UK Undersampling Calculations

Paul Smith,

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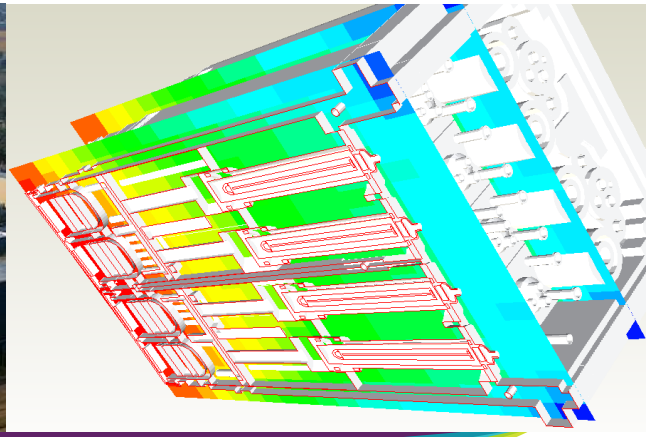


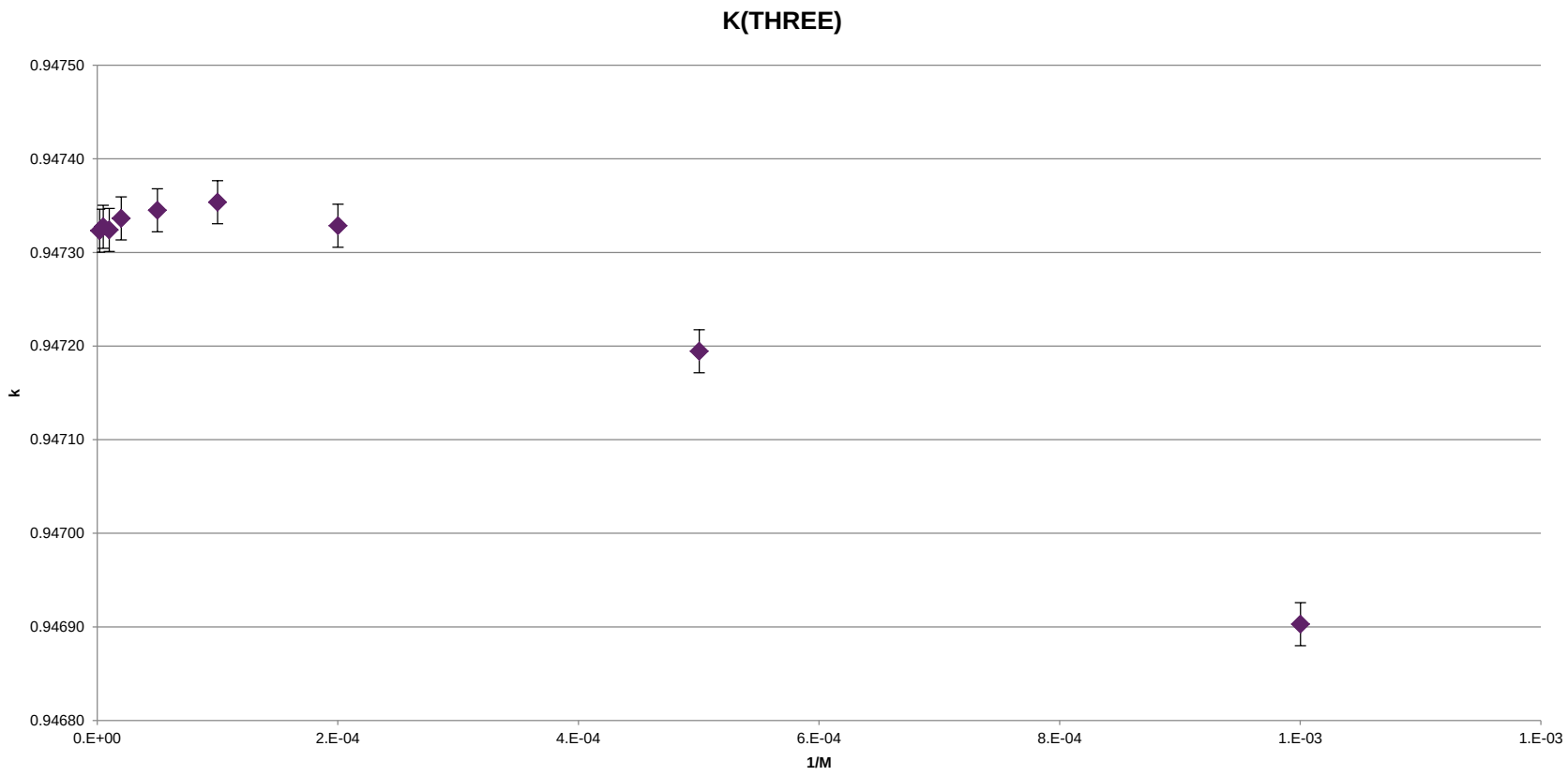
Introduction

- Calculations performed by Simon Richards, Geoff Dobson and Nigel Davies
- Calculations performed for scenario S2
- All calculations performed with at total of 10^9 samples (or very close).

