

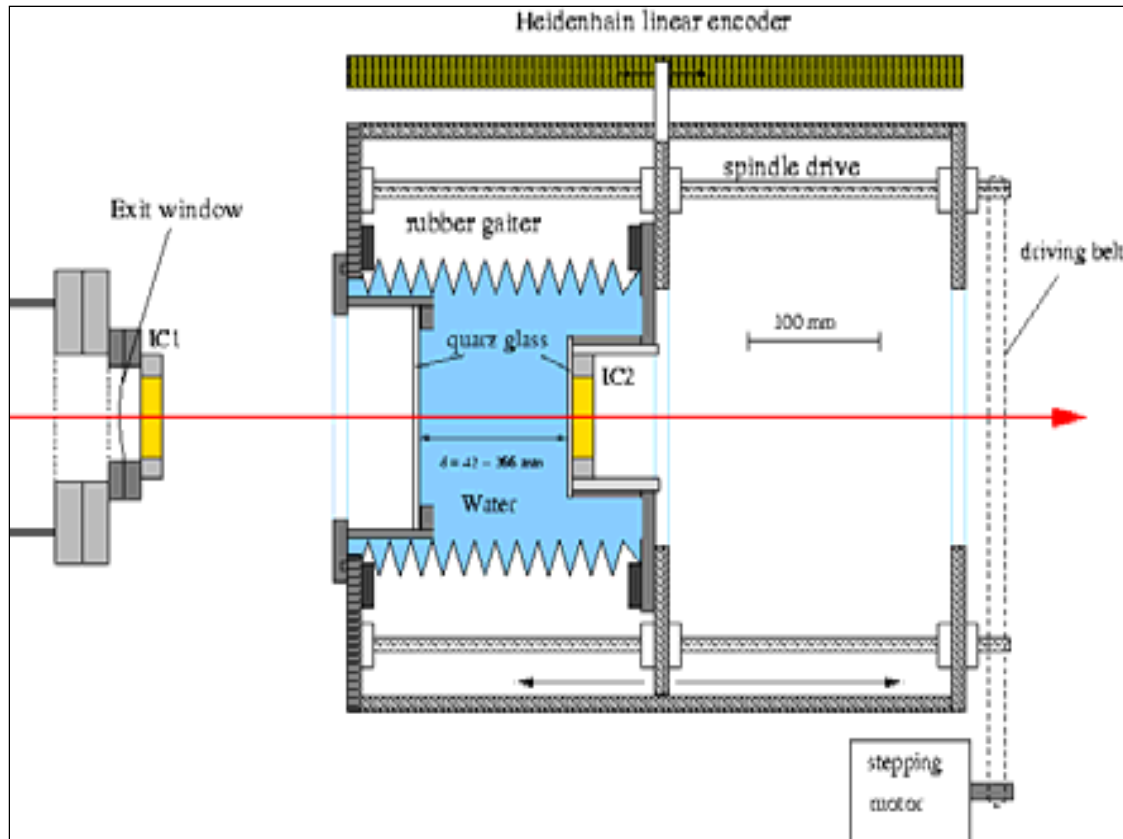
Ion Range Validation in Water

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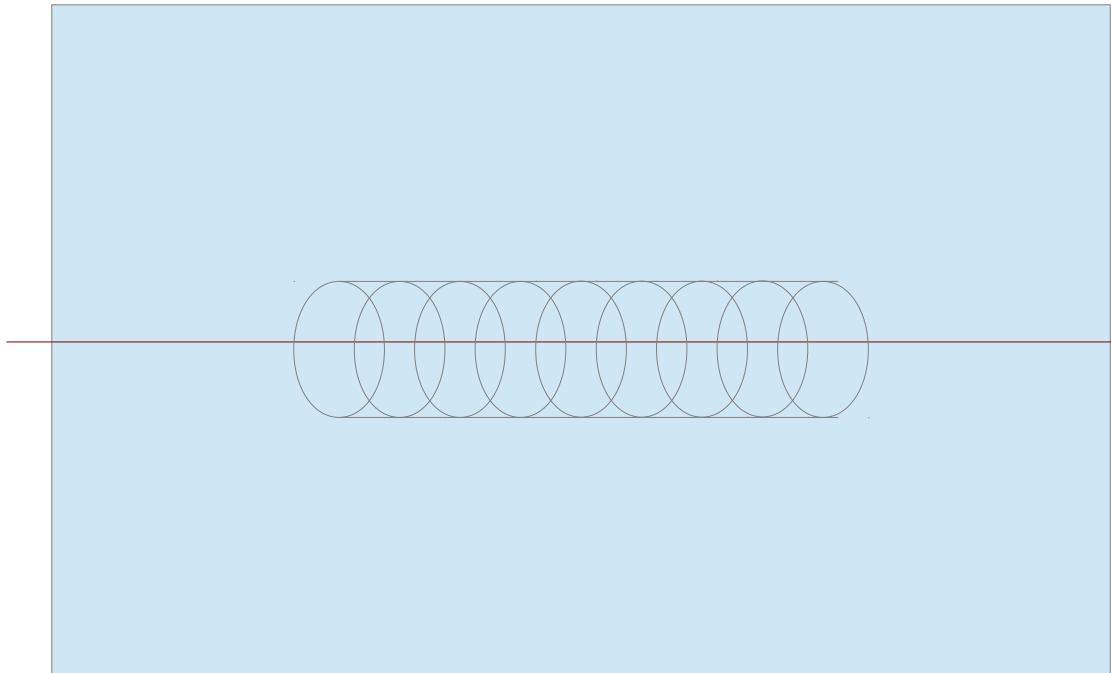
INTRODUCTION



