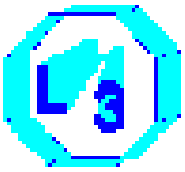
2000-07-24



First results from the L3+C experiment at CERN

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L3 collaboration

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

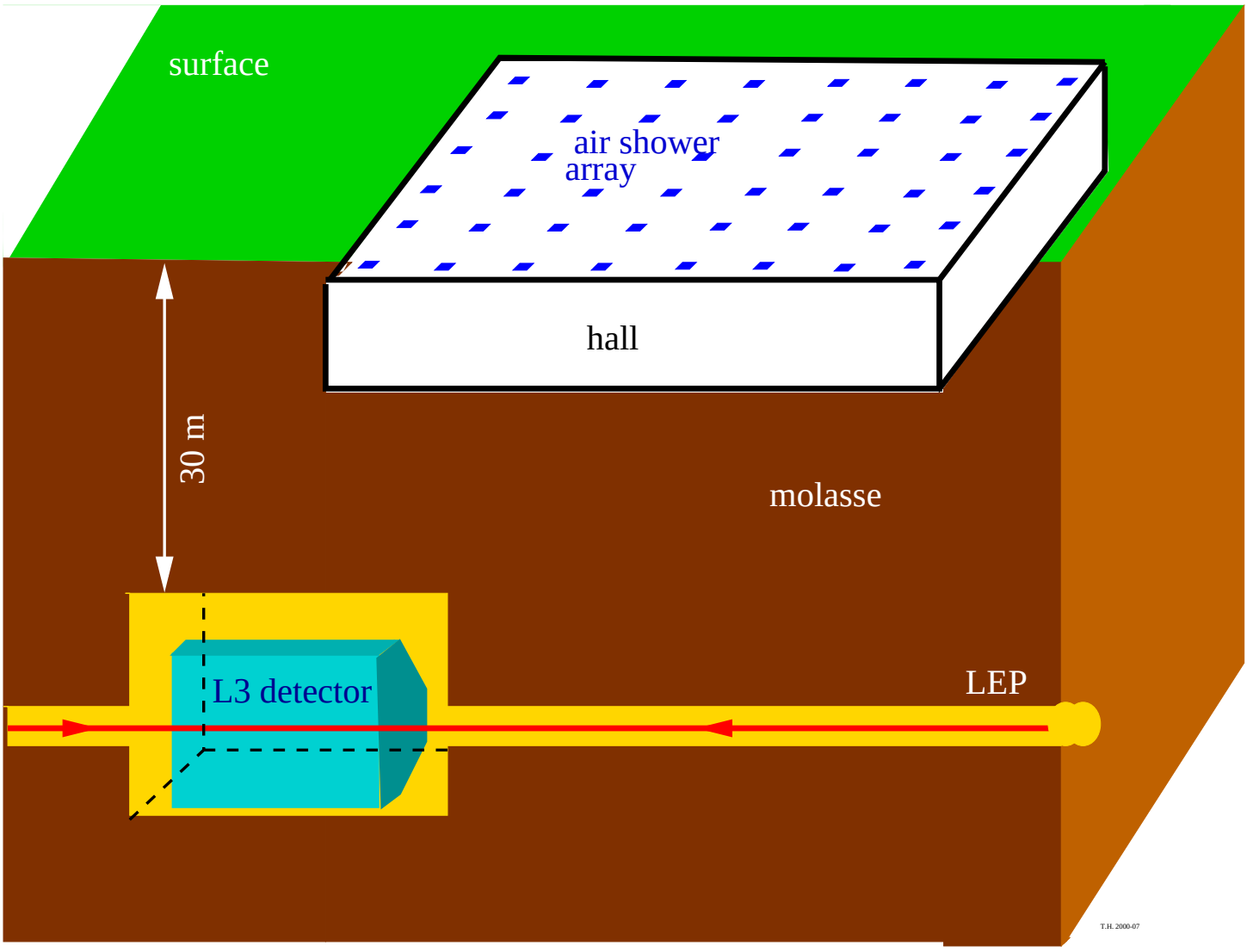
- The L3+C Experiment
- Detector Performance and Data Taking
- Very First Results
  - Single muon momentum spectrum and charge ratio
  - Multimuon events
  - Air shower energy distribution
- Summary and Conclusions

