

Recent validation results (bremsstrahlung) and plans for 2012

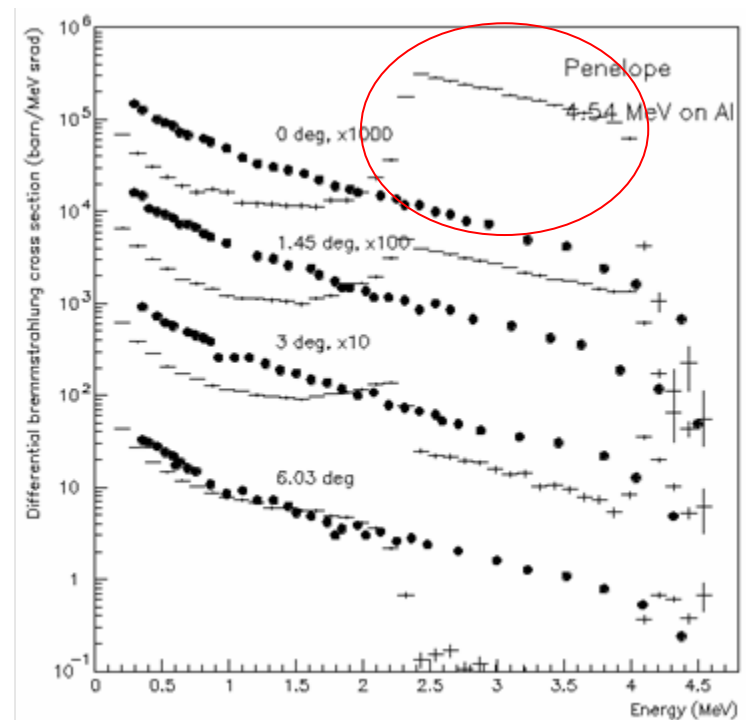
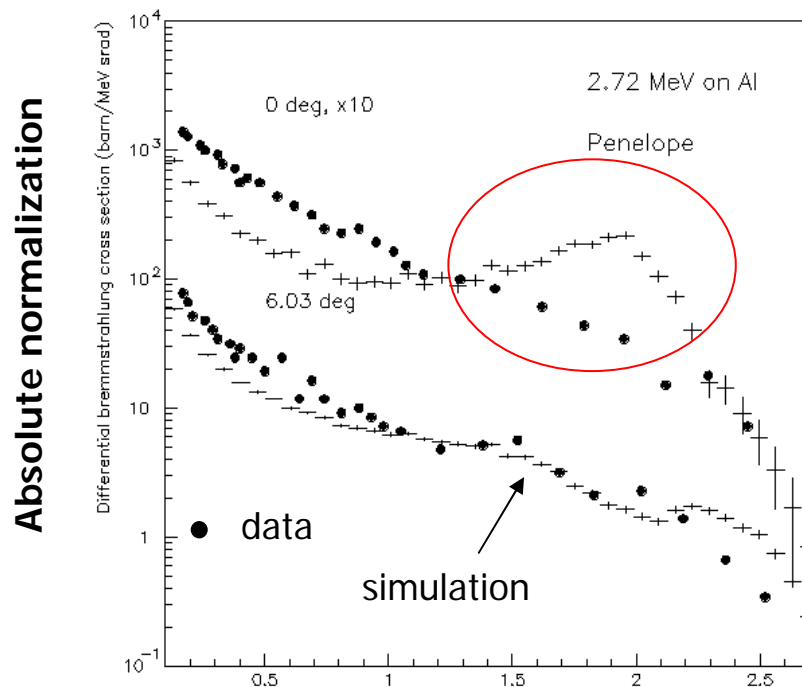
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Something about validation: bremsstrahlung

