Completion of the Spectrometer

- History
- The initial layout
- Hadron set-up: production of exotics
- EM Calorimetry
- A look to the various programmes
  - Polarisability of Kaons and pions
  - Exclusive meson production and DVCS
  - Double Charm set-up
- RICH-II
- RICH wall tracking detector
- Further tracking options
- Conclusions
History

- **1996** Mar: proposal for full COMPASS
  - muon and hadron programme
- **1997** Feb: conditional approval
- **1998** adaptation to available resources
  - Jul: approval of reduced ‘initial layout’
  - Sep: MoU for initial layout, omitting commitments for:
    - Large area tracking and triggering
    - Rich II
    - EM calorimetry
    - Full-scale DAQ
  - Goal remains the complete spectrometer
COMPASS initial layout

full layout

beam Large angle spectrometer Small angle spectrometer

initial layout

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## Physics with initial layout

<table>
<thead>
<tr>
<th><strong>Missing detectors</strong></th>
<th><strong>Related physics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Large area tracking</td>
<td>High-$Q^2$ DIS</td>
</tr>
<tr>
<td>Rich II</td>
<td>PID only up to 30 – 40 GeV/c</td>
</tr>
<tr>
<td>EM Calorimetry, reduced DAQ</td>
<td>Basically no hadron program, apart from semi-leptonic decays</td>
</tr>
</tbody>
</table>
Status of initial layout

Eventually completed
to do:
- **RICH-I**
  3/8 photon detectors to be fixed for 2003
- **Straw detectors**
  9 of 15 installed and working
  5 ready to be shipped mid October 2002
  1 to be fixed for 2003
- **Polarised target magnet**
  using SMC magnet
  good performance, limited acceptance

S. Dalla Torre
PT Magnet

- Apart from acceptance same specification as SMC magnet
- Construction not satisfactory
- Original contract with OIS terminated amicably
- New contract being negotiated with different company
- Presently magnet being inspected
- Idea: build new coils
- Earliest ready for 2004 run, likely later
PT magnet acceptances

COMPASS magnet

SMC magnet

180 mrad

65 mrad

μ

preliminary - all

with Λ

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Initial layout ++

- **GAMS** 2000 lead glass blocks
- **ECAL** 1 frame
- Large area tracking
  - Trigger hodoscopes
  - Muonwall 1
  - Muonwall 2
  - SMC W45 chamber
    8 views, performance to be studied
- 3rd Saclay drift chamber
  - Replacing missing straw, 98% acceptance for SMC magnet
- Extra fibres and MWPCs
Production of Exotics

e.g.: \[ pp \Rightarrow \eta \eta \Rightarrow 4\gamma \]

- Existing (to be refurbished):
  - Liquid hydrogen target, 40 cm
  - Recoil Proton detector RPD

- Essential: EM calorimetry, options:
  - ECAL1+GAMS (\(\equiv\) ECAL2 ')
  - ECAL1+ECAL2
  - Additional wide angle Detector
EM Calorimetry

ECAL1 + GAMS
geometrical
\( \gamma \)-acceptance 18 %
for \( \eta \eta(4\gamma) \)

ECAL1 + ECAL2
\( \gamma \)-acceptance 36 %
EM Calorimetry

ECAL1 + ECAL+
WAD
\(\gamma\)-acceptance 95 %
\(\eta\eta(4\gamma)\)
ECAL 1&2

• ECAL1
  – Frame installed
  – Cassette under construction
  – Operational 2004

• ECAL2
  – Design finished
  – Construction to be clarified
  – Operational 2006

• ADC readout
  FIADC: Fast integration, about 3000 channels existing of 8000, cables needed!
  SADC: Sampling ADC, design ongoing
ECAL1 frame
ECAL2

624 Matrix blocks (75x75mm**2)

764 lead/scintillator blocks (38.3x38.3mm**2)

2672 GAMS blocks (38.3x38.3mm**2)

Central hole (380x380mm**2)
ECAL Sampling ADC

- **SHAPER**
  - Stretching and smoothing
  - optimized for lead glass signals
- **ADC**
  - 100 MHz sampling
  - 10 bit resolution
- **FPGA**
  - Data compression
  - Signal fitting
  - Amplitude and Time

**Simplified diagram of single channel ADC**

- Shaper
- ADC
- 10 bit/100 MHz
- FPGA data processing
- Trigger
- data to DAQ

Input signal 10 GeV electron
Reshaped signal
Digitized signal

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SADC cont.

• **Advantages**
  – elimination of long signal cables
  – very good time resolution 1-2 ns
  – rejection or correction of pileup events

• **Status and plans**
  – The design is being simulated and optimized
  – Full prototype test in summer 2003
  – Production in 2003 – 2004
Polarisability of K and $\pi$

- Kaon and pion beams
- Pb target, target veto
- EM calorimetry
Exclusive mesons and DVCS

\[ \rho^0 \Rightarrow \pi^+ + \pi^- \quad \pi^0 \Rightarrow \gamma \gamma \quad \mu p \Rightarrow \mu' p' + \gamma \]

d'Hose

- muon beam needs long liquid hydrogen target
- Recoil proton detector
- maybe same wide angle ECAL as for exotics
Double Charm target set-up

- Production of double charm hadrons
- Proton beam 280 GeV
- Pack of silicon detector for decay vertices
- DAQ upgrade
- Second level trigger/filter farm indispensable
Space for RICH-II
RICH-II

- **Baseline proposal (under discussion):**
  - \( \pi/K \) separation 30 – 120 GeV/c as in proposal
  - Covers up central region and high momentum region, where RICH-I is weaker (e.g. beam pipe)
  - Use photons in visible and near UV (\( \lambda > 200 \text{ nm} \))
    RICH-I operates in \( \lambda < 200 \text{ nm} \) (CsI), less photons
  - Keep resolution unchanged \( \sigma_{\gamma,g} \cdot \sqrt{n_{\gamma}} \propto \text{cost} \)
  - Can release spacial (angular) resolution
  - Option: multi-anode PM: HAMAMATSU H6568-03
    already about 100 in COMPASS (SciFi)
RICH-II photon detection

- fast RICH, less pile-up
  - 10 ns vs 1 μs RICH-I
- reasonably simple
  - could be achieved for 2007
- large number of γ per ring
- readout
  - 1120 PMs per 2.8 m²
  - 18000 channels
  - effective pitch: ~ 11 mm
Rich Wall Detector
Rich Wall

- Improvement of Cherenkov ring resolution
- Improvement of momentum resolution
- Similar technique as muon wall 1
- Eight planes of 5.3x4.3 m²
- Ready for 2004, if approved in 2002
Further tracking options

- Strengthening of beam momentum reconstruction in BMS
  - two more planes (currently 4 planes, 92 % efficiency)
- Chamber in first spectrometer magnet
  - to improve pattern recognition and resolution
  - Larger tracking downstream of magnet SM2
- New large $Q^2$ hodoscopes in muon wall 1
  - presently calorimetric trigger only
- Larger tracking downstream of magnet SM2
  - current trackers smaller than aperture
- Replacing old SMC large-area drift chambers
  - 2002 performance to be understood
Further tracking options
Conclusion

- Projects of various maturity
- A must: EM calorimetry and DAQ filter
- Important: RICH-II and more tracking
- Planning for completion has started
- Still open for good suggestions AND ......... new collaborators