



CIDeR Meeting Updates

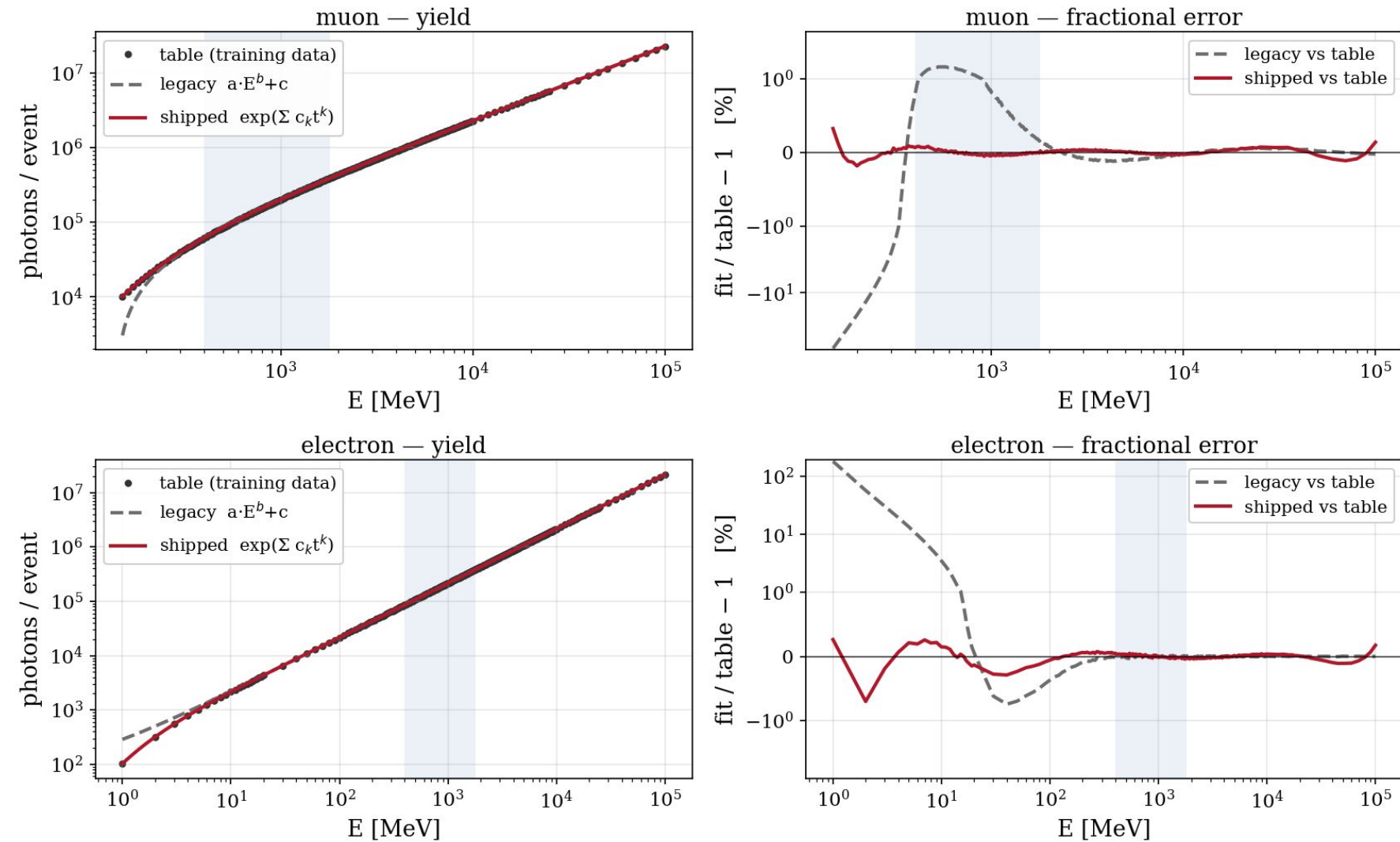
Omar Alterkait

Tufts University / IAIFI / SLAC

New Energy Parameterization

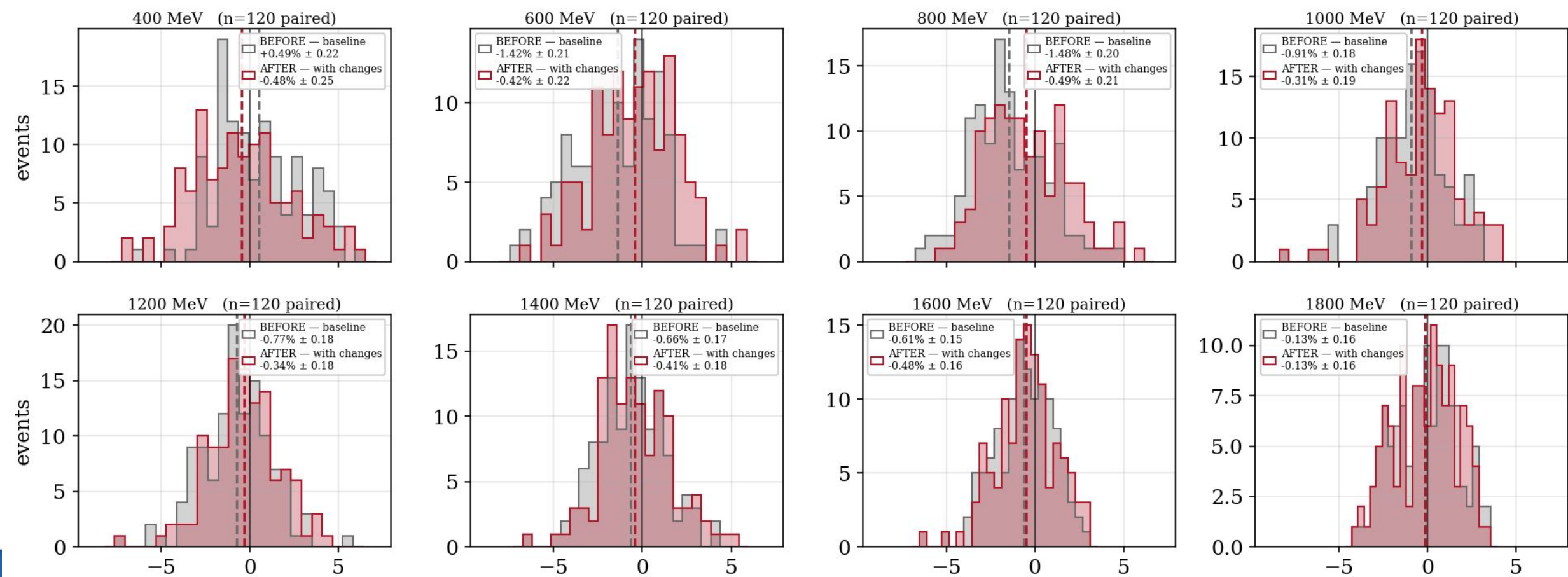
- Old: a power law $a \cdot E^b + c$, fitted unweighted to raw photon counts, so the 400–1800 MeV band carried almost no weight in the fit.
- New: a degree-7 polynomial in $\log E$, fitted to $\log N$. It matches the table to 0.043% rms (muon) and 0.067% (electron).
- The coefficients have been added in git for now as `data/water/<particle>/nphot.json`

