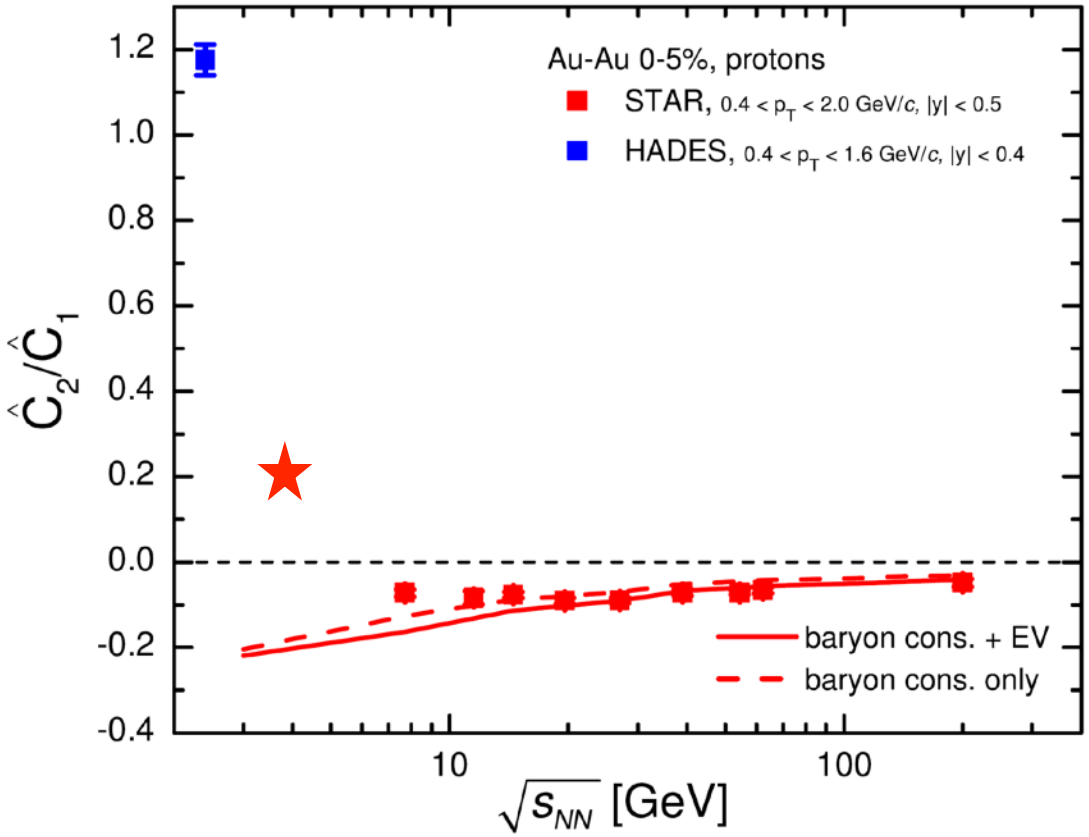
Lower energies $\sqrt{s_{NN}} \leq 7.7$ GeV

- Intriguing hint from HADES @ $\sqrt{s_{NN}} = 2.4$ GeV: huge two-particle correlations! [HADES Collaboration, PRC 102, 024914 (2020)]
- Extend the calculations down to $\sqrt{s_{NN}} = 3$ GeV by means of the blast-wave model
- No change of trend in the non-critical baseline
- Other important effects to consider
  - Light nuclei formation
  - Nuclear liquid-gas transition



Data from STAR-FXT eagerly awaited!

