

FRANK E. PAGE MEMORIAL SYMPOSIUM
BROOKHAVEN NATIONAL LABORATORY
MAY 2, 2018

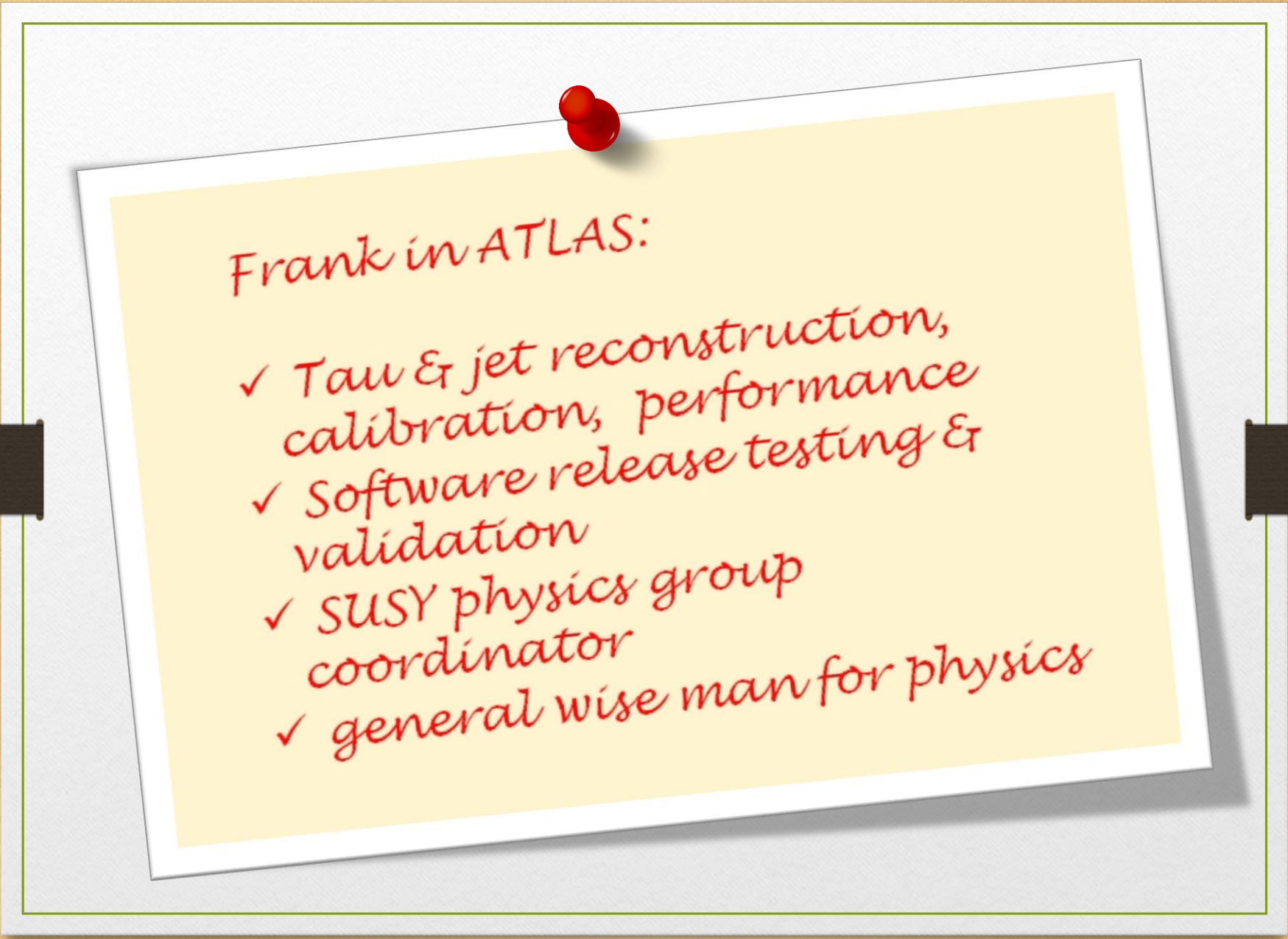
Frank in ATLAS



Peter Loch

Department of Physics

University of Arizona



Frank in ATLAS:

- ✓ Tau & jet reconstruction, calibration, performance
- ✓ Software release testing & validation
- ✓ SUSY physics group coordinator
- ✓ general wise man for physics

τ Reconstruction in Athena

H. Ma, F.E. Paige, S. Rajagopalan

Hadronic τ 's hard to separate from QCD jets and to measure, but offer unique information.

