Summary from Cone Jet Algorithms Discussions

QCD@RunII Workshop, FNAL Nov 6, 99.

Or, what it takes to hone the jet cones:

- IR/Collinear Safety
- Boost Invariant
- Fully Specified!: (Energy, angles, and underlying event, pre-clustering, merging, and splitting)
- Detector/'Level' independence
- Simplicity and elegance!

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for the
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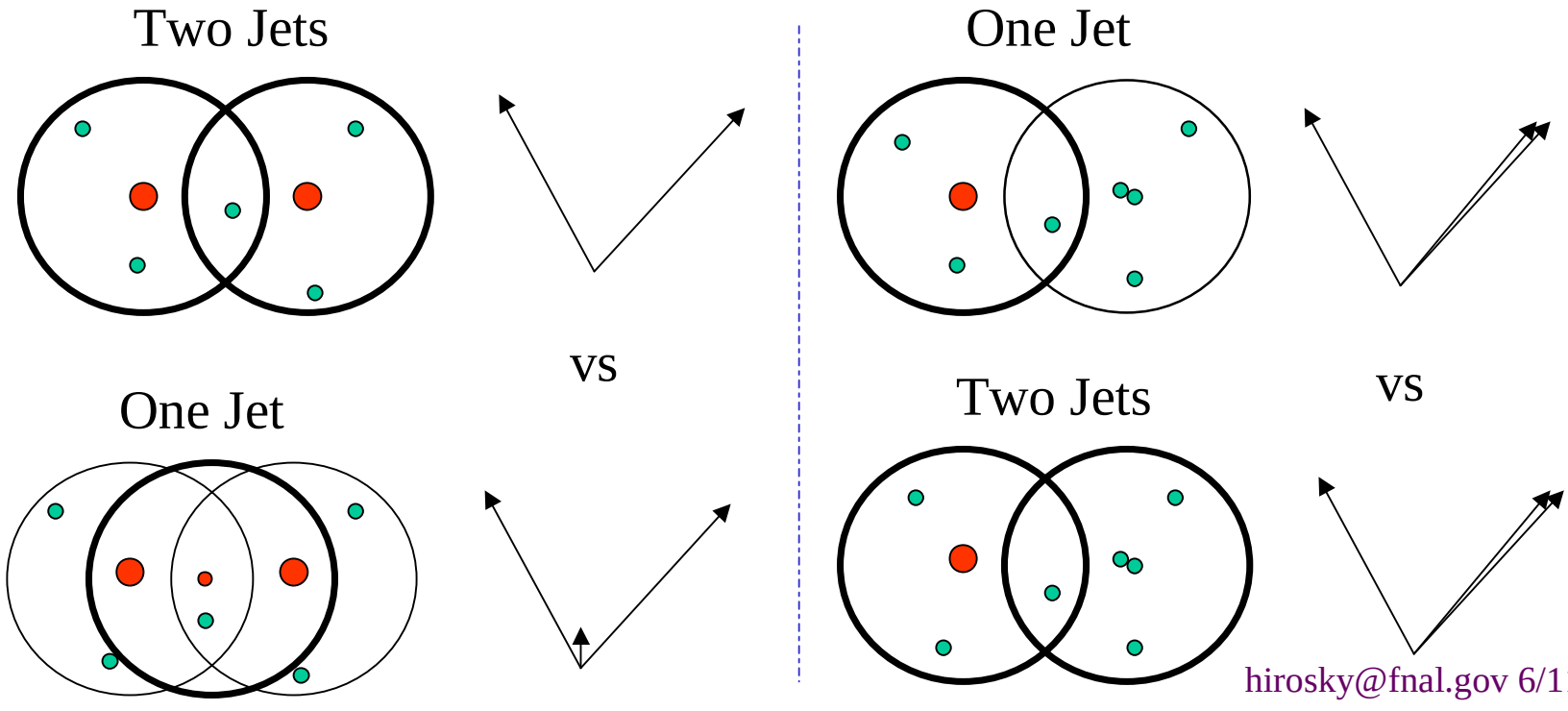
IR/Collinear Safety in the Workplace

Two basic concepts:1) algorithm is insensitive to soft radiation
2) algorithm is insensitive to 'small structure'

Consider clustering jets around seeds



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Basically, a well behaved algorithm finds the maximal ET cones in an event and the ET in the cone is what maters, not it's distribution.

