JEFF-3.3 covariance application to ICSBEP using SANDY and NDaST

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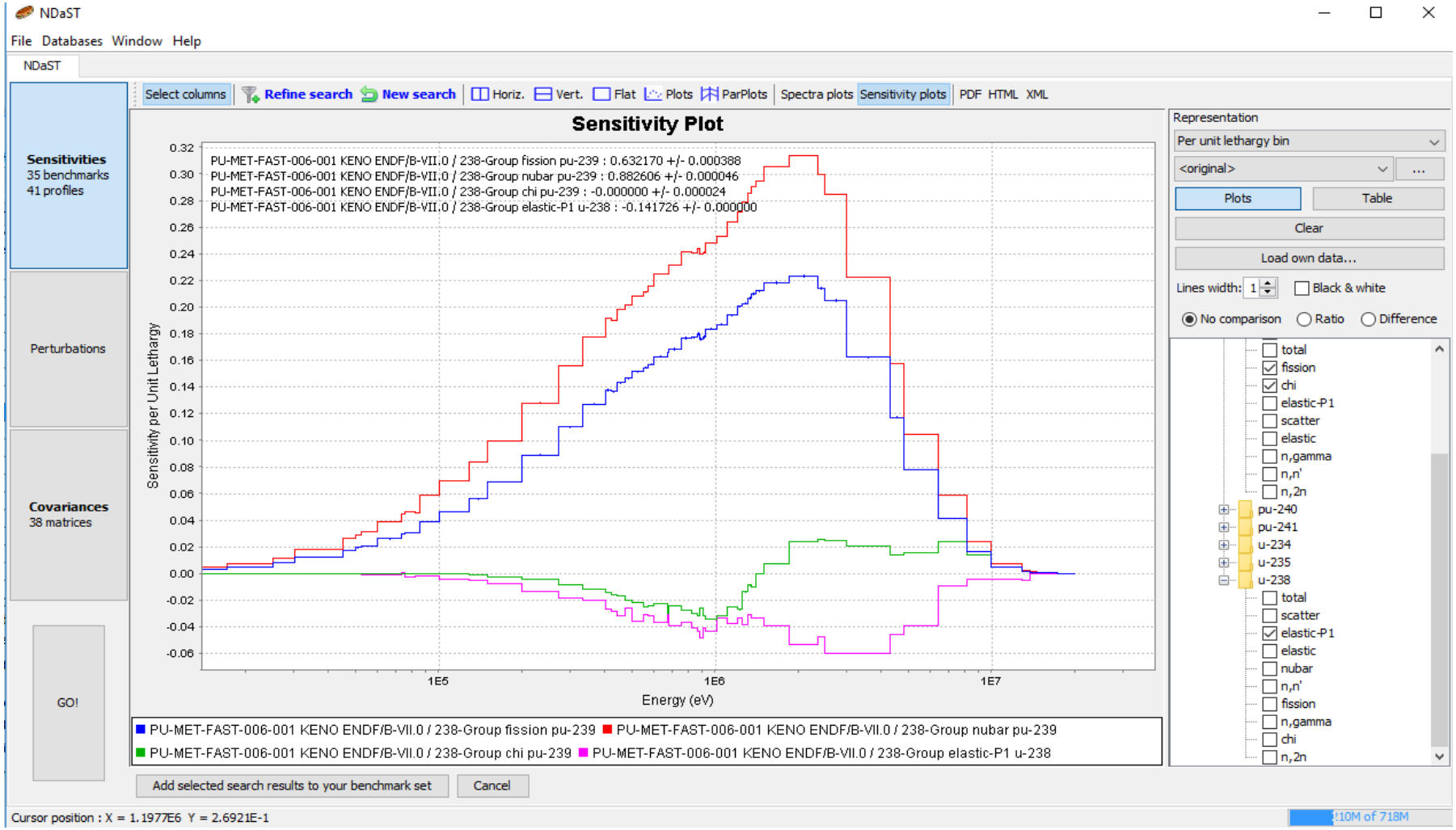
WPEC SG44: Nuclear Data Week – November 2018

Objectives

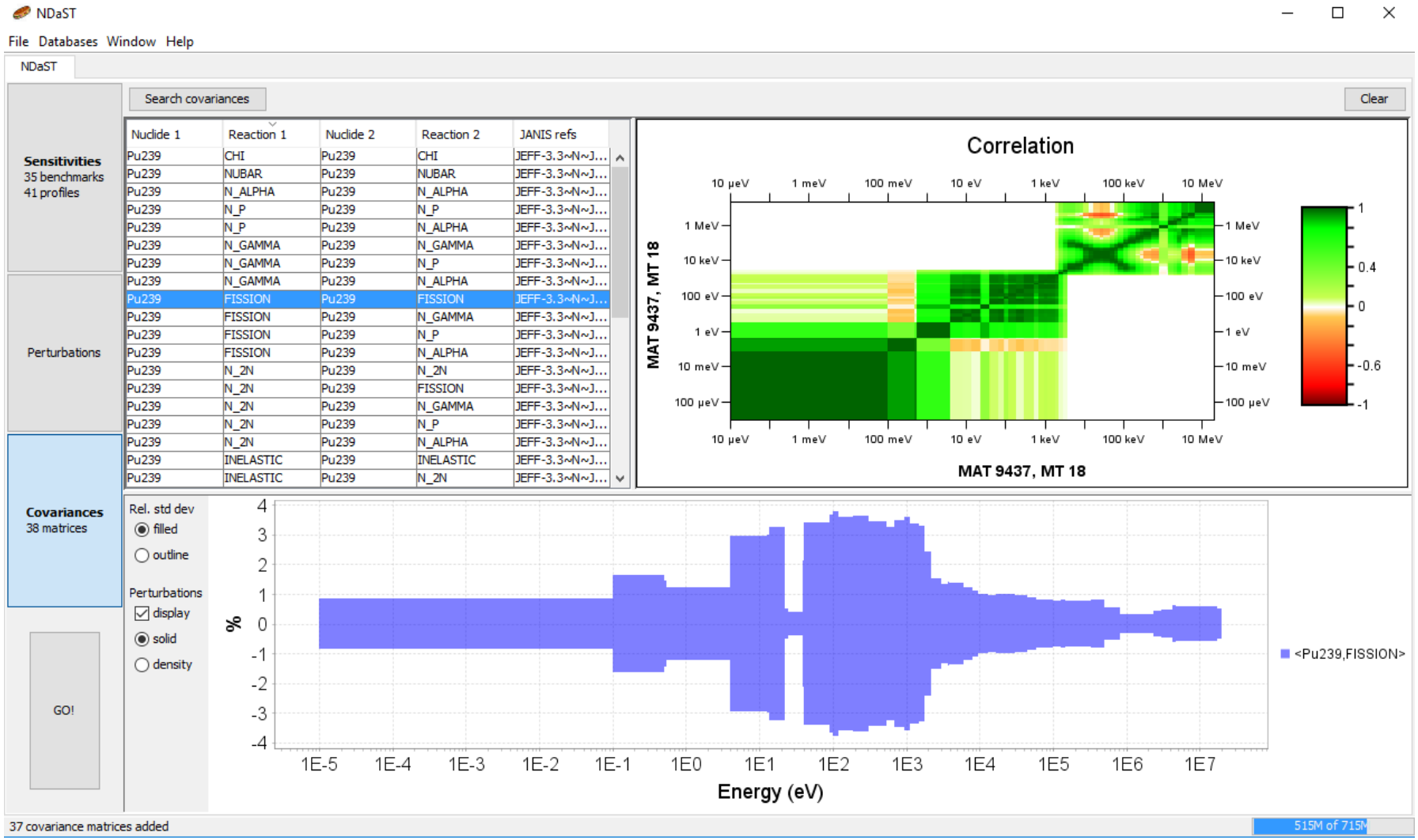
- Code comparison for uncertainty quantification on a selection of ICSBEP cases
- Focus on newly implemented features (P1 elastic)
- Identification of shortcomings in data and methodologies

NDaST	SANDY
Sensitivity tool	Nuclear data sampling tool
Java-based software	Python package

