A Hadronic L1 Trigger for $B \rightarrow h^- h^+$

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D0 TN-3432
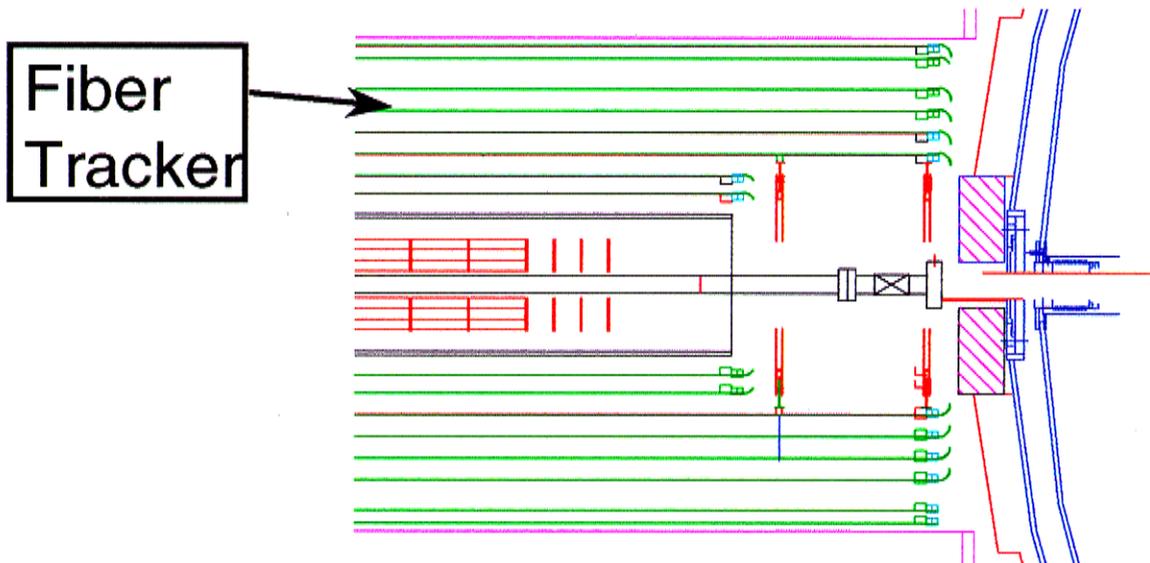
D0 TN-3249

Michele Petteni (Imperial)
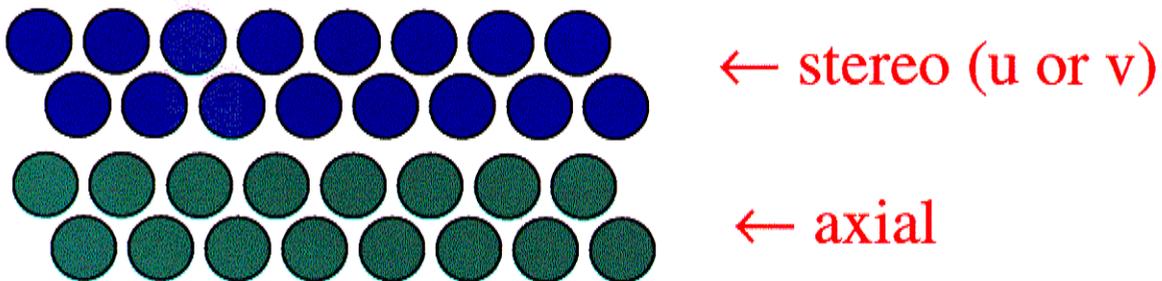
B→Kπ,ππ

- CKM angles α, γ

- CDF has triggers on oppositely charged

  tracks with $p_t > 2$ and 3 GeV

  (Level 1 rate $\geq$ 20 KHz)

- What can be done in DØ?