Thermodynamic analysis of HADES data

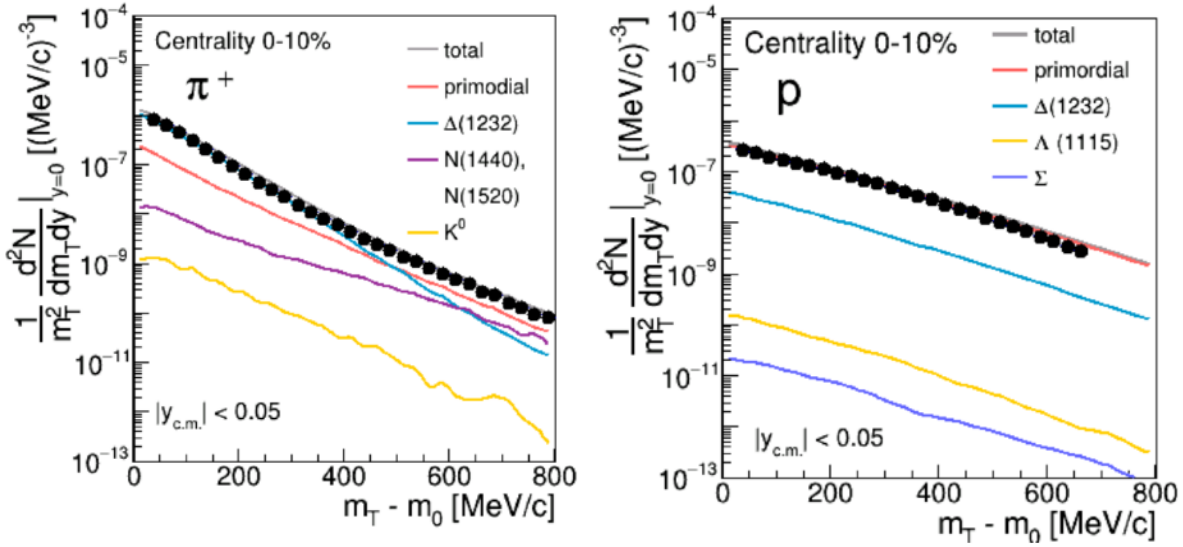
VV, Koch, in preparation

- Single freeze-out scenario: Emission from Siemens-Rasmussen hypersurface with Hubble-like flow

  → Pion and proton spectra o.k.

  [S. Harabasz et al., PRC 102, 054903 (2020)]

- Uniform $T \approx 70$ MeV, $\mu_B \approx 875$ MeV across the fireball [A. Motornenko et al., PLB 822, 136703 (2021)]



- Fluctuations:
  - Same as before but incorporate additional binomial filtering to account for protons bound in light nuclei
  - Uniform fireball → Final proton cumulants are linear combinations of baryon susceptibilities χ_n^B

→ Extract χ_n^B directly from experimental data

Calculation

Use fireball from Tetyana et al

Accepted protons is simply a binomial prob.

$$p_{\mathrm{acc}}(x) = \frac{\int_{p\in\Delta p_{\mathrm{acc}}} \frac{d^3p}{\omega_p}\, d\sigma_\mu(x) p^\mu f[u^\nu(x)p_\nu]}{\int_p \frac{d^3p}{\omega_p}\, d\sigma_\mu(x) p^\mu f[u^\nu(x)p_\nu]}$$

$$\hat{C}_n(accept) = p^n \hat{C}_n(full) = \frac{N^n_{accept}}{N^n_{total}} \hat{C}_n(full)$$

