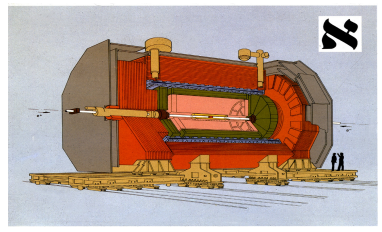
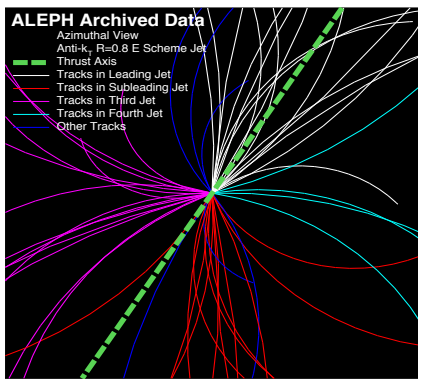
Study of high multiplicity e^+e^- collisions using archived data from the ALEPH detector at LEP

Anthony Badea, Quark Matter 2018, May 13-19, 2018, Venice

badea@mit.edu

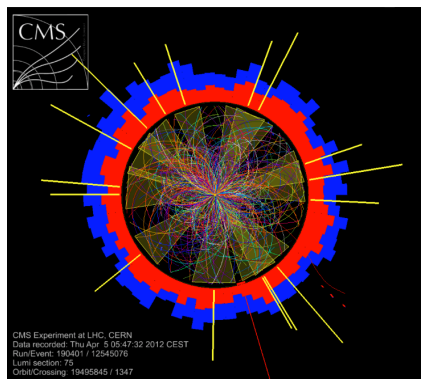




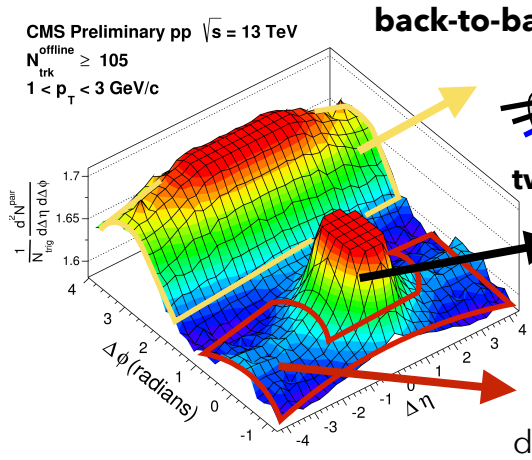
LEP1 e^+e^-

Motivation

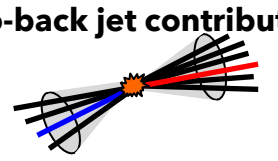
1. Search for signs of collectivity in e^+e^- collisions
2. Study high multiplicity event shape
3. Apply most advanced analysis techniques from pp collisions in a system with definite initial characteristics
4. Develop framework to study jet fragmentation in e^+e^- as a function of multiplicity



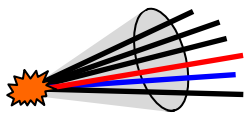
CMS pp



back-to-back jet contribution



two-particles from the same jet



"collective effect"
two particles with very different η are "correlated"

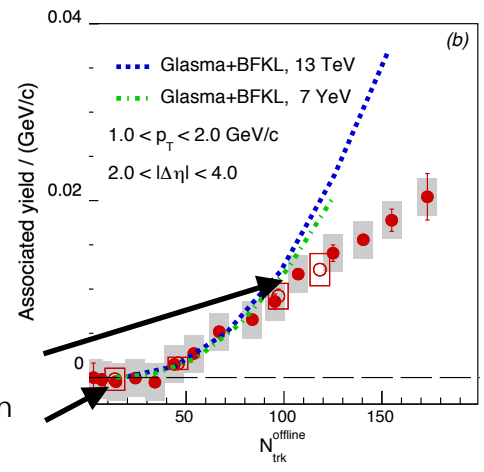
Analysis Technique

- **Two Particle Correlation**

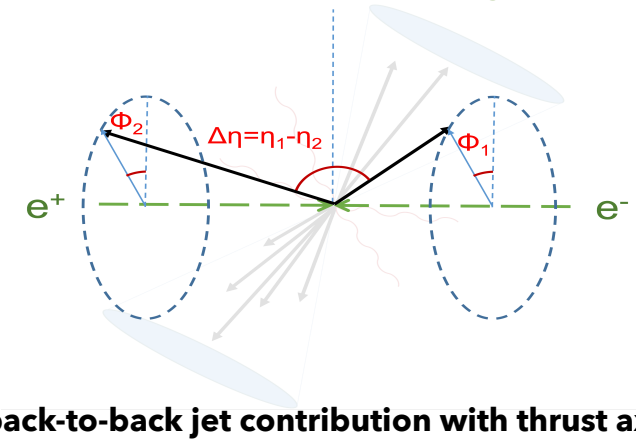
$$\frac{1}{N_{\text{trig}}}\frac{d^2N^{\text{pair}}}{d\Delta\eta d\Delta\phi} = B(0,0) \times \frac{S(\Delta\eta,\Delta\phi)}{B(\Delta\eta,\Delta\phi)}$$