  → require lepton flavor tag in

    the trigger
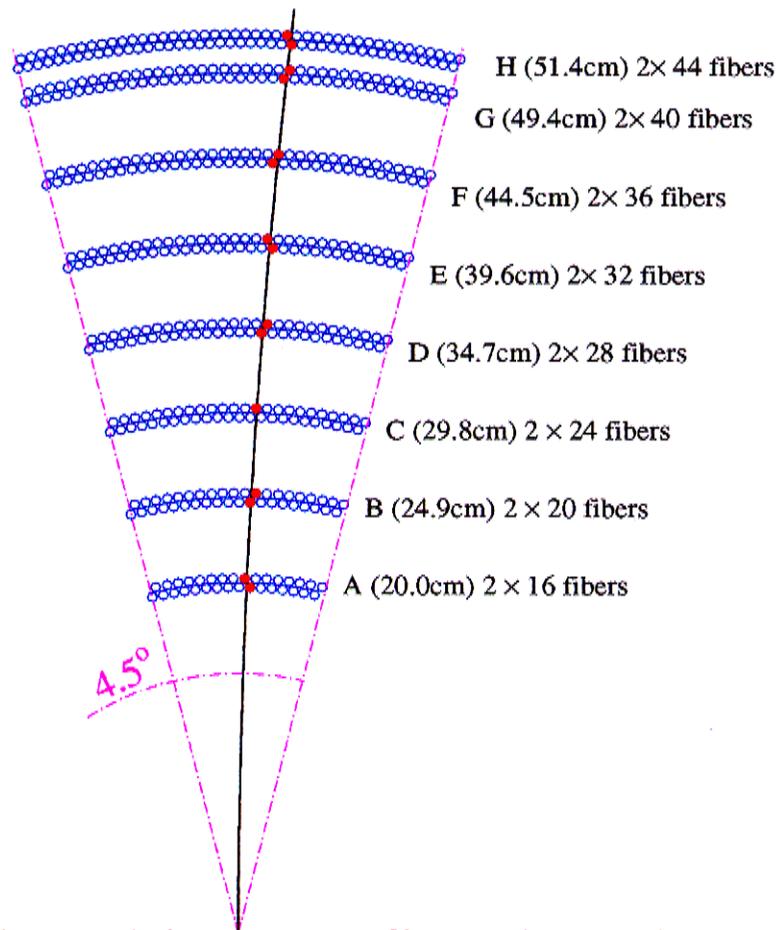
  → require local isolation of tracks

Fiber Tracker

- **Fiber Cylinders (8 super layers)**
  - 20<r<50cm
  - each super layer layer consists of two double layers of axial and stereo fibers

← stereo (u or v)

← axial

  - full coverage to η =1.7
  - hit resolution: 90 μm
→ fast response - L1 trigger

→ 50 μm precision for fiber location

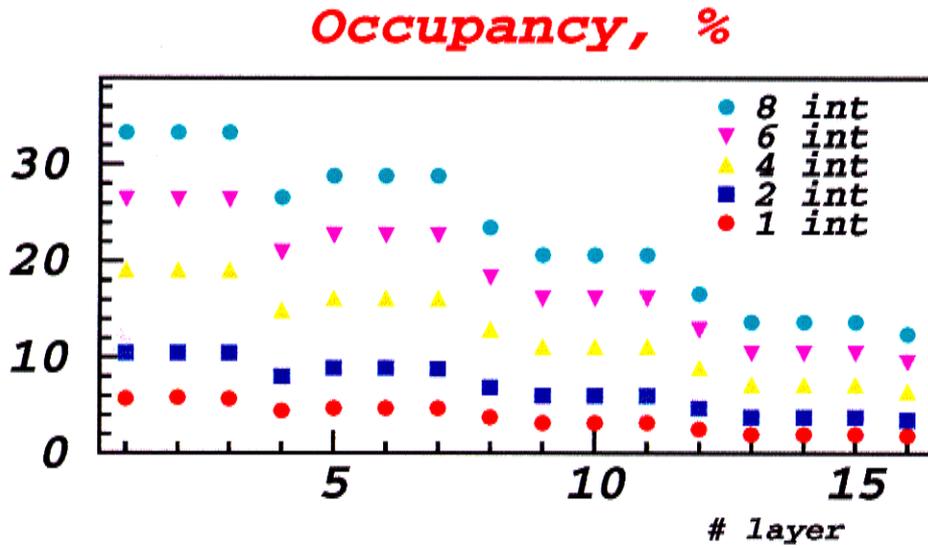→ low mass ($\approx 0.06X_0$) to minimize multiple scattering

