B-physics at DØ

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- B-physics program at DØ
- Upgraded detector
- Current analyses and first results
- Conclusions

B-factory at Hadron Collider

- **Huge amount of $b\bar{b}$ pairs produced:**

$$\begin{aligned} \sigma(p\bar{p} \to b\bar{b}) &= 150\mu\text{b (at 2 TeV)} \\ \sigma(e^+e^- \to Z^0 \to b\bar{b}) &= \textbf{7 nb} \\ \sigma(e^+e^- \to \Upsilon(4S) \to b\bar{b}) &= \textbf{1 nb} \end{aligned}$$

- **Contrary to $\Upsilon(4S)$ factory, all B-hadrons produced:**

$$B_u,\ B_d,\ B_s,\ \Lambda_b,\ B_c \text{ etc}$$

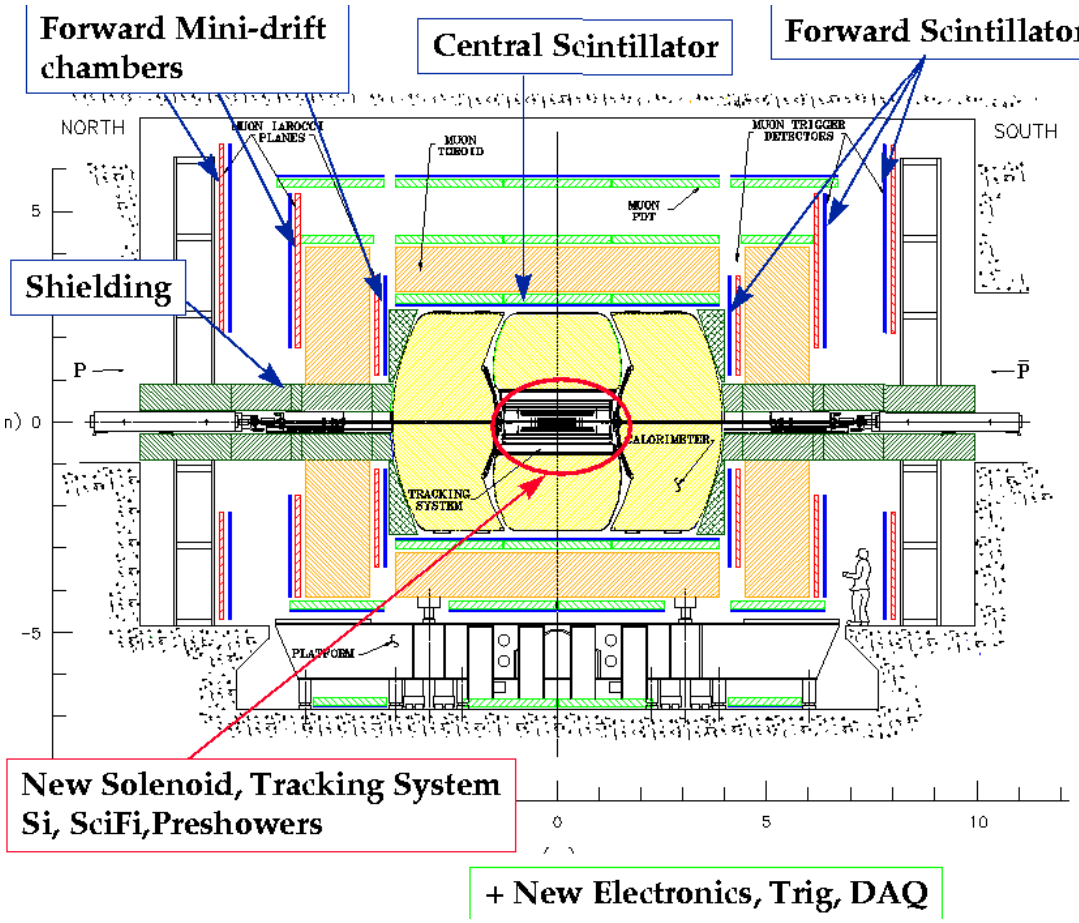
- **But much higher background ($\sigma_{tot} \simeq 75$ mb) requires more sophisticated selection of interesting events.**

