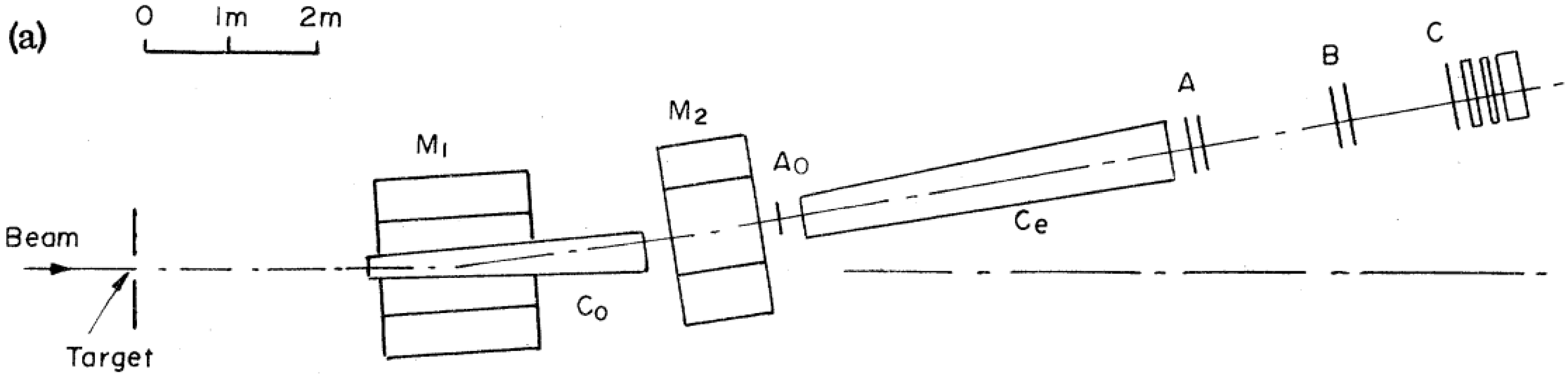
Experimental Observation of a Heavy Particle J

2018-07-06

Spectrometer



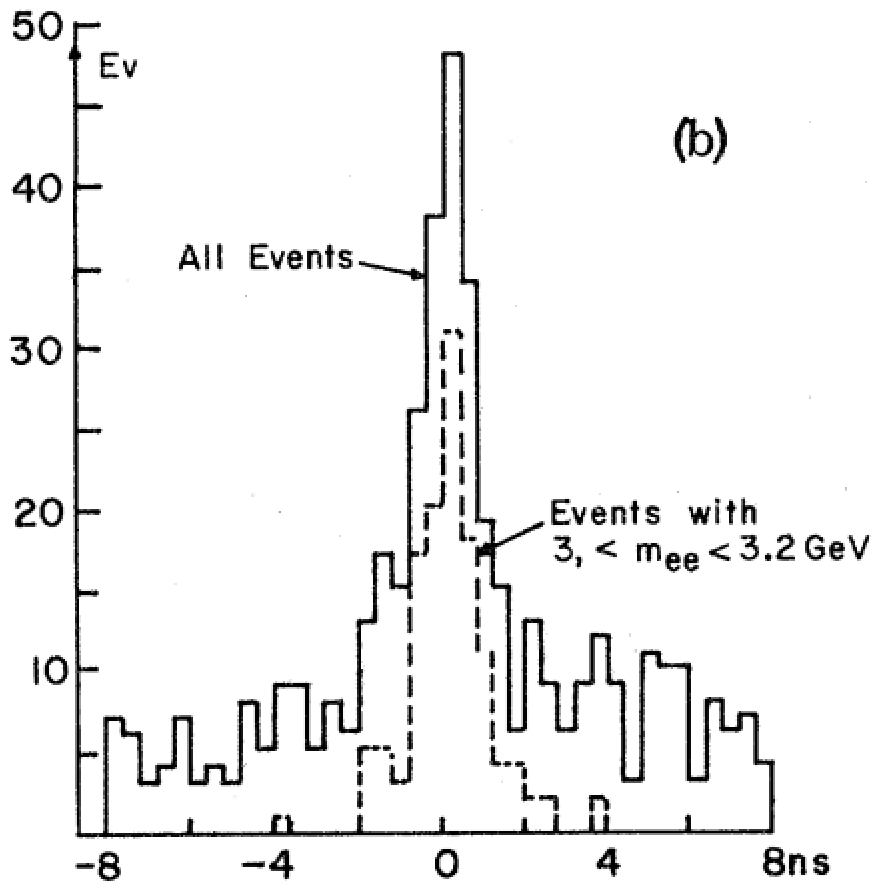
M1, M2: magnet, decouple the angle and the momentum of the particle
Co, Ce: Cherenkov counter, record the angle and the momentum of the particle(Calibration of these counters is done with approximately 6-GeV electrons produced with a lead converter target)
Other Chambers(2*Ao, 3*A, 3*B, 3*C): reduce multitrack confusion
25 lead glass counters: behind C, further reject hadrons from electrons and improve track identification

