PHENIX Forward Calorimeters

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PHENIX

RHIC's Experiments

The RHIC Charge

Move from exploration of **new matter formed in A+A collision to** ***characterization of*** **its properties**

Accelerate progress **in the** ***developing spin*** **program**

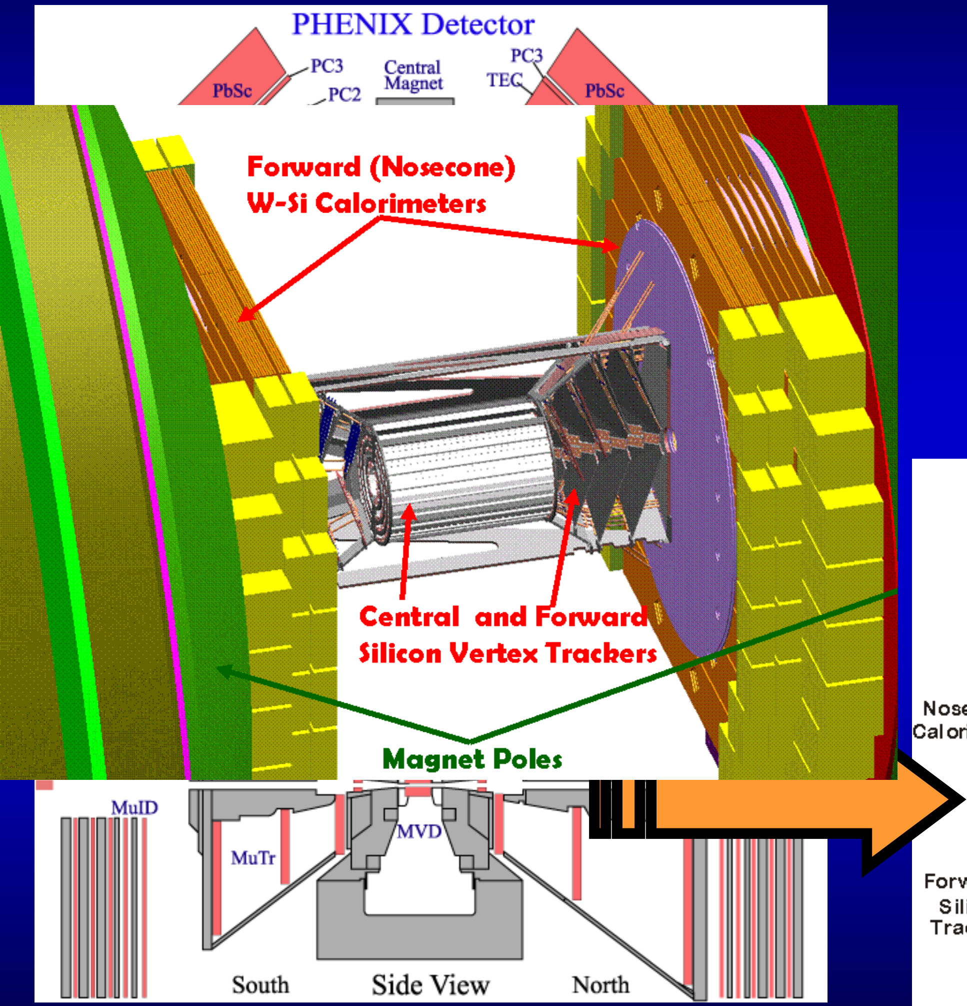
Upgrade two major detectors (PHENIX and STAR)

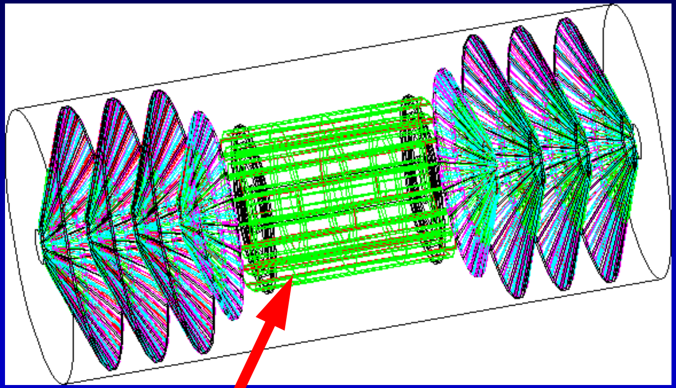
Increase acceptance
Implement vertex tracking
Implement jet measurements

