Contents
 The COMPASS Experiment
 The Electromagnetic Calorimeters
 Analysis of Final States
 Conclusion and Outlook

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 0000000
 0000000
 0000000

Analysis of Final States with Neutral Mesons and Performance Studies of the Electromagnetic Calorimeters at COMPASS (CERN)

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Contents	The COMPASS Experiment	The Electromagnetic Calorimeters	Analysis of Final States	Conclusion and Outlook

## Contents

## The COMPASS Experiment at CERN

- Location
- Physics
- Setup
- 2 The Electromagnetic Calorimeters at COMPASS
  - ECAL1 and ECAL2
  - Tests for an ECAL2 Laser Monitoring System
- $\textbf{③} \ \text{Analysis of Final States with } \pi^0, \eta \text{ and } \eta^{'} \text{ Mesons }$

• 
$$\pi^- p \rightarrow \pi^- \eta' p$$
  
•  $\pi^- p \rightarrow \pi^- \pi^0(\eta) p$ 

Onclusion and Outlook



### COmmon Muon and Proton Apparatus for Structure and Spectroscopy





Sabine Dinter

 Contents
 The COMPASS Experiment
 The Electromagnetic Calorimeters
 Analysis of Final States
 Conclusion and Outlook

 •••
 •••
 •••
 •••
 •••
 •••
 •••
 •••
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The COMPASS Experiment

## Physics at COMPASS

#### Muon Program

(2002-2007, 2010,..): Polarized muons  $(160 \frac{GeV}{c})$ : Deep Inelastic Scattering on polarized deuterons and protons

#### Hadron Program

(2008, 2009, 2011,..):  $\pi$ , K, p (190 $\frac{GeV}{c}$ ): Search for exotics in diffractive excitation and central production, polarizability of  $\pi$ ,K





#### The COMPASS Experiment

## **Experimental Setup**



Contents The COMPASS Experiment The Electromagnetic Calorimeters Analysis of Final States Conclusion and Outlook

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The Electromagntic Calorimeters

## Experimental Setup of ECAL1 and ECAL2



#### Different lead glass modules, characterized by their properties:

Type of lead glass, PbO-concentration, density,  $X_0$ , moliere-radius, refraction index, cross-section, length



#### The Idea:



- Why is a new laser system for ECAL2 needed:
  - Permanent monitoring for all ECAL channels
  - Time stability

Contents The COMPASS Experiment The Electromagnetic Calorimeters Analysis of Final States Conclusion and Outlook

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-2

The Electromagnetic Calorimeters

## Setup for Test Measurements on ECAL Modules



Contents The COMPASS Experiment The Electromagnetic Calorimeters Analysis of Final States Conclusion and Outlook

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The Electromagnetic Calorimeters

## Performed Tests and first Results

#### Performed Tests

- Laser light-coupling tests for different modules types
- Tests with different laser intensities at variable distances
- Usage of different integrating spheres

#### Result of the Tests

- Setup with new laser system is working
  - Good light coupling
  - Efficient light input/output ٩
  - Time stabilization is possible
- Next step: a laser monitoring system for ECAL2

#### Analysis of Final States

## Analysis of Final States with neutral Mesons

The Idea:

- Neutral Mesons:  $\pi^0, \eta$  and  $\eta'$
- Analysis of the following reactions:

• 
$$\pi^- p \rightarrow \pi^- \eta' p$$

• 
$$\pi^- p \rightarrow \pi^- \pi^0 \pi^0(\eta \eta) p$$

• 
$$\pi^- p \rightarrow \pi^- \pi^0(\eta) p$$



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Analysis of Final States

# Analysis of Final States with $\pi^0, \eta$ and $\eta'$ Mesons

### Analysis of $\pi^- p \rightarrow \pi^- \eta' p$

•  $\eta' \to \pi^+ \pi^- \eta$  (dominant decay with  $\frac{\Gamma_i}{\Gamma} =$  44.3 %)

• 
$$\eta \rightarrow \gamma \gamma \ (\frac{\Gamma_i}{\Gamma} = 39.4 \%)$$

• Search for the exotic:  $\pi(1600) \rightarrow \pi^- \eta'$ 

## Analysis of $\pi^- p \to \pi^- \pi^0(\eta) p$ and $\pi^- p \to \pi^- \pi^0 \pi^0(\eta \eta) p$

- Evidence for: diffractively produced states, like:  $\rho(770)$ ,  $a_2(980)$ ,  $f_0(1500)$ ...
- Reconstructed  $\pi^0$ s are used for ECAL performance checks

Event and Data Selection

## Event and Data Selection



#### Data Selection

- 2008 data
- $\approx$  140 runs (= 2 weeks of data taking)
- In total  $\approx 10^9$  events with incoming  $\pi^-$  beam at 190  $\frac{GeV}{c}$

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## Invariant Mass Plots



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Analysis of  $\pi^- p \rightarrow \pi^- \eta' p$ 

## Invariant Mass Plots









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Analysis of  $\pi^- p \to \pi^- \pi^0(\eta)p$ 

# Time stability of the reconstructed $\pi^0$ s on a run by run basis and different module types



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## Conclusion and Outlook

- **1** Test measurements for a new ECAL2 laser monitoring system
  - Setup with laser system is working
  - Next step: implementation of a laser monitoring system for ECAL2 (planned for 2011)
- 2 Analysis of final states with  $\pi^{\rm 0},\eta$  and  $\eta^{'}$  mesons
  - Analysis of  $\pi^- p \to \pi^- \eta^\prime p$ 
    - Clear  $\eta$ ,  $\eta'$ ,  $f_1$ ... signal seen
    - First hint for  $\pi_1$  (1600) at COMPASS
    - 4-vectors already produced: ready for PWA
  - Analysis of  $\pi^- p \to \pi^- \pi^0(\eta) p$ 
    - Correction of time instabilities in  $\pi^{\rm 0}$  reconstruction

#### Thank you for your attention!

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