Alternatives Physics Lists

ATLAS Report

https://its.cern.ch/jira/browse/ATLASSIM-3468

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Introduction

Alberto prepared alternative physics lists for ATLAS simulations (w/ Geant4 V10.1)

Goal: physics list variations to be used for ATLAS extrapolation of data-drive uncertainties to higher kinematic ranges

SimplifiedCaloriemter results:

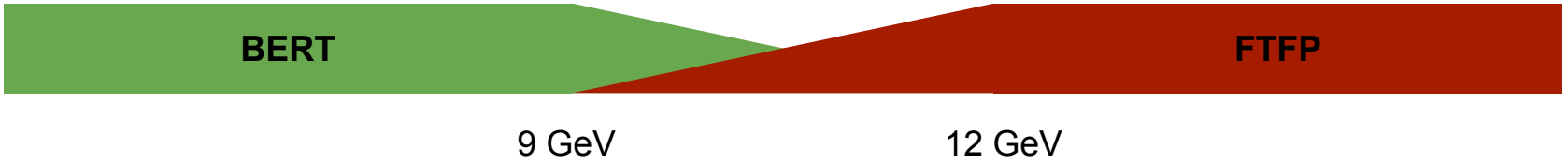
- shower shapes
- detailed spectra of secondaries

For Fe/Sci (Tile), Pb/LAr (ECAL), W/LAr (FCAL)

Baseline

Production physics list (baseline for all following comparisons):