E.g., in SUSY expect differences from RGE running, gaugino mixing, and $\tilde{\tau}_L$ - $\tilde{\tau}_R$ mixing. Best chance to probe chiral structure.

Have implemented τ reconstruction in Athena.

- Combines tracking and calorimeter information.
- Requires separation of EM and hadronic energy.
- Uses “energy flow” to reconstruct visible τ mass.
- Requires energy calibration.

Also test Athena usability by non-expert.

MARCH 7, 2002

...the first contribution involving Frank in the electronic ATLAS archive!



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physics motivation

- Combine
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detector employment & signal use

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Software testing & validation

- Requires energy calibration.

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τ Reconstruction in Athena

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Hadronic τ decay, but offer unique info

Collaboration with experimentalists

E.g., in SU(2)_C × SU(2)_F no mixing, and $\tilde{\tau}_L$ - $\tilde{\tau}_R$ mixing. Best chance to probe chiral structure.

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...mining the energies of its constituents. The energy density of the cell itself. We thus define the EM scalar

$$E_{\text{em}} = \sum_{i=\text{cells}} E_i$$

is the energy in the cell i for the considered jet. We then define a jet weighted 4-vector

$$E = \sum_{i=\text{cells}} w_i E_i \quad \vec{P} = \sum_{i=\text{cells}} w_i \vec{P}_i$$

the i -th cell energy and momentum (whose direction is defined by the direction of the cell, and whose magnitude is equal to E_i), and w_i are correction factors that depend on the cell energy E_i and the jet energy E , where V_j is the jet energy.

...rapidity bins are also defined. Table 1 shows the definition of the weight in the k -th calorimeter region, in the j -th energy density bin is defined to be:

$$w_i^{(k,j)} = \sum_{m=0}^{N_p-1} a_m^{(k)} \log^m(E/V)_j \quad (3)$$

... (the number of parameters used in the fit) is a number which depends on the region k . The weight $w_i^{(k,j)}$ is defined at the lower edge of the j -th bin.

*Now used for local
hadronic calibration of
calorimeter cell clusters*

...minimizing the energies of its constituents...
...energy density of the cell itself. We thus define t

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...the i -th cell energy and momentum (whose direction is defined by...
...magnitude is equal to E_i), and w_i are correction factors...
... E/V , where V is the jet volume.

...rapidity bins are also defined. Table 1 shows...
...the weight in the k -th calorimeter region, in the j -th energy density bin is defined to be:

$$w_i^{(k,j)} = \sum_{m=0}^{N_p-1} a_m^{(k)} \log^m(E/V)_j \quad (3)$$

... (the number of parameters used in the fit) is a number which depends on the region k ...
... $\log(E/V)_j$ is defined at the lower edge of the j -th bin.

...mining the energies of its constituents.
 ...energy density of the cell itself. We thus define the EM scalar

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$$E = \sum w_i E_i \quad \vec{P} = \sum w_i \vec{P}_i$$