$N_{photons}(E)$ in water — legacy power law vs the shipped log-log polynomial
shaded: the 400–1800 MeV reconstruction band



Energy Bias Before and After

The per-event energy bias moves towards zero at every energy, on the same events in both arms. For example: 600 MeV $-1.42\% \rightarrow -0.42\%$, 800 MeV $-1.48\% \rightarrow -0.49\%$, 1000 MeV $-0.91\% \rightarrow -0.31\%$.



Broken Fixes

#	What was wrong	Effect	Fix
1	Light deposited on sensors behind the photon	Mostly a photon re-depositing on the PMT it had just reflected off. 6.65% of data charge, 5.67% of model charge	Deposit only ahead of the photon
2	Overlap probability not capped per photon	At grazing incidence, 23 sensors took a combined 19 photons' worth from one photon	Survival product caps the sum at 1
3	Overlap table's dense region ended too early (3σ)	Spurious overlap at $d/r = 1.5\text{--}3$, growing as the width narrowed	Cutoff 8σ
4	Overlap table accumulated in float32	An exact overlap of 1.0 came out $1.4\text{e-}5$ off, and got worse with a finer grid	float64: $3.6\text{e-}14$
5	Photon-yield power law (slide 3)	Energy scale off by $\sim 1\%$ in band, -70% at 150 MeV	Log–log polynomial
6	Small charge bias from sim scaling	Overlap was scaling the charge	Overlap width made $0.02r$ after fixes above

Broken 2: The leg bound (optional feature, off by default)

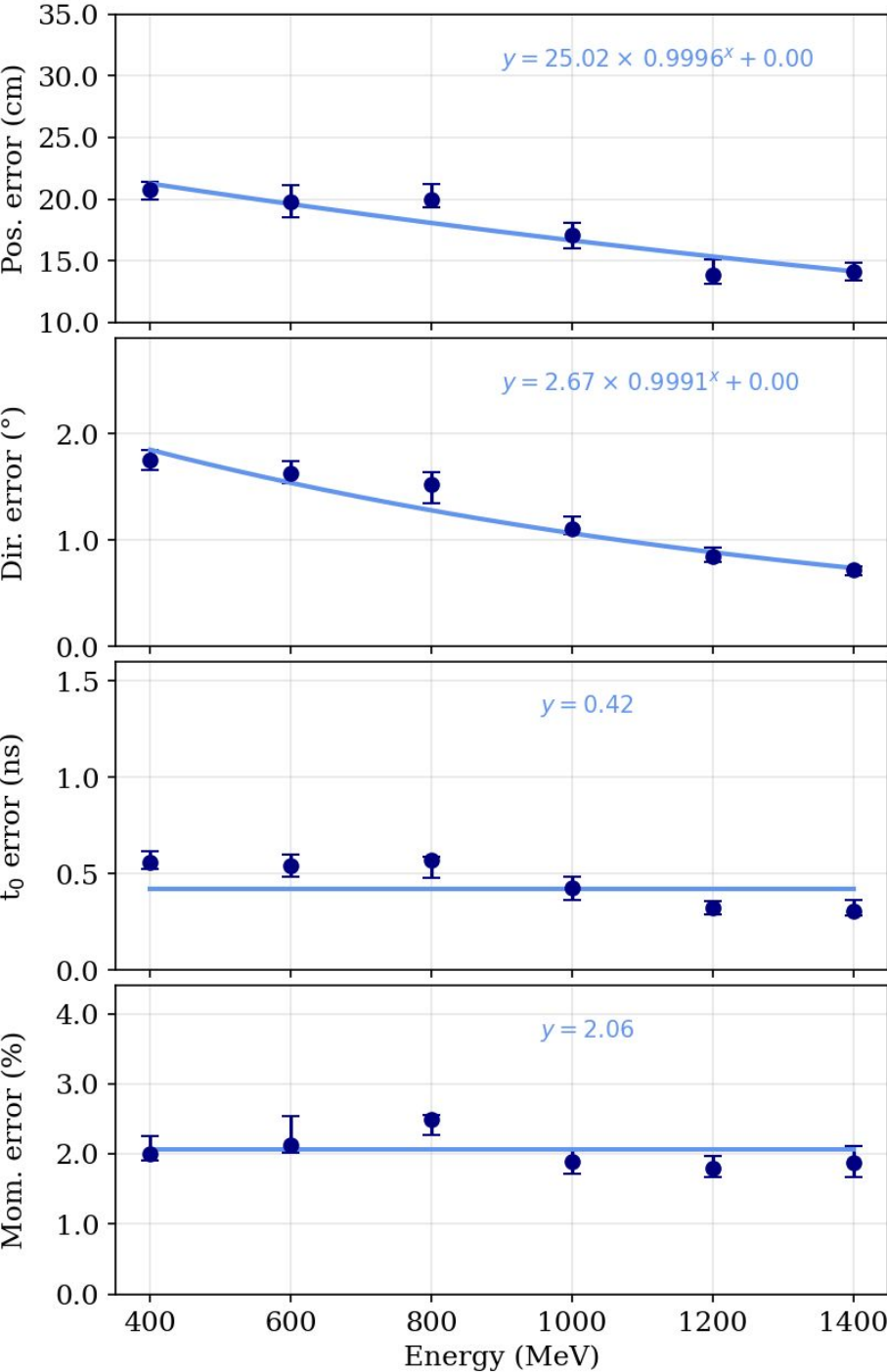
What it is: limits the deposit to the part of the ray the photon actually travelled. Before we counted a hit with a sensor even if it behind the wall.

