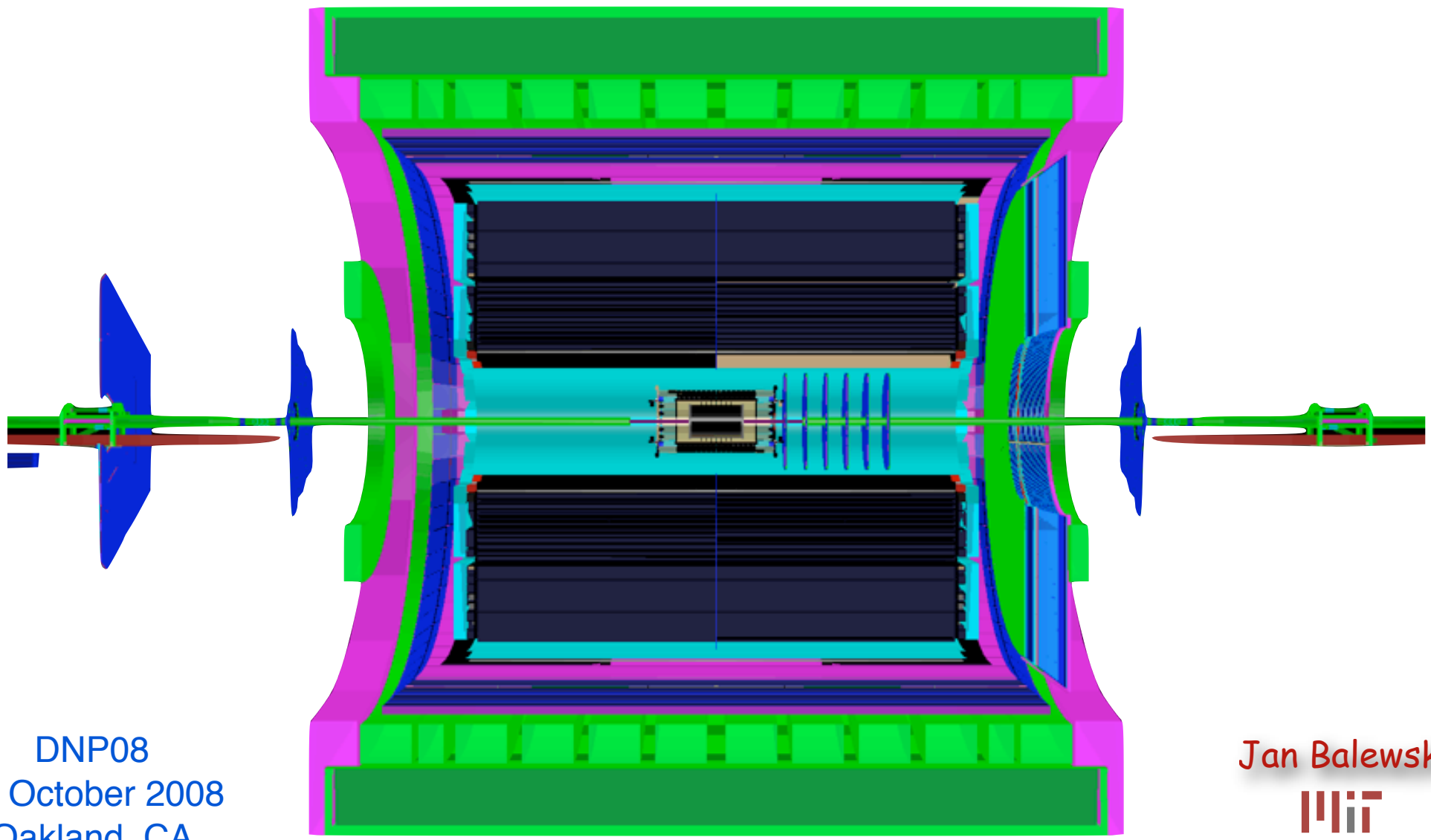




The STAR Forward GEM Tracker



DNP08
24 October 2008
Oakland, CA

Jan Balewski
The MIT logo, consisting of the letters "MIT" in a stylized, blocky font.

FGT Physics motivation - W program

□ What do we know about u/d anti-quark polarization?

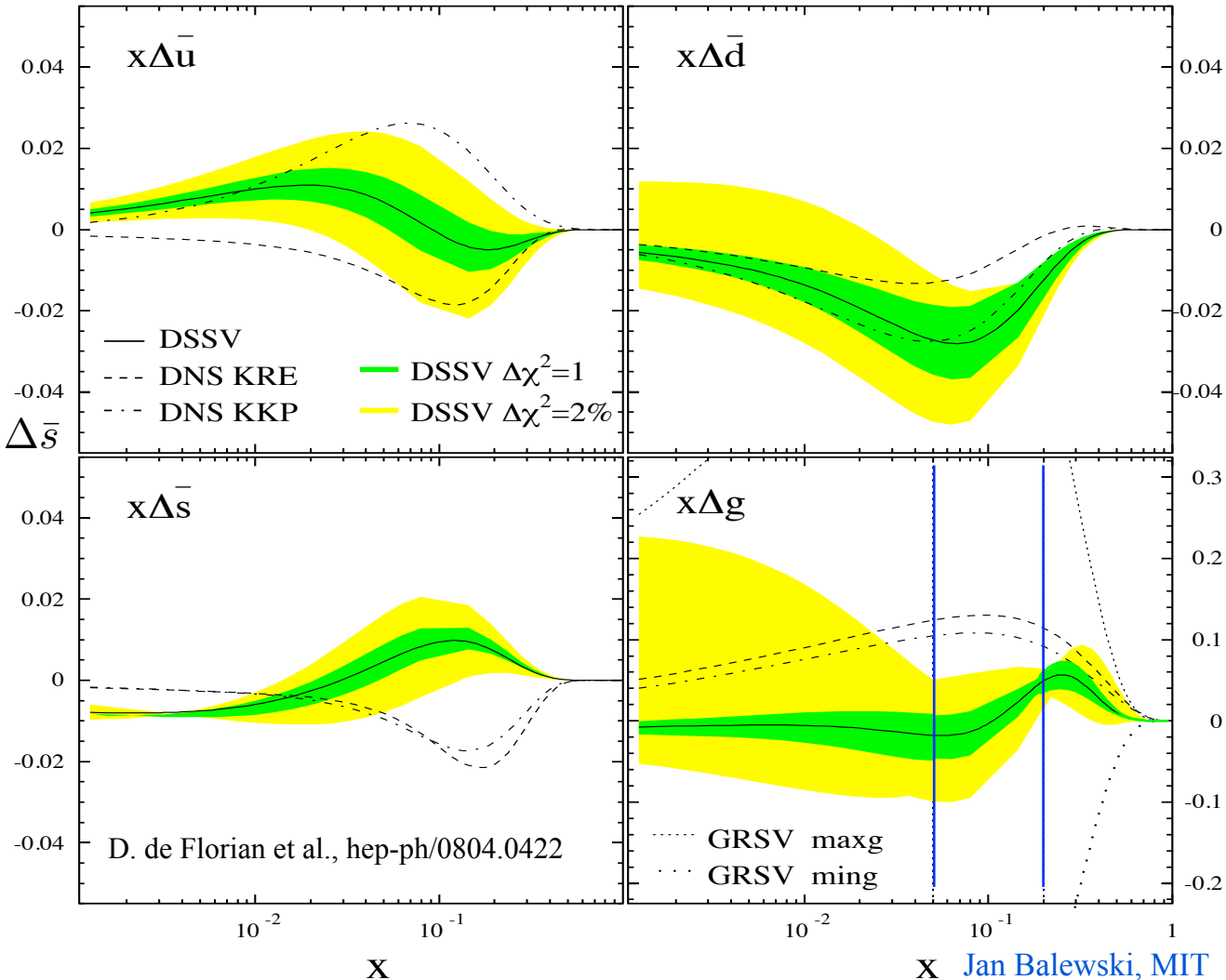
○ Spin carried by quarks is very small ($\Delta \Sigma \sim 0.4$)!

polarized u/d anti-quarks distributions based on SI-DIS

$$\frac{1}{2} = \underbrace{\langle S_q \rangle + \langle S_g \rangle + \langle L_q \rangle + \langle L_g \rangle}_{\frac{1}{2} \Delta \Sigma}$$

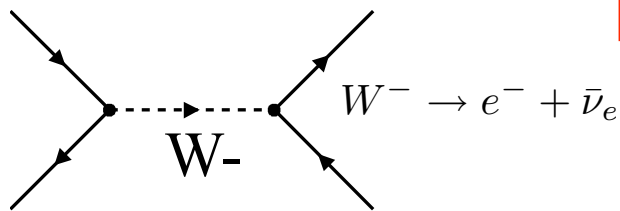
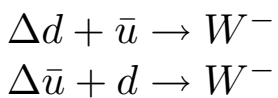
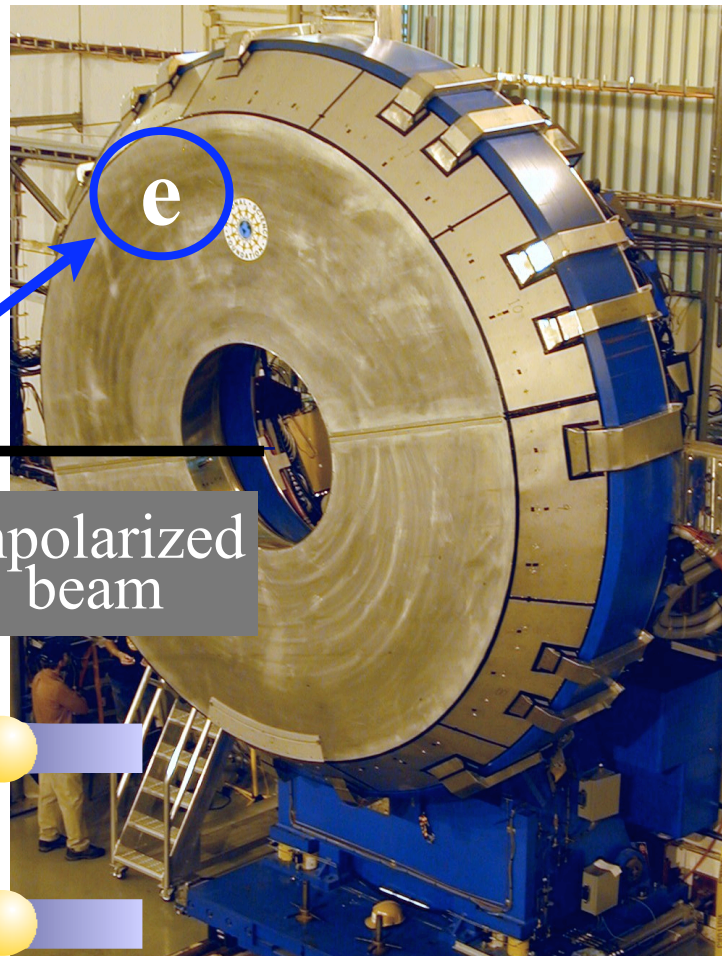
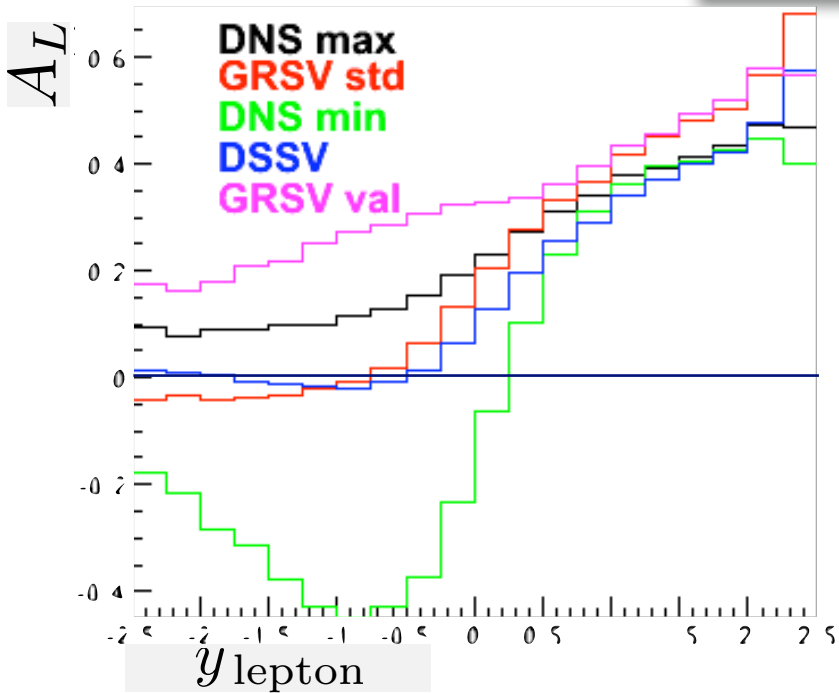
$$\Delta \Sigma = \Delta u + \Delta \bar{u} + \Delta d + \Delta \bar{d} + \Delta s + \Delta \bar{s}$$

