

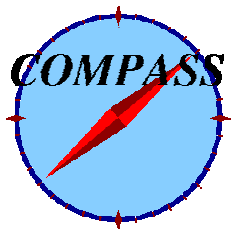
STATUS REPORT on the COMPASS EXPERIMENT

Franco BRADAMANTE
Trieste University and INFN

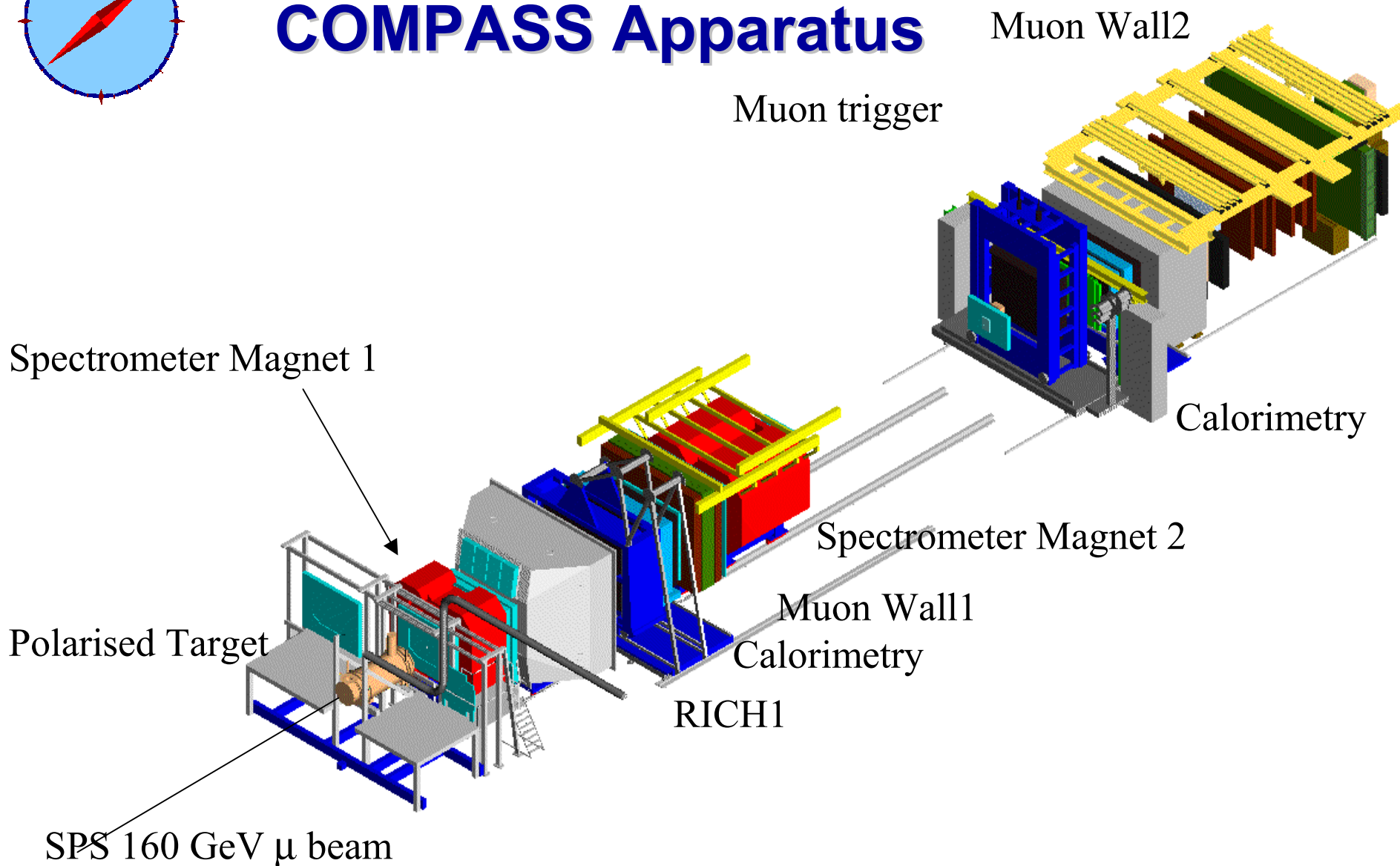
On behalf of the COMPASS COLLABORATION

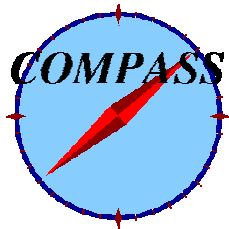
**Bielefeld, Bochum, Bonn (ISKP), Bonn (PI), Burdwan and Calcutta,
CERN, Dubna (LPP and LNP), Erlangen, Freiburg, Heidelberg,
Helsinki, Mainz, Moscow (INR), Moscow (LPI), Moscow (State University),
München (LMU), München (Technical University), Nagoya, Protvino,
Saclay, Tel Aviv, Torino (University and INFN), Trieste (University and INFN),
Warsaw (SINS), Warsaw (TU)**

More than 200 physicists from 26 Institutes



COMPASS Apparatus





ABSTRACT

YEAR 2001 RUN : SATISFACTORY

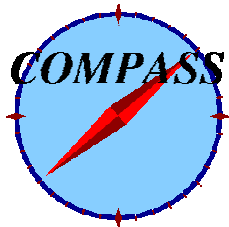
- all components installed, tested, and commissioned as foreseen in May 2001
- mention will be made of the performance of the novel detectors
- 30 TB of data collected
 - 50% for detectors calibration and commissioning
 - 50% of physics data, at the end of the period
- some analysis results

YEAR 2002 RUN: READY TO START WITH THE INITIAL LAYOUT

plus MW1 & MW2 electronics
large Q^2 triggering and tracking system in the SAS

**MANY MORE DETECTORS AS COMPARED TO THE ONES
WE HAD IN 2001**

OUTLOOK



DETECTORS

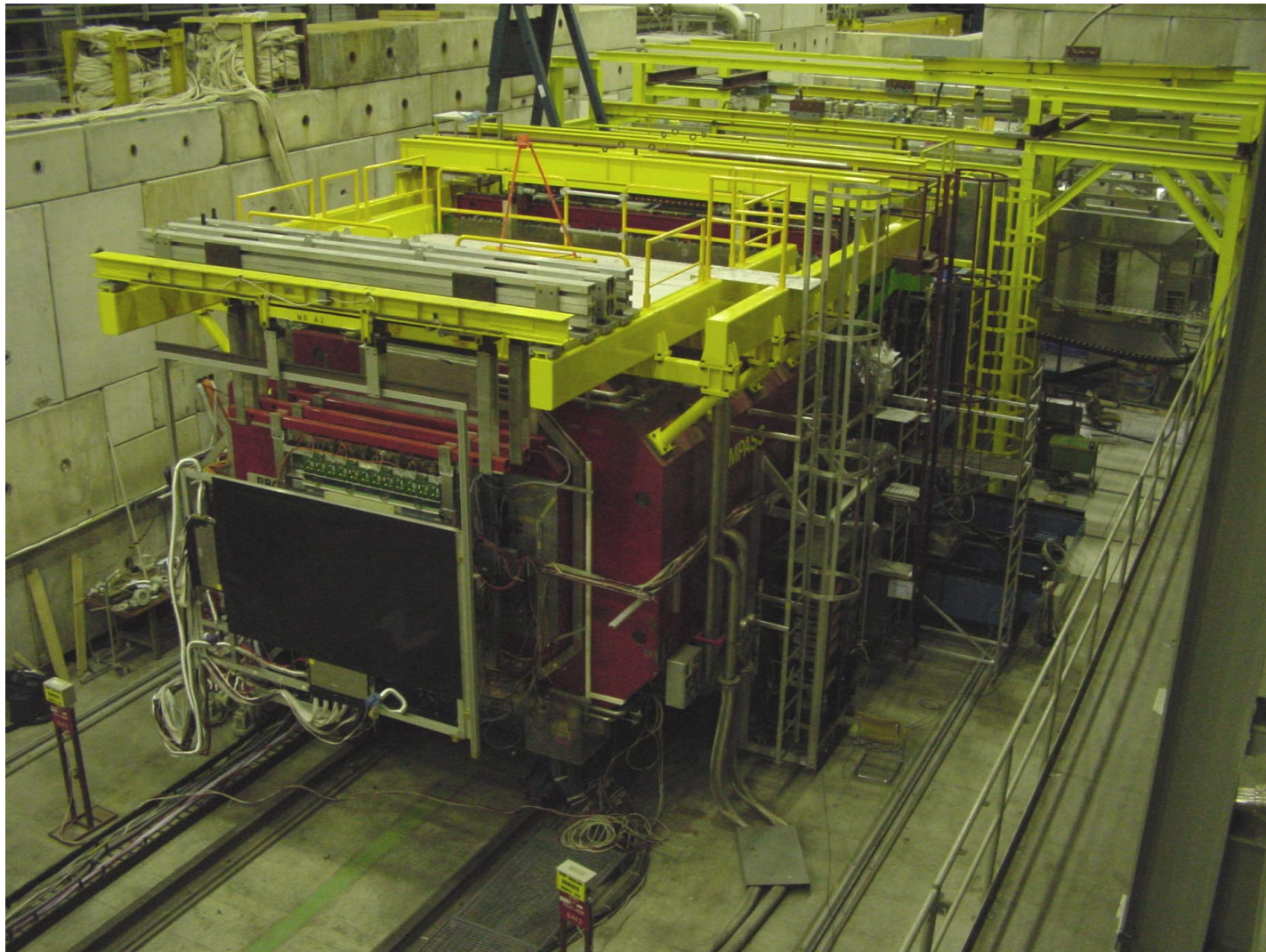
- **A QUICK LOOK IN THE EXPERIMENTAL HALL**
 - the Large Angle Spectrometer (LAS)
 - ECAL1 frame
 - HCAL1
 - MW1
 - MW2
 - W45 in clean room
- **PERFORMANCE OF THE DETECTORS IN THE YEAR 2001 RUN**
 - MENTION ONLY: PT
 - TRACKING DETECTORS: SciFi, Silicon
 - MicroMega's, GEM's
 - MWPC, SDC1, STRAWS
 - RICH1

for the full list, see SPSC-M-686, May 12, 2002

for a full description see the SPSC transparencies of S. Paul on May 2001



LAS + SM2 in the hall



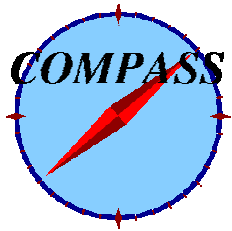
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ECAL1 frame



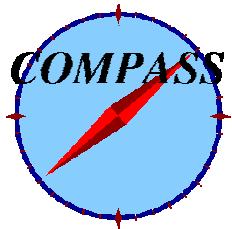
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HCAL1

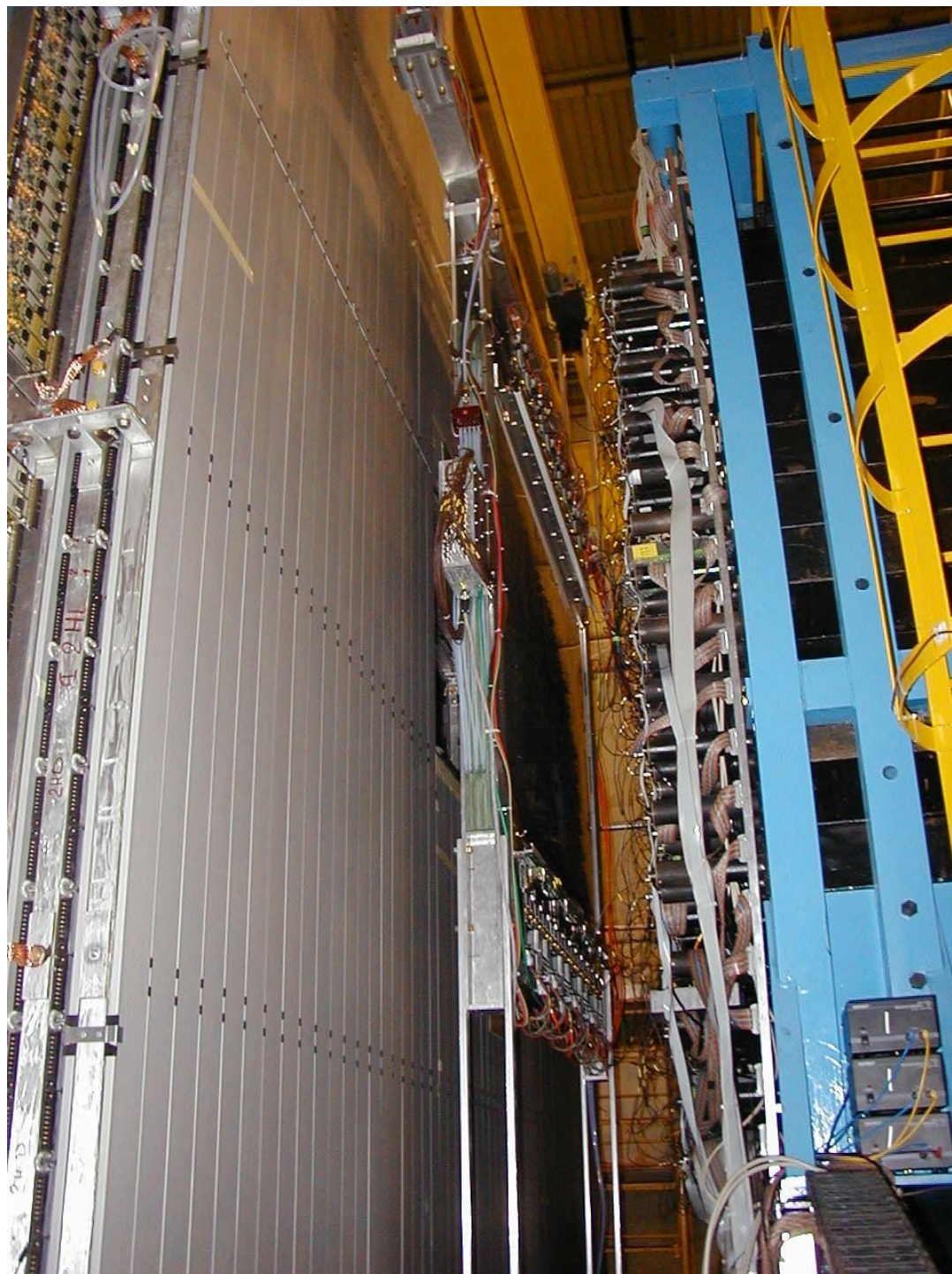


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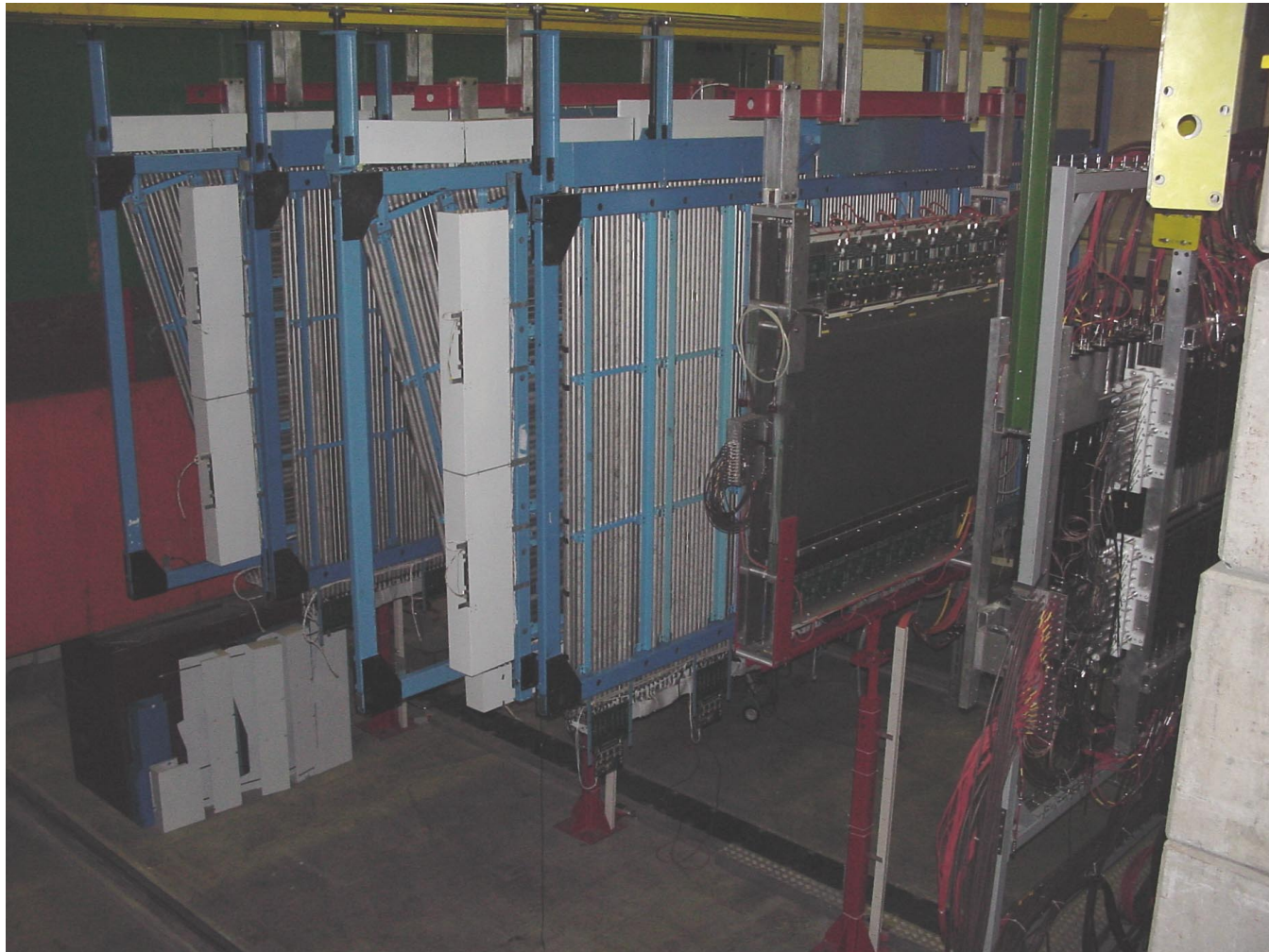
Muon Wall 1

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Muon Wall 2



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W45 in the clean room

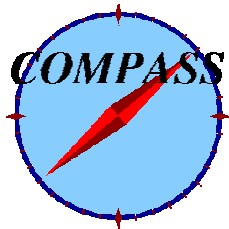


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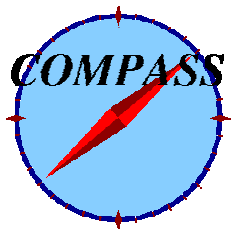


2001 RUN

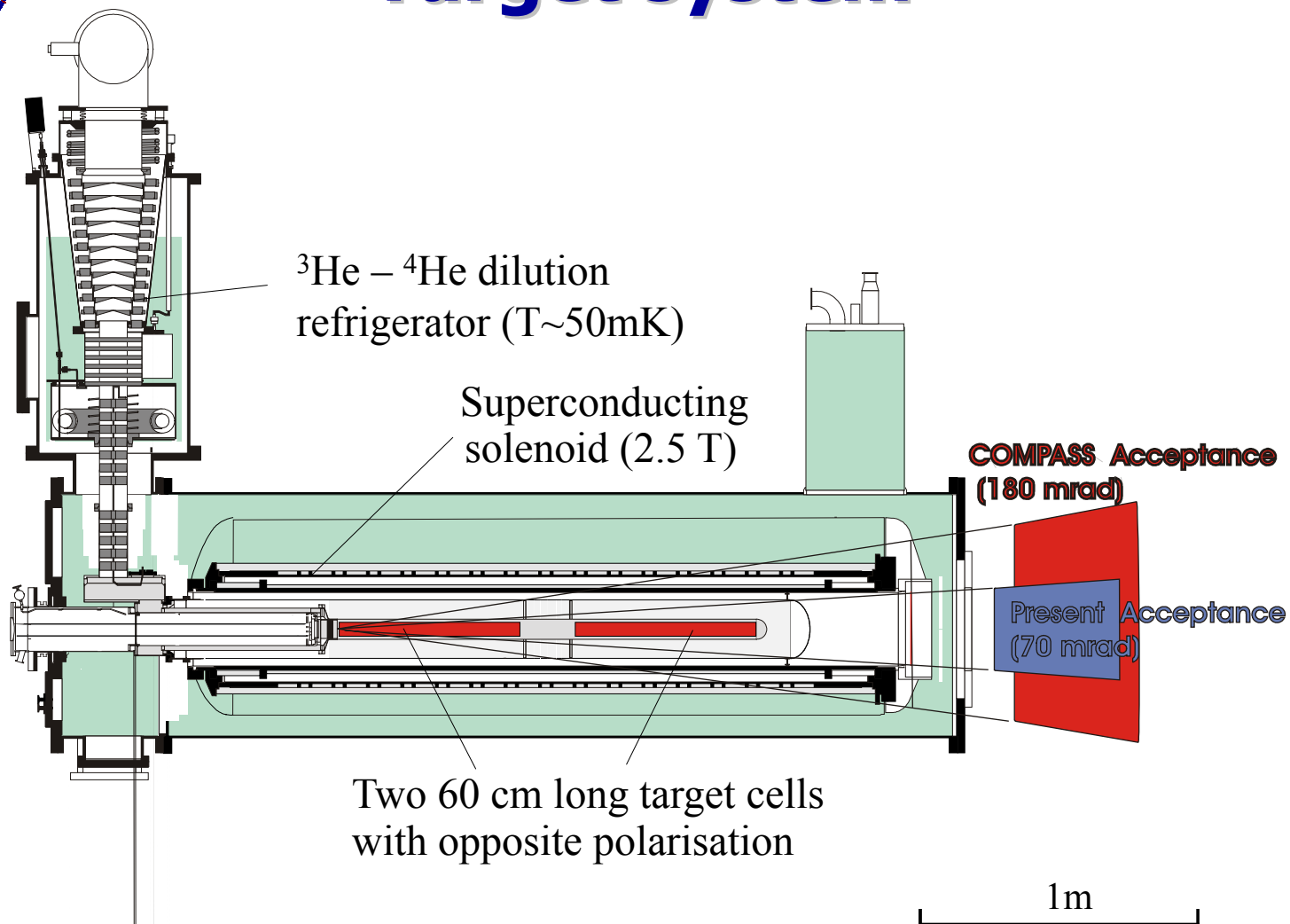
- All types of detectors on the floor
- Many systems fully commissioned
- Many novel detectors operated in nominal conditions ($2 \cdot 10^8 \mu/s$)
- Tracking: half of the channels
- RICH1 fully equipped
- The polarized target hosted in the SMC magnet



