## Supplementary Material A. Luminescence dating protocols

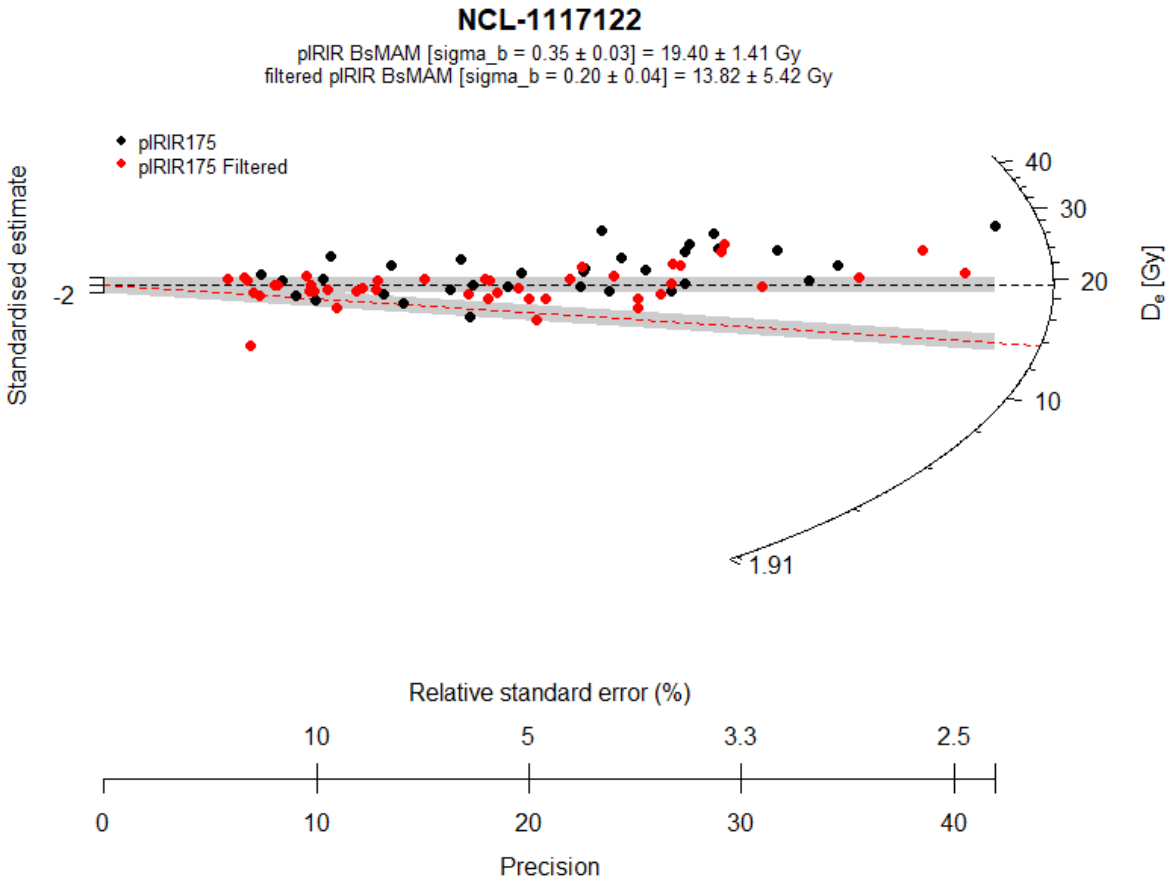
**Supplementary Material A.1: Luminescence dating protocol used for small-aliquot quartz OSL measurements.**

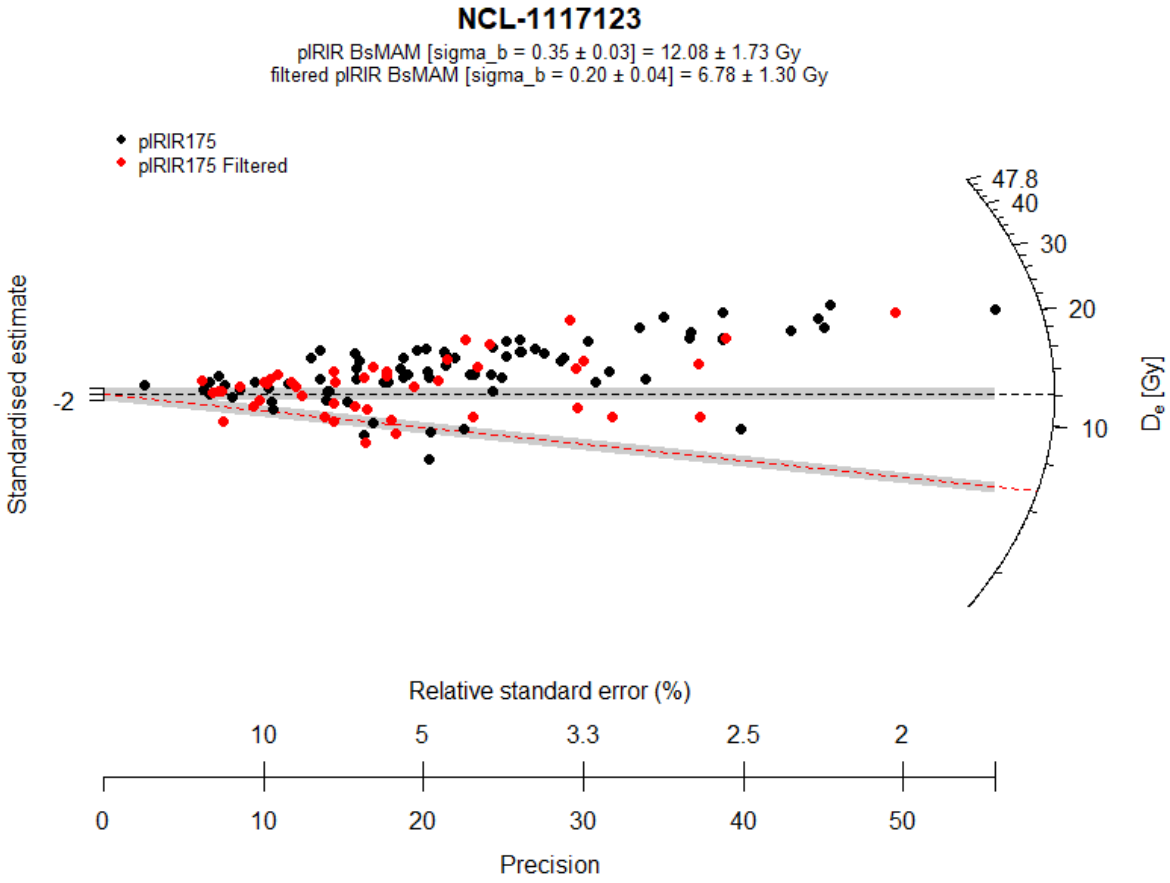
| Step | Action | Measured |
|---|---|---|
| 1 | Beta dose (or Natural dose) | |
| 2 | 10s preheat to 200°C | |
| 3 | 20s blue stimulation at 125 °C | Ln/Li |
| 4 | Beta test dose | |
| 5 | 10s cutheat to 180°C | |
| 6 | 20s blue stimulation at 125 °C | Tn/Ti |
| 7 | 40s blue bleach at 210°C | |
| 8 | Repeat step 1-7 for a range of doses (incl. zero and repeat dose) | |
| Extra 1 | Reepeat step 1-7 with added infrared bleach at 30°C prior to step 3 | |

