FVTX Simulation Status

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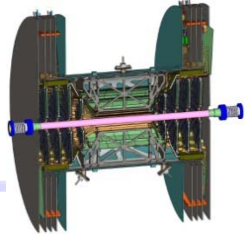
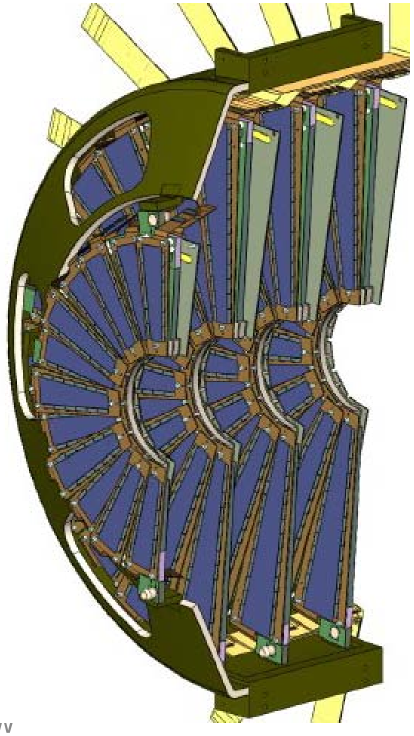
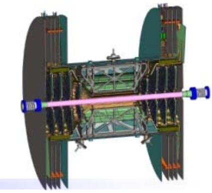


- Physics Motivation
- Detector Performance
- (Un)-blind Analysis
- Summary and Future Work



Physics Motivation



Measurement in p + p, d + Au and Au + Au Collisions

Single Muons measurements:
- Precision heavy flavor and hadron measurements
- Separation of charm and beauty through semi-leptonic decay
- Improve W background rejection

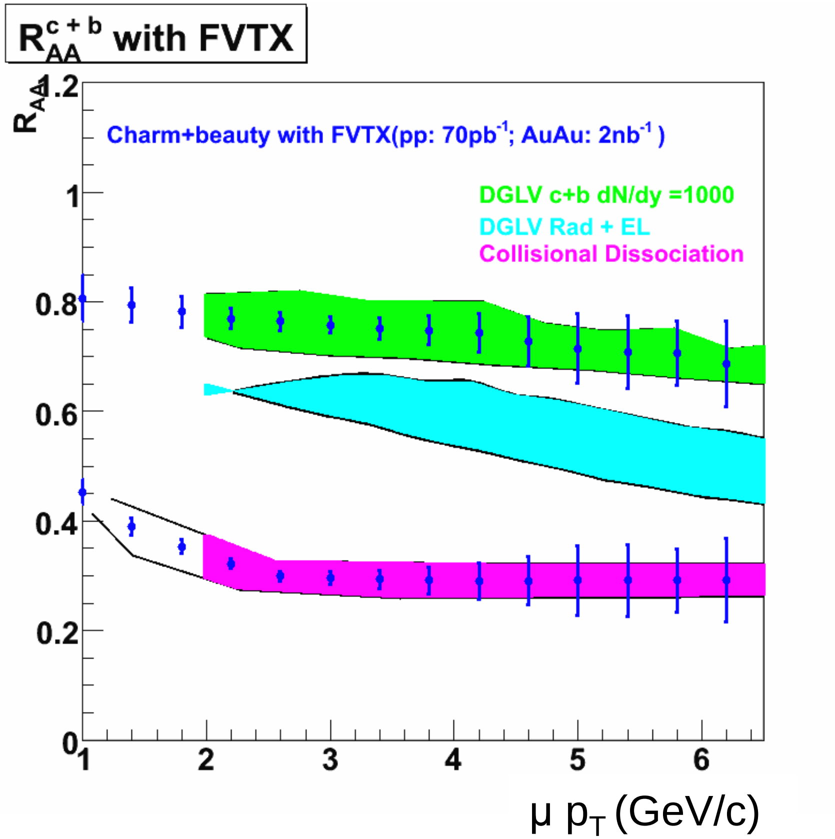
Dimuons measurements:
- Separation of J/ψ from ψ' at forward rapidity
- B→J/ψ, golden channel to measure B cross section.
- First Drell-Yan measurement

Physics FVTX Can Access:

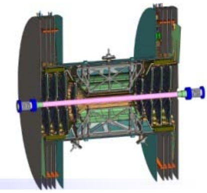
- Energy loss mechanism in hot dense medium (Heavy flavor $R_{AA,}$ v_2)
- Cold nuclear effects (Heavy flavor R_{dAu})
- Gluon polarization $\Delta G/G$ (Heavy flavor A_{LL})
- Sivers function, higher twist (Heavy flavor A_N)
- crucial test of QCD non-universality (Drell-Yan A_N)

