Measurement of $Br(B^0 \rightarrow D^* D_s^*)$ and $Br(D_s \rightarrow \phi\pi)$ @ BaBar

Silvia Pennazzi

Universita' di Perugia – INFN

LNF Spring School, May 18 2004

Outline

- Motivations
- Strategy
- $B^0 \rightarrow D^* D_s^*$
- $D_s \rightarrow \phi\pi$
- Polarization measurements
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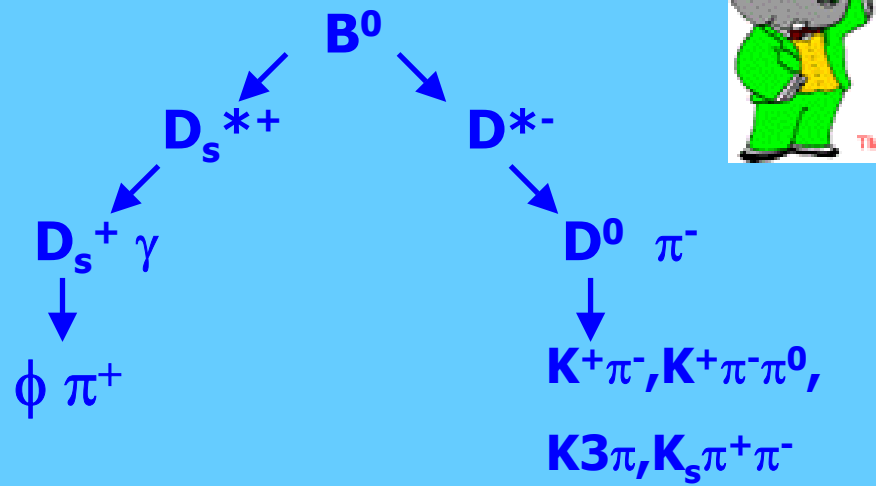
Motivations

- $B^0 \rightarrow D^* D_s^*$
  - First Br($B \rightarrow D^* D_s^*$) independent on Br($D_s \rightarrow \phi\pi$)
  - Factorization tests at high q^2 values ($q^2 \sim M(D_s^*)^2$)
  - Polarization control sample for D*D*(CP-eigenstate)
  - Constraint on γ hep-ph/03010252
- $D_s \rightarrow \phi\pi$
  - All the D_s Branching ratios (and $B \rightarrow D_s^{(*)} X$) are normalized to it
  - Current error on Br($Ds \rightarrow \phi\pi$) is 25%
- Analysis based on 114 fb^{-1}

Strategy



Reconstruction of $B^0 \to D^* D_s^*$

- Partial(D^* + γ from D_s^*)
- Full(D^*+ γ + $D_s \to \phi\pi$)

$$Br(B^0 \to D^* D_s^*) = \kappa \frac{N_{D_s \to X}}{\sum \varepsilon_i Br_i(D^0)}$$

$$Br(B^0 \to D^* D_s^*) Br(D_s \to \varphi\pi) = \kappa \frac{N_{D_s \to \varphi\pi}}{Br(\varphi \to KK) \sum \varepsilon'_j Br_j(D^0)}$$

- $\kappa = \left(2 N_{B\bar{B}} Br(D^* \to D^0\pi) Br(D_s^* \to D_s\gamma)\right)^{-1}$ common to both B_1 and B_2

$$Br(D_s \to \varphi\pi) = \frac{B_2}{B_1} = \frac{N_{D_s \to \varphi\pi} \sum \varepsilon_i Br_i(D^0)}{N_{D_s \to X} Br(\varphi \to KK) \sum \varepsilon'_j Br_j(D^0)}$$

Candidates selection

Preliminary cut on R2 and to reject continuum events

Photon selection:

- E*>130 MeV
- Z_{20}>0.82
- LAT>0.016

Best photon from Lr(E,E*,LAT,# of cr.)