- **Δϕ Projection**

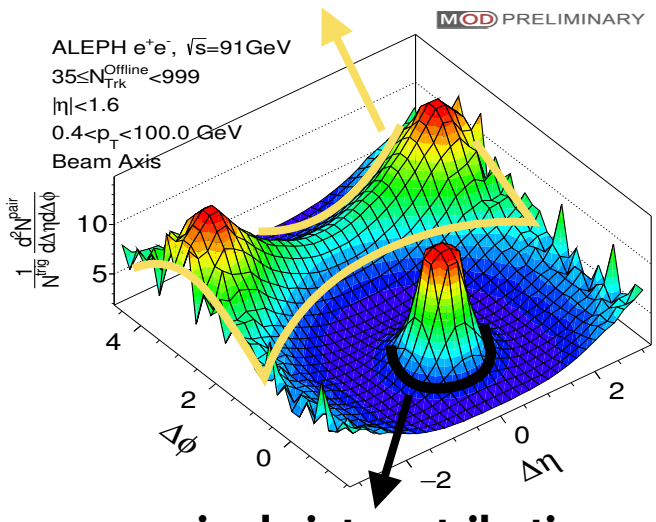
almost linear increase with multiplicity
no associated yield after ZYAM subtraction in low multiplicity



Beam axis study

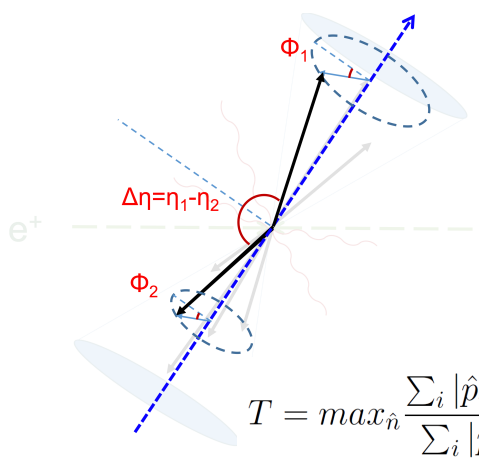


back-to-back jet contribution with thrust axis randomly orientated with respect to the beam axis

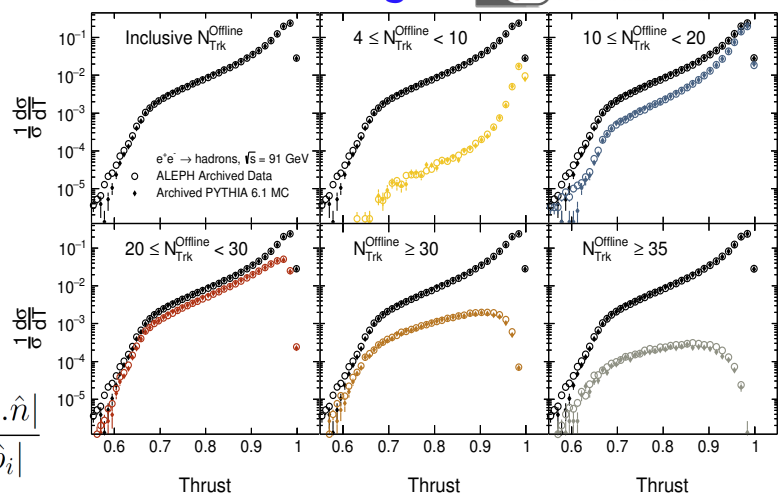


single jet contribution

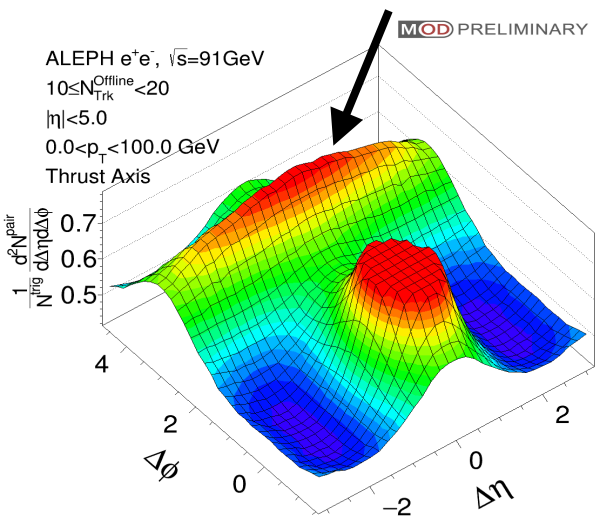
Thrust axis to follow the "direction of the color strings"

