

The Silicon Track Trigger $(S\bar{T}T)$ at D \emptyset

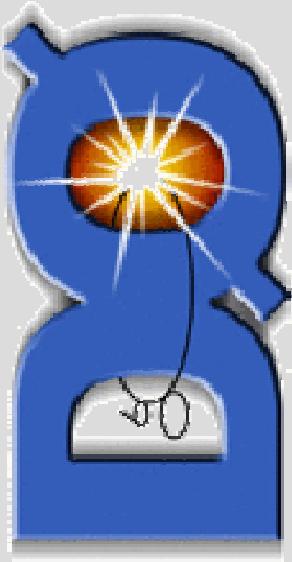
Beauty 2005 in Assisi, June 2005



Tag

fast . . .

beauty



Sascha Caron
for the D \emptyset collaboration

N K H E F

The Silicon Track Trigger at D \emptyset

OUTLINE

- D \emptyset detector
- D \emptyset trigger
- What is the STT?
- dataflow
 - clustering and tracking
- B identification
- Performance
- Summary



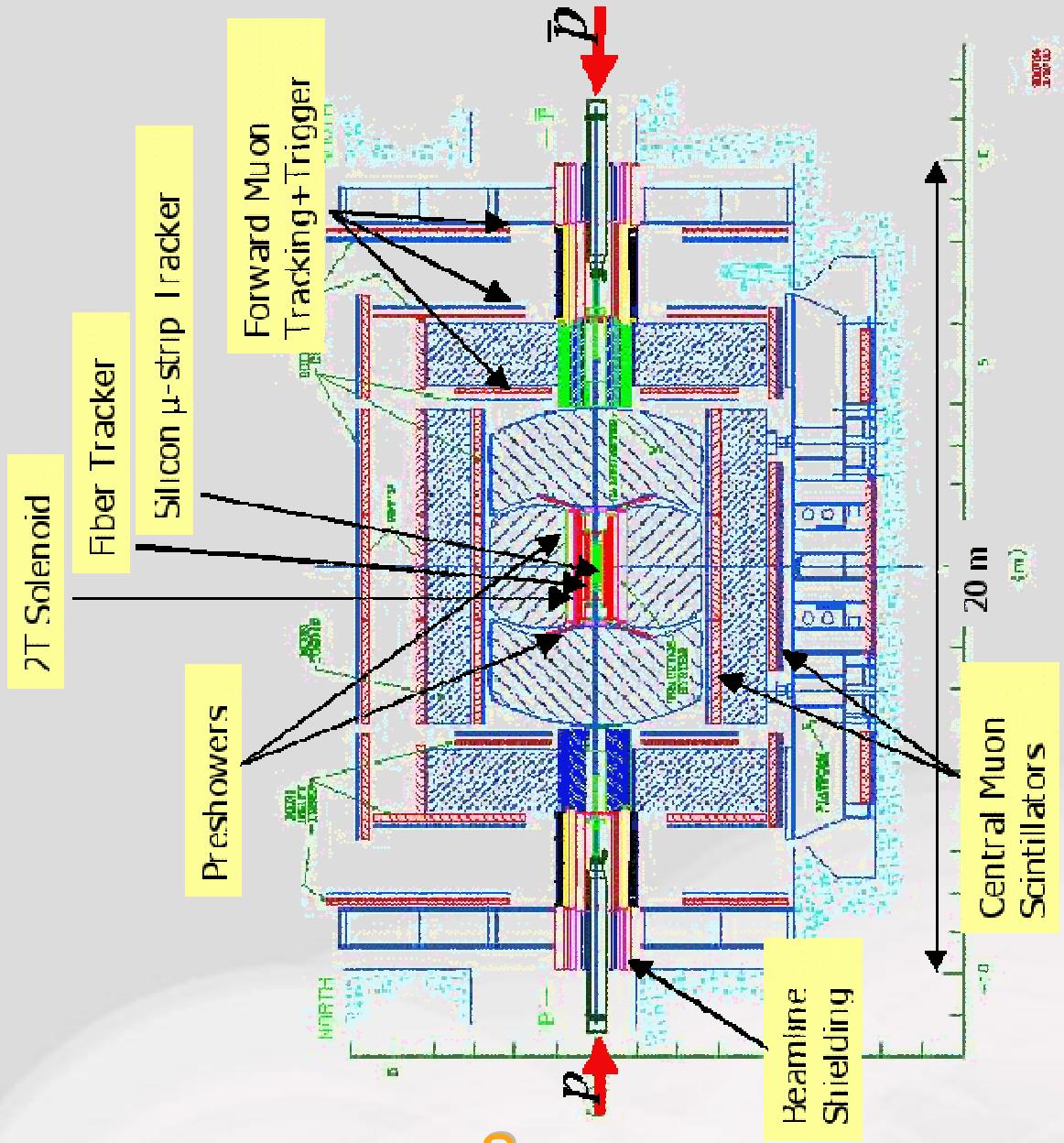
The Silicon Track Trigger at D \emptyset