- In 2006, effort for the validation of the bremsstrahlung models available in Geant4
 - Initiated by M.G. Pia
 - Chauvie et al., NSS Conf. Records 2006, 1511
- A few papers containing reference data had been considered at that time
 - Ambrose et al., Nucl. Instrum. Meth. B **56** (1991) 327
 - Dance et al., J. Appl. Phys. **39** (1968) 2881
 - Starfelt and Koch, Phys. Rev. **102** (1956) 1598
- Idea: re-use the same tools and extend the coverage to the Penelope08 models
 - Also possible to test newer version of the EM models!
- Partially repeated analysis based on data from Starfelt
 - Double differential bremsstrahlung cross sections in thin targets

Penelope v01 bremsstrahlung

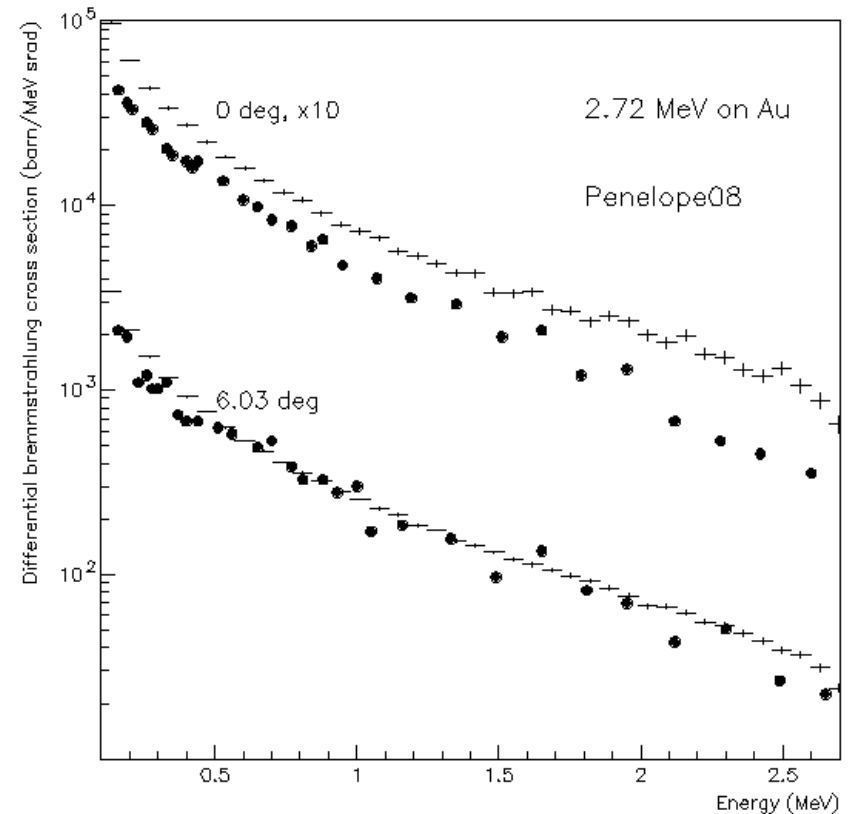
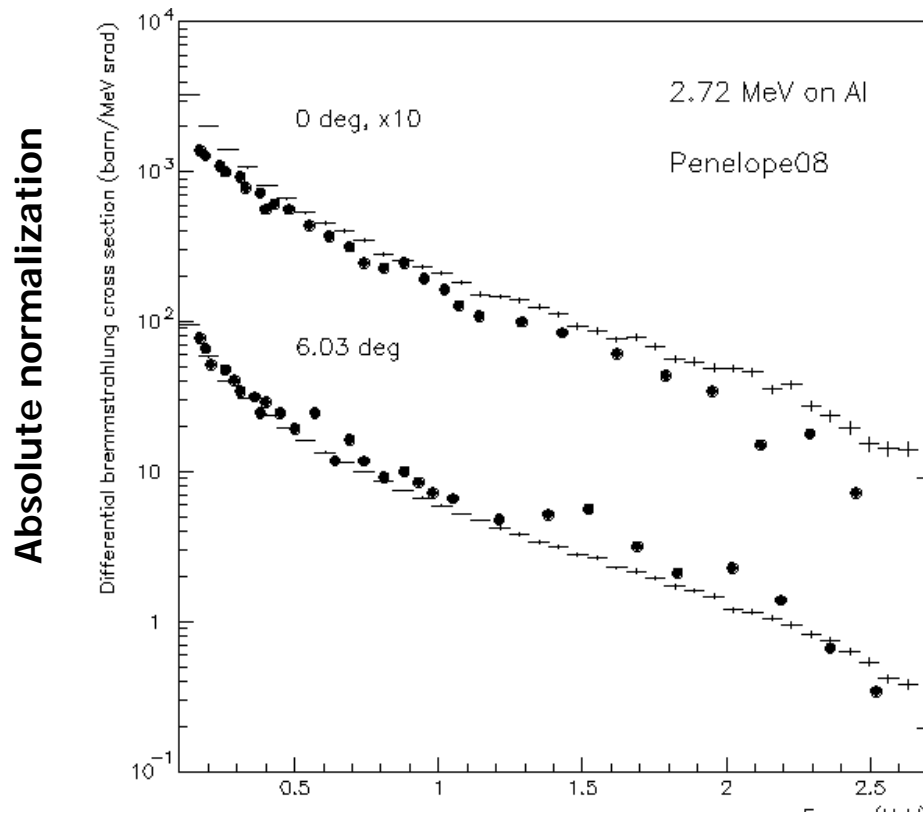
- While Penelope v01 gave fair results for total cross section and single-differential distributions, **problems in double differential!**



