STAR Tracking Possible Upgrade

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STAR tracking improvement in the short term both barrel and "forward" directions

- How to "struggle" with TPC space charge problem?
- Additional tracking / calibration Detectors in front of TPC, and (may be) a good reason is to use one ToF slat for the coordinate Detector behind TPC
- Additional tracking a front of EEMC.
- "Forward Physics" at STAR (?!)

TPC can be a factor 1.5 faster Detector Now !?

Yes, If we can work with ~45-50 kV TPC HV

-- CF4 (3.– 4. %) instead of CH4 (+ Ar)
(“no problem with Gas System”, LK)

-- Drift speed → 8.5 – 9.0 cm/μs

-- Diffusion → twice smaller

-- Space charge distortions → twice smaller

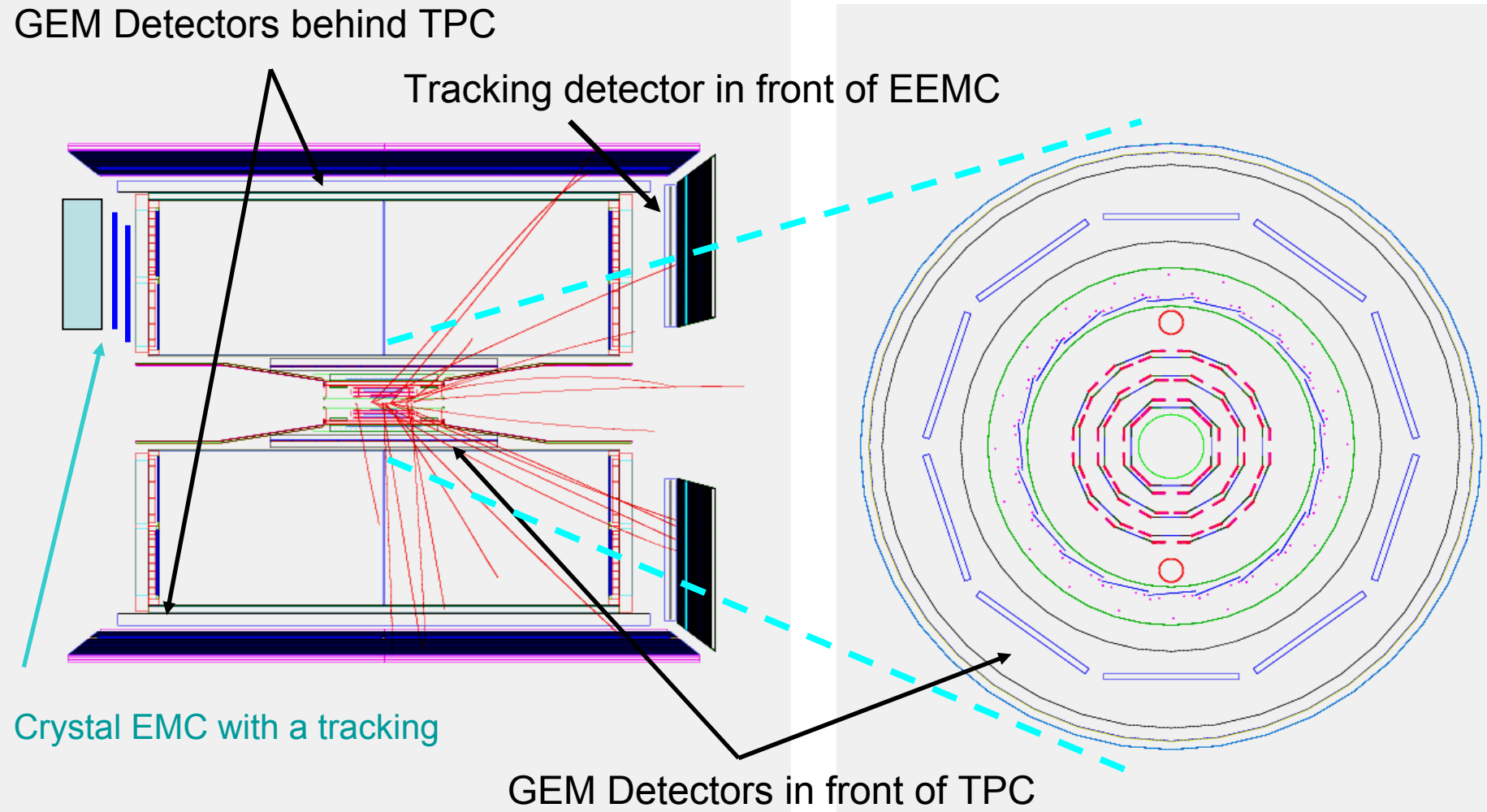
It needs:

- “special gas” in FC isolation gaps,
- new FEEs, DAQ but with future application

Near Term STAR Tracking Improvements

- Additional tracking / calibration detectors inside and outside of TPC
  - Pad Detectors (GEM) ideal:
    - » Required 3d- precision
    - » low mass,
    - » fast.
  - Solves TPC space charge distortions correction problem { but, a precision ?..("charge" value, model, fluctuations)} and more.
- Convenient to use same technology as additional tracking in front of EEMC ($1<|\eta|<2$)
  - Improve track finding and momentum resolution for high P_t (~40 GeV/c) particles.
- Together with other "fast" detectors solves the "Event pile-up" problem.
- More Physics with "very forward" tracking/PID set up.

