

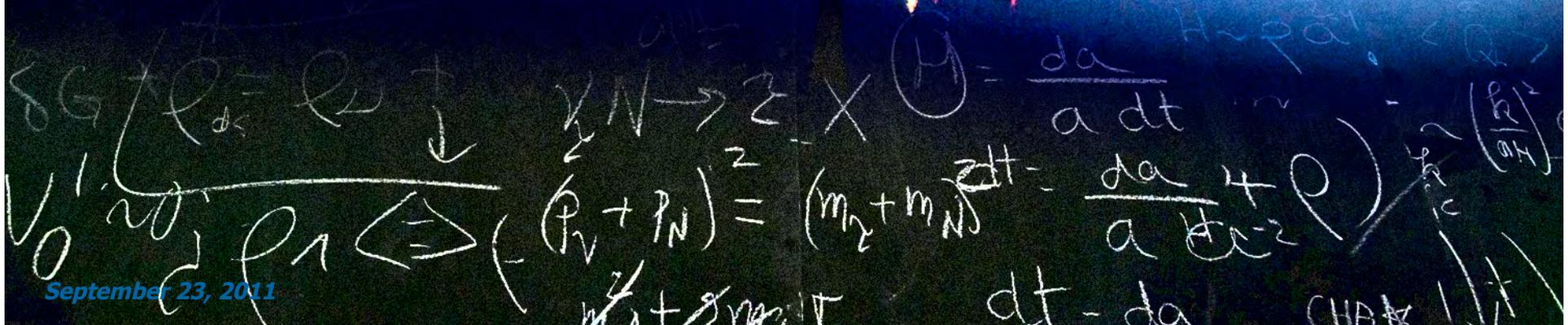
# D<sup>+</sup> yield at low p<sub>T</sub>

Summer School  
Fermilab 2011

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Mentors: M. Mussini, F. Rimondi

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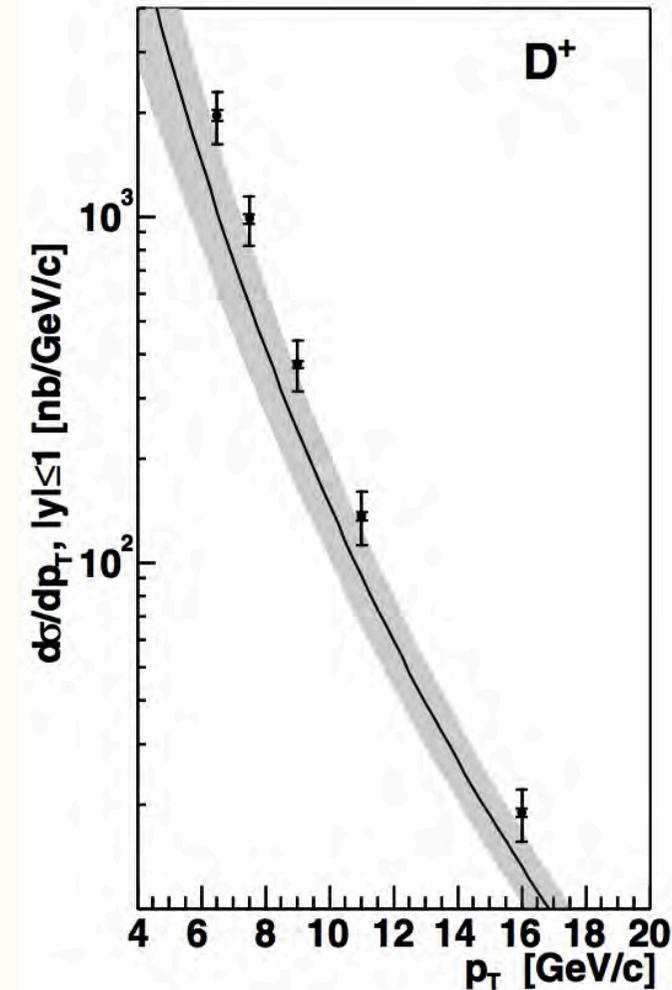


