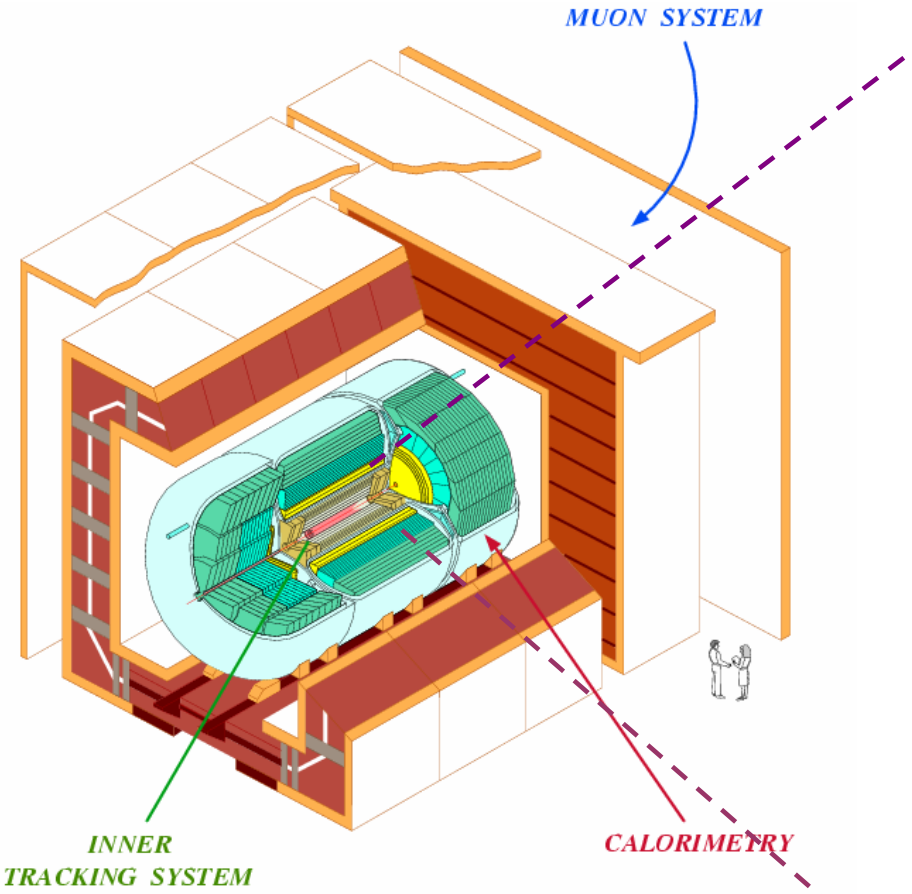
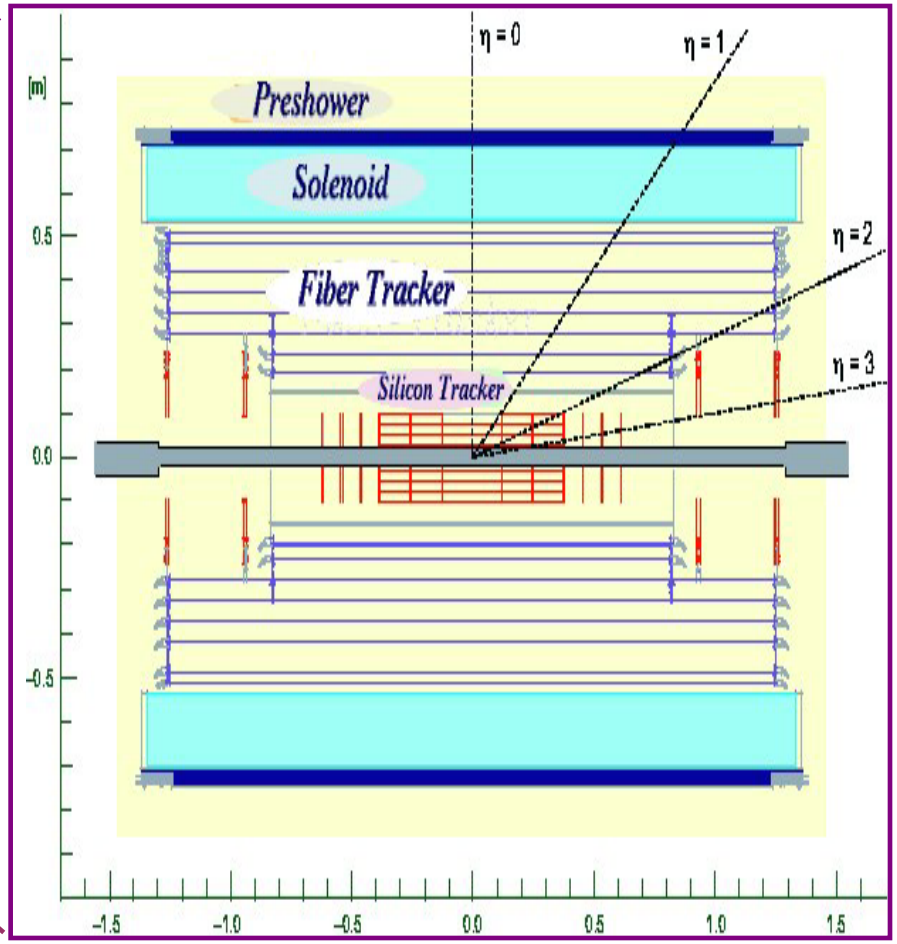
Observation of semileptonic B decays into orbitally excited D final states