L3+C Experiment

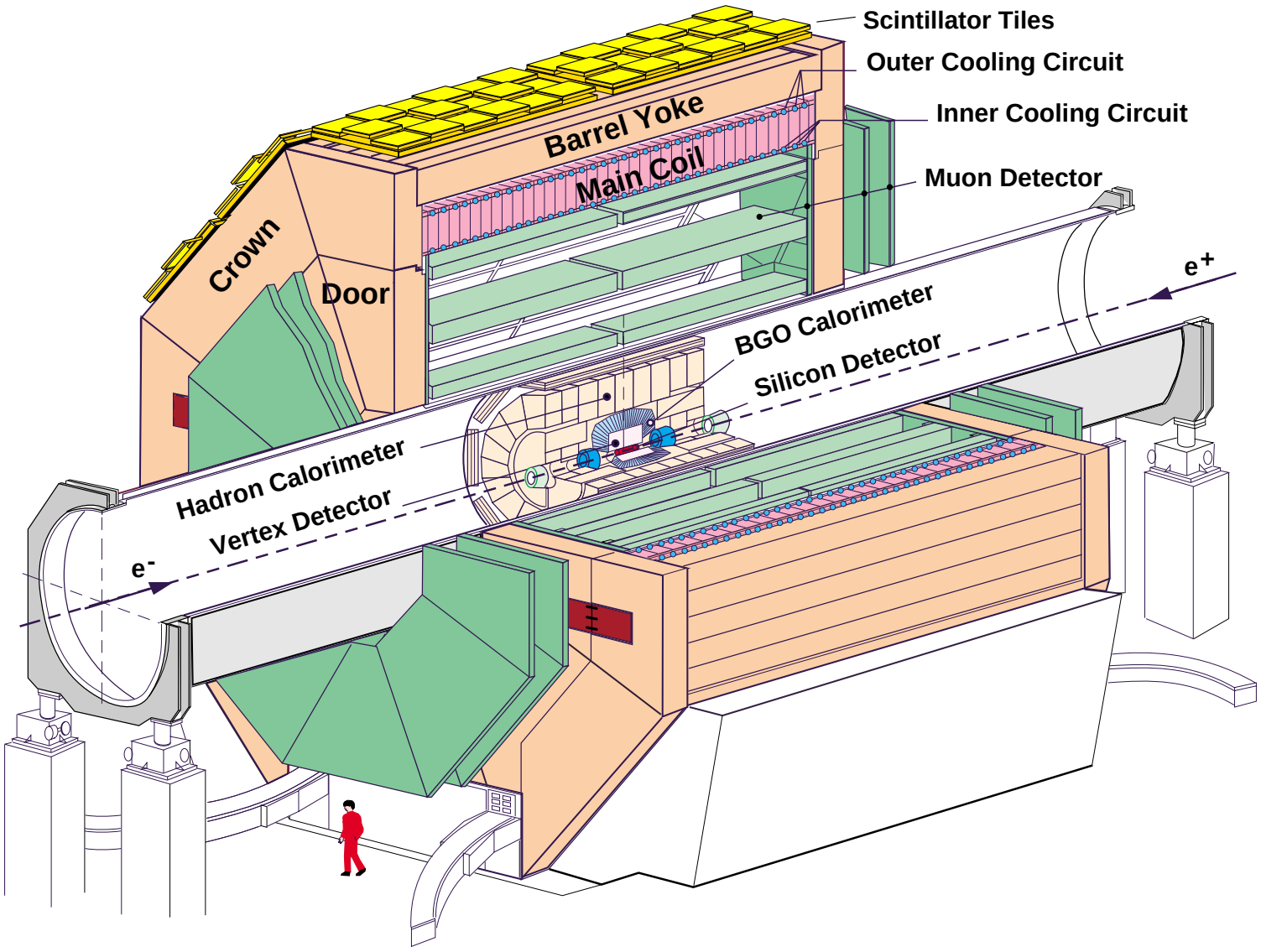
At LEP accelerator, CERN

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

- air shower array
- muon spectrometer (L3 detector)



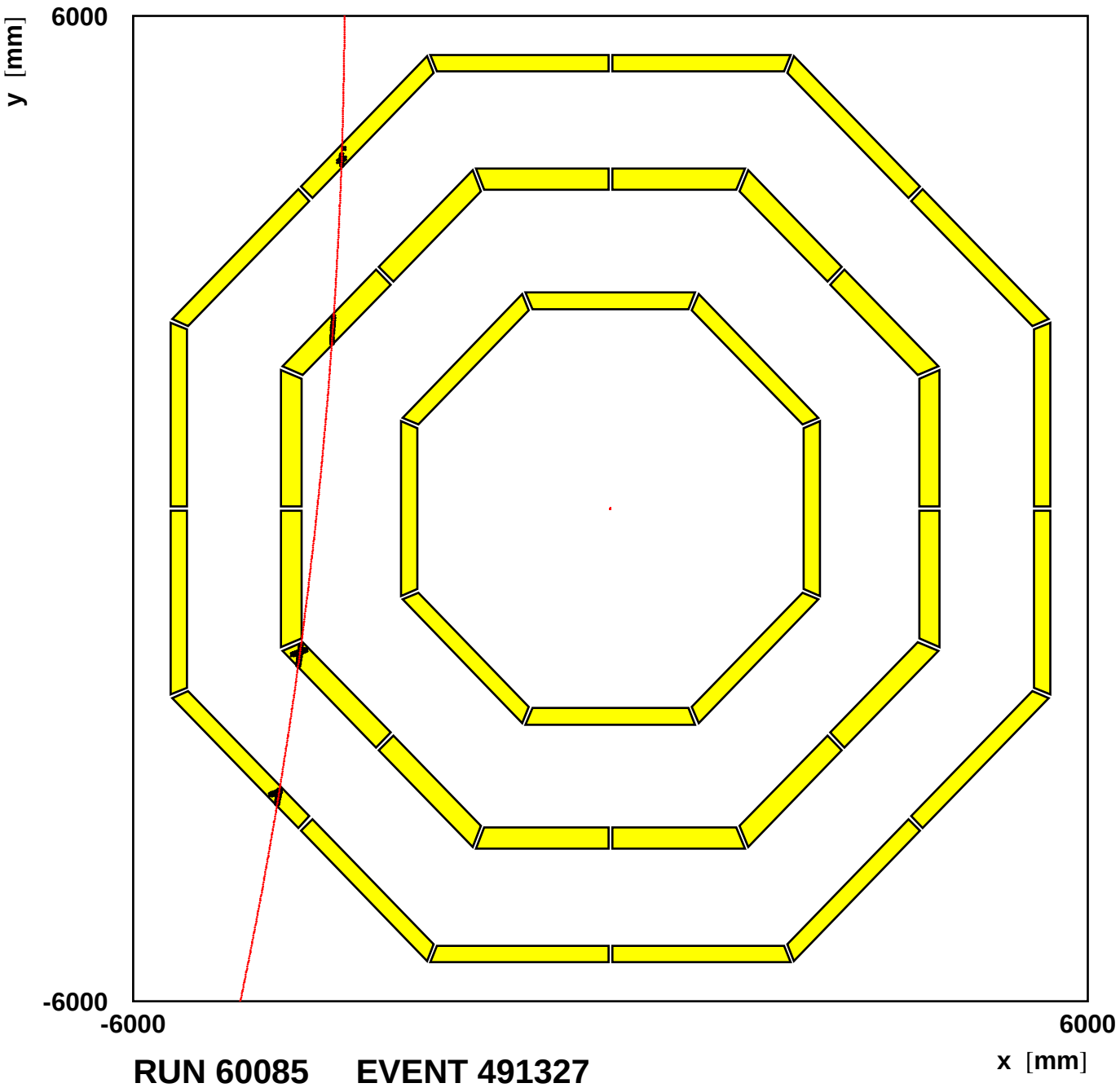
L3 Detector (LEP, CERN)