$$\Rightarrow \hat{C}_n \sim N^n$$

Thermodynamic analysis of HADES data

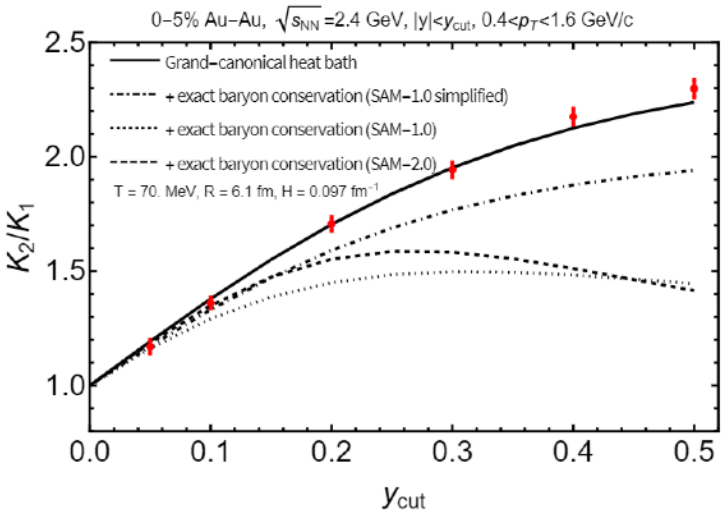
VV, Koch, in preparation

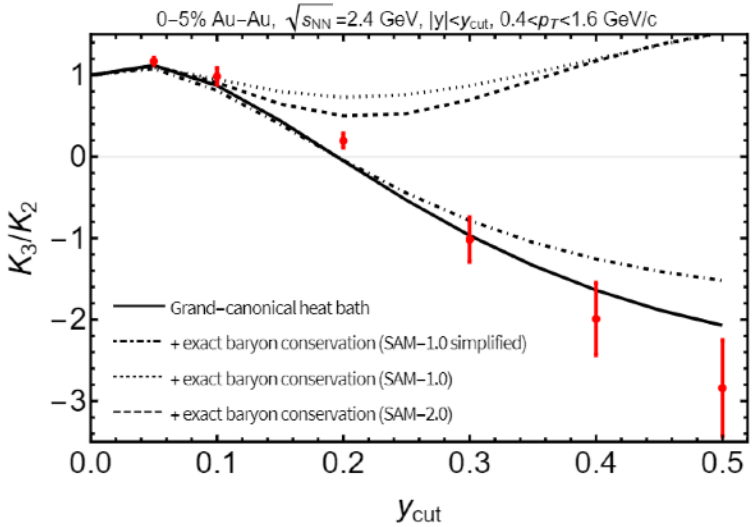
- In the grand-canonical limit (no baryon conservation) the data are described well with

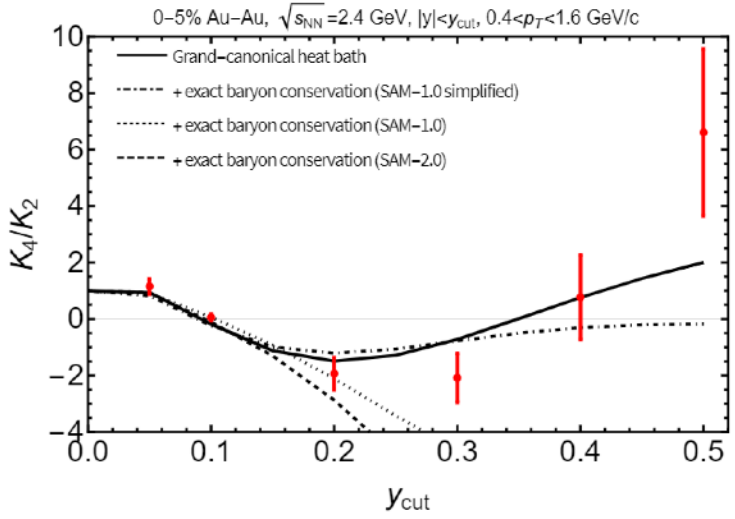
$$\frac{\chi_2^B}{\chi_1^B} = 9.35 \pm 0.40, \qquad \frac{\chi_3^B}{\chi_2^B} = -39.6 \pm 7.2, \qquad \frac{\chi_4^B}{\chi_2^B} = 1130 \pm 488$$

- Could be indicative of a critical point near the HADES freeze-out at $T \approx 70$ MeV, $\mu_B \approx 875$ MeV

