The PHOBOS Detector at RHIC

Present Status and Future Plans

Robert Pak (BNL)

for the PHOBOS Collaboration

Quark Matter 2001

Jan. 16, 2001

Robert Pak for

PHOBOS Collaboration

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BROOKHAVEN NATIONAL LABORATORY

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UNIVERSITY OF ILLINOIS AT CHICAGO

Russell Betts, Christopher Conner, Clive Halliwell, Rudi Ganz, Richard Hollis, Burt Holzman, Wojtek Kucewicz, Don McLeod, Rachid Nouicer, Michael Reuter

UNIVERSITY OF MARYLAND

Richard Baum, Richard Bindel, Jing Shea, Edmundo Garcia-Solis, Alice Mignerey

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Primary Physics Objectives

- PHOBOS searches for signatures of QGP at RHIC
  - » Multiplicity of charged particles for $|\eta| < 5.4$
  - » Particles down to low p_T near $y = 0$
  - » Particle ratios, spectra, and correlations
- PHOBOS "lives" on analog signals of our silicon detectors
  - » dE/dx as multiplicity estimator
  - » dE/dx method for particle identification
  - » Background rejection
  - » Pattern recognition

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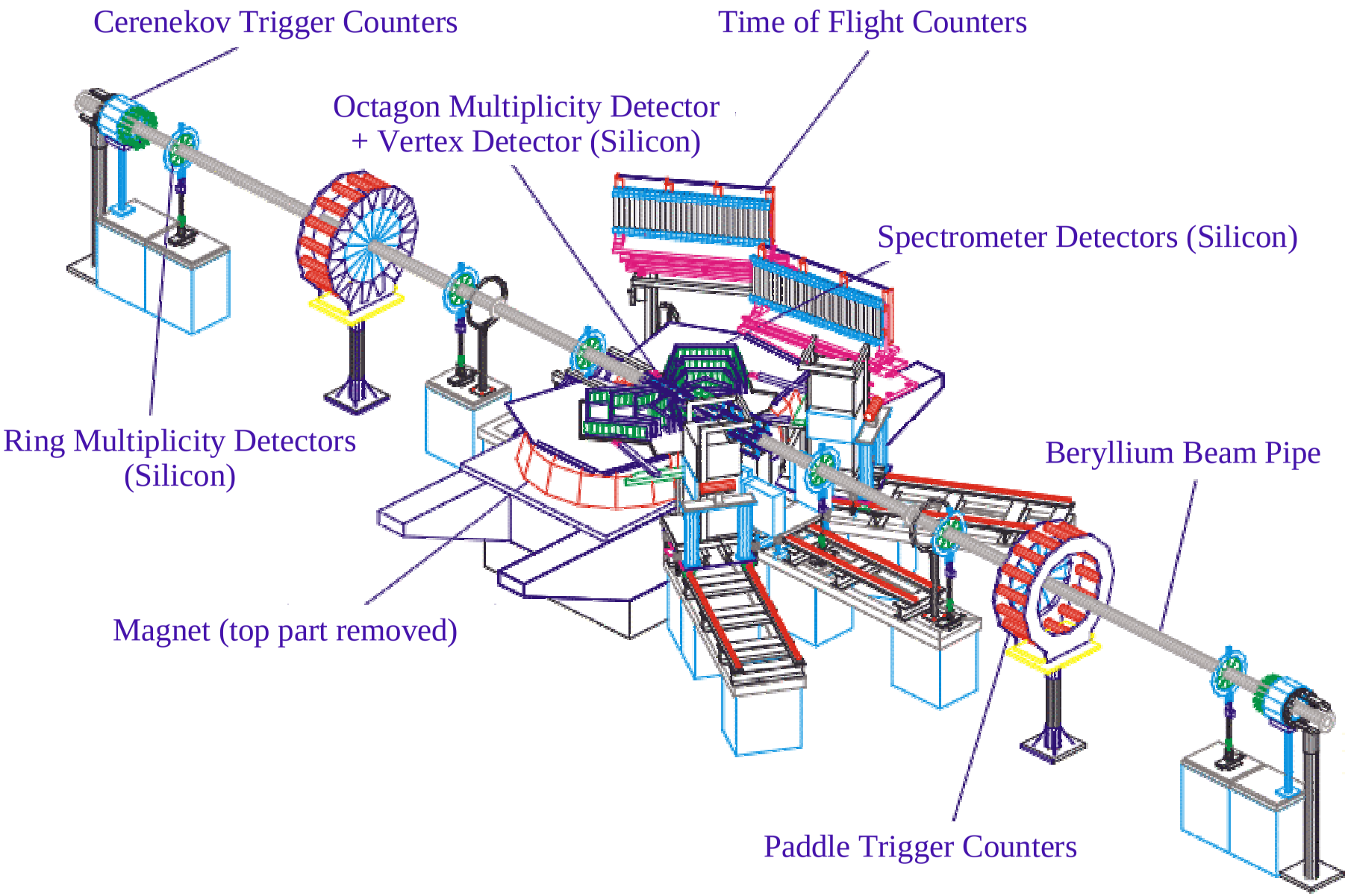
PHOBOS Apparatus



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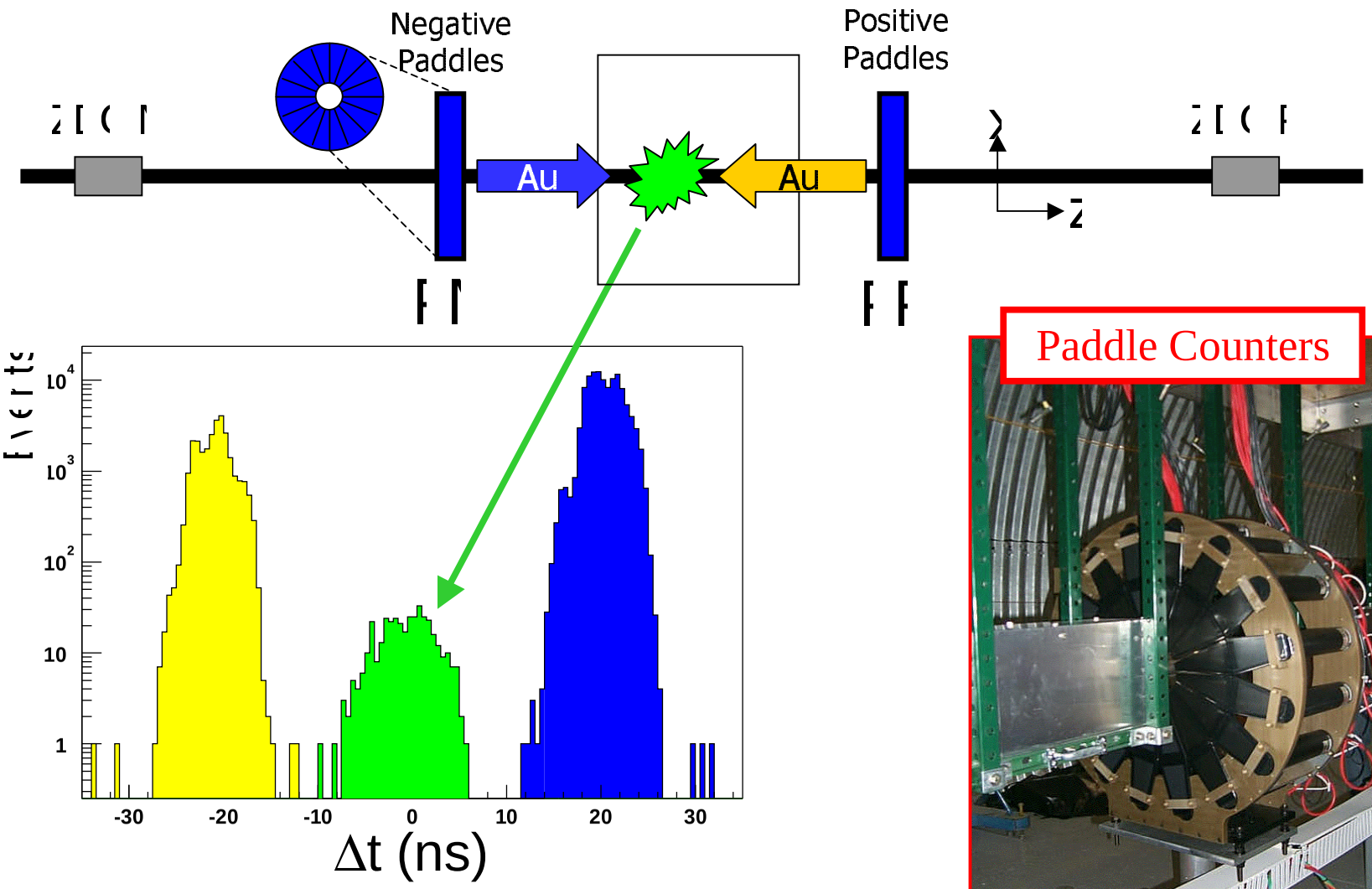
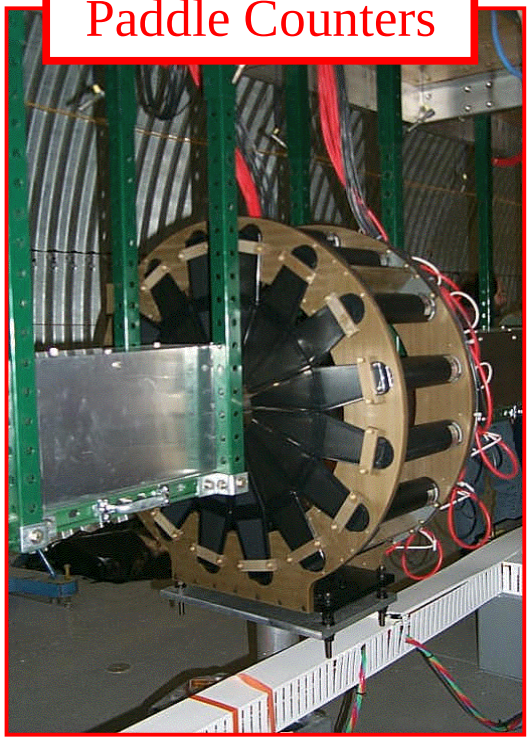
Event Selection