Or perhaps more simply,

A jet ≡ Transverse Energy in a Cone

This is essentially the definition used in DØ for deriving data-based reconstruction efficiency estimates,

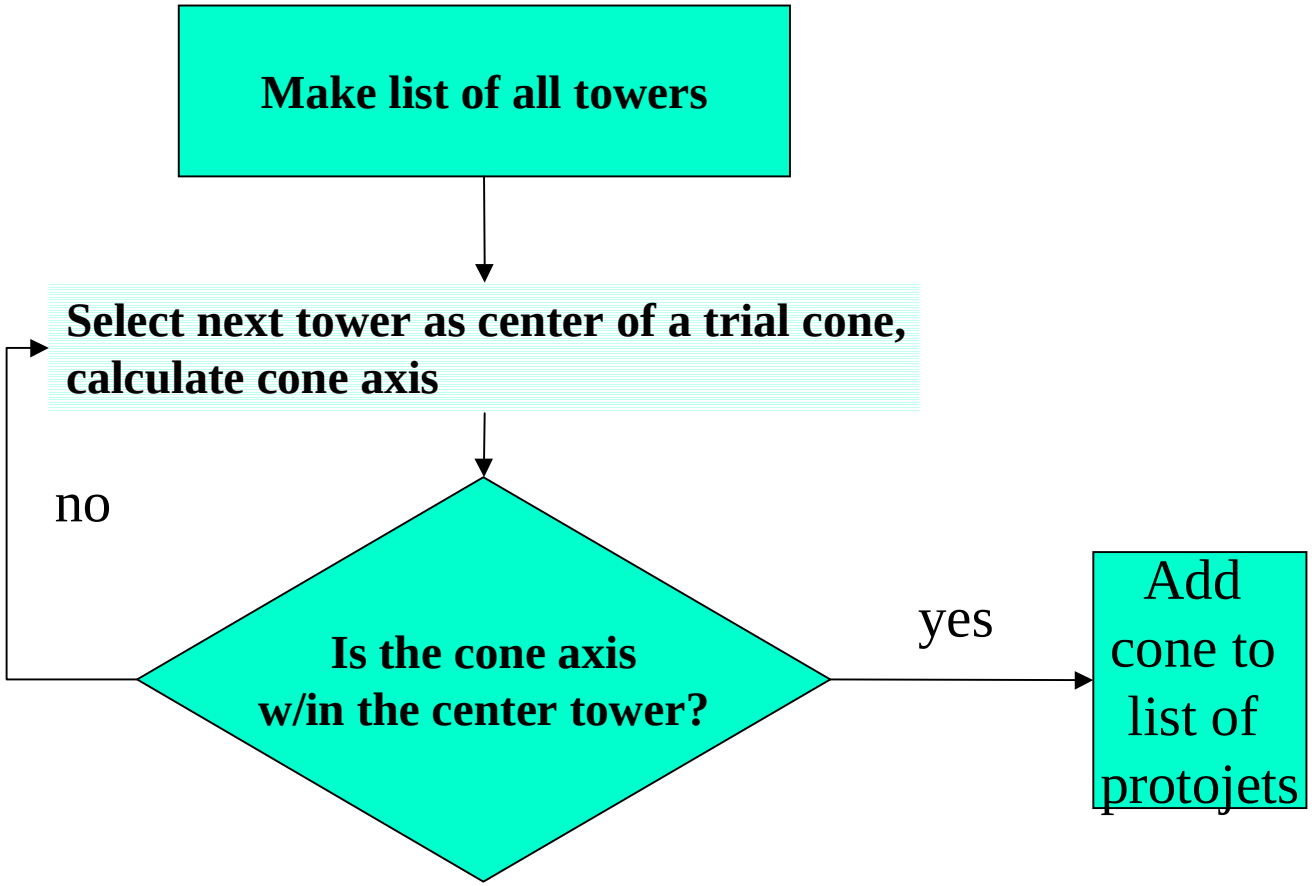
and,

applied religiously, a variety of ad hoc parameters can be dropped from an algorithm definition