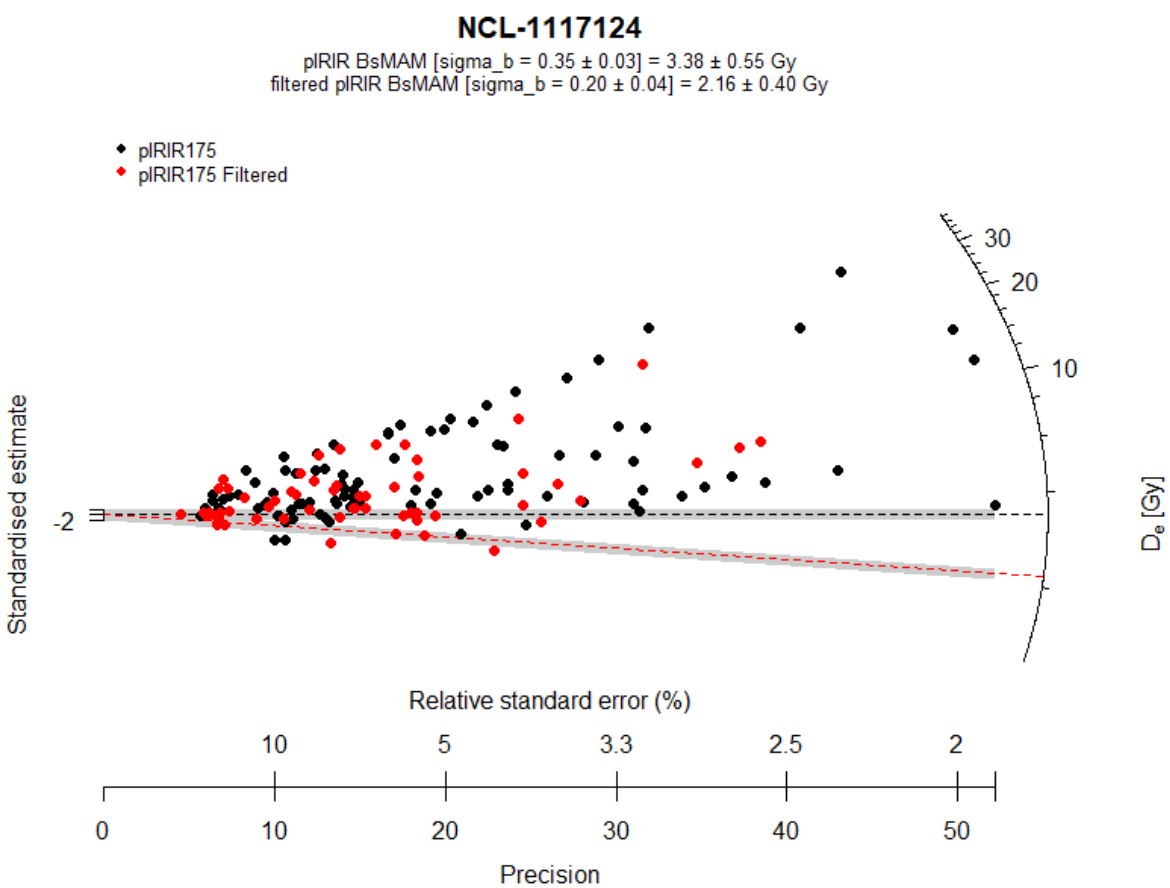
**Supplementary Material A.2: Luminescence dating protocol used for single-grain feldspar pIRIR measurements.**