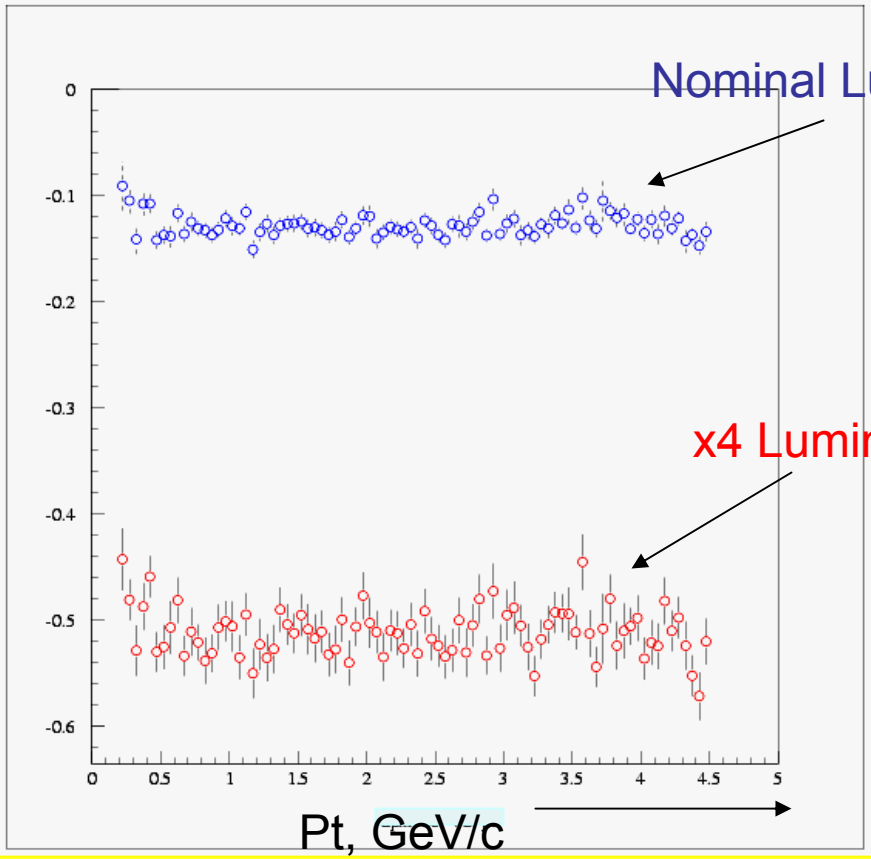
Additional tracking / calibration detectors in STAR

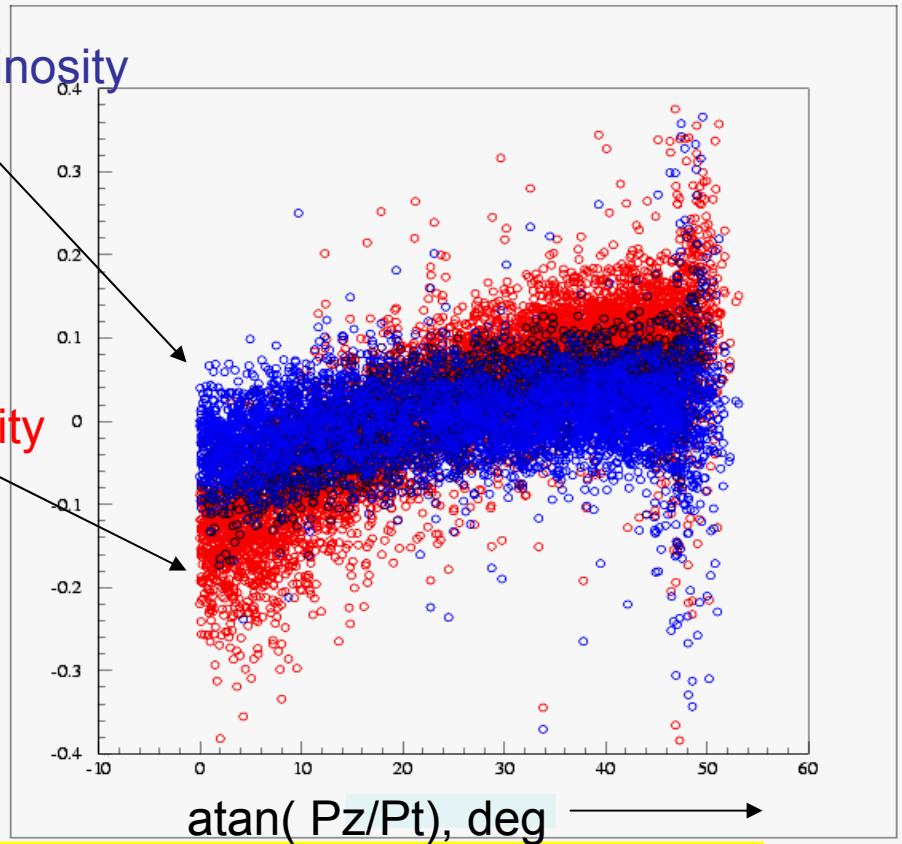


Difference in RΦ between a TPC track crossing point and a GEM reconstructed hit position, cm