With it on: some fits failed to converge. Gradients need to be investigated more thoroughly for a proper fix. For now turned off by default. A possible cause is that each ray only considers 4 candidate PMTs, chosen with the gradient switched off. With the leg bound, PMTs moving on or off that list matter, and the gradient misses them.

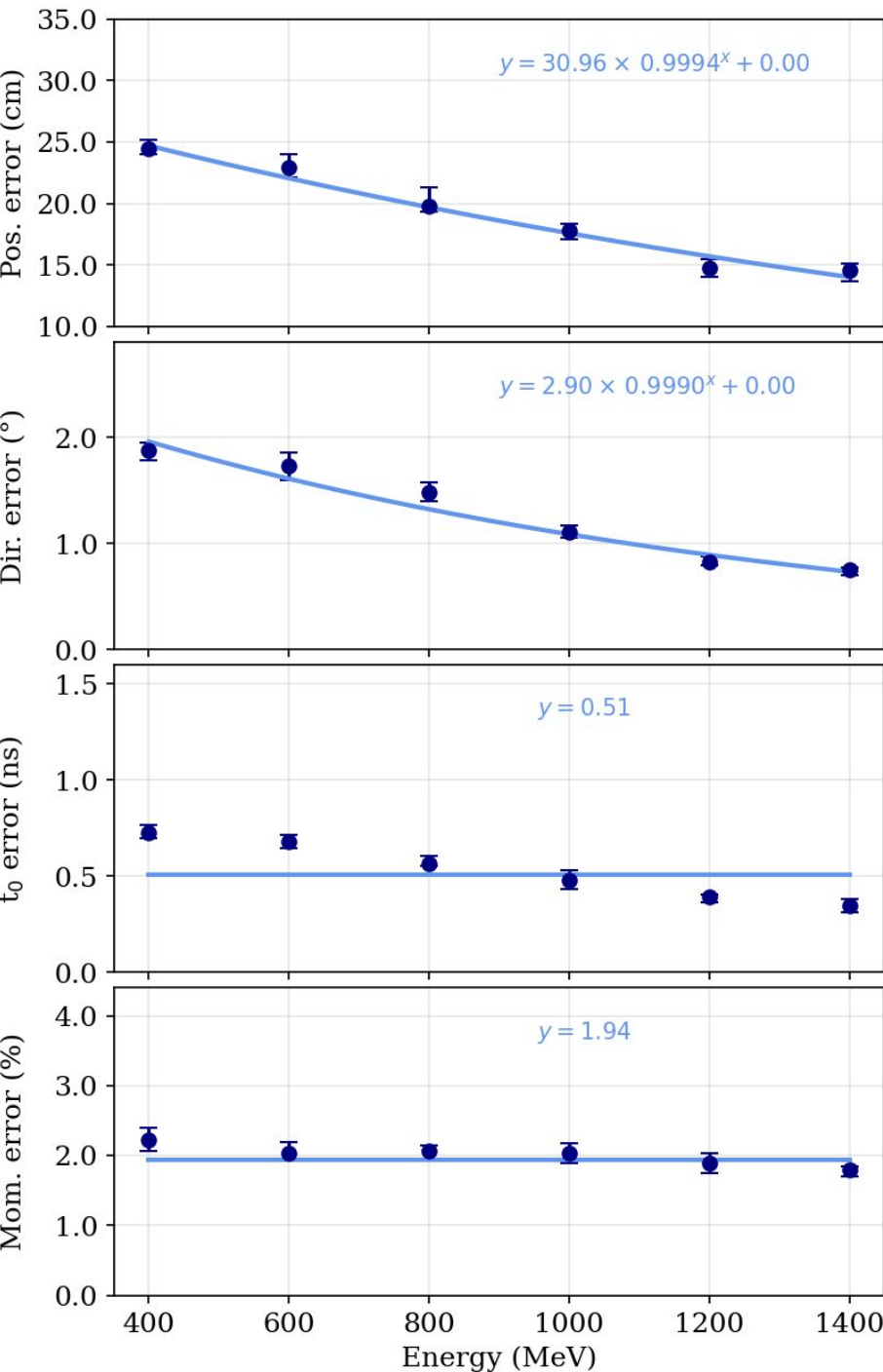
Gradients still mostly usable although slightly worse and more noisy

