

LCWS07 Tracking Summary

The combined Vertexing/Tracking sessions:
scheduled 11.5 hours , 37 presentations

Of these, 23 were Tracking, which is the content of this talk.

In addition,
there were a few presentations in Simulation/Reconstruction sessions
that are relevant to this discussion.



the presentations

The 23 tracking presentations covered topics relevant to the R&D organizations.

SiD Tracking

Track resolution studies with the 'LiC Detector Toy' MC tool
Digitization and hit reconstruction for Silicon Tracker
in MarlinReco

Winfried Mitaroff (*OEAW Vienna*)

Sergey Shulga (*JINR Dubna*)
Robert Kutschke (*Fermilab*)

Tracking in SiD
Non-Prompt Track Reconstruction with
a Calorimeter Assisted Tracking Algorithm
(simulation session) Simulation of an All-Silicon Tracker

Dmitry Onoprienko (*Kansas State Univ.*)
Bruce Schumm (*UCSC Santa Cruz*)

SiLC

Progress on long-shaping-time readout at SCIPP
SiLC tracking studies report
Source Test of the 180 nm chip with GLAST and CMS sensors

Bruce Schumm (*UCSC Santa Cruz*)
Marcel Vos (*IFIC Valencia*)
Wilfrid Da Silva (*LPNHE - Paris*)

4th Concept Tracking

The Cluster Counting Drift Chamber of the 4th Concept

Franco Grancagnolo (*INFN Lecce*)

(generic)

Digital Active Pixel Array for Vertex and Tracker Systems

George Bashindzhagyan (*Moscow State Univ.*)

(the presentations)

(The 23 tracking presentations covered topics relevant to the R&D organizations.)

LC-TPC (13 presentations)

(framework/reconstruction)

MarlinTPC: Towards a common TPC software framework
Track Resolution Studies for a MPGD TPC
(simulation) TPC FADC Sim/Reco in Marlin and LCIO

Peter Wienemann (*Bonn Univ.*)
Klaus Dehmelt (*DESY*)
James Hunt (*Cornell*)

(TPC background hits)

TPC reconstruction dependence on noise
using a FADC simulation
Geant4 Simulations of Machine-Induced Background in a TPC

Daniel Peterson (*Cornell*)
Adrian Vogel (*DESY*)

(readout)

Pad occupancy in LDC TPC with TDC-based readout electronics Alexander Kaukher (*Rostock University*)

(studies of MPGD / gas)

Measurements using a Bulk Micromegas in the
Cornell/Purdue TPC Prototype
A study of resolution of a GEM TPC with
Ar-CF₄-Isobutene gas mixtures

Daniel Peterson (*Cornell*)
Hirotoshi Kuroiwa (*KEK*)

(large prototype)

Study of TPC PrePrototype
Status of the Large TPC Prototype (note: field cage)
Measuring distortions in a TPC with photoelectrons
Simulation study of GEM gating for LC-TPC

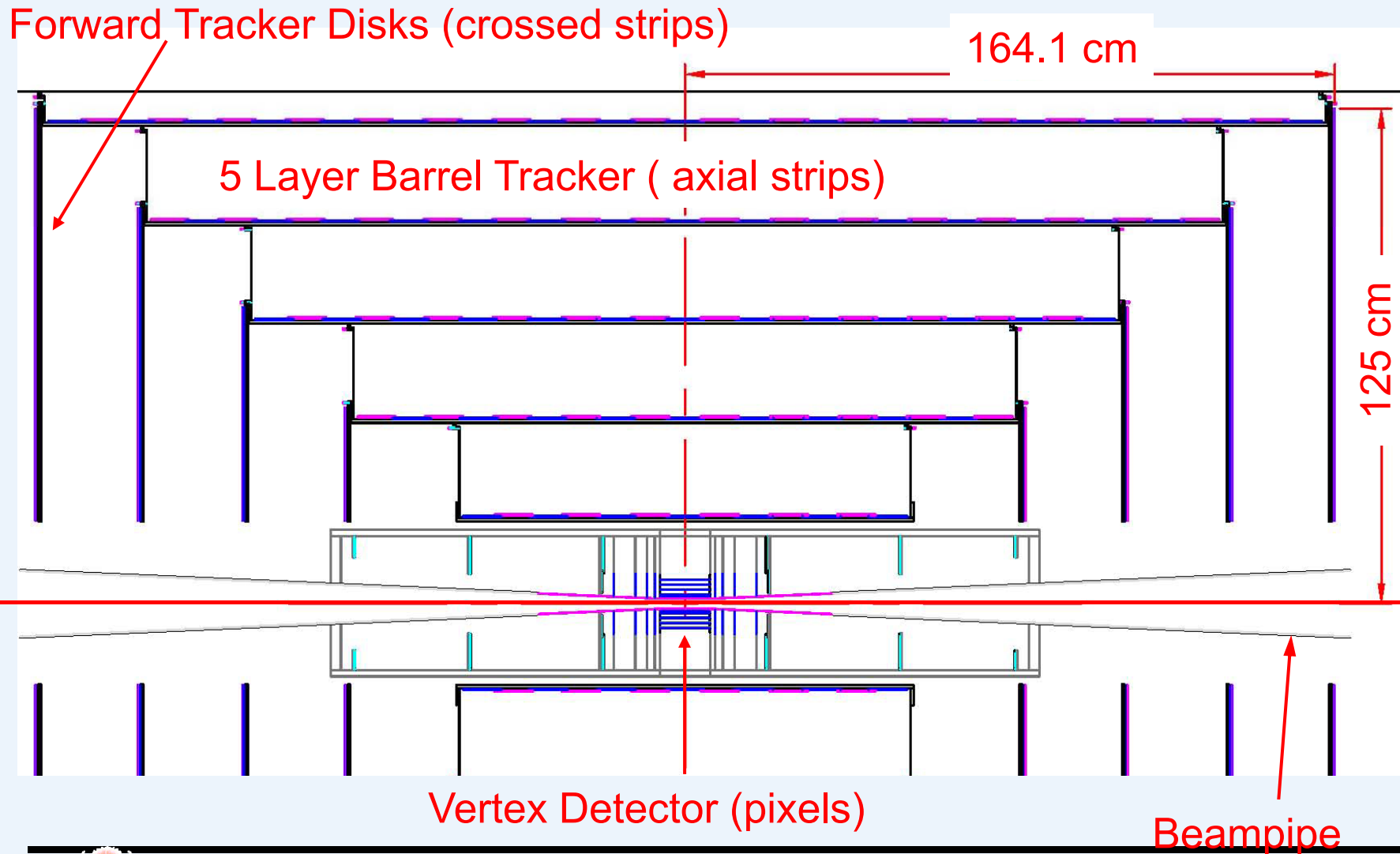
Akimasa Ishikawa (*Saga Univ.*)
Lea Hallermann (*DESY/Univ Hamburg*)
Dean Karlen (*Univ. Victoria and TRIUMF*)
Akira Sugiyama (*Saga Univ.*)

(pixel readout TPC)

Determination of track properties using the GEM-TimePix setup
Recent Gridpix results

N. Vlasov (*Freiburg Univ.*)
Maximilien Chefdeville (*NIKHEF Amsterdam*)

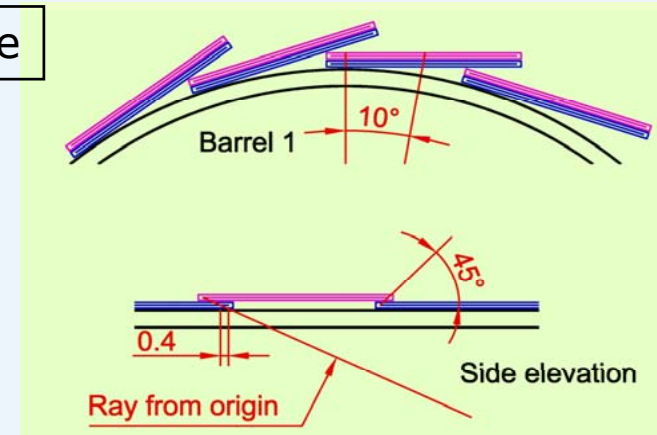
SiD tracking - Vertical Section



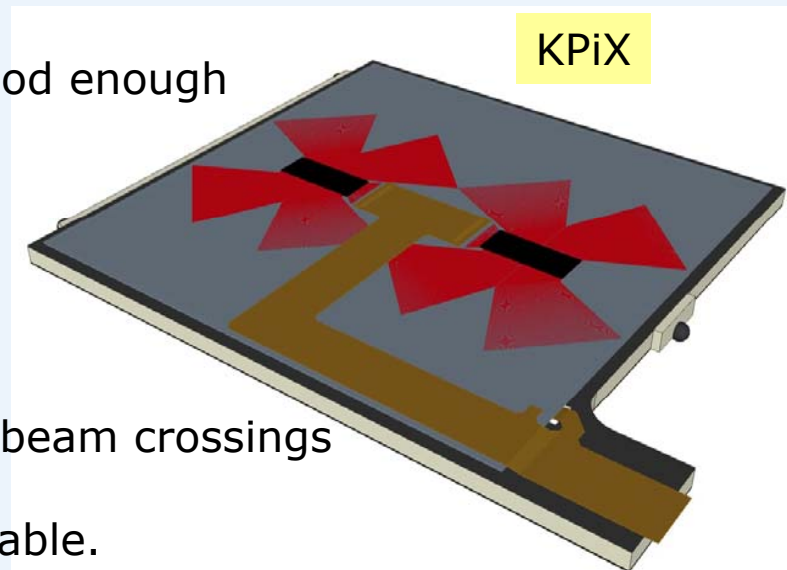
SiD tracking Sensor options

SiD is investigating 3 Readout options: See R. Kutschke

- * KPiX (baseline option)
 - + shortest dead time of the 3 options
 - + small, low mass package
 - + synergy with W-Si ECAL
 - bump bonding is perceived as risky
 - double metal and noise(Power traces cross some signal traces)