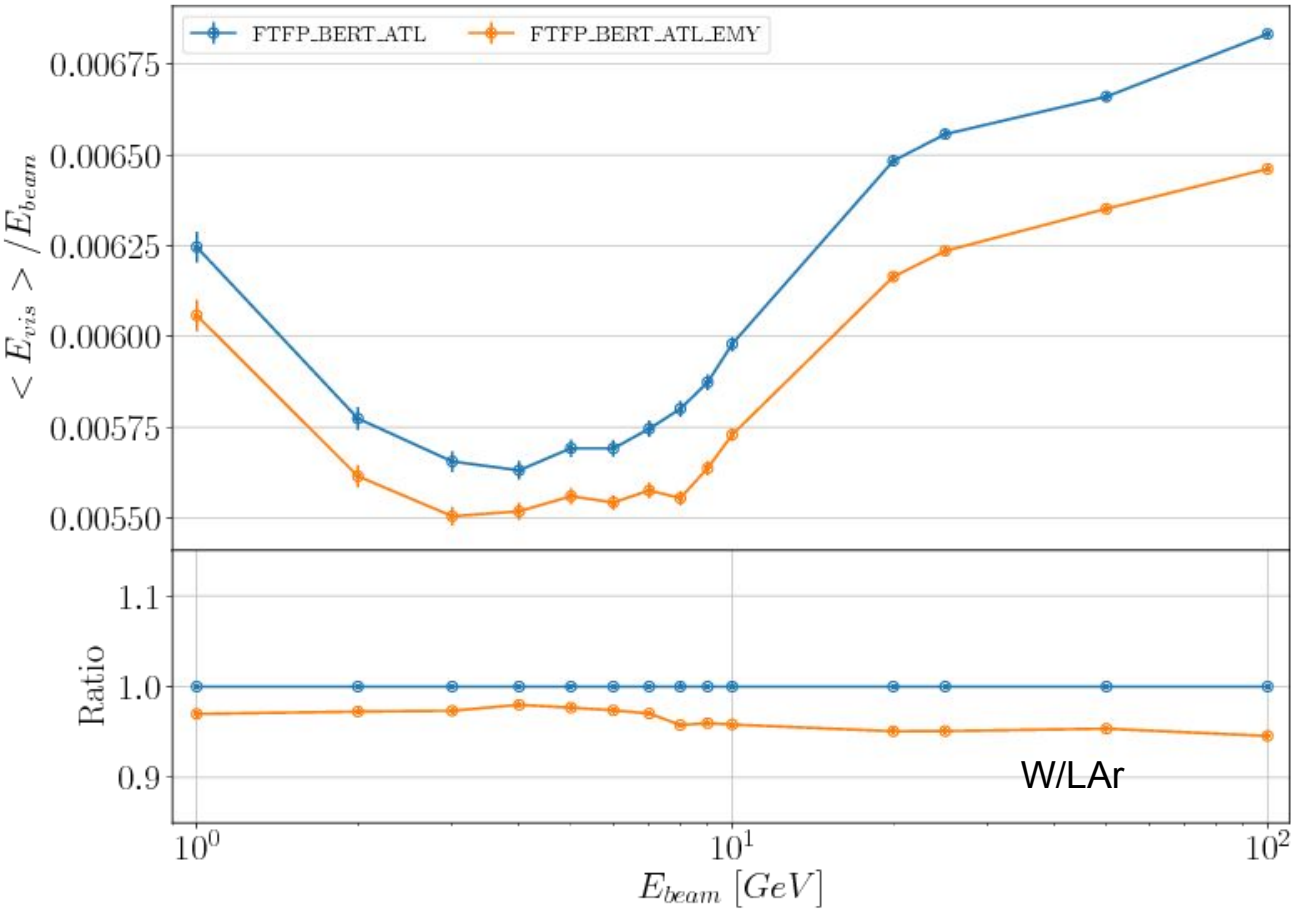
FTFP_BERT_ATL



Electro-magnetic Variant

FTFP_BERT_ATL_EMY

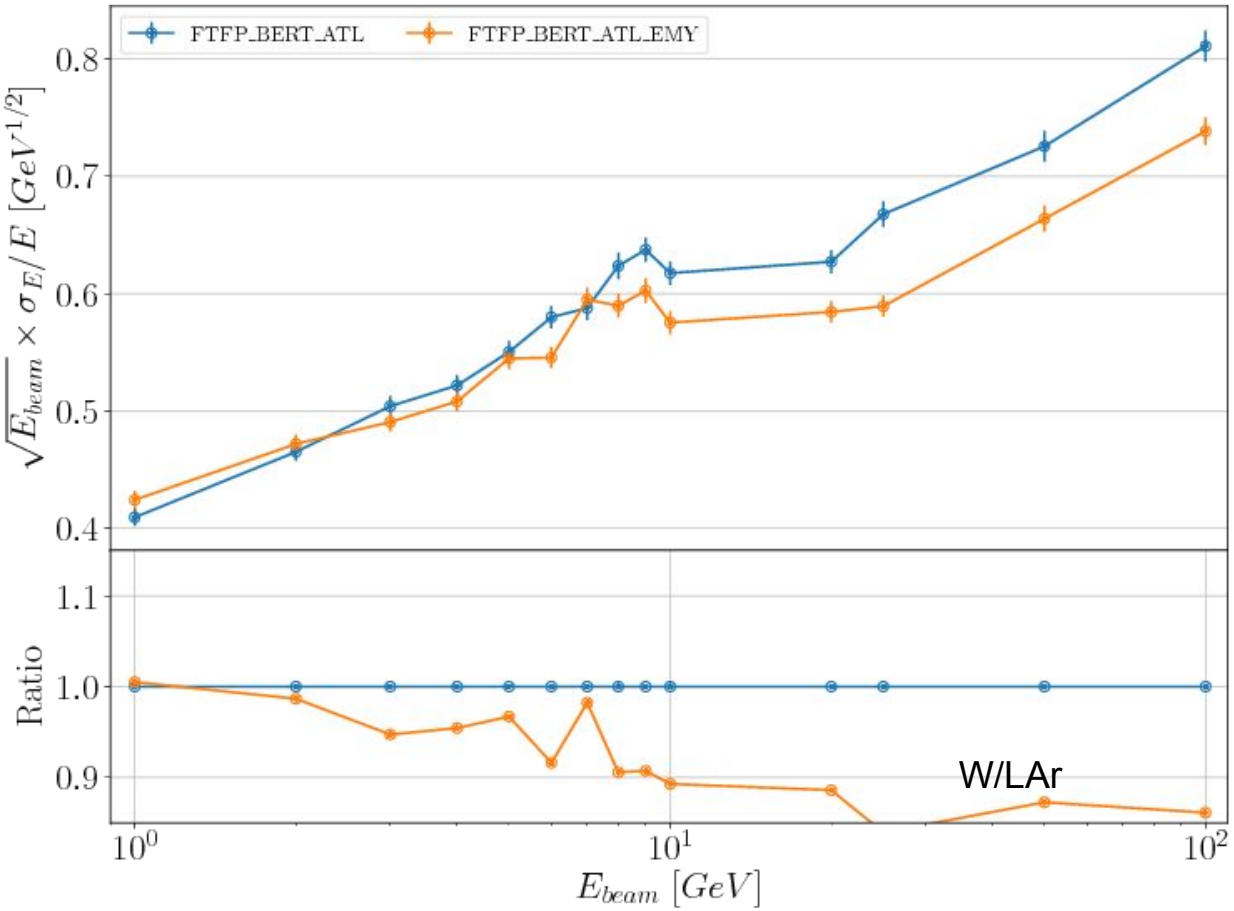
Only EM variant, high-precision em processes
~20% slower (very rough estimate)



Largest difference seen on W/LAr calo type (<10%)

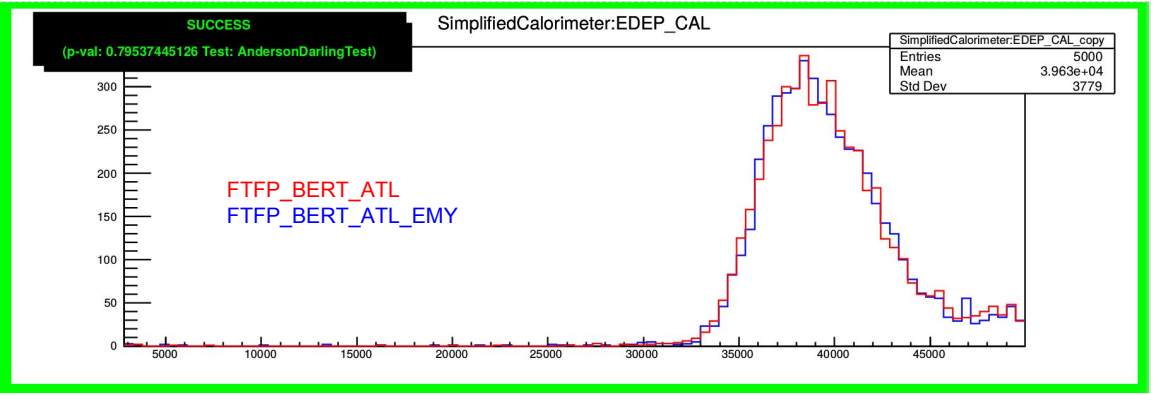
Other calos are less pronounced

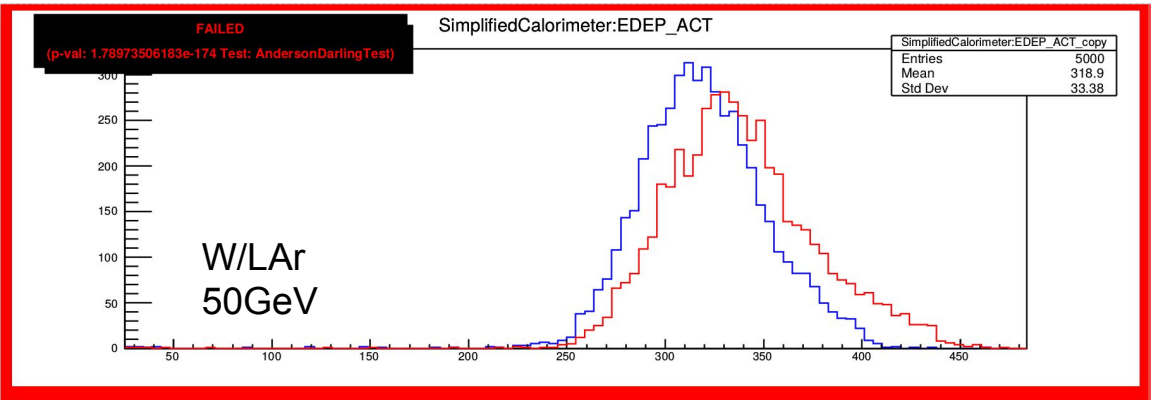
Less energy released on all configuration