Rich B-Physics Program

- **Discovery and study of new particles: B_c, Ξ_b, Ω_b ...**
- **B-hadron spectroscopy;**
- **precise measurement of lifetime and masses of B_u, B_d, B_s, Λ_b ...**
- **B_d and B_s mixing, $\Delta\Gamma_{B_s}$;**
- **CP Violation in B_d and B_s systems;**
- **Properties of B hadron decay;**

Hadron collider provides unique possibility for B-physics. Some of these measurements are possible only at hadron colliders, many other will significantly improve the precision.

Upgraded DØ detector



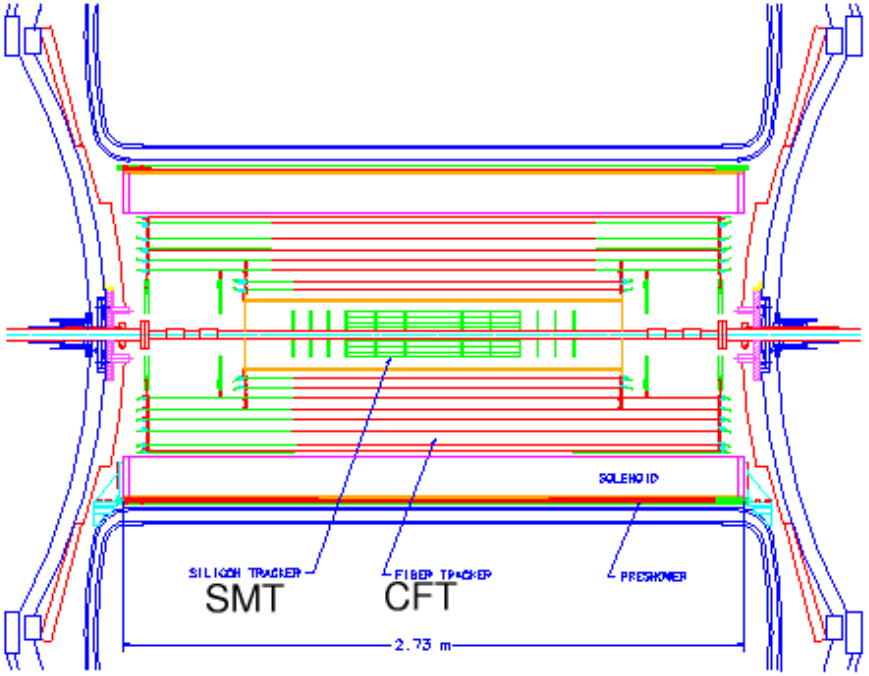
New in Run II:

- **Solenoid**
- **Si + fiber Tracker**
- **Preshower**
- **Forward muon system**
- **Enhanced trigger system**
- **New electronics, DAQ**

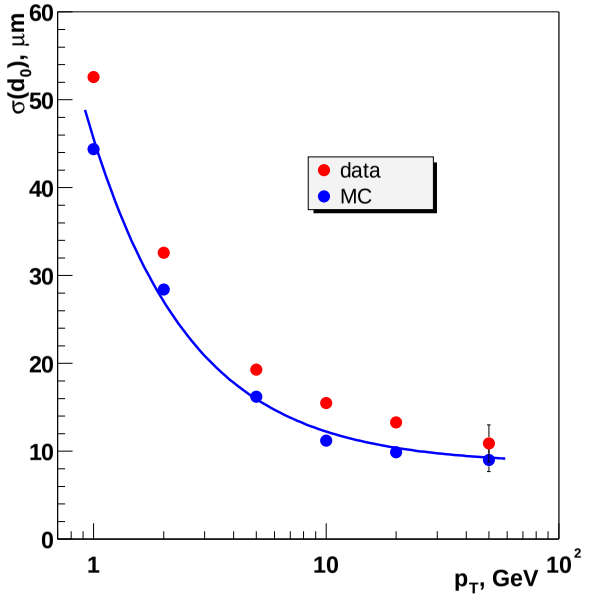
Tracking system adds new capabilities and transforms DØ into qualitatively new experiment

DØ Tracking System

Precise charged track measurement is essential for B-physics. DØ tracking includes 16 layers (axial + stereo) of fiber tracker (CFT), 8 layers of silicon microstrip tracker (SMT) and 16 silicon discs, which improve precision for forward tracks.