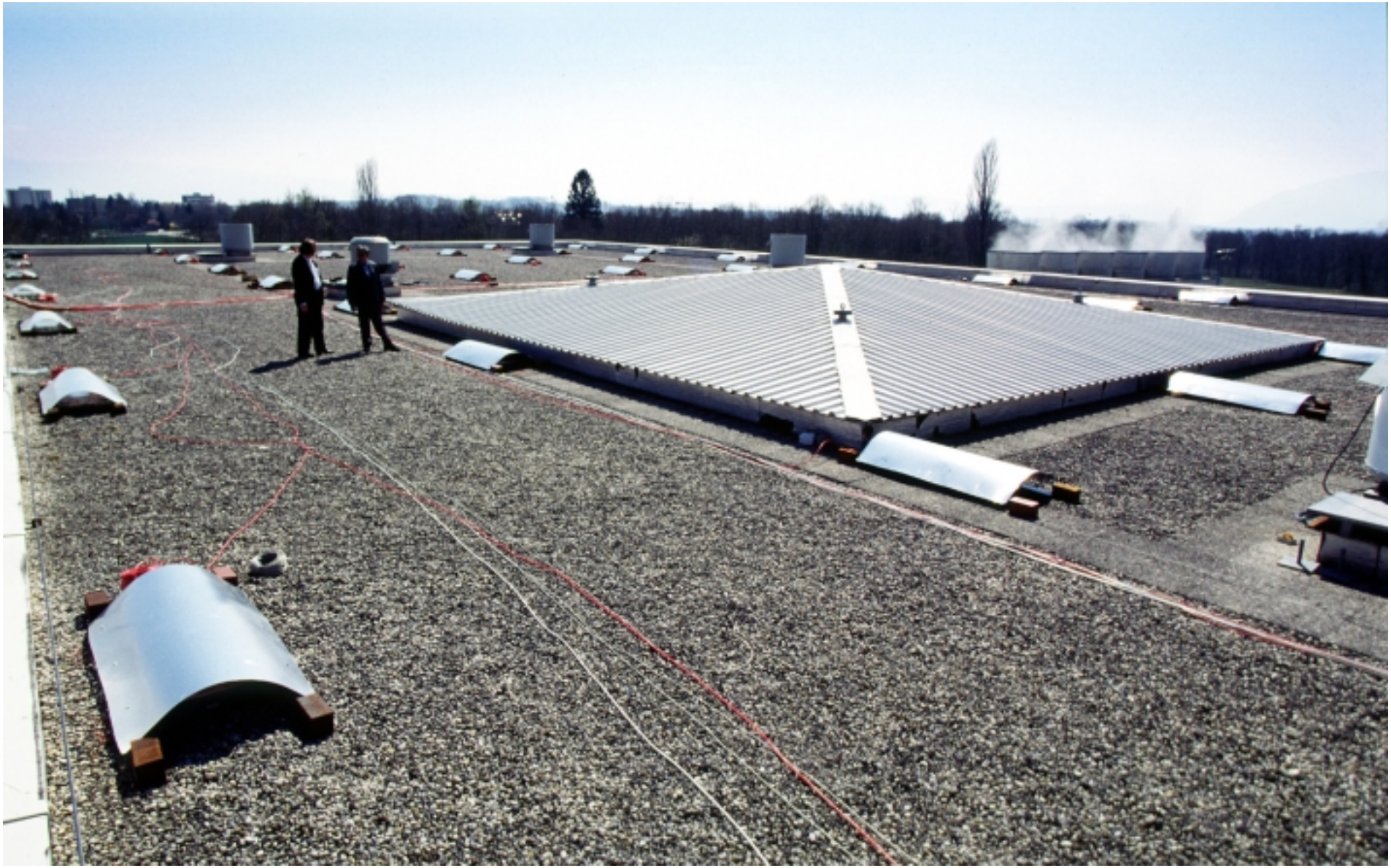


Huge and precise magnetic spectrometer

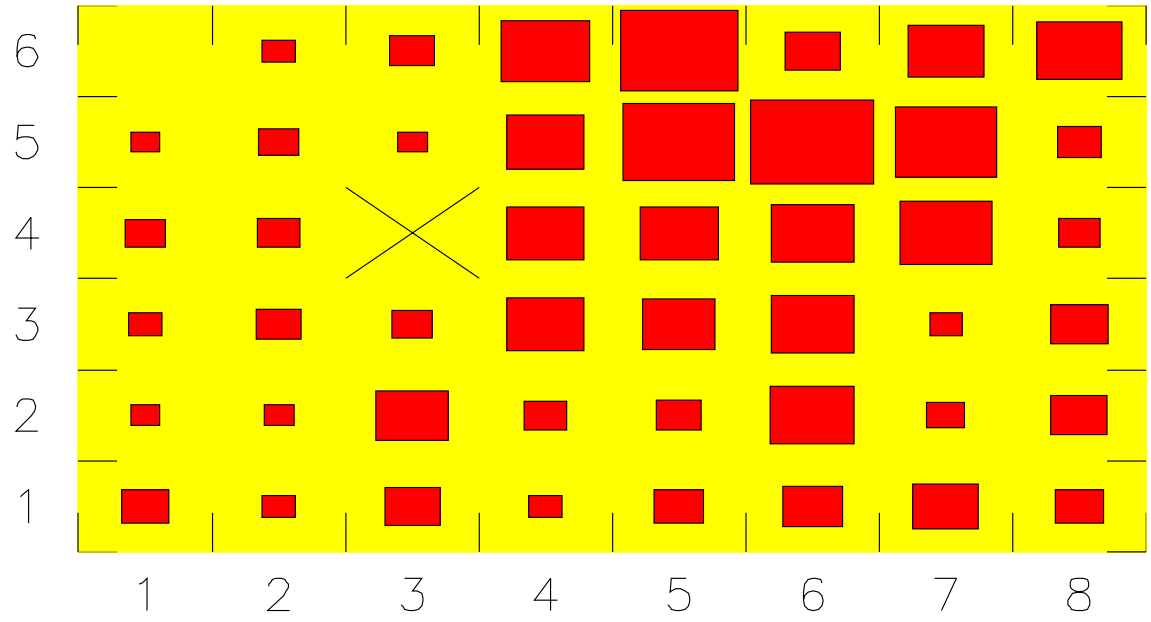
$$B = 0.5\ \mathrm{T} \qquad V \approx 1000\ \mathrm{m}^3$$

L3+C Single Muon event

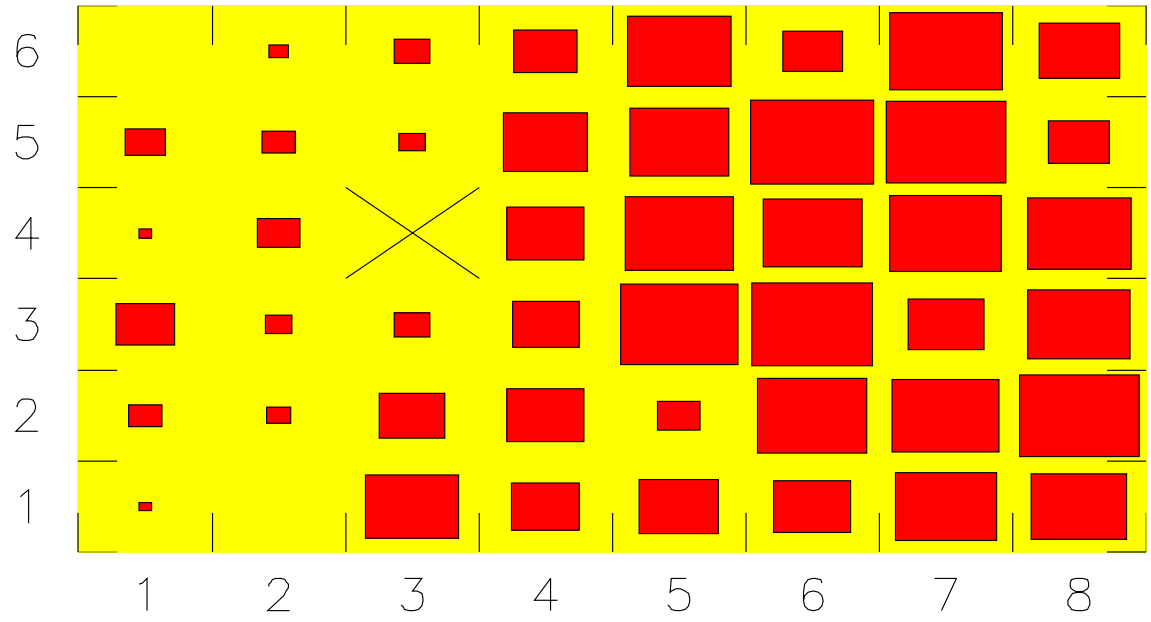




L3+C Air Shower Events



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 $20\,\mathrm{GeV} - 2\,\mathrm{TeV}$
  zenith angles $0^0 - 60^0$