- * Charge Division
 - + allows stand-alone tracking if the σ is good enough
 - + no double metal
 - longer dead time
 - 2x the readout, material, heat
- * Time over threshold.
 - + digital, no analog hold
 - longer dead time, shaping time of $O(10)$ beam crossings



Open to other options when sample chips available.
Submissions to test all are going out – sensors by October 2007.

SiD stand-alone tracking in main tracker

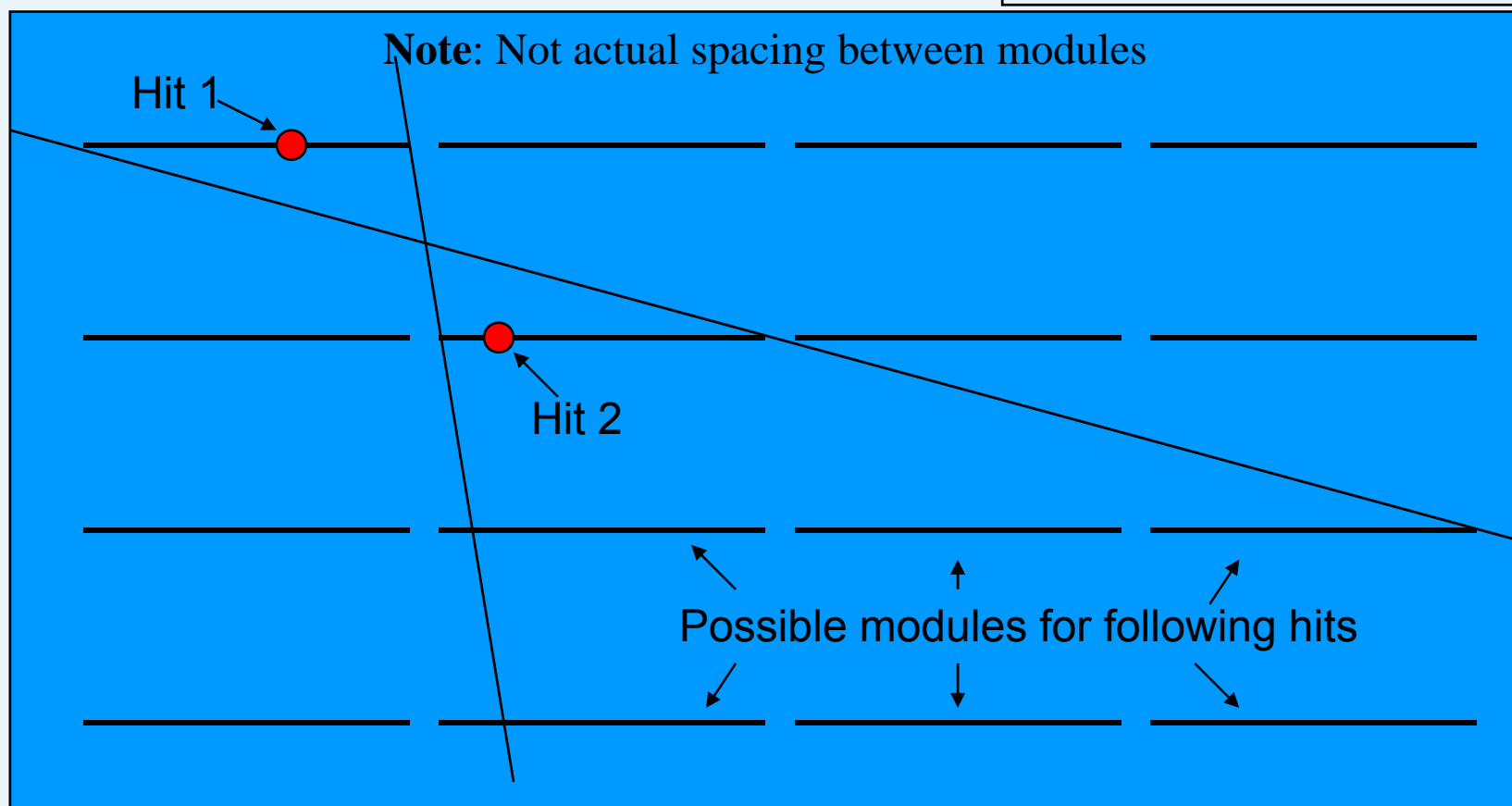
Z Segmentation

Can we use z-segmentation to further clean up seeds and eliminate fake tracks?

Can we make 4-hit tracks usable?

For now, apply only to three-hit seeds...

See B. Schumm (simulation)



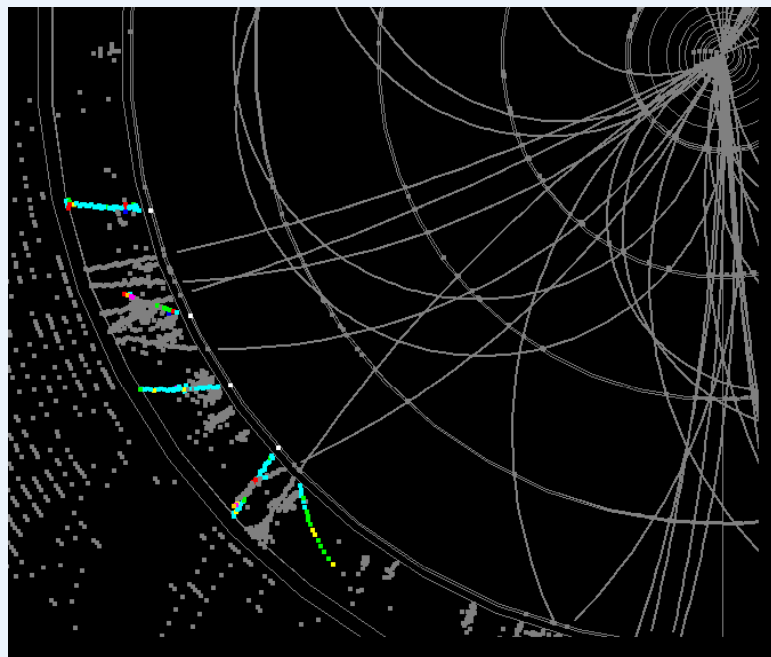
SiD stand-alone tracking in main tracker

	Two halves (original)	30cm segments	10cm segments	5cm segments	1cm segments
# MCPs	304	302	302	302	302
Found with 5 hits	145	142	147	152	152
Found with 4 hits	112	113	114	110	101
Missed	47	47	41	40	49
4-hit fake	157	201	141	108	45

"Preliminarily, need z-segmentation substantially finer than 10cm to clean up "seeds" for stand-alone central tracking"

The "charge division" sensor option may effectively provide this segmentation though resolution.

SiD: Calorimeter assisted Tracking



See D. Onoprienko

Note MIP stubs and missing tracks

Showed performance for K^0

The performance numbers are just the current snapshot – significant improvements are expected.

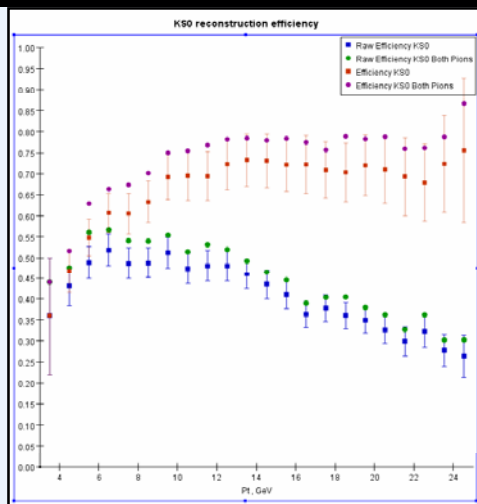
MIP stub finder
(currently using a Calorimeter hit cluster)

MIP stub handling in a fit

Interoperability with other packages
fitters, propagators, etc.