$$\Delta q_i(Q^2) = \int_0^1 \Delta q_i(x, Q^2) dx$$



Exploring W/lepton phase space @ STAR

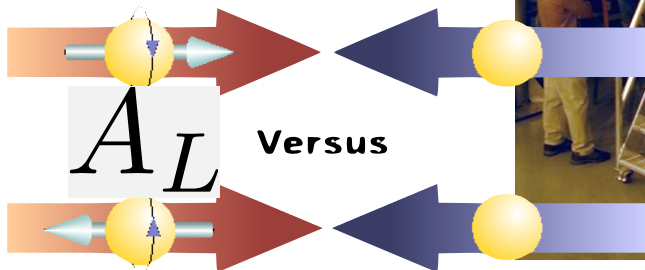
$W^- \quad p_T > 20 \text{ GeV}/c$



$$A_L^W = \frac{1}{P} \frac{N^+(W) - N^-(W)}{N^+(W) + N^-(W)}$$

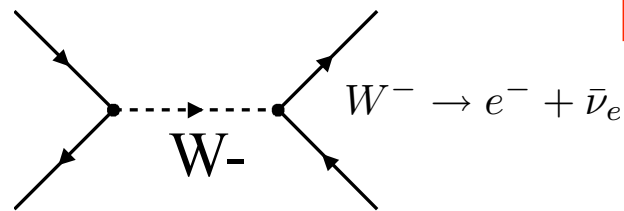
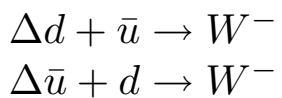
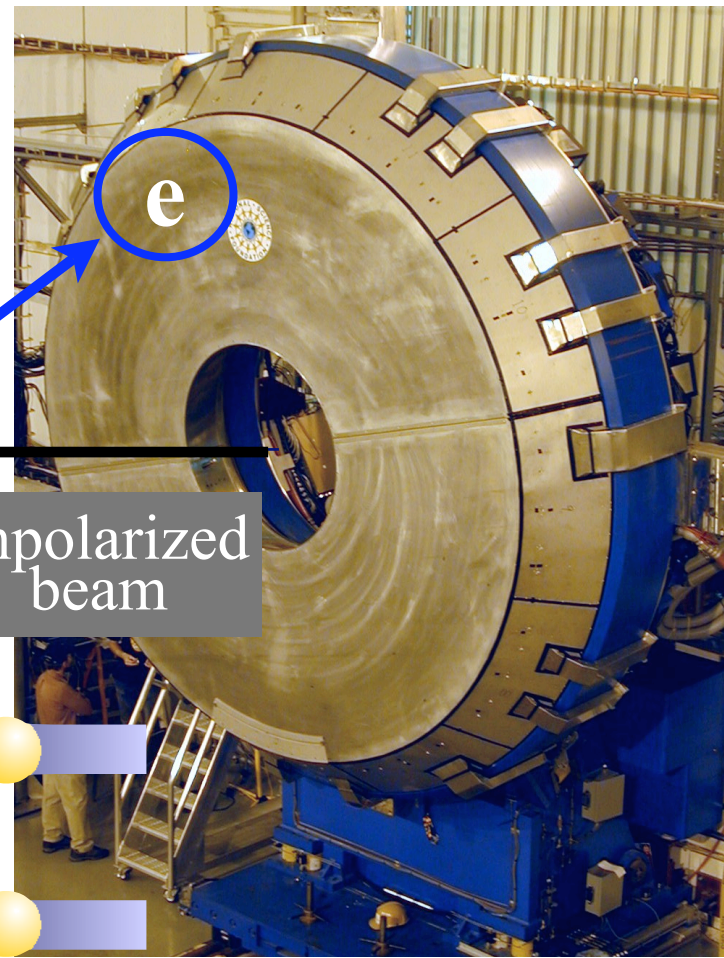
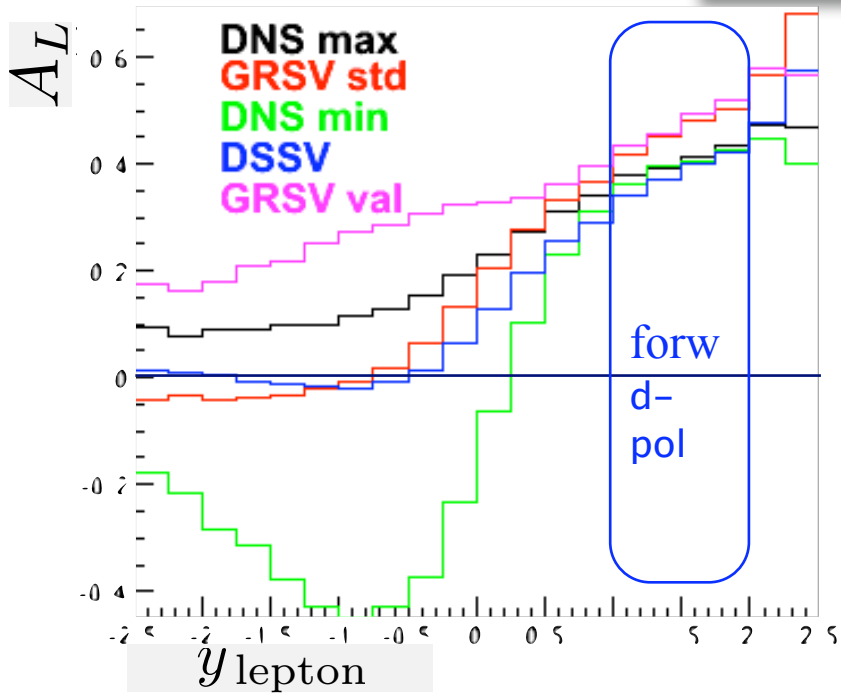
polarized beam

unpolarized beam



Exploring W/lepton phase space @ STAR

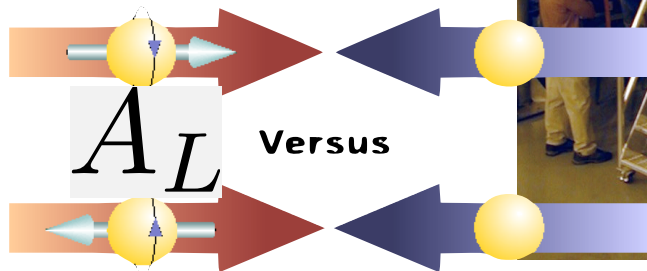
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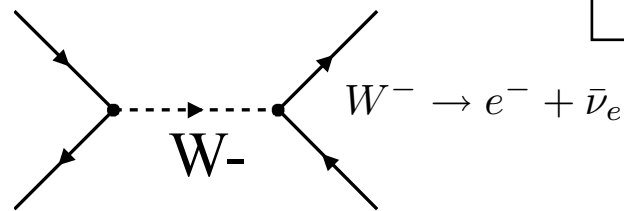
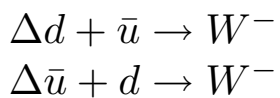
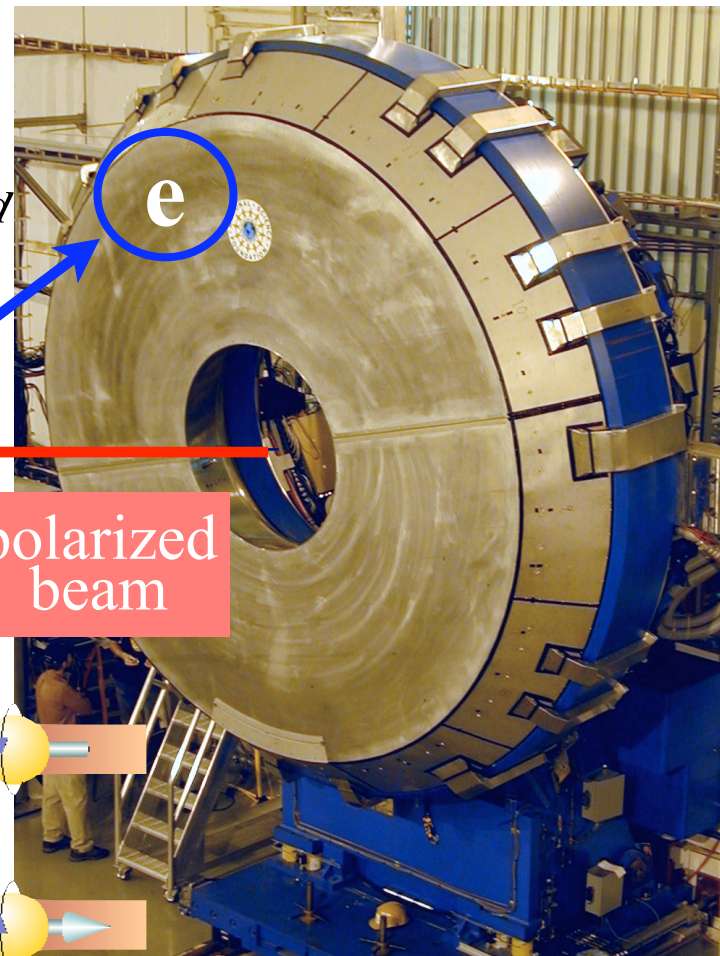
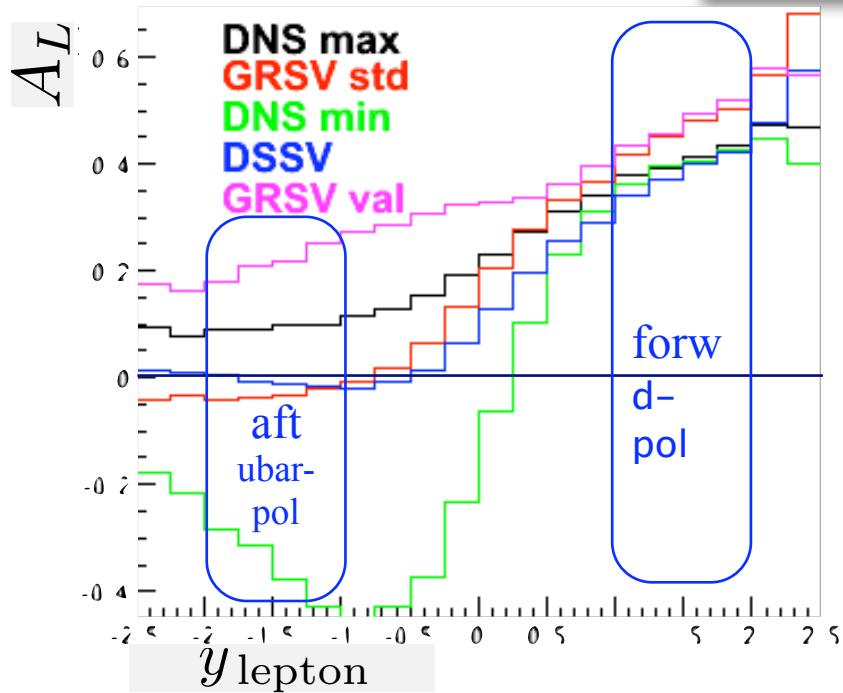
polarized beam