Detector a front of TPC

Detector behind of TPC



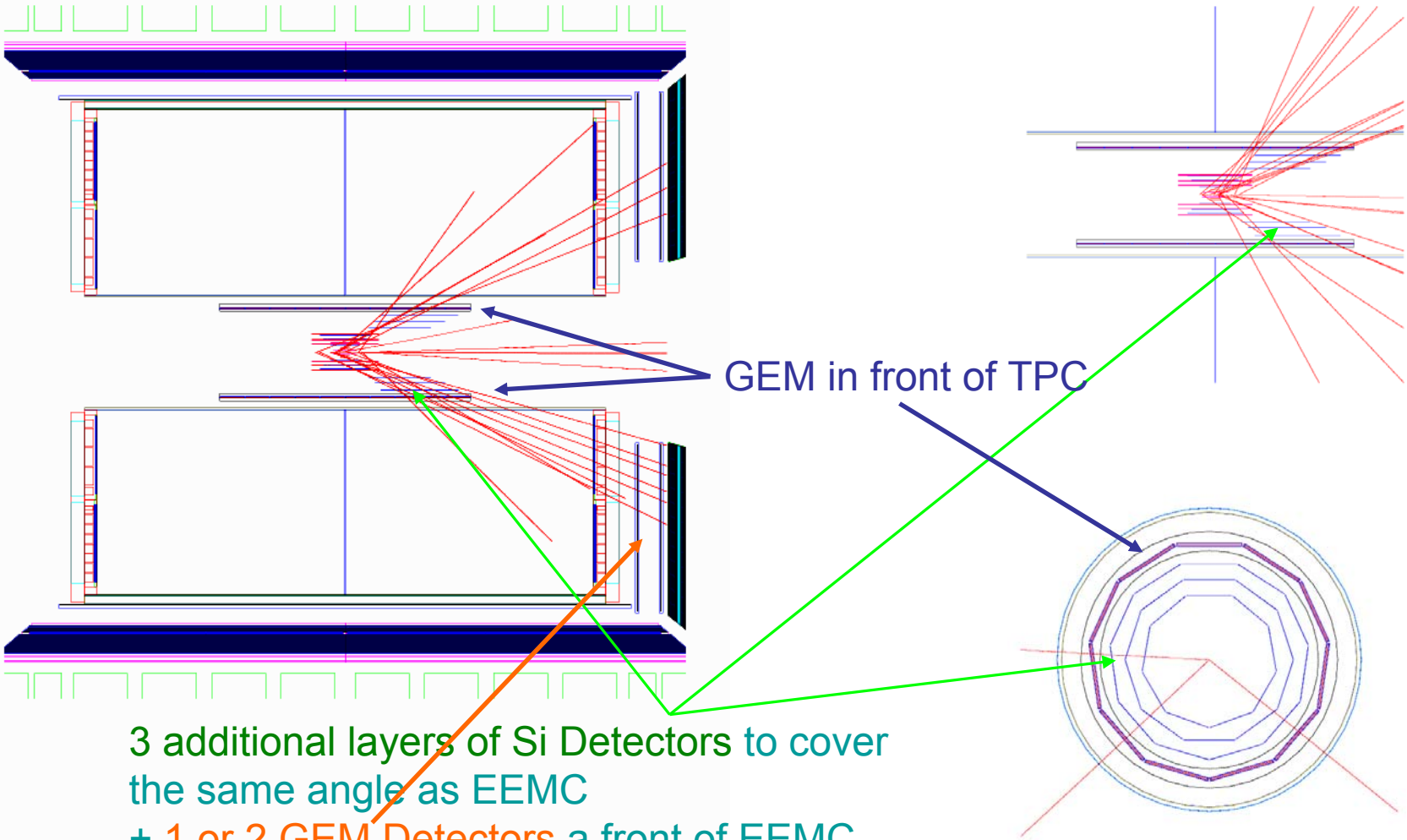


Detector precision (in RΦ direction) should be ~100. μm

Detector has to have more-less the same stereo-angle as TPC

-→ GEM Pad Detector

Additional tracking in 1<|η|<2 direction (in front of EEMC) (together with B.Surrow and S.Vigdor)



Simulation conditions

- One particle / event
- Pt – uniform in (10 – 40) GeV/c
- Vz : σ_z = 12. cm. Vertex position is not in a fit

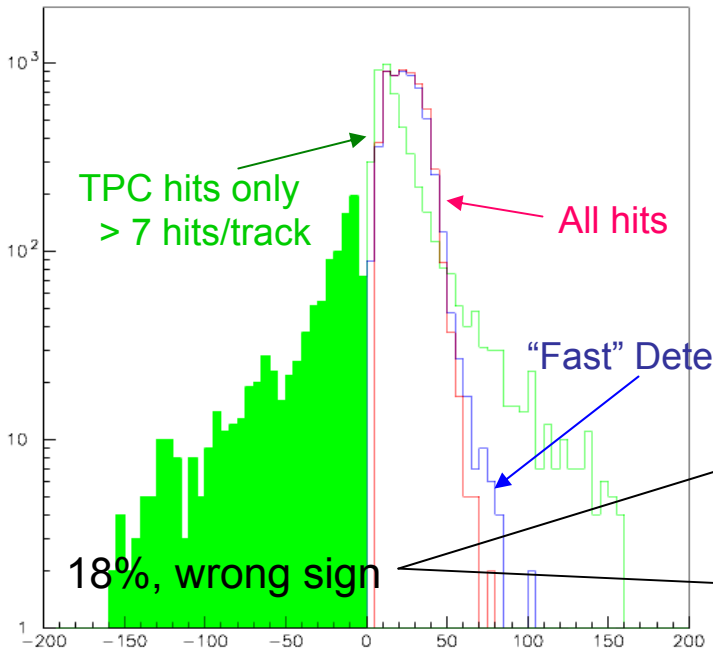
- Hits – gaussian smearing (cm)
  "SVT": σ_{drift}=0.005, σ_{pad}=0.05
  "GEM in front TPC": $\sigma_{r\varphi}$ =0.01, σ_z=0.87 (3./$\sqrt{12}$)
  "GEM behind TPC": $\sigma_{r\varphi}$ =0.01, σ_z=2.02 (7./$\sqrt{12}$)
  "TPC": $\sigma_{r\varphi}$ =0.04, σ_z=0.06
  " Si ": $\sigma_{r\varphi}$ =0.005, σ_z=0.87 (3./$\sqrt{12}$)
  "GEM in front EEMC": $\sigma_{r\varphi}$ =0.01, σ_r=1.44 (5./$\sqrt{12}$)