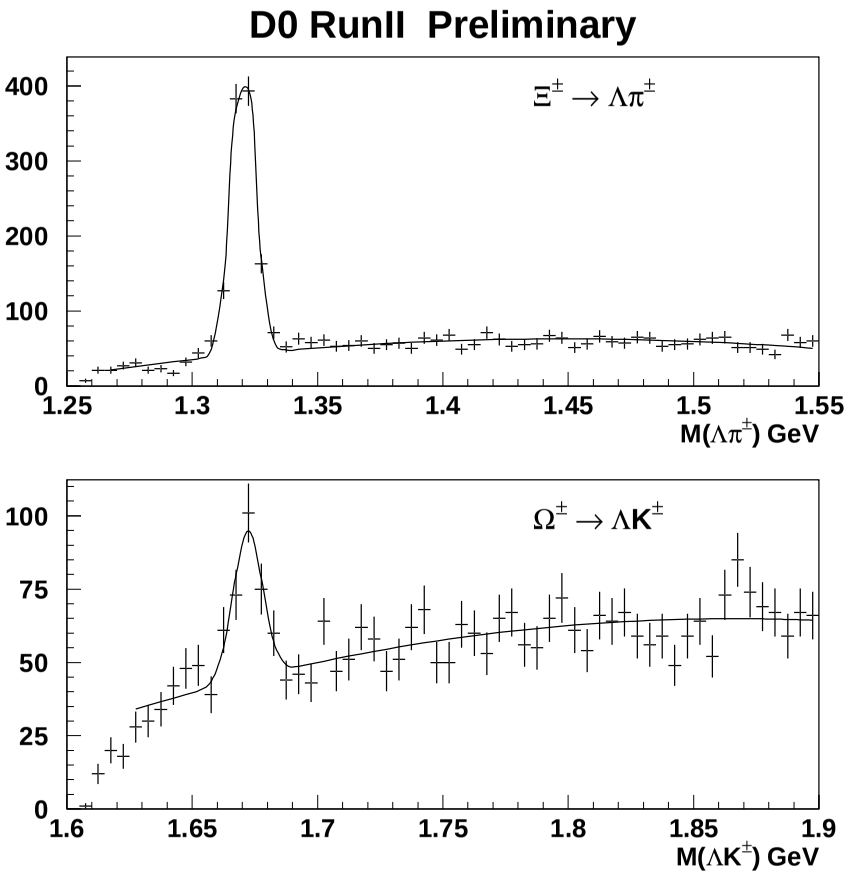
Impact parameter resolution



Although small in size, DØ tracking system shows good performance, adequate for B physics studies, in a wide η acceptance ($|\eta| < 3.5$).

DØ Track reconstruction

- **Decay products of B hadrons have small momentum: $p_t \sim 1$ GeV/c.**
- **Reconstruction of $\Xi^{\pm}$ and $\Omega^{\pm}$ illustrates our capabilities to find soft tracks with high efficiency and small fake rate.**
- **Their observation opens exciting possibilities for B-hyperon physics in DØ .**