A Seedless Algorithm, suggested by Ellis&Soper

No seed Thresholds

All towers searched for viable cone centers



Next step = splitting/merging

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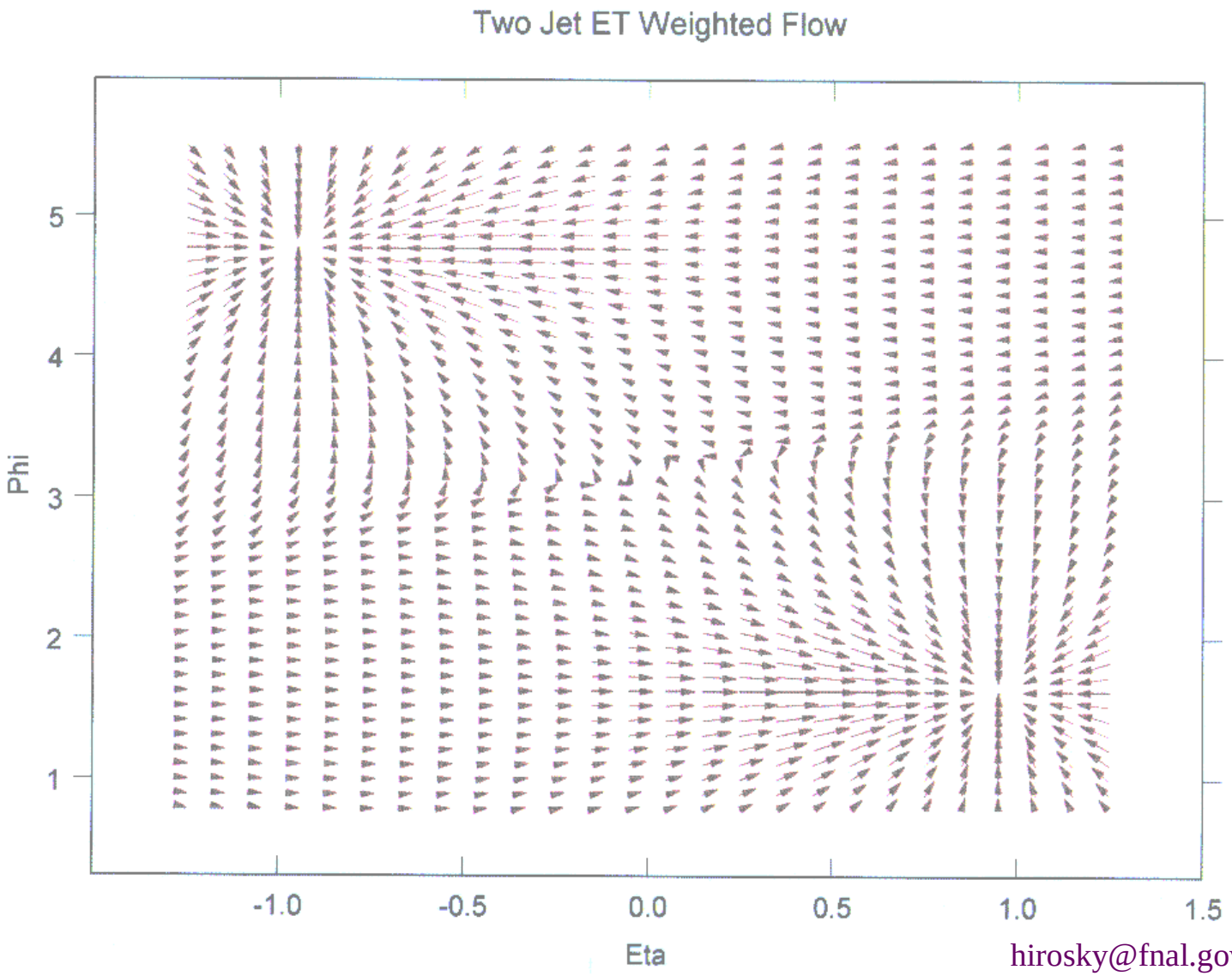
Steve Ellis' - test of flow in 1st step of seedless algorithm using toy jets/detector



