Evidence for $B_s \rightarrow \phi\phi$ and $B_{d,s} \rightarrow VV$ decays at CDF

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Outline

- B decays to Vector Vector
- Bs phenomenology
- Recall on $B_s \rightarrow J/\psi\ \phi$ angular analysis and $\Delta\Gamma_s$
- The SVT trigger and $B_{u,d,s}$ charmless VV decays
- Observation of $B_s \rightarrow \phi\phi$ decays
  - BR and ACP for $B_u \rightarrow \phi K$
- Obervation of Vector resonances in CDF and $B_d \rightarrow \phi K^*$
- Future

B→VV

- Different helicity amplitudes contribute, expressing the decay rate in terms of linear polarization amplitudes:

$B_d \to \phi K^{*0}$

$$\frac{1}{\Gamma}\frac{d^3\Gamma}{d\cos\theta_1\, d\cos\theta_2\, d\psi} = \frac{9}{8\pi\Gamma}\left\{ L_1 \cos^2\theta_1 \cos^2\theta_2 + \frac{L_2}{2}\sin^2\theta_1 \sin^2\theta_2 \cos^2\psi + \frac{L_3}{2}\sin^2\theta_1 \sin^2\theta_2 \sin^2\psi + \frac{L_4}{2\sqrt{2}}\sin 2\theta_1 \sin 2\theta_2 \cos\psi - \frac{L_5}{2\sqrt{2}}\sin 2\theta_1 \sin 2\theta_2 \sin\psi - \frac{L_6}{2}\sin^2\theta_1 \sin^2\theta_2 \sin 2\psi \right\},$$

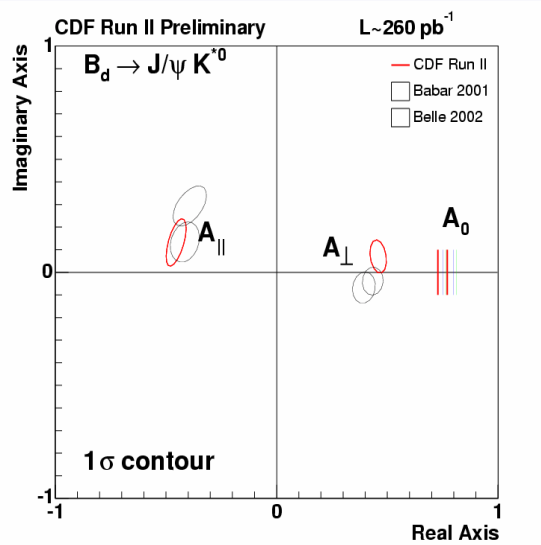
$L_1 = |A_0|^2$ CPeven $L_4 = \mathrm{Re}[A_{\|} A_0^*]$,

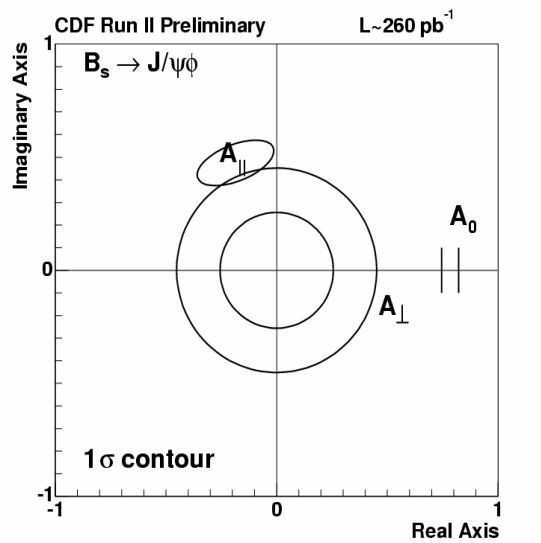
$L_2 = |A_{\|}|^2$ CPeven $L_5 = \mathrm{Im}[A_{\perp} A_0^*]$,

$L_3 = |A_{\perp}|^2$ CP odd $L_6 = \mathrm{Im}[A_{\perp} A_{\|}^*]$.

- Measuring angular distribution of decay products determine pol. amplitudes and their relative phases through interference effects
- New Physics could be detected by CP violation in any of the amplitudes and different models generate different patterns of CP violation (e.g. in the $B_d \to \phi K^{*0}$ case:Giri,Mohanta hep-ph/0309282)
- Decay to CP eigenstate gives even more observables to test SM/measure NP parameters (Datta et al., hep-ph/0406192), in general require tagged samples and time dependent angular analysis
  - → Triple product ($\vec{q}\cdot(\vec{e}_1\times\vec{e}_2)$) coefficients ($L_5+\bar{L}_5$, $L_6+\bar{L}_6$) (SM=0) are untagged quantities and might be ≠0 even if NP amplitudes have no strong phase difference wrt to SM ones (in contrast to direct CP asymmetries).
- Ratio of polarization amplitude $|A_{\perp}|^2/|A_{//}|^2$ test of the presence of right handed current (A.Kagan 0407076)

$B_s \rightarrow J/\psi\phi$ angular analysis and $\Delta\Gamma_s$





$$A_0 = 0.784 \pm 0.039 \pm 0.007$$
$$A_{\|} = (0.510 \pm 0.082 \pm 0.013)e^{(1.94 \pm 0.36 \pm 0.03)i}$$
$$|A_{\perp}| = 0.354 \pm 0.098 \pm 0.003$$
$$\tau_L = 1.05 \,^{+0.16}_{-0.13} \pm 0.02 \text{ ps}$$
$$\tau_H = 2.07 \,^{+0.58}_{-0.46} \pm 0.03 \text{ ps}$$
$$\Delta\Gamma/\Gamma = 0.65 \,^{+0.25}_{-0.33} \pm 0.01$$
$$\Delta\Gamma = 0.47 \,^{+0.19}_{-0.24} \pm 0.01 \text{ ps}^{-1}$$

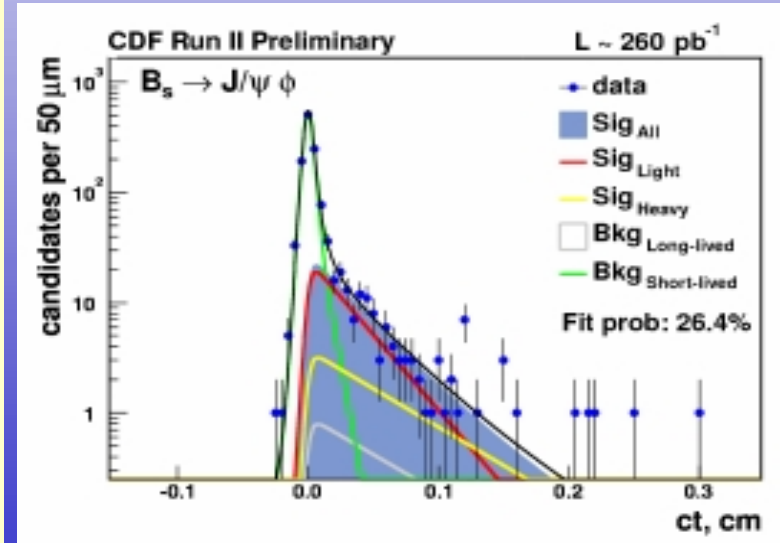
- With 260 pb^{-1} of data measure (time dependent) polarization amplitudes from angular distribution of $B_d \rightarrow VV$ and $B_s \rightarrow VV$

-B_d amplitudes compare well with Babar/Belle

-Extract $\Delta\Gamma$ from time dependent B_s

- With ~200 signal events CDF finds a large value for the lifetime difference (1/84 odds of being compatible with the SM value 0.12, ~3 sigma away from $\Delta\Gamma_s$=0)

-Tantalizing for untagged CP violation studies in B_s decays exploiting a large $\Delta\Gamma_s$



Untagged Bs decays

- Sizeable $\Delta\Gamma$s would be good news for untagged studies
  - hadron colliders colliders like them most because of the lower tagging efficiency
- $B_s(t)+\overline{B}_s(t)$ rate for decays to a CP eigenstate:

$$\Gamma[f(t)] \propto \left[\left(1+\left|\xi_f^{(s)}\right|^2\right)\left(e^{-\Gamma_L^{(s)}t}+e^{-\Gamma_H^{(s)}t}\right)-2\,\mathrm{Re}\,\xi_f^{(s)}\left(e^{-\Gamma_L^{(s)}t}-e^{-\Gamma_H^{(s)}t}\right)\right].$$

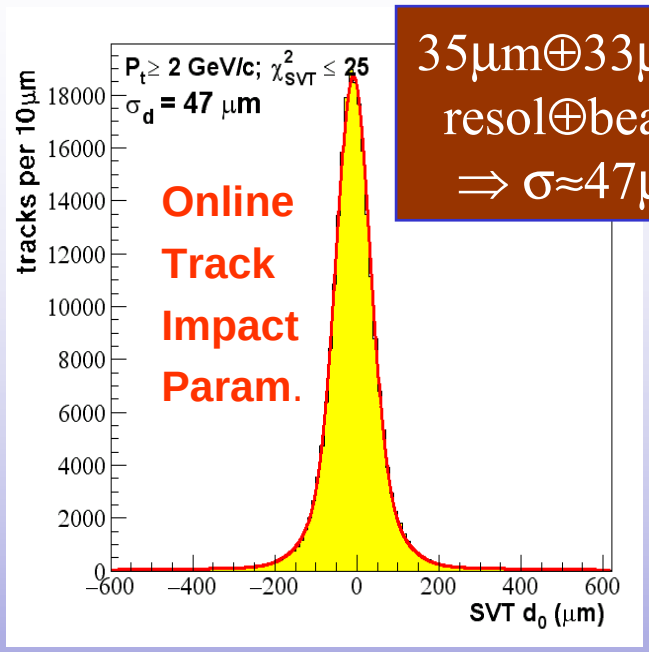
$$\xi_f^{(q)} = \exp\left[-i\,\Theta_{M_{12}}^{(q)}\right]\frac{A(\overline{B_q^0}\to f)}{A(B_q^0\to f)},$$

NB: in case of VV decays this is valid for terms arising from the square of each of the helicity amplitudes. Interference terms not shown here (similar expressions).

