

Status of Tevatron and D0

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September 6, 2002



D0 = detector at
interaction region D0



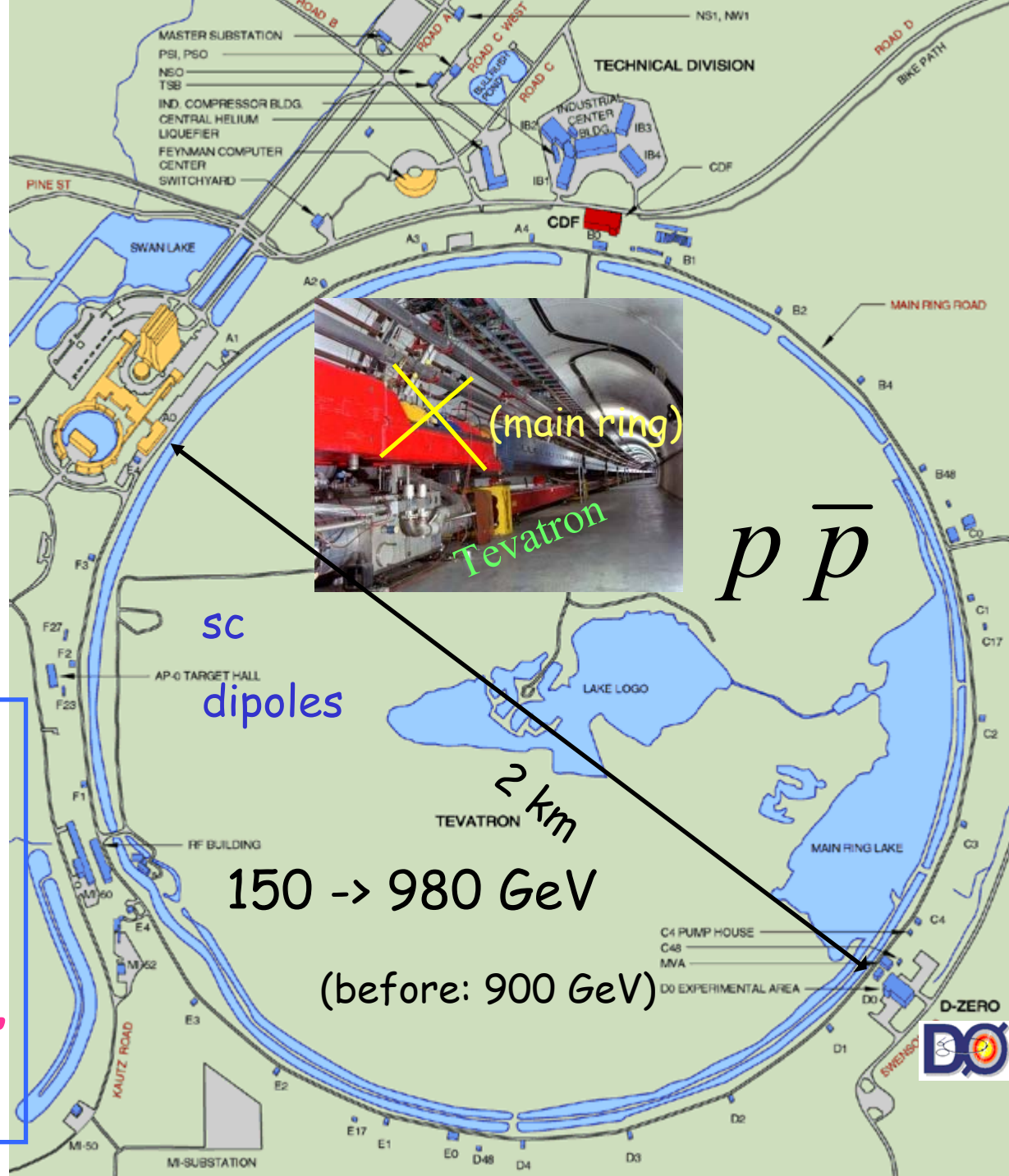
Tevatron = TeV machine

$p + \bar{p}$ 980 GeV each

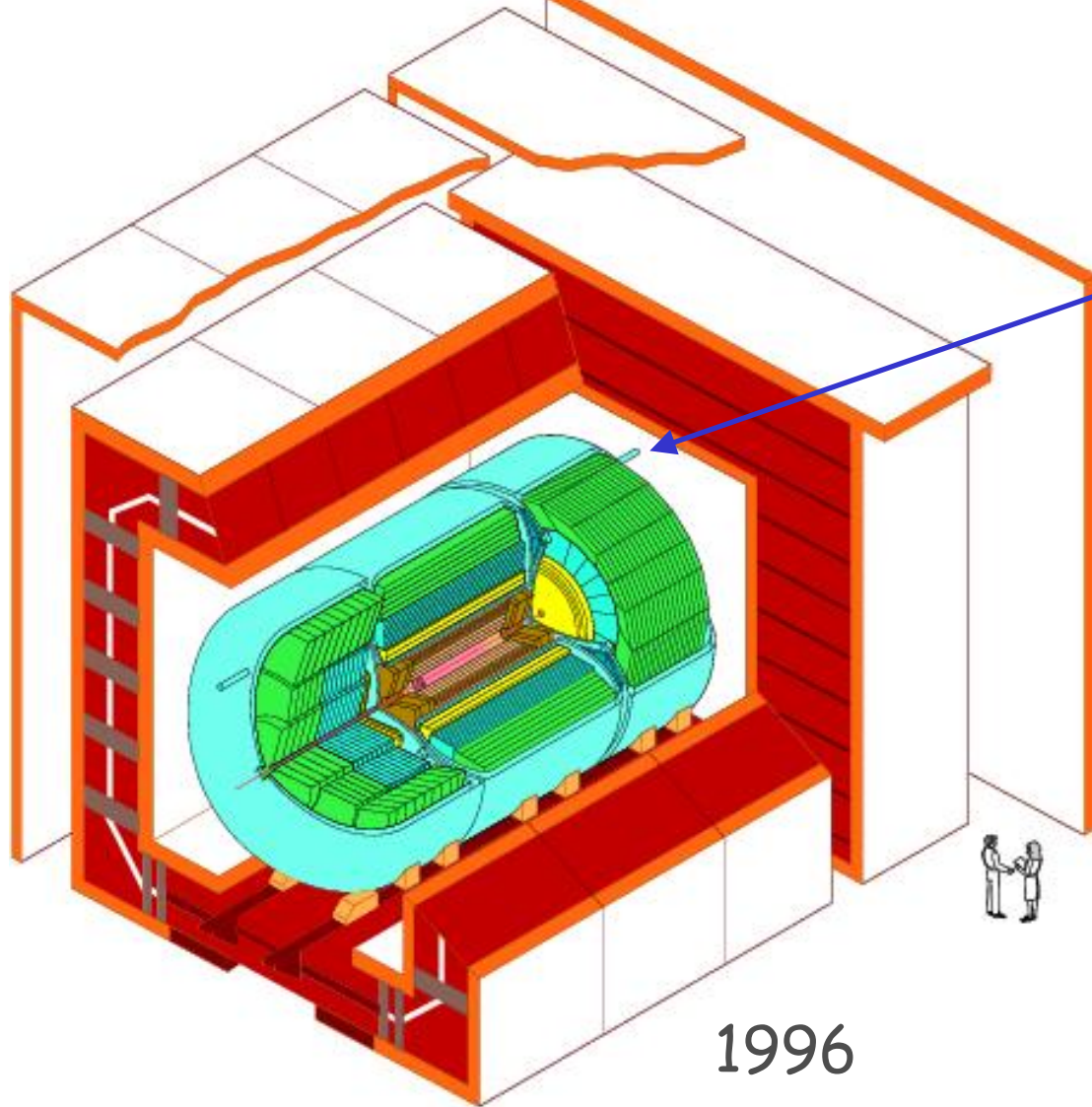
The Tevatron

major upgrade
1997-2000

8 → 150 GeV
antiprotons x 3
new
collects used antiprotons
recycler



Footnote: D0 and Main Ring



main ring
passes
through D0
calorimeter!

no magnetic
field in
central
detector!

noise and
beam losses!

1996

D0 Detector

(CDF: main ring lifted above detector)

Luminosity: History/Future

- 1992-1996: Run I (1.8 TeV): $L \sim 2 \cdot 10^{31} / \text{cm}^2 / \text{s}$
 total $\sim 100/\text{pb}$ per detector
 > 100 publications per experiment
 (compare: LEP I $\sim 100/\text{pb}$, LEP II $\sim 500/\text{pb}$, HERA I $\sim 100/\text{pb}$)

- 2001-2004: Run II a (2.0 TeV): $L \rightarrow 2 \cdot 10^{32} / \text{cm}^2 / \text{s}$
 goal: luminosity increase by factor 10
 total $\sim 2/\text{fb}$ per detector
- 2005-2007: Run II b: $L \rightarrow 4 \cdot 10^{32} / \text{cm}^2 / \text{s}$
 goal: luminosity increase by factor 2
 total $\sim 15/\text{fb}$ per detector

Luminosity Upgrade for Run II

$$L \sim \frac{B \cdot n_p \cdot n_{\bar{p}}}{\beta^* \cdot \mathcal{E}}$$

for each
interaction zone

B = number of bunches per beam

n = number of particles per bunch

β^* = beta function at interaction point

\mathcal{E} = emittance

Run Ib:

6

$2 \cdot 10^{11}, 0.5 \cdot 10^{11}$

35 cm

$\sim 20\pi$ mm mrad

Luminosity Upgrade for Run II

$$L \sim \frac{B \cdot n_p \cdot n_{\bar{p}}}{\beta^* \cdot \mathcal{E}}$$

for each
interaction zone

Run Ib:

6

$2 \cdot 10^{11}, 0.5 \cdot 10^{11}$

35 cm

$\sim 20\pi$ mm mrad

- + B = number of bunches per beam
- x n = number of particles per bunch
- 0 β^* = beta function at interaction point
- x \mathcal{E} = emittance

x n, \mathcal{E} limited by beam-beam instabilities!