Not a Geant4 bug: same behavior observed in the original PENELOPE (FORTRAN)

Distribution with Penelope v08

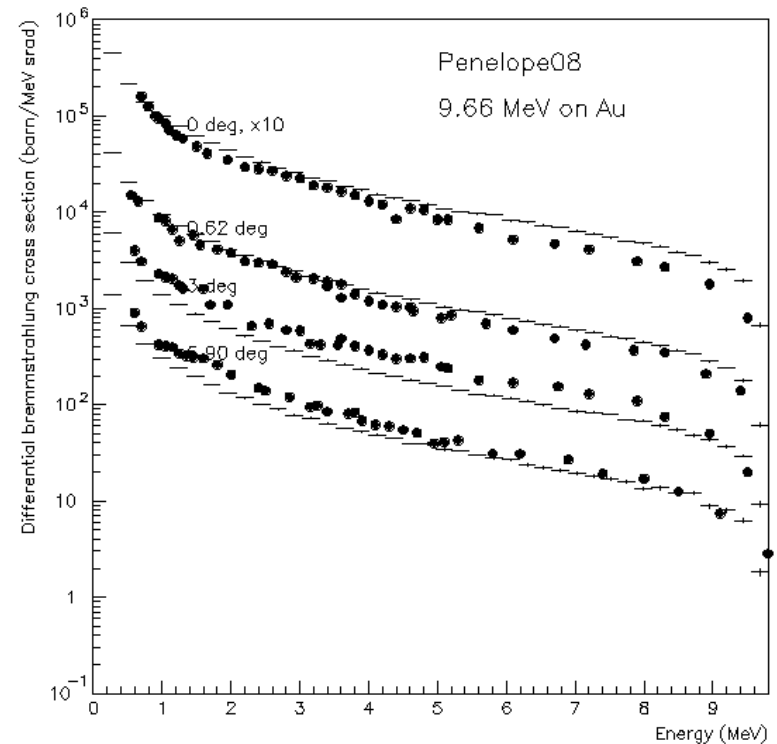
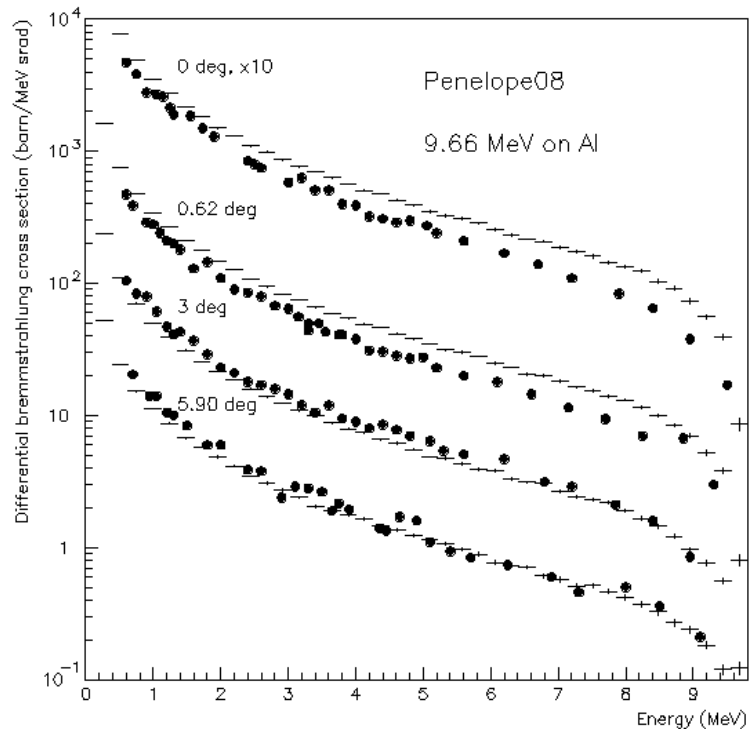
■ 2.72 MeV e^- on Al and Au



