SEP status in Rome Tor Vergata

AMS Italia @ La Sapienza

Jian Tian 10/October/2025

Content

- Proton integrated flux and daily flux in 13.5 years (2012-05 to 2024-12), all sky and in the magnetic polar region
- SEP Proton flux

- Proton integrated flux and daily flux in 13.5 years (2012-05 to 2024-12), all sky and in the magnetic polar region

DST: NAIA v1.2.0

ISS B1236

MC: H.1308

Selections:

standard selections from AMS Wiki for Proton analysis

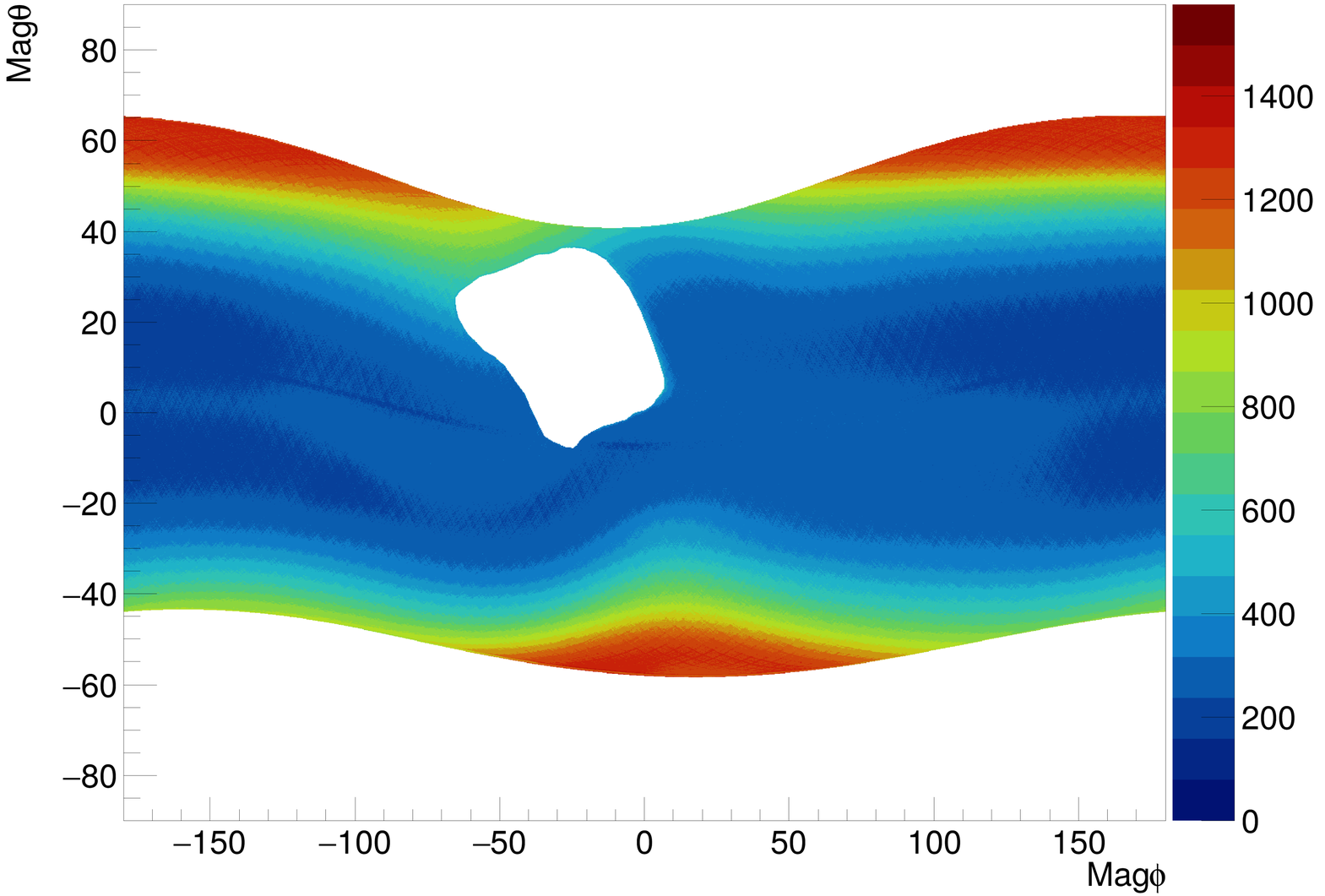
- all sky Use cutoff

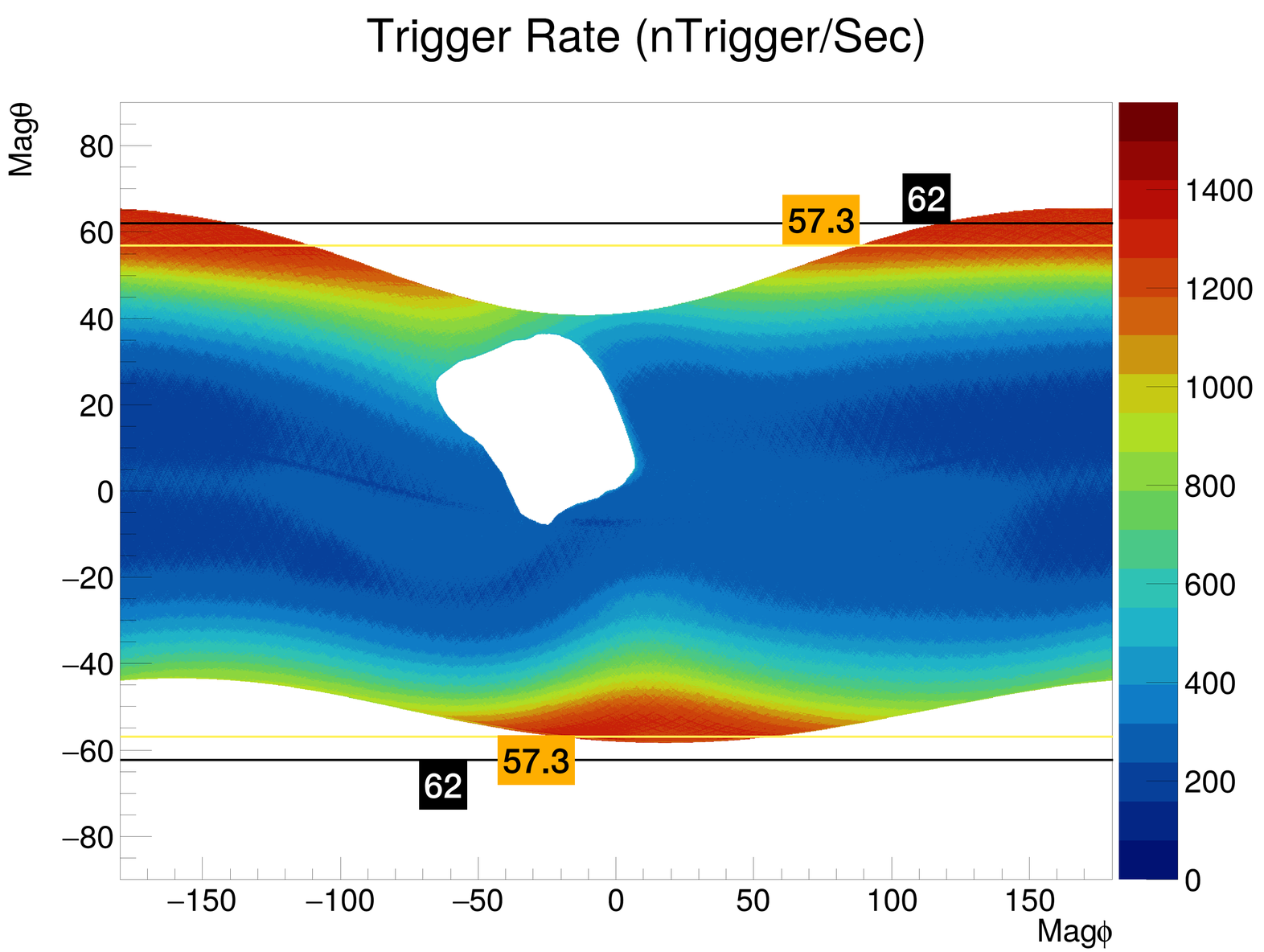
- magnetic polar region

Not use cutoff ThetaM>57.3 (1 rad)

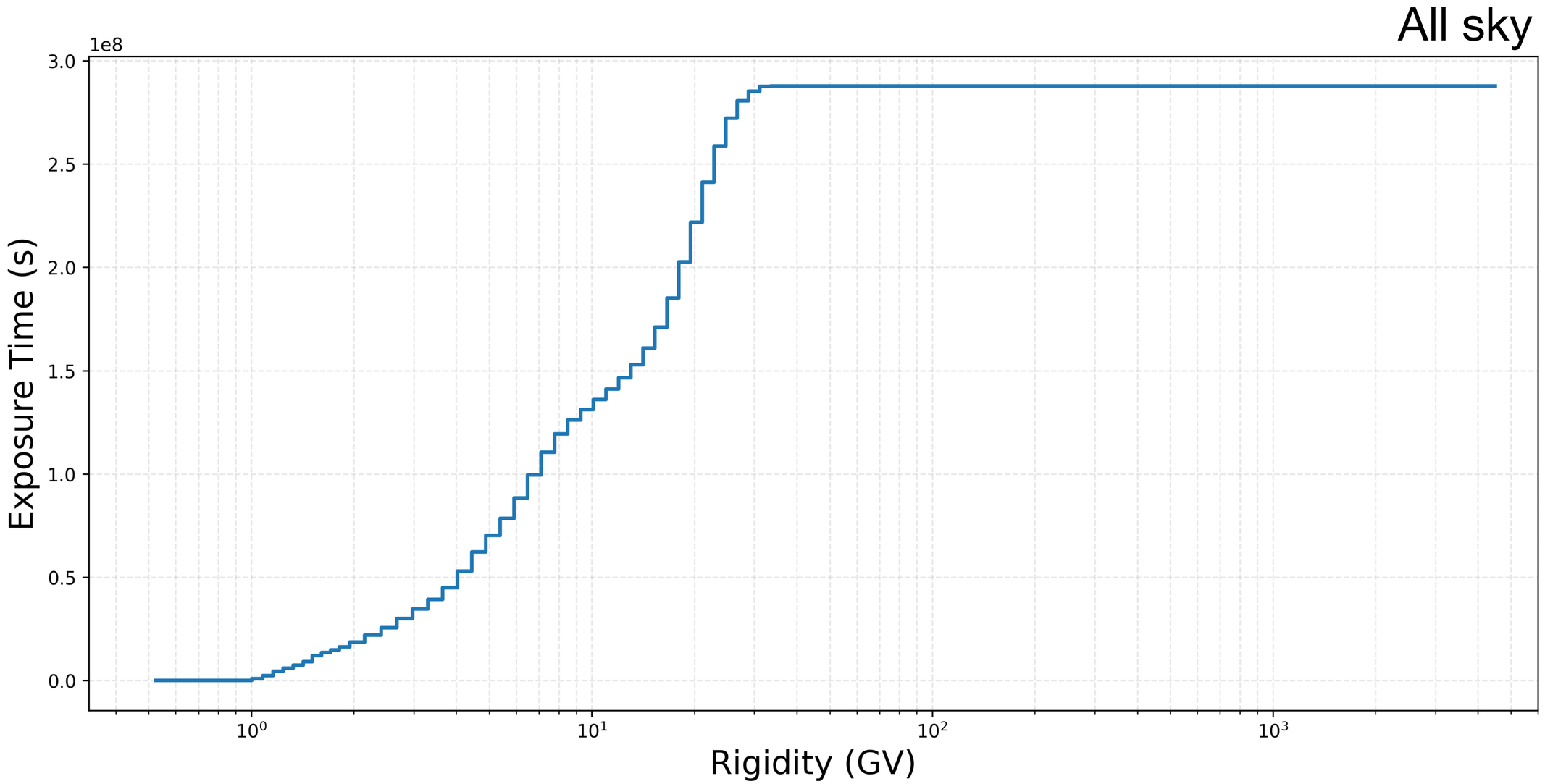
Mass selection and Livetime>0 ThetaM>62

Trigger Rate (nTrigger/Sec)

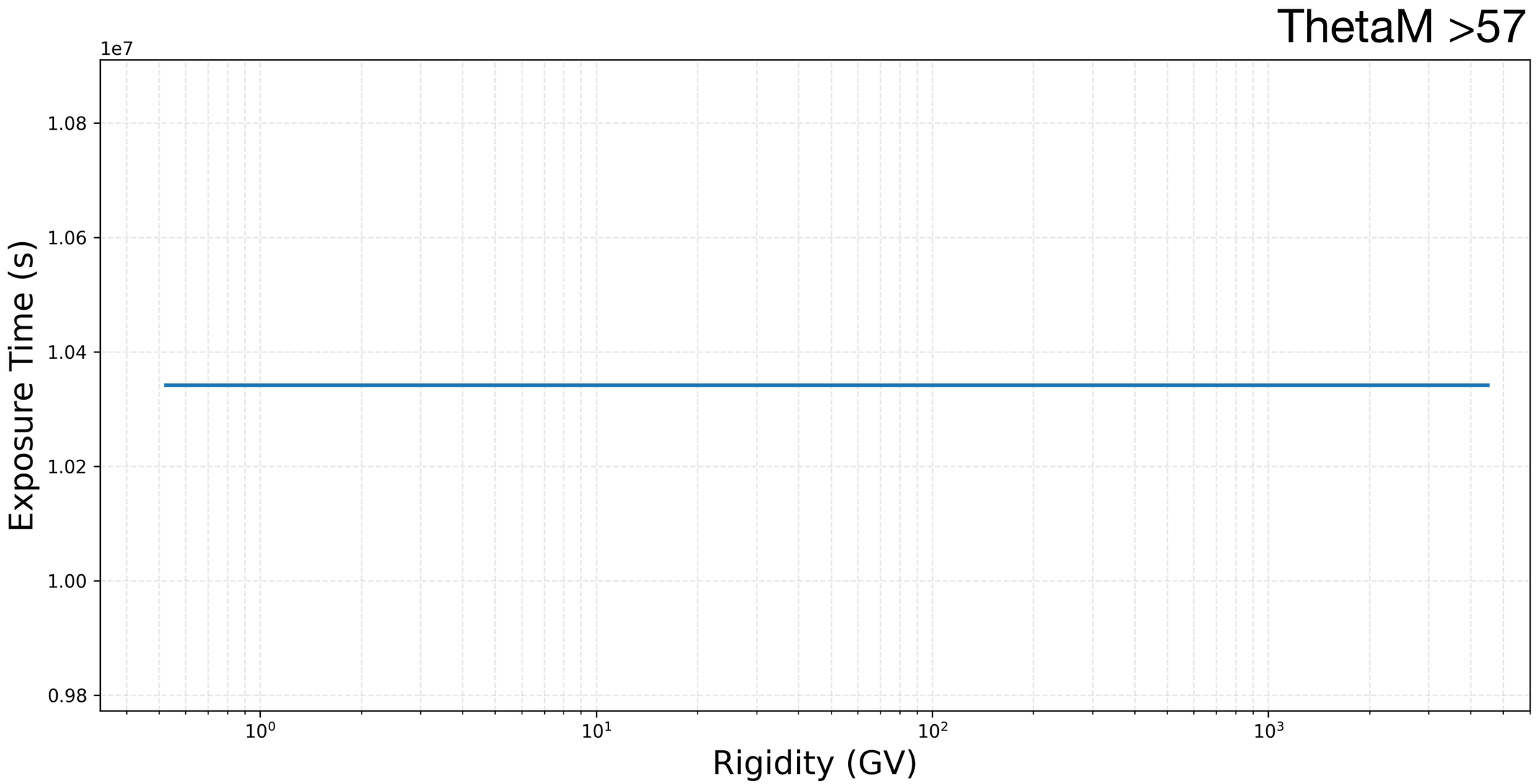



Trigger Rate (nTrigger/Sec)
Magθ
80
60
40
20
0
−20
−40
−60
−80
62
57.3
57.3
62
−150
−100
−50
0
50
100
150
Magϕ
1400
1200
1000
800
600
400
200
0