Important: unexpected smaller fluctuations at HE

No changes for longitudinal/lateral shapes





Total energy (Abs+Act) is compatible between the two

It is not the case for active material only (MSC effect?)

Note: set-up w/ very low sampling fraction (<1%)

Hadronic Variants

FTFP_BERT_ATL_HP (run w/o Doppler broadening) ~80% slower

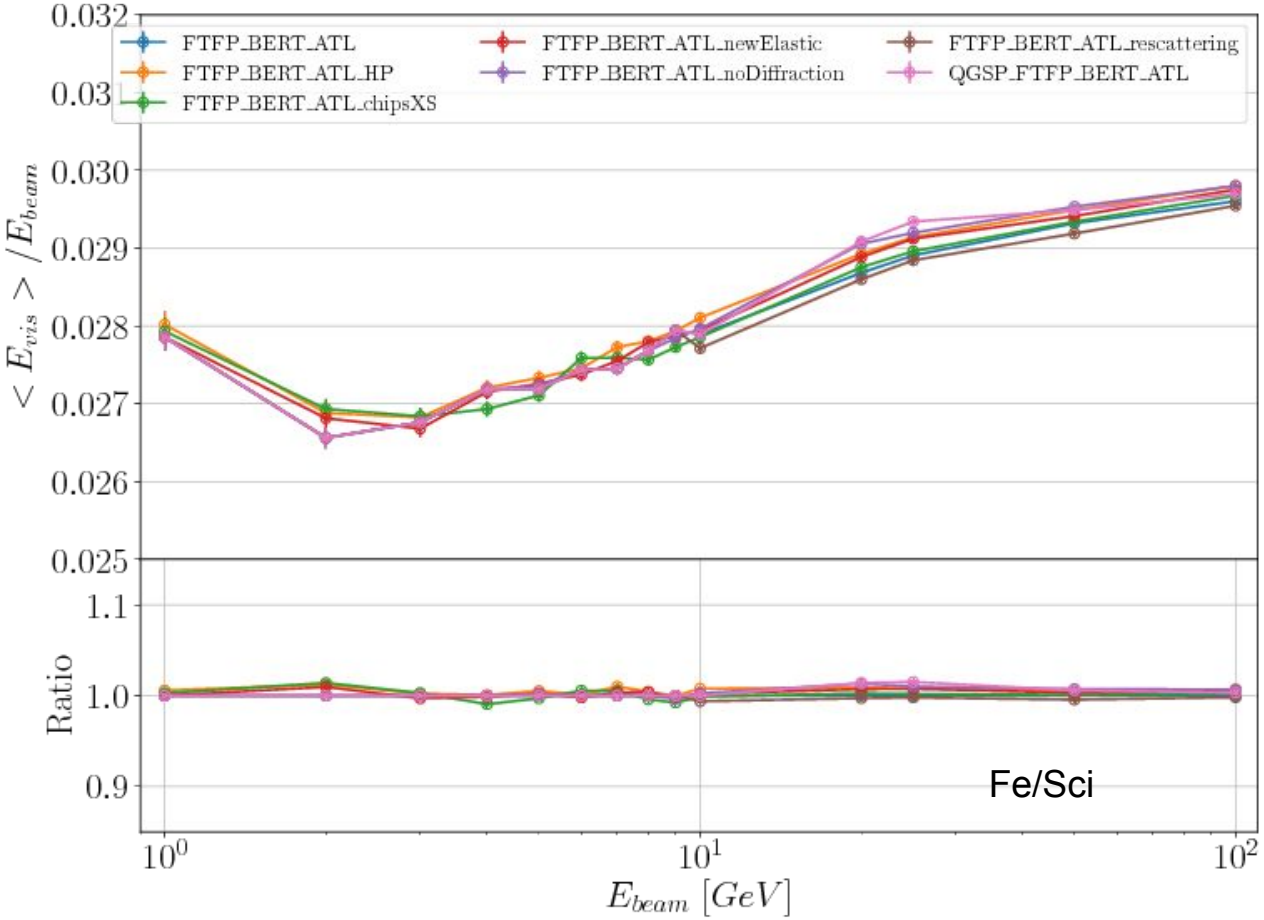
FTFP_BERT_ATL_chipsXS (pi,p,n uses Chips for XS) ~50% slower

FTFP_BERT_ATL_newElastic (G4HadronHElastic)

FTFP_BERT_ATL_noDiffraction (target&proj diff. off)