# Motivation



- ❖ The quark  $c$  is the only up-type quark whose hadronization and subsequent weak decay can be studied
- ❖ Extension of the previous CDF measurements of the differential cross section for the inclusive production of charmed meson at low  $p_T$   
( $p_T \geq 6.0 \text{ GeV}/c \rightarrow 1.5 \text{ GeV}/c$  ???)
- ❖ The theoretical model for npQCD needs to be studied in depth

PRL 91,241804(2003)



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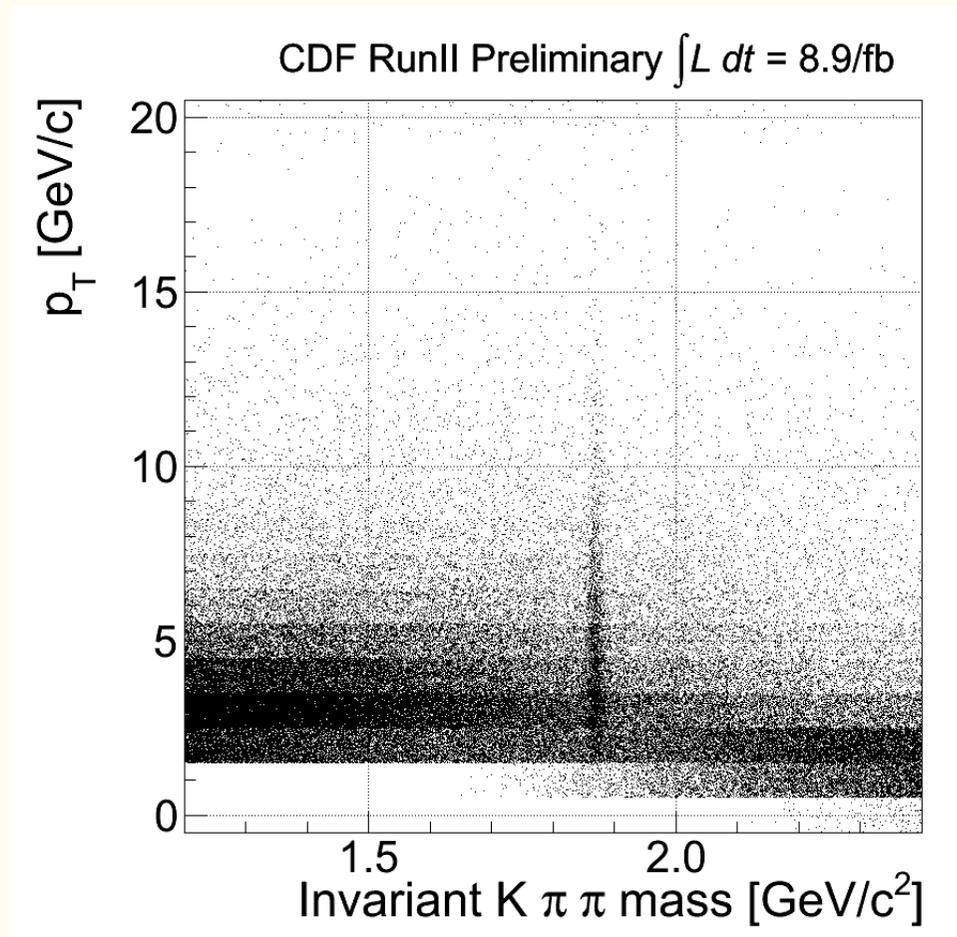
$D^+$  yield at low  $p_T$  1



# WORK FLOW



- ✓ **Unfold  $D^+$  signal from the background**
- ✓ **Maximize the signal yield over the background ( i.e. Optimization )**
  - ✓ .....
- ✓ **Measurement of the production cross section**