0 reduction below bunch length (60cm) not helpful

+ YES! implies: $B \cdot n_p$ increases: need more \bar{p}

Luminosity Upgrade for Run IIa (goals)

- increase antiproton production rate by factor 3.5

Antiproton source/booster (8 GeV) $\rightarrow 2 \cdot 10^{11} / \text{hour}$

Main injector (8-150 GeV)

Tevatron: **increase number of bunches from 6+6 to 36+36**
bunch spacing now 396 ns

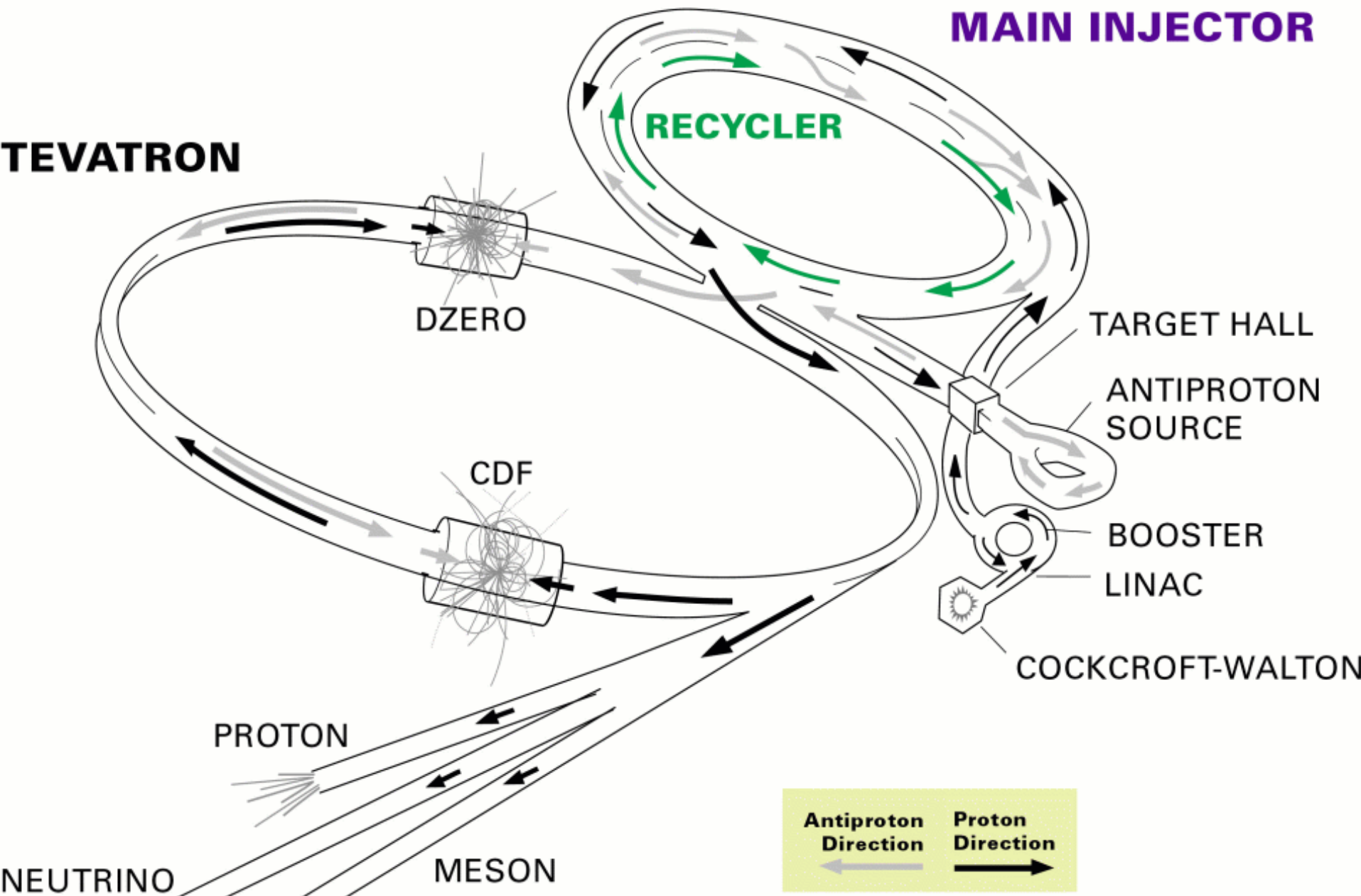
- several smaller improvements: L higher by factor 1.5

Tevatron (150-1000 GeV)

- reuse antiprotons at end of store (=fill): increase L by > 2

Recycler (9 GeV)

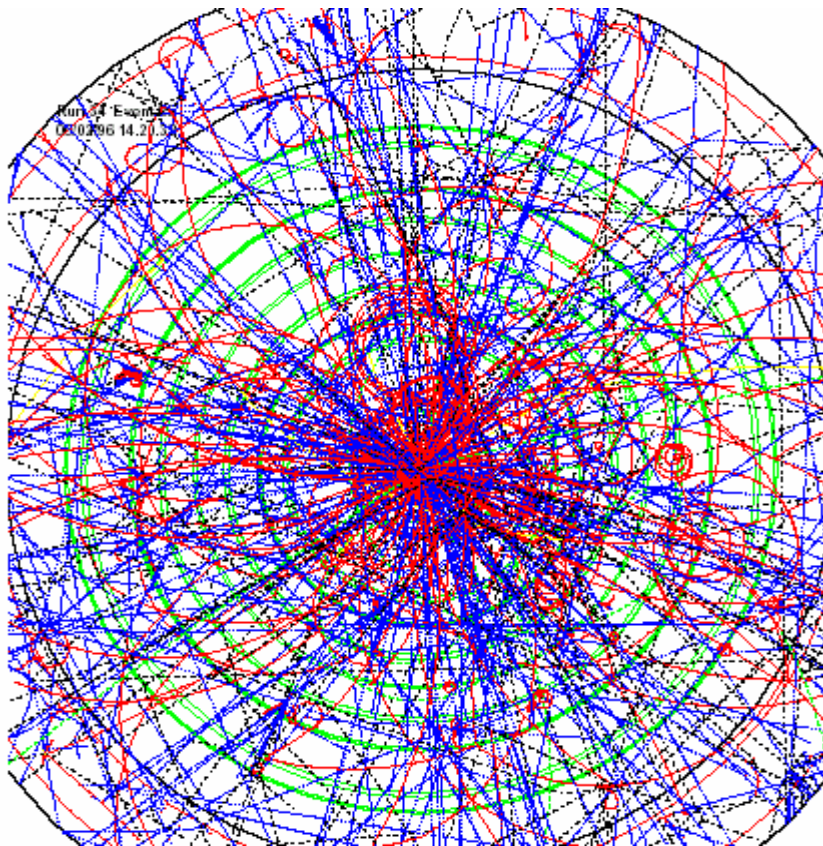
FERMILAB'S ACCELERATOR CHAIN



Accelerator Upgrade and Experiments

bunch spacing reduced from ~ 3000 to ~ 400 ns

+ number of interactions per crossing limited to ~ 5

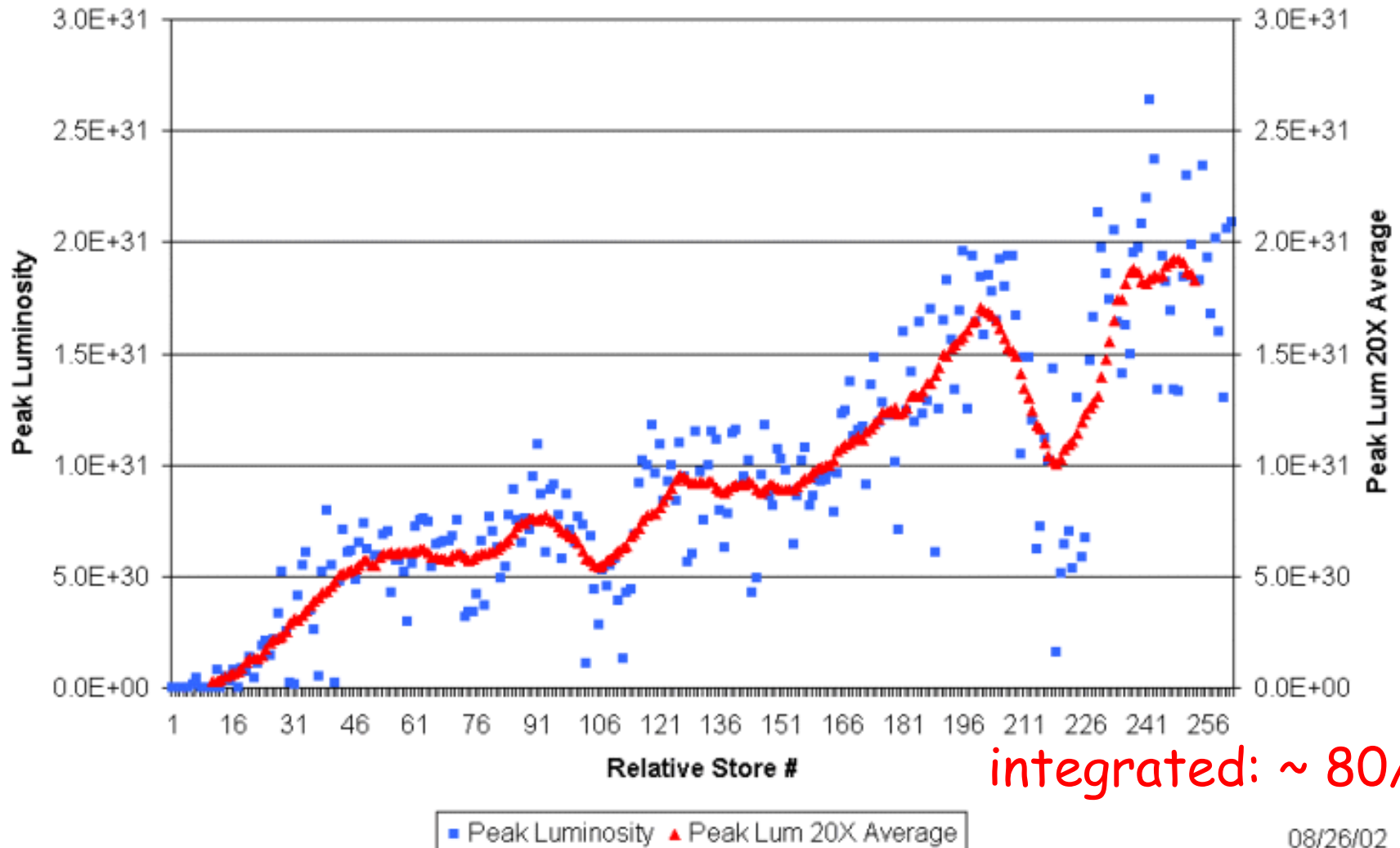


- need new detector
electronics/
trigger/DAQ

Luminosity Run IIa (August 2002)

planned: $1 \cdot 10^{32} / \text{cm}^2 / \text{s}$ achieved: $2 \cdot 10^{31} / \text{cm}^2 / \text{s}$

Collider Run IIA Peak Luminosity



integrated: $\sim 80/\text{pb}$

Problems and Solutions

missing:

factor 2

- Antiproton production rate low

accumulator emittance large cooling upgrade

Low transfer efficiencies between accelerators

factor 2

several causes

.....

