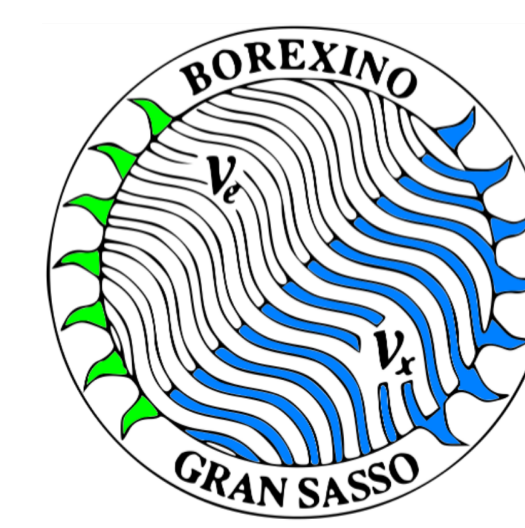


The Borexino Monte Carlo simulations for the CNO neutrino detection

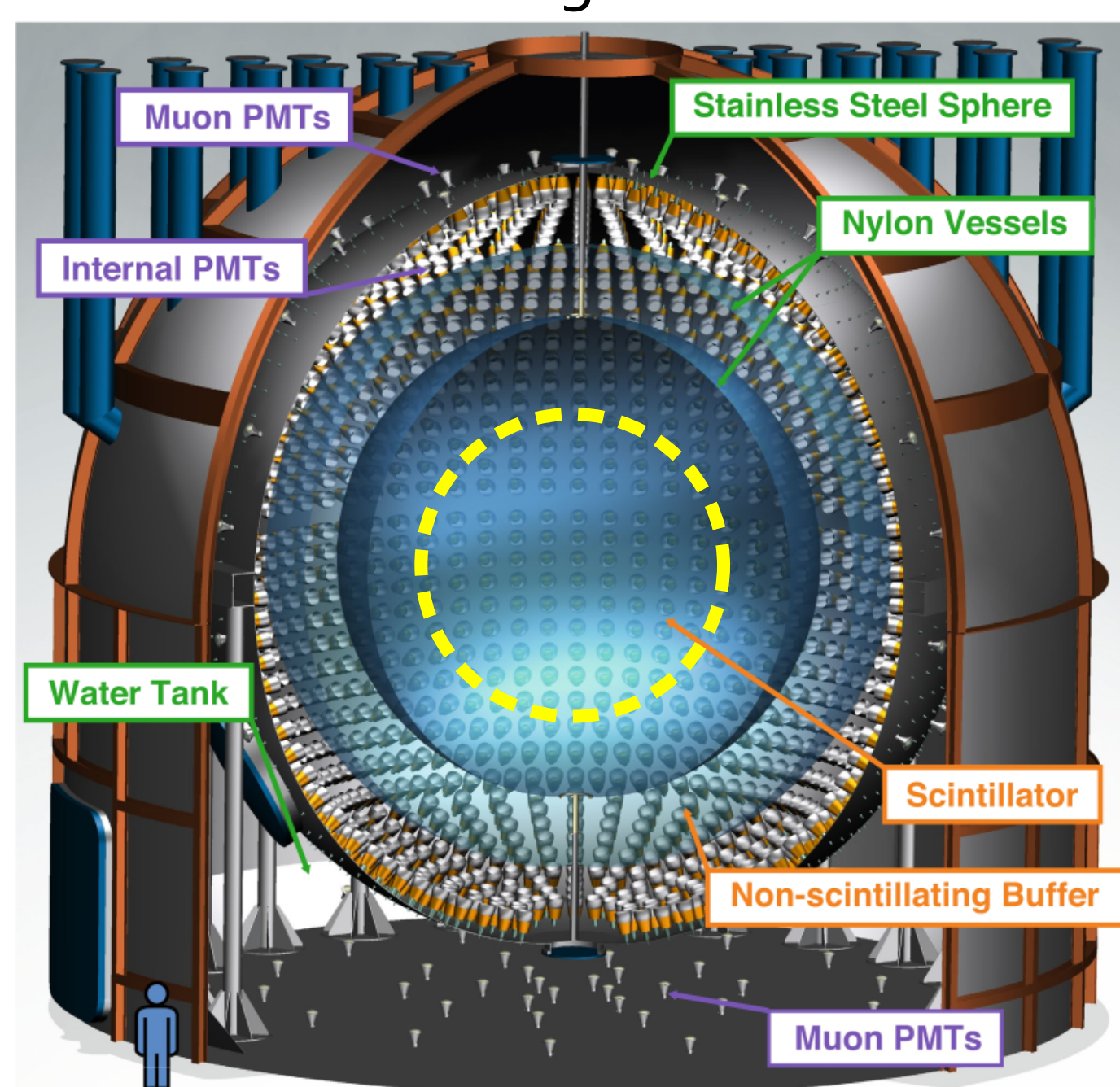


Improvements of Borexino simulations