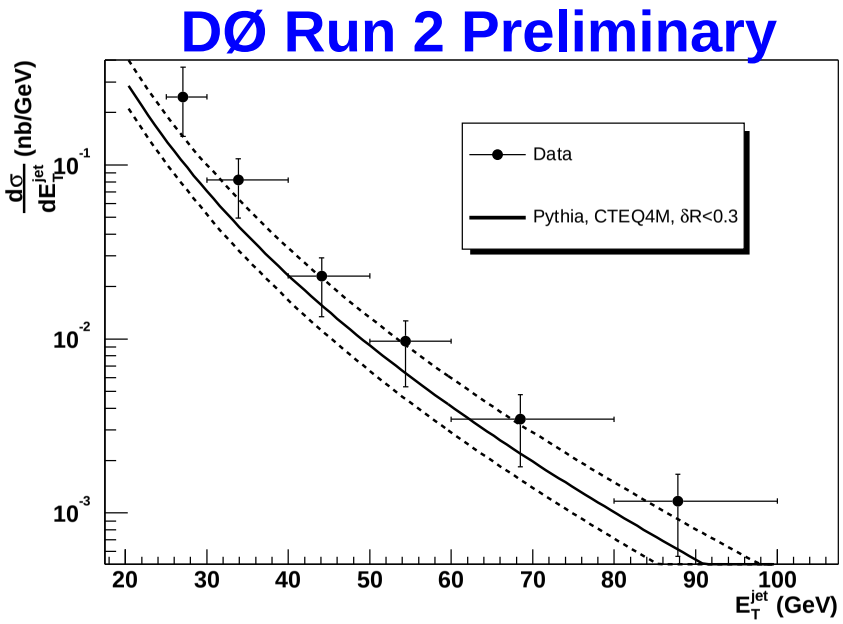


Trigger

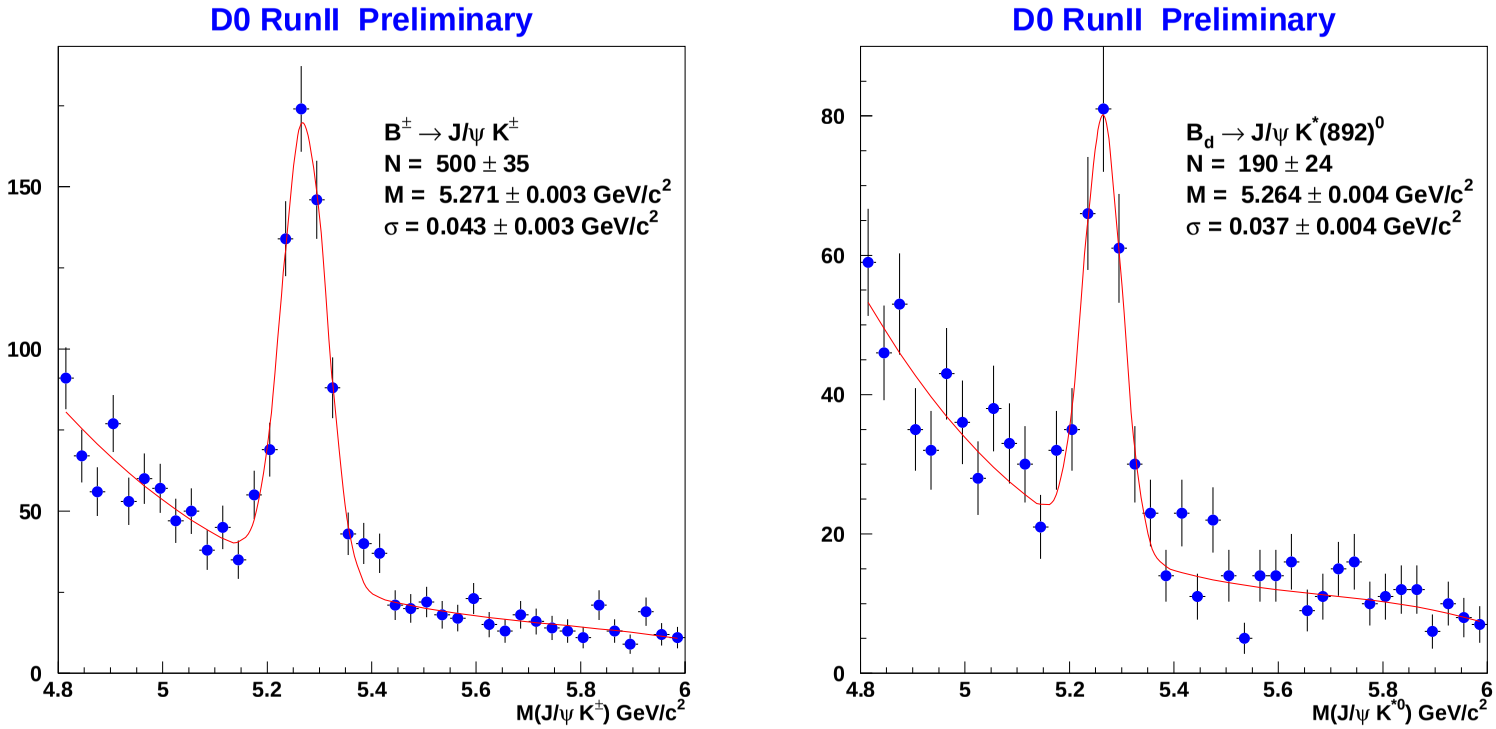
- **Trigger is the crucial part of experiment at hadron collider.**
- **2.5 MHz crossing rate have to be reduced to 50 Hz writing to disk (250 KBytes/event).**
- **Triggers for B-physics so far include identified muons:**
  - **single muon trigger;**
  - **dimuon trigger;**
  - **large muon acceptance $|\eta| < 2$;**
  - **$p_t > (2 - 3.5)$ GeV/c depending on η;**
- **recently added:**
  - **track match to μ trigger;**
- **coming soon:**
  - **impact parameter trigger;**