Handling of low Pt tracks

Geometry optimization



SiLC

<http://silc.in2p3.fr/> Urgent simulation studies

See M. Voss

(due by the end of 2007)

Tracking in mixed gas-silicon concepts.

Especially important is the transition in the forward region between TPC and forward disks.

Machine and physics backgrounds and their impact on tracking in the very forward and internal barrel regions.

Study background levels in different detector,
and study pattern recognition in the presence of this background.

Pattern recognition:

Requirements that derive from pattern recognition are not well studied.

What granularity is needed in the different tracking regions to ensure that pattern recognition converges even for some of the toughest cases: in dense jet topologies and for non-prompt tracks?

Feedback to global layout optimization.

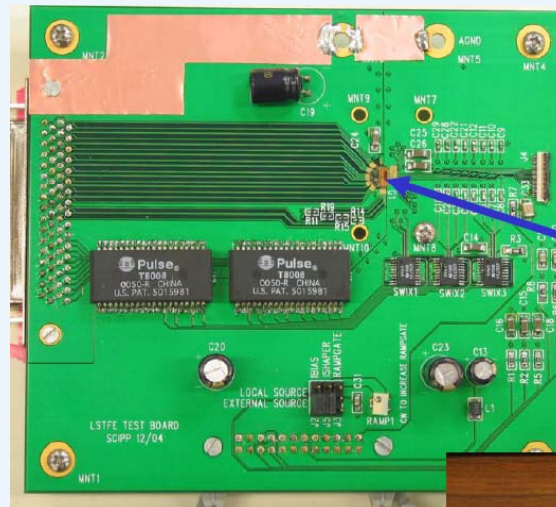
Optimize the overall design based on physics requirements.
Special attention to the material budget.

SiLC

long shaping time
long ladder

See B. Schumm

Time Over Threshold readout - relevant to SiD readout technology



INITIAL RESULTS

LSTFE chip
mounted on readout
board

FPGA-based
control and data-
acquisition system



4th Concept – cluster counting drift chamber

Proposal is to implement a low-mass drift chamber as a central tracker

The multiple scattering term is reduced through the use of a Helium gas mixture.

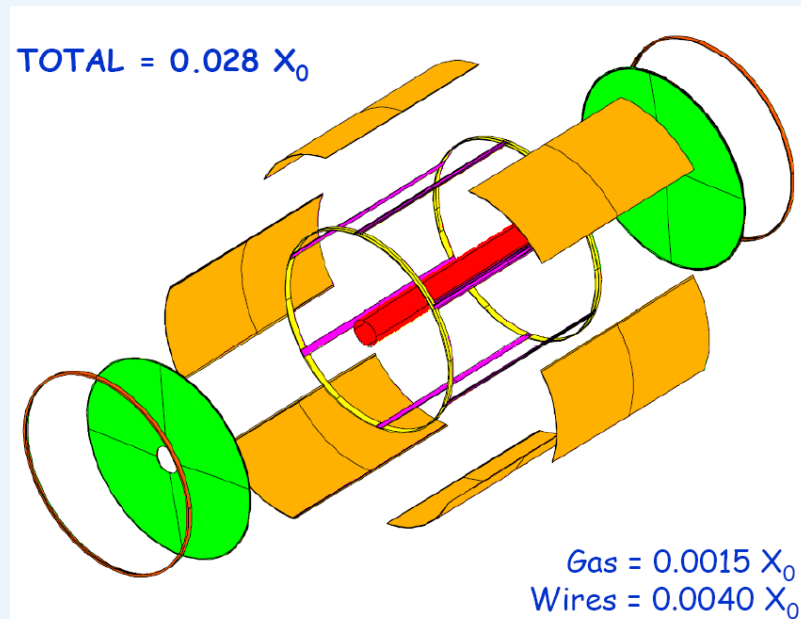
Multiple scattering contribution (equivalent L/X_0):

60,000 20 μm W sense wires $\rightarrow 1.8 \times 10^{-3} (X_0 = 0.35 \text{ cm})$

120,000 80 μm Al field wires $\rightarrow 2.2 \times 10^{-3} (X_0 = 8.9 \text{ cm})$

2 m gas (90% He + 10% $i\text{C}_4\text{H}_{10}$) $\rightarrow 1.5 \times 10^{-3} (X_0 = 1300 \text{ m})$

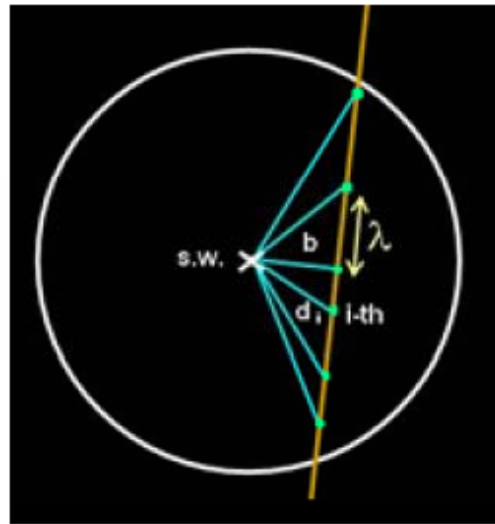
Equivalent $L/X_0 = 5.5 \times 10^{-3}$



The point measurement term is reduced through the use of a cluster-counting readout. (follows)

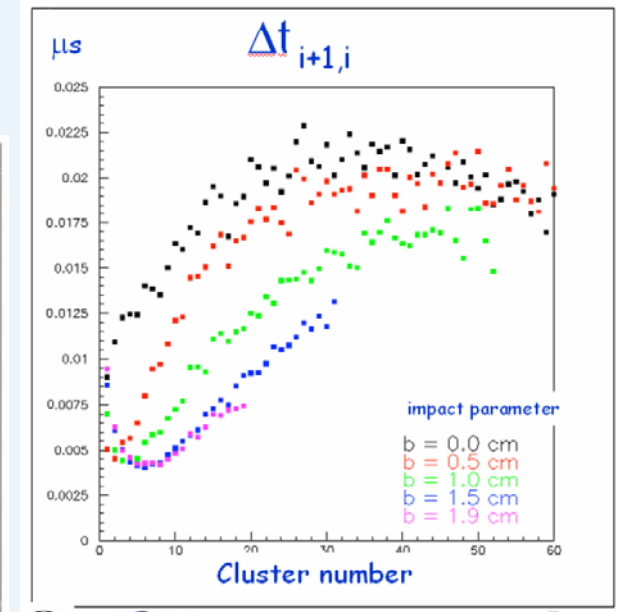
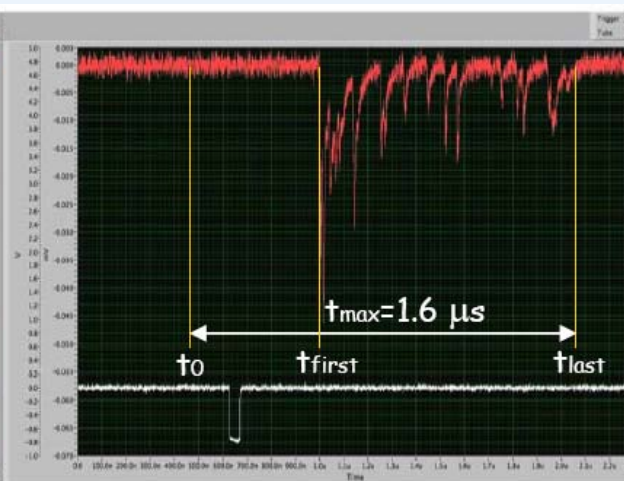
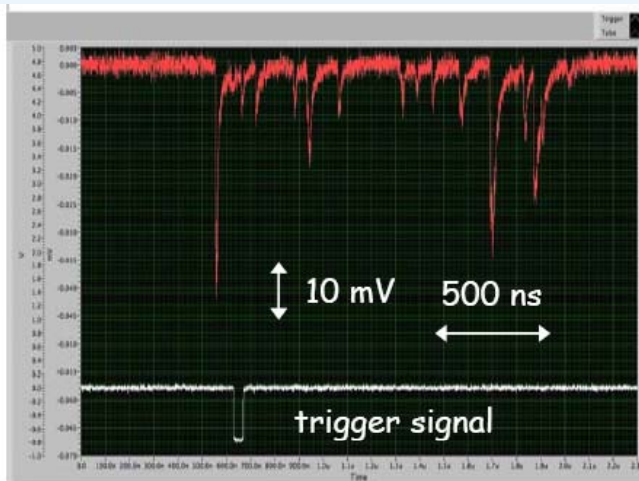
See F. Grancagnolo