FTFP_BERT_ATL_rescattering (FTF+BIC) 5% faster

QGSP_FTFP_BERT_ATL (QGS >25GeV) <5% faster



Minimal differences on all setups:

response O(%)

resolution, lateral <10%

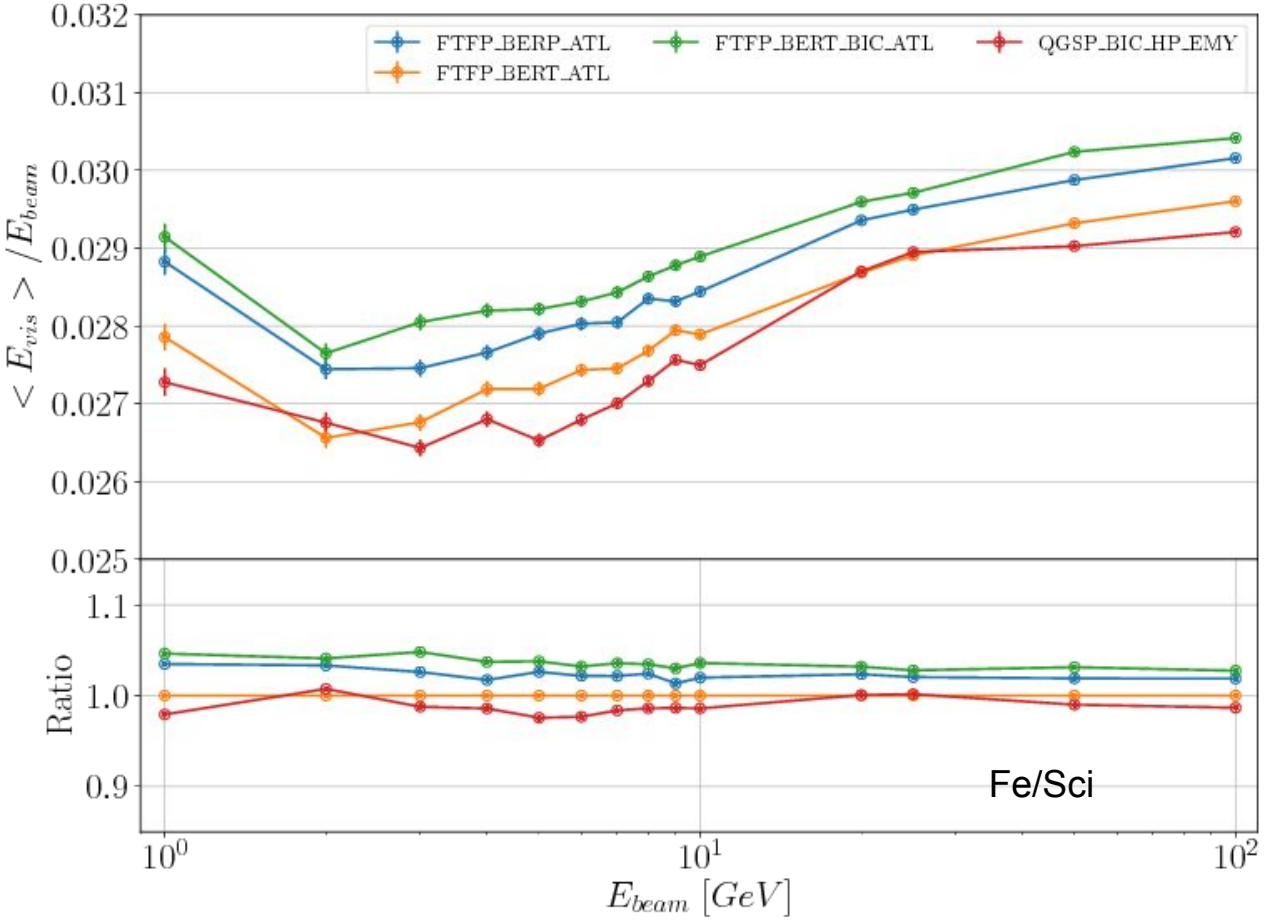
longitudinal O(%)

Hadronic Alternatives (more important differences w.r.t. baseline)

FTFP_BERP_ATL (G4Precompound instead of Bertini's) ~20% faster

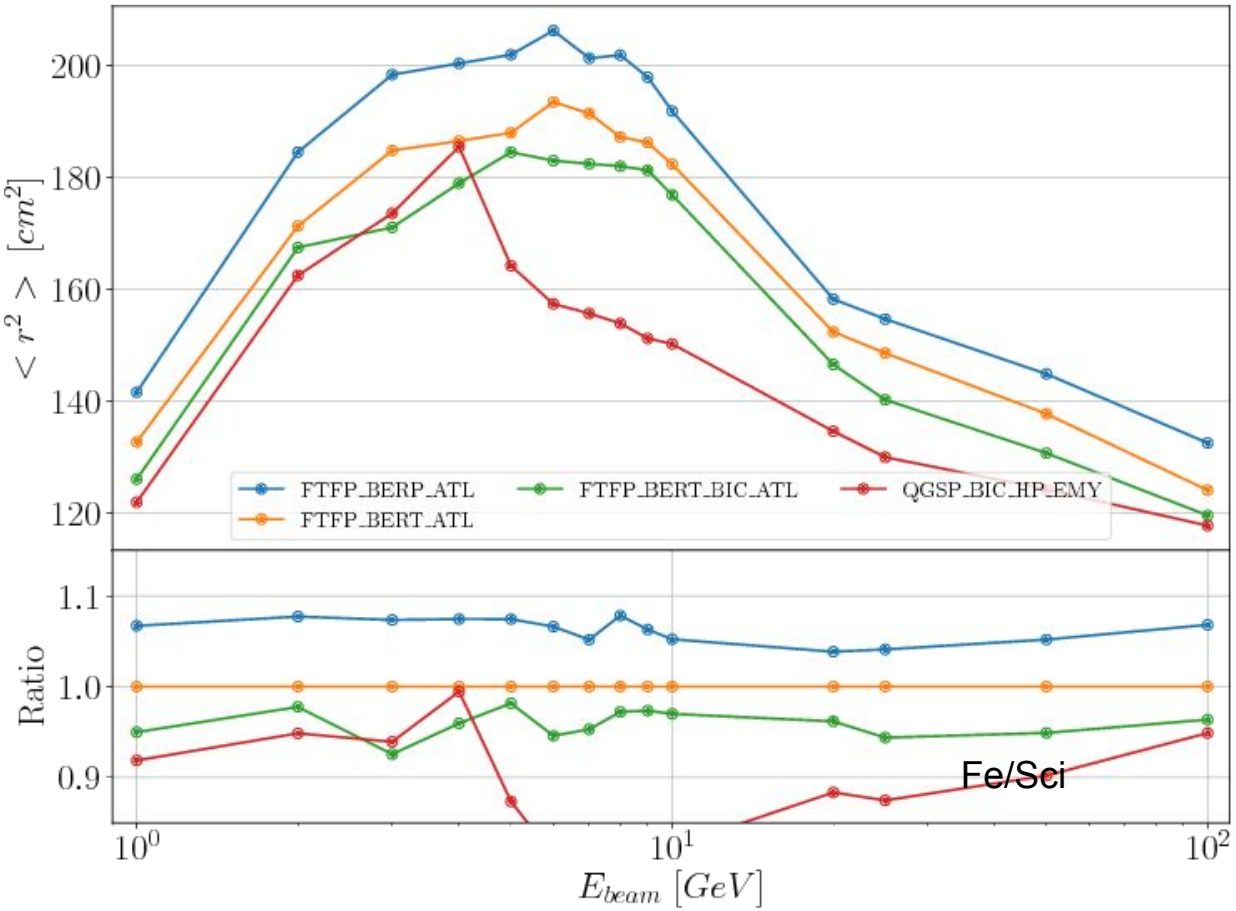
FTFP_BERT_BIC_ATL (Binary p<5GeV,pi<1.5GeV) ~20% faster