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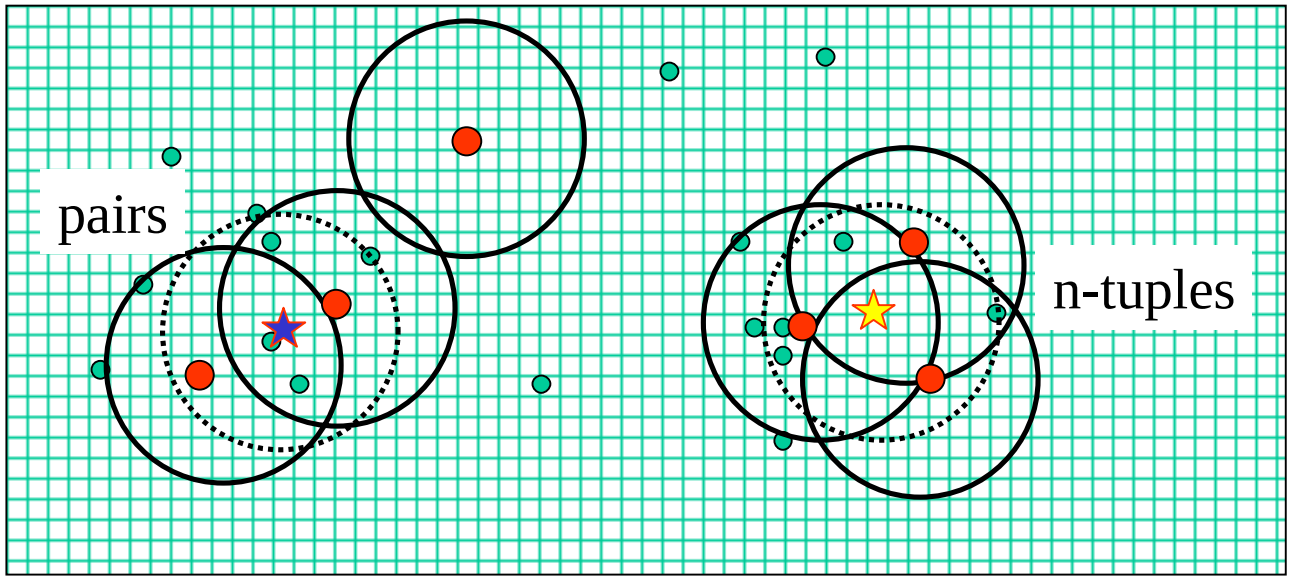
A less computationally ambitious approximation:

The **MidPoint Algorithm** adds new 'pseudo seeds' between each pair of jet seeds satisfying the distance (ΔR) requirement:

For seeds in: Rcone < ΔR < 2*Rcone Midpoint adds starting points



Seed > ~1 GeV

MidPoint Alg. added seeds placed at ET-weighted midpoints

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Deiter Zeppenfeld showed a nice test of the equivalence of the Seedless (ES) algorithm and the MidPoint (aka ILCA) algorithm

Tests for:

-algorithm smin dependence (technical parameter to separate 2/3 parton states, a non-observable)

-algorithm seed dependence

-NLO jet structure

ILCA = Improved Legacy Cone Algorithm

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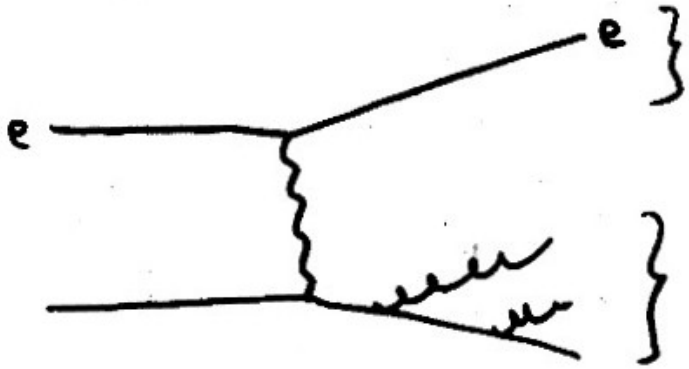
Properties of ILCA for up to 3 partons in a jet can be probed with MEPJET