Detector	Detail	2001	Remarks
Target	Magnet	SMC	new OIS magnet not delivered
	Material	${}^6\text{LiD}$	
	Polarisation	+57 -49%	world record
BMS			ok
SciFi-Japan		4/4	ok
SciFi-D		8/8	ok
Silicon		2/4	about ok, see text
GEM		7/10	about ok, see text
Micromegas		6/12	ok
Driftchambers		1/2	ok
Straws		4/15 DL	3 ok
MWPC		15/15	ok
RICH1	mirrors	120/120	ok
	photon detectors	8/8	about ok, see text
	radiator gas	50% C_4F_{10}	topped up with N_2
MW1		100%	10% electronics
MW2		20%	10% electronics
HCAL1		100%	ok
HCAL2		100%	ok
Trigger	muon-scattering	100%	small Q^2
DAQ		50%	ok

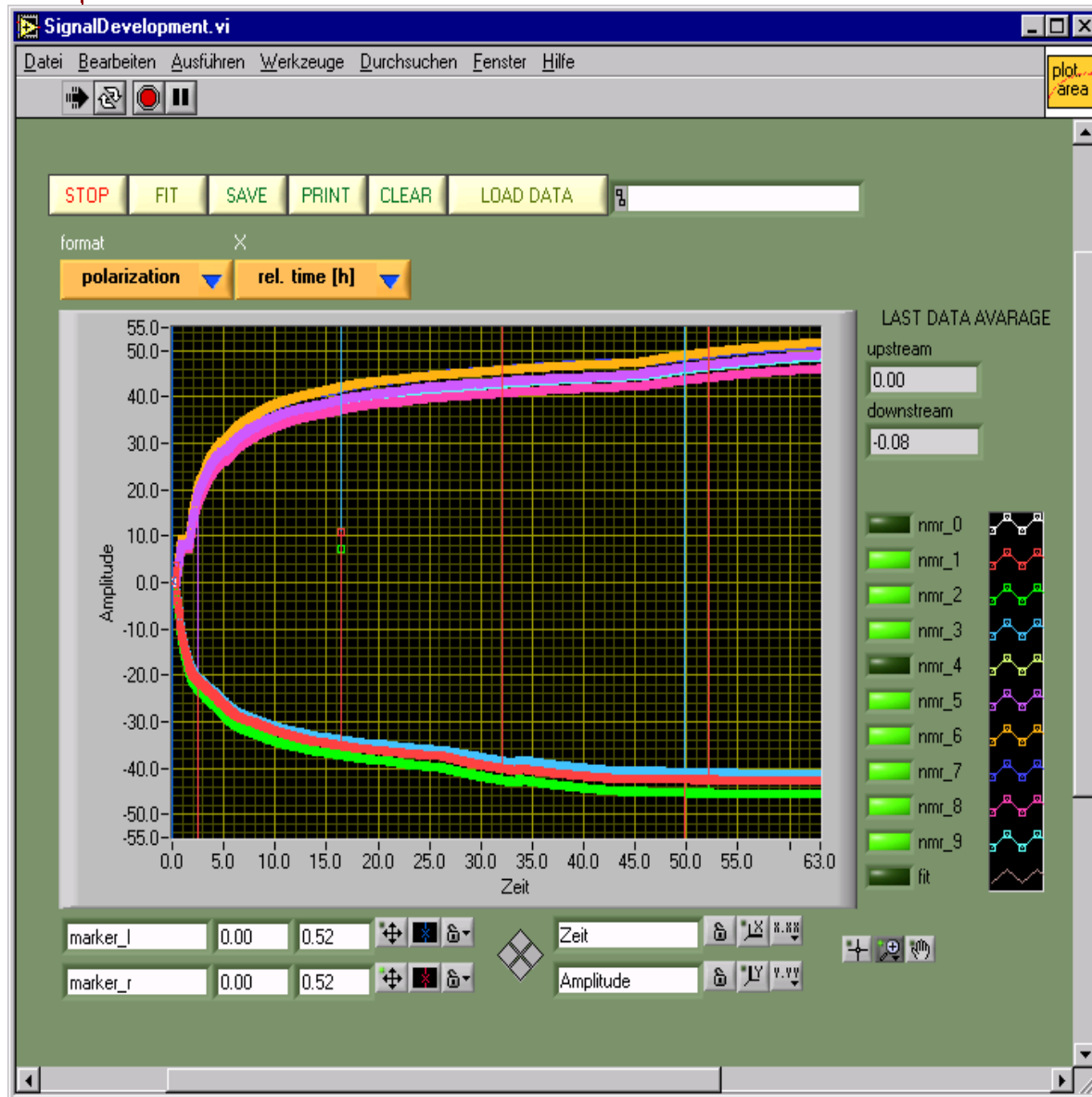


Target system





^6LiD Target



Dynamic Nuclear Polarization

Dilution factor ~50%

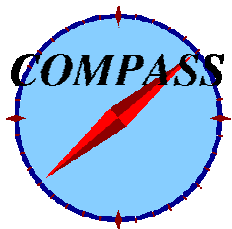
Maximum P values

- 49% + 57%

Spin relaxation time:

-Longitudinal spin (2.5 T):
too long to be measured

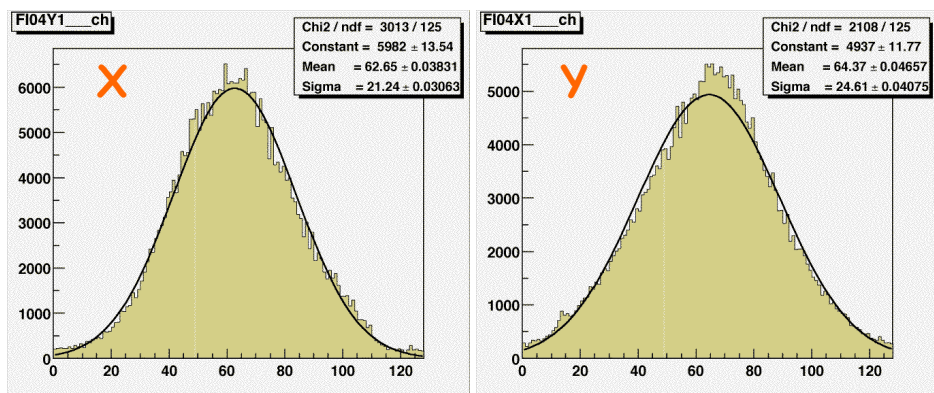
-Transverse spin (0.5 T):
>1000 hours



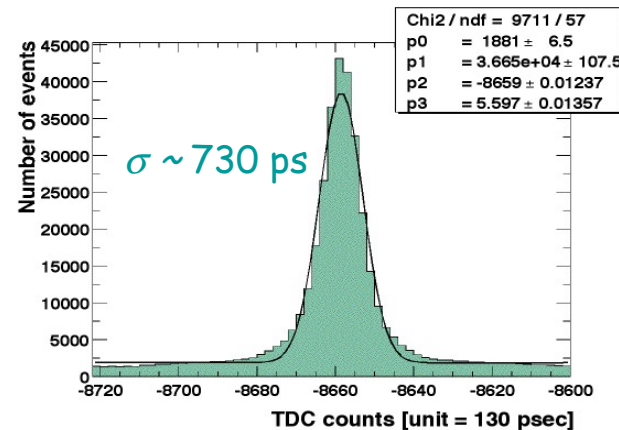
Scintillating Fiber Detectors

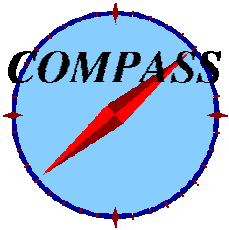
- 8 stations of scintillating fibers for tracking in the beam
total of 18 coordinates, 3816 channels (1152+2x1132)
- fiber diameter 0.5 mm to 1 mm
- enormous rate capability: 5 MHz per fiber
- efficiency: typically 99%
- spatial resolution: 130 to 250 μm
- time resolution: 450 to 550 ps
with TDC double precision mode additional improvement expected (350 ps)

Beam profiles on SF4

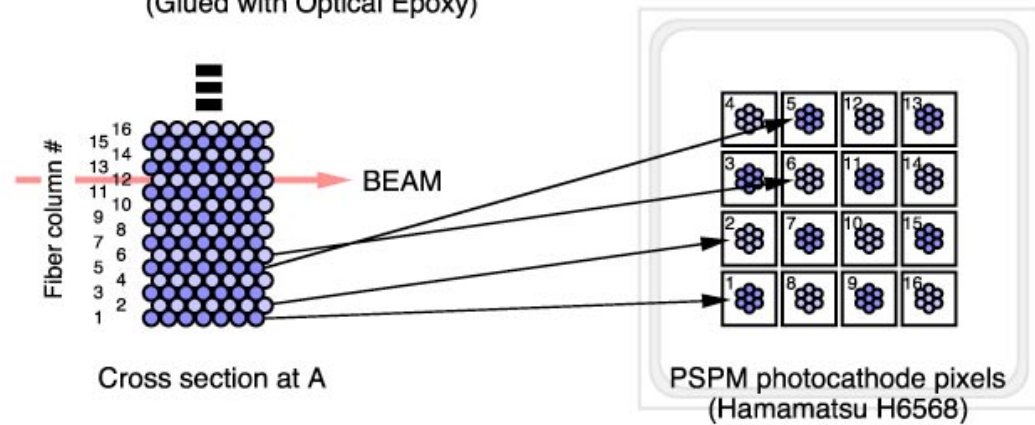
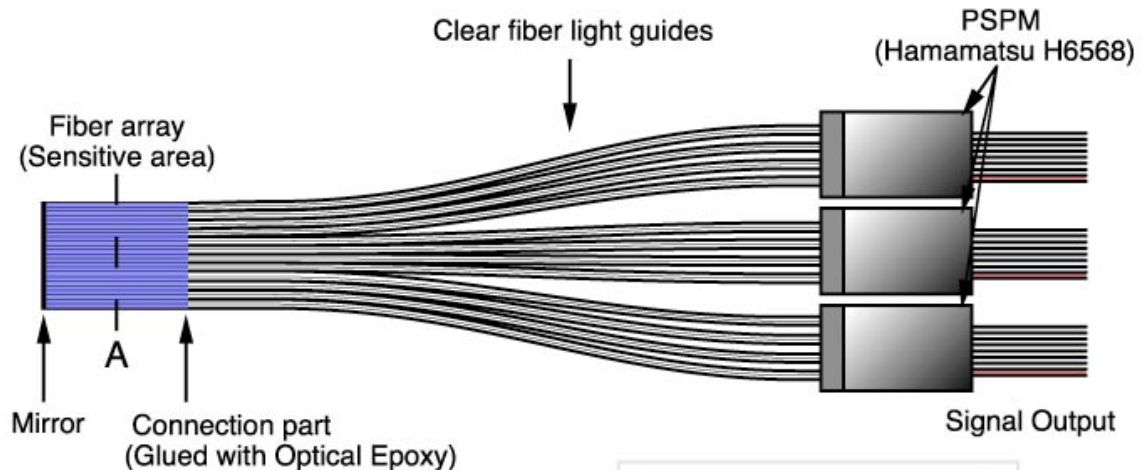


time difference “SF1X -SF1Y”
(time resolution SF1: $\sigma \sim 520$ ps)





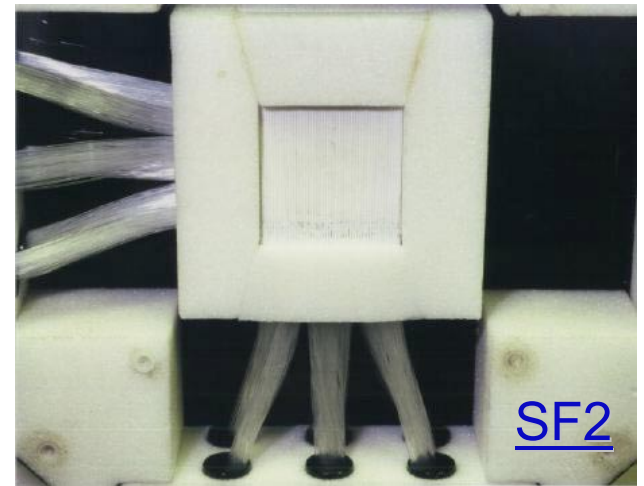
Japanese SciFi



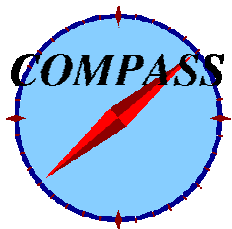
Position-Sensitive Photomultiplier (PSPM):

H6568MOD (HAMAMATSU)

- 16 ch Multi-Anode
- Booster for the last 4 stages of dynodes

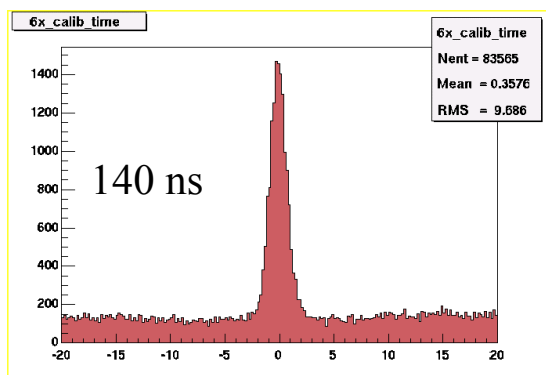


Sensitive area:
7-layers of Kuraray SCSF-78MJ 0.5 mm Ø

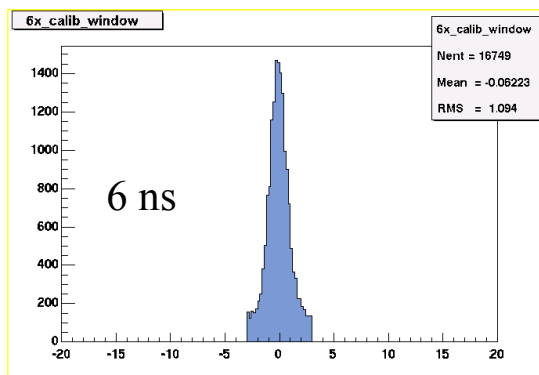


Station F106 X – German SciFi

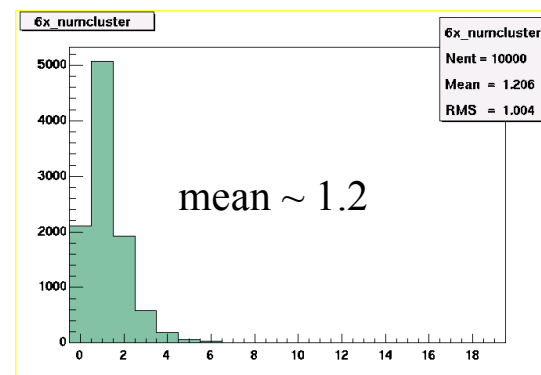
full time window



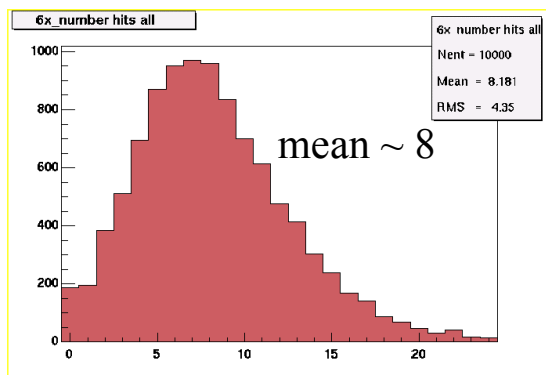
small time window



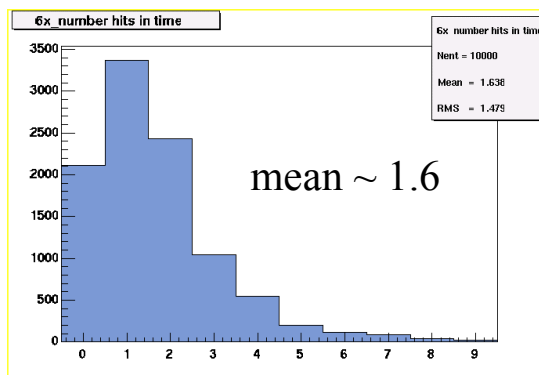
small time window



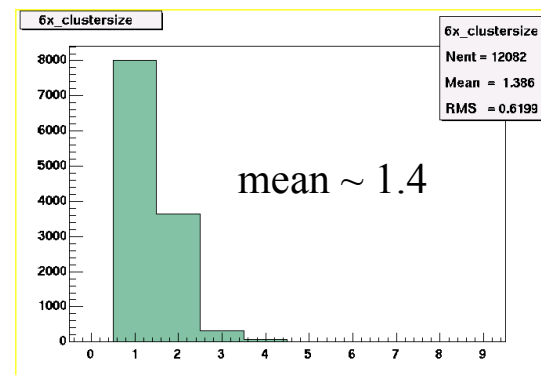
number of clusters



number of hits



number of hits

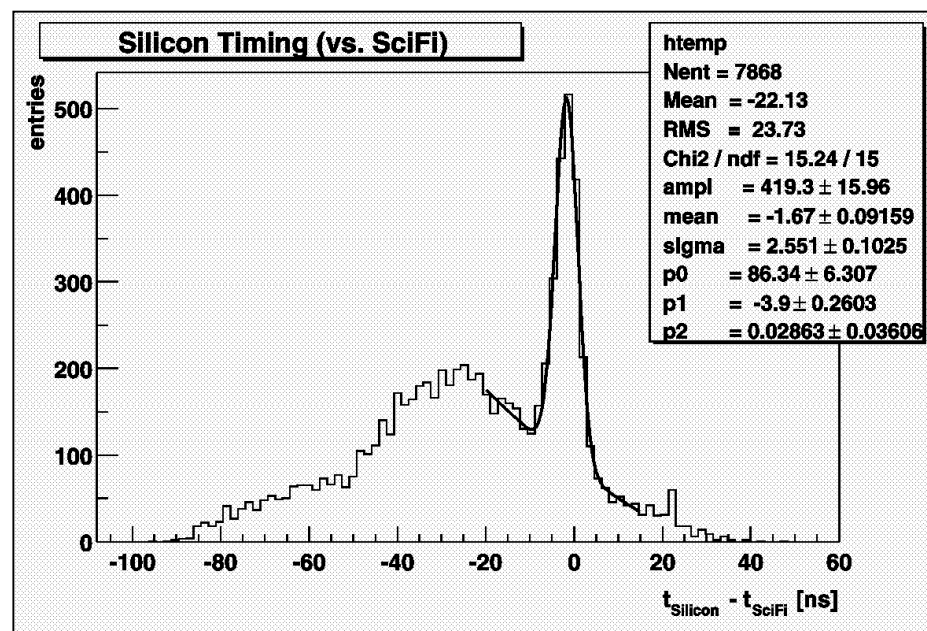
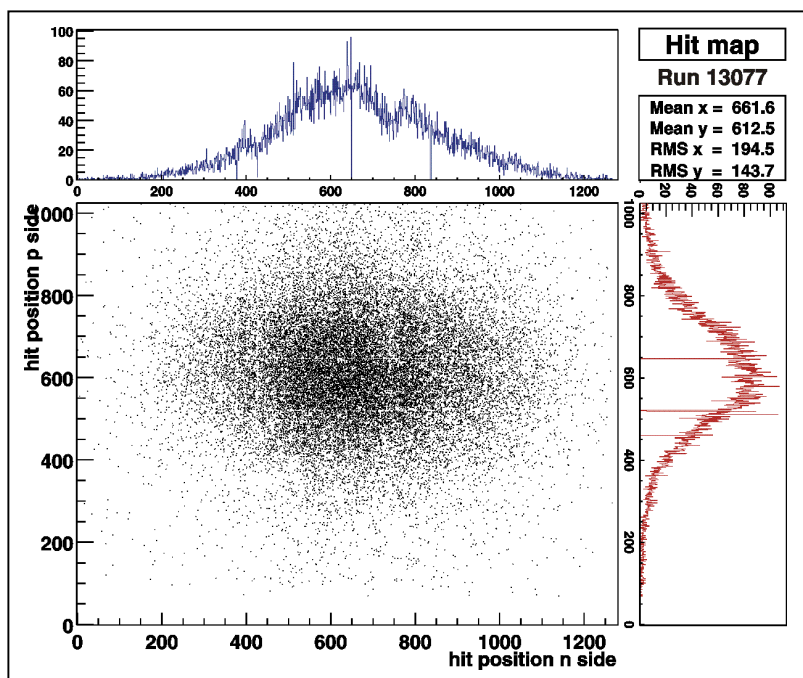