4th Concept – cluster counting drift chamber

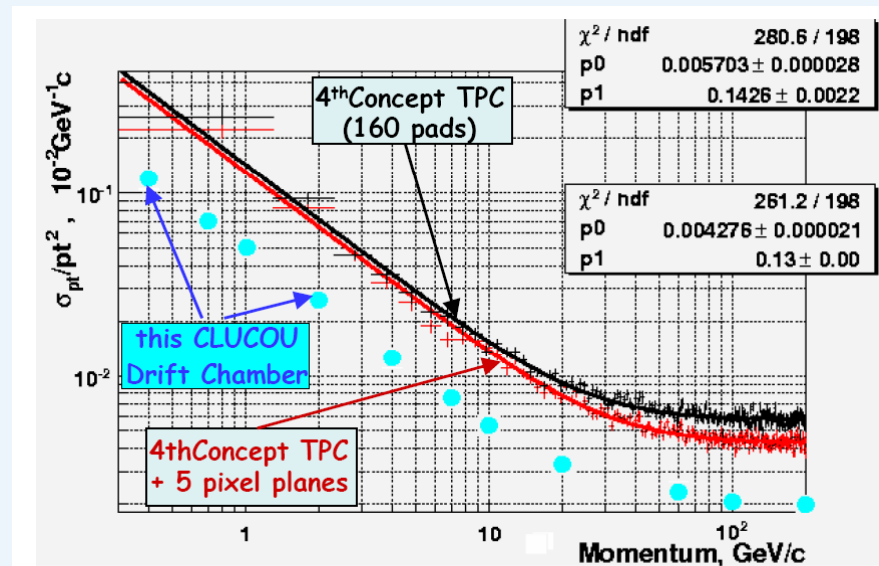


Sampling the drift chamber signal provides more information than the threshold-crossing time.

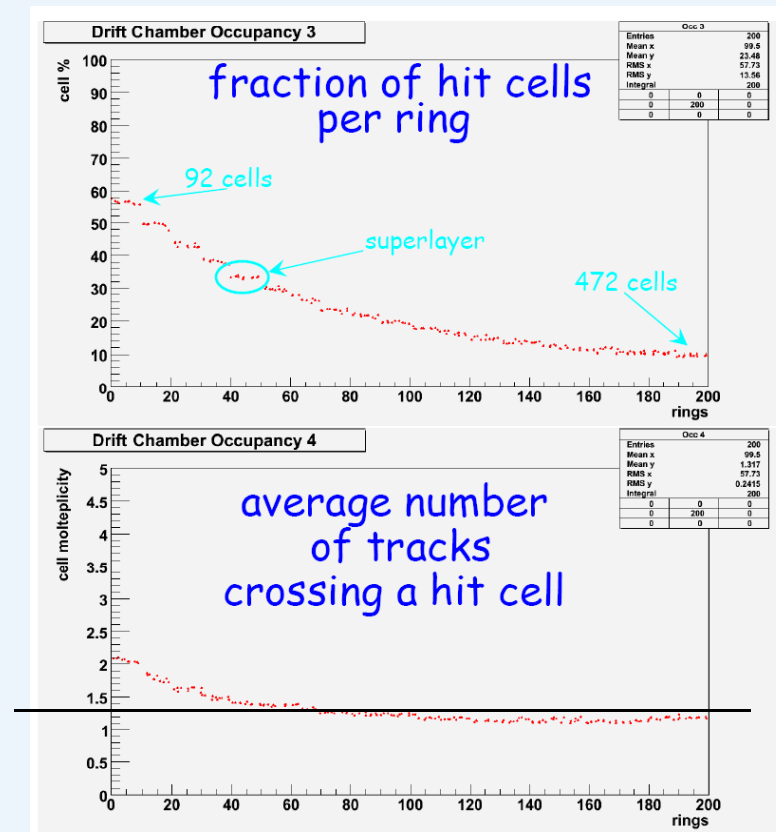
Measurement resolution = 50 μm expected.



4th Concept – cluster counting drift chamber



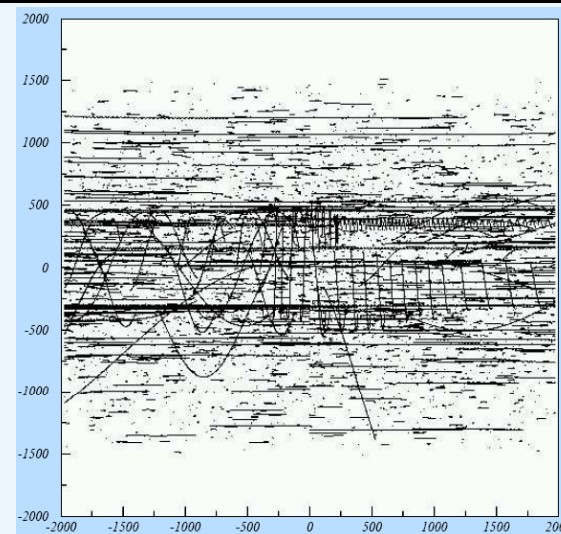
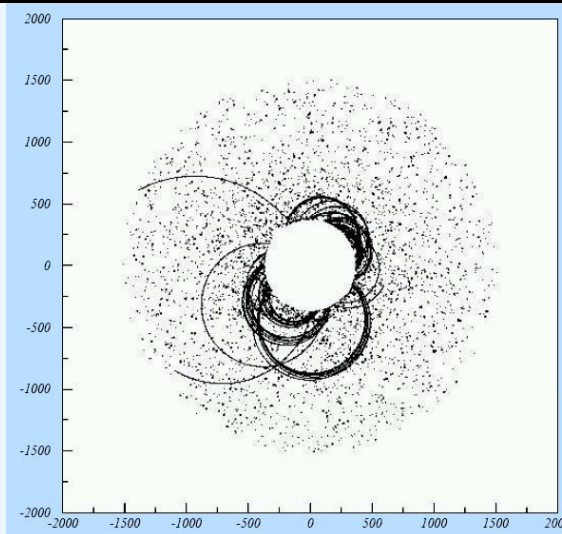
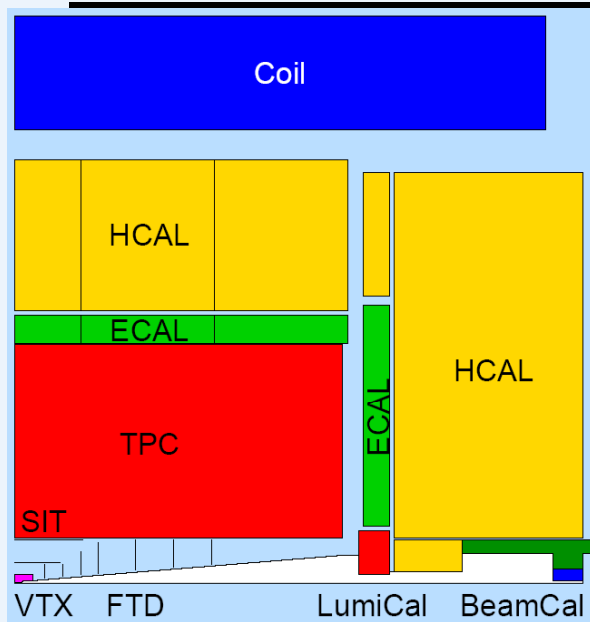
The Reduced scattering and point resolution are expected to provide improved momentum resolution.



higher multiplicity
 $e^+e^- \rightarrow \tau\tau \rightarrow 6 \text{ jets}$

10% of cells, at large radius, have multiple tracks.

LC-TPC: beam noise hit issues



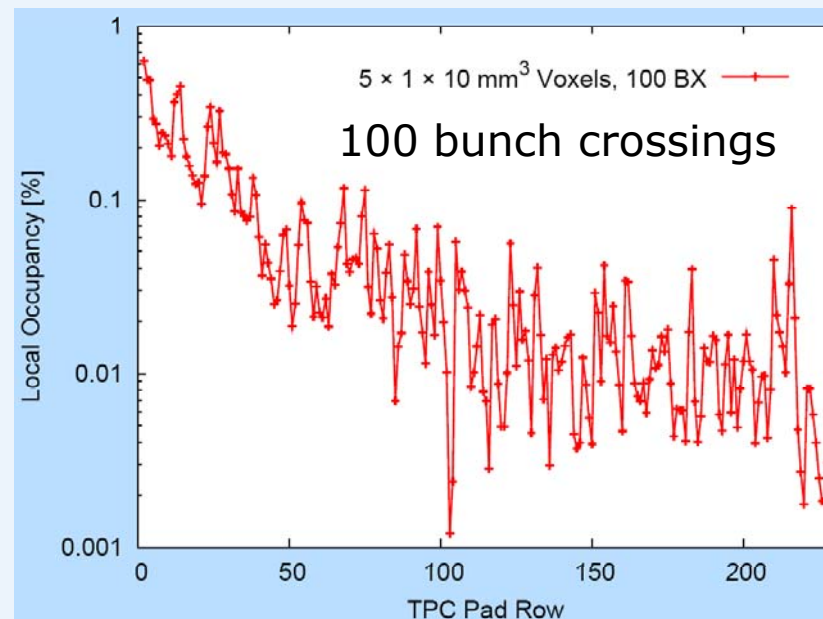
See A. Vogel

Beam particles are simulated in “Guinea Pig”.
TPC “hits” (ionization centers in the detector)
are simulated in Mokka.