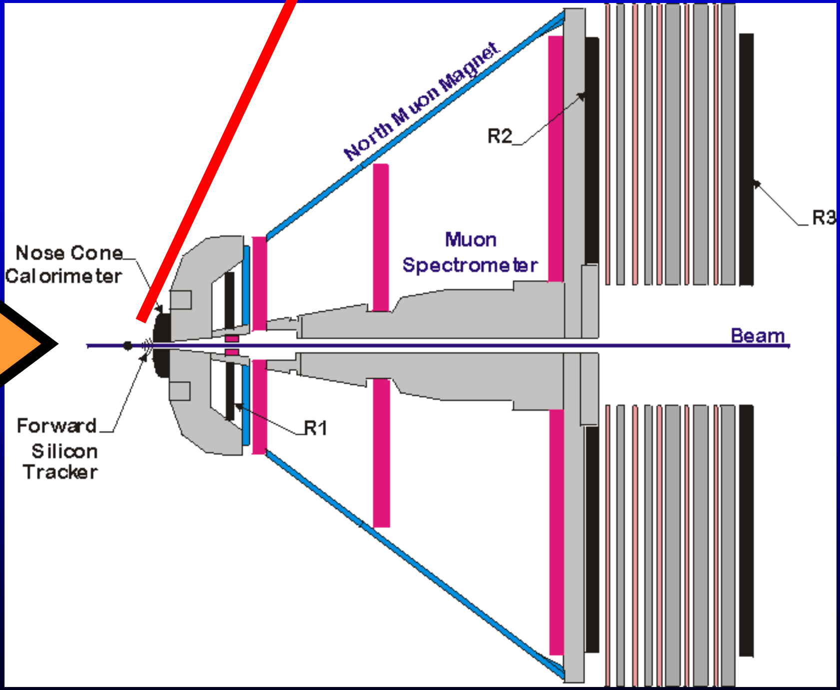
Upgrade RHIC

X40 increase in luminosity

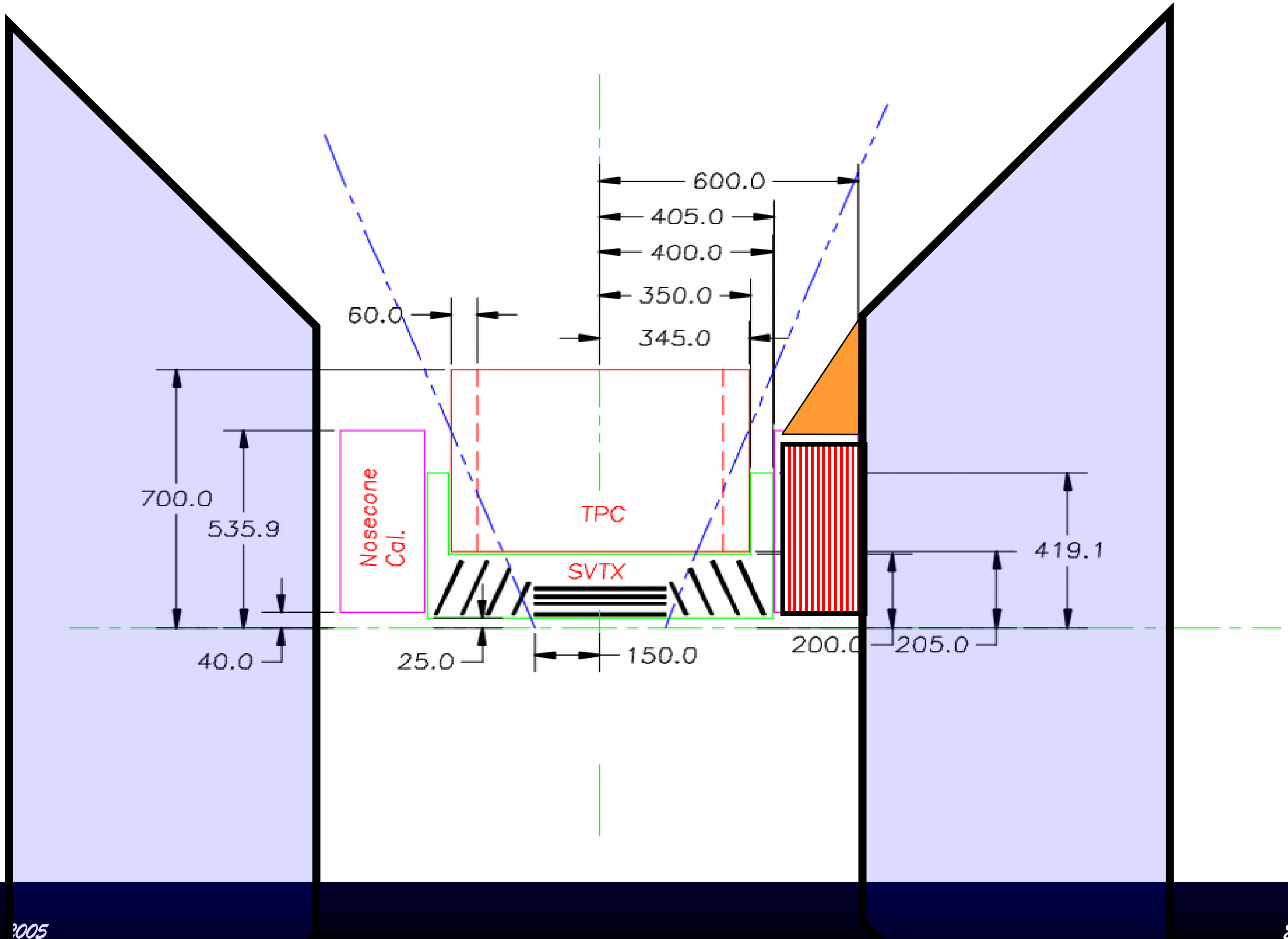