- No antiproton recycling yet

factor 2

recycler not yet ready

2003

factor ~10

The D0 Experiment



Aachen IIIa:

C. Autermann

D. Käfer

A. Meyer (12/02)

M. Wegner

T.Hebbeker

D0 Collaboration



U. of Arizona
 U. of California, Berkeley
 U. of California, Irvine
 U. of California, Riverside
 Cal State U., Fresno
 Lawrence Berkeley Nat. Lab.
 Florida State U.
 Fermilab
 U. of Illinois, Chicago
 Northern Illinois U.
 Northwestern U.
 Indiana U.
 U. of Notre Dame
 Iowa State U.
 U. of Kansas
 Kansas State U.
 Louisiana Tech U.
 U. of Maryland
 Boston U.
 Northeastern U.
 U. of Michigan
 Michigan State U.
 U. of Nebraska
 Columbia U.
 U. of Rochester
 SUNY, Stony Brook
 Brookhaven Nat. Lab.
 Langston U.
 U. of Oklahoma
 Brown U.
 U. of Texas, Arlington
 Texas A&M U.
 Rice U.
 U. of Virginia
 U. of Washington



INP, Kraków



U. de Buenos Aires



Charles U., Prague
 Czech Tech. U., Prague
 Academy of Sciences, Prague



LAFEX, CBPF, Rio de Janeiro
 State U. do Rio de Janeiro
 State U. Paulista, São Paulo



U. San Francisco de Quito



IHEP, Beijing



ISN, IN2P3, Grenoble
 CPPM, IN2P3, Marseille
 LAL, IN2P3, Orsay
 LPNHE, IN2P3, Paris
 DAPNIA/SPP, CEA, Saclay
 IReS, Strasbourg
 IPN, IN2P3, Villeurbanne



U. de los Andes, Bogotá



U. of Aachen
 Bonn U.
 IOP, U Mainz
 Ludwig-Maximilians U, Munich
 U. of Wuppertal

The DØ Collaboration



Panjab U., Chandigarh
 Delhi U., Delhi
 Tata Institute, Mumbai



KDL, Korea U., Seoul



CINVESTAV, Mexico City



FOM-NIKHEF, Amsterdam
 U. of Amsterdam/NIKHEF
 U. of Nijmegen/NIKHEF



Lund U.
 RIT, Stockholm
 Stockholm U
 Uppsala U.



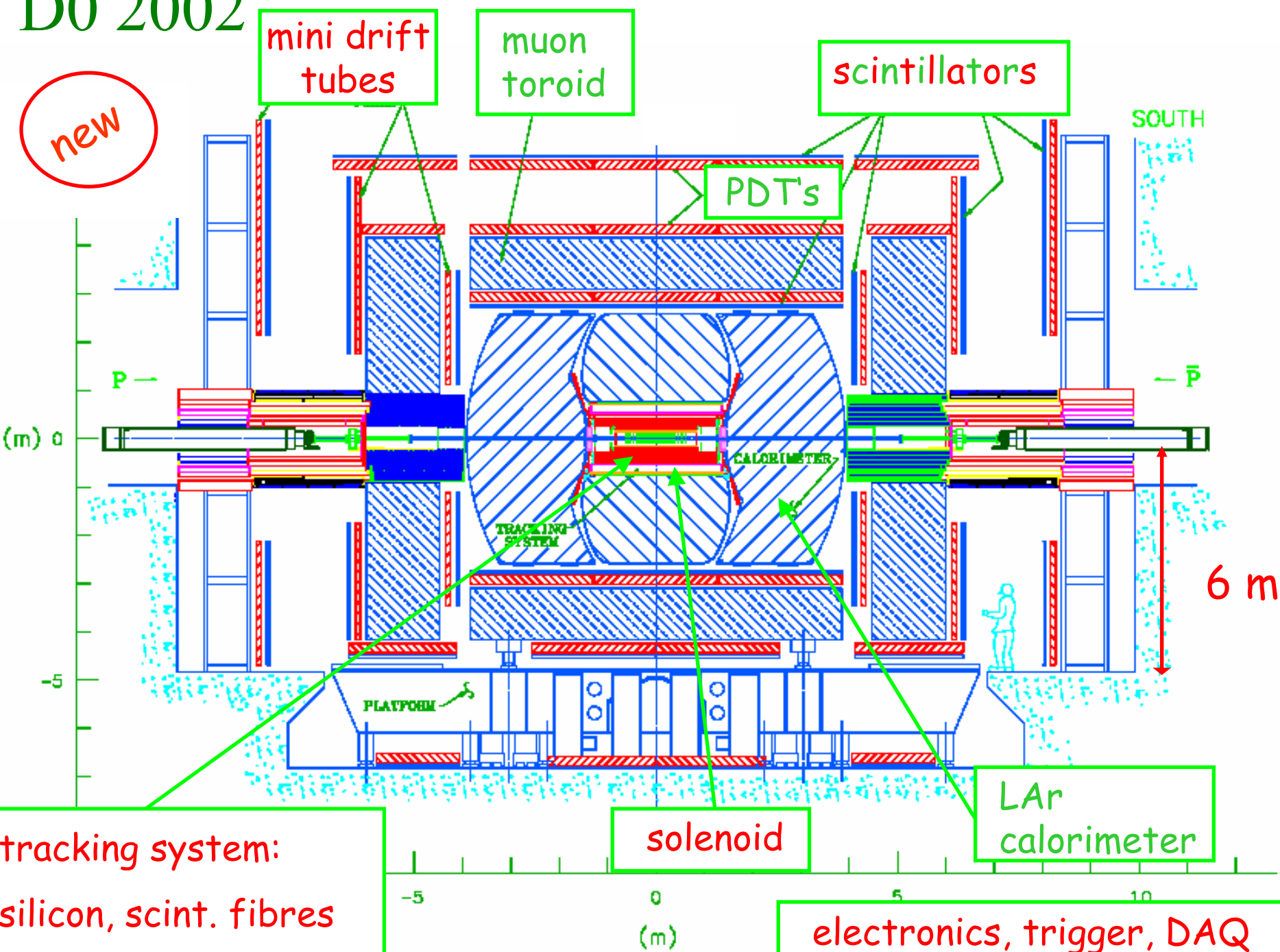
Lancaster U.
 Imperial College, London
 U. of Manchester



HCIP, Hochiminh City

D0 2002

new



mini drift tubes

muon toroid

scintillators

PDT's

SOUTH

P

P

(m) 0

CALORIMETER

TRACKING SYSTEM

6 m

-5

PLATFORM

LAr calorimeter

tracking system:
silicon, scint. fibres

solenoid

electronics, trigger, DAQ

-5

0

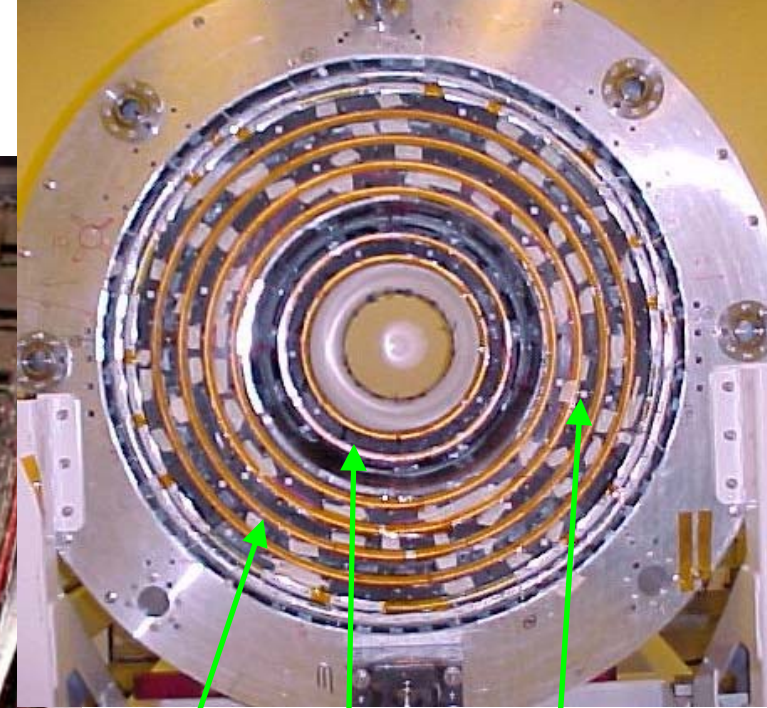
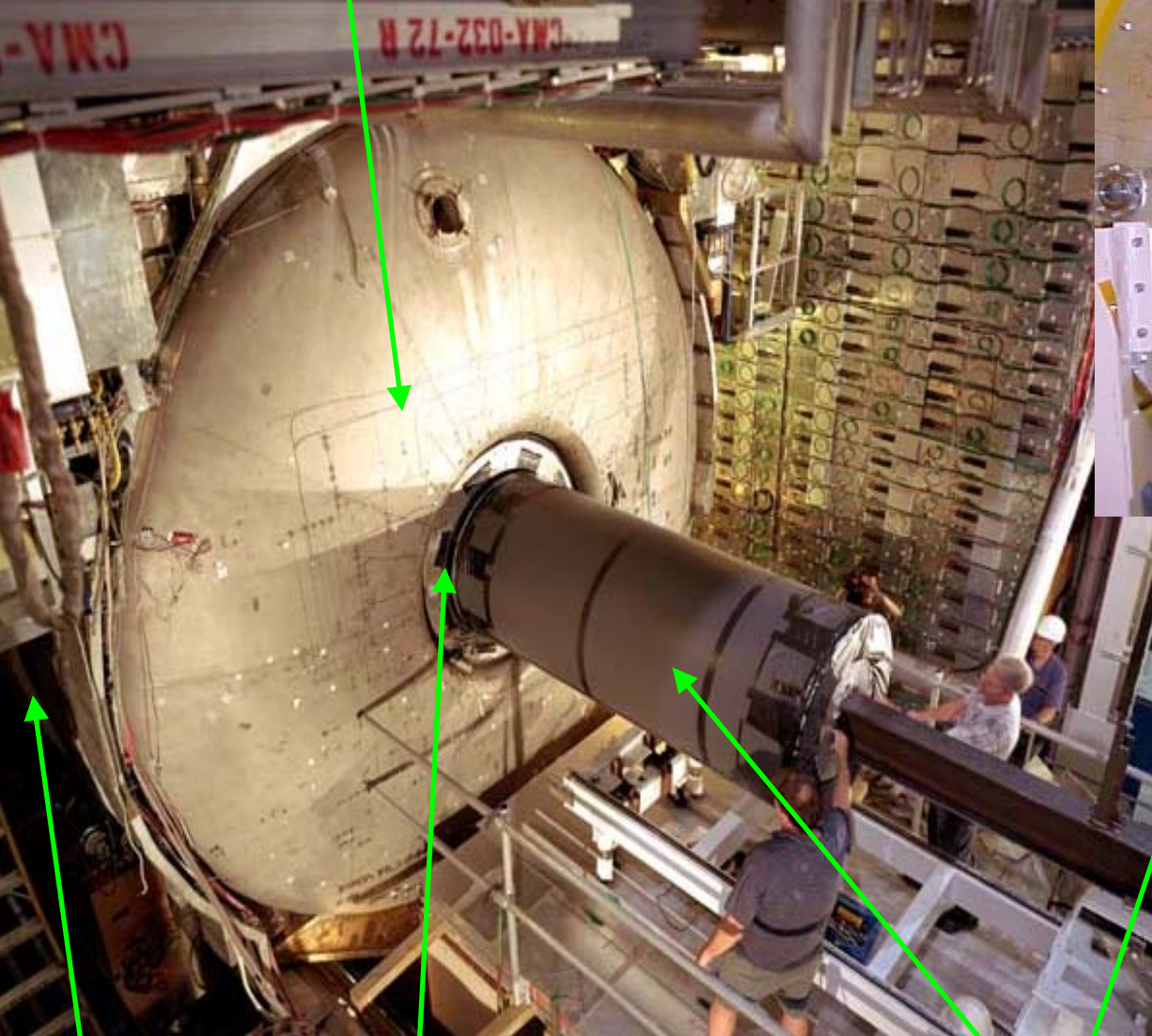
(m)