Reco Energy Dependence

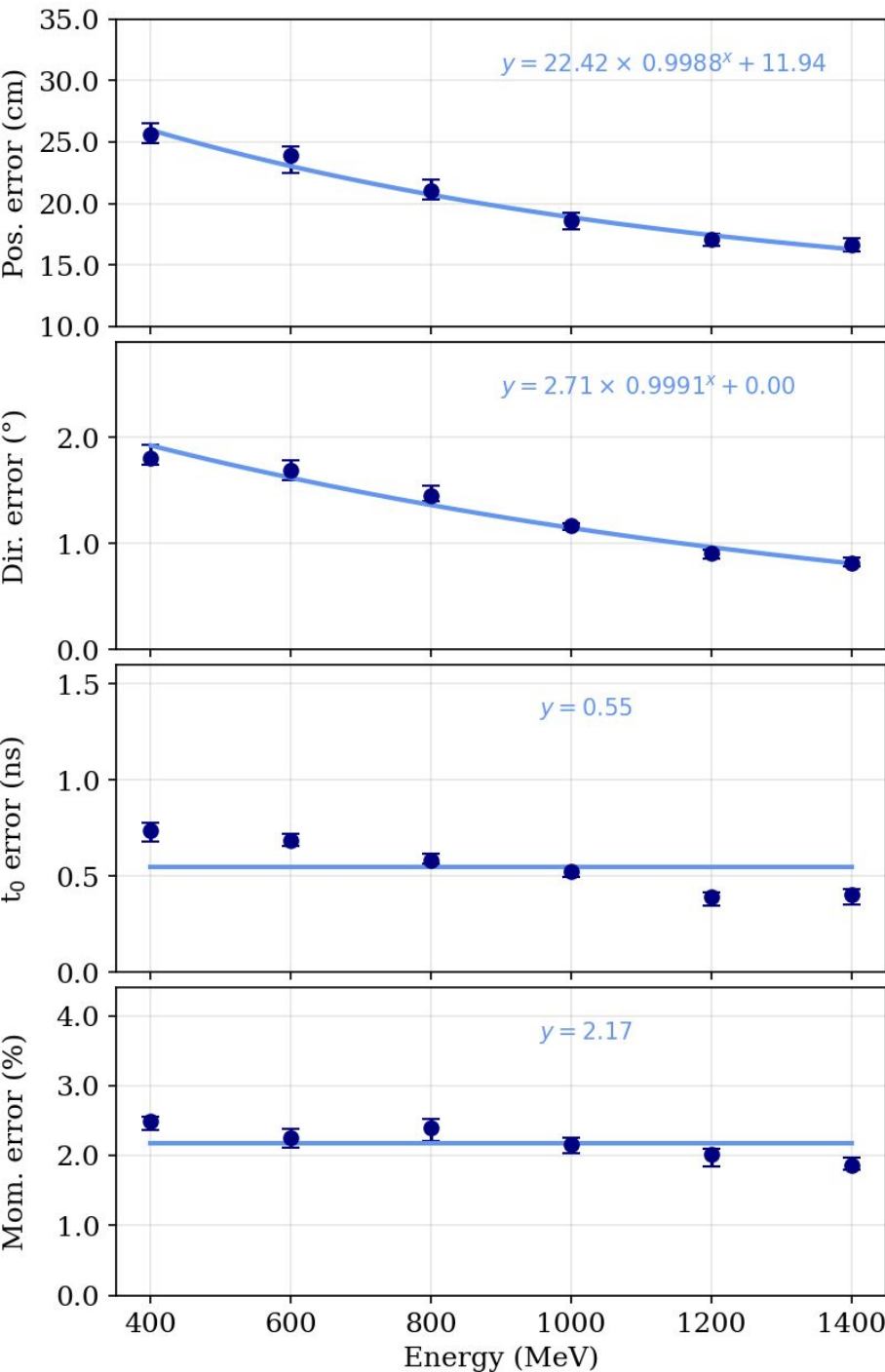
BEFORE: shipped baseline
720 events, 400-1400 MeV, 150 iterations



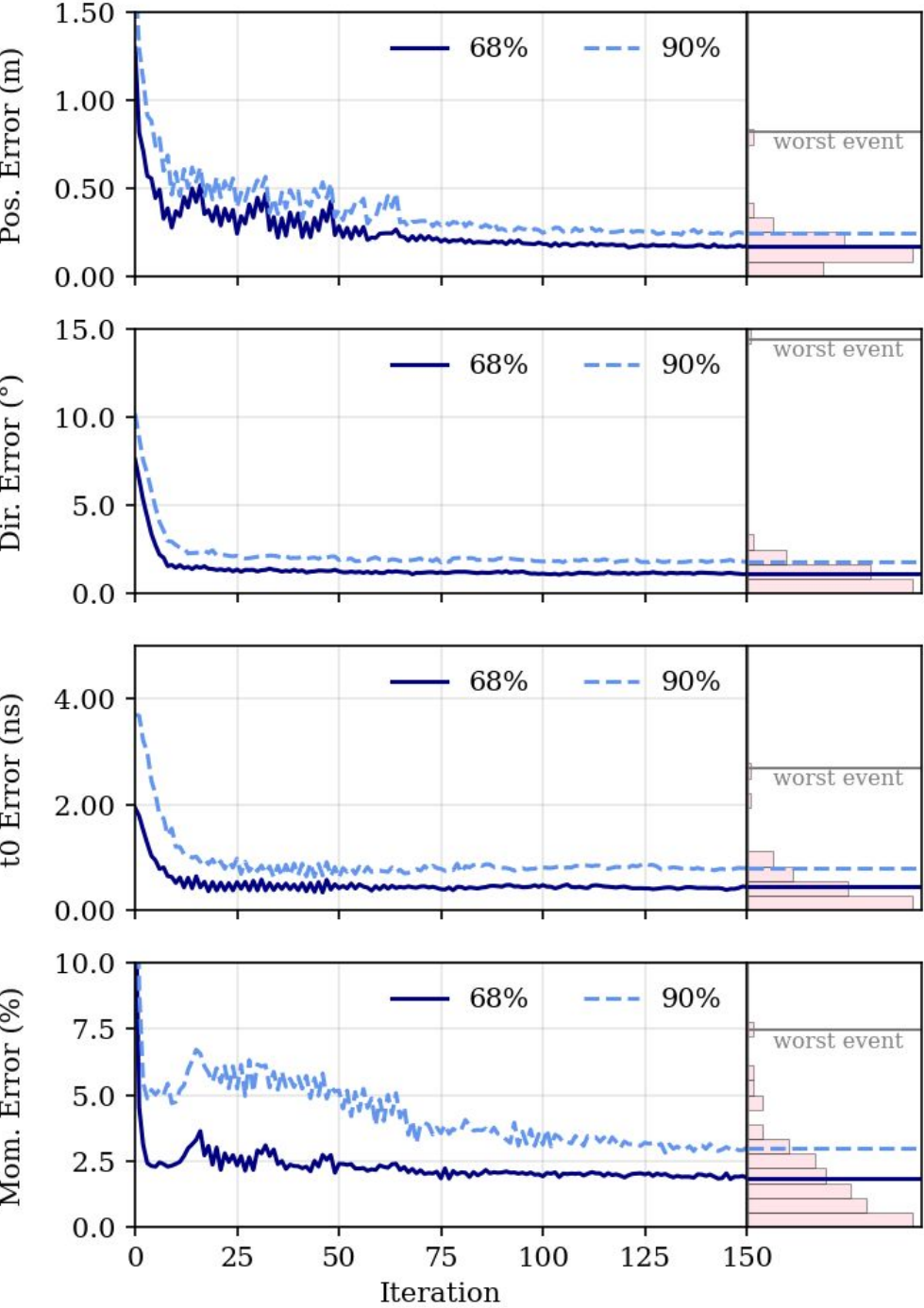
AFTER: deposit port + fixes
1440 events, 400-1400 MeV, 600 iterations