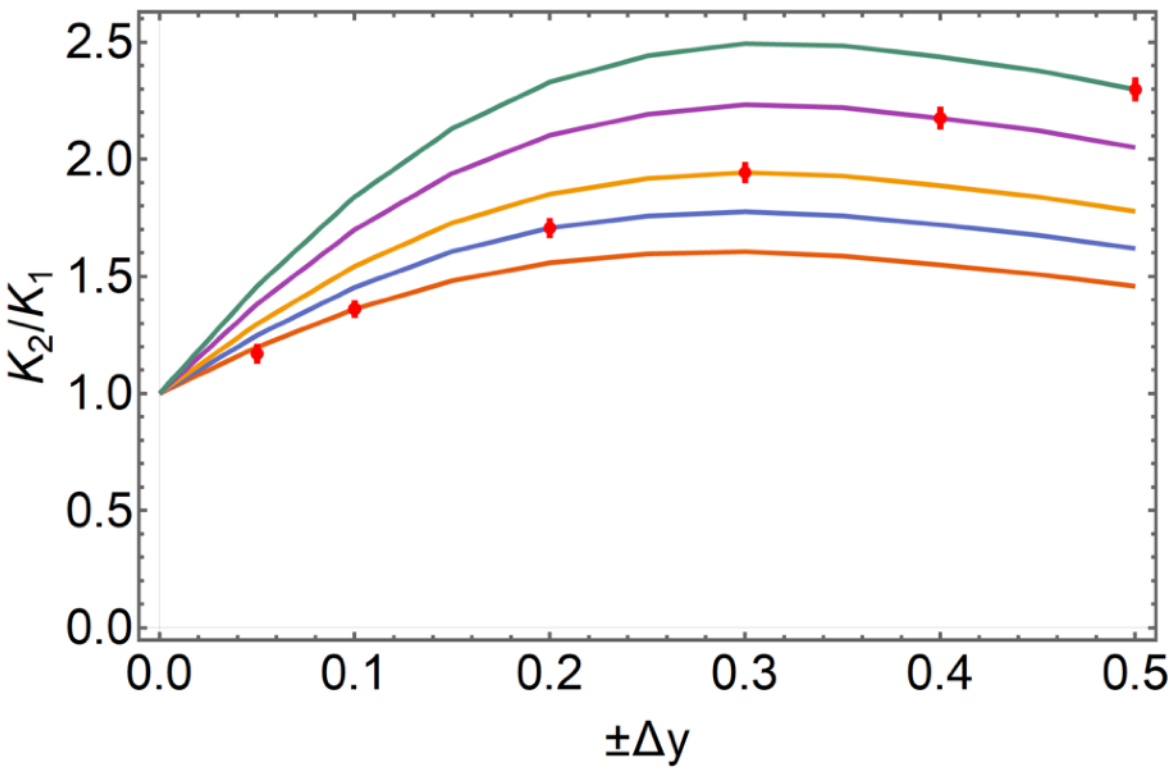
- However, the results are challenging to describe with baryon conservation included