crucial to detect the CNO solar neutrinos based on 2016-2020 data.

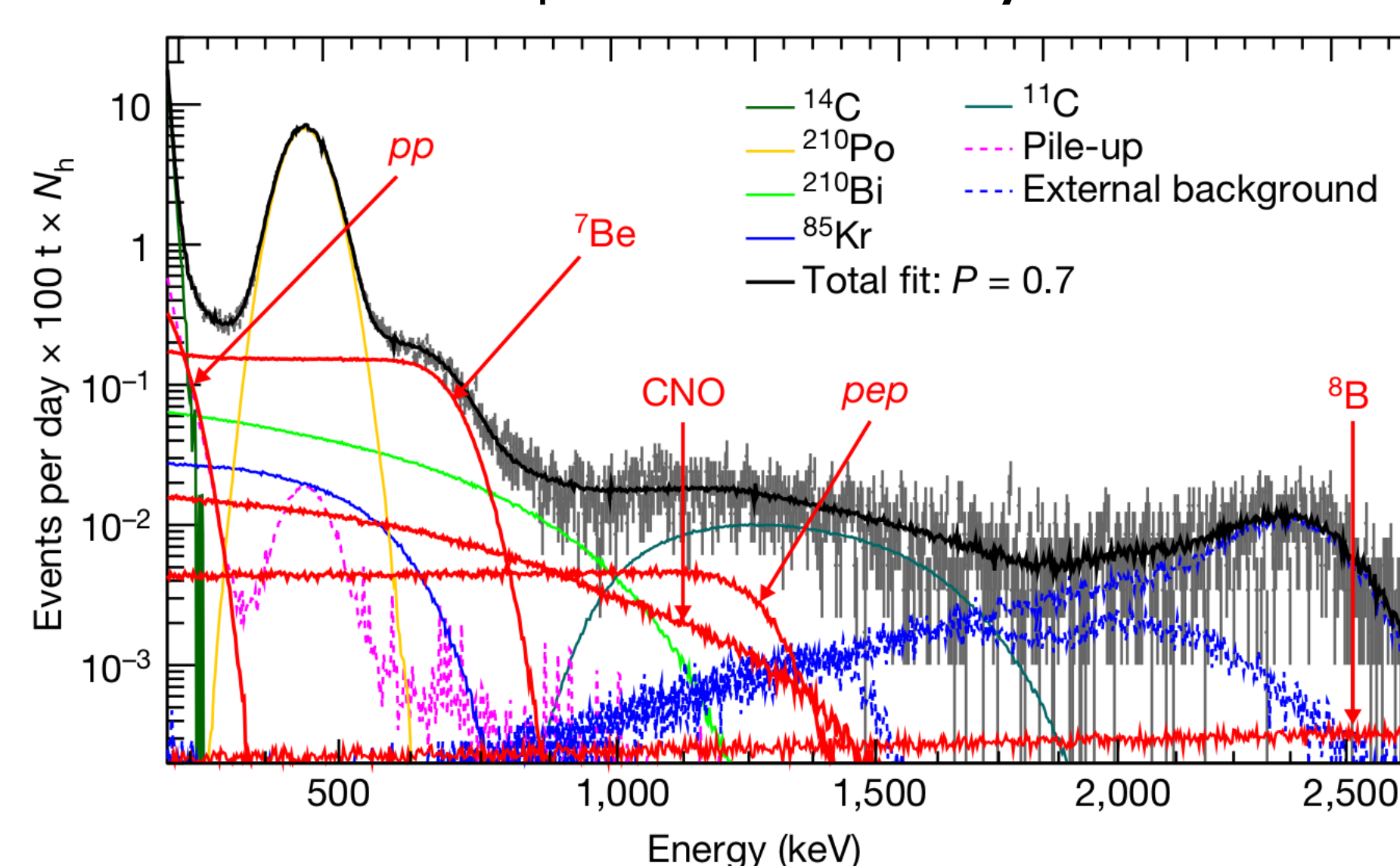
Davide Basilico (University of Milan and INFN) on behalf of the Borexino Collaboration