Paddle Counters



Coincidence (38 ns) between paddle counters

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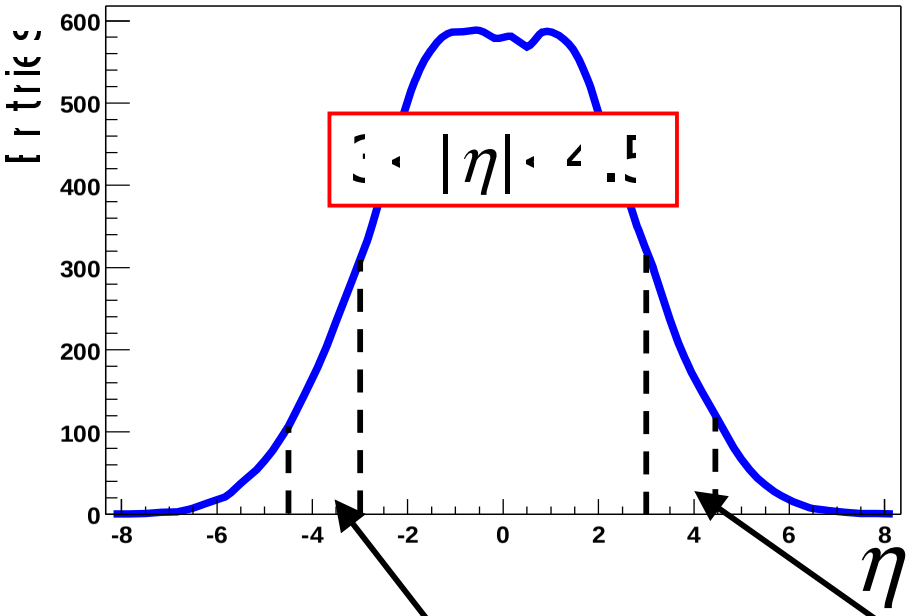
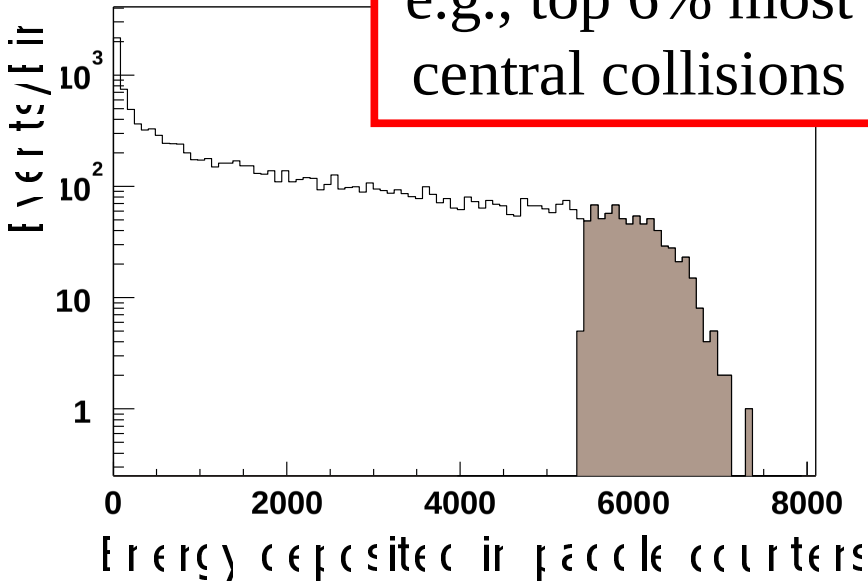
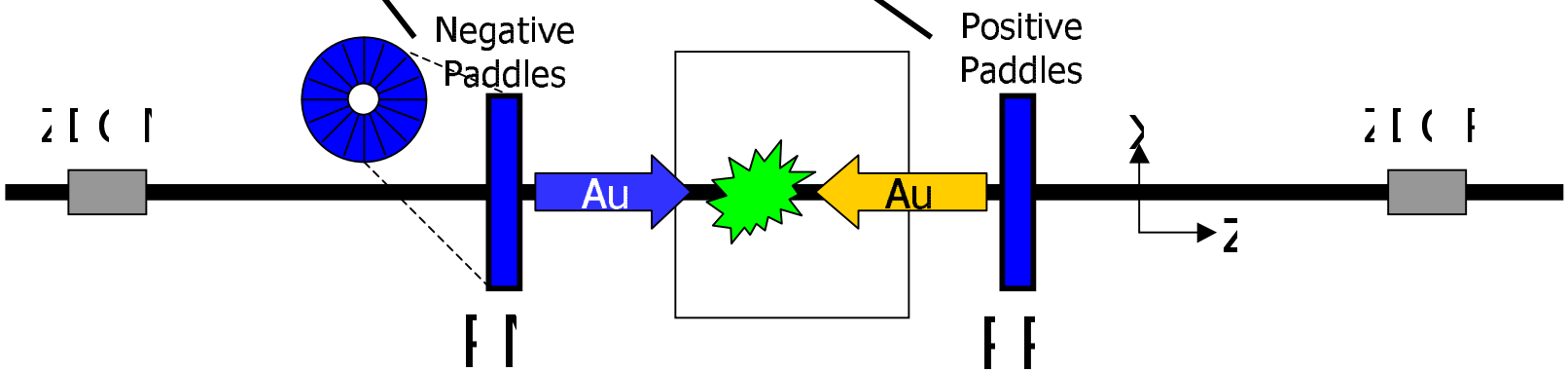
Centrality with Paddles





e.g., top 6% most central collisions



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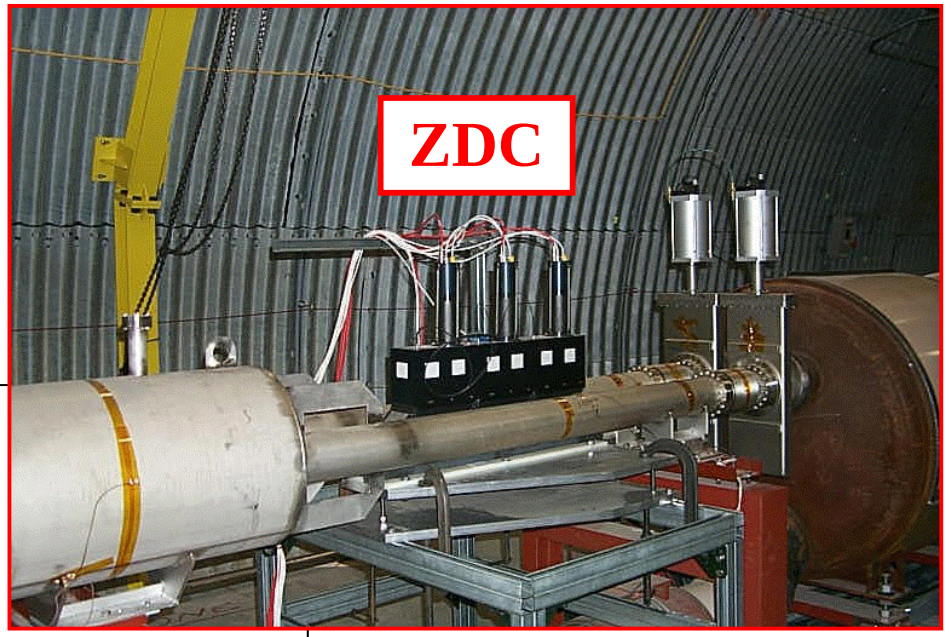
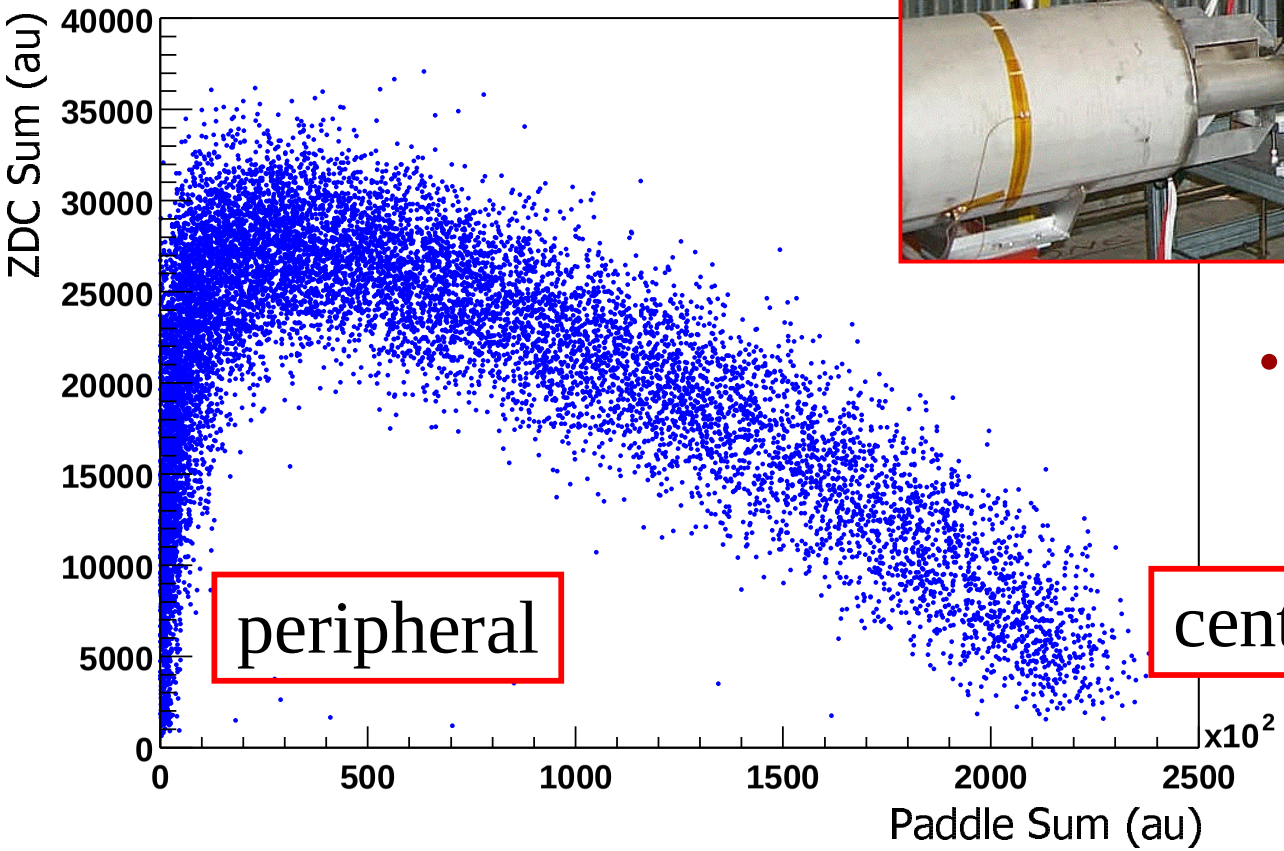
Centrality with ZDCs

ZDC sum vs. Paddle sum: Independent methods to determine centrality that correlate well





- See J.M. Katzy in Parallel Session II for details

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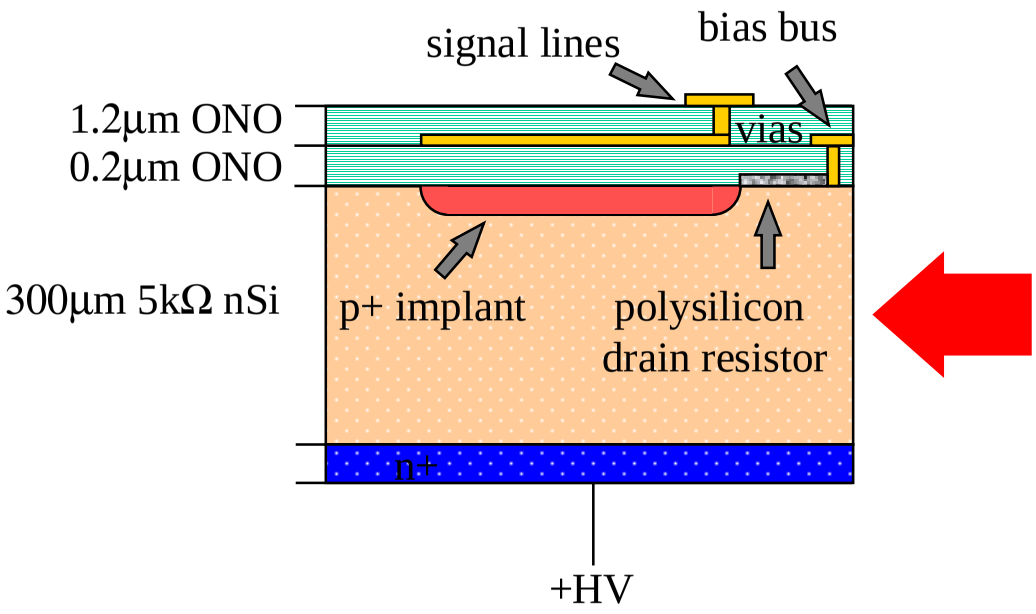
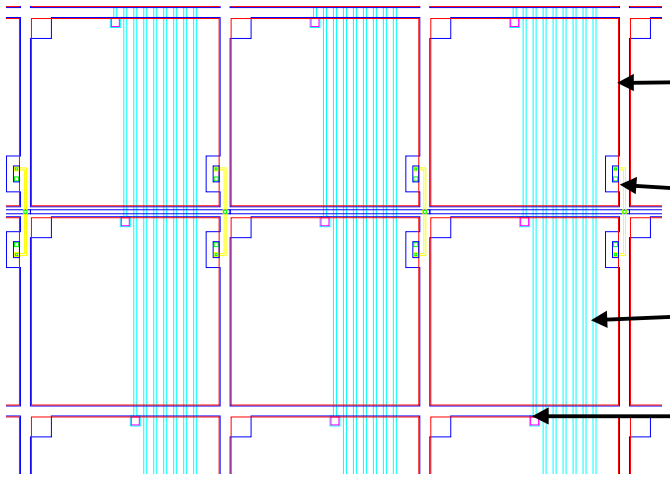
Silicon Pad Technology