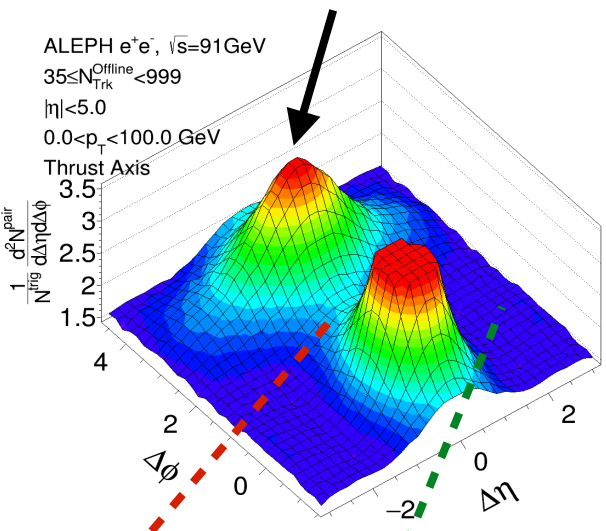


$$T = max_{\hat{n}} \frac{\sum_i |\hat{p}_i.\hat{n}|}{\sum_i |\hat{p}_i|}$$

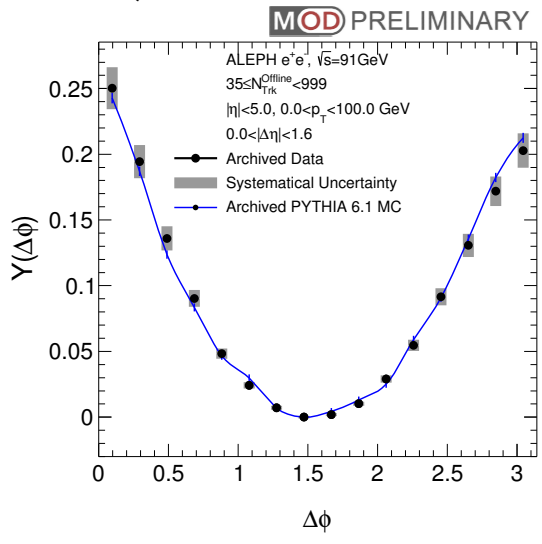


away side peak becomes narrower at higher multiplicity → residual contribution from three jet events
back-to-back jet in e+e- similar to the beam remnant in pp collisions

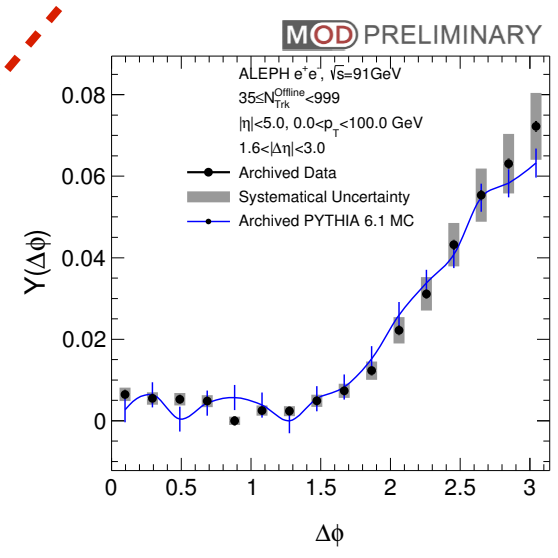




Δϕ Projection (Zero Yield at Minimum (ZYAM) subtracted)



$0 < |\Delta\eta| < 1.6$ (Jet Region)



$1.6 < |\Delta\eta| < 3.0$ (Long Range)

Conclusion

1. First understanding of event shape as a function of multiplicity → enables the study of non-perturbative flow contribution
2. No clear sign of collective flow in e+e- collisions
3. Two particle correlation function also reveals the evolution of jet substructure modification as a function of event multiplicity
4. Looking forward to analysis with event shape selection and with LEP2 data, which have higher multiplicity reach

Collaborators: Austin Baty, Gian Michele Innocenti, Yen-Jie Lee, Christopher McGinn, Michael Peters, Jesse Thaler, Paoti Chang, Tzu-An Shen and Marcello Maggi