Sudhir Malik

for
The D0 Collaboration

The DØ Detector





Observation of B → μ ν D** X

- D** are orbitally excited D meson states
- In heavy quark limit
  - Two narrow states (decay via D-wave)
  - Two broad states(decay via S-wave)
- Search for narrow states of D** via
  - $D^0_1(2420) \rightarrow D^{*+} \pi^-$
  - $D^{*0}_2(2460) \rightarrow D^{*+} \pi^-$

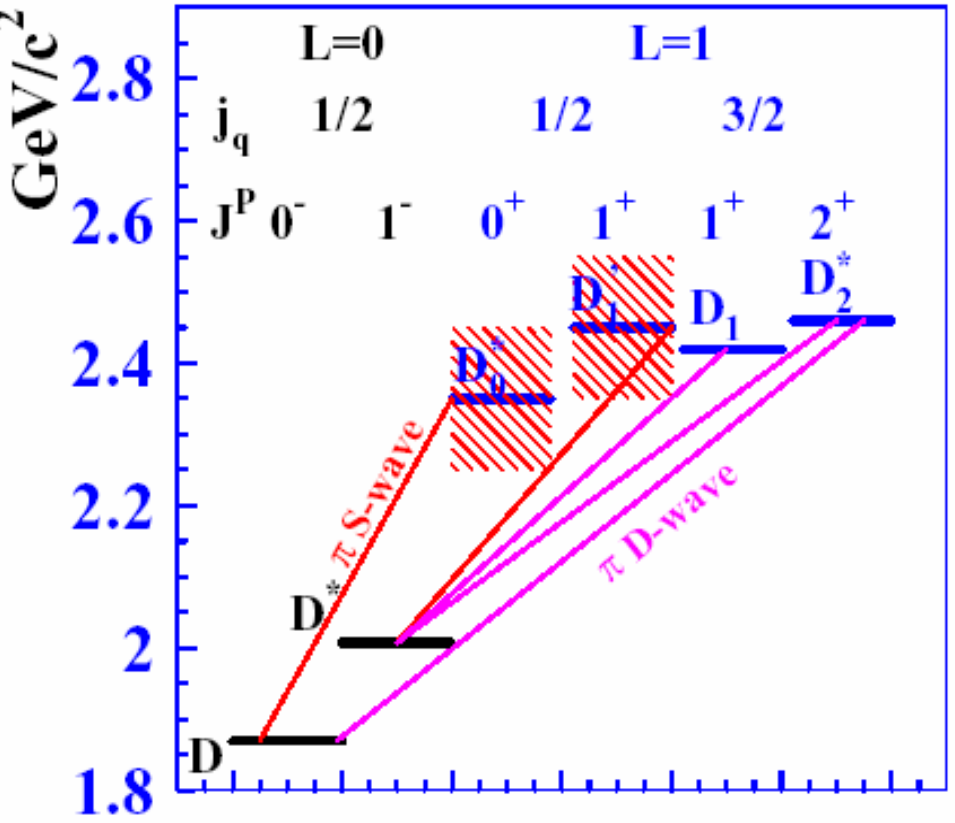
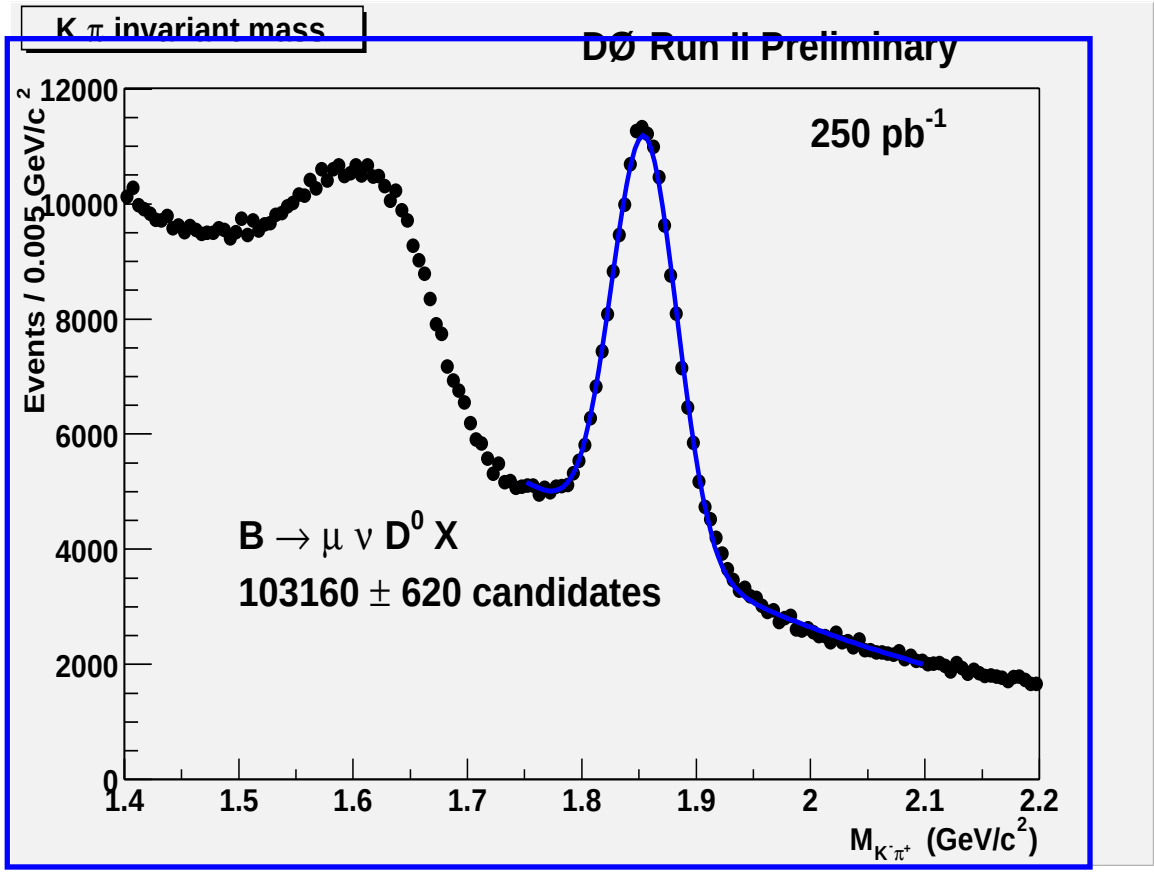