Double Metal, single-sided, AC coupled, polysilicon biased detectors produced by ERSO in Taiwan



AC coupled pad (p-implant + metal 1 pad)

polysilicon bias resistor

metal 2 readout line

contact hole metal 1- metal 2

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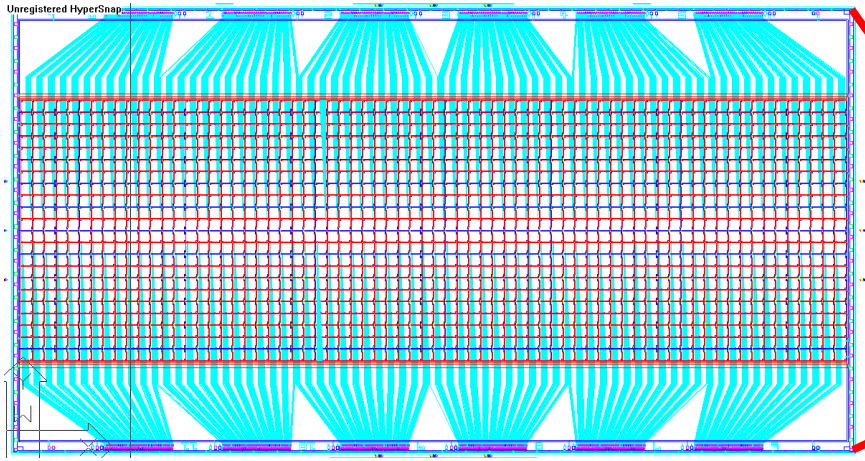
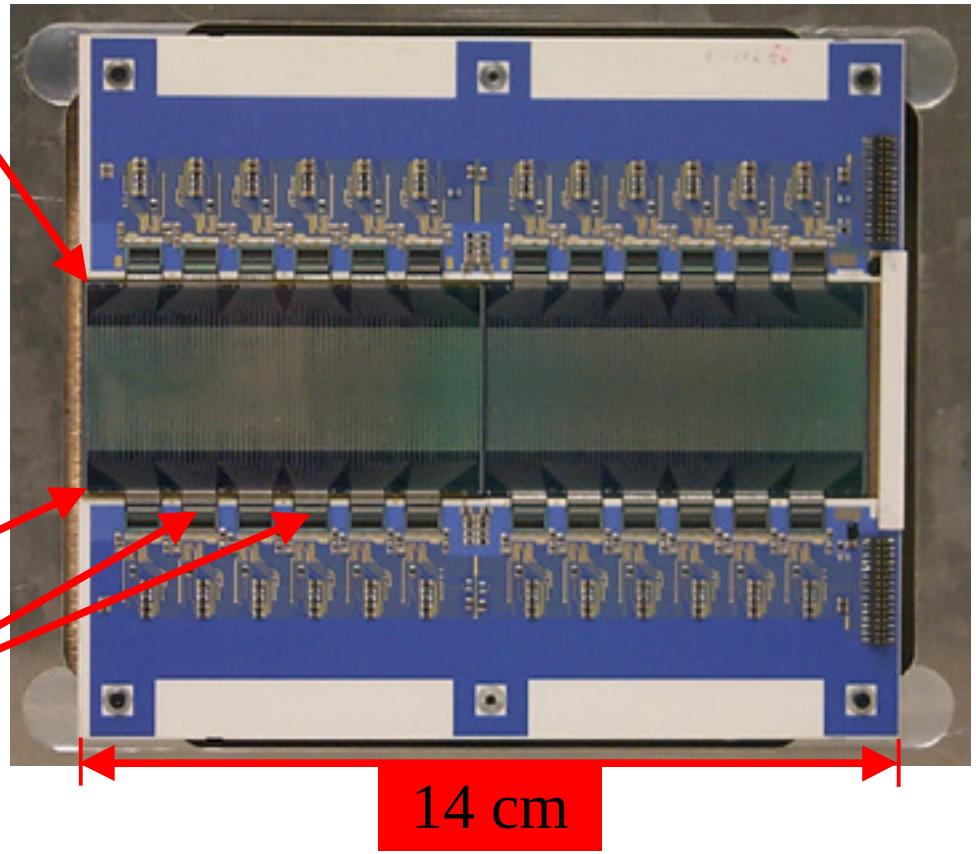
Silicon Pad Sensors

Typical pad layout





IDE VA-HDR1
Readout Chips

- High dynamic range (> 100 MIPs), peaking time 1.1 µs
- Si latch-up system interlocks during single-event upset to protect against chip damage

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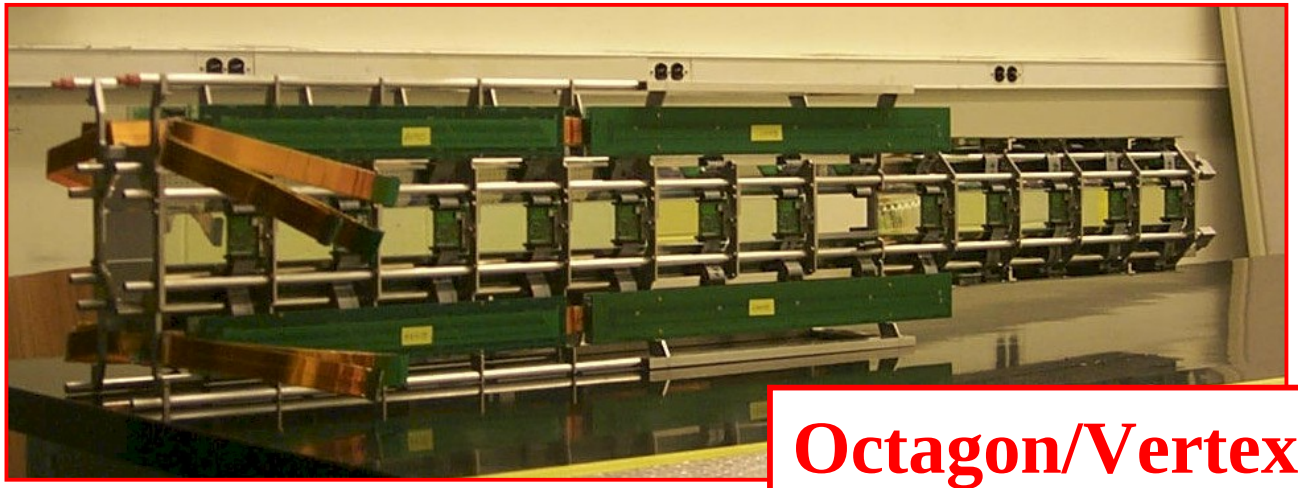
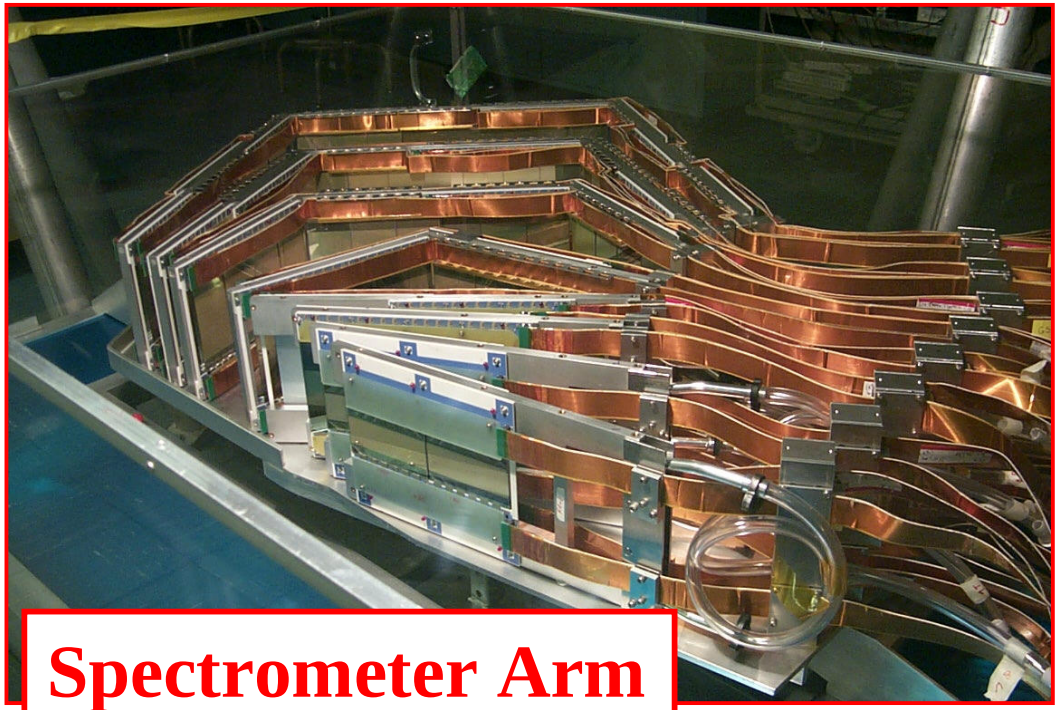
Silicon Everywhere