PHENIX Upgrade



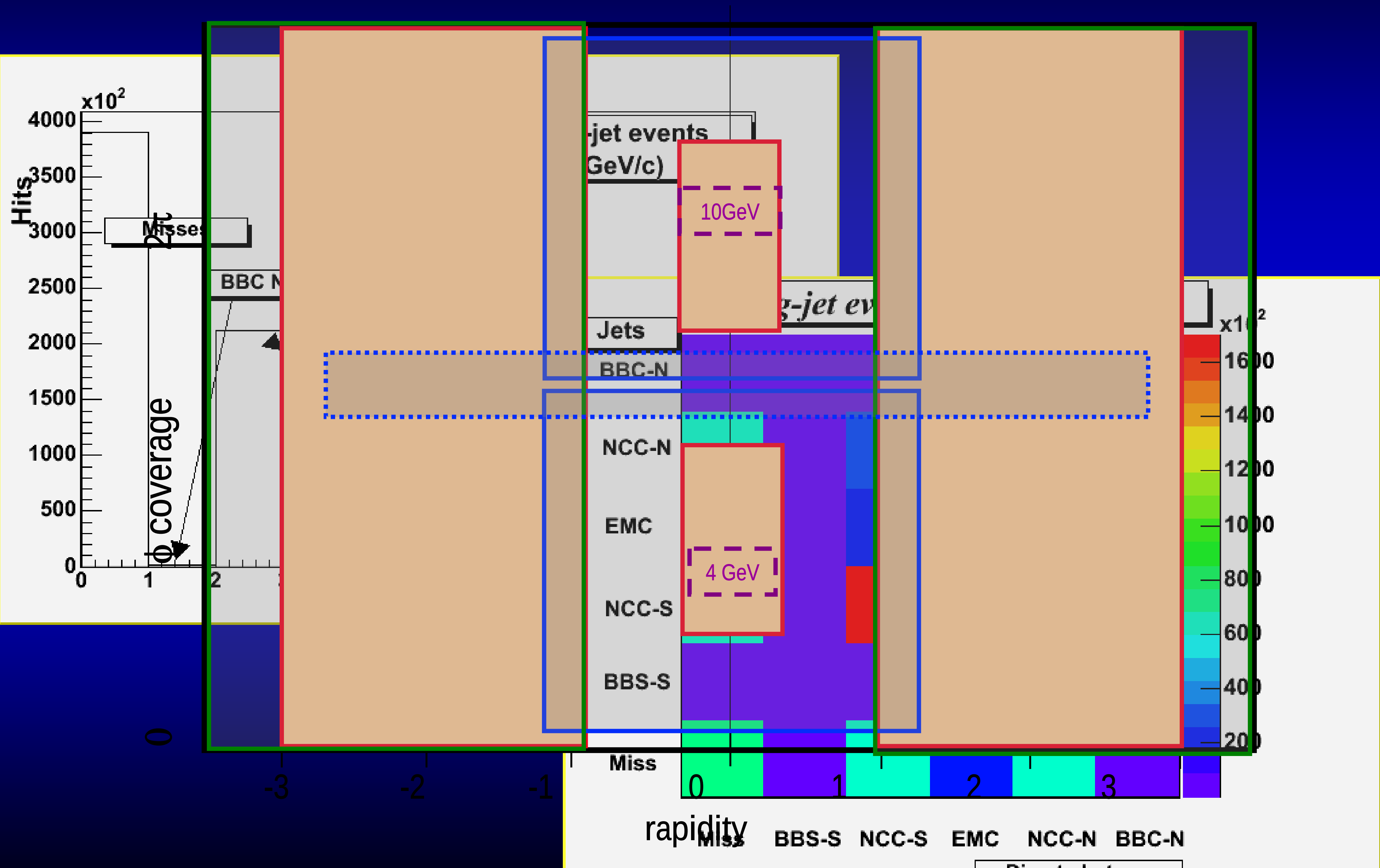




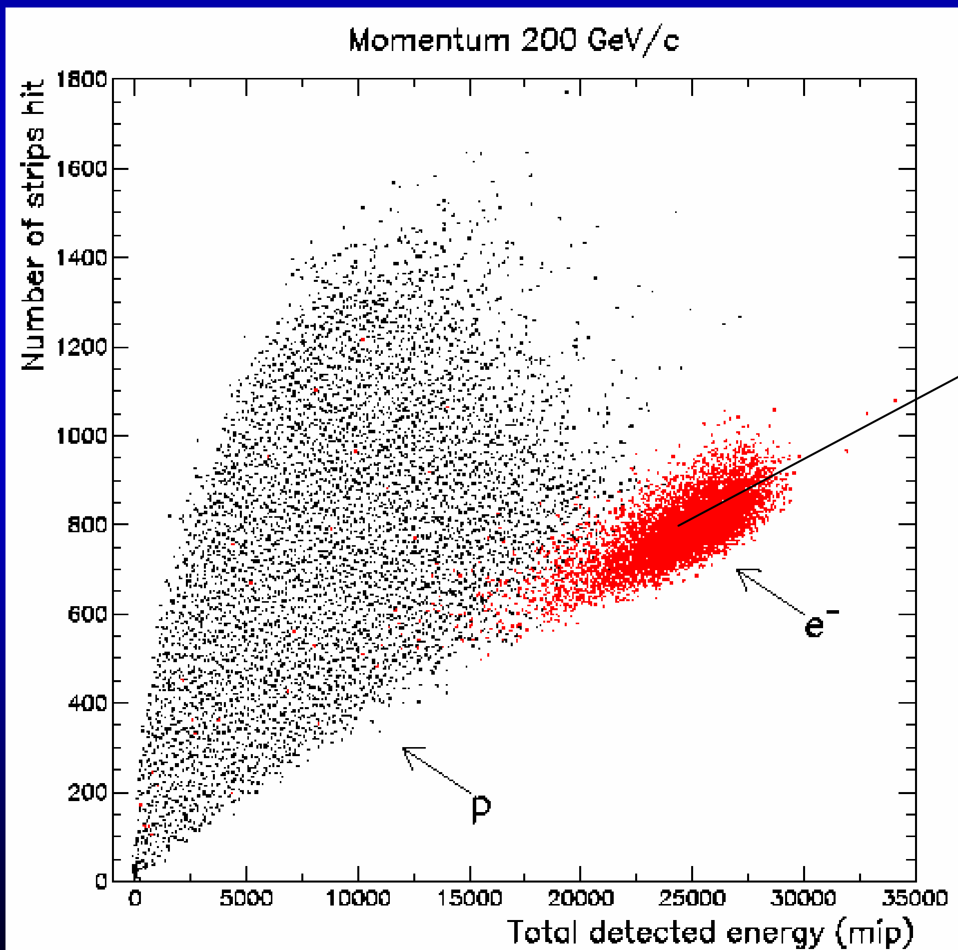
Real estate ....