Calculations on 16 cores

Number of Calculations	Number of Samples per stage
63	500,000
66	200,000
64	100,000
61	50,000
22	20,000
22	10,000
10	5,000
10	2,000
9	1,000

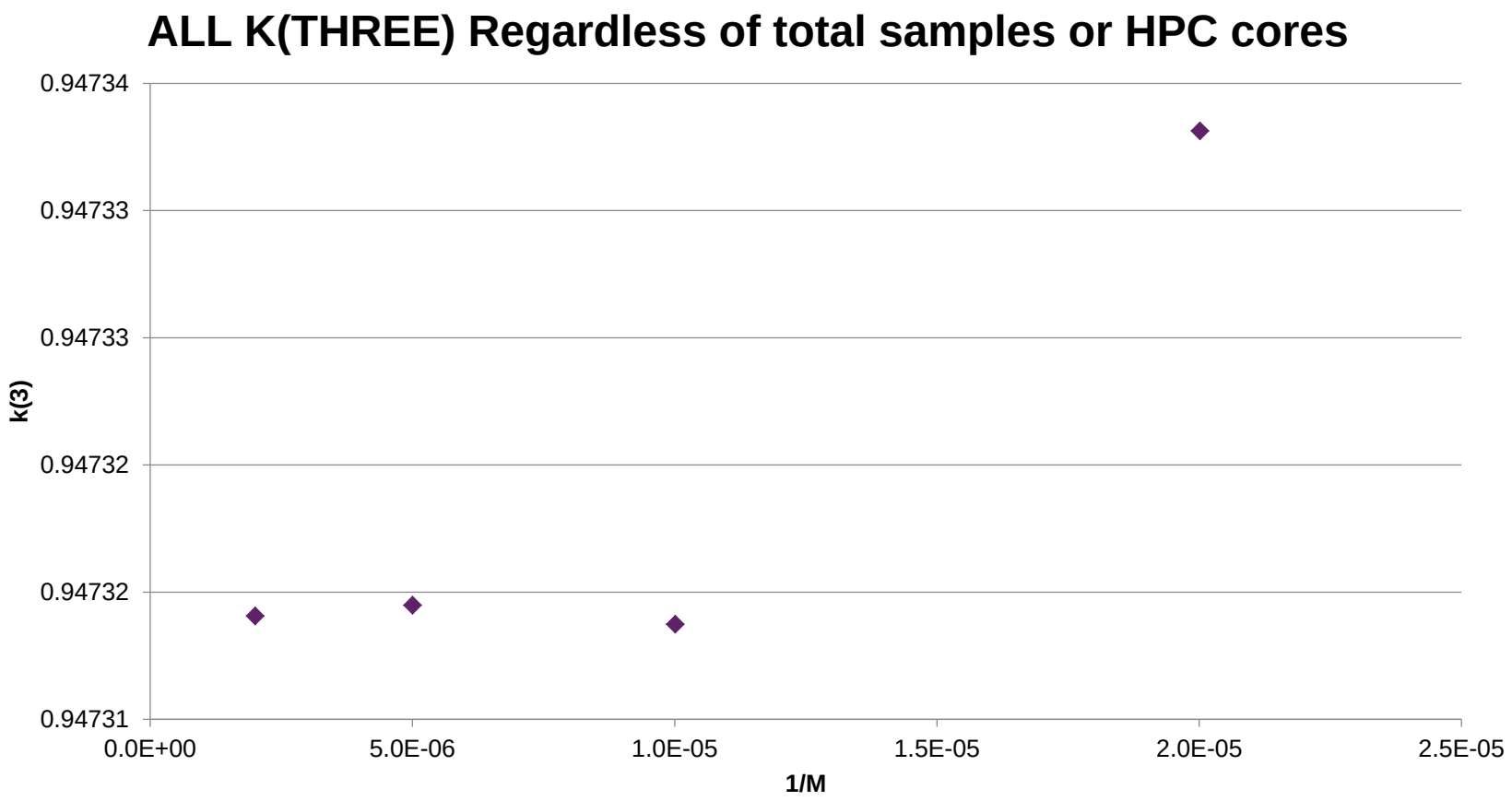
16 Core Results



16 Core Results - continued

- Clear evidence of undersampling bias at low numbers of samples per stage.
- Renormalisation at the end of a stage introduces a bias into the results.
- Renormalising often can lead to a significant bias.
- Superhistory powering reduces the bias but is not effective at very low numbers of samples per stage.

