Analytical limitations on age uncertainty – solution U/Pb & LA Pb-Pb

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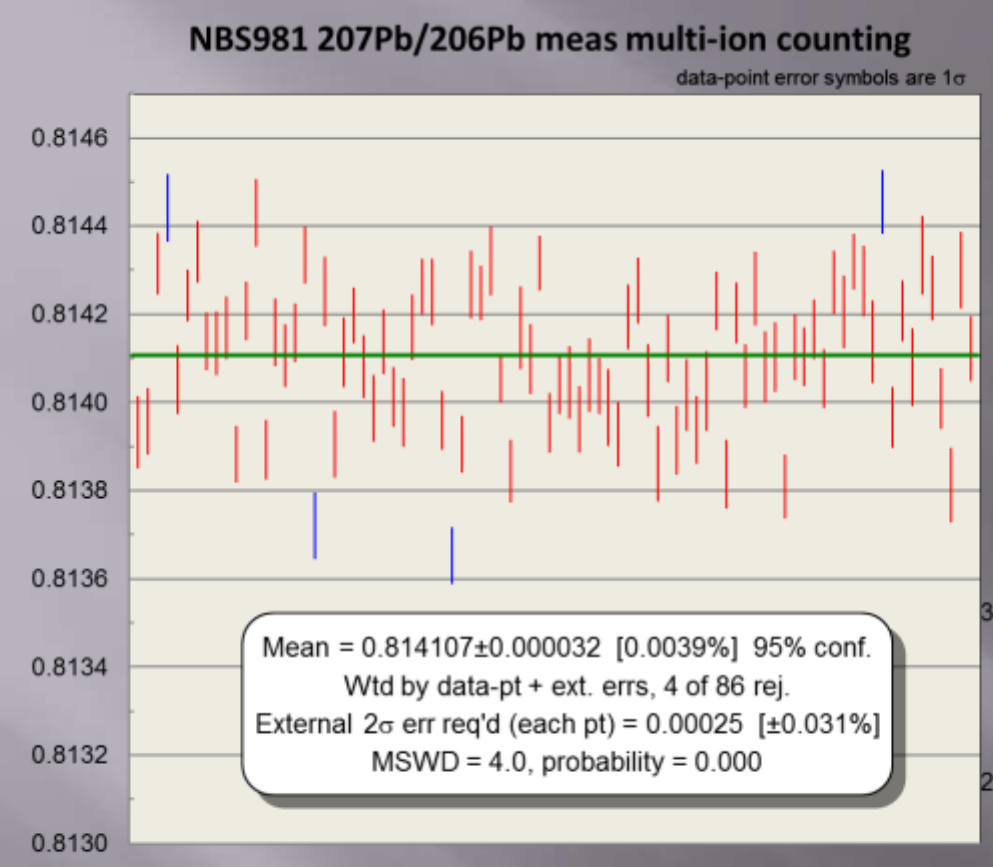
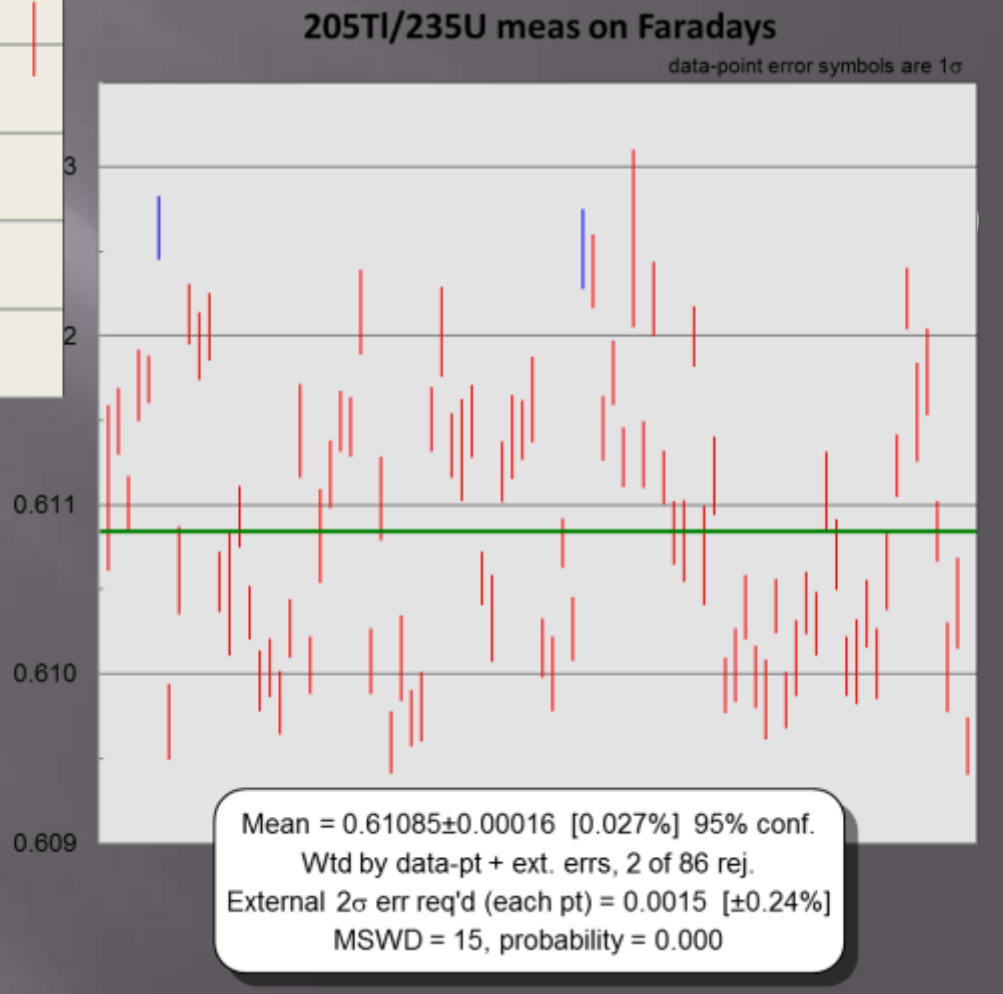
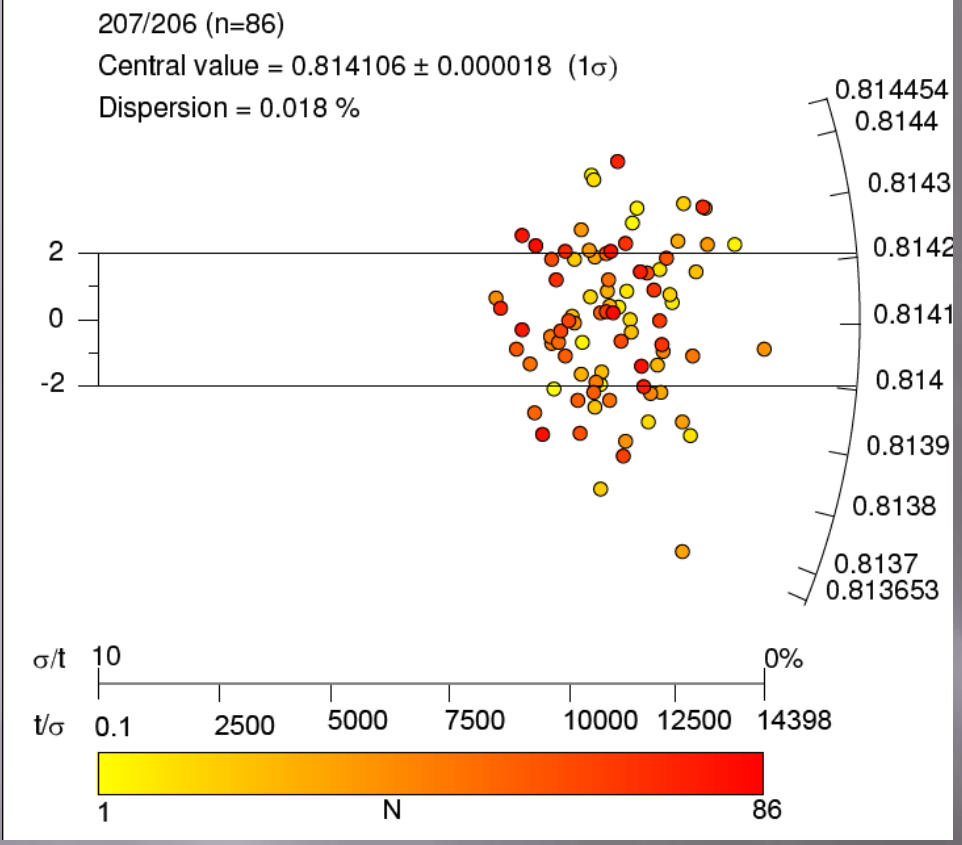
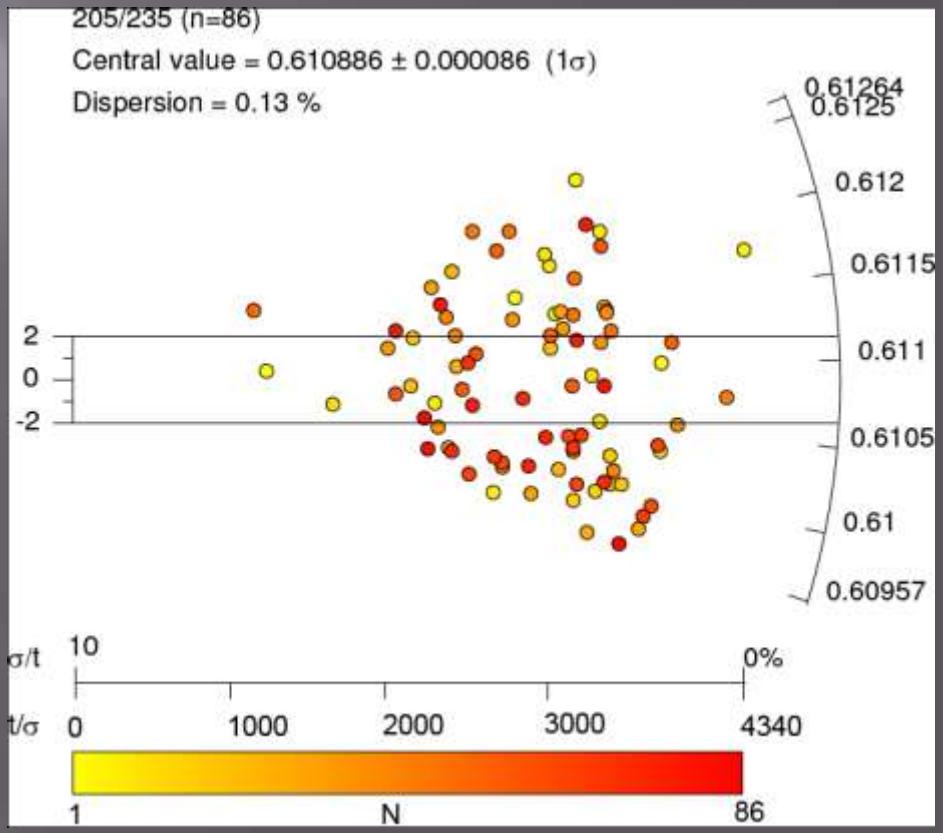
- San Francisco – “Create & distribute U-Th-Pb solution to determine ICPMS bottom line for simple Pb/U. These analyses will help evaluate the best possible precision of Pb/U ratios by ICPMS where no interferences are present.”
- Stern & Amelin 2002 – determined over-dispersion in Pb/Pb and Pb/U for SHRIMP using NIST glass and reference zircons
- This is an on-going study……