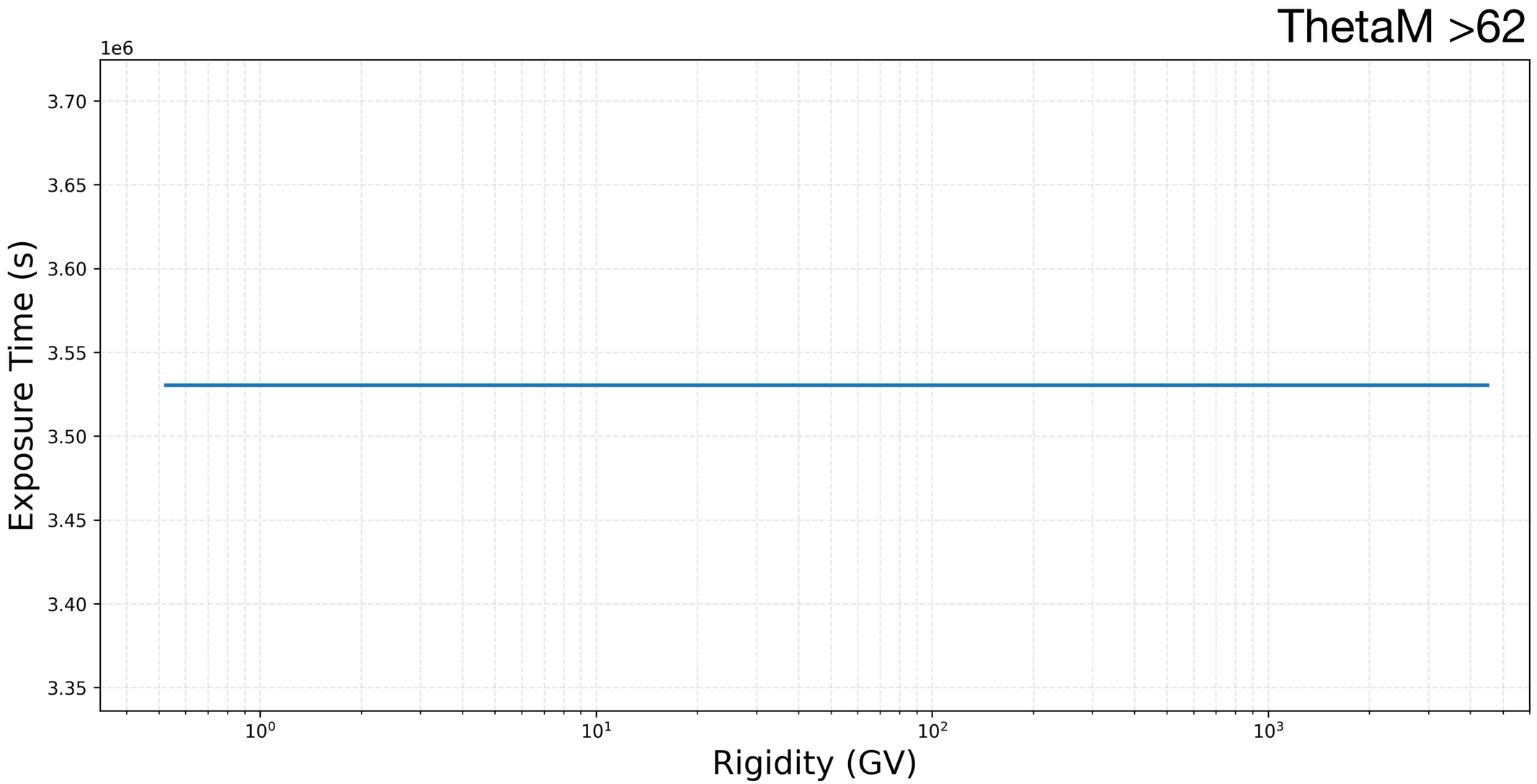
EXPOSURE TIME



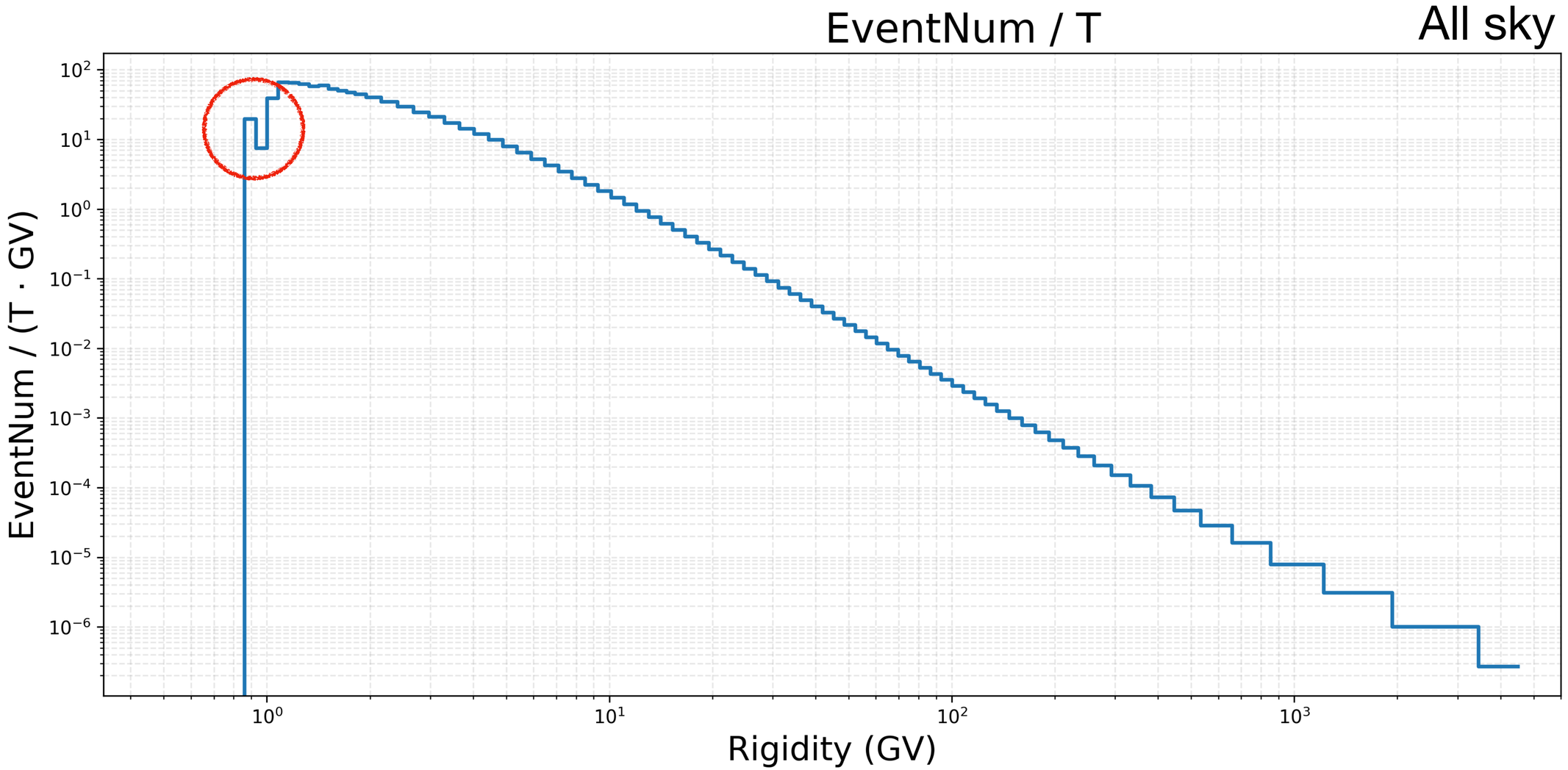
EXPOSURE TIME



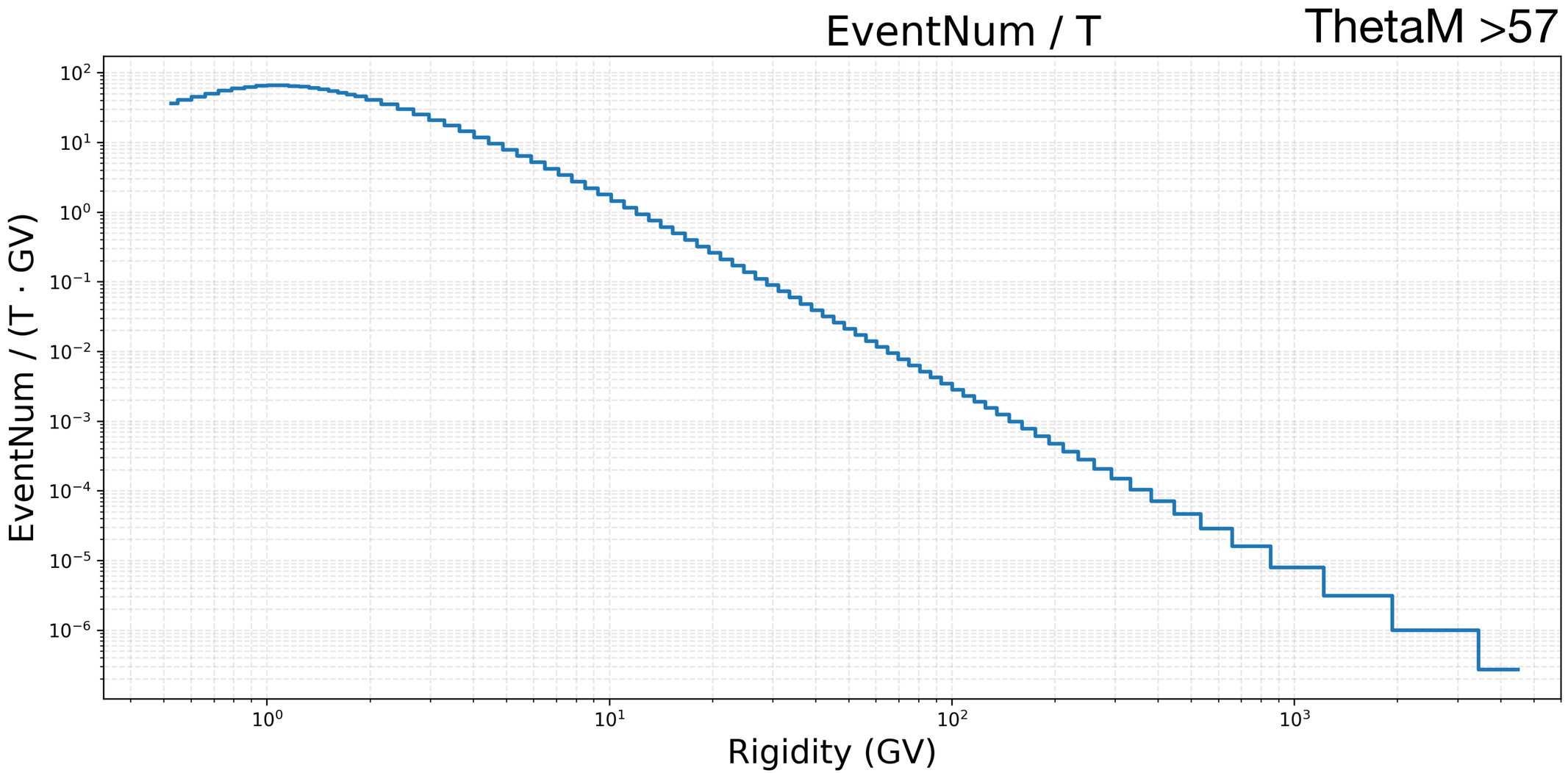
EXPOSURE TIME



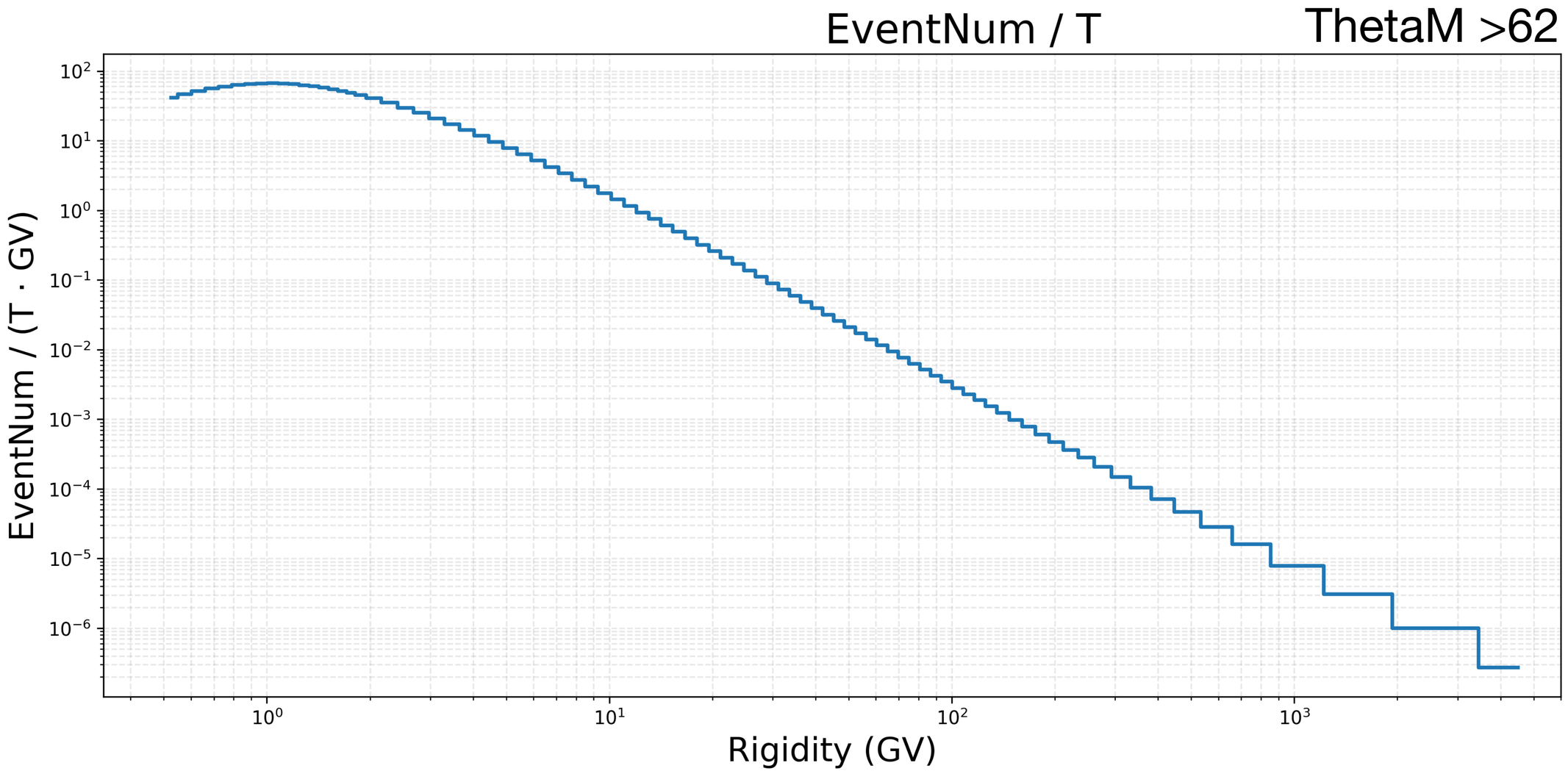
EVENT RATE


EventNum / T
All sky
EventNum / (T · GV)
Rigidity (GV)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{0}
10^{1}
10^{2}
10^{3}