MEPJET : NLO $ep \to ejjX$ Monte Carlo



Study merging of 3 partons

2 jet $\longrightarrow$ 1 jet transition

Study E_T flow inside DIS current jet

NLO jet shape

D. Zeppenfeld

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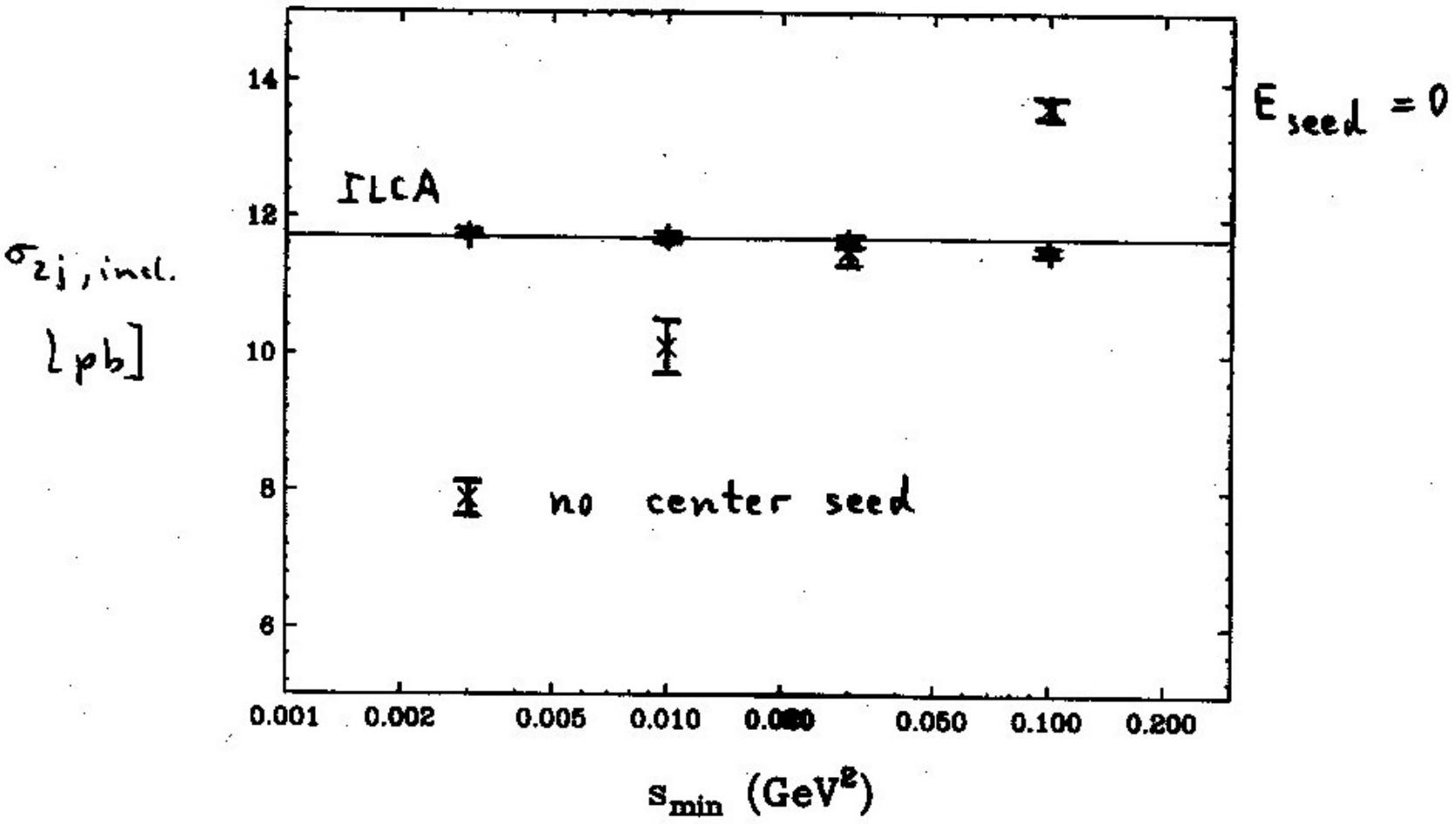
dijet cross section, $R_{jj} < 2$, cone size $\Delta R = 1$

