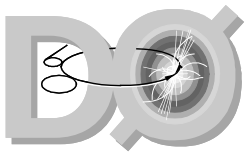


DØ Upgrade Run II

Pierre Pétroff

LAL Orsay France

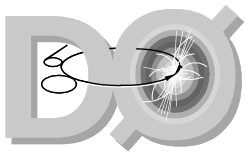
for the

D∅ Collaboration

- **Introduction**
- **Physics Goals**
- **Tevatron Upgrade**
- **DØ Upgrade**
- **Conclusion**

H C P Mumbai 14-20 Jan 99

PP/HCP99



Tevatron in the 90 ’s

* **Fermilab p p-bar collider**
  - With $\sqrt{s}$ = 1.8 TeV : highest energy accelerator since mid-80’s
  - Peak luminosity of~ 1.6 x10^{31} $cm^{-2}s^{-1}$
  - $\int L\,dt$ =120 pb^{-1} delivered to CDF and D0 during 1992-1996 (Run I)
  - Many exciting studies including:
    - Discovery of Top quark; W Mass measurement
    - Limits on triboson Anomalous Coupling
    - Limits on SUSY, leptoquarks, exotics
    - Tests of QCD
    - b-quark physics
* **x20 integrated luminosity achievable with machine/detectors upgrade**
  - Goal : $\int L\,dt \approx$ **2 to 4 fb^{-1}**

Physics Goals

∗ **Top quark studies**: Measure m_{top} to $\pm$ 3GeV; single top production: width, $\delta V_{tb} \approx 0.1$ *unique*; rare top decays $B(t \to c\gamma) < 2\ 10^{-3}$ $B(t \to cZ) < 10^{-2}$ $B(t \to H^{+}b) < 15\%$

∗ ***W/Z* bosons**: *W* mass to < 50 MeV; $WW\gamma$,WWZ,$ZZ\gamma$ and $ZZ\gamma$ couplings at 0.1 level (large mass scales) ; *W* and *Z* forward backward charge asymmetries

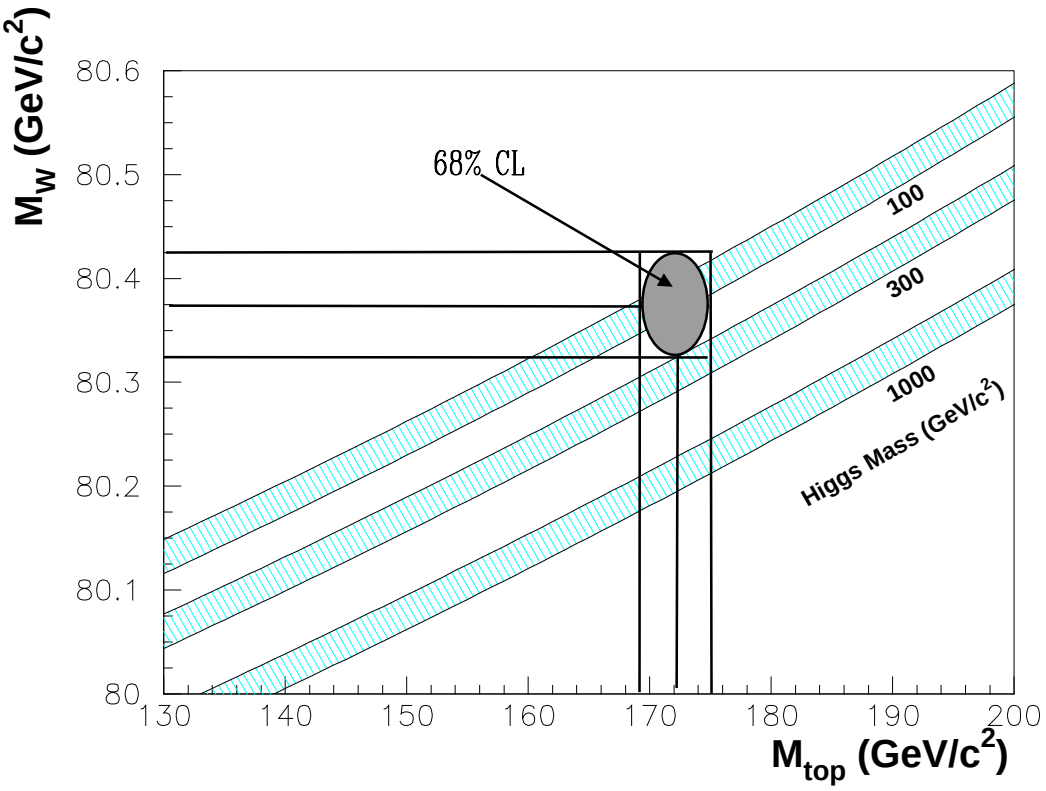
∗ **Light Higgs**: production WH , $H \to bb$
(need lum !!)

∗ **New Phenomena**: SUSY: mass extended by a factor ≈1.5 over Run I, leptoquarks, many topics

∗ **B physics**: B_s mixing ($x_s \approx 20$); study of heavy *b* quark mesons (B_c,B_s,Λ_b), CP violation in $Bd \to J/\psi K_s$; Rare *B* decays ($Bd \to \mu\mu$, $Bd \to K\mu\mu$ etc)

∗ **QCD physics**: probe largest E_t with jets, production of *W/Z*,γ, *b*-quarks

Higgs Update



In the Standard Model, M_W and M_{top} provide indirect measurement of M_{Higgs}

Combining CDF and DØ results will yield $\delta M_{Higgs} \approx 80\%\ M_{Higgs}$ after Run II