unpolarized beam



Exploring W/lepton phase space @ STAR

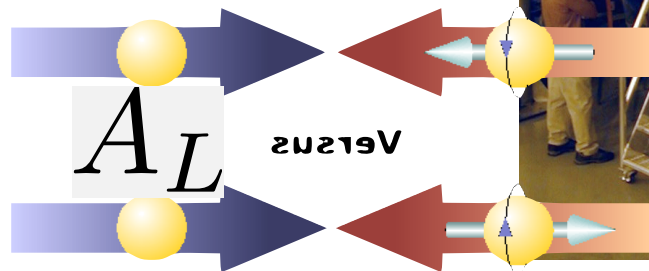
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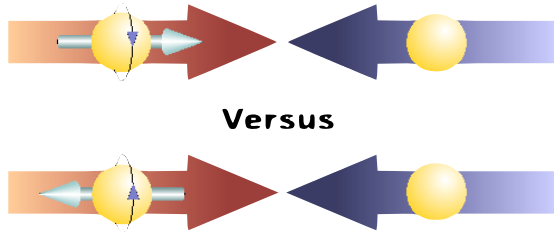
unpolarized beam

polarized beam



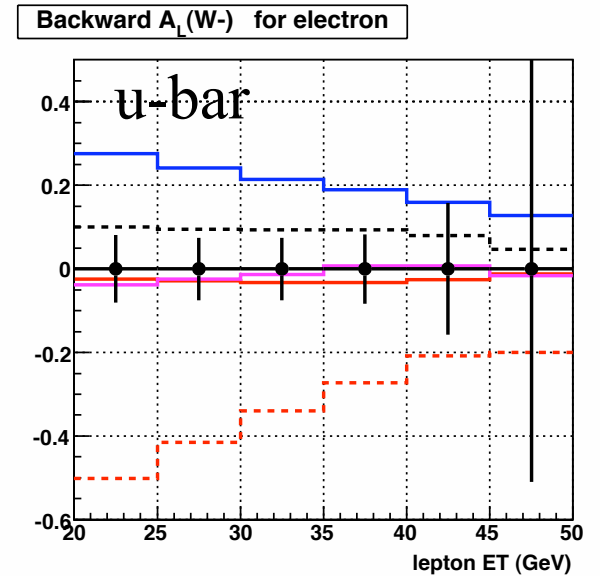
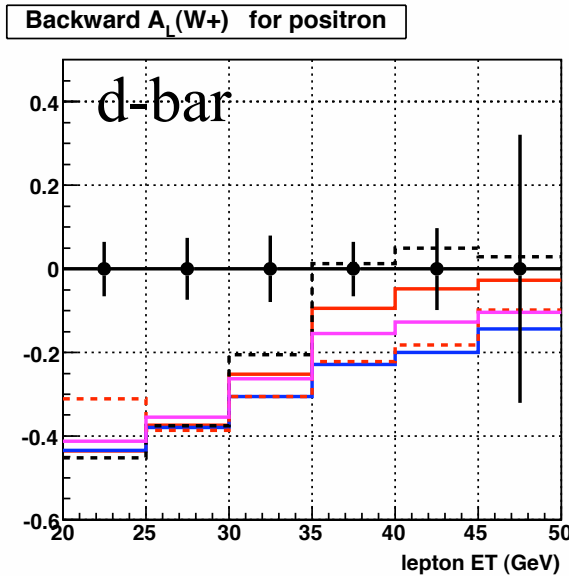
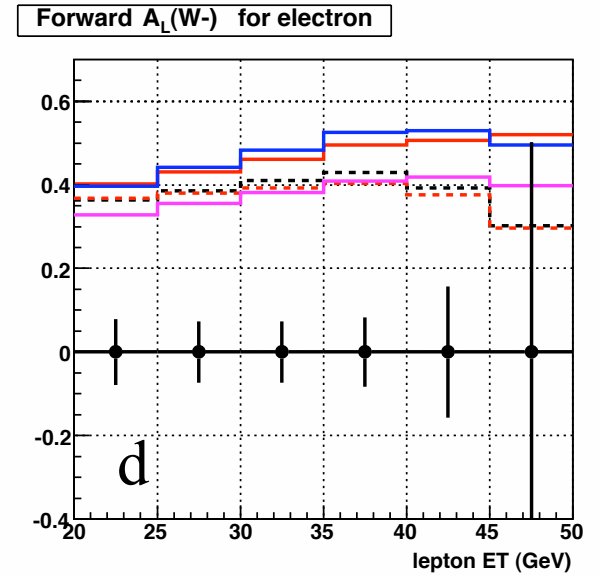
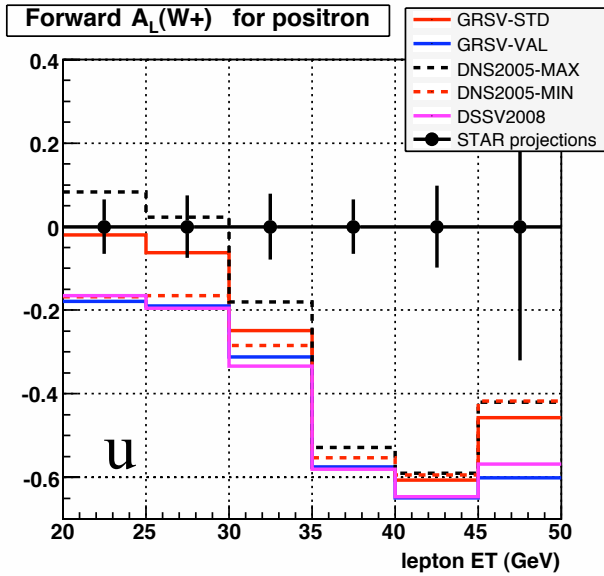
STAR Projections: $q/q\bar{q}$ polarization at forward rapidity

A_L



- 5 years integrated, $LT=300/pb$
- Large asymmetries dominated by quark polarization - Important consistency check to existing DIS data with $100pb^{-1}$ (Phase I)
- Strong impact constraining unknown antiquark polarization requires luminosity sample at the level of $300pb^{-1}$ for 70% beam polarization (Phase II)

STAR projections for $LT=300 pb^{-1}$, $Pol=0.7$, $eff_i=70\%$, no QCD background, no vertex cut

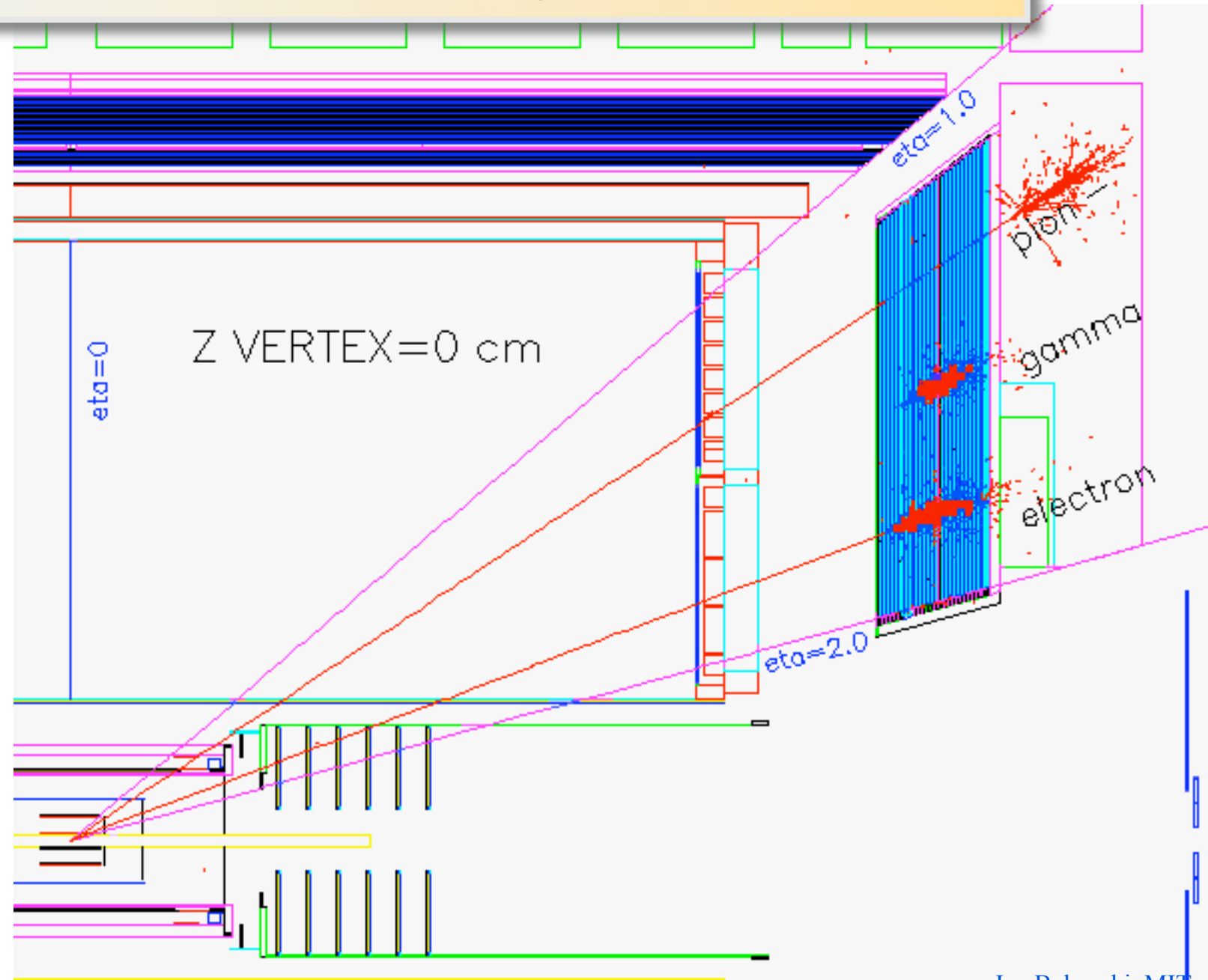


Particle ID

Lets throw

- pi-
- gamma
- electron

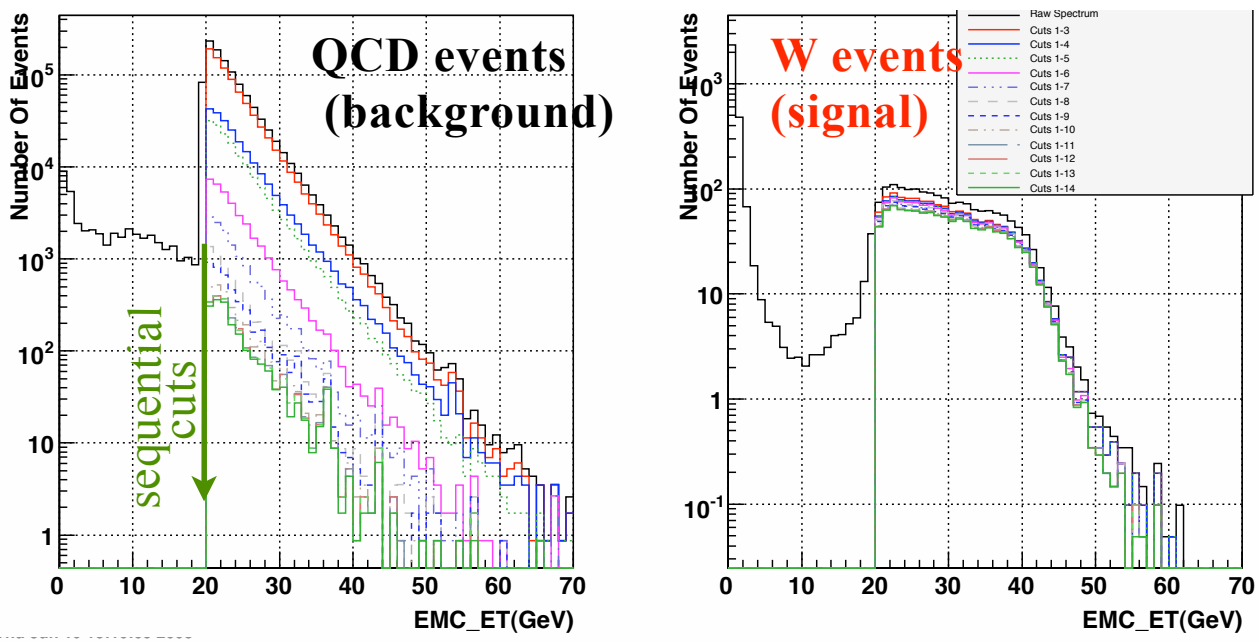
ET=20 GeV



QCD Physics Background Suppression Algo

- generated 10e10 QCD pythia events w/ full detector response
- e/h separation: Full PYTHIA QCD background and W signal sample including detector effects