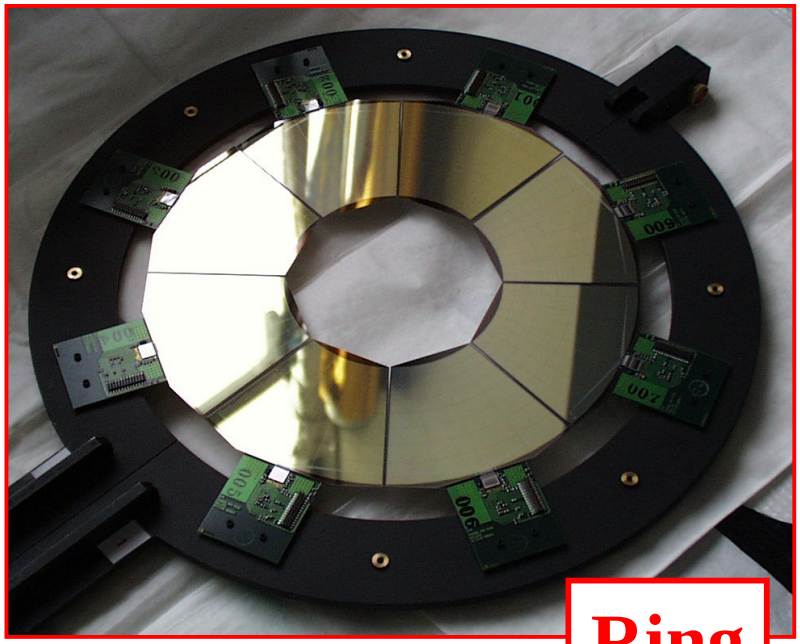


Octagon/Vertex

137,000 channels in total



Spectrometer Arm



Ring

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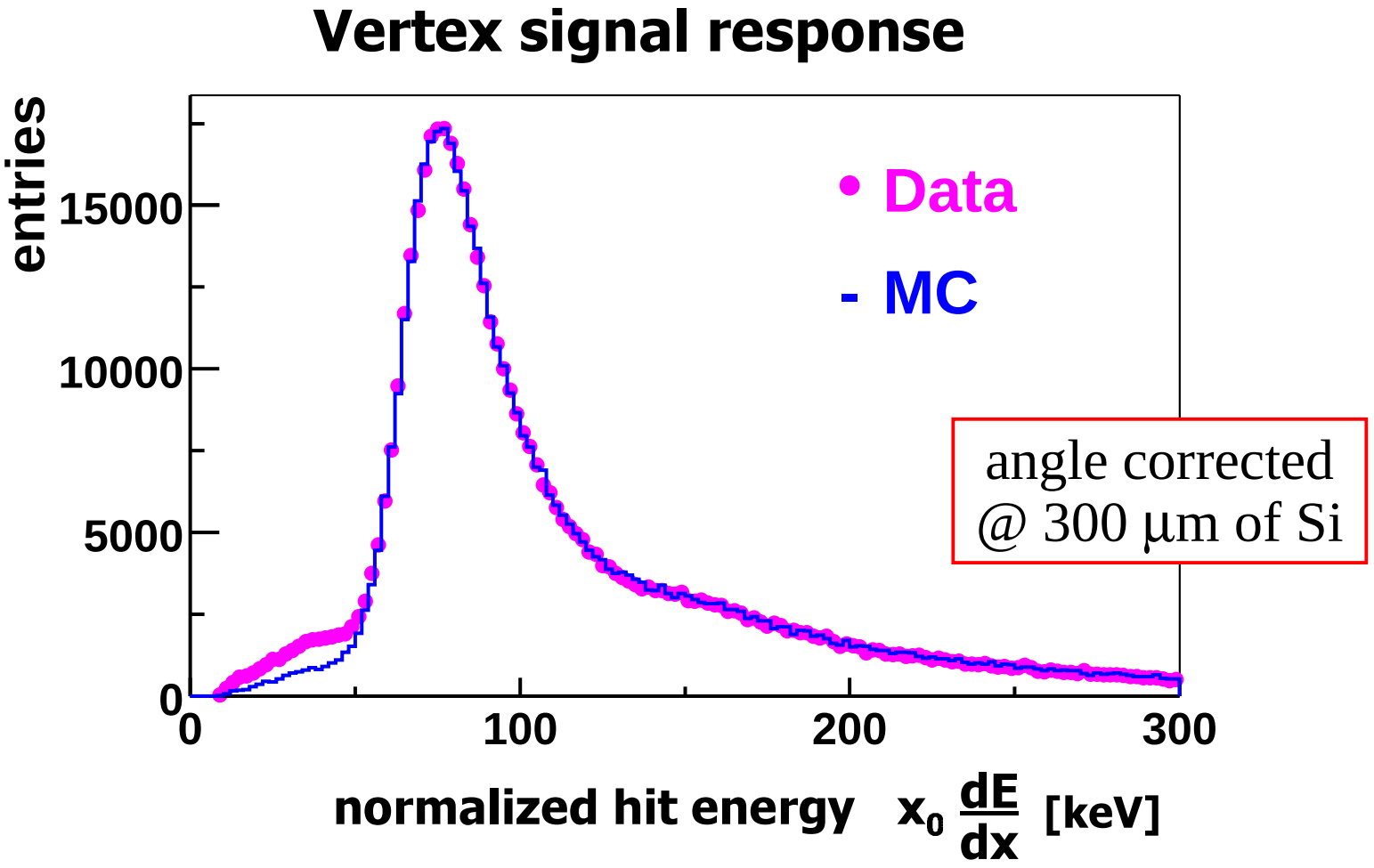
Si Signal Simulation



- Full understanding of detector signal at the most basic level

Sensor Uniformity

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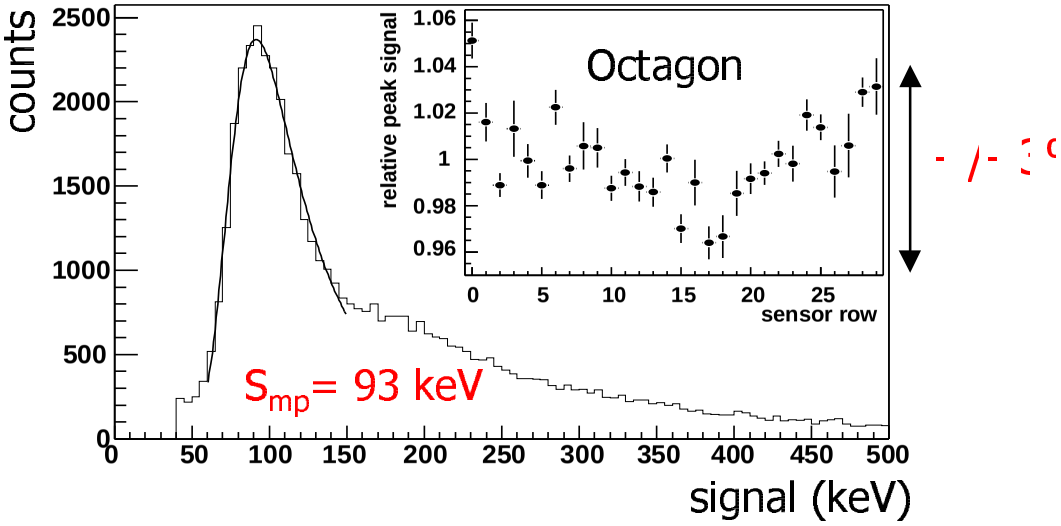

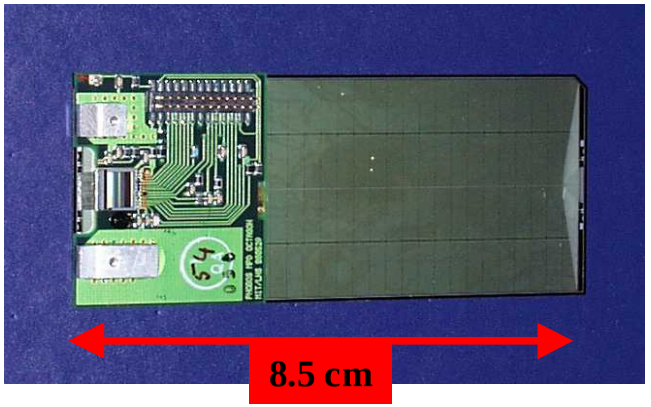

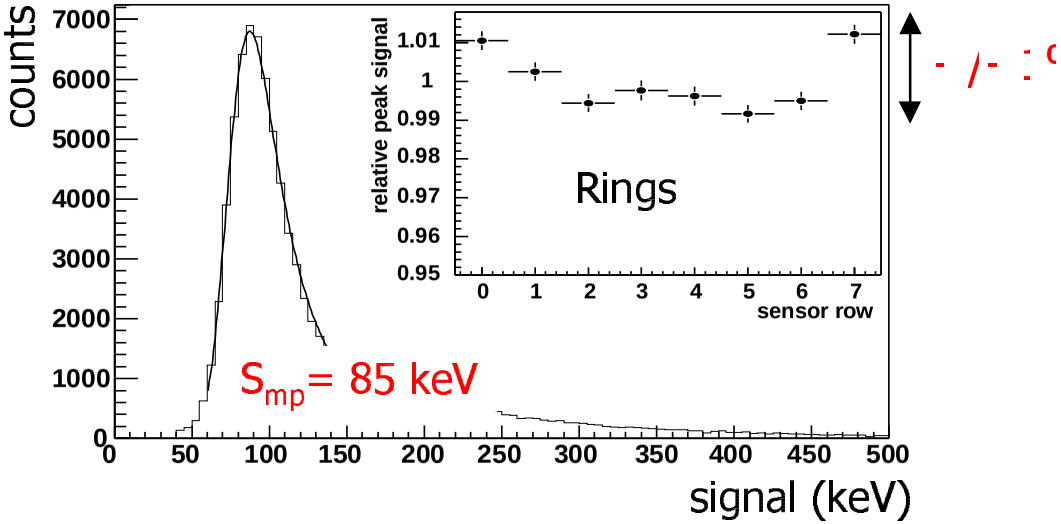

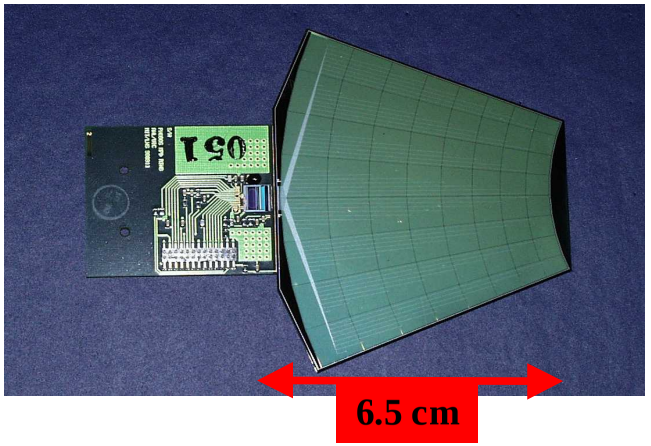

No substantial signal variation due to different layout
(double metal line routing and/or varying pad size)

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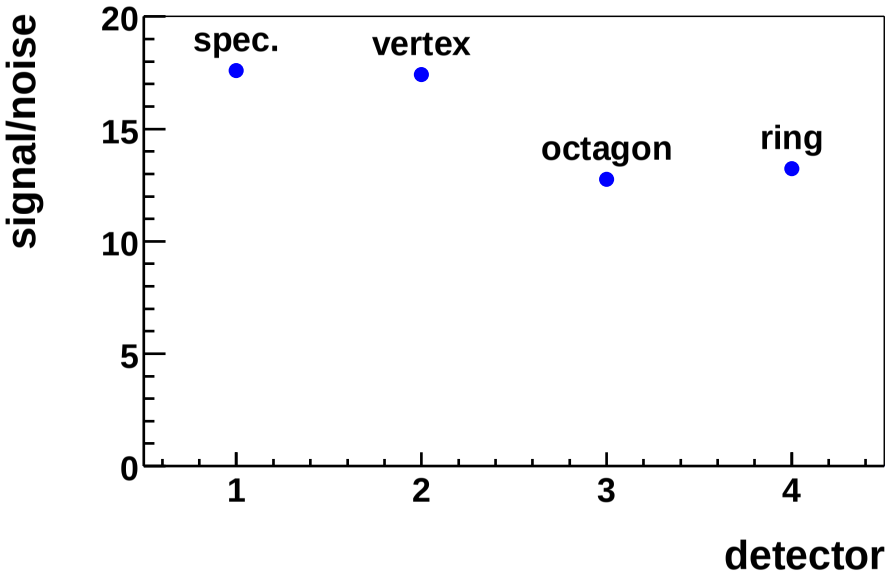
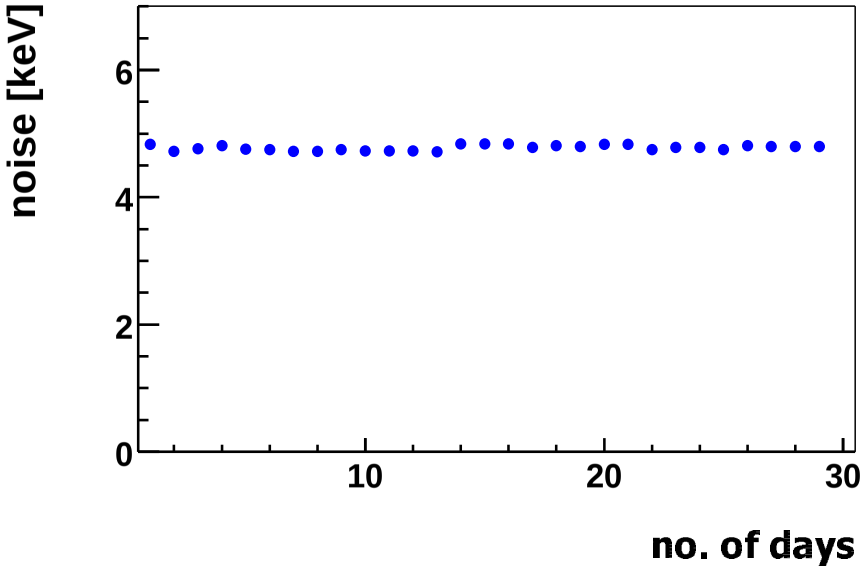
Signal/Noise Ratios