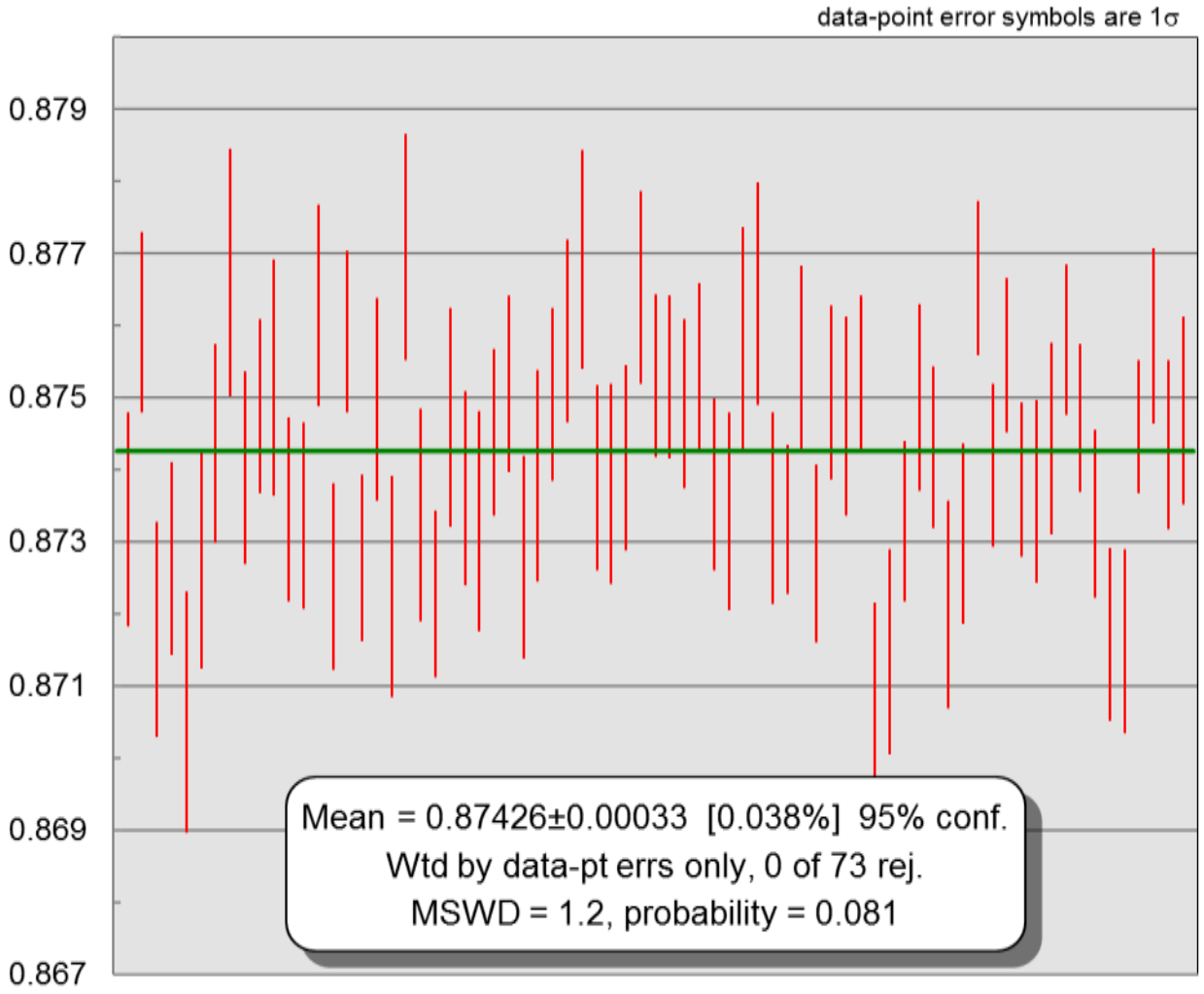

NBS981 207Pb/206Pb meas multi-ion counting
data-point error symbols are 1σ
0.8146
0.8144
0.8142
0.8140
0.8138
0.8136
0.8134
0.8132
0.8130
Mean = 0.814107±0.000032 [0.0039%] 95% conf.
Wtd by data-pt + ext. errs, 4 of 86 rej.
External 2σ err req'd (each pt) = 0.00025 [±0.031%]
MSWD = 4.0, probability = 0.000