QGSP_BIC_HP_EMY: the most different from baseline, 50% slower



On **light materials** the differences are *small(-ish)*

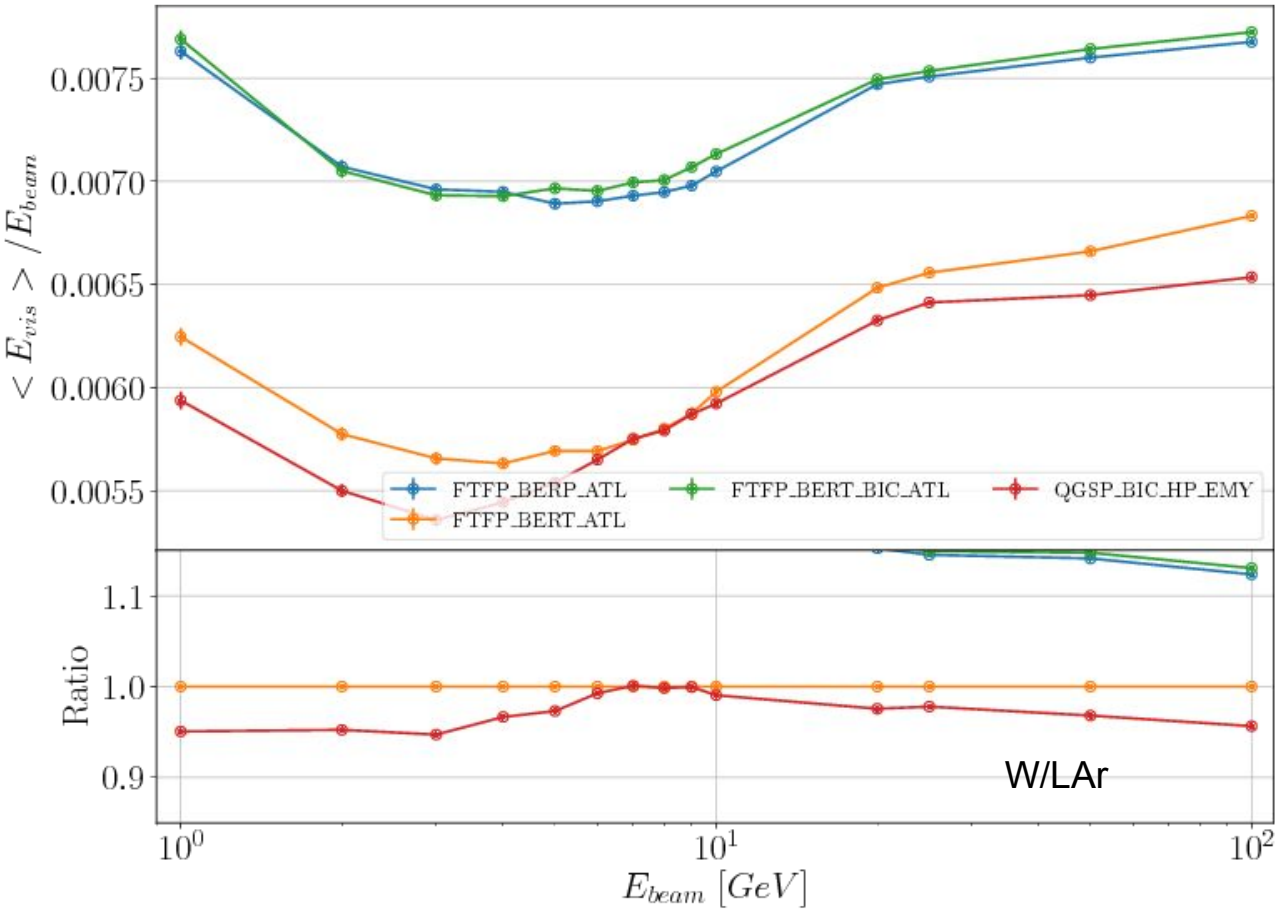
response few%
resolution <10%
longitudinal O(%)



