Reconstruction of D-mesons from three body hadronic decay

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Road Map

- Physics Motivation
  - ✓ why do we need many channels?
- Simulation Strategy
  - ✓ $D^+ \rightarrow K\pi\pi$
  - ✓ $D_s \rightarrow KK\pi$
- Tools used for the Analysis
  - ✓ Grid Analysis FrameWork
- Summary

Physics Motivation

- To measure charm yield more precisely, we need to measure as many channels as we can.
  - reduces the systematic error on the absolute cross-section
- Study of different ways of hadronization:
  - String fragmentation:

    D_s^+ (cs) / D^+ (cd) ~ 1/3

    it should be easier to take a light meson from vacuum than strange one.
  - Recombination:

    D_s^+ (cs) / D^+ (cd) ~ N(s)/N(d) (~ 1 at LHC?)

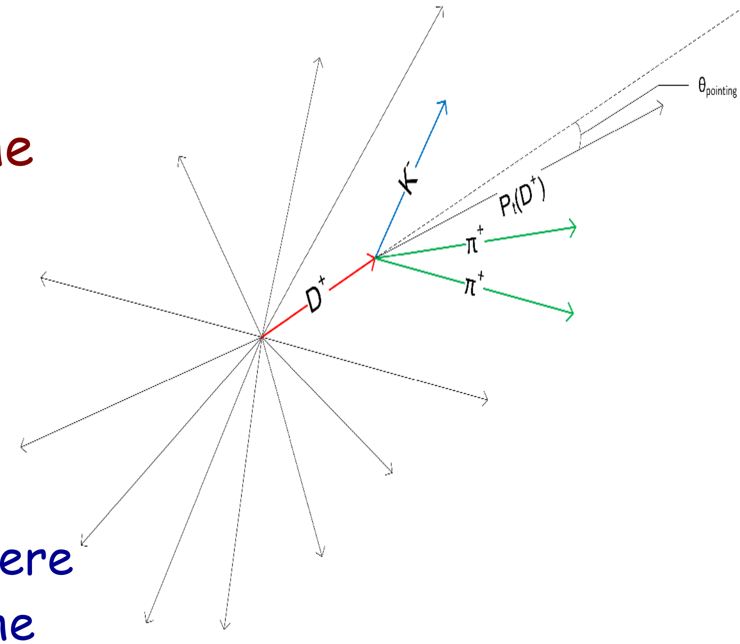
    recombination occurs inside the medium.

D Mesons: Main features

	D^0	D^+	D_s^+
Expected abundance per event (0-5% Pb-Pb @ 5.5 TeV) from NLO pQCD + binary scaling (|η| < 0.9)	28	8	5
Decay Channel	$K^-\pi^+$	$K^-\pi^+\pi^+$	$K^-K^+\pi^+$
Branching Ratio	3.89%	9.2%	5.5%
# charged body	2	3	3
# of combinations in full mass range for dN/dy = 6000 (with ideal PID)	10^6 pairs	10^9 triplets	10^8 triplets
Decay length	123μm	312μm	150μm
Resonant channel	□	✓ $D^+ \rightarrow K^{0*}\pi^+ \rightarrow K^-\pi^+\pi^+$	✔ $D_s^+ \rightarrow \phi\pi^+ \rightarrow K^-K^+\pi^+$ $D_s^+ \rightarrow K^{0*}K^+ \rightarrow K^-K^+\pi$

$D^+ \rightarrow K\pi\pi$: Selection Strategy: invariant-mass analysis of fully-reconstructed topologies originating from displaced vertices

- ✓ Various selection steps have been applied to extract the signal from the large combinatorial background



  - ✓ Distance between primary and secondary vertex (d_{ps})
  - ✓ Cosine of pointing angle ($Cos\theta_p$), where θ_p is the angular distance between the reconstructed D+ momentum and D+ flight line.
  - ✓ Sum of squared impact parameters