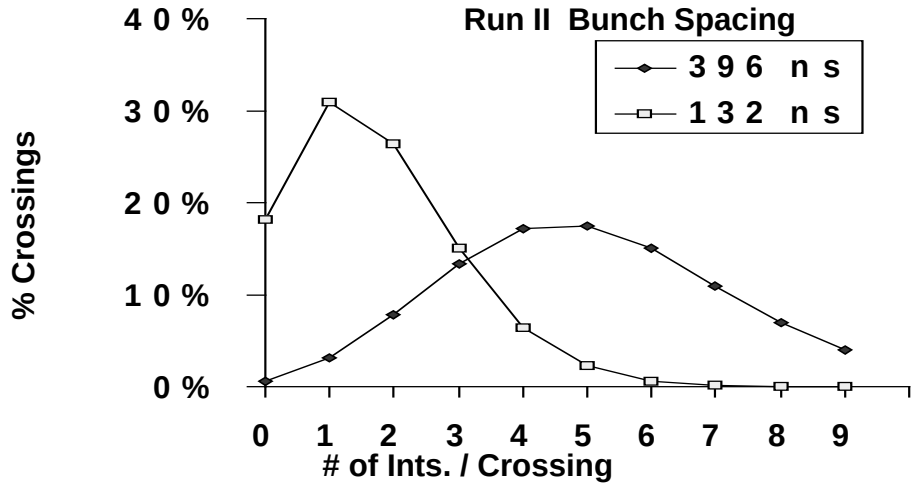
PP/HCP99

New Physics Reach

Search	Run 1 Mass Limit (GeV/c^2)	Run 2 Mass Limit (GeV/c^2)
squark and gluino pairs	260 (mg=mq)	200-300
gaugino pairs	90-150 (model dependent)	130-200 (model dep.)
stop	~95	150
$W' \rightarrow e\nu$, $Z' \rightarrow ll$	720,690	~1000
$LQ \rightarrow eq$ (scalar)	225 ($\beta = 1$)	260
$LQ \rightarrow \mu q$ (scalar)	180 ($\beta = 1$)	220
Composite-ness (Λ^+, Λ^-)	3800,2600 (eeqq)	5000
Technirho $\rightarrow$ dijets	$250 < M < 500$	$200 < M < 770$
$t \rightarrow H^+b$	~150 for $\tan\beta > 100$	~150 for $\tan\beta > 30$

Run II Parameters

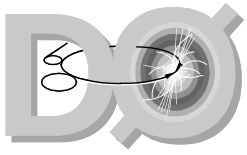
Parameter	Run IB (1993-1995)	Run II MI plus Recycler	Units
Energy	900	1000	GeV
Protons/bunch	23×10^{10}	27×10^{10}	
P-bars / bunch	5.5×10^{10}	7.5×10^{10}	
Bunches	6	$36 \rightarrow$???	
P-bar stacking	6×10^{10}	20×10^{10}	per hour
Luminosity	1.6×10^{31}	2.1×10^{32}	$cm^{-2}\ s^{-1}$
Bunch Spacing	3500	$396 \rightarrow 132$	nsec
Interactions per crossing	2.7	$5.8 \rightarrow 2.0$	



Demographics

* **Collaboration of 12 Countries**
* **52 Institutions**
* **480 physicists**
* **New Institutes: US and Europe**

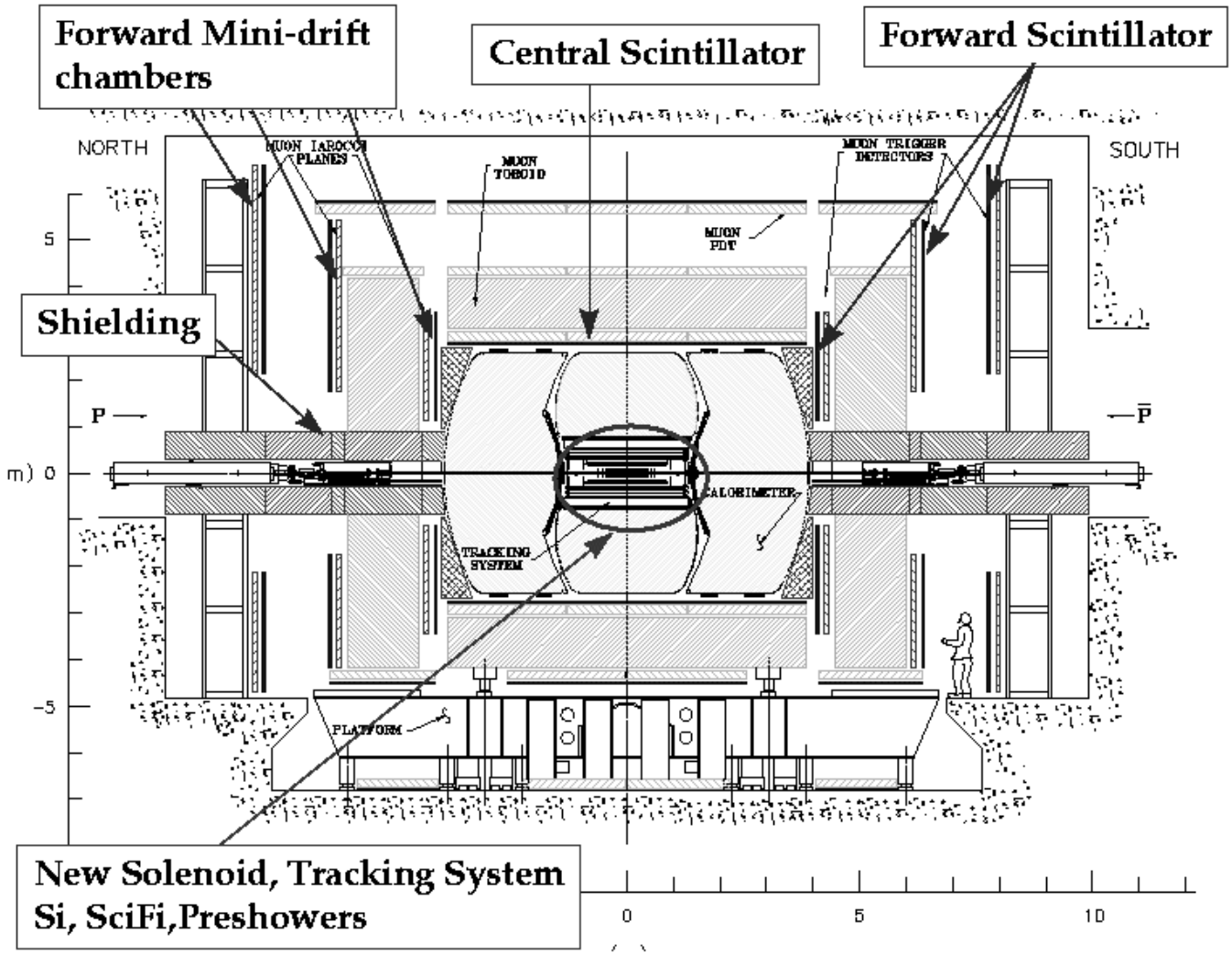
  (England, France, Holland, ...)