Current DØ Analyses: B-jet cross section

- **Basic measurement for B-physics;**
- **Important for understanding the quark dynamics and tuning theoretical models;**
- **Small data set used (3.4 pb^{-1});**
- **Our result is 2-3 times higher than predictions;**
- **New result is consistent with Run I measurement;**
- **Main systematic error: jet energy scale uncertainty;**



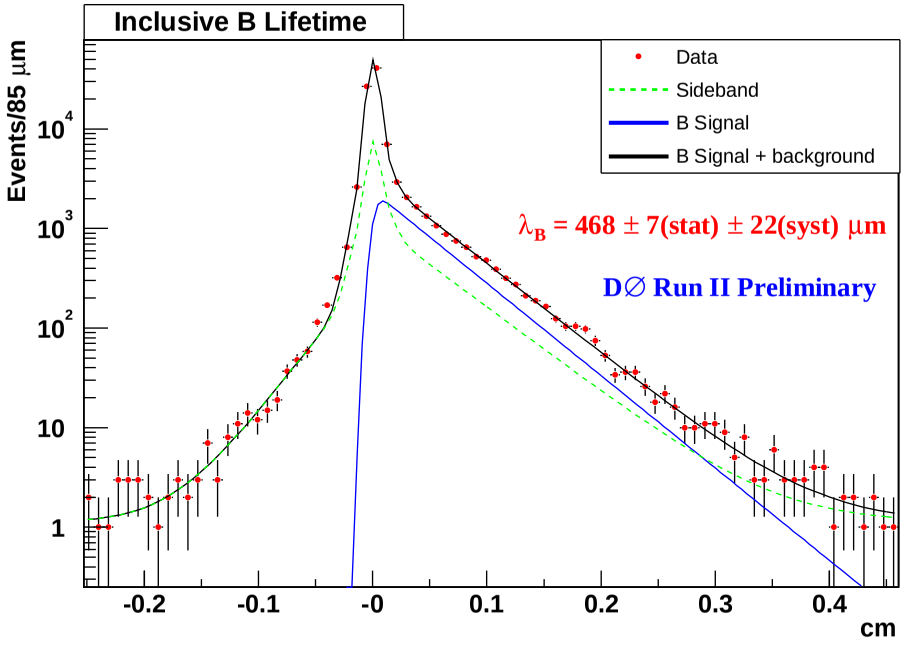
Exclusive B decays with J/ψ

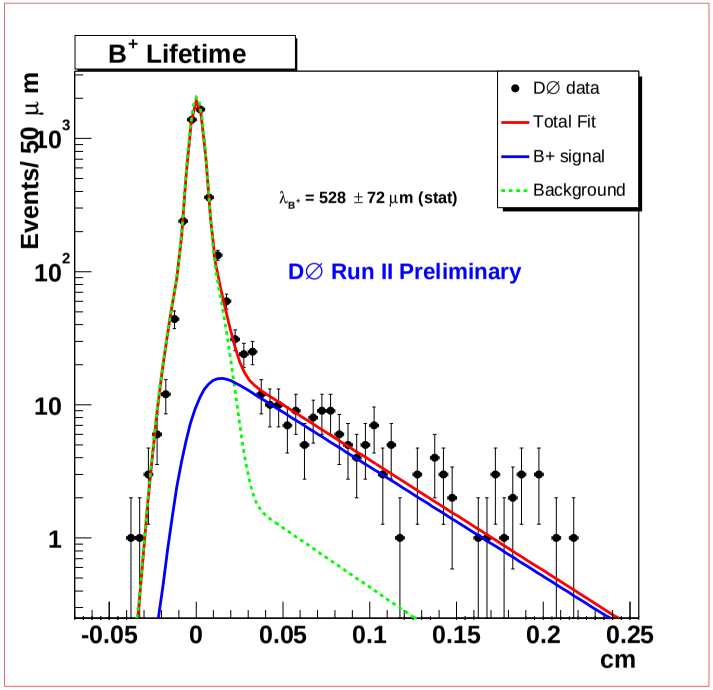


- **~ 50 pb^{-1} of data analysed;**
- **~ 110K $J/\psi \to \mu^+\mu^-$ selected;**
- **Good reconstruction rate in all studied channels;**
- **Use these channels to measure B lifetimes and B_d oscillation;**

B Lifetime Measurement

- **DØ measures both inclusive B lifetime (from total J/ψ sample) and exclusive B^+ lifetime (from $B^{\pm} \to J/\psi K^{\pm}$).**
- **Both results agree with world average, although errors are still large.**
- **Inclusive B lifetime: $\tau_B = 1.561 \pm 0.024 \pm 0.074$ ps**
- **Exclusive $B^{\pm}$ lifetime: $\tau_B = 1.76 \pm 0.24$ ps**