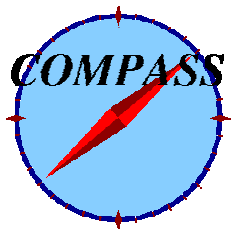
clustersize



Silicon trackers

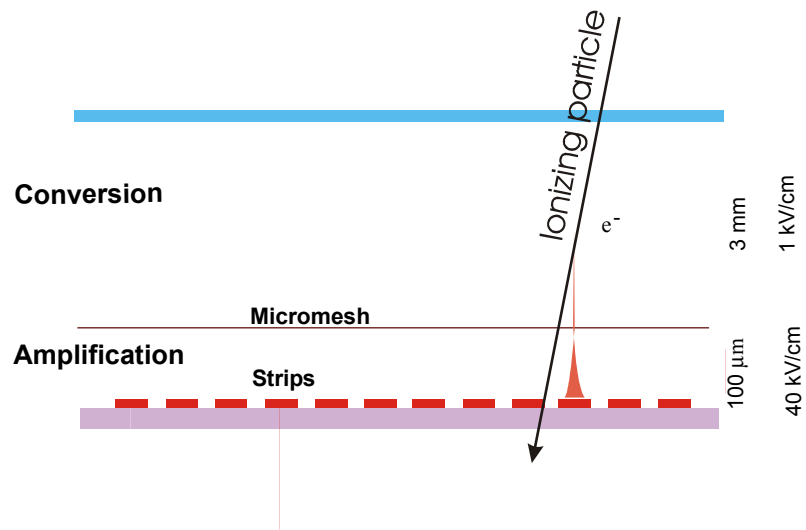
- 1 double sided silicon detector operated in 2001 (4 in 2002)
- strip pitch 50 μm
- dimensions 59.7x52.9 mm²
- time resolution 2.5 ns



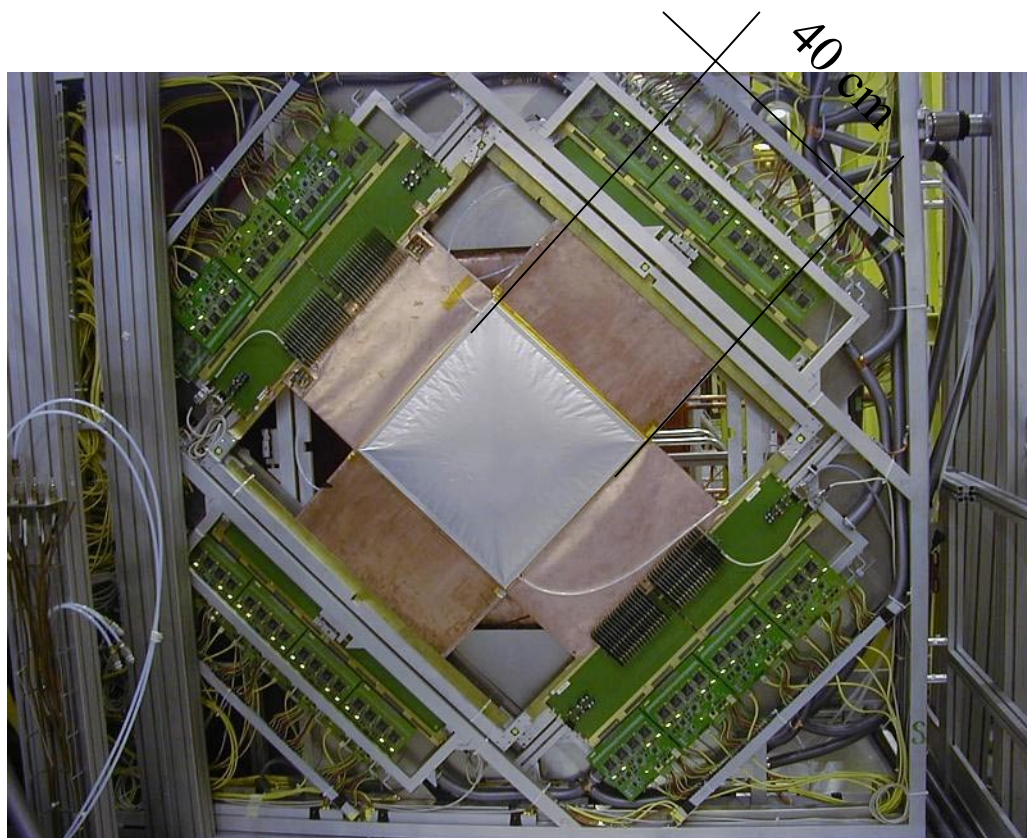


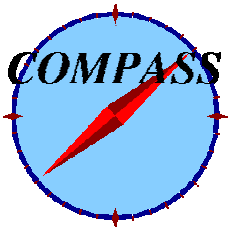
MicroMegas (Micro Mesh Gas Detectors)

Novel gaseous detector



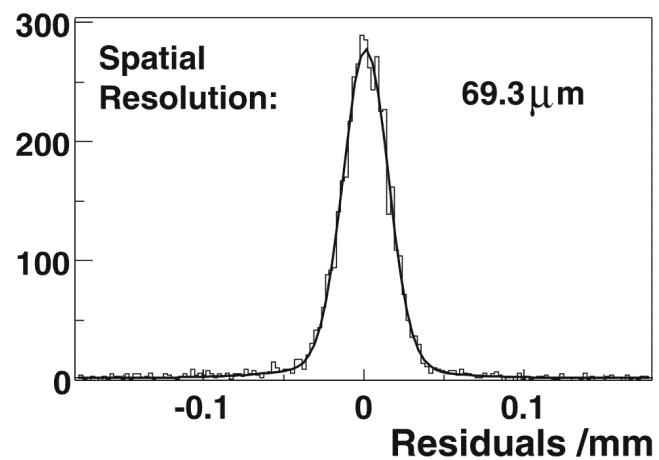
40x40 cm²





MicroMegas

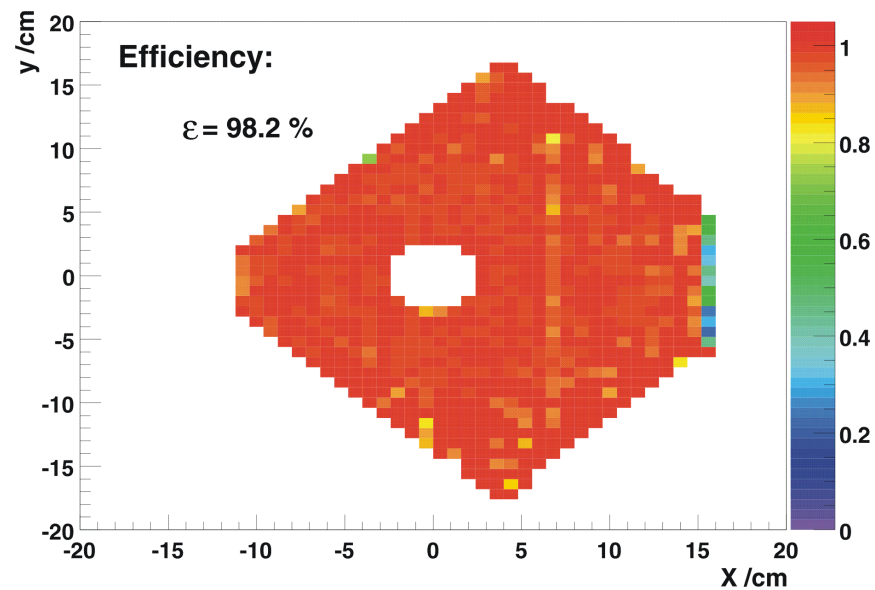
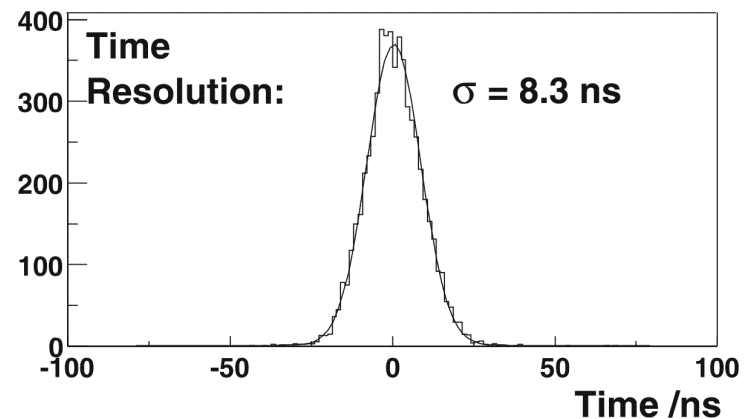
**spatial resolution
below 70 μm**

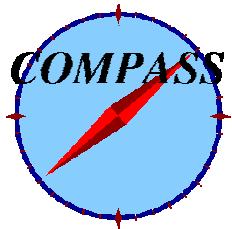


**efficiency
larger than 97%**

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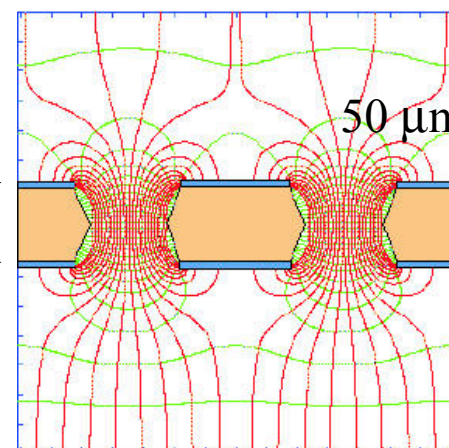
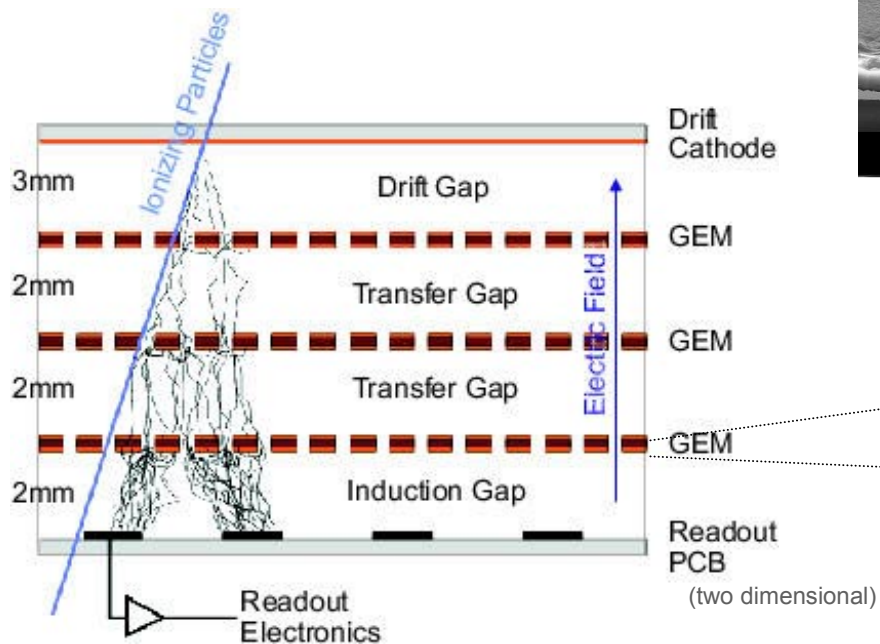
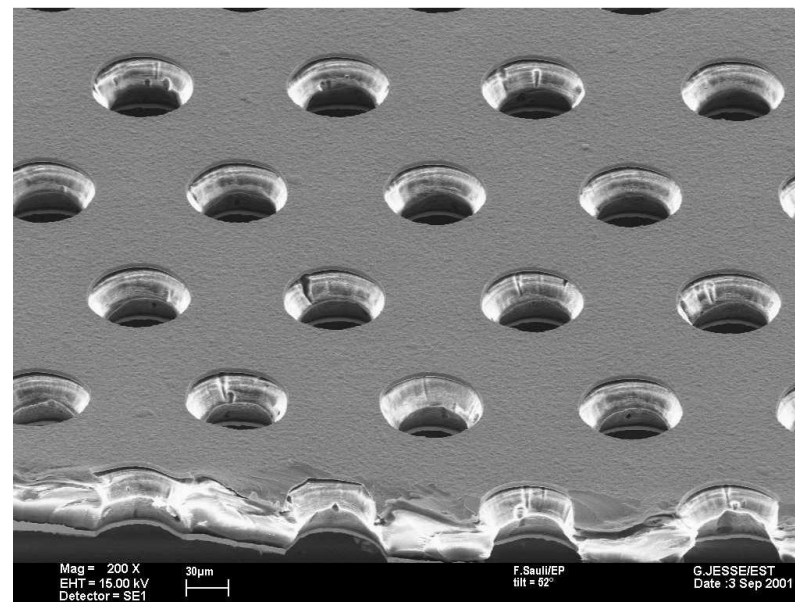
time resolution below 10 ns

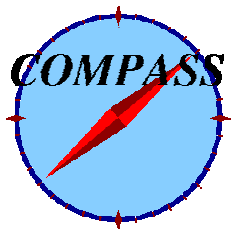




GEMs

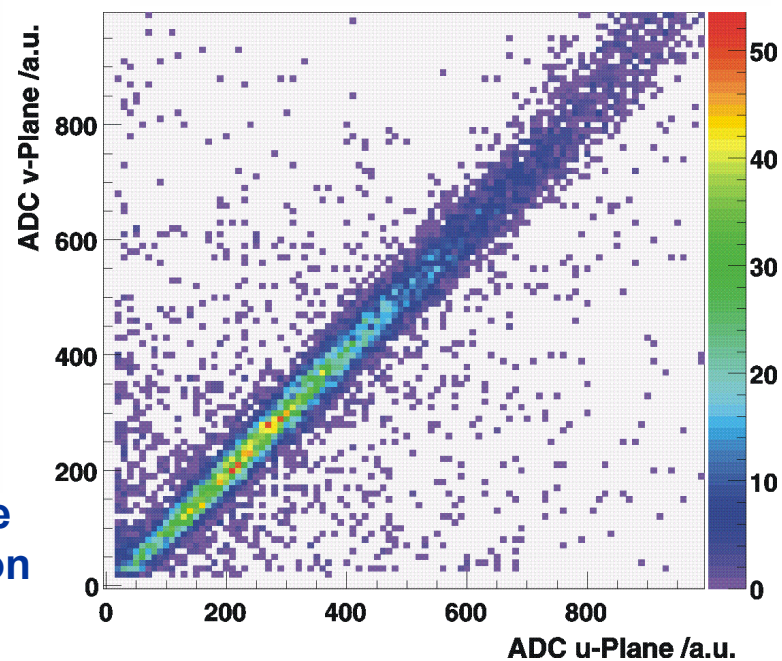
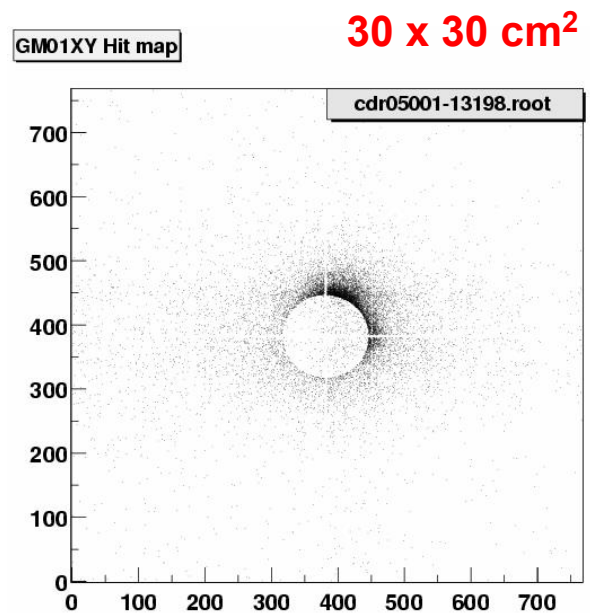
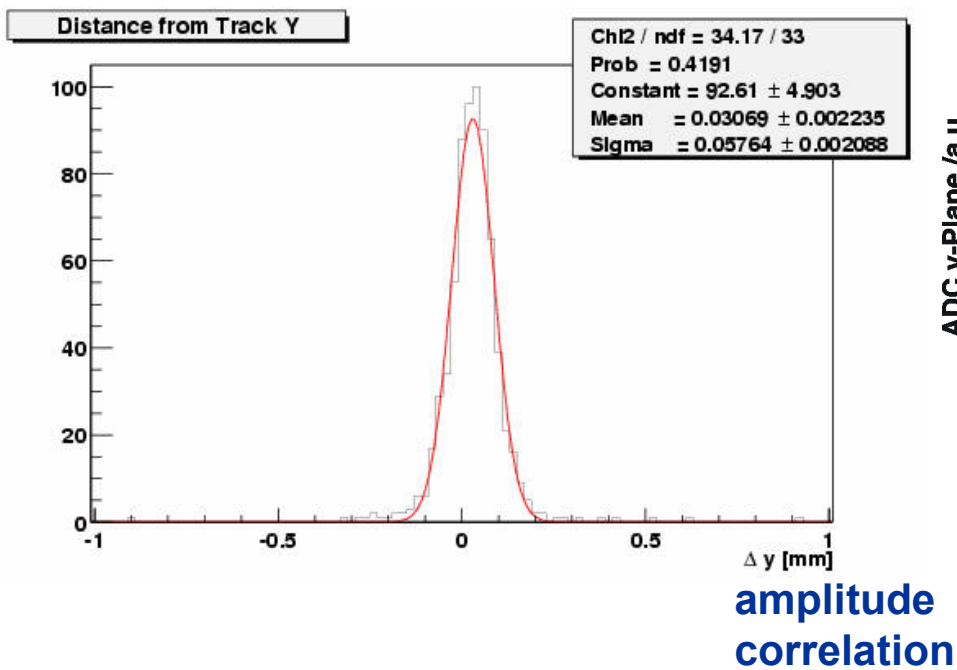
- novel gaseous detector
- efficiency ~ 96 – 97%





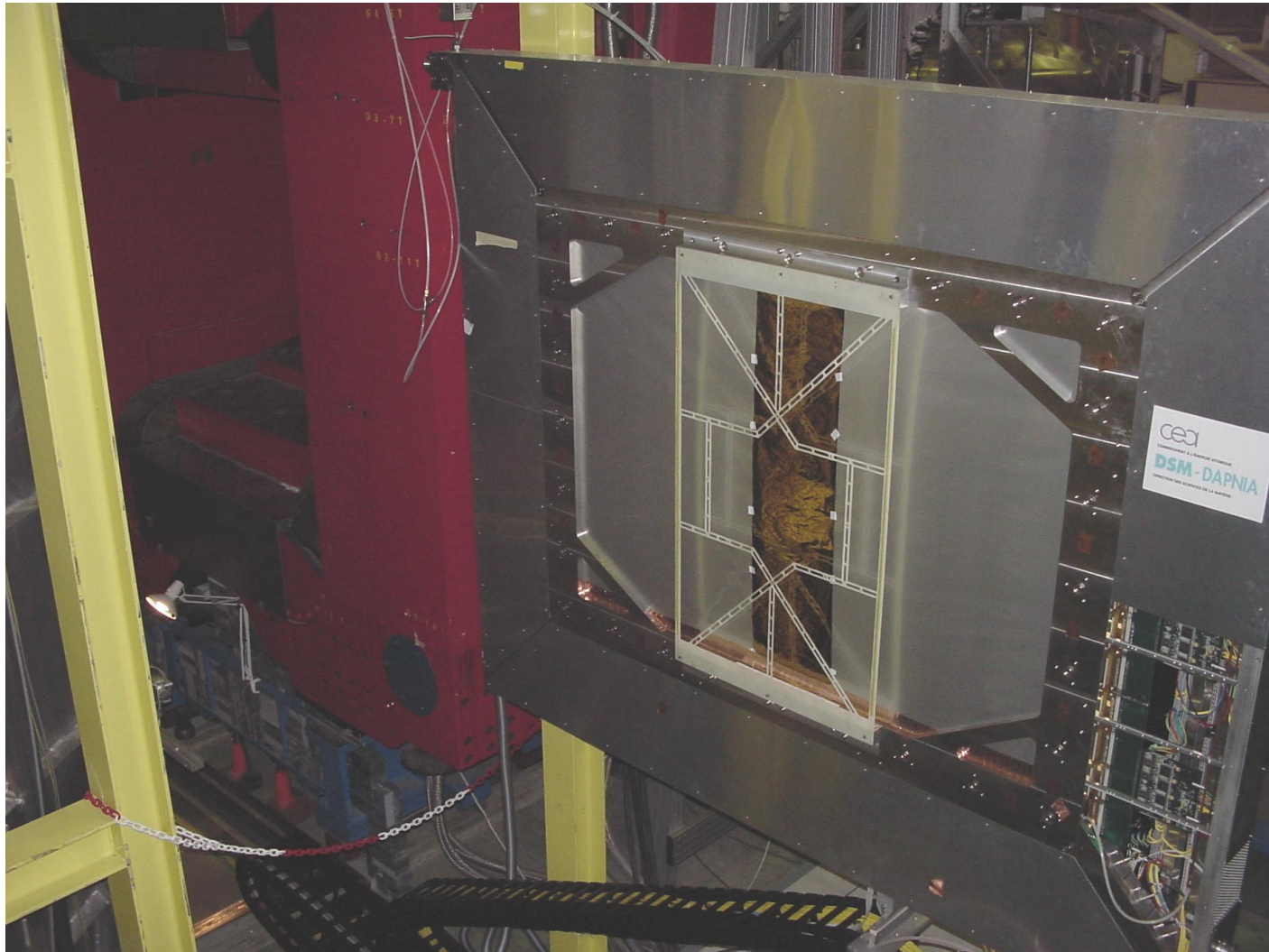
GEMs

- two dimensional read-out
- spatial resolution $\sim 60 \mu\text{m}$
- time resolution $\sim 15 \text{ ns}$
- deregulation of trigger timing in 2001

