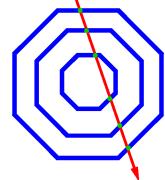




# First results from the L3+C experiment at CERN



Thomas Hebbeker  
Humboldt University, Berlin, Germany  
L3 collaboration

XXXth International Conference on High Energy Physics  
Osaka, Japan  
July 29, 2000

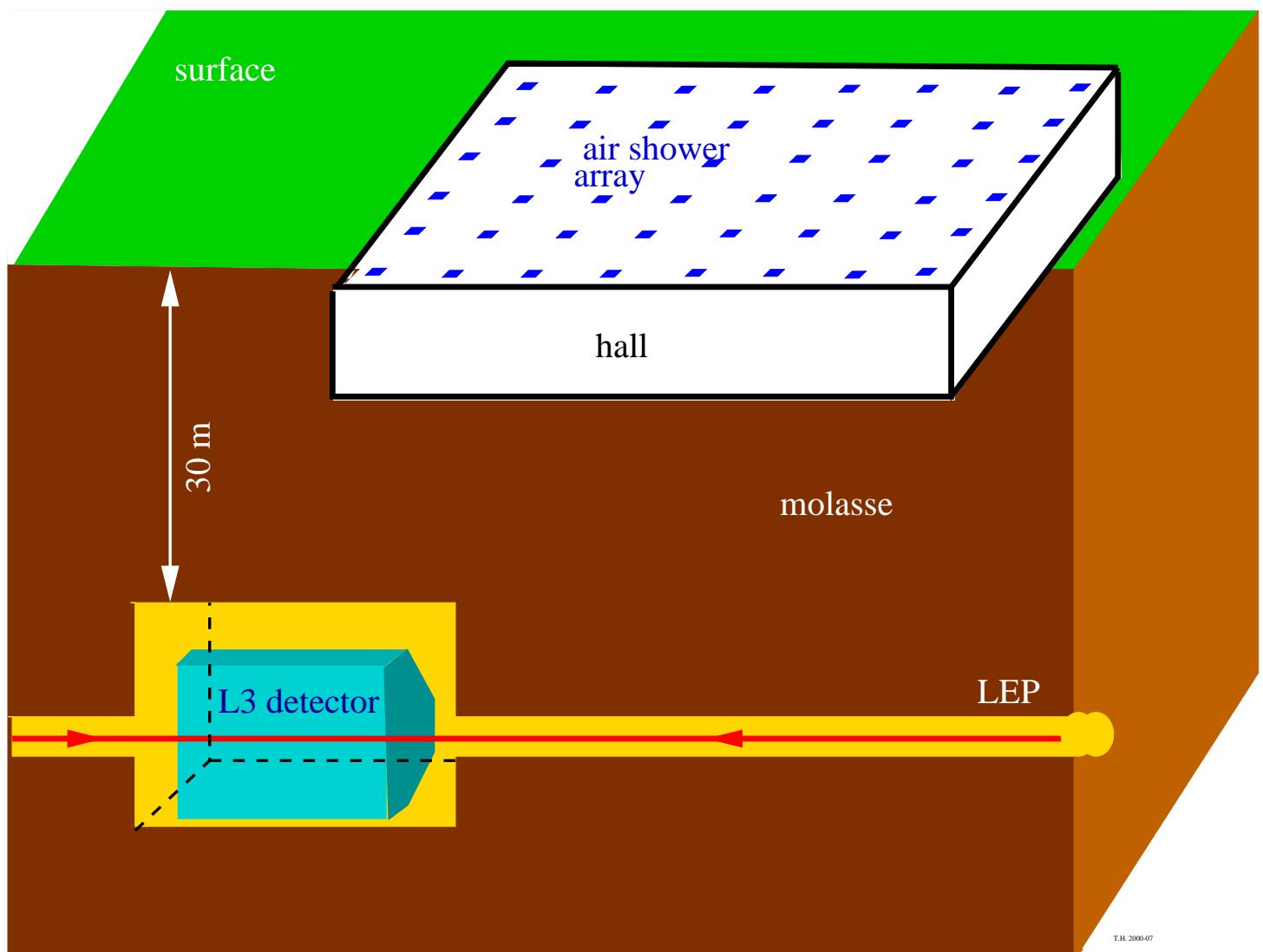
- The L3+C Experiment
- Detector Performance and Data Taking
- Very First Results
  - Single muon momentum spectrum and charge ratio
  - Multimuon events
  - Air shower energy distribution
- Summary and Conclusions