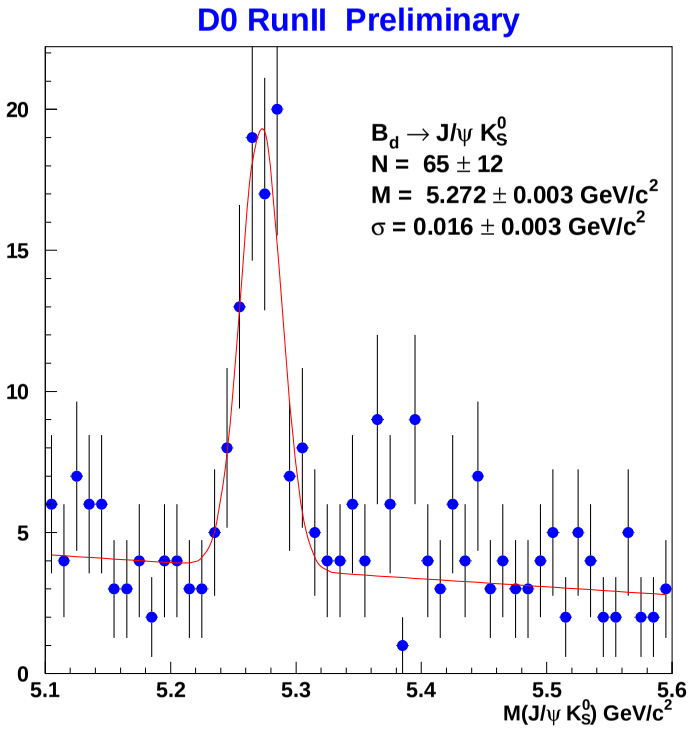
Mixing of B hadrons

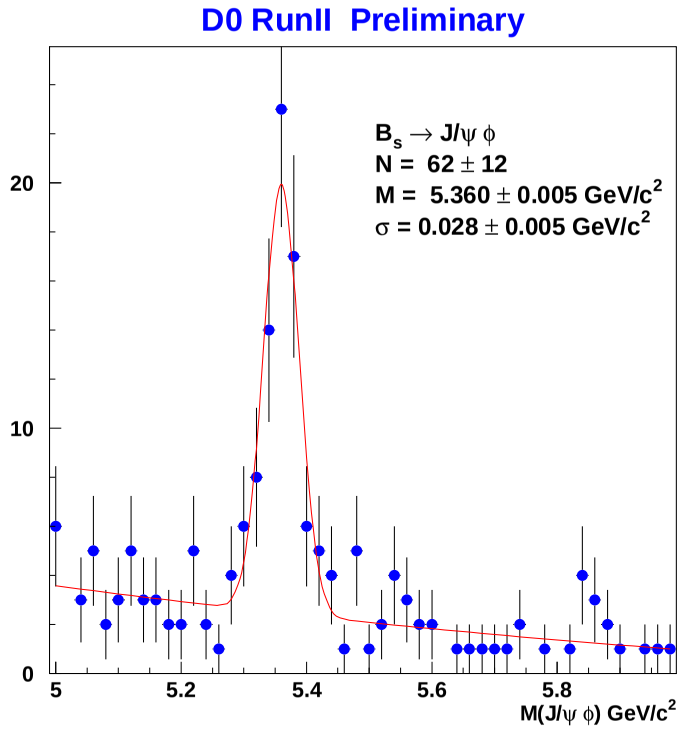
- **To measure mixing of B_d and B_s the initial state of B-hadron should be determined (B flavour tagging).**
- **Currently DØ develops 2 methods of B flavour tagging:**
  - **Jet charge tagging;**
  - **Opposite muon tagging;**
- **Performance of both methods, measured in $B^{\pm} \to J/\psi K^{\pm}$ sample, is close to expected from simulation.**