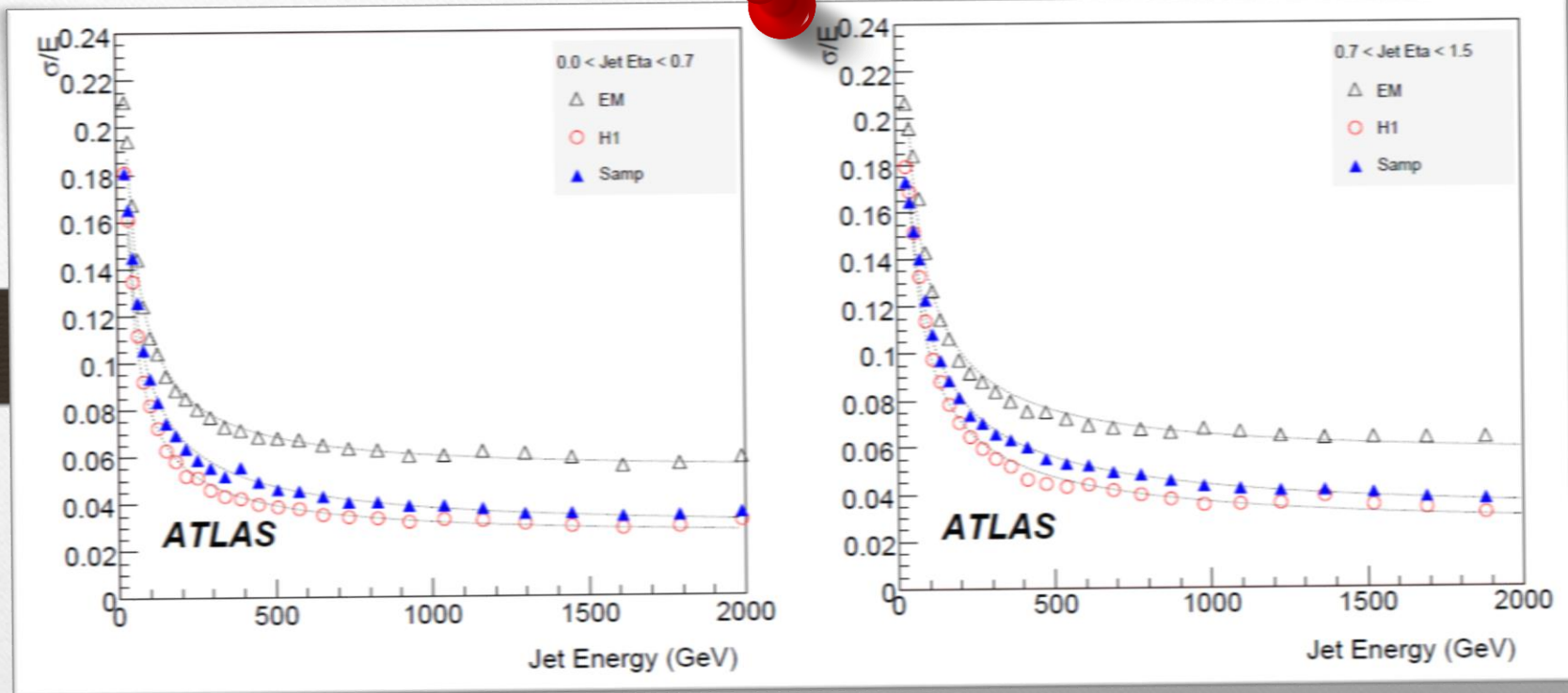
*Same functional form now used with
 different kinematic variables for overall
 smooth jet energy calibration functions in
 given bins of phase space!*

...rapidity bins are also defined. Table 1 shows a summary of the bins.
 The weight in the k -th calorimeter region, in the j -th energy density bin is defined to be:

$$w_i^{(k,j)} = \sum_{m=0}^{N_p-1} a_m^{(k)} \log^m(E/V)_j \quad (3)$$

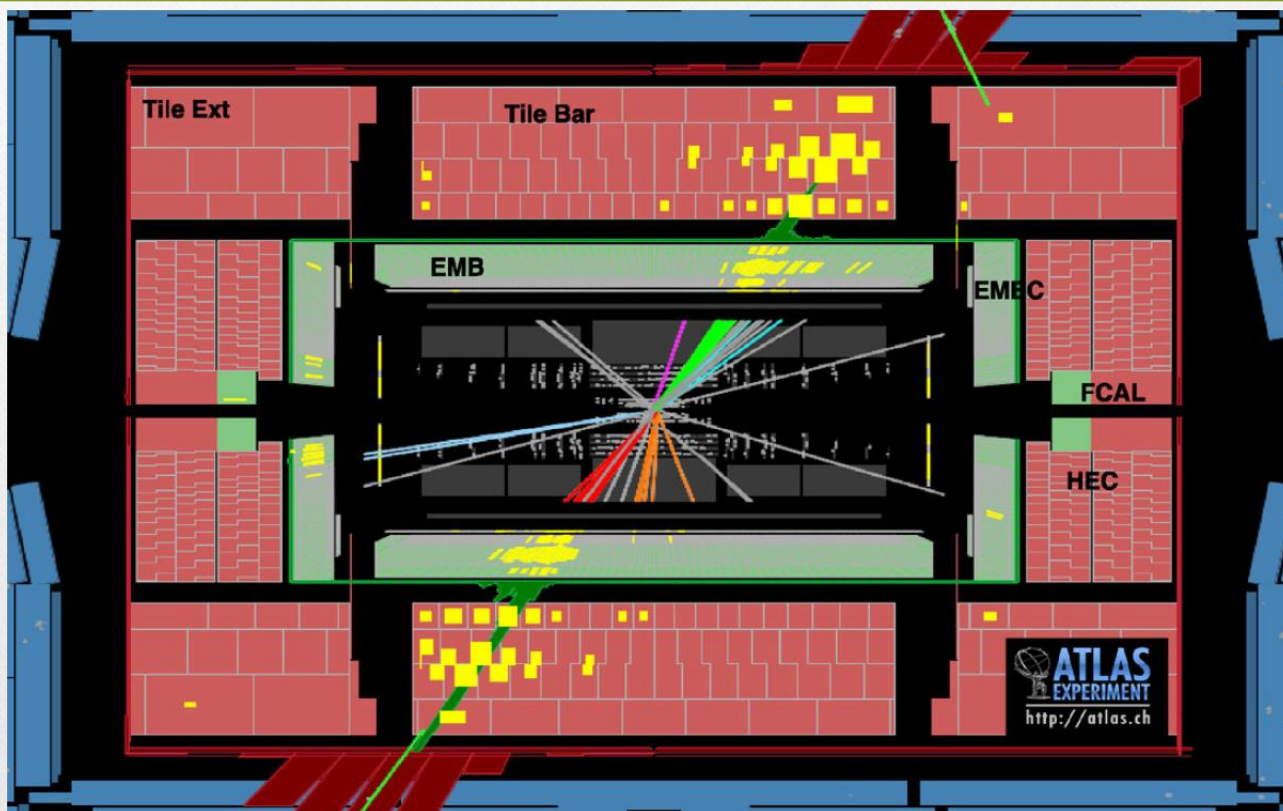
(the number of parameters used in the fit) is a number which depends on the region k .
 $\log(E/V)_j$ is defined at the lower edge of the j -th bin.

And it worked very well, too!



arXiv:0901.0512

Data arrived in 2010...