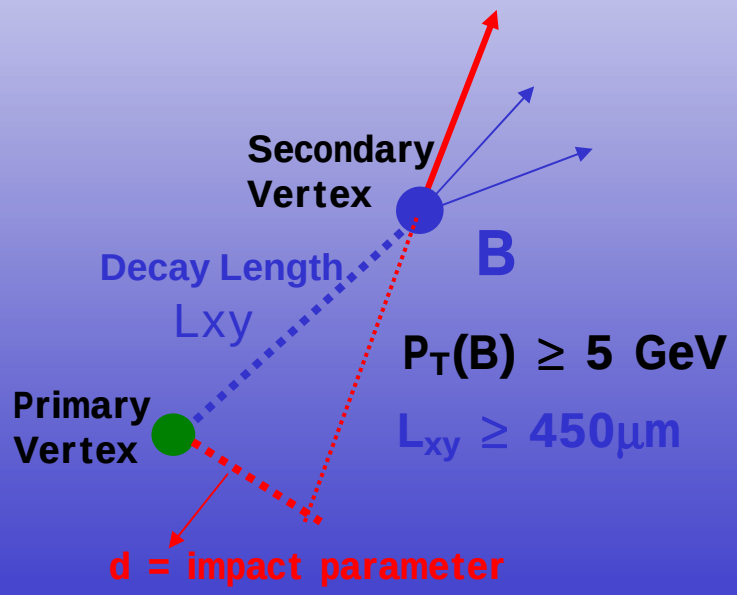
- Measure ϕ_s with the golden $B_s \to J/\psi\phi$ from untagged sample (time dependent angular analysis)
- Measure "γ" from $B_s \to K^{*+}K^{*-}$ and $B_s \to K^{*0}K^{*0}$ (R.Fleisher,I.Duniets '96)
- In general, provided a large lifetime difference, CP asymmetry parameters in B_s decays may be measured this way.

Silicon Vertex Tracker

- Triggering on displaced vertex at CDF opened up entirely new area of study in Heavy Flavour physics, just at ICHEP04:
  - $B_{d,s} \rightarrow h^+h'^-$ (Punzi, CP-6)
  - Charm Physics (Cerri, HQ-4)
  - $B \rightarrow VV$ this talk



35μm⊕33μm resol⊕beam ⇒ σ≈47μm



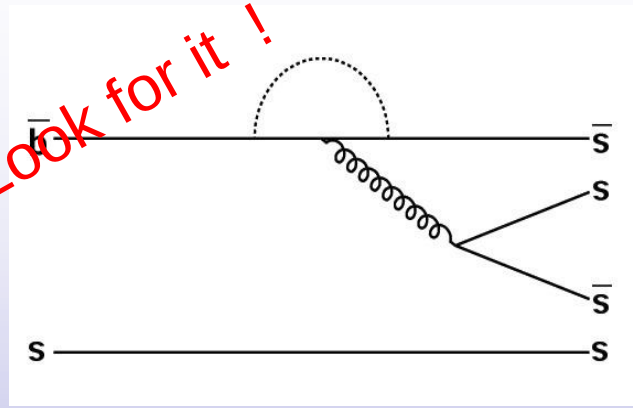
Main Trigger requires:

- 2 opposite charge tracks,
- $P_t \geq 2$ GeV/c,
- impact parameter $|d_0| > 120$ μm
- Scalar pt sum > 5.5 GeV/c
- Projected decay length $L_{xy} > 200$ μm
- $2° < \Delta\phi < 90°$

Add a dynamically prescaled LOWPT trigger with no opposite charge and no Pt sum to fill available bandwidth at low luminosity

Why $B_s \rightarrow \varphi\,\varphi$

- $b \rightarrow sss$ transition (other SM diagrams <1%) , Bs counterpart of $B_d \rightarrow \phi K^{*0}$
- Pure penguin decay (with EWP too)
- Both B_s and anti-B_s initial states decay into $\phi\phi$
- (time dependent) angular analysis project out the CP components
  - Access $\Delta\Gamma_s$ as in $B_s \rightarrow J/\psi\phi$ (what about if they are different ?)
  - Test polarization predictions from theory (compare with $B_d \rightarrow \phi K^{*0}$)
- No direct asymmetry expected in the SM, but new physics in $b \rightarrow sss$ transition motivated by $S(\phi K_S)$ naturally lead to O(1) CP asymmetry for $B_s \rightarrow \varphi\,\varphi$ (e.g. M.Raidal hep-ph/020891)



	NF	QCDF
BR(10^{-5})	1.79	3.68
$\Gamma_\perp/\Gamma_{Tot}$	0.117	0.084

Recent appearance in litterature:

- M.Raidal cited
- Atwood, Soni (2001)→ angular correlation in untagged sample to be compared with $b \rightarrow d$ penguin decays (e.g. $Bs \rightarrow K^{*0}\,\rho^0$) and SU(3) assumptions (no need of time dependence or tagging)
- Datta et al (hep-ph/0406192) → determine new physics parameters from time dependent angular analysis of $B_s \rightarrow \varphi\,\varphi$ (and $B_d \rightarrow \phi K^{*0}$)
- Li-Lu-Yang hep-ph/0309136 (published in PRD) calculated BR and perp. polarization in QCDF; rate is particularly large

$B_s \rightarrow \varphi\,\varphi$ Analysis highlights

A blind analysis was performed in anticipation of a small signal rate

Normalize rate using another $B_s \rightarrow VV$ decay: $B_s \rightarrow J/\psi\phi$

- some systematic on efficiency cancel
- sizeable rate
- production ratio of B_s vs B_d (fs/fd) cancels
- one $\phi \rightarrow K^+K^-$ in the final state

Optimized cuts

- L_{xy} : transverse decay length projected along B_s flight direction
- χ^2_{xy} : B_s vertex χ^2 in the transverse plane
- $d0_B$: B_s impact parameter wrt to the beam line
- $Pt(\phi)$: Transverse momentum of f candidates
- $d0_{min}(\phi)$: min impact parameter wrt the beam line of ϕ daughter tracks

Maximize the score function:

$$\frac{1}{S_{\min}} \propto \frac{\varepsilon(t)}{a/2+\sqrt{B(t)}} \quad ; \; a=3.$$

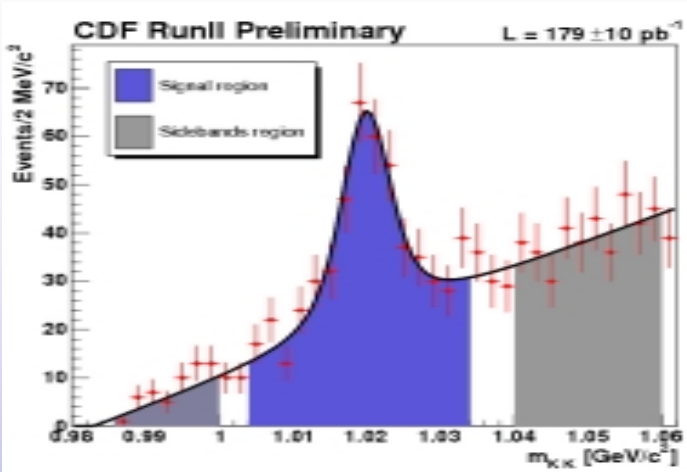
where $\varepsilon(t)$ is the signal efficiency from MC
And B(t) is the expected background
From sideband estrapolation for the set t of selection cuts.
For a=3 maximize the sensitivity region for a 3 σ discovery with 99% CL.
(G.Punzi, hep-physics/0308063)

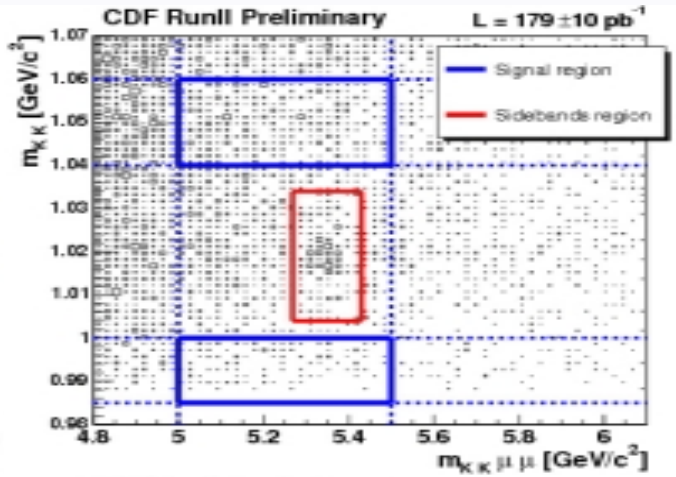
Nice feature : optimization independent of MC normalization

For the control sample maximize usual significance:

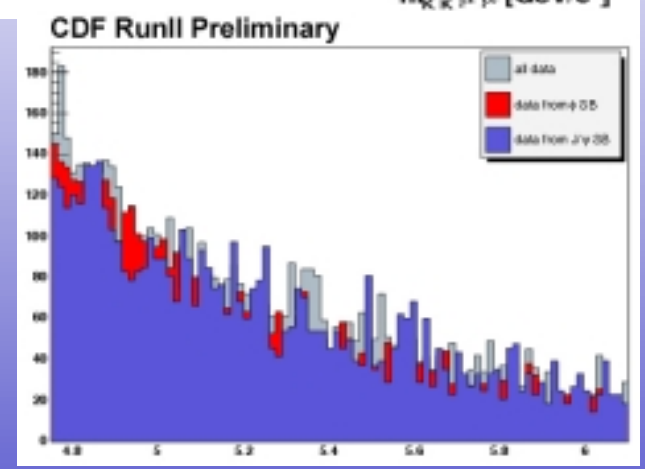
$$Sig = \frac{S(t)}{\sqrt{S(t)+B(t)}}$$

Optimization sample





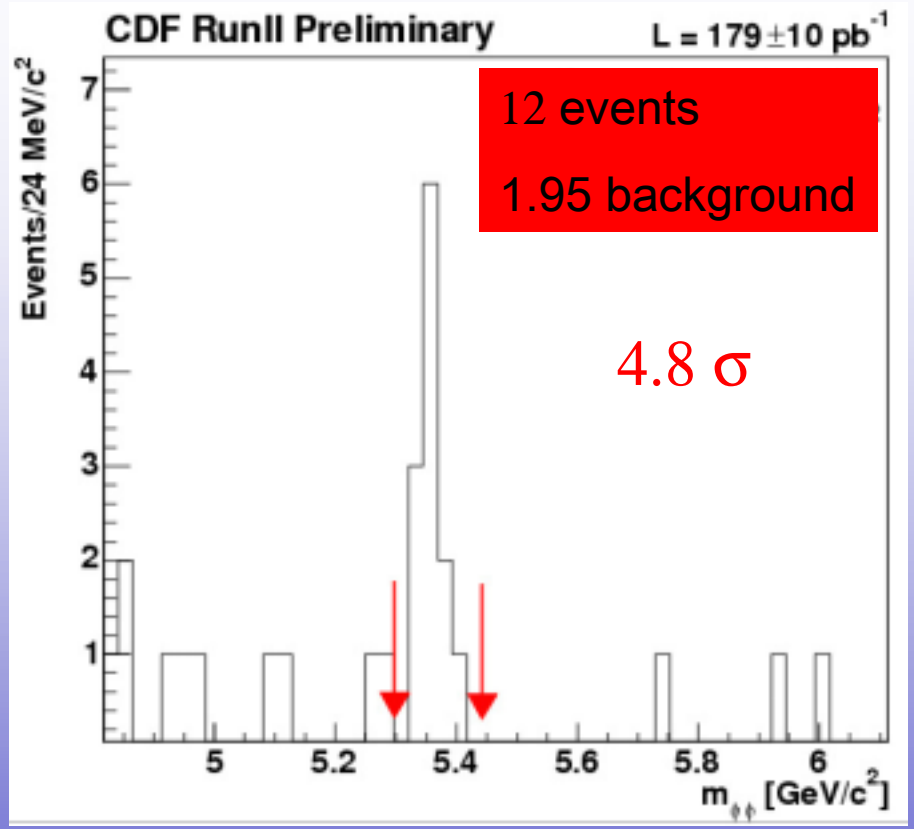
Decay	Signal region	Sideband
J/ψ φ	$\lvert M_{\mu\mu}-M_{J/\psi}\rvert<50$ MeV/c² $\lvert M_{KK}-M_{\phi}\rvert<15$ MeV/c²	$M_{KK} \in [0.985,1.0] \cup [1.04,1.06]$ GeV/c² $M_B \in [5.0,5.5]$ GeV/c²
φ φ	$\lvert M_{KK}-M_{\phi}\rvert<15$ MeV/c² for both φ's	$M_{KK} \in [0.985,1.0] \cup [1.04,1.06]$ GeV/c² $M_B \in [4.9,6.0]$ GeV/c²

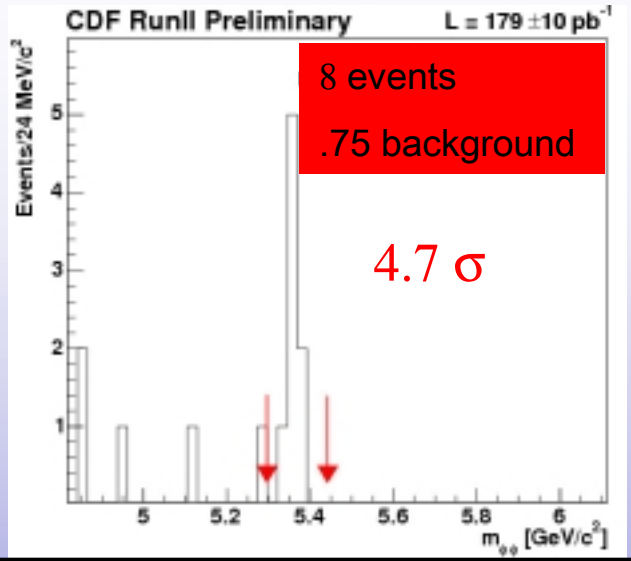


A background enriched sample from φ sidebands used for optimizing selection, and excluded from the yield measurement:

→Avoid bias in a counting experiment on top of an optimized background

$B_s \rightarrow \varphi\,\varphi$ Evidence

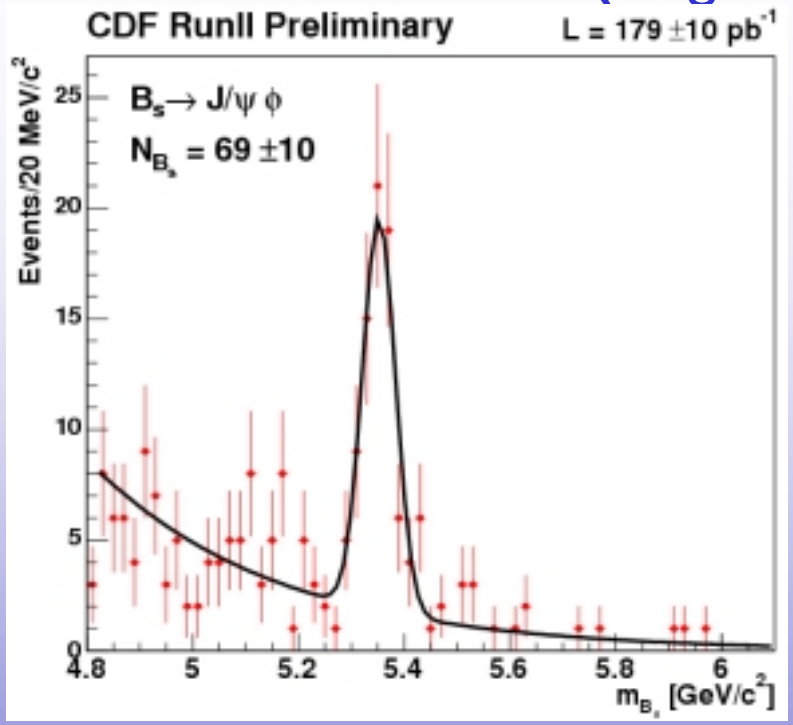


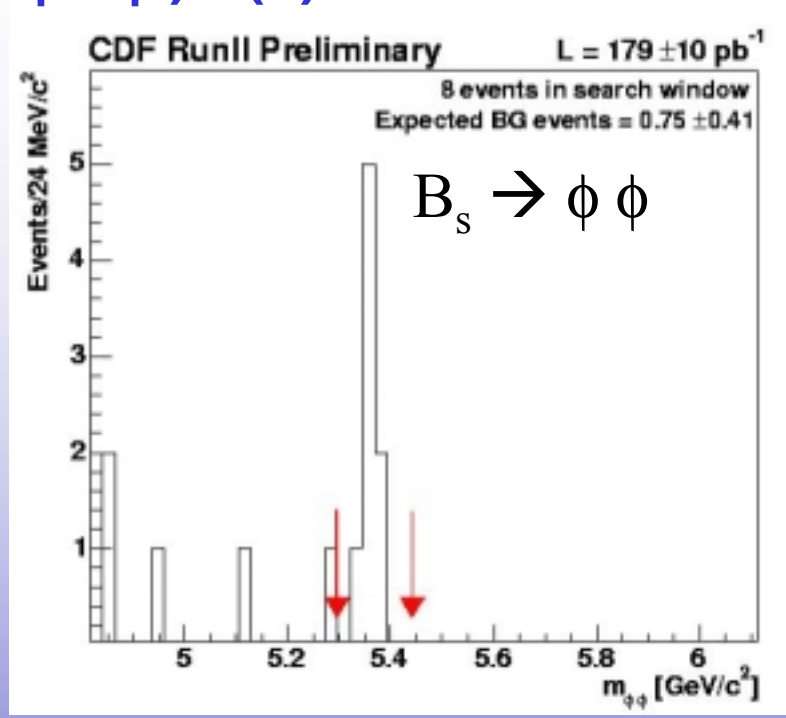


- Search window ±3σ (72 MeV/C^2) around B_s mass peak
- Combinatorial background estimated from an additional independent background sample
- Total background includes 0.45 events from $B_d \rightarrow \phi K^{*0}$ misidentification peak
- Adding the prescaled dataset only change the significance of the signal from 4.7 σ to 4.8 σ

Optimized set of cuts for $B_s \rightarrow \phi\,\phi$		
	Main dataset	LOWPT
L_{xy} [cm]	>0.035	>0.03
Ip_{B_s} [cm]	<0.008	<0.008
χ^2_{xy}	<10	<6
$P_t^{\phi 1}$ [GeV/c^2]	>2.5	>2.0
$P_t^{\phi 2}$ [GeV/c^2]		
$d0_{min}^{\phi 1}$ [cm]	>0.004	
$d0_{min}^{\phi 2}$ [cm]	>0.0011	

BR($B_s \rightarrow \varphi\varphi$) (I)





$$BR(B_s \rightarrow \varphi\varphi) = \frac{N(B_s \rightarrow \varphi\varphi)}{N(B_s \rightarrow \psi\varphi)^{corr}} \frac{\varepsilon(\psi\varphi)}{\varepsilon(\varphi\varphi)} \cdot \frac{BR(B_s \rightarrow \psi\varphi).BR(J/\psi \rightarrow \mu^+\mu^-)}{BR(\varphi \rightarrow K^+K^-)}$$

From MC

From PDG *

BR = (1.4 ± 0.6(stat) ± 0.2(syst) ± 0.5 (BR)) × 10^{-5}

QCD Factorization: BR = 3.68 * 10^{-5} (Li-Lu-Yang hep-ph/0309136)

* BR($\psi\phi$) needs to be rescaled for f_s/f_d

BR($B_s \rightarrow \varphi\varphi$) (II)