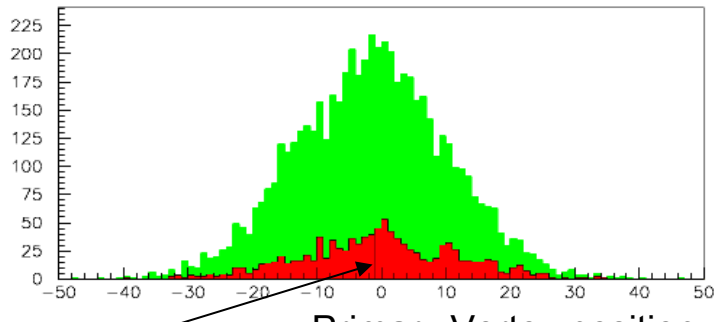
Helix fit for different variants of selected hits

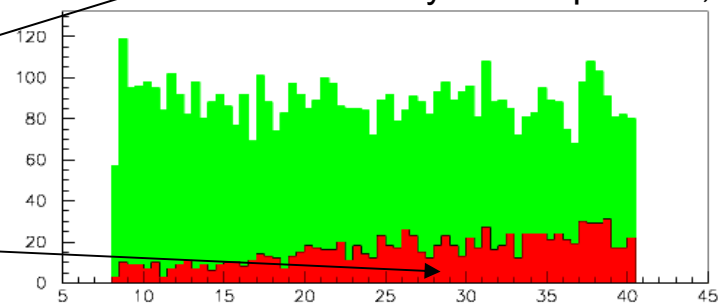
Fast simulator. One particle (π^-) / event. EEMC acceptance.

Can we measure the "sign of a charge" for high Pt particles?

