Purpose: Experimental and theoretical studies of the potential use of antiproton beams for cancer therapy have been greatly aided by Monte Carlo based calculations. Previously published data from the AD-4/ACE collaboration has shown excellent agreement between the Fluka Monte Carlo code and experimental absorbed dose data. In this research we investigate the suitability of the open source Geant4 Monte Carlo package for antiproton absorbed dose calculations.

Methods: Ionization chamber depth-dose data collected at the CERN Antiproton Decelerator and previously published by Bassler et al were used as the experimental benchmark. Version 9.3.p01 of Geant4 and Fluka version 2008.3b-02 were used. The antiproton beam was incident on a 20 x 20 x 20 cm3 water phantom with parameters set to match the experimental 126 MeV beam at CERN as closely as possible. Several reference physics lists were used covering electromagnetic and nuclear physics processes.

Results: Geant4 consistently placed the Bragg peak at the correct depth, but the shape of the depth-dose curve was inaccurate overall, regardless of physics lists chosen. In some cases, the peak-to-plateau ratio was off by an order of magnitude with fully enabled hadronic physics. This appeared to be the result of excessive in-flight annihilation and a corresponding overproduction of secondaries as well as a dearth of at-rest antiproton annihilations.

Conclusions: Currently Geant4 does appear to have the necessary physics implemented, however in-flight annihilation cross sections and low energy annihilation thresholds seem to be off in its default reference or standard physics lists. We plan to help improve this by sharing data and working with Geant4 developers.