* new measurements

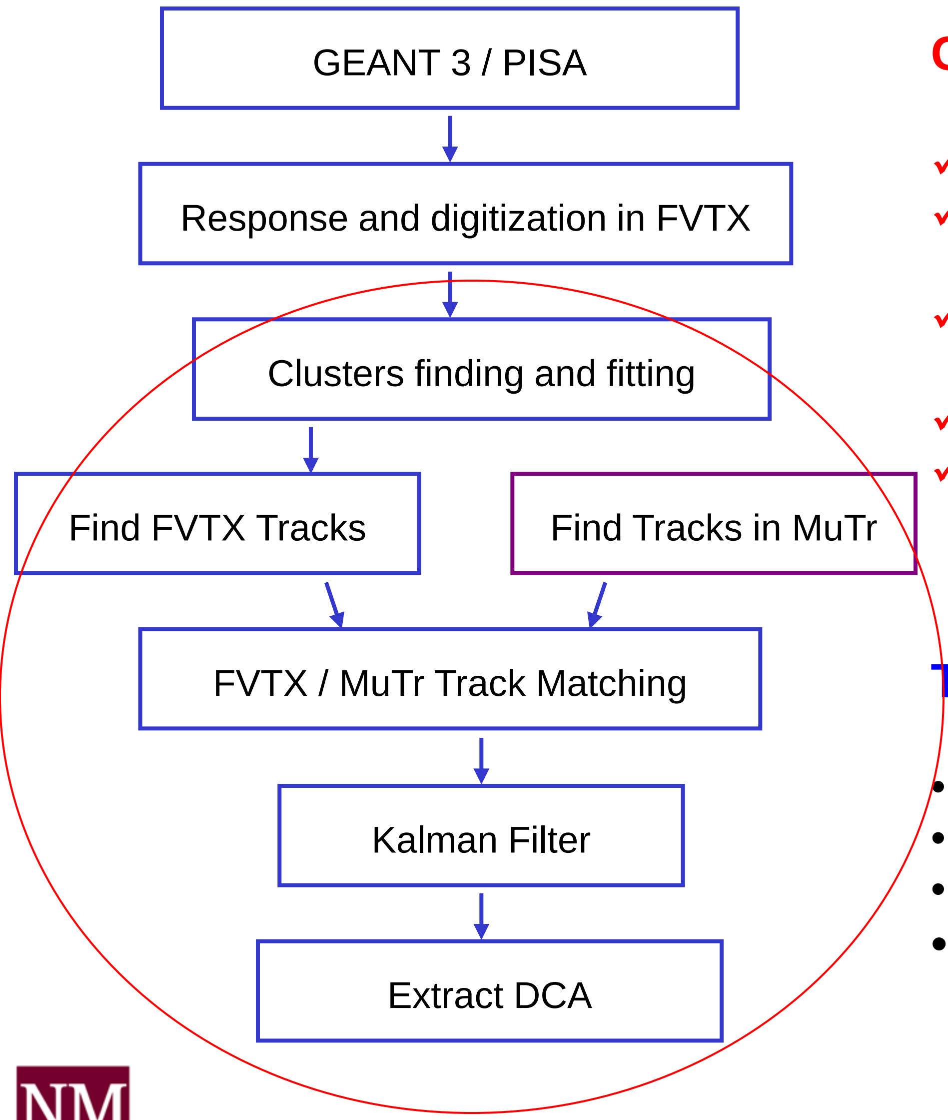
Current Status



- Various physics plots were made in 2007/2008 based on study of S:B improvement with 2007 detector design and software.
- Need to update all the physics plots using new full simulation with current detector geometry and updated offline code.
- Simulation work is also a preparation for real data analysis.



FVTX Software Status



Current status:

- ✓ All materials have been put into PISA
- ✓ Geometry implemented in root framework and offline code
- ✓ Detector response includes noise and digitization
- ✓ Cluster finding and Fitting
- ✓ Track finding and fitting

Fine tuning is still in progress

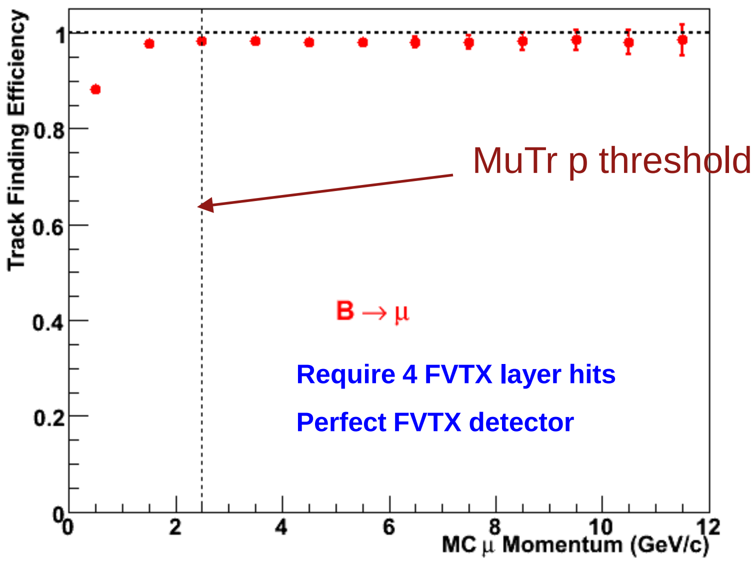
To be developed (* in progress)

- Alignment and Calibration* software
- Online Monitoring*
- Database Interface, e.g. calibration
- PHENIX Raw Data File **(PRDF)** generation