Beam and Process

Beam: The beam intensity varies from 10^{10} to $2*10^{12}$ p/pulse. The beam is guided onto an extended target, normally nine pieces of 70-mil Be, to enable us to reject the pair accidentals by requiring the two tracks to come from the same origin

Process: p+Be-> $e^{+}+e^{-}+x$ (Be is the fixed target, this is a fixed target experiment)

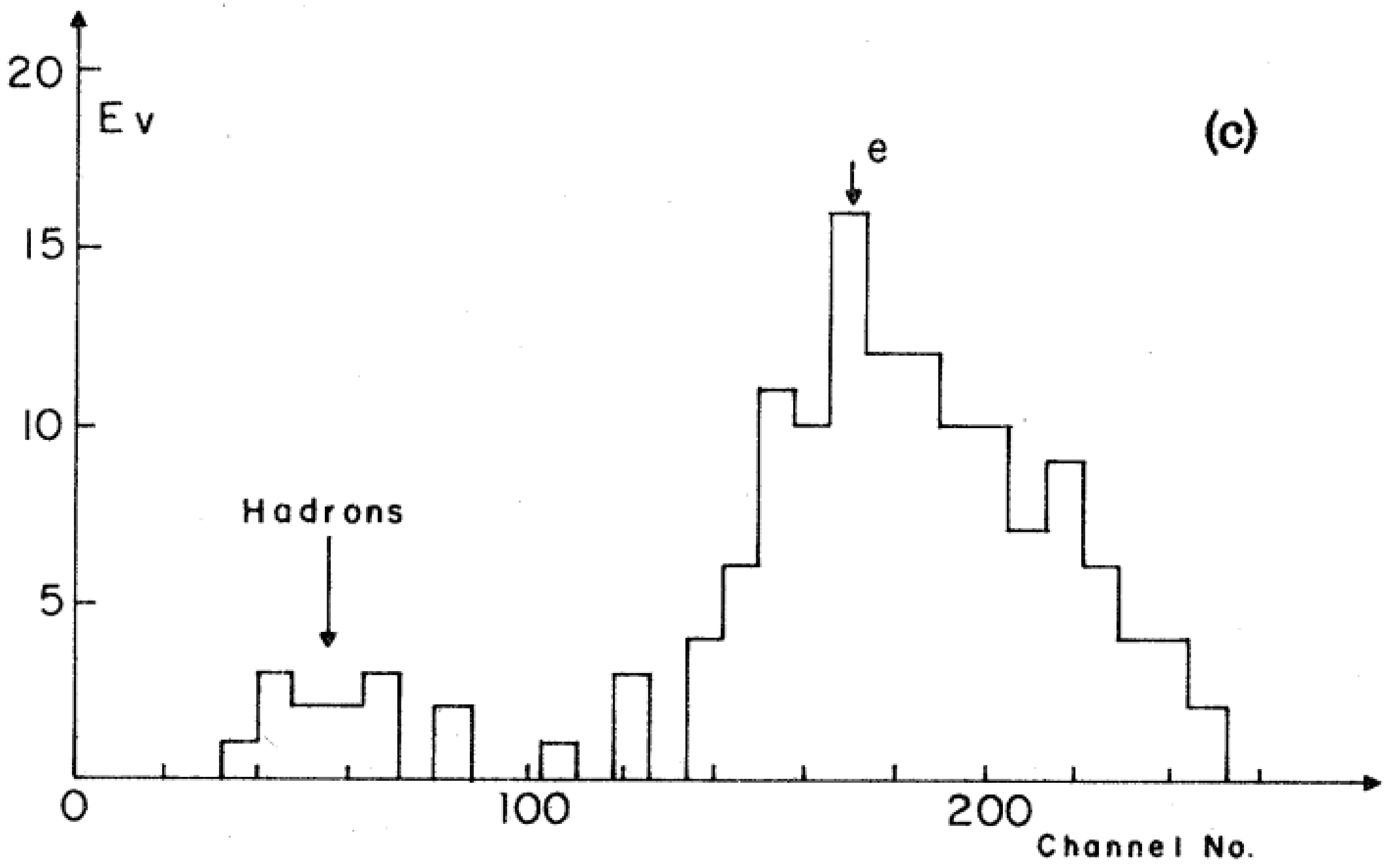
Results



The time-of-flight spectrum between the e^+ and e^- arms in the mass region 2.5<m<3.5GeV, a clear peak of 1.5-nsec width is observed

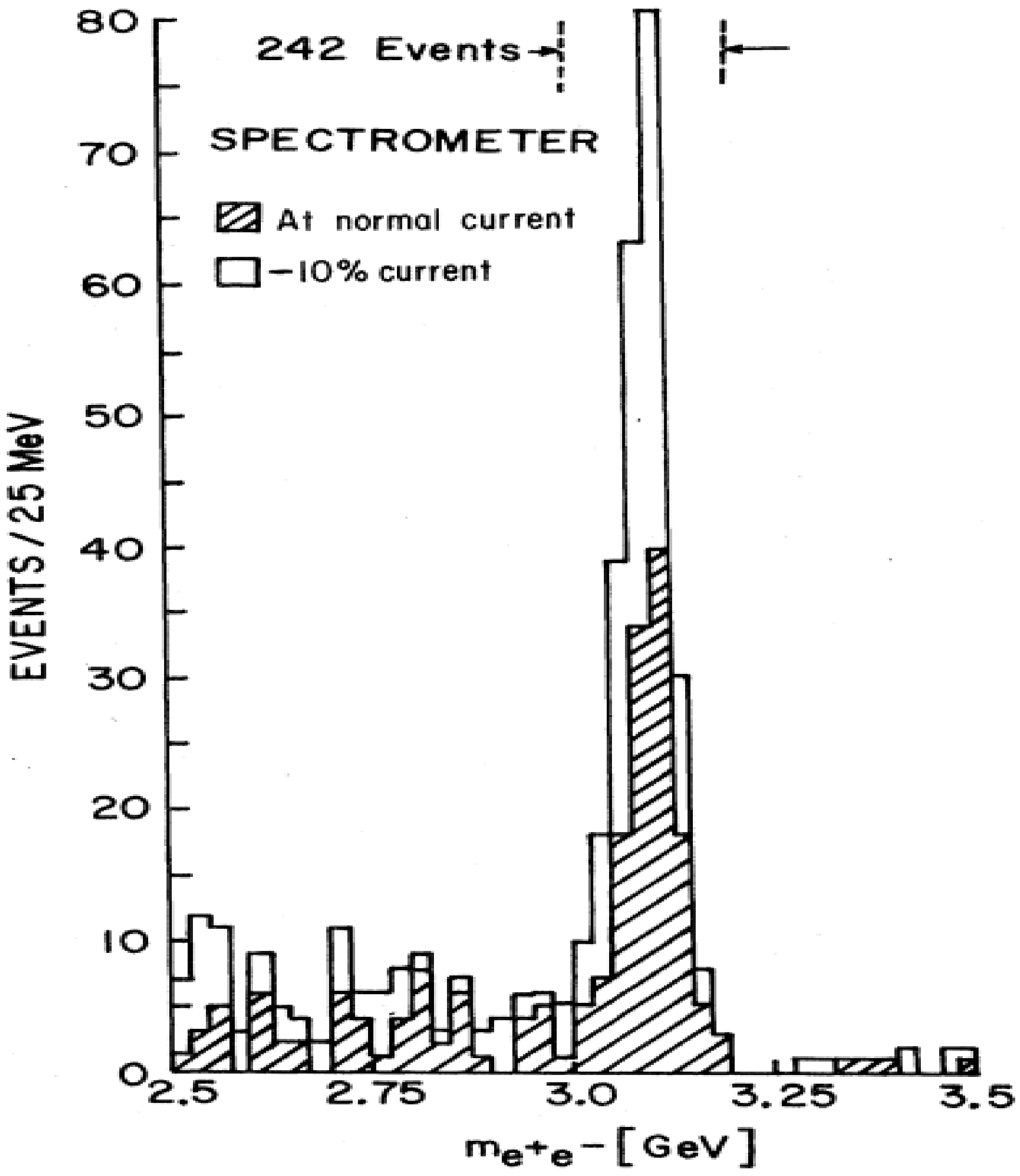
e^+ and e^- might come from same particle, to further check that, the article perform a more test to verify the particles we detected are e^+ and e^-