$E_{Tj} > 10$ GeV, $-1 < \eta_j < 2$

D. Zeppenfeld



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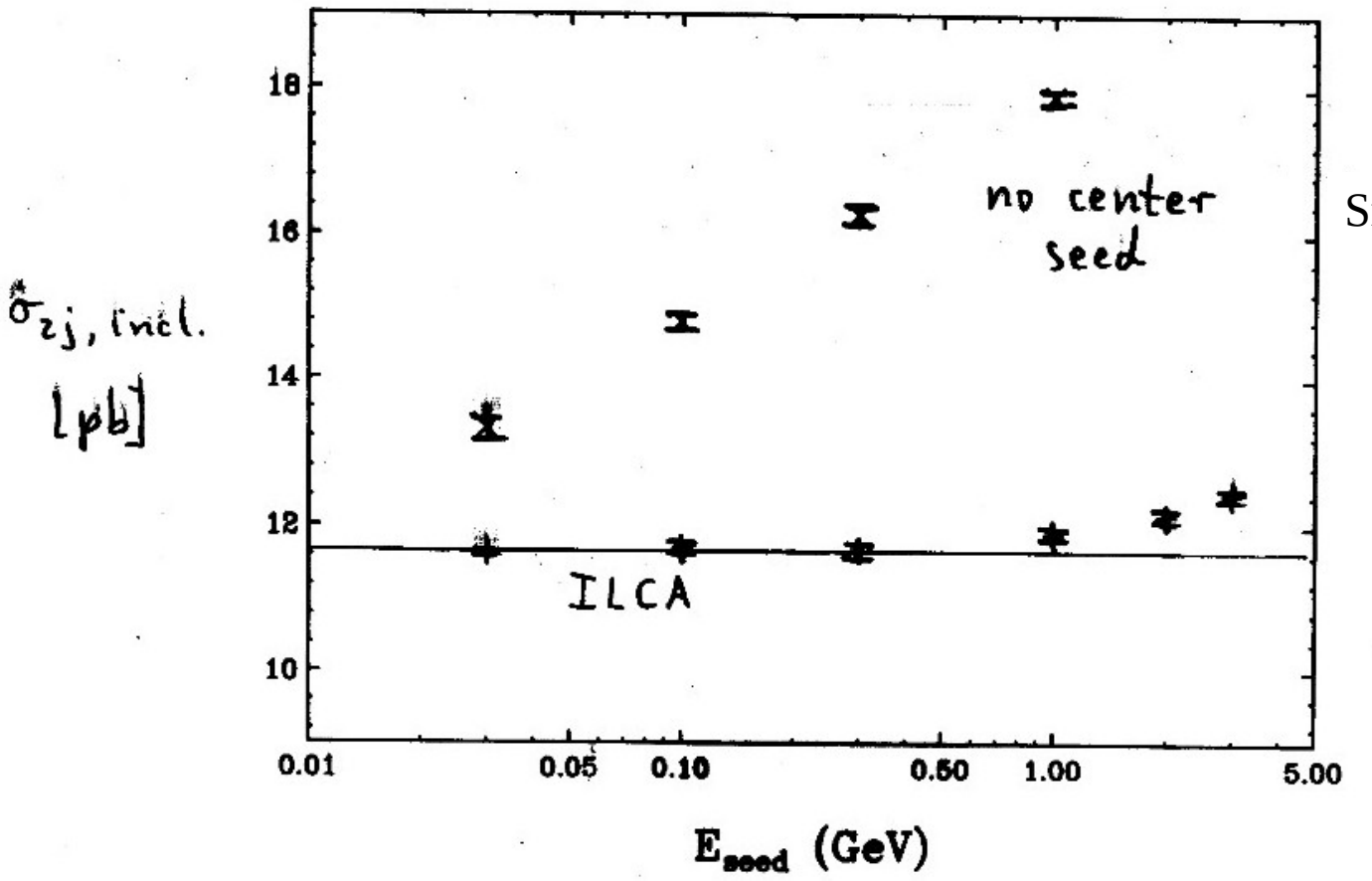
Dependence on seed threshold