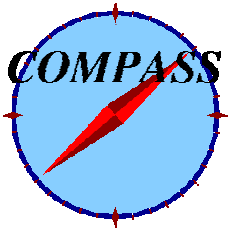




Saclay Drift Chamber (SDC)

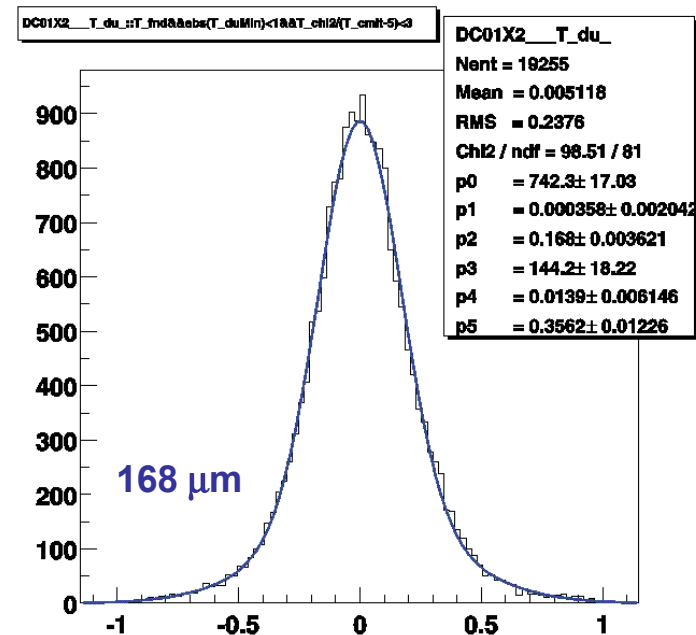
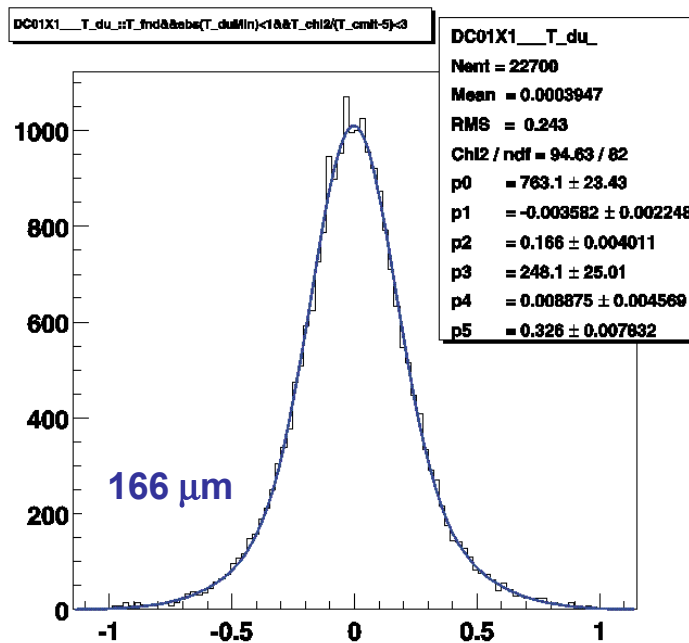


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Saclay Drift Chamber (SDC)

- Large Area Tracking in SAS
- 1 chamber in 2001, 3 in 2002
- Each chamber provides 8 coordinates with resolution $\sim 170 \mu\text{m}$
- Efficiency 95 – 99.8 %



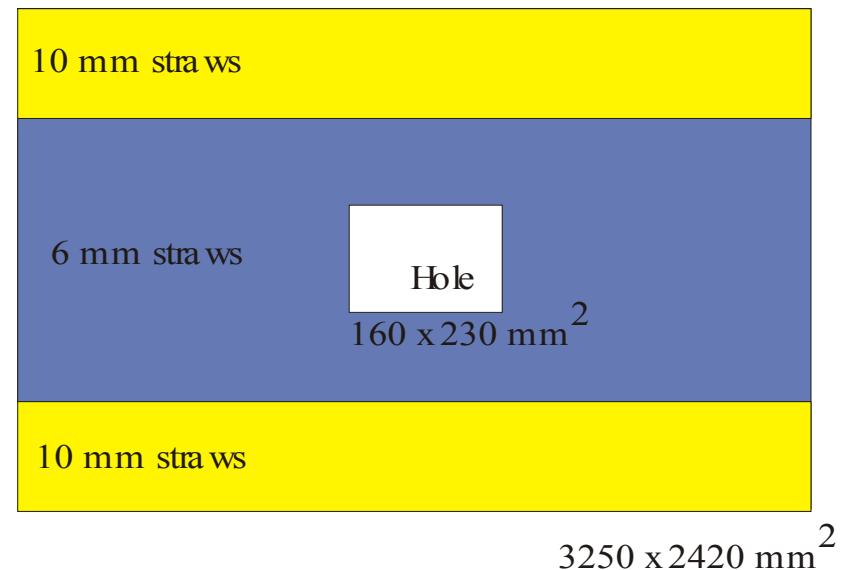


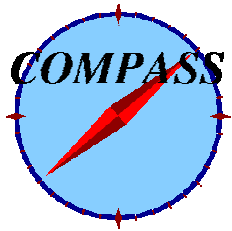
STRAWs

PROJECT IS ON TRACK

- **4 DL's** commissioned in year 2001 (**3 OK**)
efficiency 85 – 98%
spatial resolution ~ 270 μm
- **6 more DL's** presently at CERN
- production in Dubna has gone on smoothly
finished by end of August
- gluing of protection gas windows ongoing in Hall 888
- 1 full module (6 DL's) being prepared

Typical dimensions

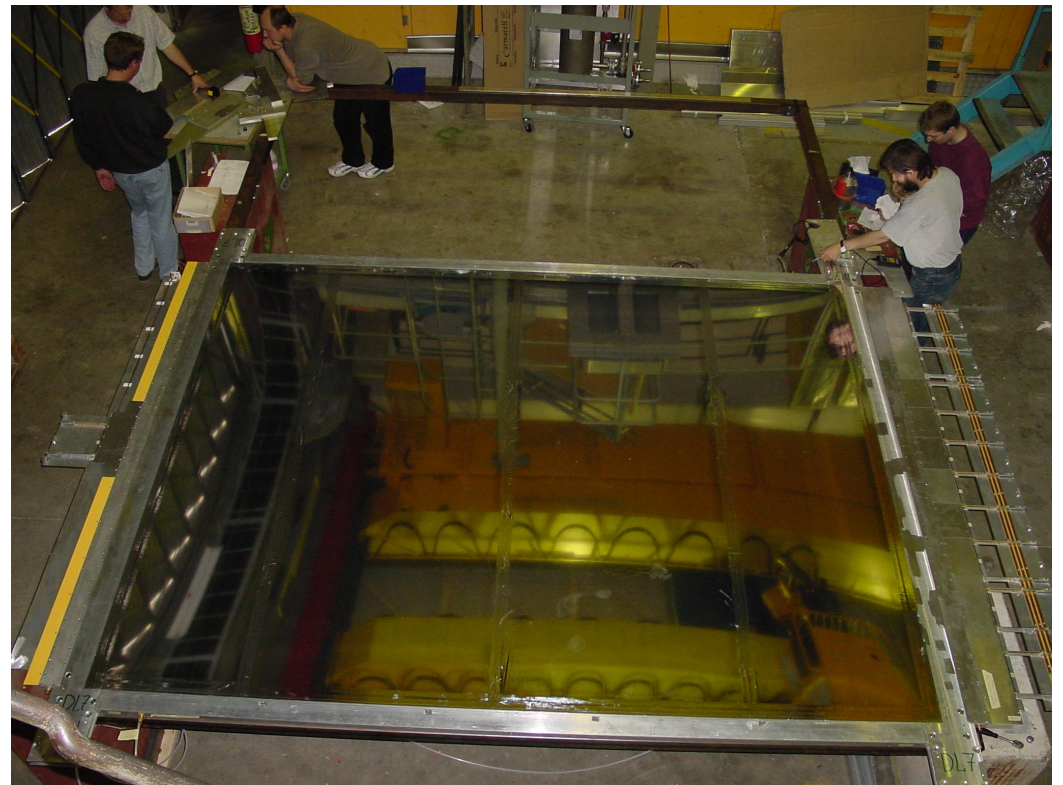




6 more Straw DL's at CERN



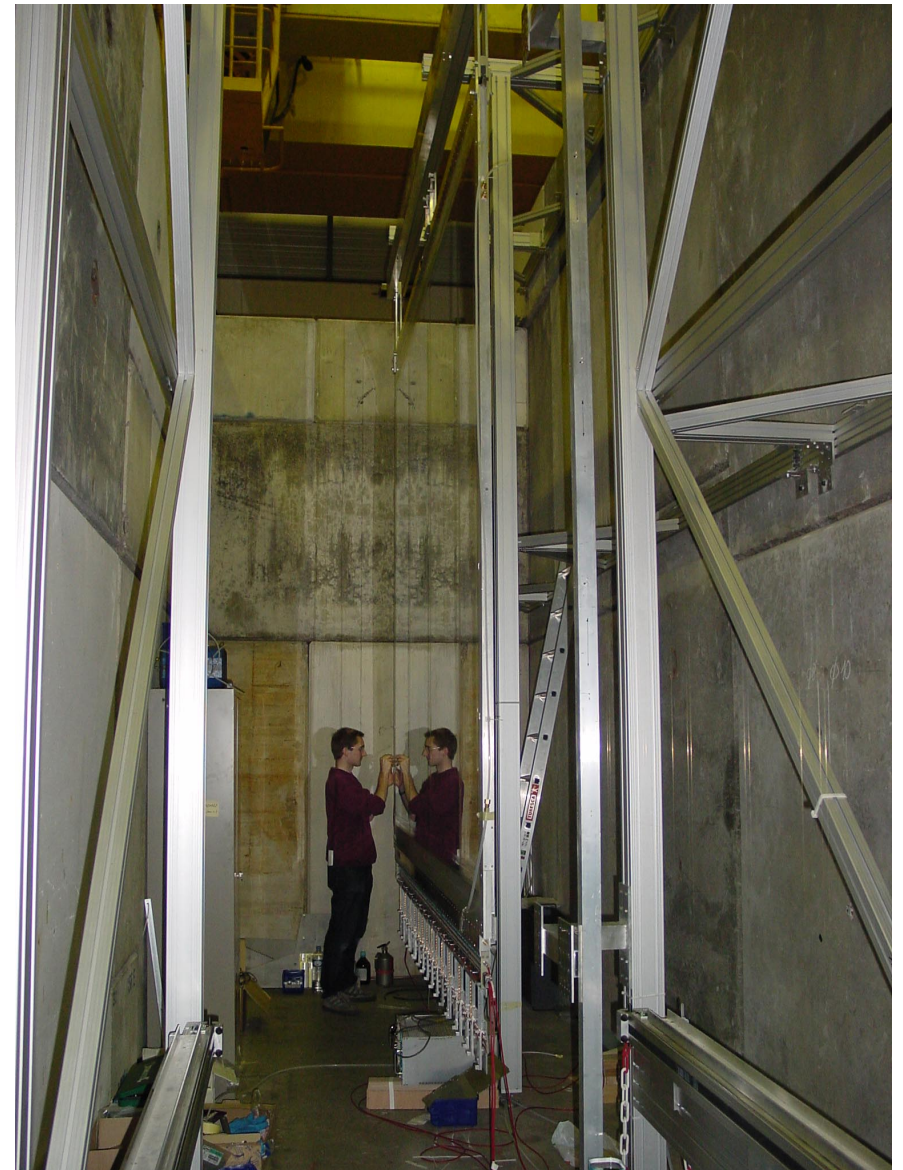
gluing of aluminized mylar foil



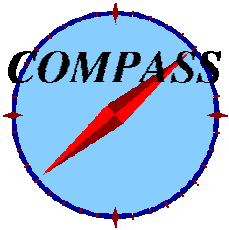
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Assembly of first Straw Module (6 DL's)

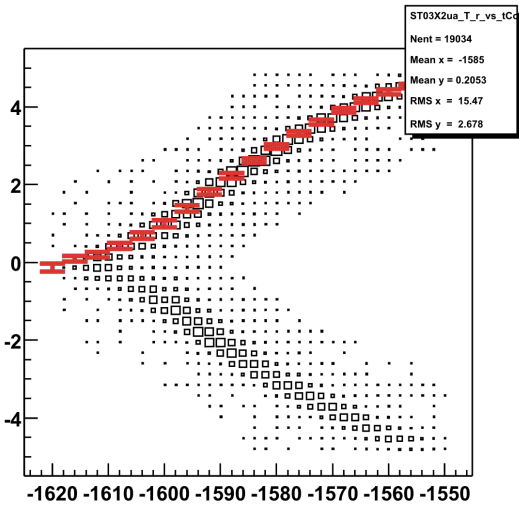


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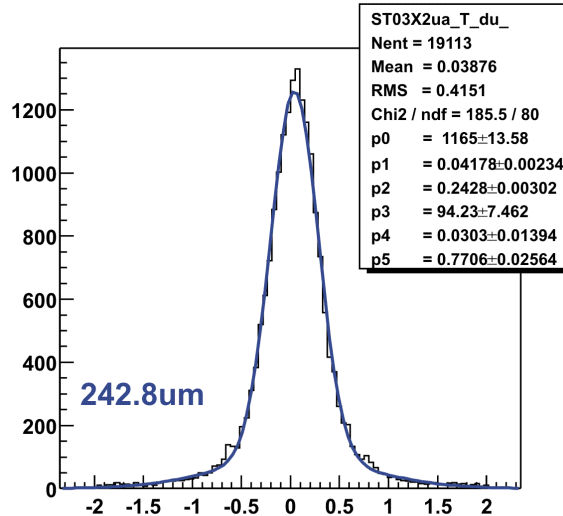
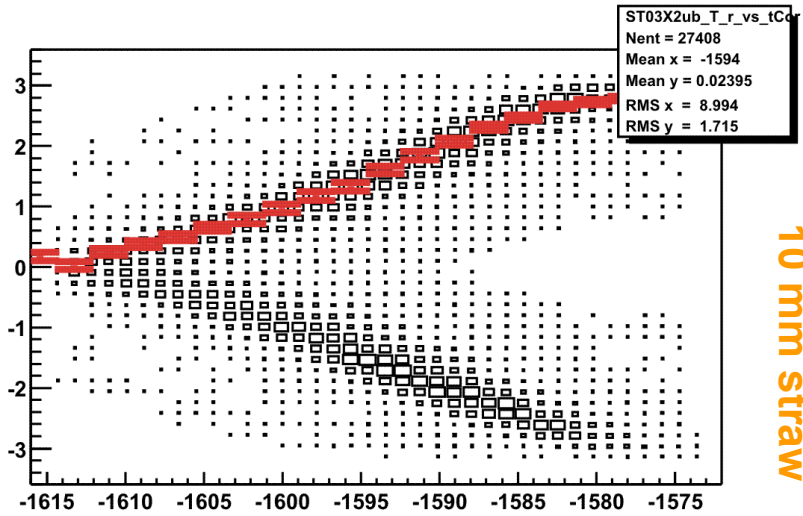
STRAWs tracking results

6 mm straw

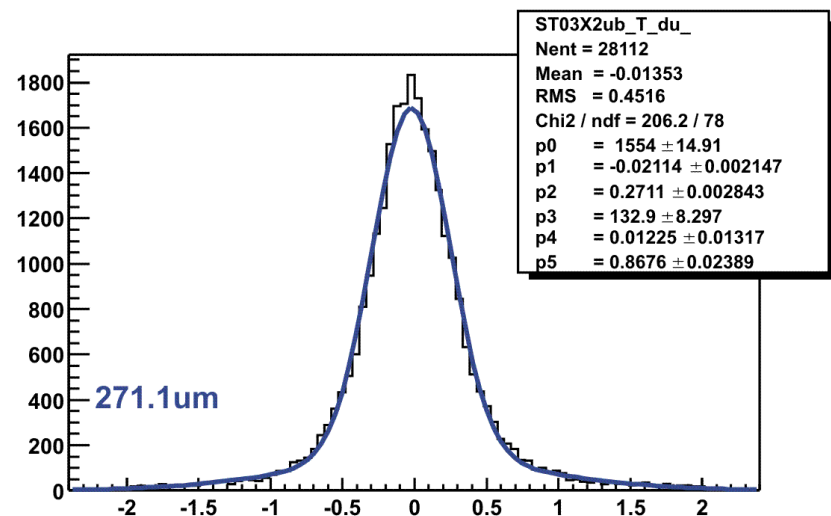


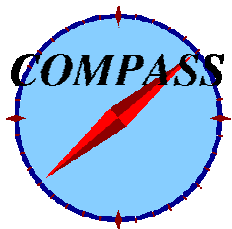
RT relations

10 mm straw



residuals

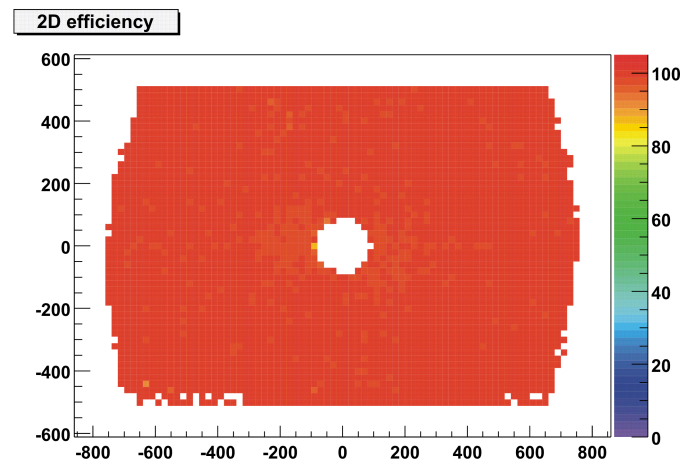
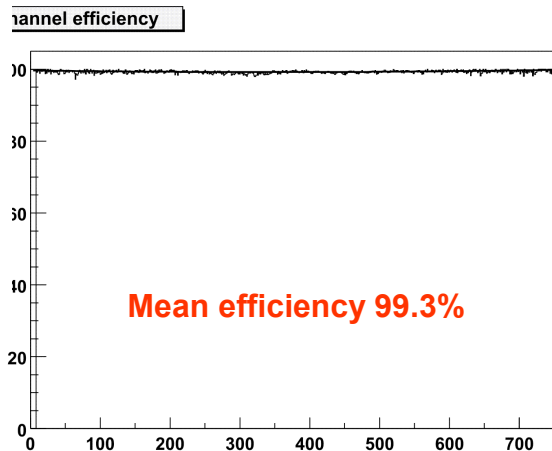
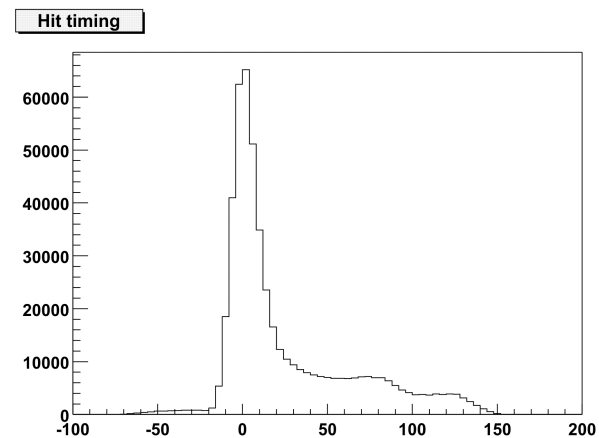
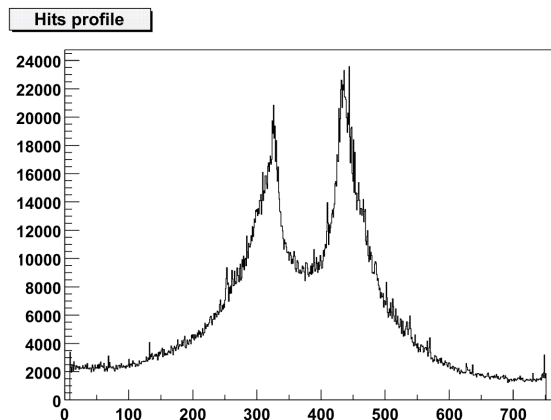