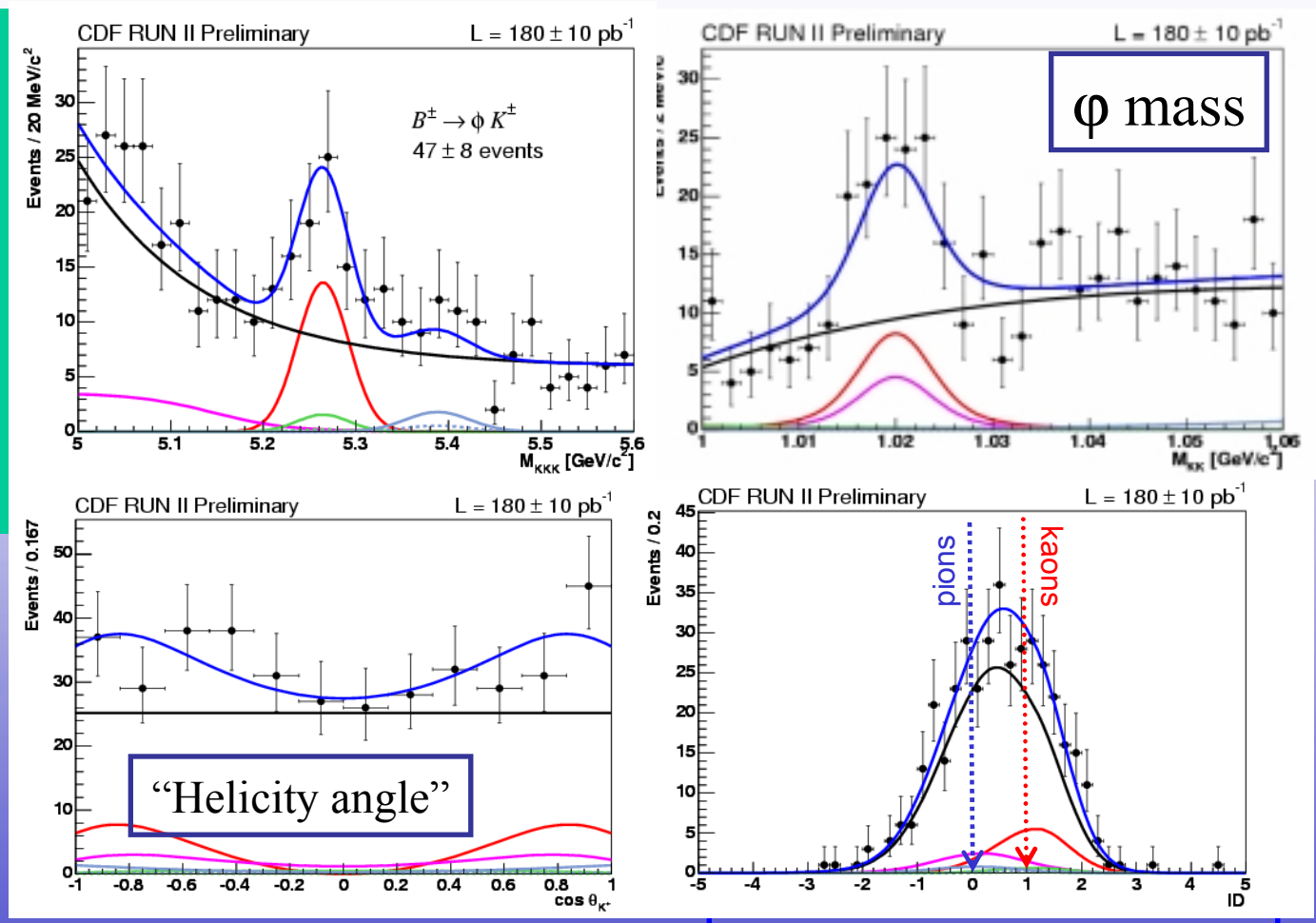
- Systematic error dominated by normalization mode BR uncertainty and already similar in size to the statistical error
- Theory uncertainty on polarization very conservative (vary longitudinal fraction in 0 % to 100% range)
- $\Delta\Gamma_s$ uncertainty based on the preferred theory value of: $\Delta\Gamma_s/\Gamma_s = 0.12 \pm 0.06$
- Polarization uncertainty indeed is related to the shorter effective lifetime for CP even component:
  - Measure soon polarization amplitude (signal very clean)
- BR is rather on the low side respect to QCDF (but large error on any single decay mode are usual)
  - probably interesting to include this mode in global fits to take advantage of correlated theory error

Source	Relative error on BR
Trigger efficiency	7.4 %
$J/\psi\phi$ yield and efficiency	8.4%
Background subtraction	3.2%
$B_s \rightarrow \phi\phi$ polarization	7.0%
$\Delta\Gamma_s$ uncertainty	3.2%
Sub Total	14 %
BR($J/\psi\phi$)	35%
Total	39%

Even More Penguin : $B^{\pm} \rightarrow \varphi K^{\pm}$

Unbinned extended maximum likelihood fit to :

- M_{KKK}
- $M\phi$
- helicity angle
- dE/dx from drift chamber



Measure:

$N(B^{\pm} \rightarrow \phi K^{\pm})$

$A_{CP}(B^{\pm} \rightarrow \phi K^{\pm})$

+ disentangle signal from $B^{\pm} \rightarrow f^0 K^{\pm}$, $B^{\pm} \rightarrow K^{*0}\pi$, $B_{u,d} \rightarrow \phi X$ and combinatorial background

Particle ID: dE/dx in central tracking chamber

$B^{\pm} \rightarrow \varphi K^{\pm}$ Results

Fit Results		
	$B^{\pm} \rightarrow J/\Psi K^{\pm}$	$B^{\pm} \rightarrow \varphi K^{\pm}$
N_B	439 ± 22	47.0 ± 8.4
A_{CP}	0.046 ± 0.050	-0.07 ± 0.17

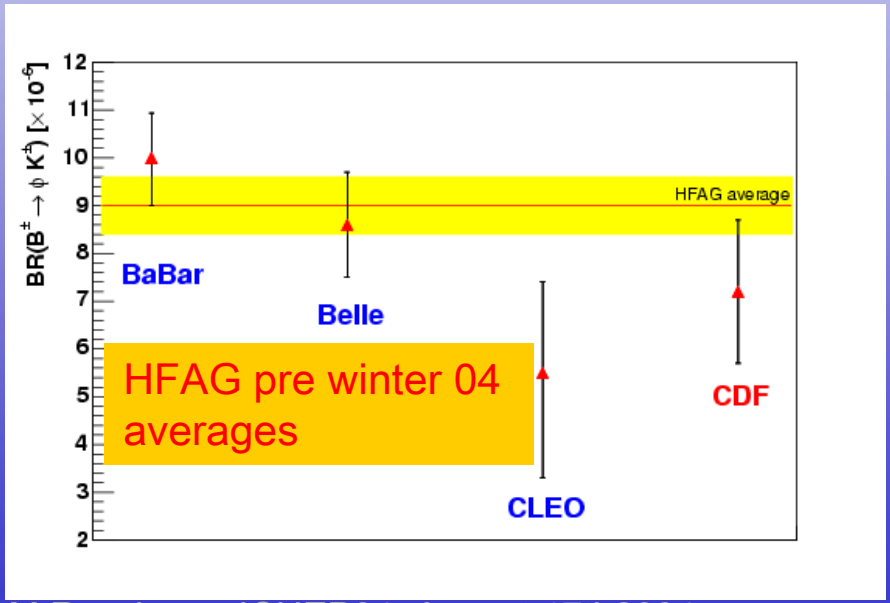
Normalize yield to $B^{\pm} \rightarrow J/\Psi K^{\pm}$ to measure BR, similar technique as for $Bs \rightarrow \phi\phi$

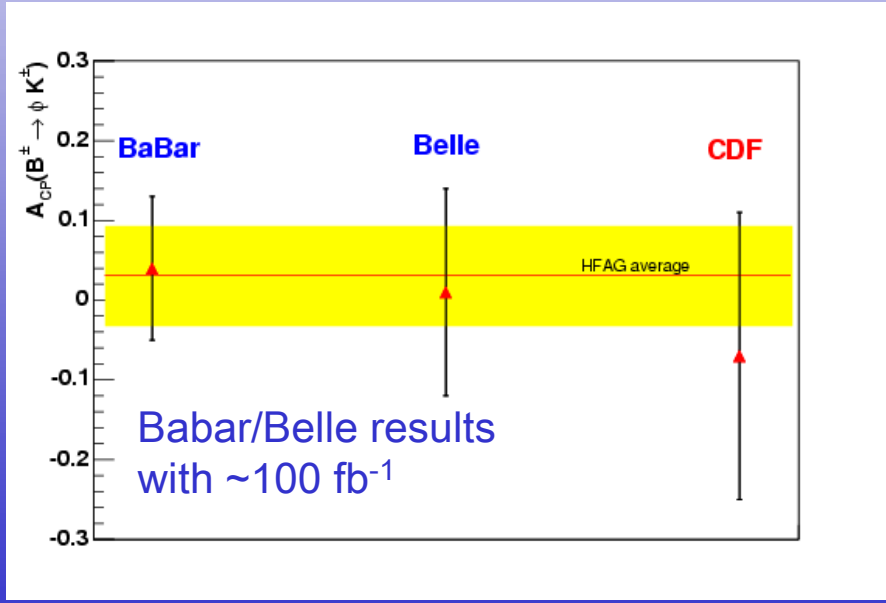
→ Cross check!

A_{CP} syst. From $J/\Psi K^{\pm}$ A_{CP} stat.

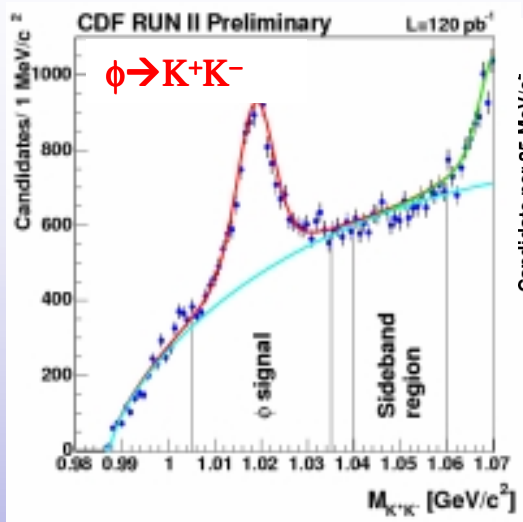
$$BR(B^{\pm} \rightarrow \varphi K^{\pm}) = \left(7.2 \pm 1.3(stat.) \pm 0.7(syst.)\right) \cdot 10^{-6}$$

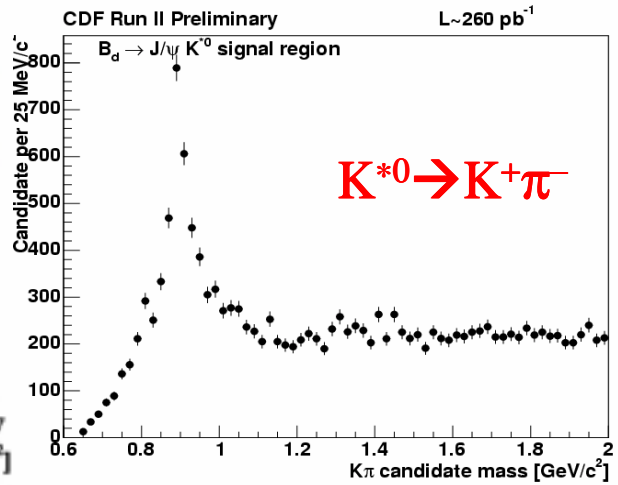
$$A_{CP}(B^{\pm} \rightarrow \varphi K^{\pm}) = \frac{\Gamma(B^{-} \rightarrow \varphi K^{-}) - \Gamma(B^{+} \rightarrow \varphi K^{+})}{\Gamma(B^{-} \rightarrow \varphi K^{-}) + \Gamma(B^{+} \rightarrow \varphi K^{+})} = -0.07 \pm 0.17(stat.)^{+0.06}_{-0.05}(syst.)$$

