 keV

From Hans Bichsel's
1988 paper



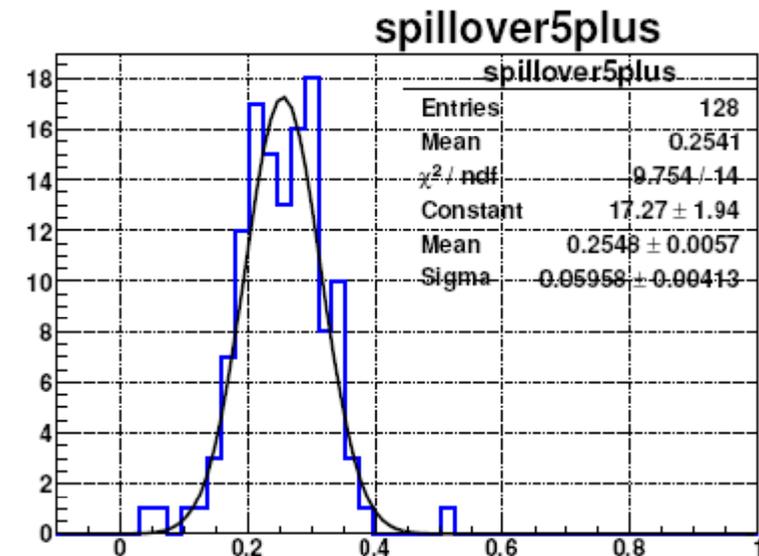
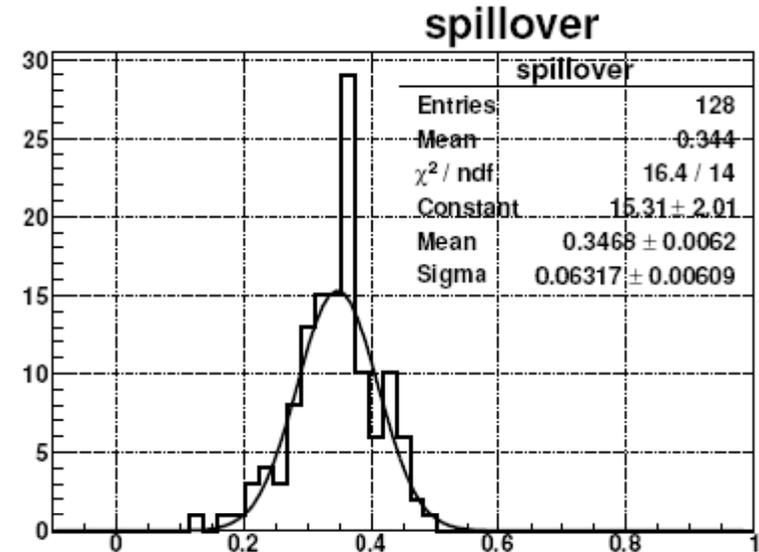
'06 to '08 Energy deposit comparison

Taking 30-50 GeV/c pions straight through silicon comparing
'06 and '08 MC, PDG value and ACDC3 VELO test beam
results

	DC'06		DC'08		PDG	ACDC3
	Clusters	MC	Clusters	MC		Clusters
Units	ADC	keV	ADC	keV	keV	S/N
MPV	34.3	109	44.3	79	88	21 – 24
Sigma	1.3	3.4	3.1	5.2		1.5 - 1.7
Gauss Smear	3.2	5.6	7.34	8.6		2.7 - 3.0
FWHM	10.1	20.9	23.5	32	30	9.4 - 10.6
FWHM/MPV	0.29	0.19	0.53	0.41	0.34	0.44 – 0.48

Timing curve may be too pessimistic

- Opposite is the spill over fraction after the peak for 128 channels in the same sensor from Kazu
- Below same if sampled 5ns after the peak for sensor 69
- Larger than expected variation: simulation is based on single measurement giving 45% after the peak (25% after peak+6ns)
- ST reports this is also temperature dependent; hope that at operating temp spillover fraction will be smaller



Sensor 69

Other topics to do

- Measure timing curve of all sensors
 - Update simulation based on the result of that
- Update VeloClusterMaker to be more realistic
 - Use bit perfect emulation if possible
- Finish optimisation of common mode, header correction etc in the TELL1 code
- Add additional effects to the simulation of imperfect common mode correction etc if required
- Add online monitoring code for monitoring farm and offline use
- Evaluate effects of delta rays on simulation if turned on

Longer term

- Studies on VELO replacements beginning
 - Add simulation of radiation damage to silicon
- Several people want to study pixel layouts and check IP resolution etc for longer term upgrades
 - Look at adding VELO “pixel” objects to simulation, PR (could be faked from MC truth) and Kalman fit