    $s=d_{01}^2+d_{02}^2+d_{03}^2$

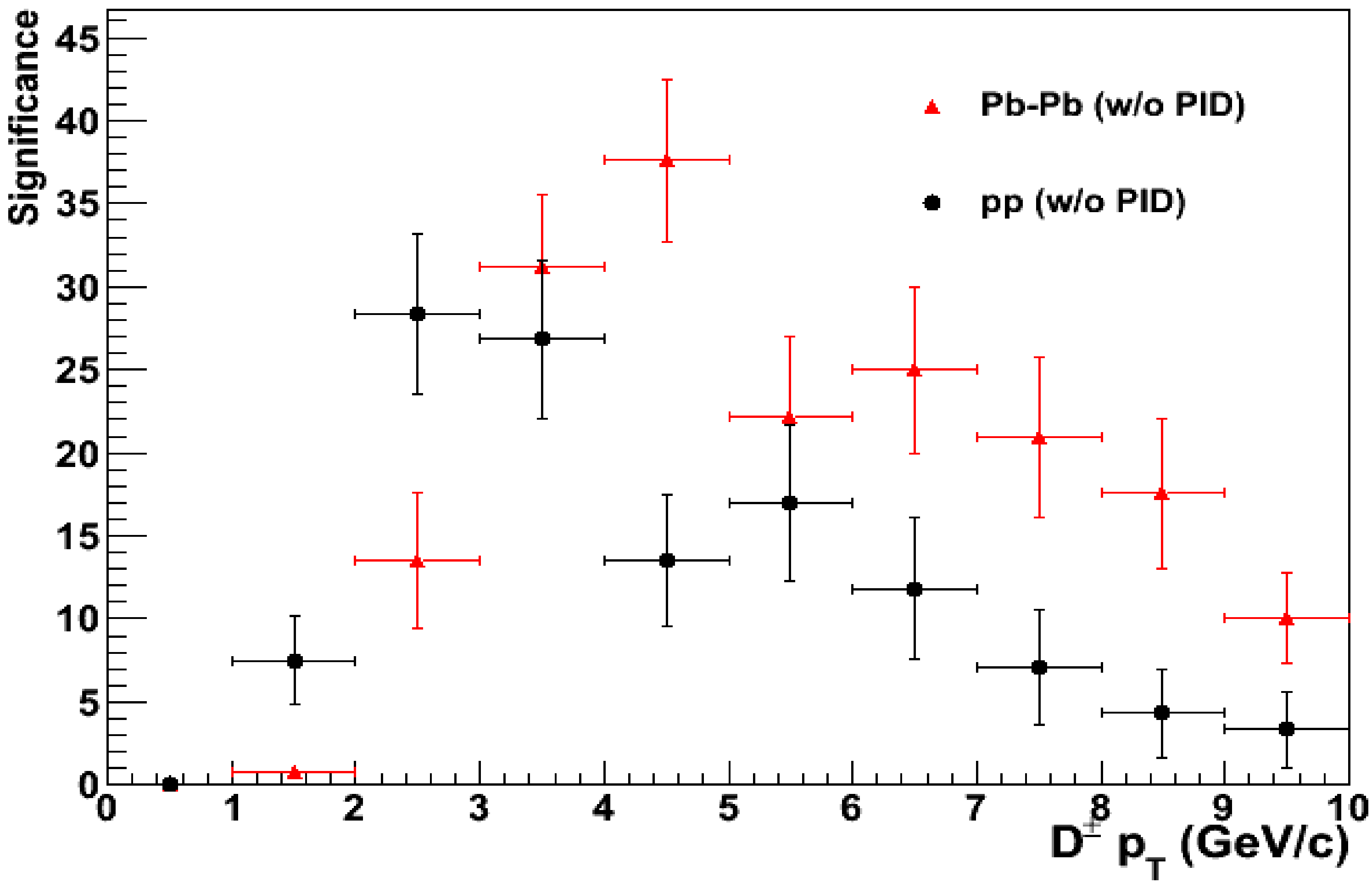
  - ✓ Max pt among the 3 tracks:

    $p_M = Max\{p_{T1}, p_{T2}, p_{T3}\}$

Expected Result

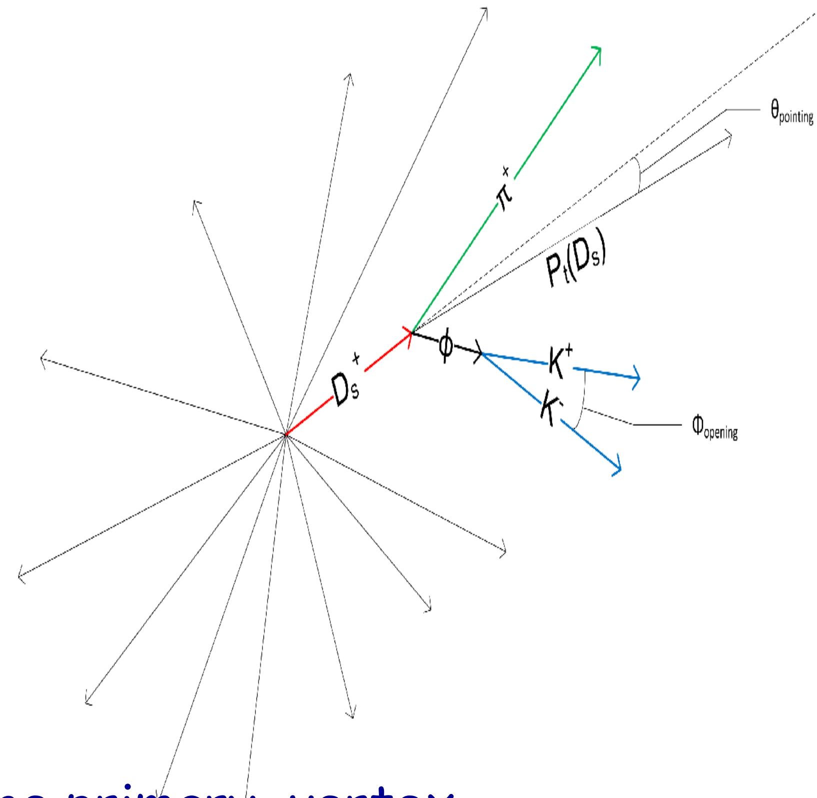
Significance ($D^+ \rightarrow K\pi\pi$)

✓ Significance $S/\sqrt{S+B}$ normalized to 10^7 events for Pb-Pb and 10^9 events for pp



$D_s \rightarrow KK\pi$: Selection Strategy

- Five variables have been chosen to perform a final selection of the useful signal:



✓ Cosine of pointing angle ($Cos\theta_p$). If the found vertex really corresponds to D_s decay vertex, then θ_p ~ 0 and $Cos\theta_p$ ~1.

✓ Cos□$_{opening}$, where □$_{opening}$ is the angle between two opposite sign tracks.

✓ Sum of the squares of the three tracks impact parameters with respect to the primary vertex.