All simu scaled to LT=300/pb



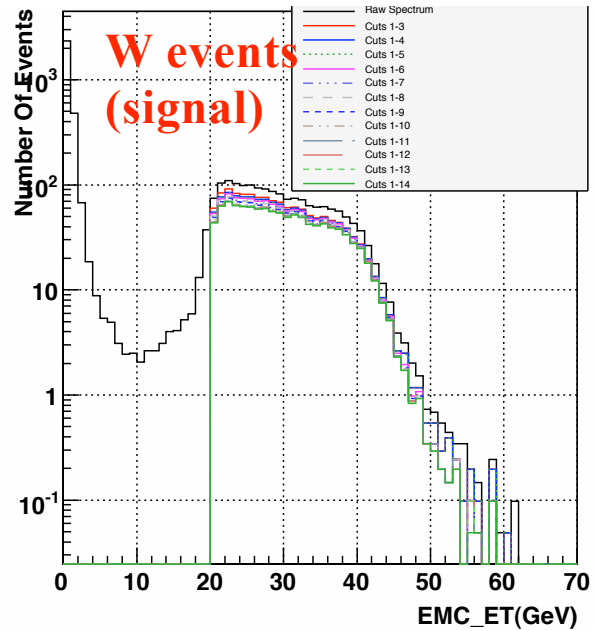
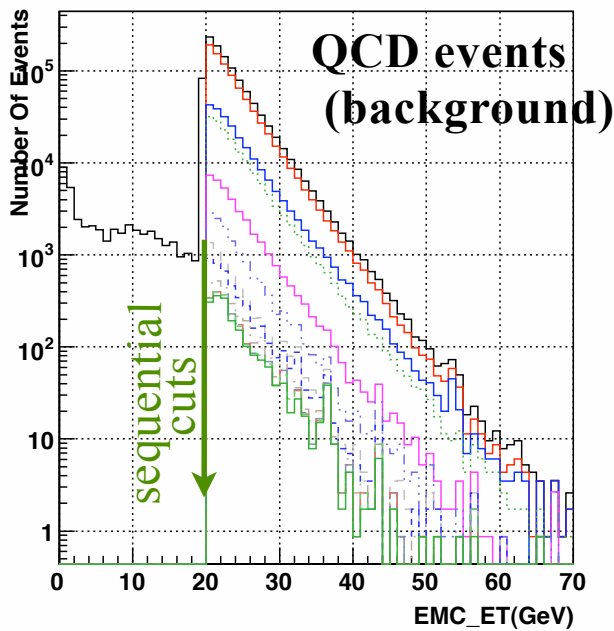
- e/h separation based on global cuts (isolation/missing E_T) and EMC specific cuts
- With current algorithm: $E_T > 30\text{GeV}$ yields $S/B > 1$
 - (tmp: 70% of Geant tracks used isolation cut)



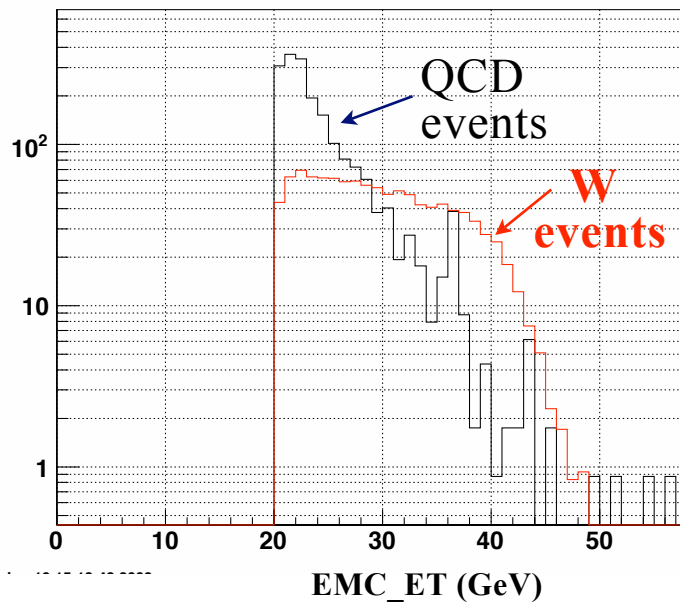
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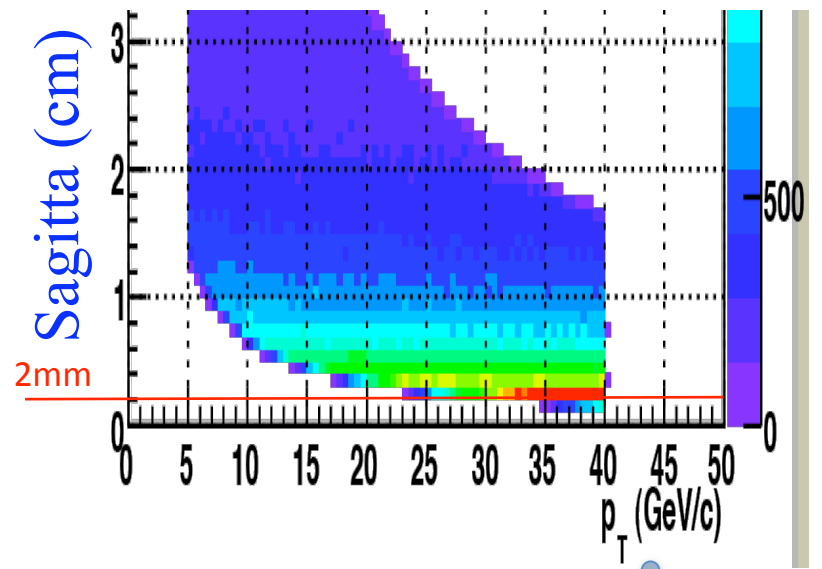
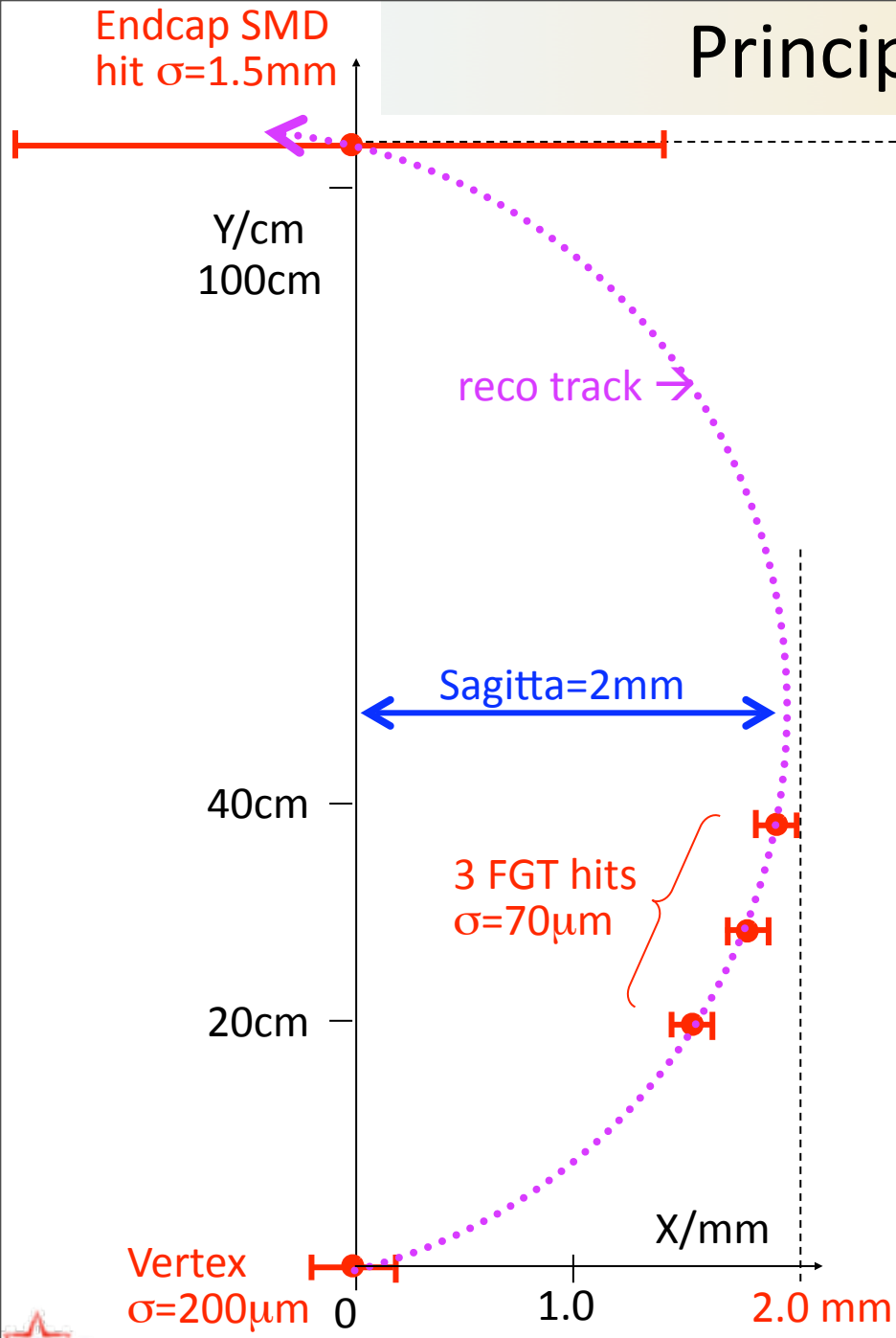
After all cuts (ver 4.0)



- e/h separation based on global cuts (isolation/missing E_T) and EEMC specific cuts
- With current algorithm: $E_T > 30\text{GeV}$ yields $S/B > 1$
 - (tmp: 70% of Geant tracks used isolation cut)



