Observation of QCD jets

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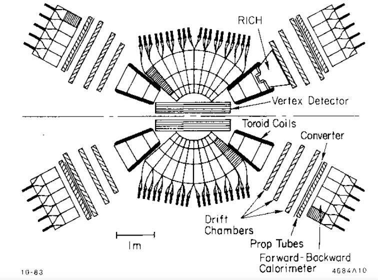
Experimental Setup

- **Apparatus :** The Underground Area2 (UA2)
  => Vertex detector consisting of cylindrical proportional and drift chambers
- The vertex detector is surrounded by a highly segmented EM and hadronic calorimeter (the central calorimeter) covering the region : $-1<\eta<1$, $40^\circ<\theta<140^\circ$ and an azimuthal range of 300°



- single arm spectrometer in the remaining $\pm 30^\circ$ azimutal interval around the horizontal plane
- Forward - backward detectors : $20^\circ < \theta < 37.5^\circ$ and $142.5^\circ < \theta < 160^\circ$, twelve toroidal magnet sectors, drift chambers, multitube proportional chamber and electromagnetic calorimeter

Experimental Challenges

- **Motivation :** The hard scattering of partons should result in two jets with the same momenta as the scattered partons.

- **Experimental challenge :** The ISR experiment observed that the jets are not as clearly identified as they are in the hadronic end state.

  => The CERN $\bar{P}$P collider has made it possible to observe high transverse momentum hadron jets

  => **Expectation :** At $\sqrt{S} = 540 GeV$, the yield of jets with $E_T > 20 GeV$ will be increased by about 4 orders of magnitude wrt the ISR energy

Signal analysis

- **Data Tacking**
  - Validation of event if $\sum E_T > 20 GeV$
  - Coincidence with external detector
  - sample of "minimum bias events"

=> S/B ratio energy dependent varying from 10 for $\sum E_T < 10$ GeV to 0.25 for $\sum E_T > 60 GeV$

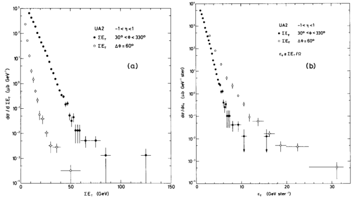
- **Data reduction**
  - Correct hit pattern in the vertex detector
  - Correct energy deposition in the calorimeter
  - for high $\sum E_t$, the reconstructed vertex of the event has to be within the collision region

=> S/B ratio $< 10\%$ after data reduction

Signal analysis

- **Transverse energy distribution :** The total hadronic energy in a cell can be measured by additioning the energies in the three compartments, with a minimum of one compartment having an energy of 150 MeV way superior than pedestal fluctuations

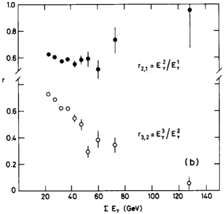
- The analysis of the following figures shows that at high center of mass energy, regions with high energy density are confined to within a small solid angle

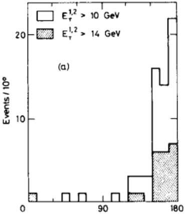


- For $\sum E_T$ from 30 GeV to >60 GeV :
  -f=1% => 15 to 6 clusters
  -f=8% => 0.7 to 2
  => Less numerous but more energetic clusters

- Two non-overlapping 45°*40° solid angles with maximum energy fraction
  - $\sum E_T$: 30 –> >60 Gev =>g : 40% –> 60%
  => Same conclusion

- **Two jet events :** One event with clear two jet structures.
- For the other high $\sum E_t$ event, E_t^1/E_t^2 (the ratio of the two highest clusters) vs E_t^2/E_t^3 illustrate the dominance of two jet structure at high transverse energy
- Azimutal separation of the two highest clusters of $\sim 180^\circ$ for event with high energy clusters $E_T^1 > 14 GeV$





Inclusive jet production

- Monte Carlo data $\propto$ real data
- Correction function : Comparison of Monte Carlo data E_T with input E_T
- Luminosity : Calculated by counting the total number of events that are recorded during data taking
- Calculated cross section is comparable with the QCD calculation of Hogan and Jacob

Conclusion

- Events with large transverse energy (> 60GeV) in a rapidity interval of two units at $\theta = 90^{\circ}$ have a dominant two jets structure at $\sqrt{s} = 540 GeV$

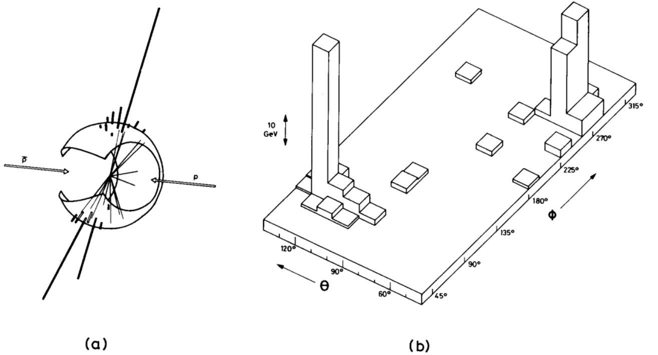


Fig. 4. Configuration of the event with the largest value of ΣE_T, 127 GeV (M = 140 GeV): (a) charged tracks pointing to the inner face of the central calorimeter are shown together with cell energies (indicated by heavy lines with lengths proportional to cell energies). (b) the cell energy distribution as a function of polar angle θ and azimuth ϕ.