Open charm prospects for RUN5 pp

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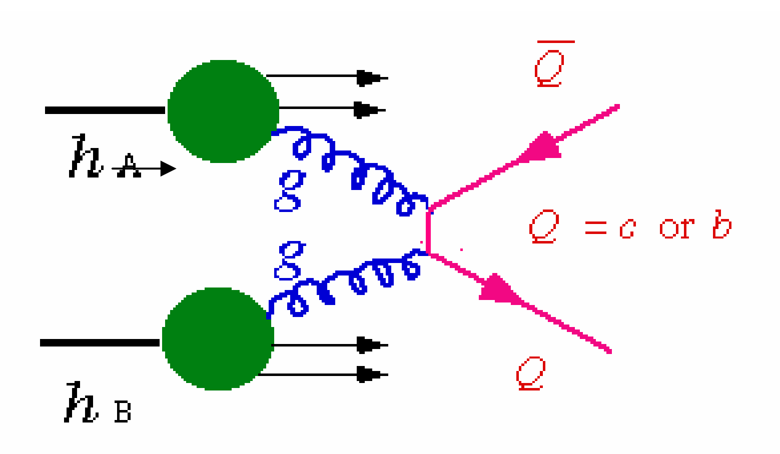
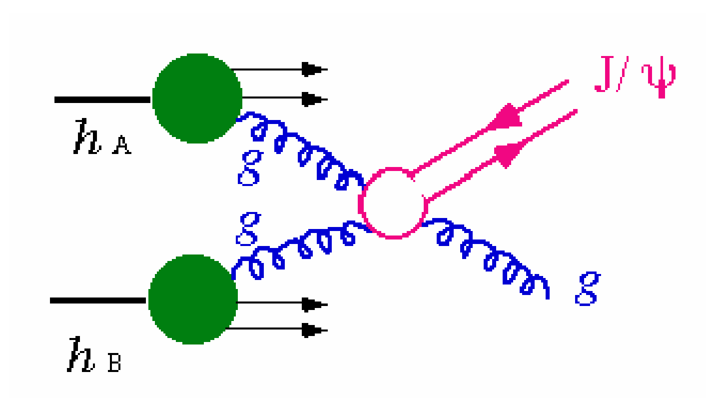
Motivation for open charm (pp)

- Charm production is dominated by Gluon-gluon fusion
  - Sensitive to gluon polarization