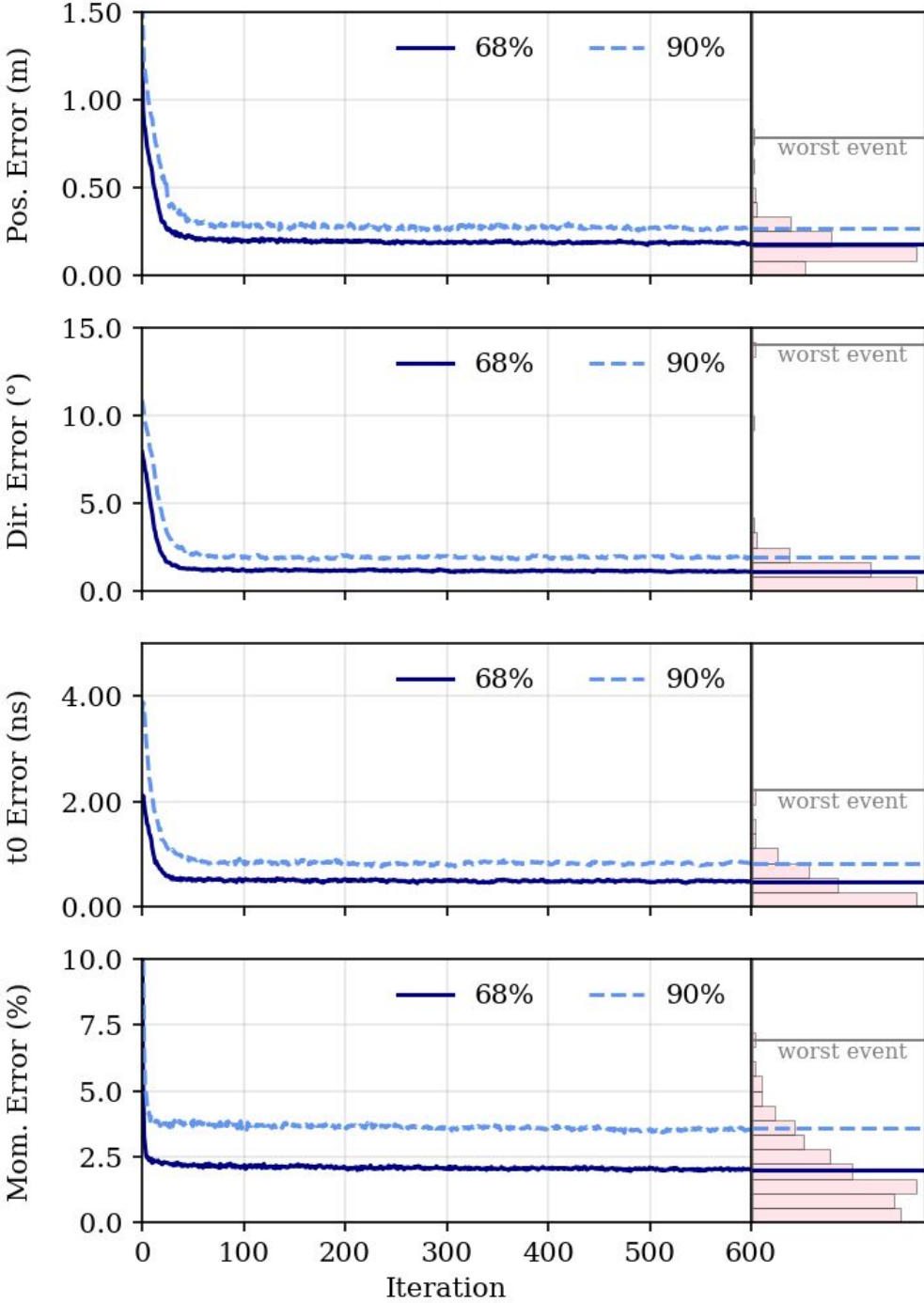
AFTER + LEG BOUND ON
1440 events, 400-1400 MeV, 600 iterations