Track Finding Efficiency

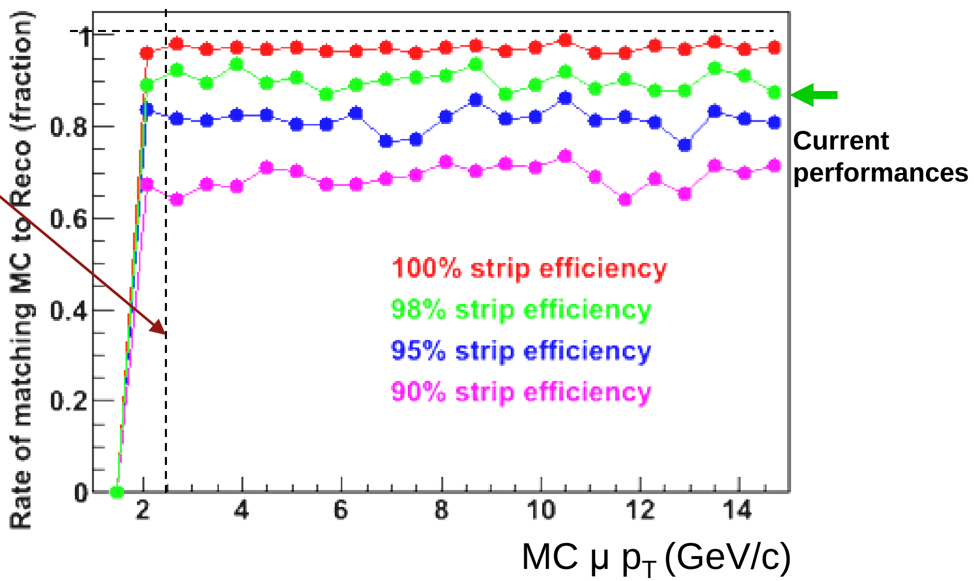
$$\varepsilon_{TrackFinding} = \frac{N_{\mathrm{Re}co}}{N_{\mathrm{Re}constructible}}$$

μ from B decay (PYTHIA).



No underlying event

Single μ embedded in MB HIJING

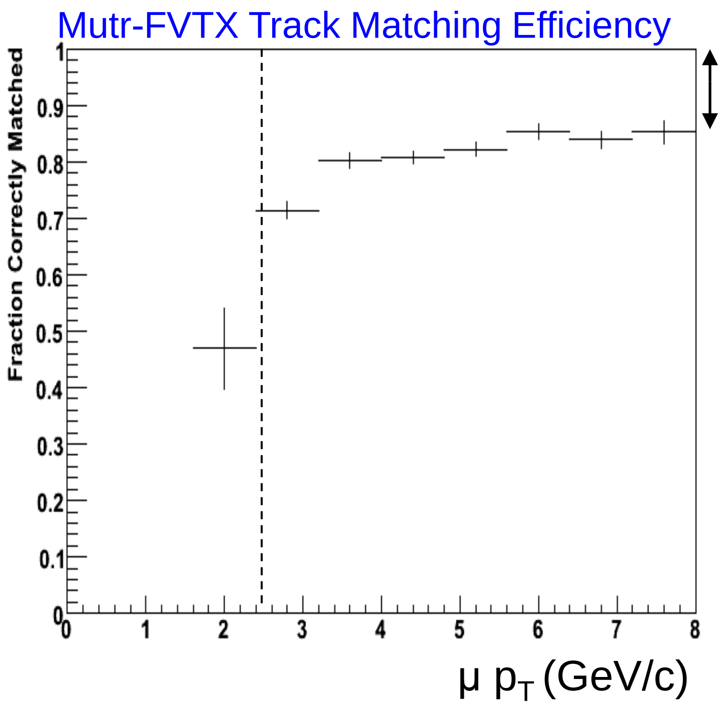


Full multiplicity in MB Au + Au

Track Matching Efficiency

$$\varepsilon_{Matching} = \frac{N_{FVTX+MuTr\_matched}}{N_{reco\_MuTr\&\&reco\_FVTX}}$$