D. Zeppenfeld



$R_{jj} < 2$

Smin = 0.03 GeV

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Conclusion

ILCA appears infrared safe, as expected.

Very small dependence on precluster threshold due to inclusion of center seeds.

ILCA jets are broader than k_T jets. Differential jet shape $s(r)$ is well behaved at NLO (except near $r = \Delta R$)

D. Zeppenfeld

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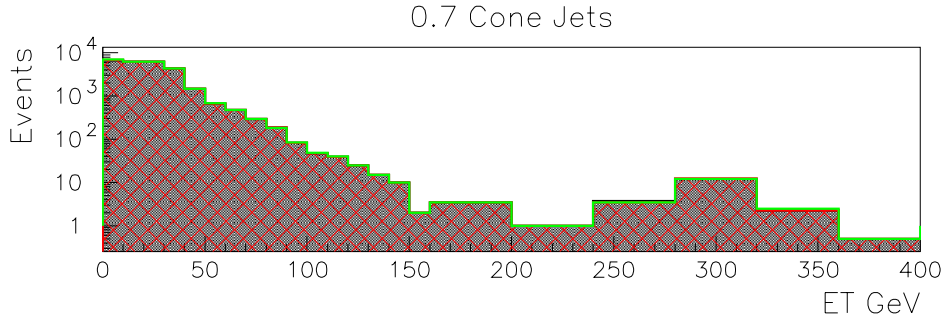
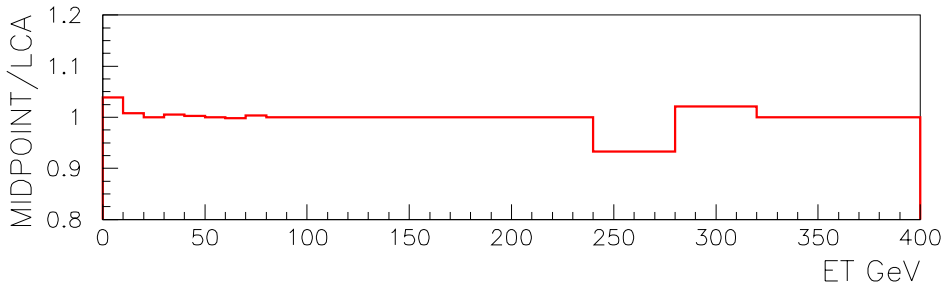
Ratio of Jet ET Spectra for LCA, and MidPoint variations

Bob Hirosky

Test equivalence of DØ cone algorithm and MidPoint



Midpoint seeds used **after** 1 GeV threshold seeds



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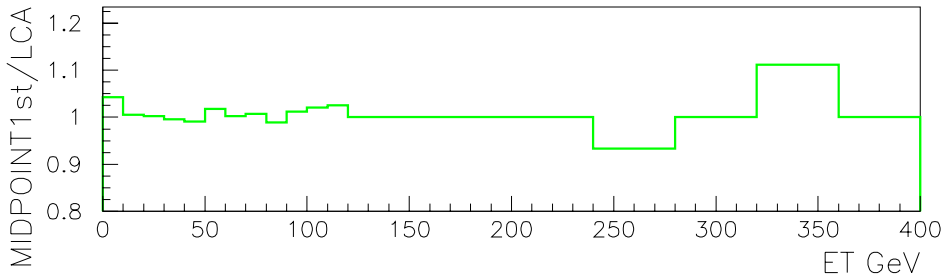

Difference is due to subtle MERGING effects!