	Jet Charge	**Opposite Muon**
efficiency (ϵ)	$55 \pm 4\%$	$8 \pm 2\%$
dilution (D)	$21 \pm 11\%$	$64 \pm 30\%$
ϵD^2	$2.4 \pm 1.7\%$	$3.3 \pm 1.8\%$

CP Violation in B hadron decays

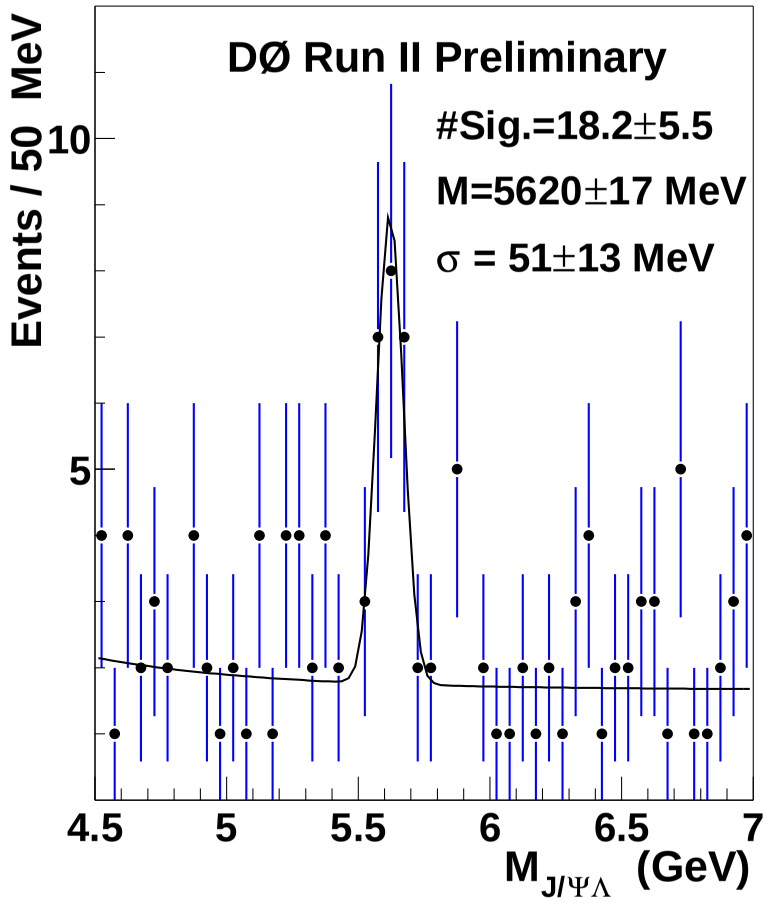
- **DØ is able to reconstruct "golden" channels for CP violation measurements: $B_d \to J/\psi K_s^0$ and $B_s \to J/\psi\phi$.**
- **High statistics measurements with B_s possible only at hadron colliders.**