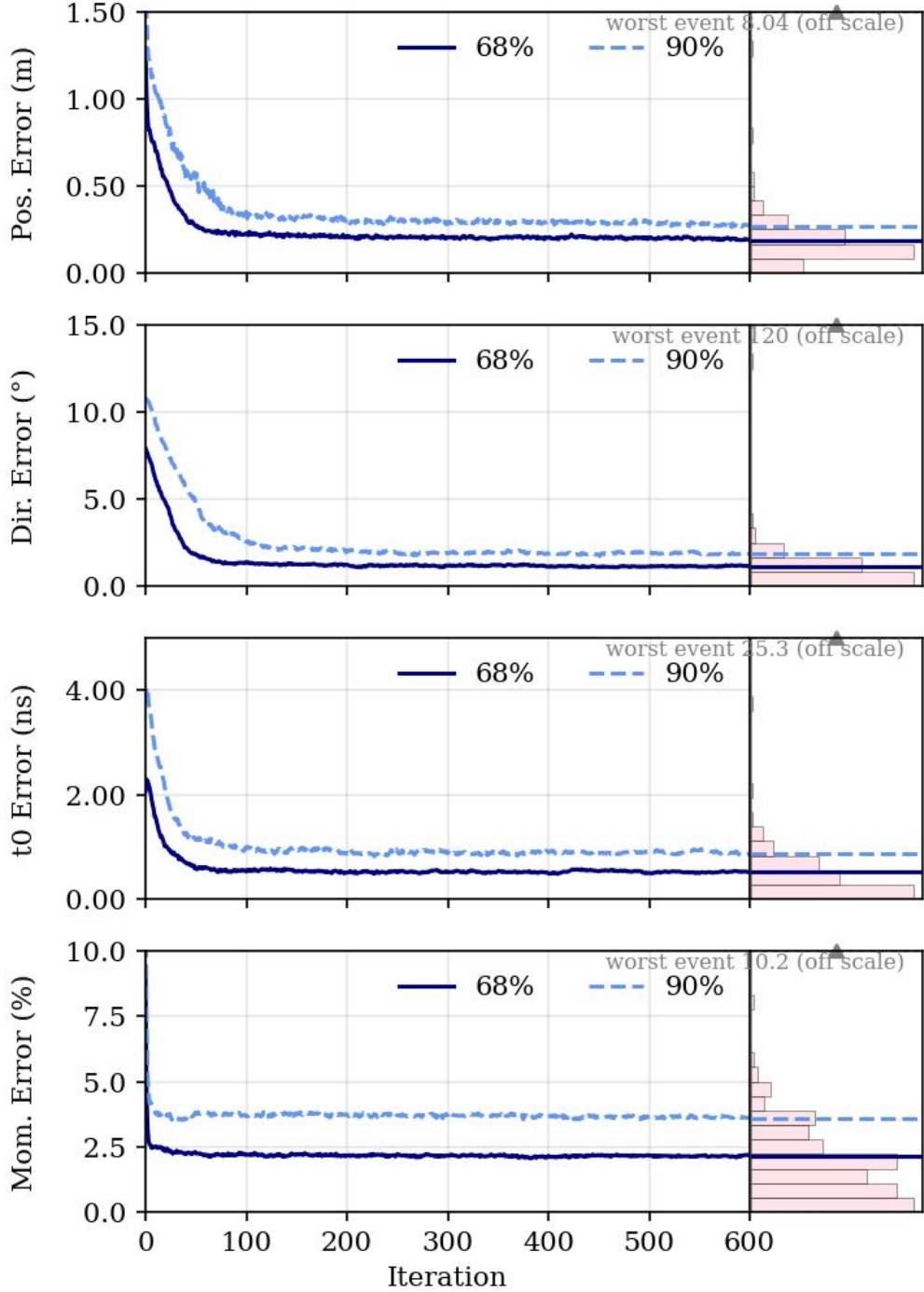
BEFORE: shipped baseline
1000 MeV, 120 events, 150 iterations