5

10

liquid argon calorimeter

D0 assembly



toroid

solenoid

tracking system

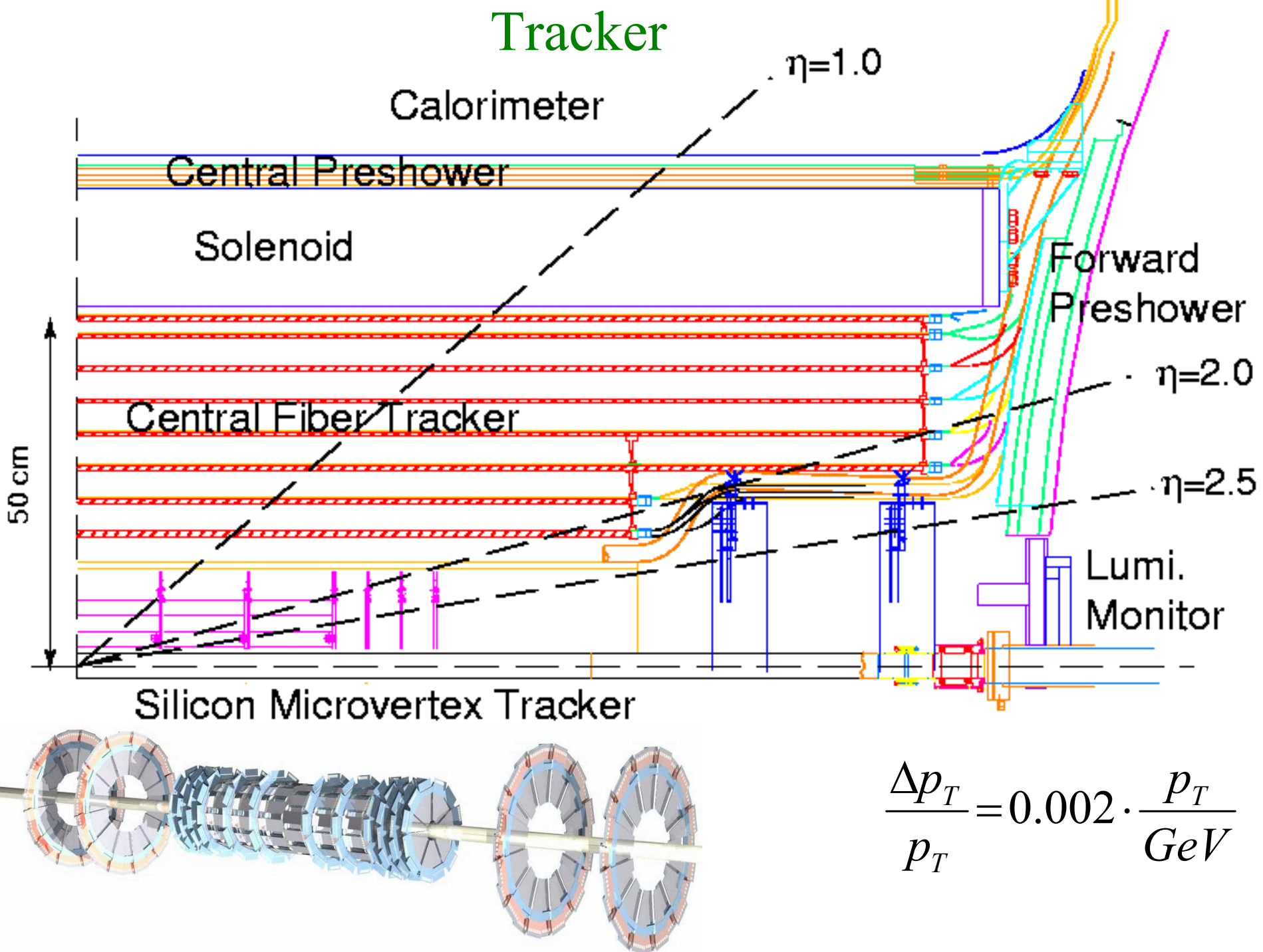
{ silicon
 scint. fibres + VLPC

D0 detector

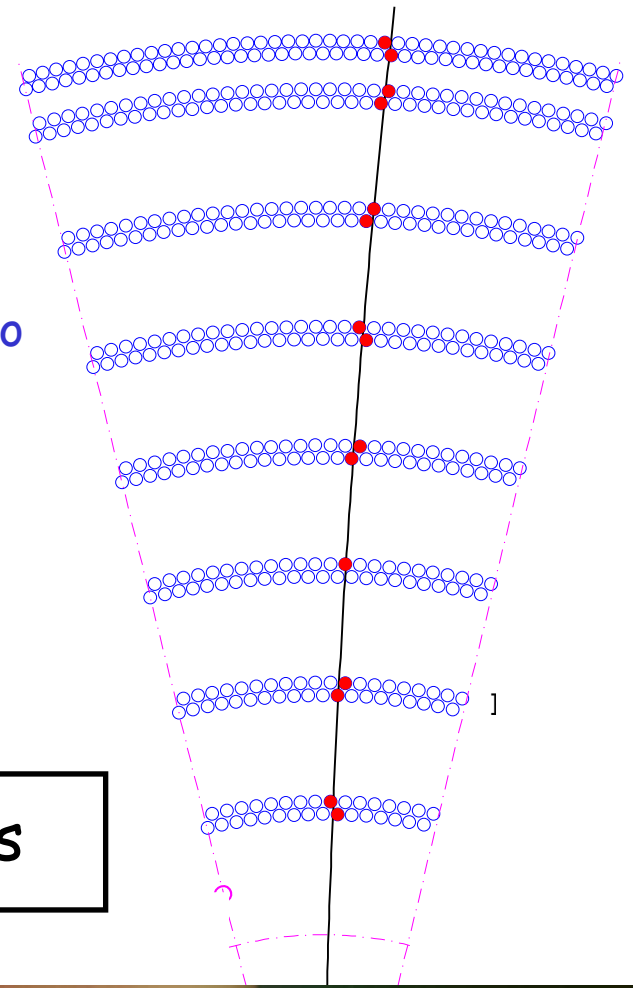
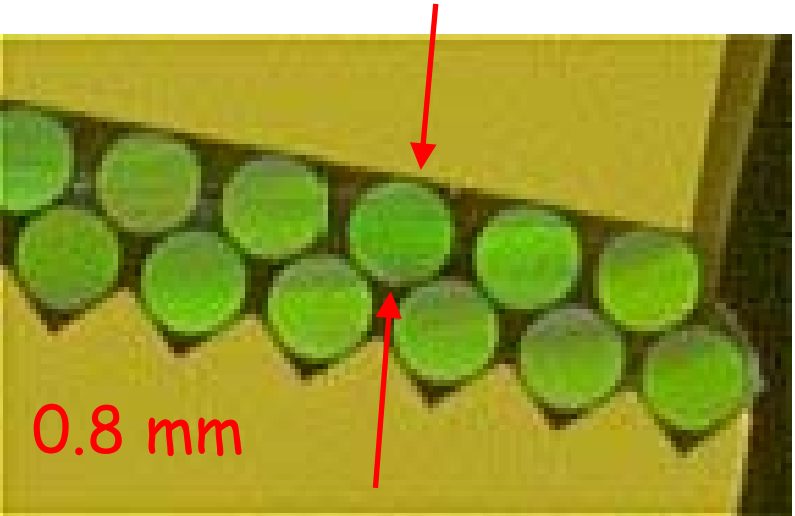