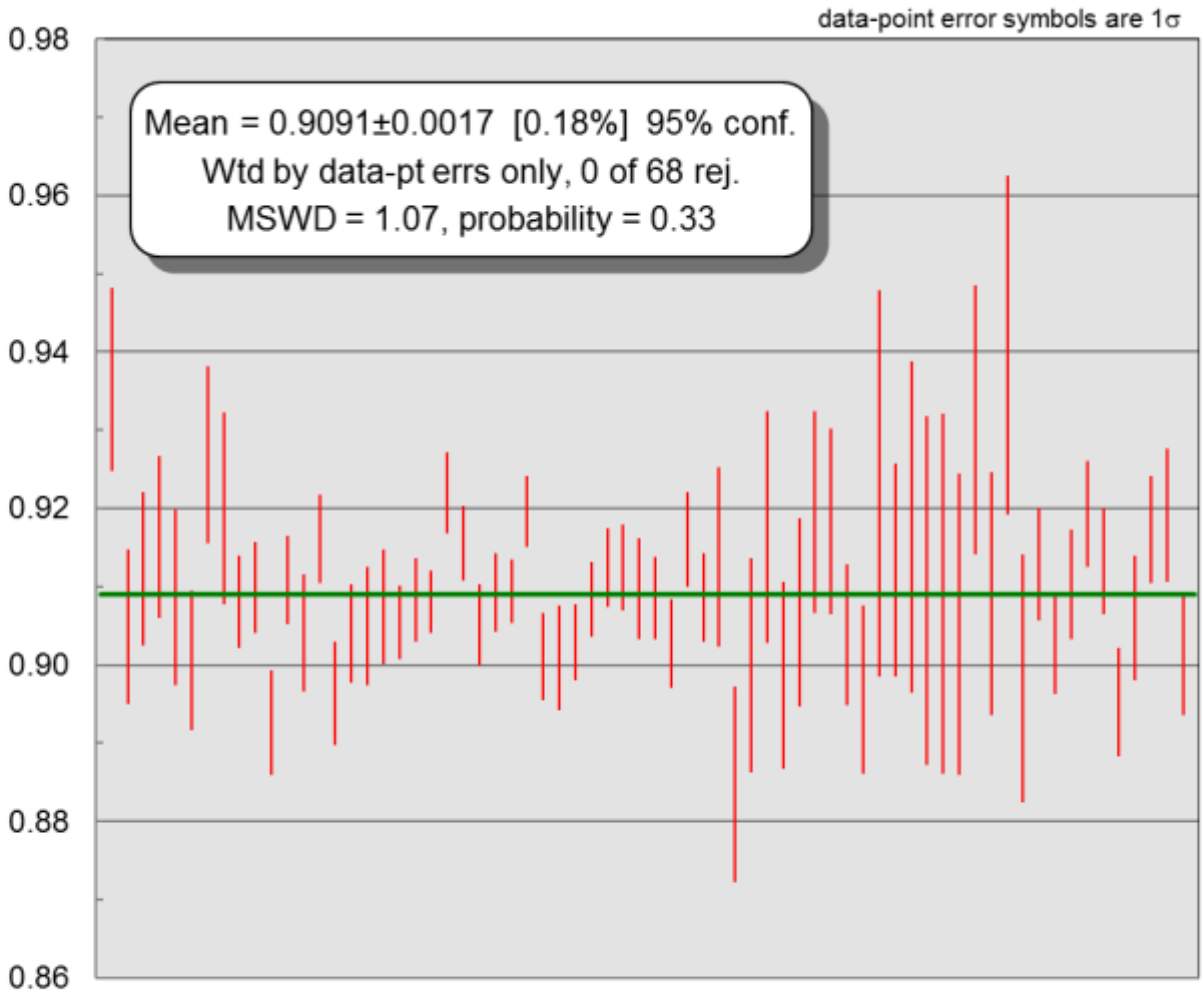

205Tl/235U meas on Faradays
data-point error symbols are 1σ
0.611
0.610
0.609
Mean = 0.61085±0.00016 [0.027%] 95% conf.
Wtd by data-pt + ext. errs, 2 of 86 rej.
External 2σ err req'd (each pt) = 0.0015 [±0.24%]
MSWD = 15, probability = 0.000