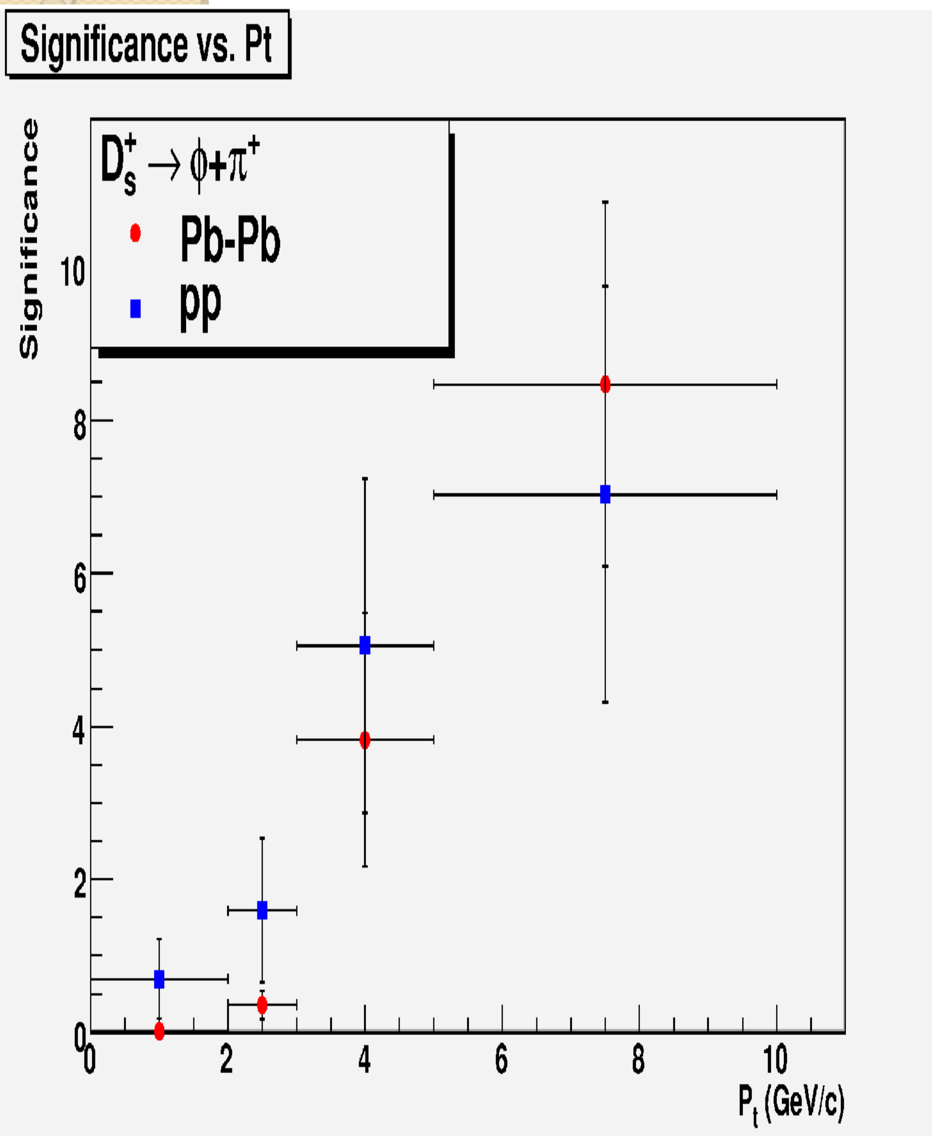
✓ Distance between the primary and secondary vertices

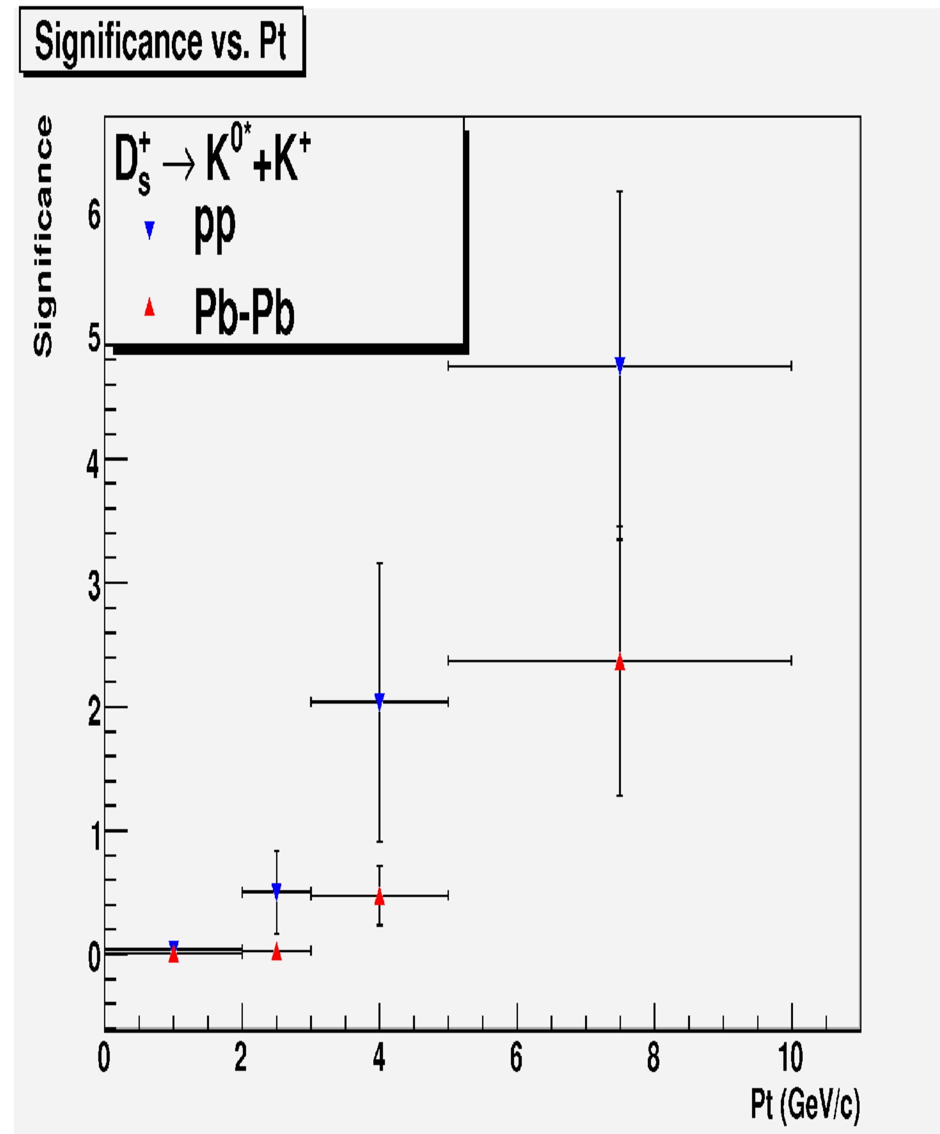
✓ Dispersion of secondary vertex (additional tunning)