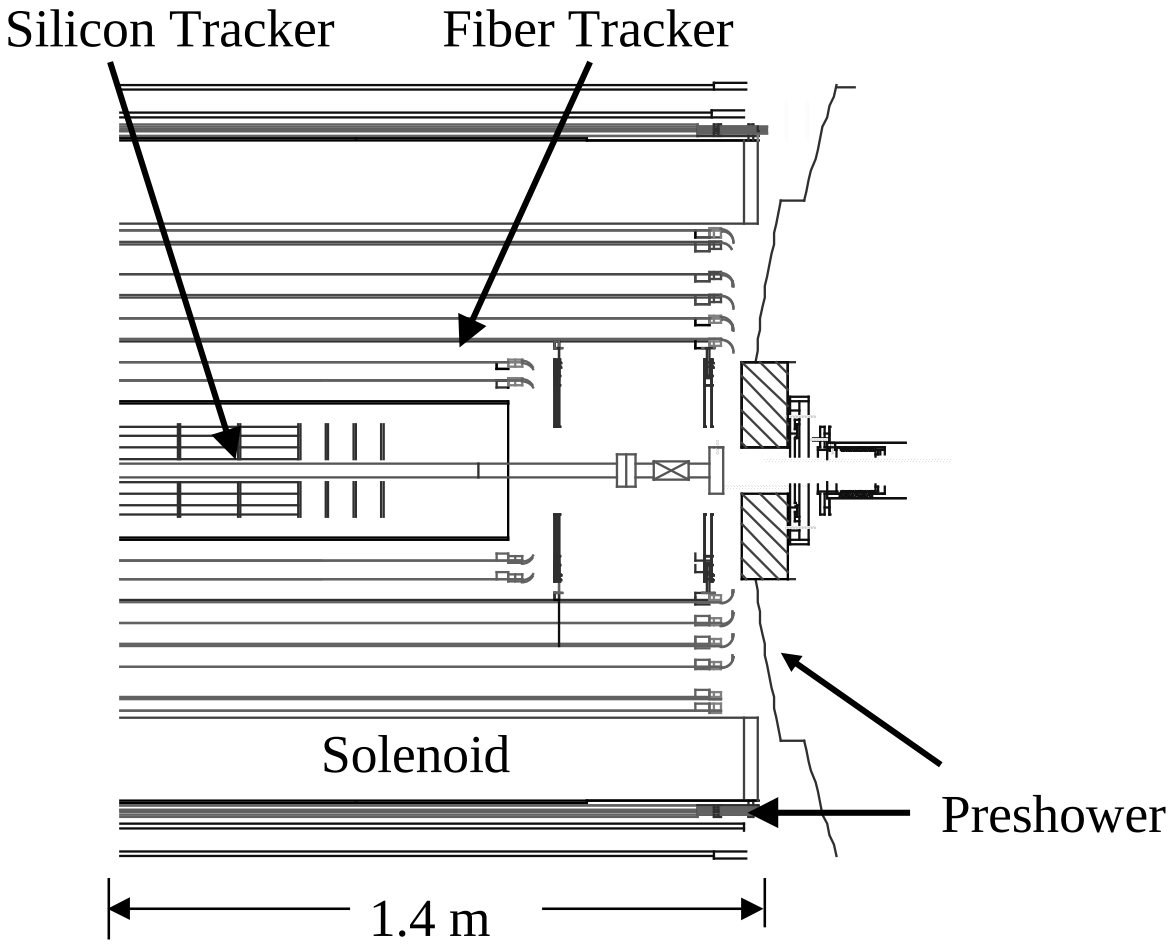
Detector Upgrade

- **Build on existing strengths to identify leptons, photons, and jets (calo + muon detector)**
- **Accomodate higher luminosity and shorter bunch spacing times (396 ns then 132 ns)**
  - **New tracking detectors**
  - **Improve muon systems**
  - **New readout electronics with pipeline storage**
  - **High rate trigger and DAQ system**
- **Add new capabilities to improve physics reach**
  - **Solenoid and Silicon**
  - **Displaced vertex（b quark)**