scintillators

muon chambers



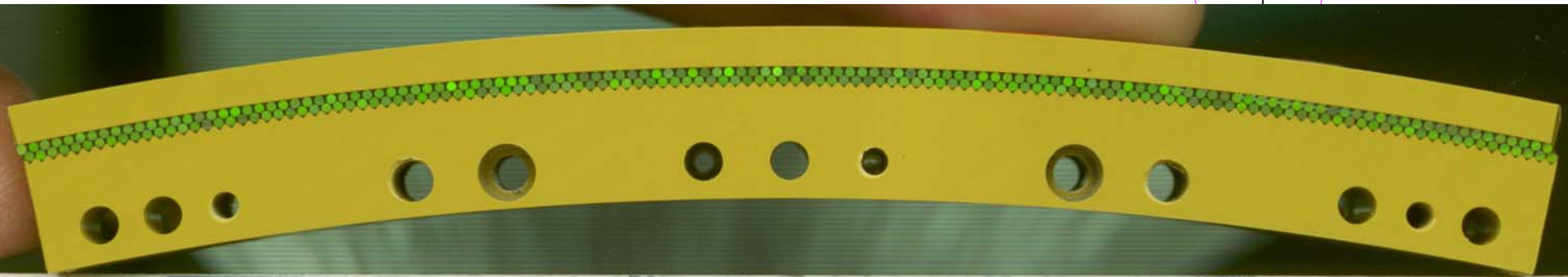
Fiber Tracker



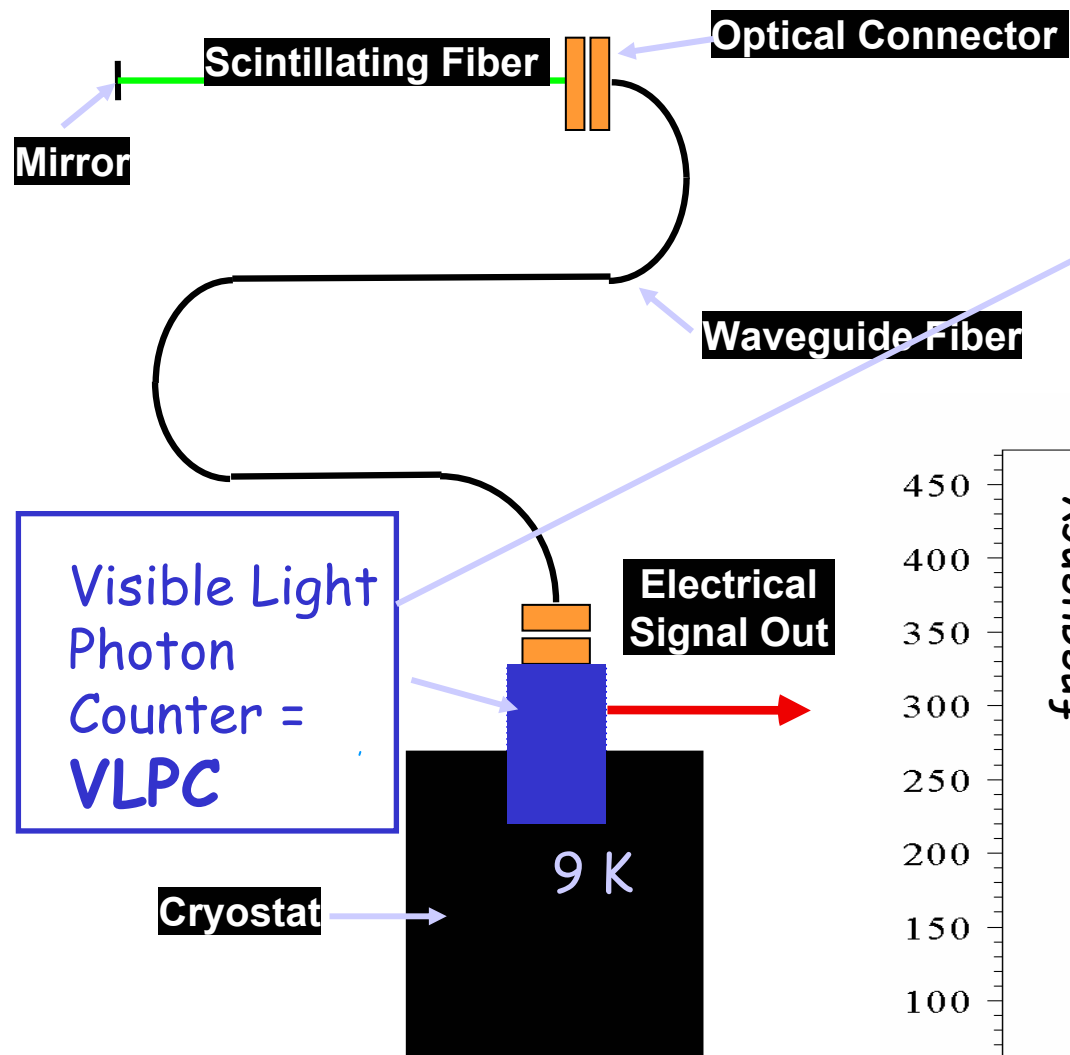
(+ stereo layers)

resolution $\sim 100 \mu$

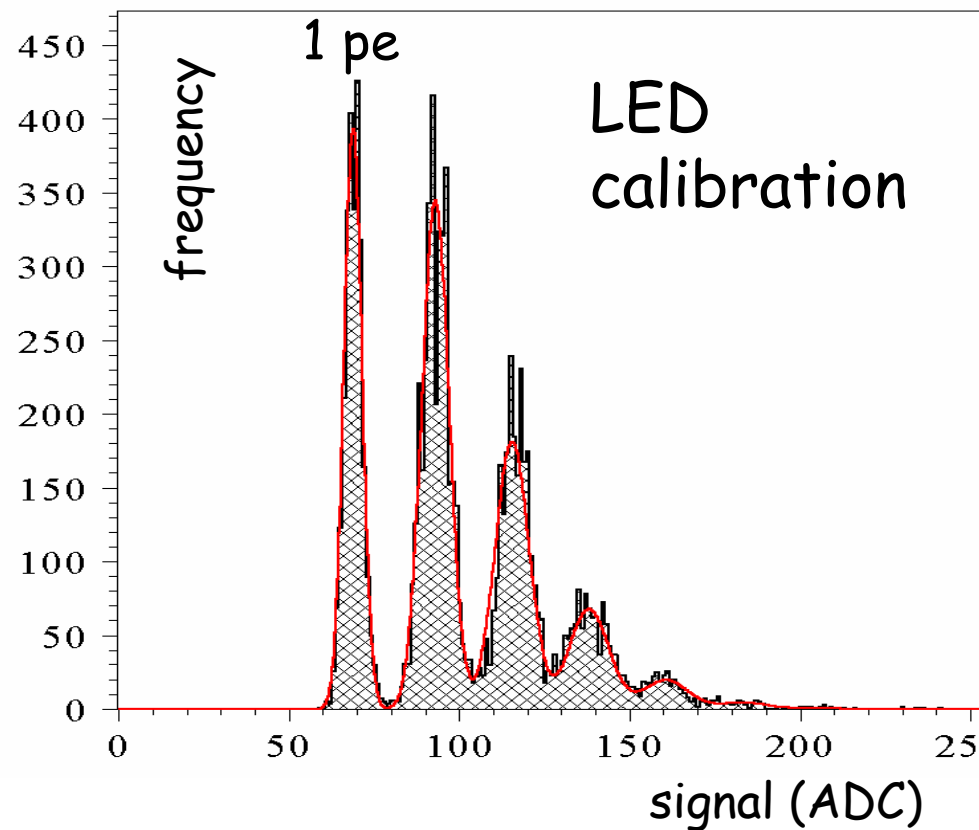
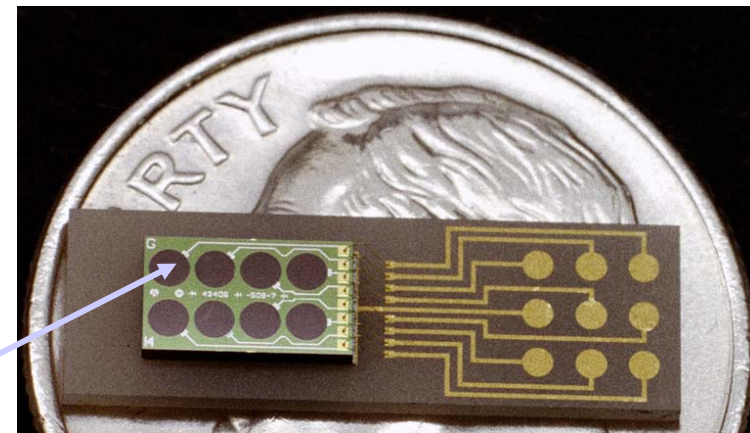
total of 77000 scintillating fibres



Fiber Readout



quantum efficiency 70-80%

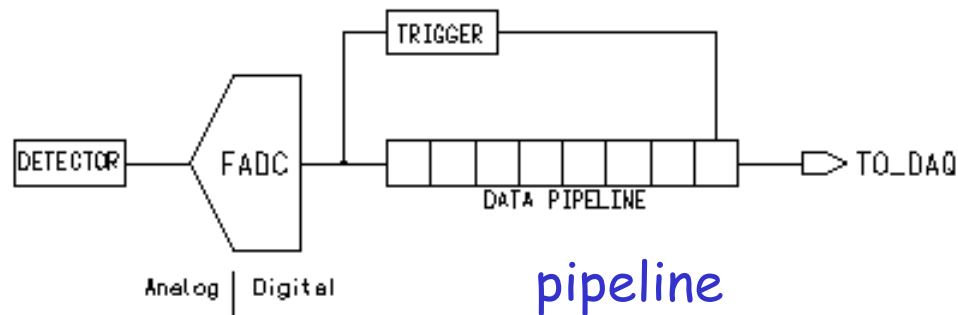


D0 trigger and DAQ

Trigger:

- level 1:

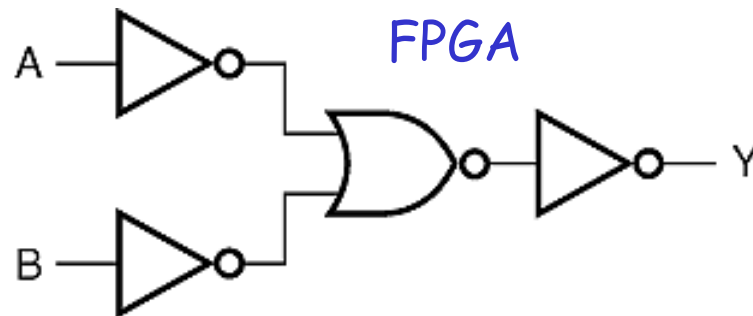
pipelined, FPGAs
3 MHz \rightarrow 10 kHz



"Pipeline" Electronics

- level 2:

DEC alpha processors
10 kHz \rightarrow 1 kHz



- level 3:

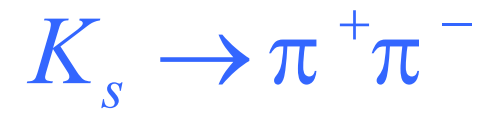
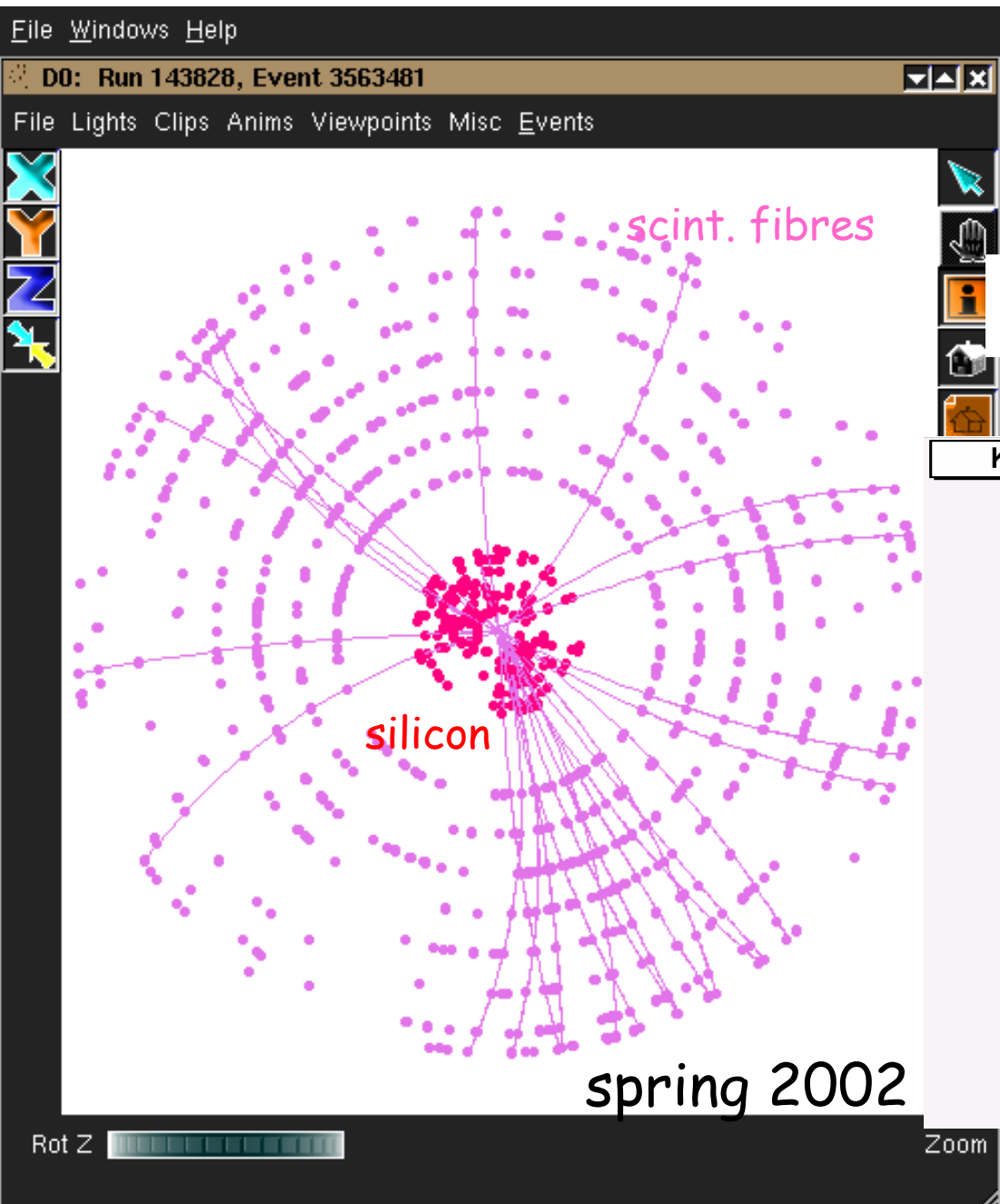
Linux PC farm
1 kHz \rightarrow 50 Hz

Aachen: (M. Grünewald), M. Wegner

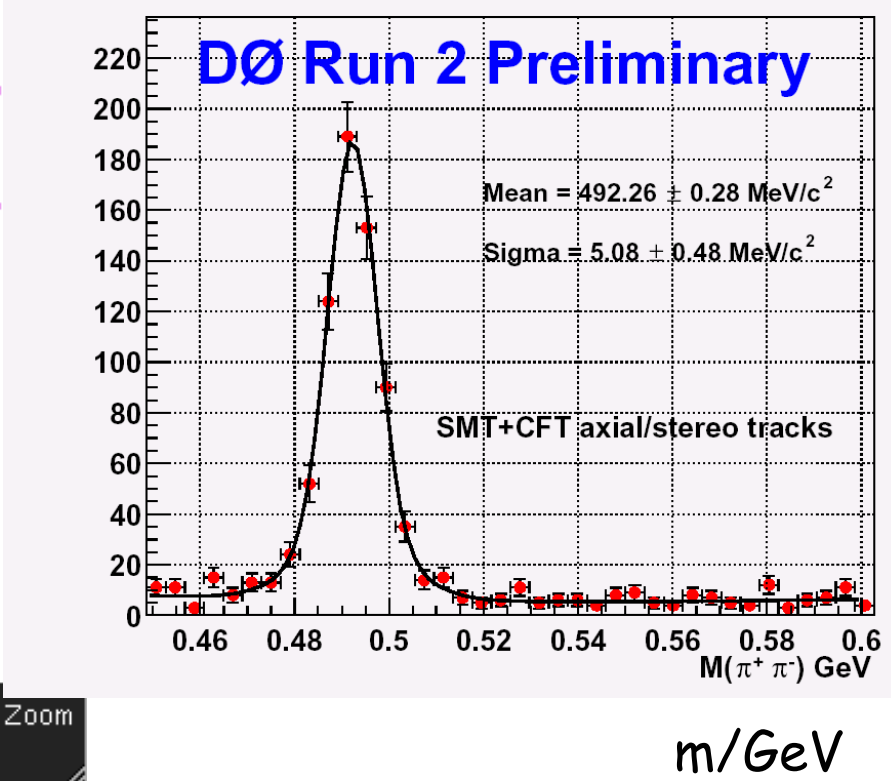
DAQ:

◇ pentium processors in VME system

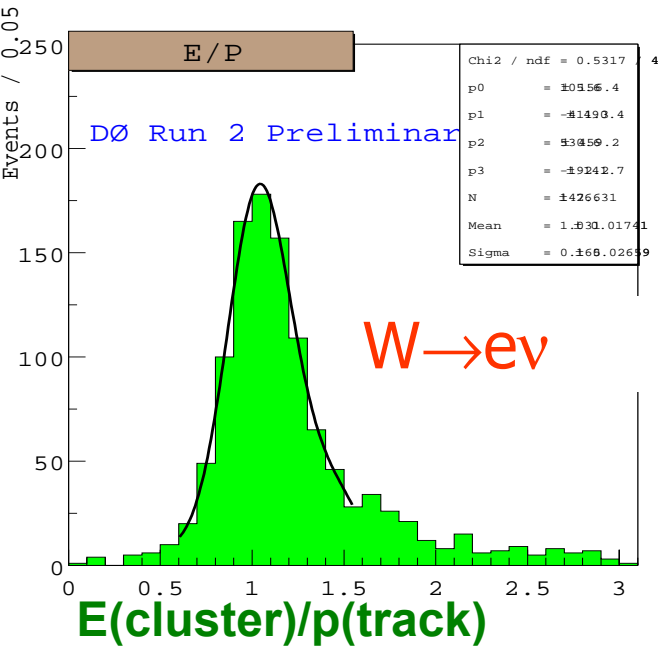
Central Tracker Performance



K_s^0 Invariant Mass



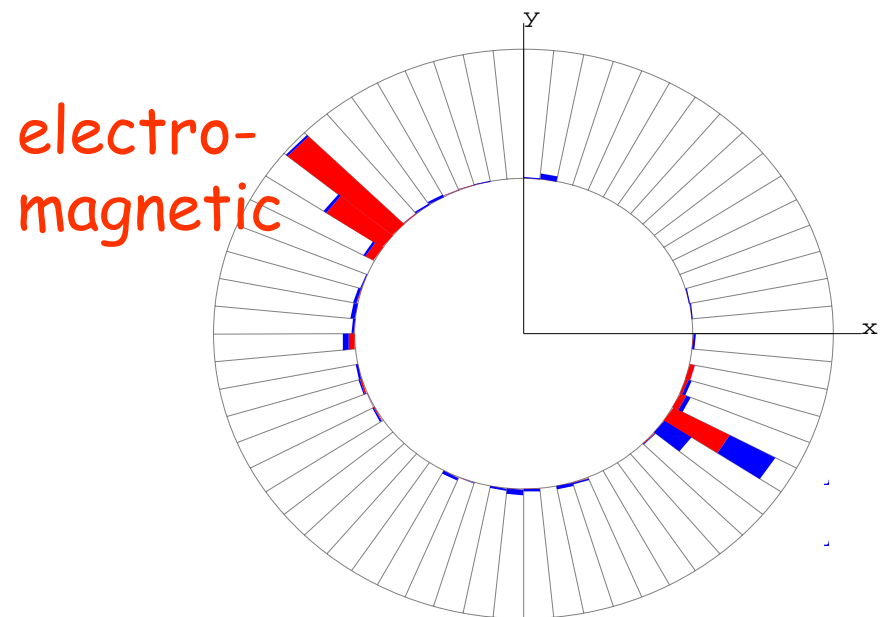
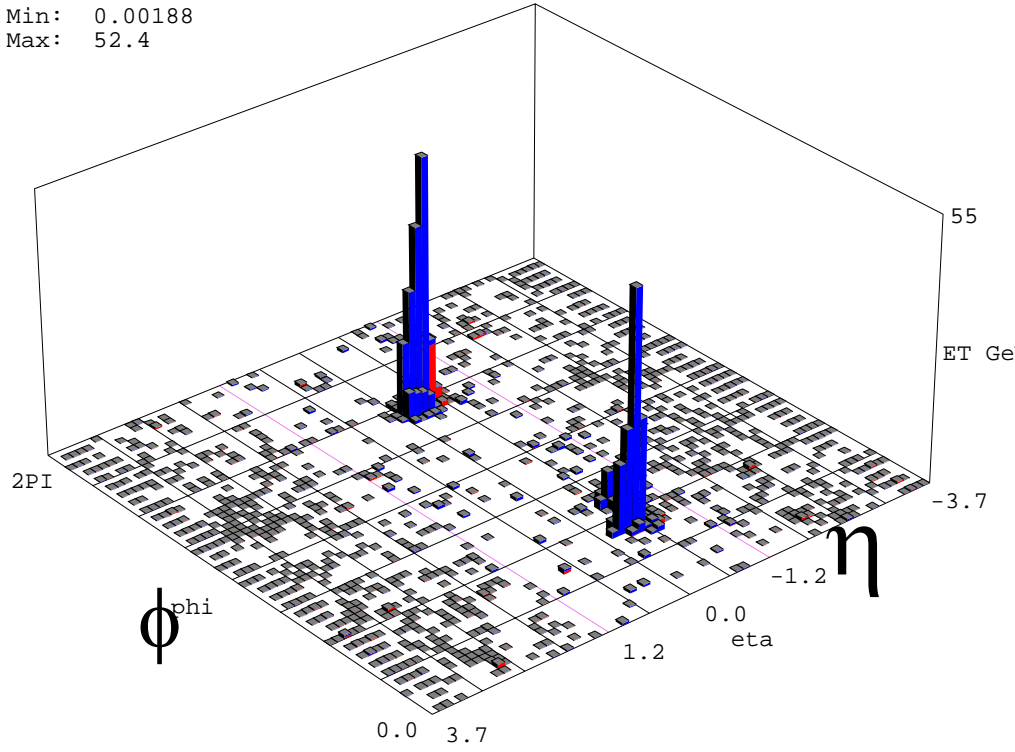
Calorimeter Performance: Jets, W, ...