D* selection:

- 1,4GeV<p*(D*)<1.9GeV
- $|M(D^0)_{rec}-M(D^0)_{pdg}|<2.5\sigma_i$
- $Q_i^{min}<Q(D^*)<Q_i^{max}$

Best D* from $\chi^2(m(D^0),Q(D^*))$

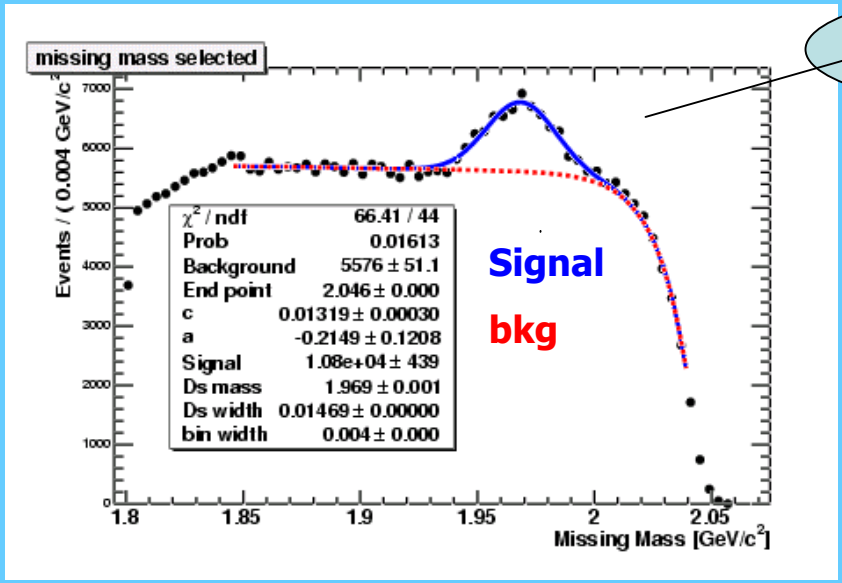
Optimized maximizing $S/(S+B)^{1/2}$ in $|m_{miss}-m(D_s)_{pdg}|<32$MeV

$$m_{miss}=\sqrt{(E_{beam}-E_{D^*}-E_\gamma)^2-(\vec{p}_B+\vec{p}_{D^*}+\vec{p}_\gamma)^2}$$

$Br(B^0 \rightarrow D^* D_s^*)$

- Efficiencies from Mc
- Br from PDG
- N_{Ds} from fit to m_{miss}
- Pdf: B(bkg)+gauss(signal)

$$B(m) = a\left(1 - e^{-\frac{m - m_{max}}{b}}\right)\left(\frac{m}{m_{max}}\right)^c$$



N_{Ds}~10000

Statistic error:	6.0%
Systematic errors:	
•Photon eff.	4.6%
•Br(D^0)	3.2%
•Bkg shape	2.9%
•Other	4.5%
Total	7.8%

Preliminary error(114 fb^{-1})

9.8%

Previous measurement(19.3 fb^{-1})

$Br(B^0 \rightarrow D^* D_s^*) = (1.50 \pm 0.16 \pm 0.12) \times 10^{-2}$

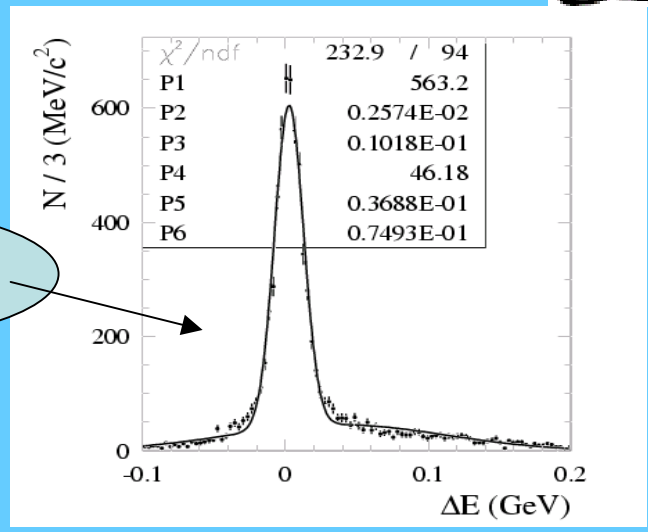
Candidates selection

- Selection:
  - $R_2<0.35$
  - $|Q(D^*)-Q(D^*)_{pdg}|<2$ MeV
  - $E^*\gamma>0.090$ GeV
  - $|\cos\theta_{hel}|>0.35$
  - $|M(\phi)-M(\phi)_{pdg}|<13$MeV
  - $0{,}125\text{GeV}<Q(D_s^*)<0.160\text{GeV}$
  - $|\Delta E|<0.06$GeV