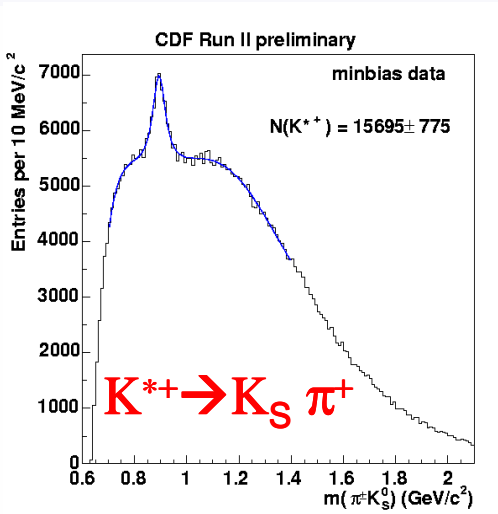


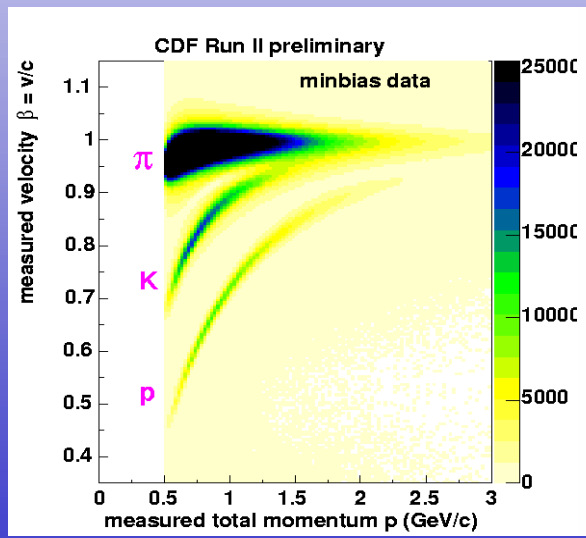


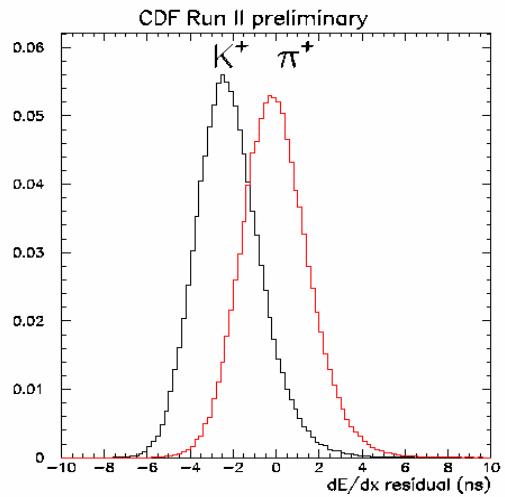
Which other Vectors?









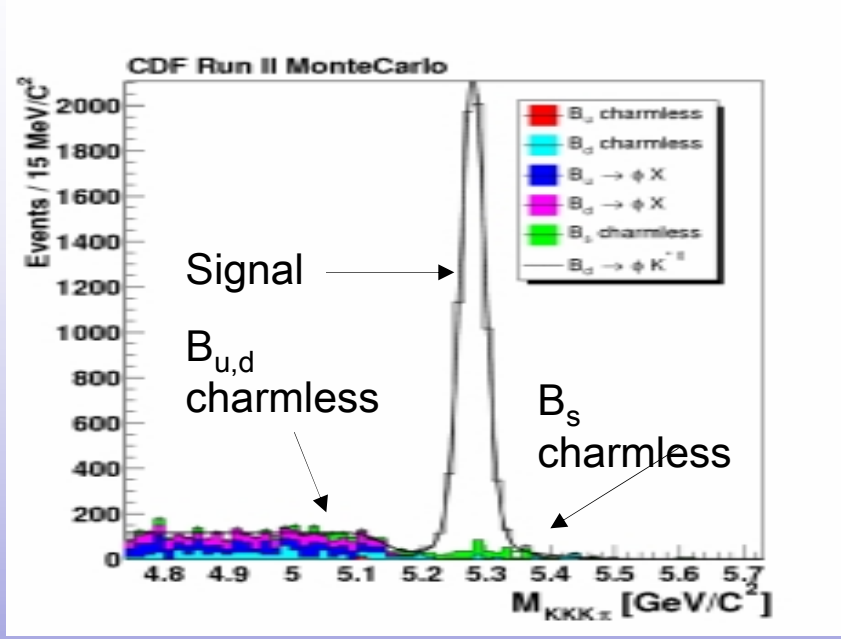


K^{*0},$K^{*\pm}$, ϕ clearly visible even without PID

Sufficienctly clean signals

Can improve with PID in the future

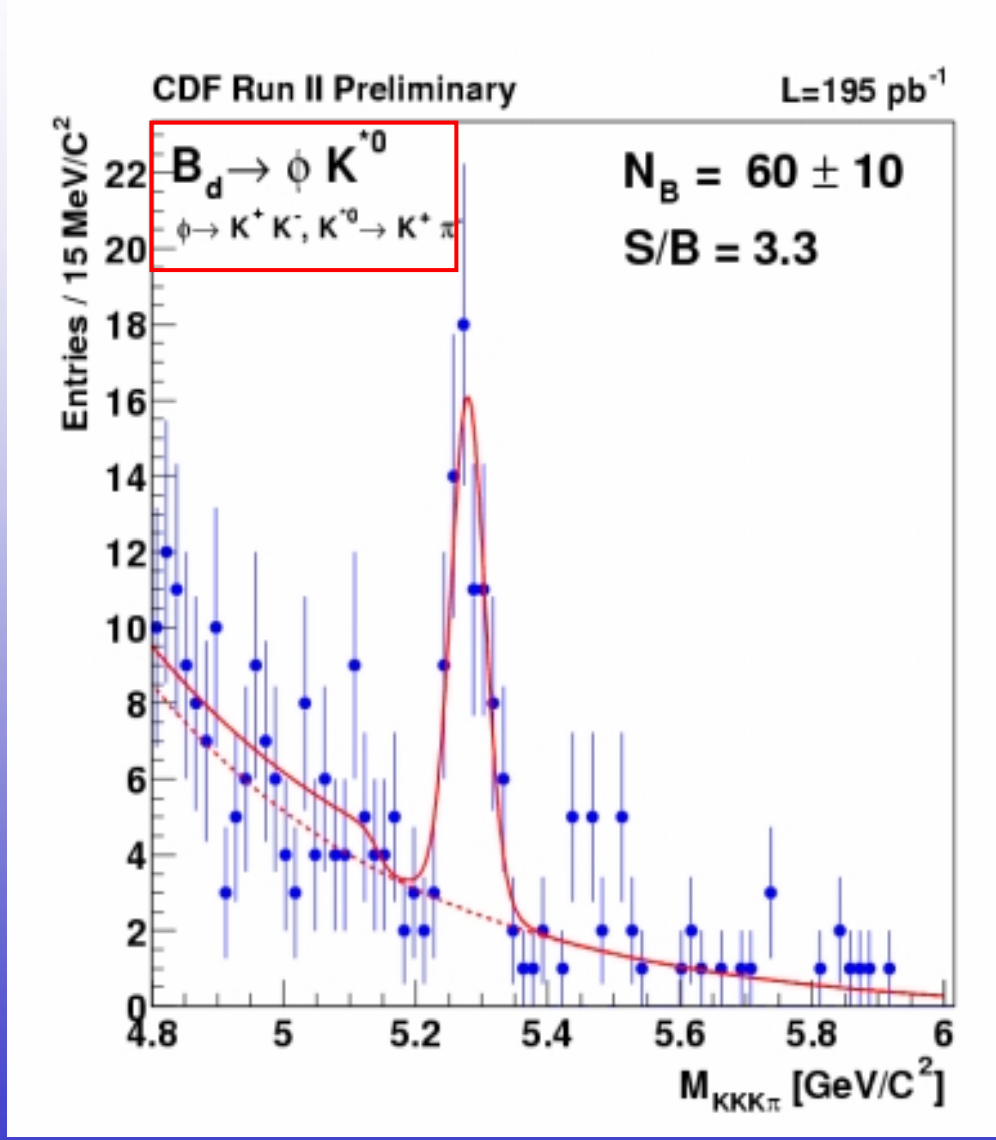
Not only $\phi\phi$!



Selection similar to $B_s \rightarrow \phi\phi$

$B_d \rightarrow \phi K^{*0}$ with 180 pb^{-1} of CDF data comparable in size and purity with B factory samples with ~80 fb^{-1}

In the near future expect to see more data (x2 on tape), improved calibration (signal width) and much better efficiency in silicon tracking (online and offline)



further B_s modes

- Rich harvest of interesting $B_s \rightarrow VV$ decays
  (Li,Lu,Yang hep-ph/0309136)
- Only the π^0-less shown in the table here
- Measure them all!
  - $K^{*+}K^{*-}/K^{*0}$anti-K^{*0} untagged angular analysis gives γ (with SU(2) assumptions)
  (Fleisher,Duniets)
  - $\phi\rho^0$ dominated by Electro Weak Penguin

	Decay	BR(10^{-6})	BR/BR($\phi\phi$) (including daugher BR)
b→d	$K^{*0}\rho^0$	1.95	0.14
b→s	$K^{*+}K^{*-}$	2.10	0.009
b→s	$\rho^0\phi$	1.67	0.09
Pure penguin	K^{*0} anti-K^{*0}	3.72	0.17
Pure penguin	$K^{*0}\phi$	0.2	0.007
Pure penguin	$\phi\phi$	36.8	1

Trigger efficiency not included
(but expected very similar)

Conclusion and perspective

We have selected 12 signal candidates for the pure penguin $B_s \rightarrow \phi\phi$ decays in 180 pb^{-1} of CDF II data (4.8 σ evidence). We measure:

$$BR(B_s \rightarrow \varphi\varphi) = \left(1.4 \pm 0.6(stat.) \pm 0.2(syst.) \pm 0.5(BR)\right) \cdot 10^{-5}$$