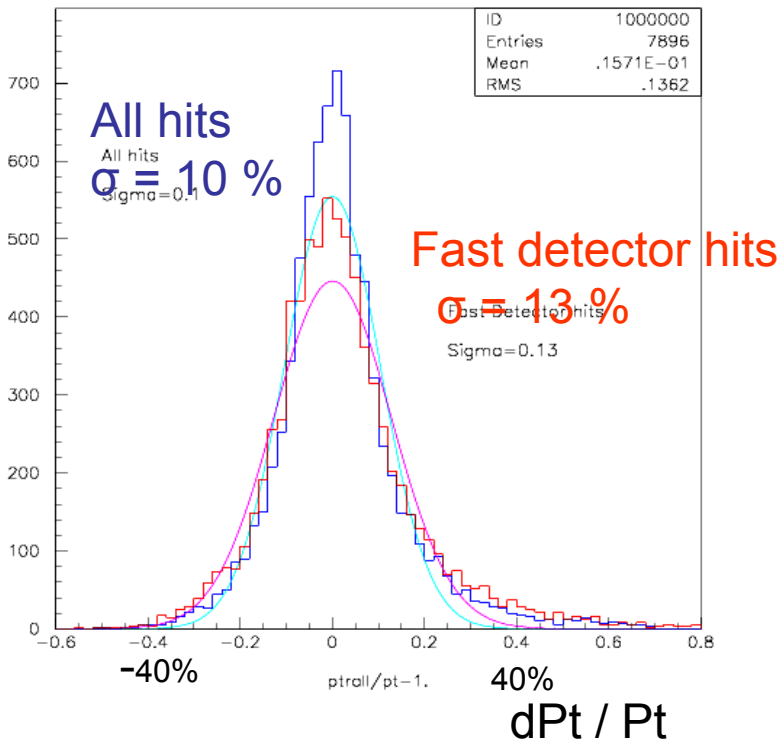
Sag for Pt=30.0 GeV/c is ~2.5 mm

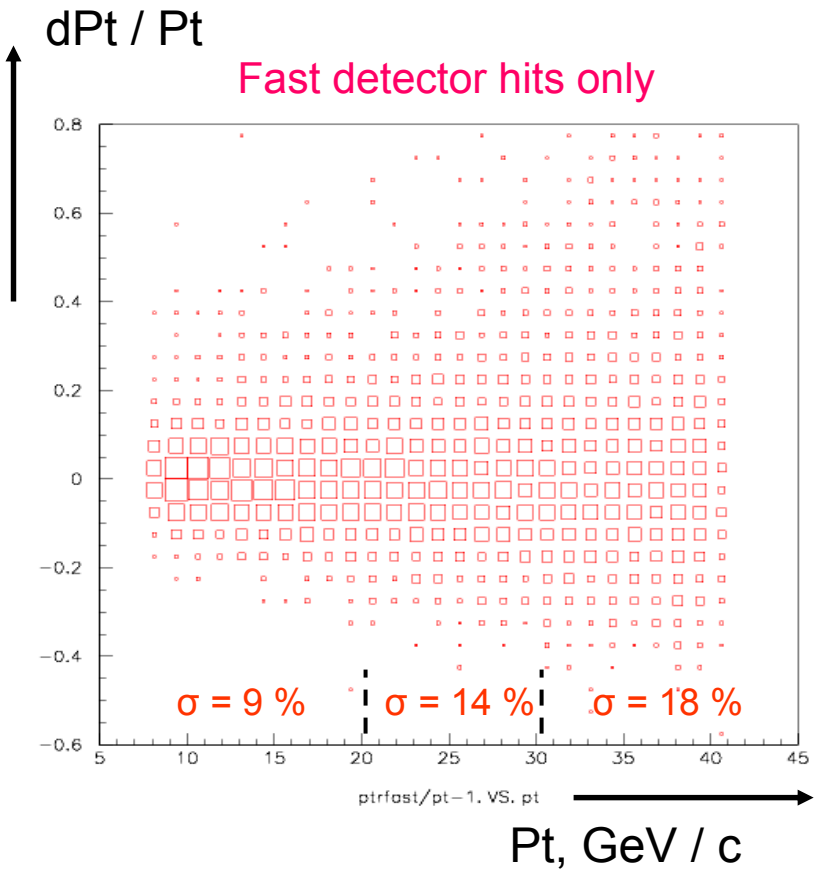




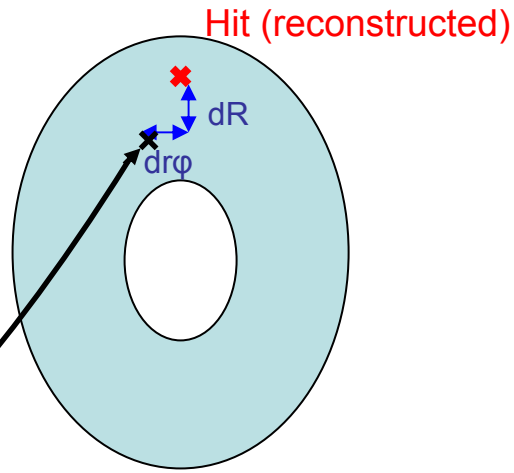


Momentum reconstruction performance

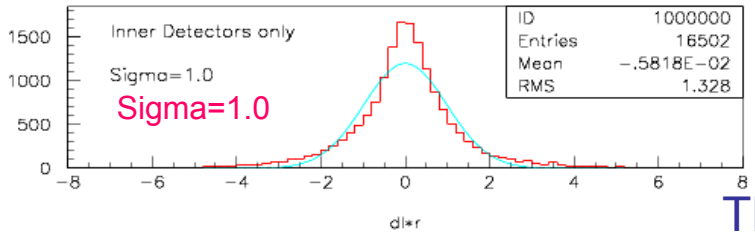


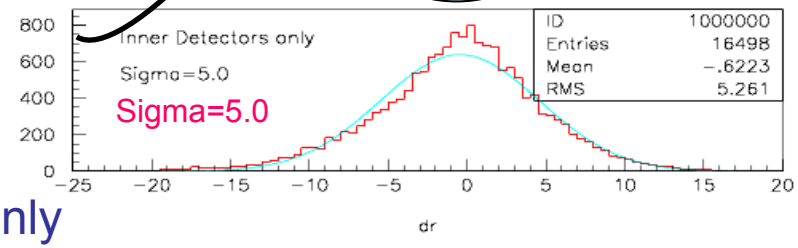


Difference in rφ and R between a track crossing point and a GEM in front EEMC reconstructed hit position, cm