- S/N ratios better than 10:1 design specification
- Larger pads & longer readouts ⟶ lower S/N ratio
- Ave. noise in entire detector setup stable over time

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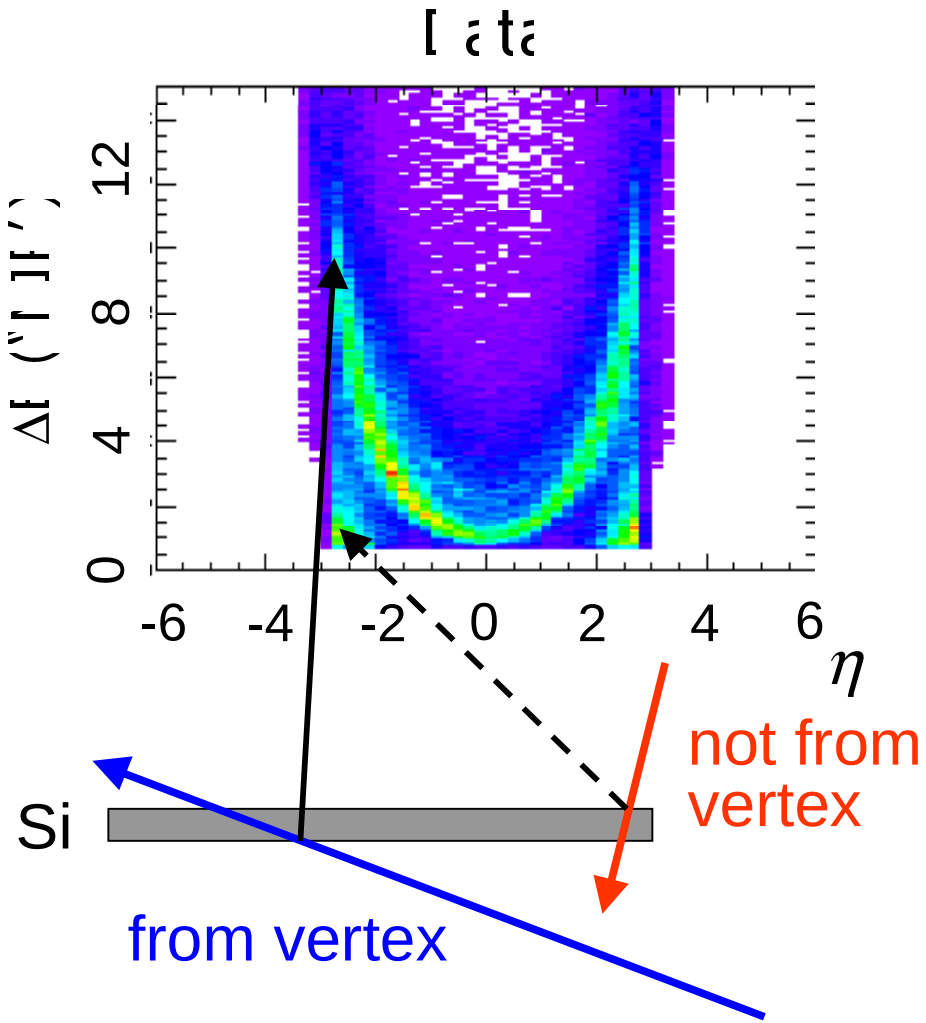
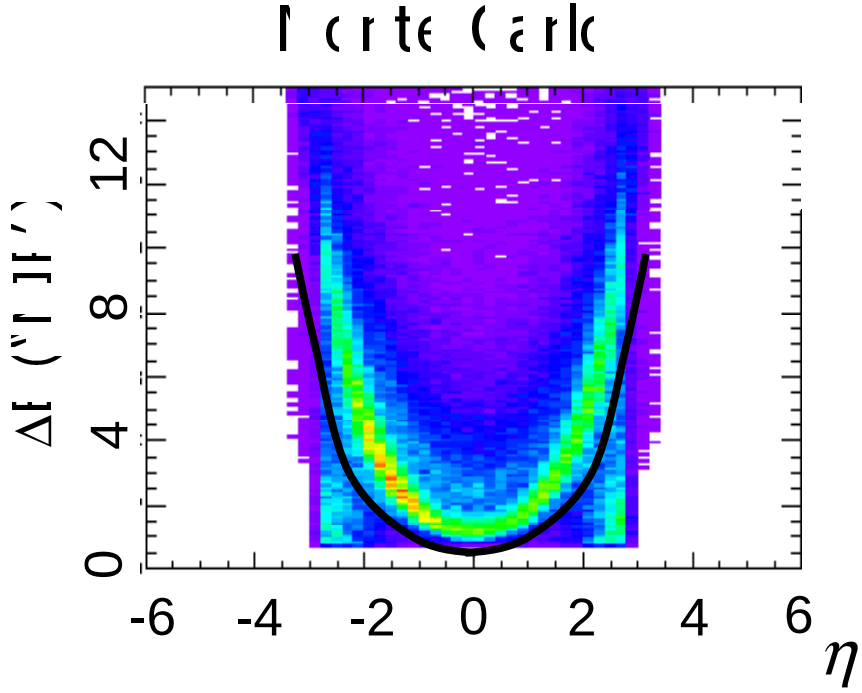
Background Suppression

Δ E vs. η in the Octagon





- Good agreement between data and simulation
- Powerful method to reject background

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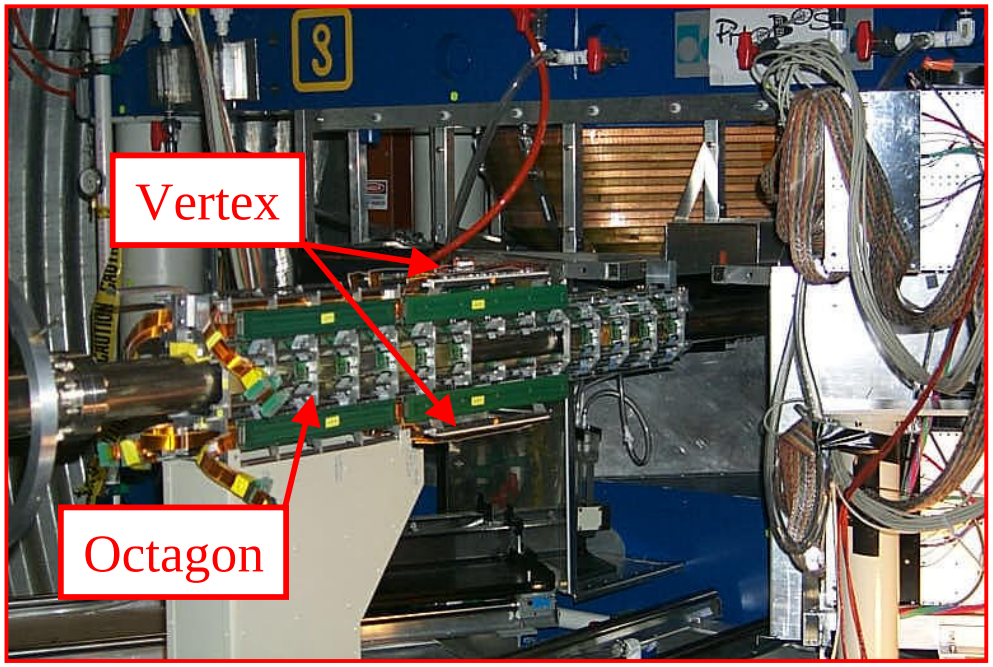
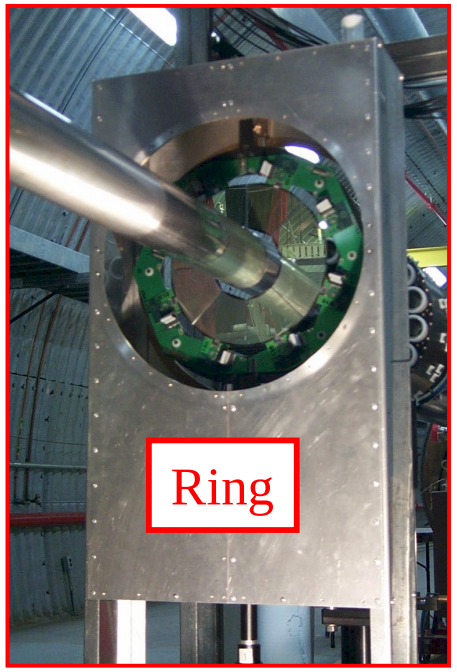
Multiplicity & Vertex Array





Multiplicity:

- Single layer of Si with large pads

Vertex:

- Two layers of Si with “strip” pads

Count single hits or sum of analog signals in a detector area as a measure of particle multiplicity