# L3+C Experiment

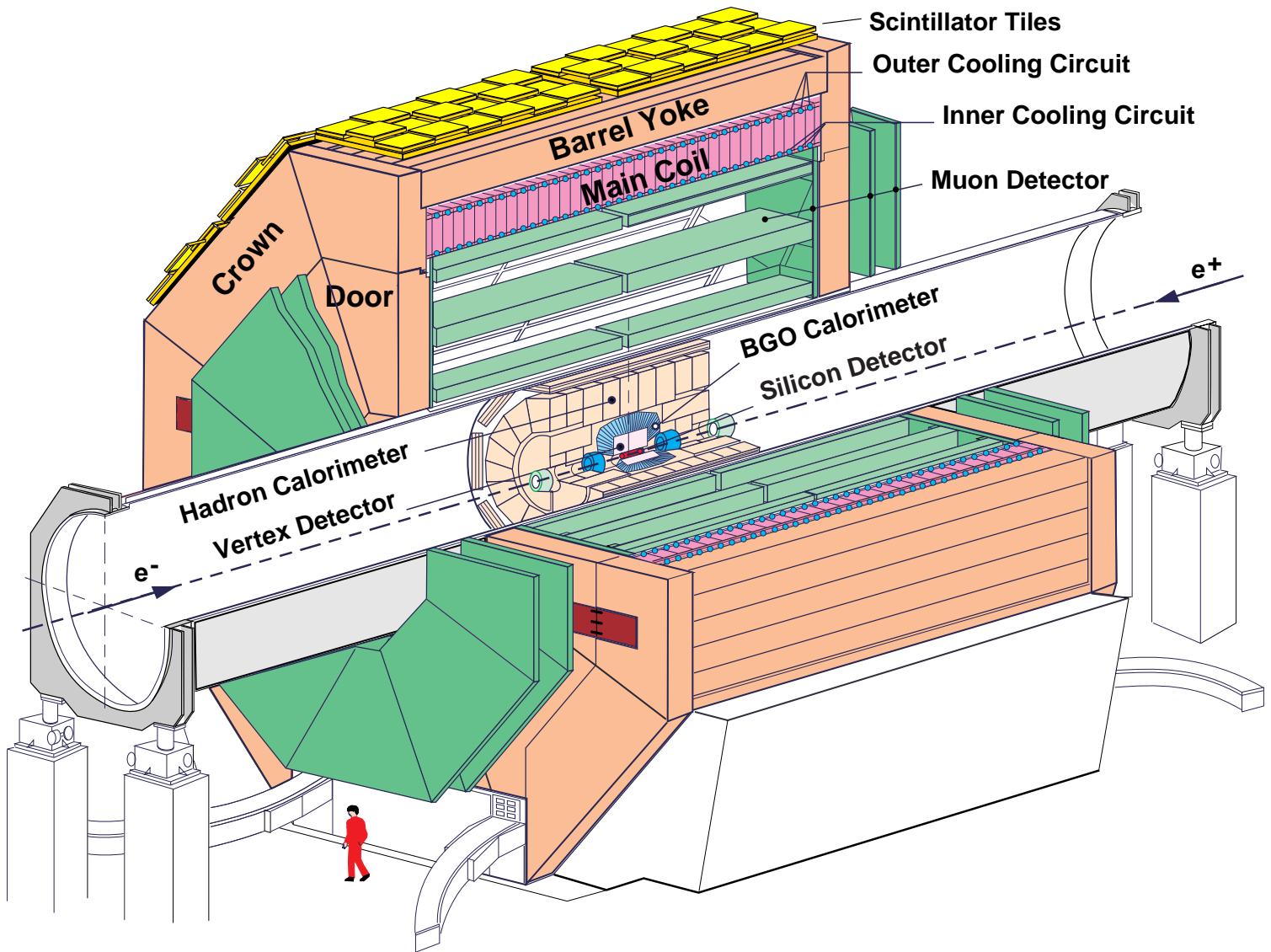
At LEP accelerator, CERN

coordinates:  $6.02^0E, 46.25^0N$ . altitude: 450 m

- air shower array
- muon spectrometer (L3 detector)