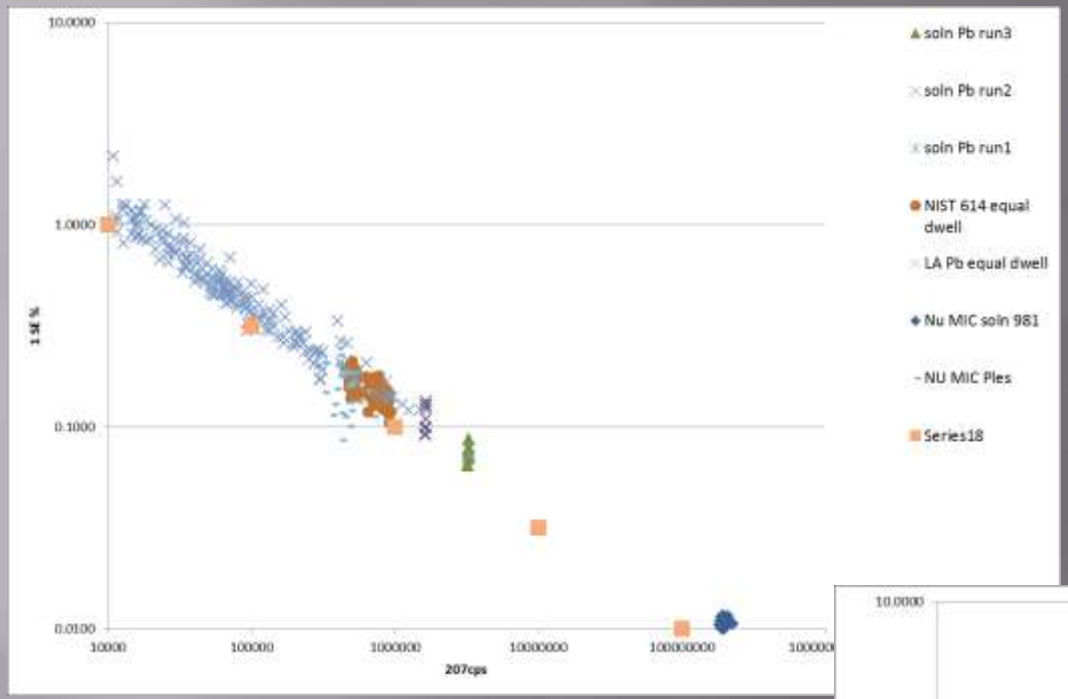

207/206 (n=86)
Central value = 0.814106 ± 0.000018 (1σ)
Dispersion = 0.018 %
0.814454
0.8144
0.8143
0.8142
0.8141
0.814
0.8139
0.8138
0.8137
0.813653
2
0
-2
σ/t
10
0%
t/σ
0.1
2500
5000
7500
10000
12500
14398
1
N
86