D \emptyset in Run II

The Silicon Track Trigger is based on information of the :

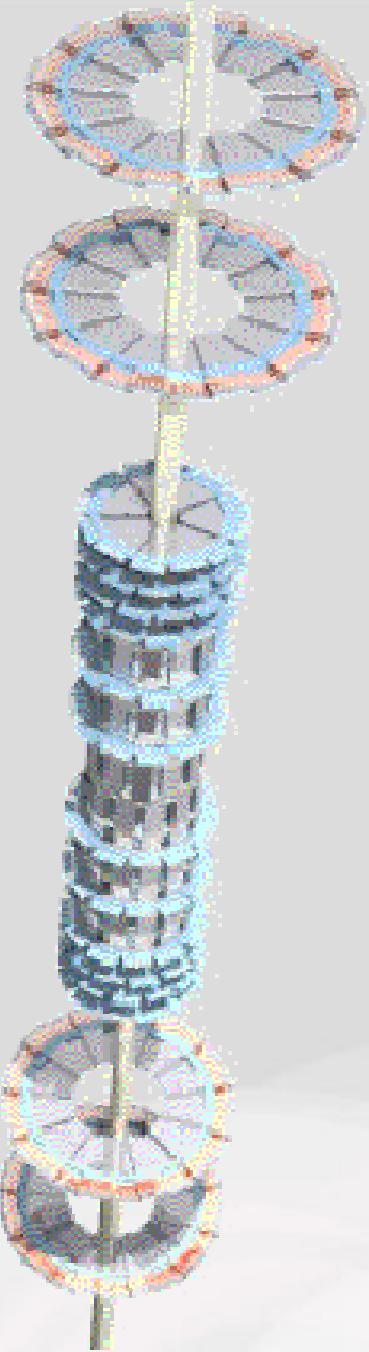
Silicon Microstrip Tracker

Central Fiber Tracker



DO in Run II

The Silicon Track Trigger at D \emptyset



The Silicon Track Trigger is based on information of the :

Silicon Microstrip Tracker

- 50 μm pitch strips (parallel to beam)
- 800000 readout channels
- Only axial strips used for STT tracks

Central Fiber Tracker

- Scintillating fibers
- Coverage: $|\text{Rapidity}| < 1.7$



The Silicon Track Trigger at D \emptyset

Aim: High E_T
 $Z \rightarrow b\bar{b}$, $HZ \rightarrow bbvv$,
 $H \rightarrow b\bar{b}$, etc.
Hopefully B physics