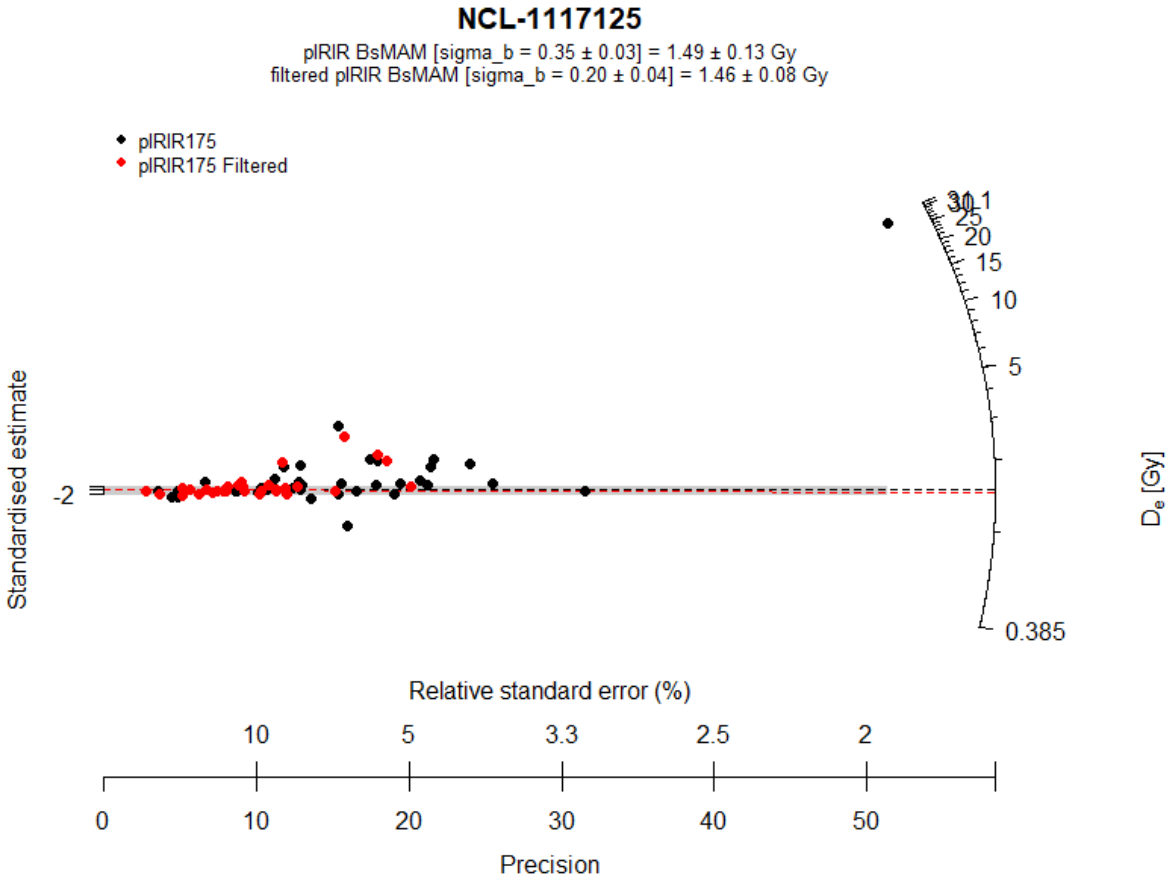
| Step | Action | Measured |
|---|---|---|
| 1 | Beta dose (or Natural dose) | |
| 2 | 120s preheat to 200°C | |
| 3 | 2s single-grain IR laser stimulation at 50°C | |
| 4 | 2s single-grain IR laser stimulation at 175°C | $L_n$, $L_i$ |
| 5 | Beta test dose | |
| 6 | 120s cutheat to 200°C | |
| 7 | 2s single-grain IR laser stimulation at 50°C | |
| 8 | 2s single-grain IR laser stimulation at 175°C | $T_n$, $T_i$ |
| 9 | 300s IR stimulation at 210 °C | |
| 10 | Repeat step 1-10 for a range of doses (incl. zero and repeat dose) | |

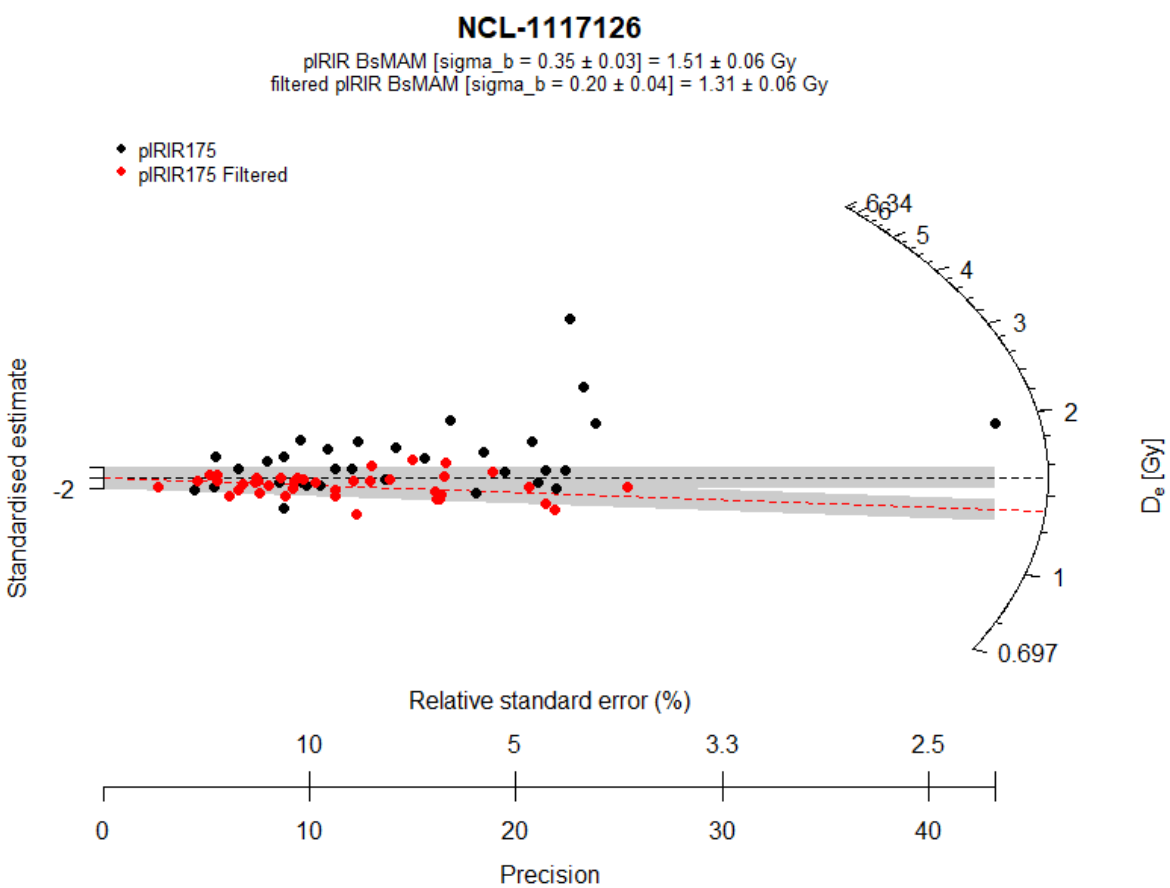
**Supplementary Material B. Radial plots of single-grain feldspar pIRIR measurements.**