Borexino

- Detector:**
- 280 ton of ultrapure liquid scintillator
 - 2200 PMTs to detect light and times
 - elastic scattering: solar $\nu - e^-$



- CNO- ν (and solar ν) analysis:**
- Multivariate MC fit: amplitudes of **solar neutrinos** and backgrounds are free parameters of the energy spectrum fit.
 - PDFs shapes built from simulations
 - detector response **included by simulations**



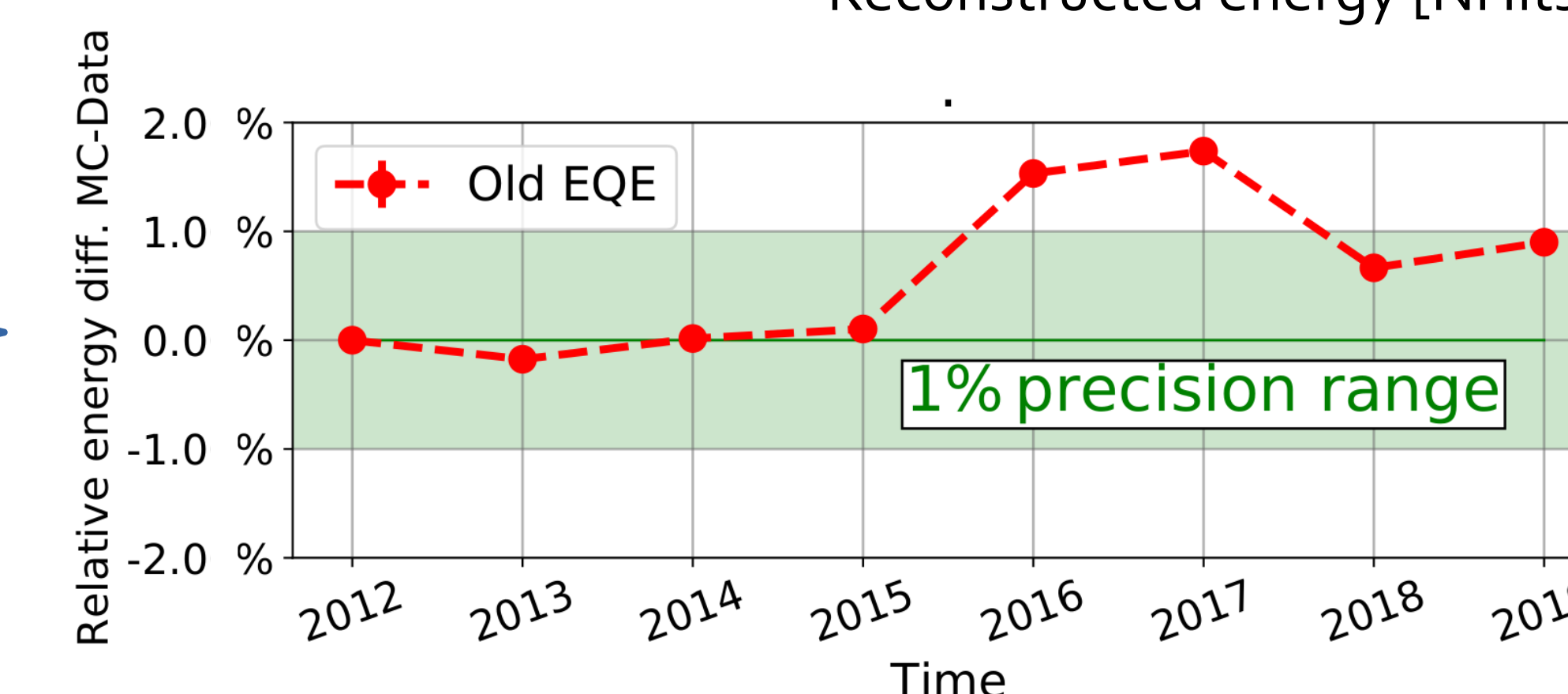
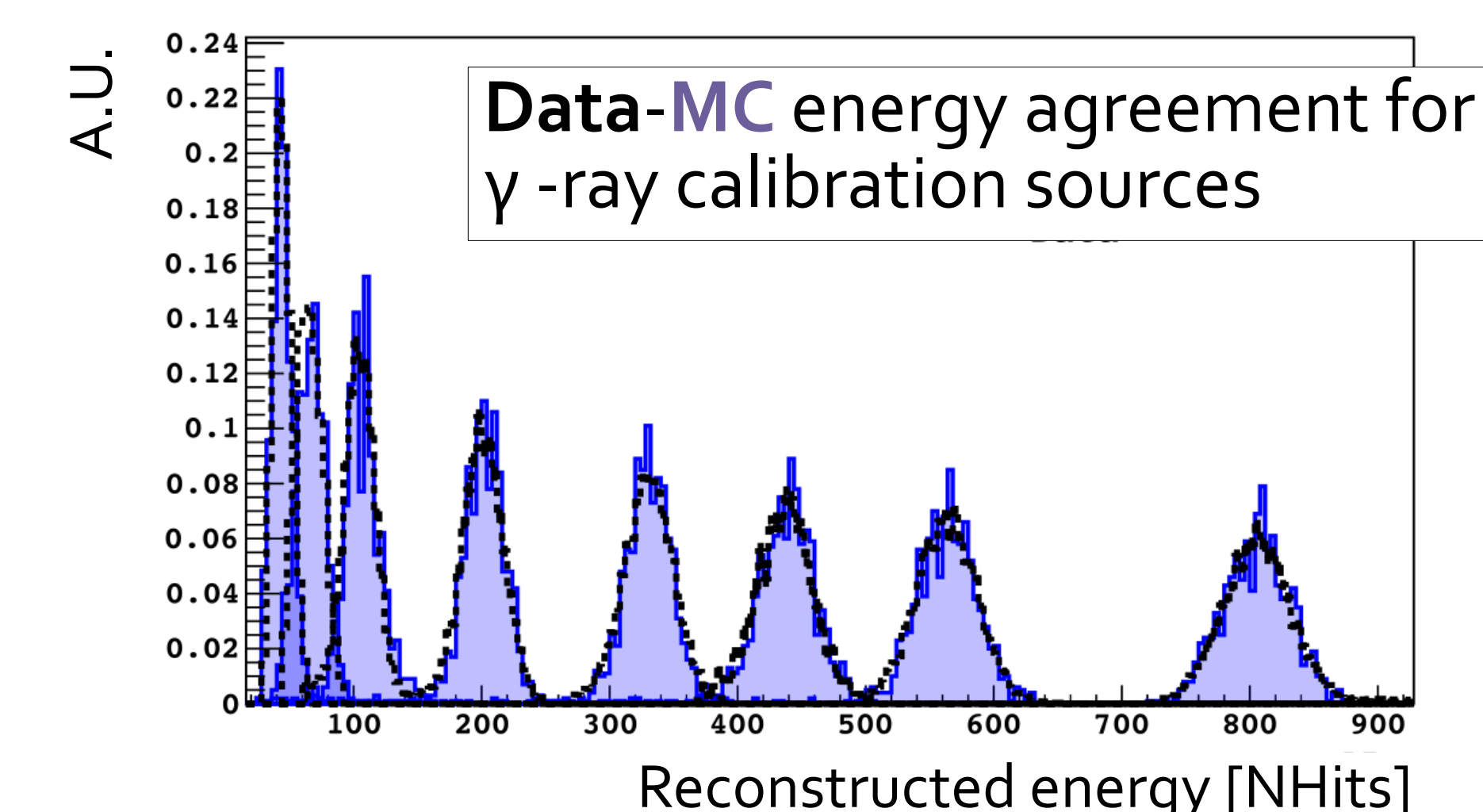
Simulations and "BxPuzzle"

- Geant4-based code: energy deposition + light emission, propagation and detection + signal processing.
- Reproduction of detector energy and position response, within the CNO analysis volume (2.8 m sphere), at 1% precision (100 keV – MeV range).