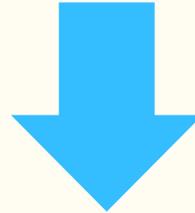


# D<sup>+</sup> : FEATURES



- **Mass = (1869.60 ± 0.16 ) MeV/c<sup>2</sup>**

- **$c\tau = 311.8 \mu\text{m}$**



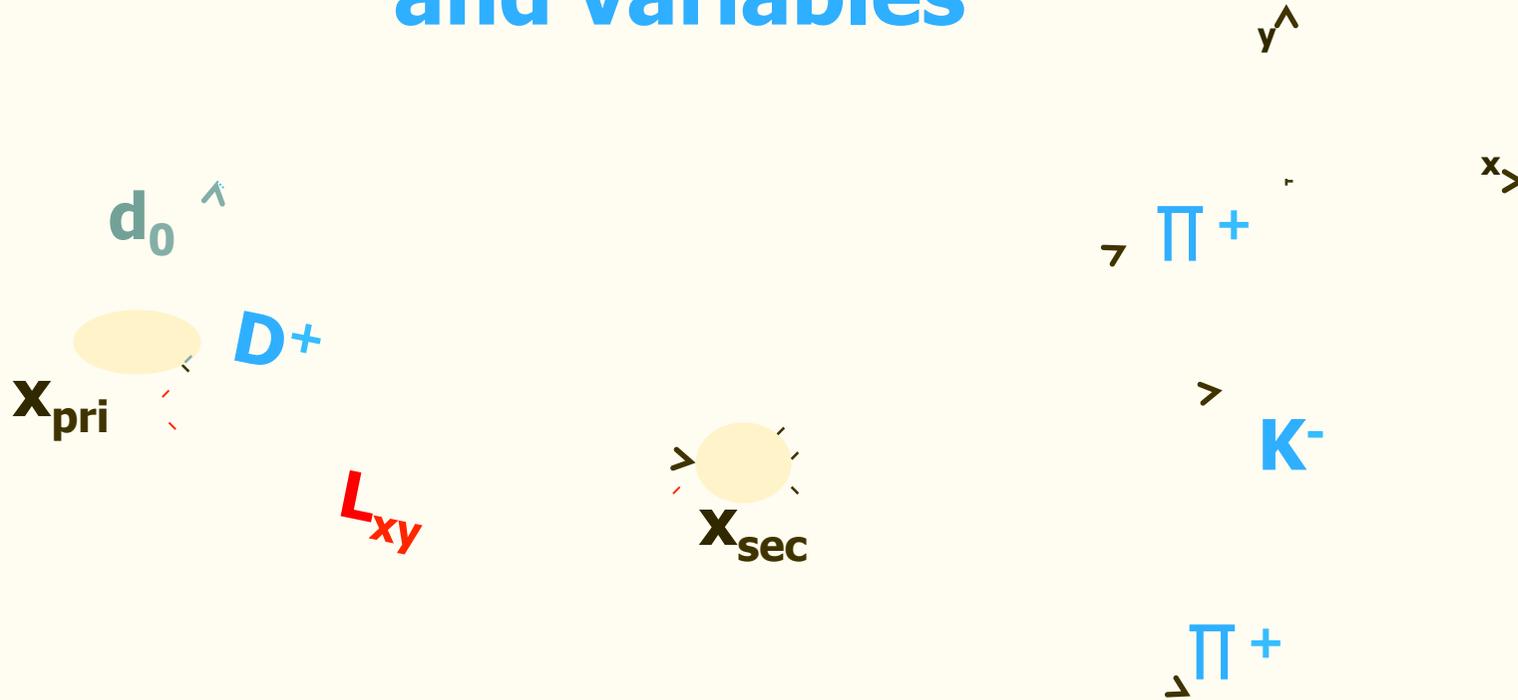
**We only see the charged decay products**

- **Decay mode studied in this analysis :**





# D<sup>+</sup>: Decay Channel of interest and variables



$$L_{xy} = \frac{(\vec{x}_{sec} - \vec{x}_{pri}) \cdot \vec{p}_T}{p_T}$$

$\Delta z_0$  among the three tracks is the difference of the z coordinate at their maximum approach to the beam.