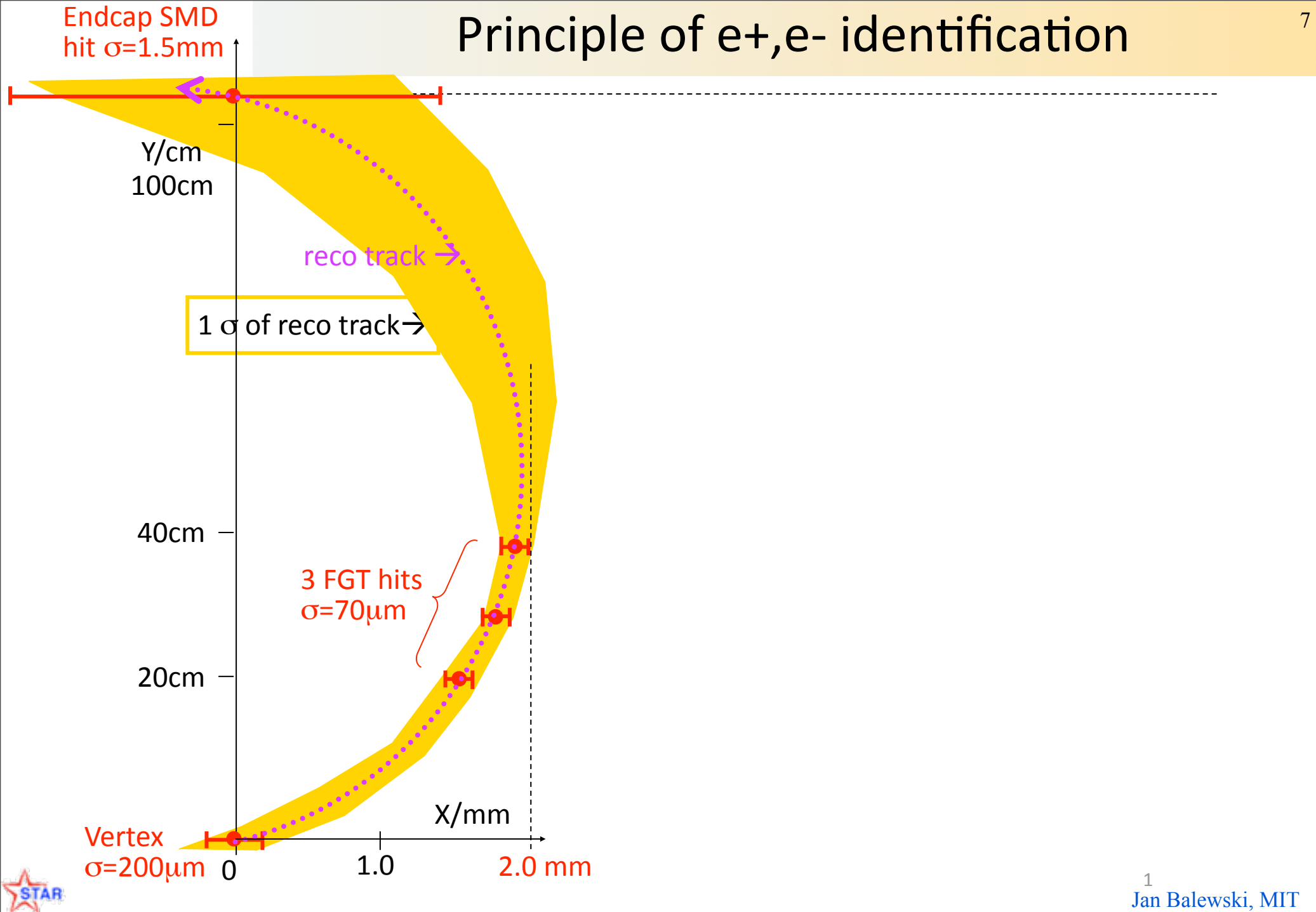
Principle of e+,e- identification



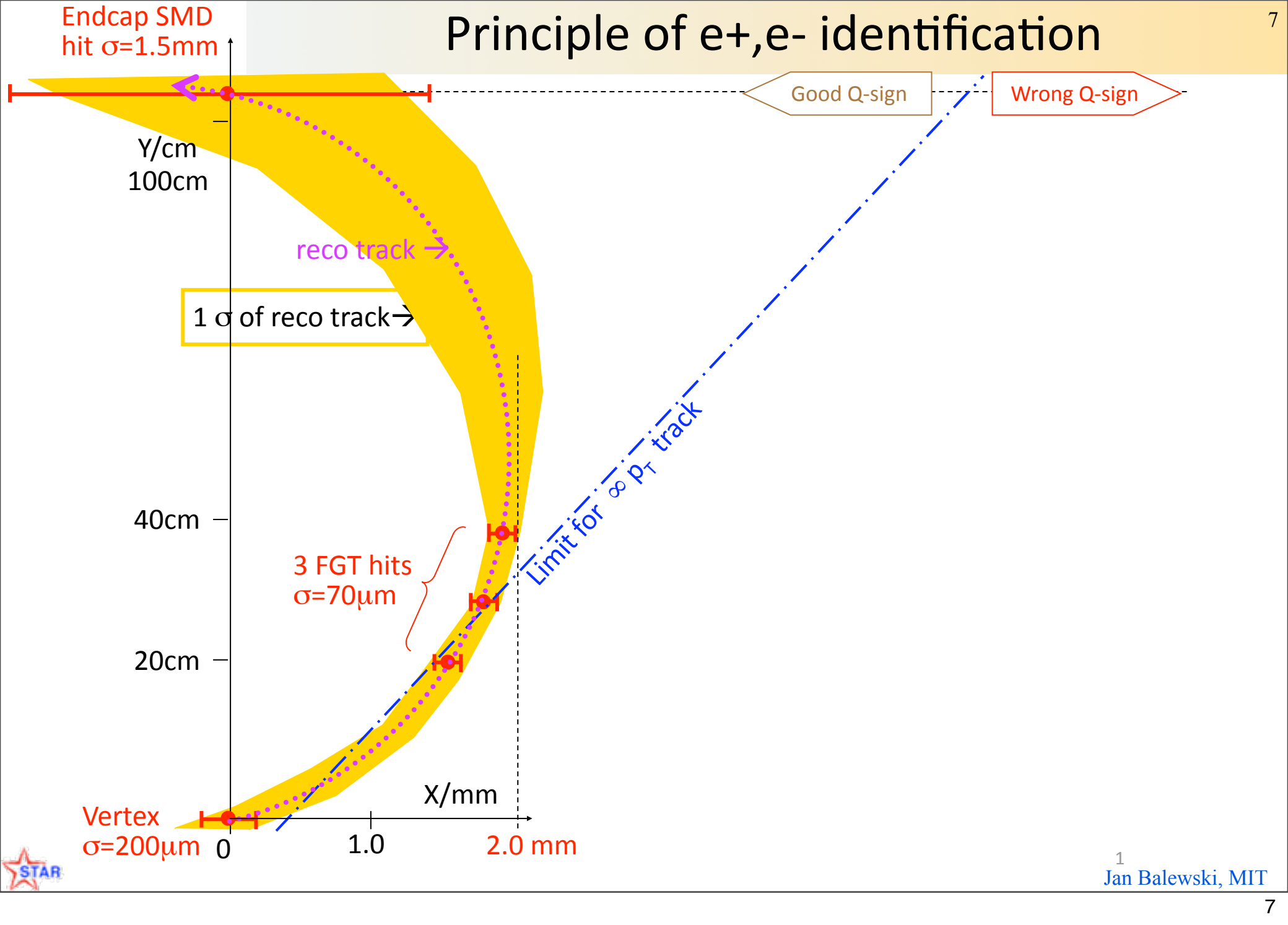
Include vertex & Esmd



Principle of e^+,e^- identification

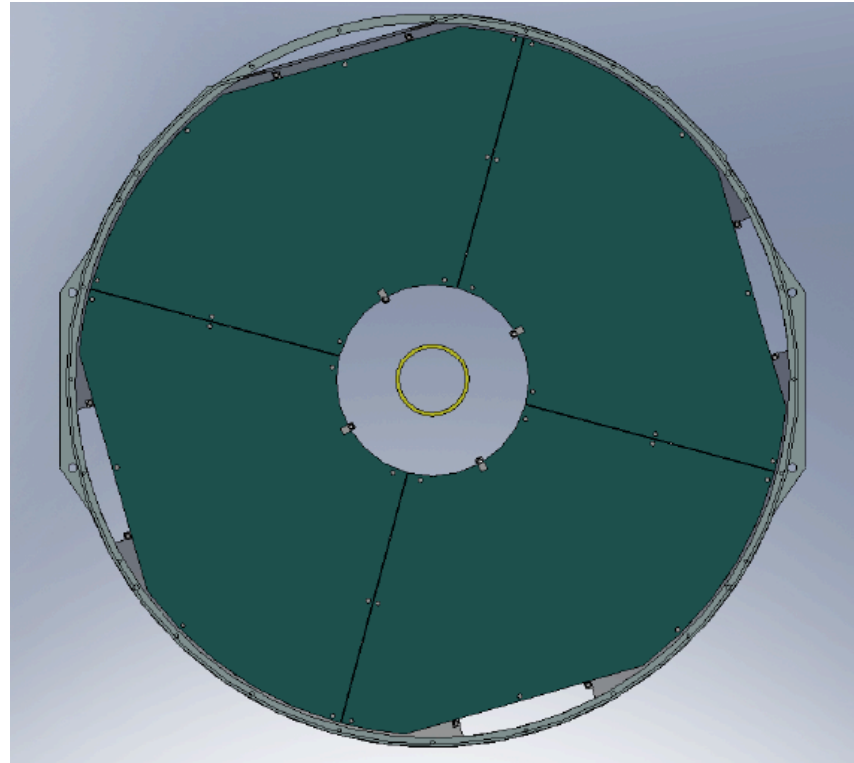
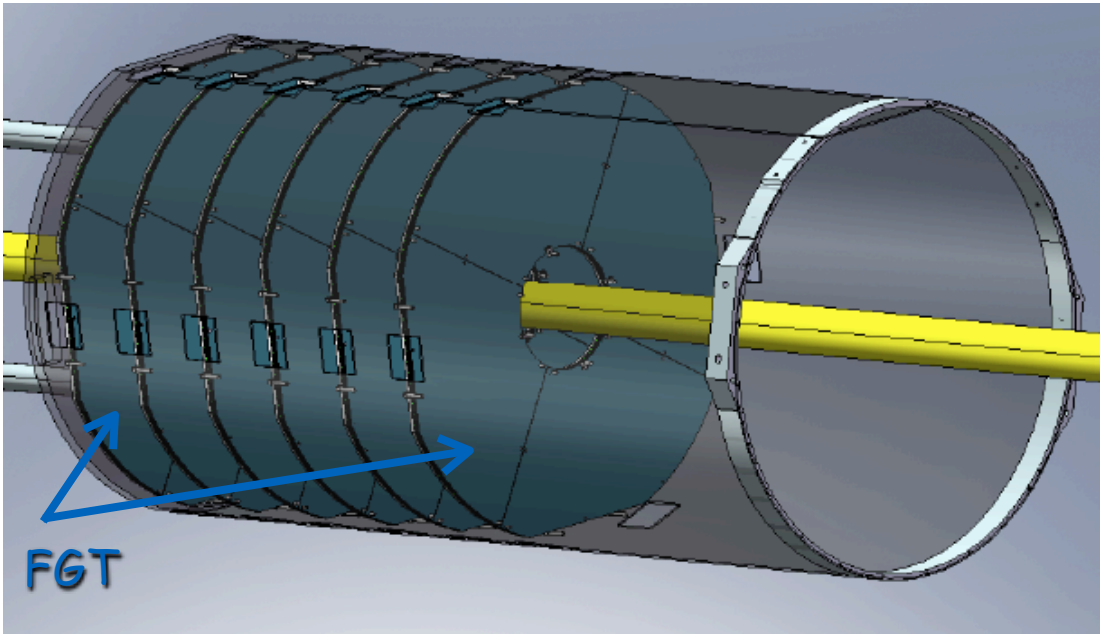