Upgrade

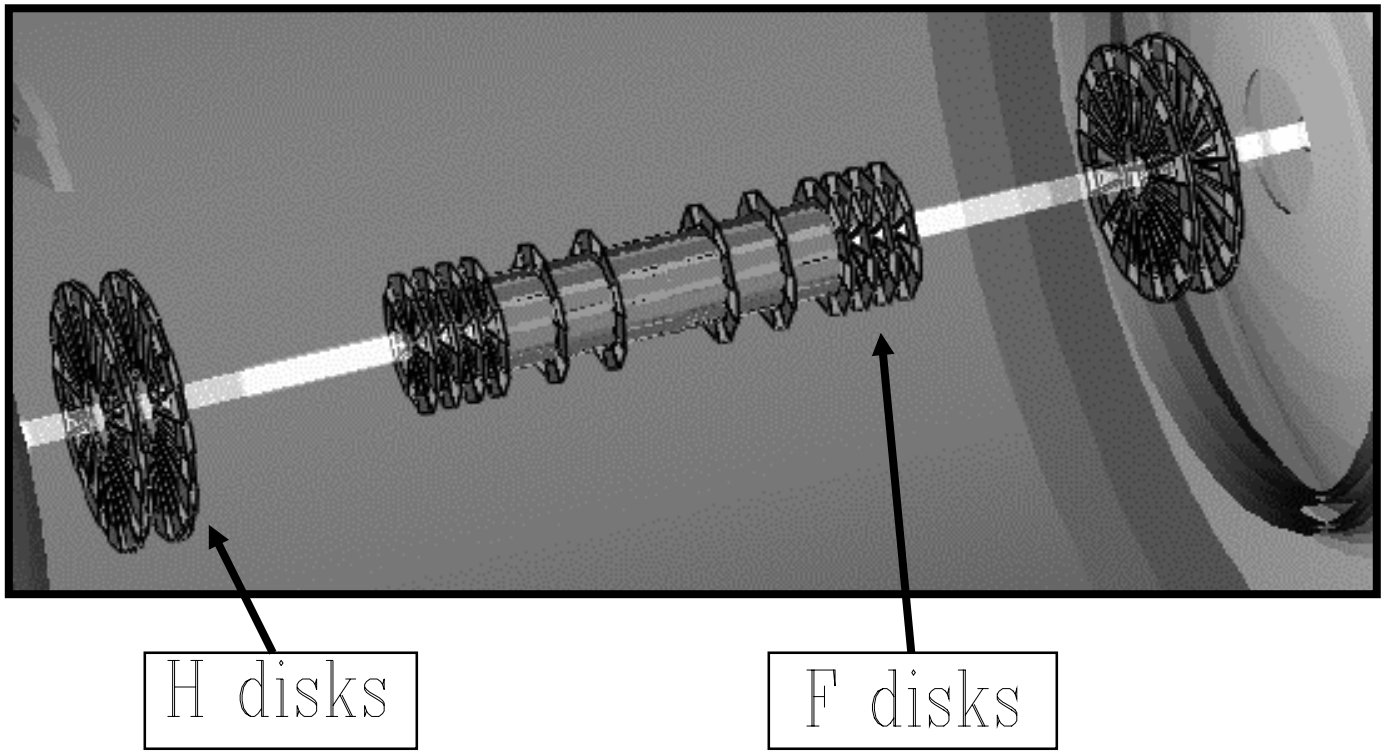

Forward Mini-drift chambers
Central Scintillator
Forward Scintillator
NORTH
SOUTH
MUON TOROID
MUON PDT
Shielding
P
$\bar{P}$
TRACKING SYSTEM
CALORIMETER
PLATFORM
New Solenoid, Tracking System
Si, SciFi,Preshowers
+ New Electronics, Trig, DAQ

Tracking System



* **840,000 channel silicon detector**
* **77,000 channel scintillating fiber tracker**
* **2 Tesla Superconducting coil**
* **Scintillating strip preshower in central and forward regions.**

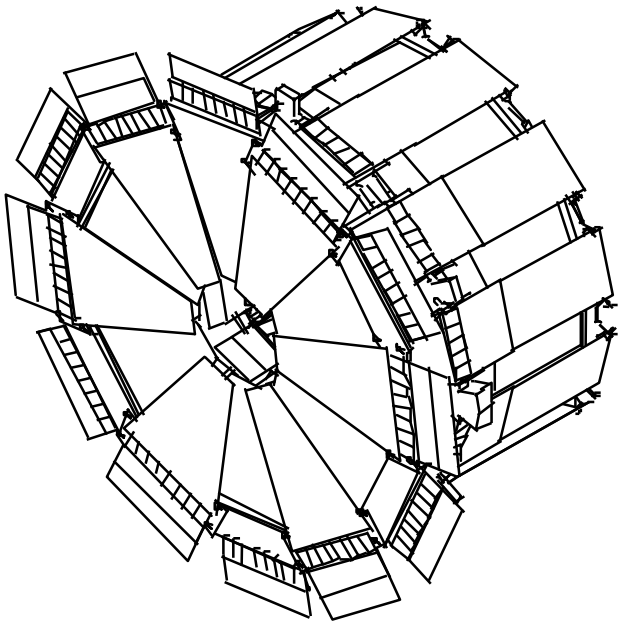
Silicon Detector



- Located in region from 2,5<r<10 cm
- Provide track reconstruction to η=2.5
- Detectors and associated readout must be radiation hard to ~ 1Mrad
- Provide point resolution of 10μm
- SVX II readout chip

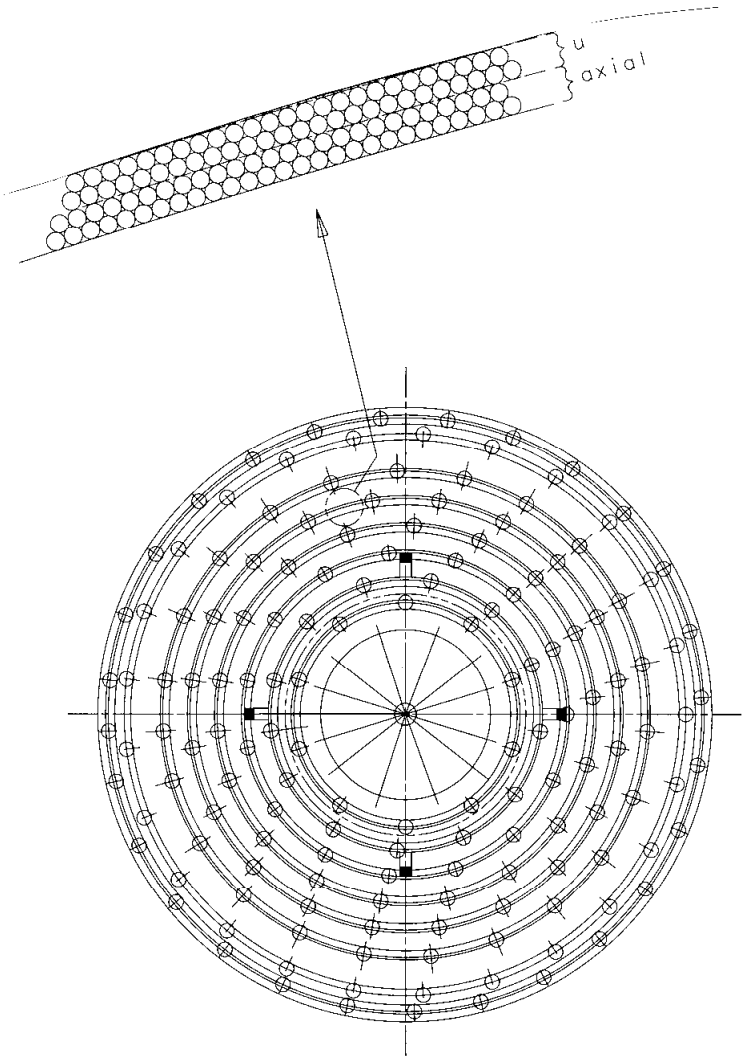
Silicon Tracker

Disk/barrel module



* **Central**
  - **4 layers double sided Si (rϕ plus 2° or 90° stereo)**
  - **Six 12 cm disk/barrel modules**
  - **50 and 62.5 μm pitch**
* **Forward**
  - **F disks ($\pm$ 15 ° stereo)**
  - **H disks ($\pm$ 7.5 ° stereo)**