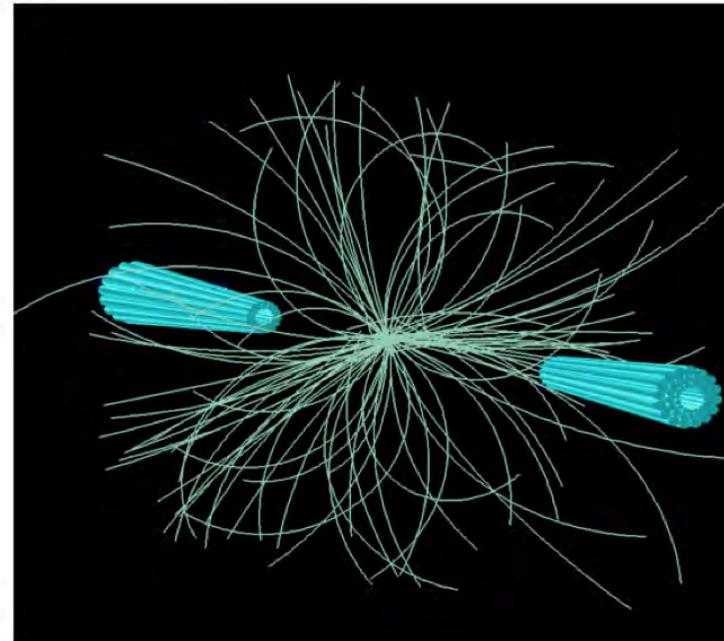
# Data Sample



In this analysis we use data collected by two different Triggers paths:

a) **Zero Bias (ZB): Prescale 1M. 1.6 events per second are collected whether or not collisions occur**

b) **Minimum Bias (MB): CLC signal coincidence + L3 rate limit to 1 Hz. 1 event per second is collected**





# Signal and Background

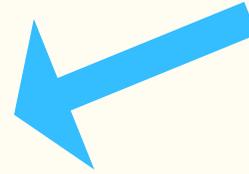


## D<sup>+</sup> Reconstruction:

Threesome of tracks combined together in each event

Fitting their helices and looking for an intersection point displaced by the primary vertex....

Common origin for the three tracks?  
D<sup>+</sup> Candidate



## Background:

- Secondary component :  
 $B^+ \longrightarrow D^+ + X$

- **C o m b i n a t o r i a l**  
**B a c k g r o u n d : K n n**  
invariant mass evaluated with unrelated tracks



# Offline Selection



- To Optimize the selection we used the following variables:

**Candidate daughters**



- $p_T$
- $d_0$

**Daughters Threesome**



- $\Delta z_0$

**D<sup>+</sup> Candidates**



- $\chi^2 / \text{NDOF}$
- $L_{xy}$



## Strategy



- **Development of a cuts matrix: all the possible combinations are studied testing several thresholds for each variable**

$$p_T \geq [0.6, 0.7, 0.8, 0.9, 1.1, 1.2] \text{ GeV}/c^2$$

$$d_0 \geq [50, 70, 90, 110, 130, 150, 170, 190] \mu\text{m}$$

$$\Delta z_0 \leq [0.1, 0.2, 0.3, 0.4, 0.5] \text{ cm}$$

$$\chi^2 / \text{NDOF} \leq [2, 3, 4, 5, 6]$$

$$L_{xy} \geq [300, 350, 400, 450, 500, 600, 650, 700] \mu\text{m}$$



# Selection Optimization



- For each possible selection we perform a fit of the Invariant  $K \pi \pi$  Mass extracting the signal (S) and the background (B) yields under the peak

- ◆ Figure of Merit :