- Relative ionization measurements (IC2/IC1) courtesy of D. Schardt (GSI).
- Precise measurement of absolute depth in water.
- Reported uncertainty of 0.2 mm for the Bragg peak absolute depth.

D. Schardt *et al.*, GSI Scientific Report 2007

SIMULATION FEATURES



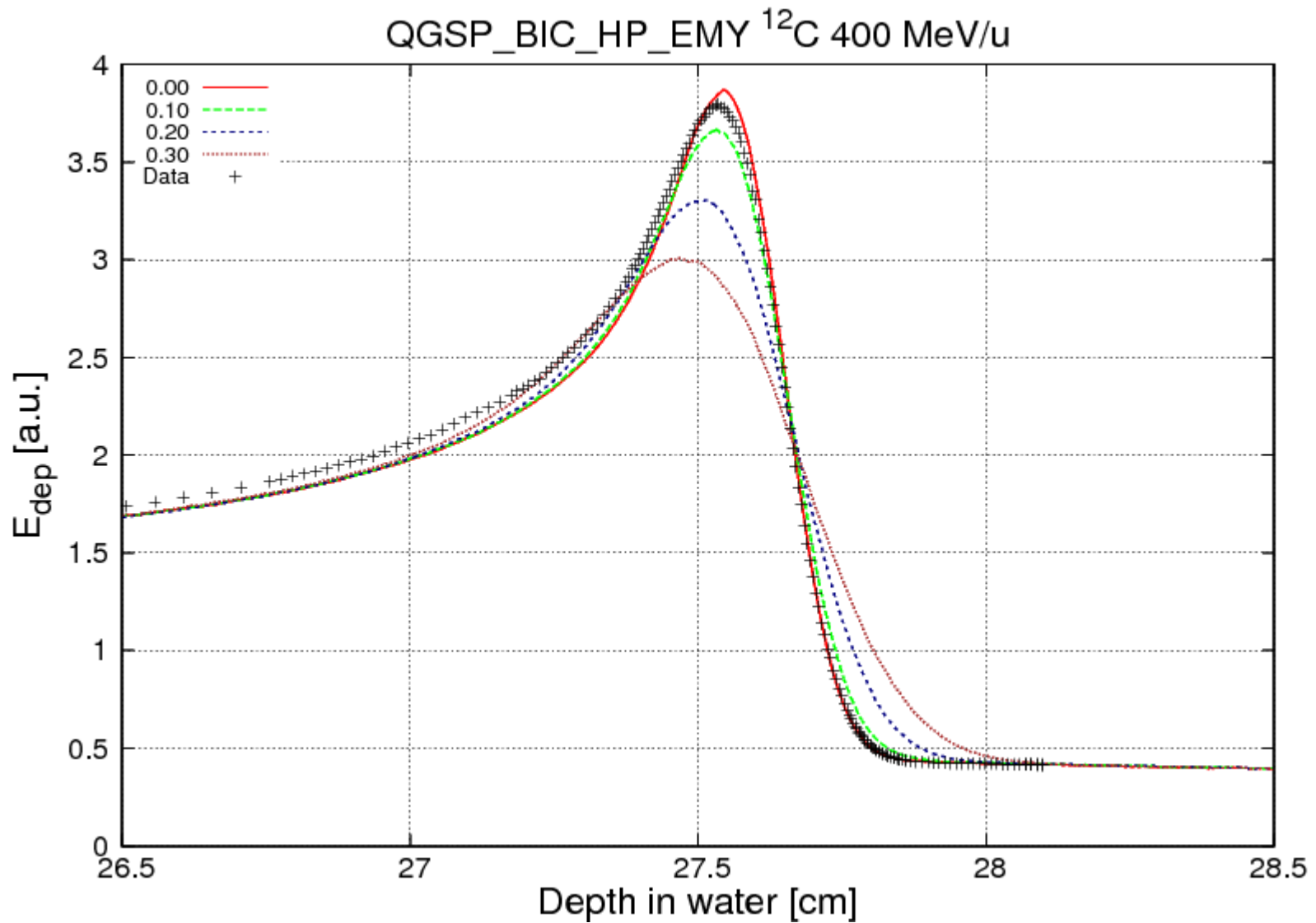
D. Schardt *et al.*, GSI Scientific Report 2007

- Just a water tank (G4_WATER).
- Water density corrected according to report (24°C, 0.997 g/cm³).
- Energy deposition scored in cylindrical voxels along beam axis, with same radius as IC2 (28 mm). Thickness of 50 microns, similar to water equivalent thickness of Ics (46 microns).
- Data for ¹H, ⁷Li, ¹²C & ¹⁶O.