  2.5% systematic uncertainty (goal)

  $\rightarrow$ reduced uncertainty in atmospheric NEUTRINO spectrum

- **Precise measurement of muon charge ratio**
  uncertainty 1% (goal)

  $\rightarrow$ constrains models of atmospheric shower development

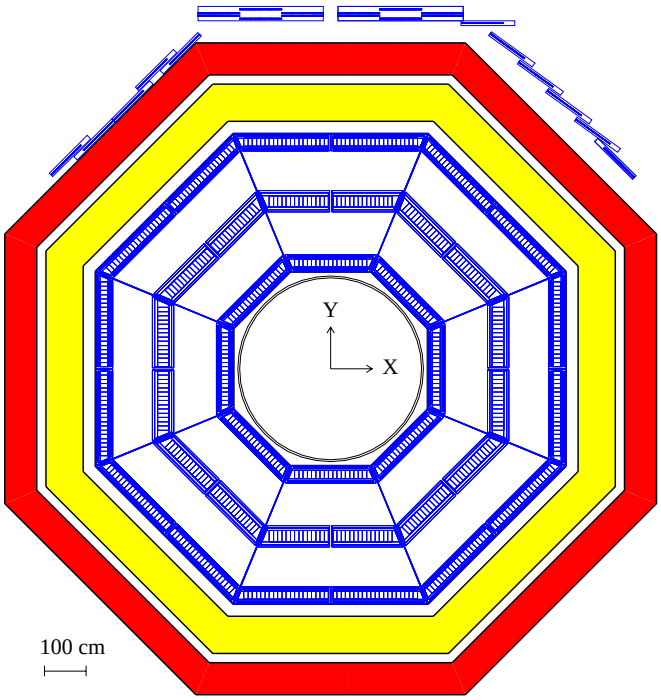
- **Study of multi muon events**
  shower energy from array
  muons measured in L3

  $\rightarrow$ primary chemical composition

- . . .