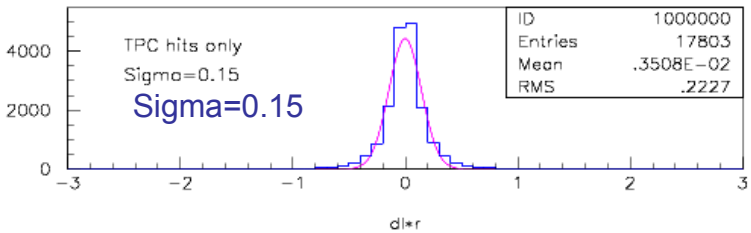


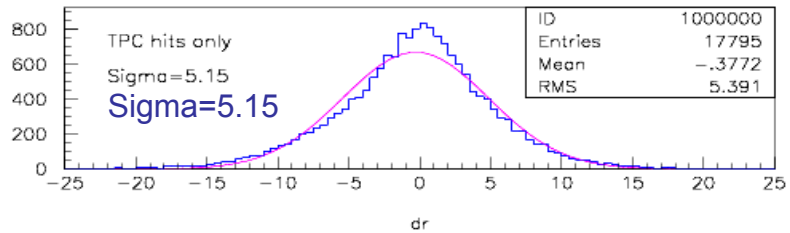
Inner detectors hits only, no TPC hits



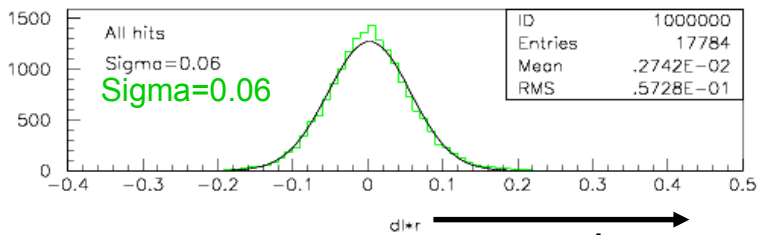


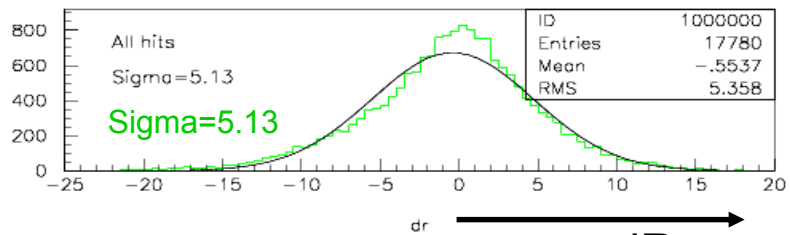
TPC hits only





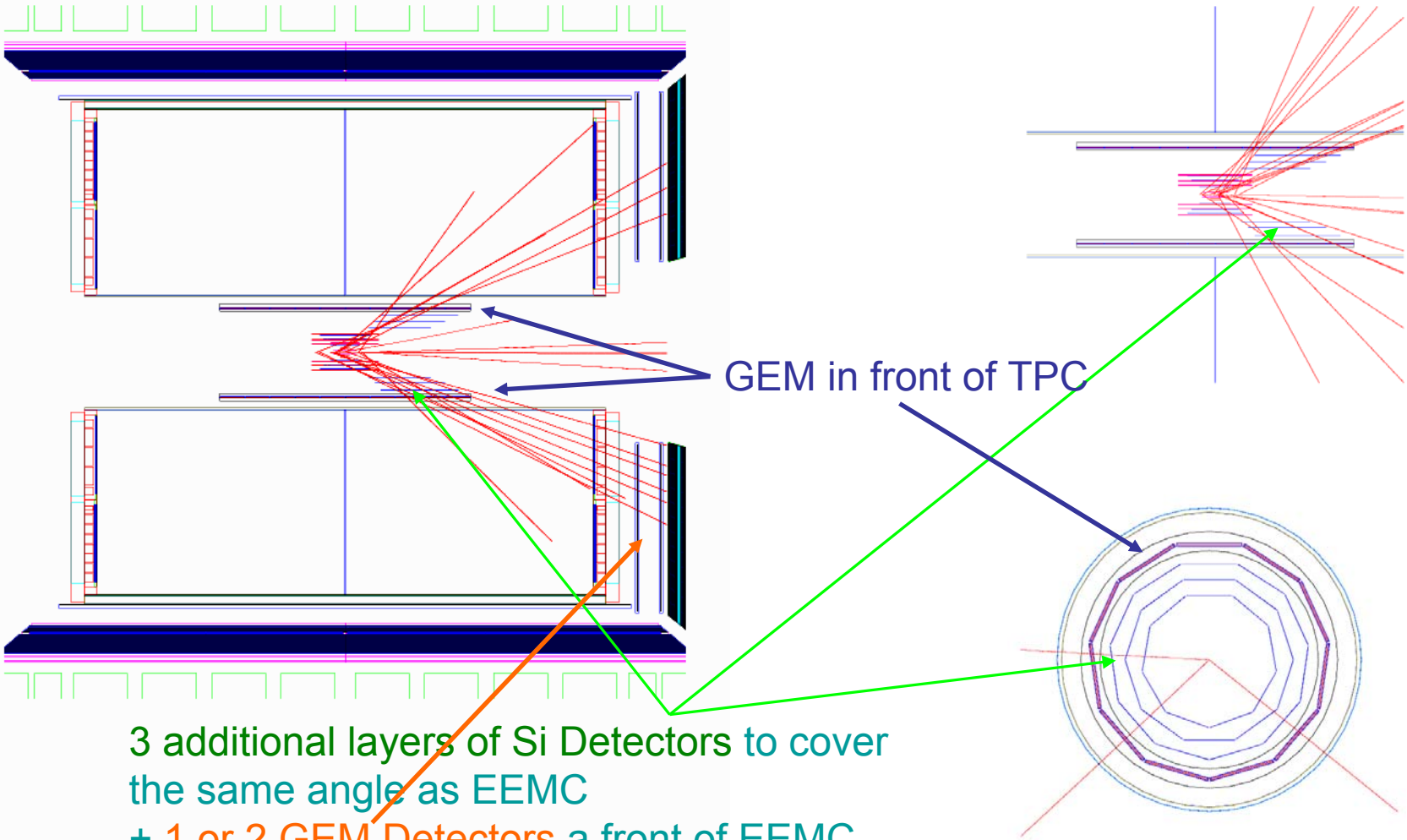
All hits





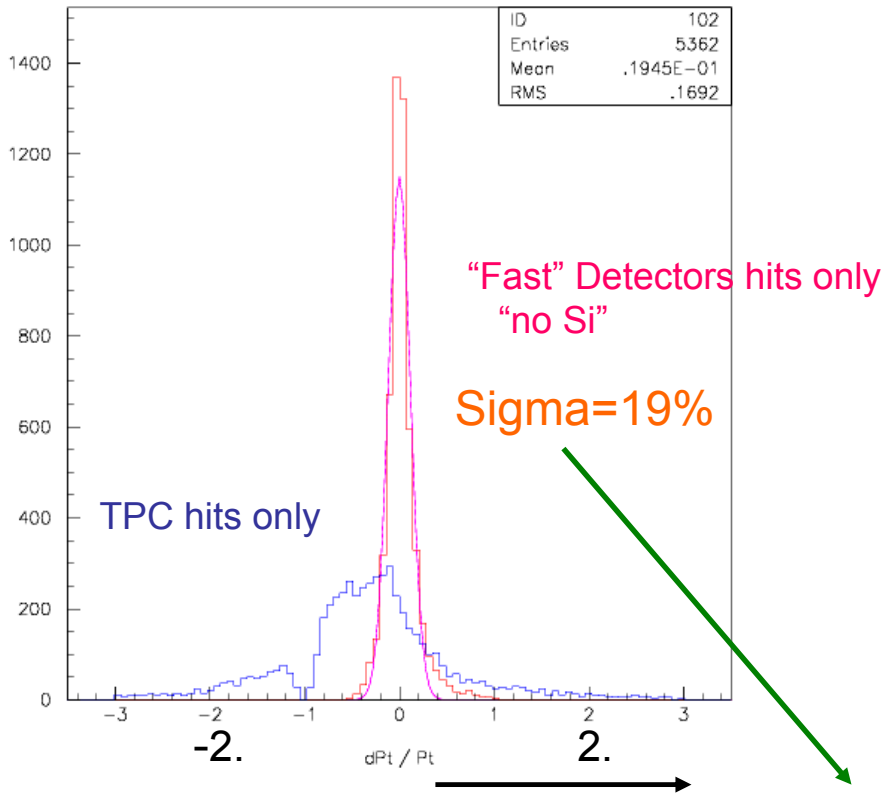
Background, occupancy, noise, …→ “realistic” simulation and small prototype