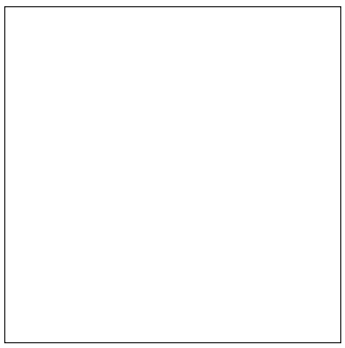
Fiber Layout



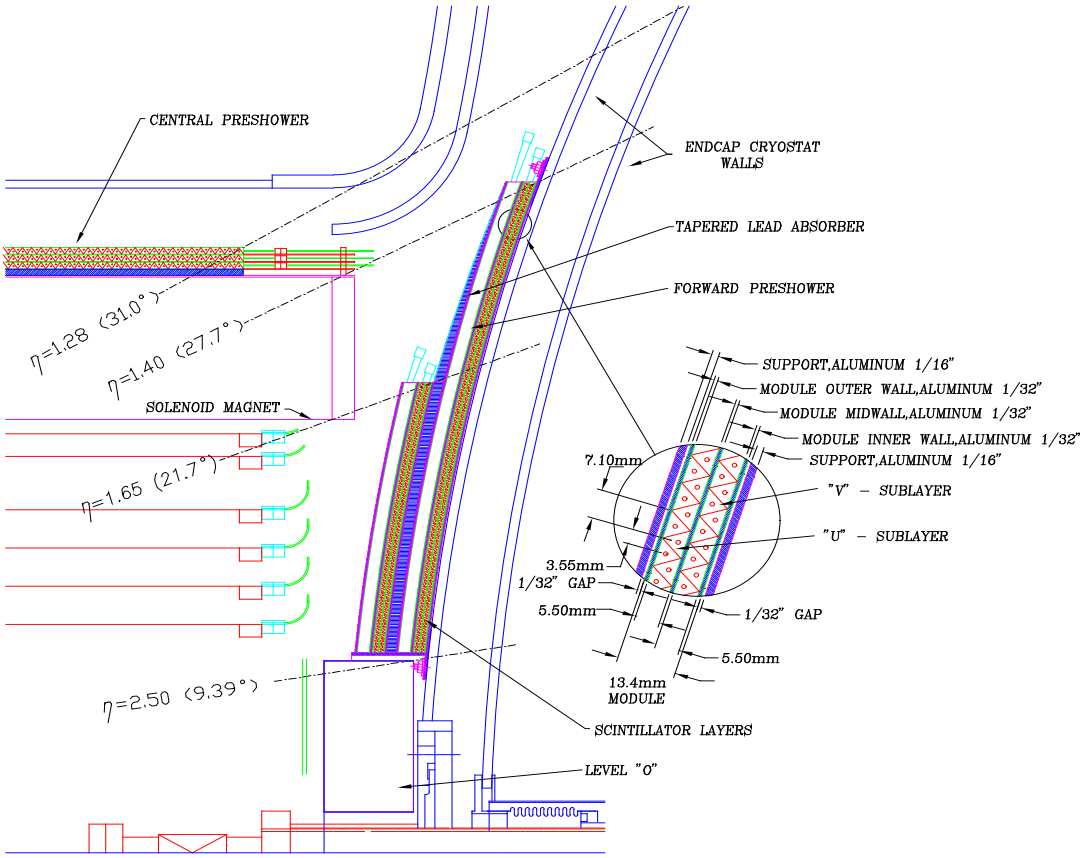
* **Axial doublet layers on each of 8 cylinders**
* **Alternate u or v stereo layers on successive cylinders**
* **VLPC and SVX II readout**

VLPC Photodetectors

* **Visible Light Photon Counters**
  - **Quantum efficiency of 80%**
  - **High efficiency even at 40 MHz background**
  - **Gain of 30,000**
  - **12 pe's per MIP**