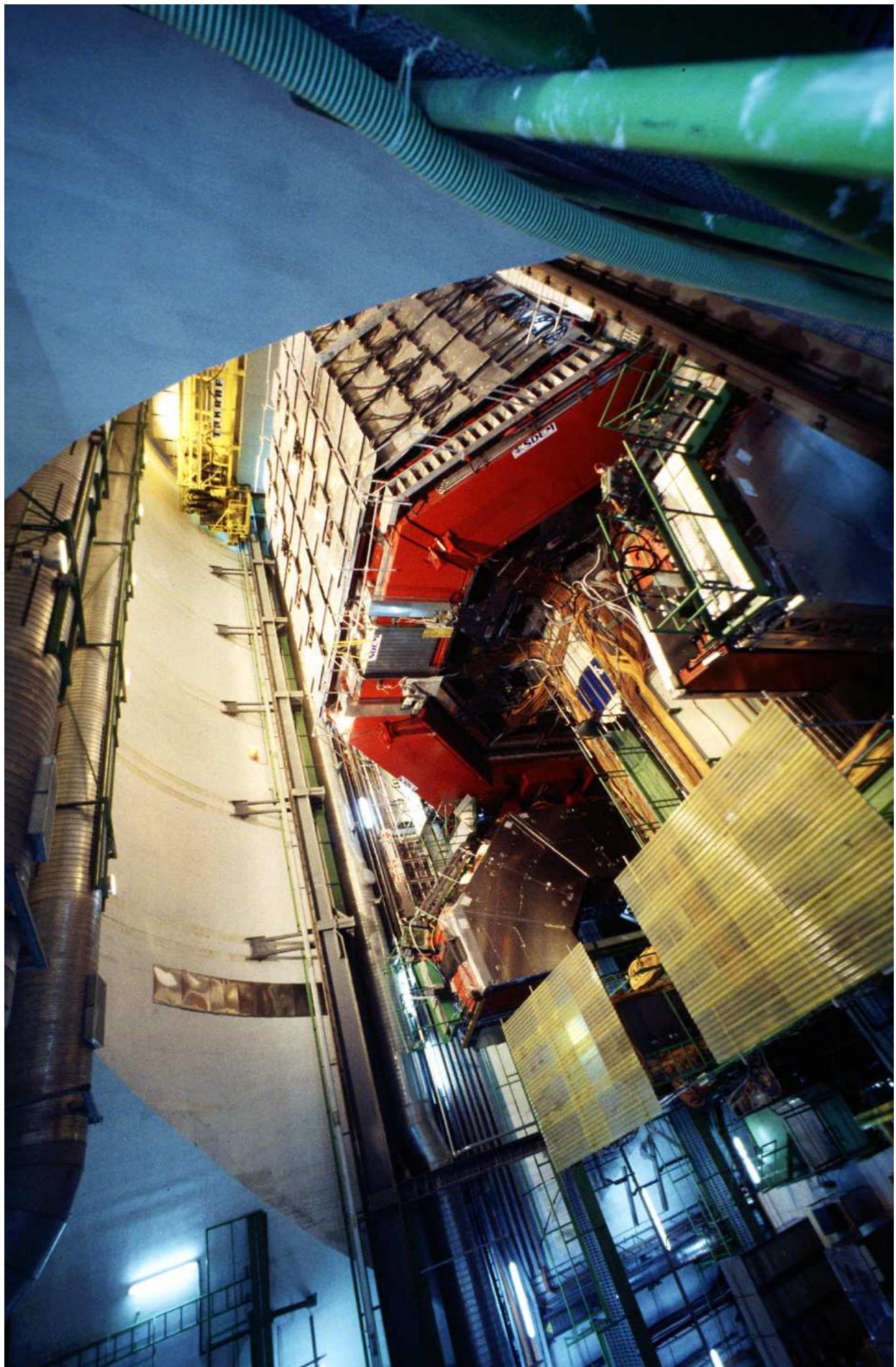


# L3 Detector (LEP, CERN)

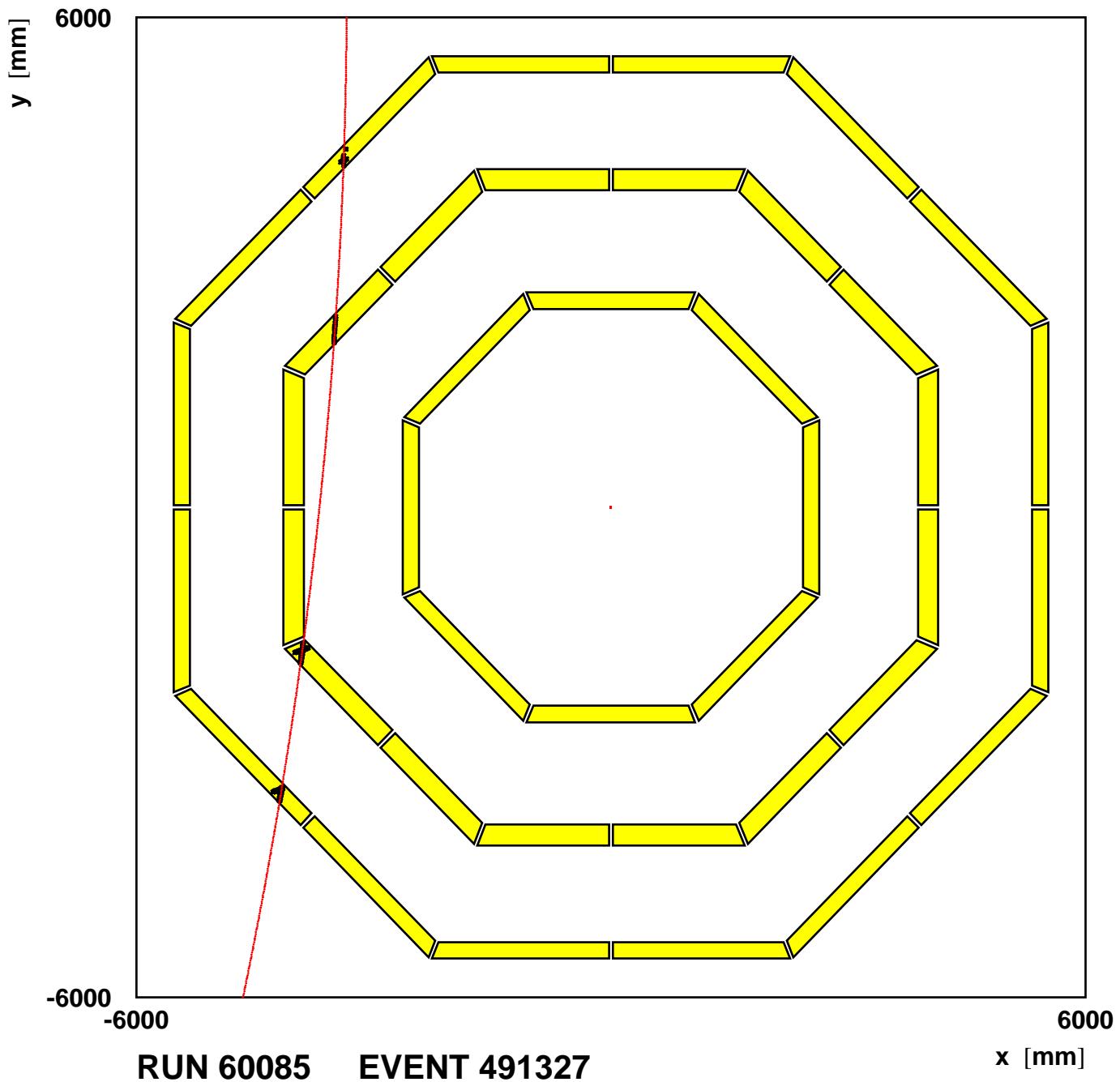


Huge and precise magnetic spectrometer

$$B = 0.5 \text{ T} \quad V \approx 1000 \text{ m}^3$$

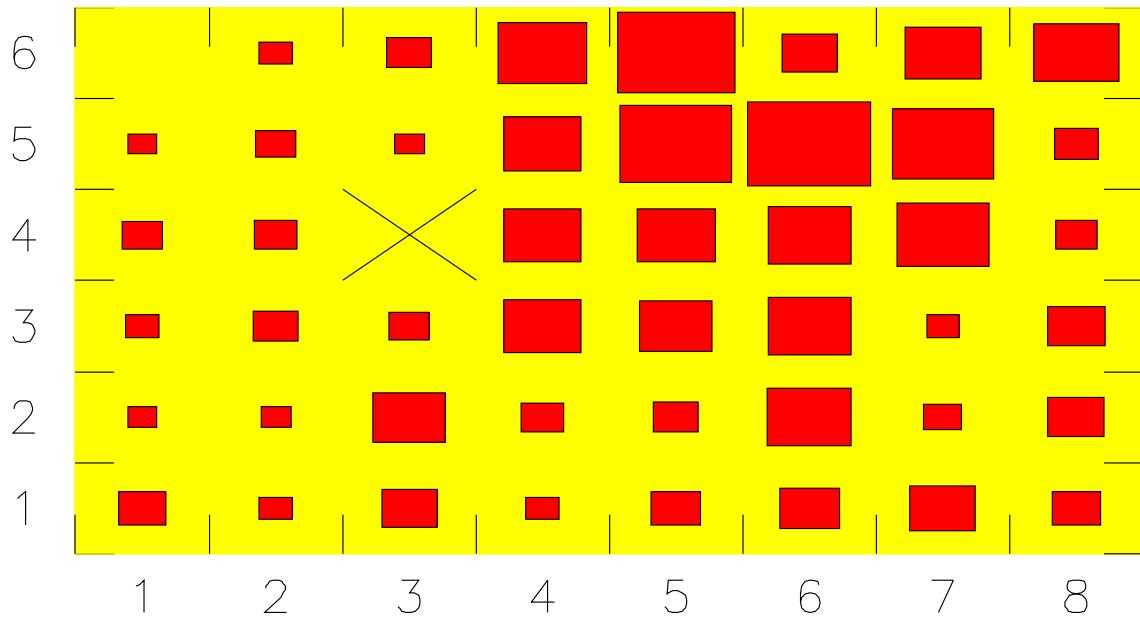


# L3+C Single Muon event

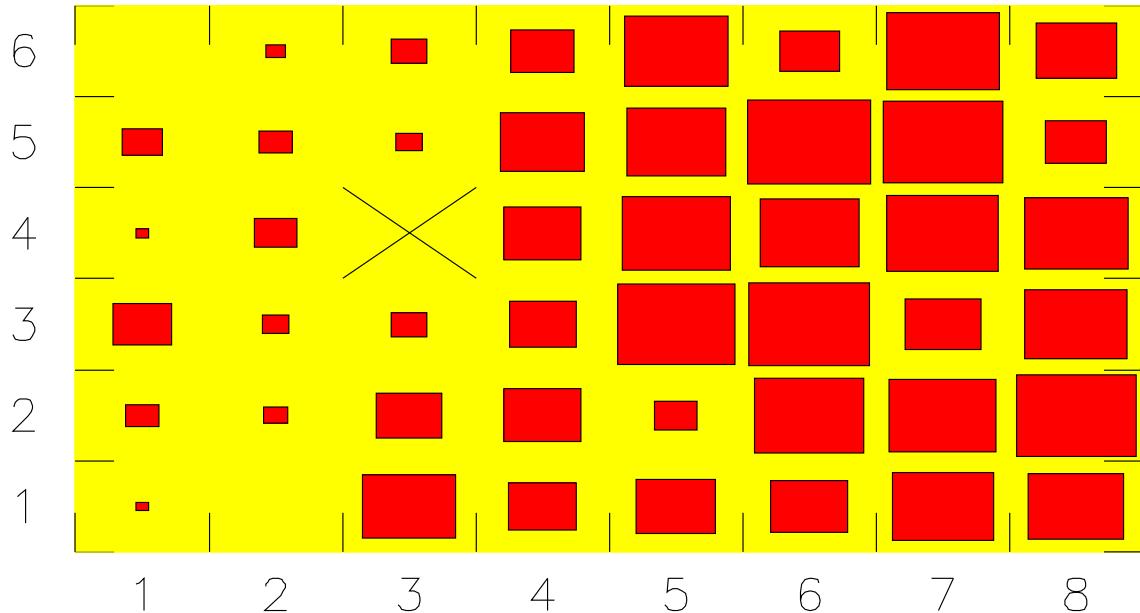




# L3+C ir Shower Events



Event 5501 day=120 18h19mn12.957570s



Event 6240 day=120 19h29mn25.715210s

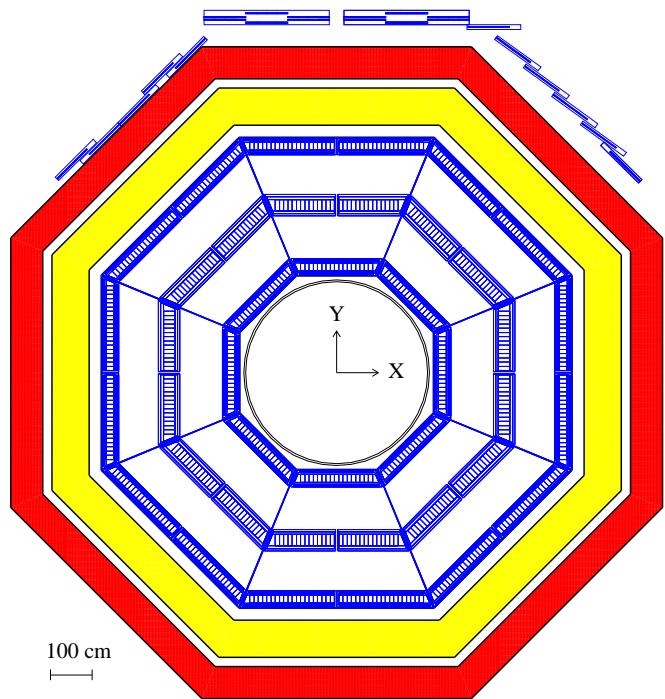
# Purpose of L3+C

- Precise measurement of atmospheric muon momentum spectrum
  - momentum range  $20 \text{ GeV} - 2 \text{ TeV}$
  - zenith angles  $0^\circ - 60^\circ$
  - 2.5% systematic uncertainty (goal)
- reduced uncertainty in atmospheric NEUTRINO spectrum
- Precise measurement of muon charge ratio
  - uncertainty 1% (goal)
- constrains models of atmospheric shower development
- Study of multi muon events
  - shower energy from array
  - muons measured in L3
- primary chemical composition
- • •