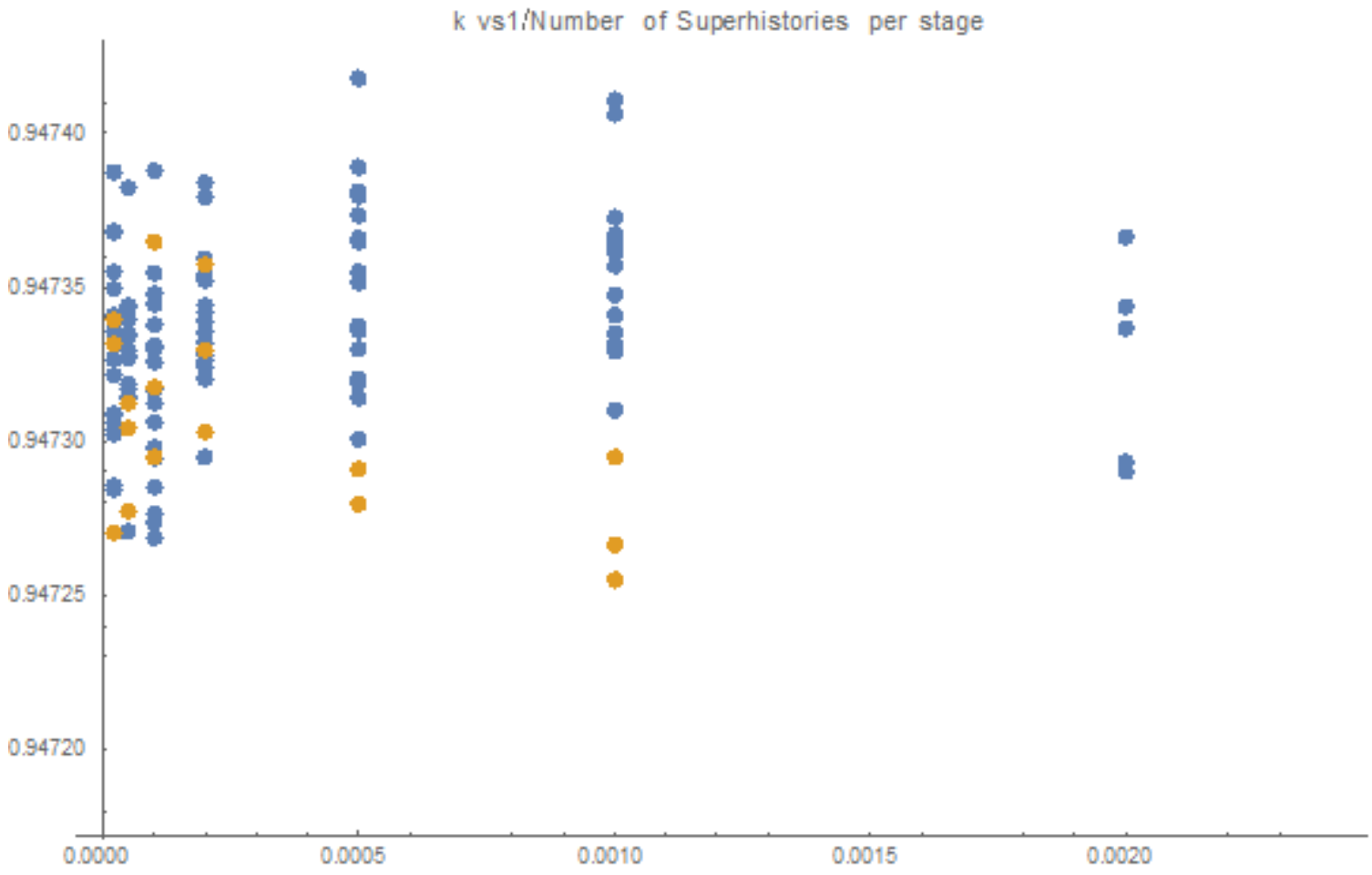
All Results at Low 1/M



Case E: Correlation Matrix

- Calculations converged to 0.3 pcm
- 6 sigma drop is statistically significant
- Thought to be a multi-processor effect.