AFTER: deposit port + fixes
1000 MeV, 240 events, 600 iterations

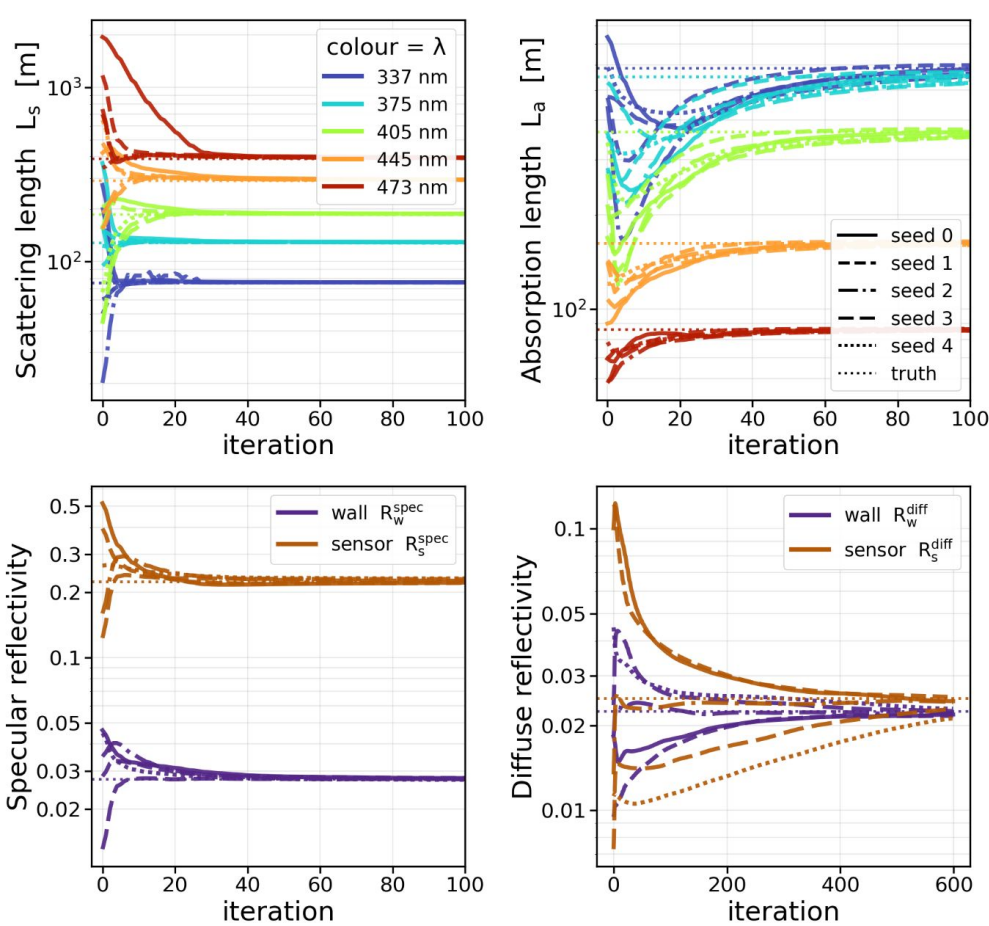


AFTER + LEG BOUND ON
1000 MeV, 240 events, 600 iterations

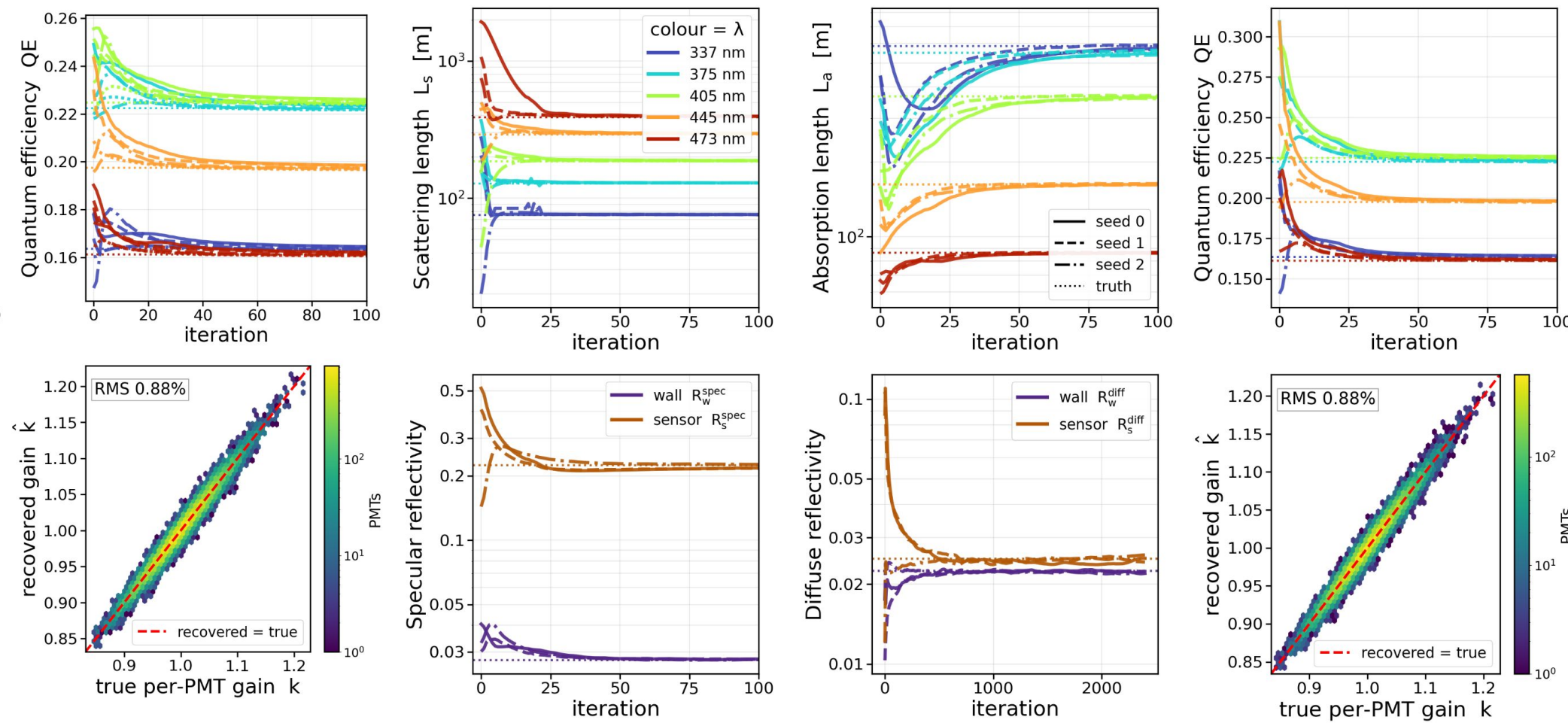


Calibration changes after

BEFORE: shipped baseline
19-parameter optical fit, 5 seeds, 600 steps

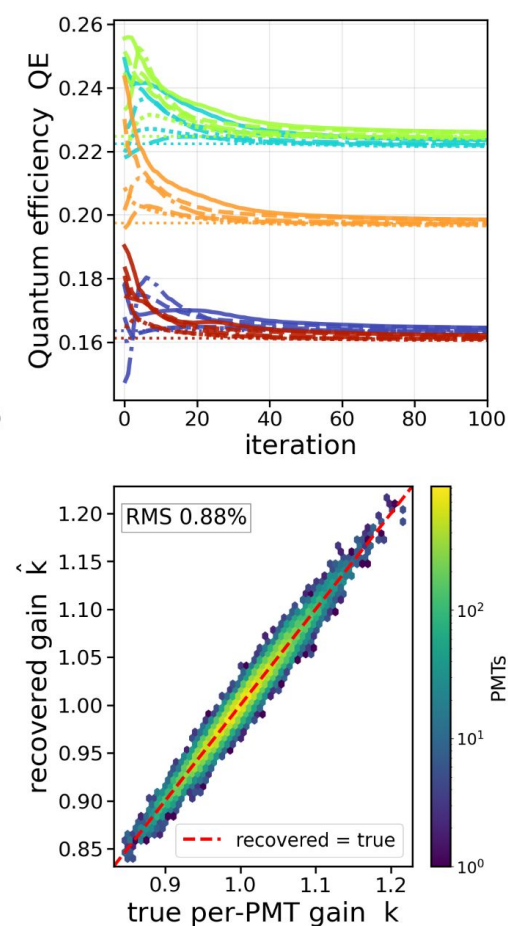
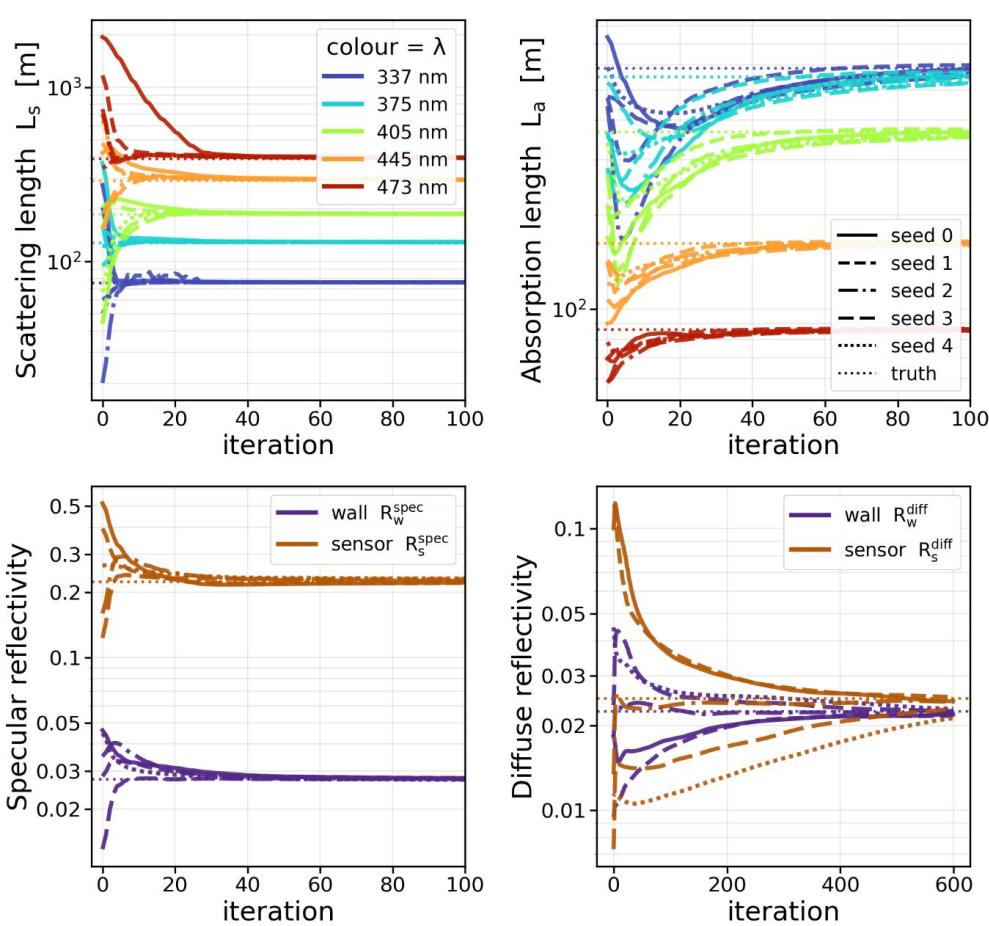