Lateral shower fluctuates more

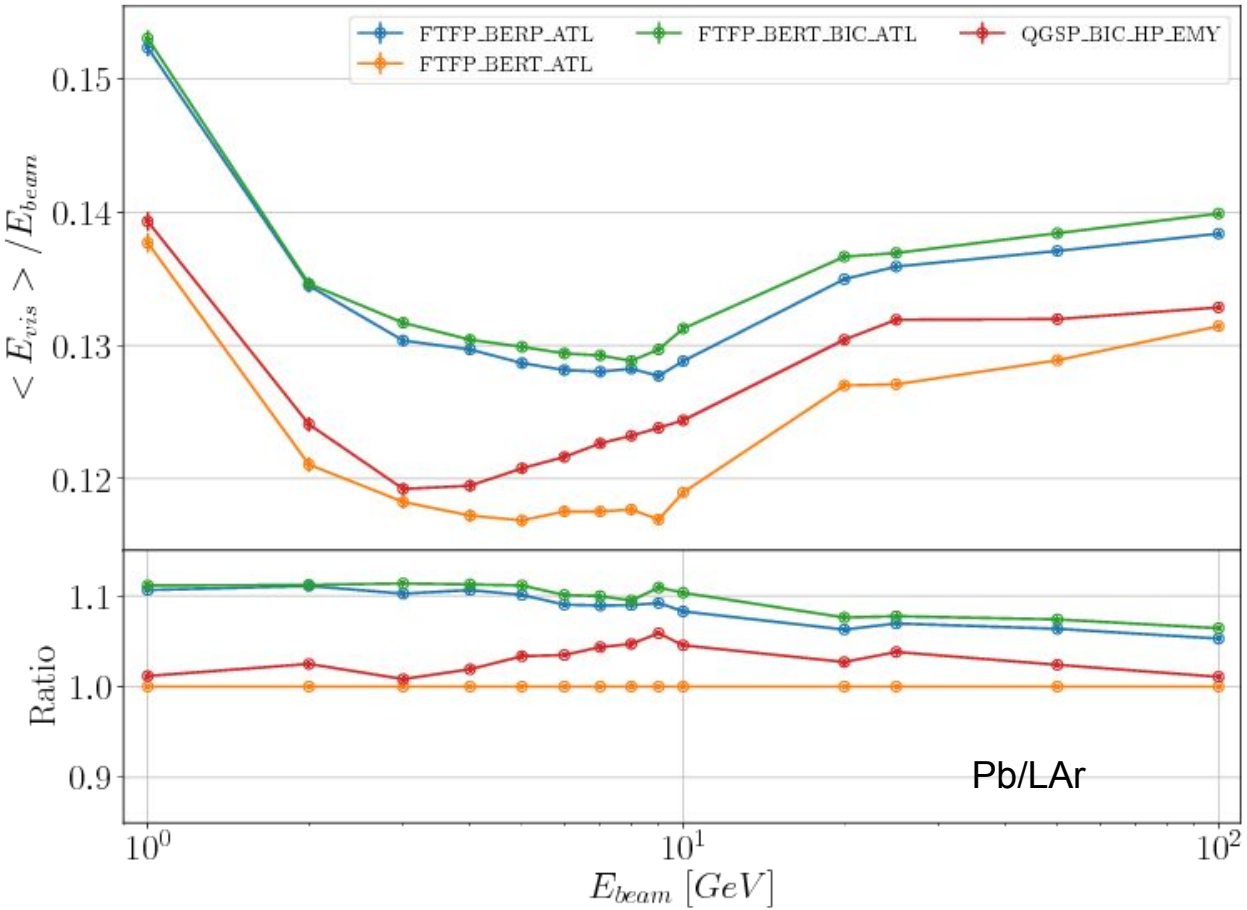
QGSP_BIC_HP_EMY shows transition regions

Note use of G4Preco+BERT produces substantially larger showers



Large differences on heavy materials when G4Preco/BIC are used

QGSP_BIC_HP_EMY reduced response could be also due to EMY effect (pushing down response)



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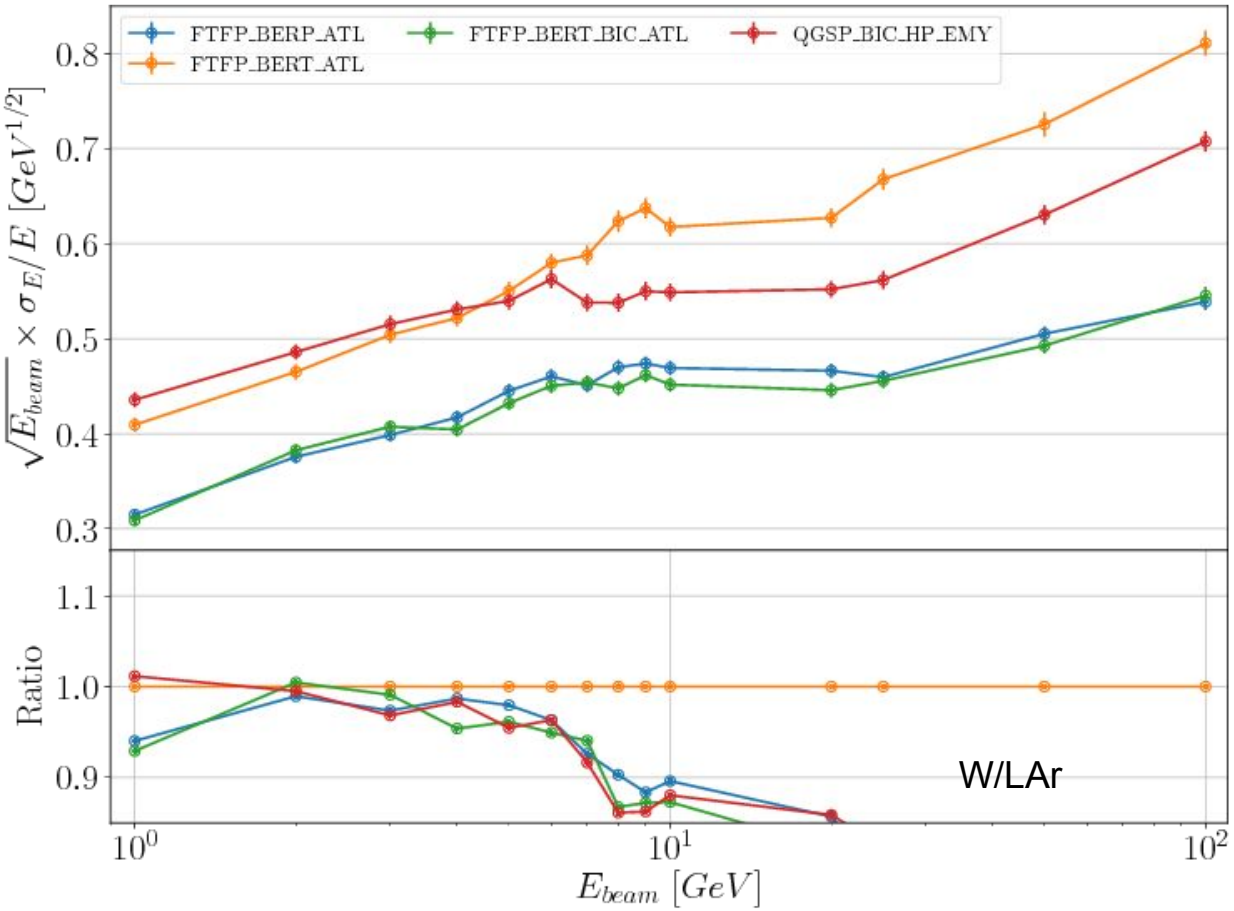