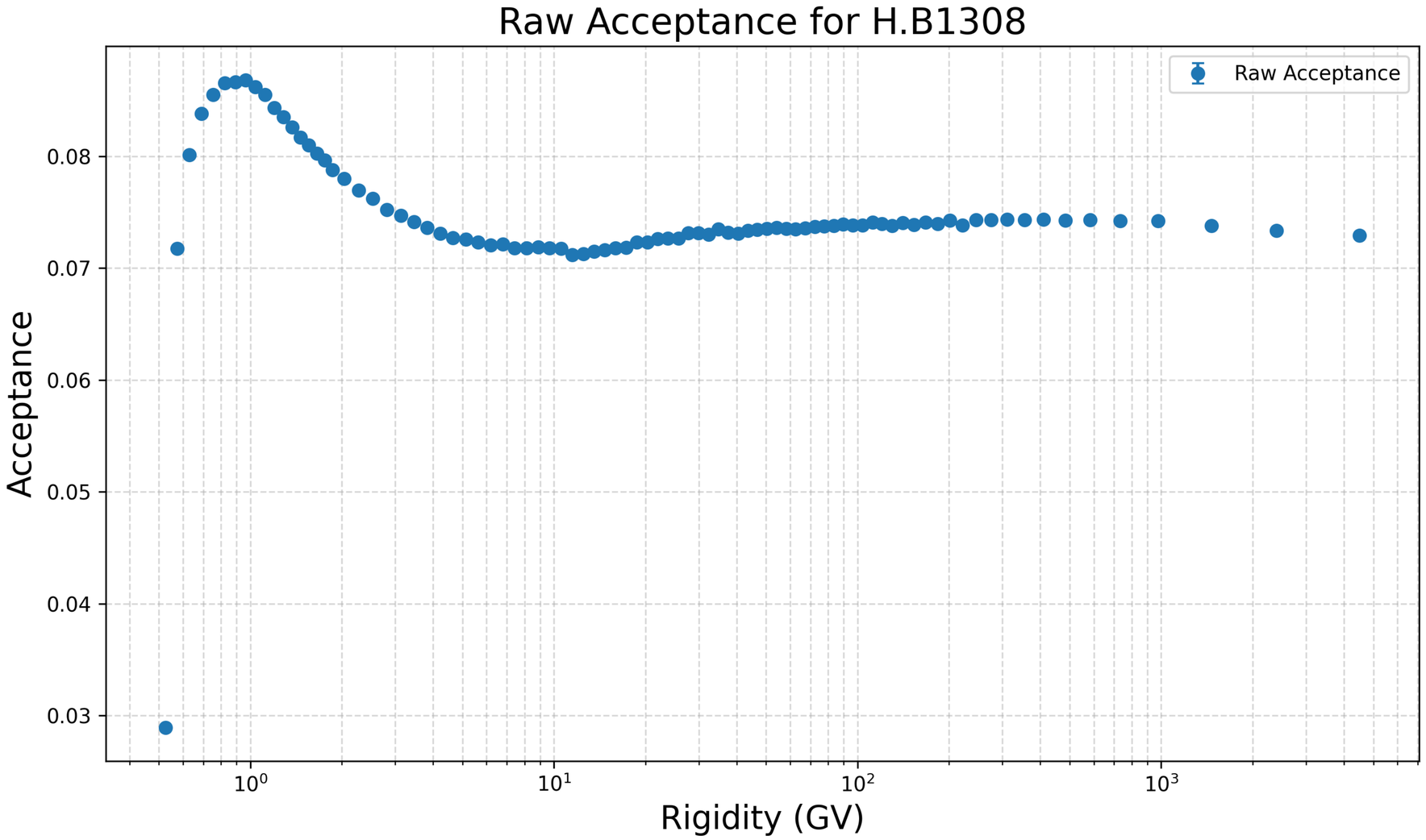
EVENT RATE


EventNum / T
ThetaM >57
EventNum / (T · GV)
Rigidity (GV)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{0}
10^{1}
10^{2}
10^{3}

EVENT RATE

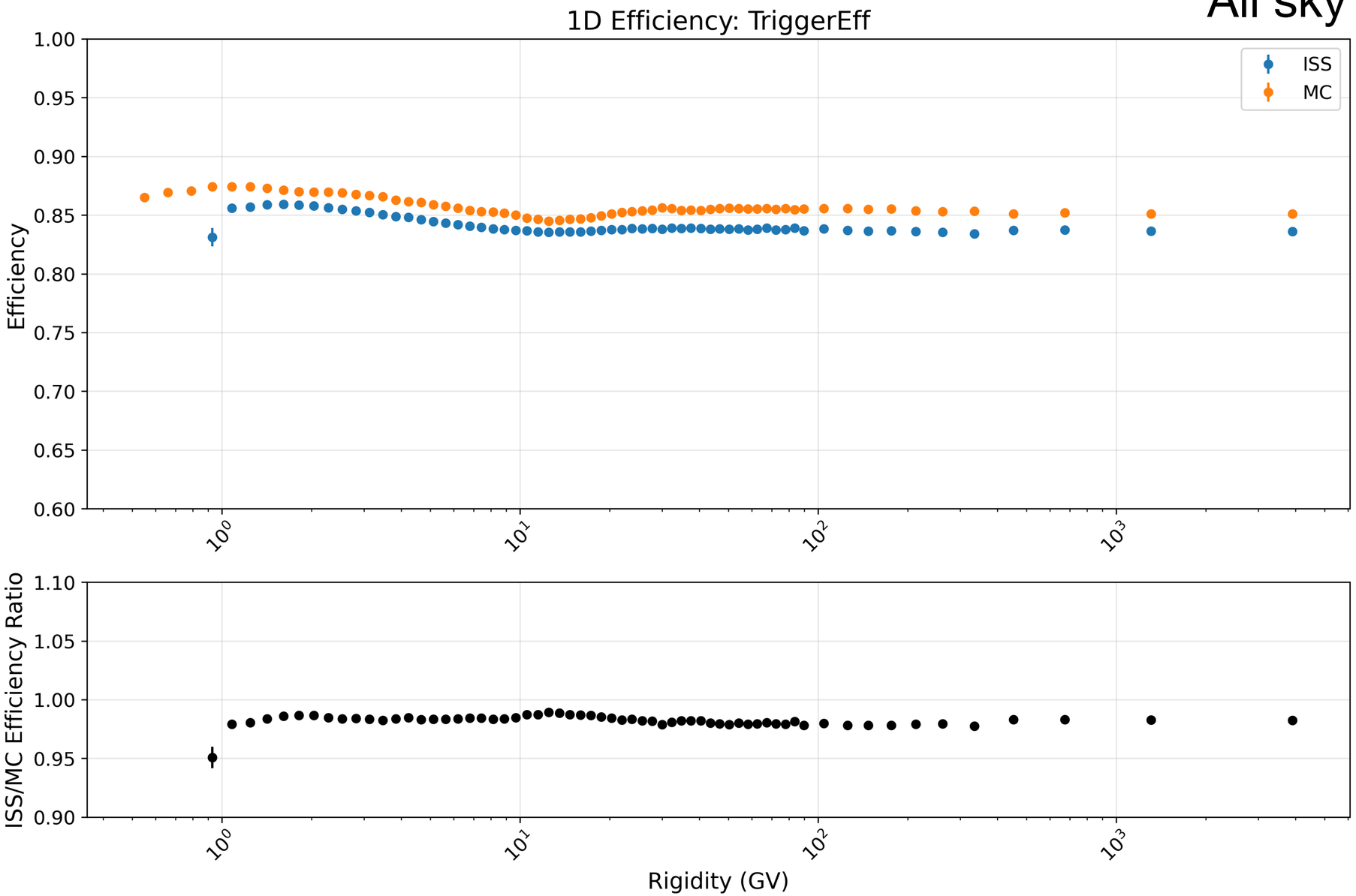

EventNum / T
ThetaM >62
EventNum / (T · GV)
Rigidity (GV)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{0}
10^{1}
10^{2}
10^{3}