- Reference for J/Ψ suppression or enhancement





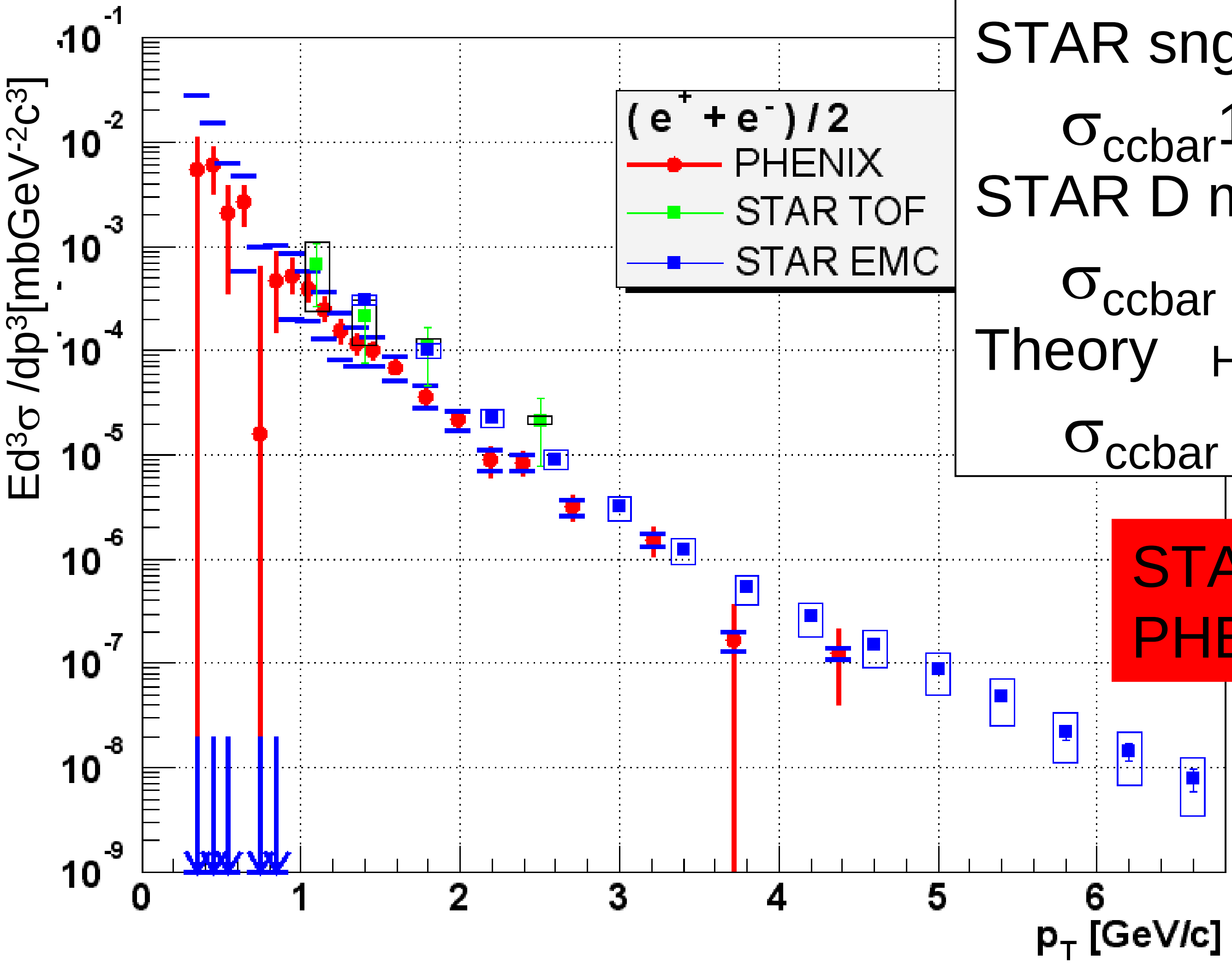
Yield estimation in RUN5

$$\boxed{\text{Yield} = \sigma \times L \times BR \times \eta_{acc}}$$

- charm production Cross-section (σ)
- integrated luminosity in RUN5 (L)
- Decay branch (BR)
- PHENIX acceptance (η_{acc})

- significance

Single electron spectra PHENIX VS STAR



PHENIX sngl. electron

σ_{ccbar} 709ub +/- 85 $^{+332}_{-281}$

STAR sngl. electron

σ_{ccbar} 1120ub +/- 200 +- 370

STAR D meson

σ_{ccbar} 1300ub

Theory Hep-ex/0404032

σ_{ccbar} ~130 ub

STAR is slightly above PHENIX systematically

Need to understand Systematically using Different channels!!

Taken from Ralf Averbeck’s slide(QM2004)

How to identify open charm

PHENIX trigger

- Direct measurements
  - $D^0 \rightarrow \pi^+K^-$ STAR preliminary (d Au) (BR 3.8%) MinBias
  - $D^{*+} \rightarrow \pi^{+(slow)} D^0$, $D^0 \rightarrow \pi^+K^-$ ~30% (BR 67.7% x 3.8%) MinBias
  - $D^{*0} \rightarrow \pi^{0(slow)} D^0$, $\pi^0 \rightarrow \gamma\gamma$, $D^0 \rightarrow \pi^+K^-$ ~30% (BR 61.9% x 3.8%) MinBias /π^0 trig
  - $D^0 \rightarrow \rho^+K^-$, $\rho^+ \rightarrow \pi^+\pi^0$ (BR 10%) π^0 trig.
- Inclusive measurements
  - $D^0 \rightarrow \mu^+ X$ (BR 6.5%) μ trig
  - $D^0 \rightarrow e^+ X$ PHENIX (pp) and STAR preliminary (pp, dAu) (BR 6.8%) e trig
- Combination of above