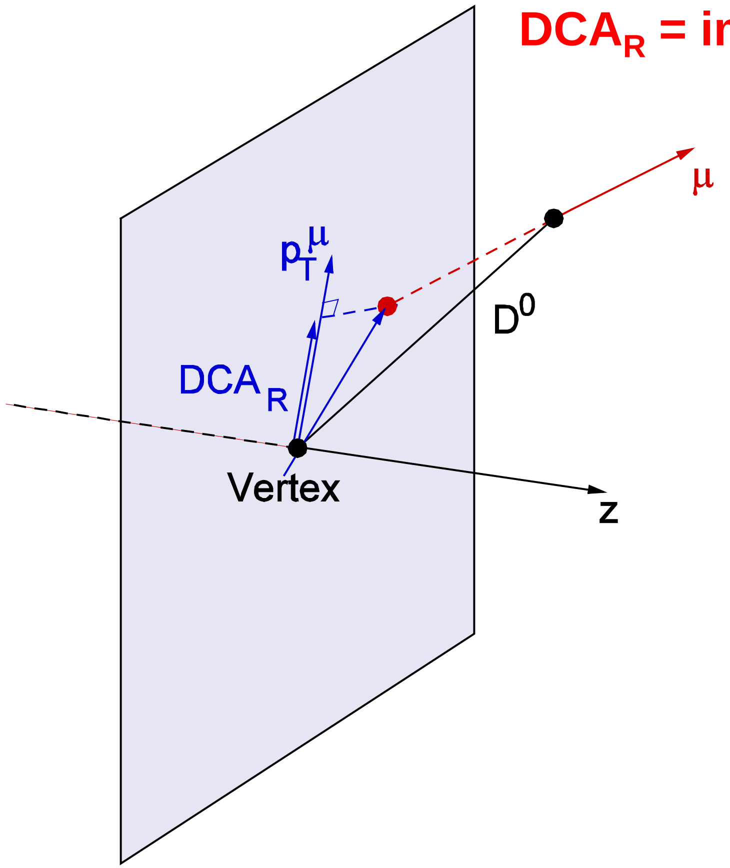
Central Au + Au event

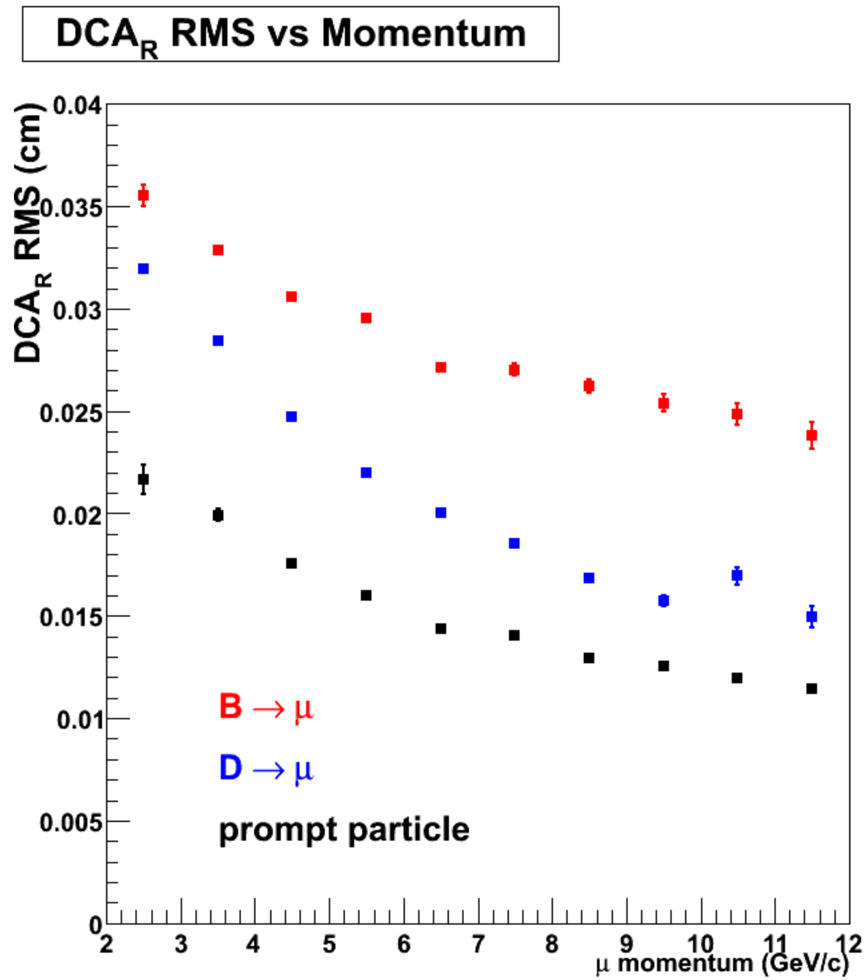


About 15% efficiency loss due to incorrect track matching in high multiplicity environment.

DCA_R

DCA_R = impact parameter projected onto μ p_T.

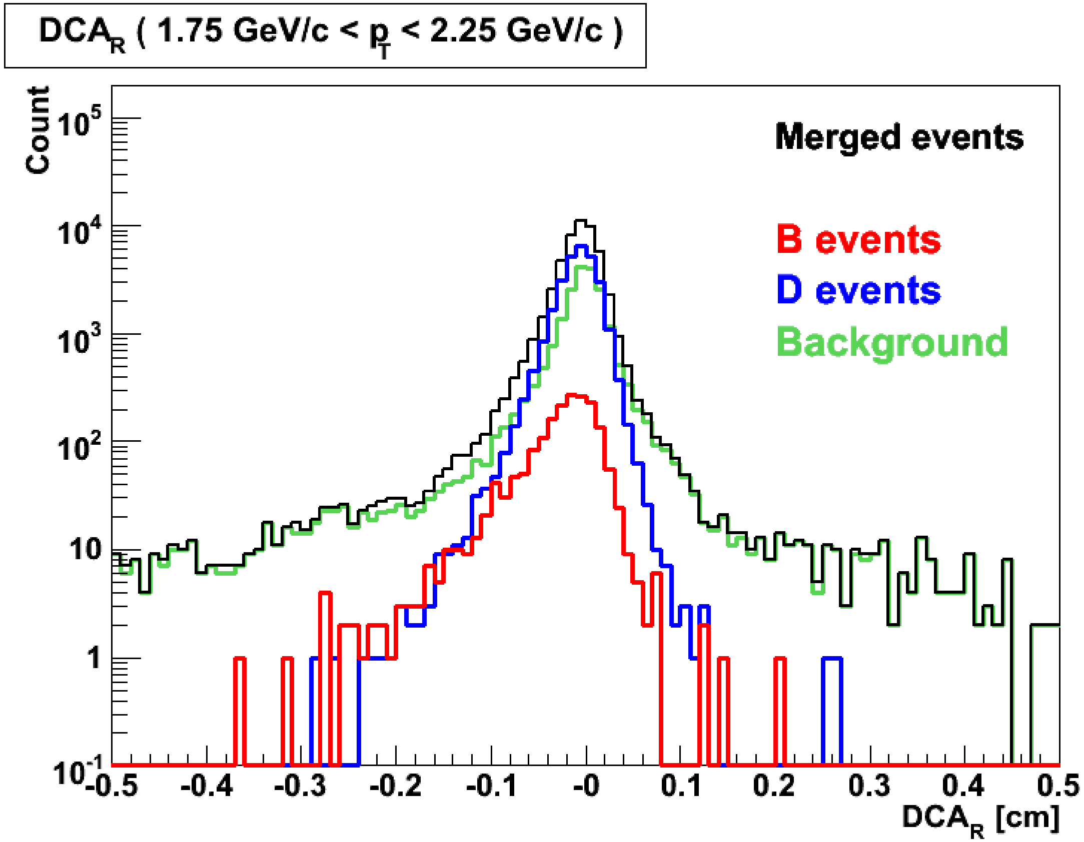




$$DCA_R = x0reco*\left(\frac{px0reco}{\sqrt{px0reco^2 + py0reco^2}}\right) + y0reco*\left(\frac{py0reco}{\sqrt{px0reco^2 + py0reco^2}}\right);$$