NB: Before these, cuts on invariant mass of KK pair to select resonant decays through Φ or Kπ(opposite sign) to select resonant decays through K^{0*} is applied.

Significance ($D_s \rightarrow KK\pi$)

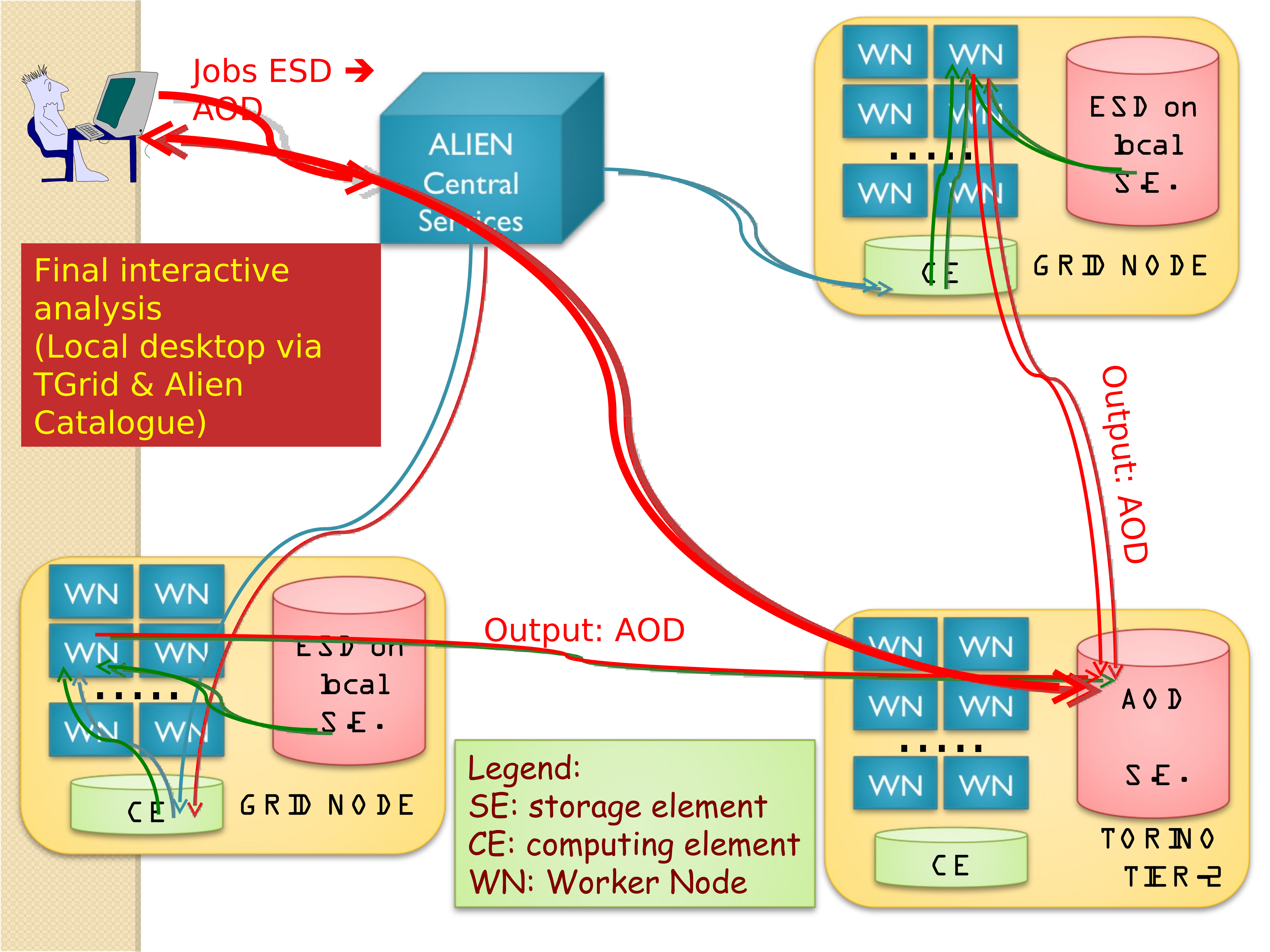
Significance $S/\sqrt{S+B}$ normalized to 10^7 events for Pb-Pb and 10^9 events for pp





Software tools for the analysis on the Grid

- Three kinds of data analysis
  - **Fast pilot analysis** of the data "just collected" to tune the first reconstruction at CERN Analysis Facility (CAF)
  - **Scheduled batch analysis** on the Grid (ESDs and AODs)
  - **End-user interactive or batch analysis** using GRID (AODs and ESDs)



Jobs ESD → AOD
ALIEN Central Services
Final interactive analysis (Local desktop via TGrid & Alien Catalogue)
WN
ESD on local S.E.
CE
GRID NODE
Output: AOD
AOD S.E.
TORINO TIER-2
Legend:
SE: storage element
CE: computing element
WN: Worker Node

AODs produced on the Grid

- ✓ 48M min-bias pp events (LHC09a4)

  /alice/cern.ch/user/m/mgheata/analysisESD/output_train_default_28May2009_09h33/ .