# Detector performance

- Muon detector

- momentum cutoff 15 GeV (30 m molasse)
- 80 drift chambers grouped in octants
- single wire resolution 200  $\mu\text{m}$
- magnetic field 0.5 T
- scintillators to measure arrival time
- momentum resolution  
6.6% at 100 GeV
- angular resolution  
 $0.2^\circ$  at 100 GeV



- Shower Array

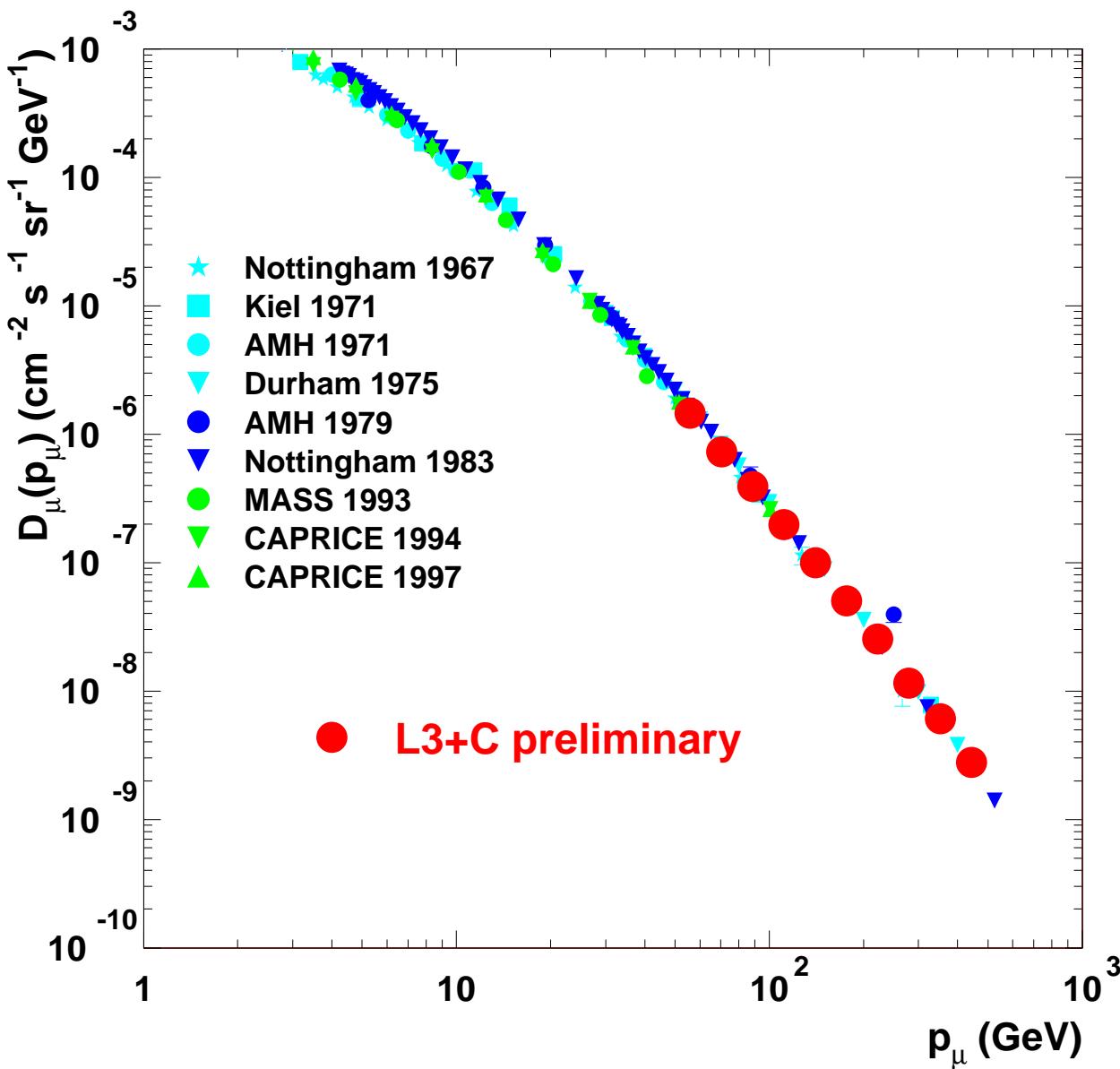
- 50 scintillators of  $0.5 \text{ m}^2$
- area  $30 \times 54 \text{ m}^2$
- energy threshold  $\sim 10 \text{ TeV}$
- energy resolution  $\sim 30\%$
- angular resolution  $\sim 1^\circ$  (arrival times)

# Data Taking

- Muon detector
  - May - November 1999 and April - October 2000
  - Trigger rate: 450 Hz
  - Events on tape:  
8 billion (10 billion by October)
- Air shower array
  - April - October 2000
  - Trigger rate: 1.7 Hz
  - 30% of all showers are accompanied by muons in L3
  - Events on tape:  
20 million (30 million by October)