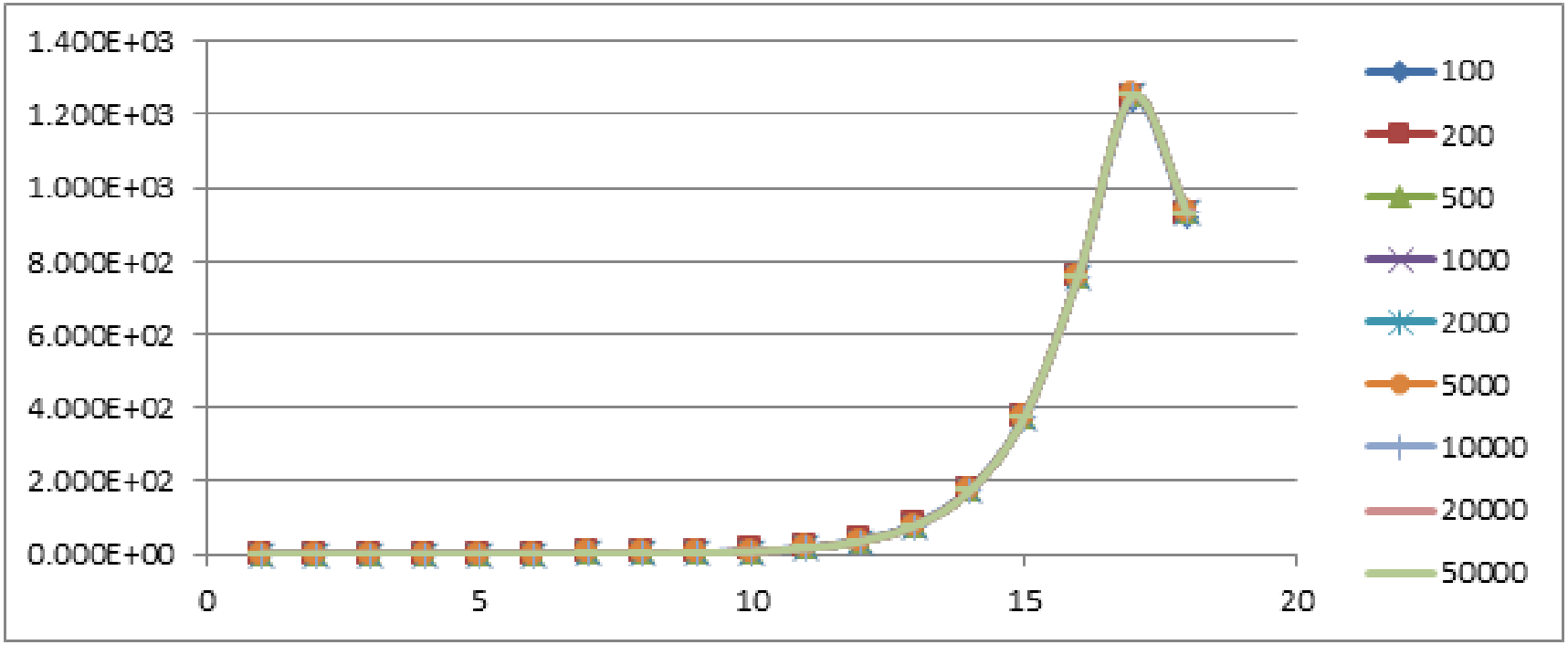
Multi-processor effect



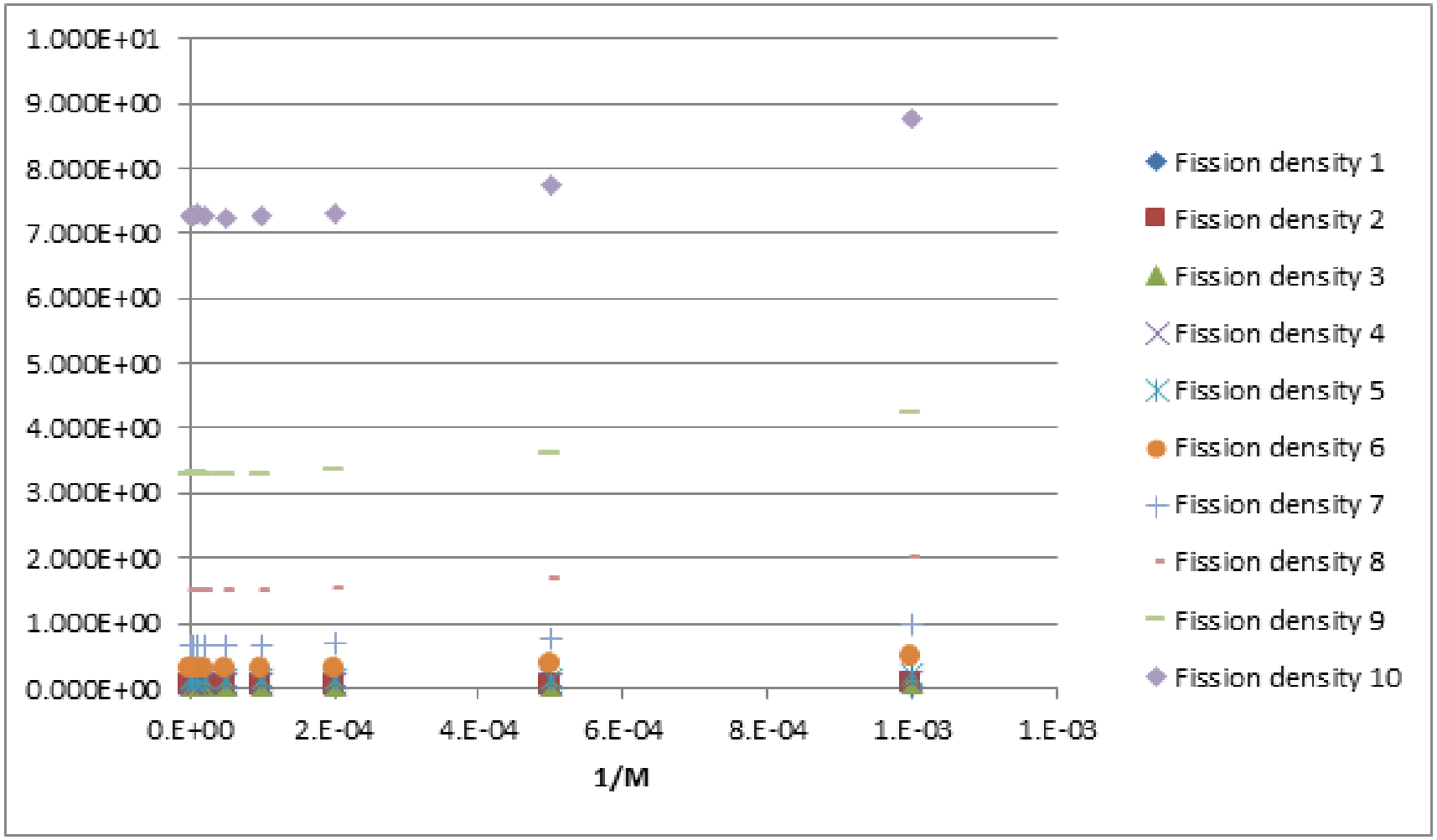
Multi-processor Bias

- Observe a dependency on the number of cores at low numbers of samples per stage.
- Effect is of order a few pcm for the number of cores used.
- The effect is not observed at larger numbers of samples per stage.
- Thought to be due to the way in which the delay stores are interleaved at the end of each stage.
- The delay, reserve and birth stores are being restructured for the MONK11 release and this effect will be removed.