DCA_R Shape

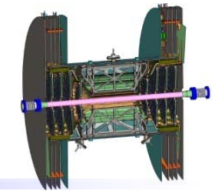
- **μ decay from D, B and hadrons have different DCA_R shapes in a given μ p_T bin.**
- **DCA_R shape also depends on the parent particle and the decay μ p_T.**



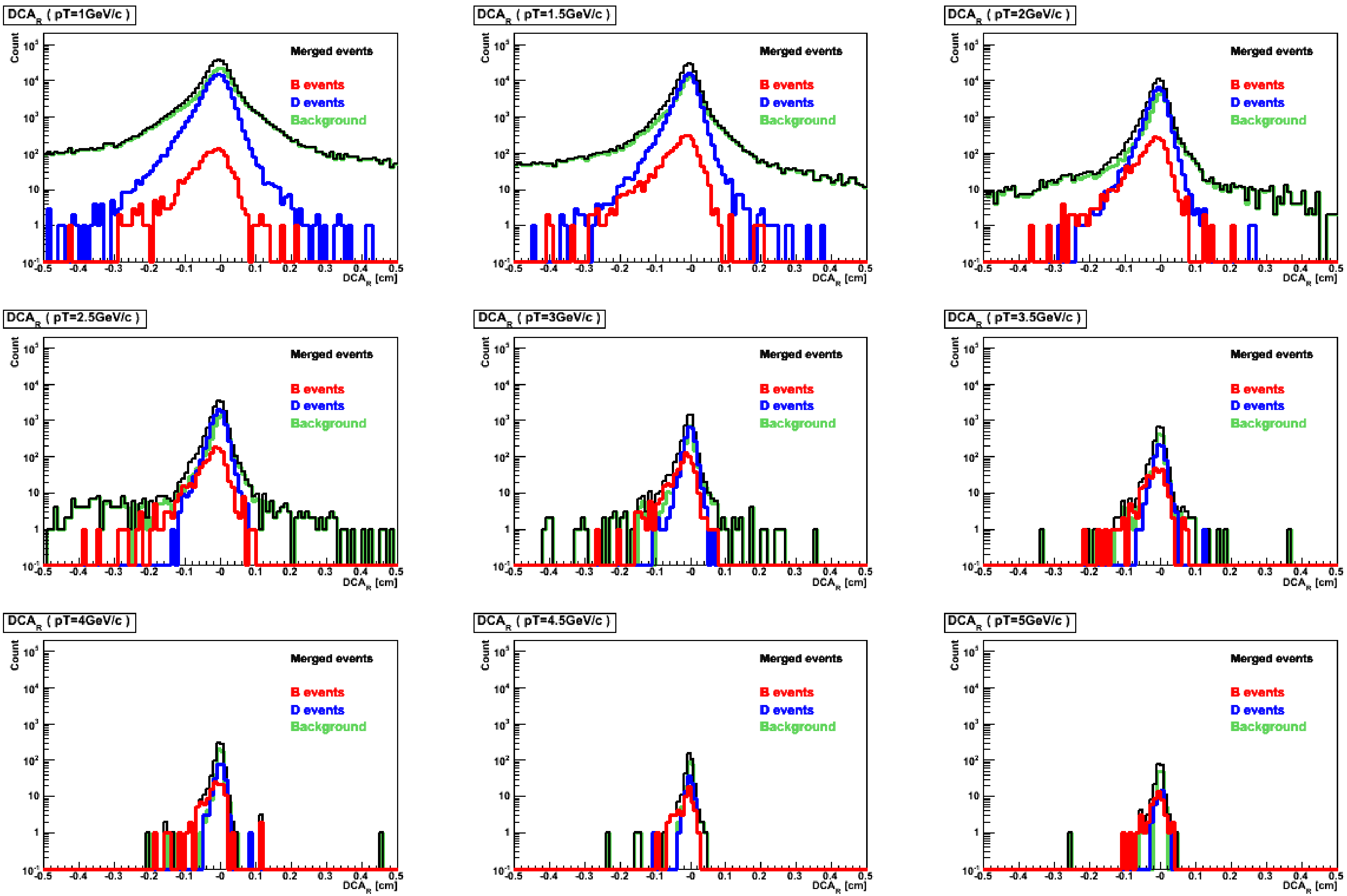
Distributions are normalized according to PHENIX cross sections.

- Single particle shapes can be evaluated using MC.