Events
per
second

10
1

QCD $E_T > 30$ GeV
dijet production

Find b-events
early to keep
high efficiency
at an acceptable
rate

b-jets $E_T > 30$ GeV

$Z \rightarrow b\bar{b}$

0.001

0.0001

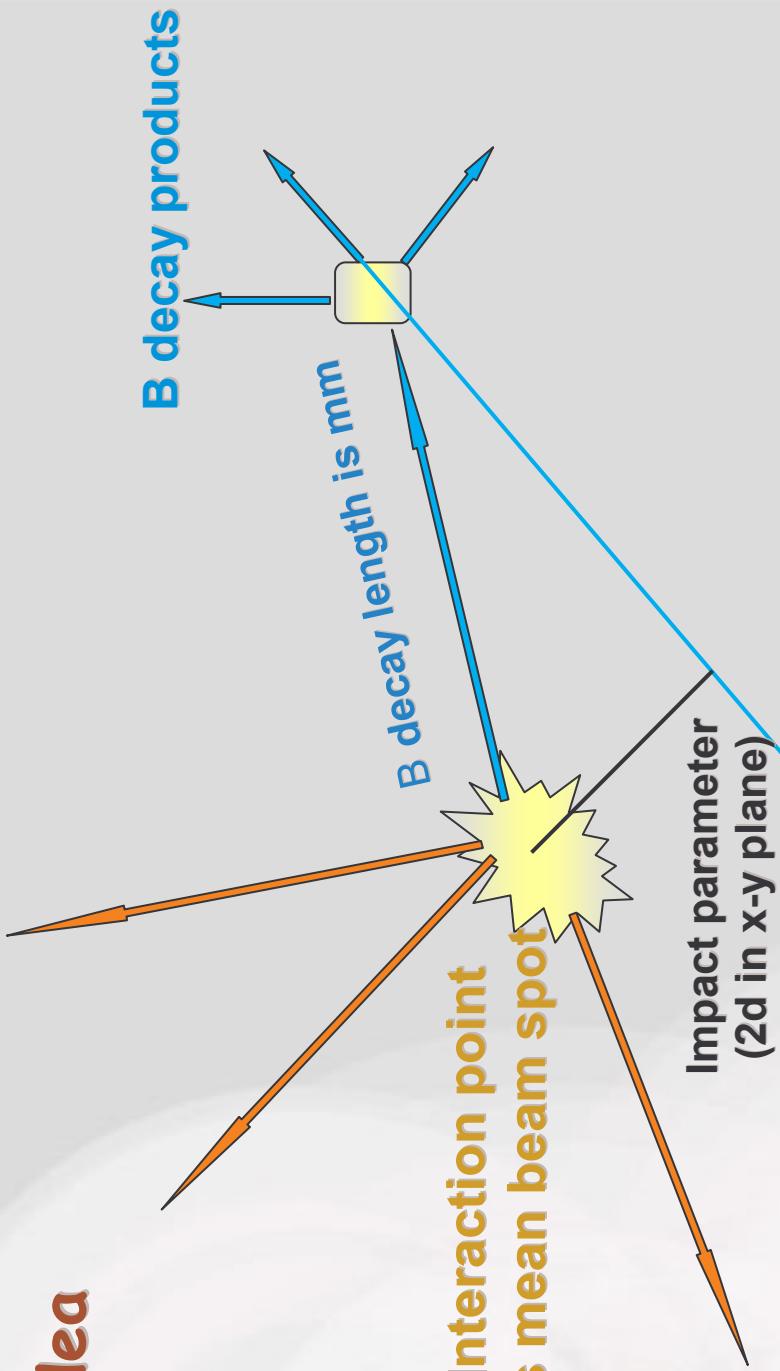
Higgs $\rightarrow b\bar{b}$

$ZH \rightarrow bbvv$, $bH \rightarrow bbb$ etc.



The Silicon Track Trigger at D \emptyset

Principal Idea



- Silicon Improved Tracks with 2d impact parameter
- Select events with large impact parameter tracks



The Silicon Track Trigger at D \emptyset

Trigger System

p \bar{p} bunch
crossing
frequency
2.5MHz

L1 Trigger
(1500)
5000 Hz
decision time
about 4 μ s

L2 Trigger
(700)
1000Hz
decision time
about 200 μ s

L3 Trigger
50 Hz
decision time
about 50 ms

- o Hardware based
 - o CTT tracks,
 - o calorimeter towers,
 - o muons

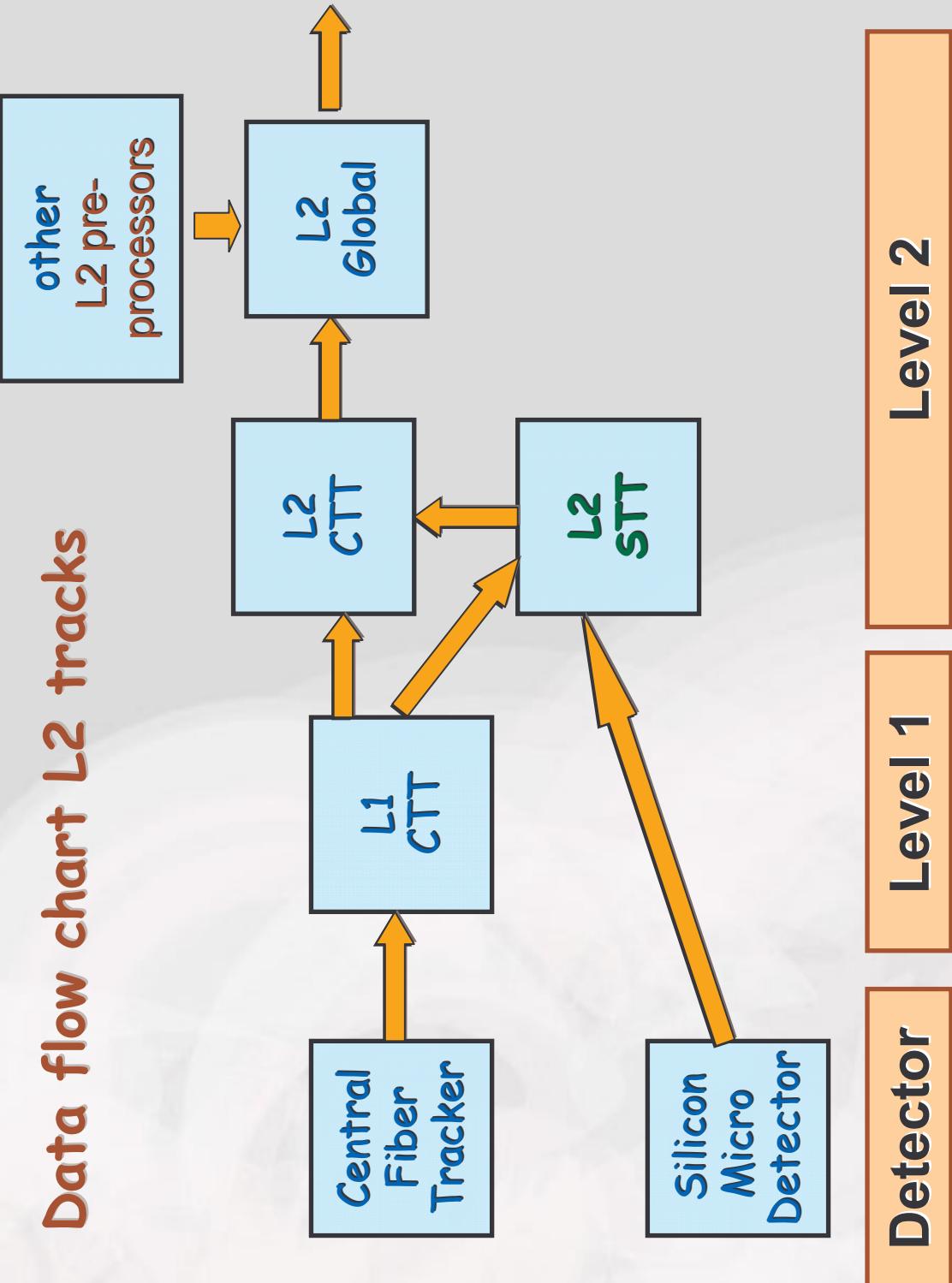
- o Hardware/Software
 - o simple jets, electrons, muons, taus
- o **Silicon Microvertex Improved tracks (STT)**
 - o global processor to combine information (e.g. STT tracks for Bid)