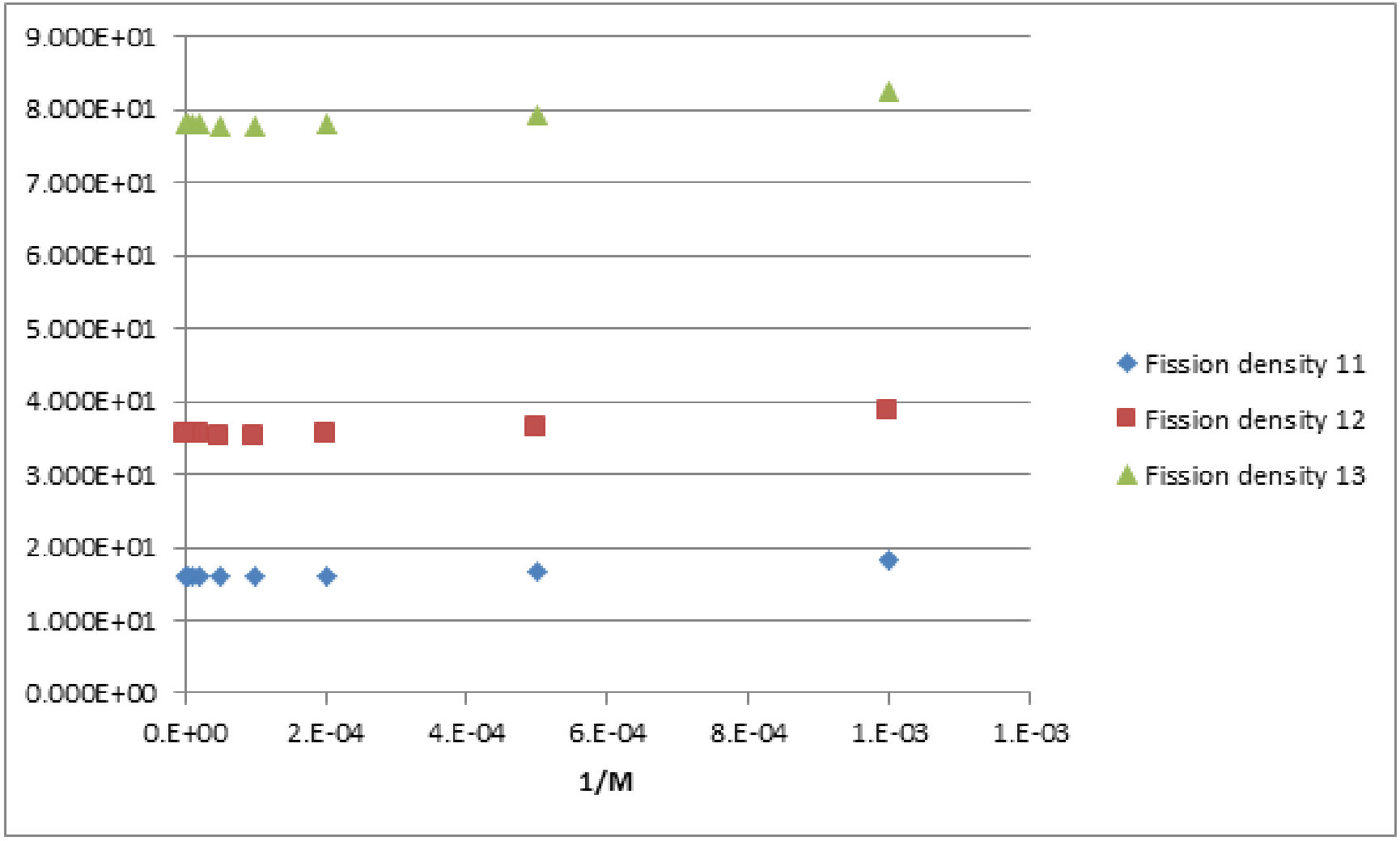
Axial Fission Density Distribution



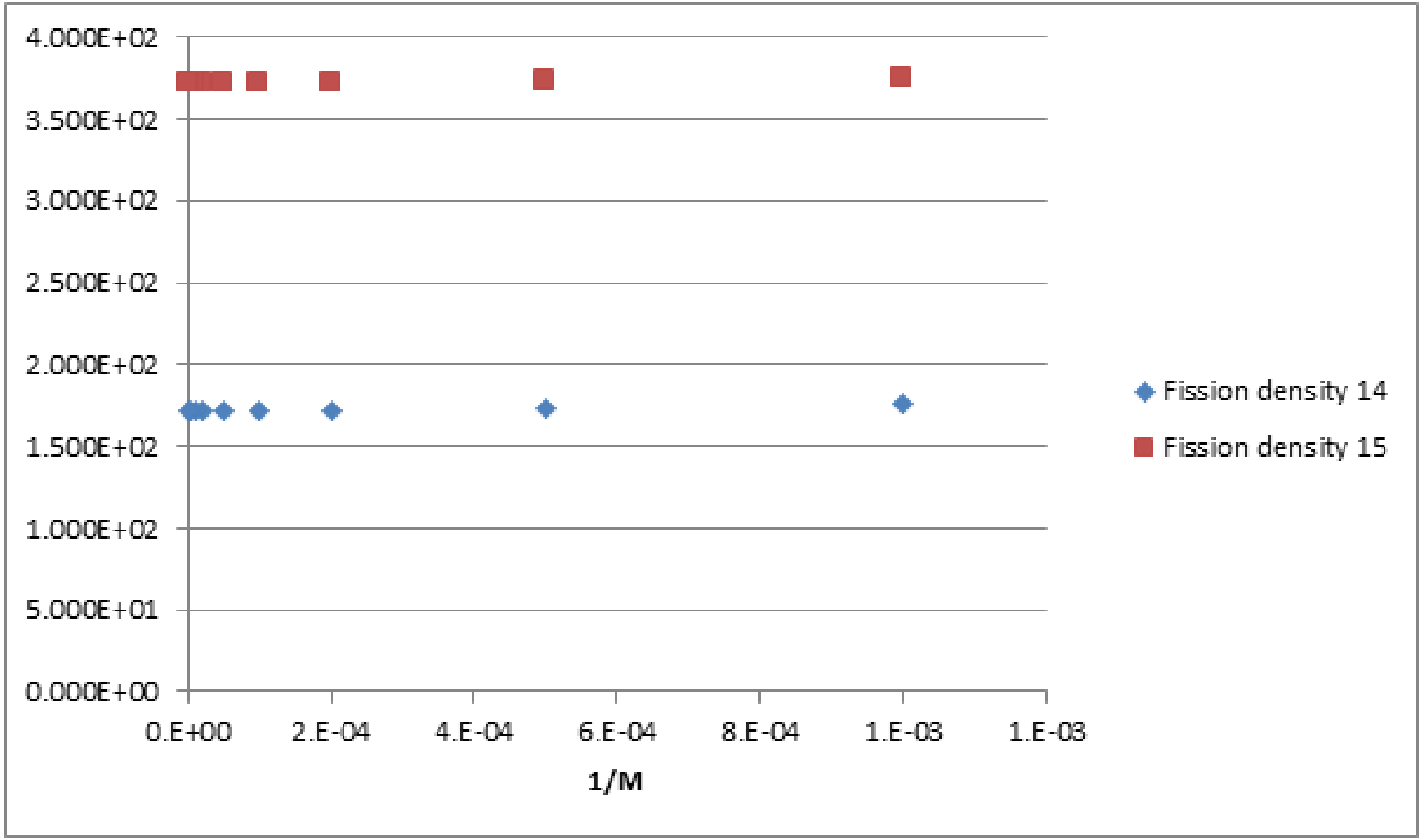