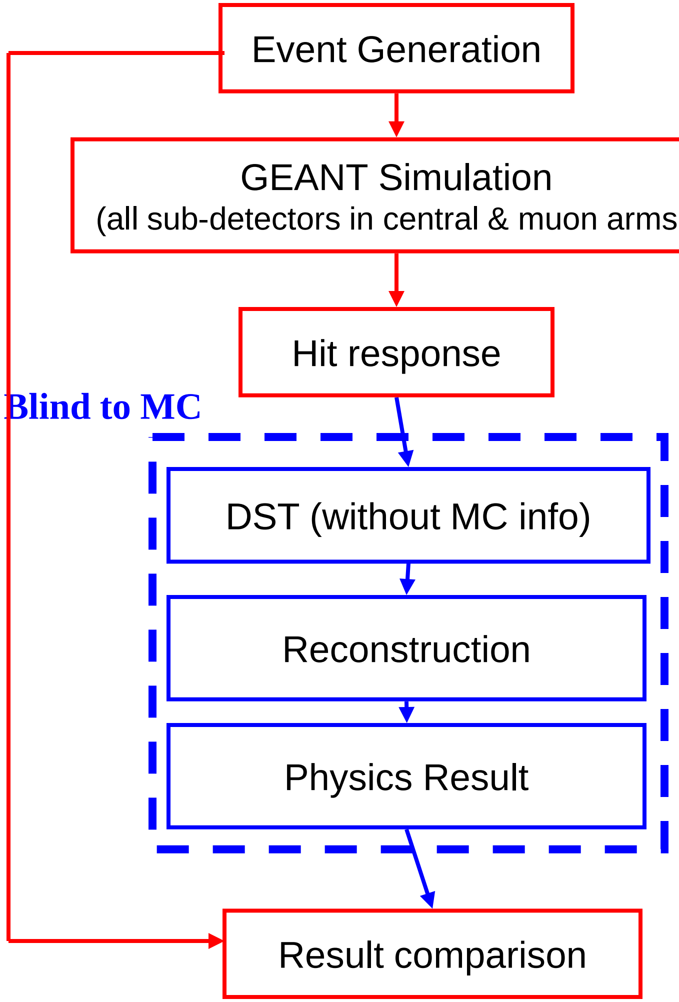
- They can be fitted together to the merged event shape, to get B, D and BG contributions.



DCA_R Shape vs p_T



Blind Analysis Challenge



Outline of the Analysis Note

Introduction
- Physics Goals
- How the FVTX detector is used to achieve our physics goal in p+p collisions

Simulation Framework
- Full PYTHIA Generation
- Geant-3 modeling fo the FVTX/VTX
- Detector Response
- Track Finding and Reconstruction
- Reconstruction variables and track quality cut

Event Generation
- Luminosity and Statistics
- Event Generation

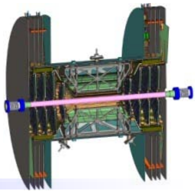
Un-blind analysis
- Analysis method
- Results

Blind analysis
- Statistics issue
- Work to be done

Summary

* Work in progress

PHENIX



Un-blind Analysis

- Analysis procedures for the un-blind analysis are exactly the same as for the blind one.
- FVTX team generates the MC event and mix them with a known fraction.
- Simulated samples (B/D/BG) are split in two

  First part is used to generate the B/D/BG shapes used for the fit. (training sample).

  Second part is used to generate the inclusive measured sample.

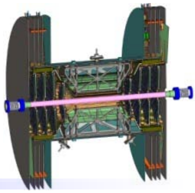
Note on the intermediate results shown in **this** presentation:

- Right now the same BG sample is used for the training sample and the mixed sample
- The same D and B p_T spectra are used for training and mixed samples

These limitations are known to bias the results and we are working on addressing them.

NM STATE

Blind and Un-blind Statistics



Event Type	Goal Statistics N_{event} ($10pb^{-1}$)	Achieved Blind Statistics Today	Achieved Un-blind Statistics Today
D Event (All D meson)	4.25 B	250 K	202 M 202 M (training)
B Event (All B meson)	24 M	250 K	1.1 M 1.1 M (training)
BG Event I (PYTHIA) (p_T > 2.75 GeV/c)	240 B	1 M	10 B
BG Event II (0.75 < p_T < 2.75 GeV/c) (Single Particle Generator)			10 B
Mixed Measured Sample		10 M	202 M (D) + 1.1M (B) + 10B (BG)

Mixed using ratios consistent with the cross sections measured by PHENIX.

c and b Separation -- Method

1. Use Monte Carlo to determine DCA_R shapes for each particle type in each p_T bin (0.5 GeV/c wide)

2. Then for mixed sample, in each given p_T and in each DCA_R bin

$$N_{total}^{measure}(p_T, DCA_R) = \underline{N_D(p_T) f_D^{sim}(p_T, DCA_R)} + \underline{N_B(p_T) f_B^{sim}(p_T, DCA_R)} + \underline{N_{BG}(p_T) f_{BG}^{sim}(p_T, DCA_R)}$$

$$N_D(p_T) + N_B(p_T) + N_{BG}(p_T) = N_{total}^{measure}(p_T);$$

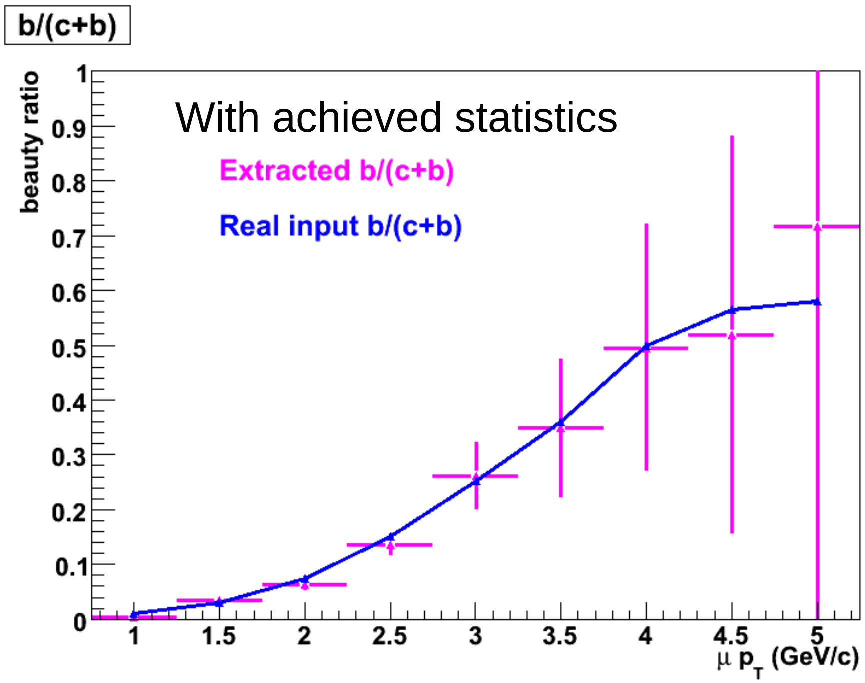
$N_i(p_T)$ are fit parameters.