- ✓ 7M pp charm, forced to hadronic decays, events(LHC09a5)

  /alice/cern.ch/user/m/mgheata/analysisESD/output_train_LHC09a5_11Jun2009_10h07/

- ✓ 1.4M, pp beauty, $B \rightarrow J/\Psi \rightarrow ee$ decay(LHC09a6)

  /alice/cern.ch/user/m/mgheata/analysisESD/output_train_default_26May2009_16h30/

Analysis of candidates from AODs

- RunAnalysisAODVertexingHF.C (Prepared by A. Dainese): a steering macro to analyze the AODs (Standard + vertexingHF)

- This macro creates the analysis manager + event handlers, defines the input data and analysis mode.

- Each task provided by a macro AddTaskXXX.C.

- We have 12 tasks (wagons) included in RunAnalysisAODVertexingHF.C (Train)

Eg. CompareHF (vertex resolution), D0InvMass, Dplus , Like Sign BKG …

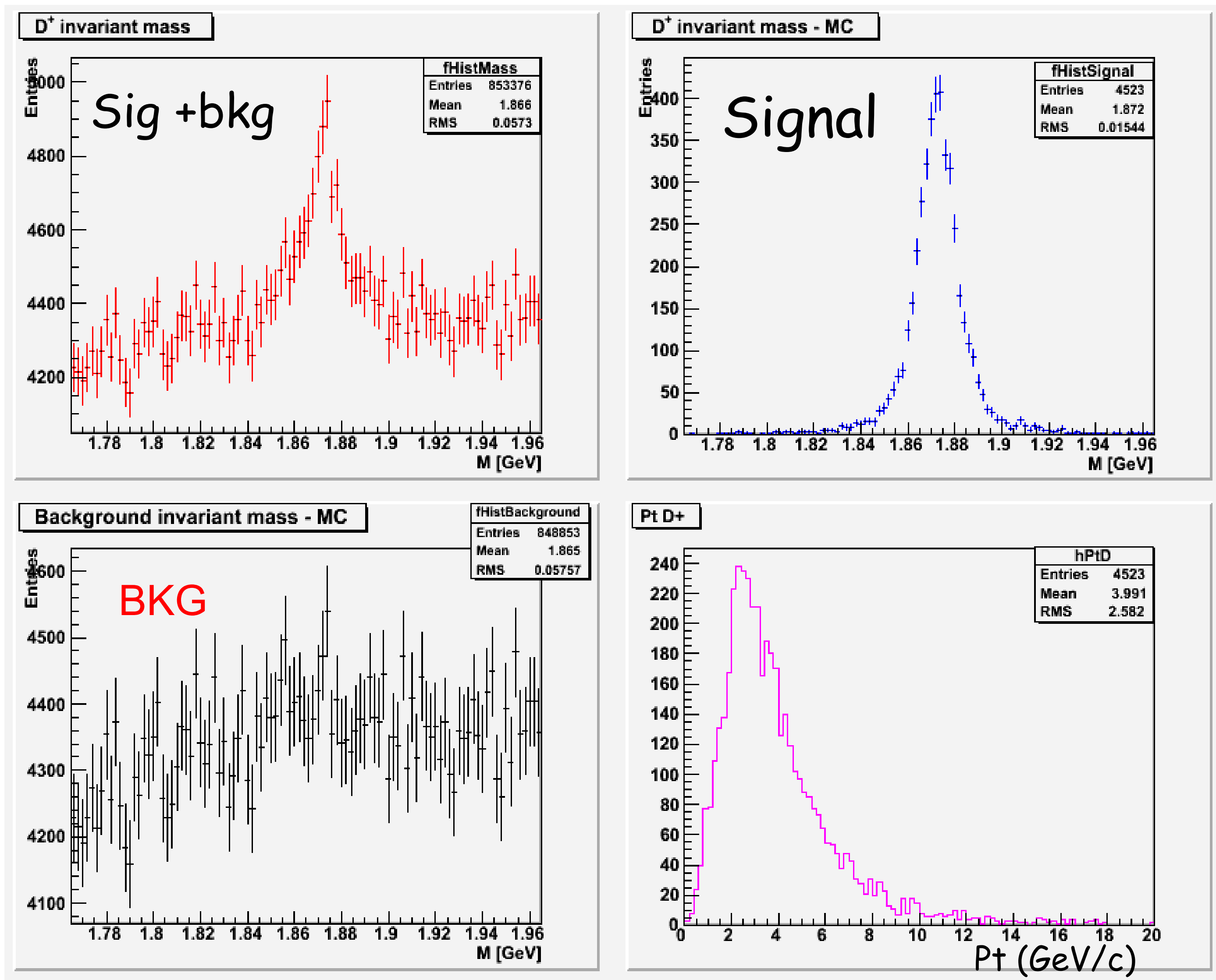
AddTaskDplus (To extract D^+ from the background)