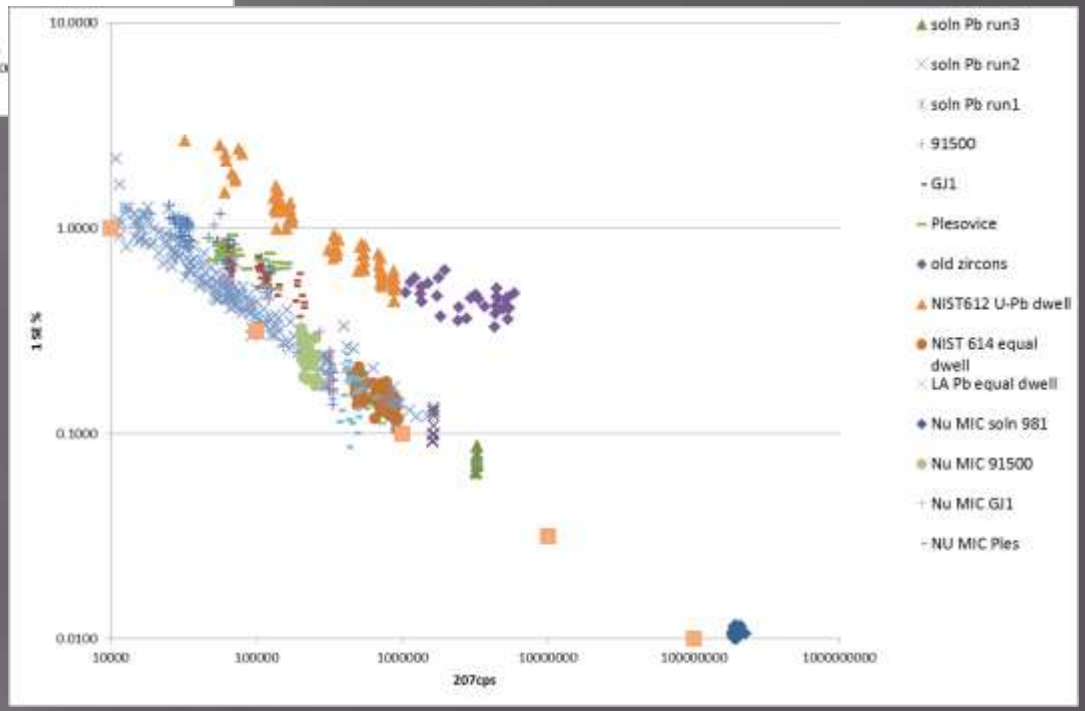

205/235 (n=86)
Central value = 0.610886 ± 0.000086 (1σ)
Dispersion = 0.13 %
0.61264
0.6125
0.612
0.6115
0.611
0.6105
0.61
0.60957
2
0
-2
σ/t
10
0%
t/σ
0
1000
2000
3000
4340
1
N
86

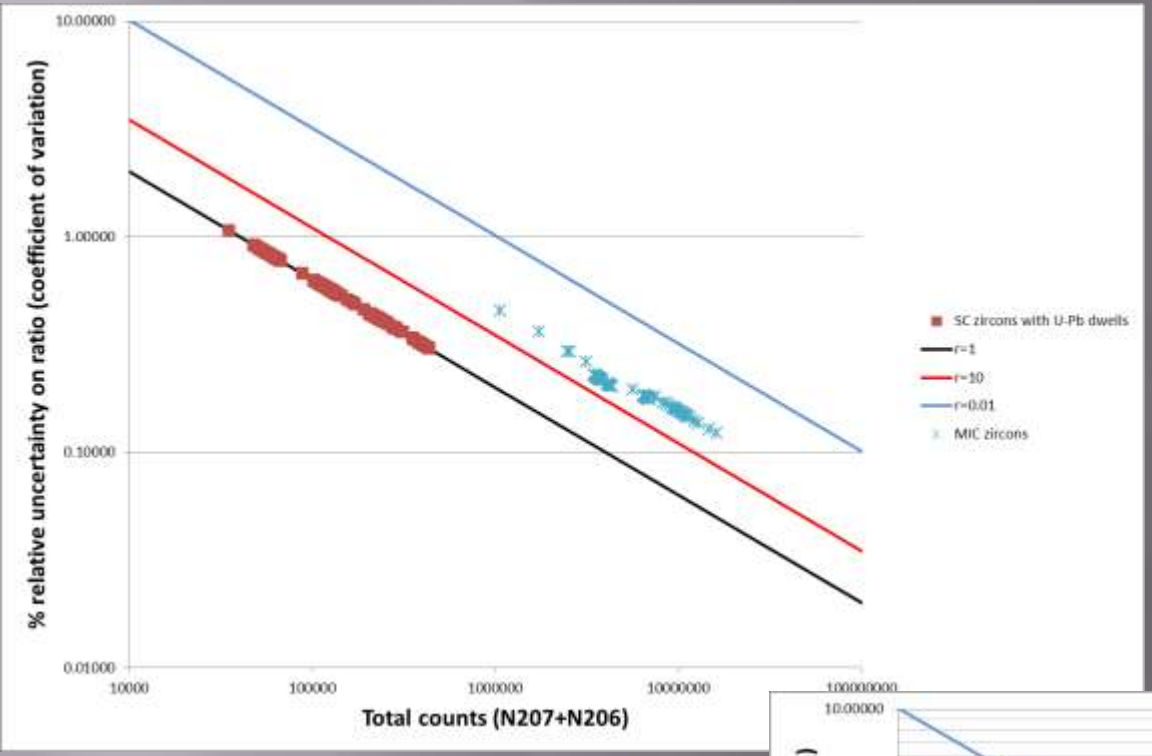
NIST 614 (optimal dwell times)