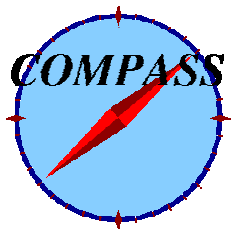


MWPCs

- Backbone tracking system in SAS
- 10 stations installed for a total of 31 planes

- Gas mixture:
70% Ar, 20% CF₄, 10% CO₂
- High voltage:
4.25 kV
- Discr. threshold:
4fC

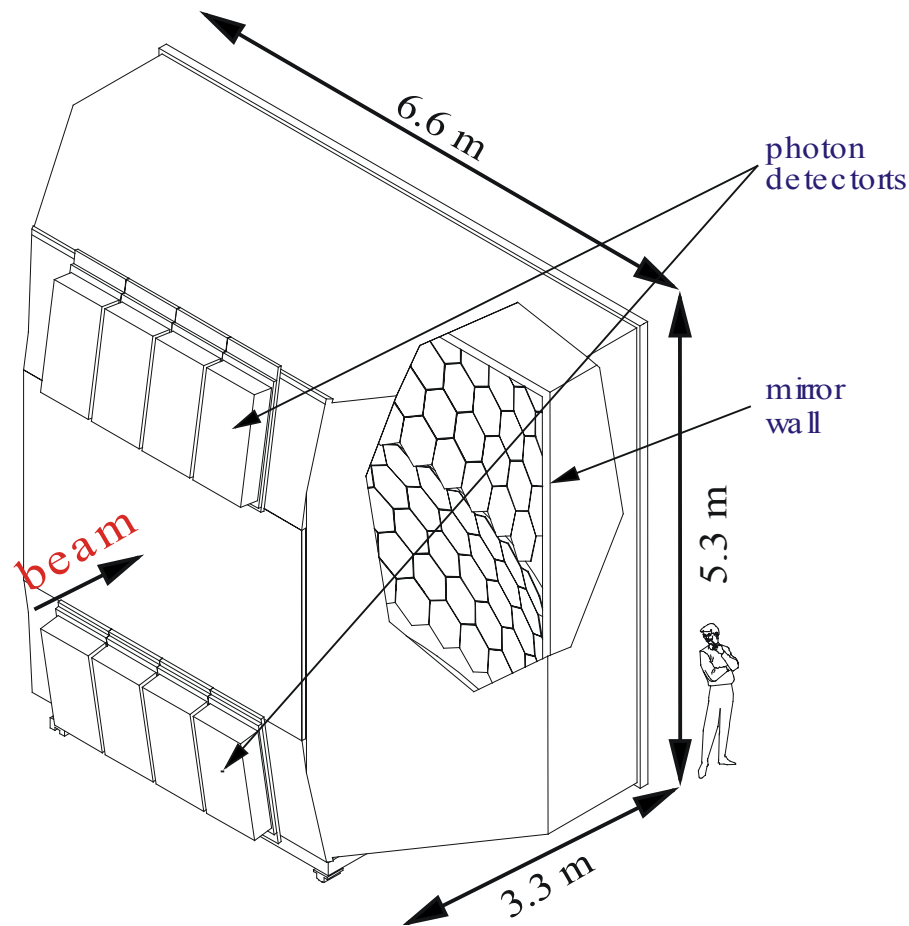


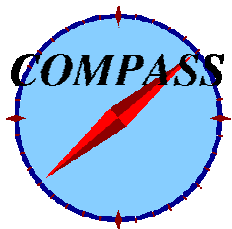


RICH1

Ring Imaging Cherenkov

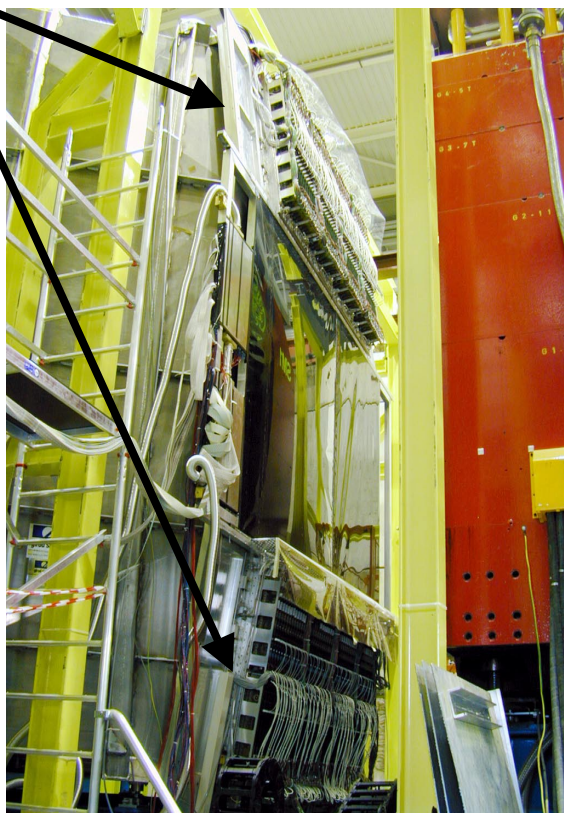
- 90 m³ (3 m C₄F₁₀)
- 116 mirrors (3.3 m focal length)
- 5.3 m² UV detectors
 - MWPC CsI photon-sensitive cathods
 - 8x8 mm² pads
- 84k channels
- p/K/ π separation up to 60 GeV



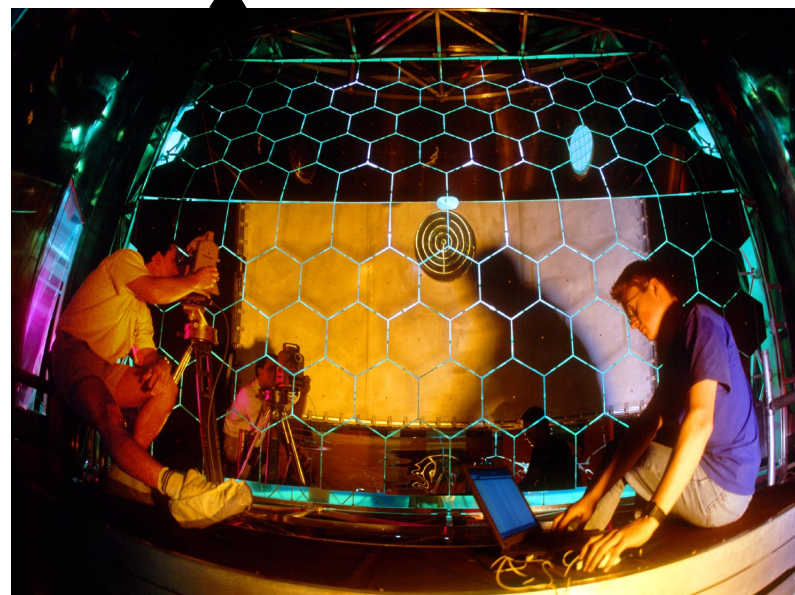


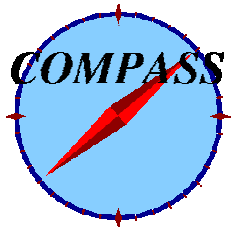
RUN 2001 – RICH1 FULLY INSTRUMENTED

**Photon detectors (PD) : 5.3 m² of CsI MWPCs,
84,000 analogic read-out channels**



**VUV mirror wall, 20 m²,
116 mirror pieces**





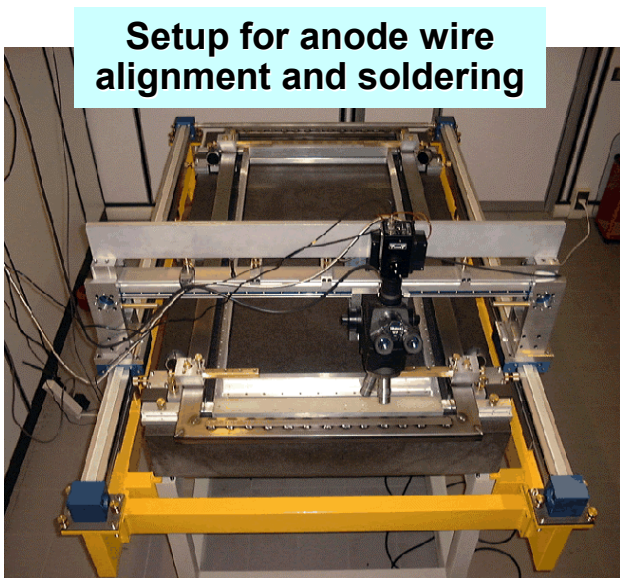
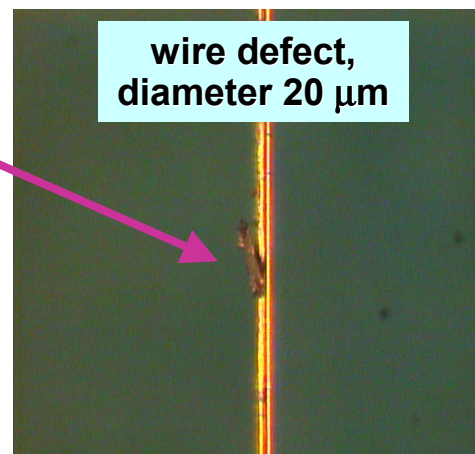
RICH1 – PHOTON DETECTORS

PDs electrical instability at high beam rate (6 over 8 PDs operated at 100-150 V lower than nominal HV)

Actions taken:

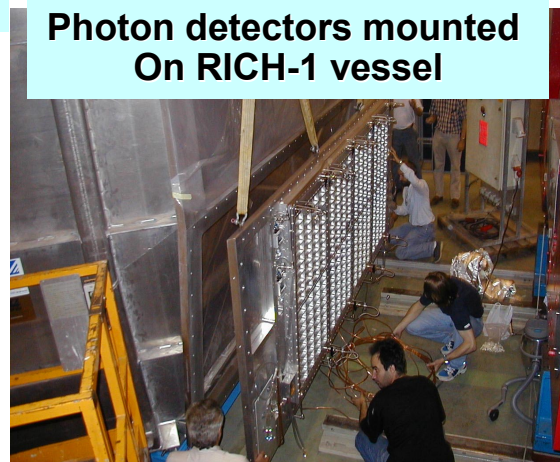
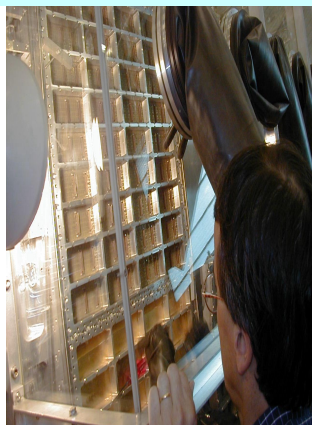
- hunting the technical problem: **local wire defects**
- 4 refurbished wire planes
- 2 new wire planes (wire LUMAMETALL → OSRAM)

Status: PDs mounted again on RICH-1 vessel



Setup for anode wire alignment and soldering

CsI photocathodes mounted with glove box

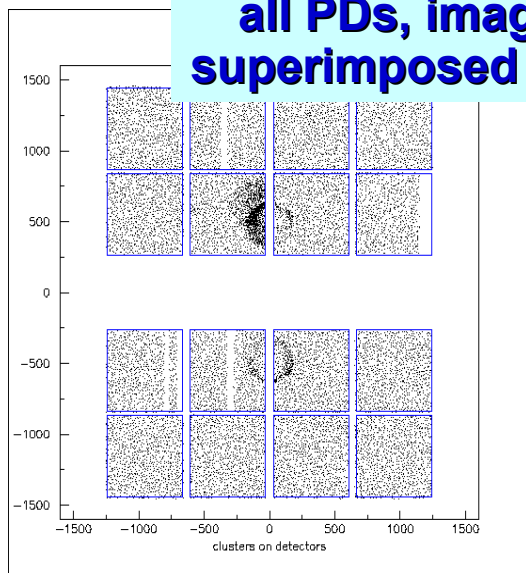


Photon detectors mounted On RICH-1 vessel

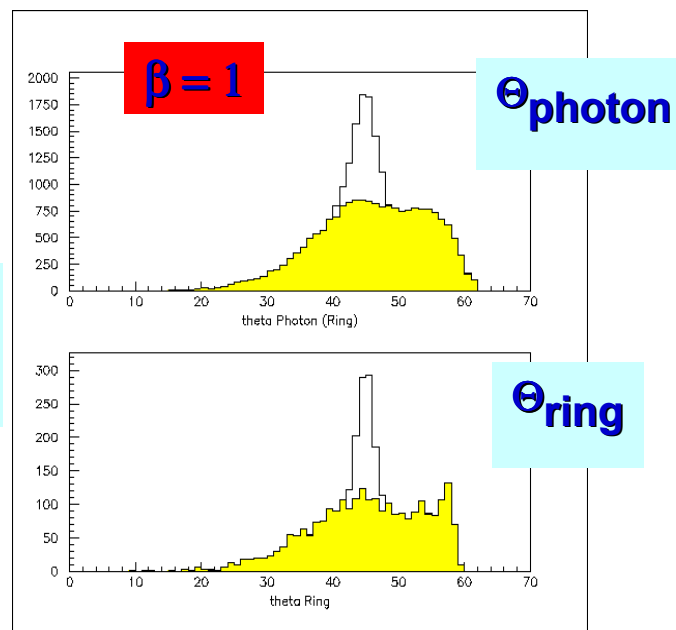


RICH1 – 2001 DATA

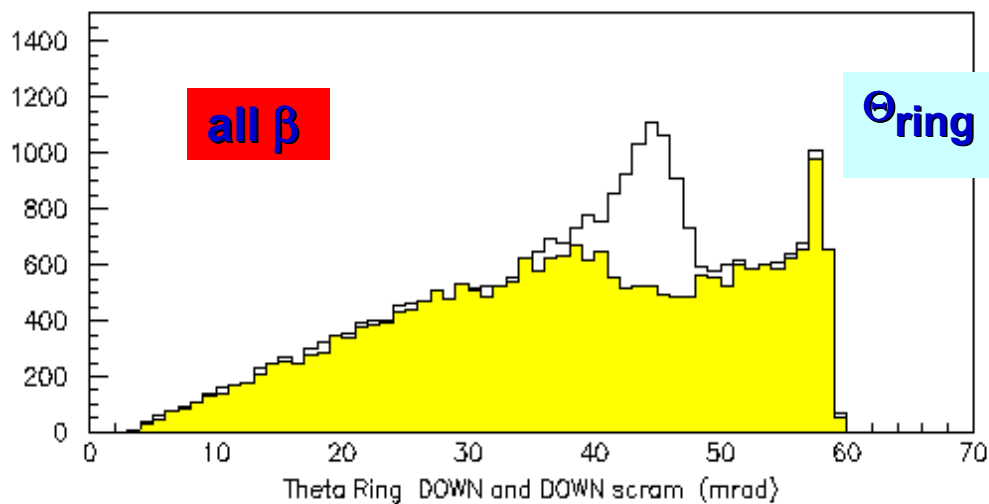
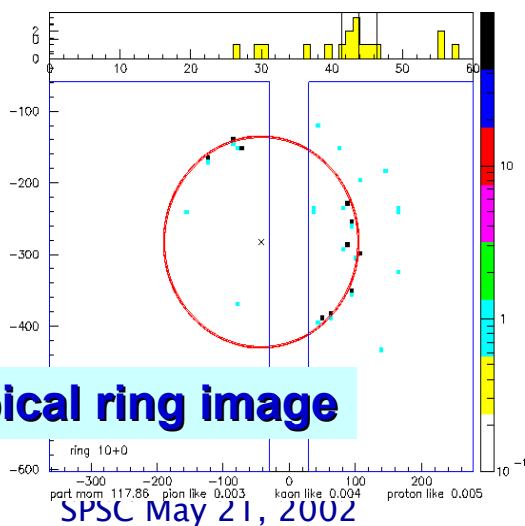
all PDs, image of superimposed events

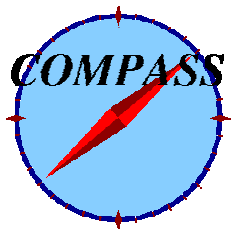


angular spectra for reconstructed Rings (signal and uncorrelated)



typical ring image



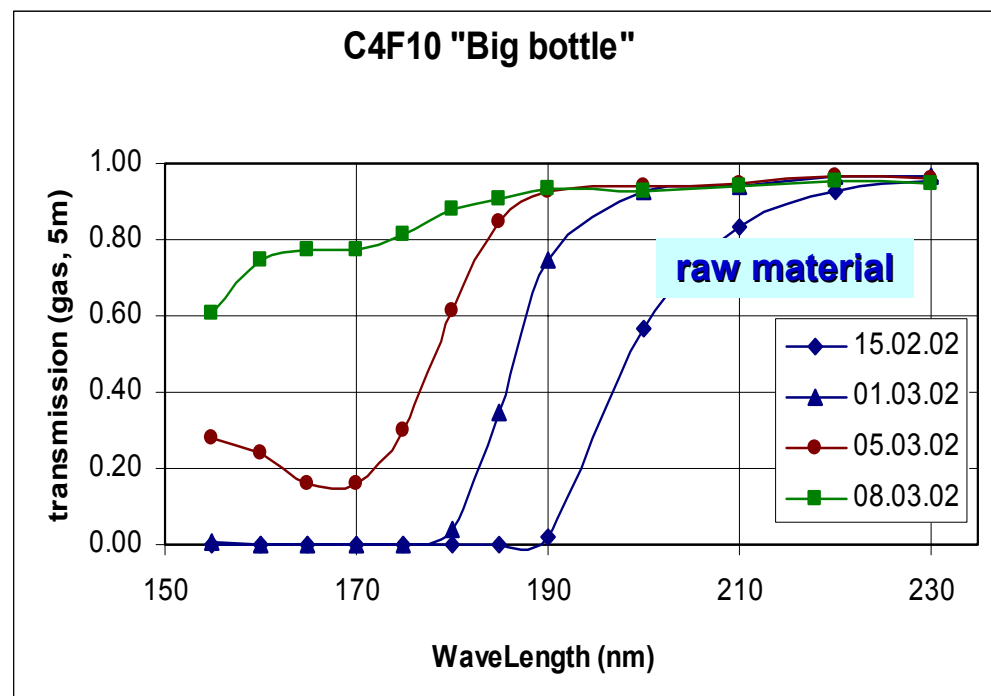


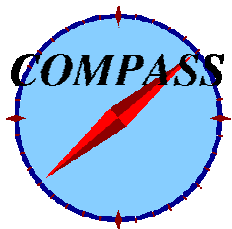
RICH1 – RADIATOR GAS, 2002 MATERIAL

- new C₄F₁₀ delivery, 570 Kg
- better quality, polluting contamination:

mainly water

- new pre-cleaning
installation:
cleaning in gas phase

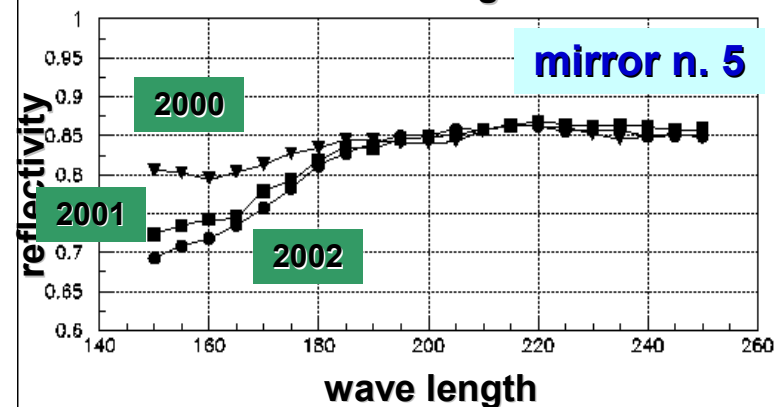
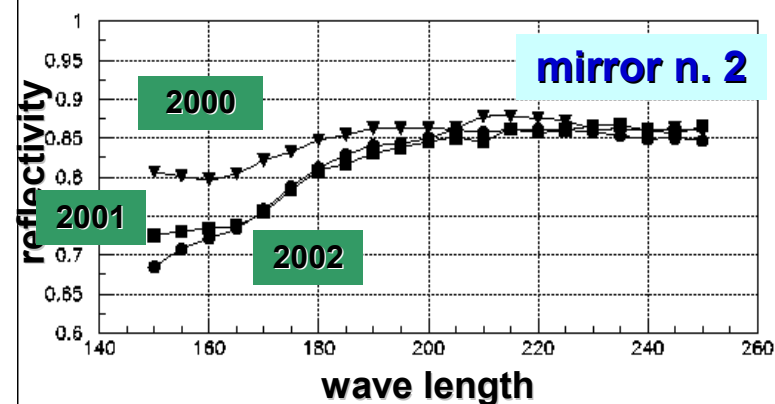