Sensitivities from DICE



Covariances from JANIS



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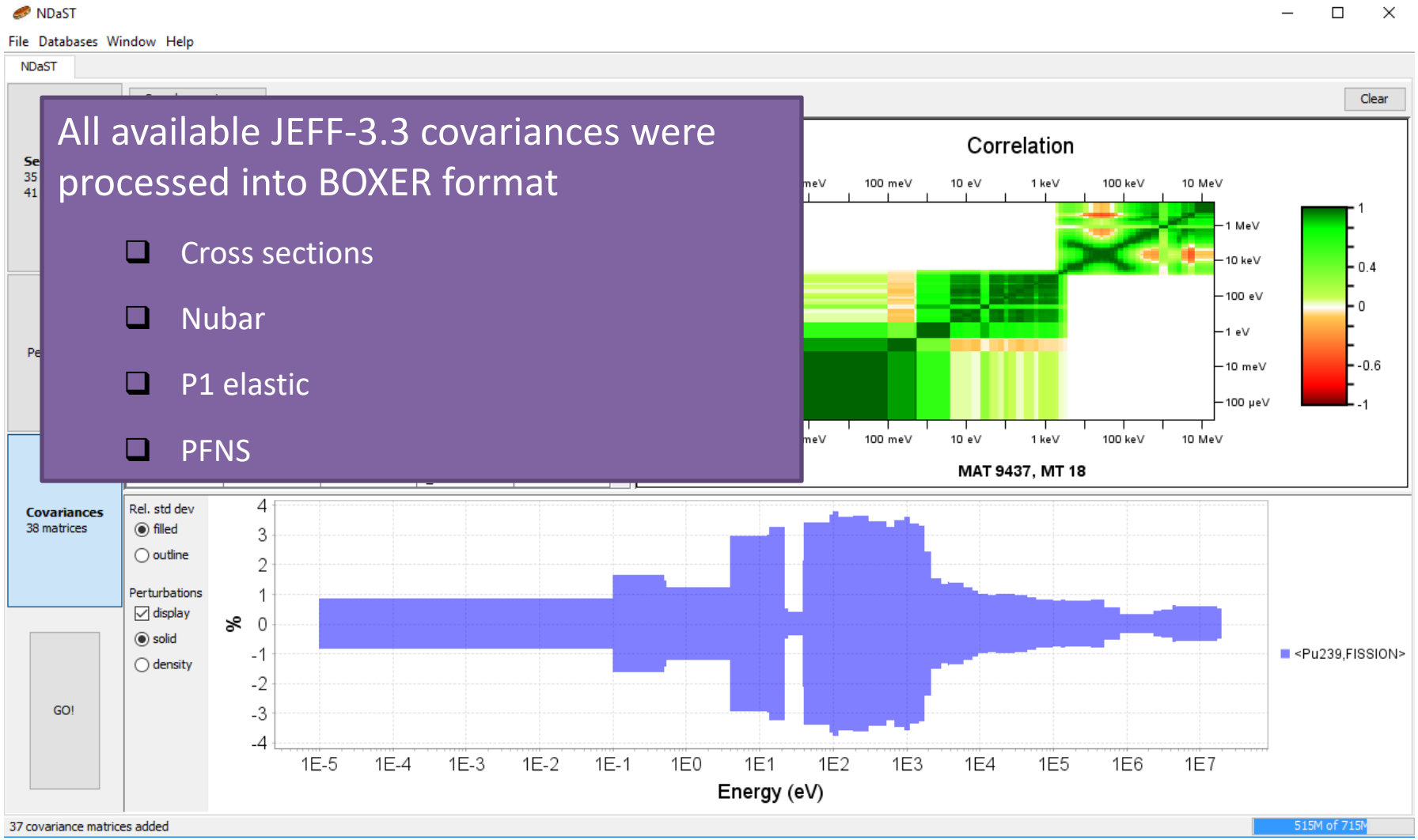
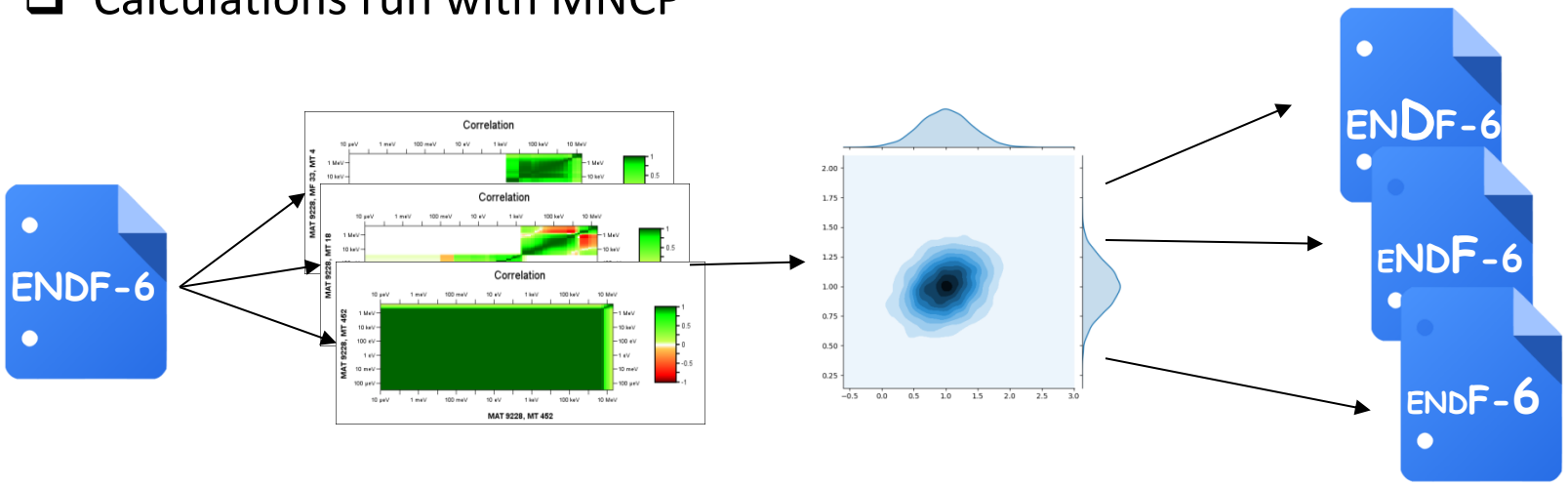


SANDY

- Production of *perturbed* files for brute force uncertainty propagation

$$x_1^{(1)}, x_2^{(1)}, \dots, x_3^{(1)} \longrightarrow f(x_1^{(1)}, x_2^{(1)}, \dots, x_3^{(1)}) \longrightarrow y^{(1)}$$
$$x_1^{(2)}, x_2^{(2)}, \dots, x_3^{(2)} \longrightarrow f(x_1^{(2)}, x_2^{(2)}, \dots, x_3^{(2)}) \longrightarrow y^{(2)}$$
$$x_1^{(N)}, x_2^{(N)}, \dots, x_3^{(N)} \longrightarrow f(x_1^{(N)}, x_2^{(N)}, \dots, x_3^{(N)}) \longrightarrow y^{(N)}$$
$$\Big\} COV_y$$