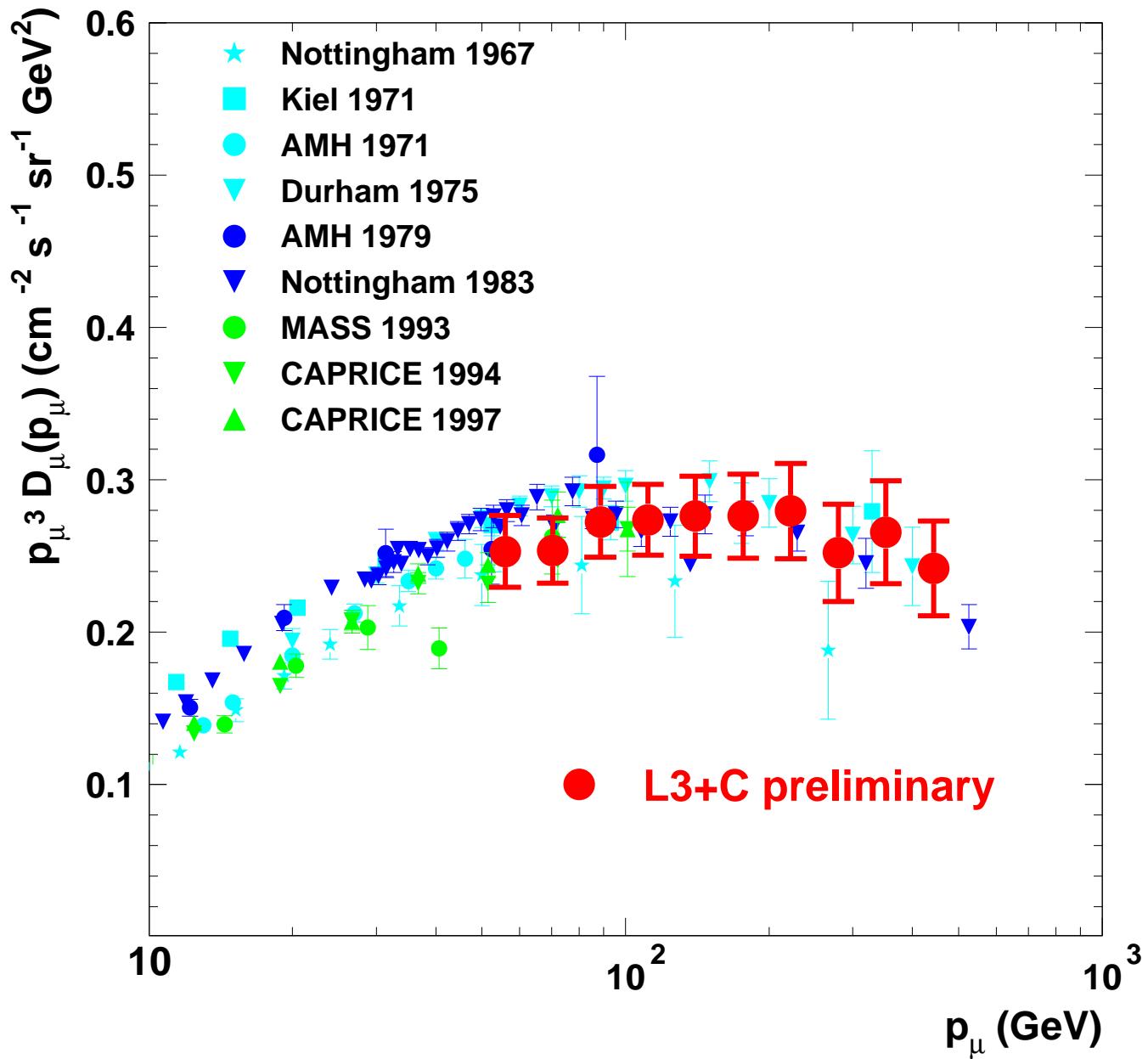
# Vertical Momentum Spectrum

- 1999 data corresponding to livetime of 30 days
- ‘golden’ muons only: passing upper and lower octant
- zenith angle  $< 10^0$
- momenta 50 GeV - 500 GeV  
 $\rightarrow \sim 50000$  events