Convergence of Fission Density: Locations 1-10



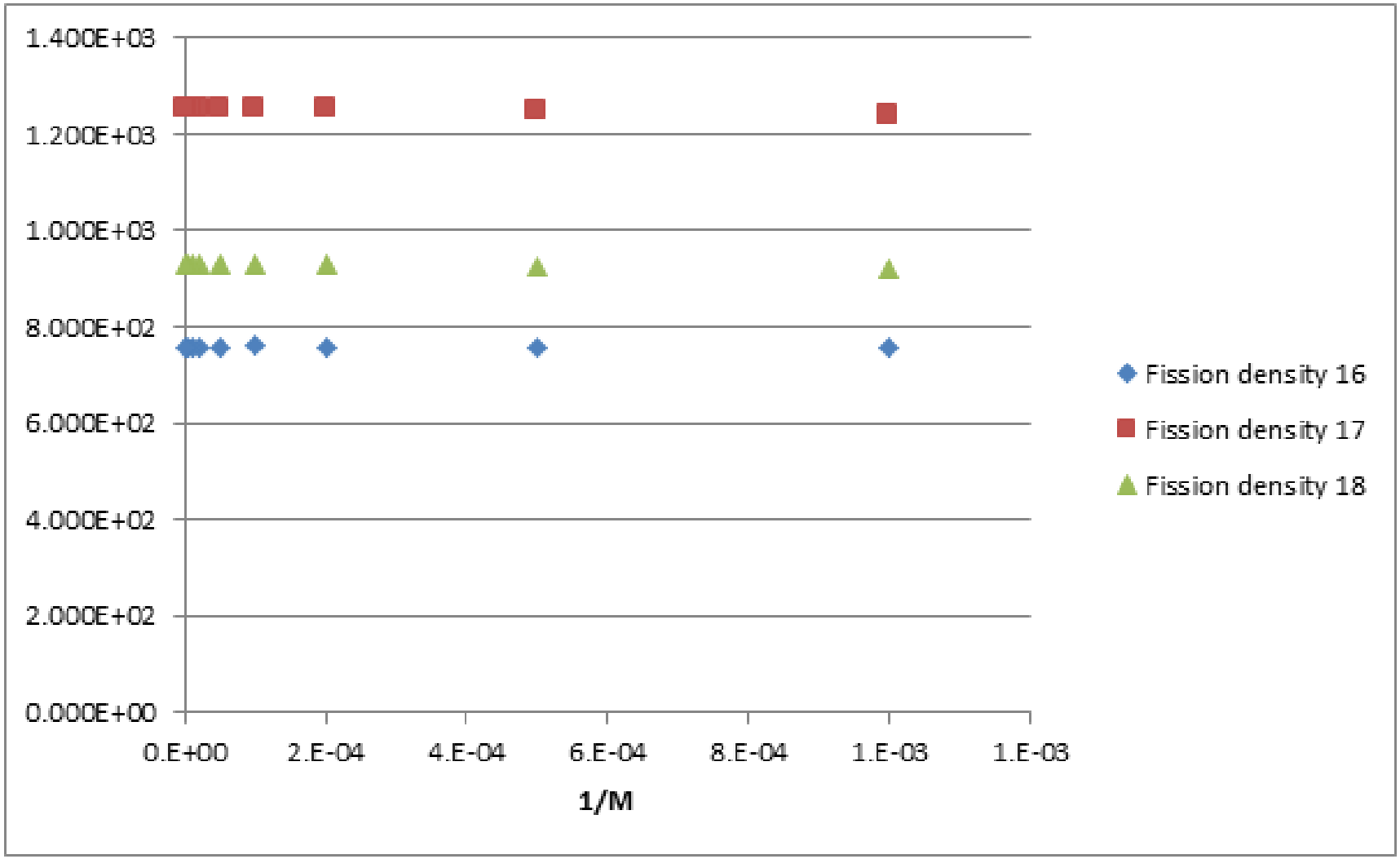
Convergence of Fission Density: Locations 11-13