Principle of e+,e- identification



FGT Technical realization

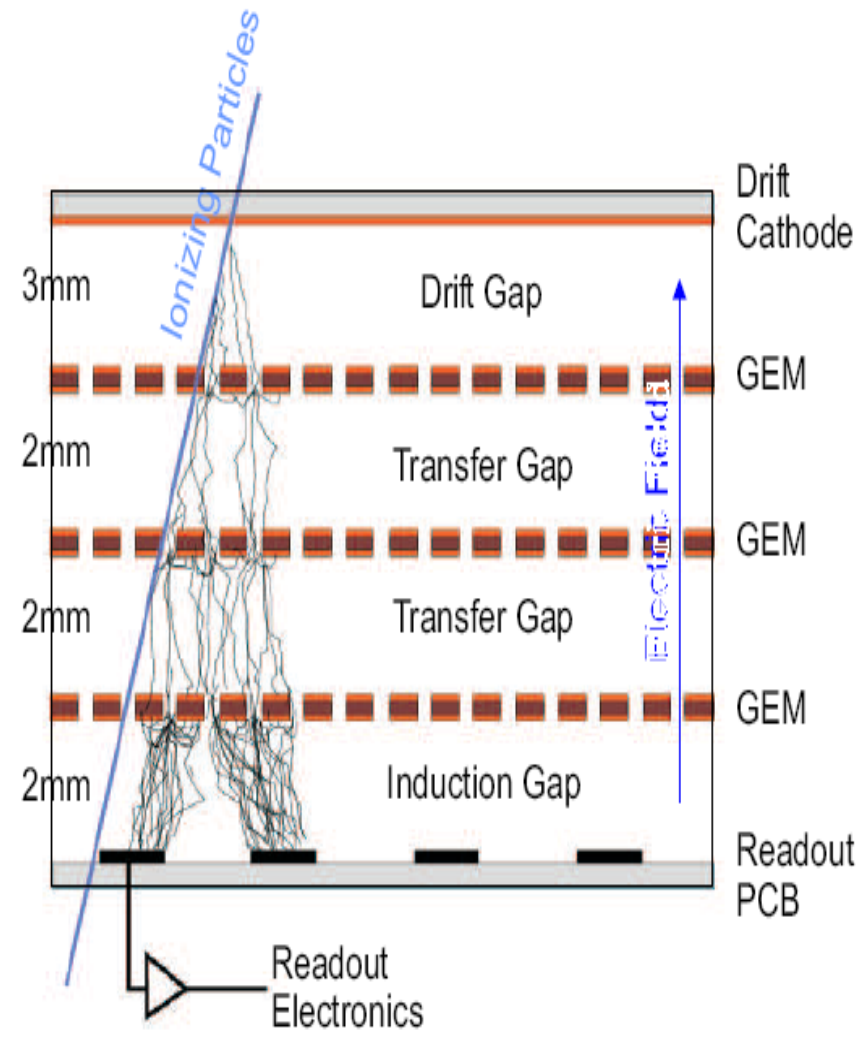
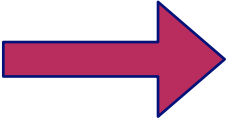
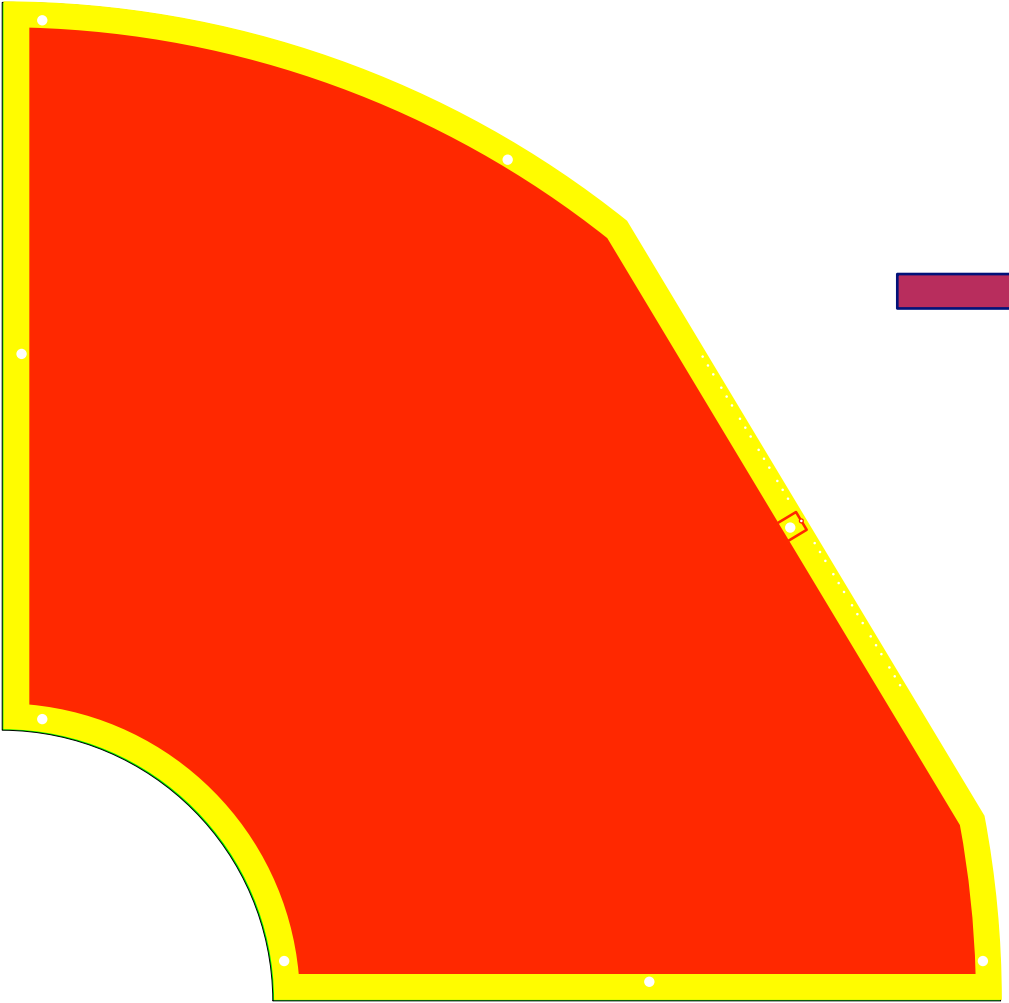
□ Mechanical design



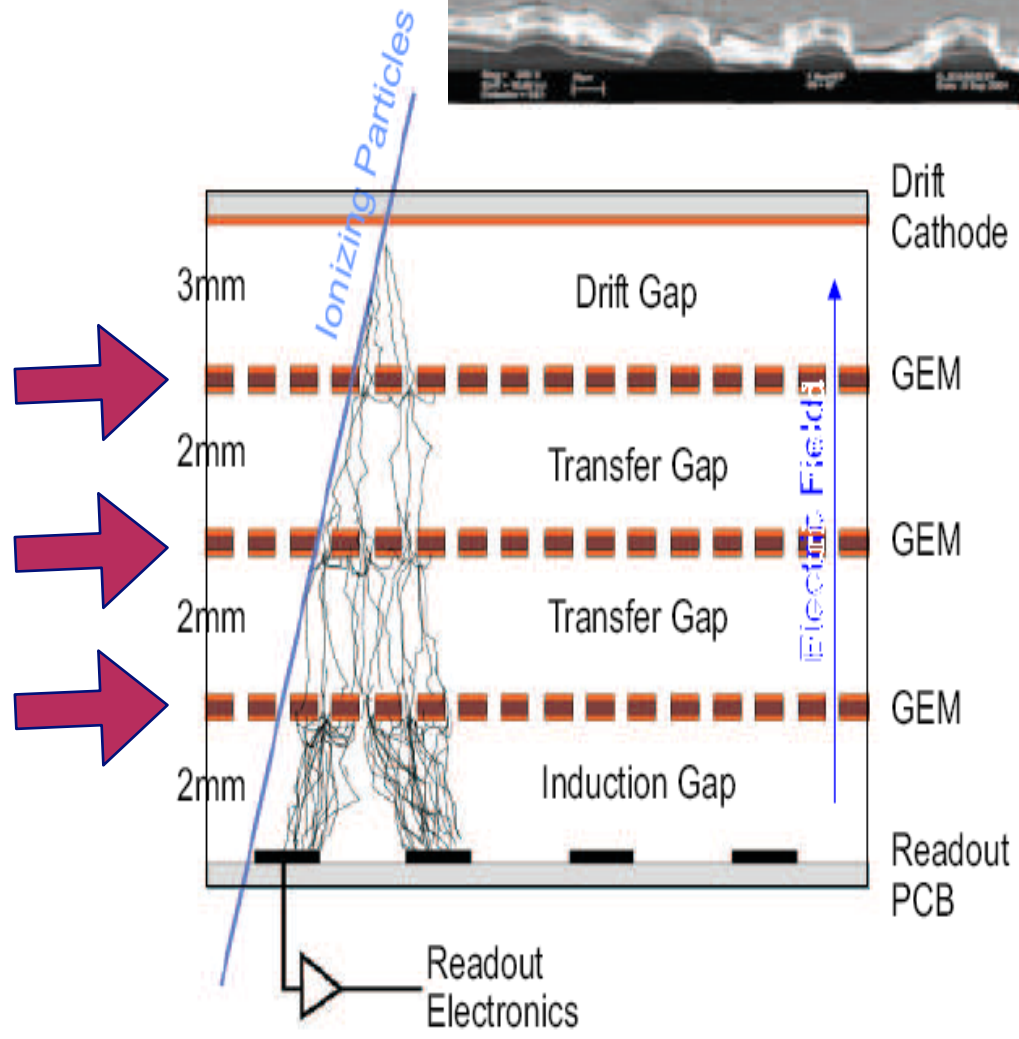
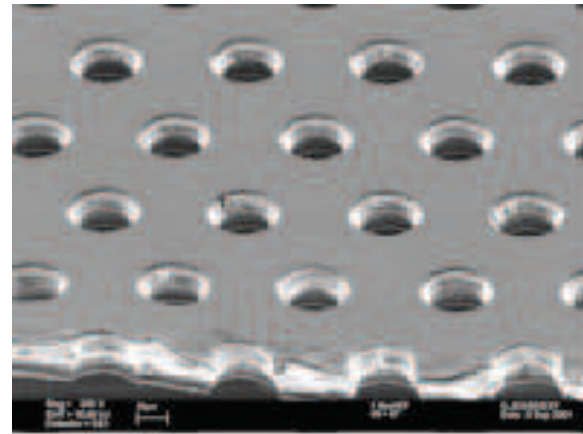
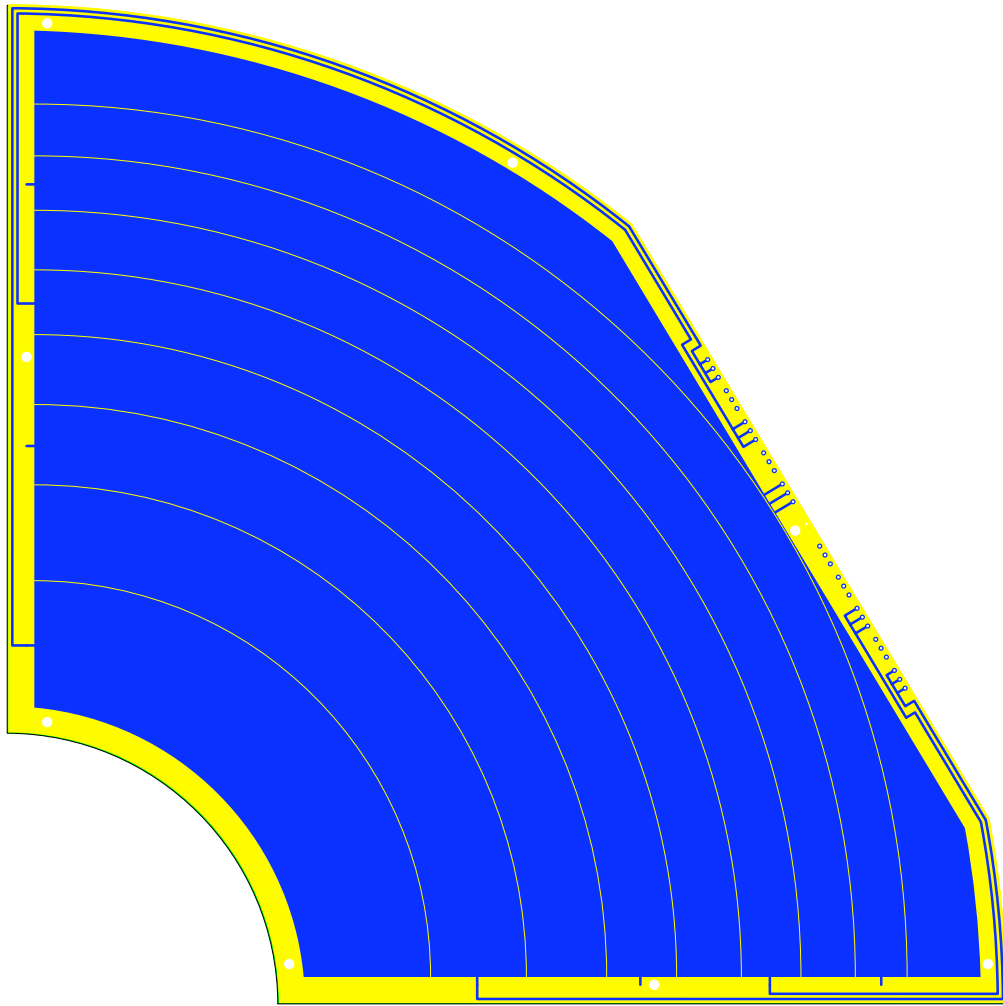
- FGT: 6 light-weight disks
- Each disk consists of 4 triple-GEM chambers (Quarter sections)