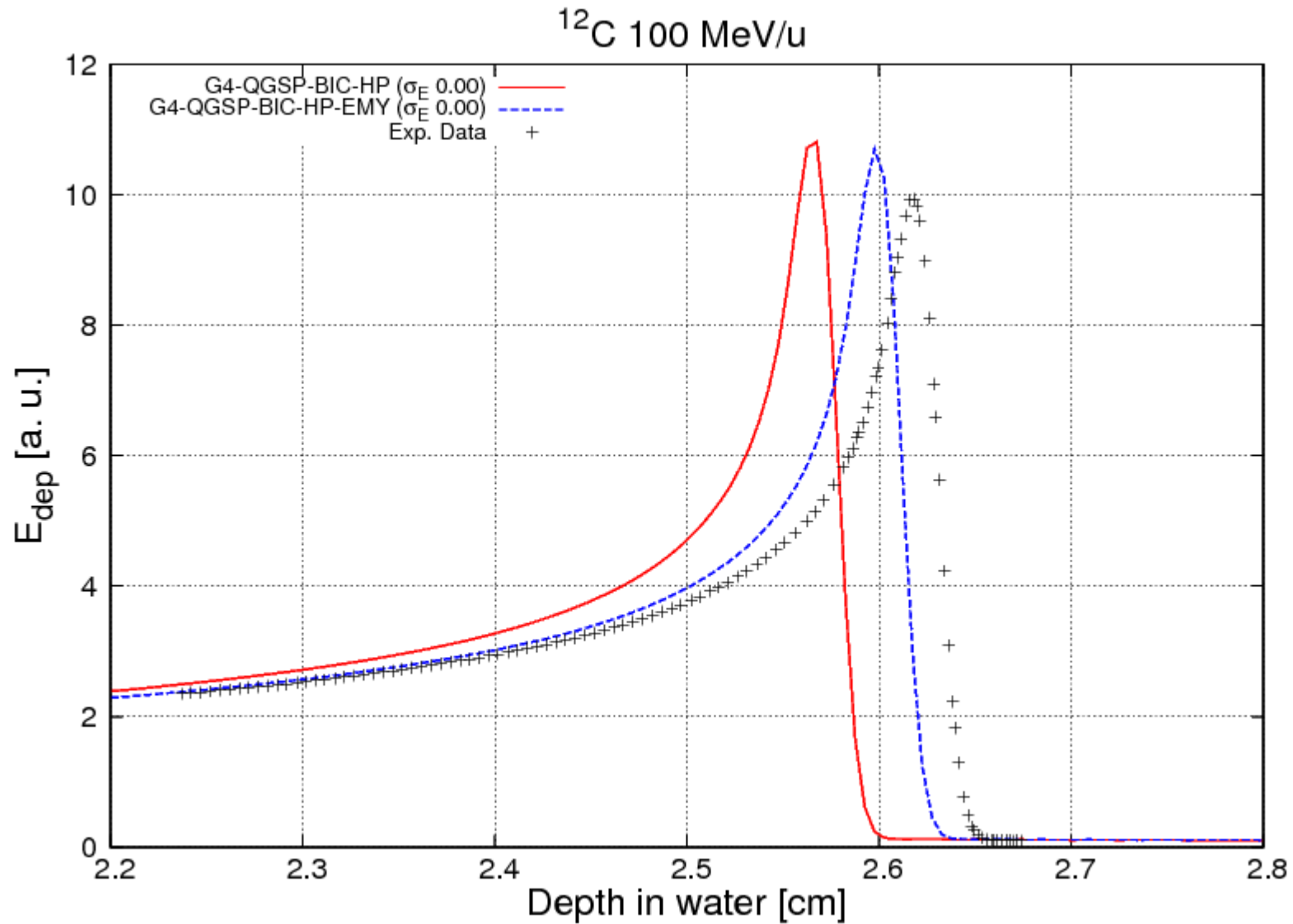
AIM OF THE STUDY

- Set the beam energy spread in best agreement with experimental measurements, using the penumbra as figure of merit.
- Penumbra: distance between 80% and 20% dose at Bragg Peak distal fall-off.
- This fit was done for protons & carbon ions.
 - The idea is to create a beam data library for the testing tool of the Medical Simulations Benchmarking Group, including all the particle beams mentioned before.
- Range test has been done with EMStandard and EMStandard_opt3.