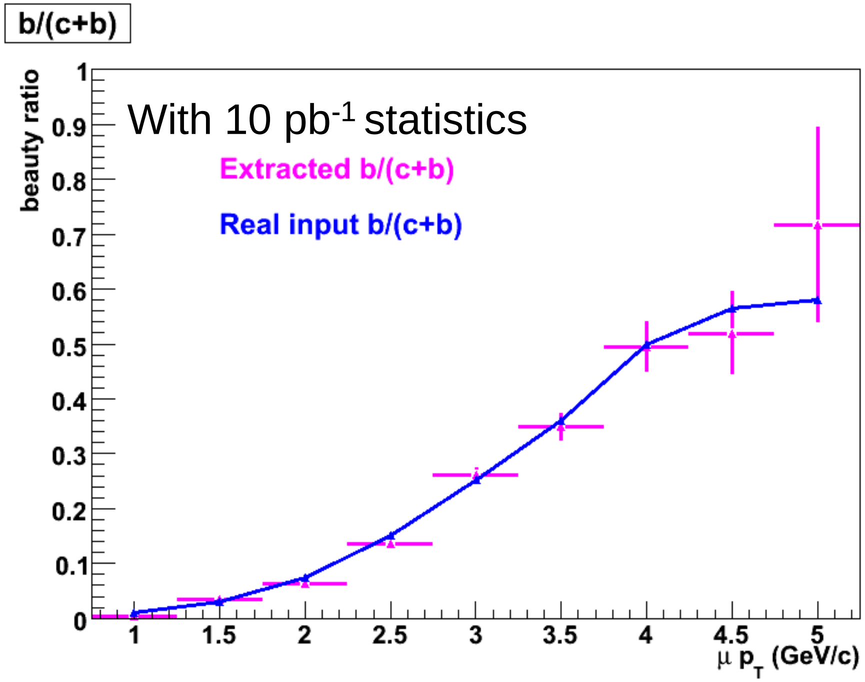
$$where,\ f^{sim}{}_i(p_T, DCA_R) = \frac{N_i(p_T, DCA_R)}{N_i(p_T)}, i = B, D, BG$$

f_i^{sim} are training samples

3. For each p_T bin, use TMinuit to fit all DCA_R bins. It will give the N_i value for B, D and background.

c and b Separation -- Results





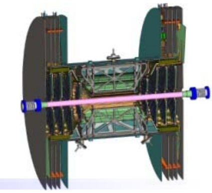
Limitations:

Same p_T spectra for B and D and same background sample are used in training sample and mixed sample.

Systematic error need to be quantified.

Preparation for Real Data Analysis

-- *manpower*



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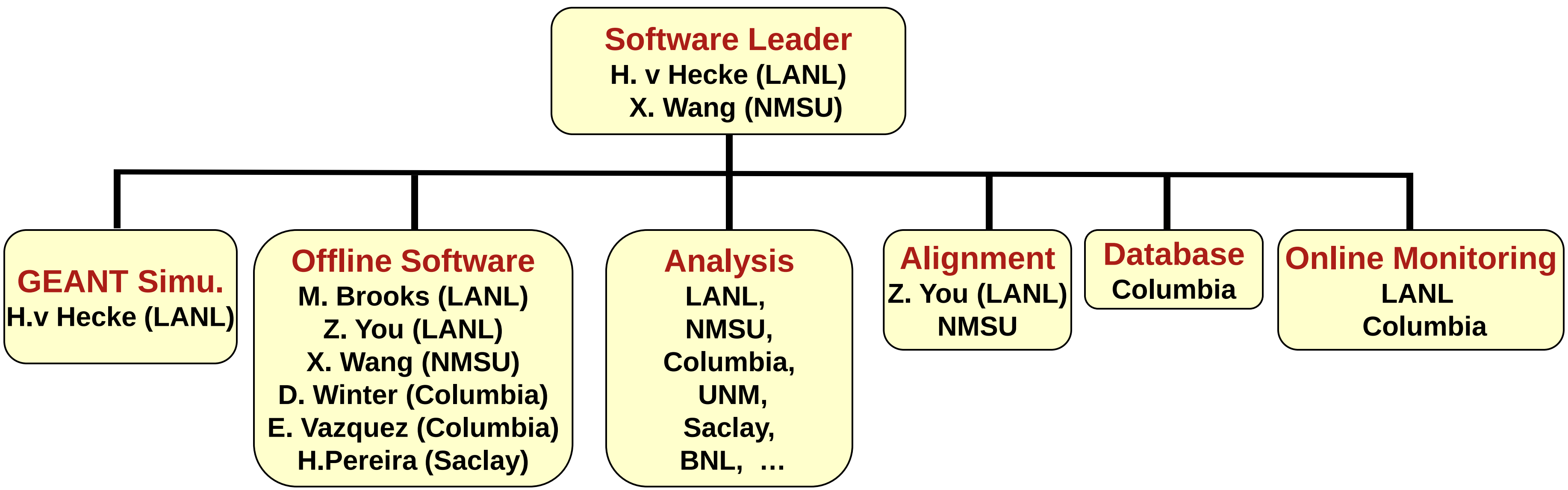
Columbia University: Dave Winter, Eric Vazquez, AAron Veicht
SUNYSB: Axel Dress, Benjamin Bannier