- Data and covariances from JEFF-3.3
- Calculations run with MNCP

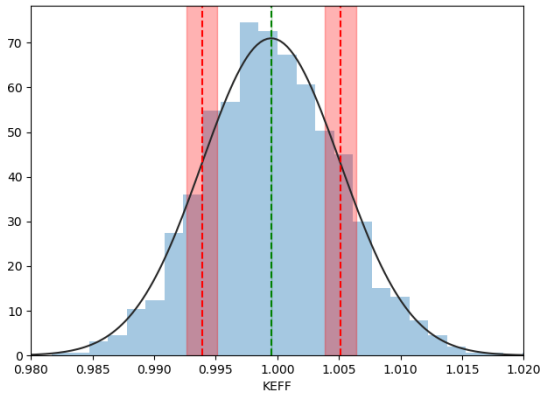


Comparison NDaST / SANDY

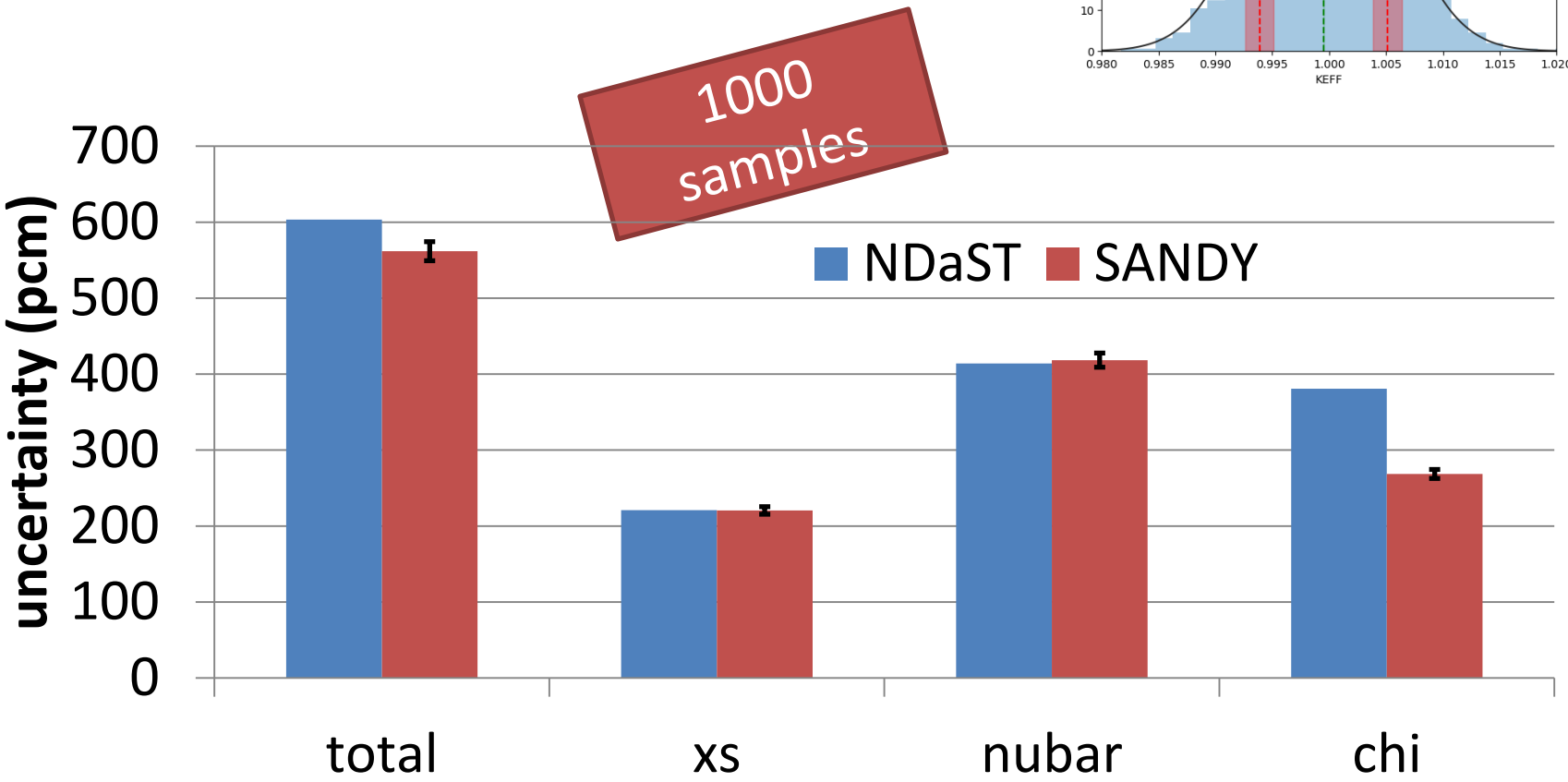
Mosteller's suite

- Jezebel
- Plutonium benchmarks
- PMF6

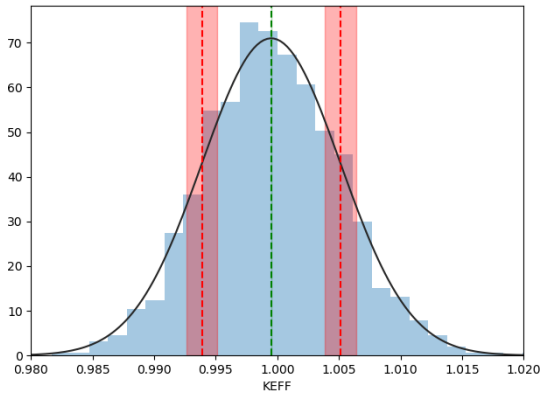
Jezebel



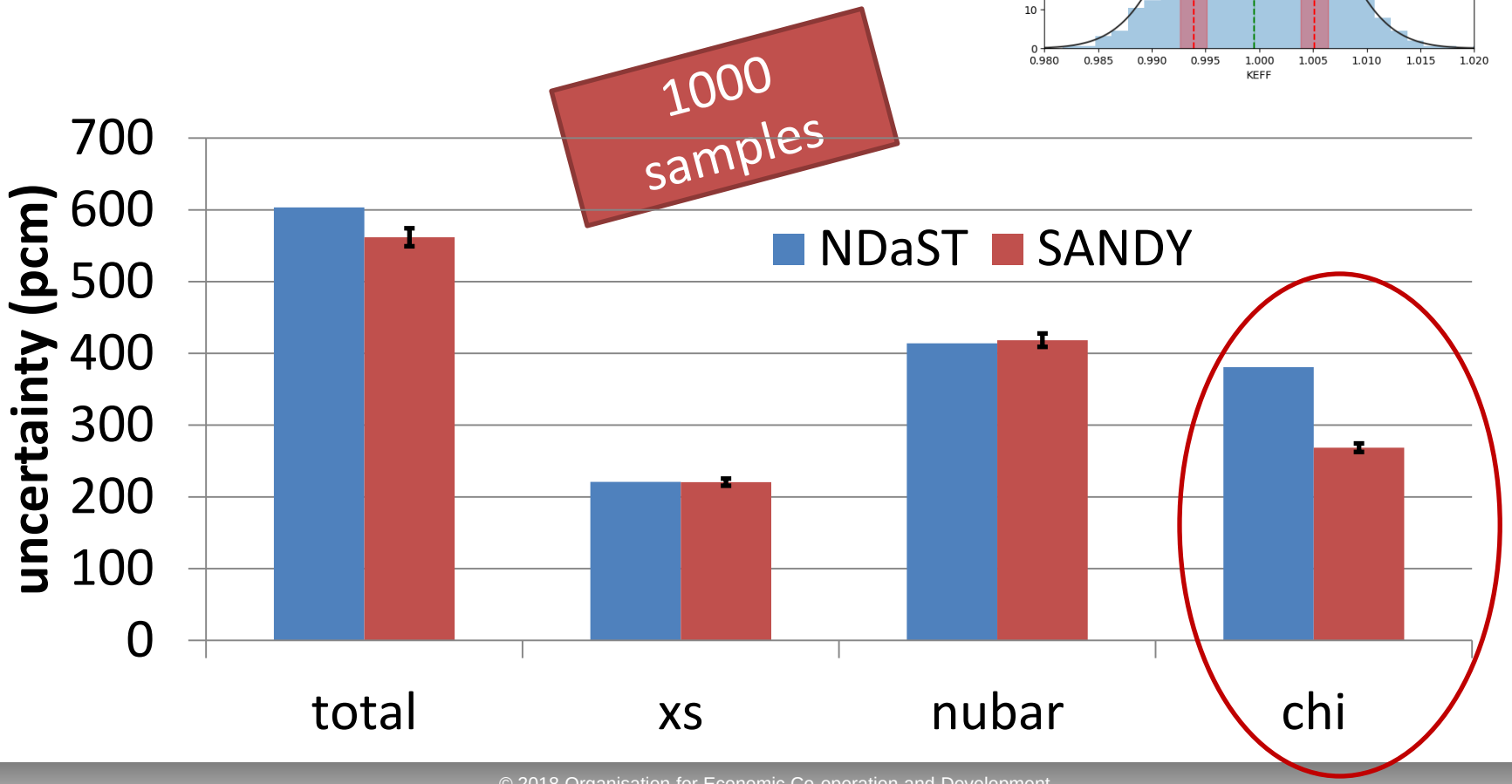
- Comparison NDaST / SANDY for Pu239
- No covariances for angular distributions



