Exclusive B decays to η_c K: $\eta_c \to 4K\ (\Phi\Phi)$

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- Published results
- Events selection
- PID optimization
- Background studies
- Predicted sensitivity & conclusions

Literature

Cleo 2000 (based on L=9.13 fb^{-1}) : f f

Channel	Efficiency	Yield
$B^{+/-} \rightarrow \eta_c K^{+/-}$ / $\eta_c \rightarrow \phi\phi$	22.0 %	1.4+1.7-1.0
$B^0 \rightarrow \eta_c K^0$ / $\eta_c \rightarrow \phi\phi$	6.0%(18.1%)*	1.0+1.4-0.7

Efficiency includes K0 branching fractions to K0s -> $\pi+\pi-$
In brackets selection efficiency is derived*

No published results on not-resonant 4k

Belle : no results on any of the 4 prongs decay ...yet

Branching Ratios (PDG 2000)

Channel	BR(10^{-3})	Topological BR (10^{-3})
η_c -> K+K+K-K-	$21 \pm 10 \pm 6$	21 ± 12
η_c -> $\Phi\Phi$	7.1 ± 2.8	($\Phi \rightarrow$ K+K-) 1.7 ± 0.6

The (inclusive) BR to 4K is based on a single (indirect) measurement by Argus (Albrecht et al.,1994)

Event Selection

The analysis is still blind.
We are performing an inclusive search ($4K + \Phi\Phi$) and an exclusive $\Phi\Phi$ search.

Simple cut&count method:

- choose a set of discriminating variables by comparing signal and background shapes
- optimize S/Sqrt(S+B) on the basis of MC
- Cross-check background predictions using data (sidebands)

Selection cuts for charged and neutral B

Common cuts to B0 and B+/-:

1. Tag : ExclToEtac4Prongs and Bcounting
2. Signal Box (|DeltaE| < 45 Mev, |MBes-MBpdg| < 8 MeV)
3. PID K from eta_c: 3 Ktight, 1 NotAPion (NN)
4. η_c Mass: +-70 MeV from PDG value
5. R2 < 0.35
6. Cos Thrust B-rest < 1-R2

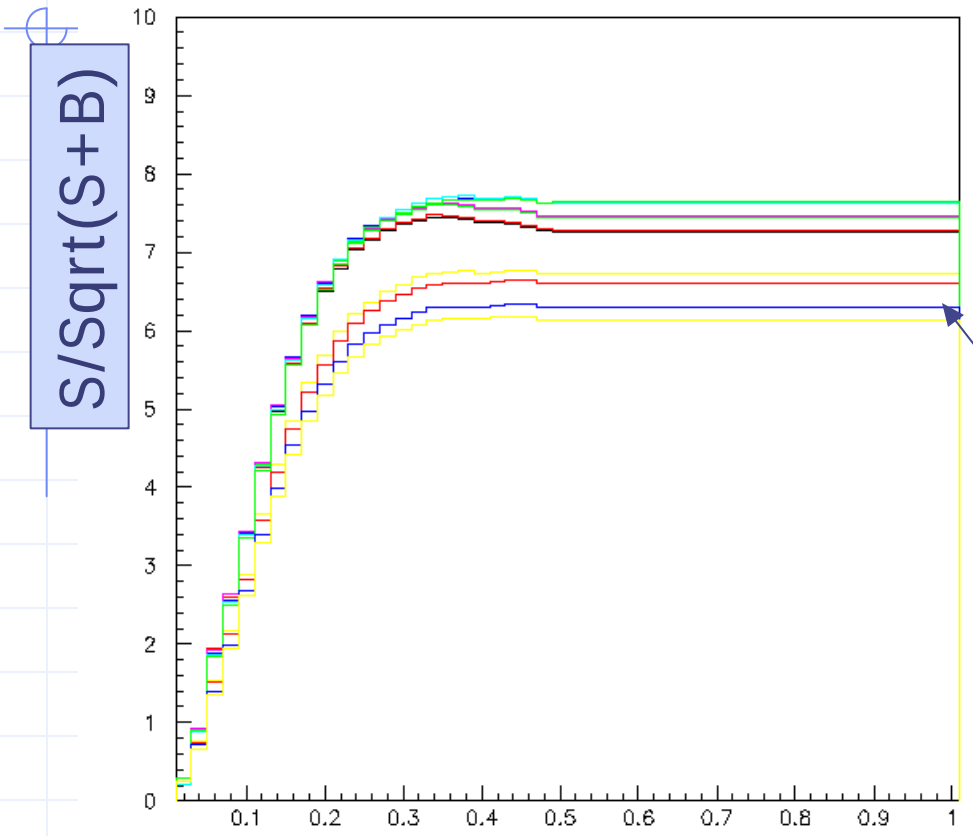
Charged B:

- PID fast K : KVeryLoose (NN)

Neutral B:

- Ks Mass: +- 10 MeV from PDG center value
- Cos θ (p Ks – flight direction) > 0.999

PID vs R2 optimization: S/SQRT(S+B)



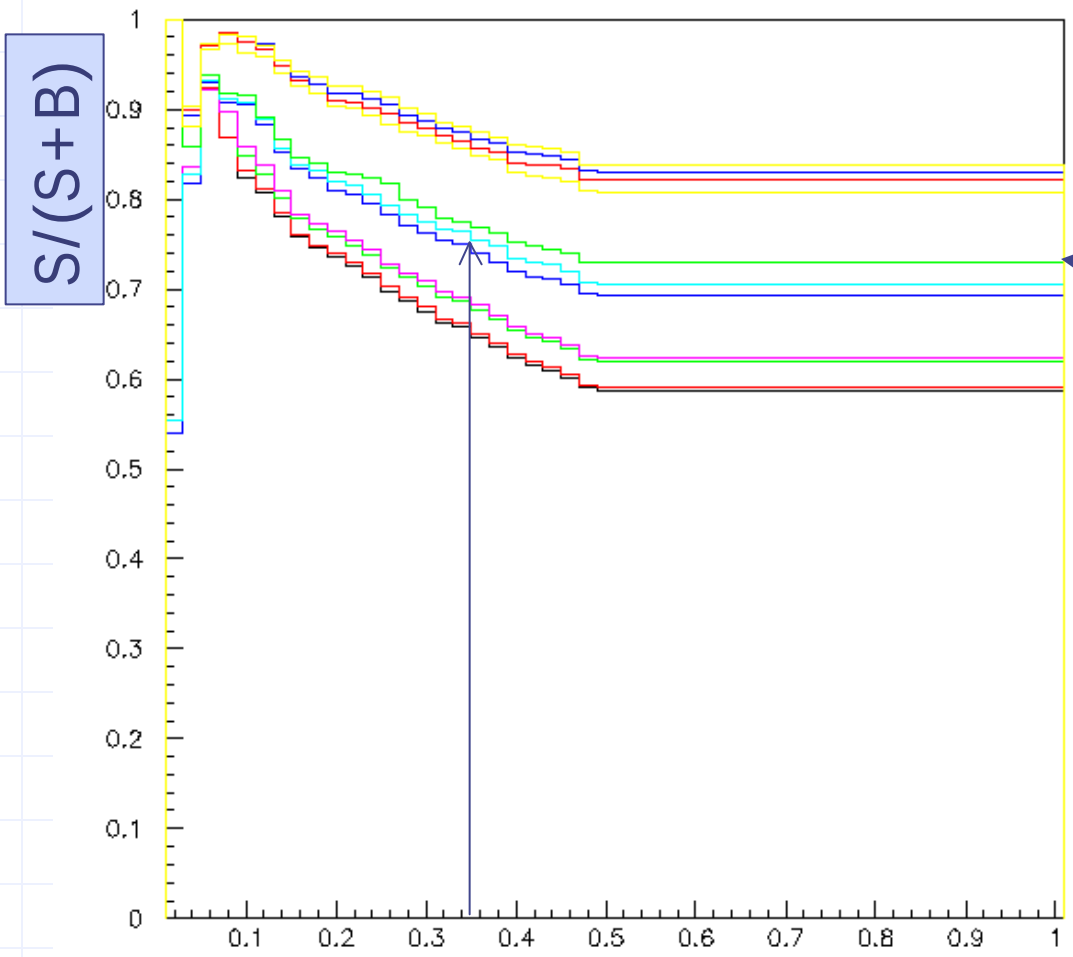
10 different PID Combinations are plotted:
Best =
3 positive kid + 1NotApi (NN selectors)

4 positive identified Kaons : 4VL, L, T,VT

R2 upper limit cut

Do we need shape cuts?