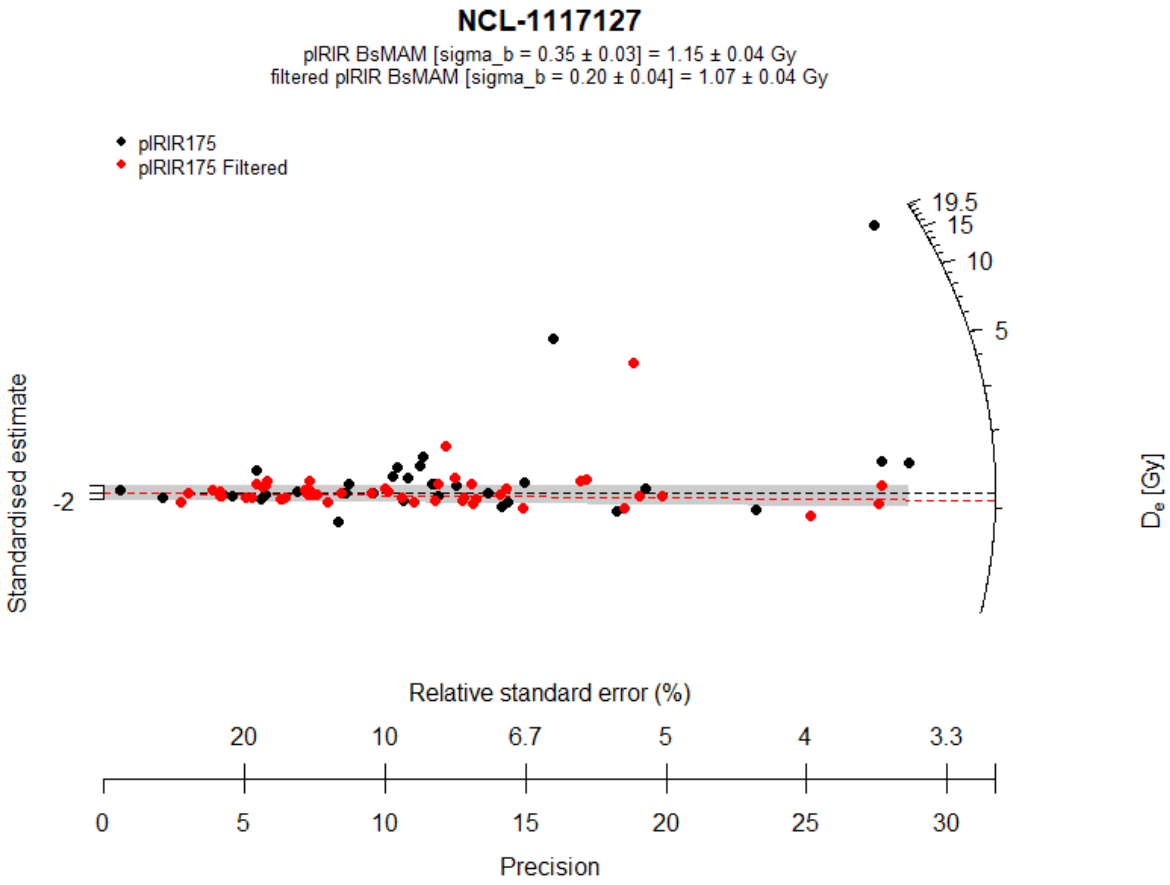


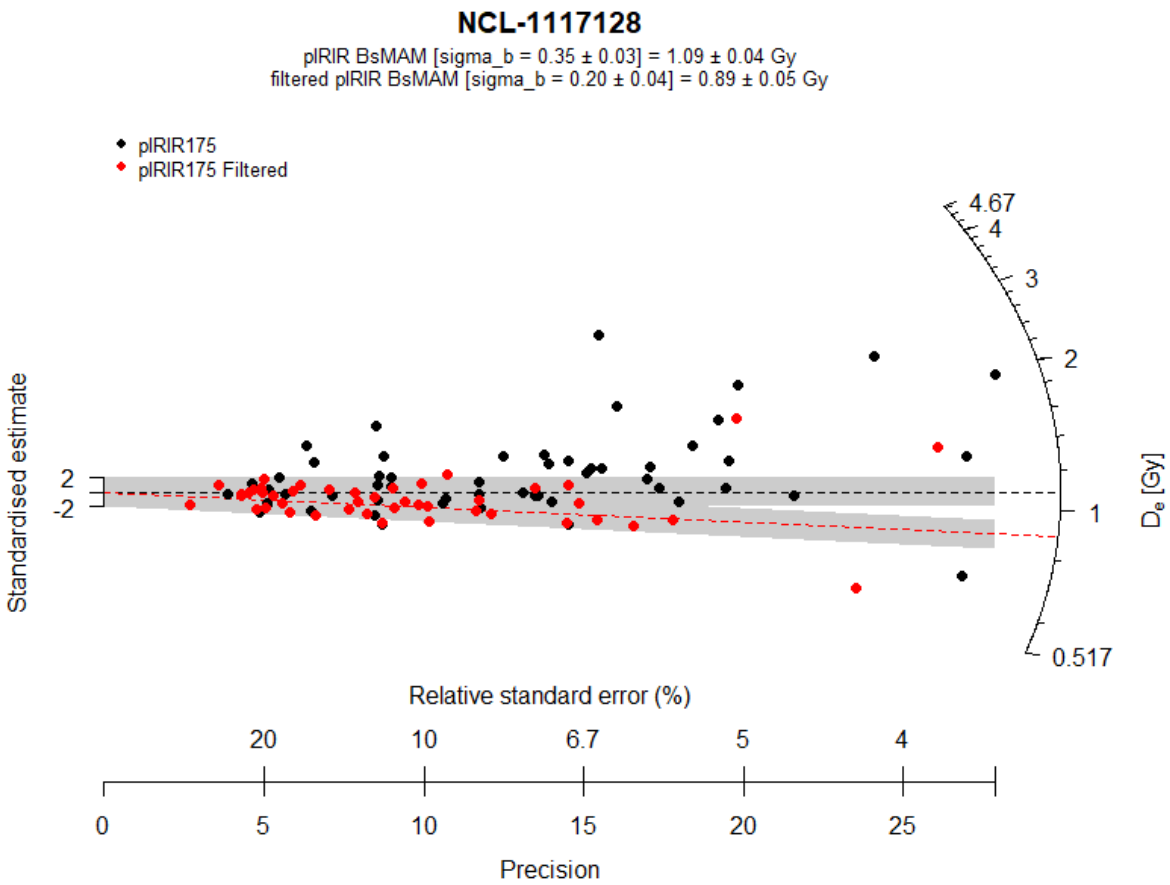

NCL-1117123
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 12.08 ± 1.73 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 6.78 ± 1.30 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
47.8
40
30
20
10
De [Gy]
Relative standard error (%)
10
5
3.3
2.5
2
0