Optimized maximizing $S/(S+B)^{1/2}$ in $5.27\text{GeV}<M_{es}<5.29\text{GeV}$

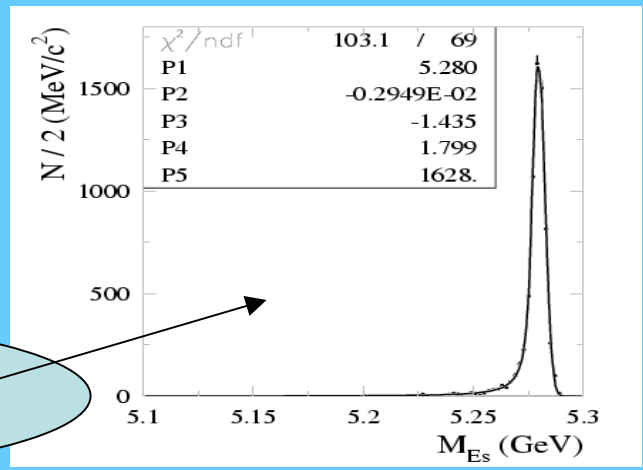
- Best candidate(D^*,γ,D_s) from minimum $|\Delta E|$

$\Delta E=E_{beam}-E_{D^*}-E_{Ds^*}$



MC signal sample

$M_{es}=(E^2_{beam}-(p_{D^*}-p_{D^*}))^{1/2}$



$Br(D_s \rightarrow \phi\pi)$

Combining partial and full reconstuctions a lot of systematics cancel

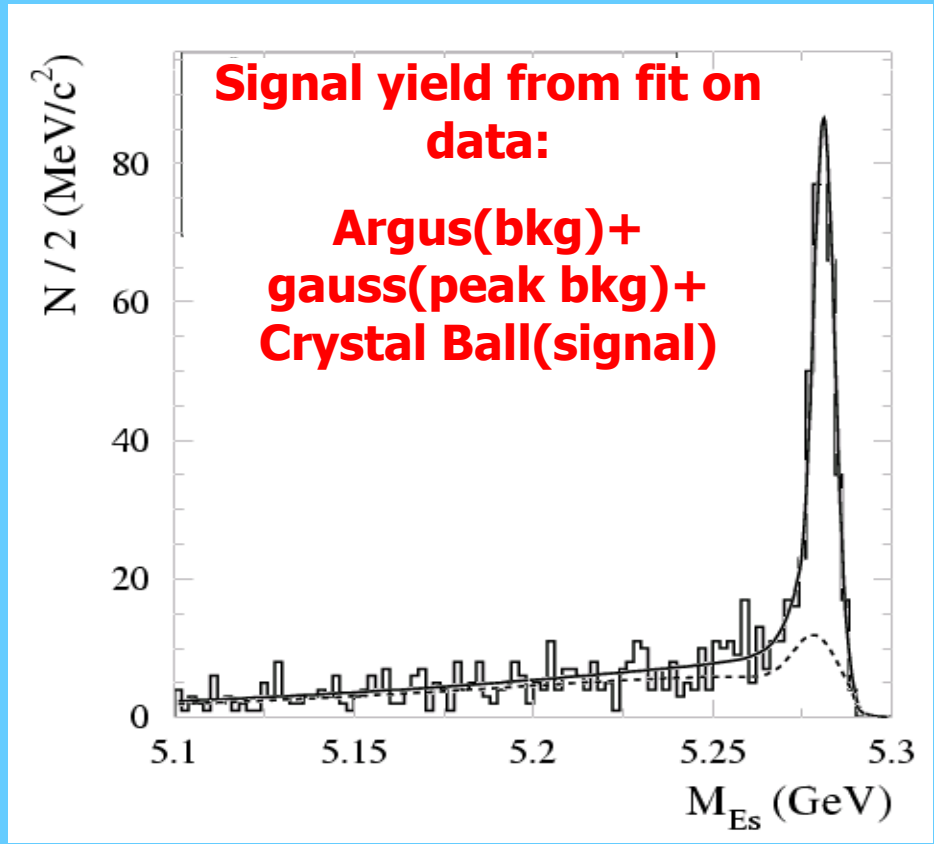
Preliminary error estimation

Systematic:

$4.4_{part} + 4.8_{full} = 6.4\%$

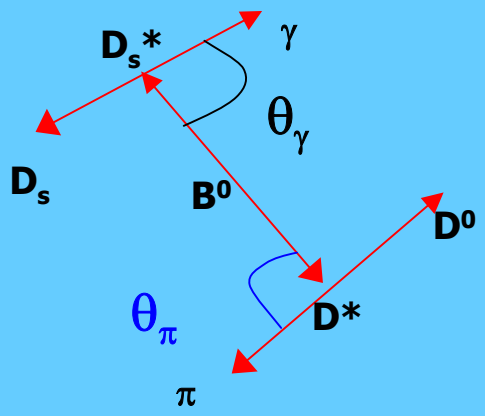
Statistic:

$6.0_{part} + 6.9_{full} = 9.1\%$



Global error = 11.1% error in PDG =25%

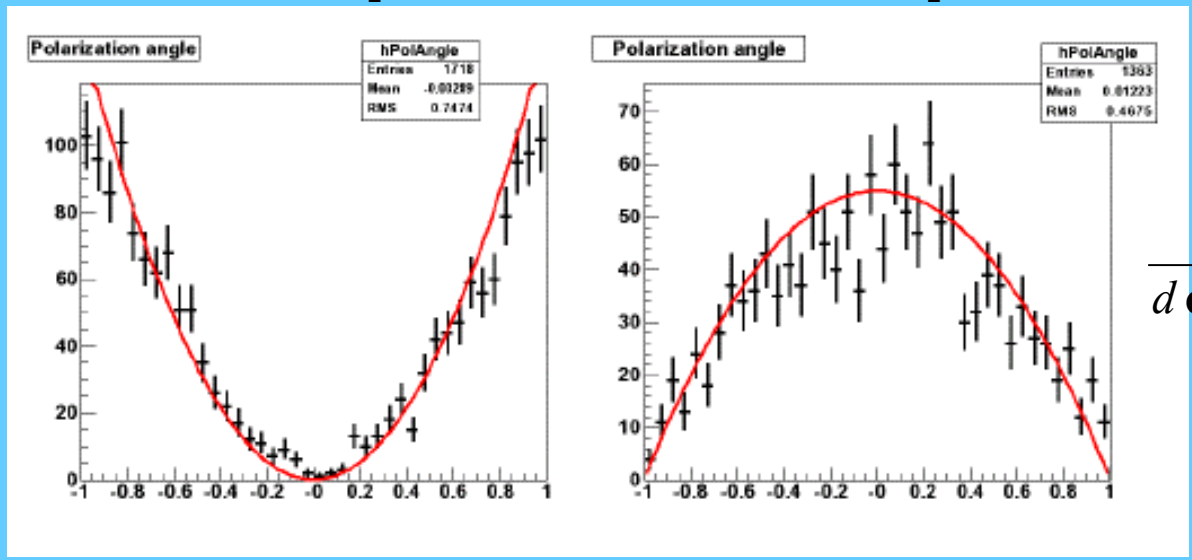
Polarization measurements(1)



B^0->$D^*D_s^*$ is a 2-body decay, so helicity must be extracted by angular distributions of secondary products (soft π from D*)

Pure Longitudinal Sample (Γ_L/Γ=1)

Pure Transversal Sample (Γ_L/Γ=0)



$$\frac{d\Gamma}{d\cos\theta_\pi} \approx \cos^2\theta_\pi$$

$$\frac{d\Gamma}{d\cos\theta_\pi} \approx \sin^2\theta_\pi$$

Polarization measurements(2)

- Strategy:
  - Pdf for signal: $f(\theta_\pi) = N\left[2\frac{\Gamma_L}{\Gamma}\cos^2\theta_\pi + \left(1-\frac{\Gamma_L}{\Gamma}\right)\sin^2\theta_\pi\right]$
  - Distribution for Bkg from M_{es} sidebands
- Preliminary errors:
  - Statistic error ~ 7.8%
  - Systematic error ~ 4.7%
    - Monte carlo statistics for efficiency
    - Bkg subtraction

Conclusions

- Br($B^0 \rightarrow D^* D_s^*$)
  - First measurement independent on Br($D_s \rightarrow \phi\pi$)
  - Statistic + systematic preliminary error =9.8%
  - Error reduced by a factor 3 respect with previous measurement
- Br($D_s \rightarrow \phi\pi$)
  - Statistic + systematic preliminary error = 11.1%
  - Error reduced by a factor 2.4 respect with previous measurement
- Polarization of $B^0 \rightarrow D^* D_s^*$ decay
  - Error expected on polarization fractions = 9%
- Results to be published this summer