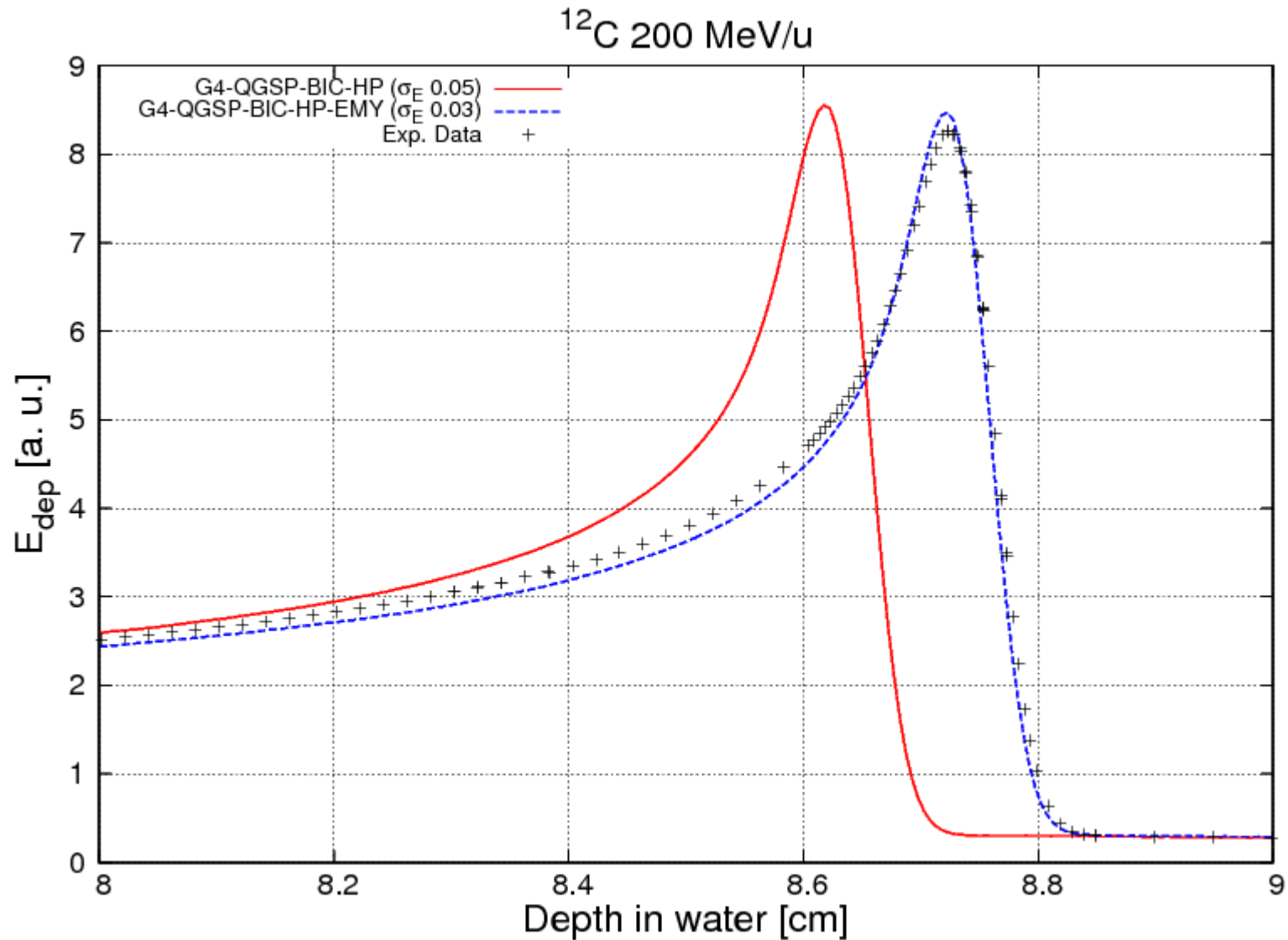
^{12}C RESULTS (v 10.01.p01)