10
20
30
40
50
Precision

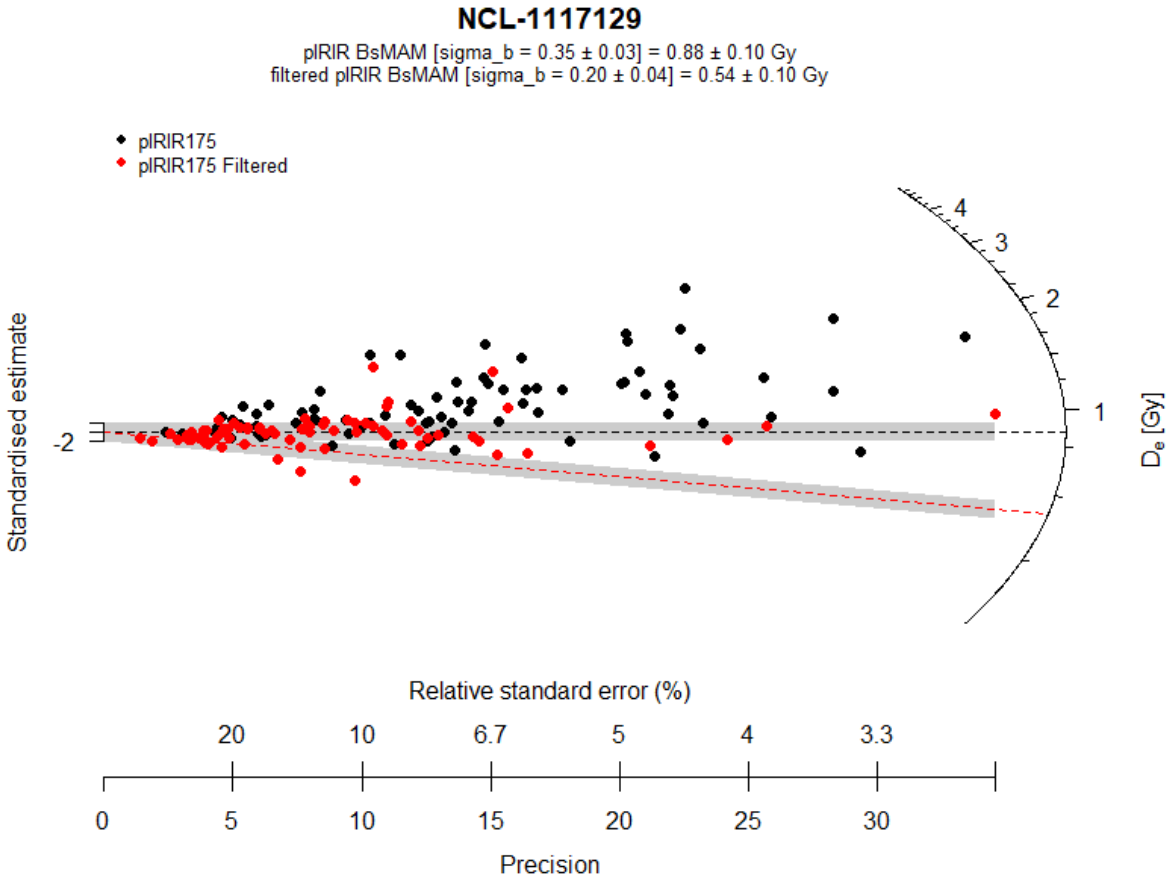

NCL-1117124
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 3.38 ± 0.55 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 2.16 ± 0.40 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
30
20
10
De [Gy]
Relative standard error (%)
10
5
3.3
2.5
2
0
10
20
30
40
50
Precision