- Procurement and assembly of full quarter section prototype in preparation

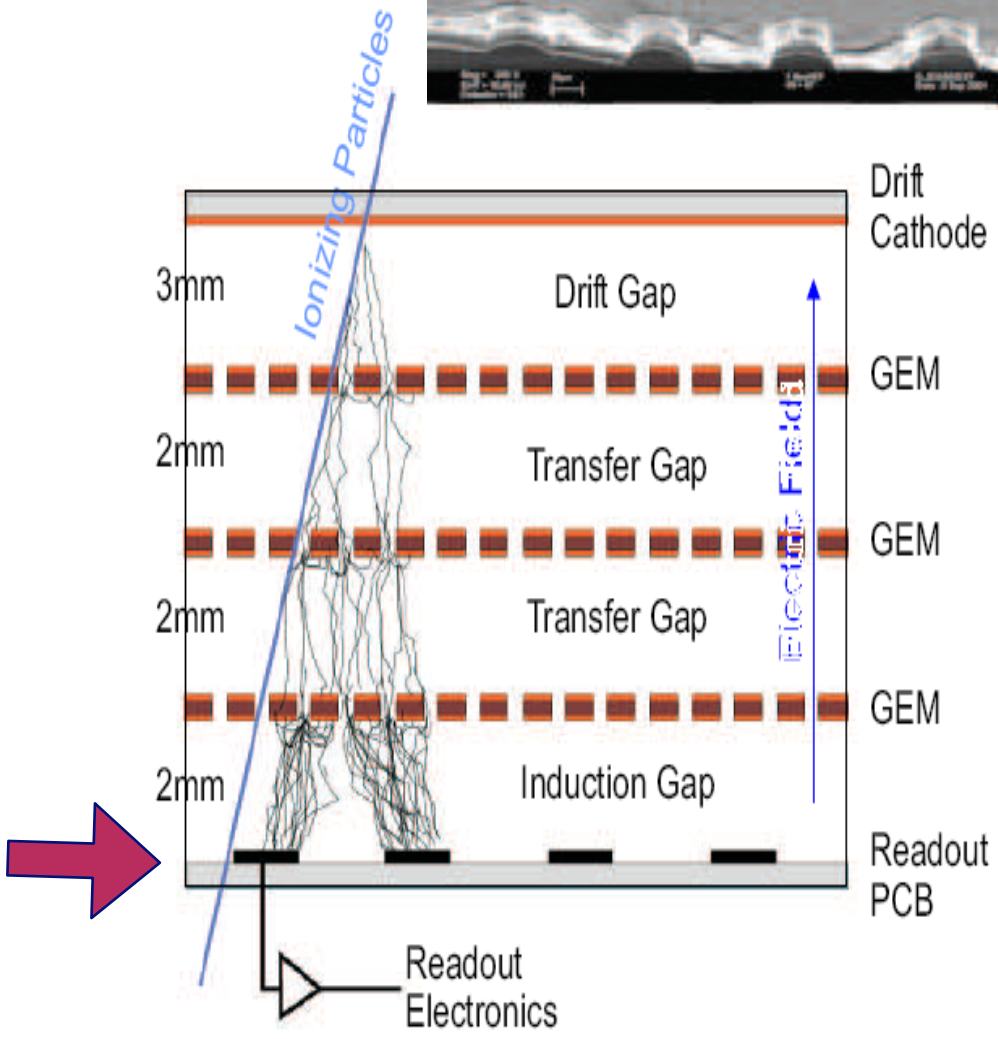
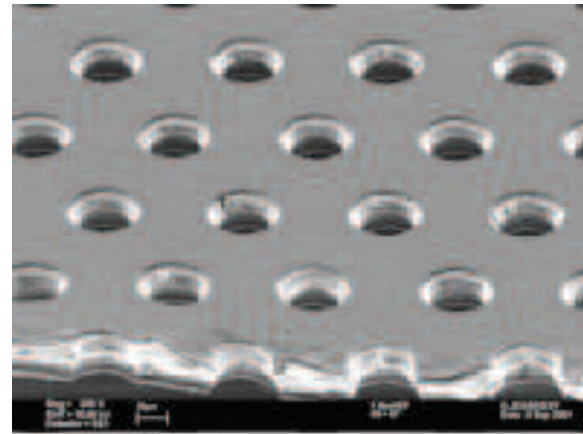
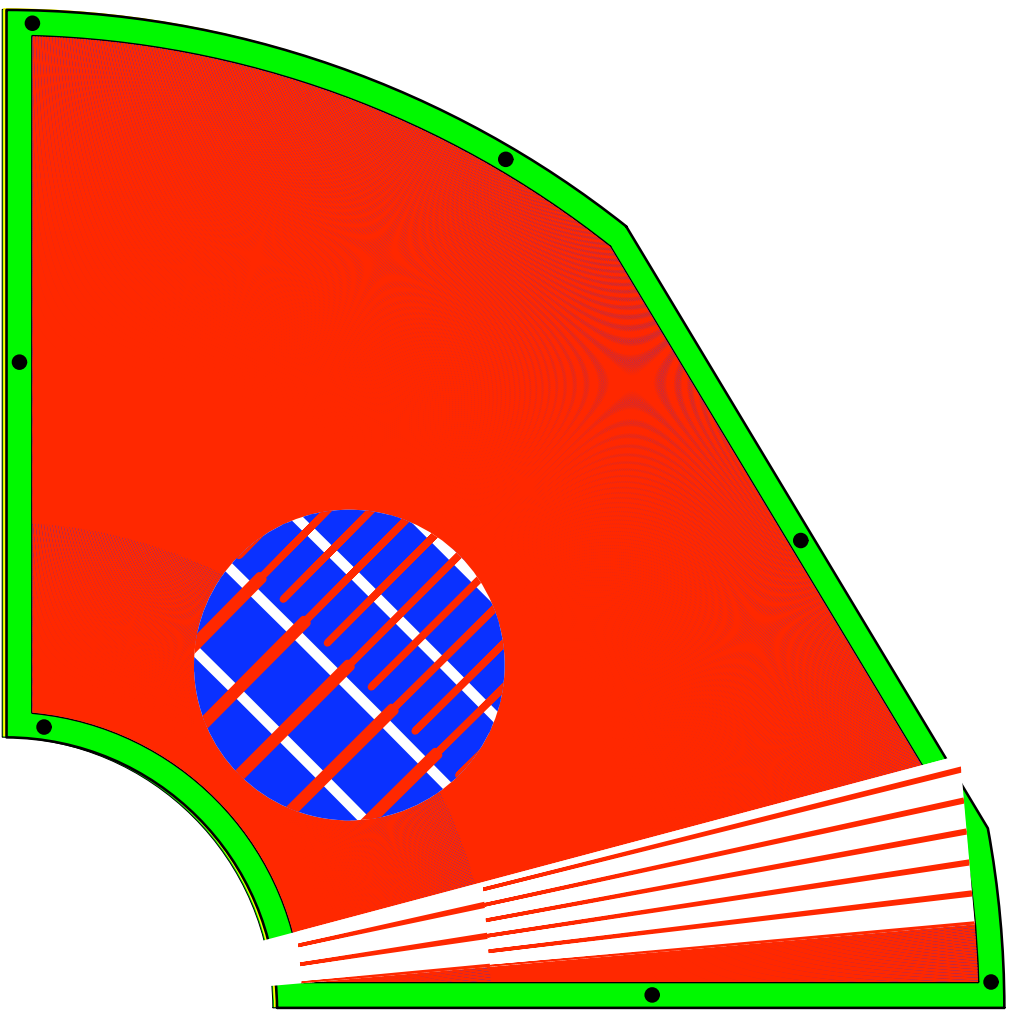
FGT Technical realization