Detector performance

- Muon detector
  - momentum cutoff $15\,\mathrm{GeV}$ ($30\,\mathrm{m}$ molasse)
  - 80 drift chambers grouped in octants
  - single wire resolution $200\,\mu\mathrm{m}$
  - magnetic field $0.5\,\mathrm{T}$
  - scintillators to measure arrival time
  - momentum resolution 6.6% at $100\,\mathrm{GeV}$
  - angular resolution 0.2^0 at $100\,\mathrm{GeV}$



- Shower Array
  - 50 scintillators of $0.5\,\mathrm{m}^2$
  - area $30 \times 54\,\mathrm{m}^2$
  - energy threshold $\sim 10\,\mathrm{TeV}$
  - energy resolution $\sim 30\%$
  - angular resolution $\sim 1^0$ (arrival times)

Data Taking

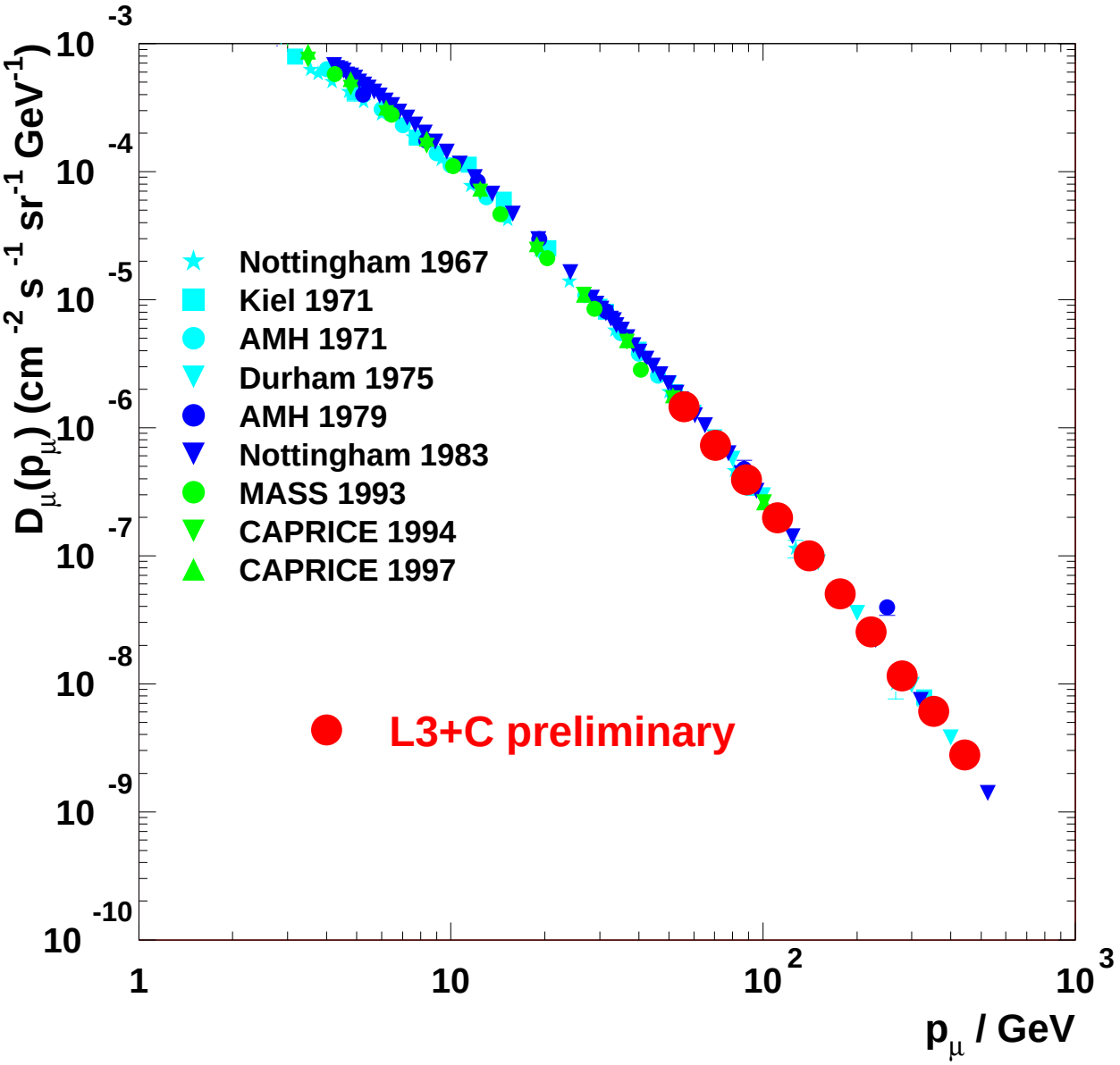
- Muon detector
  - May - November 1999 and
    April - October 2000
  - Trigger rate: $450\,\mathrm{Hz}$
  - Events on tape:
    8 billion (10 billion by October)