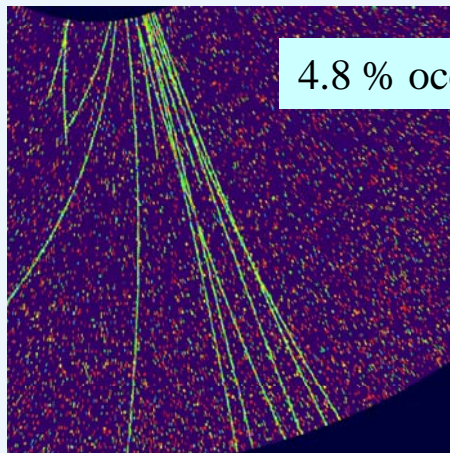
(Grid computing)

*New! This information is converted to
a voxel occupancy.*

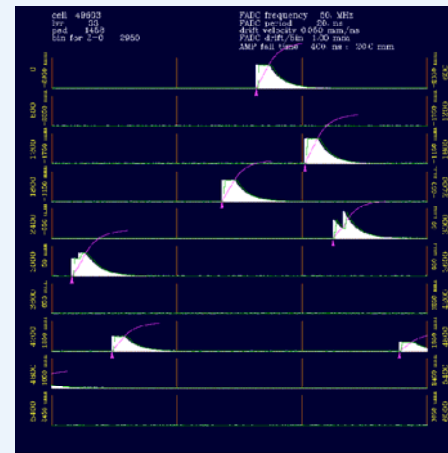
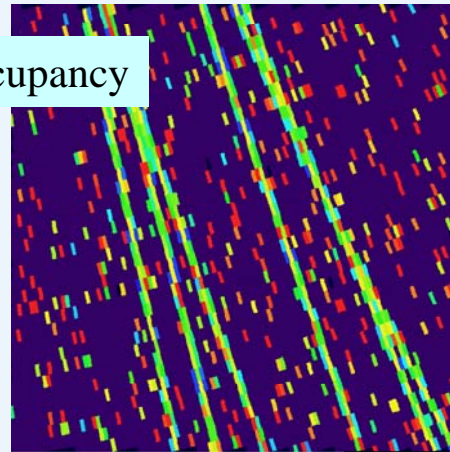
*The occupancy is 0.01% at large radius,
and as high as 1% at low radius.*



LC-TPC: beam noise hit issues



4.8 % occupancy



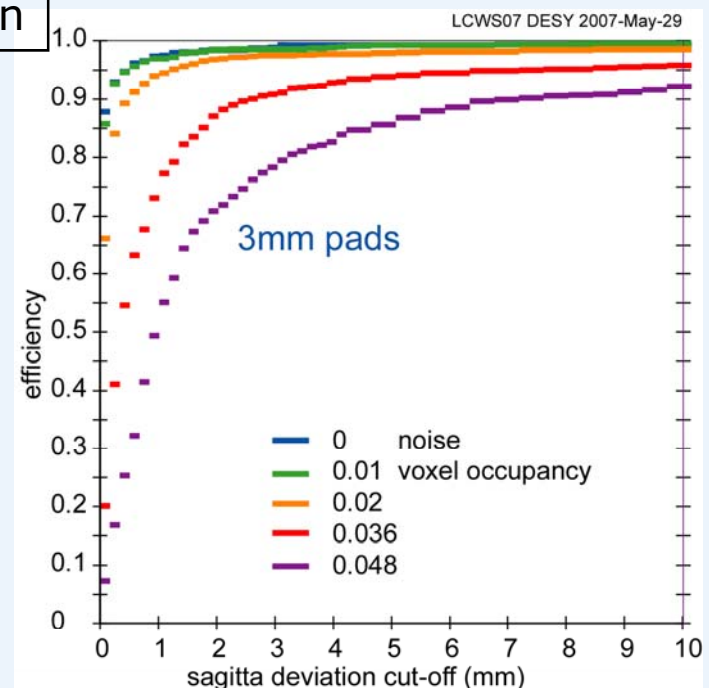
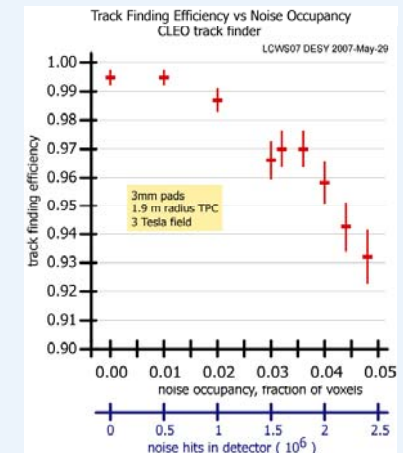
See D. Peterson

The effects of (salt and pepper) noise hits are studied by overlaying the FADC time response of track-related ionization with the response from the noise hits.

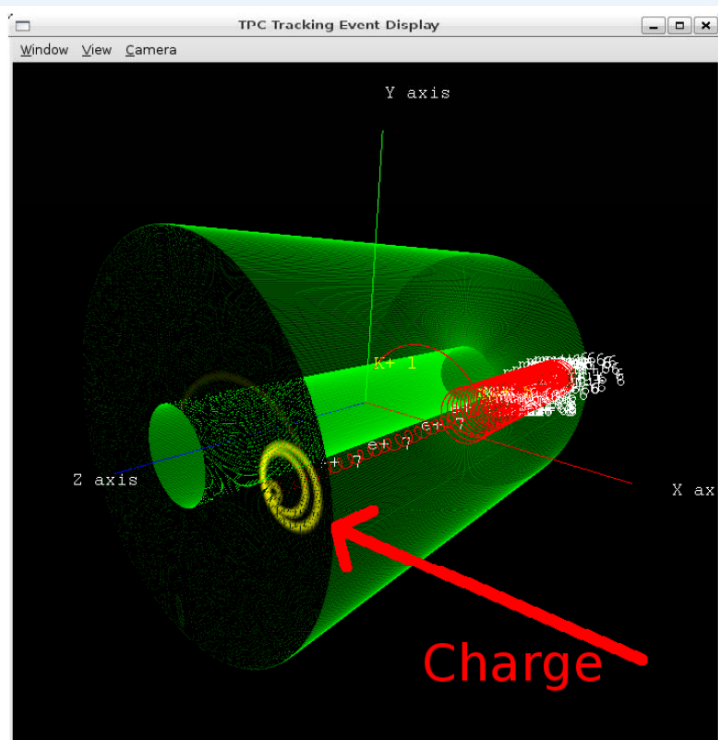
Efficiency loss is small up to 2% occupancy.

New! "Efficiency vs. resolution" has no degradation at 1% (uniform) occupancy.

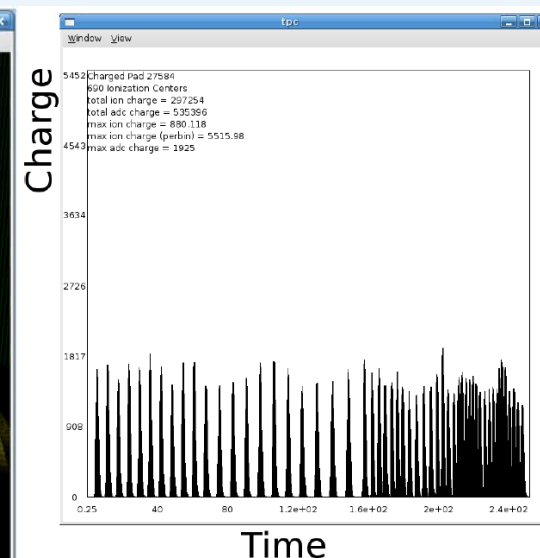
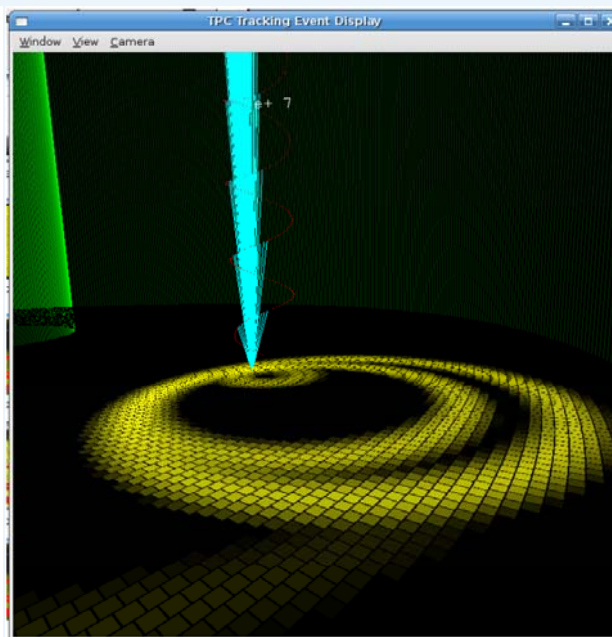
Combined with previous page, TPC occupancy appears to be under control.