Several other charmless non leptonic decays in CDF give interesting results also for $B_{u,d}$: here penguin dominated $B^{\pm} \rightarrow \phi K^{\pm}$

$$BR(B^{\pm} \rightarrow \varphi K^{\pm}) = \left(7.2 \pm 1.3(stat.) \pm 0.7(syst.)\right) \cdot 10^{-6}$$

$$A_{CP}(B^{\pm} \rightarrow \varphi K^{\pm}) = \frac{\Gamma(B^- \rightarrow \varphi K^-) - \Gamma(B^+ \rightarrow \varphi K^+)}{\Gamma(B^- \rightarrow \varphi K^-) + \Gamma(B^+ \rightarrow \varphi K^+)} = -0.07 \pm 0.17(stat.)^{+0.06}_{-0.05}(syst.)$$

With dataset now on tape some new Bs mode will become visible:

- Better tracking, PID
- X2 luminosity
- dedicated trigger on non prompt (i.e. from b) $\phi \rightarrow K^+K^-$ decays

Measure "untagged" quantities with $B_s \rightarrow \phi\phi$ events:

- Polarization amplitudes
- $\langle \tau_{\phi\phi} \rangle$

Need significantly more statistics to perform $\not{C}\not{P}$ measurements (full Run II)

Backup slides

Bs decays to J/psi ϕ

$$\frac{d^4\mathcal{P}(\vec{\rho},t)}{d\vec{\rho}\,dt} \propto |A_0|^2 \cdot g_1(t) \cdot f_1(\vec{\rho}) + |A_{\parallel}|^2 \cdot g_2(t) \cdot f_2(\vec{\rho})$$
$$+ |A_{\perp}|^2 \cdot g_3(t) \cdot f_3(\vec{\rho}) \pm Im(A_{\parallel}^* A_{\perp}) \cdot g_4(t) \cdot f_4(\vec{\rho})$$
$$+ Re(A_0^* A_{\parallel}) \cdot g_5(t) \cdot f_5(\vec{\rho}) \pm Im(A_0^* A_{\perp}) \cdot g_6(t) \cdot f_6(\vec{\rho})$$

term i	Amplitudes and time evolution ($g_i(t)$)
1	$\lvert A_0\rvert^2\left[e^{-\Gamma_L t} \mp e^{-\Gamma t}\sin(\Delta m_s t)\delta\phi_s\right]$
2	$\lvert A_{\parallel}\rvert^2\left[e^{-\Gamma_L t} \mp e^{-\Gamma t}\sin(\Delta m_s t)\delta\phi_s\right]$
3	$\lvert A_{\perp}\rvert^2\left[e^{-\Gamma_H t} \pm e^{-\Gamma t}\sin(\Delta m_s t)\delta\phi_s\right]$
4	$\pm\lvert A_{\parallel}\rvert\lvert A_{\perp}\rvert\left[e^{-\Gamma t}\sin(\delta_{\perp}-\delta_{\parallel}-\Delta m_s t) \pm \frac{1}{2}[e^{-\Gamma_H t} - e^{-\Gamma_L t}]\cos(\delta_{\perp}-\delta_{\parallel})\delta\phi_s\right]$
5	$\lvert A_0\rvert\lvert A_{\parallel}\rvert\cos\delta_{\parallel}\left[e^{-\Gamma_L t} \mp e^{-\Gamma t}\sin(\Delta m_s t)\delta\phi_s\right]$
6	$\pm\lvert A_0\rvert\lvert A_{\perp}\rvert\left[e^{-\Gamma t}\sin(\delta_{\perp}-\Delta m_s t) \pm \frac{1}{2}[e^{-\Gamma_H t} - e^{-\Gamma_L t}]\cos(\delta_{\perp})\delta\phi_s\right]$

- Decay dominated by a single amplitude
- Untagged time-dependent analysis measure lifetime different between CP even and CP odd states
- Give eventually access to CKM angles (ϕ_s)
- Give access to $\Delta\Gamma$s

Atwood Soni grid

- Atwood and Soni (hep-ex/010683) proposed a method based on the study of angular correlation in pure penguin decays (third column) compared to a tree-penguin decays which can give γ (b→s transitions) or α (b→d transitions)

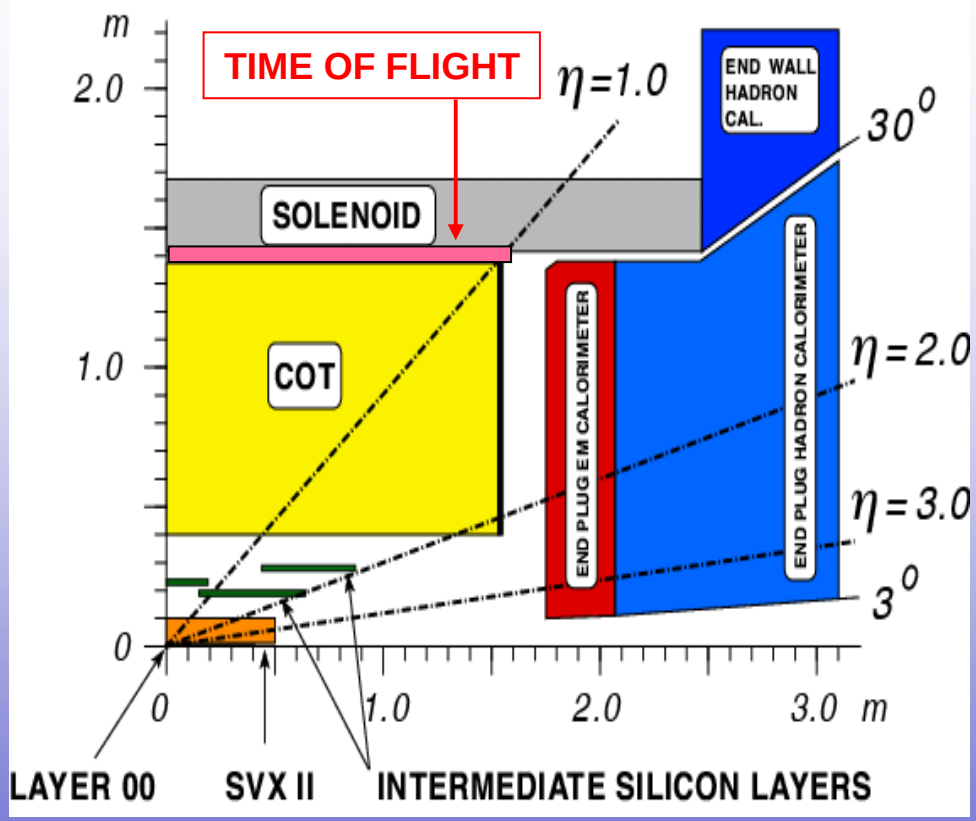
The underlined modes have a color suppressed EWP contribution; the modes enclosed in parentheses have color allowed tree contributions while the modes enclosed in square brackets have π^0 free final states.

B-meson	α-mode	γ-mode	Pure Penguin
B^+	$(\rho^+\omega)$	$[(K^{*+}\rho^0)]$, $(K^{*+}\omega)$	$[\phi K^{*+}]$, $\underline{K^{*0}\rho^+}$
B^0	$(\underline{\rho^+\rho^-})$, $[\rho^0\rho^0]$, $\omega\omega$, $\rho^0\omega$	$(\underline{K^{*+}\rho^-})$	$[K^{*0}\phi]$
B_s	$[K^{*0}\rho^0]$, $(\underline{K^{*+}\rho^-})$, $K^{*0}\omega$	see note [16]	$[\phi\phi]$, $[\underline{K^{*0}K^{*0}}]$

Many of the interesting decay color suppressed !

- Easy analysis → do not need tagging!
- A lot of useful modes are accessible to CDF/SVT, probably CDF can be successful with high luminosity
- Bs modes can give additional constraint to the $B_{d,u}$ modes available at B-factories

Quadrant of CDF II Tracker



TOF: 100ps resolution, 2 sigma K/π separation for tracks below 1.6 GeV/c (significant improvement of B_s flavor tag effectiveness)

COT: large radius (1.4 m) Drift C.

- 96 layers, 200ns drift time
- Precise P_T above 400 MeV/c
- Precise 3D tracking in $|\eta|<1$

$\sigma(1/P_T) \sim 0.1\%\text{GeV}^{-1}$; $\sigma(\text{hit}) \sim 150\mu m$

- dE/dx info provides >1.3 sigma K/π separation above 2 GeV

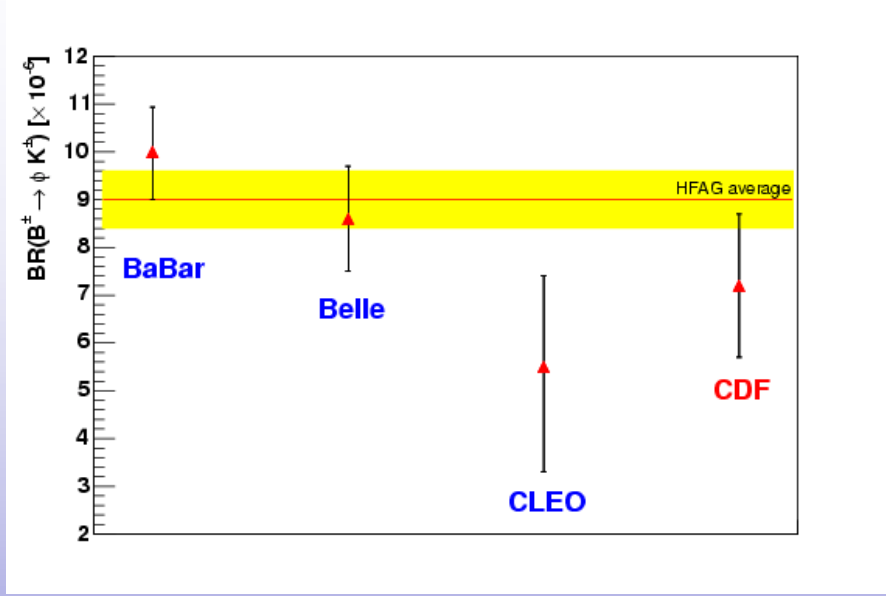
SVX-II + ISL: 6 (7) layers of double-side silicon (3cm < R < 30cm)

- Standalone 3D tracking up to $|\eta|= 2$
- Very good I.P. resolution: ~30μm (~20 μm with Layer00)

LAYER 00: 1 layer of radiation-hard silicon at very small radius (1.5 cm) (expected 50 fs proper time resolution in $B_s \rightarrow D_s \pi$)