- Air shower array
  - April - October 2000
  - Trigger rate: $1.7\,\mathrm{Hz}$
  - 30% of all showers are accompanied by muons in L3
  - Events on tape:
    20 million (30 million by October)

Vertical Momentum Spectrum

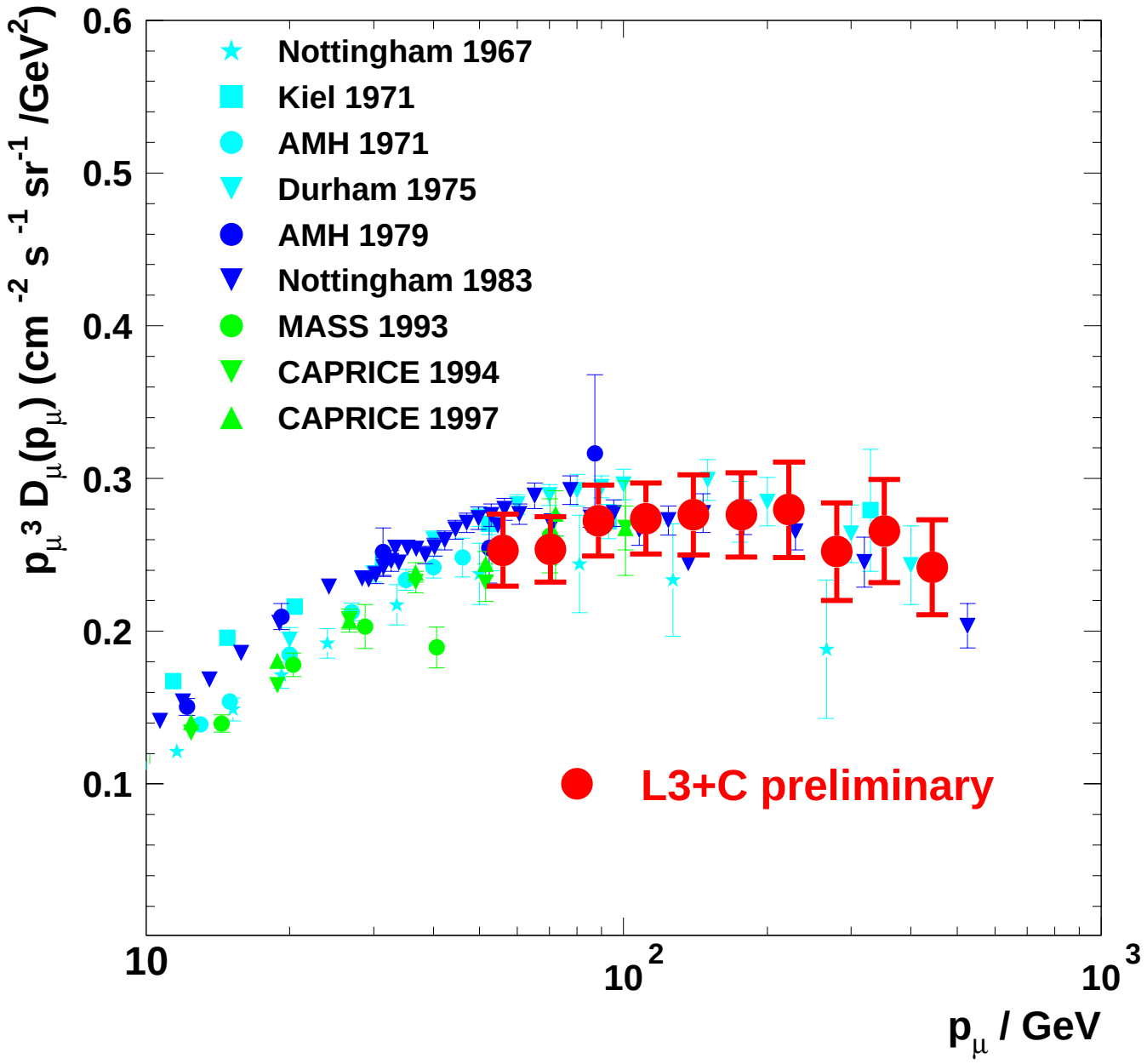
- 1999 data corresponding to livetime of 30 days
- 'golden' muons only: passing upper and lower octant
- zenith angle $< 10^0$
- momenta $50\,\mathrm{GeV}$ - $500\,\mathrm{GeV}$