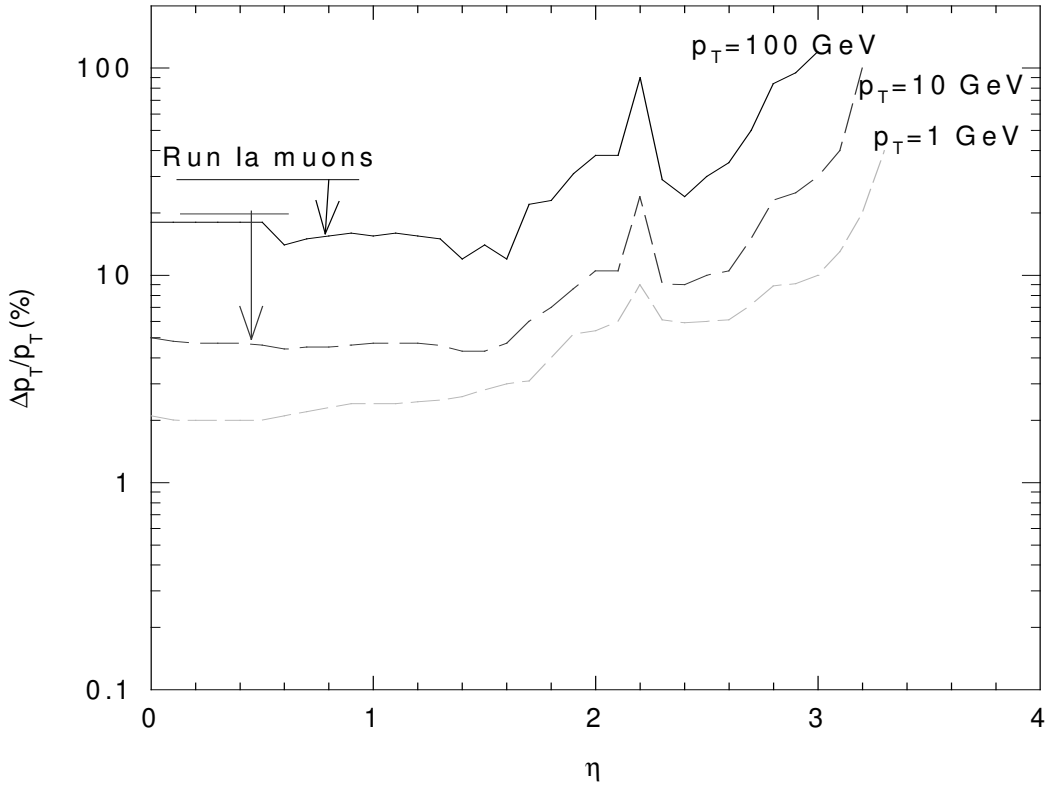


Preshower Detector



- **Central ($|\eta| < 1.2$) and forward ($1.4 < |\eta| < 2.5$) coverage**
- **Extruded triangular scintillator strips with embedded WLS fibers and Pb absorber**
- **VLPC and SVX II readout**

Tracker Performance



* **Combined Fiber, Silicon**

$\delta P_T/P_T^2$ = 0.002 (silicon + fiber tracker)