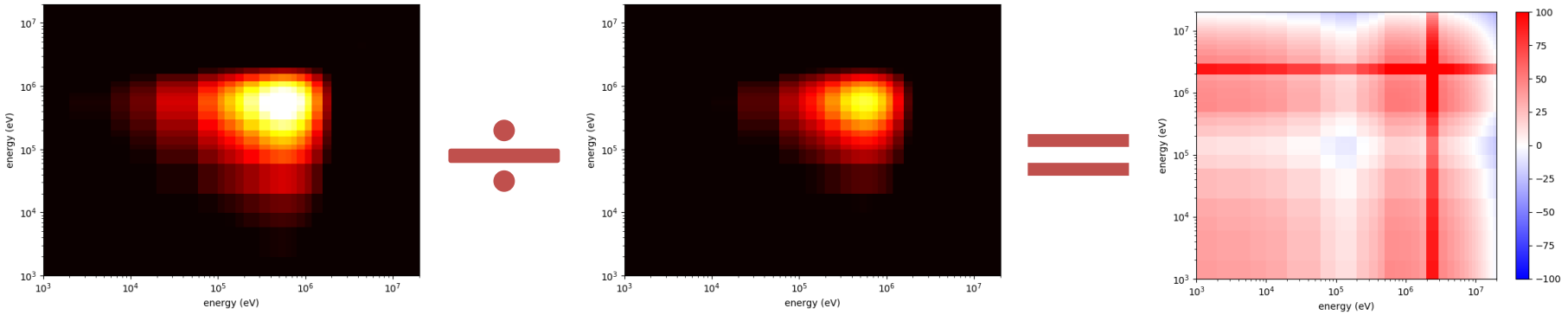
Jezebel

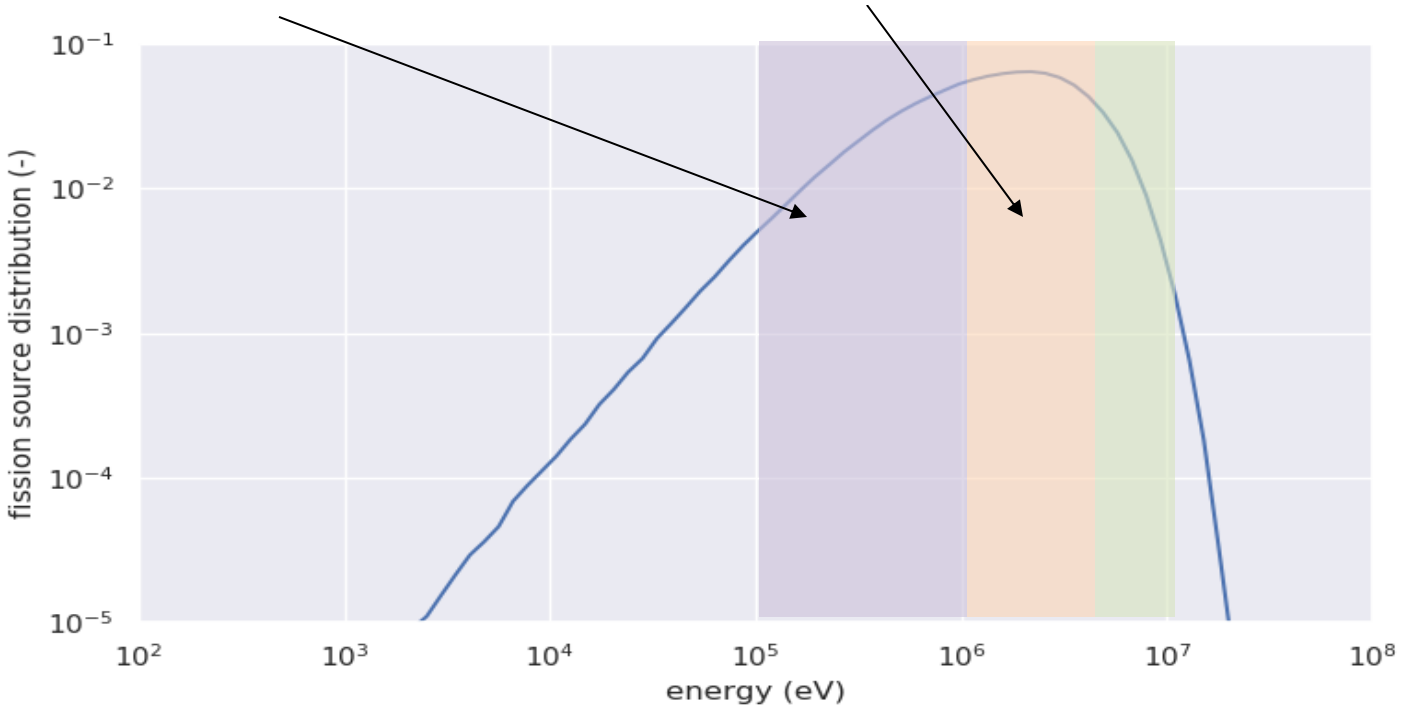


- Comparison NDaST / SANDY for Pu239
- Discrepancy for PFNS

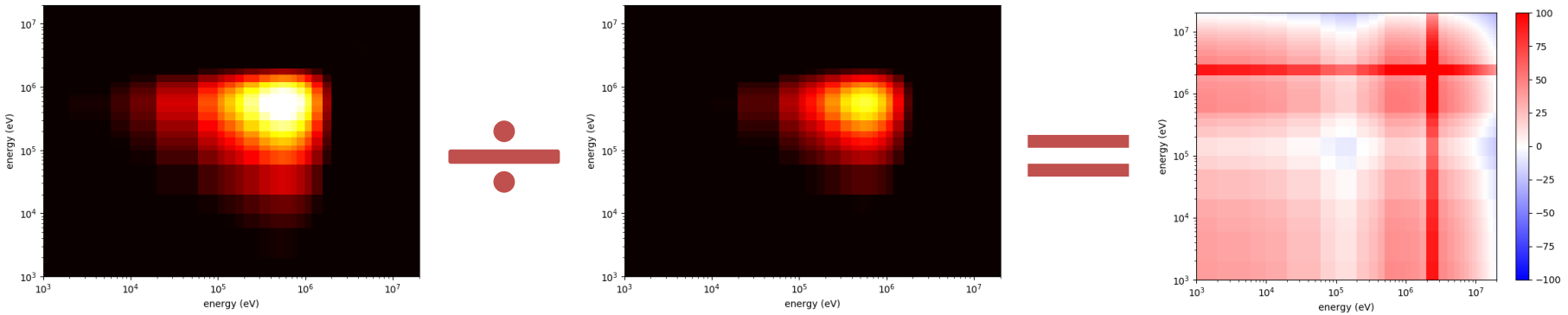


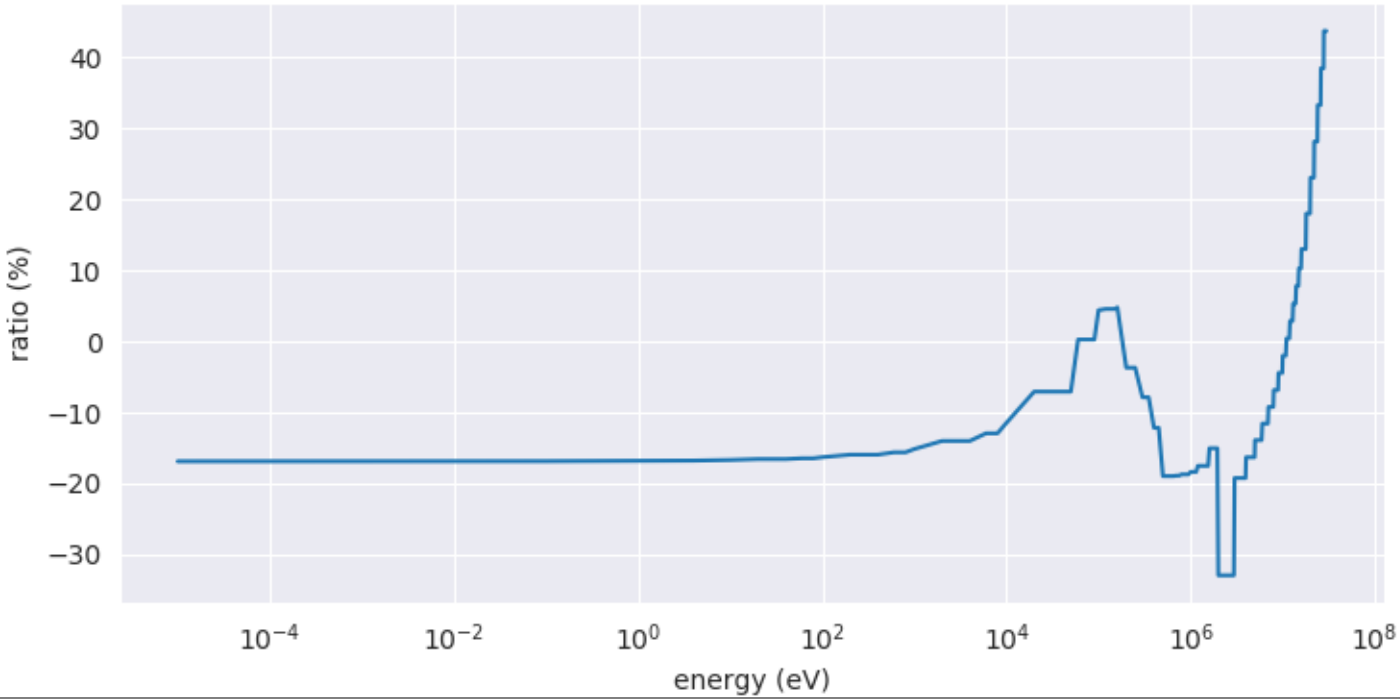
Different PFNS covariance matrices





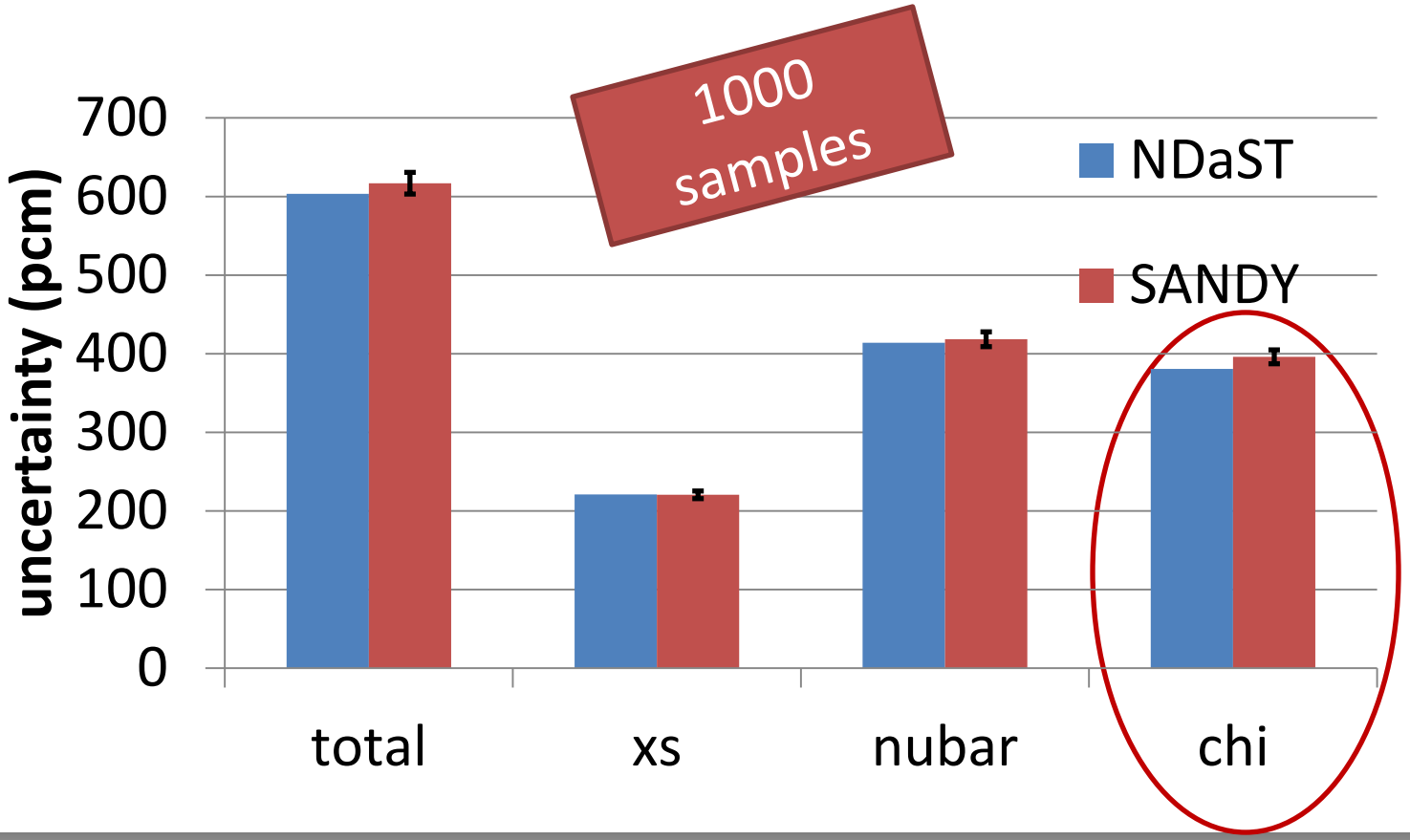
Different PFNS covariance matrices



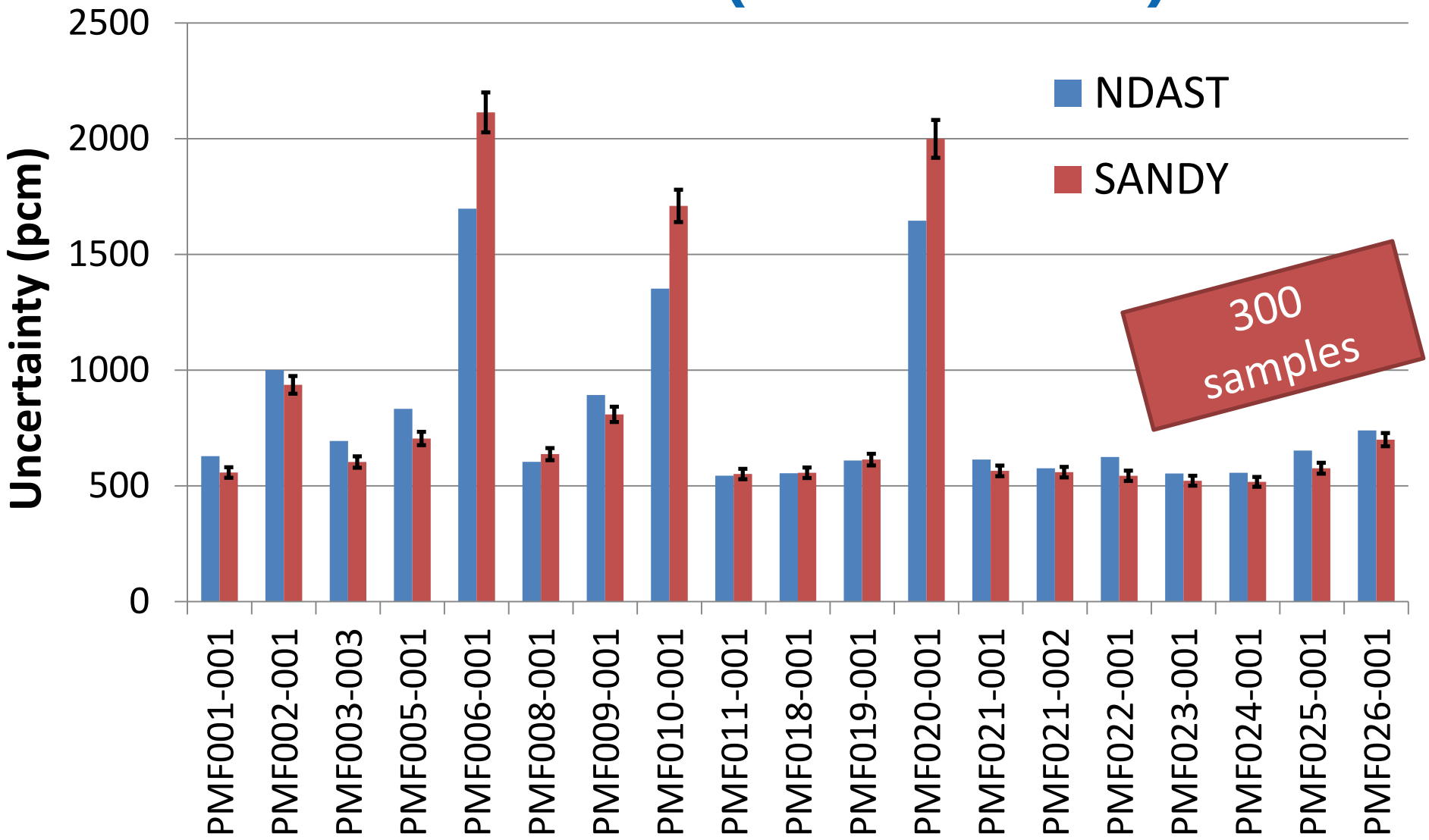


Jezebel

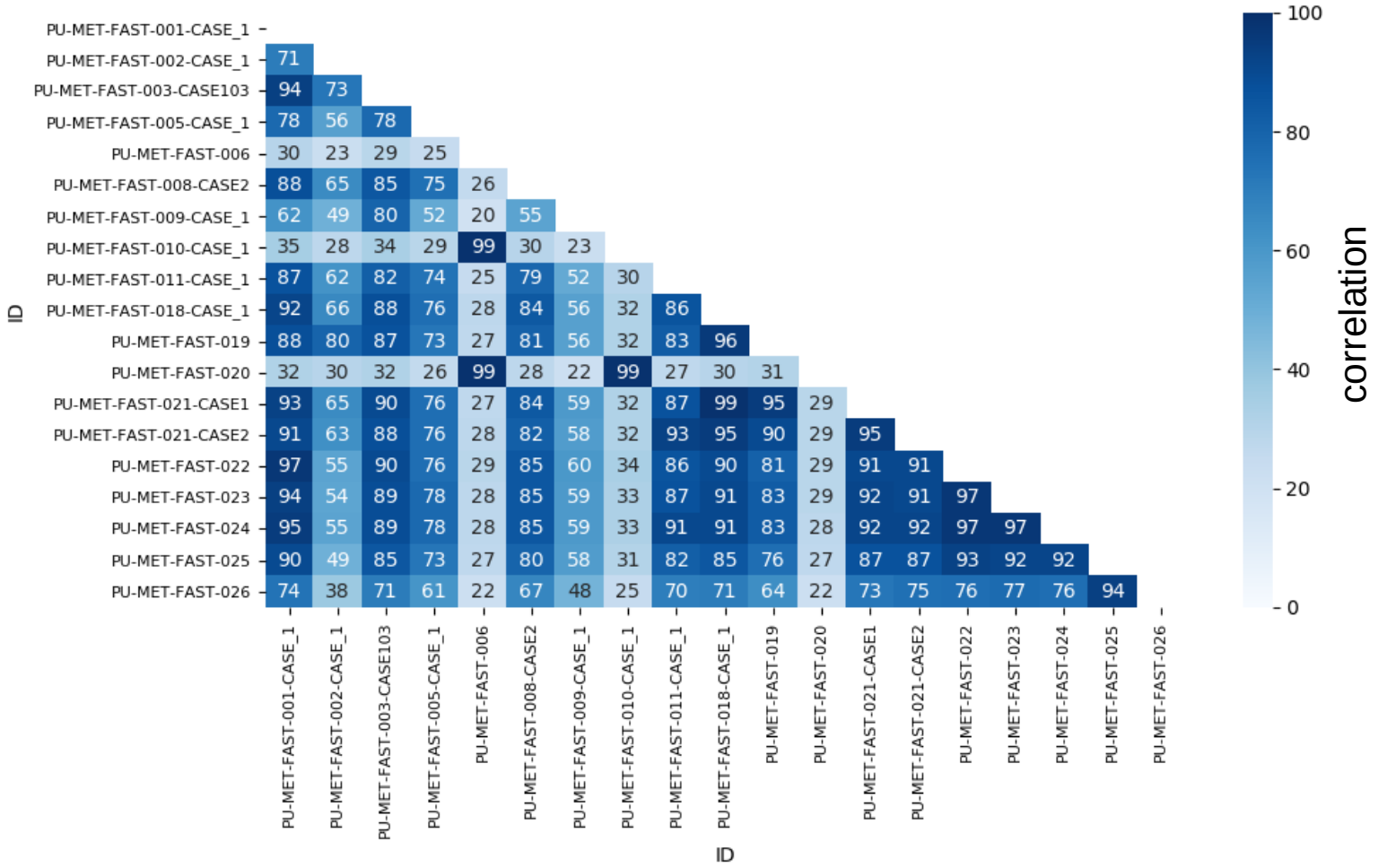
- NDaST results can be reproduced by SANDY sampling from only one covariance matrix