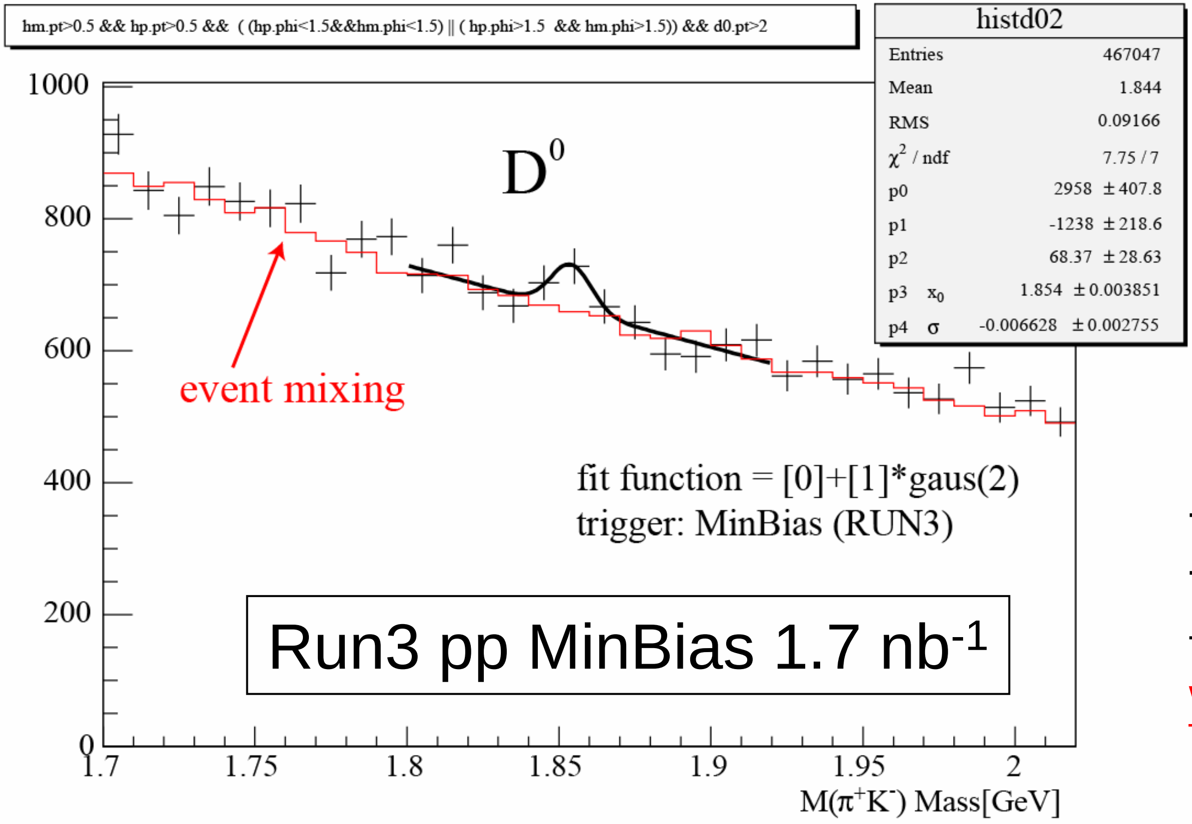
Charge conjugates of above , of course!

PHENIX
$D^0 \rightarrow \pi K$ search in central arm

- RUN3 dAu case
  - Trial By Sasha Levedef and Hua Pei
    - Forget pid. Make combinations of all hadrons.
    - Identify K in high res. TOF. Treat other hadrons as pion

  So far negative results…
- RUN3 pp case
  - I tried.

