



SOUTH DAKOTA MINES
An engineering, science and technology university

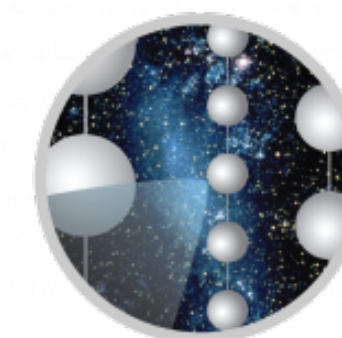


CR 3 YEAR ANALYSIS SYSTEMATIC UNCERTAINTIES

Matthias Plum
CR-WG Workshop
October 8, 2021

Outline

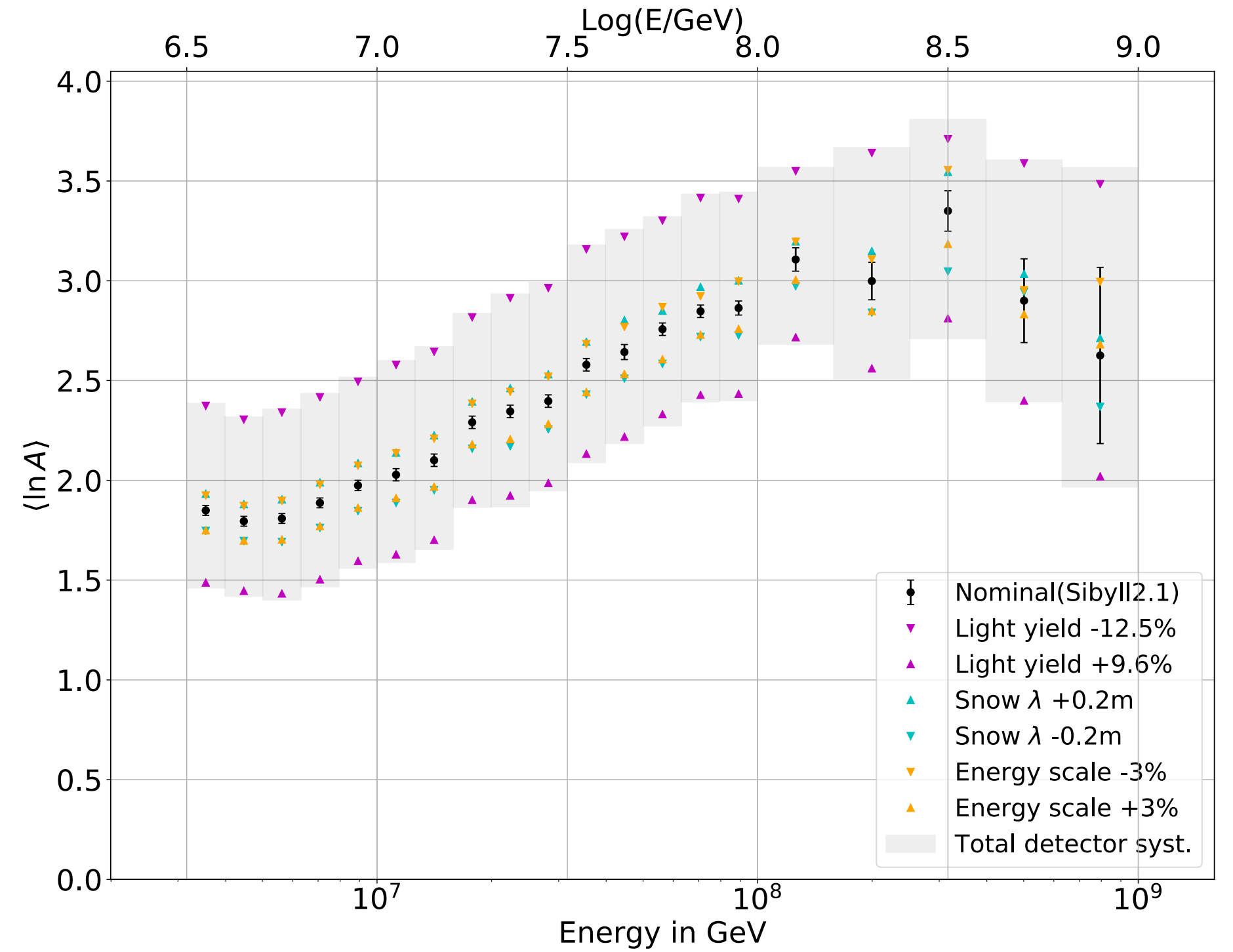
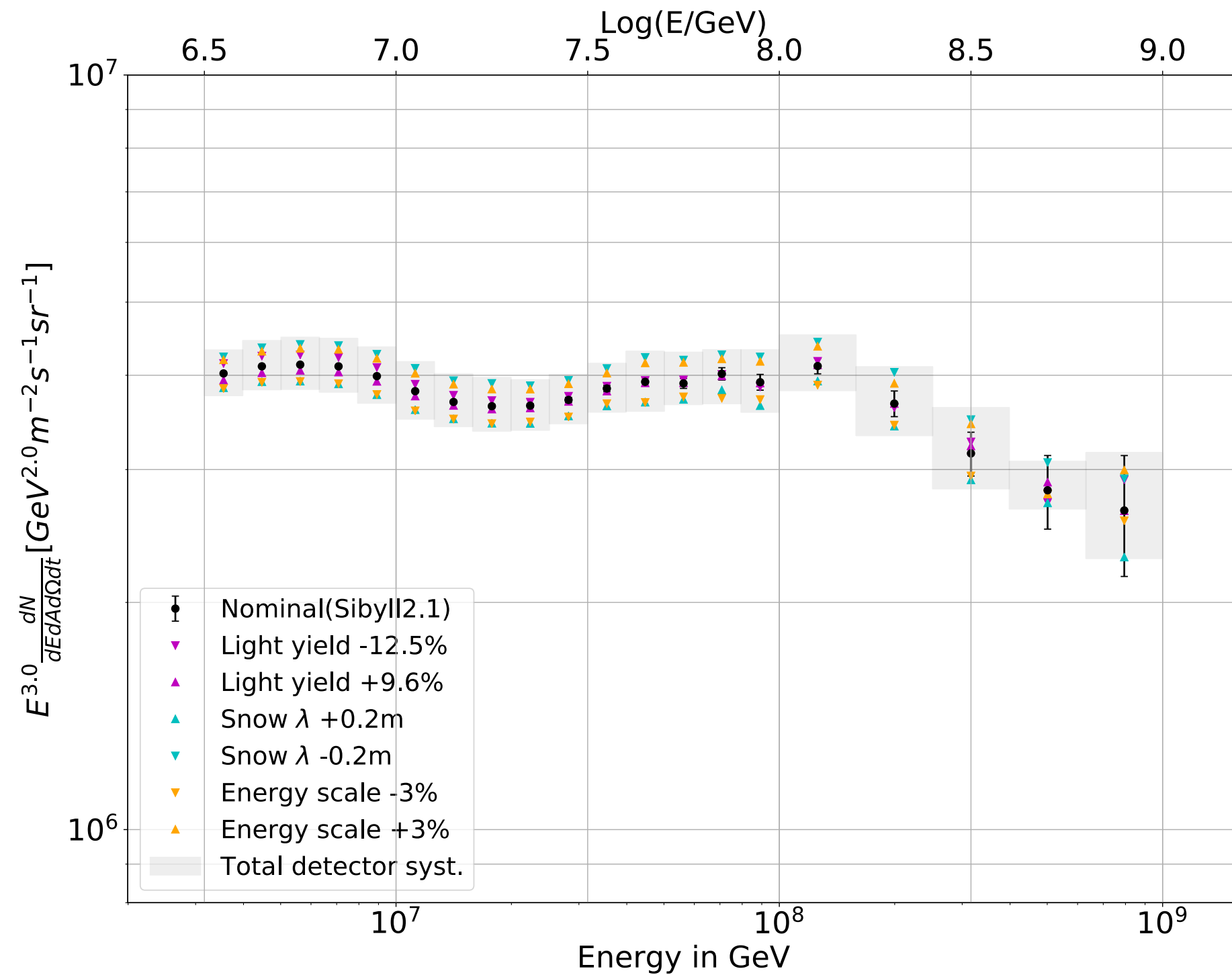
- IceTop
- IceCube
- Hadronic