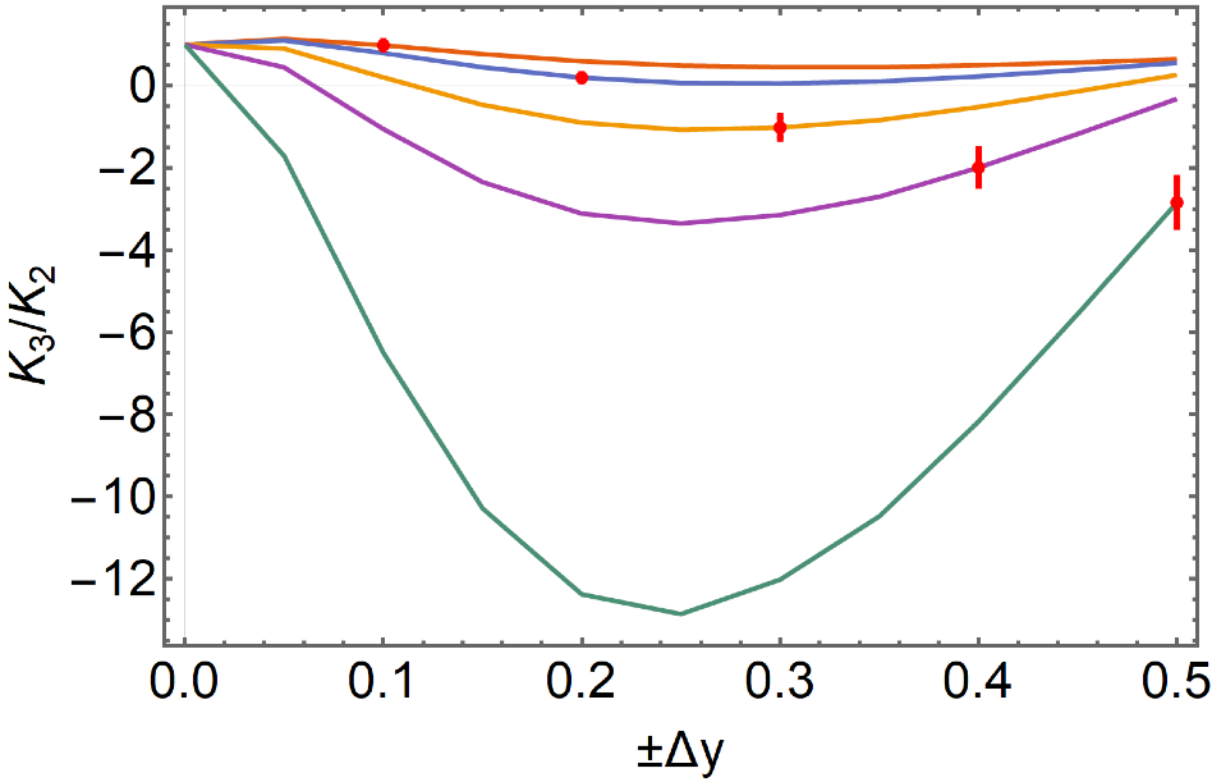




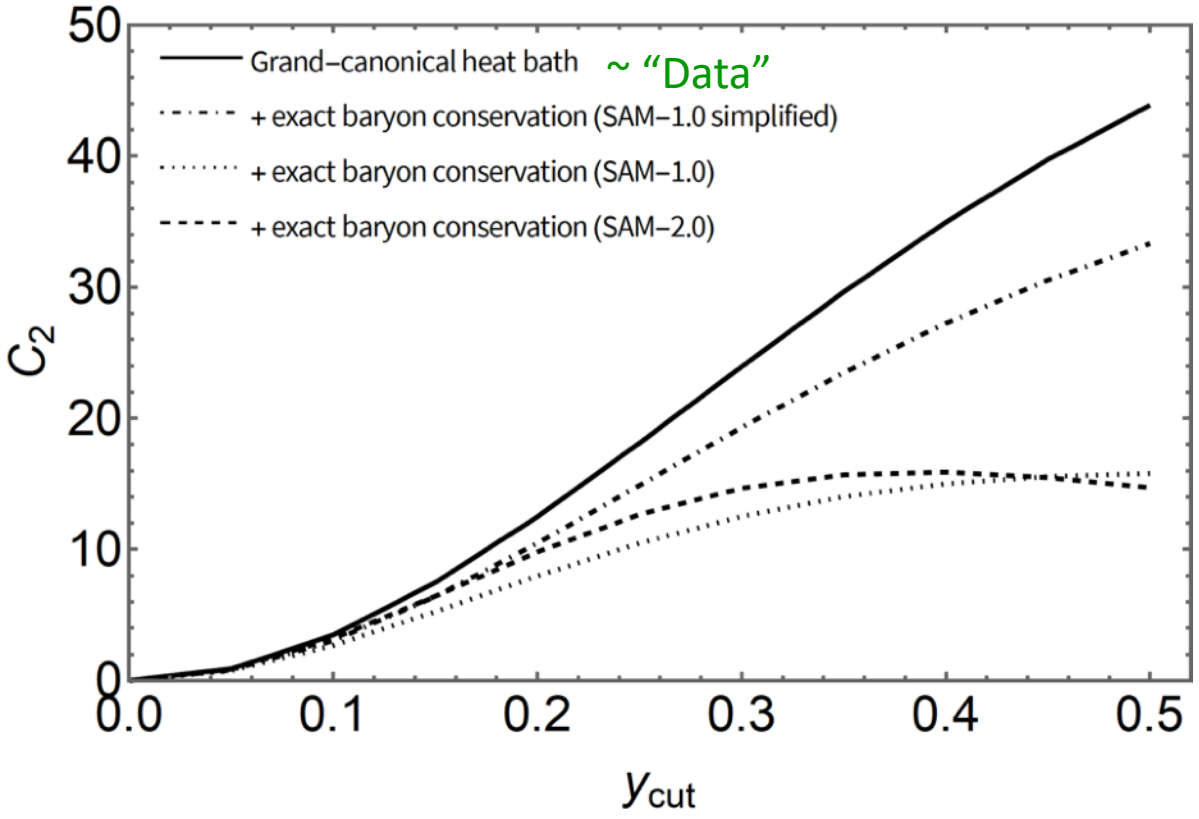


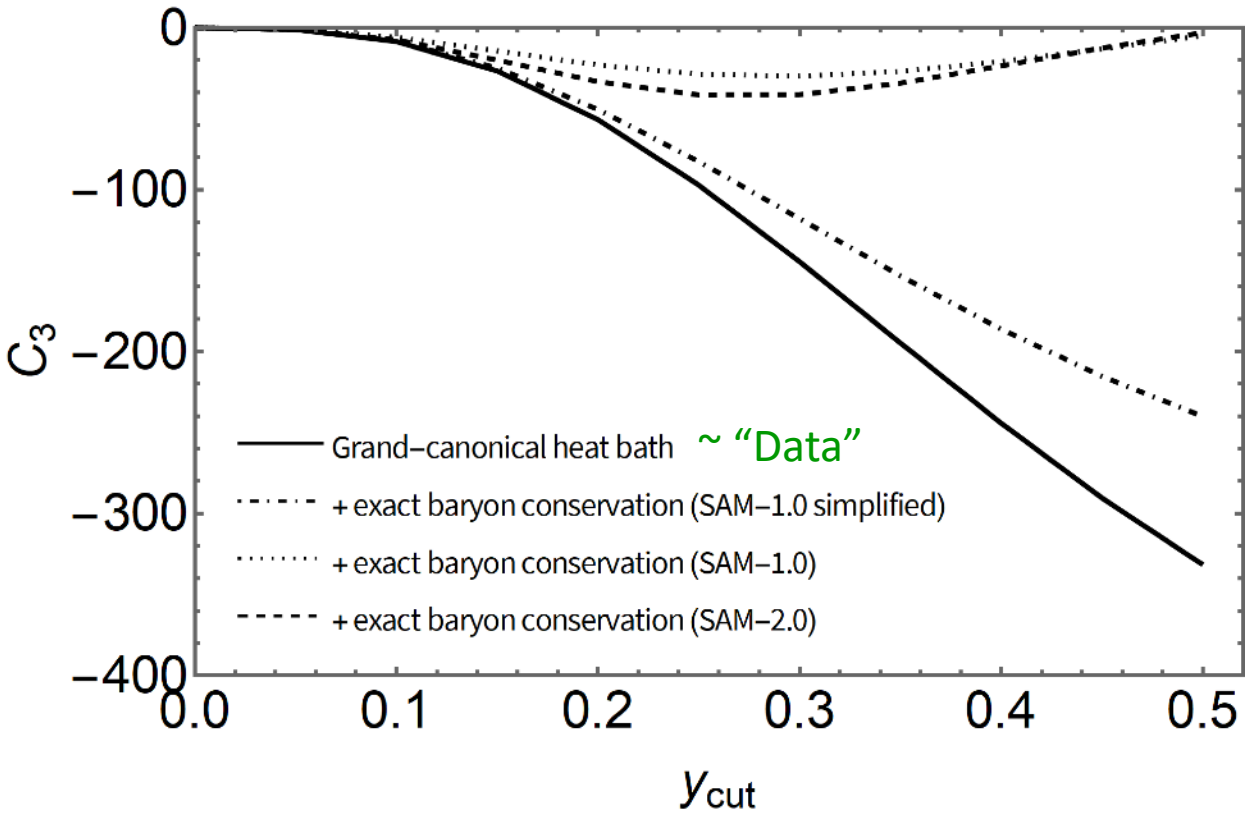