Trigger Sector

- CFT is divided into 80 sectors processed in parallel. Each sector needs hits from home and adjacent sectors (layer A is anchor)

- For found tracks preshower is checked for matching hits

H (51.4cm) 2× 44 fibers
G (49.4cm) 2× 40 fibers
F (44.5cm) 2× 36 fibers
E (39.6cm) 2× 32 fibers
D (34.7cm) 2× 28 fibers
C (29.8cm) 2 × 24 fibers
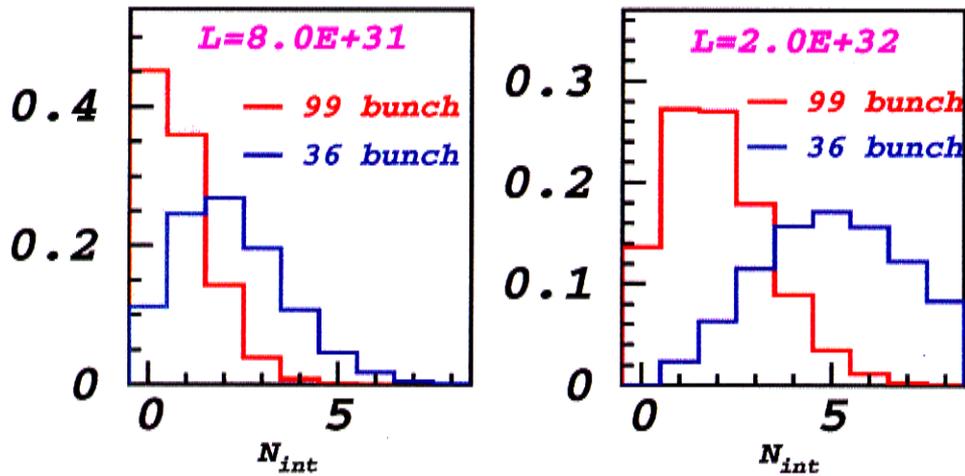B (24.9cm) 2 × 20 fibers
A (20.0cm) 2 × 16 fibers

4.5°

- Random hits can fire the trigger!