"BxPuzzle" from 2016 on:
data-MC energy scale > +1% discrepancy

- Phase-III (2016-20): CNO- ν analysis
- Evolution of detector **energy scale in time** from ^{210}Po background (α events)
- >preventing to perform MC fit

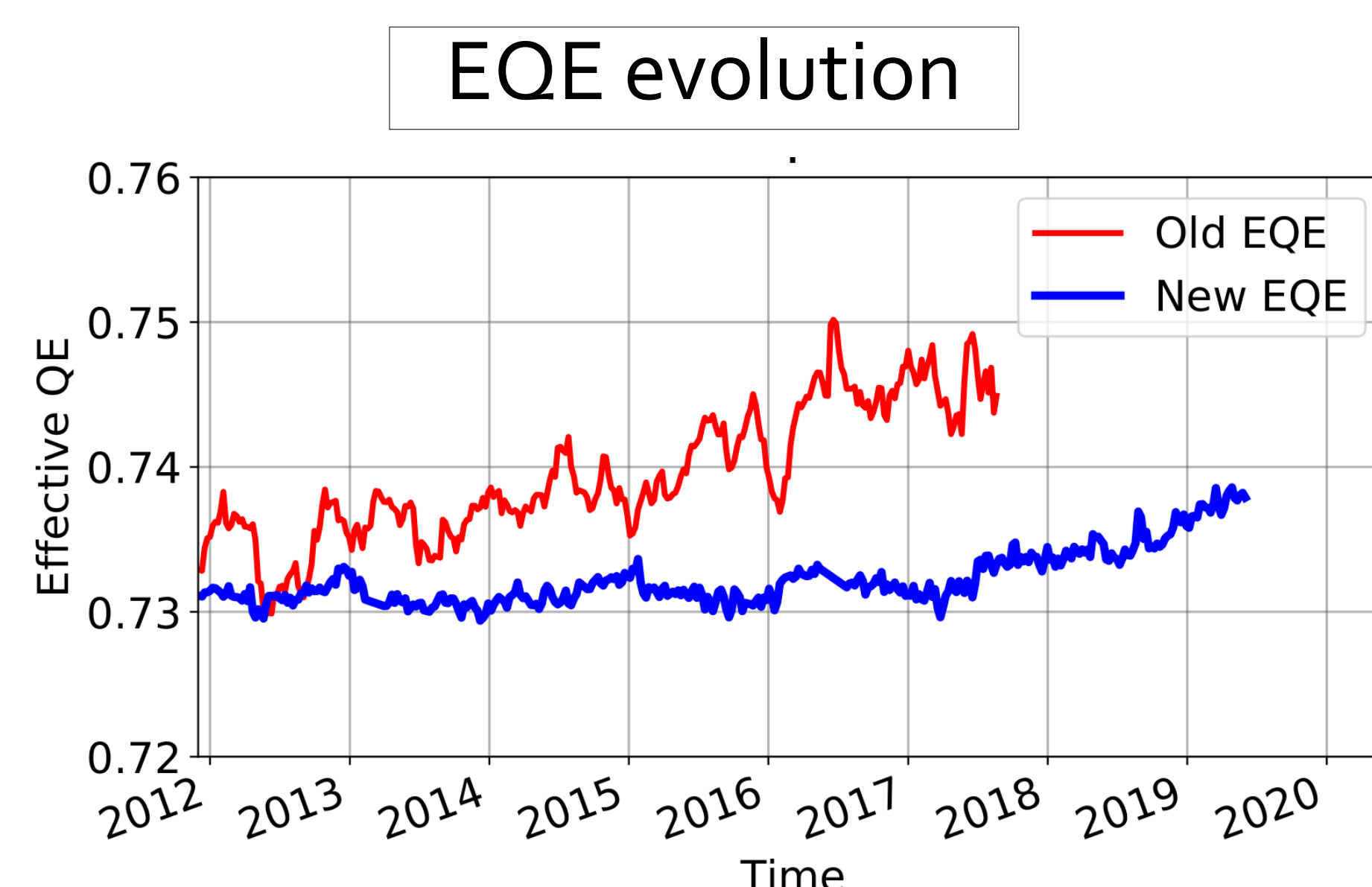
Cause: Effective QE (see bottom boxes)