LC-TPC: beam noise hit issues



See J. Hunt (simulation)

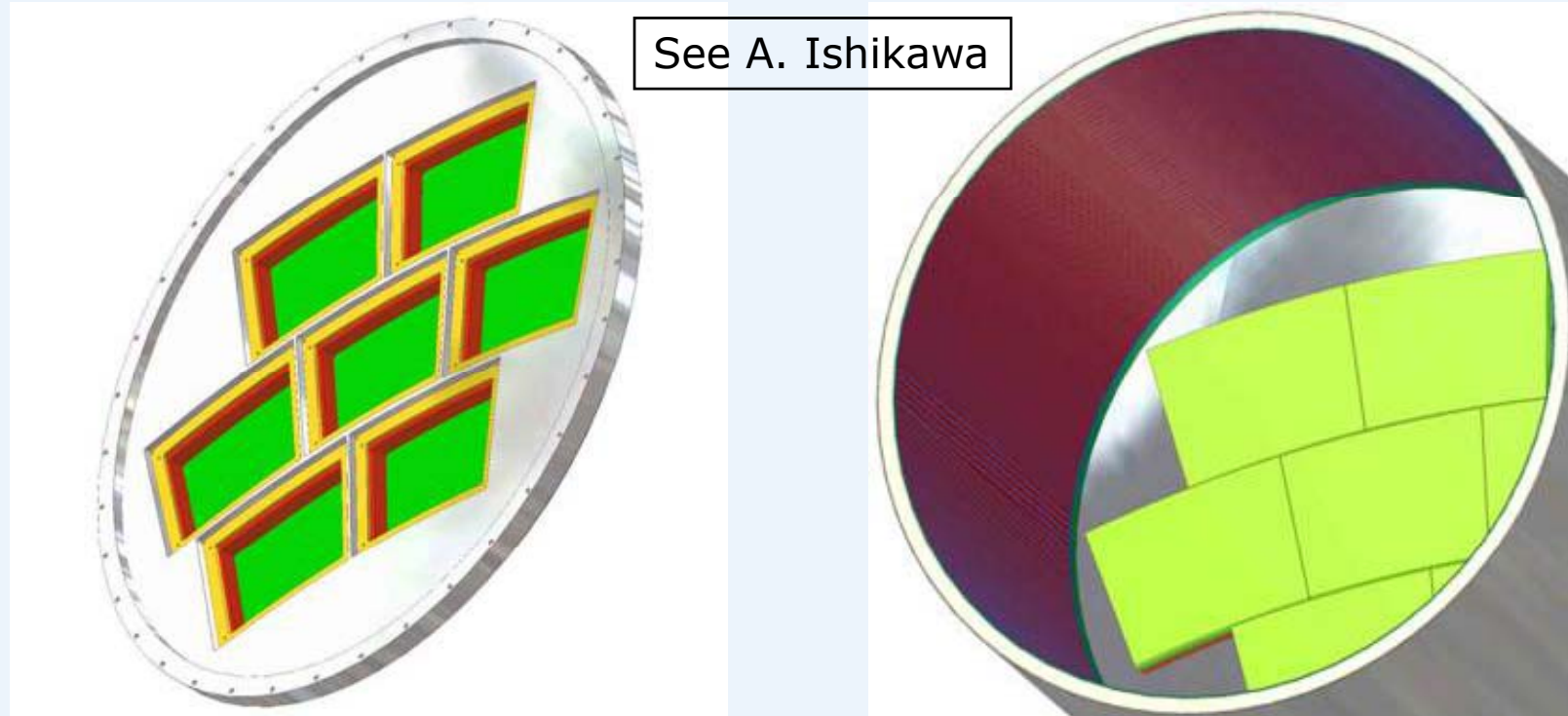


The problem with the old FADC simulation is that it is stand-alone, not part of Marlin.

New! A Marlin processor has been developed to convert the SimTrackerHits (ionization centers) to TrackerHits (TPC FADC "data").

This will allow the full overlap of the machine backgrounds with any physics process.

LC-TPC: the large prototype



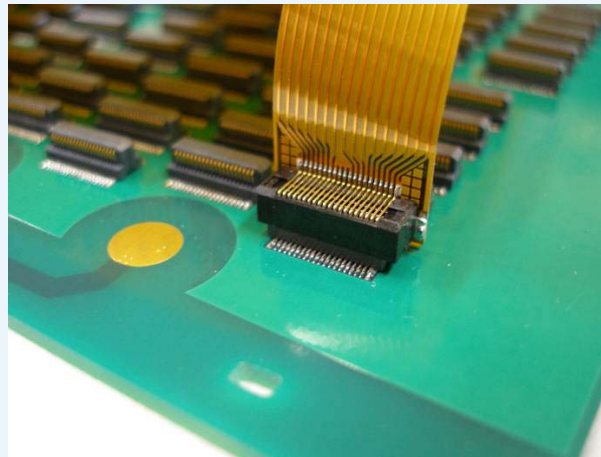
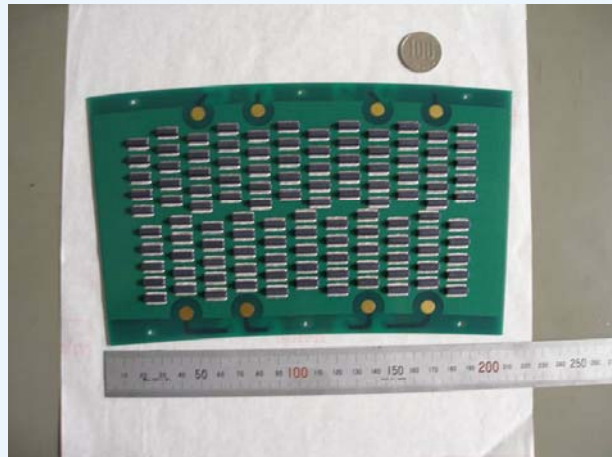
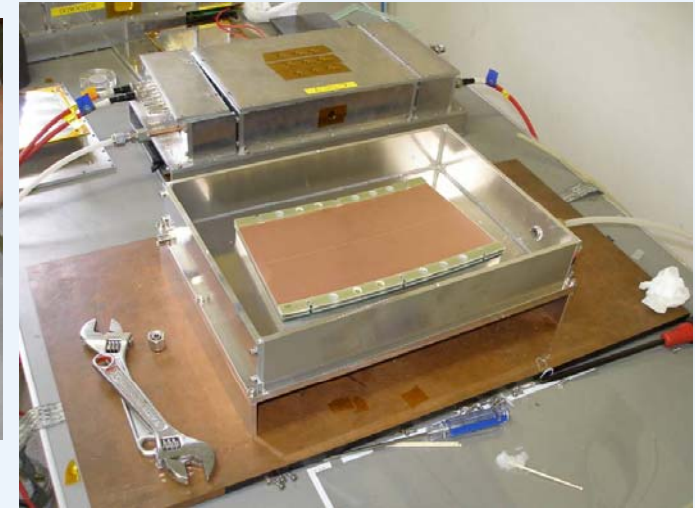
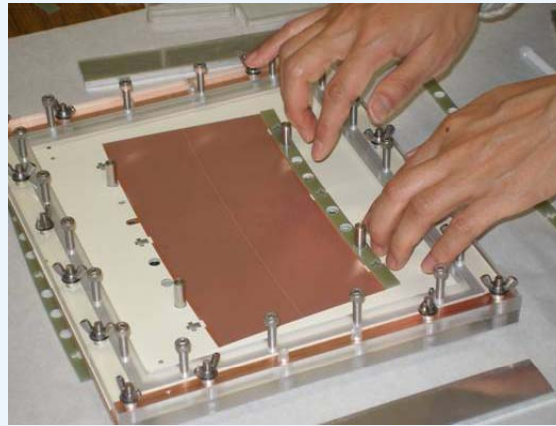
LC-TPC is constructing a “large prototype”
~80cm diameter, ~80cm length field cage.