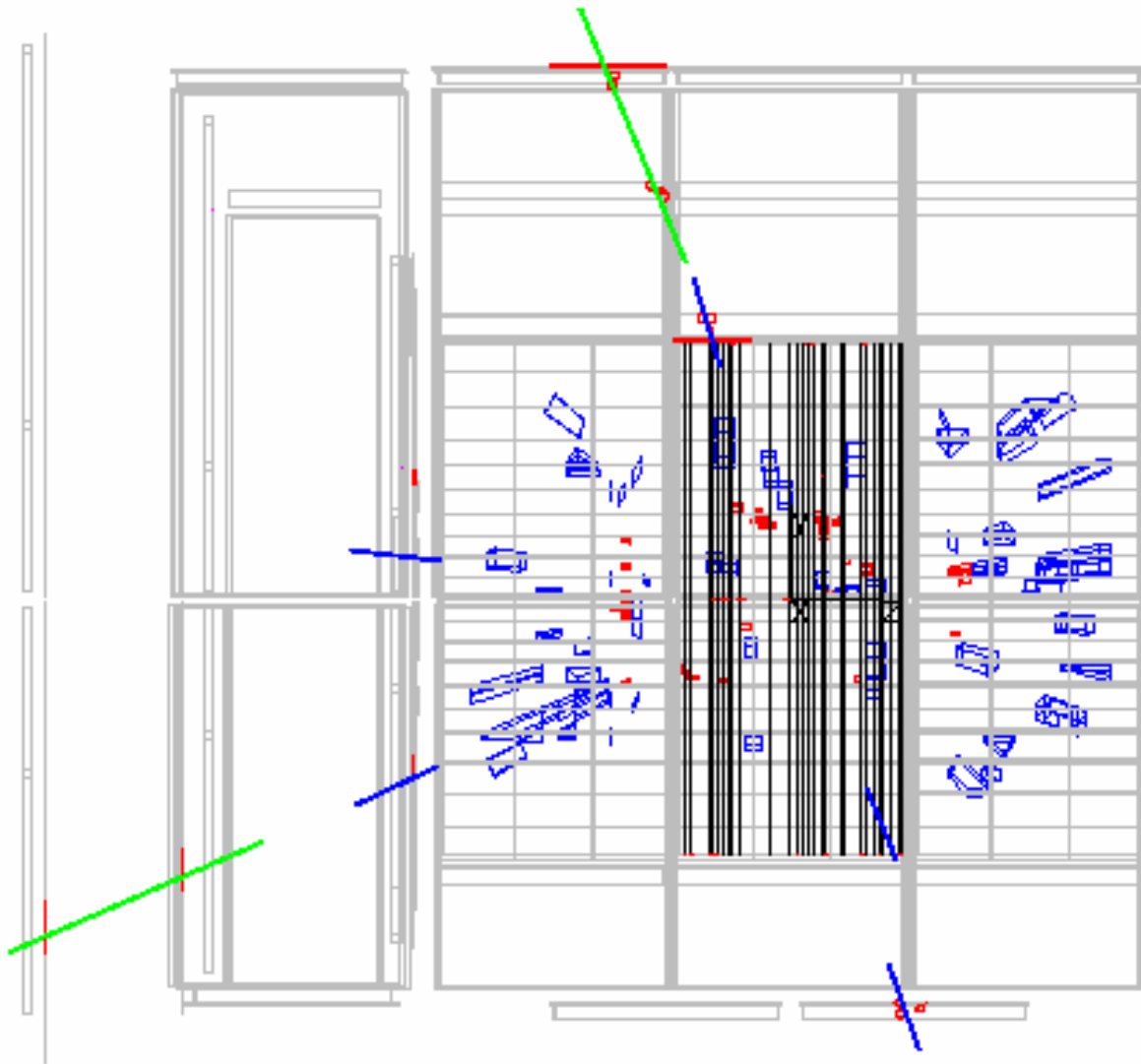
Run 131957 Event 4781549 Wed Nov 14 17:33:47 2001