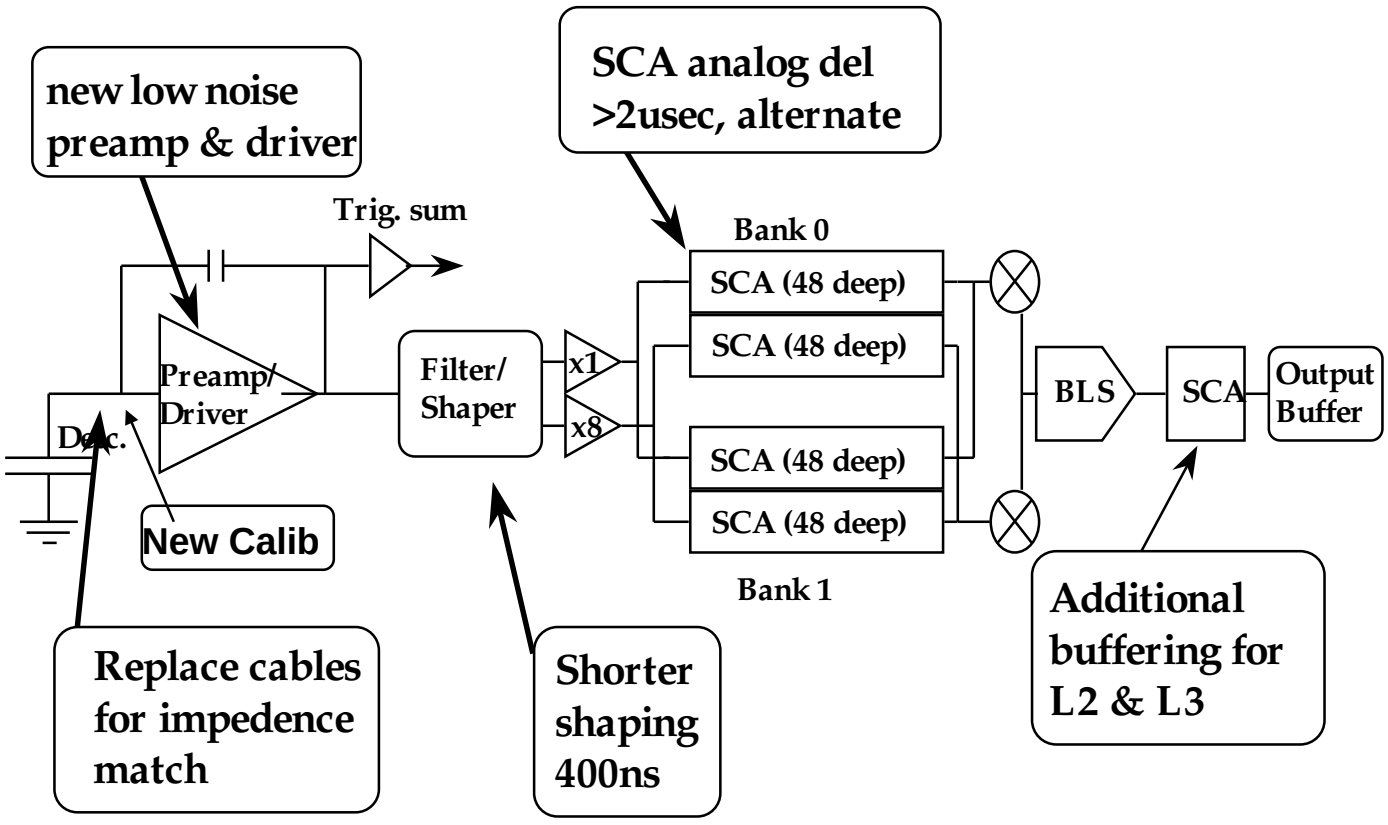
* **Mass resolutions**

30 MeV for J/PSI

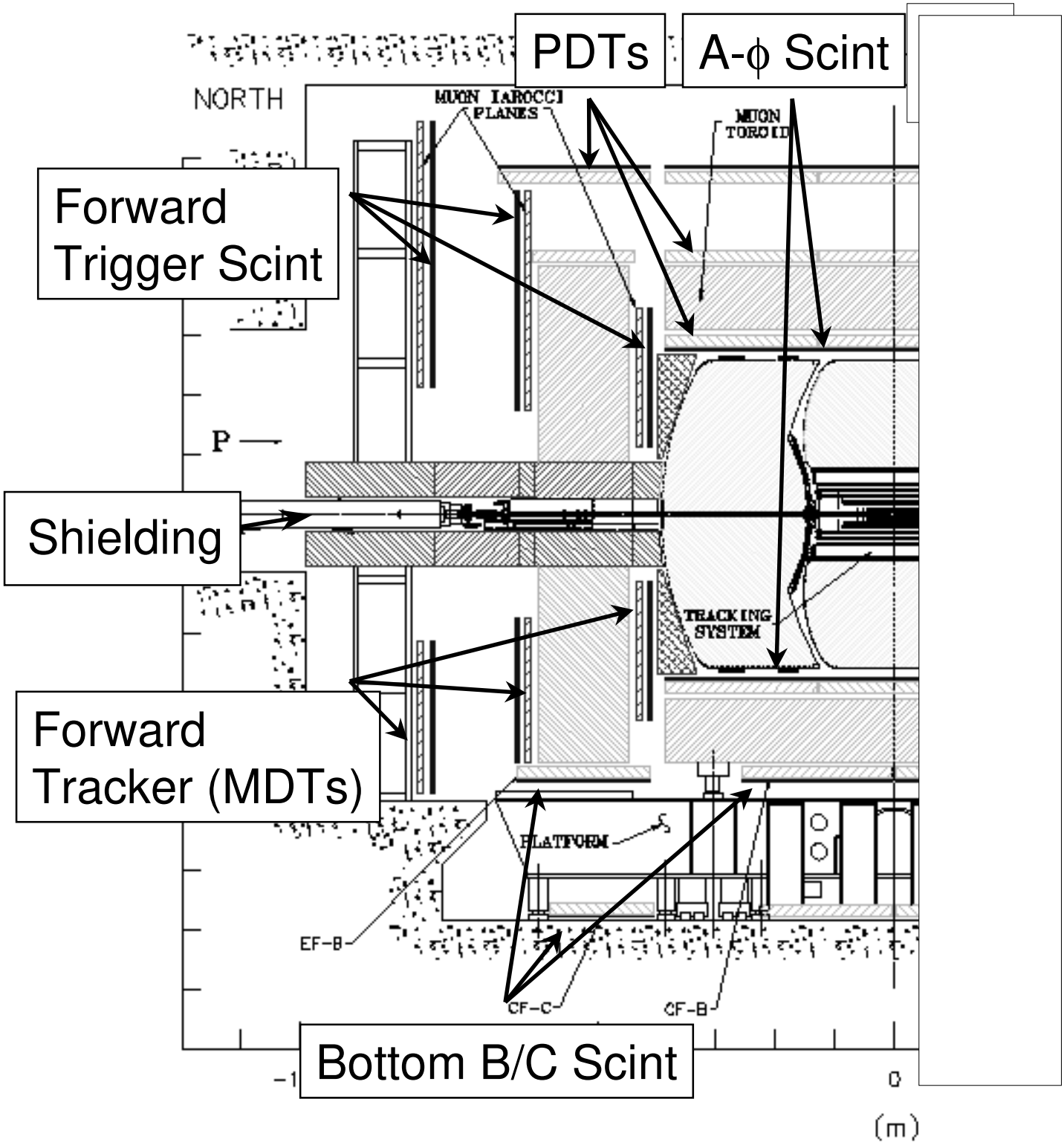
100 MeV for B mesons

Calorimeter Electronics

* **New bunch structure = new electronics**
  - **Shorter shaping time required to reduce pile-up**
    - Replace shaping circuits (BLS=baseline subtractor) with one matched to 400ns
  - **Analog delay required to pipeline signal until trigger is formed**
    - Use 48 element deep switched capacitor array (SCA)