Distribution with Penelope v08

- 9.66 MeV e^- on Al and Au

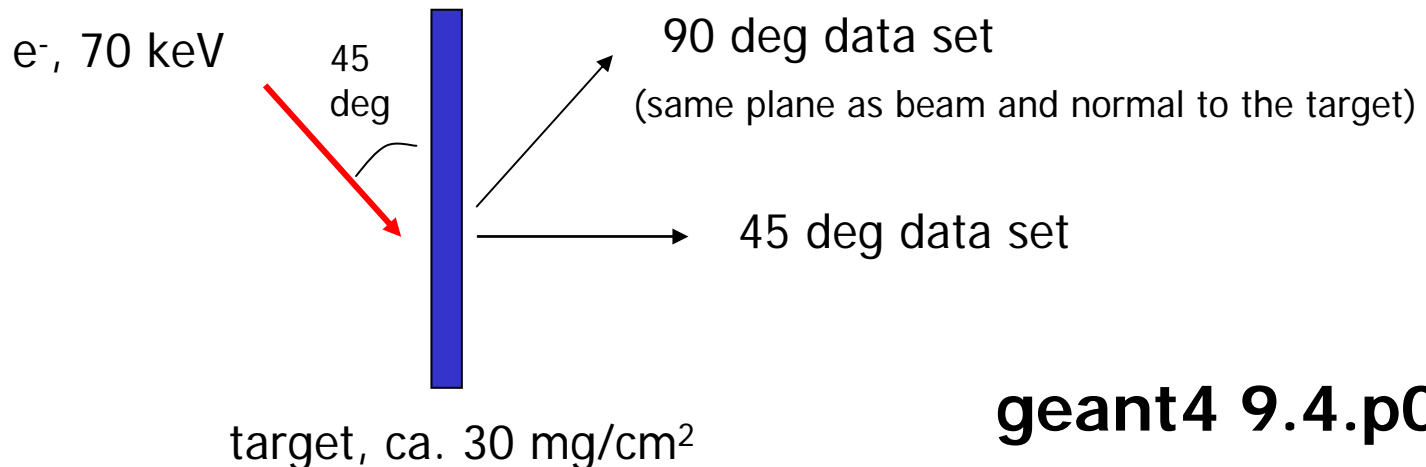
Absolute normalization



No anomaly in the shape. **Fair agreement** with data

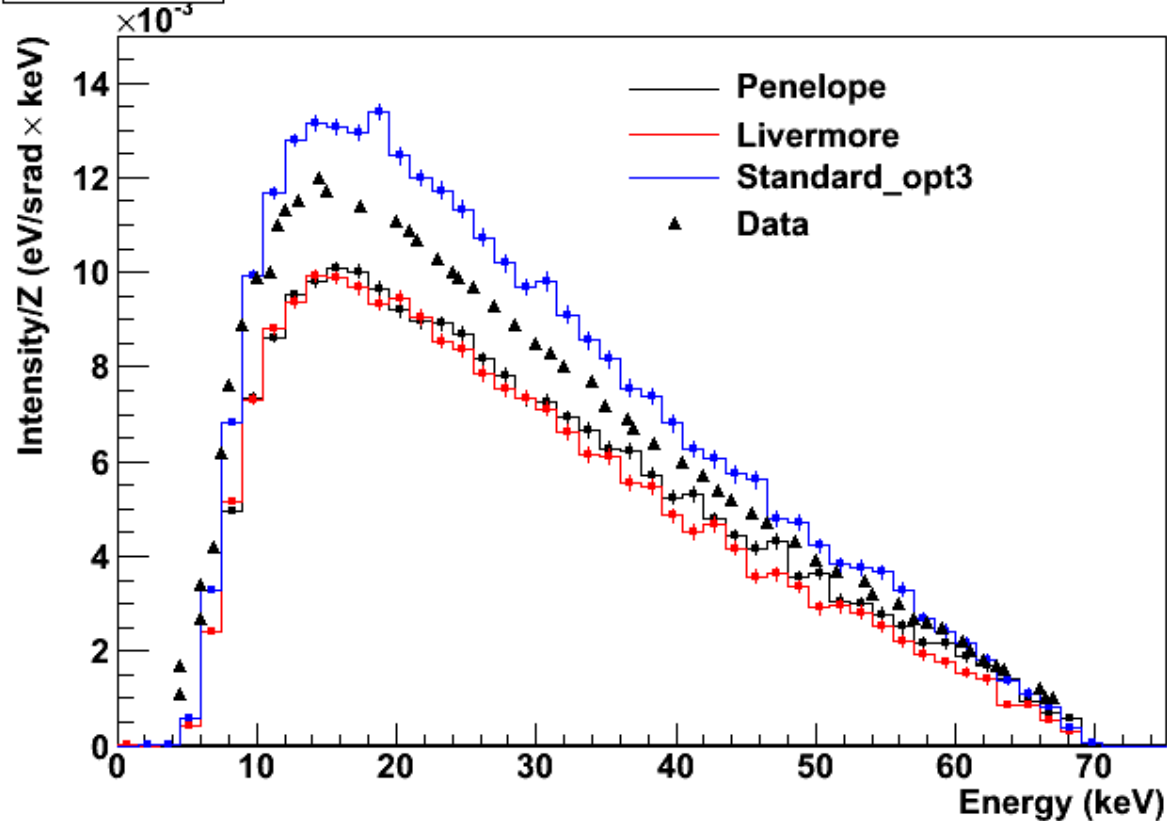
Thick target

- Taken back **old code/macros** also for the comparison against the data in
 - Ambrose et al., Nucl. Instrum. Meth. B **56** (1991) 327
 - **Thick** target data, **70 keV e⁻**, different materials
 - **Energy spectra** at two angles