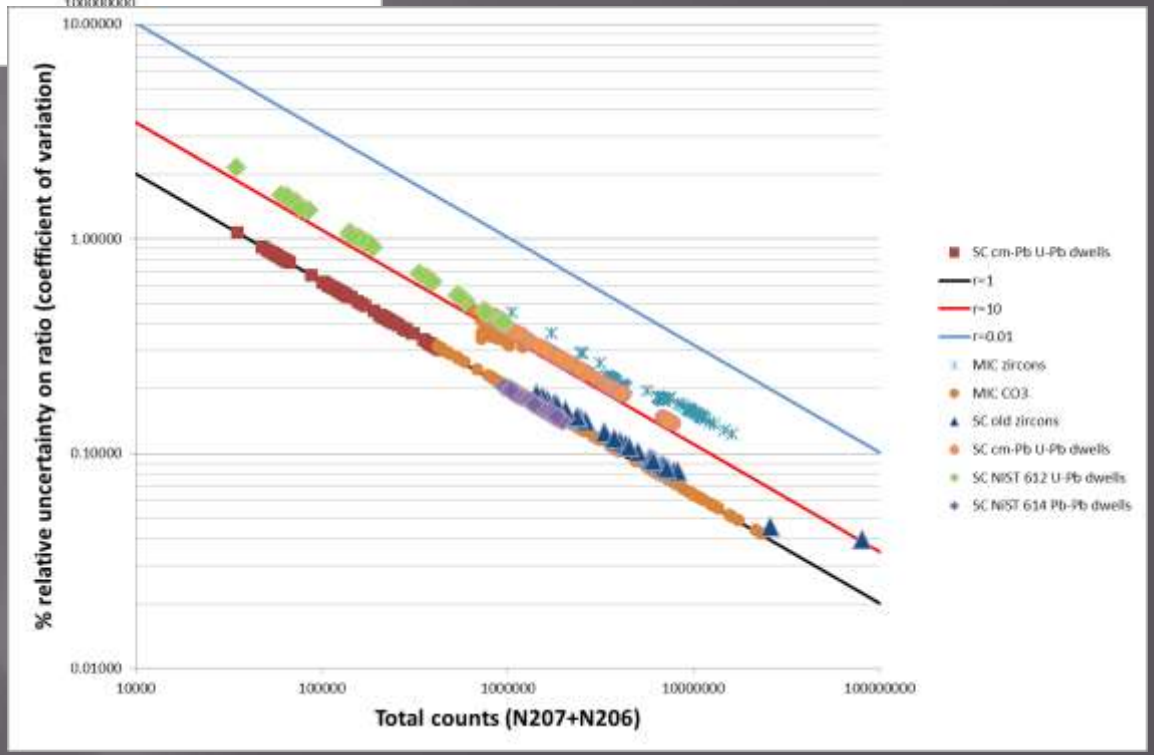


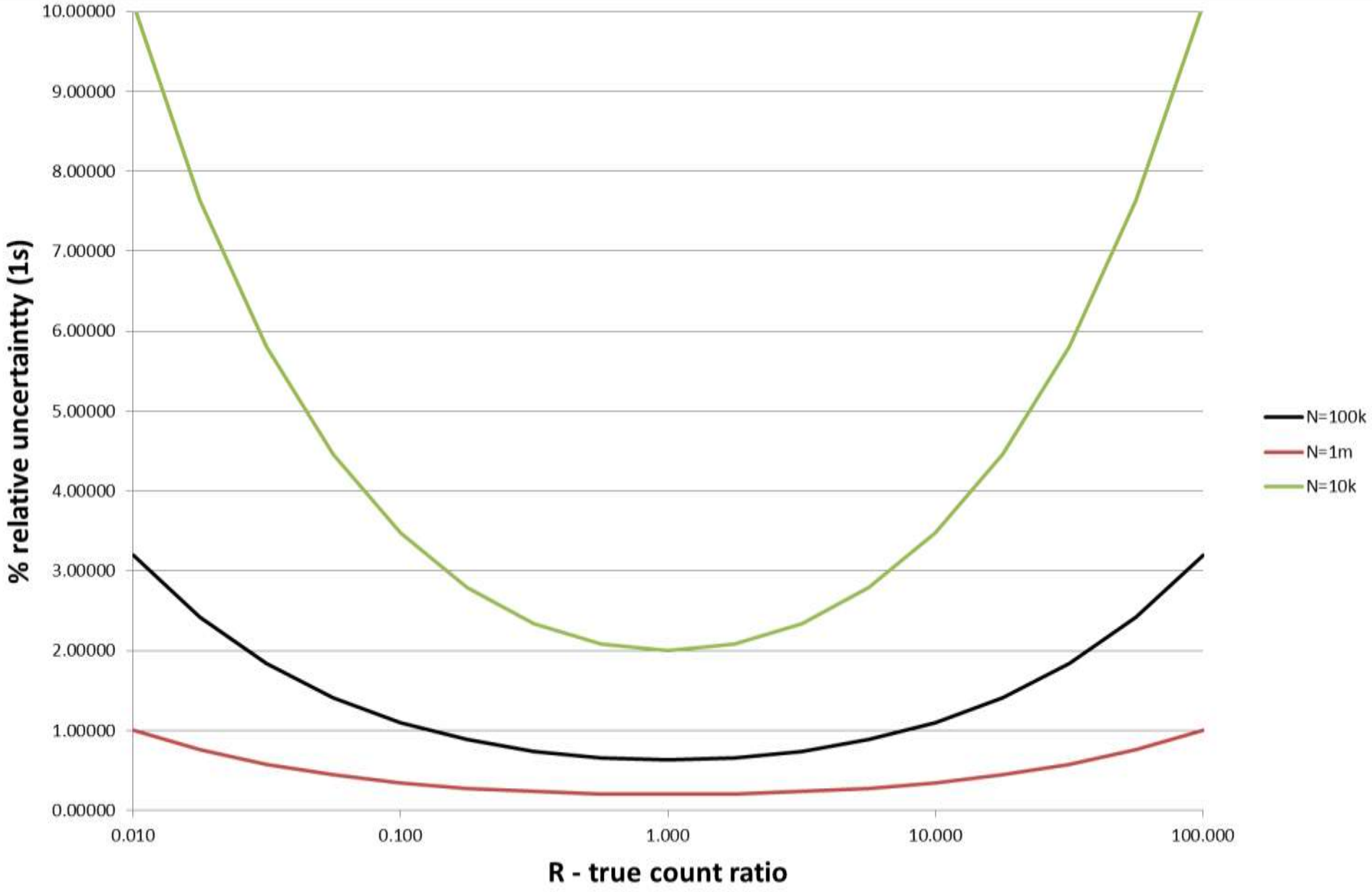

NIST 612 (U-Pb dwell times)
data-point error symbols are 1σ
Mean = 0.9091±0.0017 [0.18%] 95% conf.
Wtd by data-pt errs only, 0 of 68 rej.
MSWD = 1.07, probability = 0.33
0.98
0.96
0.94
0.92
0.90
0.88
0.86


10.0000
1.0000
0.1000
0.0100
1 SE %
10000
100000
1000000
10000000
100000000
207cps
soln Pb run3
soln Pb run2
soln Pb run1
NIST 614 equal dwell
LA Pb equal dwell
Nu MIC soln 981
NU MIC Ples
Series18


10.0000
1.0000
0.1000
0.0100
1 SE %
10000
100000
1000000
10000000
100000000
1000000000
207cps
soln Pb run3
soln Pb run2
soln Pb run1
91500
GJ1
Plesovice
old zircons
NIST612 U-Pb dwell
NIST 614 equal dwell
LA Pb equal dwell
Nu MIC soln 981
Nu MIC 91500
Nu MIC GJ1
NU MIC Ples


10.00000
1.00000
0.10000
0.01000
% relative uncertainty on ratio (coefficient of variation)
10000
100000
1000000
10000000
100000000
Total counts (N207+N206)
SC zircons with U-Pb dwells
r=1
r=10
r=0.01
MIC zircons


10.00000
1.00000
0.10000
0.01000
% relative uncertainty on ratio (coefficient of variation)
10000
100000
1000000
10000000
100000000
Total counts (N207+N206)
SC cm-Pb U-Pb dwells
r=1
r=10
r=0.01
MIC zircons
MIC CO3
SC old zircons
SC cm-Pb U-Pb dwells