Bins: 1097
 Mean: 0.405
 Rms: 2.88
 Min: 0.00188
 Max: 52.4

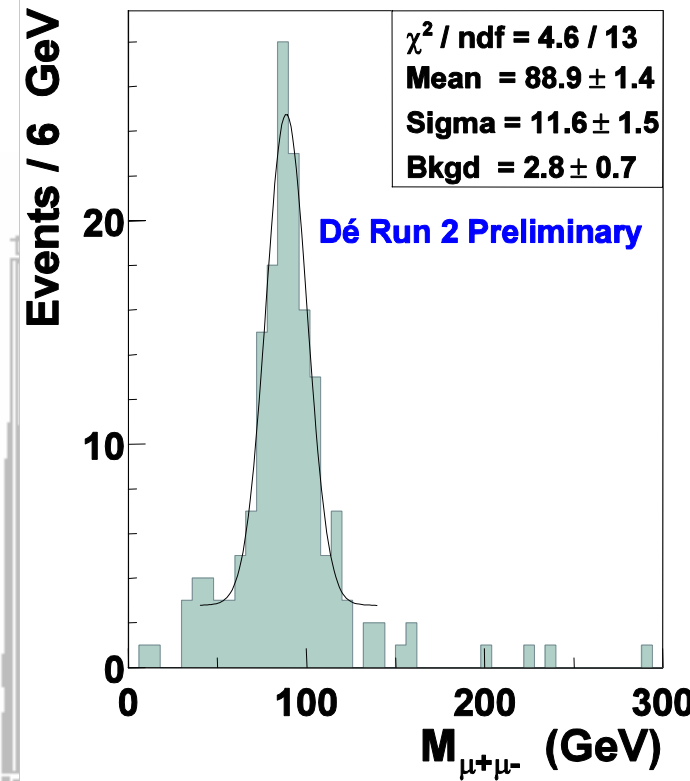
E_t : 0.0062
 ϕ_t : 160deg



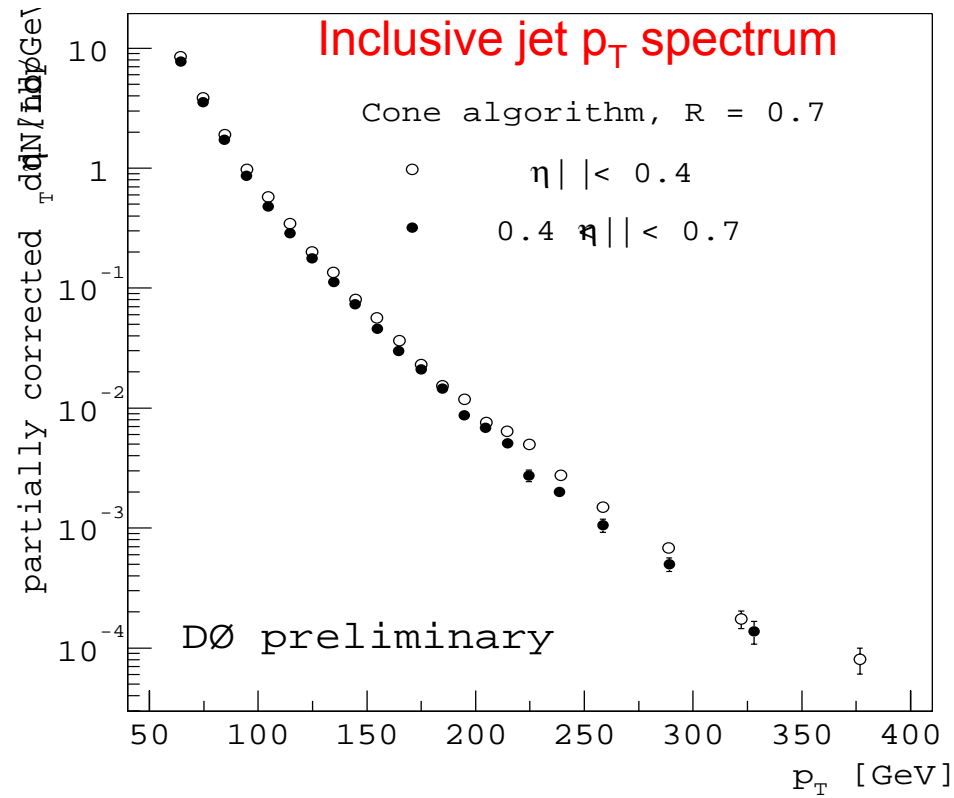
Performance of Muon System: Z



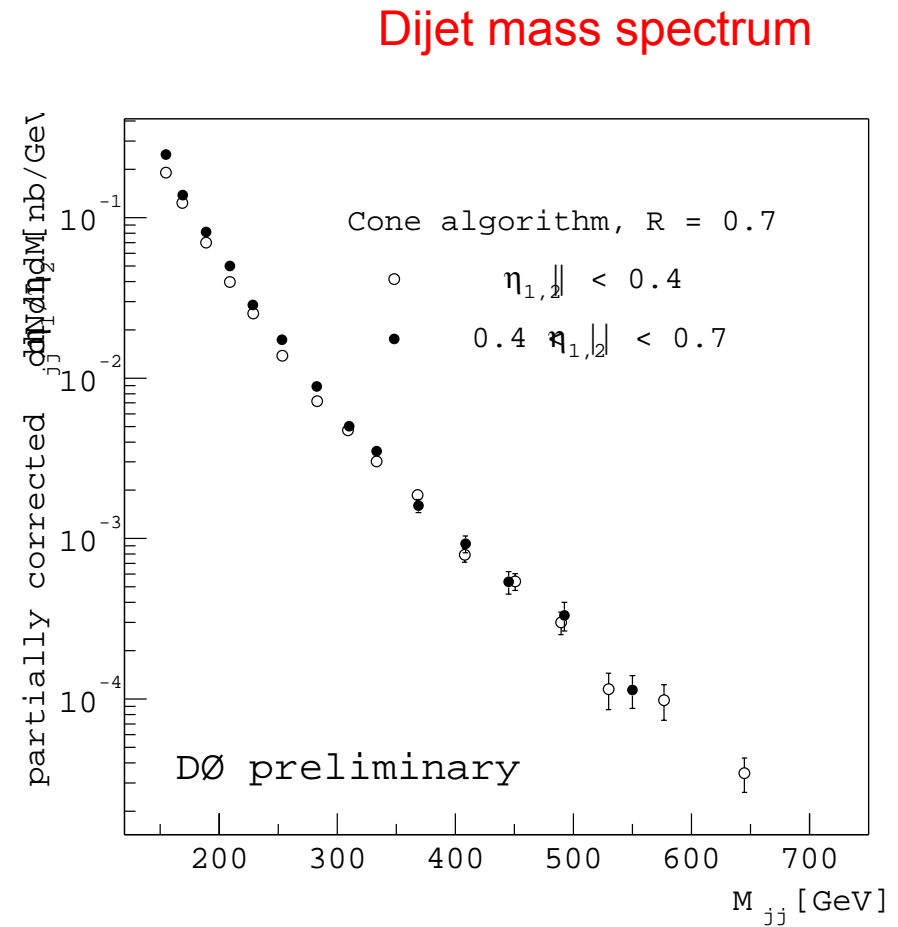
$p_{\nu} > 15 \text{ GeV}$



First Physics Results: Jets

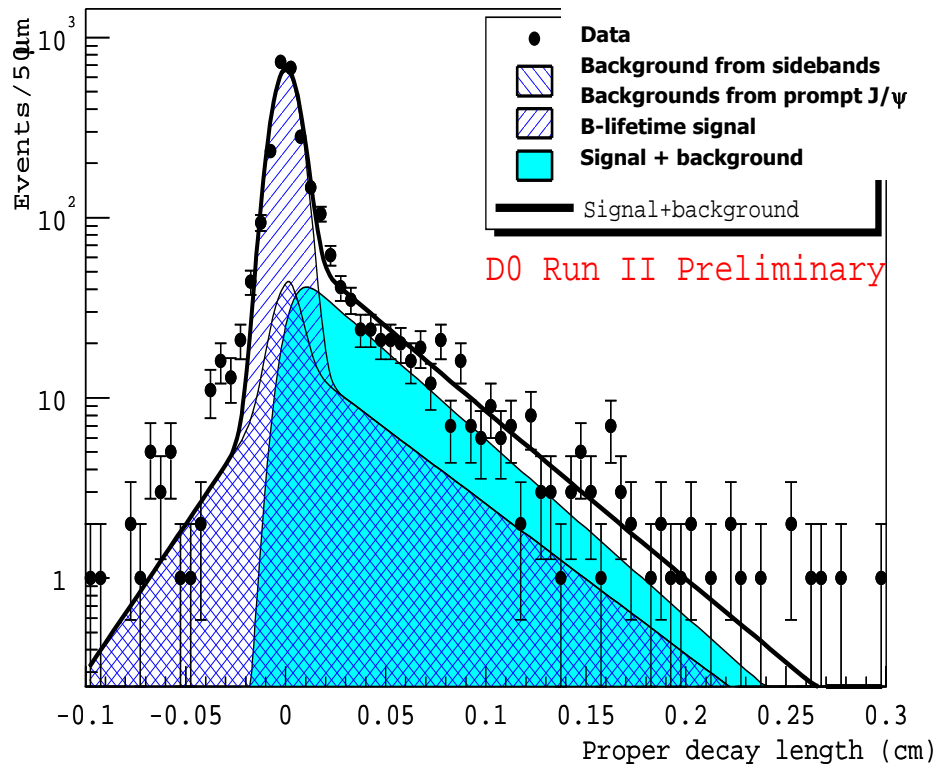


$L = 5.8/\text{pb}$



First Physics Results: c, b physics

Proper B decay length ($B \rightarrow J/\psi + X$)

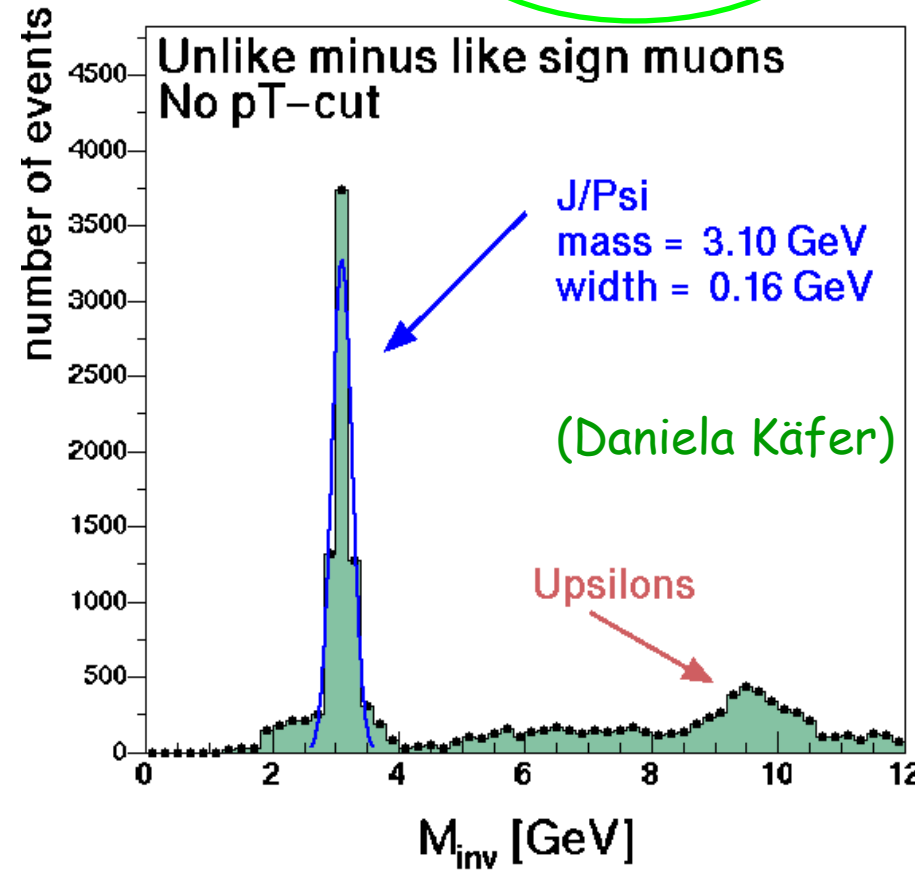


$L = 7.5/\text{pb}$

quarkonium resonances

B lifetime

$L = 5/\text{pb}$

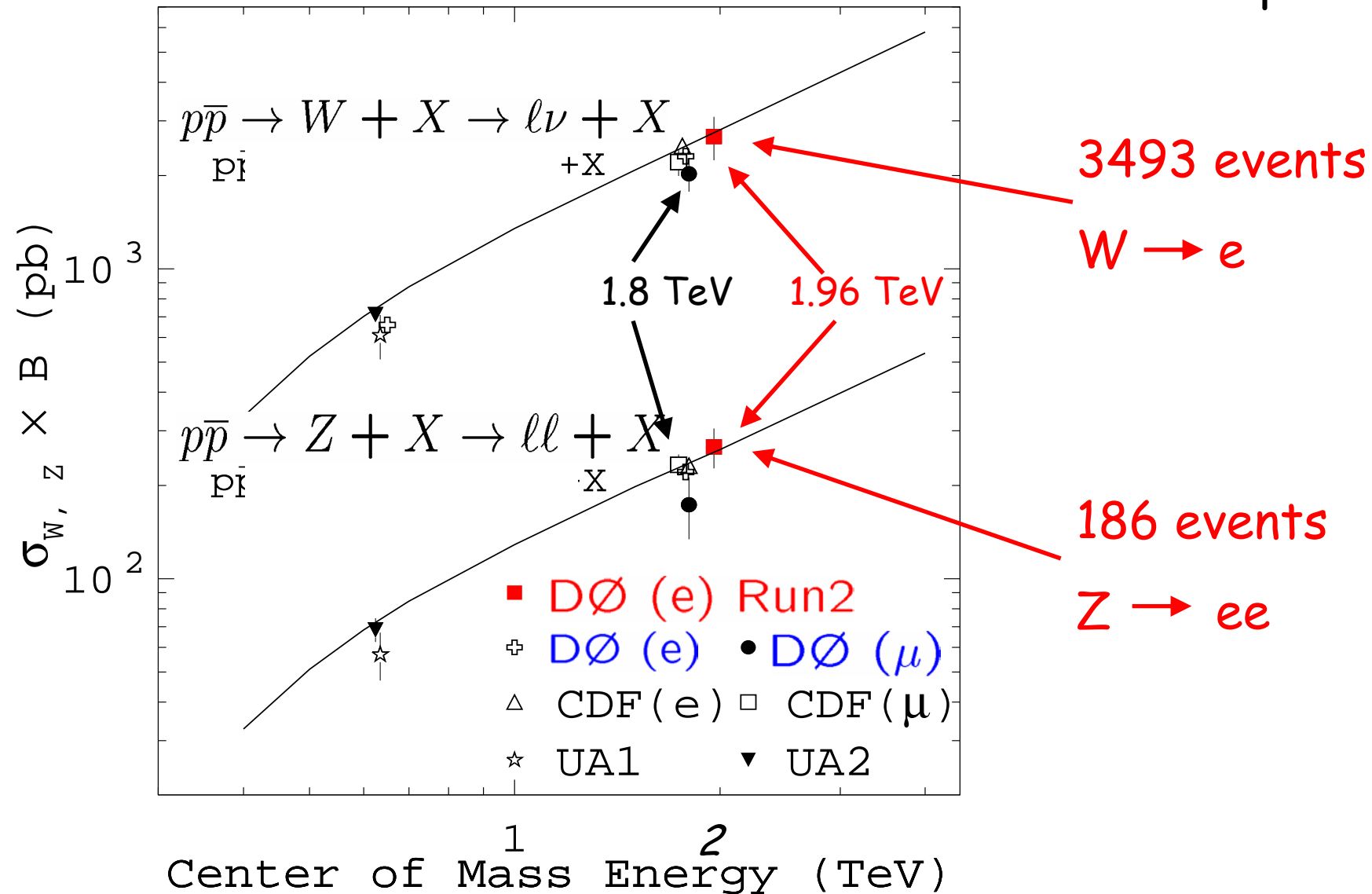


M_{inv} [GeV]

First Physics Results: W and Z production

DØ Run2 Preliminary

$L = 7.5/\text{pb}$



Status Tevatron and D0 (summer 2002)

Tevatron:



peak lumi reached = 1/10 design value for run IIa

hope: total = 200/pb in 2002 (per detector)

D0:

recorded: $> 50/\text{pb} = \sim 50$ million events

(new) detector: most parts functional

first physics results !