- o Software based
 - o partial event reconstruction



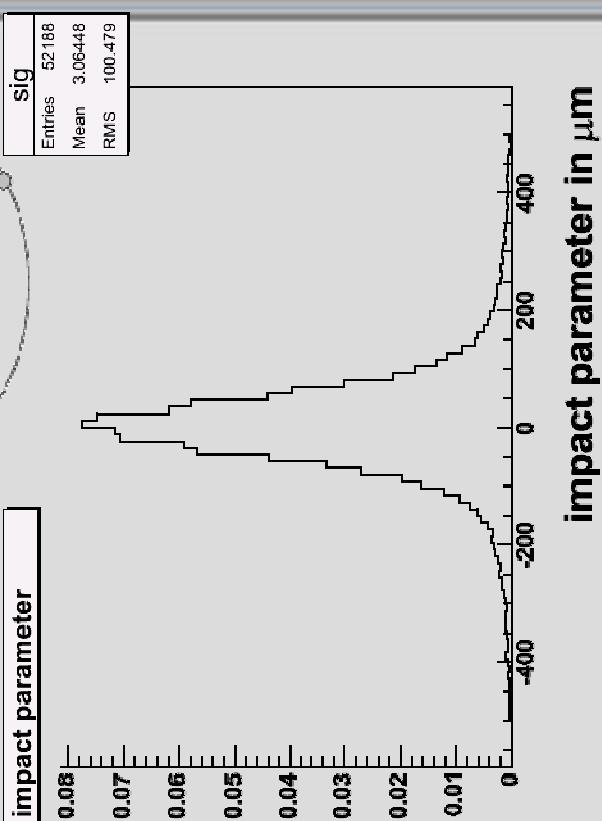
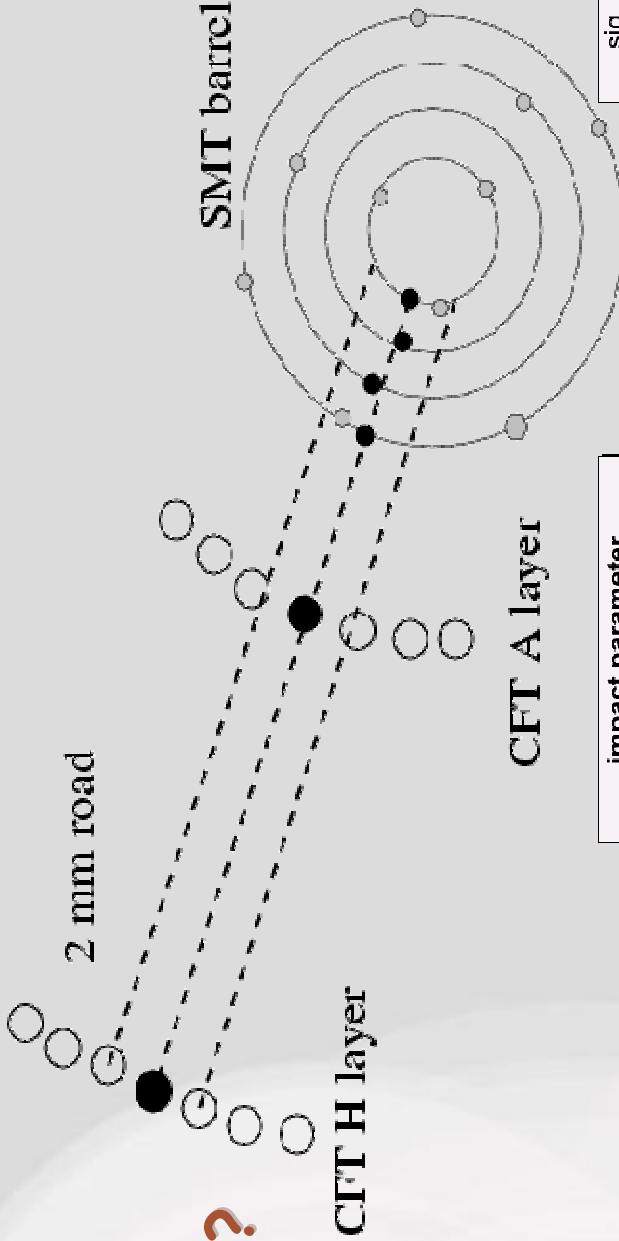
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Data flow chart L2 tracks