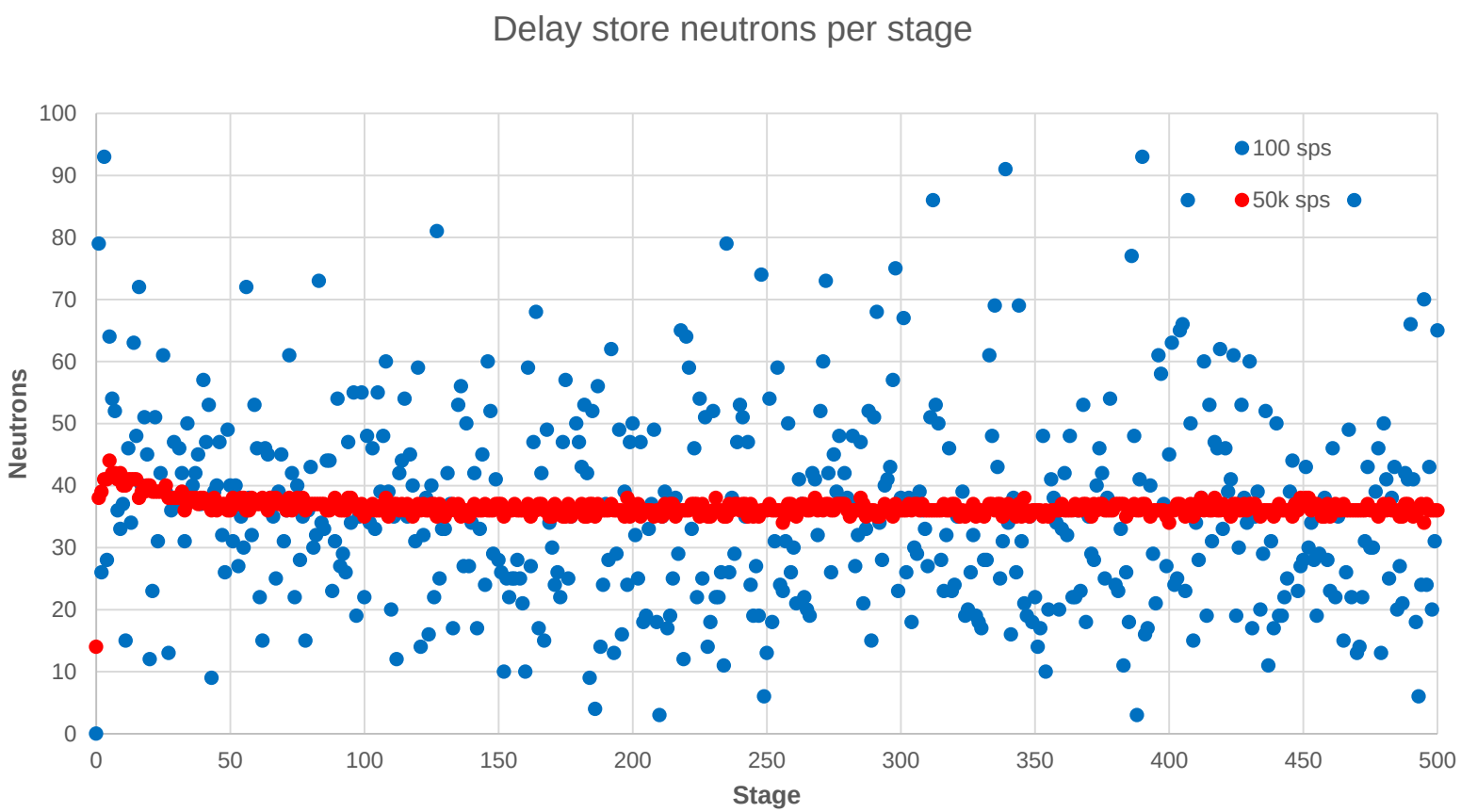
Convergence of Fission Density: Locations 14 & 15