Results



They are again in agreement with the calibration previously made by the e beam

Results



There is a clear sharp enhancement at m =3.1 GeV

Results

To ensure that the observed peak is indeed a real particle ($J \to e^+e^-$) many experimental checks were made:

- When we decreased the magnet currents by 10%, the peak remained fixed at 3.1 GeV(see last slide)
- To check second-order effects on the target, we increased the target thickness by a factor of 2. The yield increased by a factor of 2, not by 4
- To check the pileup in the lead glass and shower counters, different runs with different voltage settings on the counters were made. No effect was observed on the yield of J
- To ensure that the peak is not due to scattering from the sides of magnets, cuts were made in the data to reduce the effective aperture. No significant reduction in the J yield was found
- To check the read-out system of the chambers and the triggering system of the hodoscopes, runs were made with a few planes of chambers deleted and with sections of the hodoscopes omitted from the trigger. No effect was observed on the J yield
- Runs with different beam intensity were made and the yield did not change
- To avoid systematic errors, half of the data were taken at each spectrometer polarity

Questions from Ryuta

In this paper, they report the e+e- spectrum from { p + p ->e+e- + X } reaction.
Then, there might be { p + p ->mu+ mu- + X } reaction as well,
or at least dimuon pairs can be mixed in this channel.
I think this is an fixed target experiment rather than a beam experiment so, actually the process is p+Be→e^+e^-X, may be in this process muon can't be produced
How they can separate muons from electrons ?
****** Following is my consideration ******
Suppose the electrons/muons have momentum of P=2 GeV/c,
Q1.1 Can we separate muon/electron by time of flight difference,
where we assume the path of 10 m distance (like "Ao" to "C" in Fig.1(a)) ?
We can't separate muon/electron by time of flight, but a pre-PID of electron has been done(see Fig.2)
Q1.2 Can we separate muon/electron by the existence of Cherenkov light,
where the Cherenkov counter is filled with H2 (written in the middle of page1) ?
Same answer as Q1.1

Questions from Tao

How to understand Fig2.?

Time of flight distribution refers to the time differences between time of flight of e^+ and e^- in their own arms, if they come from the same particle decay, this value should be zero