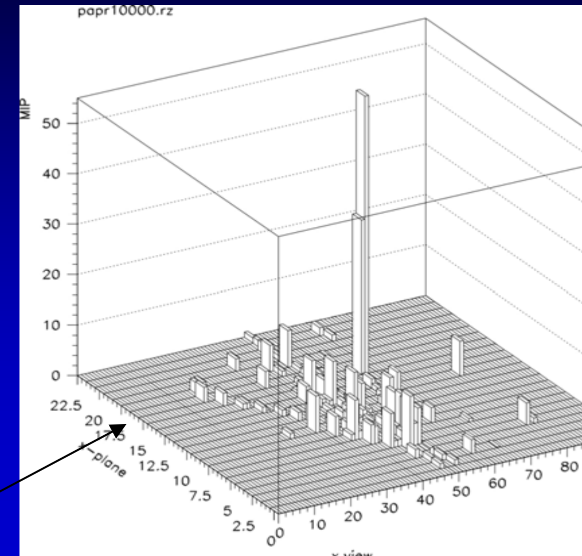

600.0
405.0
400.0
350.0
345.0
60.0
700.0
535.9
40.0
25.0
150.0
Nosecone Cal.
TPC
SVTX
200.0
205.0
419.1

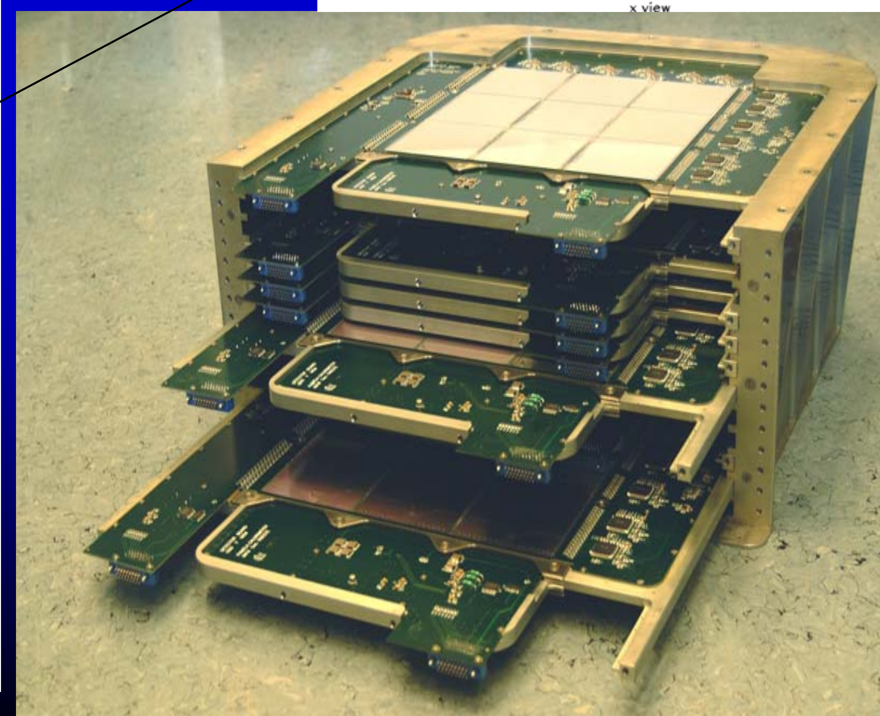
Upgraded PHENIX



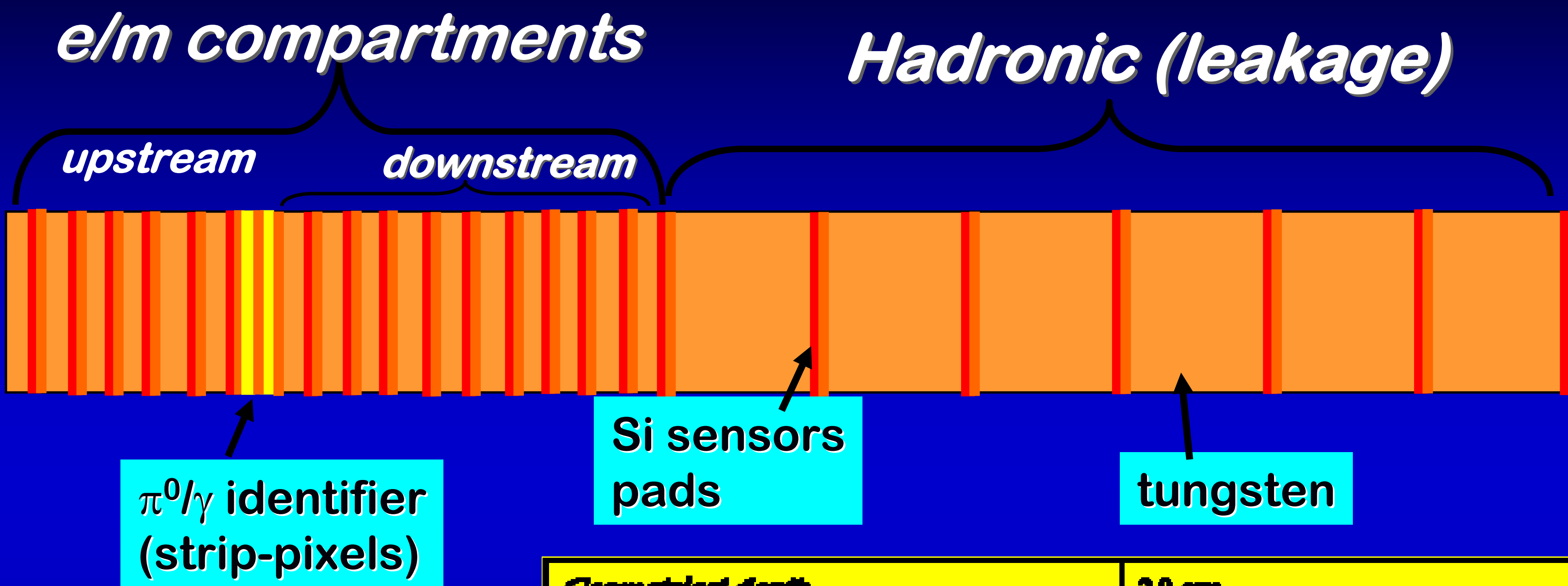
Inspiration: PAMELA







longitudinal structure



Geometrical depth	20 cm
Area coverage	ϕ 50 cm
Cell structure	fine: W(2.5 mm)+Si coarse: W(16 mm)+Si
Hadron absorption depth	1.6 Λ_{abs}
Photon absorption depth	43 X_0
Longitudinal segmentation	4 X_0 + 6 X_0 + 33 X_0
Lateral segmentation	1.5 x 1.5 cm^2 everywhere
γ/π^0 identifier	Single layer of stripPixels