Monte Carlo upgrades

1. Effective QE upgrade

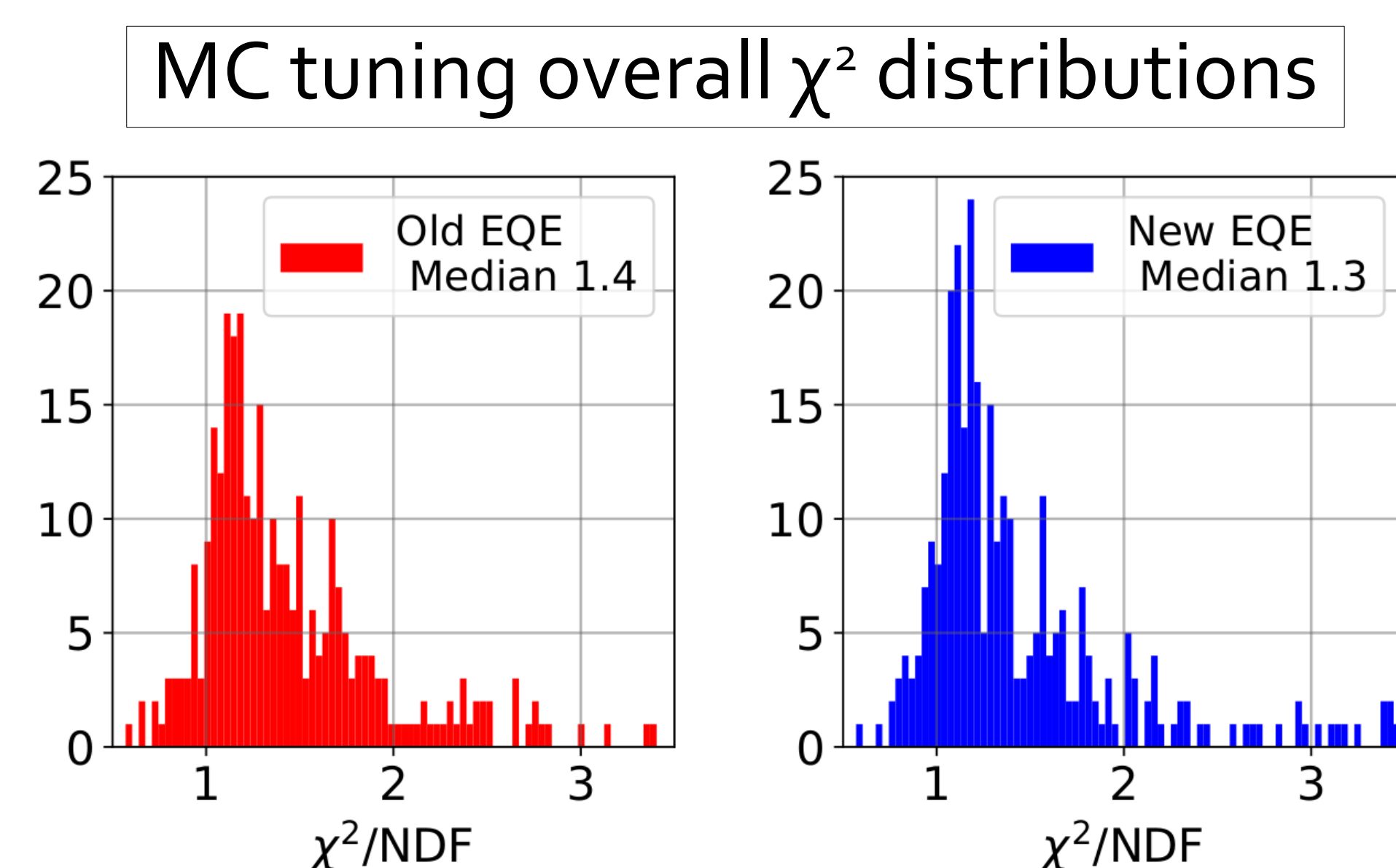
- Effective QE:** PMTs QE + electronic channel differences + variations in scintillator properties
- Time-dependent, **simulations input**
 - Calculated on periodic basis on ^{14}C data