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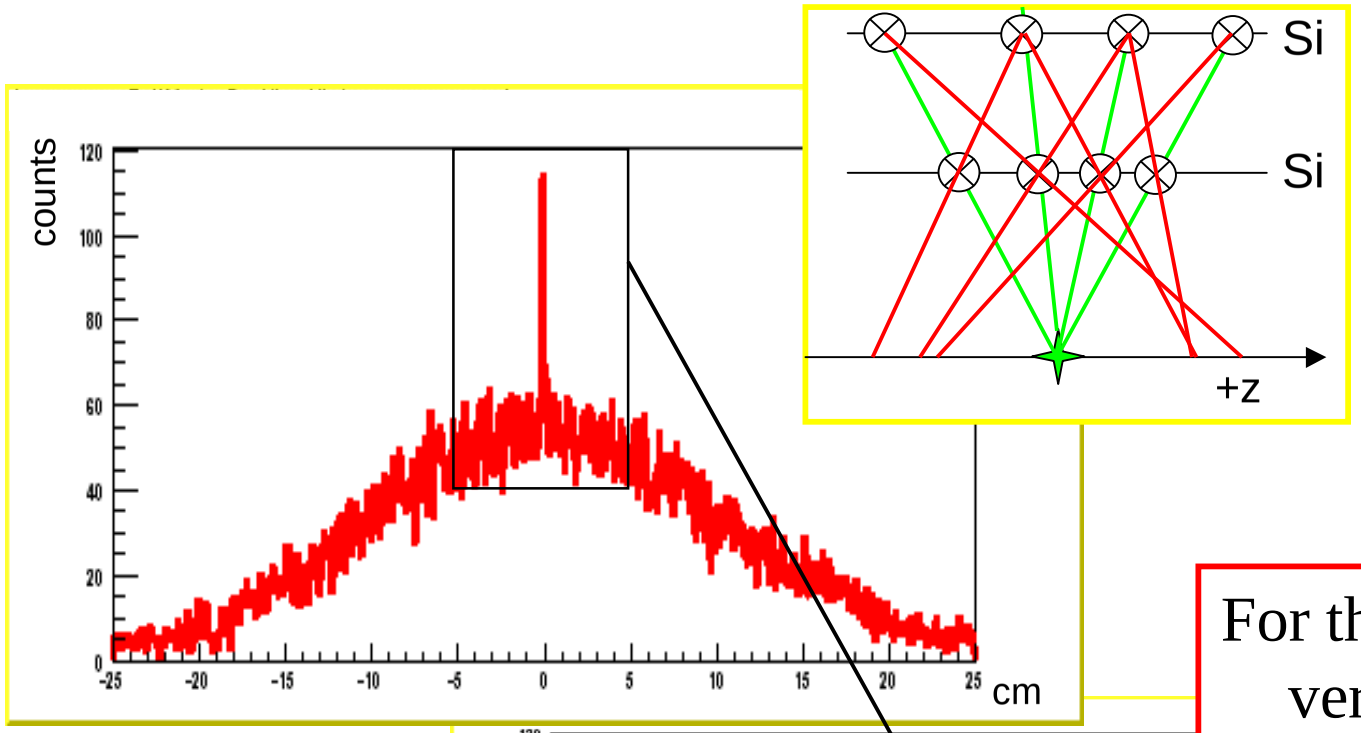
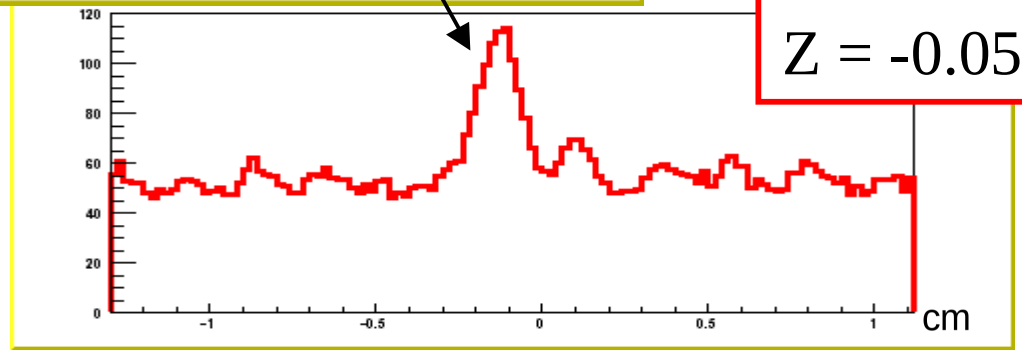
Vertex Determination





For this event:
vertex @
Z = -0.054 cm

Vertex Resolution:

$\sigma_x \sim 450\ \mu m$

$\sigma_y \sim \sigma_z \sim 200\ \mu m$

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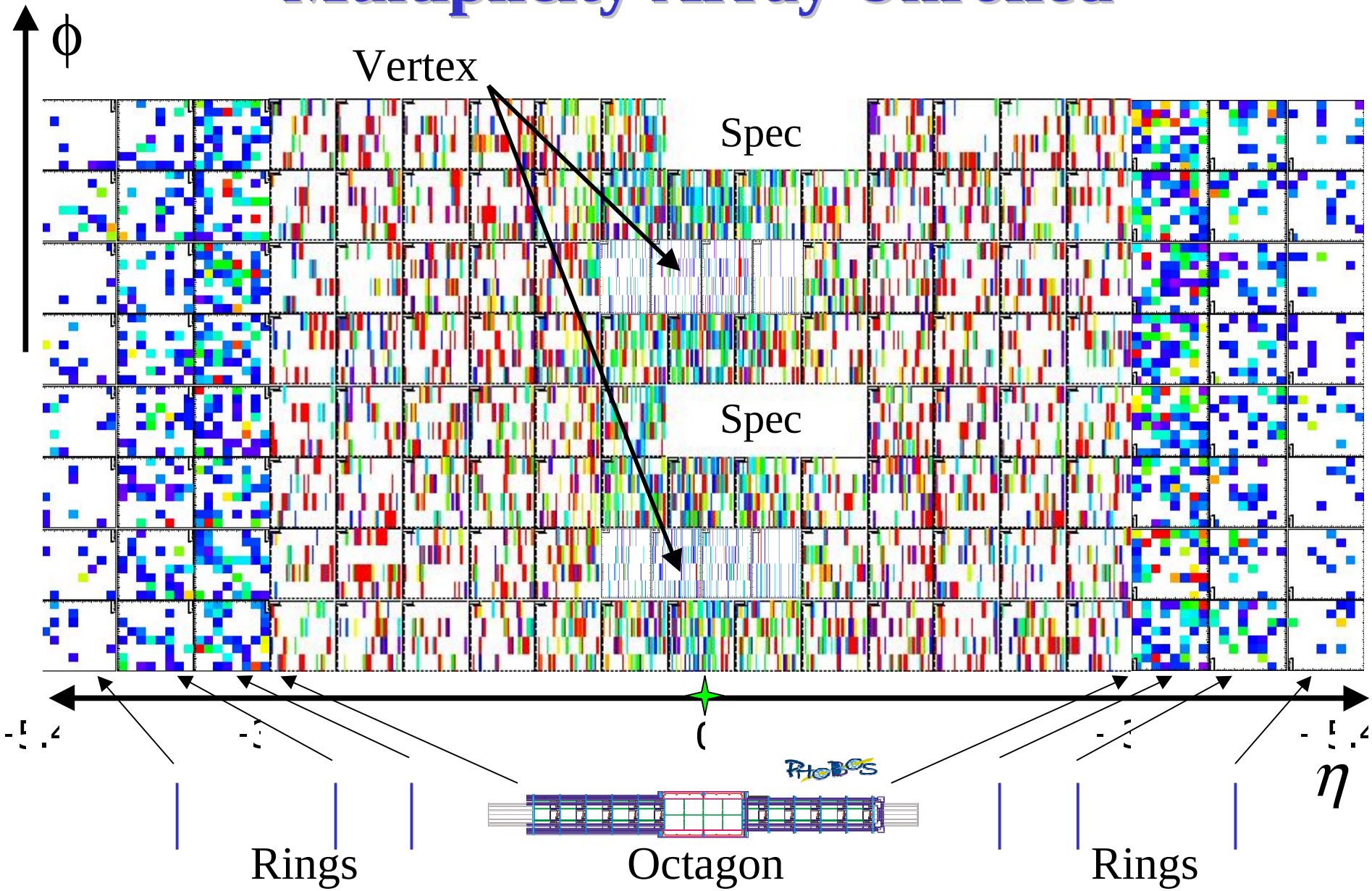
Multiplicity Array Unrolled



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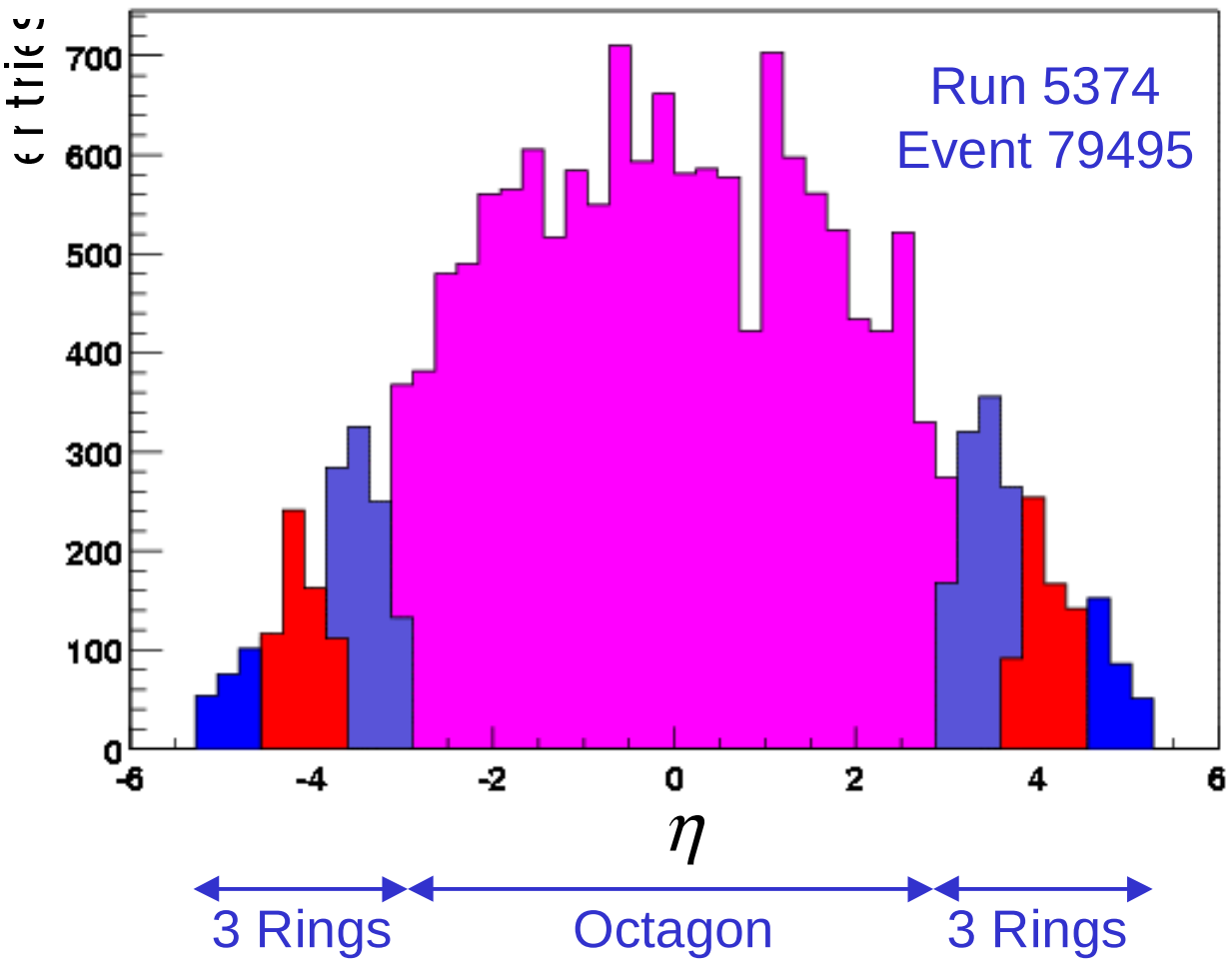
Multiplicity Distribution



- See A.H. Wuosmaa in Monday Plenary Session for details
- Also Collective Effects: See I.C. Park in Parallel Session II