The Silicon Track Trigger at D \emptyset

How is the tracking improved?



impact parameter in μm

- Tracks found at L1 with the Central Fiber Tracker are used to define roads into the Silicon

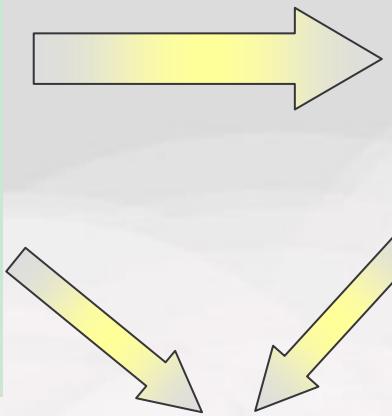
- Silicon hits are clustered
- Track is re-fit within the road



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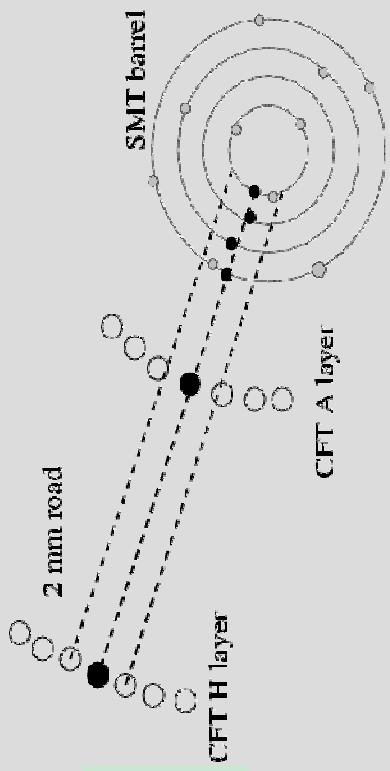
Silicon Track Trigger cards

Road data to
Fiber Road Card



Fitting done
in Track Fit Card

L2CTT



Done in parallel for each
of the 12 sectors

2 sectors in 1 crate
-> 6 Crates with
1 Fiber Road Card
9 Silicon Trigger Cards
2 Track Fit Cards

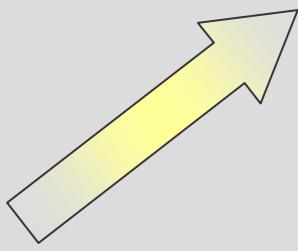


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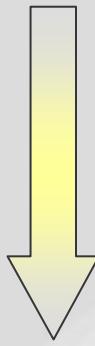
Silicon Track Trigger cards

- Receives and distributes L1 tracks
- Communicates with Trigger framework

Road data to
Fiber Road Card



SMT data to
Silicon Trigger
Cards



Fitting done
in Track Fit Card

- receives road and axial clusters
- convert to physics coordinates via LUT
- perform track fit $\phi(r) = b/r + kr + \phi_0$
- beam spot correction
- output tracks to L2CTT

- Perform clustering and cluster-
road matching
- Clusters SMT hits + pedestal
correction
- Axial clusters are matched to
the roads