  → 8 double hits out of 8

  → narrow roads
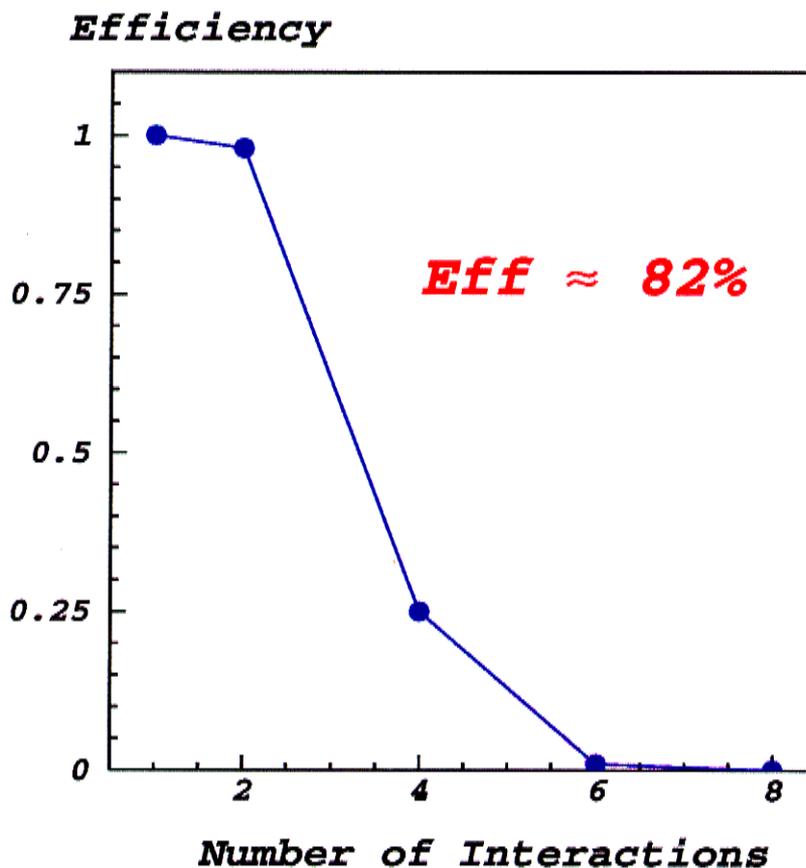
Environment

Occupancy, %

Number of Interactions/crossing

Occupancy Trigger
(Multiple Interactions Trigger)

- Occupancy threshold = 12%

- Maximum number of segments exceeding occupancy threshold = 68

Efficiency

$Eff \approx 82\%$

Number of Interactions

All minimum bias

B→Kπ,ππ

- Trigger:
  - tight quality muon with
    $p_t > 1.5$ GeV and $|\eta| < 1.7$
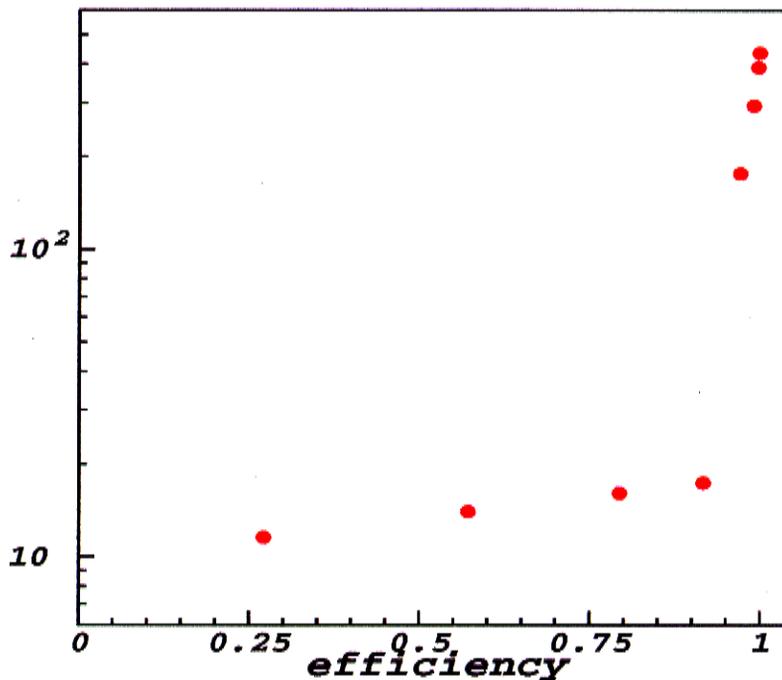   (has rate of about 20 KHz)
  - three tracks with $p_t > 1.5$ GeV
  - two isolated tracks with $p_t > 1.5$ GeV
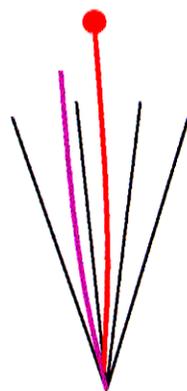 - one isolated track with $p_t > 4.0$ GeV
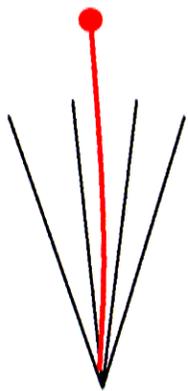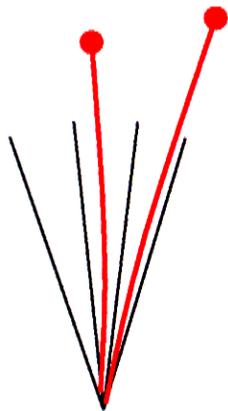
Rate, Hz

- Efficiency of kinematic and isolation cuts
  is about 50% (fast MC, no GEANT)

Isolated "electron"

"electron" is isolated if it is the only

one in home and both adjacent sectors

- isolated "electrons"

- not isolated "electron"
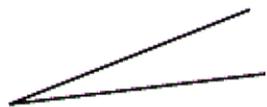
- CFT sector

Track with CPS match

Track without CPS match

Implemented Trigger

- 2 triggers; one on the generated events, other on the reconstructed tracks.