RAW ACCEPTANCE



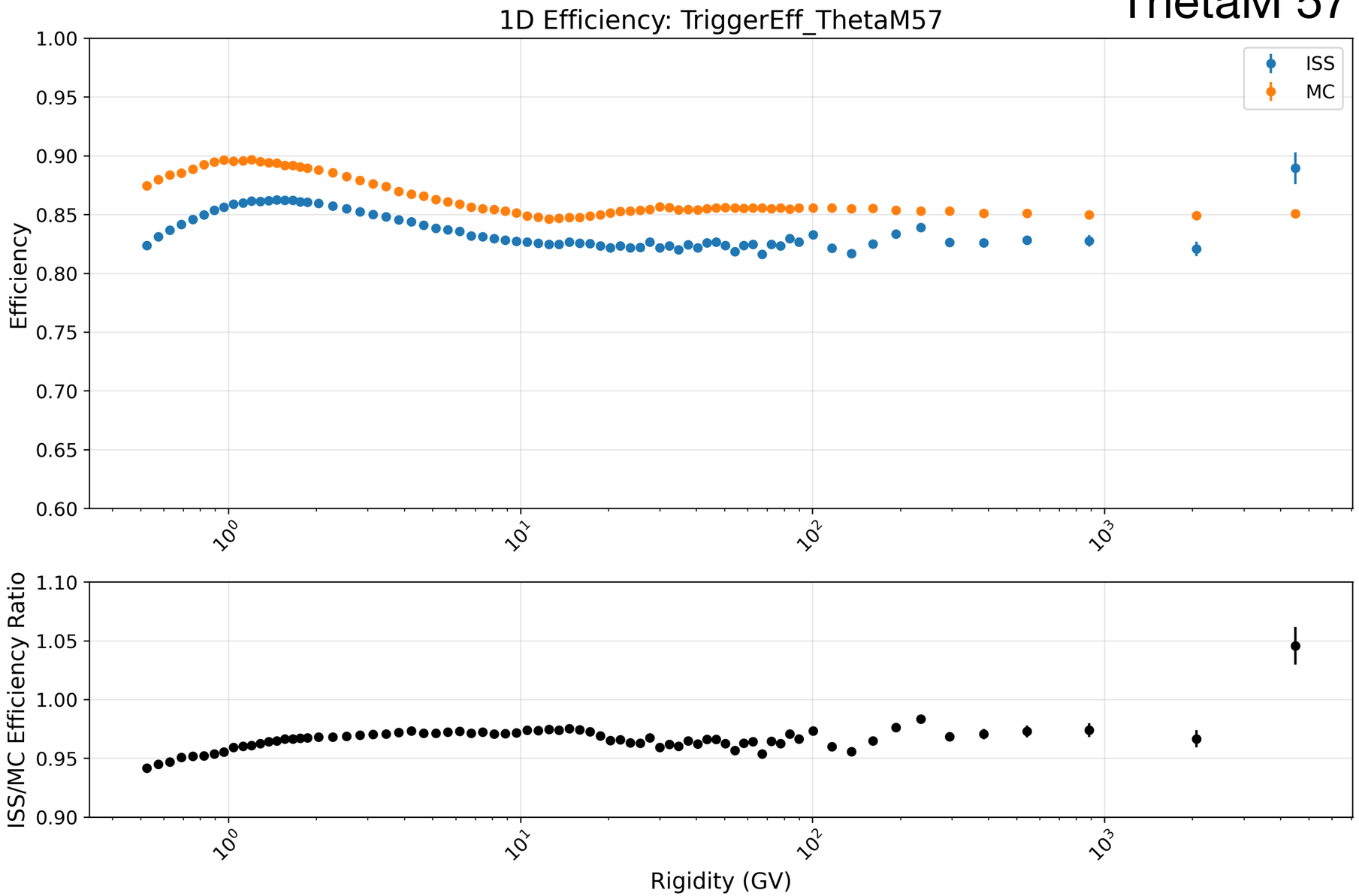
TRIGGER EFFICIENCY

All sky



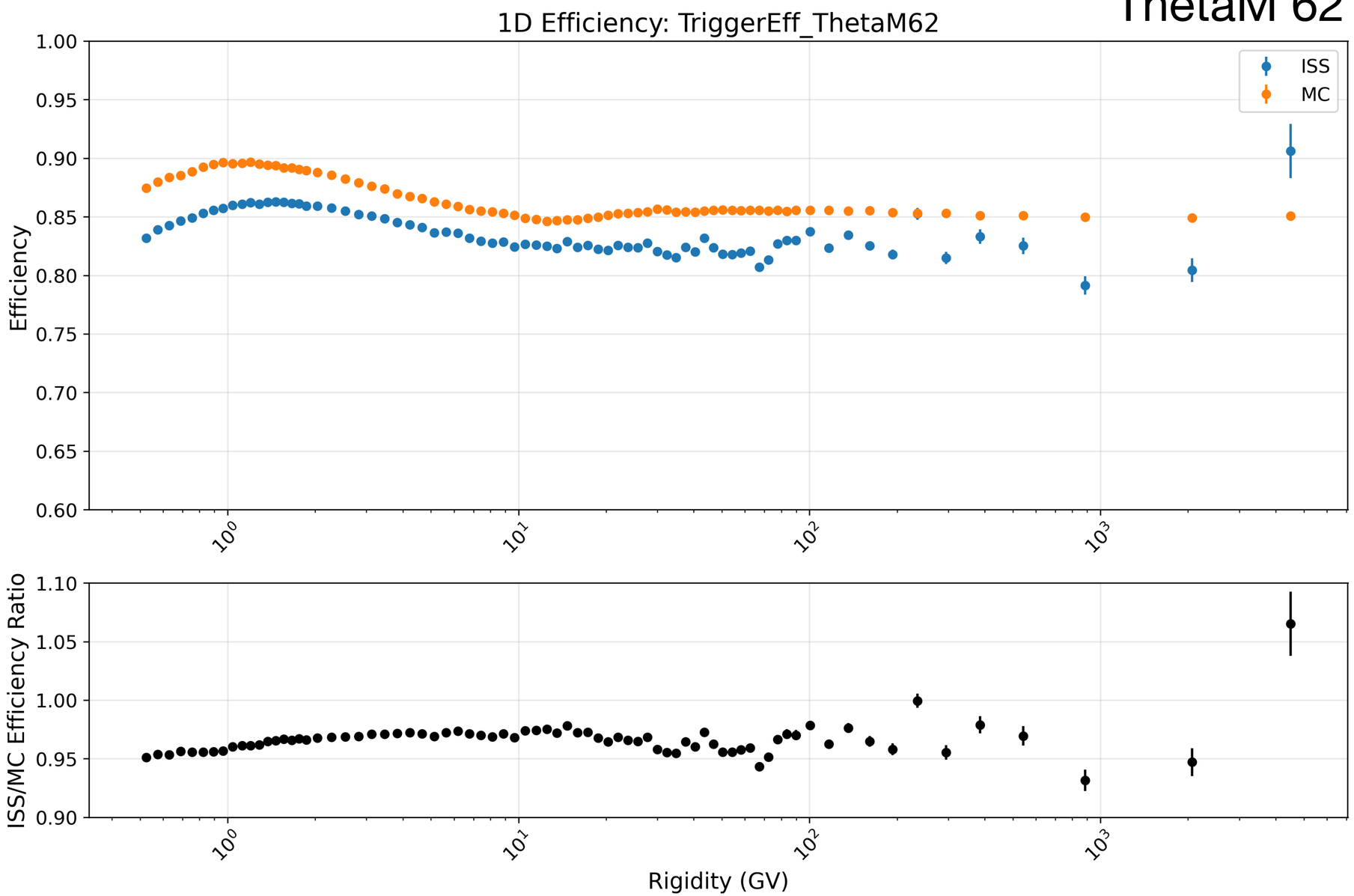
TRIGGER EFFICIENCY

ThetaM 57



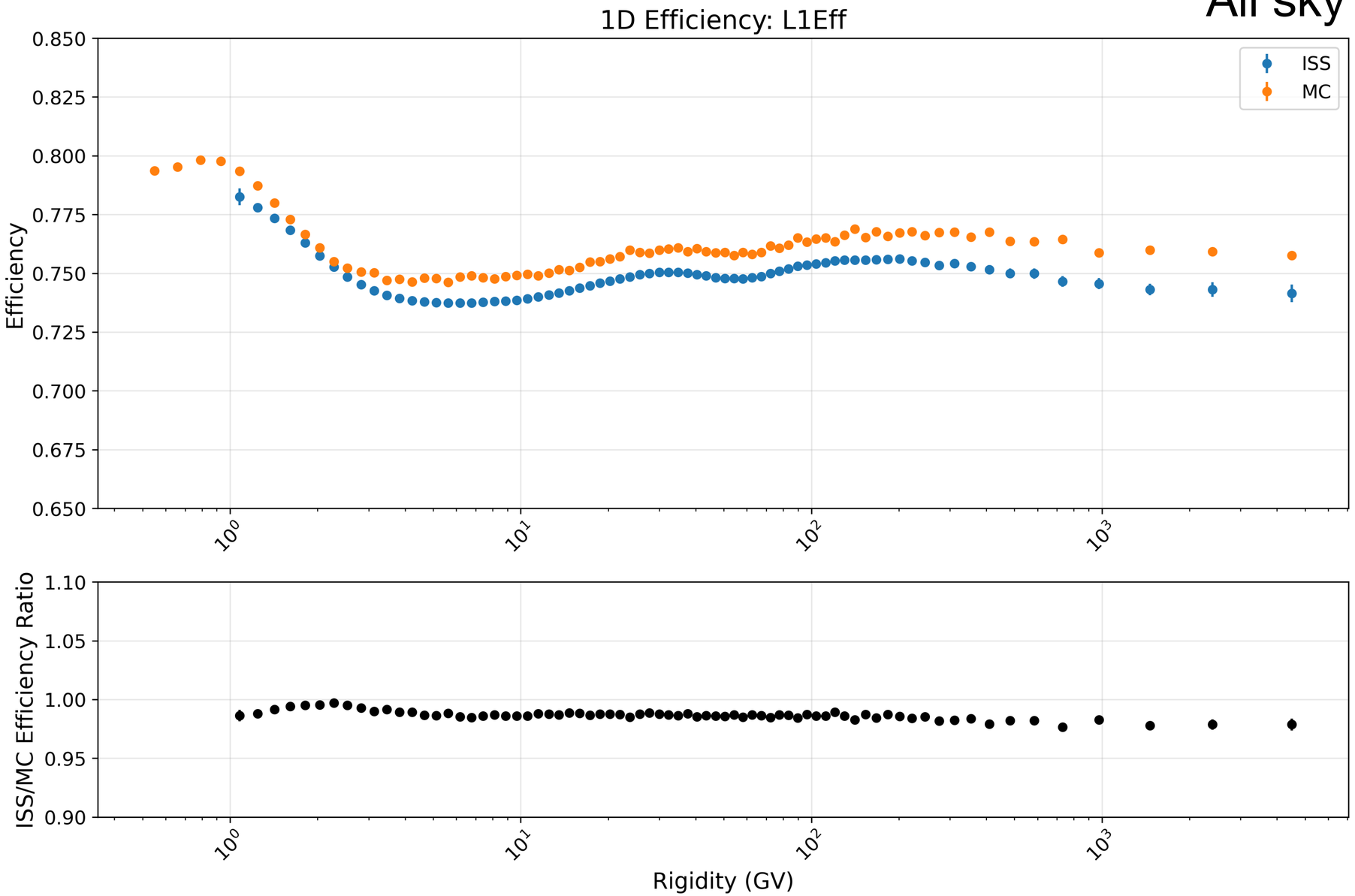
TRIGGER EFFICIENCY

ThetaM 62



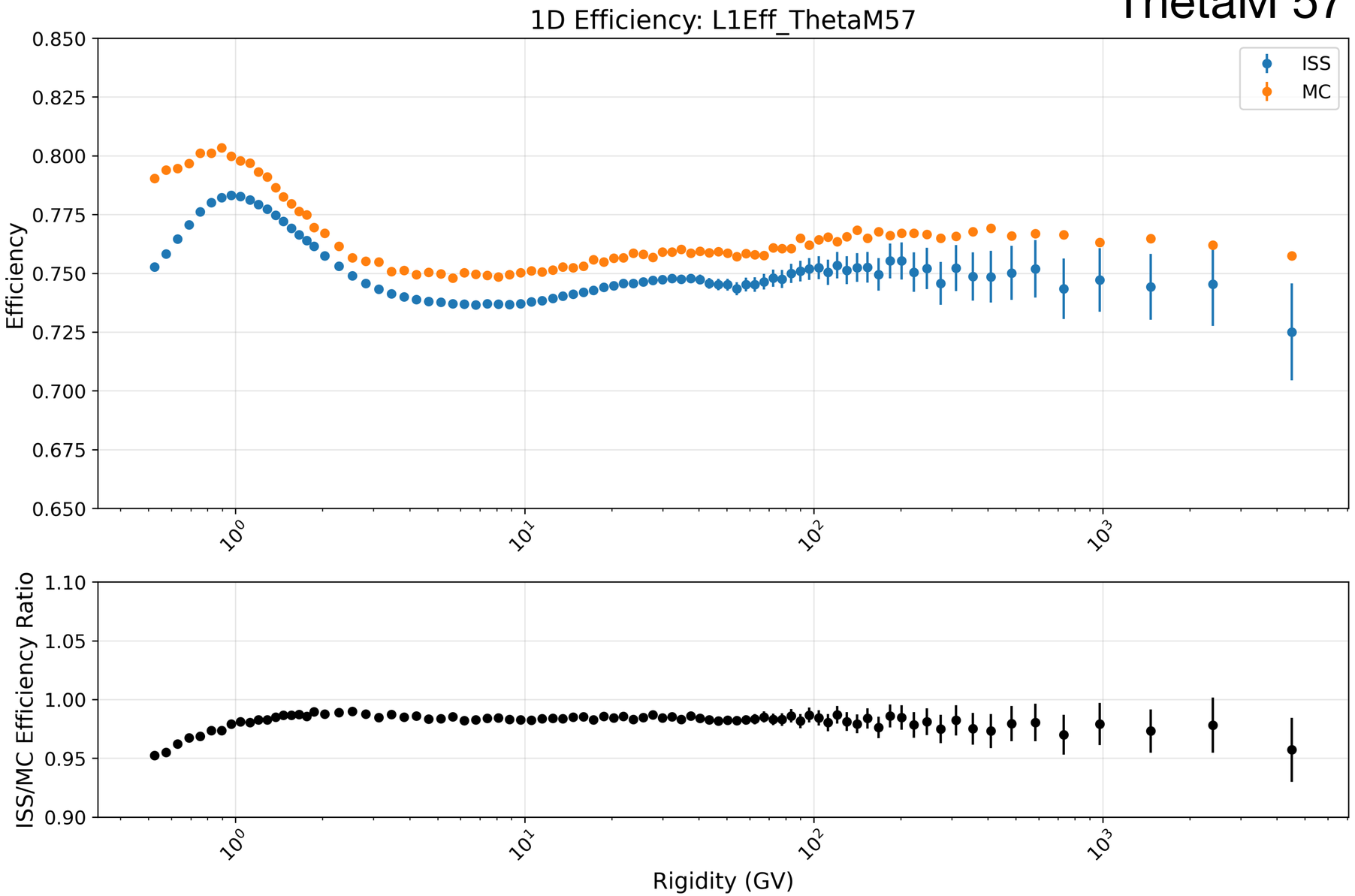
TRACKER L1 EFFICIENCY

All sky



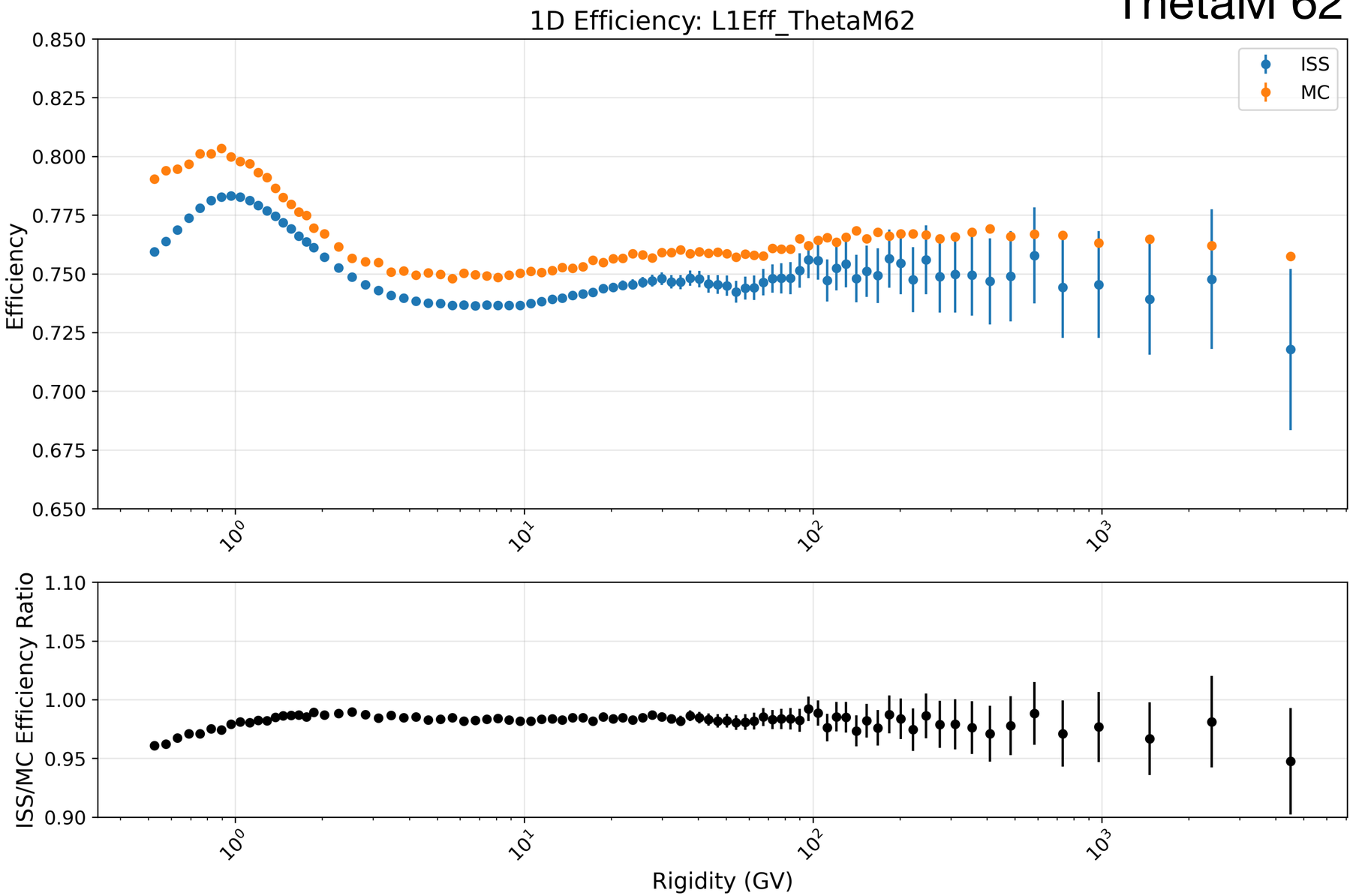
TRACKER L1 EFFICIENCY

ThetaM 57



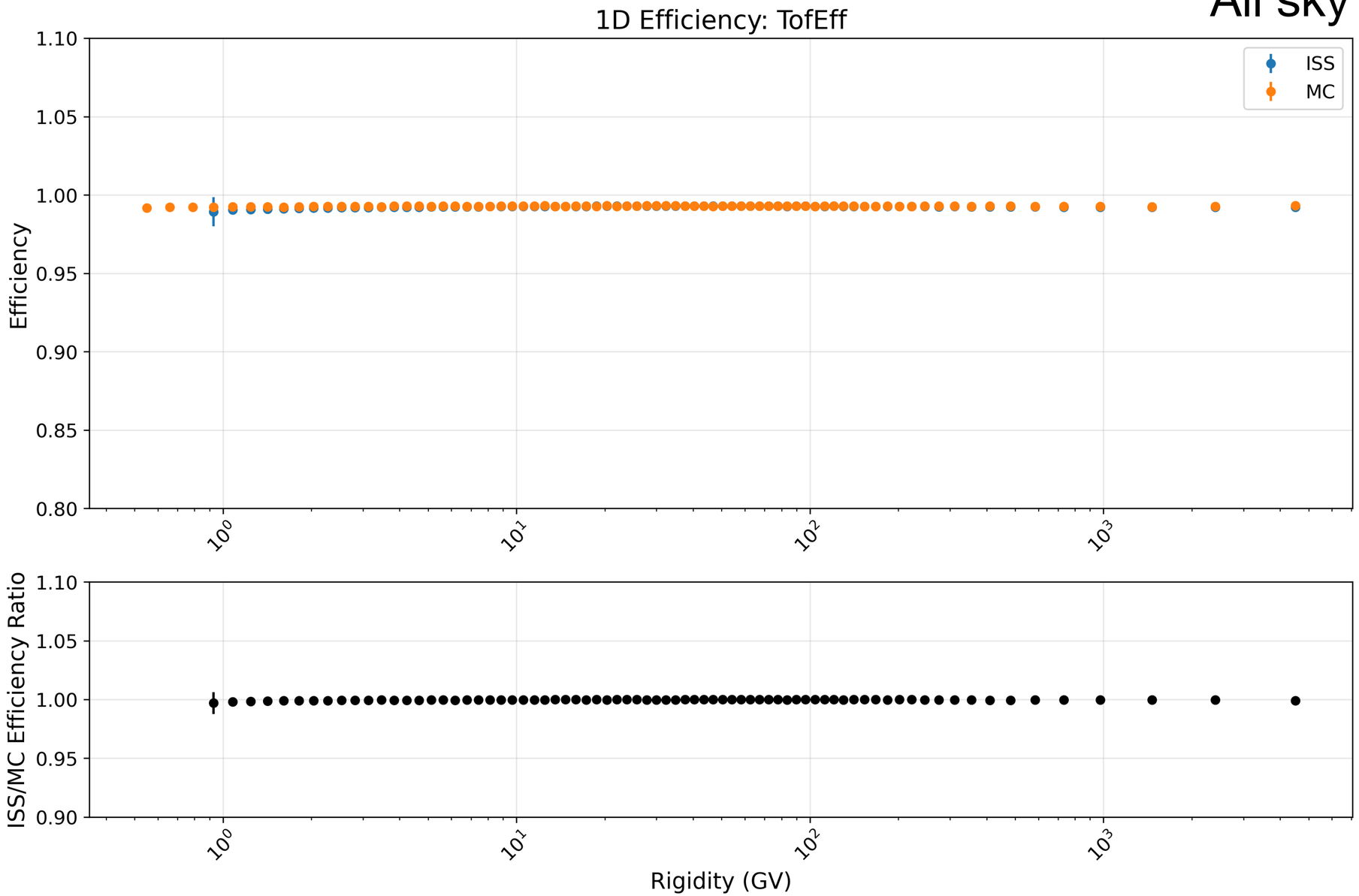
TRACKER L1 EFFICIENCY