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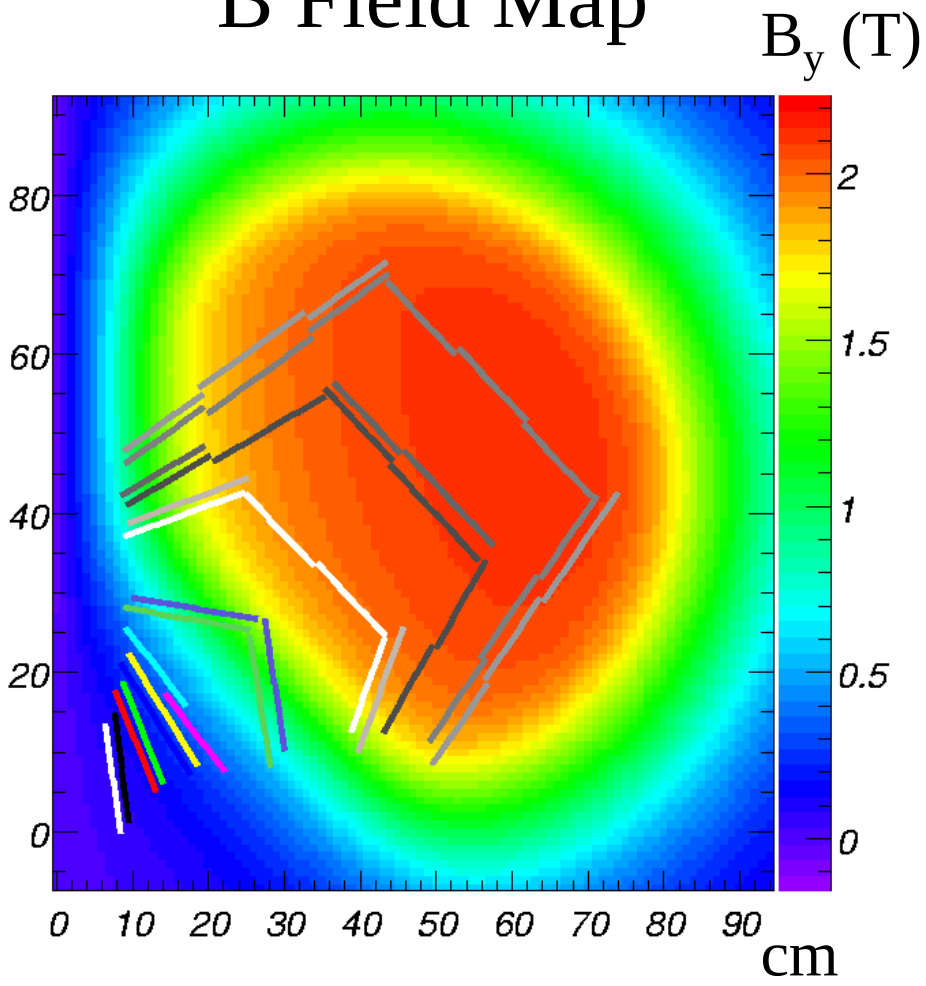
PHOBOS Magnet

Reproducibility of absolute field strength better than 1%

$\vec{B}$ Field Map



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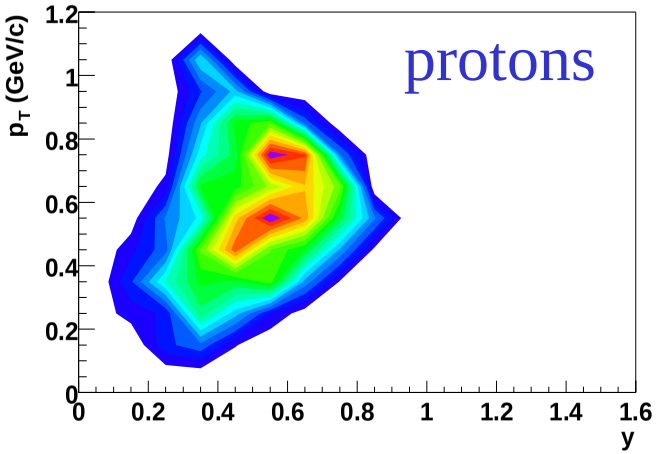
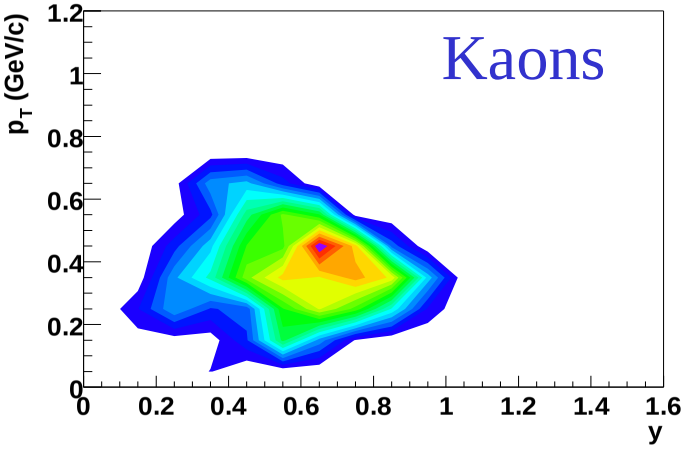
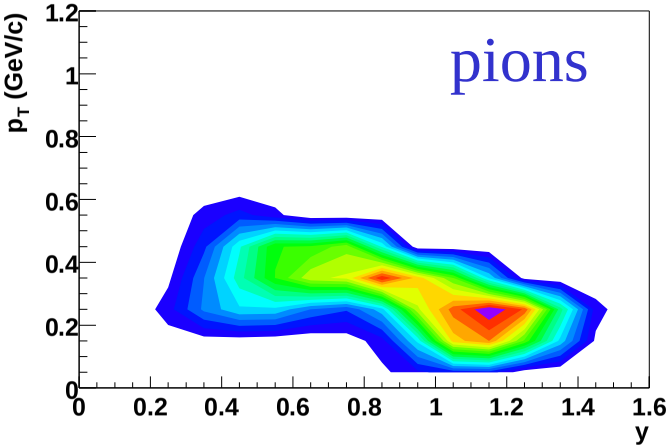
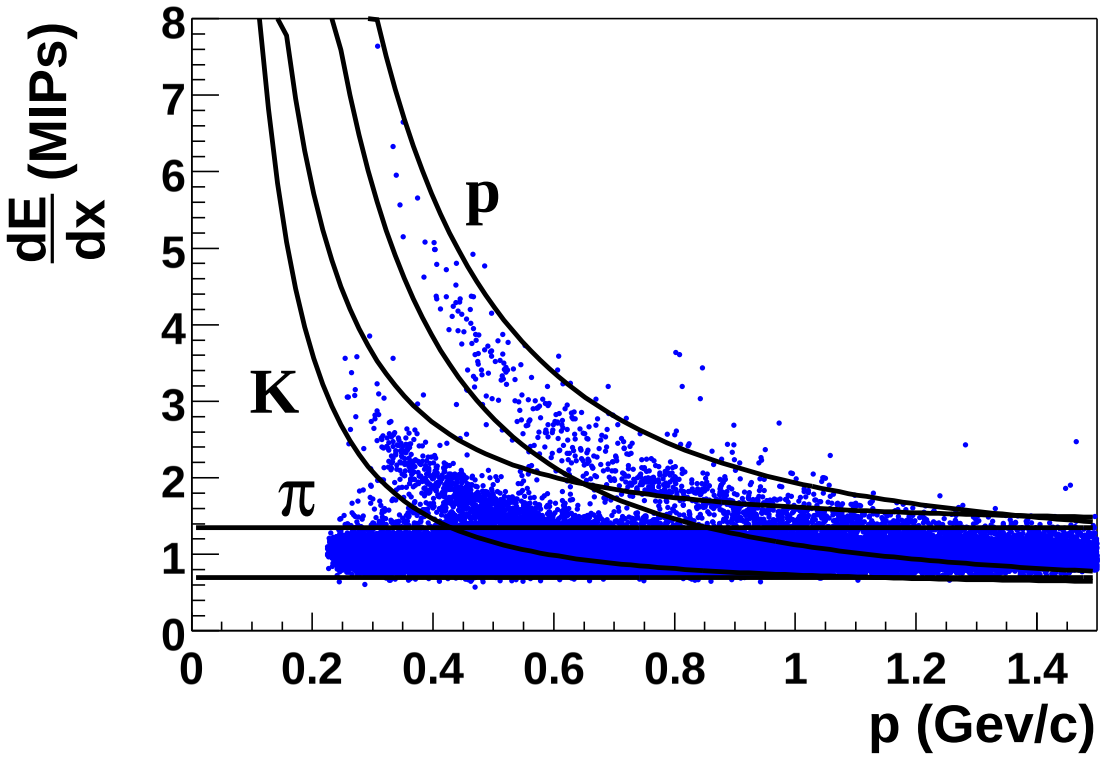
Full Tracking







- Particle ID with the spectrometer
- See N.K. George in Parallel Session III for details



Run 5332 Event 35225 08/31/00 06:59:24
PHOBOS Online Event Display

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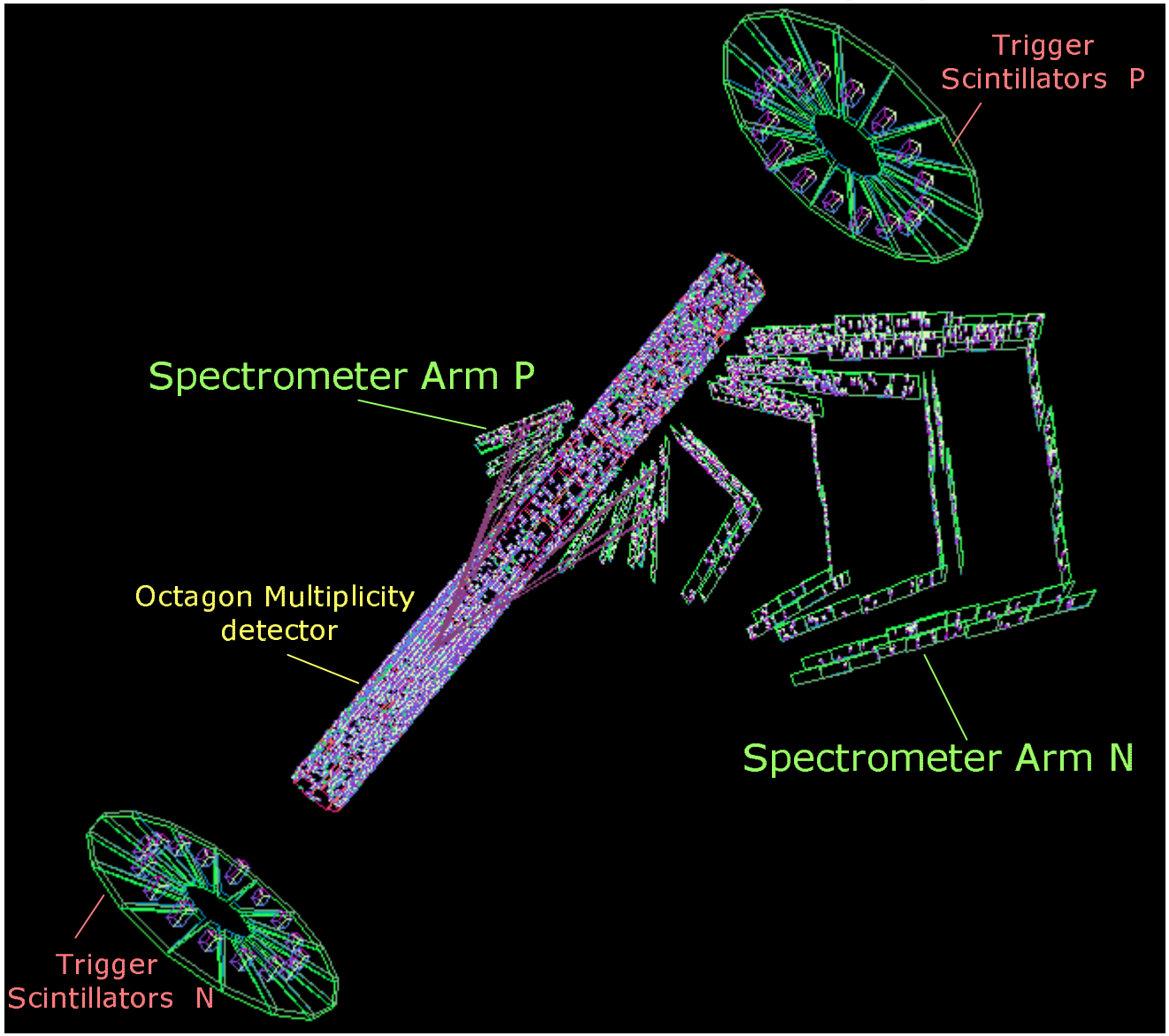