PID/R2 Optimization: Purity



4 positive id kaons

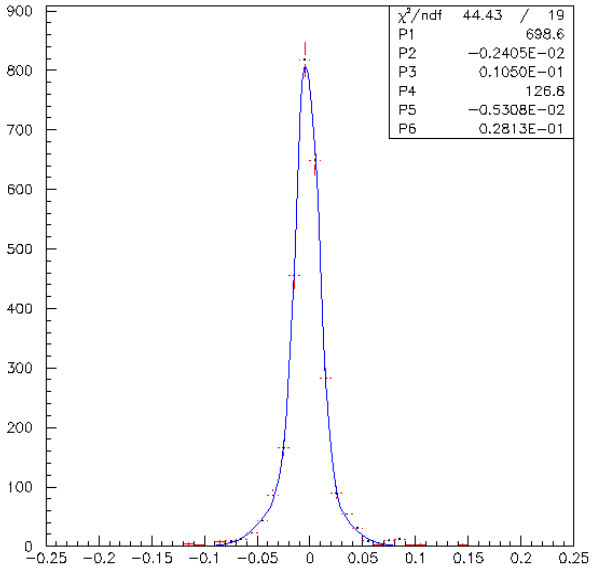
3Tight 1 NotAPi

R2 upper limit cut

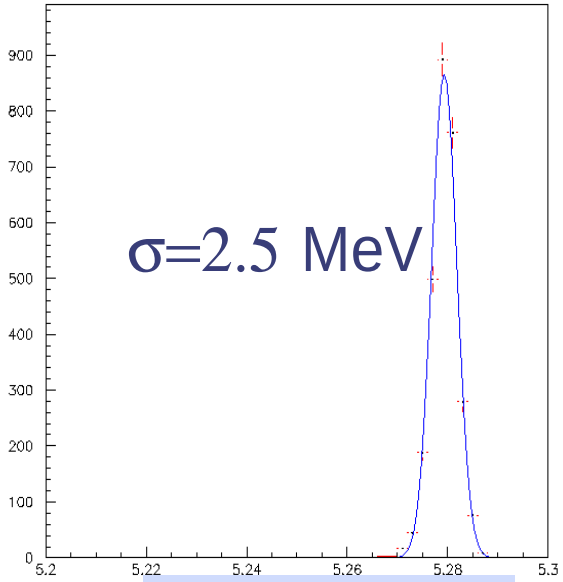
R2 <0.35 would
Not increase significance
But improves purity

MC Signal: DeltaE and MBes resolution after cuts

All reconstructed decays – Long DeltaE tails
mainly due to η_c reconstructed from tracks satisfying VeryLoose only requirements.
However requiring GTL would reduce the reconstruction efficiency by a factor ~2



DeltaE (GeV)



MBes (GeV)

Efficiency (raw MC) – signal charged B-

	S 20.7 fb-1	e (%)
Tag	107	30.8
Signal box	94	27.0
PID	84	21.7
PID (fast kaon)	71	20.5
Mass EtaC	71	20.4
R2	67	19.3
Cosq(T-B)	56	16.3
Best DeltaE	56	16.1

4.8 $\Phi\Phi$ are selected by these criteria ($\varepsilon = 16.7\%$)