(various MPGD technologies will be used)

7 modules, each 39000 mm² (~4x the (10cm)² used in many small prototypes)

(*Discussion of endplate, including fabrication precision and assembly,
will occur at the LC-TPC meeting, 04-June.*)

LC-TPC: the large prototype, module



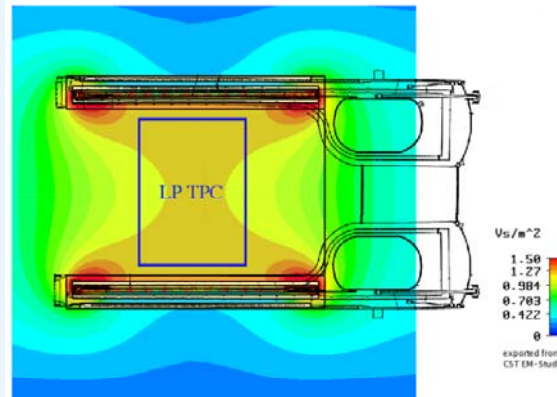
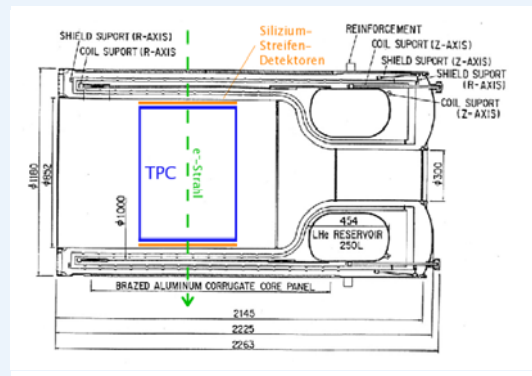
Constructing a pre-module.

pad board
stretching a GEM
module in test box
(back) connectors

Gain tests have been done.

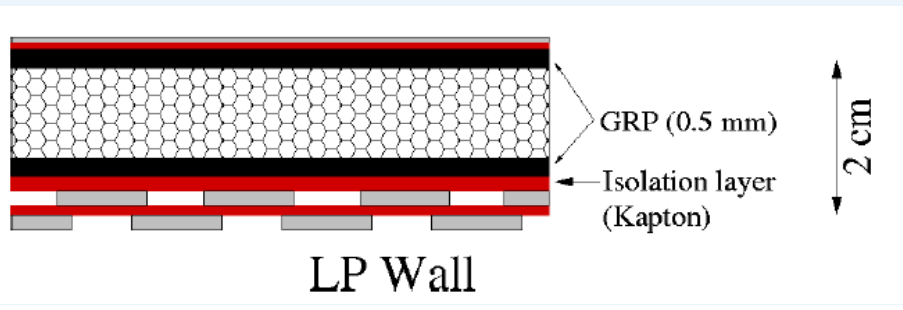
See A. Ishikawa

LC TPC: large prototype field cage

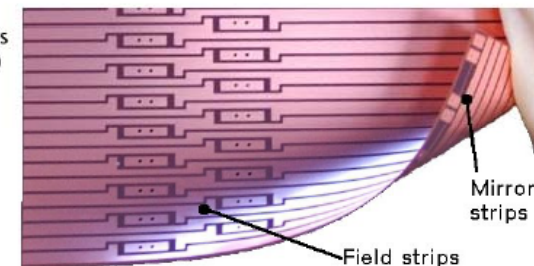
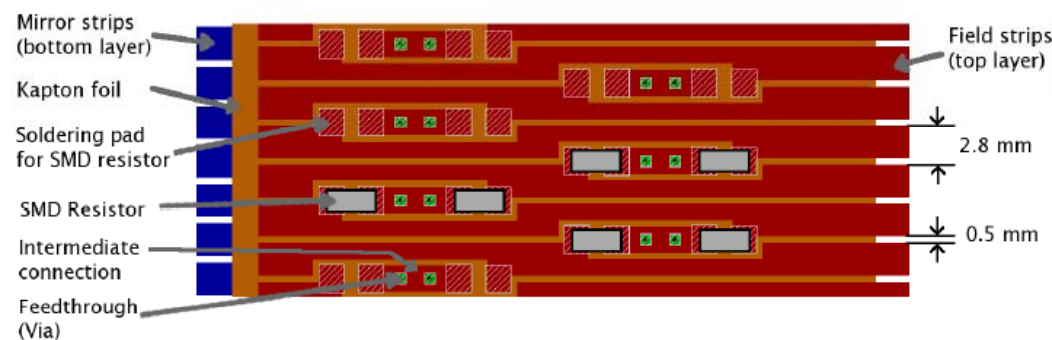


See L. Hallermann

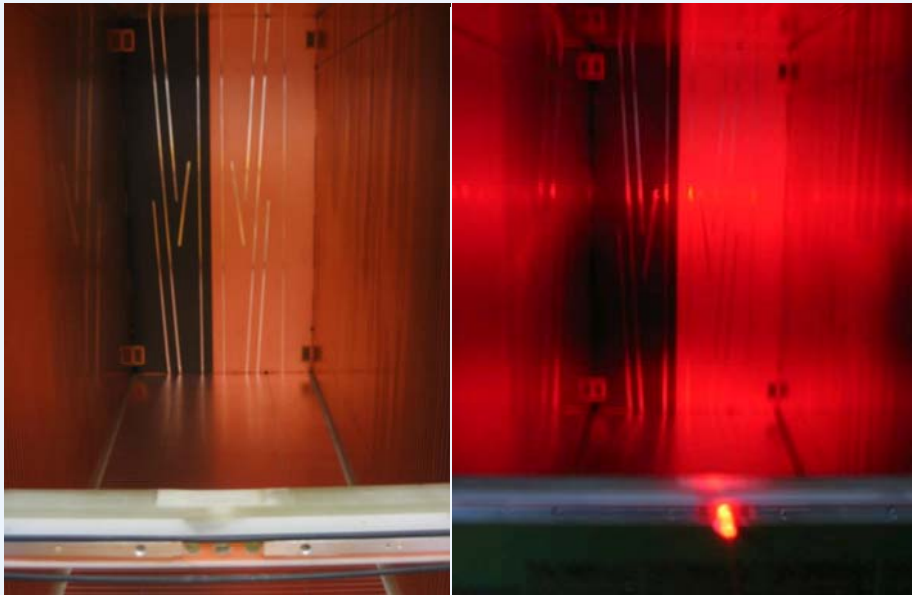
1.25 Tesla magnet at
DESY EUDET facility



Composite field cage construction
Field strip foil expected in next few weeks.



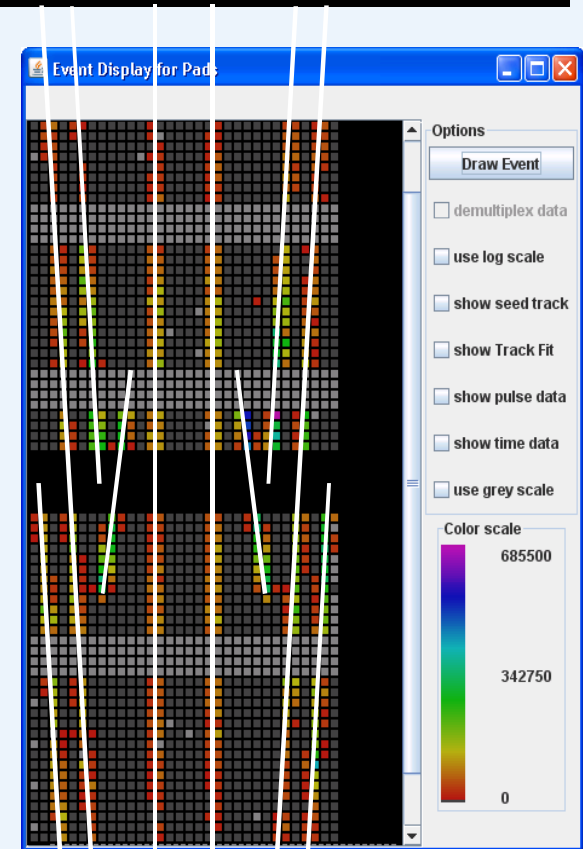
LC TPC: large prototype, distortion measurement



To produce photoelectrons for distortion measurements, place on the central cathode a pattern of metal with a lower work-function.