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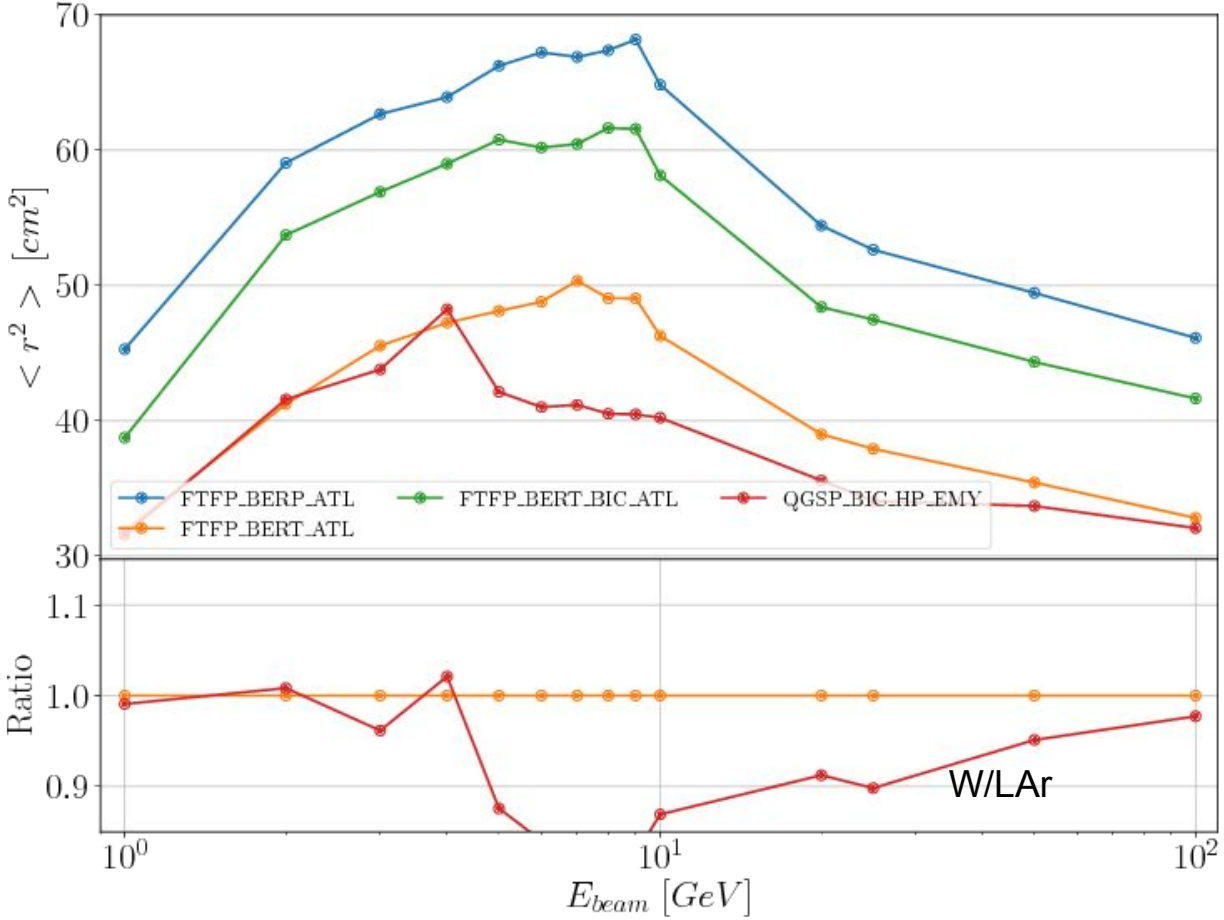