Figure from Belle, hep-ex/0307021

D^0 sample

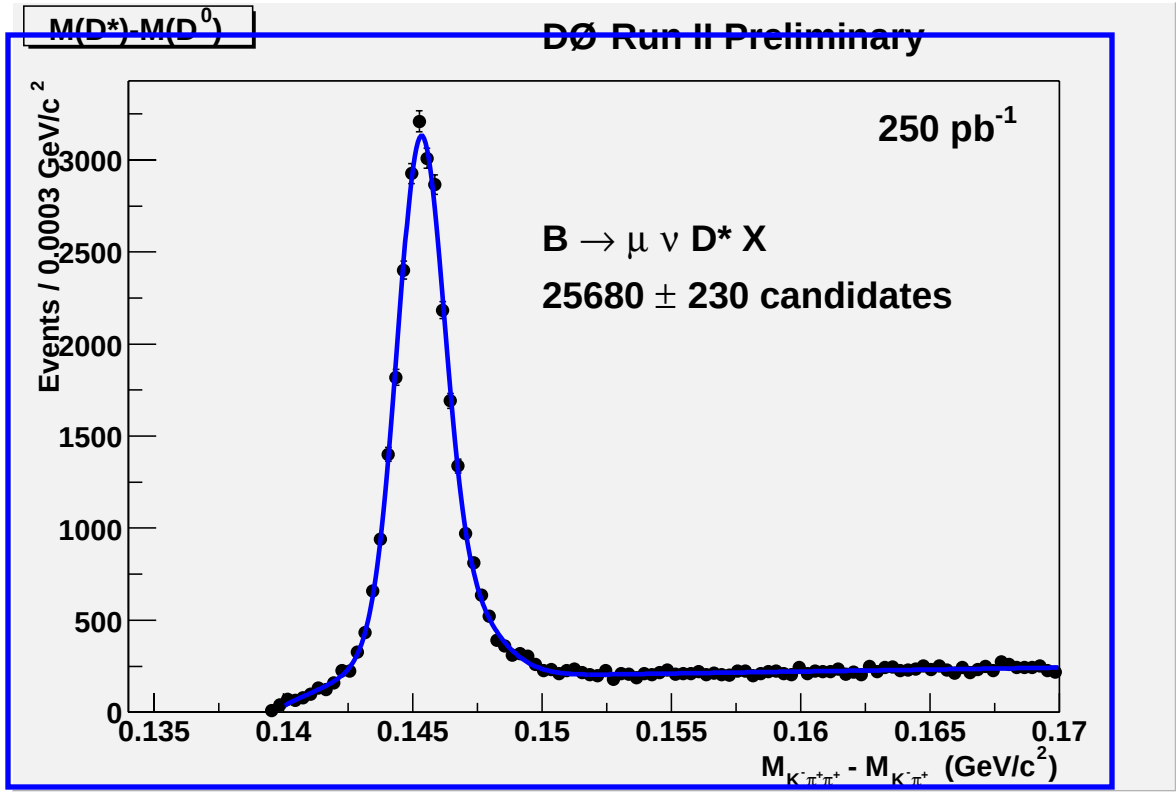
- D_1^0 and D_2^{*0} observed in several experiments
- DØ is studying D_1^0 and D_2^{*0} in B semileptonic decays
- Start with $B \rightarrow \mu\ D^0\ X$