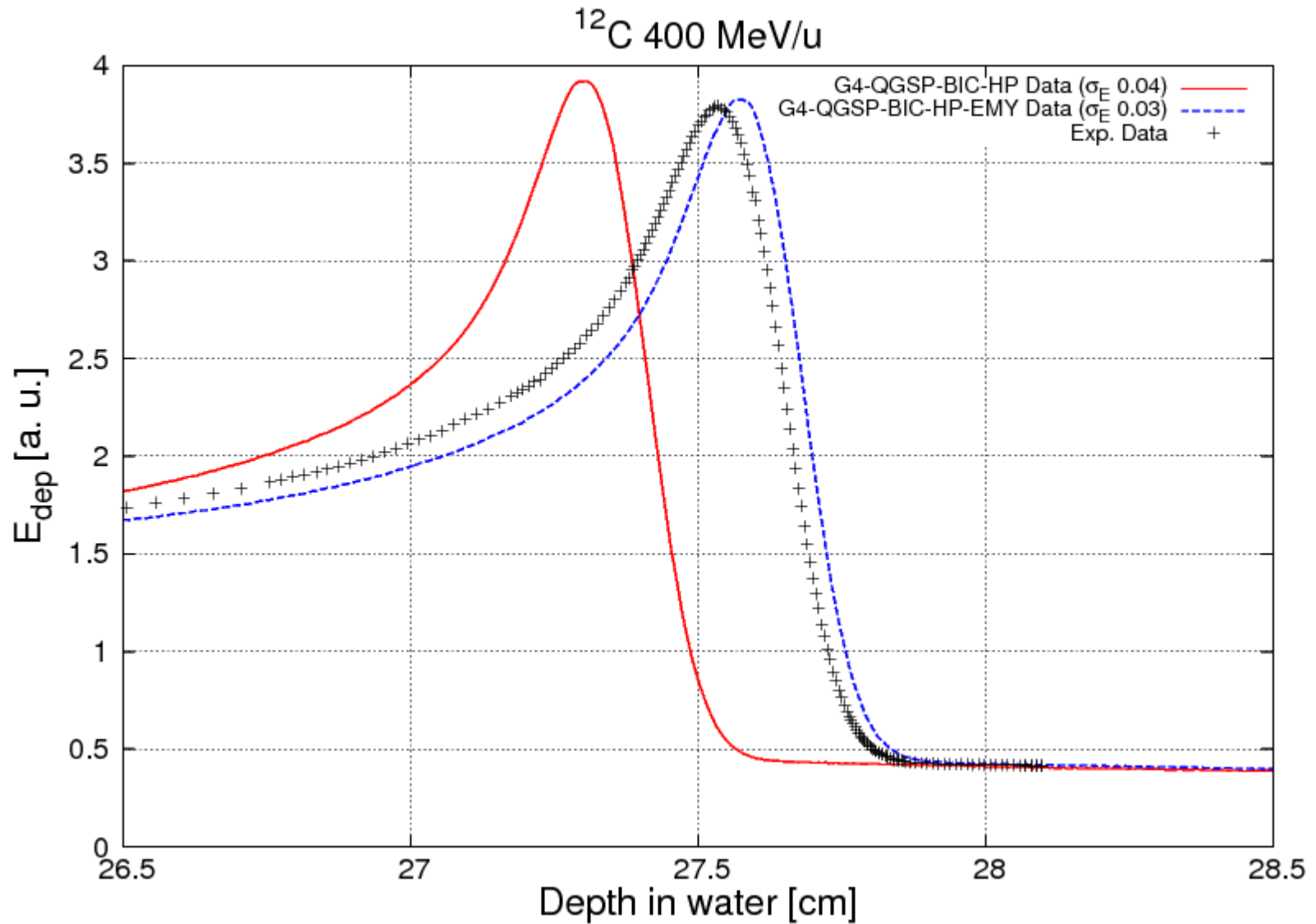
^{12}C RESULTS (v 10.01.p01)



^{12}C RESULTS (v 10.01.p01)



^{12}C RESULTS (v 10.01.p01)



^{12}C RESULTS

Range at 82% of Bragg Peak

- QGSP-BIC-HP-EMY

Energy (MeV/u)	GSI (mm)	Geant4 (mm)
100	26,26	26,06
200	87,49	87,45
400	276,1	276,4