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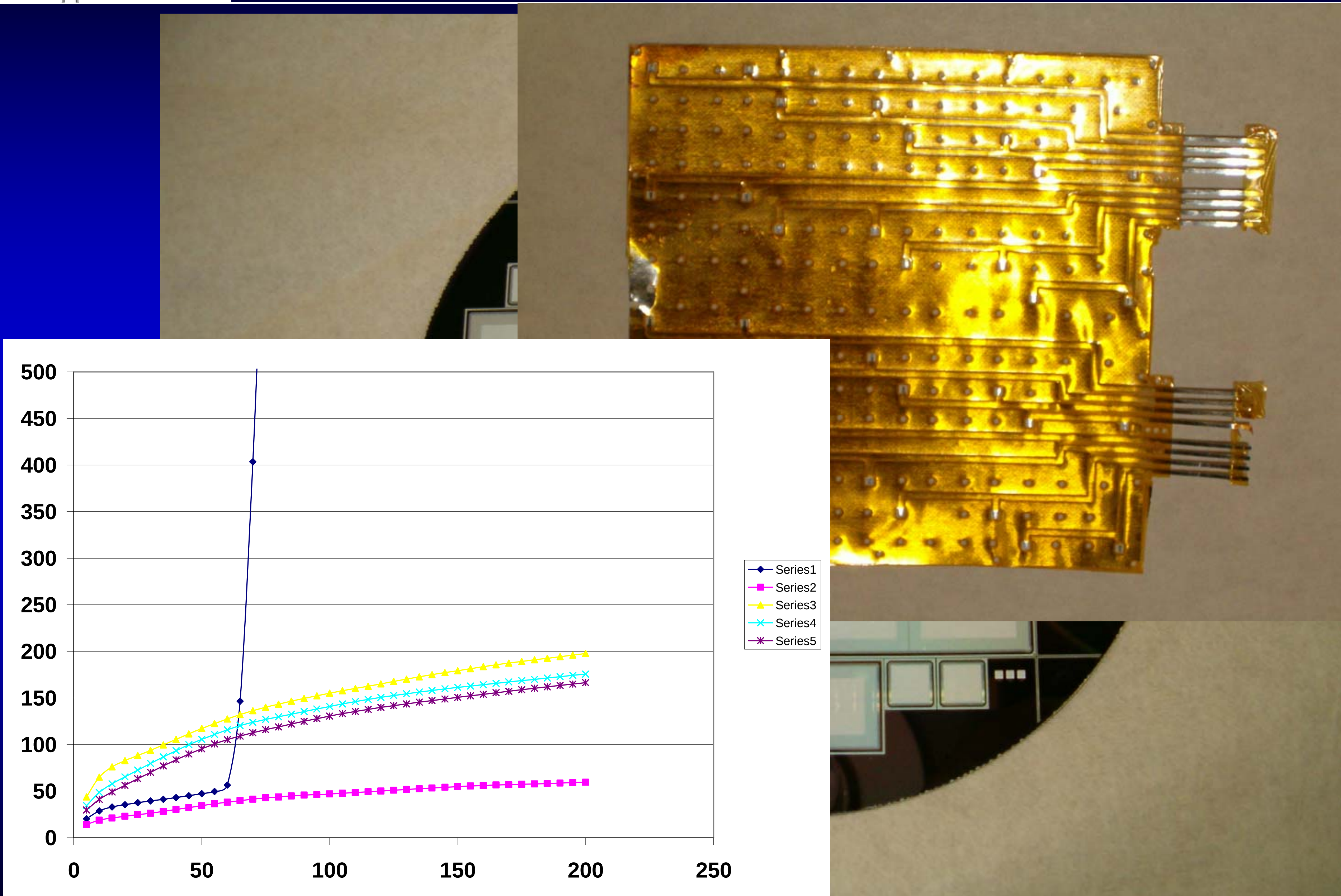
PHENIX

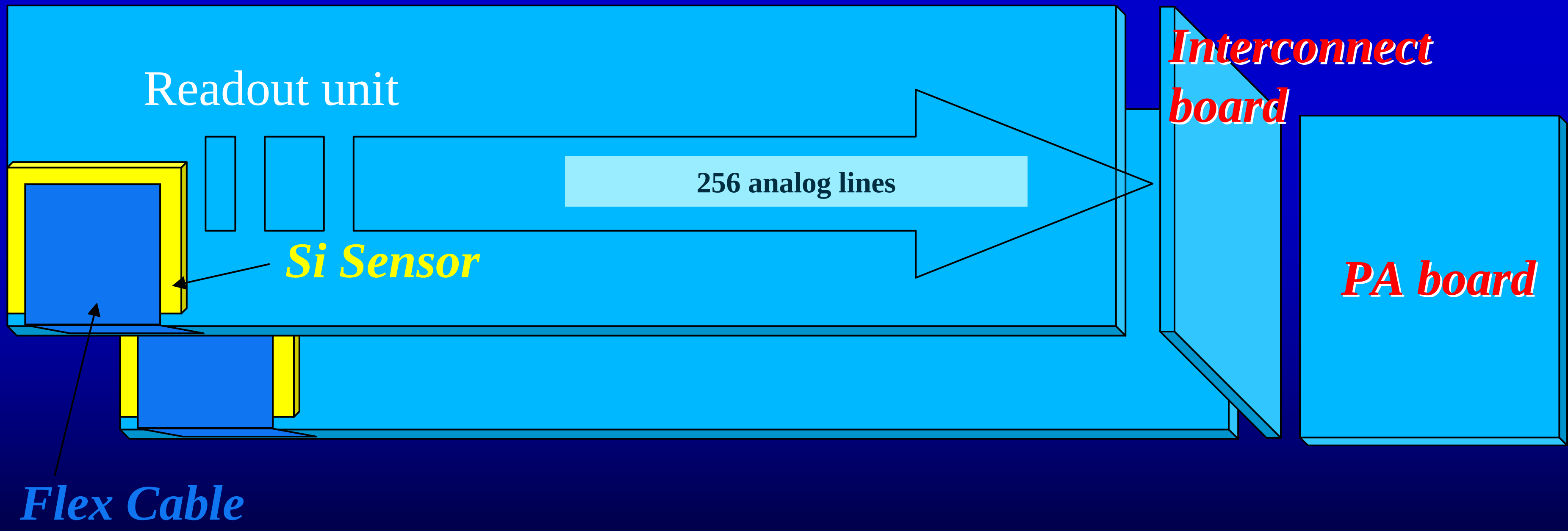
Lateral structure & Sensors



NCC signal packaging concept

-This is the calorimeter – all pads in the subtower are contributing to signal;