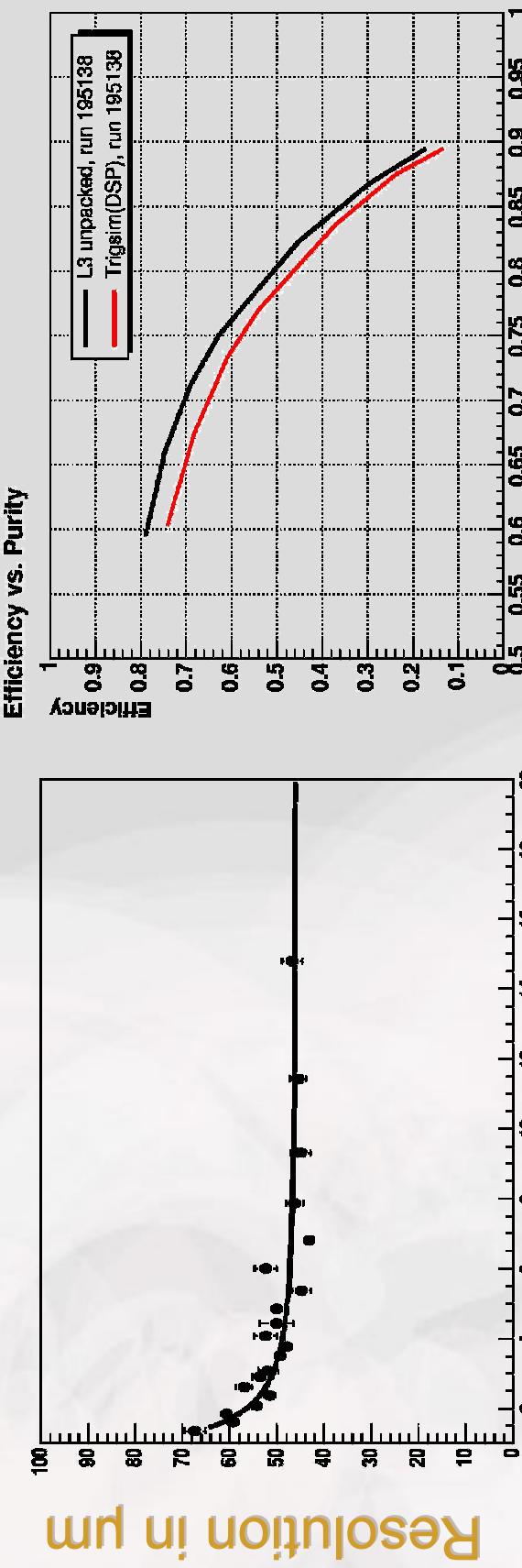


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Performance studies STT tracks

Impact Parameter resolution

Correlation to RECO



Including beam spot size 35 μm
and 15 μm SMT resolution



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B identification

Store 2d signal (b events) to background (light quarks) ratio into a lookup table

Define "good tracks"

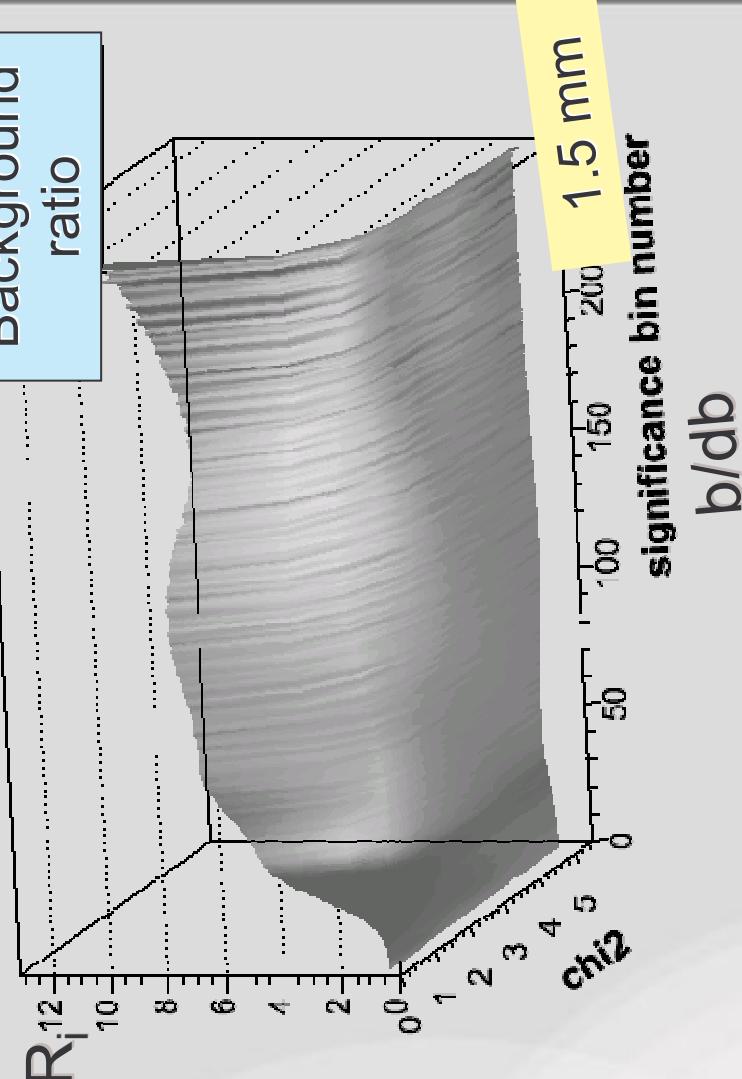
Loop over tracks i and derive the product