25.4 mg/cm² Al, 45 deg

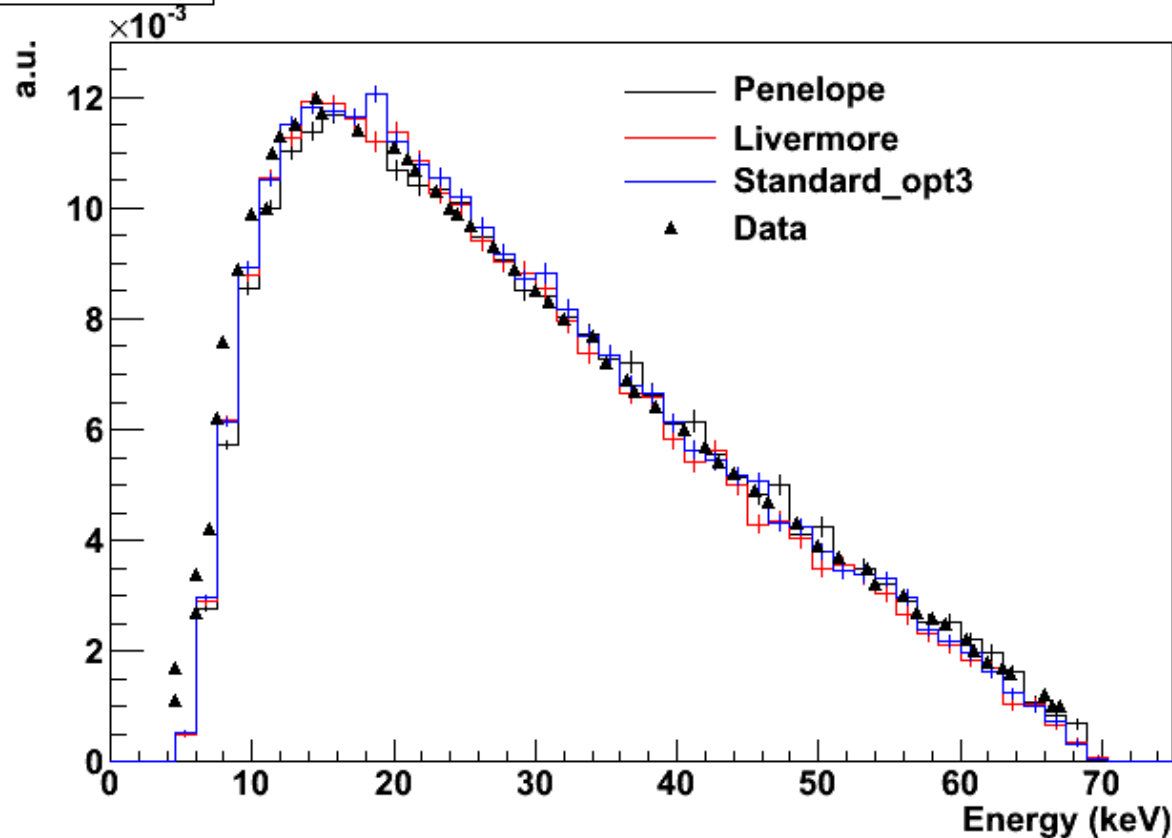
Al, 45 deg



- **None** of the available models can reproduce the **absolute value**
- Penelope and Livermore give very **similar cross sections** (15-20% smaller than data)
- Standard_opt3 predicts **more events** than actually observed (10%)