- At the generator level:
    - Physical limitations of the detector.

    - Need 1 lepton and 2 other particles passing the following cuts:

    - $|\eta| < 1.7$, $p_T > 1.5$ GeV for 'general' particle.

    - $|\eta| < 2.0$, $p_T > 1.5$ GeV for muons.

    - $|\eta| < 2.5$, $p_T > 1.5$ GeV for electrons.

Implemented Trigger (2)

- On the reconstructed tracks the following requirements have to be met:

  - 1 tight quality lepton signature, $p_T > 3$ GeV.

  - 2 other tracks, $p_T > 1.5$ GeV.

  - 2 isolated tracks, one with $p_T > 4$ GeV.

  - All tracks have to have hits in all the CFT layers.

Isolation

- Problematic due to the absence of individual CFT segment information.

- Calculate ϕ for each track, ignore displaced vertex and enforce isolation by 'brute force'.

- L1 trigger will have access to number of tracks within each CFT segment.

Other Considerations

- Impose quality cuts on the B daughter tracks:

  - Hits in each CFT layer, i.e. $|\eta| < 1.7$

  - At least 6 hits in the silicon.

  - $P_T > 0.4$ GeV, dictated by pattern recognition.

- No cuts on the B either on generated or reconstructed tracks.

Generated Event Rates

- 1 Million Events generated using Pythia
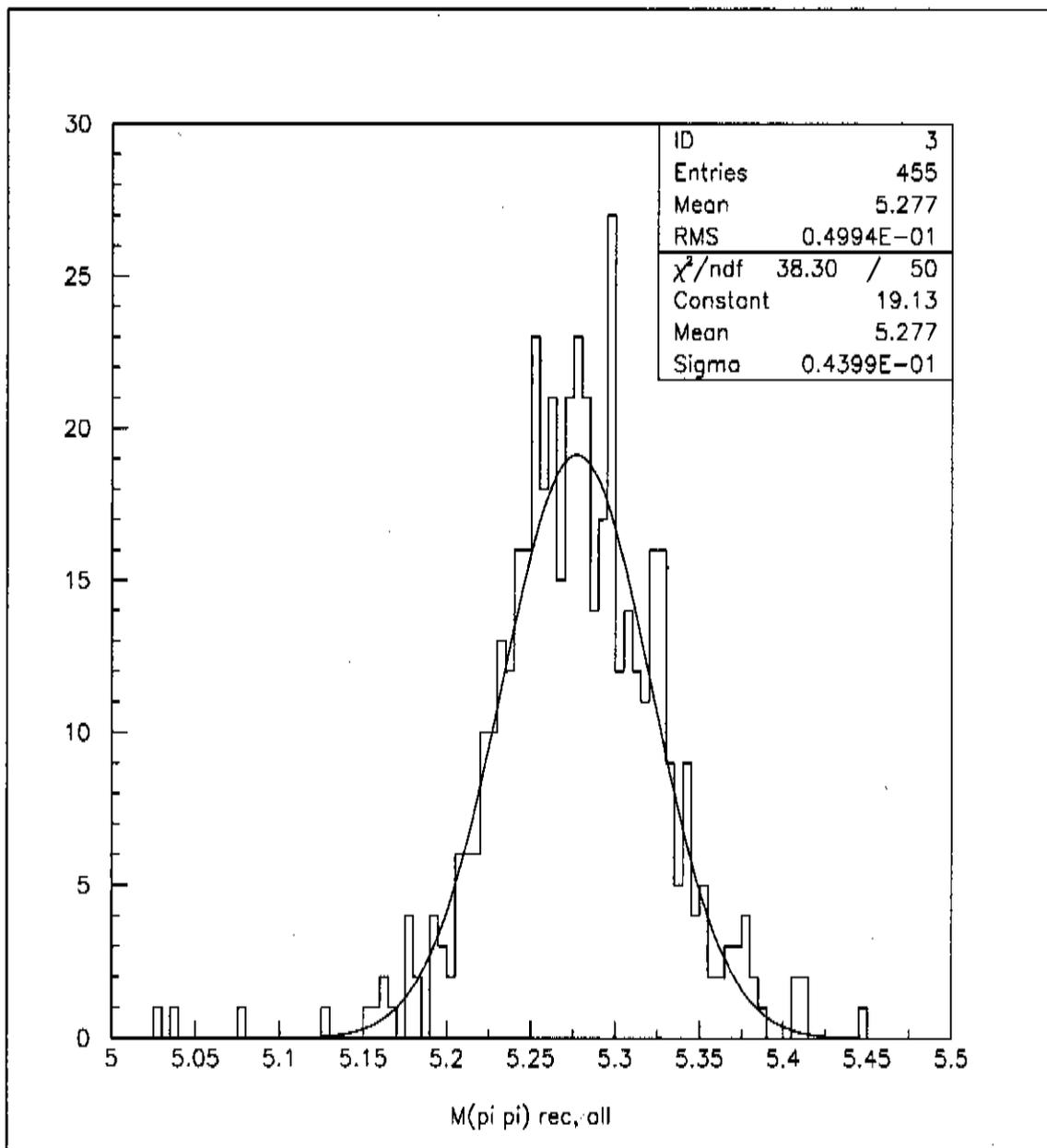- Approximate ratios used assuming SU(3) and $B_d / B_s = 2.5$ with:

$$B (B \rightarrow \pi^{+}\pi^{-}) = (4.3 \pm 1.6) \times 10^{-6}$$

$$B (B \rightarrow K^{+}\pi^{-}) = (17.2 \pm 1.6) \times 10^{-6}$$

$B_d \rightarrow \pi^+ \pi^-$	$B_d \rightarrow K^+ \pi^-$	$B_s \rightarrow K^+ K^-$	$B_s \rightarrow \pi^+ K^-$
1	4	1.3	0.3

- Data taken from CLEO and F. Würthwein talk 02/11.

$B_d \rightarrow \pi^+ \pi^-$ Mass Plots

ID	3
Entries	455
Mean	5.277
RMS	0.4994E−01
χ^2/ndf	38.30 / 50
Constant	19.13
Mean	5.277
Sigma	0.4399E−01

M(pi pi) rec, all

24/02/00

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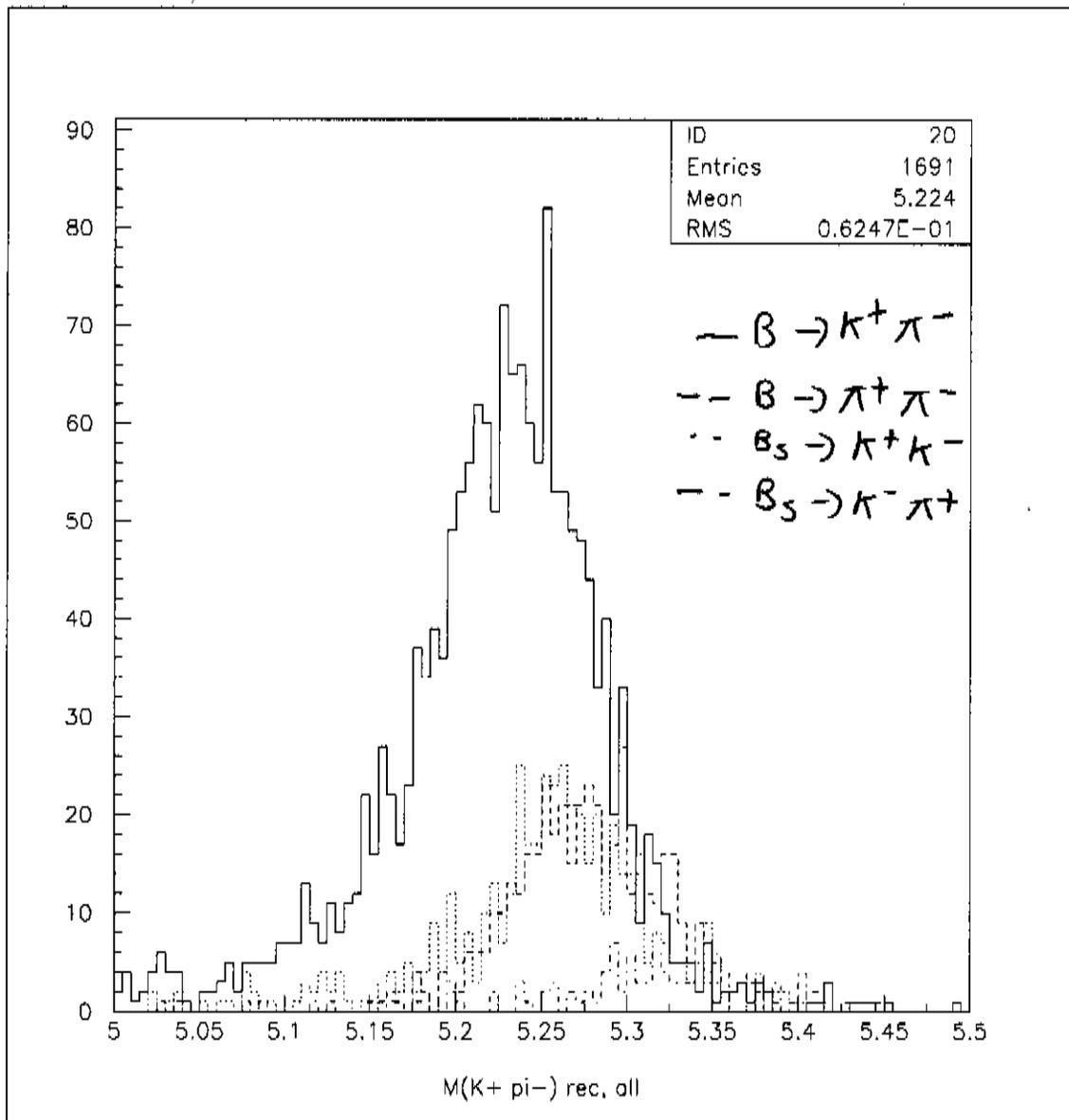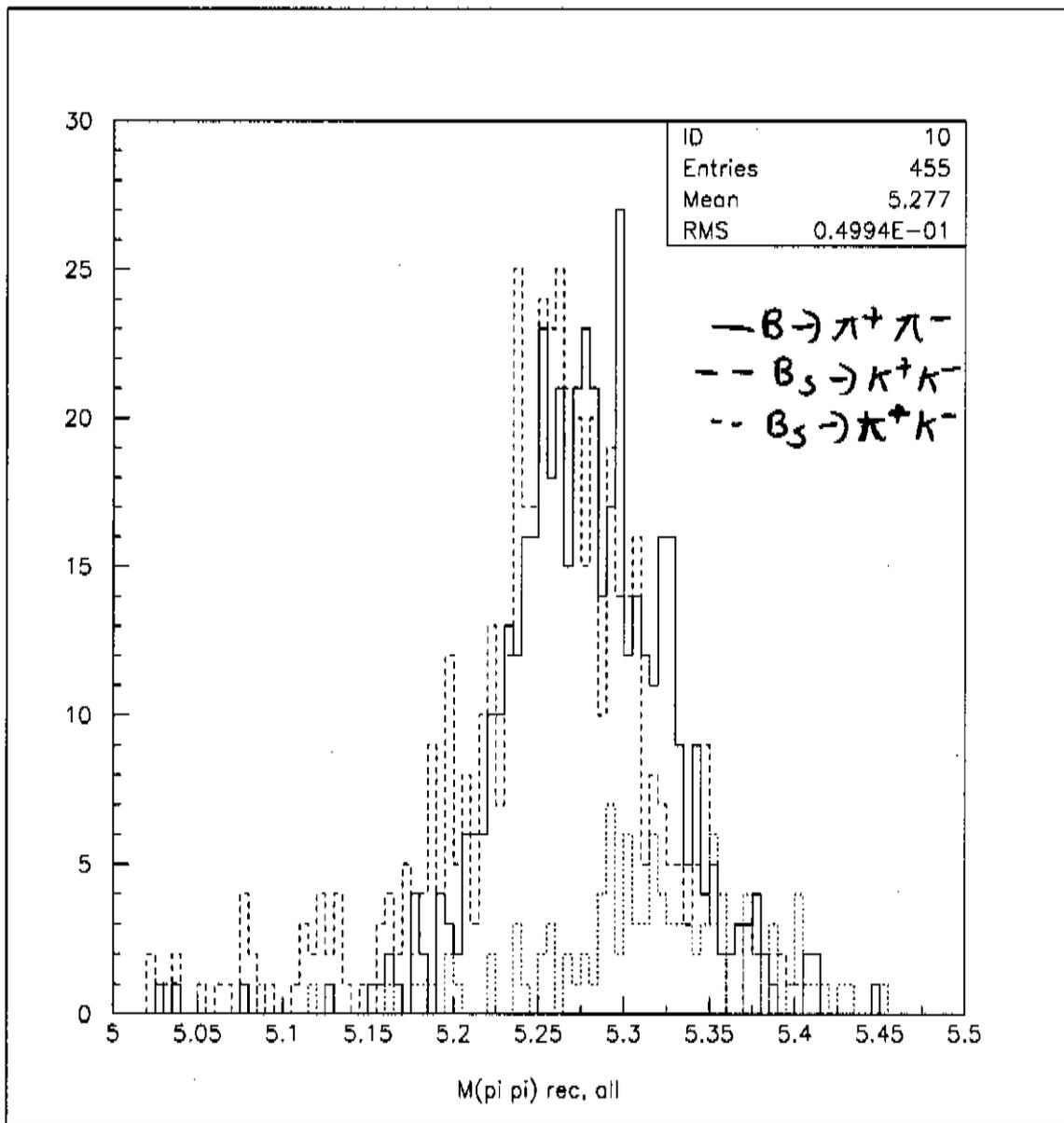# $B_d \rightarrow \pi^+ \pi^-$ And Background (1)