$\rightarrow \sim 50000$ events



Vertical Momentum Spectrum

Flux $\times p^3$

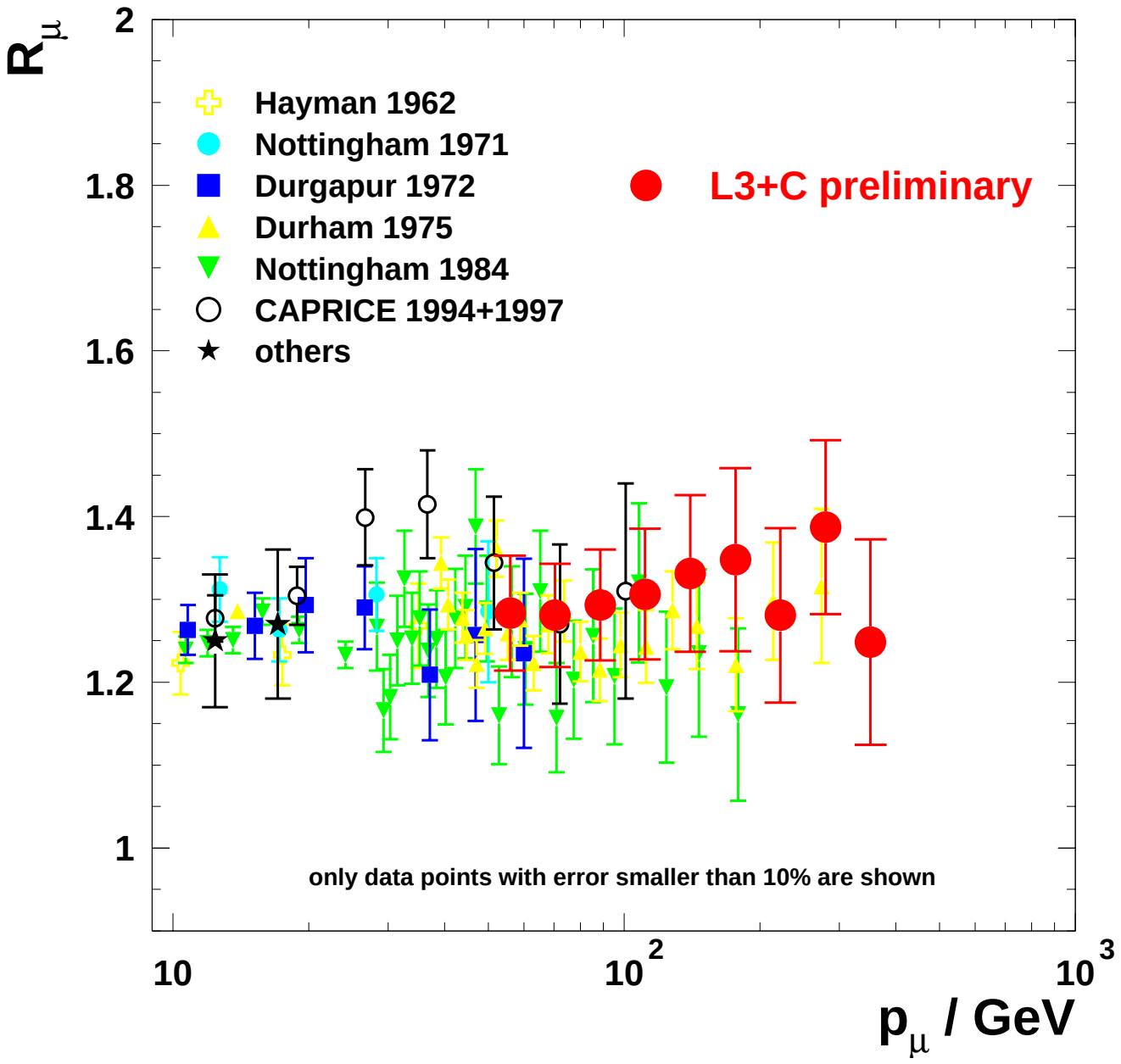


Systematic error dominant. Now: 9% Goal: 2.5%

Charge Ratio for Vertical Muons

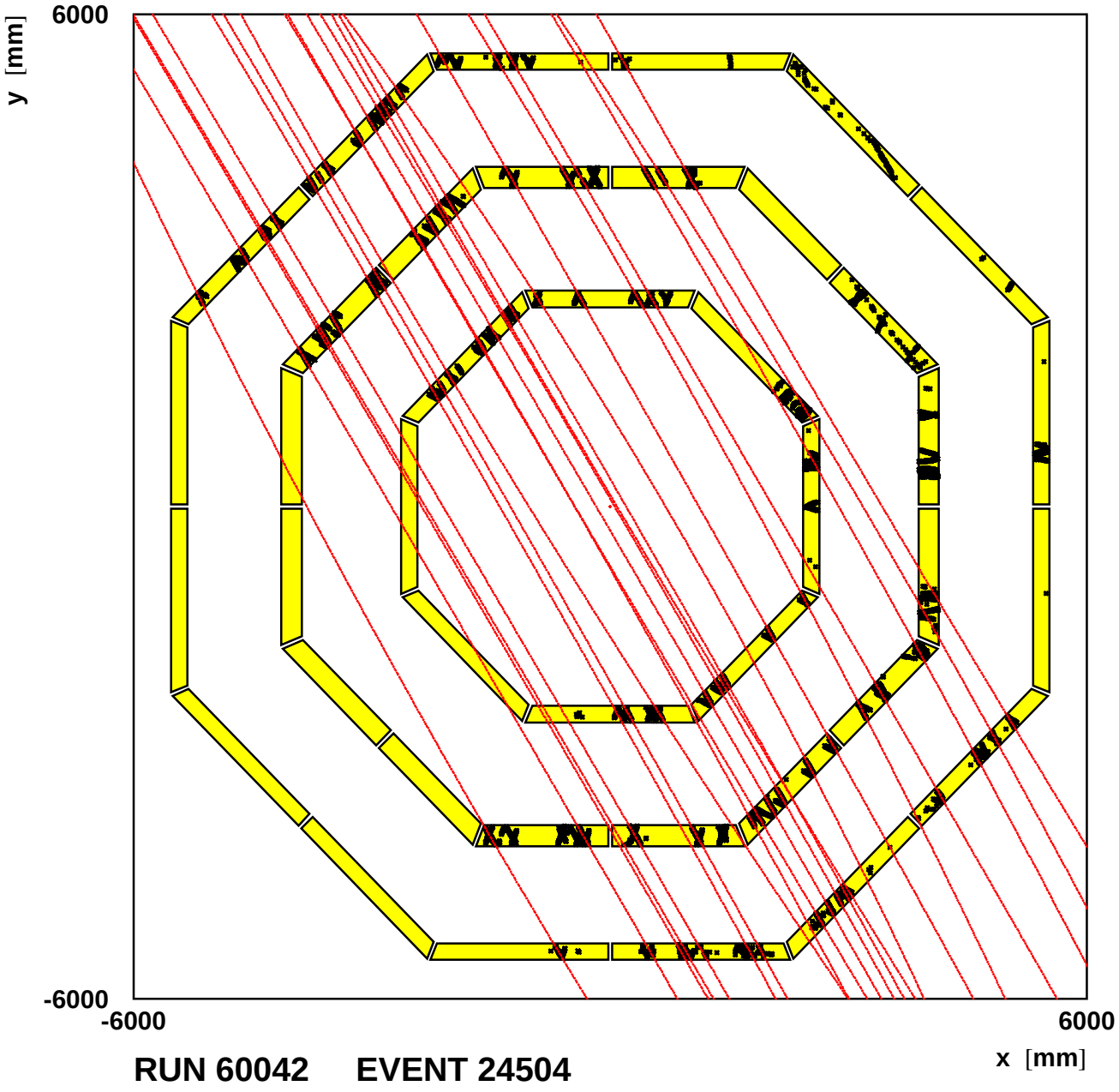
zenith angle $< 10^0$

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



Statistical error dominant at high momenta

Multimuon Events