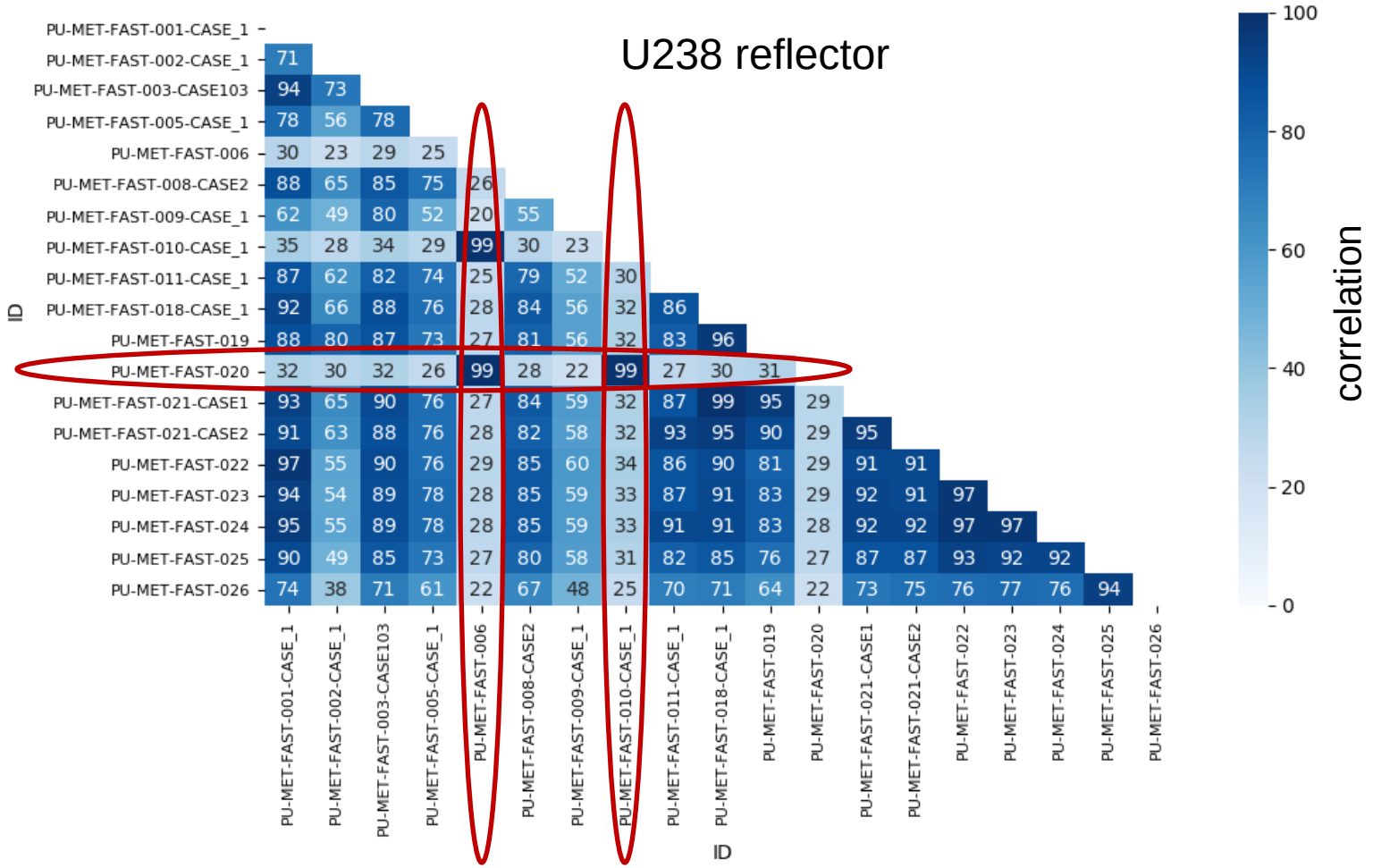
PU-MET-FAST (uncertainties)



PU-MET-FAST (correlations)

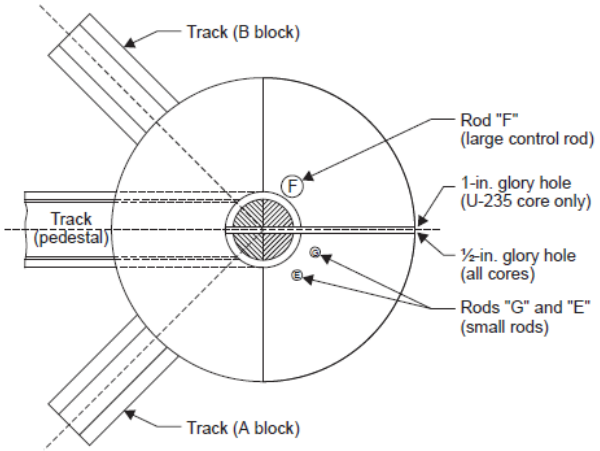


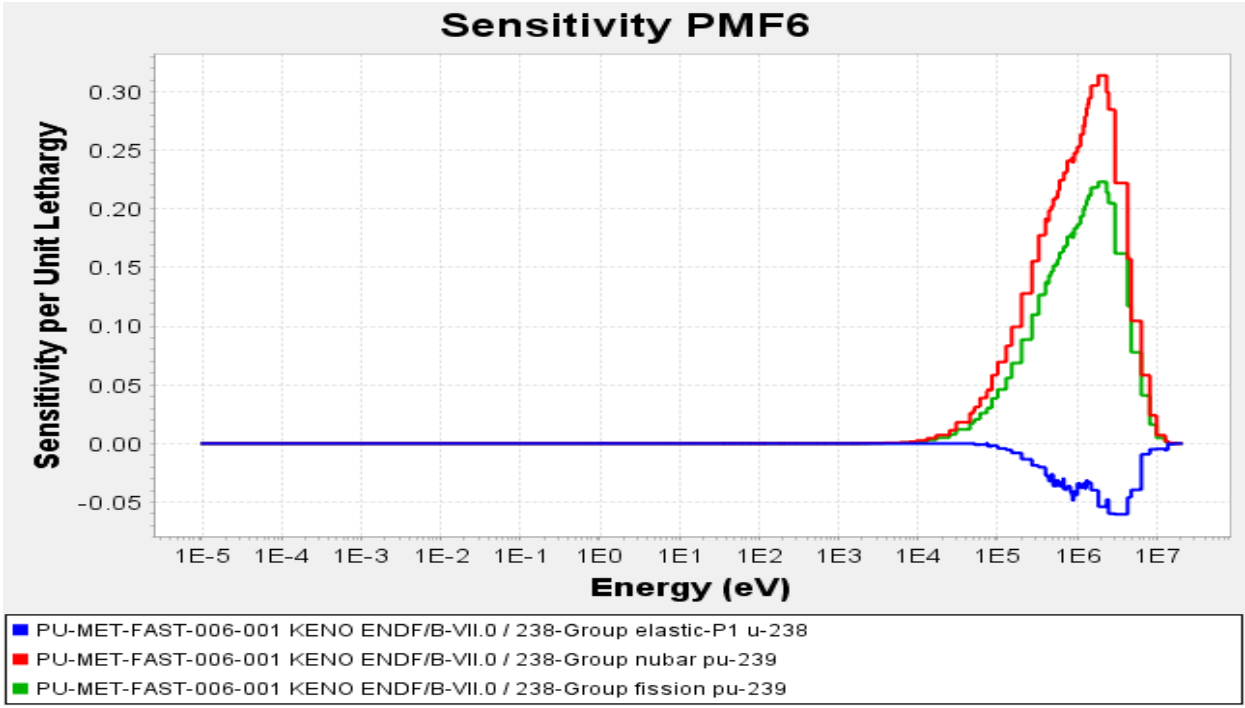
PU-MET-FAST (correlations)