ThetaM 62



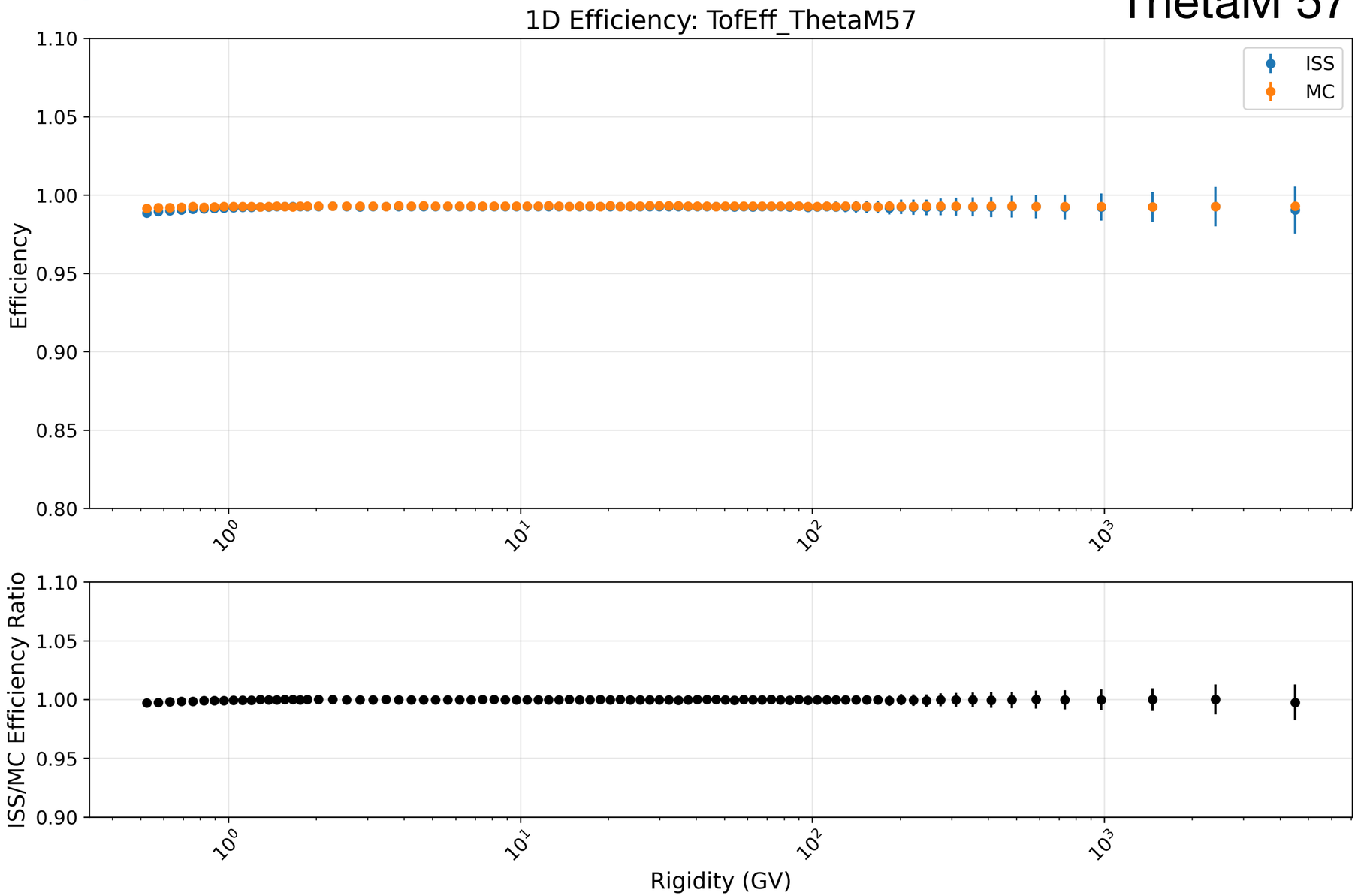
TOF EFFICIENCY

All sky



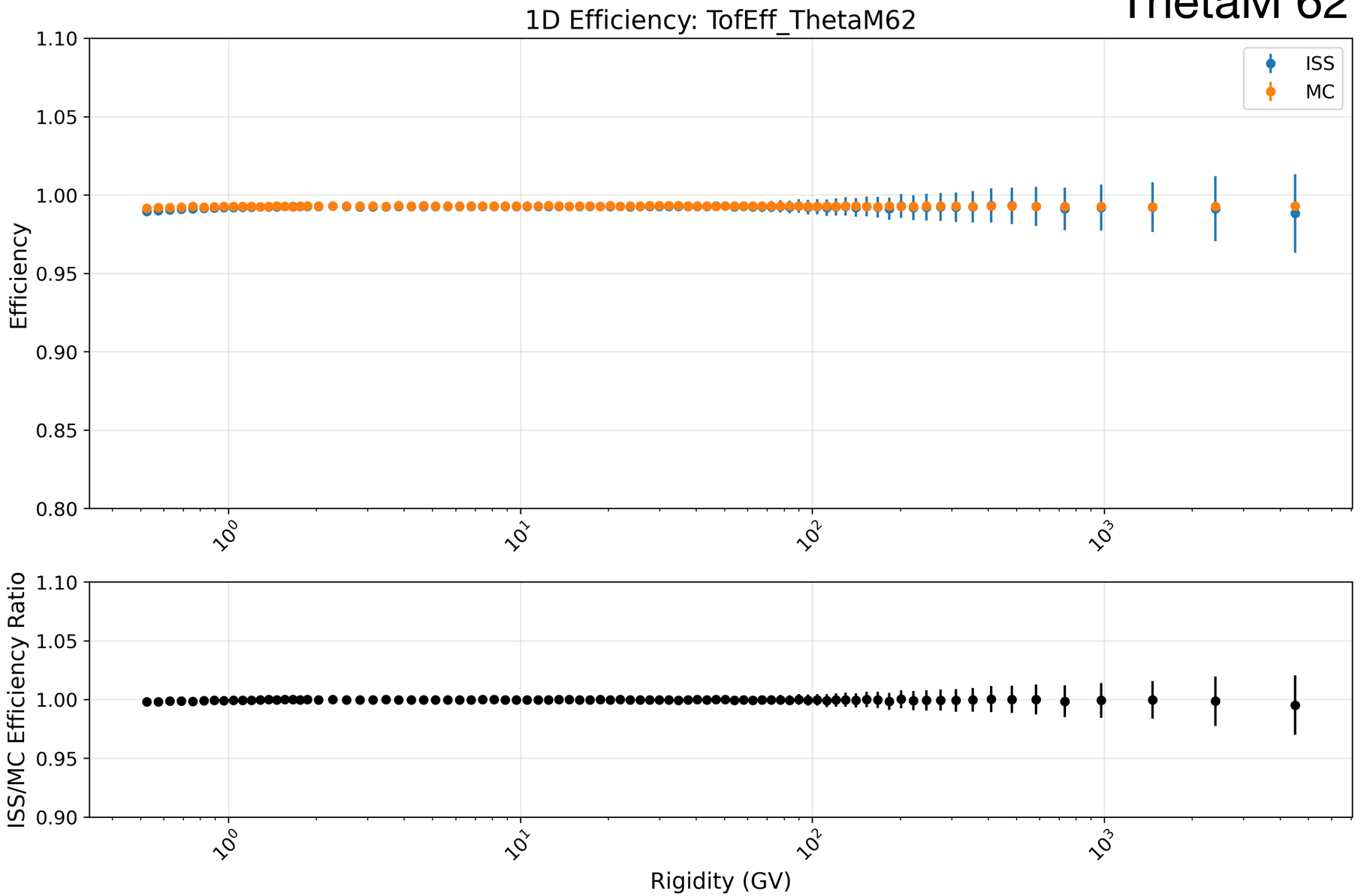
TOF EFFICIENCY

ThetaM 57



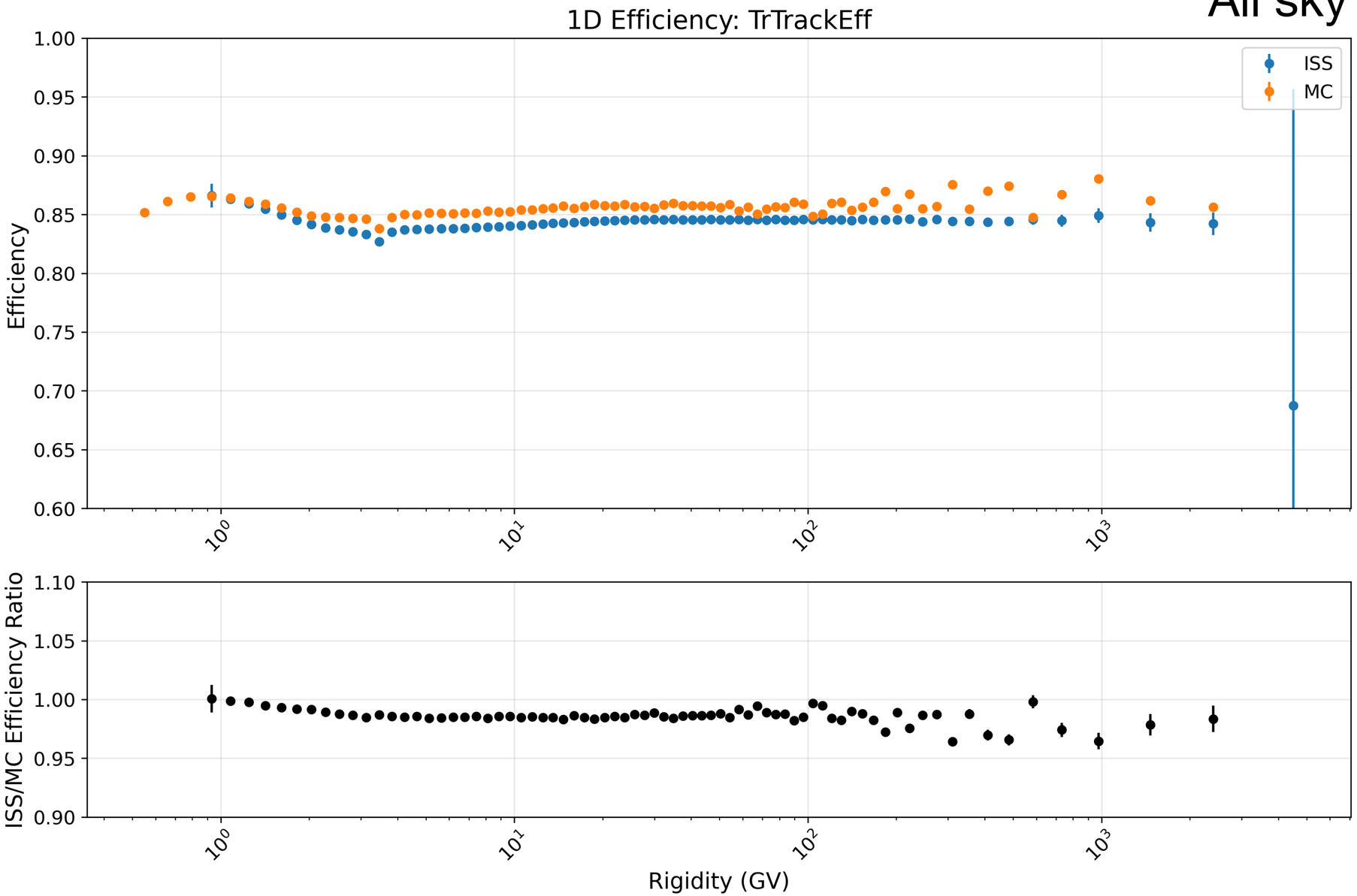
TOF EFFICIENCY

ThetaM 62



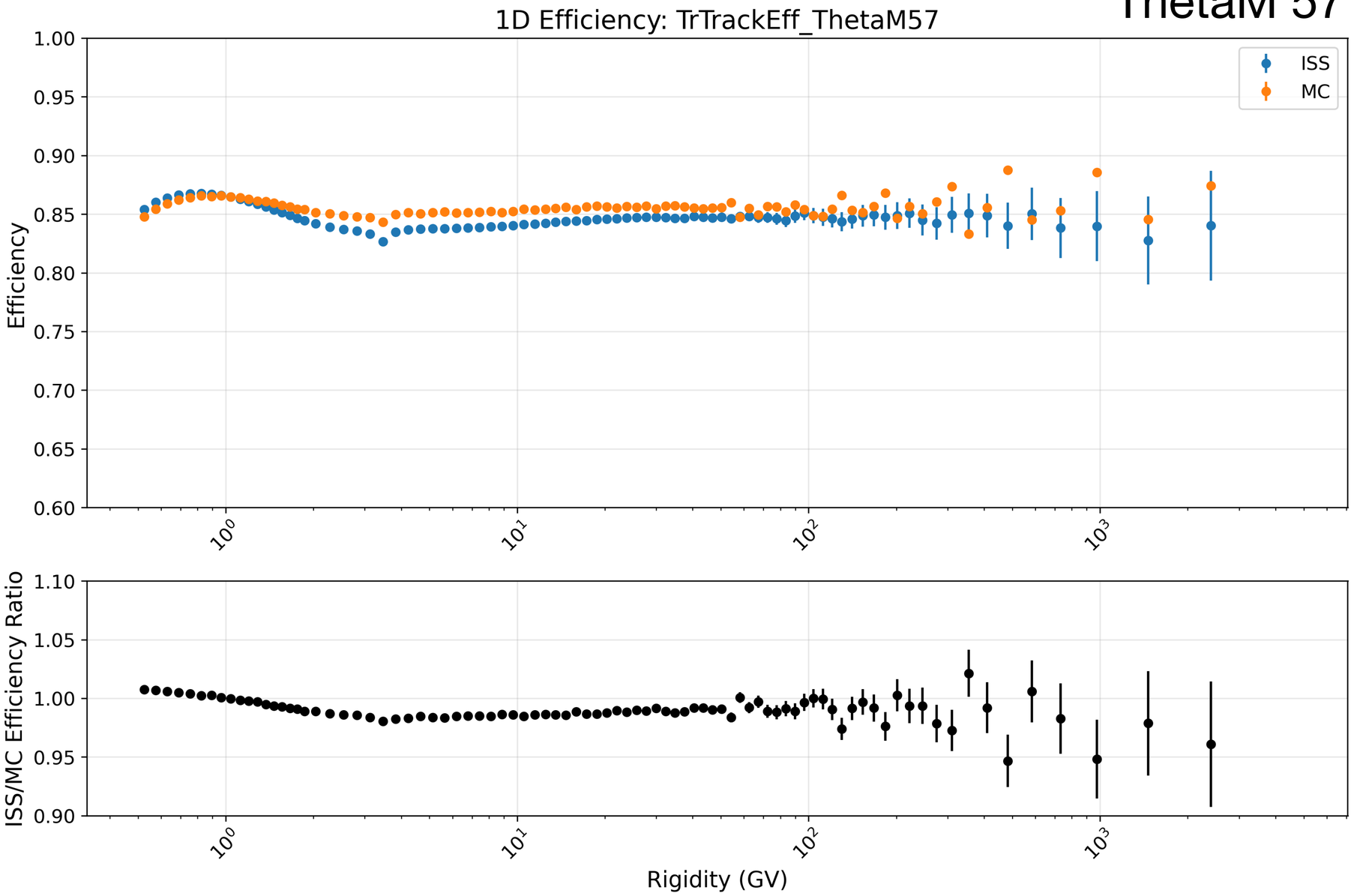
INNER TRACKER(L2->L8) EFFICIENCY

All sky



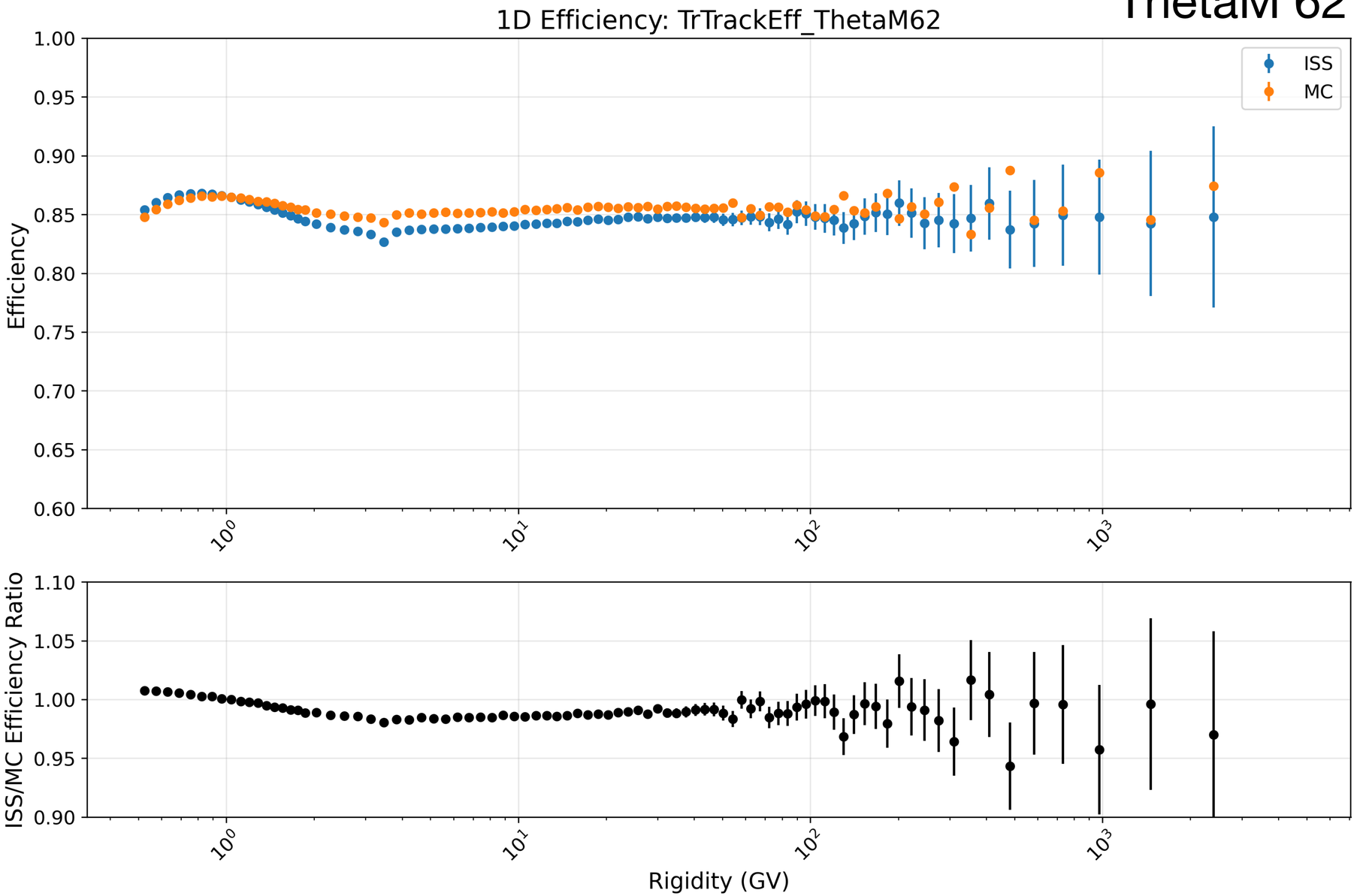
INNER TRACKER(L2->L8) EFFICIENCY

ThetaM 57



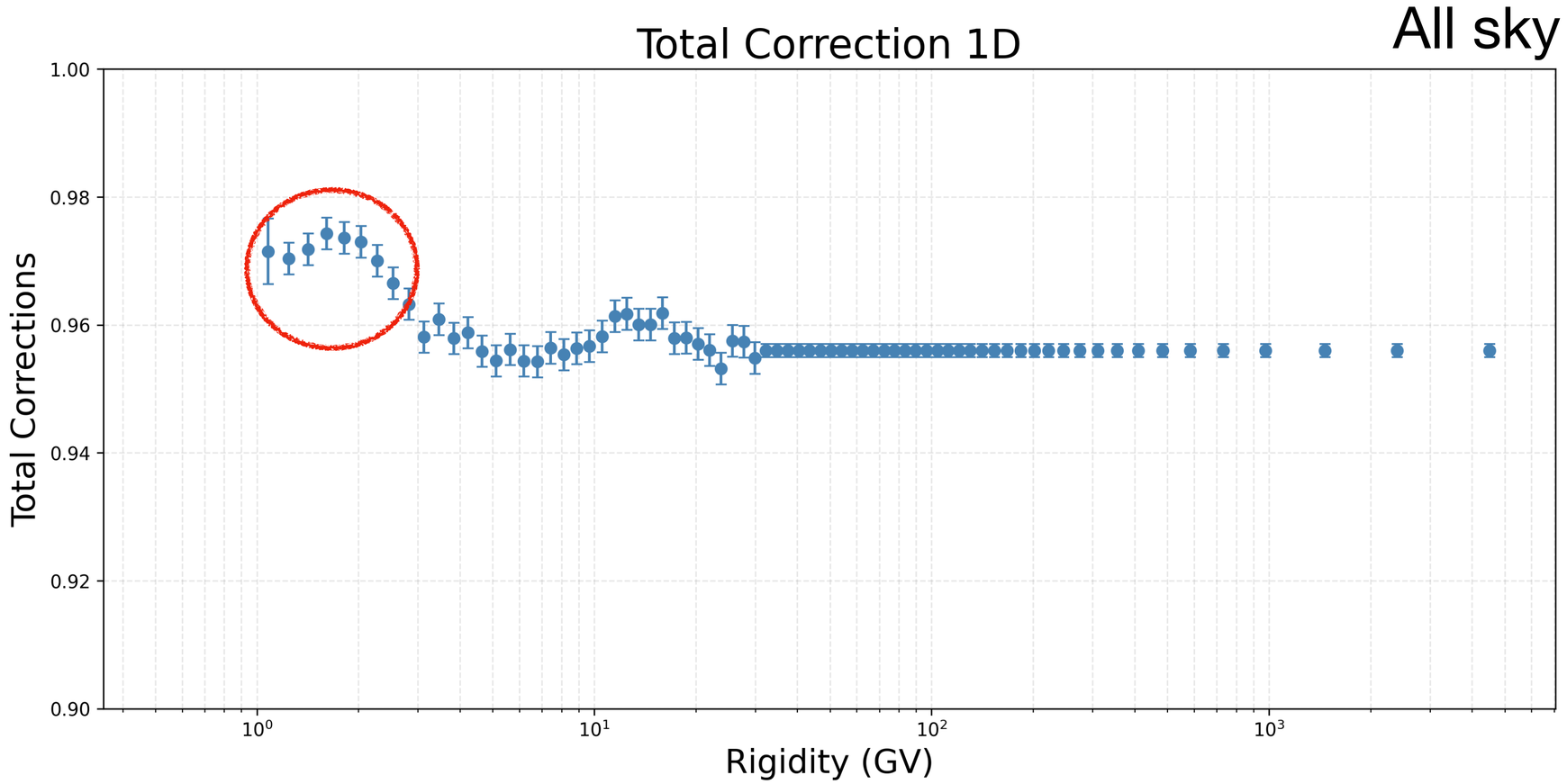