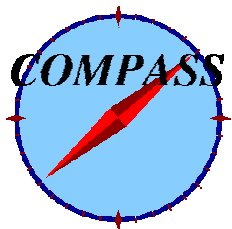


RICH1 – MIRROR WALL

reflectance of 2 test mirrors
measured after 2 years in
RICH1 vessel:
no degradation above 165 nm

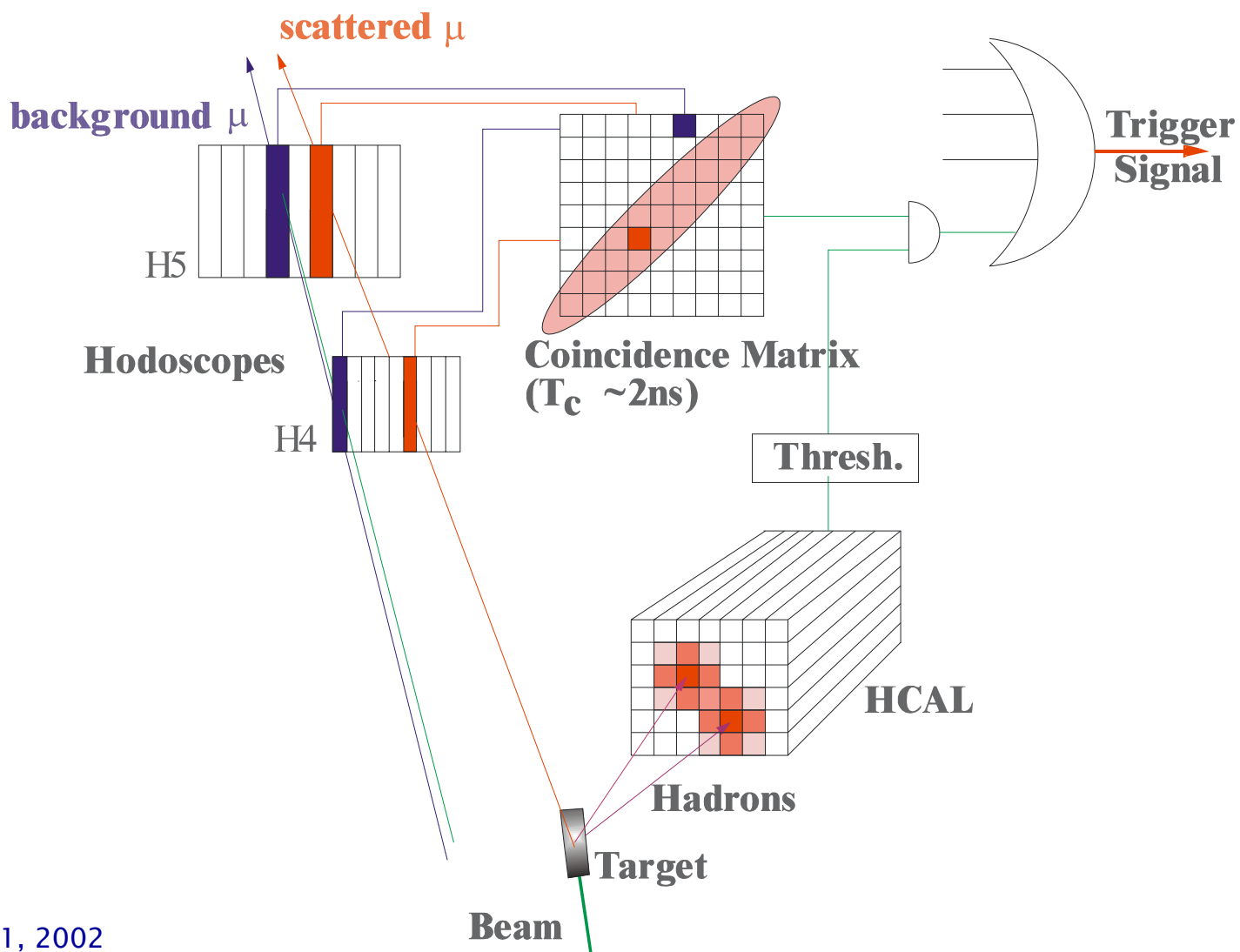
2000 = immediately after coating



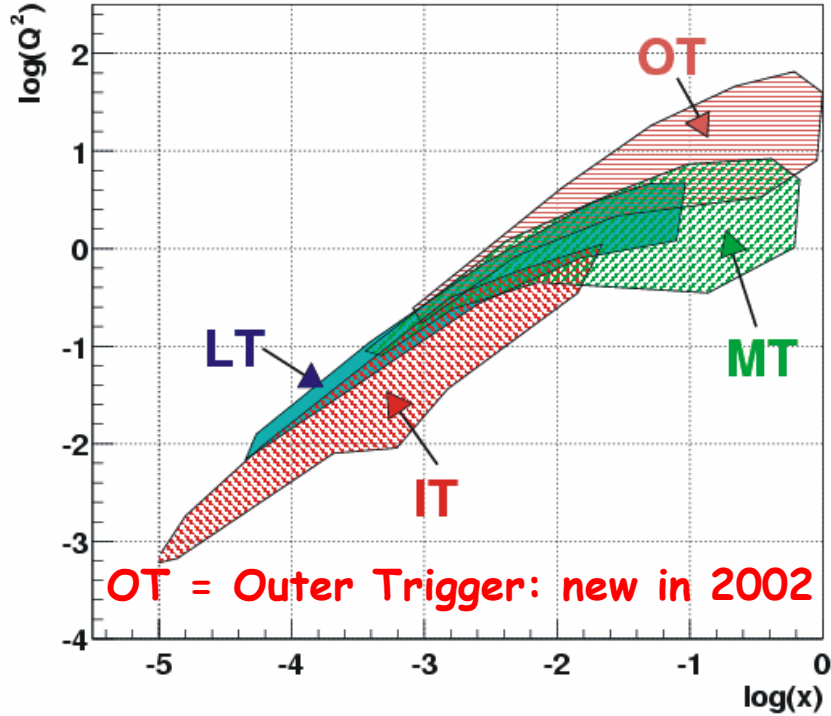


Trigger concept

$$\text{Trigger: } (H4 * H5) * (\text{HCAL1 } \vee \text{ HCAL2})$$

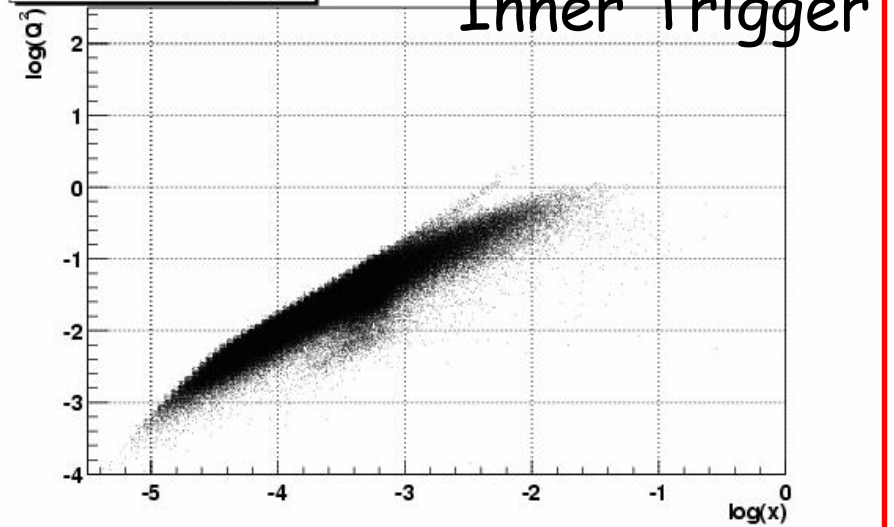


Kinematic ranges for IT, LT, MT, OT

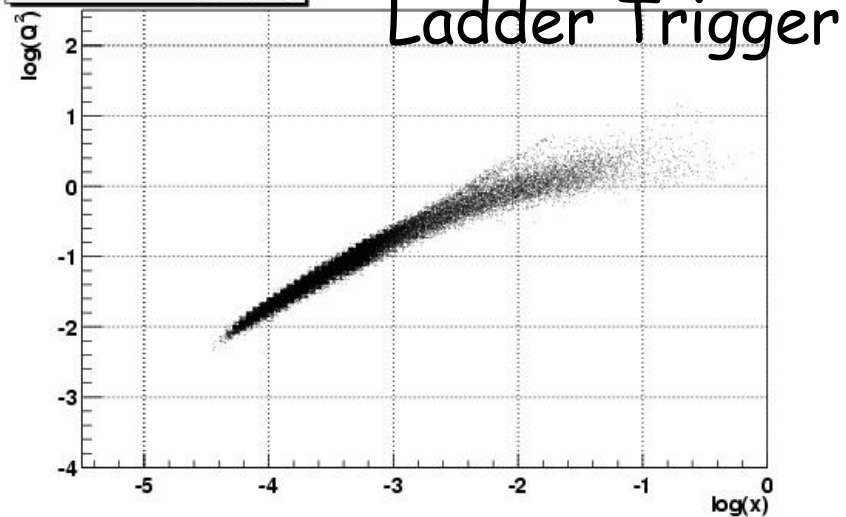


Trigger

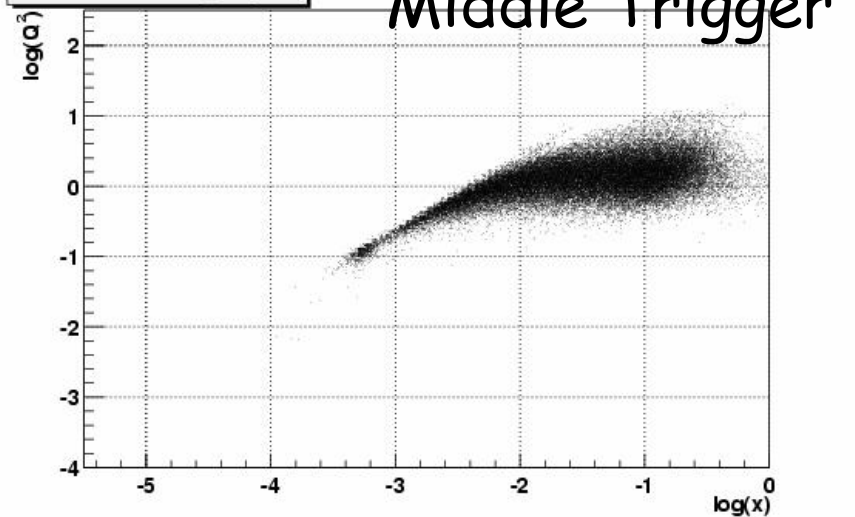
Kinematic range (IT)

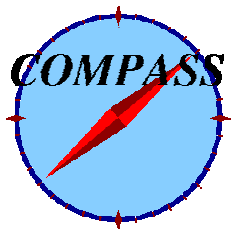


Kinematic range (LT)



Kinematic range (MT)





DAQ and ONLINE

FEATURES

- Pipelined readout architecture
- Data transfer via S-Link
- Buffering of burst (SPS duty cycle ~30%)
- Network eventbuilding

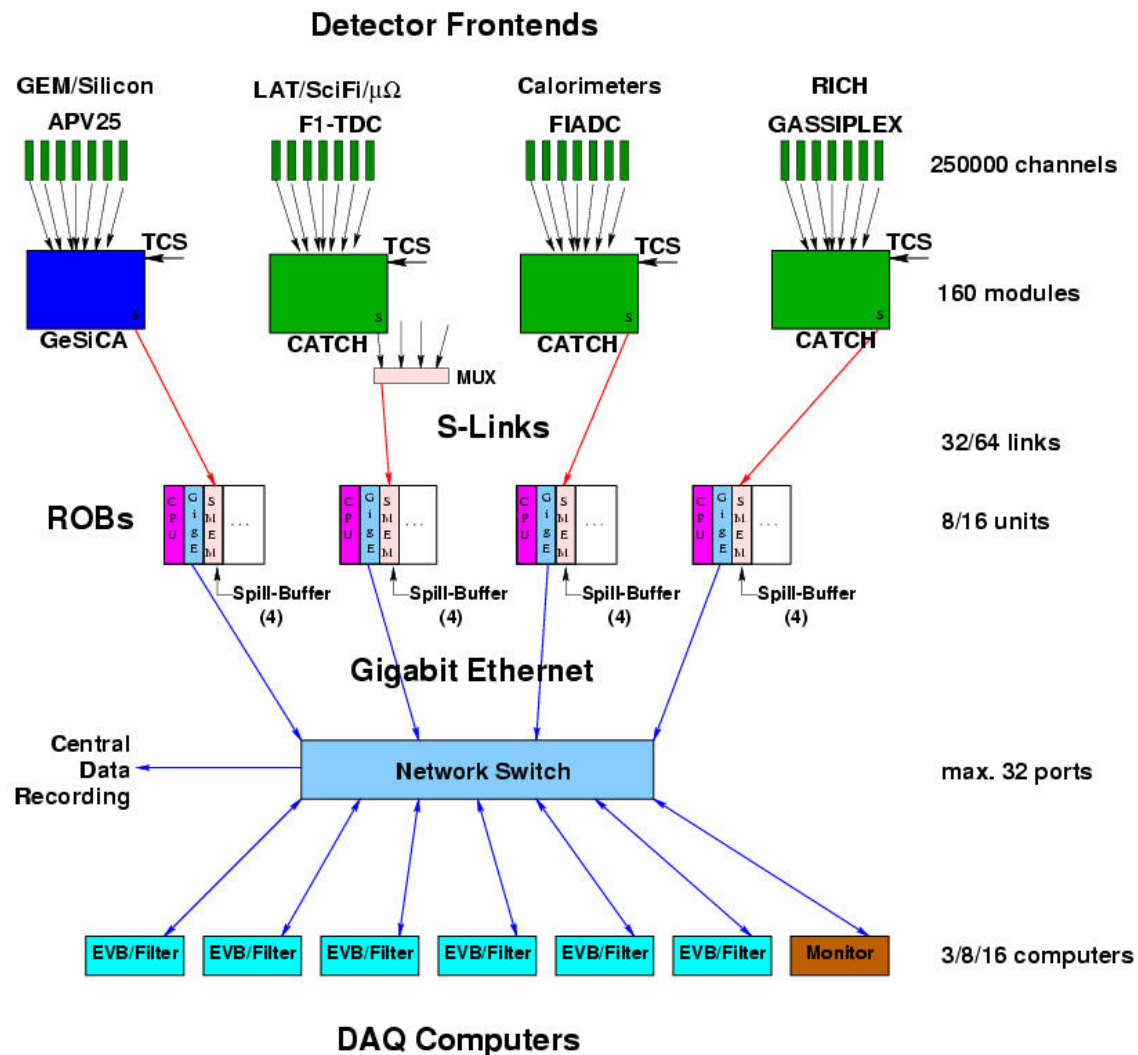
REQUIREMENTS AND PERFORMANCES

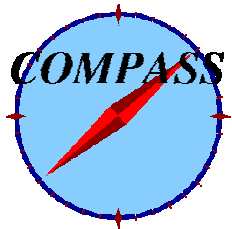
- Total number of channels 250k
- Trigger rates 5 – 50 kHz
- Event size ~ 30kB
- Data rates 0.6 – 6 GB/SPS spill

SOFTWARE

- ALICE DATE
- ROOT (COOOL)

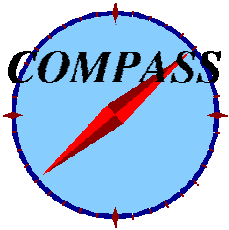
SPSC May 21, 2002





DAQ upgrade in 2002

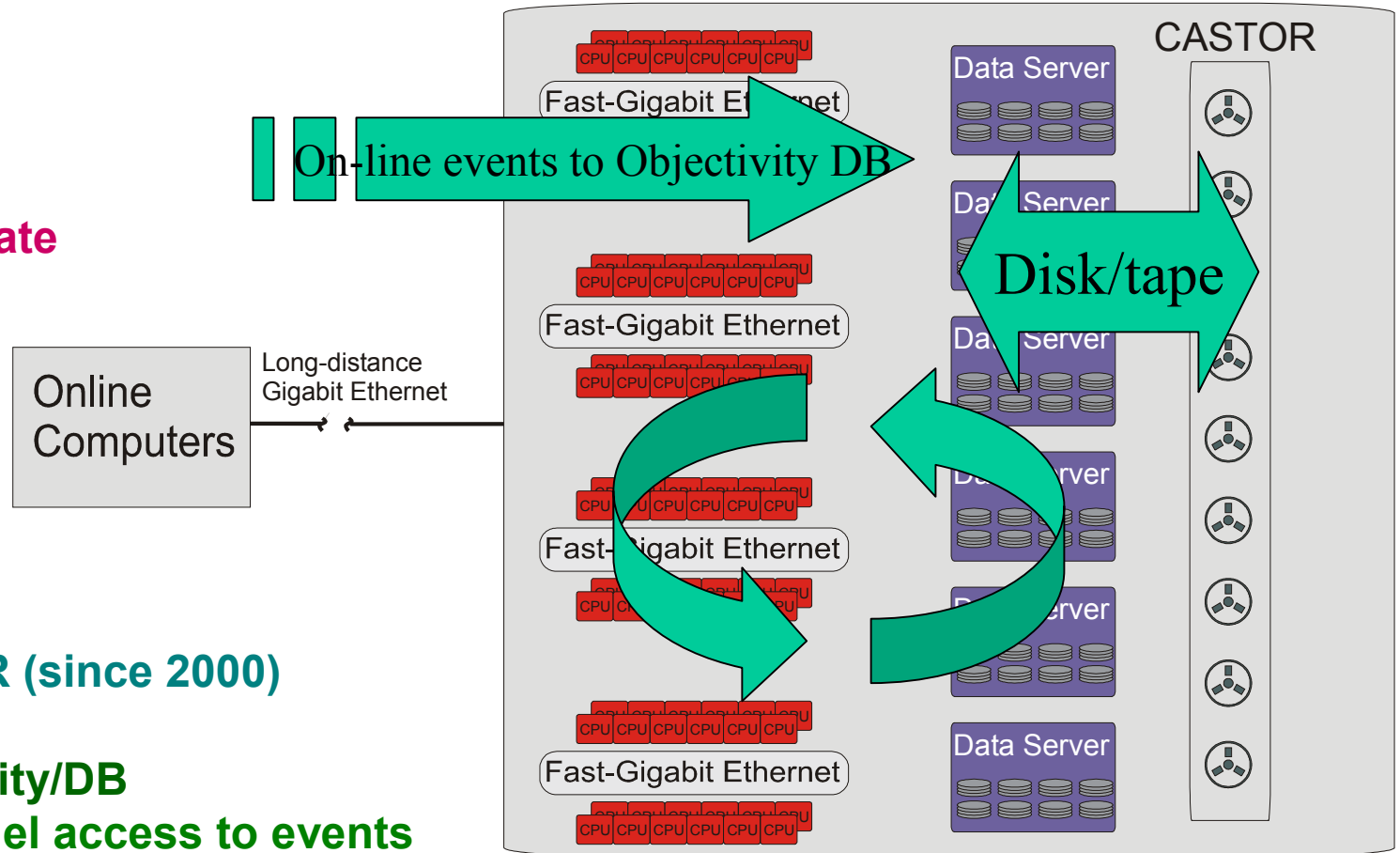
	2000	2001	2002
Eventbuilders	3	8	12
Readout Buffers	8	16	16
Spill Buffers	28	60	64
CATCH	20	112	143
Switch	1x3 9300 12 ports	3x3C 4900 24 ports	4x3COM 48 ports
Trigger/spill	10 k	10-20 k	20 k
Data/event	< 5kB	< 20 kB	~ 30 kB
Max Rate	10 MB/s	40 MB/s	40 MB/s



COMPASS Computing Farm

200 CPUs

35 MB/s input rate
300 TB/year



Use of CASTOR (since 2000)