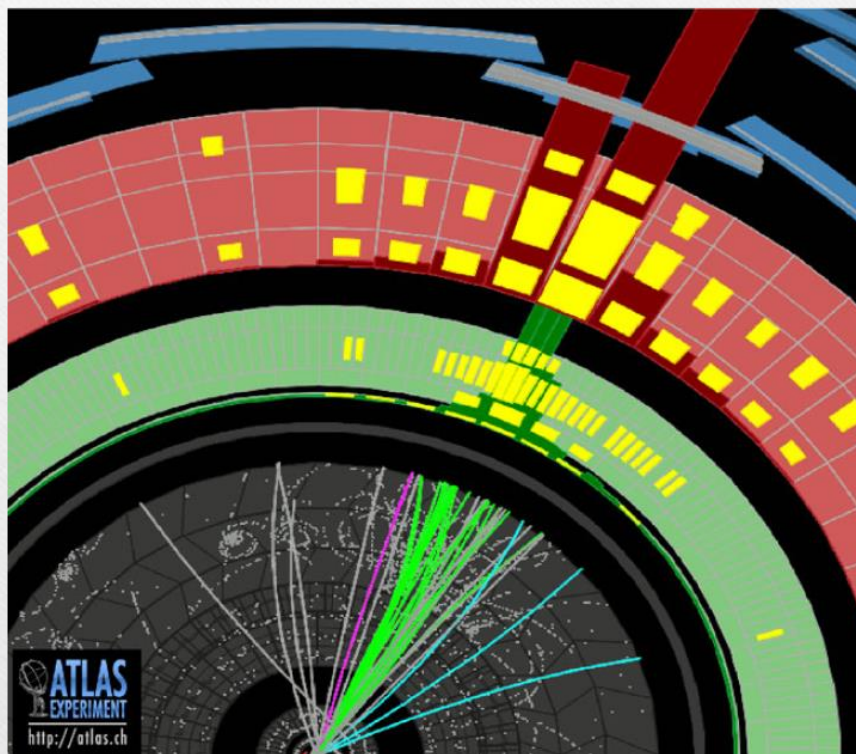


Data arrived in 2010... and Frank changed focus!

- How to validate simulation derived jet calibrations with data?

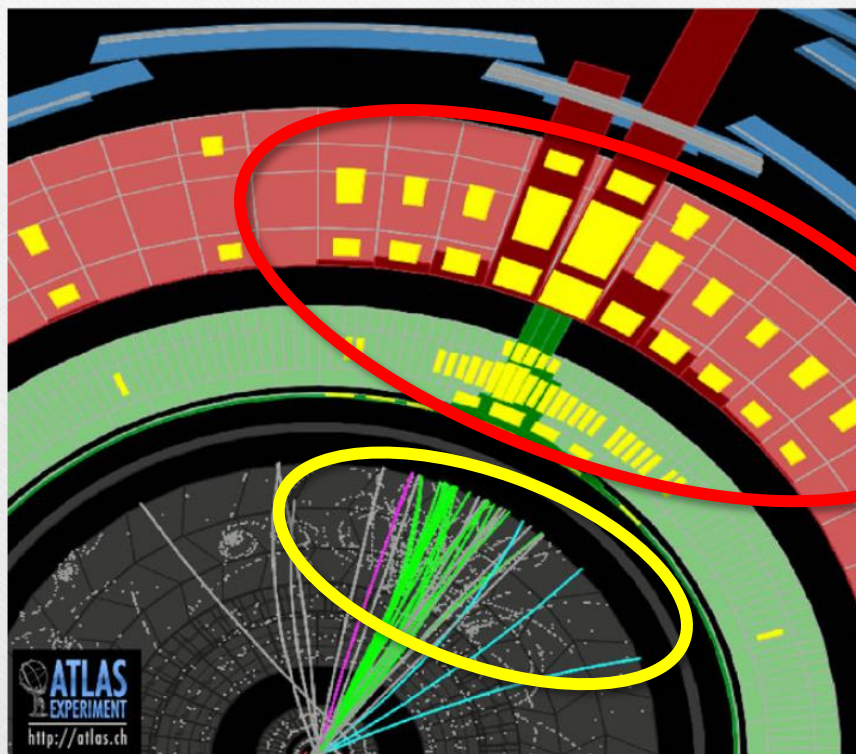
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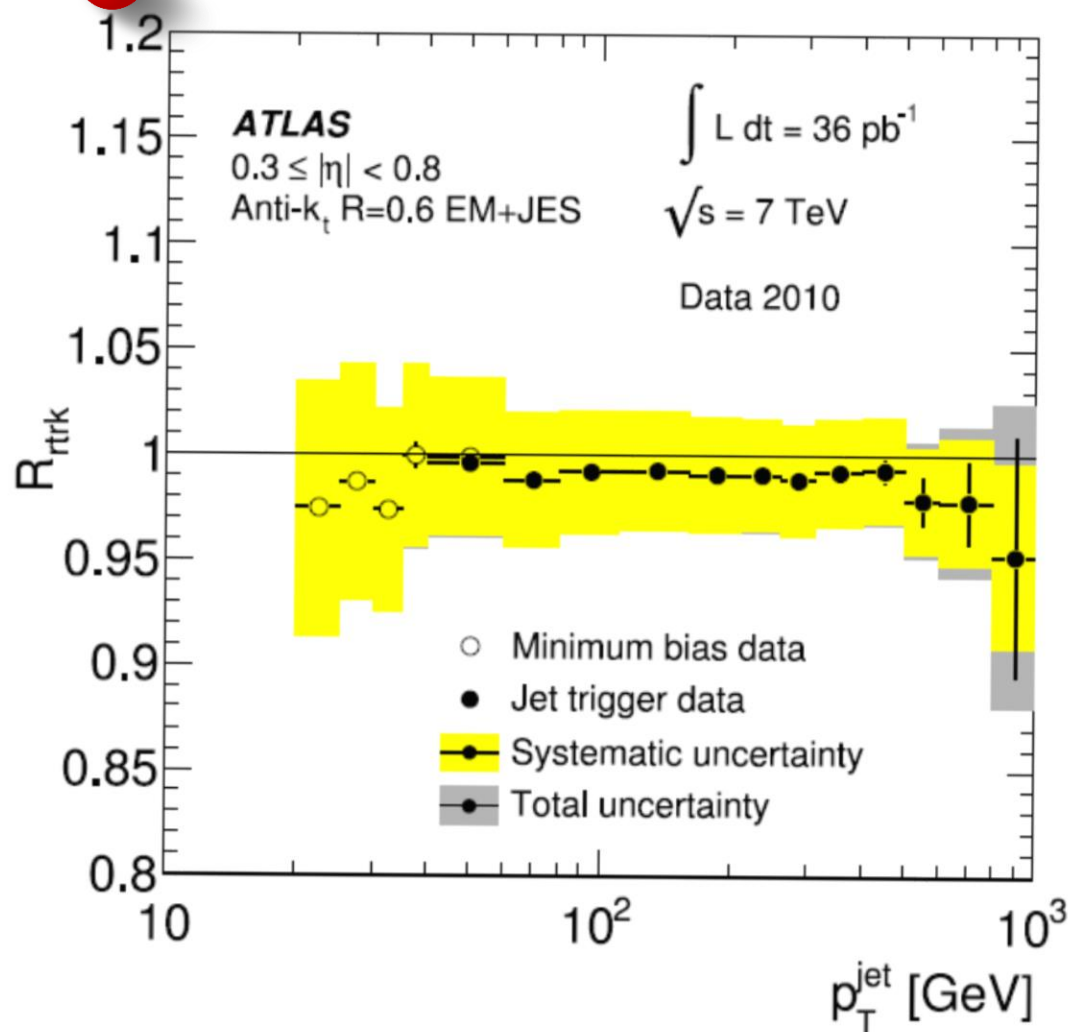
- How to validate simulation derived jet calibrations with data?