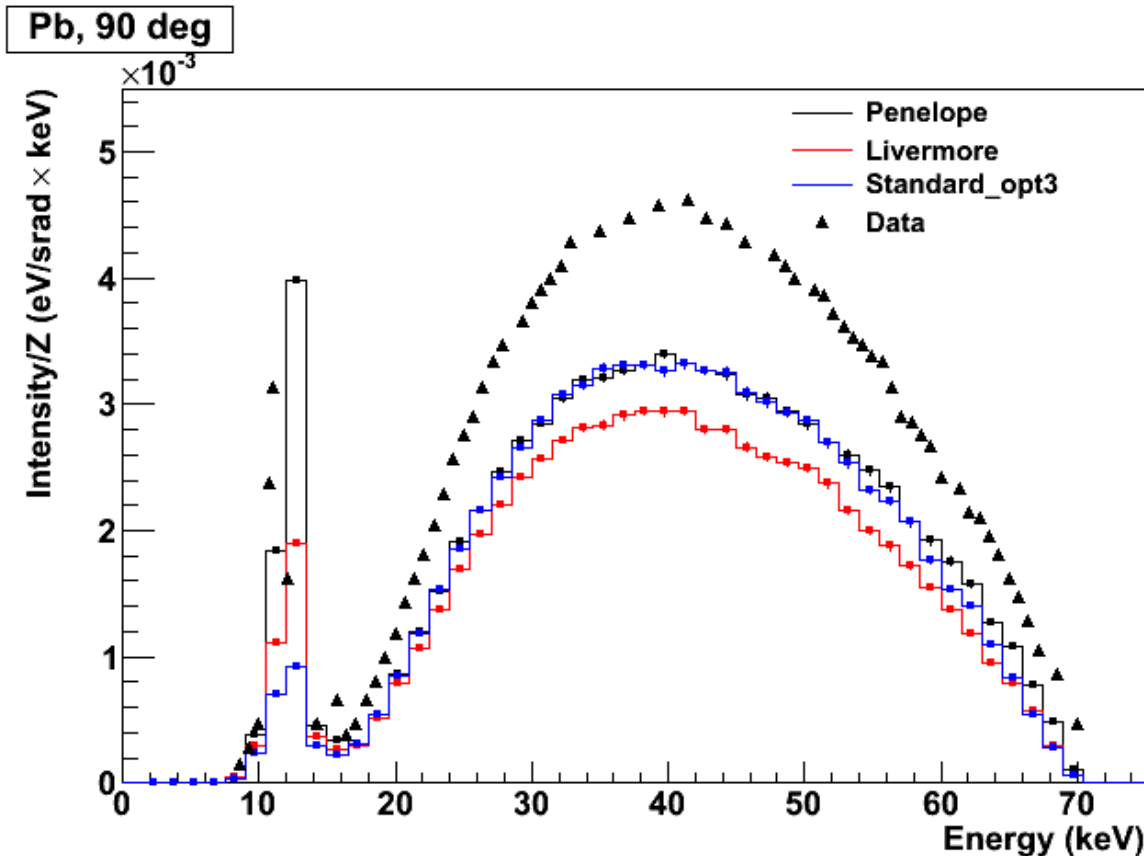
25.4 mg/cm² Al, 45 deg

Al, 45 deg



- The **shape** of the spectrum is reproduced **fairly well** by all models
- Penelope08 gives the **better agreement**
 - the other two models predict a **too steep** decrease