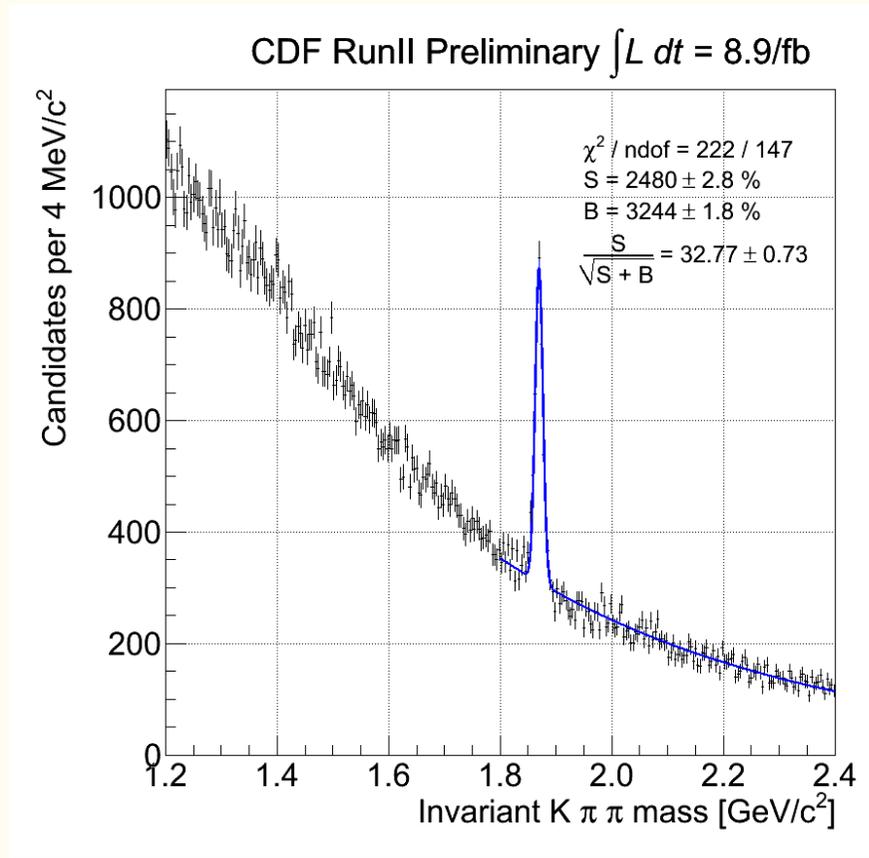
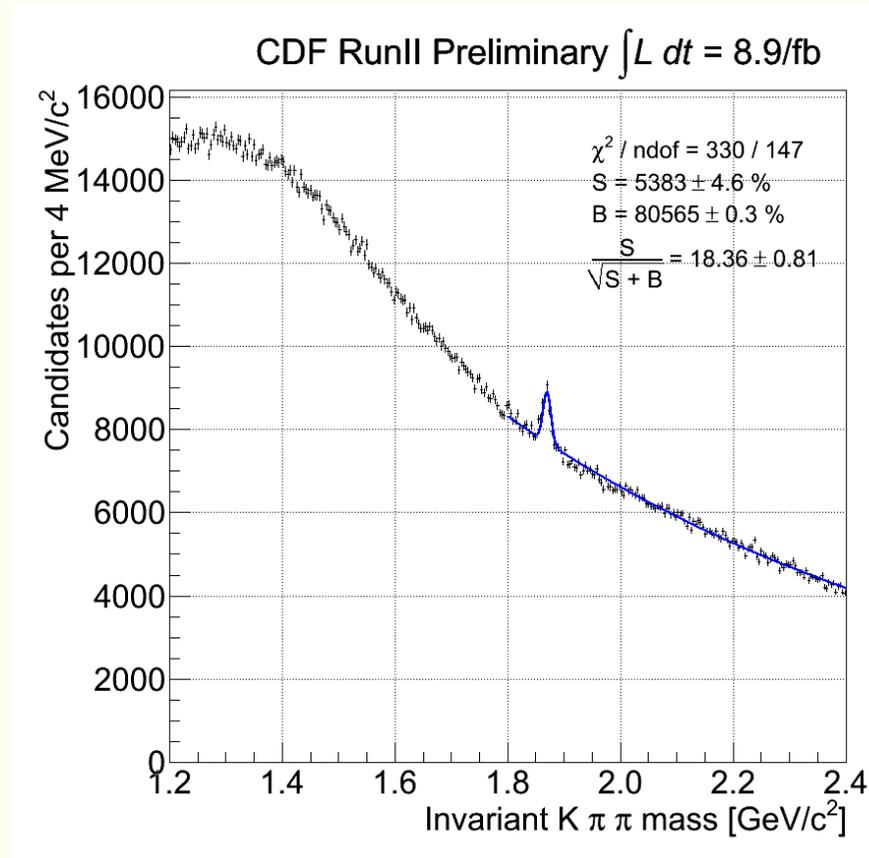
$$f(S, B) = \frac{S}{\sqrt{S+B}}$$