^{12}C RESULTS

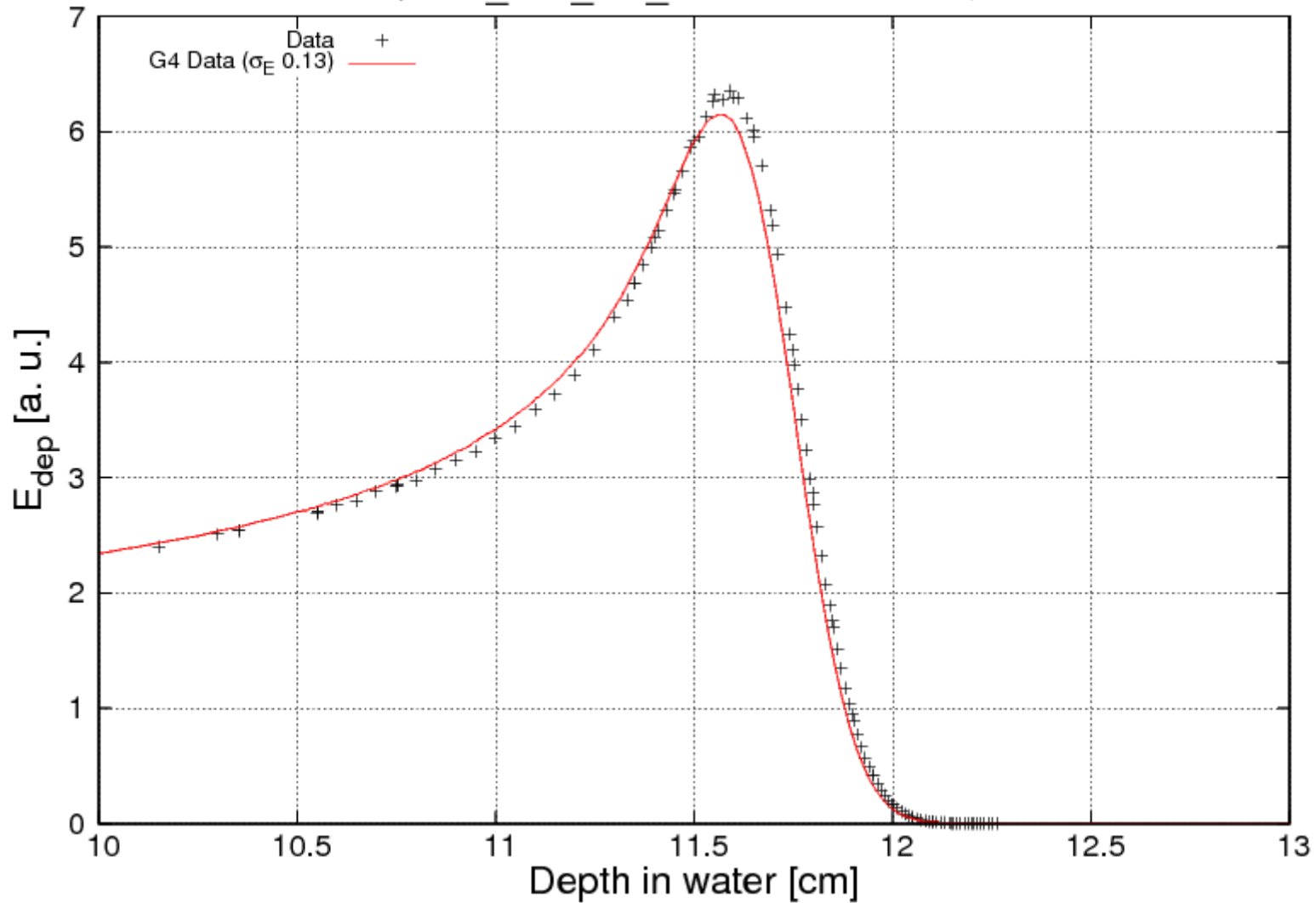
Range at 82% of Bragg Peak

- QGSP-BIC-HP

Energy (MeV/u)	GSI (mm)	Geant4 (mm)
100	26,26	25,73
200	87,49	86,42
400	276,1	273,3

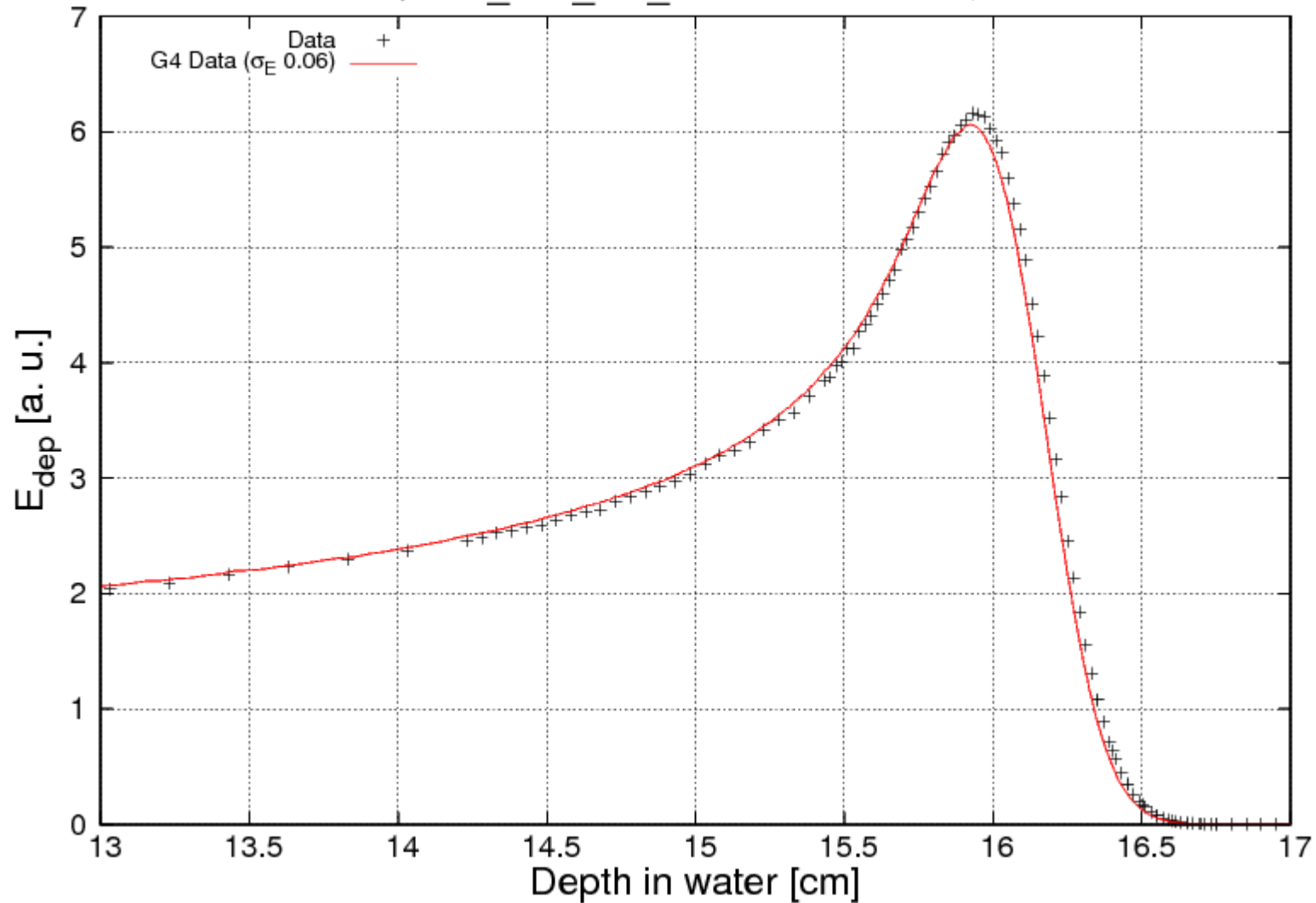
^1H RESULTS (v 10.01.p01)