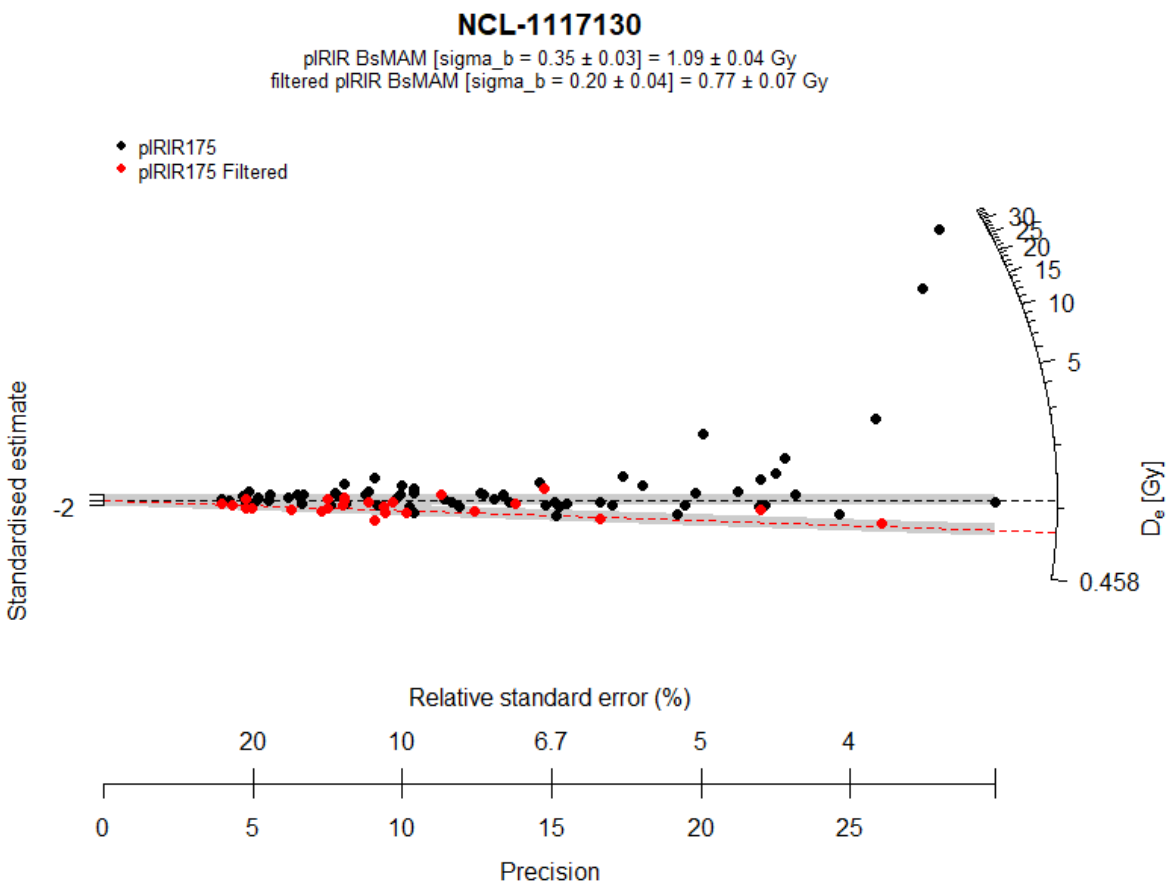

NCL-1117125
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 1.49 ± 0.13 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 1.46 ± 0.08 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
30.1
25
20
15
10
5
0.385
De [Gy]
Relative standard error (%)
10
5
3.3
2.5
2
0
10
20
30
40
50
Precision

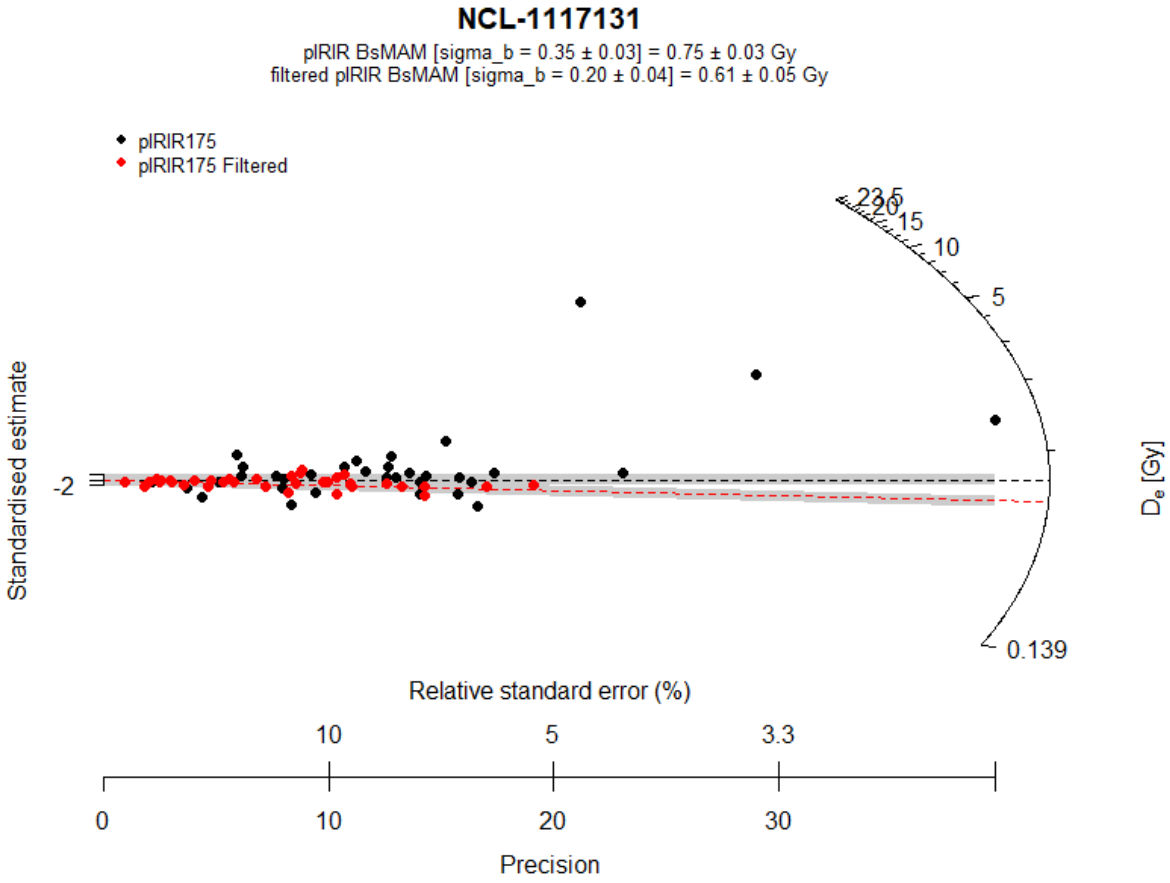

NCL-1117126
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 1.51 ± 0.06 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 1.31 ± 0.06 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
6.34
6
5
4
3
2
1
0.697
De [Gy]
Relative standard error (%)
10
5
3.3
2.5
0
10
20
30
40
Precision