24/02/00

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$B_d \rightarrow \pi^+ \pi^-$ And Background (2)

M(pi pi) rec, all

ID	10
Entries	455
Mean	5.277
RMS	0.4994E−01

— $B \rightarrow \pi^+ \pi^-$
-- $B_s \rightarrow K^+ K^-$
-- $B_s \rightarrow \pi^+ K^-$

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Efficiencies (Preliminary).

	$B_d \rightarrow \pi^+ \pi^-$	$B_d \rightarrow K^+ \pi^-$	$B_s \rightarrow K^+ K^-$	$B_s \rightarrow \pi^+ K^-$
N gen.	156 000	618 000	182 000	4 500
N rec.	455	1 691	489	107
Efficiency	0.29%	0.27%	0.27%	0.24%
N exp.	123	456	182	40

$\sigma_B = 158 \ \mu b, \ \varepsilon D^2 = 3.9\%, \ L = 2 \ fb^{-1}, \ 0.8 \ prob. \ B_d$

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Efficiencies, No Isolation Cut.

	$B_d \to \pi^+\pi^-$	$B_d \to K^+\pi^-$	$B_s \to K^+K^-$	$B_s \to \pi^+K^-$
N gen.	156 000	618 000	182 000	4 500
N rec.	577	2 205	638	145
Efficiency	0.37%	0.36%	0.35%	0.32%
N exp.	156	609	237	53

$\sigma_B = 158$ µb, $\varepsilon D^2 = 3.9\%$, $L = 2$ fb^{-1}, 0.8 prob. B_d

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Summary and Future

- Generic hadronic L1 trigger proposed.
- Require 3 tracks, of which 2 isolated and a lepton.
- $\sigma_{\pi\pi} = 44$ MeV, efficiency $\approx 0.25\%$.
- Need study of changing p_T threshold in the CFT .
- Isolation efficiency $\approx 70\%$, (originally simulated by Y. Gershtein as 50%), has to be simulated in these channels.
- Results preliminary, not 100% understood.
- Need GEANT simulation.