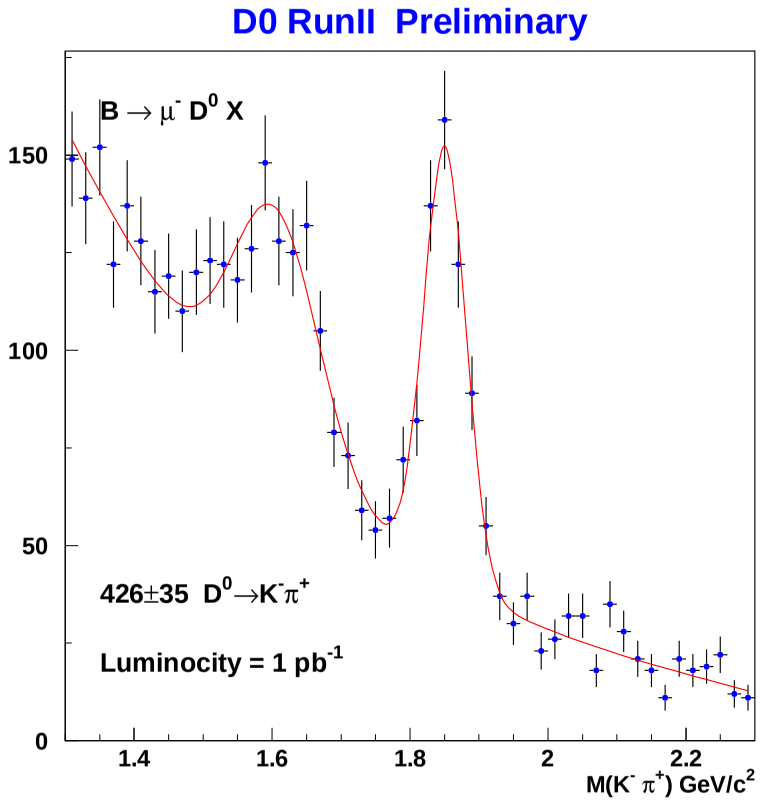
B-baryons studies started

Λ_b is reconstructed in $J/\psi\Lambda$ decay mode. This sample will be used to measure the lifetime and mass of Λ_b.



Semileptonic B decays: first look

- **Single muon trigger works!**
- **Abundance of semileptonic B-decays in DØ .**



- **Other decay channels to follow:**
  - $B \to \mu D^* X$;
  - $B \to \mu D^{\pm} X$;
  - $B \to \mu D_s X$.
- **Excellent possibilities for different B measurements.**
- **Strong source of B hadrons for different technical studies: b-tagging, trigger, flavour tagging etc...**

Conclusions

- **DØ experiment is newcomer in B-physics - just one year ago our tracking system became fully instrumented;**
- **Some time is required to understand and tune our detector;**
- **First preliminary studies show excellent capabilities of DØ in B physics;**
- **We are moving fast - already now we are able to reconstruct almost all important B decays with high rate;**
- **Significant improvements in our trigger, tracking and event selection, resulting in even better overall performance, are expected soon;**
- **Main directions of our study at this stage: properties of B-hadrons in exclusive and semi-exclusive decays involving muons.**