SC NIST 612 U-Pb dwells
SC NIST 614 Pb-Pb dwells


10.00000
9.00000
8.00000
7.00000
6.00000
5.00000
4.00000
3.00000
2.00000
1.00000
0.00000
% relative uncertaintty (1s)
0.010
0.100
1.000
10.000
100.000
R - true count ratio
N=100k
N=1m
N=10k

Conclusions

- Dwell times need optimising to obtain ultimate precision
- Optimum dwell time is equivalent to a true count ratio of 1:1
- Optimum dwell times change with ratio of sample
- Best solution would be to change dwell times 'on-the-fly' – manufacturer request?
- MC inherently not optimised for true count ratio of 1 but improved counting stats more beneficial
- Precision for SC measurements could be improved by factor of 2-10 if dwell times were optimised
- 310ppm overdispersion of Pb/Pb MC data
- 0.25% overdispersion of U/Pb data on a bad day
- No apparent overdispersion after analysing NIST 614 by SC with optimised dwell times or NIST 612 with U-Pb dwell times (at 150kcps 206). This suggests no overdisperson at this level of uncertainty .
- Overdispersion of Pb/Pb and U-Pb data represents limit to which uncertainty can be reduced for this session (additional uncertainty component?). Consistent reproduction of this will allow characterisation of instrument/set-up