New method takes better into account corrections for "dying" PMTs

2. MC Tuning

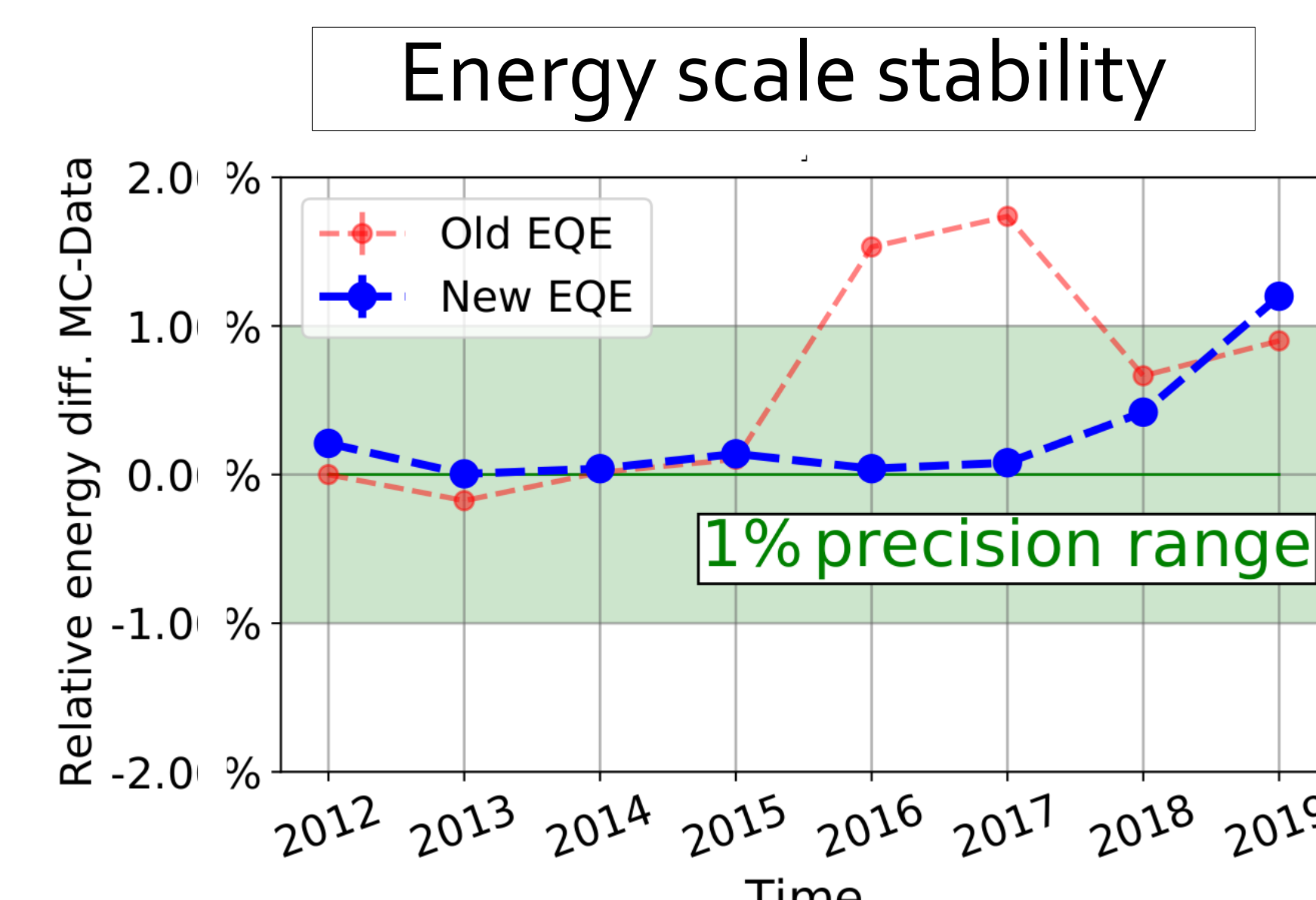
- Simulations vs 2009 calibration data**
- Energy, detection times, position, α/β
 - Tuning of response parameters
 - 40 physical variables based on re-analysis of 13 calibration runs
 - **global agreement evaluation**



Data-MC global agreement improved with respect to previous MC tuning

3. EQE validation

- Validate the new EQE approach**
- Analyzing ^{14}C or ^{210}Po data
 - New EQE characterization: light collection performances, MC datasets comparison
 - New EQE correlates better with data



Data-MC energy scale agreement better than 1% restored for 2016-20

Ready for CNO- ν analysis: massive simulations and PDFs building for MV fit

Massive **simulation campaign** of signal and background PDFs for Phase-III dataset (2016-2020).

- Following the detector response on a run-by-run basis,
- Data quality filtering, normalization

→ MC PDFs: **crucial input for the CNO- ν analysis multivariate fit** (see Poster #238 : Borexino CNO- ν results)