Efficiency (raw MC) - signal neutral B -

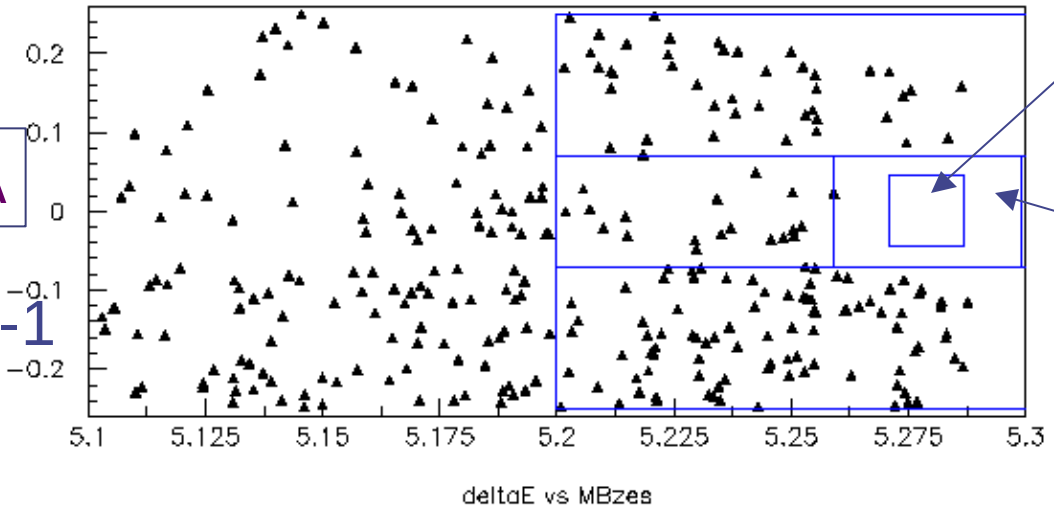
	S	e (%)
Tag	33	27.8
Signal box	28	23.8
Ks Mass	27	23.1
Cos q F-p	27	22.4
PID	22	18.3
EtaC Mass	22	18.2
R2	21	17.4
Cosq(T-B)	18	14.8
Best DeltaE	17.4	14.6

1.6 $\Phi\Phi$ are selected by these criteria ($\varepsilon = 16.3\%$)