- The macro AddTaskDplus.C implements a method AliAnalysisTaskSEDplus *AddTaskDplus() which creates, configure and connect the task to an existing analysis manager

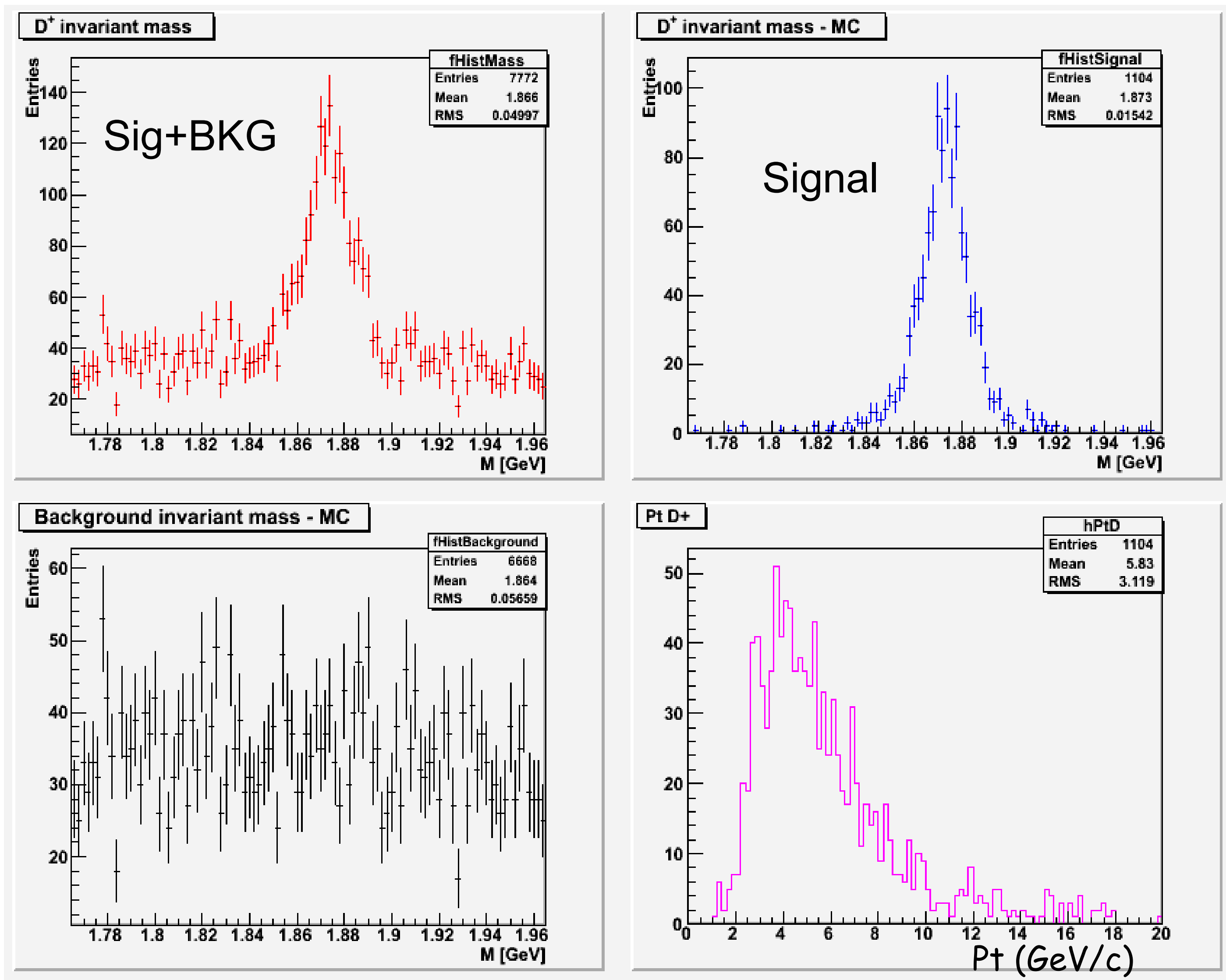
- AliAnalysisManager *mgr = AliAnalysisManager::GetAnalysisManager();
- AliAnalysisTaskSEDplus *dplusTask = new AliAnalysisTaskSEDplus("DplusAnalysis");
- mgr->AddTask(dplusTask);

- Produce some histogram as well as ntuple for signal and background (D+) in the root files “InvMassDplus.root InvMassDplus_nt1.root, InvMassDplus_nt2.root”