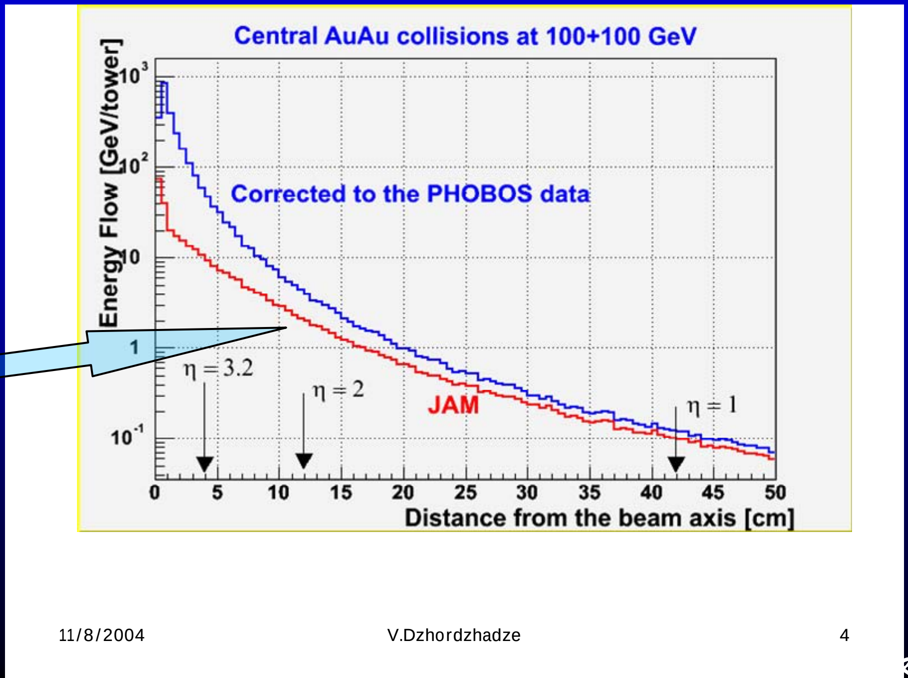
-Noise budget is set by physics: better is an enemy of the good;



Readout: Dynamic range

Dynamic range [GeV]	~100	Kinematical limit
MIP in a single Si layer (e)	24k	~300 mkm Si
MIP in a subtower (e)	144k-240k	6 to 10 Si layers
Max. charge per event in a subtower(e)	2.1 10^8 or ~ 40 pC	50 GeV deposition, 1.7% sampling fraction
Dynamic range	>10000 MIP >1000 MIP_{10}	MIP_{10} (sum over 10 layers)

Underlying event contribution can be neglected even in the central AuAu collisions



Readout: Noise budget

Compartment	I	II	II
Sampling layers	6	10	6
Sampling fraction (%)	1.7	1.7	0.26
MIP energy loss [MeV]	42	69	270
MIP energy loss in Si [MeV]	0.7	1.2	0.7
Pad capacitance [pF]	80	80	80
Trace capacitance [pF]	10-45	10-45	10-55
Tower capacitance [pF]	540-780	900-1300	540-900
Energy range of interest [GeV]		0.5 – 50	
Intrinsic energy resolution (em showers) [GeV]		0.4-1.5	
Noise limit	10 MeV	15 MeV	100 MeV
ENC budget [MeV]	0.15	0.2	0.15
ENC budget [electrons]	40 k	50 k	40 k

CSA

- CSA followed + 4-th order shaper (PSPICE);
- Rise time and shaping time optimized to achieve optimum noise performance for any given base-to-base (1% level) pulse length on the ADC input;

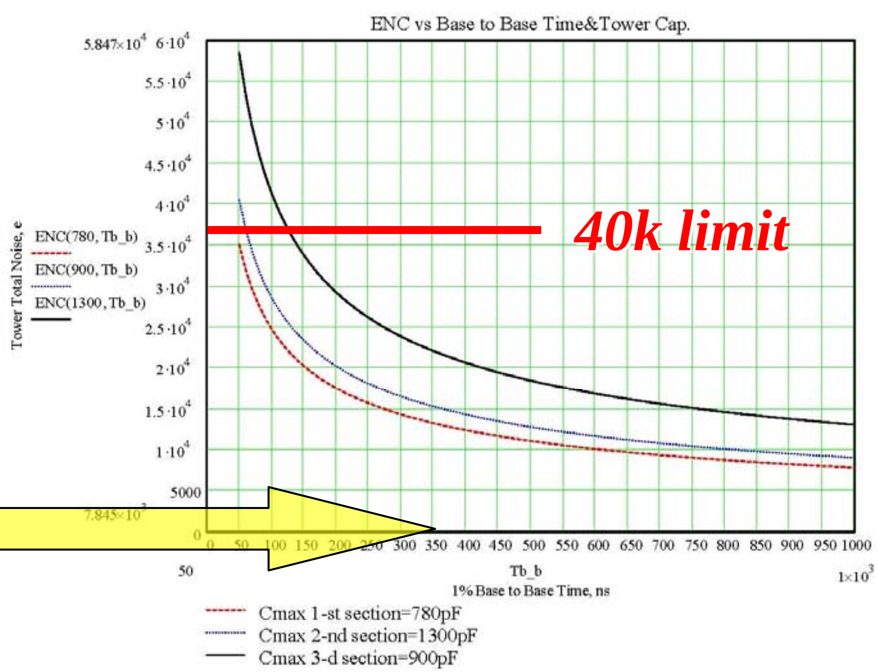
Options:

(a) Hybrid amplifier developed at BNL for ATLAS (4 channels on a common substrate);

(b) QIE – charge integrator and encoder (FNAL -> CMS);

(c) Custom chip (PAMELA, CALICE)

PHENIX NCC Detector



γ/π^0 separation

- Back of the envelope estimate based upon experience with existing PHENIX EMC:
  - PHENIX today has a brute-force pattern recognition procedure failing at around 15 GeV/c π0 momenta
  - NCC is x10 closer to production vertex

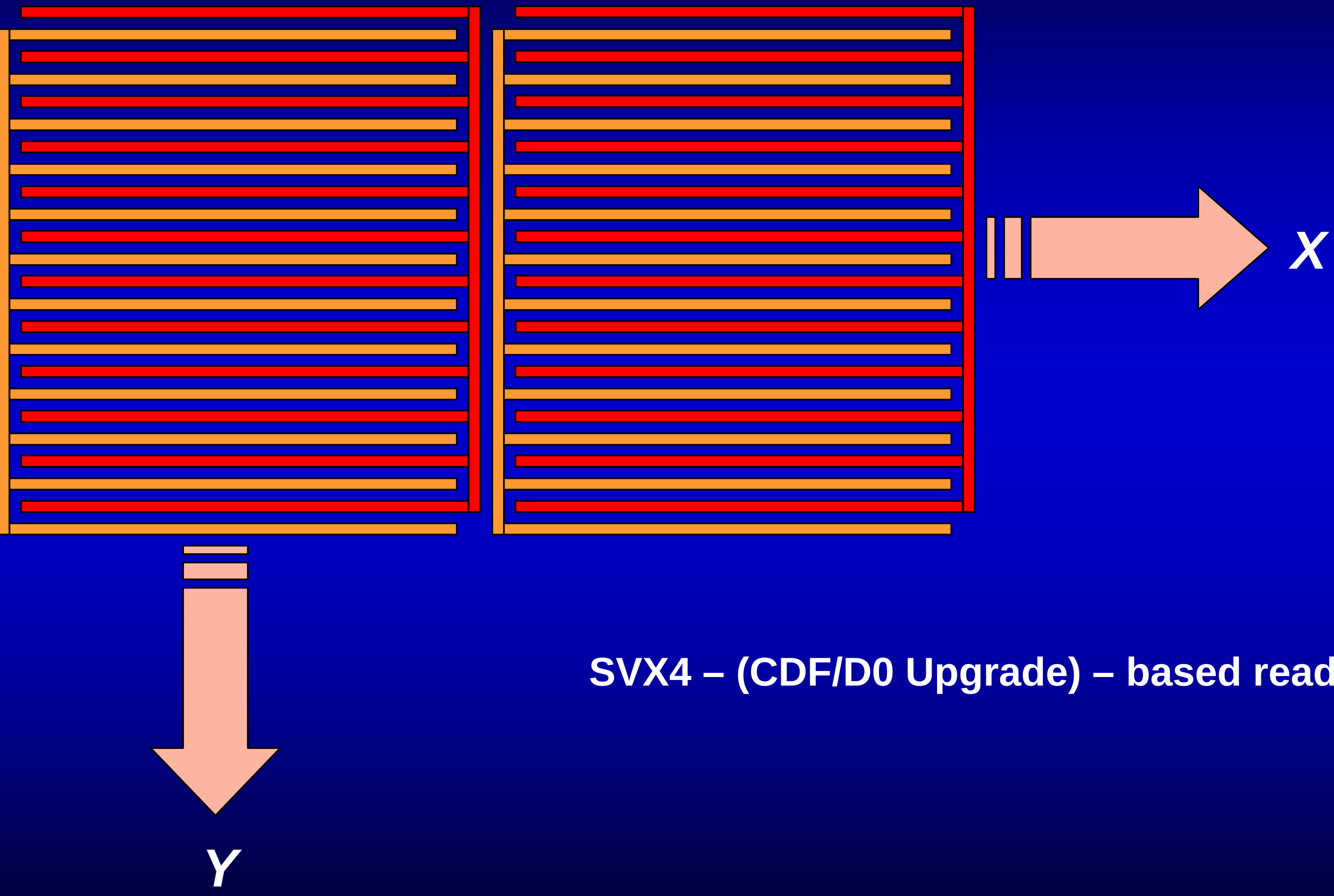
    1.5 GeV/c
  - x10 better lateral granularity (and x3 smaller molier radius) resulting in x 3.5 two photon separation

    5 GeV/c
  - With 0.5 mm strips in the shower max we can separate two close photons down to ~2 mm compared to ~ 2 cm assumed for NCC itself

    ~30 GeV/c

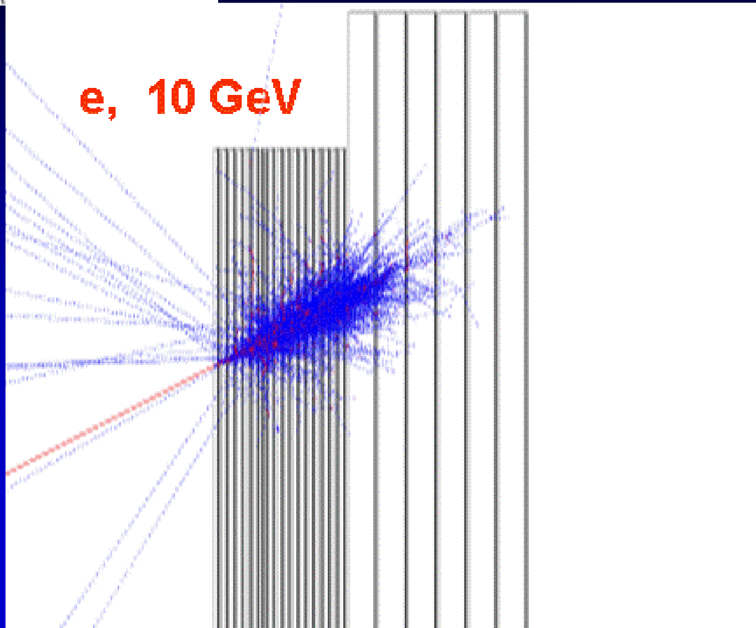
Transverse momentum reach is rapidity dependent