ICECUBE
SOUTH POLE NEUTRINO OBSERVATORY

DETECTOR UNCERTAINTIES

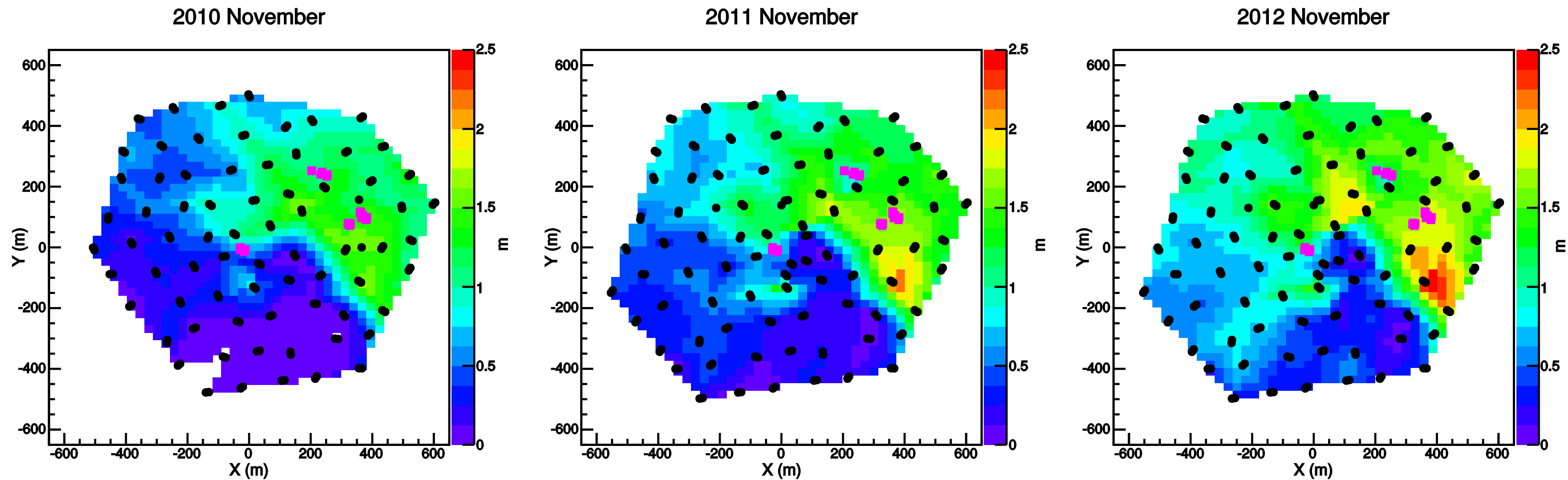
- Light yield
- Snow
- Energy Scale



ICETOP SNOW

- Due to sparse measurement data (2x year) and uneven accumulation effect, tank snow coverage is uncertain over the time of a yearly run
- During L3 reconstruction, the attenuation lambda is changed by $\pm 0.2\text{m}$

➤ Actively working to get a better snow prediction/interpolation model for every tank