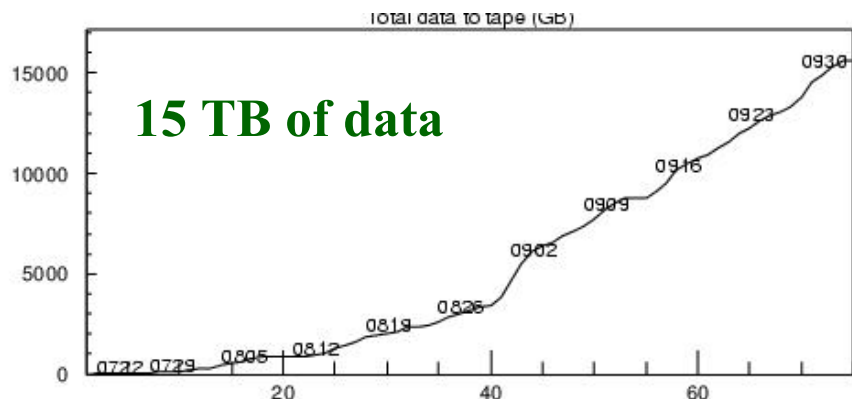
Use of Objectivity/DB

- Farm parallel access to events
- DST production
- RAW-DST connection without data duplication



Data Recording: 2001 data taking

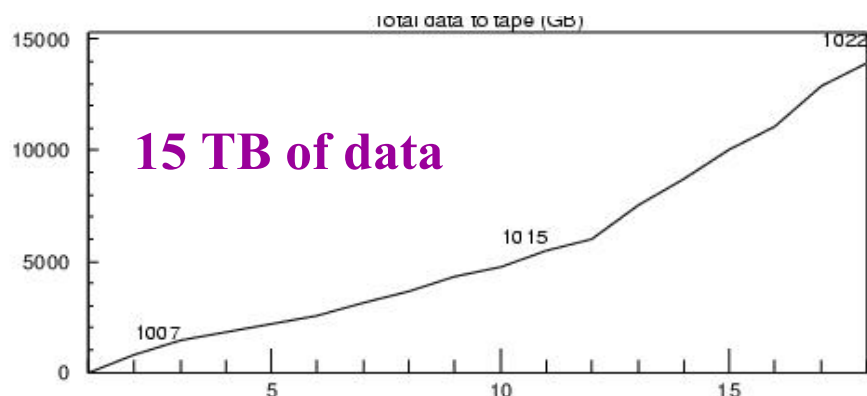
Beg. Jul → Beg. Oct



- **Setting up period**

- new detectors put in place and commissioned
- on-line system fully commissioned
- first look to the data
 - Debugging
 - Alignment
 - Calibrations

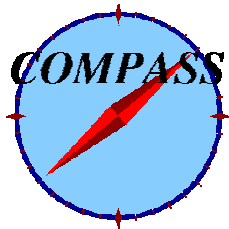
Smooth data taking



- **Two weeks “smooth data taking”**

- event size close to nominal (30 kB)
- event rate close to nominal (35 MB/s)

SPSC May 21, 2002



Off-line analysis of year 2001 data

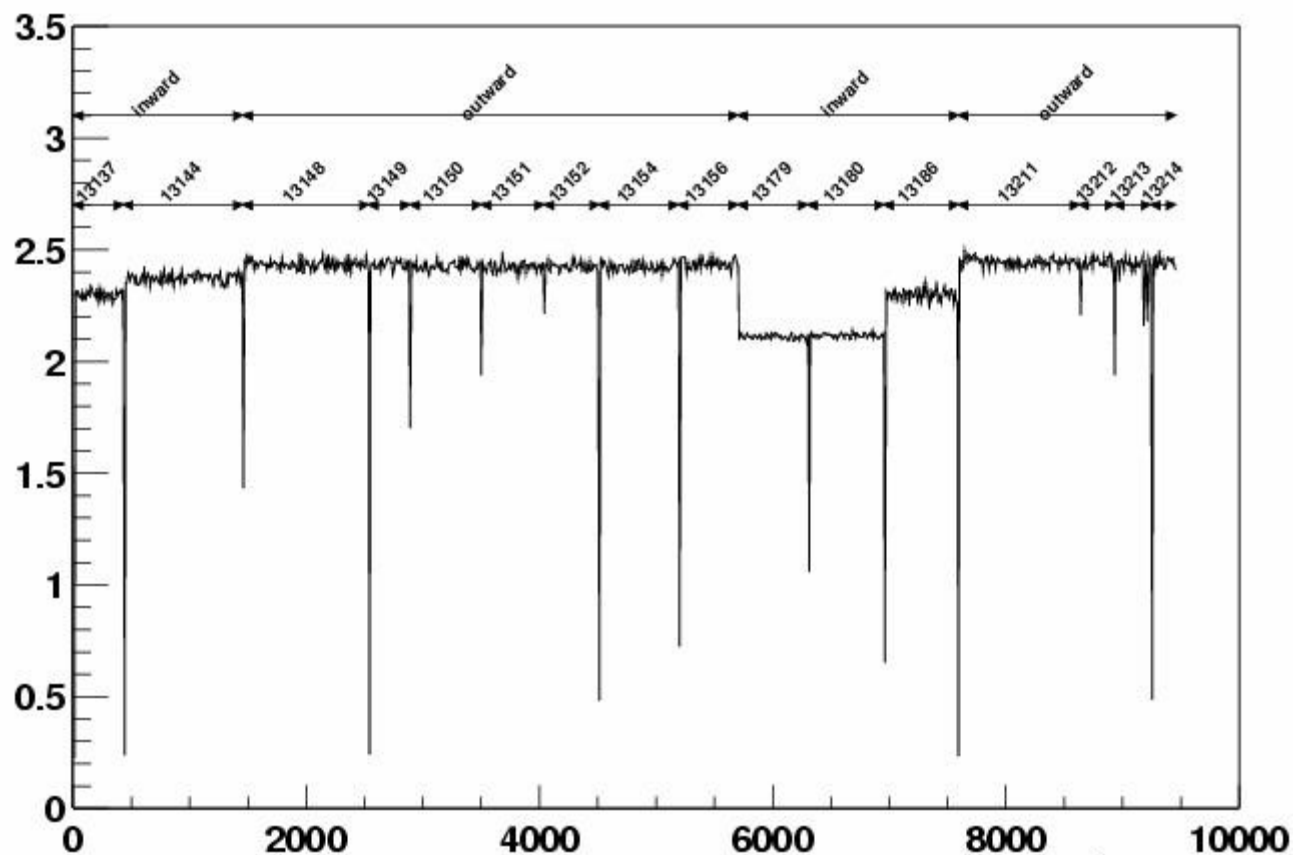
- **ON GOING**

- **HINTS ON**

- **DST production**
- **Event display**
- **Vertex reconstruction**
- **ρ , K^0 , Λ signals and mass resolution**

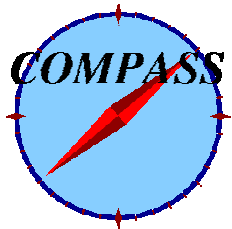


DST production



- Few days of data analyzed (20%)
- Still improving the reconstruction code, calibrations etc.
- Multiple reprocessing of the best data so far

Primary vertex mean multiplicity vs data block



Event display (2001 data)

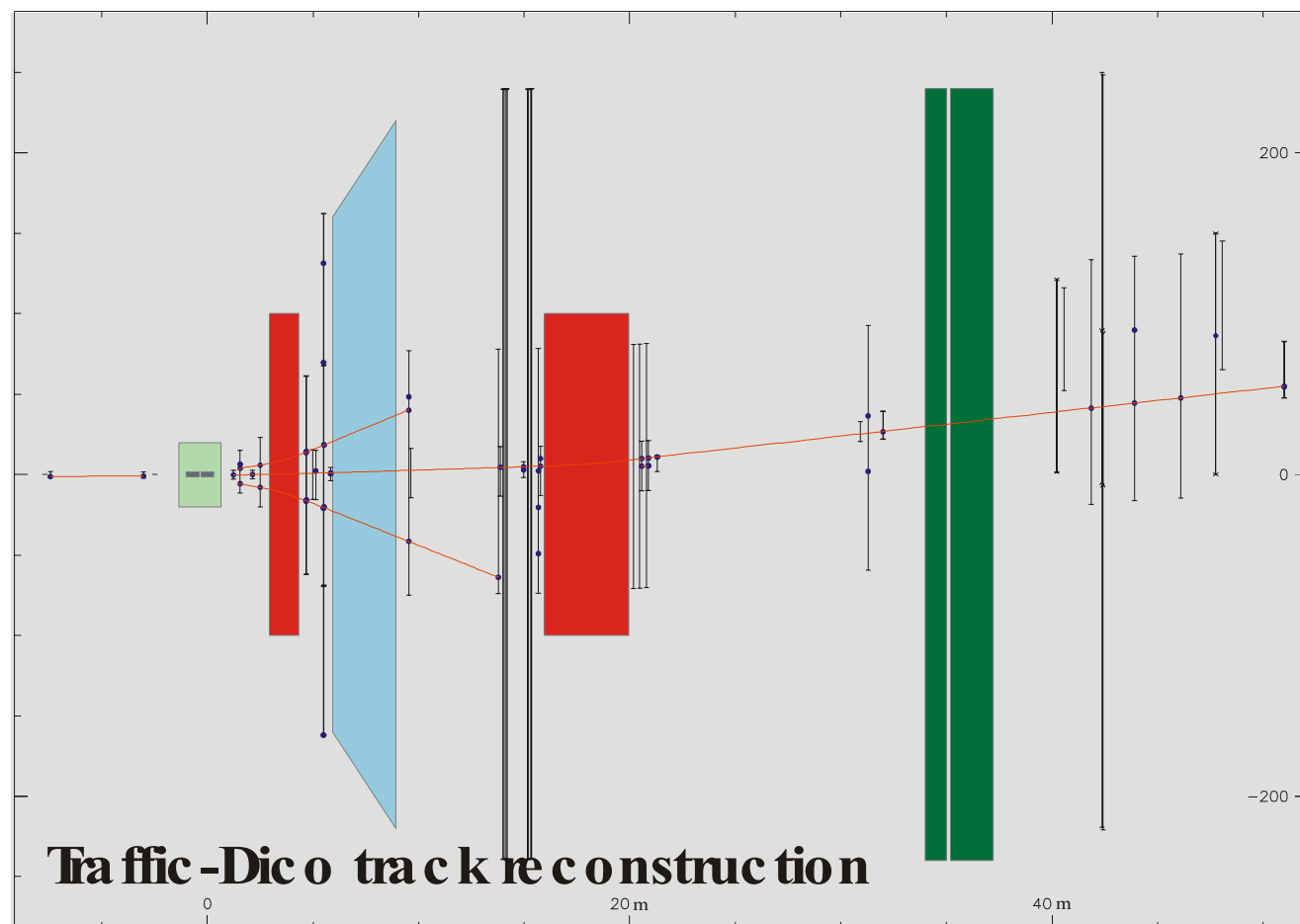
Run 13206 Event 52430226 Trigger(s) 1 Nhits 195

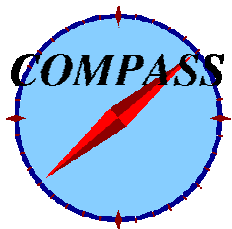
- CORAL

- Track reconstruction:

- Traffic
 - Kalman filter
- Dico
 - dictionary – look-up-table
- Recon
 - dedicated LAS tracking

- 0.3 s/ev on a CCF PC



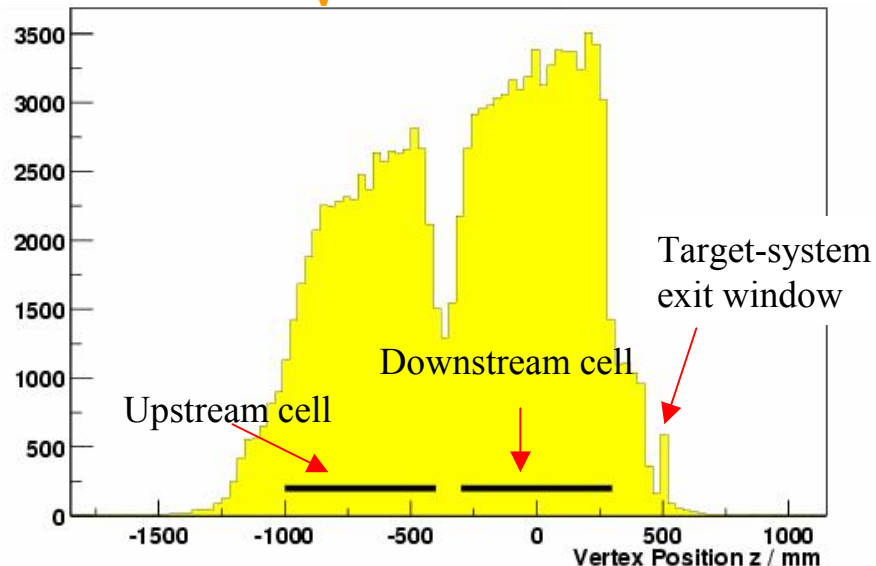


Primary vertex reconstruction

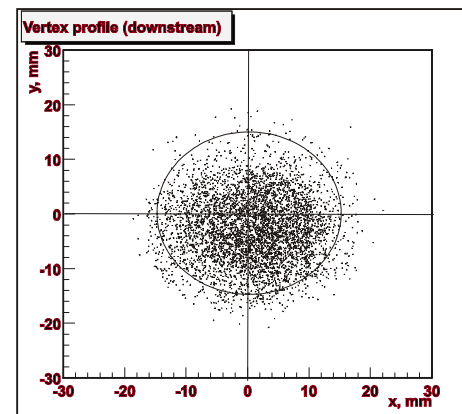
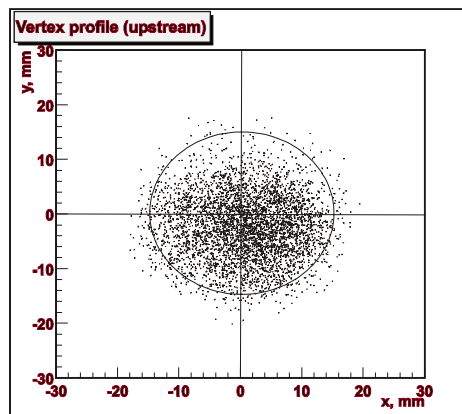
Primary vertex

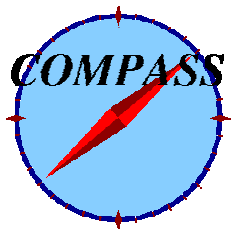
- 1 beam particle
- 1 triggered
- at least one additional track

Z_v distribution



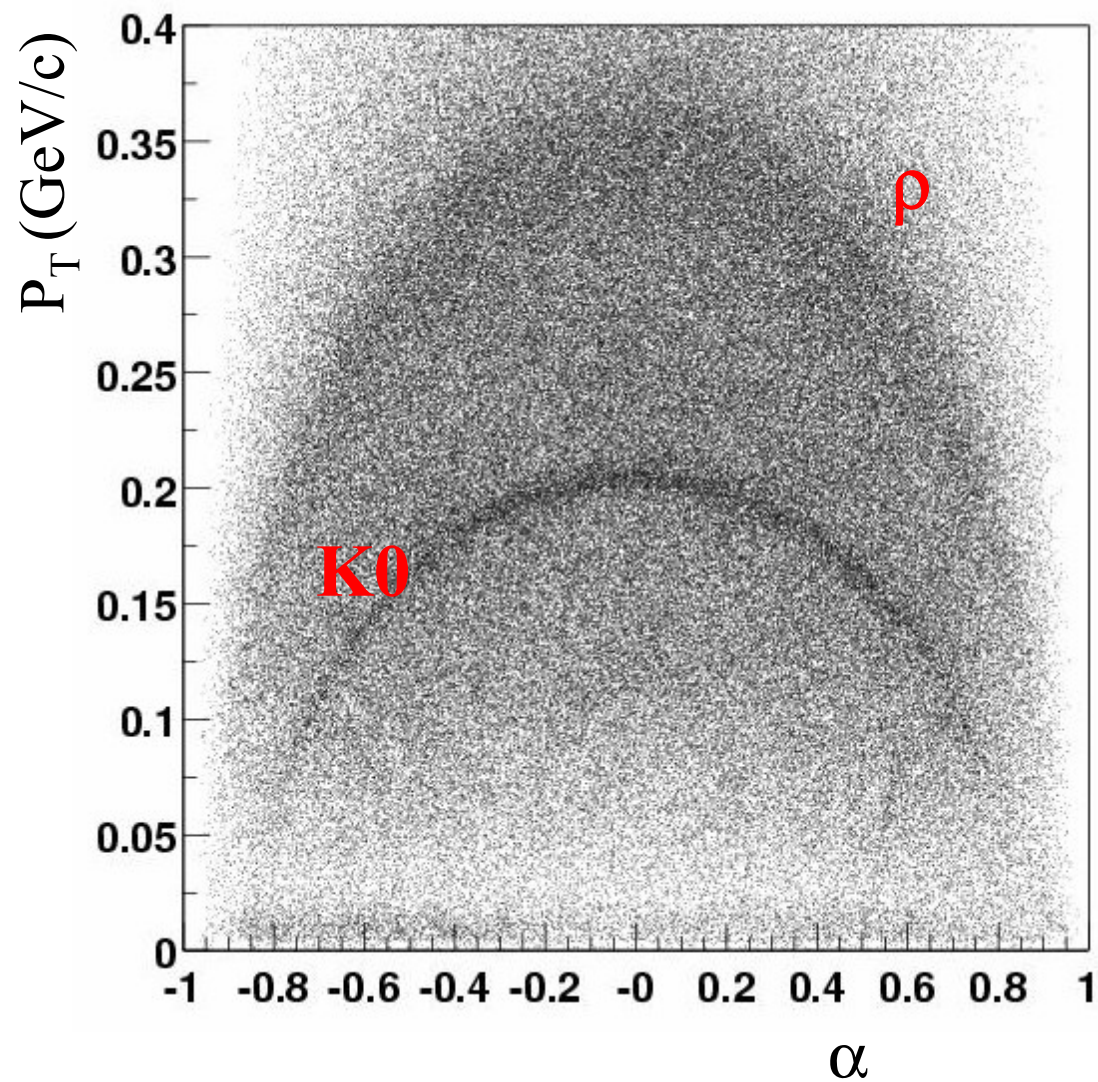
Y_v vs X_v
in the upstream
and downstream
target cells

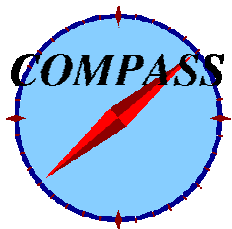




Secondary vertices

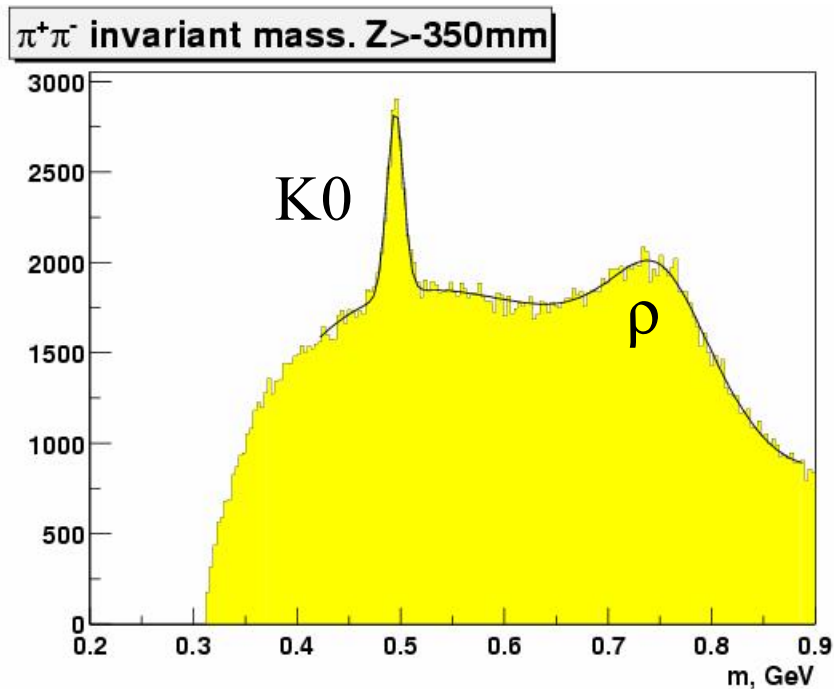
Armenteros plot
of the V0s
reconstructed
in the target region