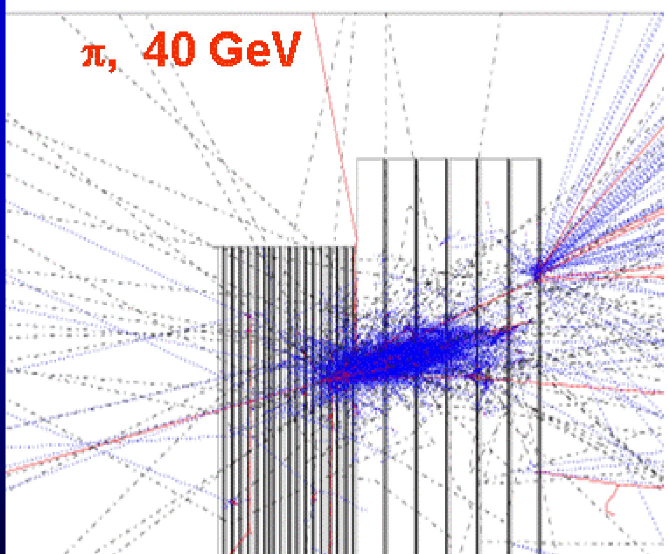
Strip-Pixel structures

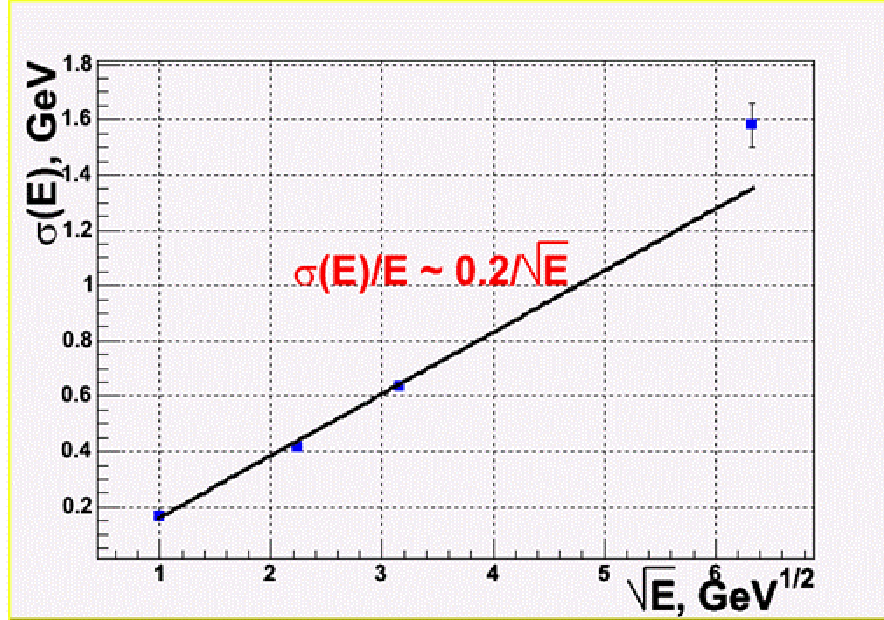


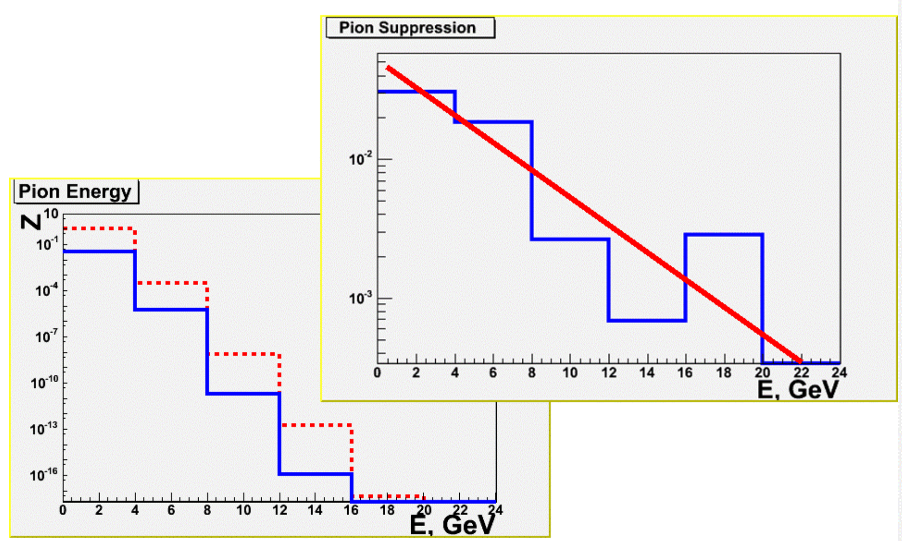
SVX4 – (CDF/D0 Upgrade) – based readout

Performance









Summary

o PHENIX has great plans for a program of new physics. It spans the whole range of pp (including polarized), pA and dA collisions at RHIC.

o Integrated forward spectrometer upgrade is the precondition for PHENIX to stay competitive in this new field of physics.

o We have technical solutions which match physics and present an excellent opportunity for new groups both in physics and instrumentation!

Backup

Probing the Density

This machine probes initial state densities using probes that are

- **Auto-generated**
  (initial hard scatterings)
- **Calculable**
  (in pQCD)
- **Calibrated**
  (measured in p+p)
- **Have known scaling properties**
  (~ A*B "binary collisions)

➡ *These features not available prior to RHIC*