PHENIX run3 pp $D^0 \to \pi K$ search in central arm



cuts

- h^+ P_T>0.5 , h^- P_T>0.5
- D^0 p_T > 2GeV/c
- Same arm
- Exp 12
- Obs 110 +- 70

There seems to be a peak
The width is much narrower than I expected.
Work in progress

Anyway , How many D^0 can we get in RUN5?

Yield estimate with PYTHIA

- ccbar X-section
  - PYTHIA 235ub (Ver. 6.1)
  - NLO pQCD 130 ub

Scaling 709/235 ~3

  - PHENIX 709ub +/- 85 (syst.+332 / -281)
  - STAR 1120ub +/- 200 +/- 370

branching	PYTHIA	PDG
$D^0 \rightarrow \pi K$	3.65%	3.8%
$D^0 \rightarrow \mu X$	7.7%	6.5%
$D^0 \rightarrow e X$	7.7%	6.87%

Integrated luminosity in RUN5 MinBias Trigger

- Only depends on the duration of RUN.
  - Trigger rate is fixed to

    $\boxed{\text{2kHz(bandwidth) x 10\%}}$
  - Duration

    $\boxed{\text{10 weeks x 50\%(PHENIX eff.)}}$
  - Integrated luminosity for MinBias

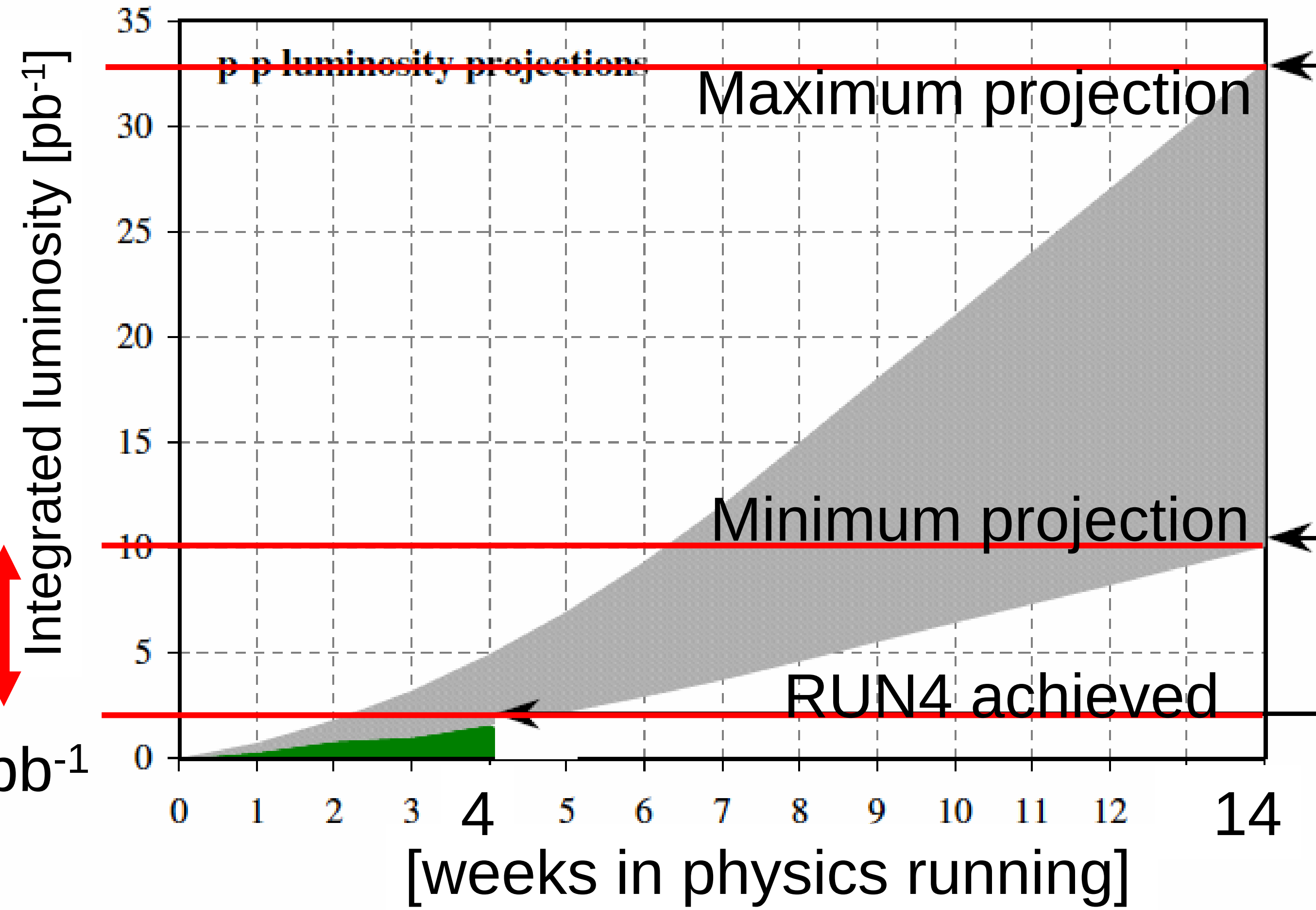
    $\boxed{\text{rate}} \times \boxed{\text{duration}} / \sigma_{BBC} = 6 \times 10^8 / 21\ \text{mb}$