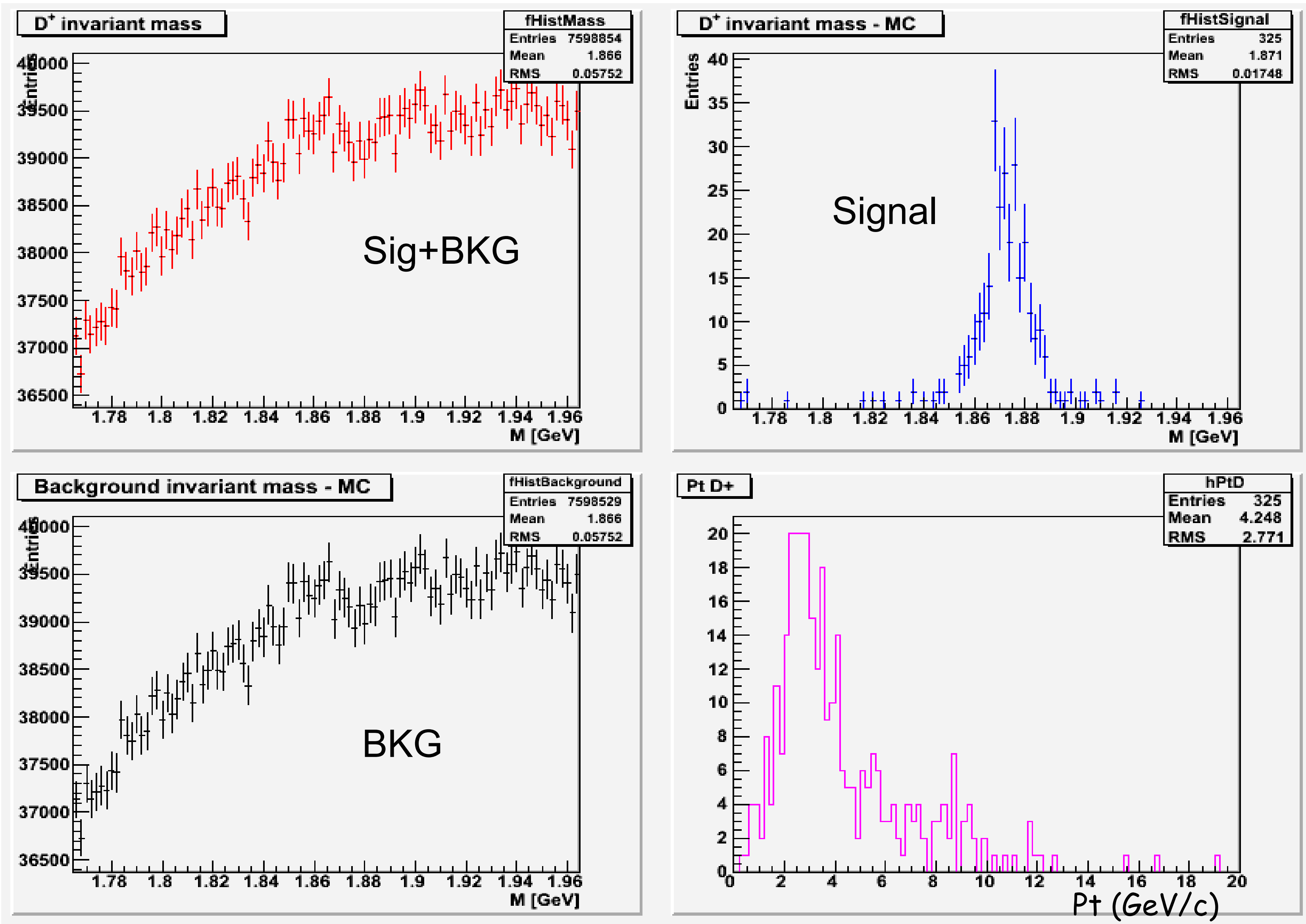
P-P charm(~4M) events (lhc09a5)→loose cuts (default ConfigVertexingHF.C)



P-P charm(~4M) events (lhc09a5) →with tighter cuts i.e Pointing Angle > 0.97 and decay length > 0.1cm