Pu-Met-Fast-006

U238-reflected Pu sphere

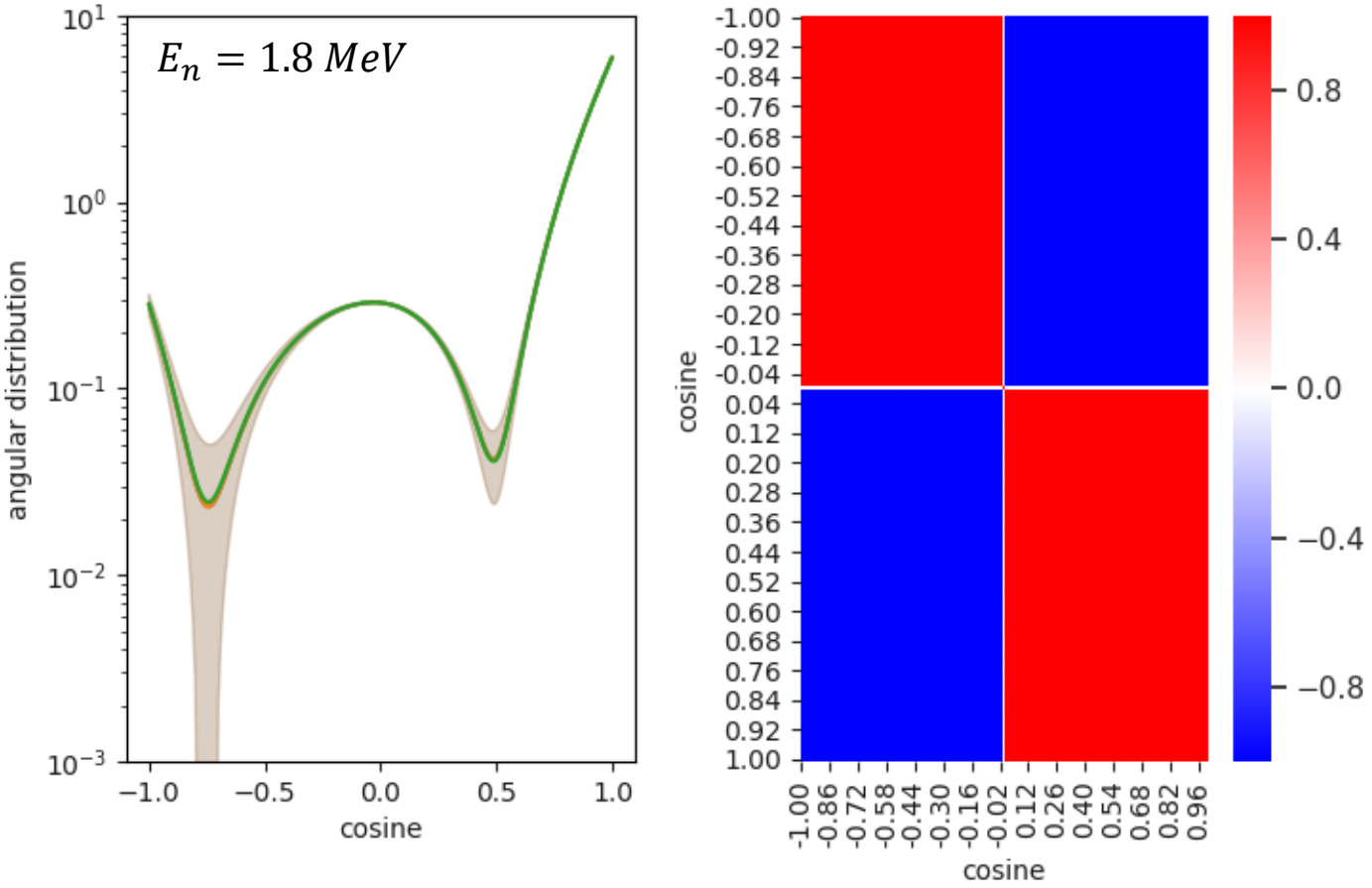




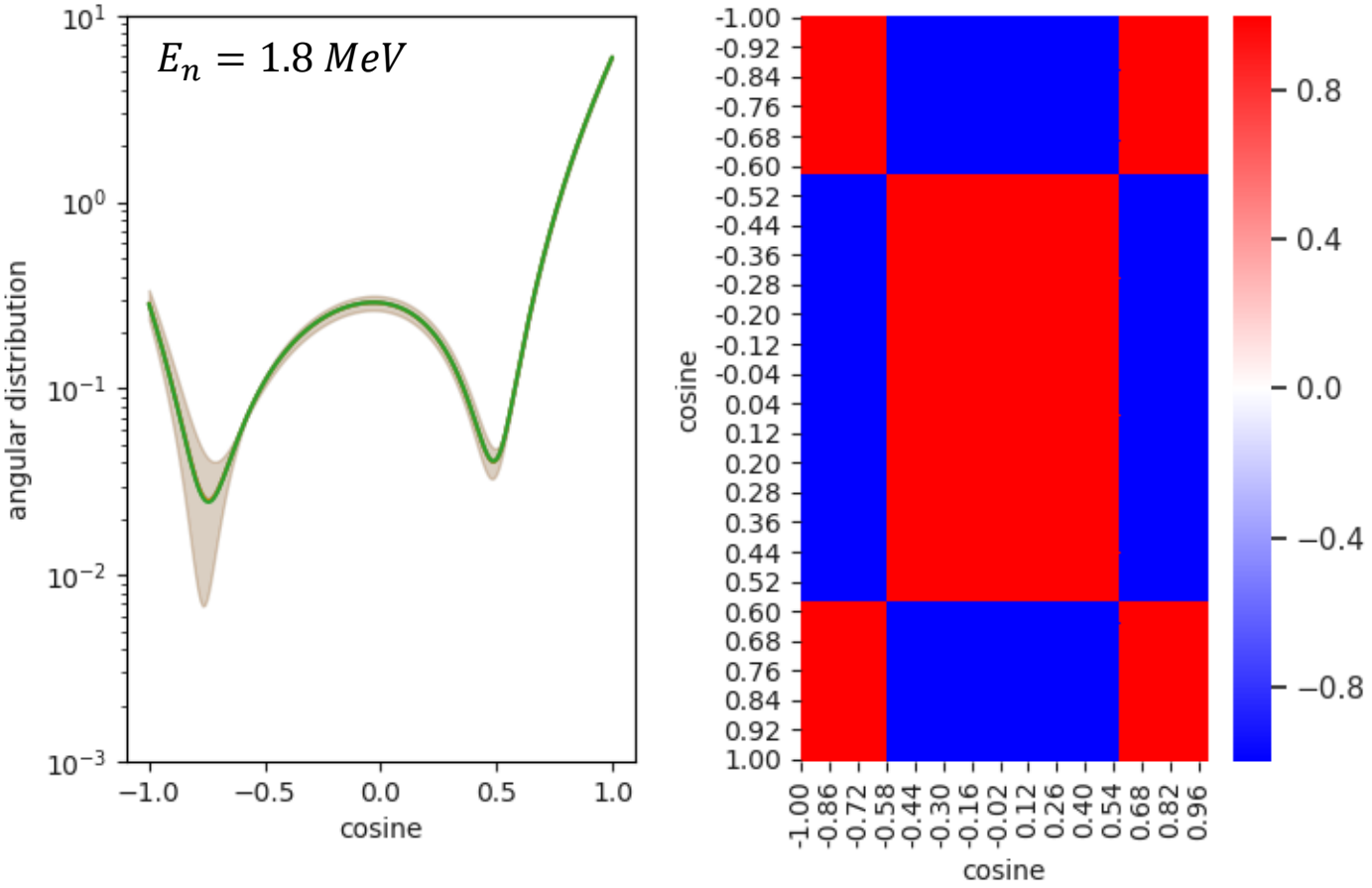
stdev SANDY = 2056 ± 555 pcm ← P1 to P6

stdev NDaST = 1382 pcm ← only elastic P1

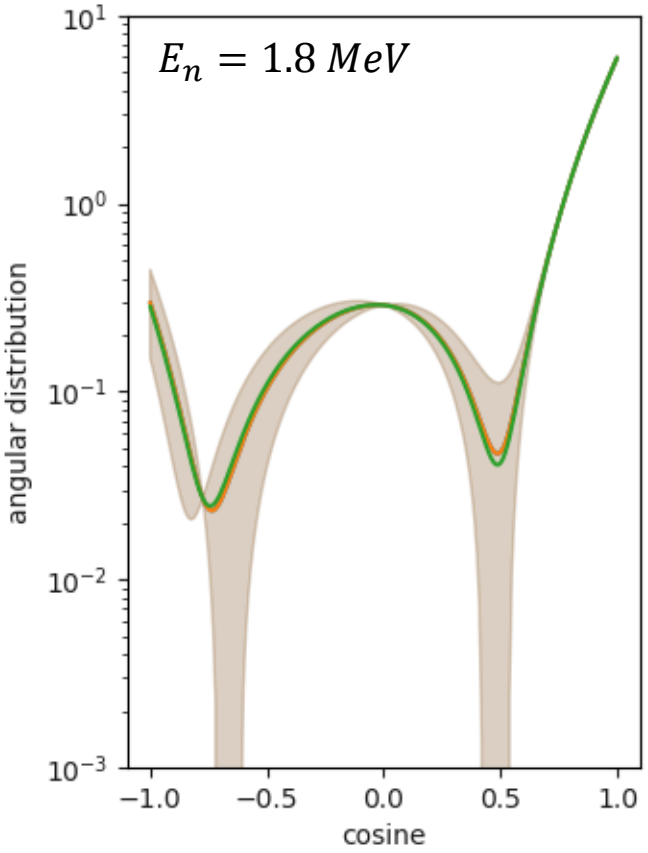
P1 covariance

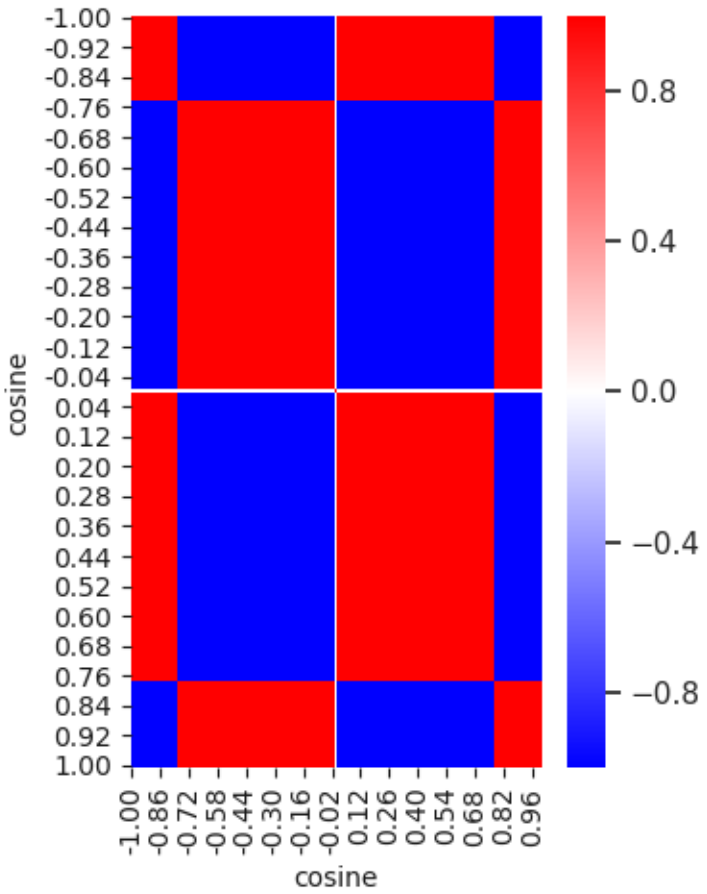


P2 covariance

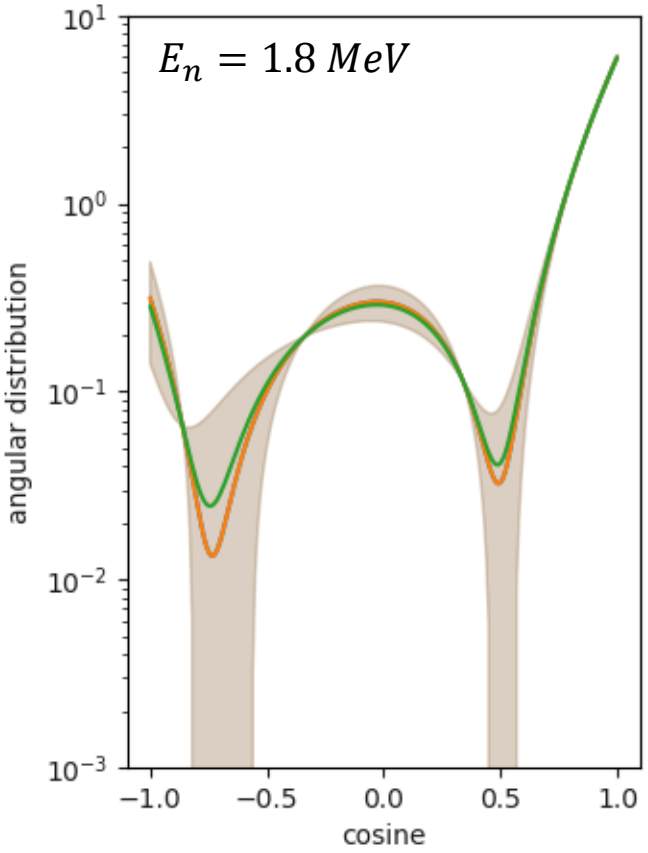


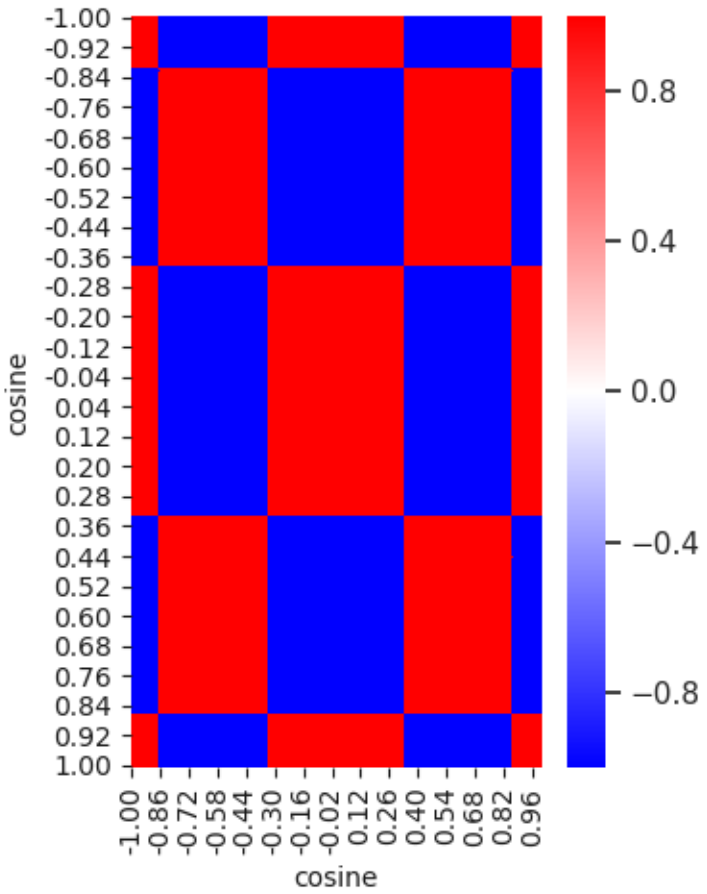
P3 covariance



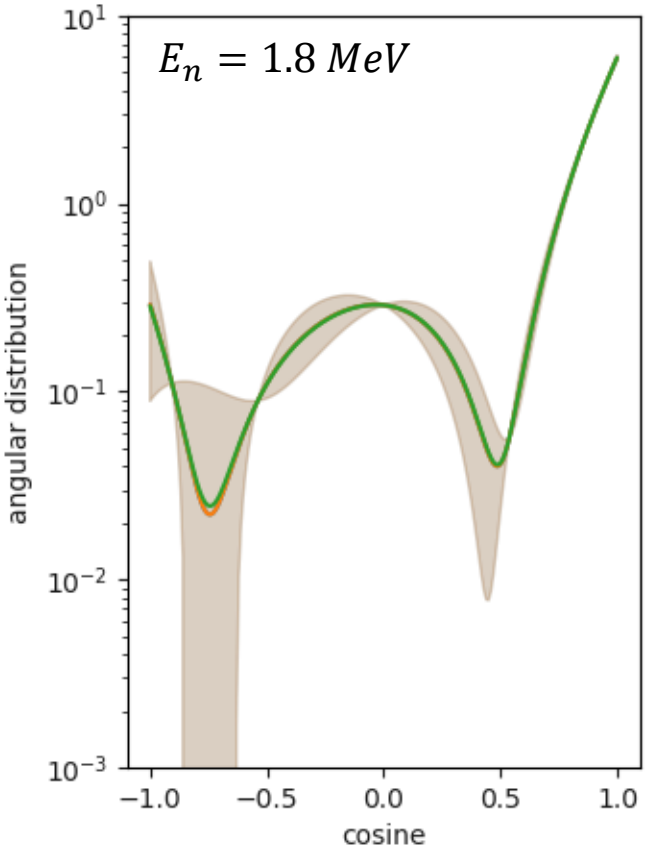


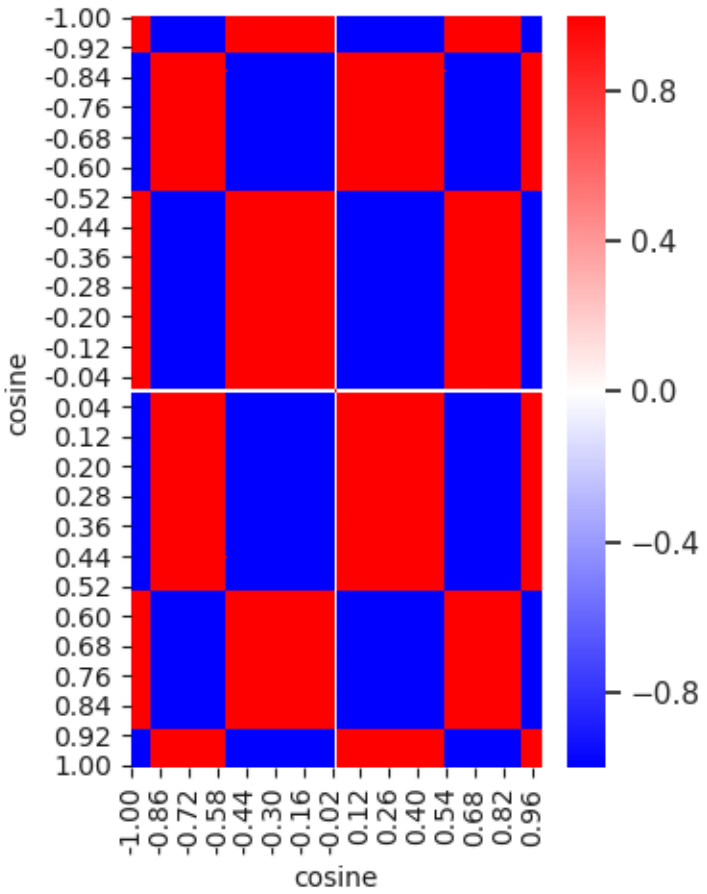
P4 covariance



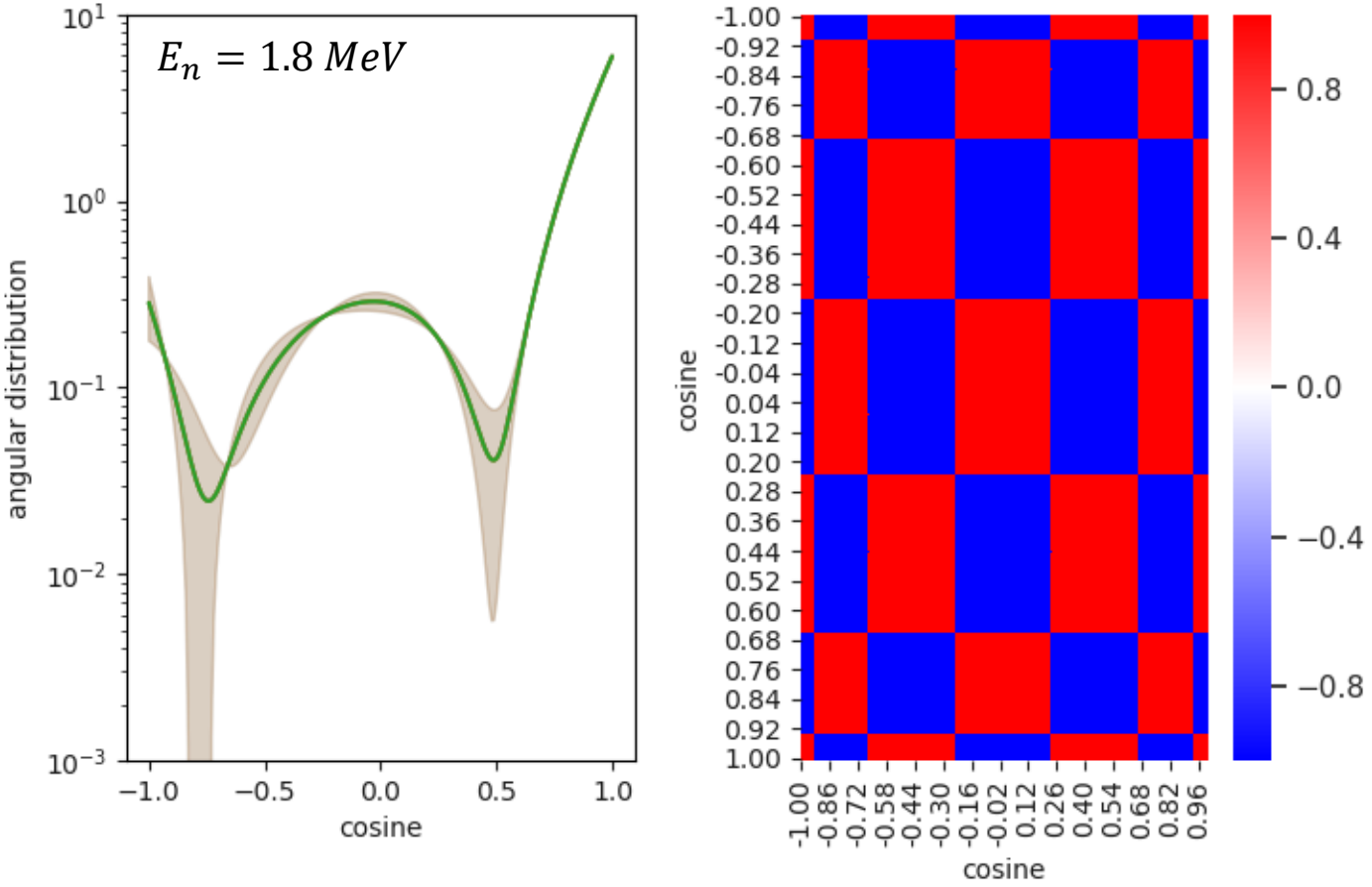