    $= 28.6\ \text{nb}^{-1}$

MinBias Ldt

Integrated luminosity in RUN5

- Roser and Fischer projections



10 weeks

delivered $30 pb^{-1}$ $8 pb^{-1}$

collected $7.5 pb^{-1}$ $2 pb^{-1}$

maximum minimum

$L_{collected} = L_{delivered}$ x 50%(vtx cut) x 50%(PHENIX)

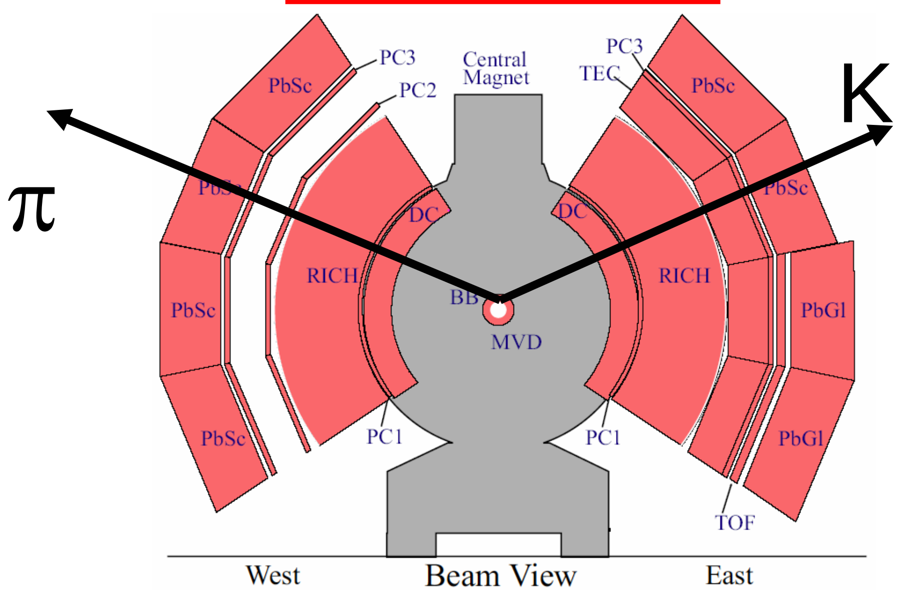
Yield estimate with PYTHIA
$D^0 \rightarrow \pi K$

P>0.4GeV/c to reach EMCal

ccbar →	D^0 →	π, K	x	Both particle in acc. P_T>0.5GeV/c	x	Decay corr. and efficiency
235ub x 3	60% x 2	3.65%		0.5% x 82%		~50%