PP min bias (lhc09a4) ~17M events→ loose cuts



PP min bias (lhc09a4) events→ with tighter cuts

Sig+BKG

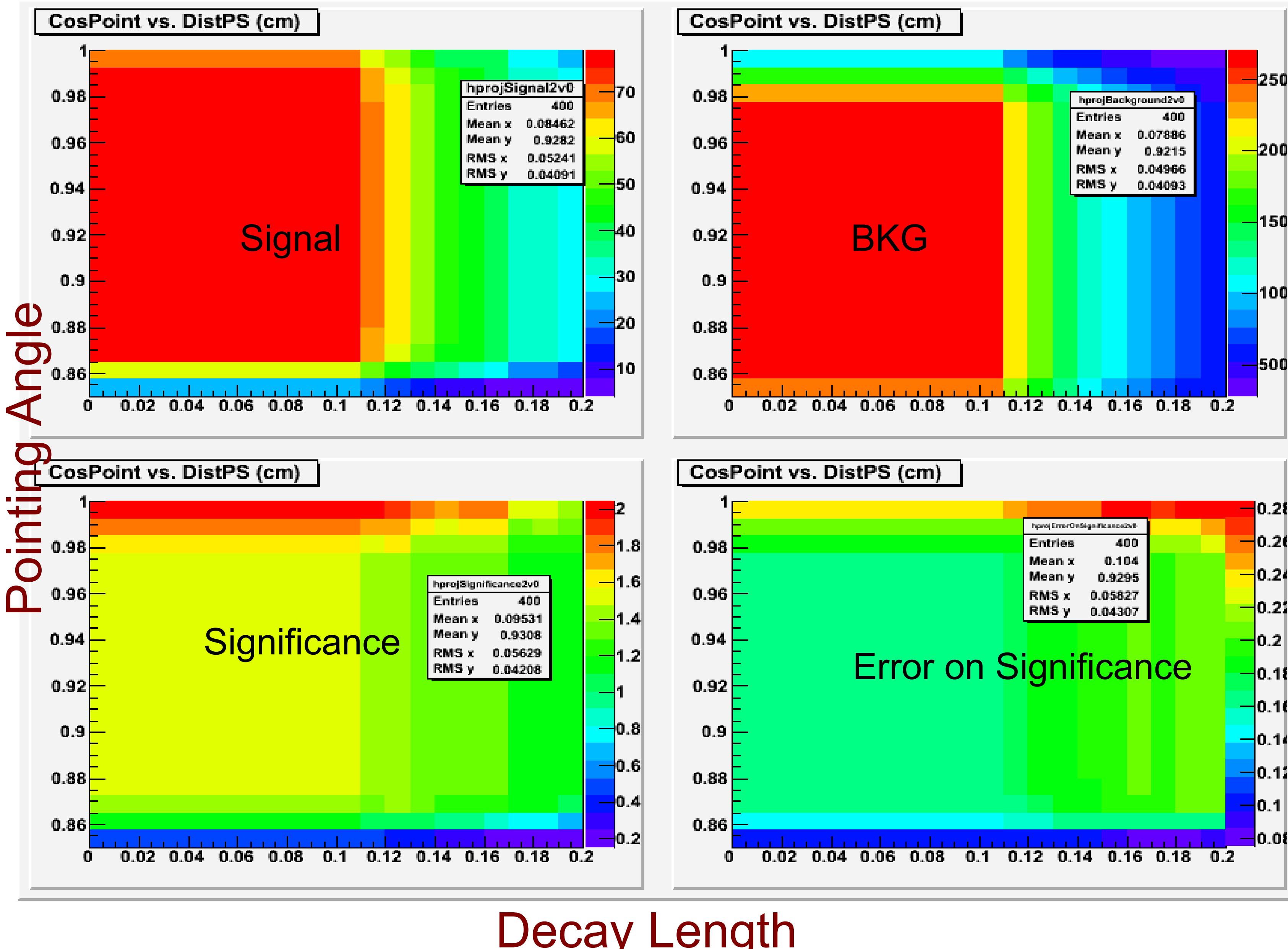
Signal

BKG

M (GeV)

Pt (GeV/c)

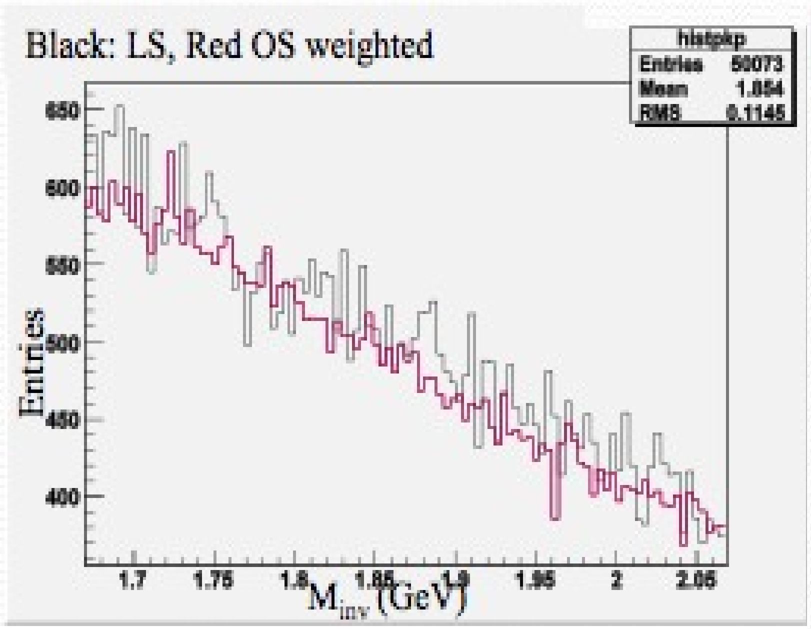
Significance (lhc09a4) with tighter cuts

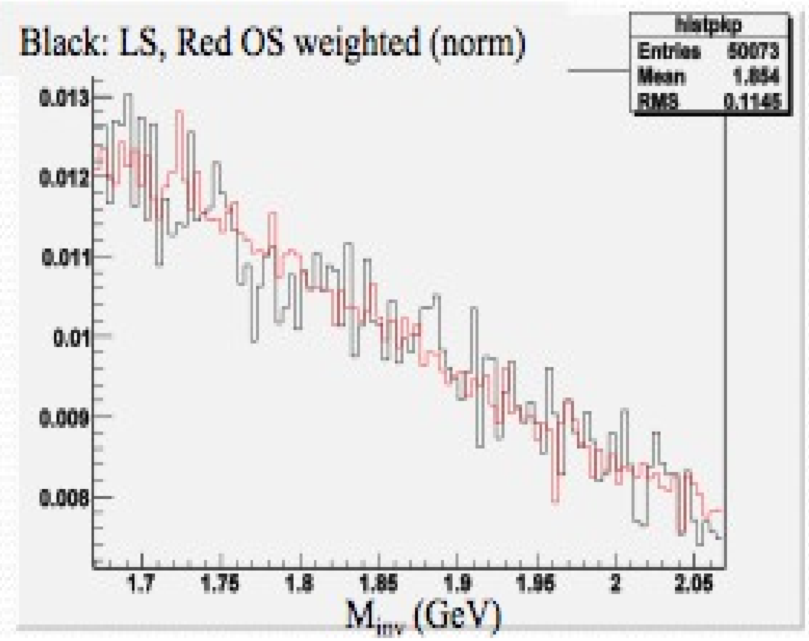


Like Sign Triplet

- For background subtraction, we are exploring the feasibility to use LS triplet
- Compare positive (+++) LS background with negative (---) background. They should provide the same result
- Compare LS background with OS (+-+) background.

LS vs OS behaviour





- The shape of the distribution around the D+ mass is same.
- OS is bit smaller(less statistics?)

Summary

- A huge statistics required to extract the signal from large background.
- Grid facilities provides the computing resources and disc space required.
- Analysis Train to analyze the data on the Grid has been developed and validated
- Analysis is feasible with good significance of exclusive D-mesons reconstruction at wide pt range(1<pt<20 GeV/c) within 1 year of data taking at nominal luminosity

Thanks