  $\hookrightarrow K\pi$



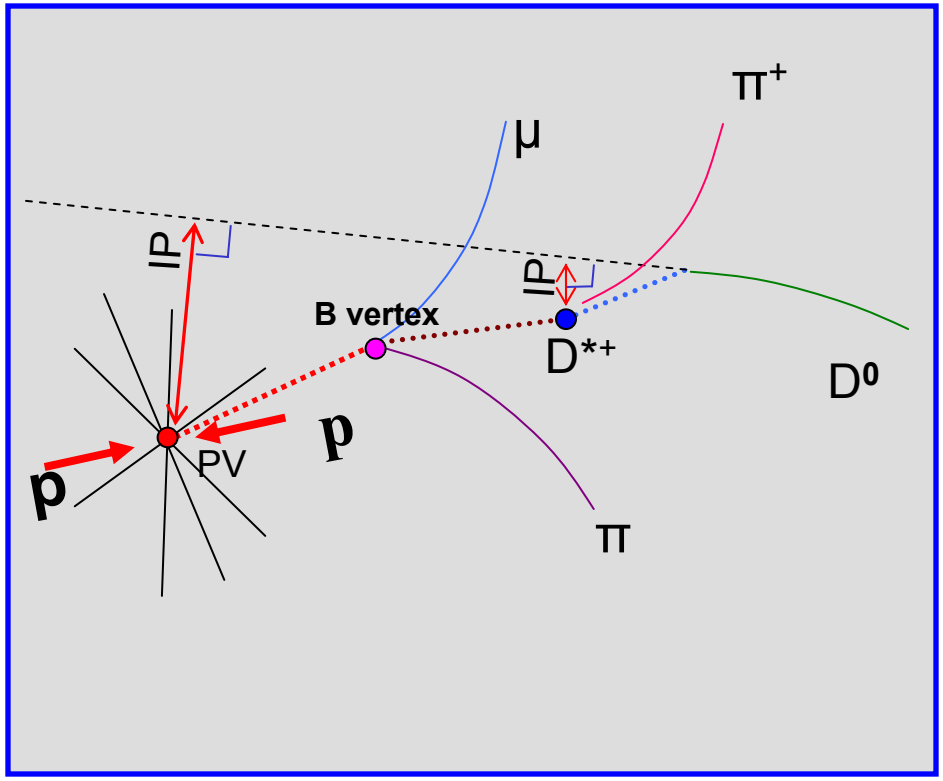
D* sample

- Additional pion P_T > 0.18 GeV
- Charge correlated with muon



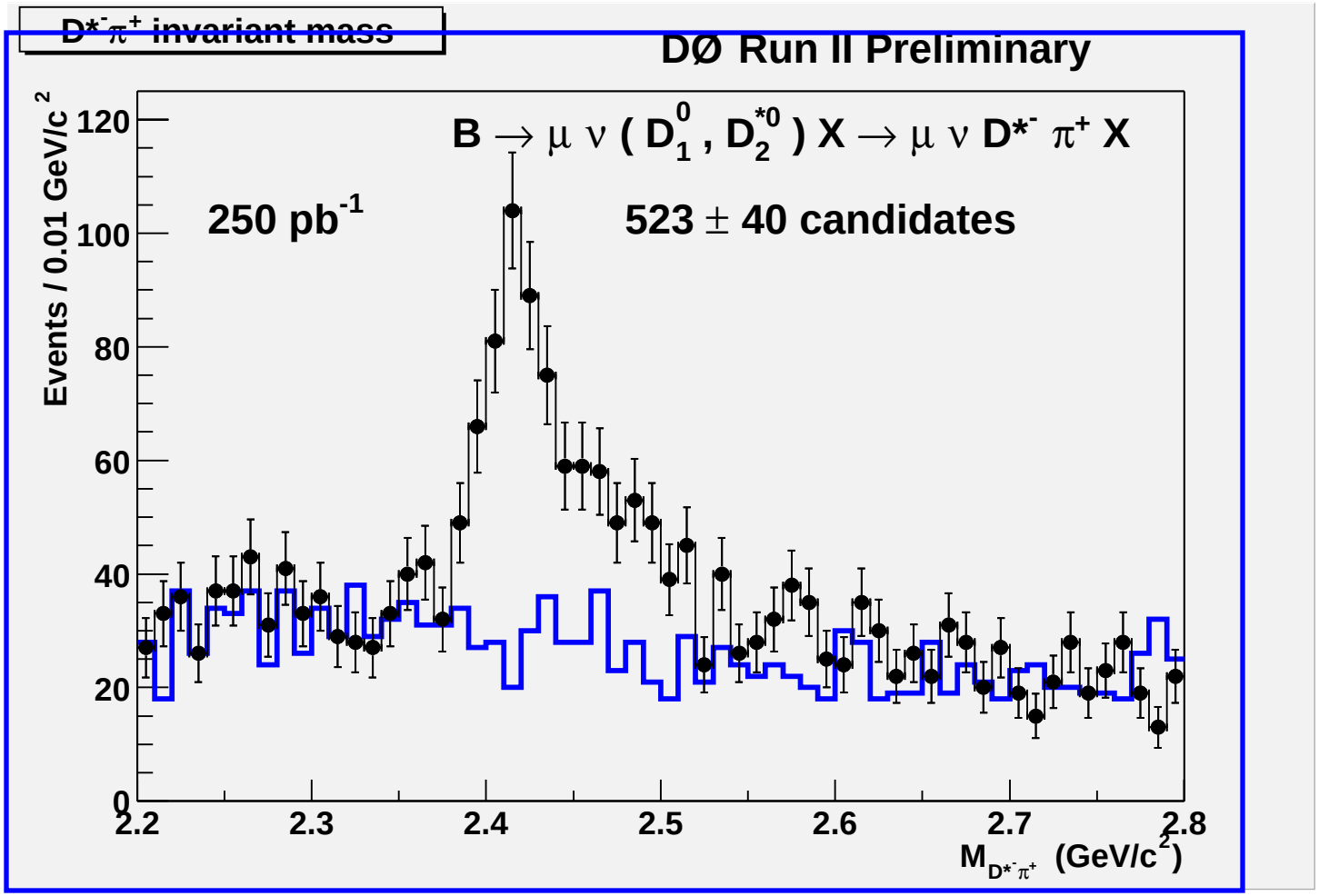
Selections for D**

- **D** selections**
  - combining **D*** with additional pion
  - pion has charge opposite to **D***
  - pion has $P_T > 0.3$ GeV
  - Ratio IP significance wrt PV and IP significance wrt **D**** vertex > 4
- **B selections**
  - SMT hits > 1, CFT hits > 5
  - χ^2 of B vertex > 25
  - pion has $P_T > 0.3$ GeV



D** signal

- Measure invariant mass of $D^{*-}\ \pi^+$ system
- Observed merged $D_1^0(2420)$ and D_2^{*0} (2460)



Branching Ratio

- Take experimentally measured number of
  D_1^0 and D_2^{*0} : $N(D_1)+N(D_2^*)=523 \pm 40$
- Measure branching ratio of $B \rightarrow \mu\ \nu\ D^{**}$(narrow) X, normalizing to known branching ratio
  $(B \rightarrow D^{*+}\ \mu\ \nu\ X)$
- $Br(B \rightarrow \{D_1^0, D_2^{*0}\}\ \mu\ \nu\ X \bullet Br(\{D_1^0, D_2^{*0}\} \rightarrow D^{*+}\ \pi^-)$
  $= 0.280 \pm 0.021(stat) \pm 0.088\ (sys)\ \%$
- Compare to LEP measurement of total
  $D^{**}\ Br\ (B \rightarrow D^{*+}\ \pi\ \mu\ \nu\ X) = (0.48 \pm 0.10)\%$