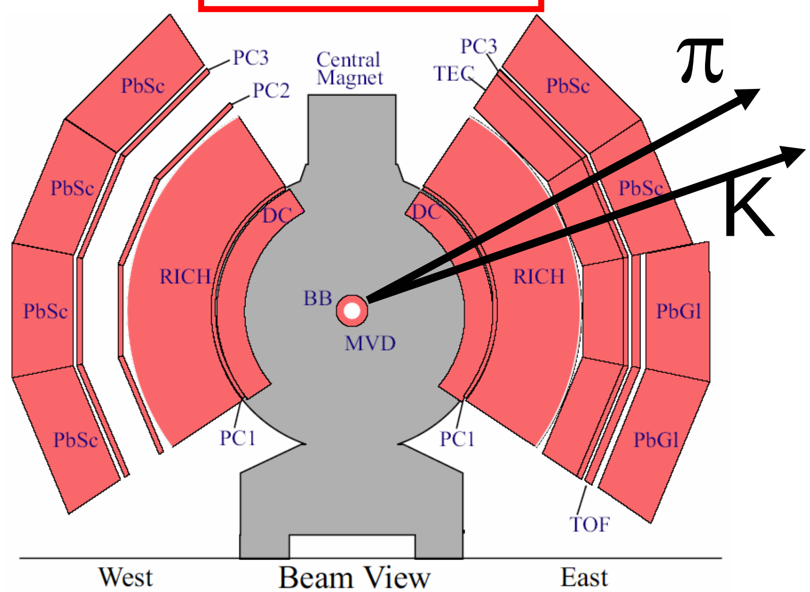
Signal ~90%

Opposite arm



Signal ~ 10%

Same arm



PYTHIA estimate (pp)

Charge conjugates included.

Channel	trig	L_{run3} nb^{-1}	${}^{rel}\sigma\eta_{acc}$	$run3_{exp}$	L^{run5}	$run5^{exp}$
$D^0 \rightarrow \pi K$	MB	1.7	1	120	28.6	2000
$D^0 \rightarrow \pi K, \mu$(north)	MuID	200	1e-2	120 ε_μ	min2000 max7500	1200 ε_μ 4500 ε_μ
$D^0 \rightarrow \pi K, \mu$(south)	MuID	200	9e-3	110 ε_μ	min2000 max7500	1100 ε_μ 4100 ε_μ
$D^0 \rightarrow \pi K, e$	ERT 2x2	200	9e-4	11 ε_e	min2000 max7500	110 ε_e 410 ε_e
$D^0 \rightarrow \rho K$	Gamma	[redacted]				

p_T>0.5 GeV/c for charged hadrons, p_T>1 for π0 , p_z>1GeV/c for μ , p_T>0.8GeV/c for e

ε_μ efficiency to detect μ in $|\eta|$ acc. = ~70%

When you use MuID only , you don't need ε_μ

Significance(S/sqrt(B)) for “same arm” case

Trig	RUN3	RUN5 MIN	RUN5 MAX
MB	0.24	0.98	0.98
Single Deep	0.54	1.7	3.3

When you identify charge of μ,

μ+ D^0bar$\rightarrow\pi^-K^+$

μ- D^0 $\rightarrow\pi^+K^-$

Signal estimate : PYTHIA

BG estimate : RUN3 REAL DATA

Make all combinations
Of charged hadrons.

Obviously these numbers are depend on cuts.
Since I imposed rather loose cut, there’s room
For optimization