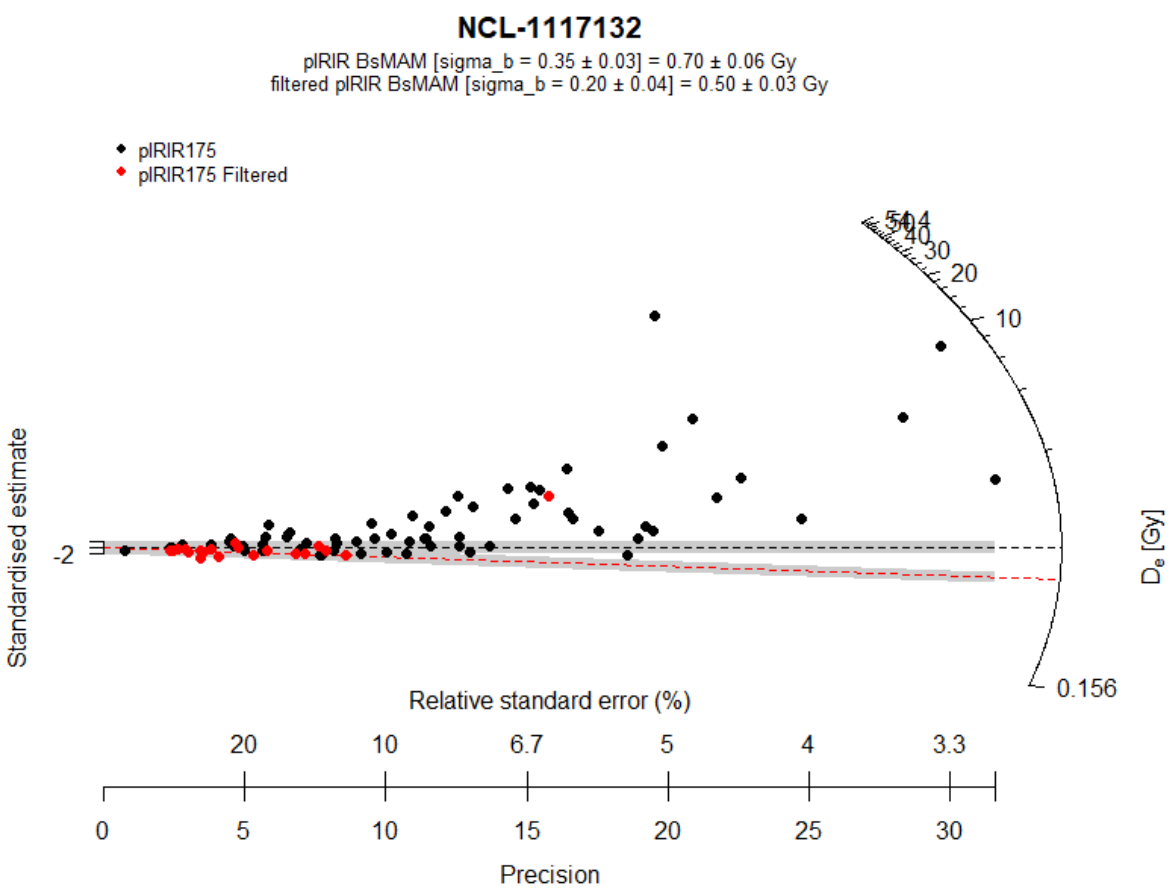

NCL-1117127
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 1.15 ± 0.04 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 1.07 ± 0.04 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
19.5
15
10
5
De [Gy]
Relative standard error (%)
20
10
6.7
5
4
3.3
0
5
10
15
20
25
30
Precision

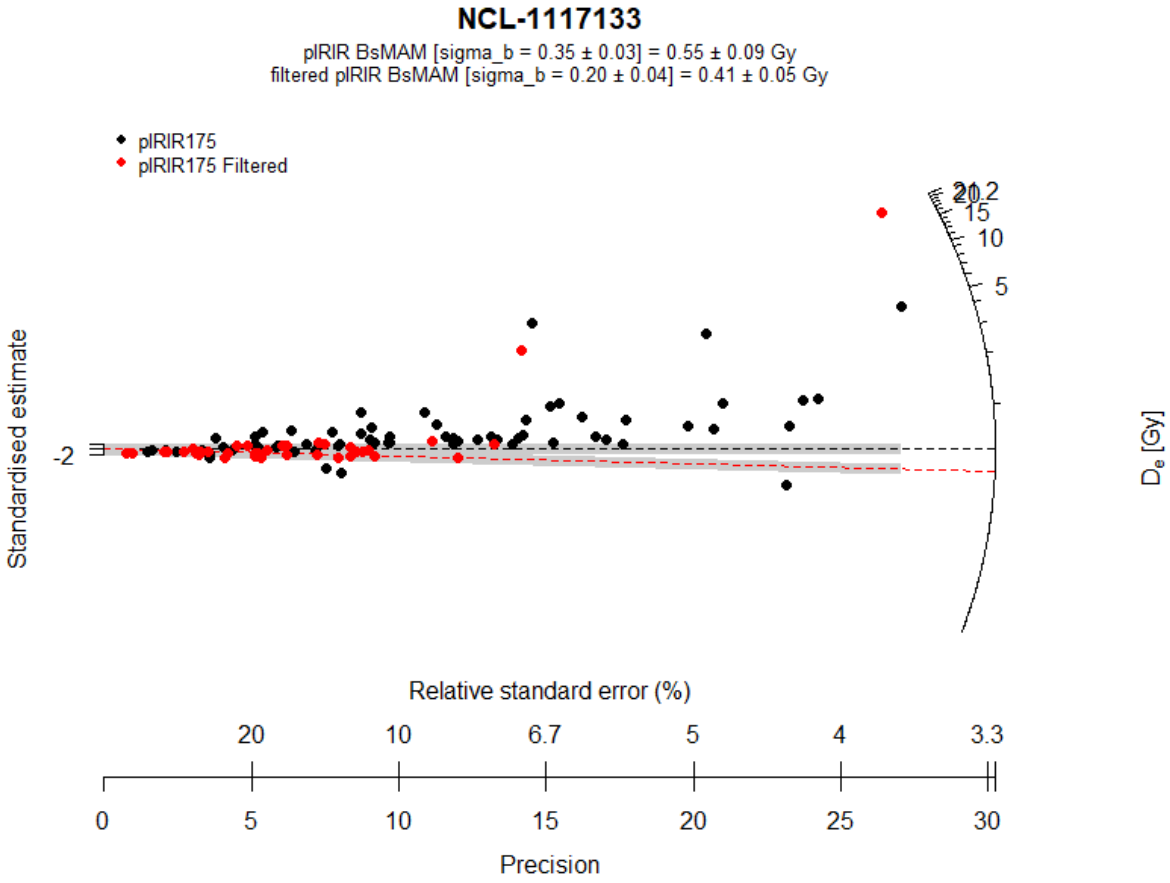

NCL-1117128
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 1.09 ± 0.04 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.89 ± 0.05 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
2
-2
4.67
4
3
2
1
0.517
De [Gy]
Relative standard error (%)
20
10
6.7
5
4
0
5
10
15
20
25
Precision