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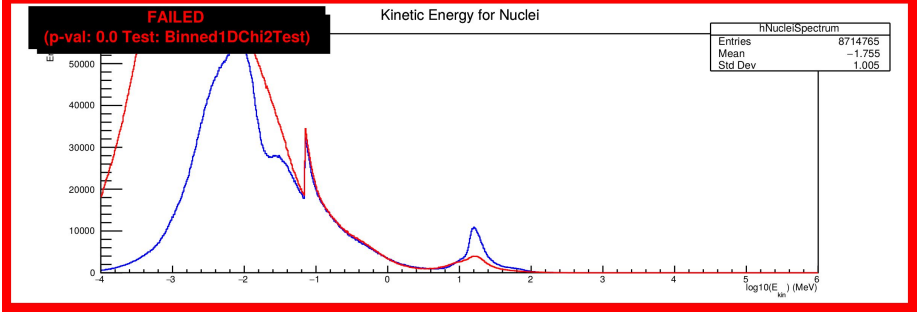
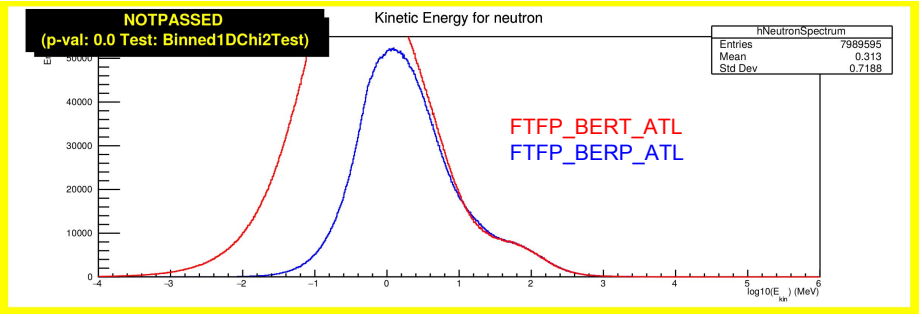
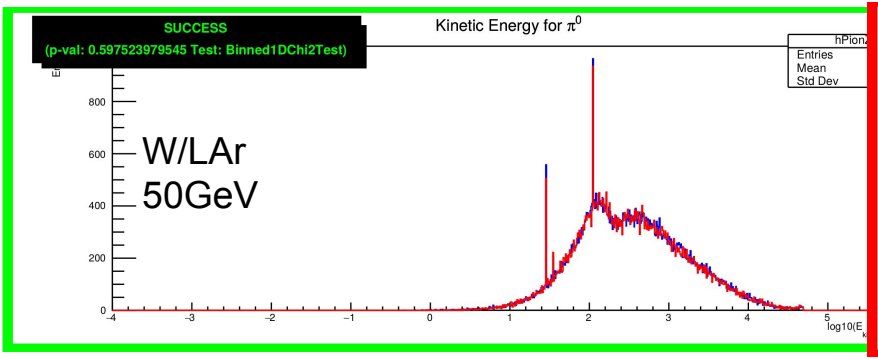


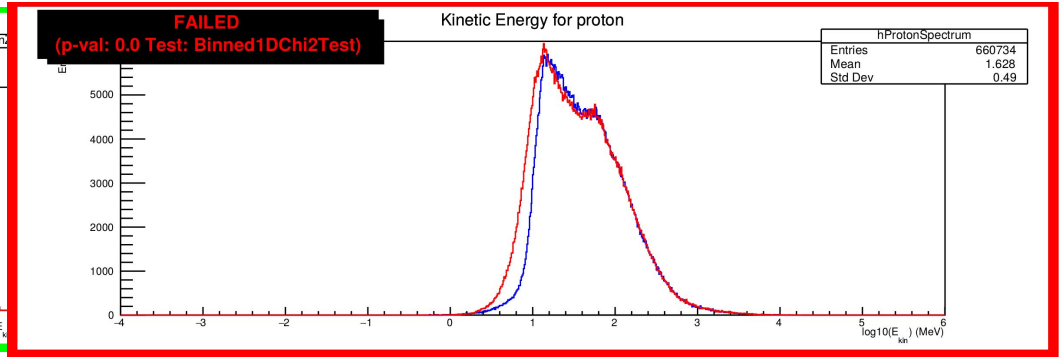


Spectra of <u>all</u> secondaries produced in shower

Bertini produces many more neutron and (nuclear) fragments at very low-energy, still observed energy is smaller

Side note: pi0 and gammas are ~similar





Recommendations for ATLAS
(following discussion at the meeting)

The use of Binary cascade (BIC) for pions < 1.5 GeV (in FTFP_BERT_BIC_ATL) is the probable source of the large difference observed. It is known that this model is not very well tuned for these interactions.

- **FTFP_BERT_BIC_ATL should not be used and discarded for the time being**

The use of Bertini with G4Precompound as de-excitation backend (in FTFP_BERP_ATL) gives some unexpected results (too high energy). This is not understood and requires more attention by experts.

- **FTFP_BERP_ATL should not be used and discarded for the time being**

Side Note: even if the name suggests otherwise QGSP_BIC_HP_EMY uses Bertini for pions thus it does not show the problem of FTF_BERT_BIC_ATL and can be safely used

Please refer to the JIRA ticket 3468 for updates on the issue

The role of QGSP_BIC_HP_EMY

This physics list is to be considered a single case with the most possible differences w.r.t. baseline.
Thus two strategies are recommended:

1. Compare FTFP_BERT_ATL and QGSP_BIC_HP_EMY
2. Or comapre FTFP_BERT_ATL with all other variants/alternatives (that have a single aspect of physics modified at the time)
3. Avoid using **both** QGSP_BIC_HP_EMY and Variants/alternatives together since it would create confusion

Conclusions

EM-Variant and Had-Variants have *small* effect (<10%) on calorimetric observables

Larger differences observed in FTFP_BERP_ATL and FTFP_BERT_BIC_ATL
Not fully understood, possible G4Precompound/Bertini effect
Especially true for heavy materials, W > Pb > Fe

Unless you disagree, given the lack of understanding **it is difficult to recommend the use of FTFP_BERP_ATL and FTFP_BERT_BIC_ATL for production quality studies**