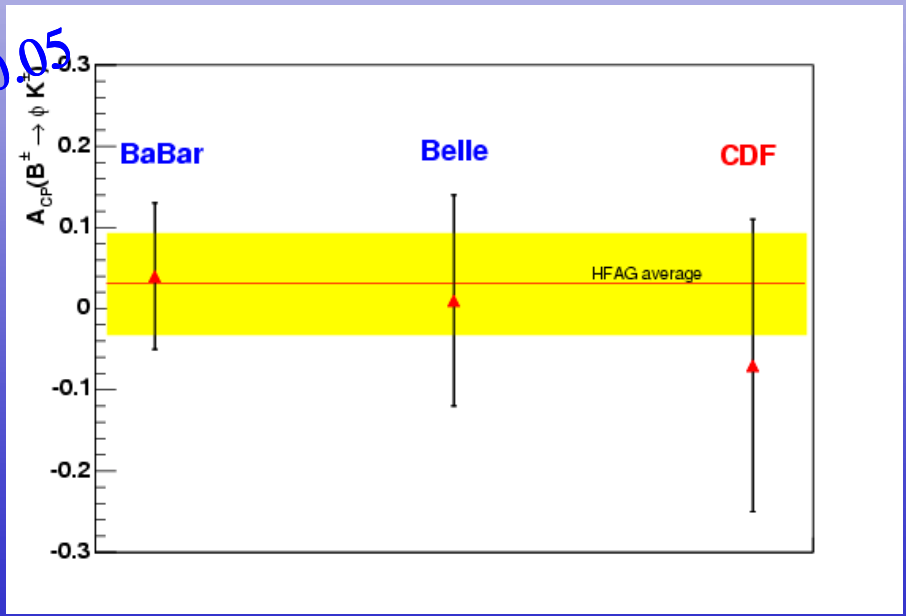
$B^{\pm} \rightarrow \varphi K^{\pm}$ Results

Fit Results		
	$B^{\pm} \rightarrow J/\Psi K^{\pm}$	$B^{\pm} \rightarrow \varphi K^{\pm}$
N_B	439 ± 22	47.0 ± 8.4
A_{CP}	0.046 ± 0.050	-0.07 ± 0.17

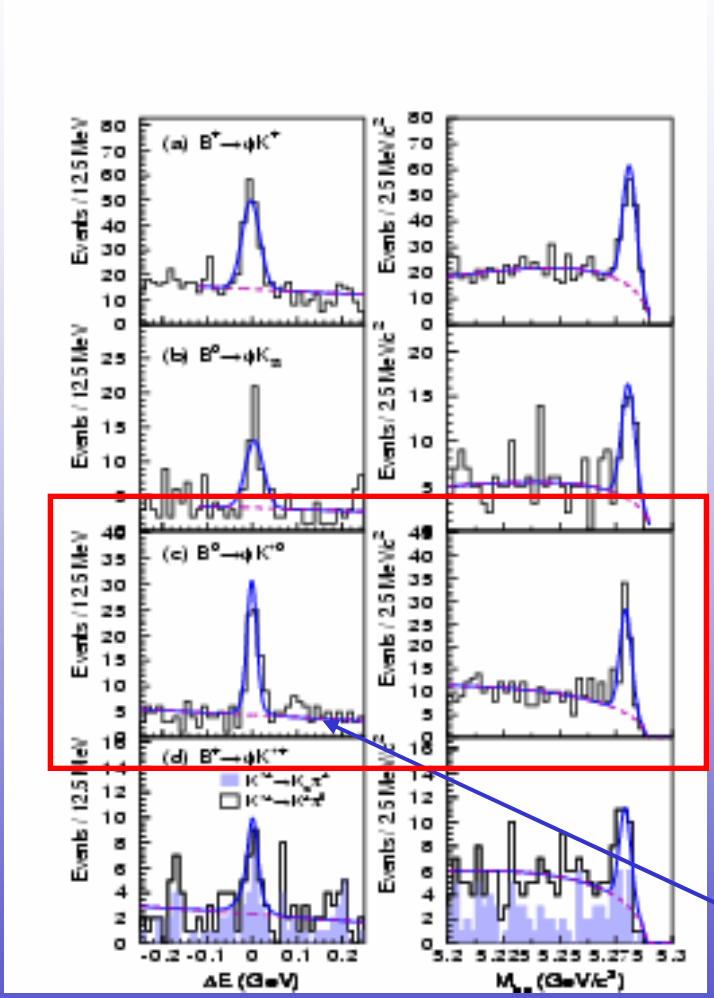


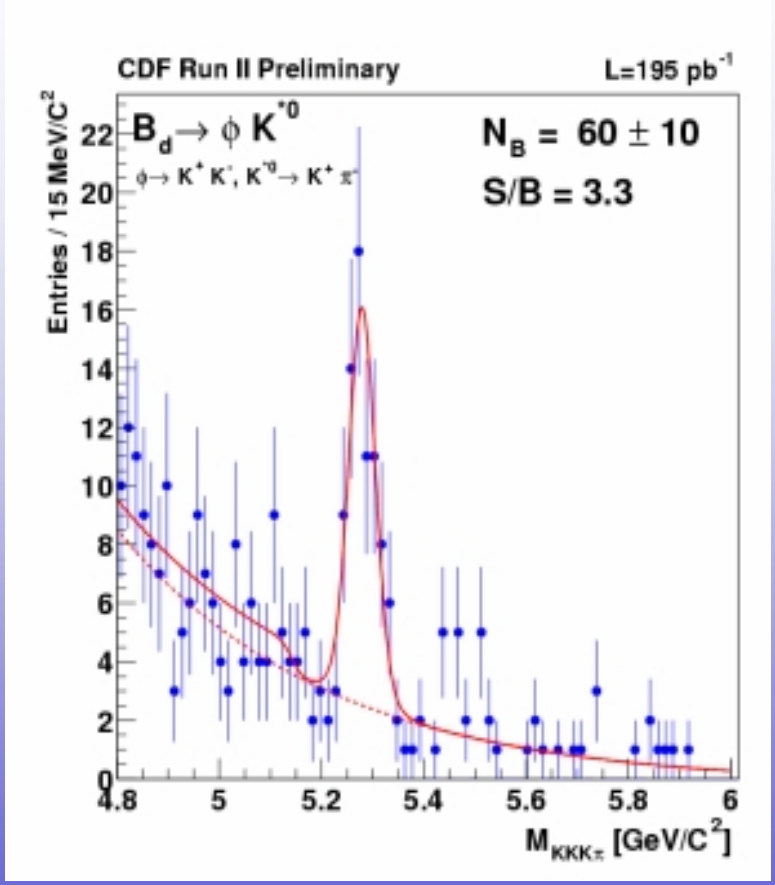
Normalize yield to $B^{\pm} \rightarrow J/\Psi K^{\pm}$ to measure BR

Experiment	BR	ACP
CLEO	5.5+2.1-1.8 ±0.06	---
Babar	10.0+0.9-0.8± 0.5	~~0.04 ± 0.09 ± 0.01~~ 0.05 ± 0.05
Belle	8.6± 0.8 ± 0.7	0.01 ± 0.12 ± 0.05
CDF	7.2 ± 1.3 ± 0.7	-0.07 ± 0.17+0.06-0.05



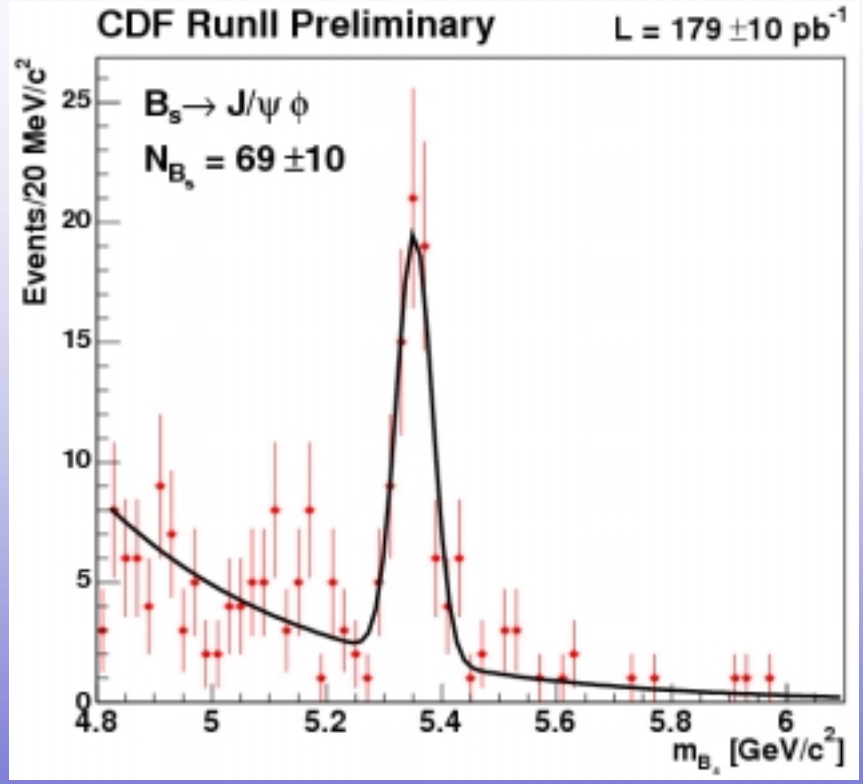
$B_d \rightarrow \phi K^{*0}$ comparision