DeltaE vs MBes : Charged B

DATA

L=20.7 fb-1

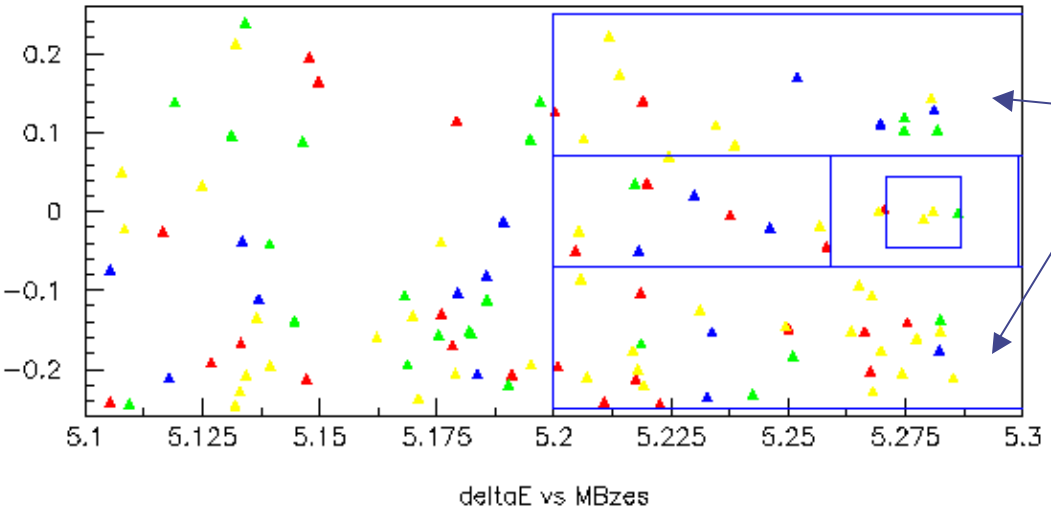


Signal region

Blind region

MC

L ~8 fb-1



Sidebands

Uds

Ccbar

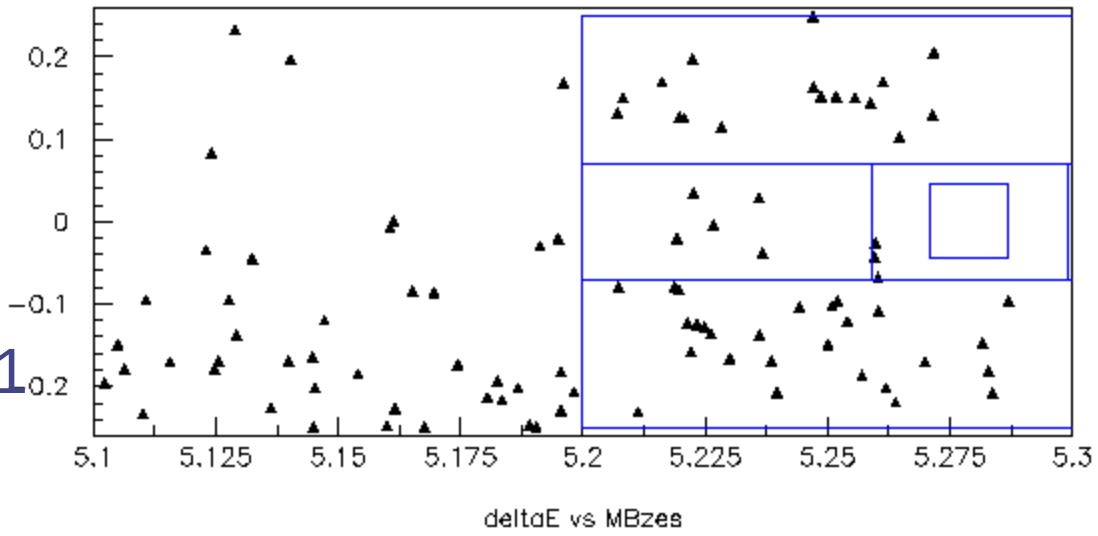
B0B0bar

B-B-

DeltaE vs MBes: Neutral B

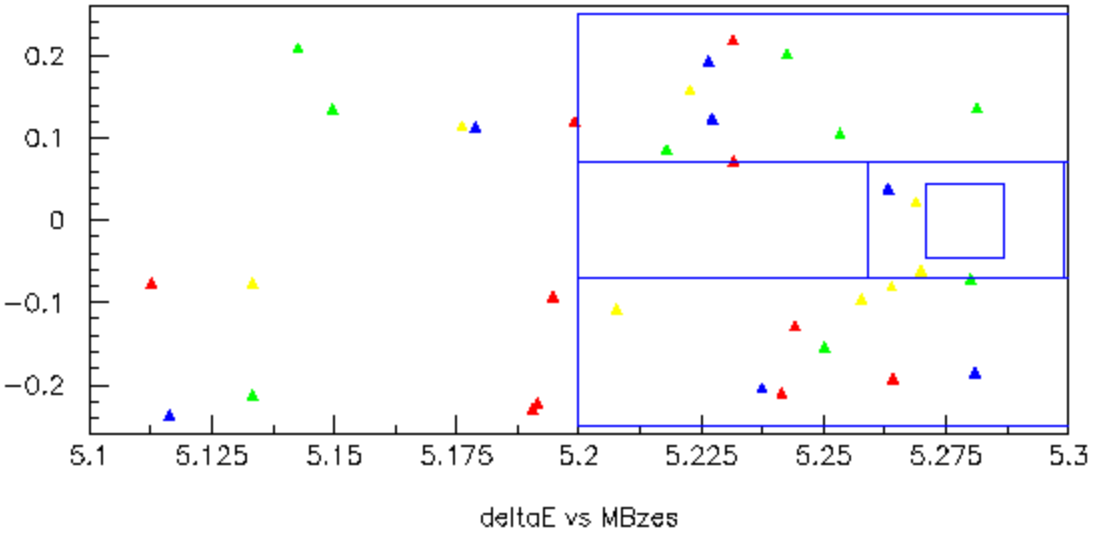
DATA

L=20.7 fb-1



MC

L ~8 fb-1



Uds

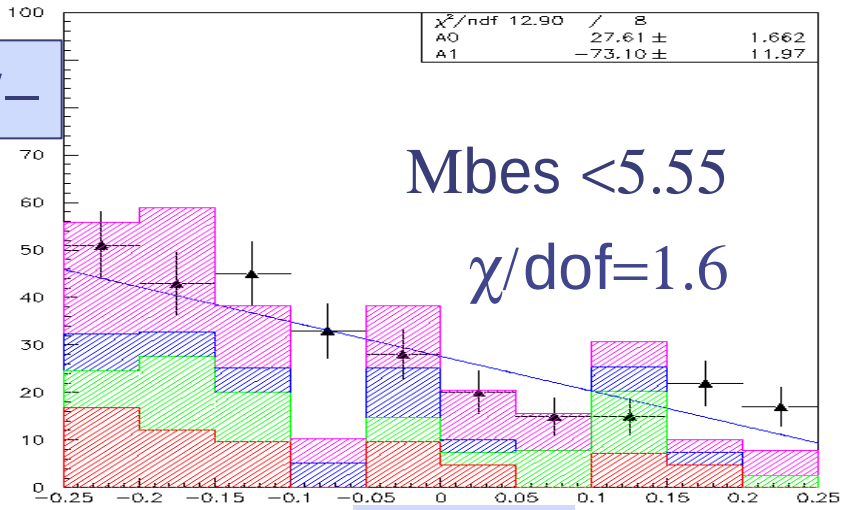
Ccbar

B0B0bar

B-B-

Background Estimation from Argus fit to sidebands
- on resonance DATA & MC -

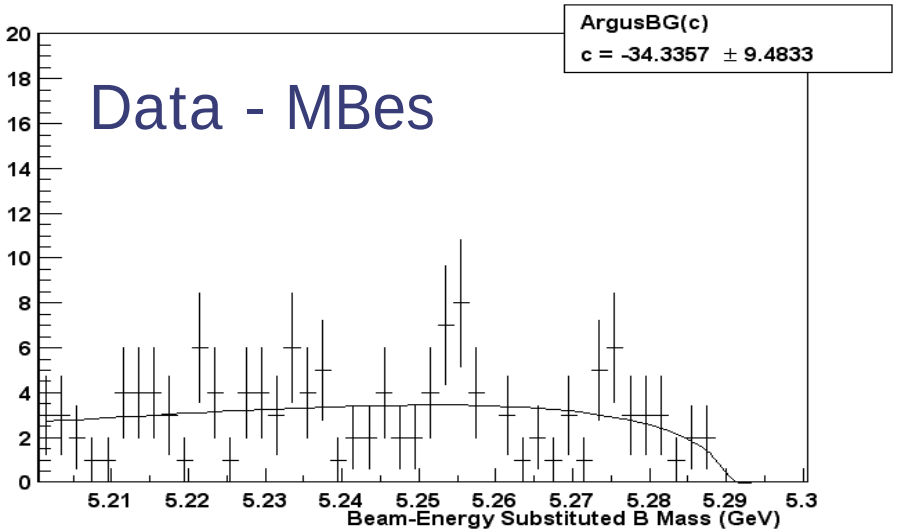
B+/−



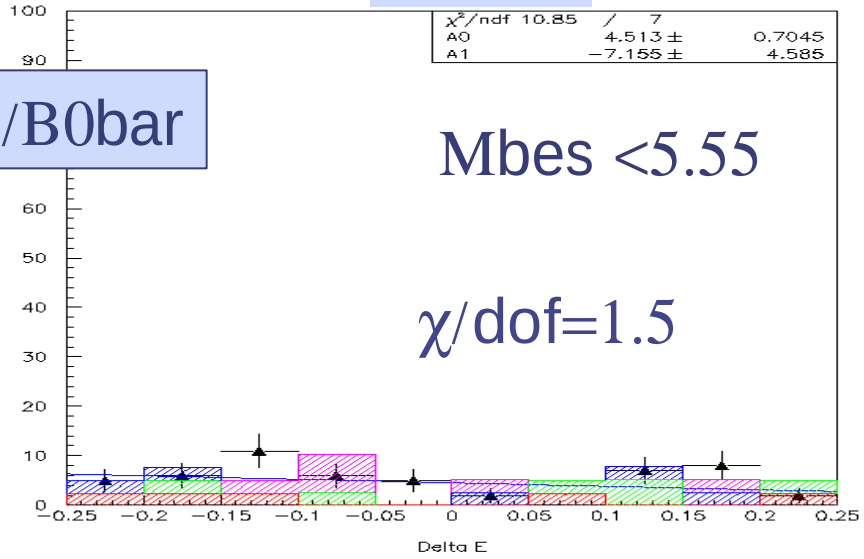
Mbes <5.55

χ/dof=1.6

DeltaE

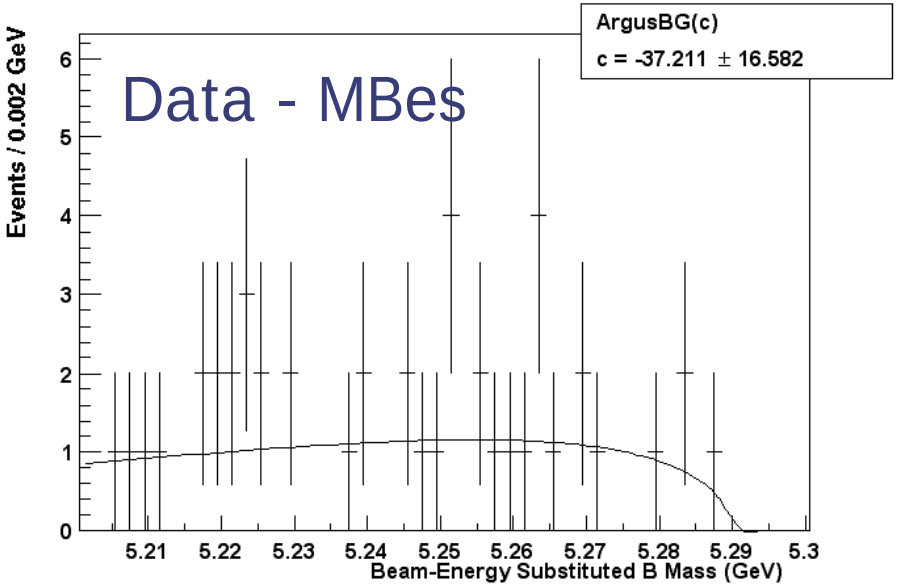


B0/B0bar



Mbes <5.55

χ/dof=1.5