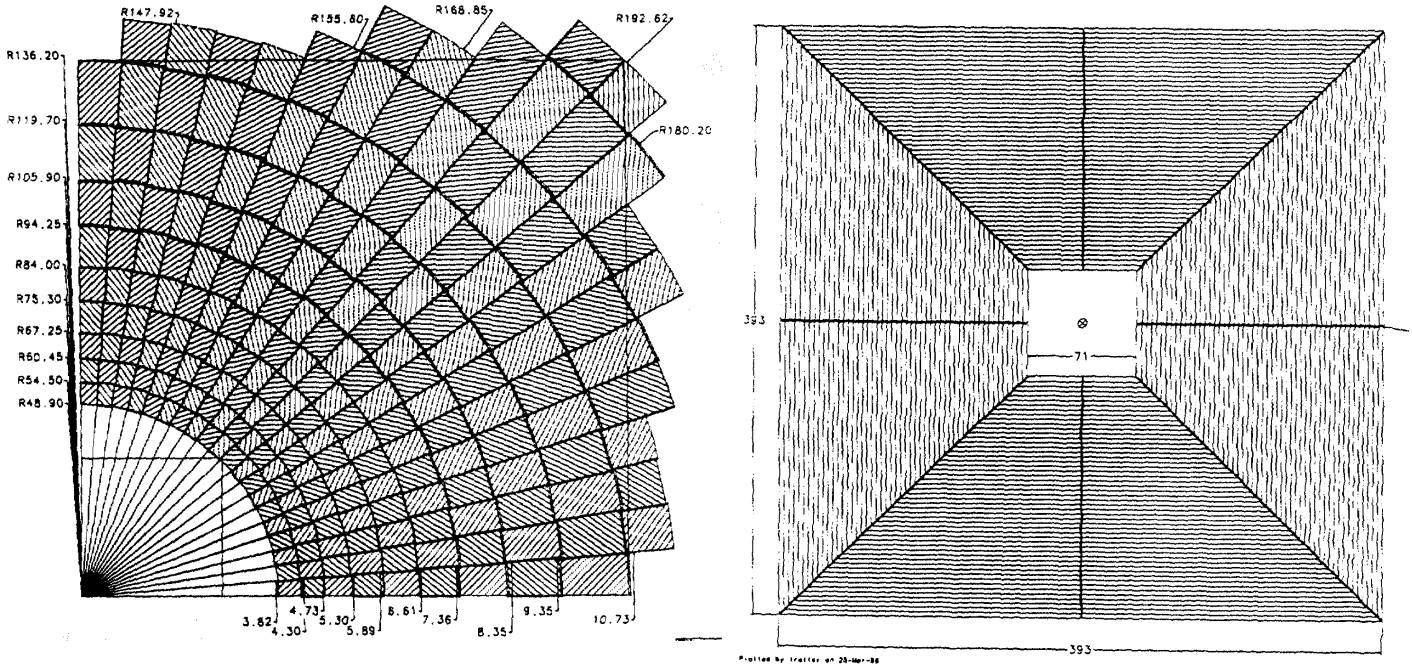


Muon System



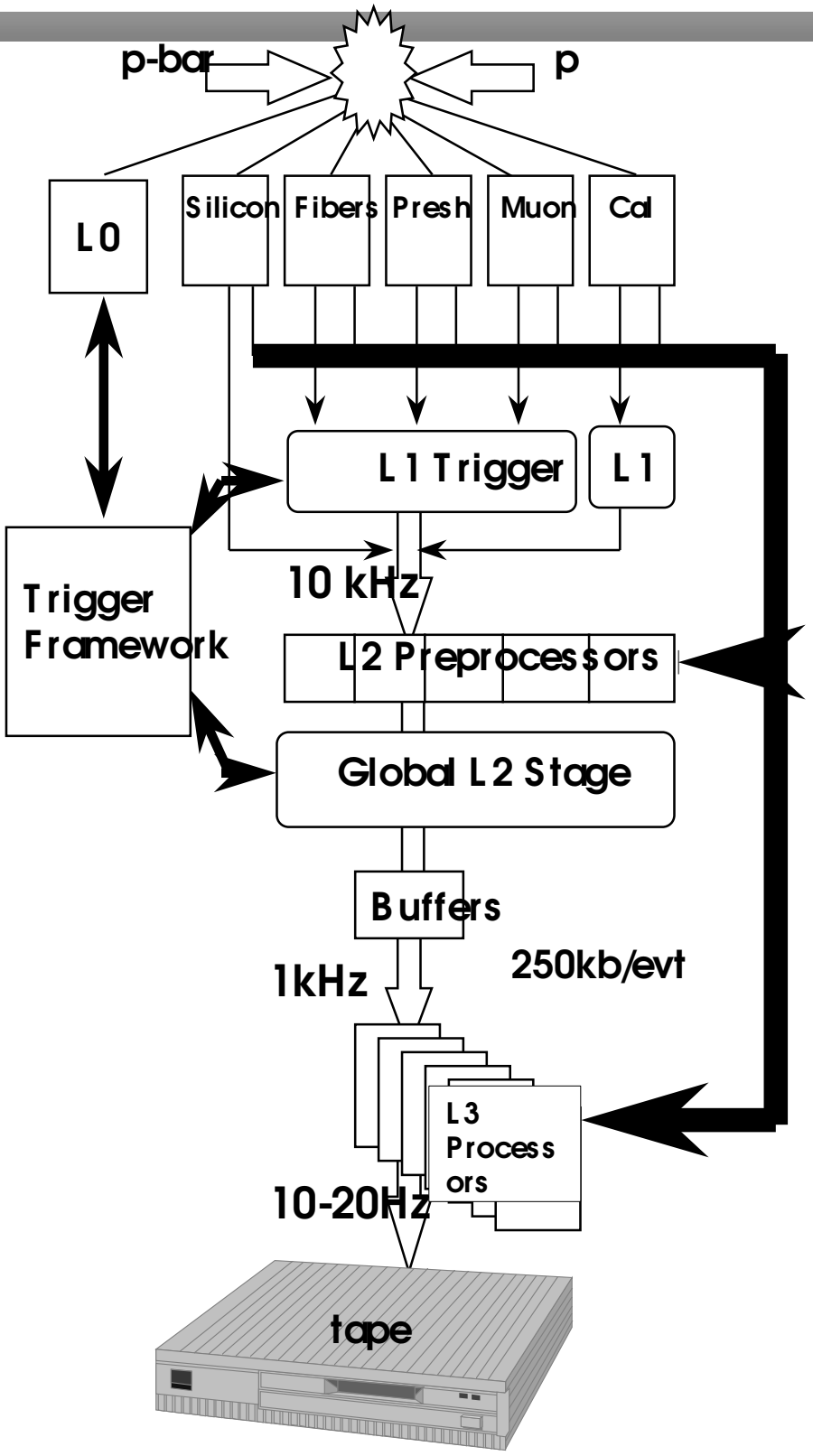
CP99

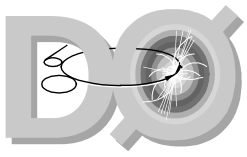
Forward Muon System



* **Forward triggering ($1 < |\eta| < 2$)**
  - **Counter sizes $\Delta\phi$ x $\Delta\eta$ = 4.5° x 0.1**
  - **3 layers to reduce combinatorics**
* **Forward tracking ($1 < |\eta| < 2$)**
  - **1 x 1 cm^2 eight cell Al extrusions**
  - **3 or 4 cell depth for each of three layers**
* **Substantial beamline shielding**

Trigger Architecture



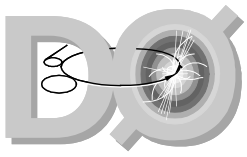


Silicon Track Trigger

* **Device Functionality**
  - **correlates hits in silicon detector at the the L2 trigger to the CFT trigger tracks**
  - **Fast track fit (SMT+CFT)**
    - improve momentum resolution
    - impact parameter determination

⇒ **Correlate high impact parameter tracks to b-jet tracks**

* **Physics benefits**
  - **High P_T physics**
    - top physics
    - Associated Higgs production
    - $Z \rightarrow b\bar{b}$ (calibration)
    - New particle searches (e.g. $\pi_T \rightarrow b\bar{b}$)
  - **B-physics**



Conclusions

* **The DØ upgrade builds on the good features of the Run I detector (hermeticity, coverage)**

* **Addition of high precision tracking system will enhance the physics capabilities in both the high p_T and B-physics areas.**

* **All systems are designed to run at high luminosity ($2*10^{32}$) and reduced bunch spacing (132ns)**

* **The DØ upgrade is on schedule**