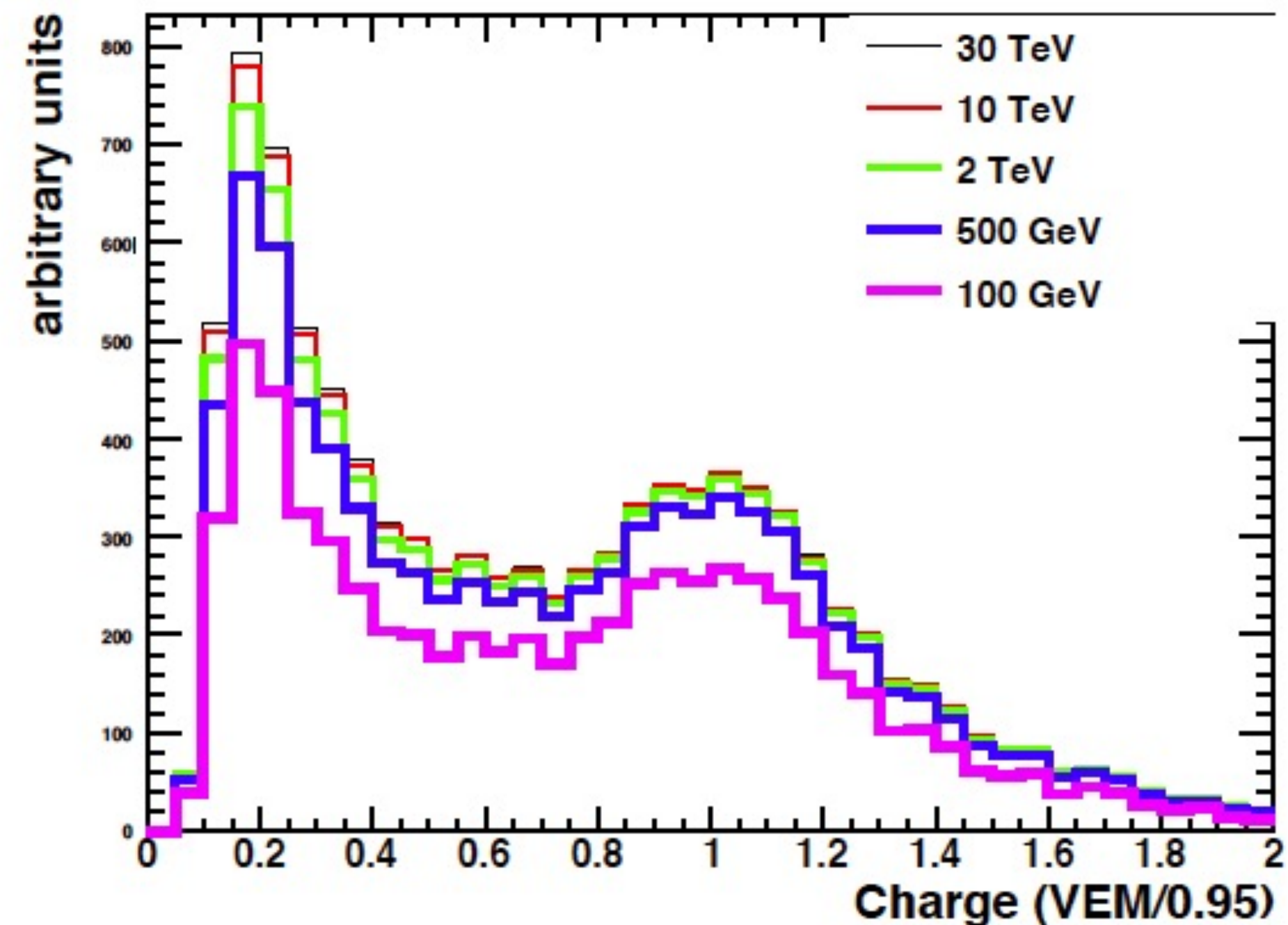
ICETOP ENERGY SCALE

- Stability of the VEM peak in the calibration charge histograms
- Stability of VEM peak is 2-3%
- Result in a $\pm 3\%$ shift of S_{125}
- Do we need to study this again?

Shift of the 1 VEM peak position

Check	$E^{-2.4}$	$E^{-2.7}$
different seeds	0.2 %	0.5 %
July vs January atmosphere	1.6 %	2.7 %
SYBILL vs QGSJET01c	0.7 %	2.9 %
10 cm to 200 cm of snow	0.4 %	0.7 %
different tanks/DOMs	1.5 %	—

Simulated Tank charge spectrum (weighted $E^{-2.7}$)