Au-Au Beam Momentum = 65.12 GeV/c

Not to scale

Not all sub-detectors shown

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PHOBOS DAQ

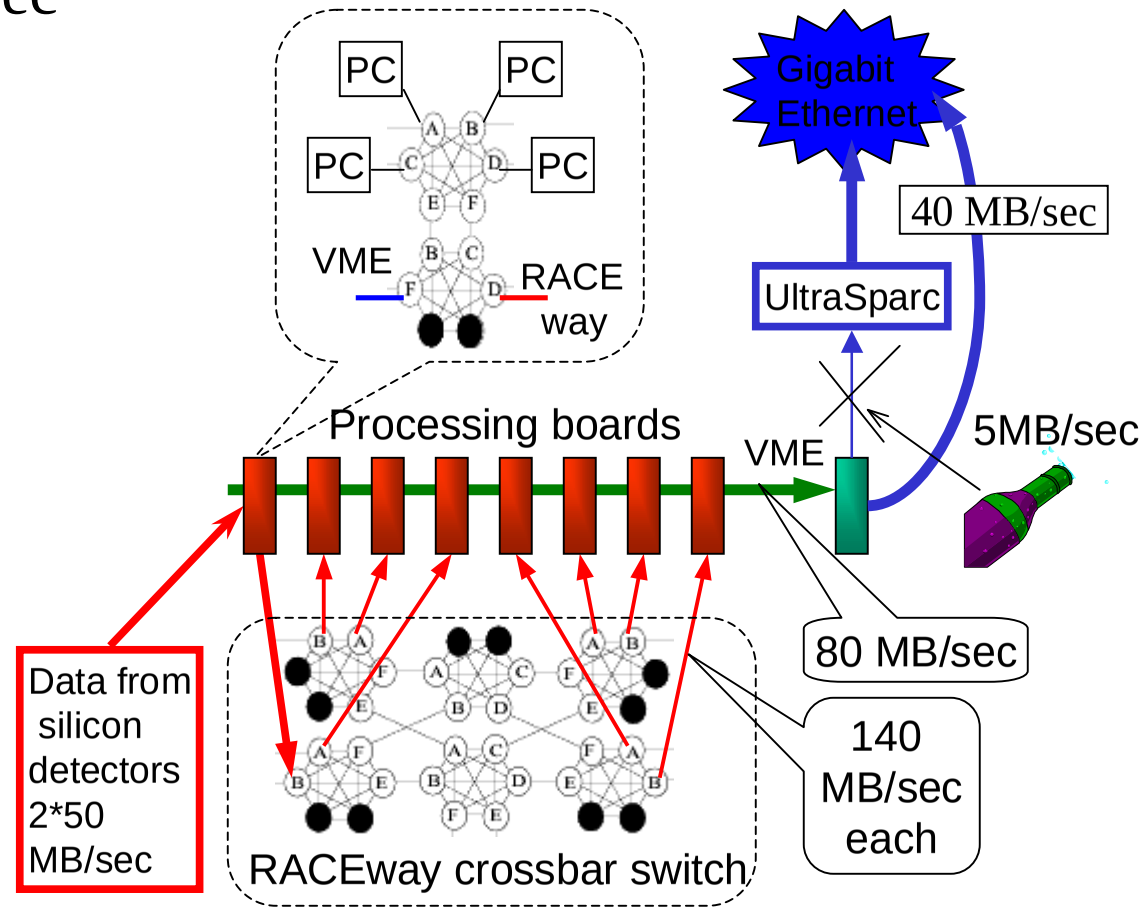
Run 2000:

Data taking rate: 15 ev/sec
Sustained: 5 MB/sec
8 PowerPC's

Run 2001:

Goal: 100 ev/sec
Sustained: 40 MB/sec
New features:

- Direct VME→Gigabit
- Multi-buffering
- Compression 2:1
- 22 PowerPC's



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Summary of 2000 Run

- RHIC delivered ~ 2.7 μb^{-1} integrated luminosity to PHOBOS over 6 weeks of running in Summer 2000.
- PHOBOS captured ~ 3.5M events on tape: mixture of minimum bias and central triggers; 99% DAQ uptime.
- Silicon systems performed to specifications: Average S/N measured in the detector was 14 to 18 depending on sensor type; 98% channels fully functional.
- Front End Electronics were stable. Every instance of latch-up in the VA chips was detected successfully during adverse beam conditions.

Future Plans: 2001 Run

- DAQ upgrade
- Complete installation of 2nd spectrometer arm
  - » Significantly improved 2-particle phase space
    - HBT for small sources
    - $\Phi \rightarrow K^+K^-$ down to $p_T = 0$
    - Back-to-back high p_T particles
  - » Doubles the one-particle statistics
  - » Symmetric system improves systematics

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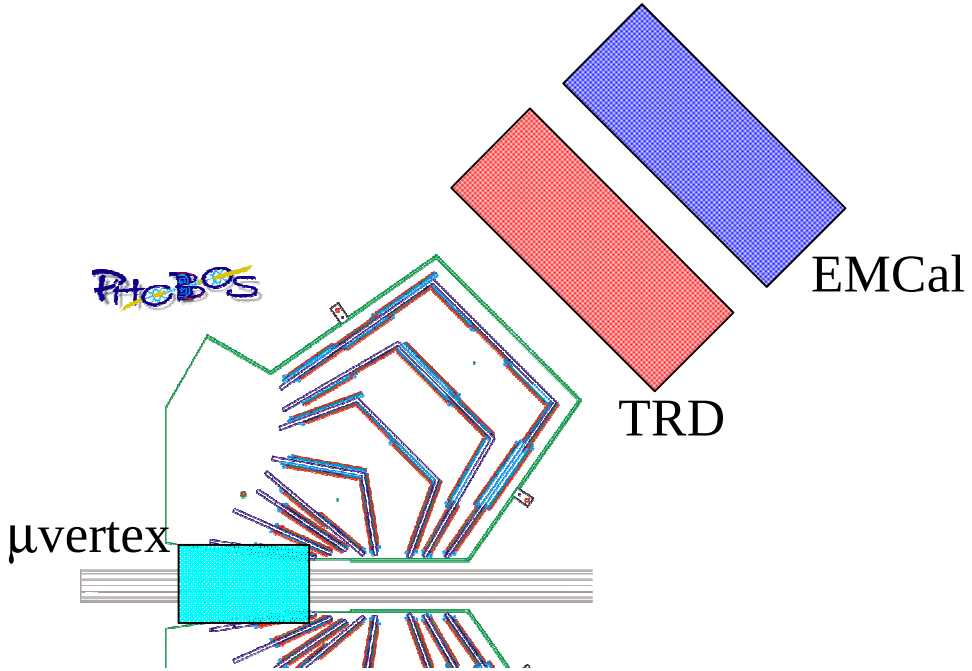
PHOBOS Charm Upgrade

- Open charm measurement is essential for understanding total charm production
- $D \rightarrow e^- + X$ is best suited for small acceptance near midrapidity



- Study single electrons at high p_T from displaced vertices
- Suppress the hadronic background
- Upgrade PHOBOS with:
  - » microvertex detector
  - » ALICE Transition Radiation Detector prototypes
  - » Electromagnetic calorimeter

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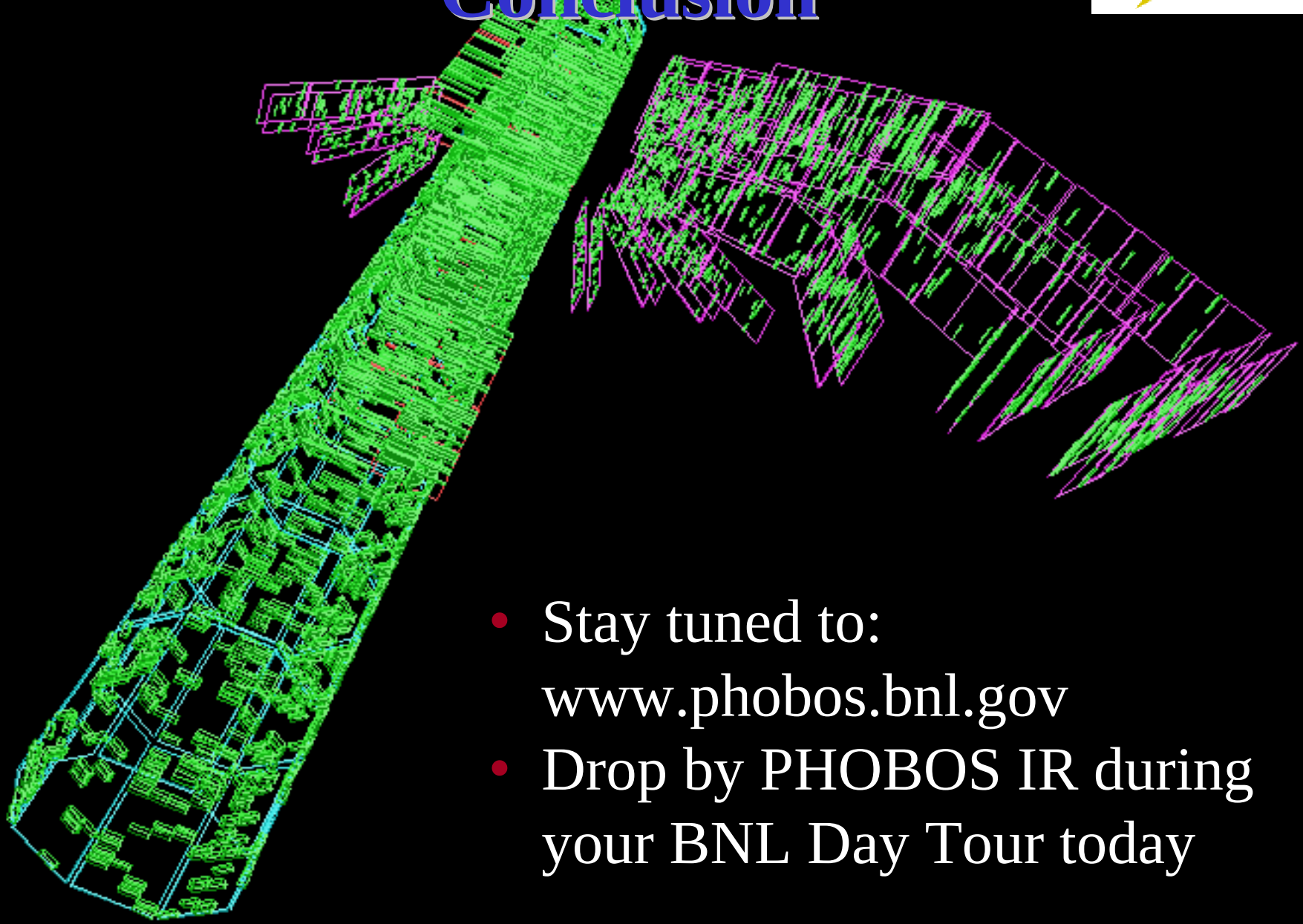
Conclusion



- Stay tuned to: www.phobos.bnl.gov
- Drop by PHOBOS IR during your BNL Day Tour today