Scientific Breakeven for Fusion Energy

For the past 40 years, the IFE fusion research community has adopted: achieving a fusion gain of ≈1 as the demonstration of scientific breakeven, where gain was defined as fusion energy produced divided the external energy incident on the fusion reaction chamber. Typical fusion power plant design concepts require a fusion gain of 30 for MFE and 70 for IFE.

Fusion energy production using lasers to compress the fuel was first described by Nuckolls et al, Nature **239**, 139, (1972) where fusion gain = (Fusion energy/Laser energy) was introduced as the measure of performance and usefulness. Brueckner and Jorna Rev. Mod Phys **46** No. 2 April 1974 pg. 325 defined ***The breakeven point, with fusion energy equal to laser energy.***

The LLNL definition of scientific breakeven was also published in:
"Laser fusion experiments, facilities, and diagnostics at Lawrence Livermore National Laboratory", by H.G. Ahlstrom, Appl. Optics **20** No. 11 pp. 1902 - 1924, Note in particular Fig. 1 on page 1903 where **target gain of 1 defines scientific breakeven.** (This is therefore a Livermore definition!)

The recent National Academy of Sciences report Assessment of Inertial Confinement Fusion Targets, ISBN 978-0-309-27062-5 (2013) states the standard definition of breakeven as:
*"**Breakeven occurs when fusion gain equals unity**—that is, when the fusion energy released in a single explosion equals the energy applied to the target." (page 45)*
and for indirect drive the target includes the hohlraum and fuel capsule (page 53)

The official NIF Project definition of Scientific Breakeven was given by the NIF Project Head Ed Moses when describing the NIF goal as : "..producing more energy than the energy in the laser pulse and achieving scientific breakeven." E. Moses, Status of the NIF Project, Lawrence Livermore National Laboratory Report UCRL-JRNL-230717, May 2007.

Statements like:
"More importantly, the self-generated energy of this target exceeded the input energy of the imploding DT fuel. This is called *scientific break-even*." or

"scientific break-even point," where the amount of energy that comes out of the fusion reaction is equal to that which was put in by the kinetic energy from the implosion. http://www.livescience.com/40035-fusion-energy-gets-closer-to-reality.html

may appear to be similar to the traditional accepted definitions used in the scientific community for the past 40 years, but they are in fact quite different. The highest performing NIF experiment as of October 15, 2013 achieved a fusion gain of 0.0078, which is a factor of 125 lower than the traditional definition of scientific feasibility that requires a gain = 1.