- ~ half the rate through narrow states

Systematic errors

Source	*Br* absolute value
D* branching rates	0.020 %
MC statistics	0.023 %
Normalisation to D^*/D^0	0.023 %
$P_t^{\pi^{**}}$ dependence	0.052 %
Possible contribution from wide resonance	0.039 %
Possible interference effects of D_1^0 and D_2^{*0}	0.040 %
Different modelling of D* fit	0.010 %
Trigger bias	0.020 %
Total systematic error	**0.088 %**

Future measurements

- $R \equiv \frac{\mathcal{B}(B \to D_2^* \ell \bar{\nu})}{\mathcal{B}(B \to D_1 \ell \bar{\nu})}$ = 0.4-0.7 predicted by HQET
  - World average =0.4 ± 0.15
- DØ can measure
  - ▲ Br($B \to \mu D_1 X$)
  - ▲ Br($B \to \mu D_2^* X$)
  - ▲ R

Conclusions

- Observed semi-leptonic B decays ($B \rightarrow \mu \nu D^{**}$)
- Measured product branching rates of

$$Br(B \rightarrow \{D_1^0, D_2^{*0}\} \mu \nu X).\ Br(\{D_1^0, D_2^{*0}\} \rightarrow D^{*+} \pi^-) =$$
$$0.280 \pm 0.021\ (stat) \pm 0.088\ (syst)\ \%$$

- Signal purity and statistics are good
- Capable of doing competitive measurements of Br and ratio of Br for two narrow D** states.
- Plans:
  - ▲ increase statistics/more luminosity
  - ▲ Loose selections for D^0
  - ▲ Add more decay modes for D^0