INNER TRACKER(L2->L8) EFFICIENCY

ThetaM 62



ACCEPTANCE CORRECTIONS

$$A(R) = G\frac{N_{trig}(R)}{N_{gen}(R)}\prod_{i=1}^{n}\varepsilon_i(R)\prod_{i=1}^{n}\kappa_i(R)$$



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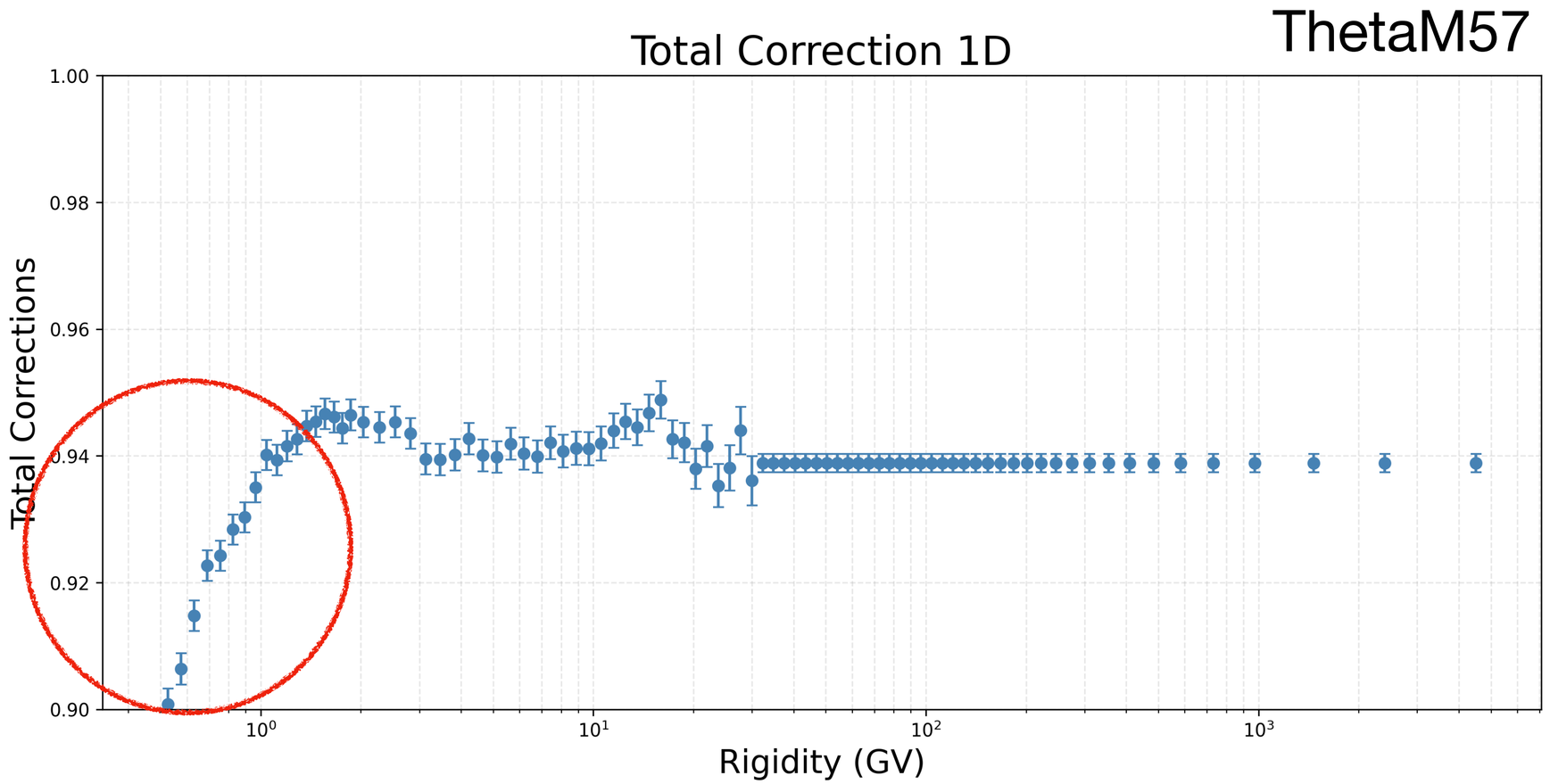

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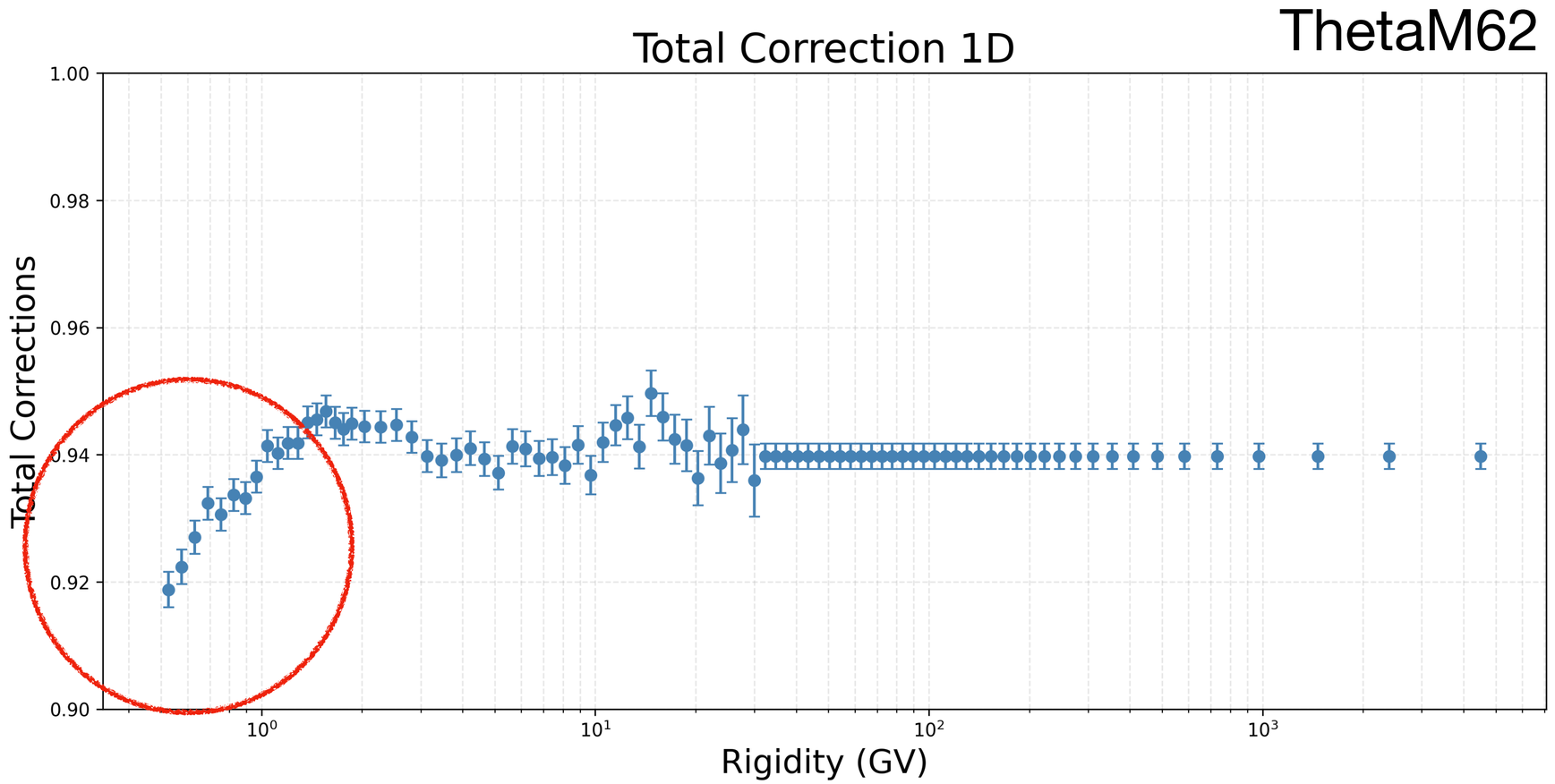

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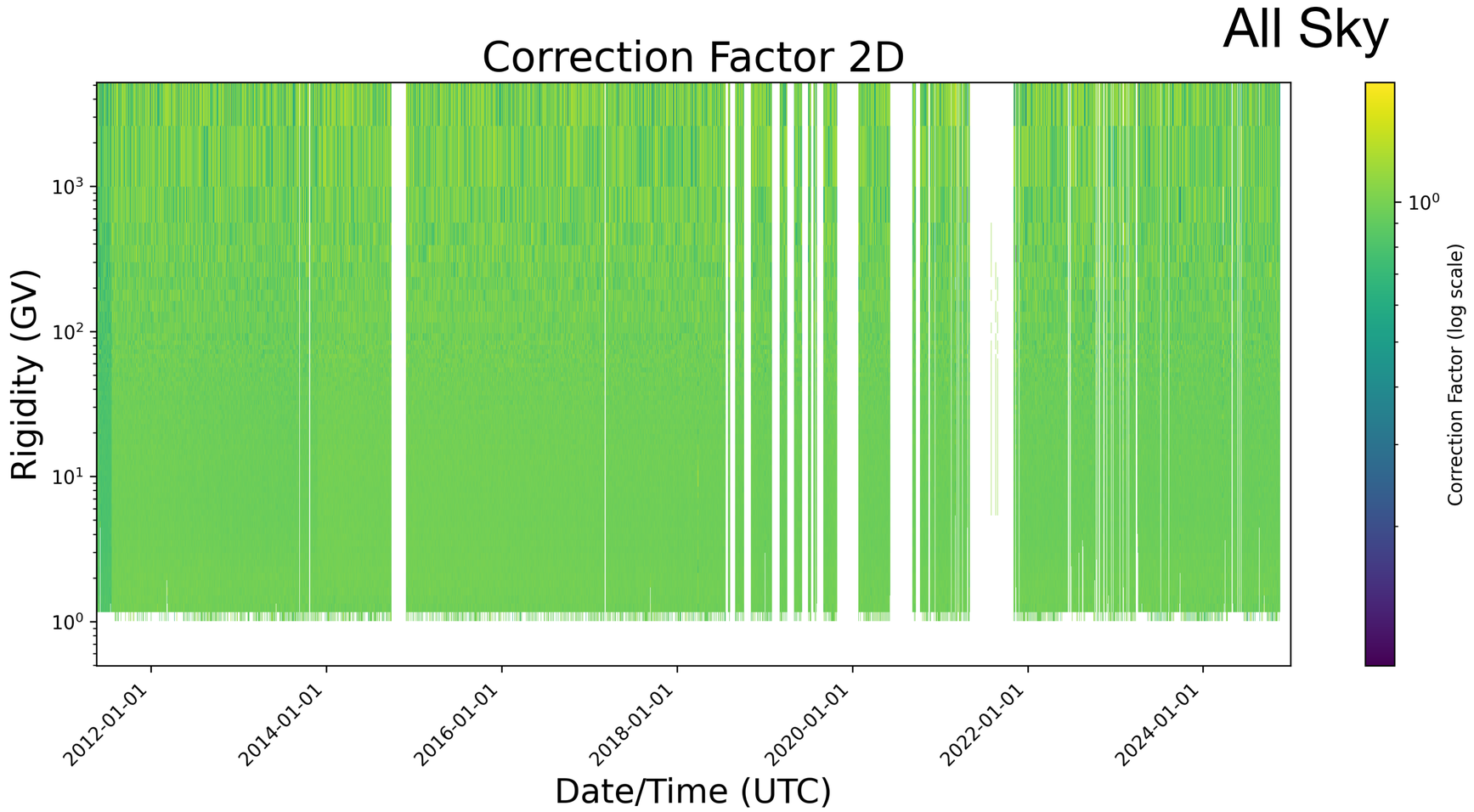