Fit WITH baryon number conservation



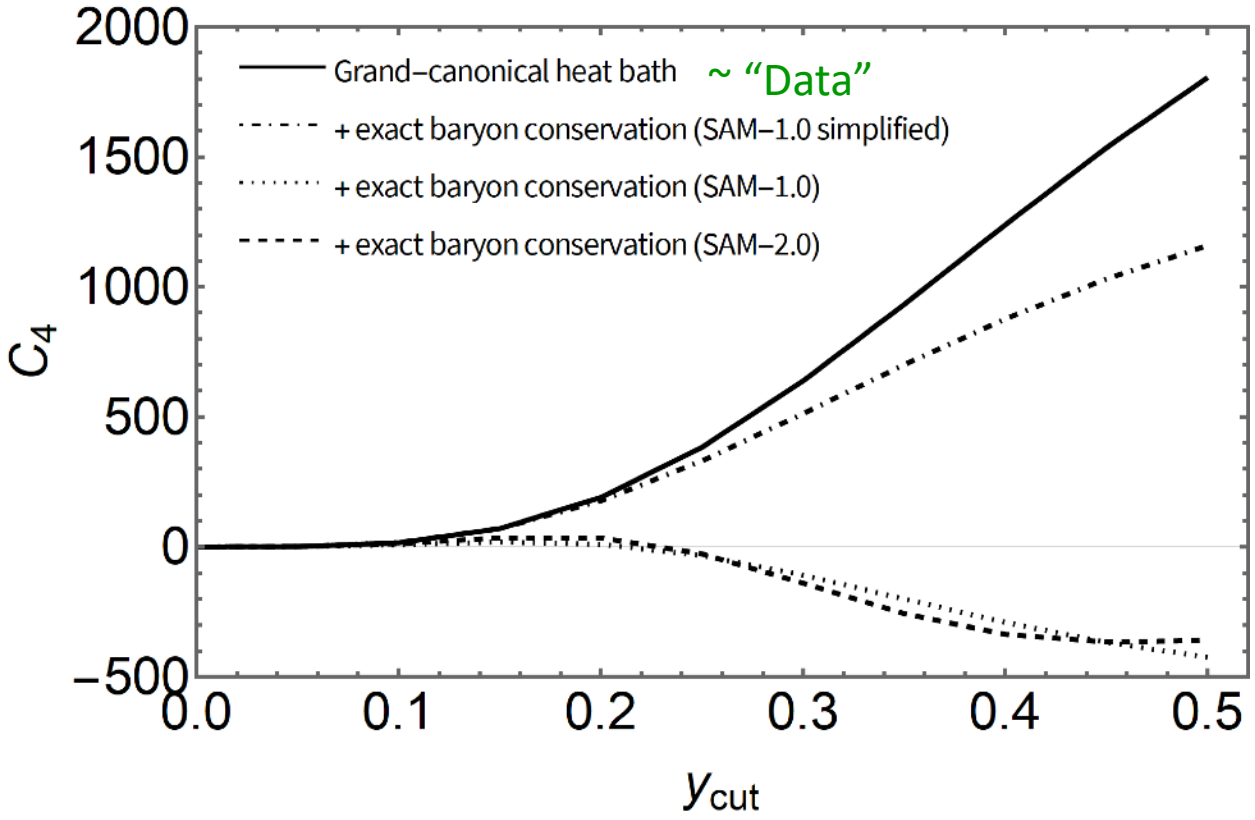


Factorial cumulants (correlations)





Factorial cumulants (correlations)



Correlations with increase in magnitude are need to get to the data

"bi-modal" would do this, but ….