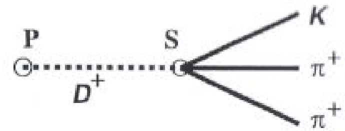
Summary

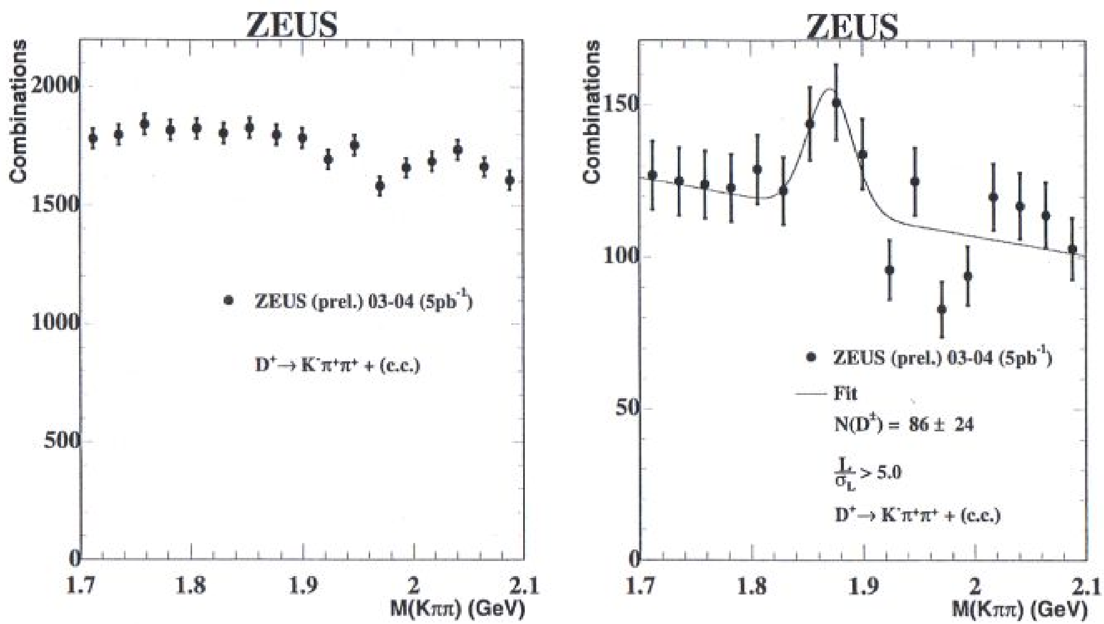
- $D^0 \rightarrow \pi K$ search in central arm
  - 2 major issues
    - Large background
      - displaced vertex cut reduces background dramatically
        $\rightarrow$ need silicon vertex tracker.
    - lack of trigger
- μ trigger enhances $D^0 \rightarrow \pi K$ in central arm
  - Currently available solution of the 2 issues above.
  - I'd like to propose the prescale factor for single μ trigger set to be as low as possible in RUN5
  - μ channel is unique to PHENIX

Impact of displaced Vertex cut

Recent Data — D^+ Signal

- Use the MVD to tag secondary vertices from charm:





- Can define a significance of seperation of secondary and primary vertices:

$$\vec{L} = \vec{S} - \vec{P}$$

- No signal visible before
- Signal enhanced by cutting on significance parameter $\longrightarrow$ Encouraging!

Trigger in RUN5

Table 2: Maximum luminosities that can be reached after a sufficiently long running period.

Mode	# bunches	Ions/bunch [10^9]	β* [m]	Emittance [μm]	$\mathcal{L}_{peak}$ [$cm^{-2}s^{-1}$]	$\mathcal{L}_{store\ ave}$ [$cm^{-2}s^{-1}$]	L_{week}
Au-Au	45	1.1	1	15-40	15×10^{26}	4×10^{26}	160 μb^{-1}
Si-Si	28	14	1	20-35	8×10^{28}	3×10^{28}	6.5 nb^{-1}
Cu-Cu	28	7	1	20-35	3×10^{28}	1×10^{28}	2.5 nb^{-1}
p↑-p↑ (I)*	79	100	1	20-30	16×10^{30}	9×10^{30}	3 pb^{-1}
p↑-p↑ (II)*	56	150	1	20-30	25×10^{30}	15×10^{30}	4.5 pb^{-1}

- Maximum case correspond to the red band.
  - Integrated lumi.
    - 3 pb^{-1}/week x 10 weeks x 50% x 50% = 7.5 pb^{-1}
  - BBCLL1 at Lumi. Peak
    - 16 x$10^3 mb^{-1}$/s x 22mb = 352kHz (min scenario.. 100kHz)
  - BBCLL1 at Lumi. Average
    - 9 x $10^3 mb^{-1}$/s x 22mb = 198kHz (min scenario.. 53kHz)