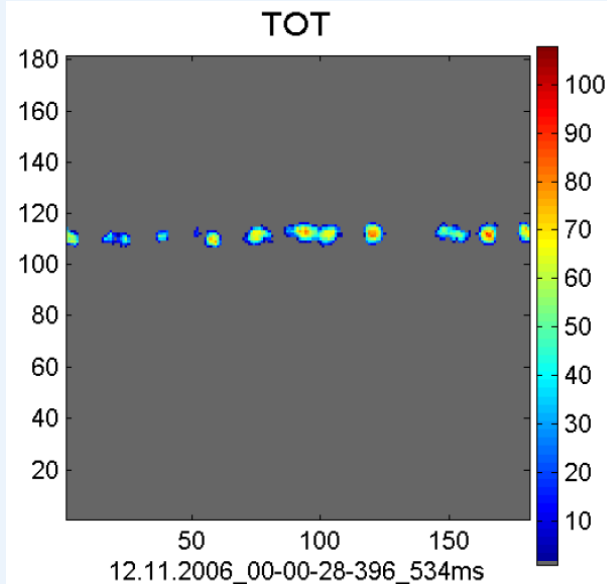
Flashing the central cathode with a light pulse of the right wavelength will produce photoelectrons only from the metal pattern. A precise survey of metal pattern allows for absolute measurements of distortions.

Technique is already being developed for T2K.

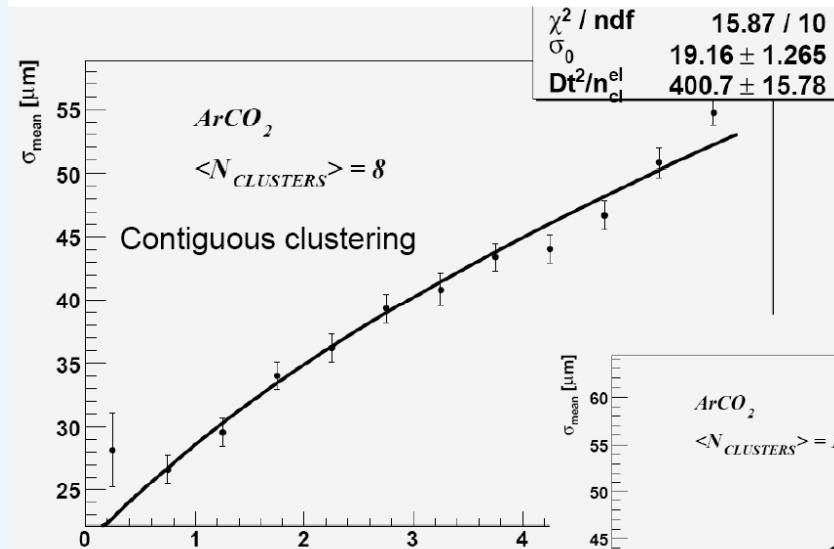


See D. Karlen

LC TPC , pixel readout, w/GEM

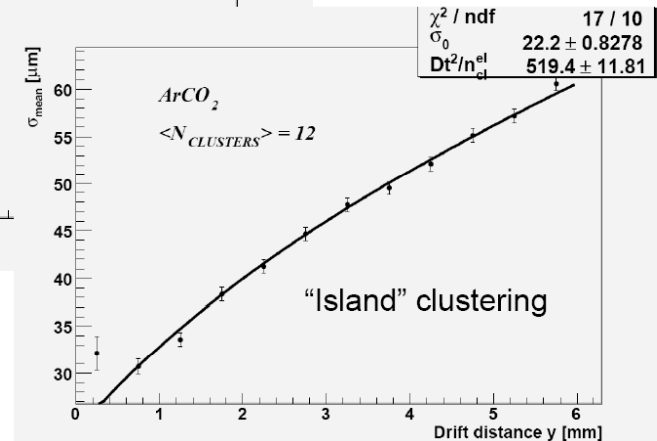


Point Resolution vs. Drift Length for Different Clustering Methods



- High statistics runs
- Increase of number of clusters per track length

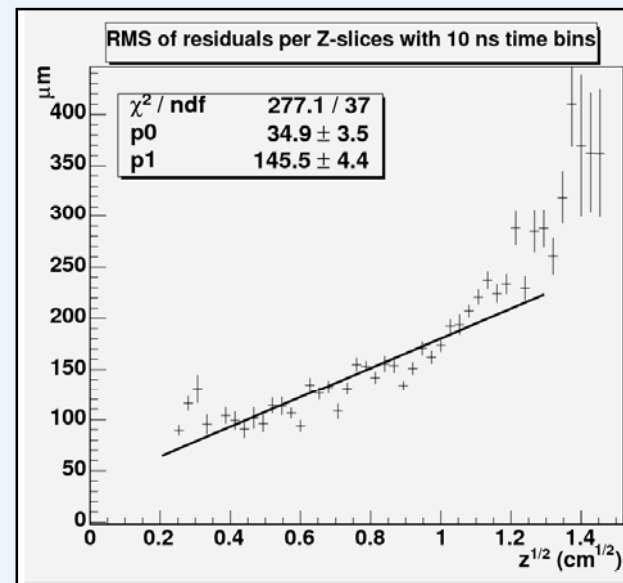
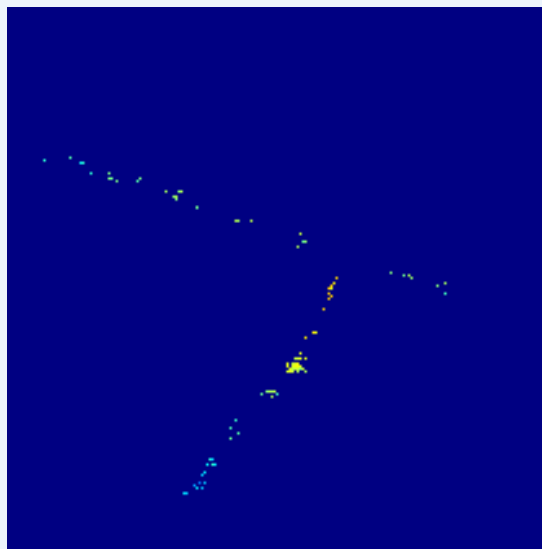
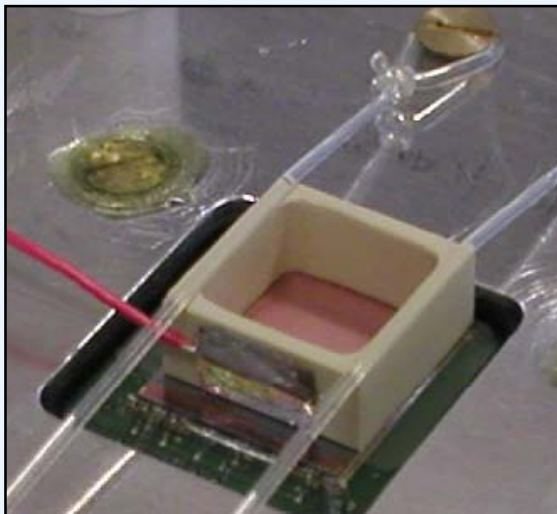
• By increasing the number of clusters the resolution per cluster goes up $\sim (12/8)^{1/2}$



Two clustering methods were presented, with point resolution measurements.

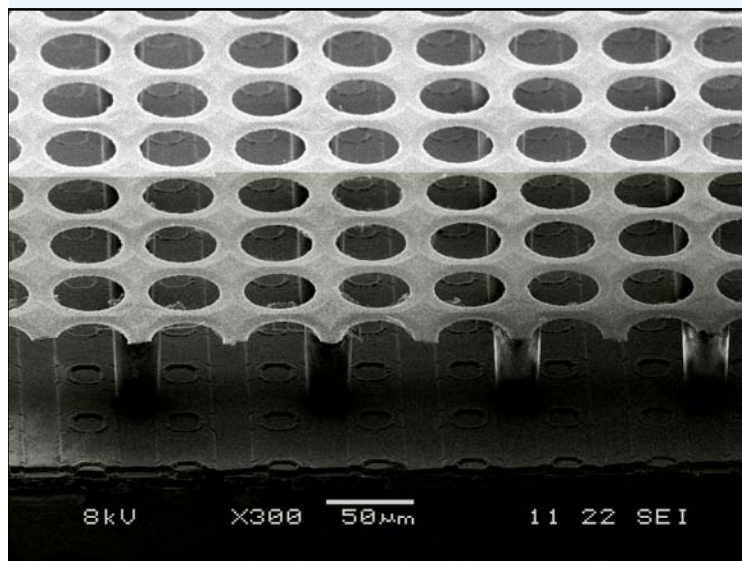
See N. Vlasov

LC TPC , pixel readout, w/Micromegas



TimePix w/Micromegas
Results of cosmic tests

See M. Chefdeville



Medipix chip wafer -
Post-processing of a 4" wafer successful!
SiProt covered
InGrid covered
Diced to individual chips