P5 covariance



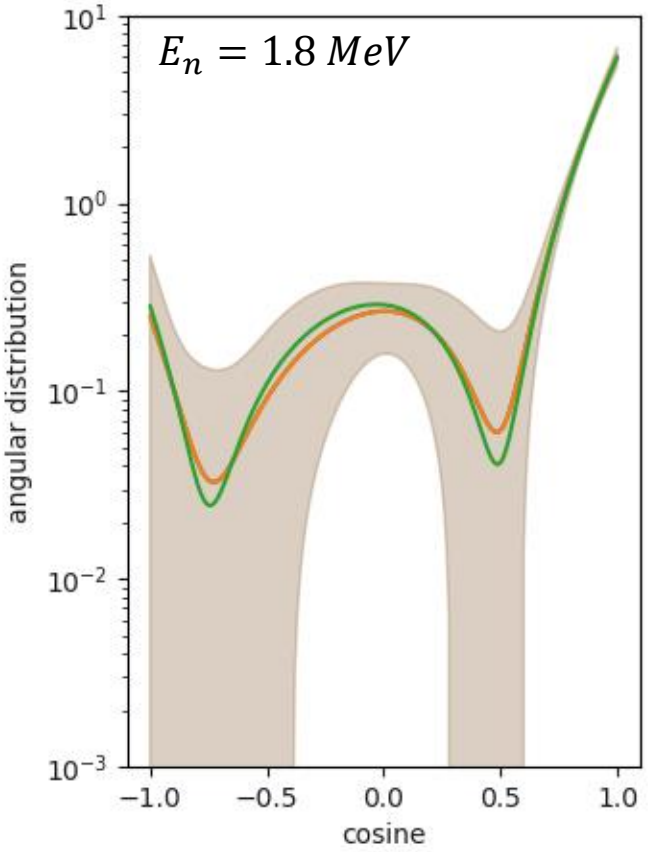


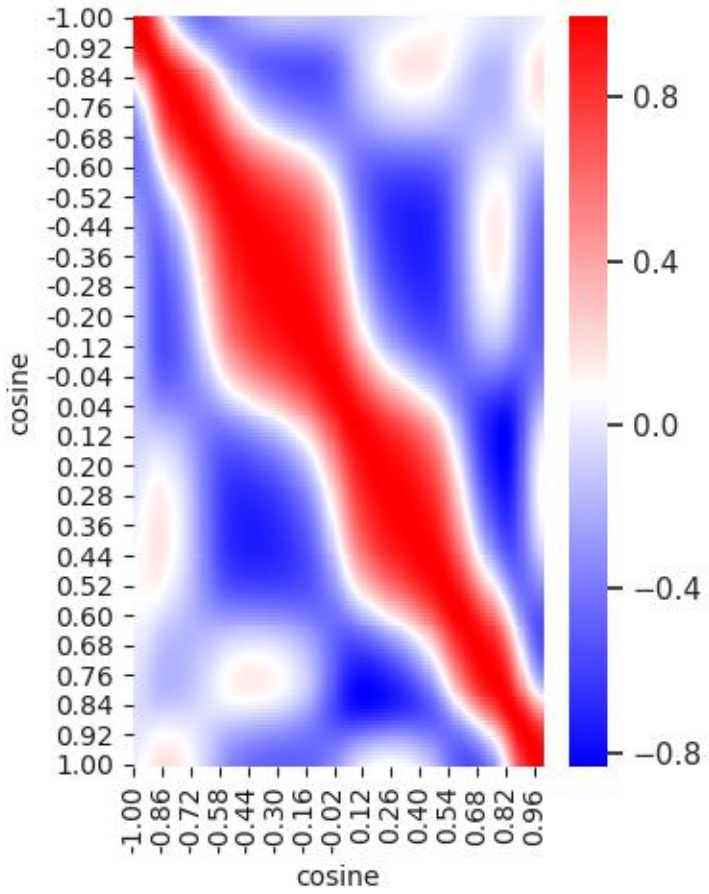
P6 covariance



All P covariances

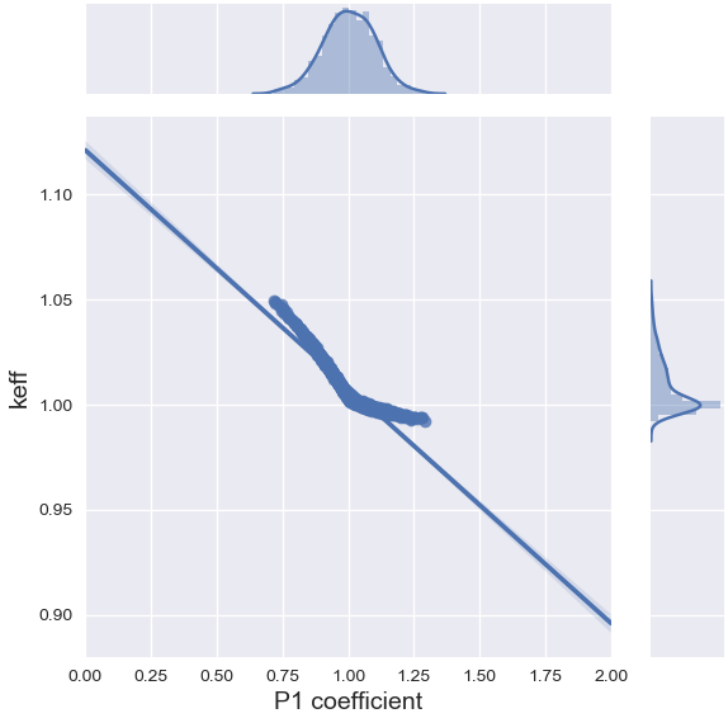
- NDaST results can be reproduced by SANDY sampling from only P1

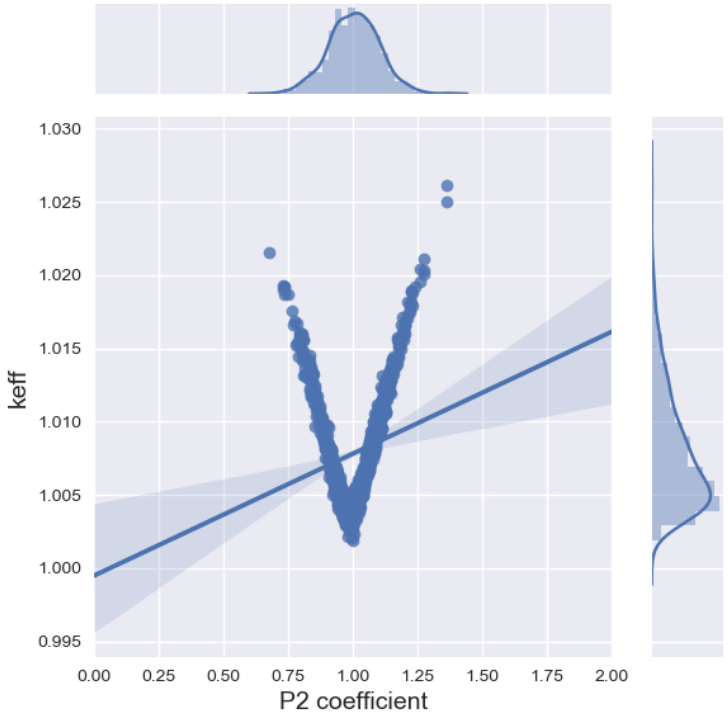




Sensitivity to P1-P2 coefficients

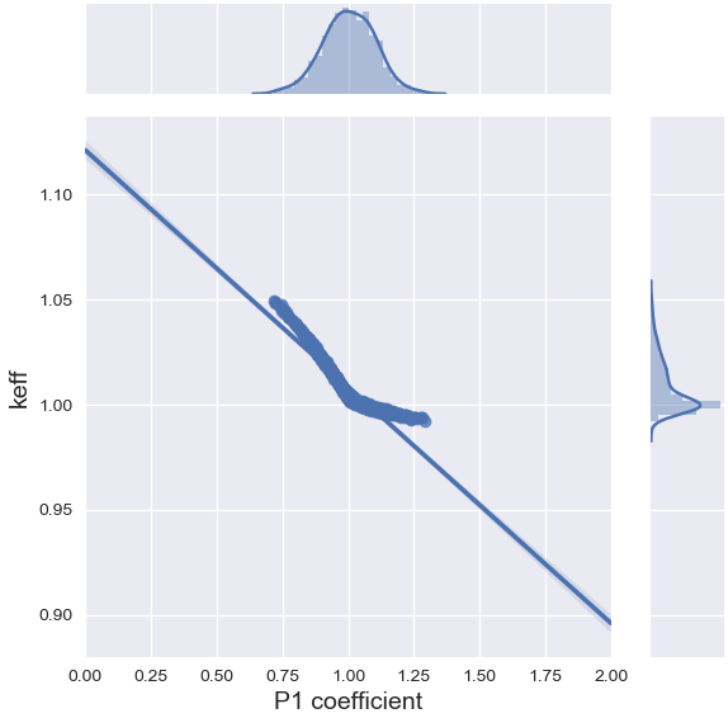
- 10% std dev over all neutron energies
- Strong non-linearity (mean shift, non-Normal PDF)
- Null-hypothesis of Normal distribution is rejected

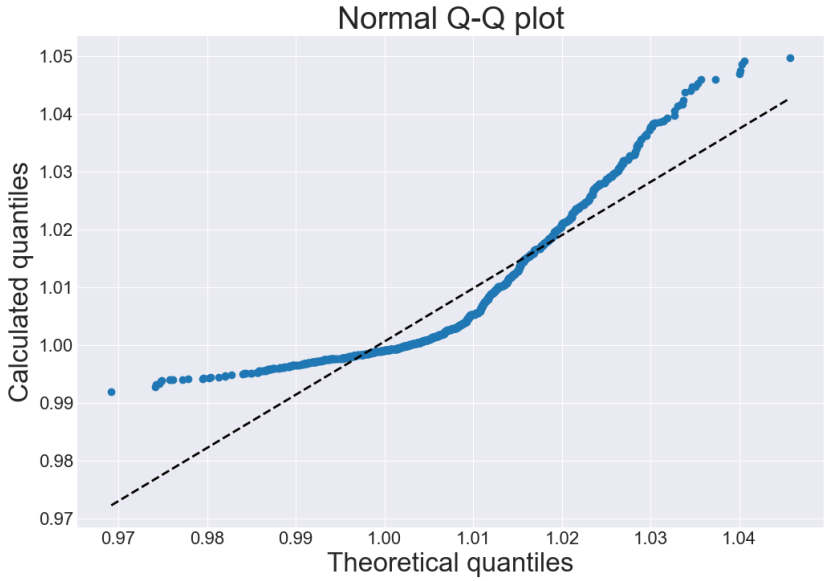




Sensitivity to P1-P2 coefficients

- Strong non-linearity (mean shift, non-Normal PDF)
- Very large uncertainty
- Null-hypothesis of Normal distribution is rejected





Conclusions

- JEFF-3.3 covariances were analyzed and propagated with NDaST and SANDY+MCNP for a suite of ICSBEP cases
- SANDY validates NDaST results for PMF
- Energy distribution covariances should be weighed on the fission rate
- Covariances for P>1 can be significant for systems such as PMF6
- The format for angular distribution covariances should be addressed to avoid non-physical correlations