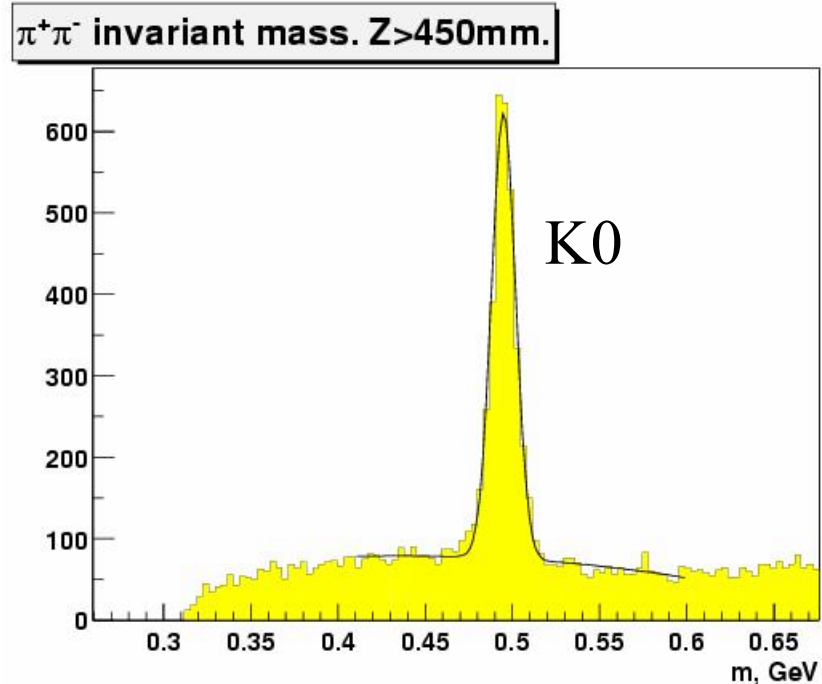


K0 and ρ

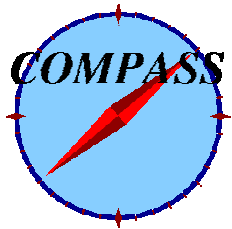
V0 from the target region



V0 outside the target

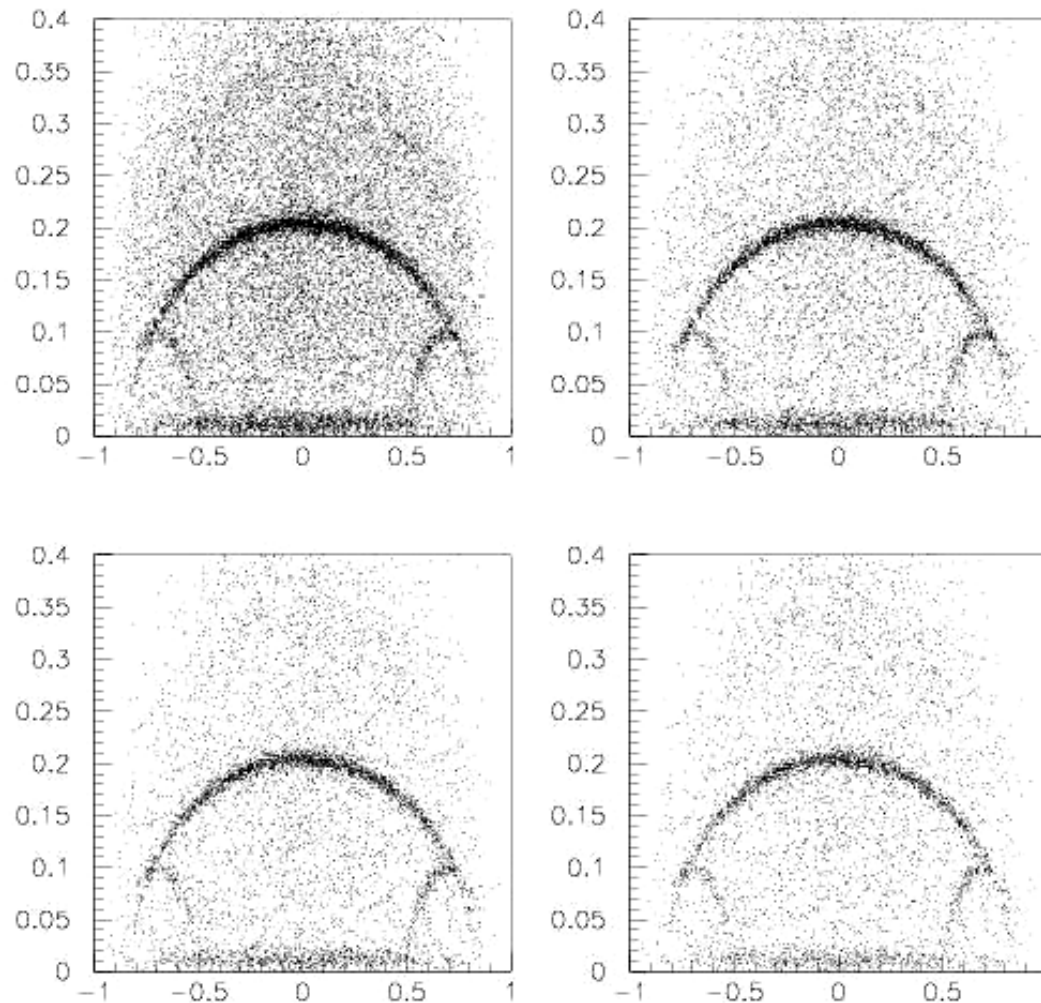


**K0 mass resolution 6 MeV
(close to the value from the simulations)**

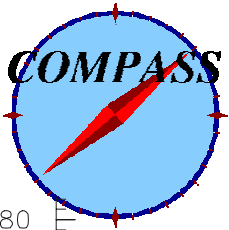


Lambda

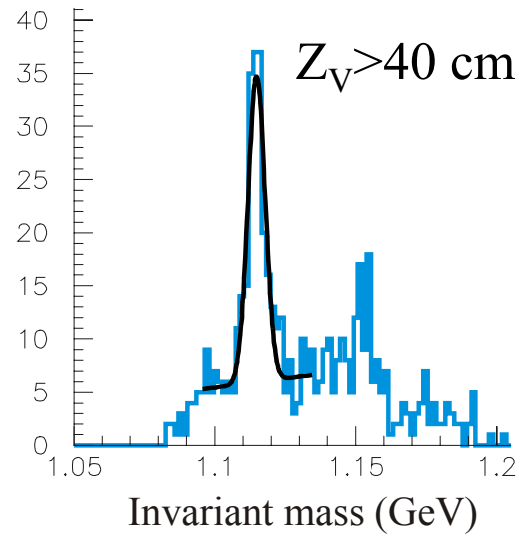
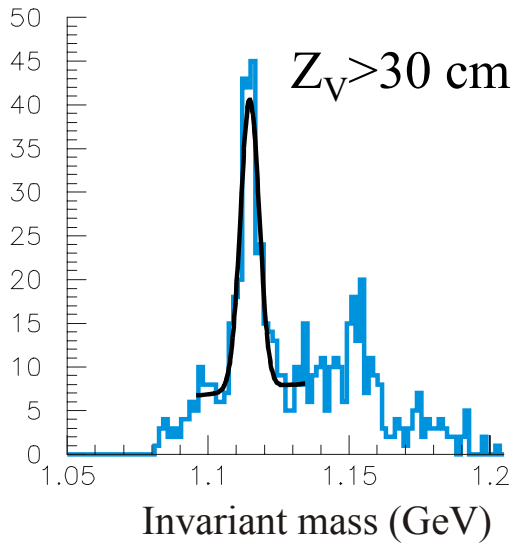
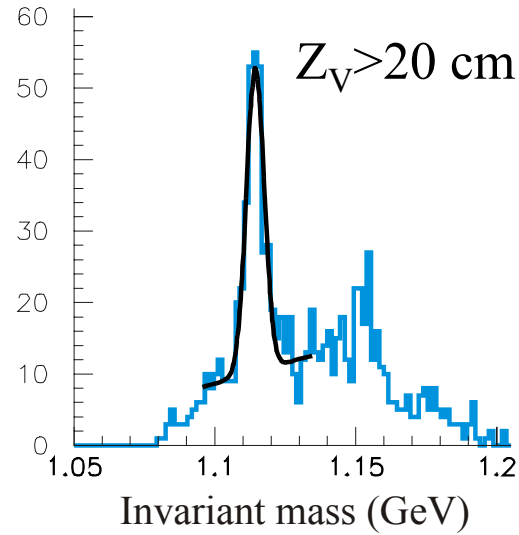
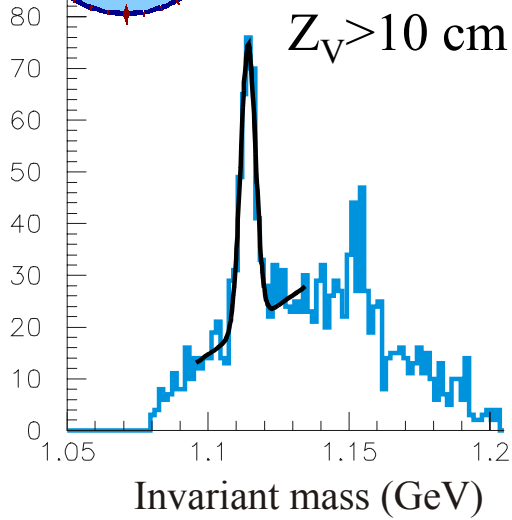
**Armenteros plots
outside the target volume**



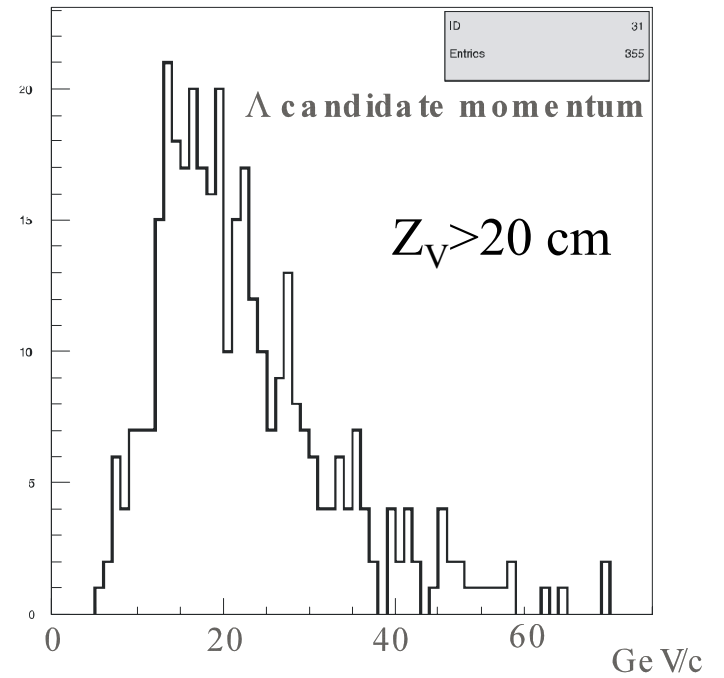
$Z_{v0} > 10$ cm, 20 cm,
30 cm, and 40 cm
from the target edge

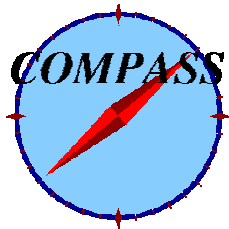


Lambda



**3 MeV/c² resolution,
close to the value from
the simulation (2 MeV/c²)**





SET-UP for 2002

INITIAL SET-UP

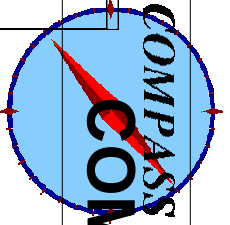
WITH SOME REARRANGEMENTS

- TRACKING BETWEEN PT and SM1
 - 3 MicroMega's stations (4 planes each)
 - 1 SDC
- TRACKING BETWEEN SM1 and RICH1
 - 2 SDC
 - 1 Straw Module (6 DL's)
- MUON WALLS fully instrumented

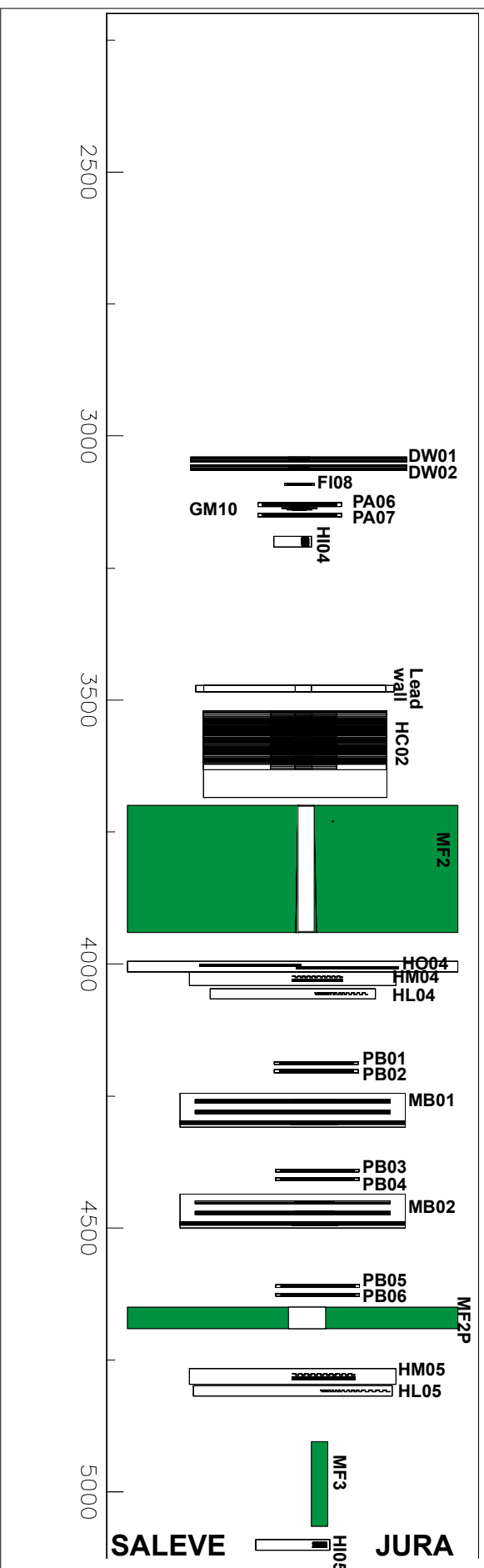
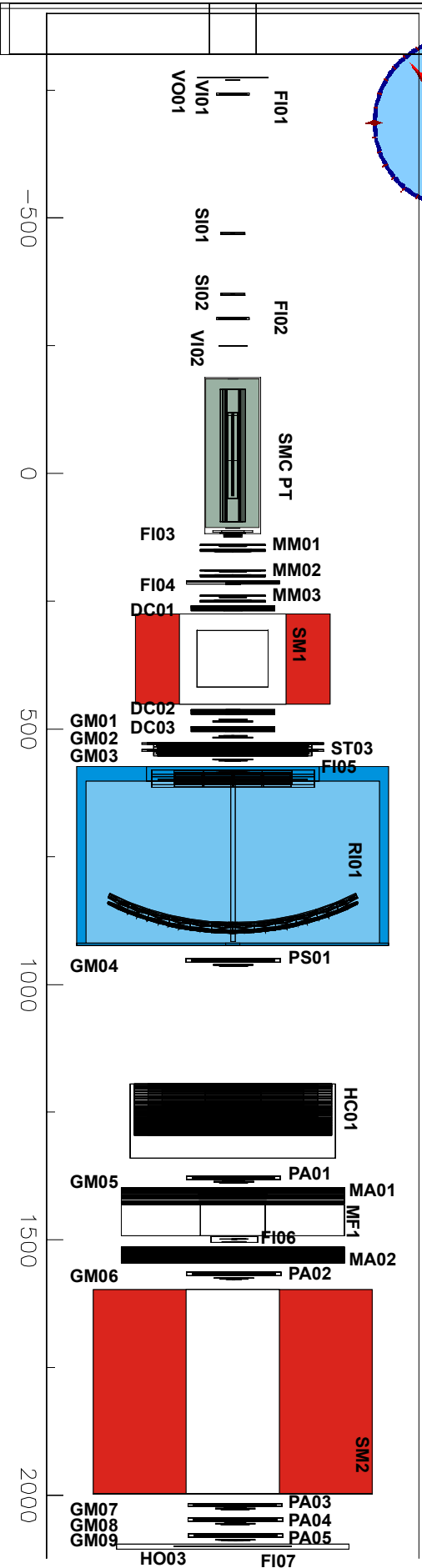
PLUS LARGE Q^2 (~50 GeV²)

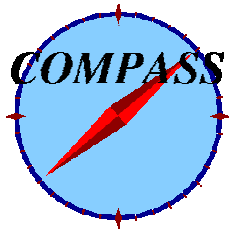
- H3 H4 Hodoscopes
- DW01 DW02 large area drift chambers
(5.2x2.8 m², former W45 in SMC, with new COMPASS read-out)

AND THE SMC PT MAGNET



COMPASS COMGeant setup 2002.01





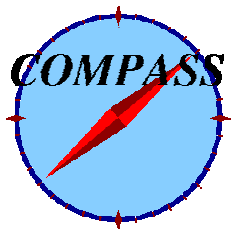
COMPASS MAGNET

- **AGREEMENT** has been reached with **OXFORD INSTRUMENTS** on the termination of the present magnet project, and the **COMPASS Collaboration** is taking over the responsibility for the completion of the magnet system.
- Several options for the completion of the **COMPASS Magnet** are under investigation (to which **OIS** might contribute).
- For the year **2002** run the **SMC PT Magnet** will still be used. The implications on the muon physics program were detailed in our **Memo of Oct. 26, 2001**



Ratio of effective acceptances for OIS and SMC target solenoids

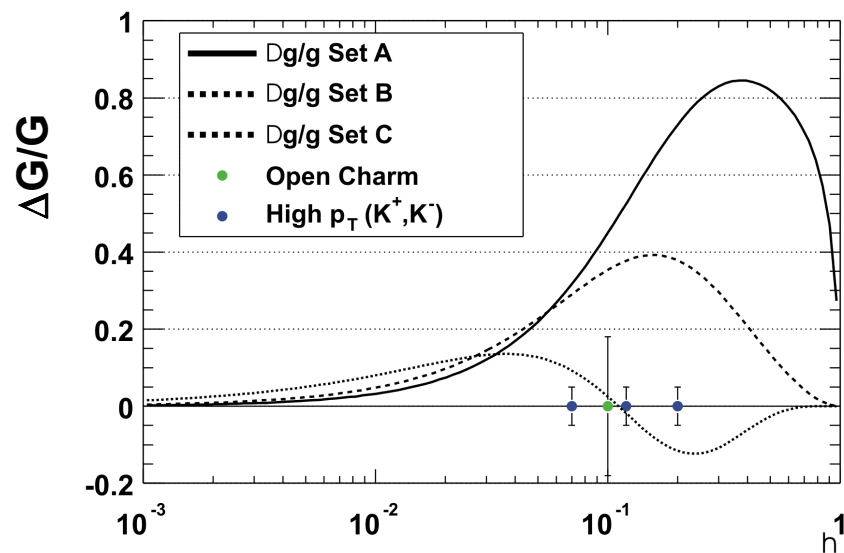
Channel	Energy (GeV)	Evaluation	SMC/OIS accept.
D^0 (D^0)	100	raw evts.	0.57
		weighted evts.	0.46
	160	raw evts.	0.76
		weighted evts.	0.67
D^*	100	raw evts.	0.36
		weighted evts.	0.44
	160	raw evts.	0.64
		weighted evts.	0.65
high P_t	160	raw evts.	0.76
semi-inclusive longitudinal target pol.	100	$x \leq 0.03$	$\simeq 1.0$
		$x \simeq 0.2$	0.54
semi-inclusive transverse target pol.	100	$x = 0.05 \quad 0.15$	0.73
		$x = 0.45 \quad 0.55$	0.23
	160	$x = 0.05 \quad 0.15$	0.76
		$x = 0.45 \quad 0.55$	0.28
polarisation	160	$x_F < 0$	0.5
		$x_F > 0$	0.98
inclusive DIS	100	$x = 0.5; Q^2 = 30 \text{ GeV}^2$	1.0
		$x = 0.5; Q^2 = 50 \text{ GeV}^2$	$\simeq 0.5$
	160	$x = 0.5; Q^2 = 50 \text{ GeV}^2$	1.0
		$x = 0.5; Q^2 = 100 \text{ GeV}^2$	$\simeq 0.65$

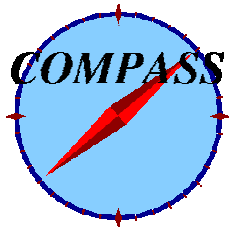


Projected results

Statistical accuracy after 80 days of ${}^6\text{LiD}$ data taking with
160 GeV muons and SMC magnet

- Open Charm Production
 - low systematic error
 - 16k reconstructed charm events
 - $\rightarrow \delta(\Delta G/G)_{\text{st}} \sim 0.18$
 - one data point at $\langle \eta \rangle \sim 0.1$
- High p_T hadrons
 - Compton background
 - low statistical error
 - $\langle \eta \rangle$ reconstructed: three data points $0.04 < \eta < 0.2$





CONCLUSIONS & OUTLOOK

IN 2002 ~ 100 DAYS OF RUNNING

→ FULLY FOCUSED ON MUON RUNNING

Running time effectively reduced by a factor of two

THE INITIAL LAYOUT IS COMPLETED (WITH ADDITIONS)
THE SPECTROMETER WORKS

detectors, DAQ , off-line are all state-of-the-art
DATA LOOK GOOD

EXCELLENT PERSPECTIVES BUT WE NEED BEAM TIME

COMPLETION OF THE SPECTROMETER

RICH2 & calorimetry

some tracking & triggering system

upgrade of DAQ

--- ONGOING ---