ICECUBE

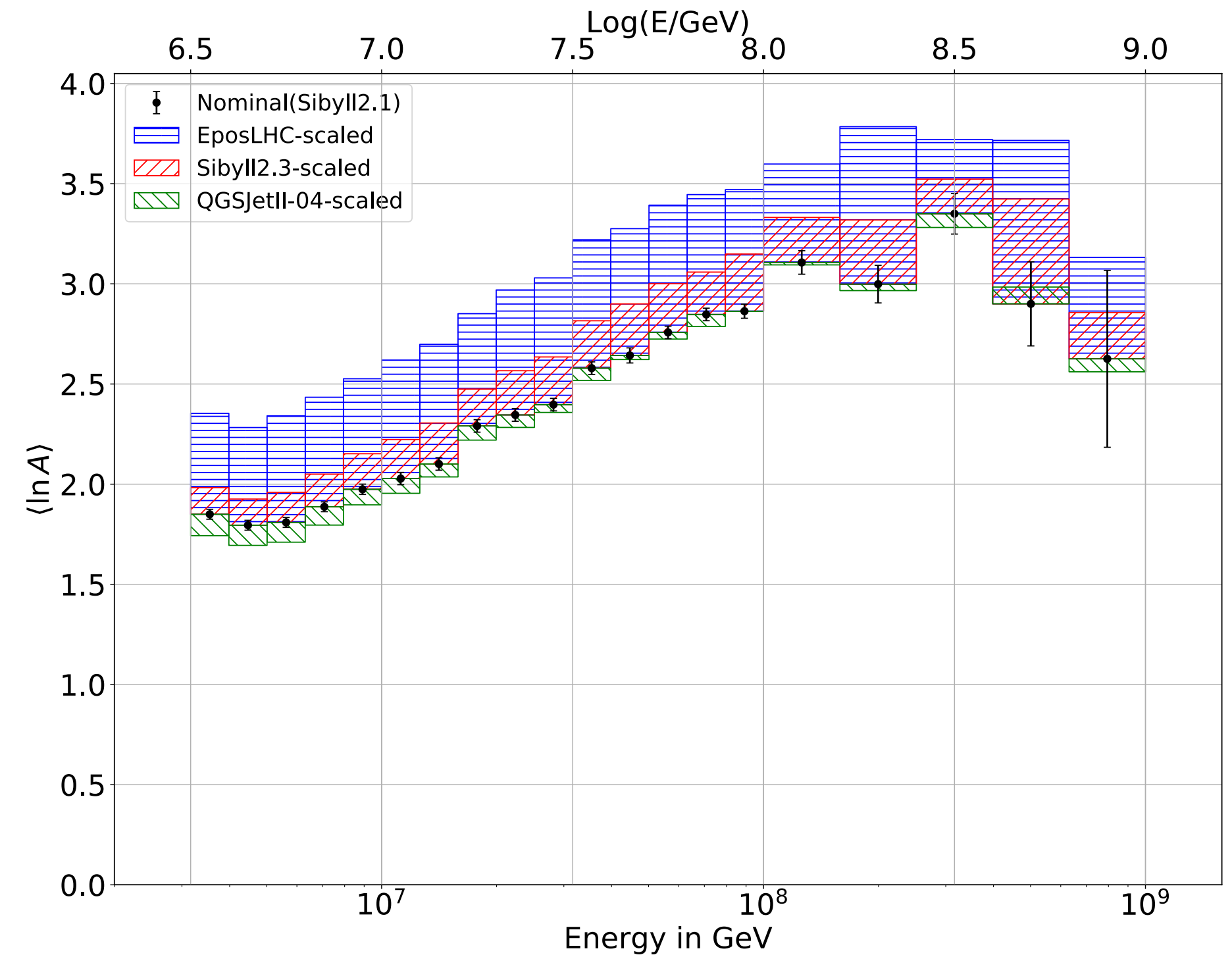
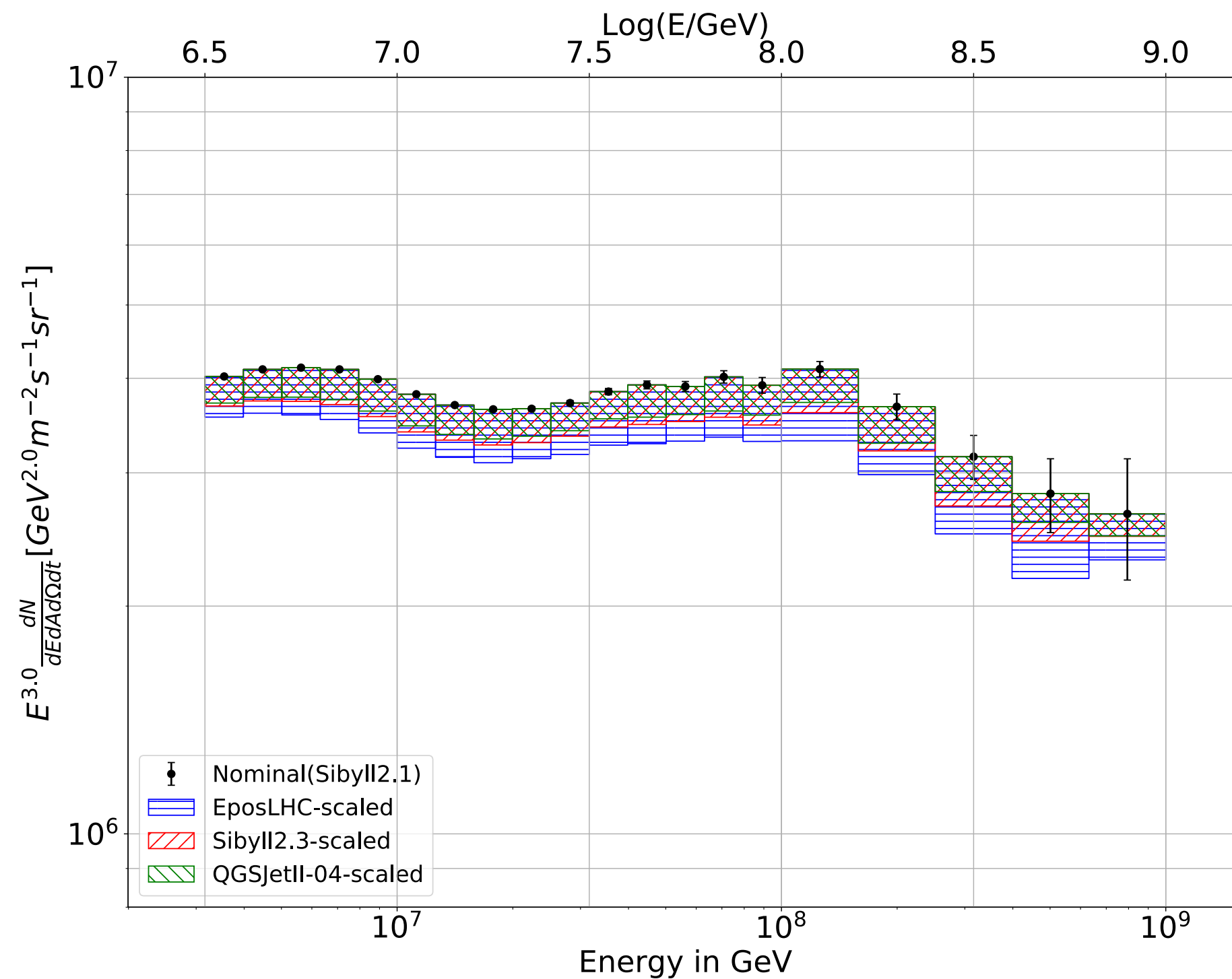
- Used in 3 year paper:
 - DOM photodetection efficiency estimated to $\pm 3\%$
 - In-ice scattering and absorption values were studied with the LED pulser campaigns for the South Pole bulk and hole ice
- Assumed uncorrelated effects, so we could combine them in quadrature
- More details on in-ice systematic determination in the following talks by Dima, Ben, Manuel

TABLE II. Systematic light yield shift

Effect	Light yield shift
+10% scattering	+3.6%
+10% absorption	-11.8%
-7.1% scattering and absorption	+7%
30 cm hole ice scattering	+4.5%
100 cm hole ice scattering	-2.9%
DOM efficiency	$\pm 3\%$
Total Light Yield Effect	+9.6%, -12.5%

HADRONIC INTERACTION MODELS

- Default model Sibyll2.1
 - EposLHC
 - Sibyll2.3
 - QGSJetII
- Only 2 primaries (proton and iron) simulated
 - Shift on S125 and dEdx were parametrized and applied to get conservative hadronic systematic estimation



TODOS FOR FUTURE ANALYSIS



- Snow uncertainty improvement is already been actively worked on (Kath's & Matthias's student)
- Revisit energy scale uncertainties?
- How to better handle in-ice uncertainties?
- Hadronic uncertainties studies in the future? Simulate more primaries?
- Plans for surface enhancement systematics?