Background composition: Extrapolation to signal region from sidebands

	ChargedB	Neutral B
uds	0.72(18%)	0.54(27%)
ccbar	0.78(20%)	0.65(32%)
B0B0bar	0.62(16%)	0.36(18%)
B+B-	1.76(45%)	0.45(22%)
All MC	**3.9 ± 0.5**	**2.0 ± 0.5**
Data	**4.8 ±0.45**	**1.6 ±0.4**

NO (!)Cross-feed from other 4-prongs decay of h_c

Generated channel	L (fb-1)	#events in signal box (B0)	#events In Sig (B+/-)
$2K2\pi$ Ks	3650	1	0
$2K2\pi K+$	1378	0	0
4πKs	5778	0	0
$4\pi K+$	2297	0	0

Background composition:
Extrapolation to signal band
(5.20 < MBes <5.255 GeV; |DeltaE |<0.45)
From Argus fit to sidebands (DATA)

	Expected	Found
Neutral	7 +- 1	5
Charged	21+- 3	19

Summary table of our present estimations

Channel	e(%)	S	B (data)	$\frac{S}{\sqrt{(S+B)}}$	S/B	S/(S+B)
4K K+/-	16.1	56 (4.8 ff)	4.8 ±0.5	7	10	91%
4K K0s	14.6	17.4 (1.6 ff)	1.6 ± 0.4	4	11	91%

Cuts have not been fully optimized for the exclusive ΦΦ search : at present exp. events ~S(4K)/10 and background compatible with 0

Conclusions

These η_c decay channels look very promising!
Background studies have started
MC expectations are in good agreement with data

A tighter cut on the Eta_c mass could further
Enhance purity and statistical significance of this sample
However, given the uncertainty on the Eta_c width
at present we prefer to keep it at a safe value
To check if we find the expected signal for charged B
and measure BR

Now we are eager...

To see it!