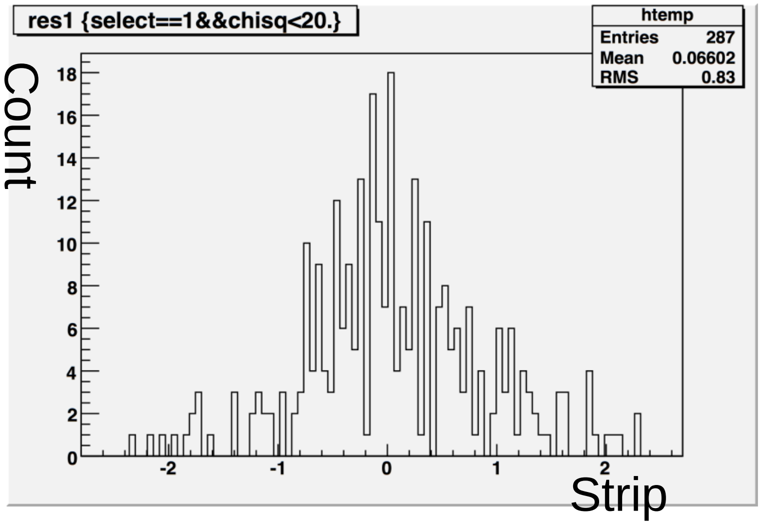


*back in Jan 2010
student

Preparation for Real Data Analysis

-- cosmic ray and beam test

Alignment and Calibration

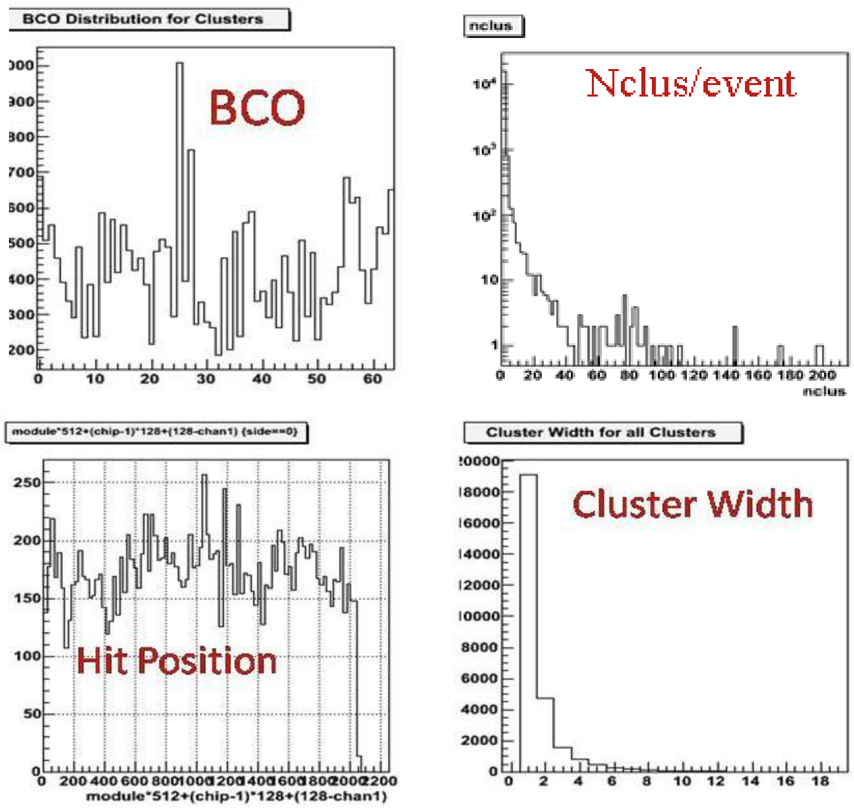


- Calibration was done regularly for the beam test.

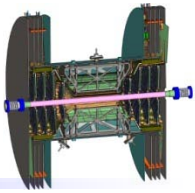
- Fit residuals after alignment read out from 4 telescopes.
- σ ~1 strip (75μm)

Jon Kapustinsky's talk

Online monitoring preparation



- BCO, hit distributions flat within statistics
- Reasonable number of 1,2,3 strip-wide clusters
- Cluster charge looks to be ~18,000 electrons



Summary and Work To Do

- FVTX software is ready for realistic data simulations and real data analysis.
- It provides high reconstruction and matching efficiency in p + p and Au + Au collisions.
- The current (un)blind analysis demonstrates that the FVTX detector provides sufficient DCA_R resolution to make c and b separation possible. However further work is needed to be completed on the analysis chain to show all the necessary steps in a c/b separation physics.
    - Quantify the sensitivity of the method described here on the input p_T spectrum and derive a corresponding systematic error.
    - Study the possible use of additional information (isolation cut, DCA_Φ, χ,et al.) to further improve S/B.
- Update physics plots.
- Some preparation work towards real data analysis has already started and will be continued.