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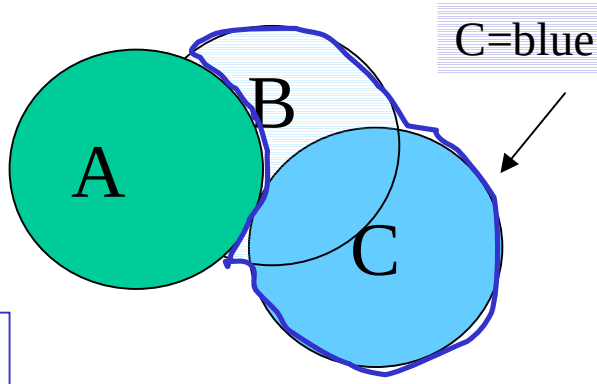
One Simple Example

Assume (B<C<A) & B∩C>B/2 & B∩A<B/2

Order of jet finding: A,C,B

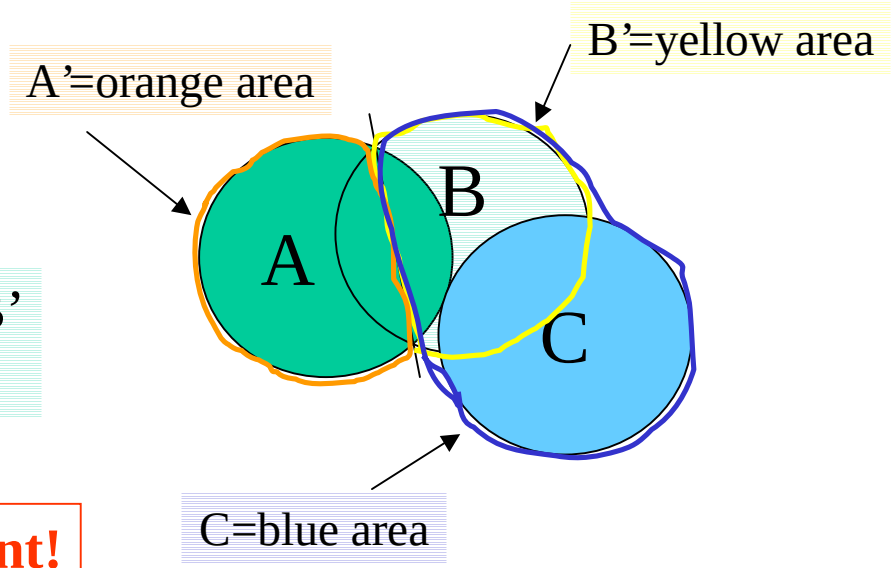
A->A
C-> C+B-(B∩A), B->0



Note: only towers unique to B are
available for merging w/ C in the DZero strategy

Order of jet finding: B,A,C

B&A are split A->A', B->B'
C-> C+B' , B'->0



Split/merge order very important!

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MidPoint Conclusions

Effects on data complex, but small:

•addition of midpoint seeds early or late in seed list changes jet ET spectrum by only a few percent for most cone sizes, very large cones show slightly more sensitivity

•in most cases adding midpoints increases the amount of splitting/ merging of jets by a few percent (more protojets available due to increased number of seeds)

•Note: Once algorithm specific resolution and escale corrections are determined and applied, the differences in the corrected jet cross sections for LCA and midpoint algs. will be further reduced!

Midpoint Algorithm is quite compatible w/ Run 1 algorithm + superior IR safety!

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Our Tasks:

Document our studies of midpoint clustering in data/MC.
Draft in 6 weeks!

•Finalize the common cone algorithm for CDF/DØ:
draft conventions are on the working group web pages,
but these need to be supplemented by detailed split/merge
specifications.

•To this end the working group has agreed to continue to ensure more excellent communication between the experiments and the
theory community.

•?Might we be able to switch to a seedless algorithm?
Advantages in efficiency calculations (less threshold parameters to consider).
Superior collinear safety
Ability to do multiple cone sizes on one pass through the data.
This may make such an algorithm cost effective.

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