FGT Technical realization

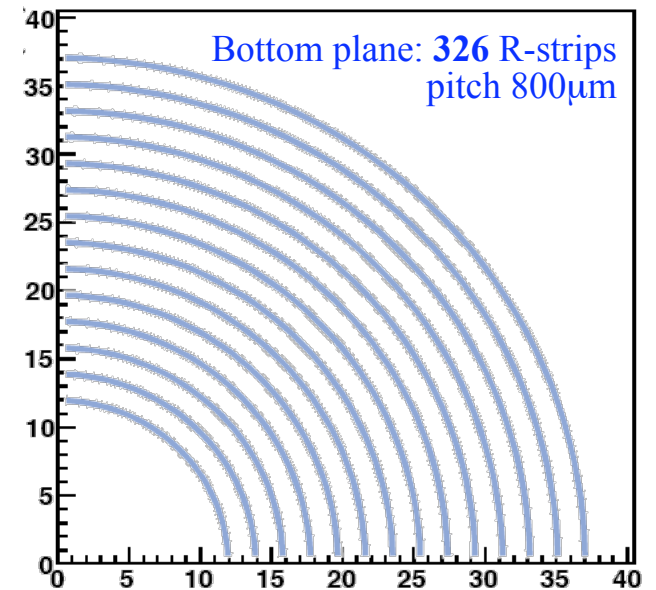
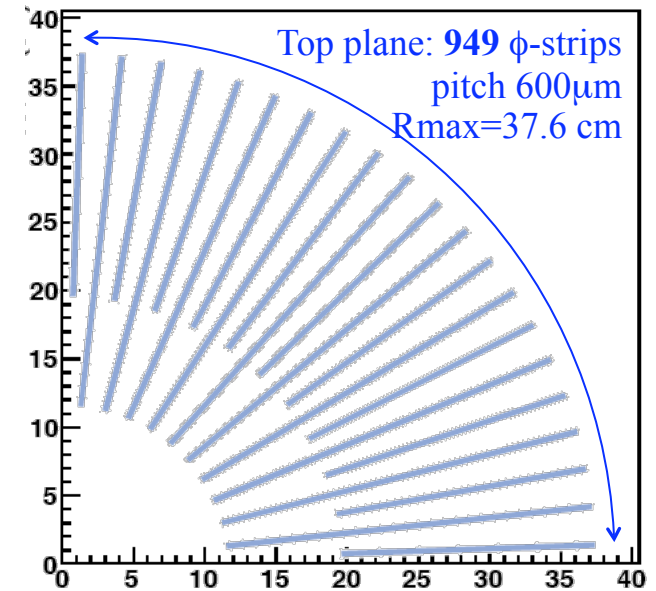
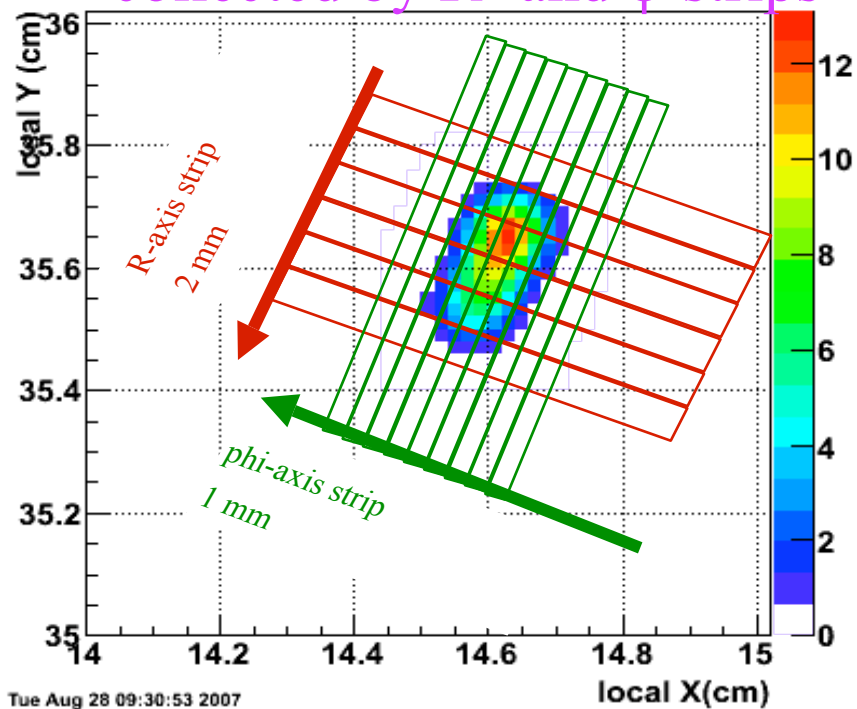


FGT Technical realization

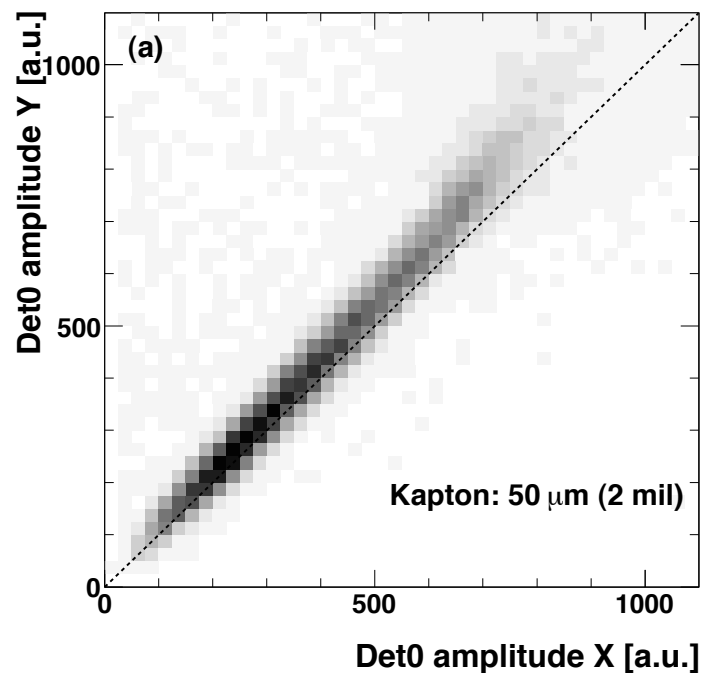
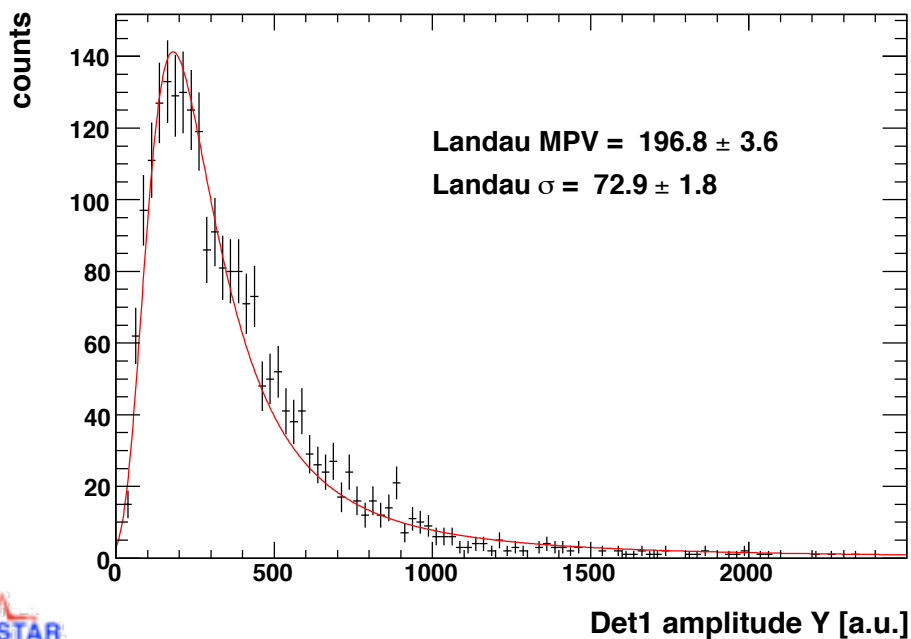
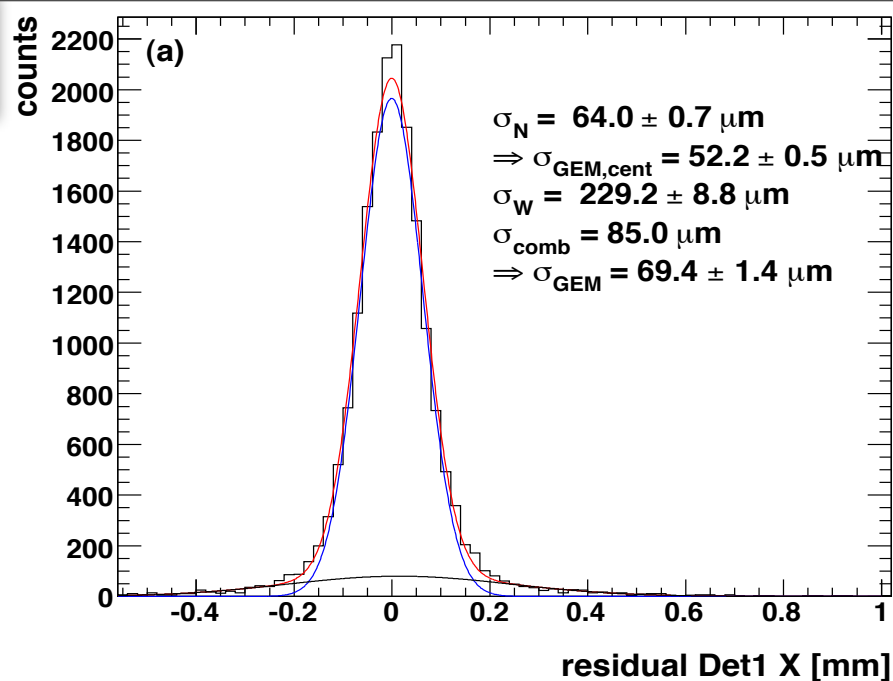


FGT Strip Layout, charge collection

Realistic MIP charge profile
collected by R- and ϕ -strips



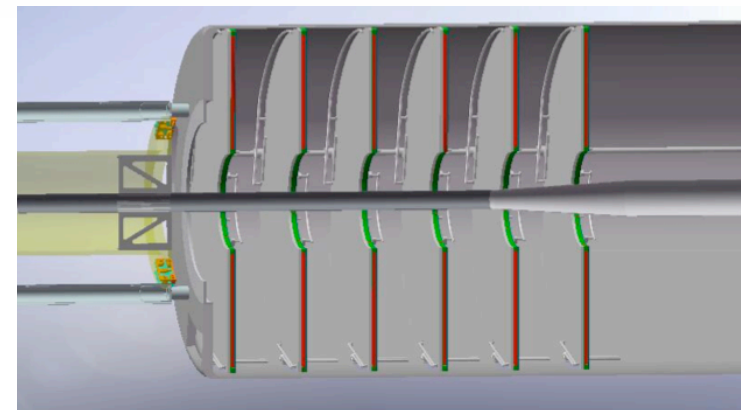
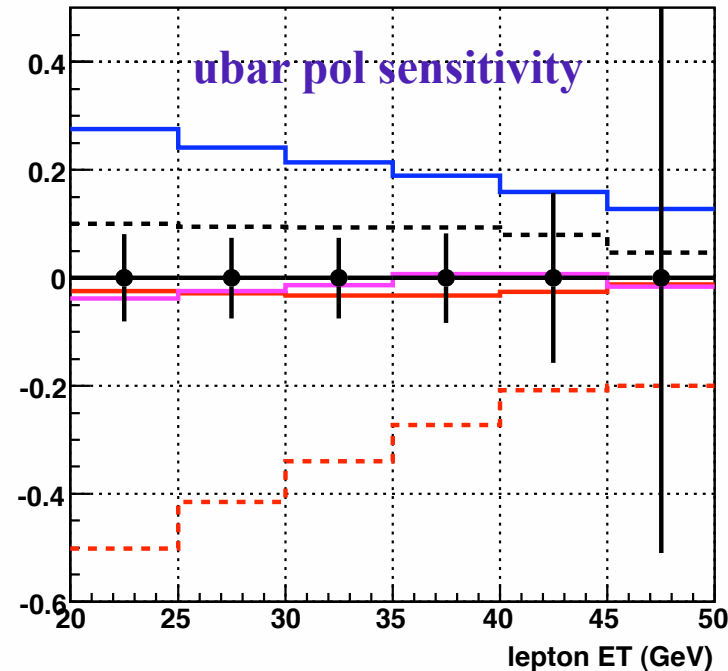
FNAL Test Beam Resolutions



Summary and Outlook

- Exciting program of **W production** in polarized proton-proton collisions at RHIC **constraining polarized u/d anti-quark distributions** - Clear sensitivity in particular at forward rapidity
- STAR experiment requires **upgrade of forward tracking system** for **charge sign discrimination of electrons/positrons**
- Triple-GEM technology** provides a cost effective way for a forward tracking upgrade solution
- Successful development of industrial production of GEM foils** (SBIR proposal with Tech-Etch Inc.) - Test of large GEM foils this year
- Successful beam test at FNAL** demonstrates that performance meets requirements
- Design work being finalized - **Pre-production underway**
- Goal**: Installation summer 2010 to be ready for Run 11

Backward $A_L(W^-)$ for electron



Jan Balewski, MIT