Convergence of Fission Density: Locations 16 - 18



Undersampling Effects on MONK Delay Store



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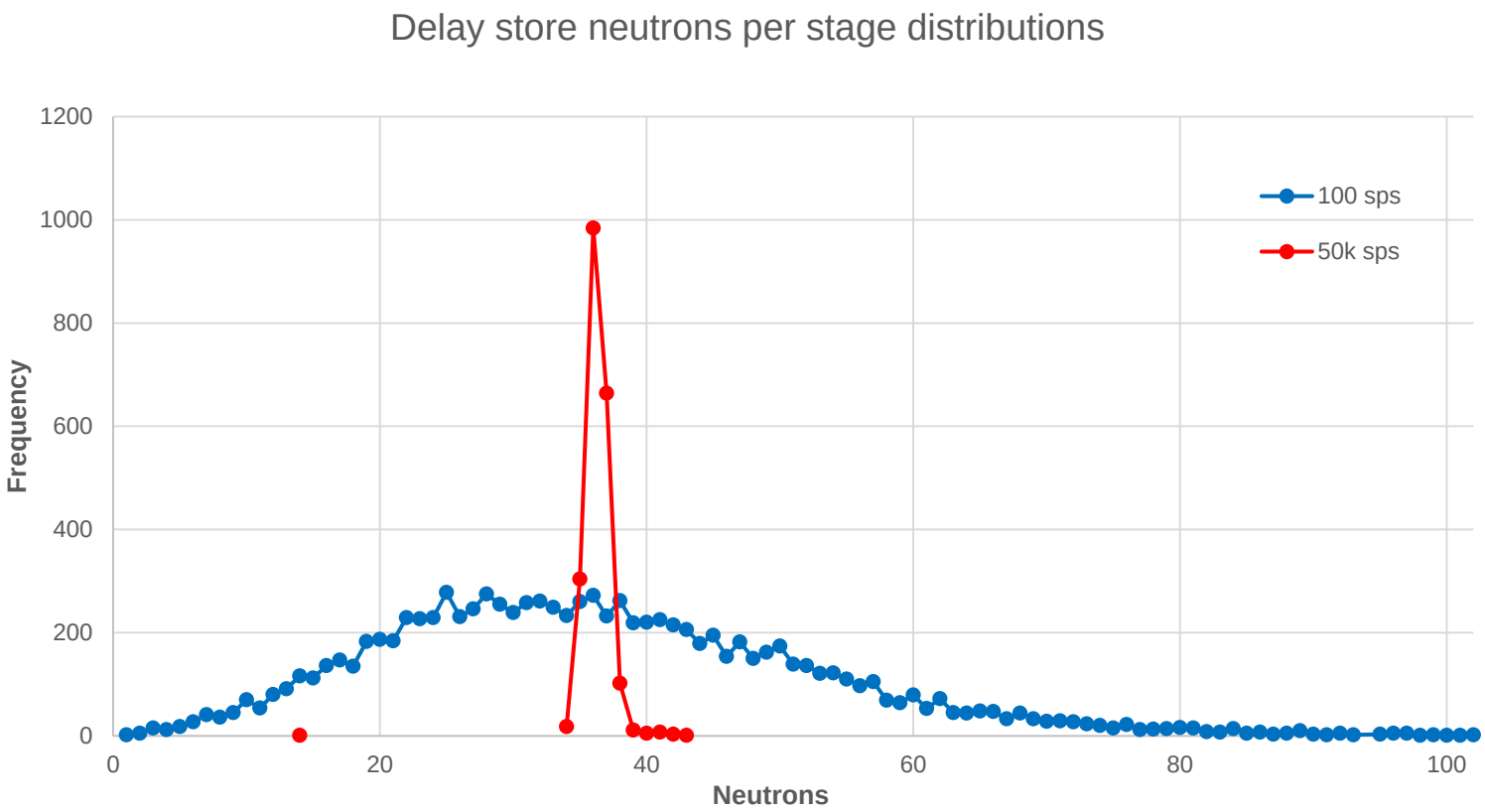

Conclusions

- MONK calculations show clear undersampling bias below 5,000 samples per stage.
  - The advice in the MONK User Guide is to always use at least 1,000 superhistories per stage, which is roughly equivalent to 10,000 samples.
- There appears to be a slight hump in the curve below 100,000 samples per stage.
  - Thought to be due to the way the delay stores are combined in parallel
  - Small effect ~ few pcm
  - Will be removed in MONK11
- Undersampling leads to over estimation of fission density in lower regions and under estimation at the top.
  - That is, undersampling leads to an under estimate of the flux gradient.