AFTER: deposit port + fixes
19-parameter optical fit, 3 seeds, 2400 steps

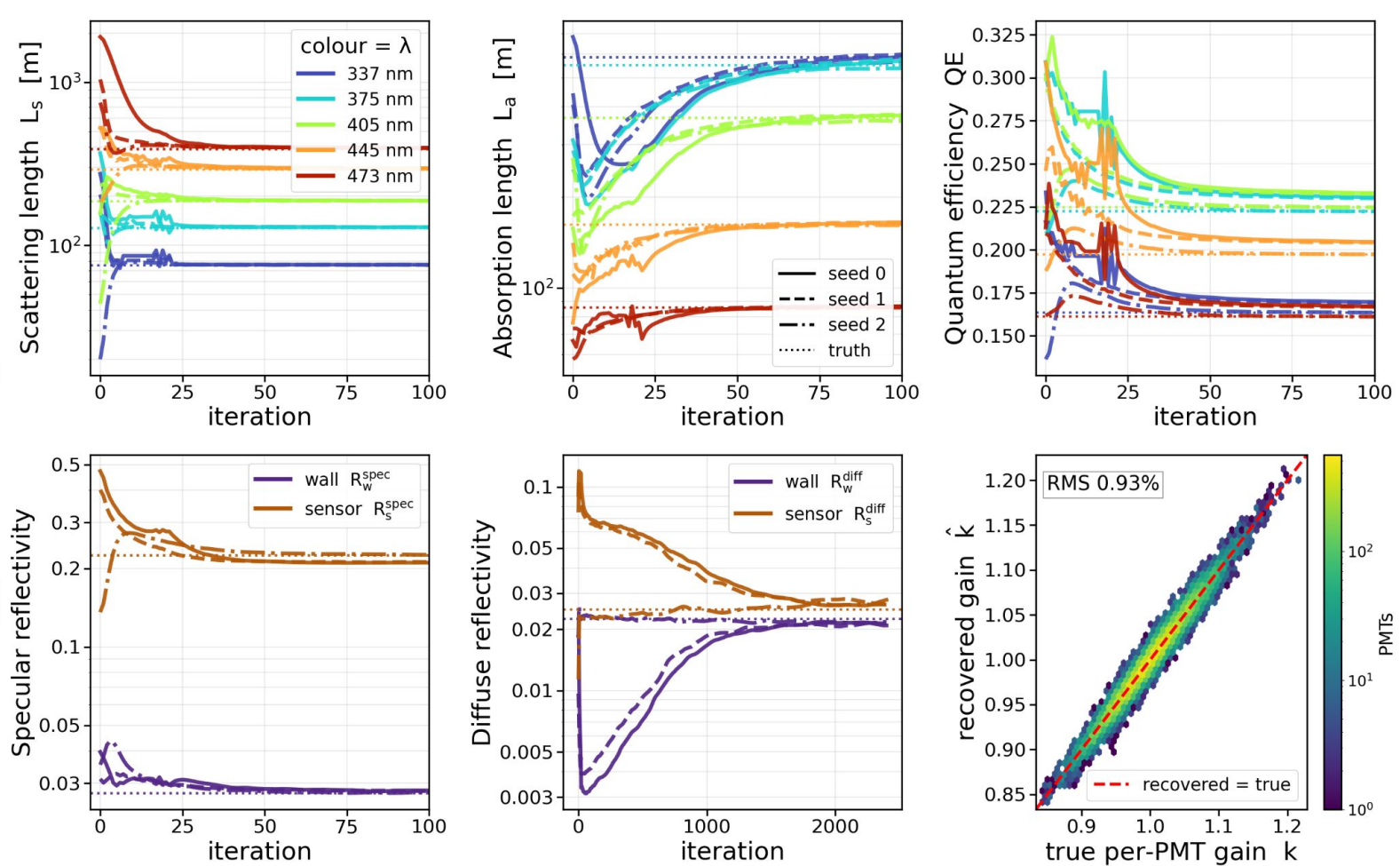


Calibration changes after + leg

BEFORE: shipped baseline
19-parameter optical fit, 5 seeds, 600 steps



AFTER + LEG BOUND ON
19-parameter optical fit, 3 seeds, 2400 steps



Next Steps

Code is currently being applied to a branch off of main and will be pushed today. Also relevant for the doraemon dataset