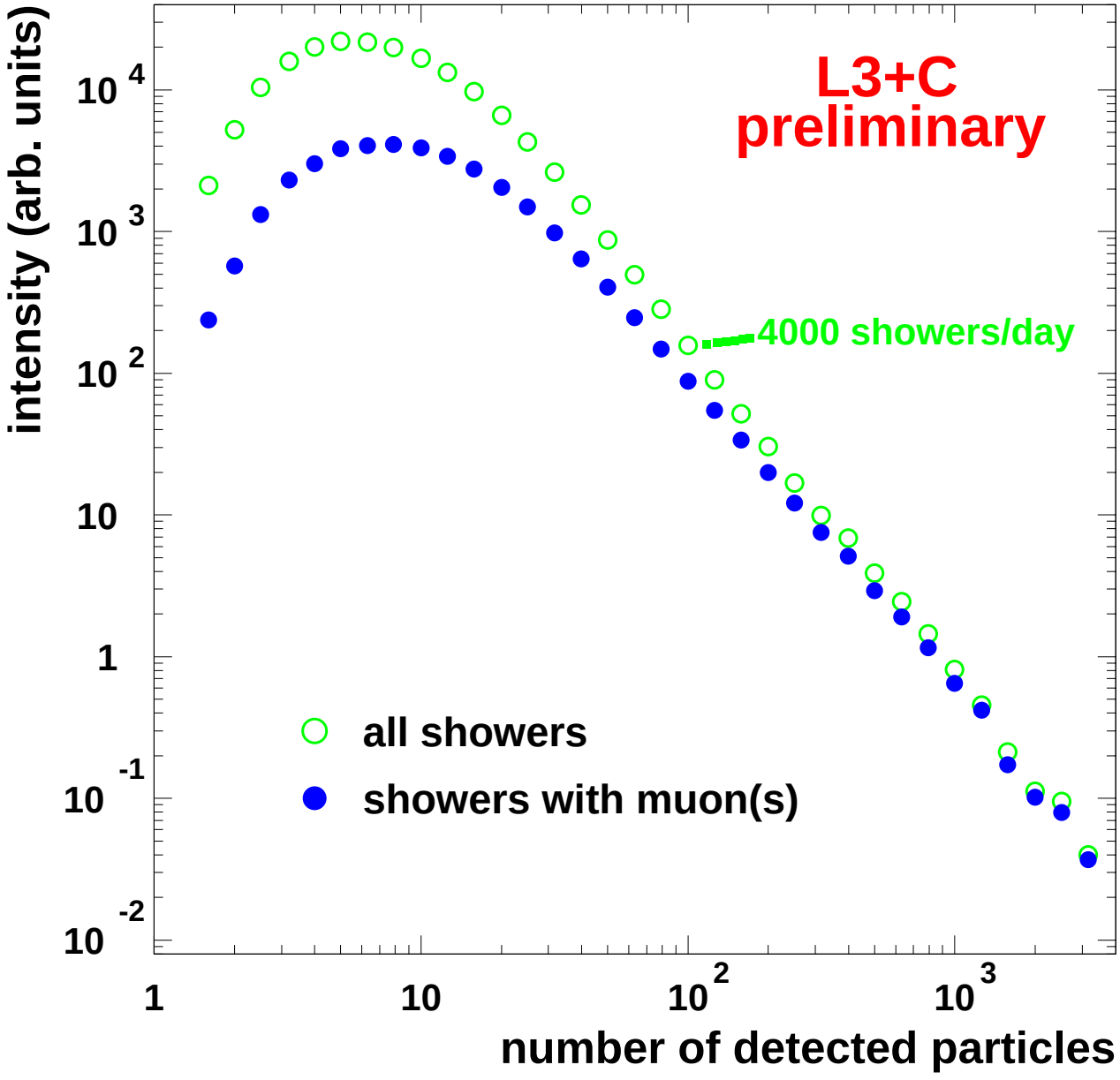
~ 200 events per day with multiplicity > 10

Multiplicity distribution depends on chemical composition

Air shower array

- data from one week (2000)

uncorrected



Roughly:

N particles in the array $\rightarrow$ shower energy $\sim N\,\mathrm{TeV}$

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 $500\,\mathrm{GeV}$
- 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