# Vertical Momentum Spectrum

Flux  $\times p^3$

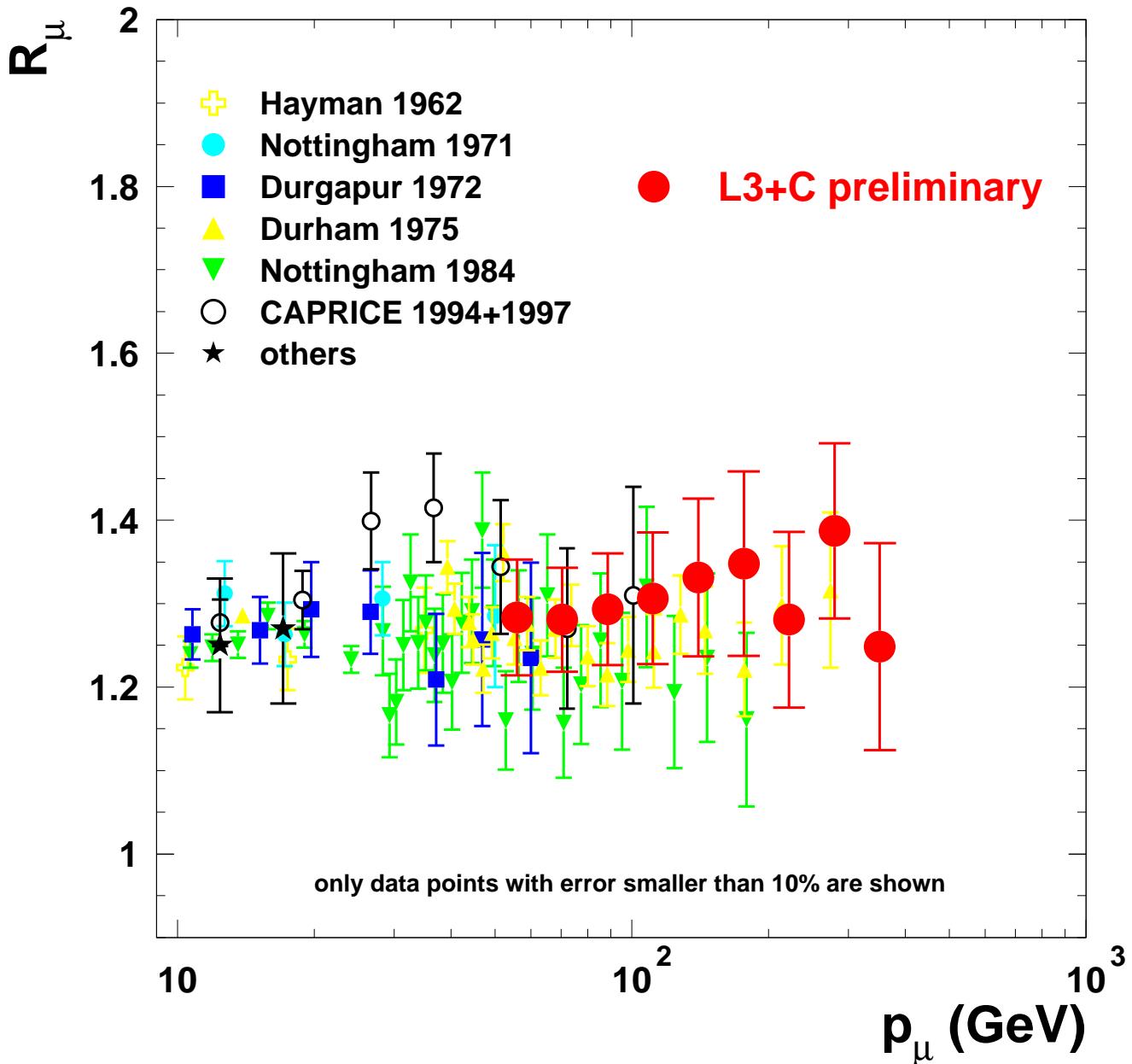


Systematic error dominant. Now: 9% Goal: 2.5%

# Charge Ratio for Vertical Muons

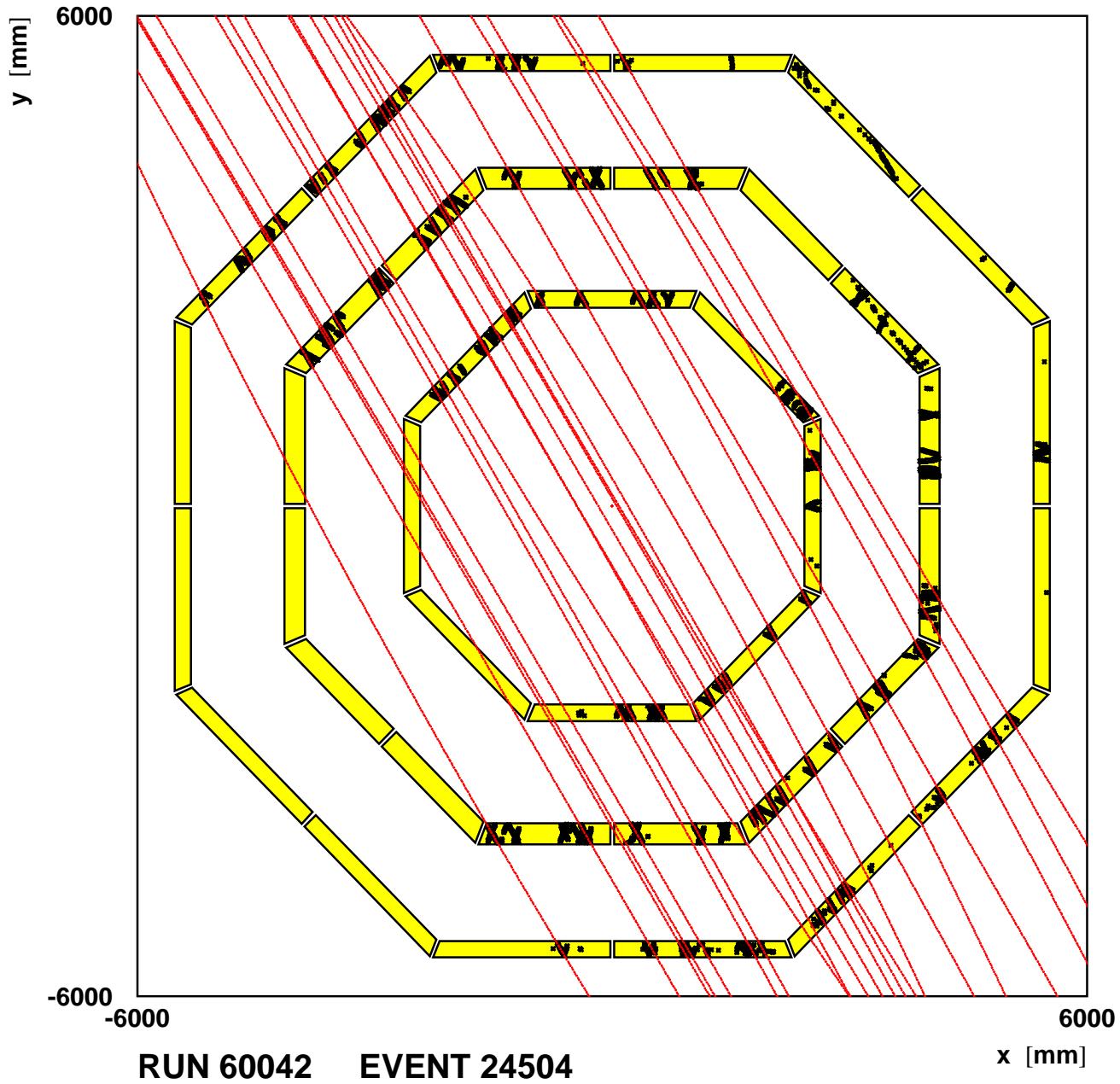
zenith angle  $< 10^0$

$$R_\mu = \frac{N_{\mu^+}}{N_{\mu^-}}$$



Statistical error dominant at high momenta

# Multimuon Events

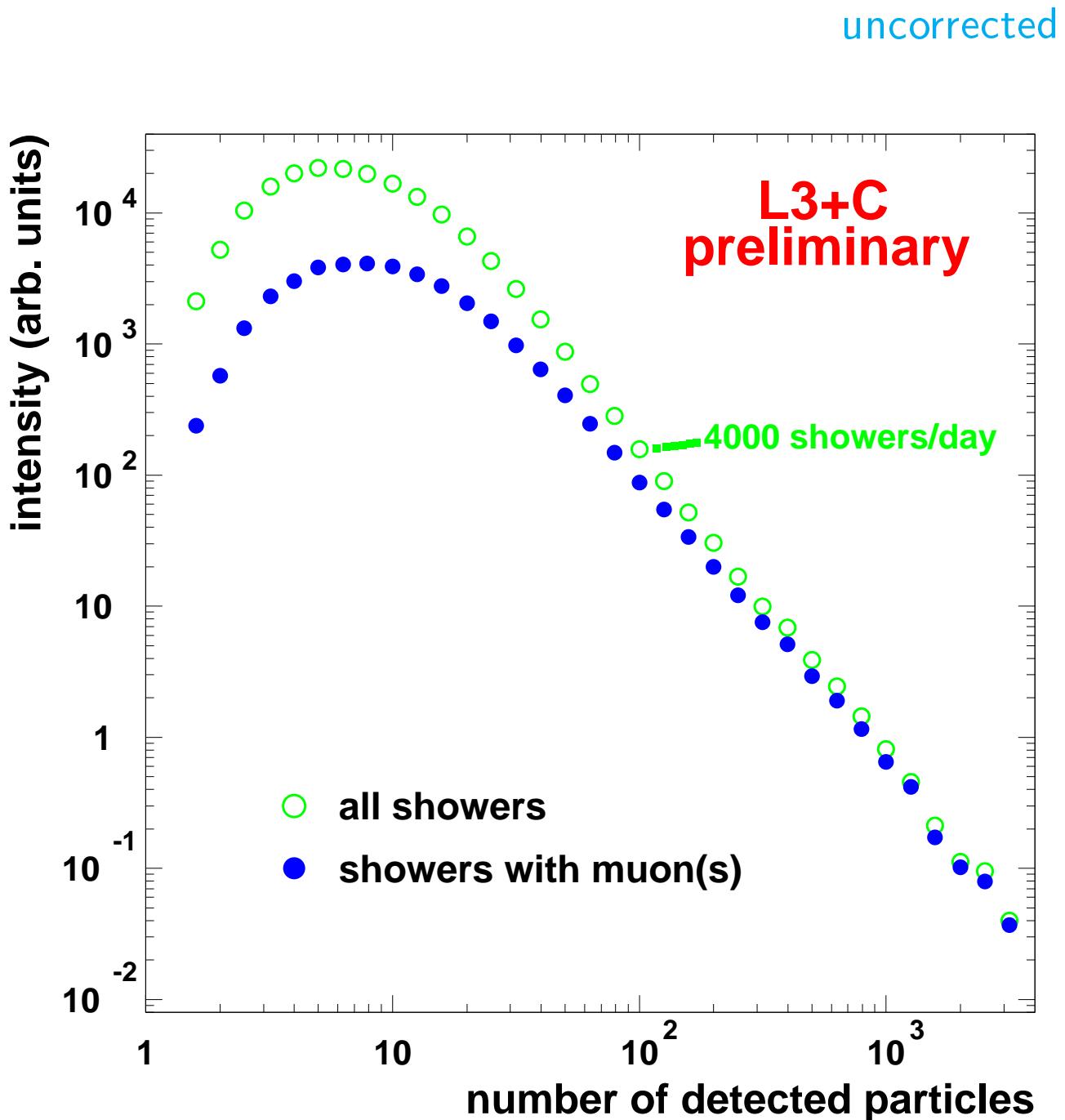


~ 200 events per day with multiplicity > 10

Multiplicity distribution depends on chemical composition

# ir shower array

- data from one week (2000)



Roughly:

$N$  particles in the array  $\rightarrow$  shower energy  $\sim N$  TeV

# Summary and Conclusions

- A new type of cosmic ray detector, L3+C, combines air shower data with precise muon measurements
- Experiment is running till autumn 2000
- First preliminary results on muon spectrum and charge ratio up to momenta of 500 GeV
- Substantial reduction in statistical and systematic errors expected in the future
- Multi-muon events and shower energy measurements will constrain the chemical composition of the primaries