Additional tracking in 1<|η|<2 direction (in front of EEMC) (together with B.Surrow and S.Vigdor)

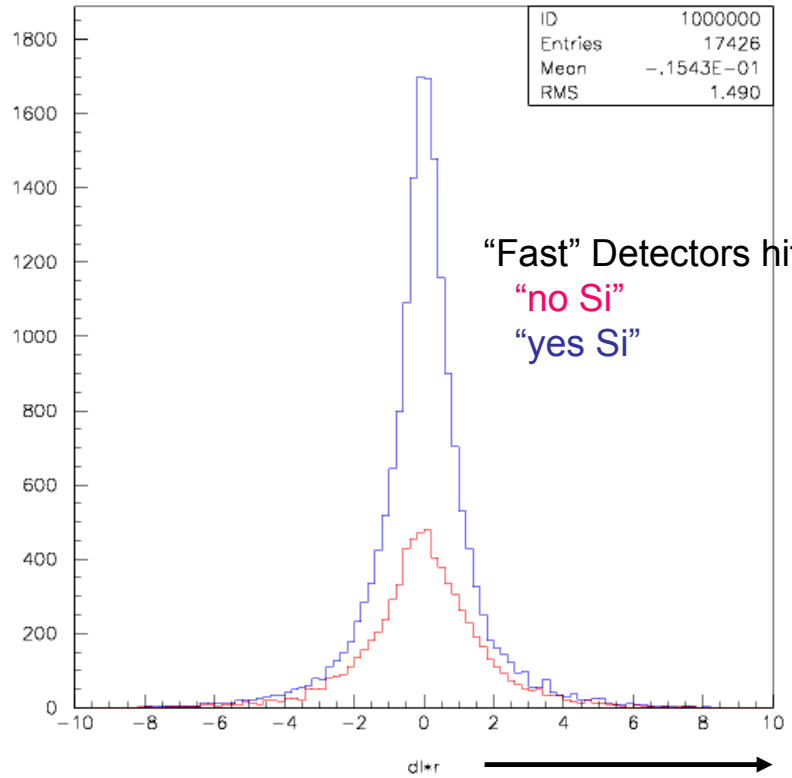


As a first step: SVT+GEM Detectors only (“no Si”)

Momentum reconstruction



Difference in rφ between a track crossing point and a GEM reconstructed hit position (in front of EEMC)



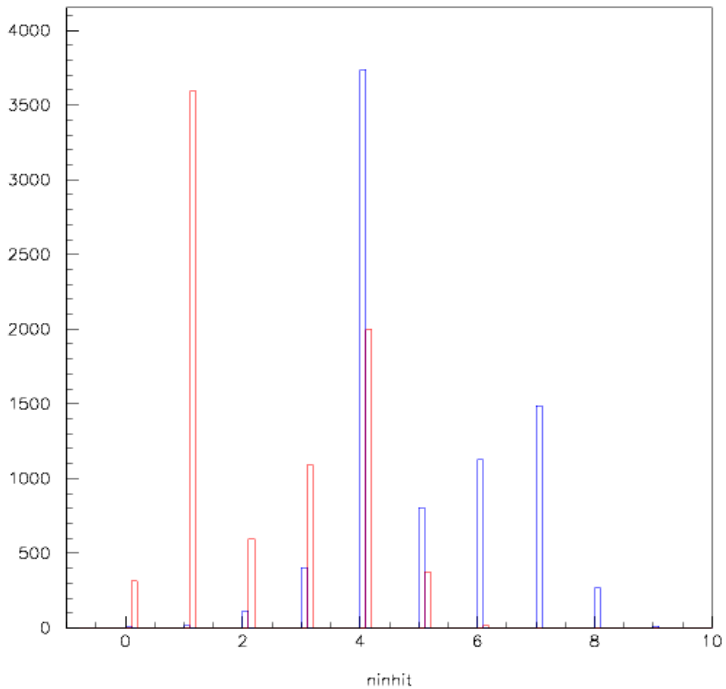
All hits → 13%

As a first step: SVT+GEM Detectors only (“no Si”)