QGSP_BIC_HP_EMY ^1H 125 MeV/u

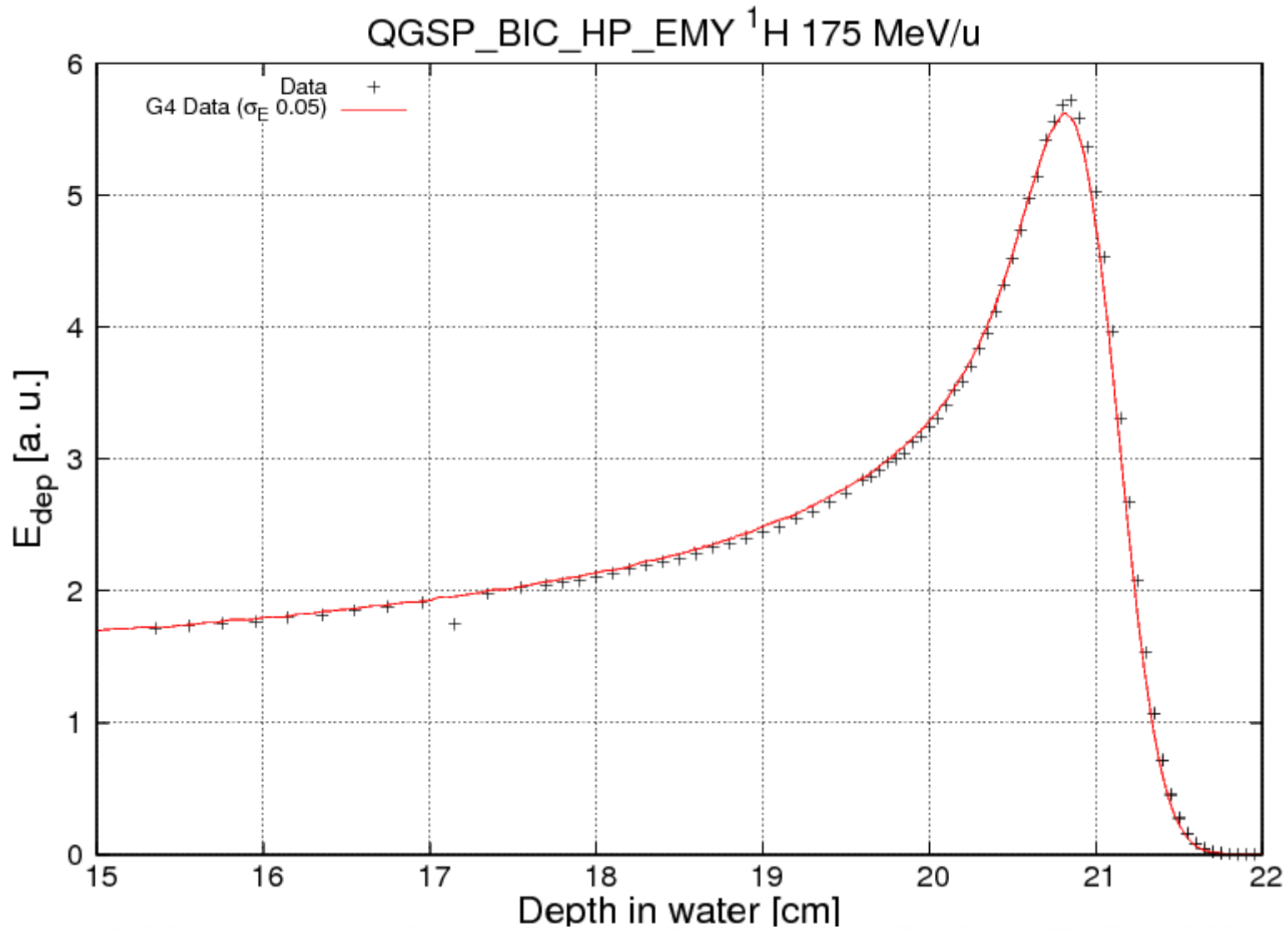


^1H RESULTS (v 10.01.p01)