Evaluation for each cuts combination

- ◆ Our best selection is the one that maximizes our function
  - ◆ Goodness of the signal  
≠ maximum number of candidates in the signal



# K $\pi$ $\pi$ Invariant Mass before and after optimization



- $p_T \geq 0.8 \text{ GeV}/c^2$   $d_0 \geq 50 \mu\text{m}$
- $\Delta z_0 \leq 0.4 \text{ cm}$
- $\chi^2 / \text{NDOF} \leq 6$ ,  $L_{xy} \geq 700 \mu\text{m}$

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$D^+$  yield at low  $p_T$  **10**



# Conclusions and Future Overview



## RESULTS:

- ✓ We have observed the  $D^+$  signal in ZB and MB events.
- ✓ We optimized the selection criteria to get the best significance.

## ✓ TO DO:

We can measure the differential production Cross section of  $D^+$  mesons..... Master Thesis???

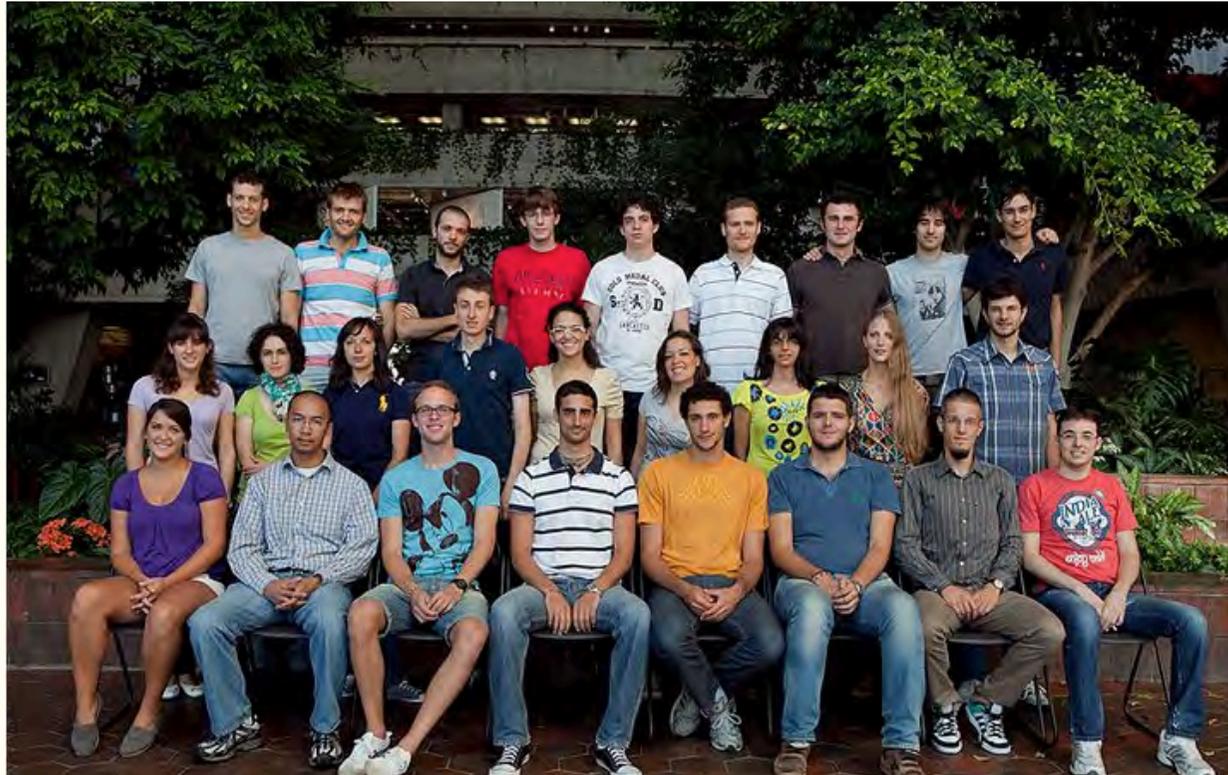


# Acknowledgments



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**All the summer students for the time spent together**



**September 23, 2011**

**$D^+$  yield at low  $p_T$**