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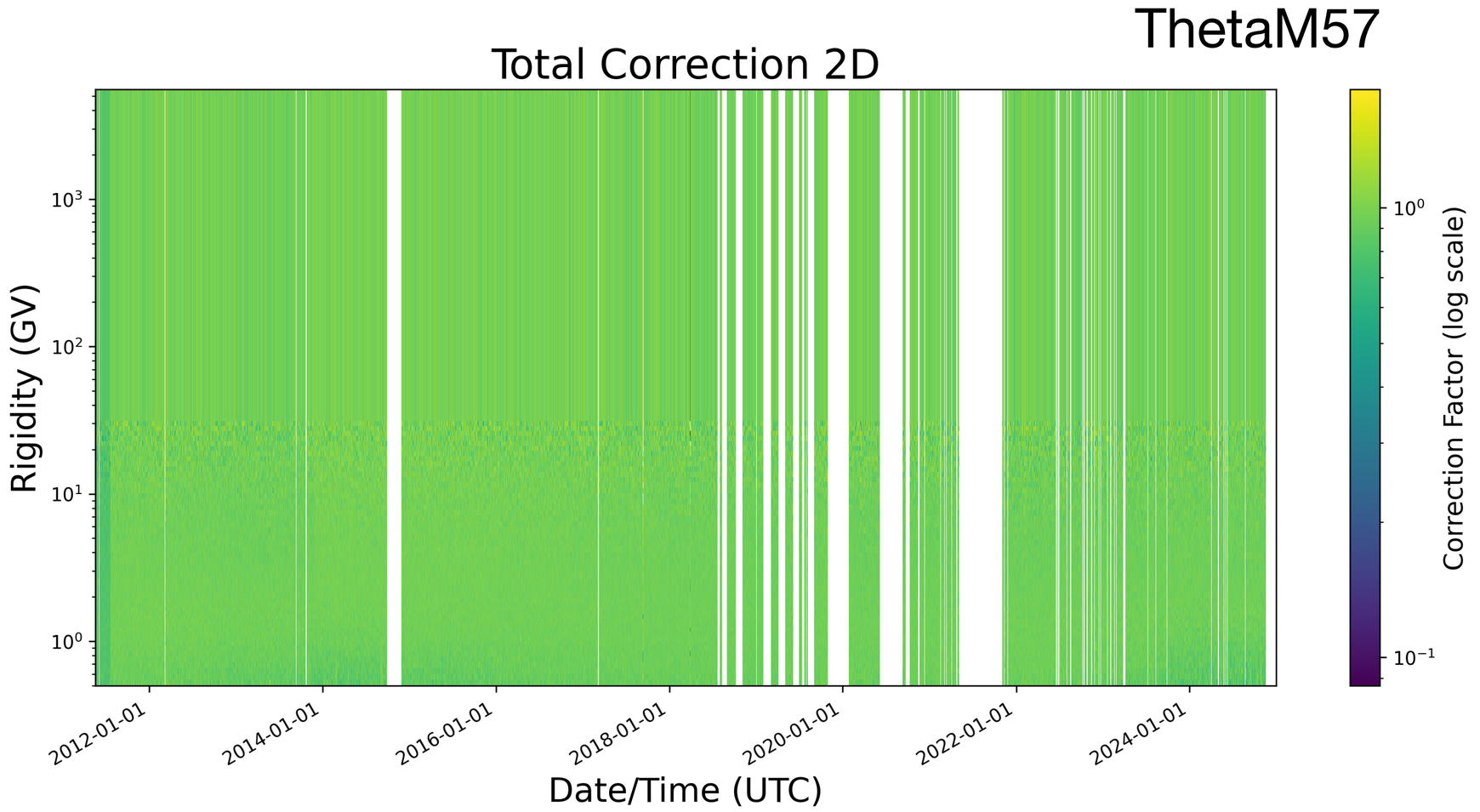

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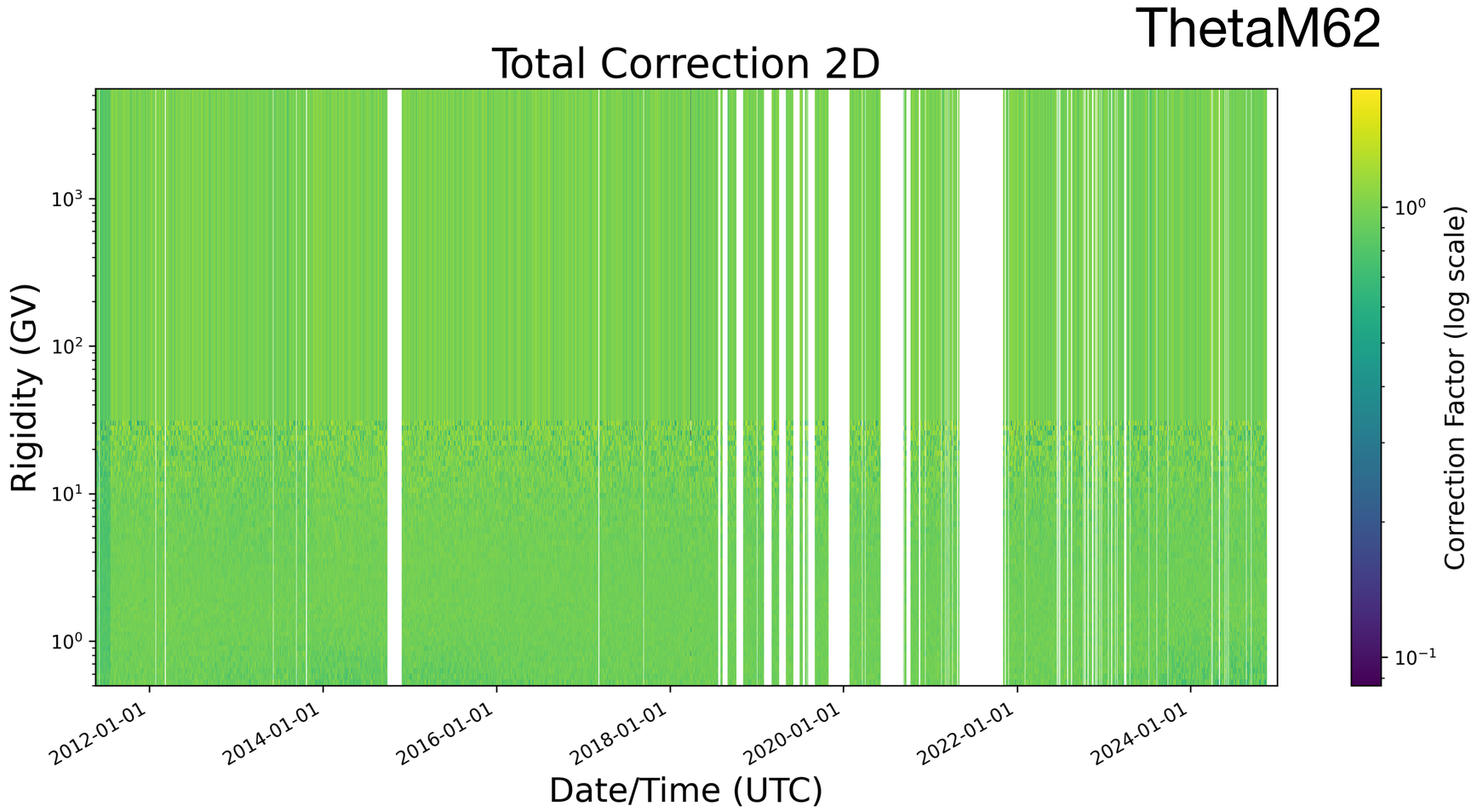
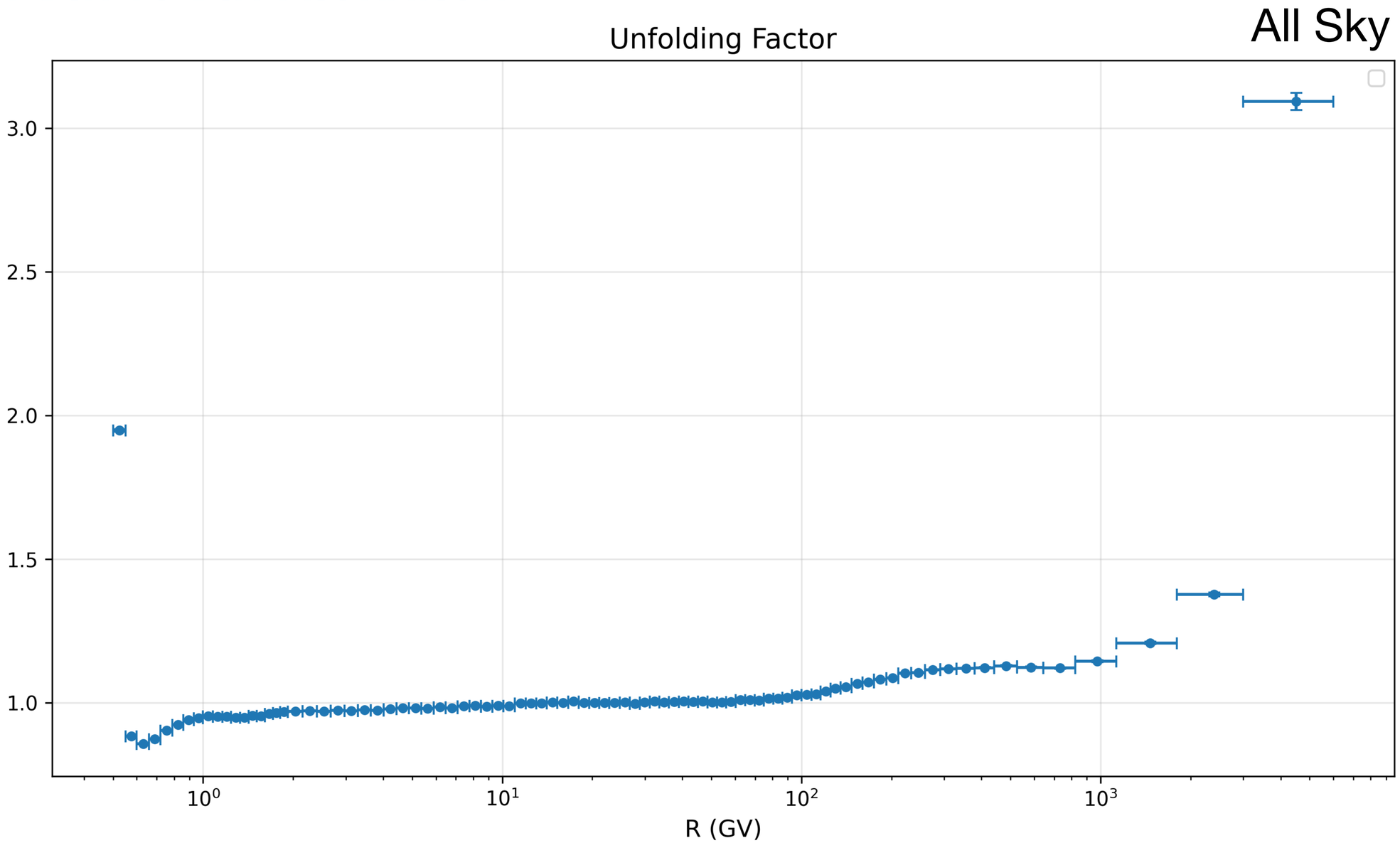
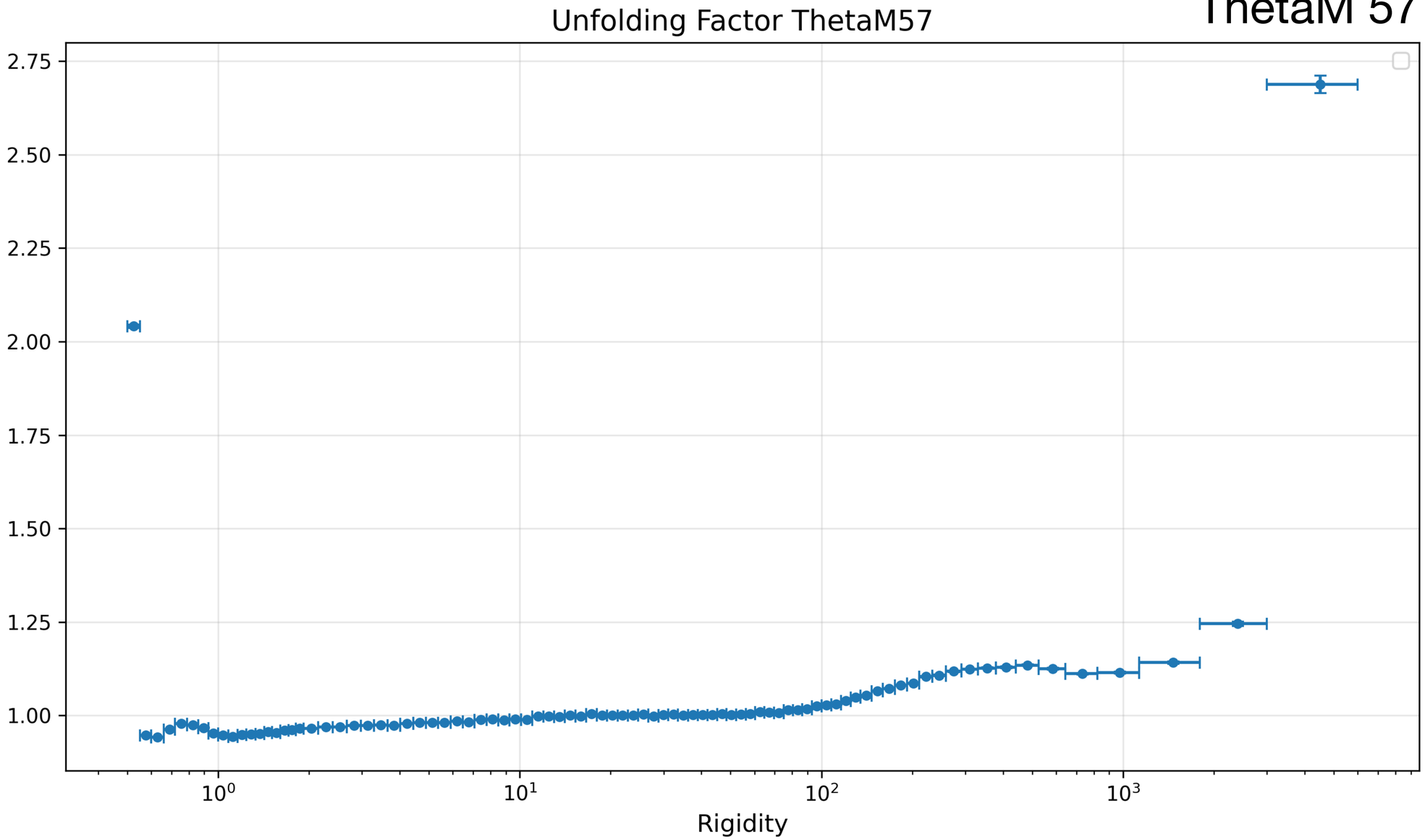