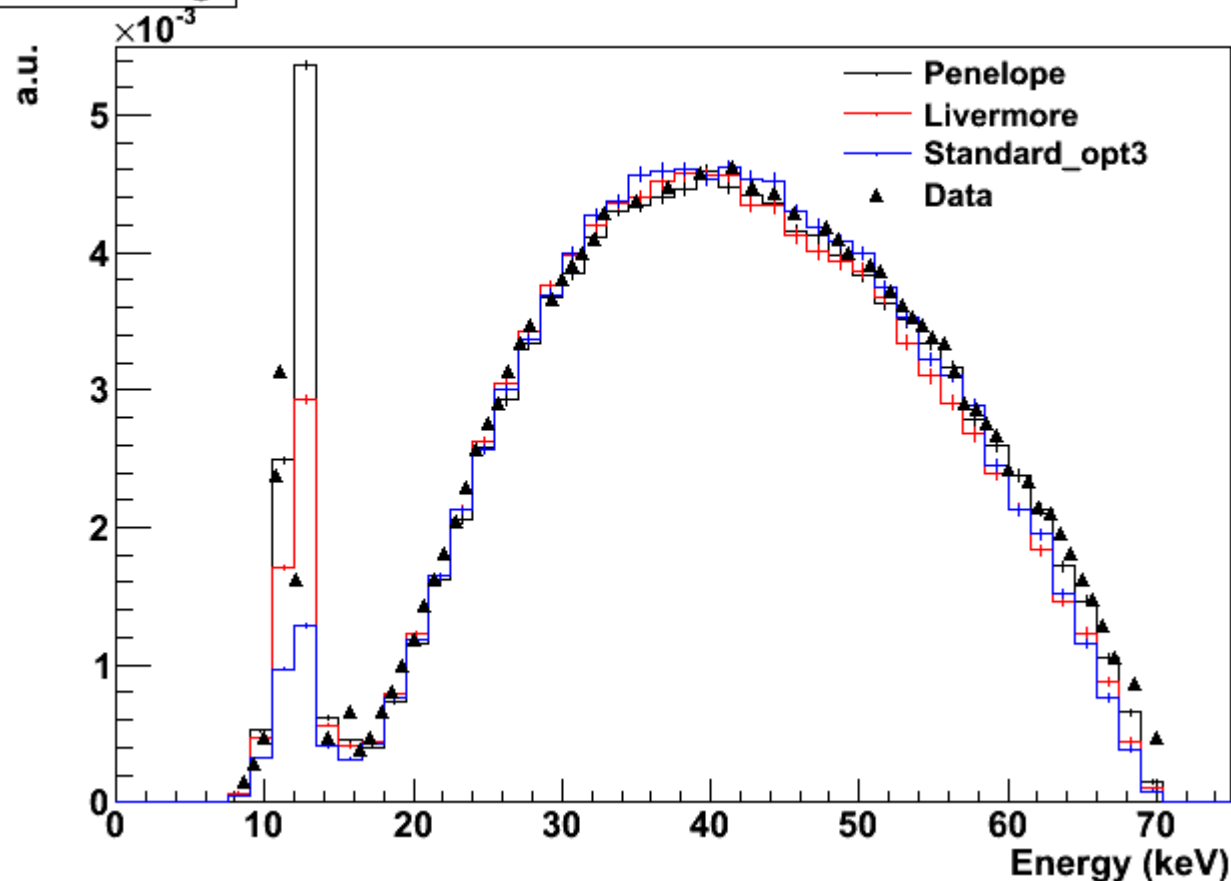
20.9 mg/cm² Pb, 90 deg



- Peak at low energy due to **fluorescence** (after ionisation)
- Models **under-estimate** bremsstrahlung γ yield
 - **opt3** and **Penelope** give similar results
- Opt3 underestimates *fluorescence yield*, Penelope overestimates. **Livermore** looks a bit better

20.9 mg/cm² Pb, 90 deg

Pb, 90 deg



- The **shape** of the brems spectrum is reproduced fairly well by all models
- Again, Penelope08 gives a slightly better agreement
 - the other two models predict a too steep decrease



Summary – part 1

- Work in progress: repeat (partially) the old analysis for the validation of the bremsstrahlung model
 - Penelope08 cures the anomaly in the double-diff spectra for thin targets which had been observed in Penelope01
 - Fairly good results obtained for thin and thick target data, all models
 - shapes are ok, absolute scales differ up to 30% at low energy
- Plans concerning bremsstrahlung validation:
 - Repeat some jobs (especially Opt3) using geant4 9.5
 - Take into account data from Dance et al. (thick target, Al/Fe, a few MeV).
 - Some jobs run, analysis to be done
 - Work already done by V. Grichine (avoid duplication)

(Basic) planning up to June 2012 (EM)

- **Penelope models**
 - Test, **debug** and **validation** of **Penelope08** models
 - fix **Coverity** reports, improve **CPU** performance, reduce **memory footprint**, if possible
 - **Removal** of **obsolete Penelope v2001** models
 - Check and cure for possible **unused files** in **G4LEDATA**
 - General **clean-up** of **obsolete Penelope helper classes**
 - **Fluorescence**
 - **Migrate** Penelope ionisation model to the **new interface** (still using the obsolete *G4AtomicDeexcitation*, other models migrated)
 - Create a new **concrete implementation** of *G4VAtomDeexcitation* for the **Penelope specific fluorescence** model (TBV)
- **Validation and test of EM models**
 - **Validation** of **bremsstrahlung** models for **thin** and **thick** targets up to a few MeV (→ paper)
 - Check **EM results vs. tag** for stability during the **development** with a HPGe application (**test67**)