Data arrived in 2010... and Frank changed focus!

- The R_{trk} method pioneered by Frank, Majorie Shapiro, *et al.* for jet response





Recent contributions

- Jet substructure for highly boosted jets – how to tag a possible 2(3)-prong decay inside the jet?
- “Skinny jets” and cell-based jet mass – challenging structural measurements ...

One of Frank's final contributions...

Skinny Jets and Boosted $W \rightarrow q\bar{q}$

B.P. Nachman (LBNL) and F.E. Paige (BNL)

Boosting $W \rightarrow q\bar{q}$ shrinks both angle between q and \bar{q} but also size of subjects. For $M_W = 5$ TeV, $\theta_{min} = 2M_W / p_T \sim 0.064$ and subject $R = 0.4M_W / p_T \sim 0.013$.

Can resolve such small subjects using tracks or EMcal cells. Need ESD to access calorimeter cells. Use 20000 $W' \rightarrow WZ$ ESD events: [hep15_13TeV_426321_Pythia8ESDGen_A148WPDF23LO_MprismNarrow_Wqqq_ESD_x5000_1recos.ESD_x5435_x2978_1_014](#)

Model has dominant $W' \rightarrow W_L Z_L$, as expected in some R-S type models [[arXiv:0810.1497](#)]. Has zero widths for W' , W , and Z .

Boosted W/Z fits easily in AntiKt4EMTopoJet. Boost \rightarrow small angles between tracks but lower multiplicity than QCD jets with same p_T .

06 Jul 2017



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Skinny Jets and Boosted $W \rightarrow q\bar{q}$

B.P. Nachman (LBNL) and F.E. Paige (BNL)

EMBARGOED!

July
6, 2017

06 Jul 2017