$$R = \prod R_i$$

or use $\max(R_i)$

Likelihood as a discriminator: $L = R/(R+1)$

- Fast, simple and efficient technique
 - Time needed is 2 operations per track and goes linear with the number of tracks -> about 1-5 μ s
 - Degrades bad tracks without cutting them



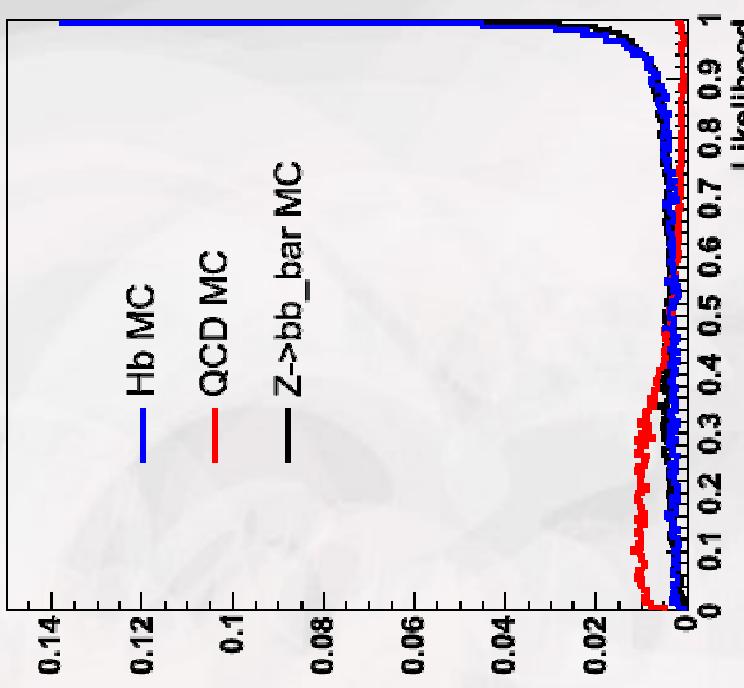
Signal to
Background
ratio



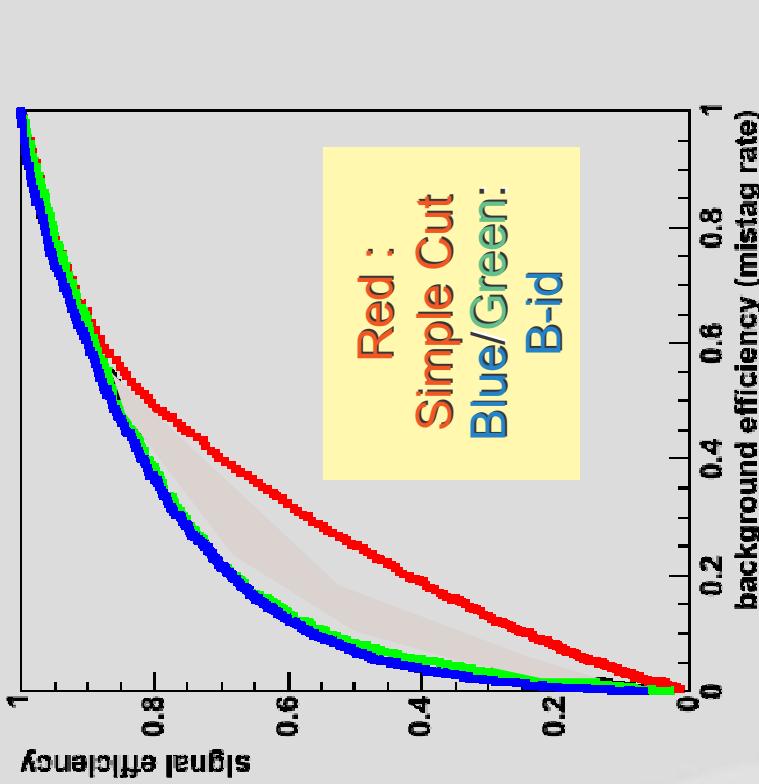
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Performance studies