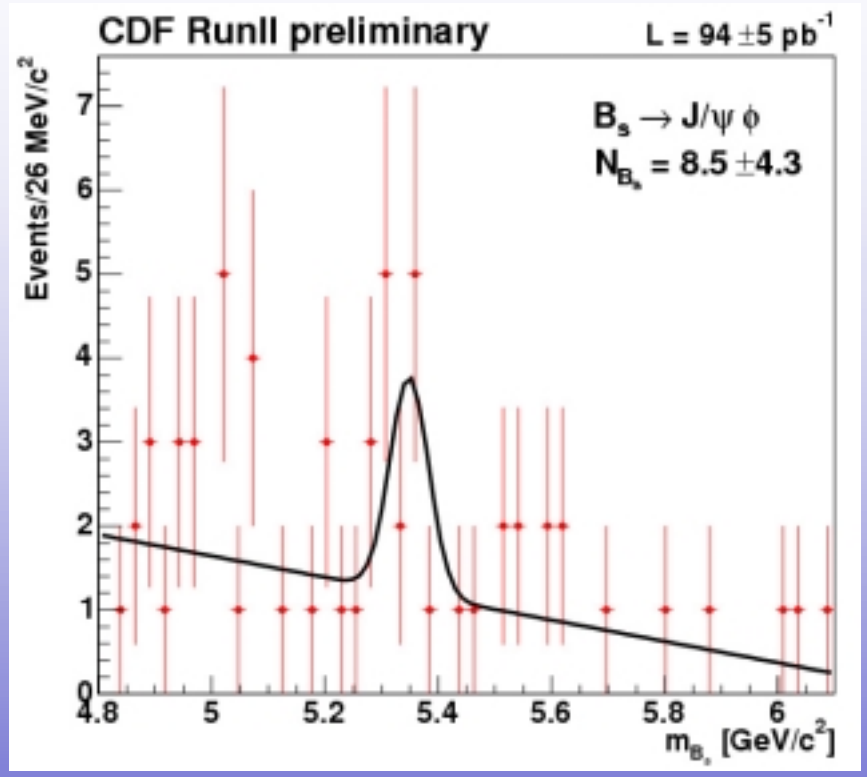




- Belle hep-ex/0307014 (80 fb^{-1}) → 59 events

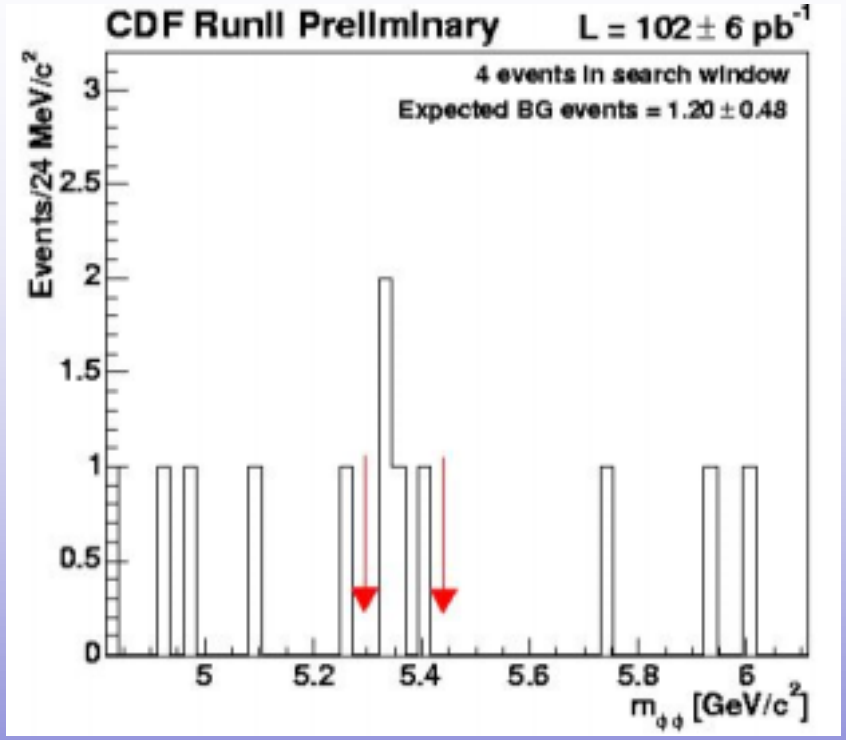
$B_s \rightarrow J/\psi\ \phi$ yields

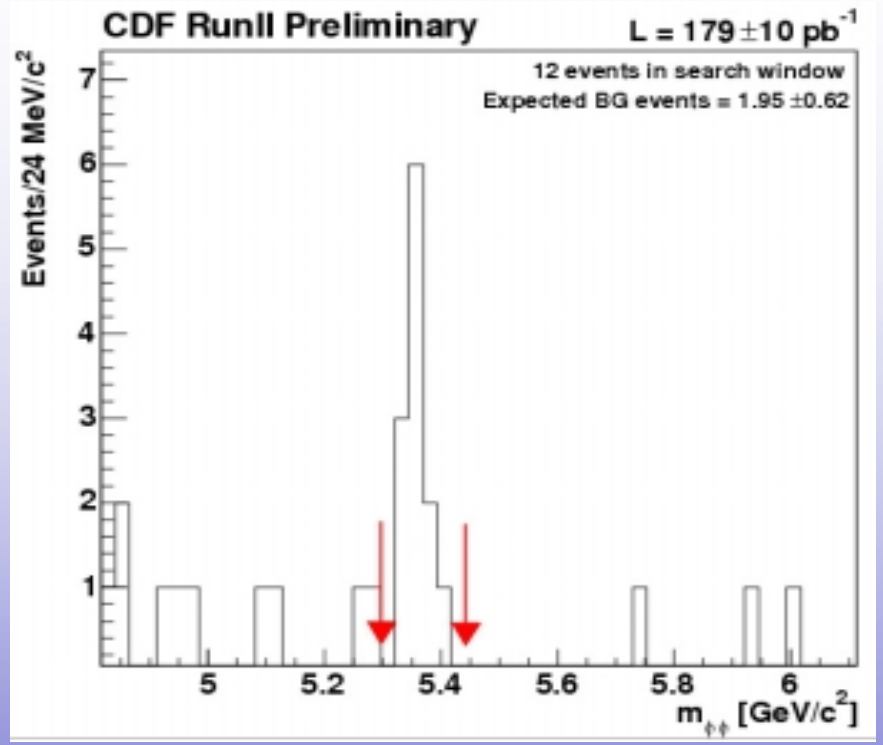




B_s mass spectrum fitted with a gaussian for the signal and an exponential model for the background. Systematic coming from the fit is taken into account

$B_s \rightarrow \phi\phi$ events adding the lowpt



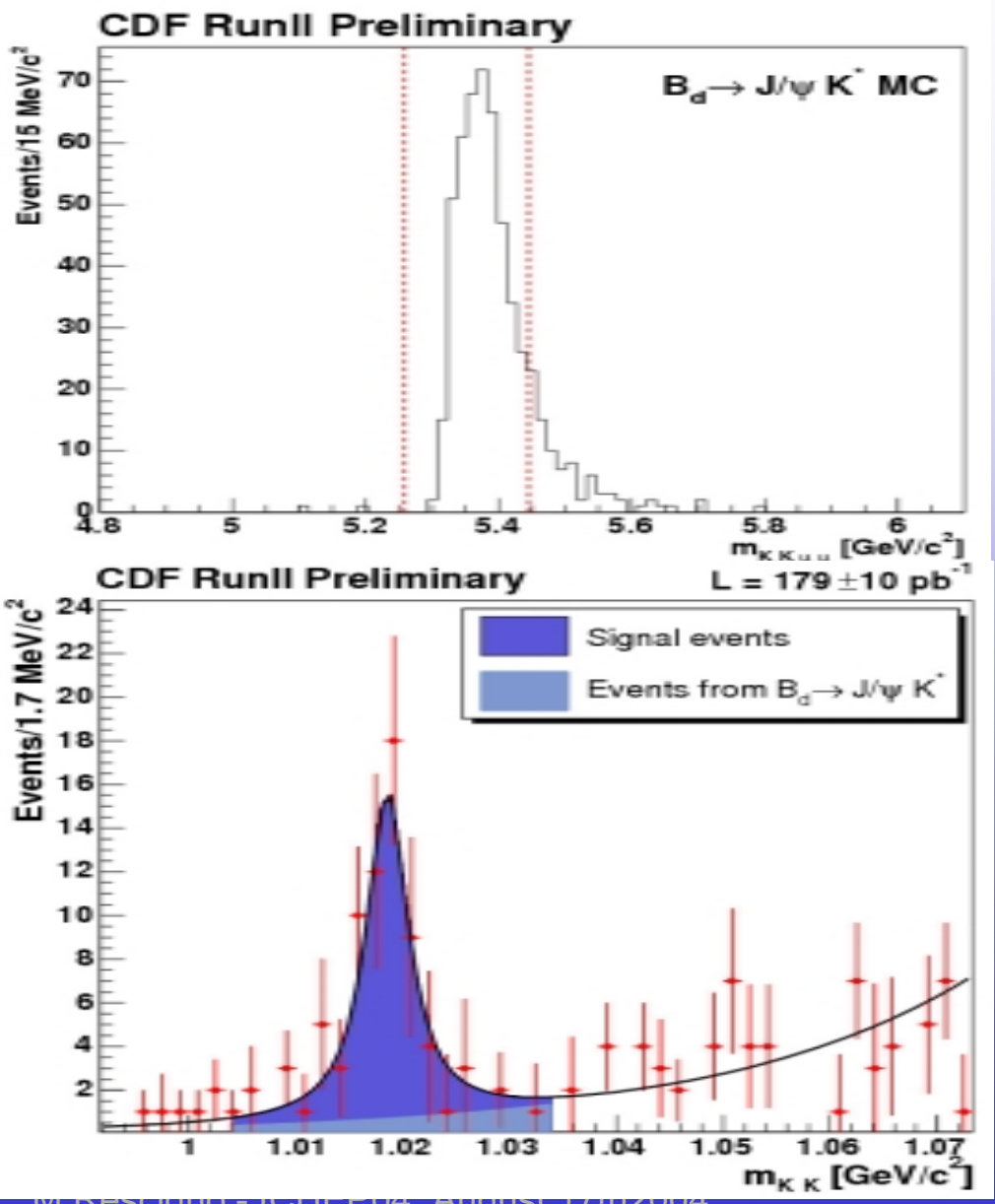


- **We can combine the significances of the Scenario A and LowPt exclusive samples to obtain the total significance of the B_s! $\phi\phi$ signal:**

$$\sigma_{tot} = \sigma_{ScA} * \sigma_{LowPt} * (1 - \log(\sigma_{ScA} * \sigma_{LowPt}))$$

The result σ_{tot} = 4.8 σ is very close to the standard 5σ criteria to claim for an observation and it can anyway be considered more than a strong evidence

Backgrounds



- Due to the large width of K* and to its close mass value to m_ϕ we get in our B_s signal window a reflection from B_d! $J/\psi K^*$ for B_s! $J/\psi\ \phi$ and from B_d! ϕK^* for B_s!$\phi\phi$
- We get an estimate of this contribution by evaluating from MC the efficiency of recostructing a B_d! $J/\psi K^*$ event as B_s! $J/\psi\ \phi$ and from the measured BRs and f_s/f_d
- As a cross-check we can evaluate the contribution from the sidebands substracted mass spectrum of the ϕ meson, in which the only remaining source of background comes from the B_d! $J/\psi K^*$ reflection that doesn't enter the B_s sidebands region