Most probable: does not work

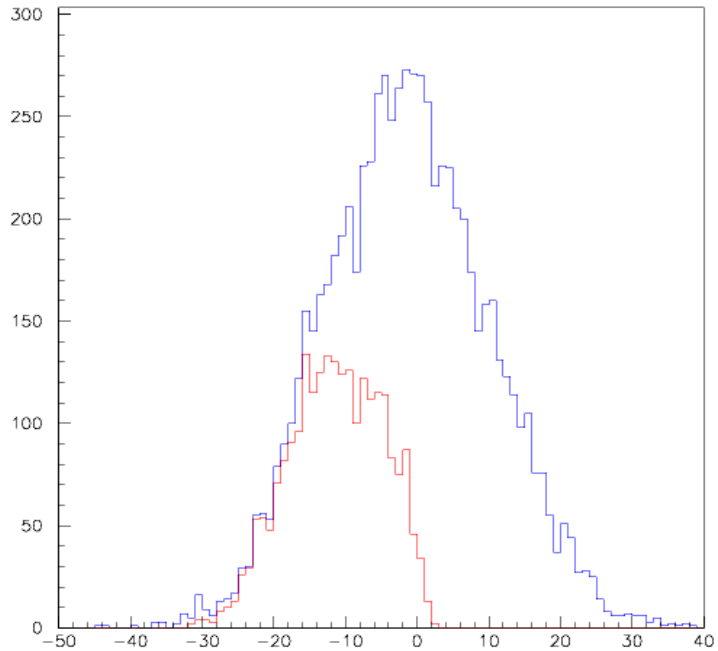
“no Si” “yes Si”

Number of “inner detectors” hits / track



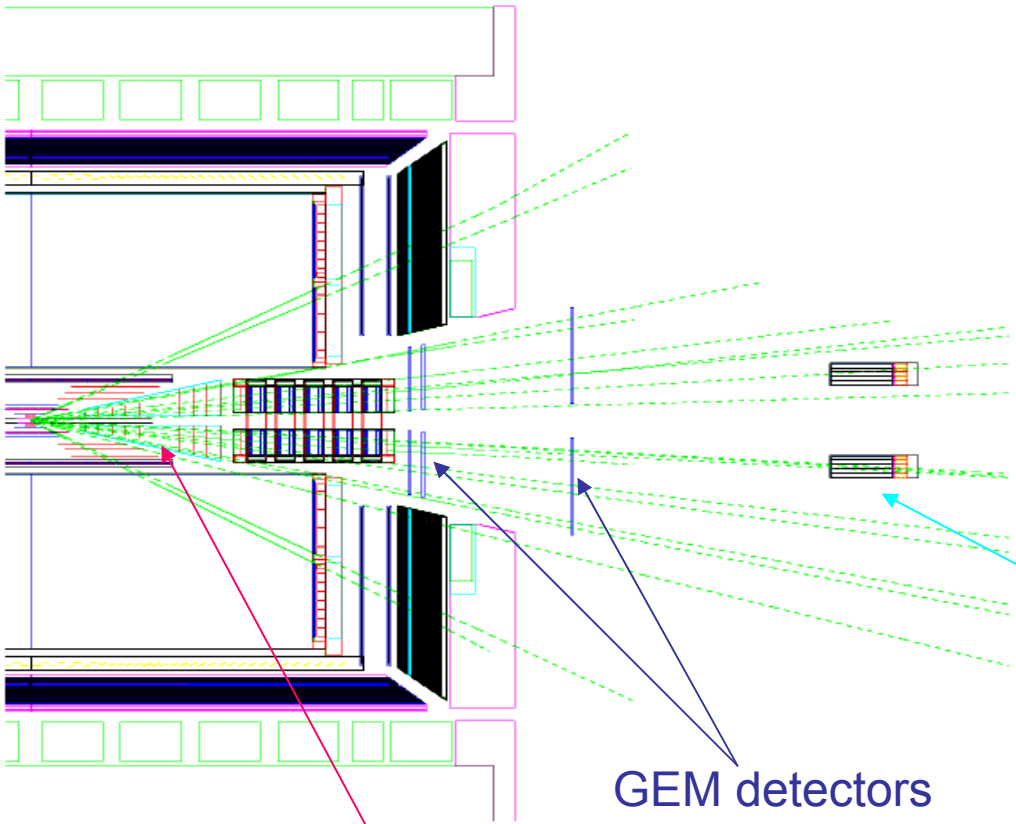
Number of hits

Vertex position (in Z) for “found” tracks



V_z, cm

STAR “forward” Physics
- unique possibilities at RHIC both for HI and pp



- “full η“ tracking coverage
- jets reconstruction
- C-, B- vertexes
- data with and without FTPC
- more Calorimeters (LB)
- more PID
- - ….
- gluon and/or parton saturation at RHIC (?!)

As a first (but urgent) step

To realize these ideas we need:

- ✓ R&D team
- ✓ R&D Lab
- ✓ Construction and test facilities
- ✓ space available (Vertex, Beam Pipe, TPC FEE upgrade)

Install ASAP GEM small size prototype(s) in STAR.

It will be continued in 7b report.

Very Forward Tracking, Pt reconstruction performance.
N of hits / track > 9., No FTPC hits,
Pt simulated:(0.2-5.) GeV/c , one particle/event,
“realistic” hit smearing