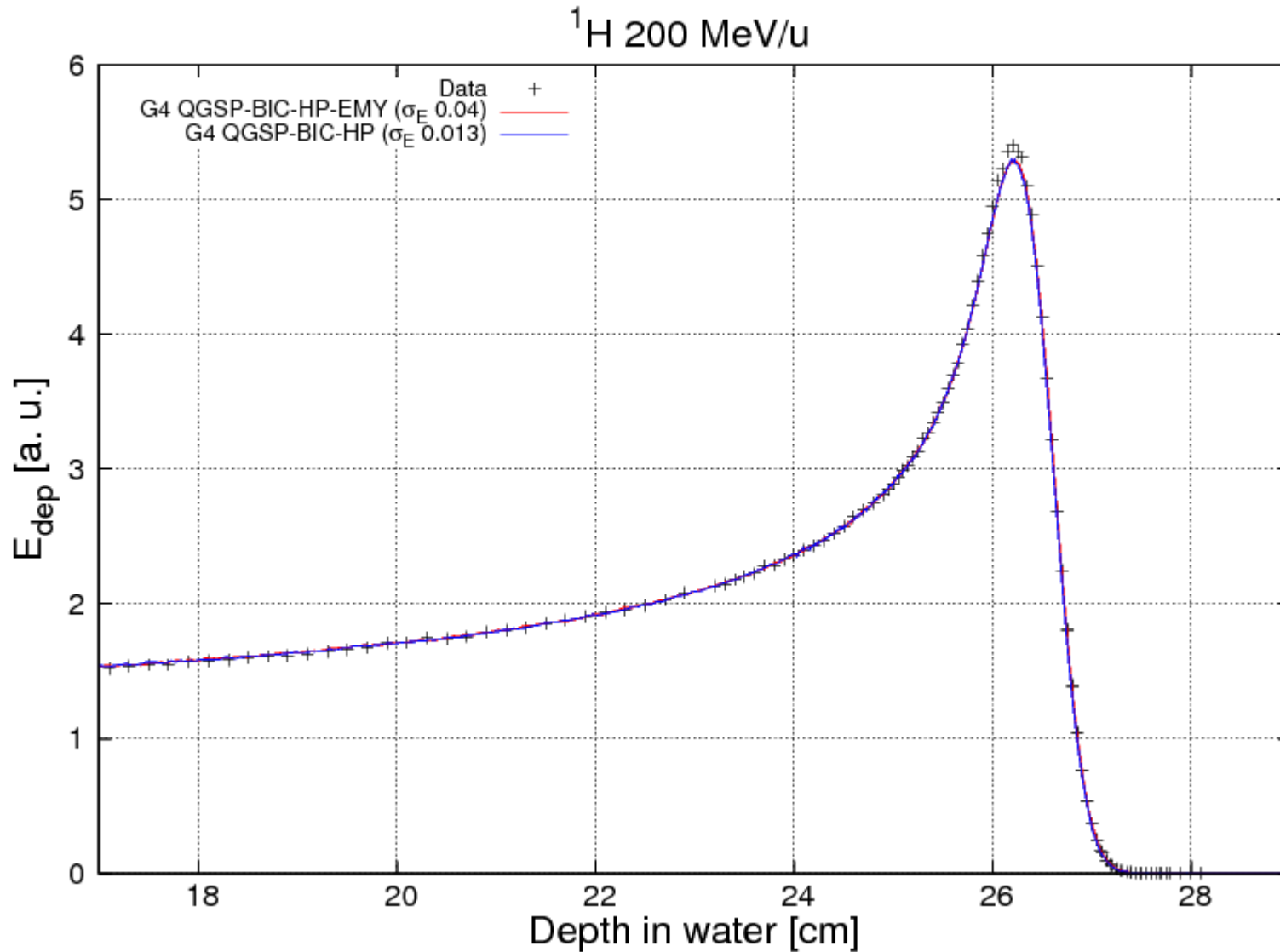
QGSP_BIC_HP_EMY ^1H 150 MeV/u



^1H RESULTS (v 10.01.p01)



^1H RESULTS (v 10.01.p01)



^1H RESULTS

Range at 82% of Bragg Peak

- QGSP-BIC-HP-EMY

Energy (MeV/u)	GSI (mm)	Geant4 (mm)
125	117	116,83
150	161	160,8
175	210,3	210,2
200	264,6	264,5 (264,4)

CONCLUSIONS

- Calculated data using EmStandard_Opt3 are closer to experimental values compared with the one obtained with EmStandard, in the case of carbon ions.
- Differences between calculated and experimental depth for 82% of Bragg Peak were within the experimental uncertainties (± 0.2 mm), with the exception of EmStandard in carbon ions (as it was the case with 10.0.p02).
- MT mode is under testing (G4MSBG).
- Including a more accurate modelization of the experimental setup is foreseen afterwards.