L2 B-id likelihood



efficiency $Z \rightarrow b\bar{b}$



Very well separation of signal and background events

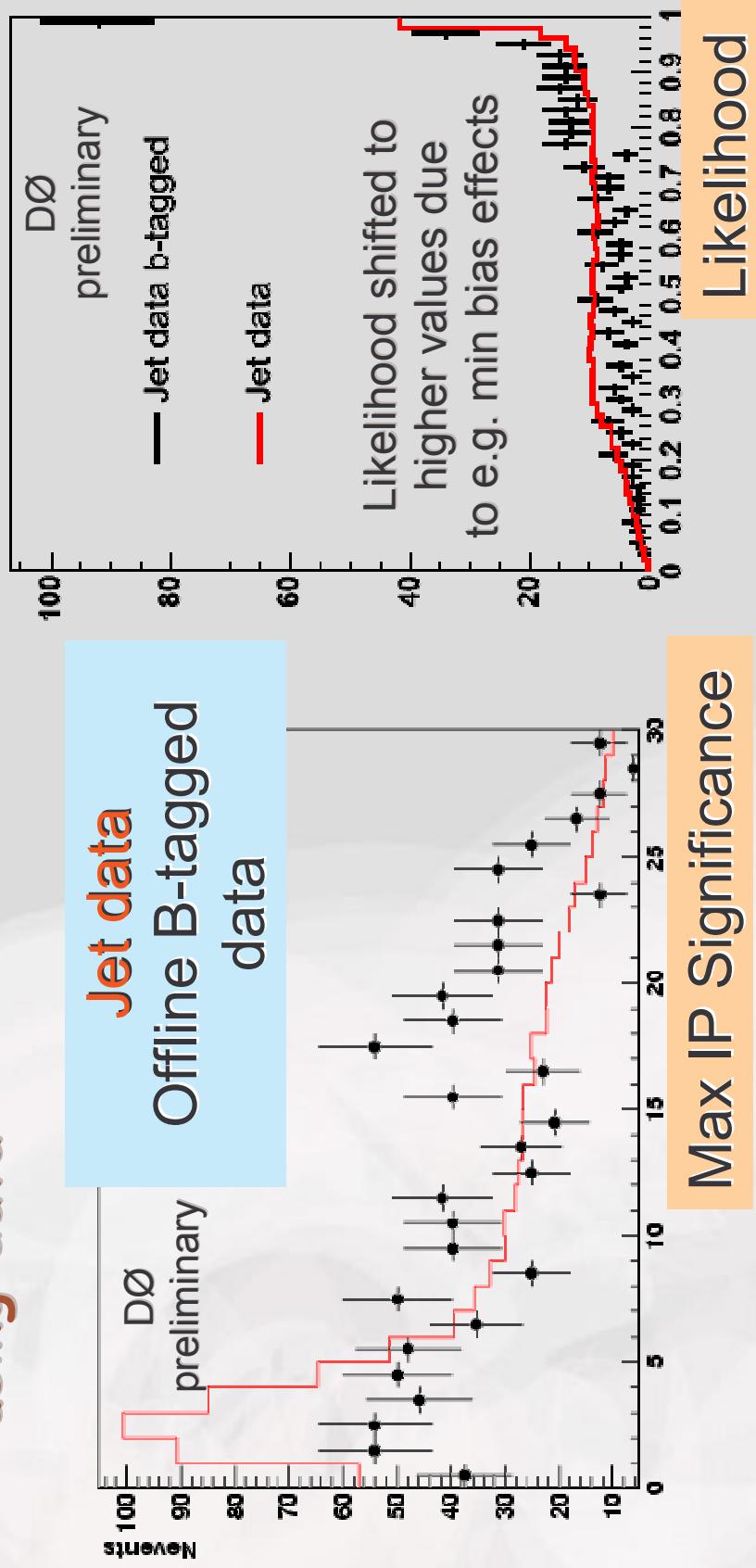
Large background reduction with L2 b-ID algorithms



First studies using data

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Using MC pdfs



L2 data well correlated with offline data
-> proof of b-id principle -> Much more studies on their way



Sascha Caron

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Summary

- The STT is operating routinely and smooth
- High Impact Parameter resolution
- Data is understood
- Very fast L2 b-id is (almost) implemented
- We expect a high potential for
 $Z \rightarrow bb$ and Higgs physics now and at $L=200E30\text{cm}^{-2}/\text{s}$

Outlook

- Implementation of new Layer 0 ($r=22\text{mm}$) into STT
-> further increase in precision and stability