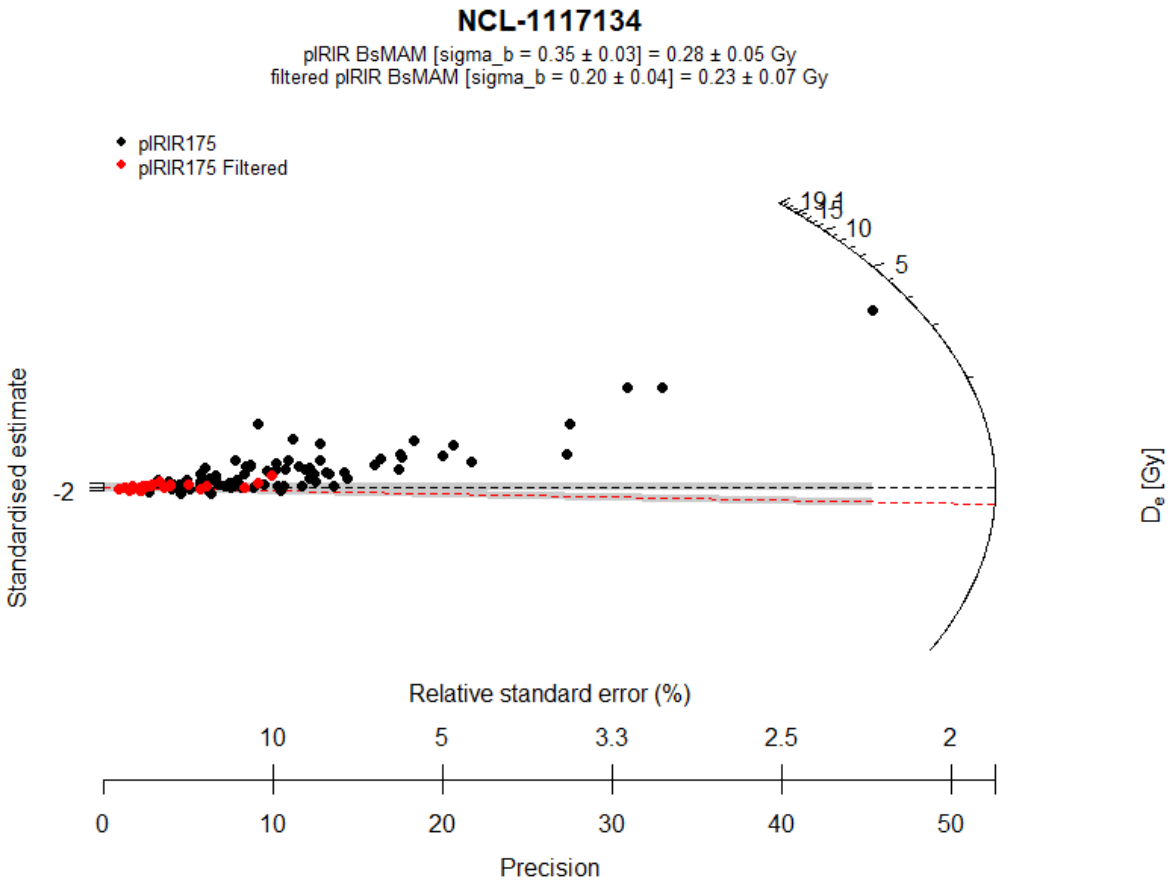

NCL-1117129
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 0.88 ± 0.10 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.54 ± 0.10 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
4
3
2
1
De [Gy]
Relative standard error (%)
20
10
6.7
5
4
3.3
0
5
10
15
20
25
30
Precision


NCL-1117130
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 1.09 ± 0.04 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.77 ± 0.07 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
30
25
20
15
10
5
0.458
De [Gy]
Relative standard error (%)
20
10
6.7
5
4
0
5
10
15
20
25
Precision


NCL-1117131
pIRIR BsMAM [sigma_b = 0.35 ± 0.03] = 0.75 ± 0.03 Gy
filtered pIRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.61 ± 0.05 Gy
pIRIR175
pIRIR175 Filtered
Standardised estimate
-2
23.5
20
15
10
5
0.139
De [Gy]
Relative standard error (%)
10
5
3.3
0
10
20
30
Precision


NCL-1117132
pIRIR BsMAM [sigma_b = 0.35 ± 0.03] = 0.70 ± 0.06 Gy
filtered pIRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.50 ± 0.03 Gy
pIRIR175
pIRIR175 Filtered
Standardised estimate
-2
50
40
30
20
10
0.156
De [Gy]
Relative standard error (%)
20
10
6.7
5
4
3.3
0
5
10
15
20
25
30
Precision


NCL-1117133
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 0.55 ± 0.09 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.41 ± 0.05 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
20.2
15
10
5
De [Gy]
Relative standard error (%)
20
10
6.7
5
4
3.3
0
5
10
15
20
25
30
Precision


NCL-1117134
plRIR BsMAM [sigma_b = 0.35 ± 0.03] = 0.28 ± 0.05 Gy
filtered plRIR BsMAM [sigma_b = 0.20 ± 0.04] = 0.23 ± 0.07 Gy
plRIR175
plRIR175 Filtered
Standardised estimate
-2
19.1
15
10
5
De [Gy]
Relative standard error (%)
10
5
3.3
2.5
2
0
10
20
30
40
50
Precision