RIGIDITY BIN TO BIN MIGRATION

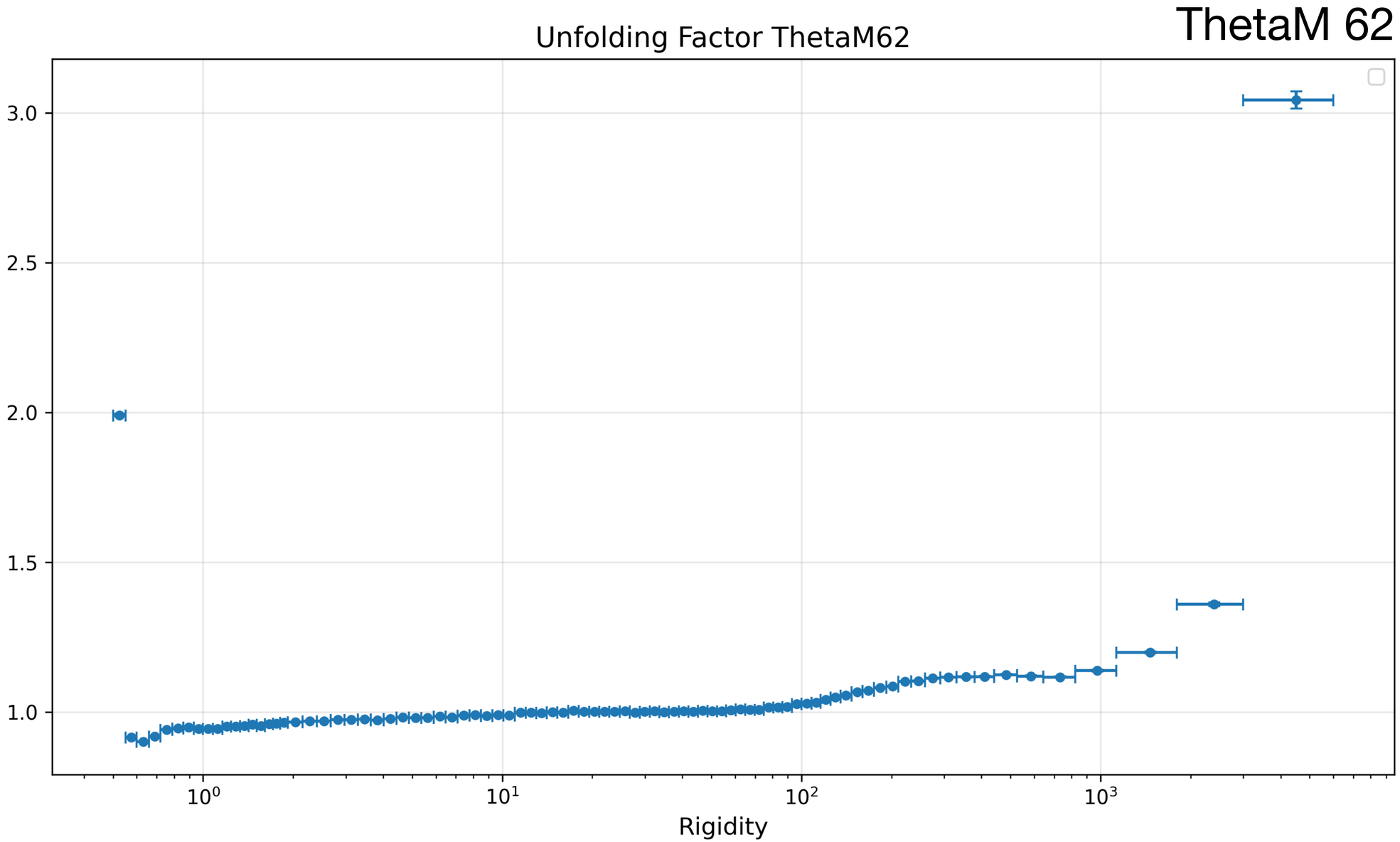


RIGIDITY BIN TO BIN MIGRATION

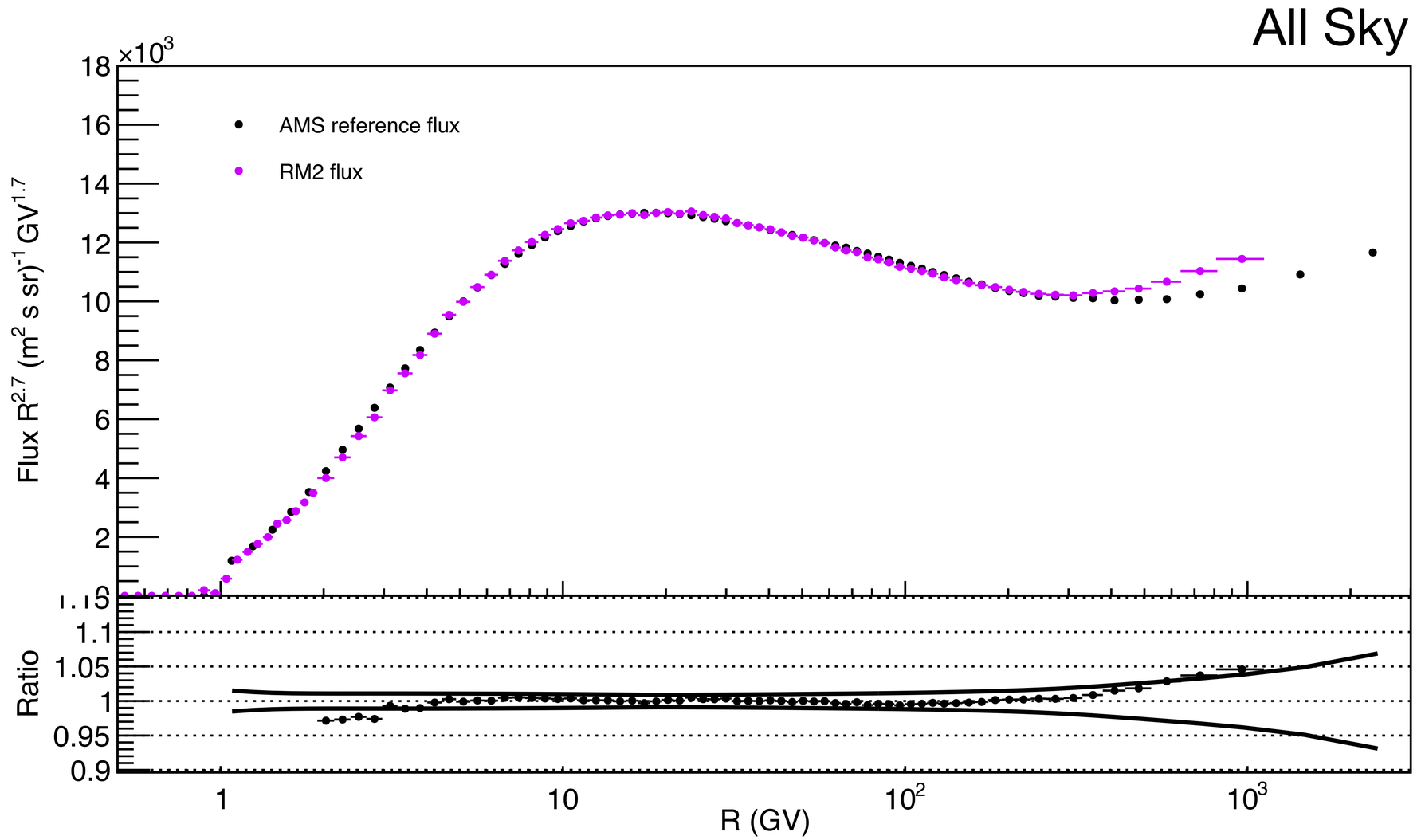
ThetaM 57



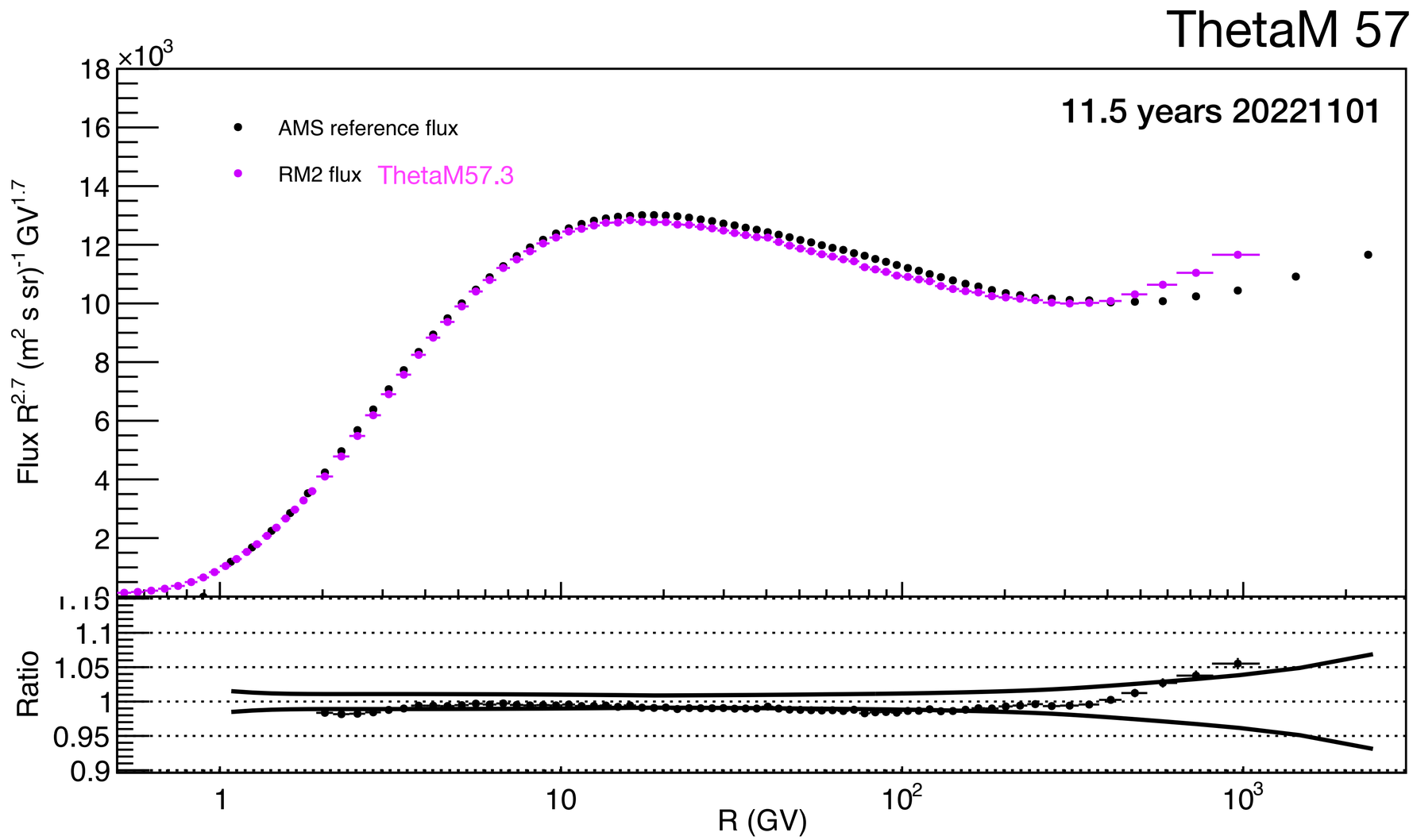
RIGIDITY BIN TO BIN MIGRATION



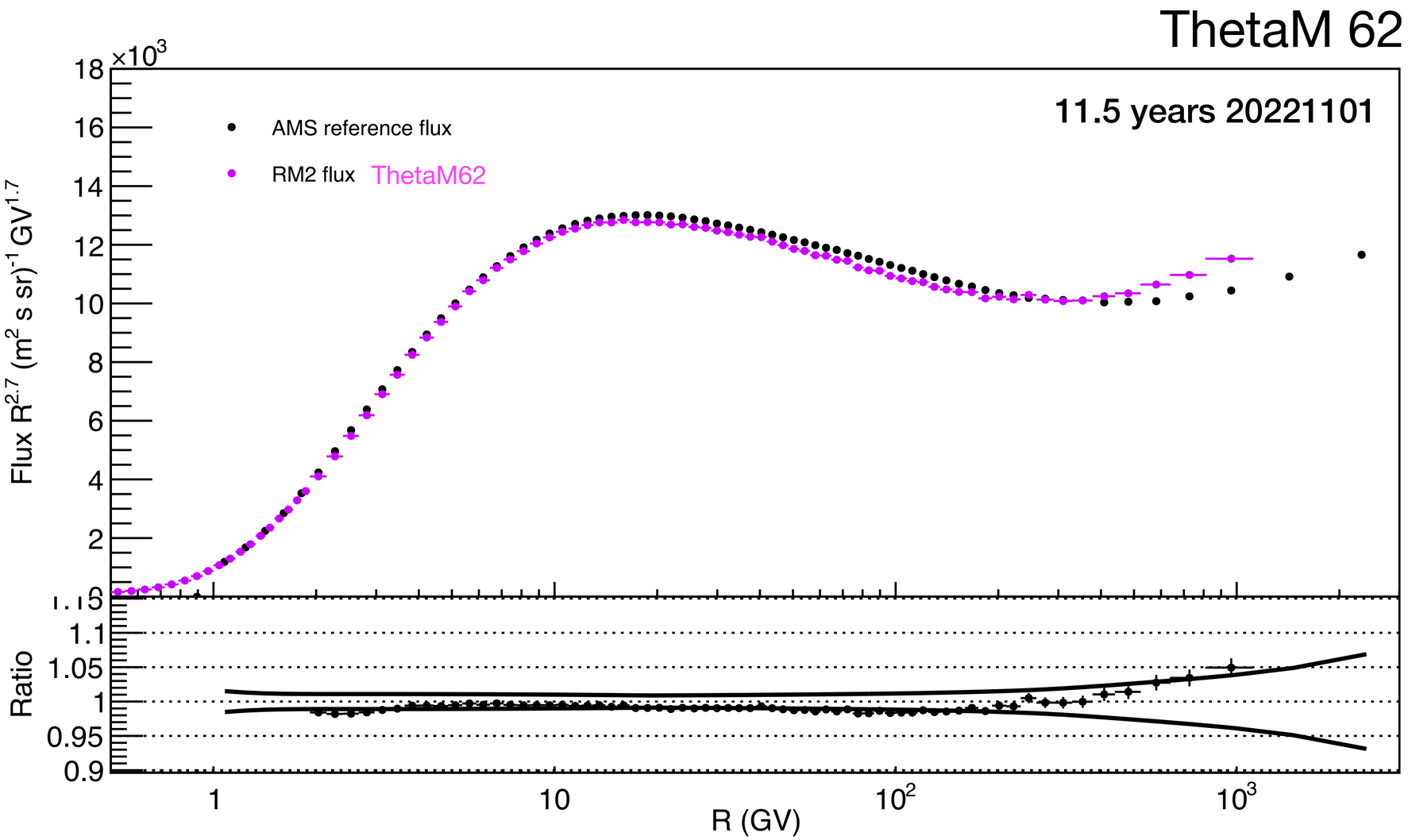
PROTON FLUX


All Sky
AMS reference flux
RM2 flux
Flux R^2.7 (m^2 s sr)^-1 GV^1.7
×10^3
18
16
14
12
10
8
6
4
2
Ratio
1.1
1.05
1
0.95
0.9
1
10
10^2
10^3
R (GV)

PROTON FLUX

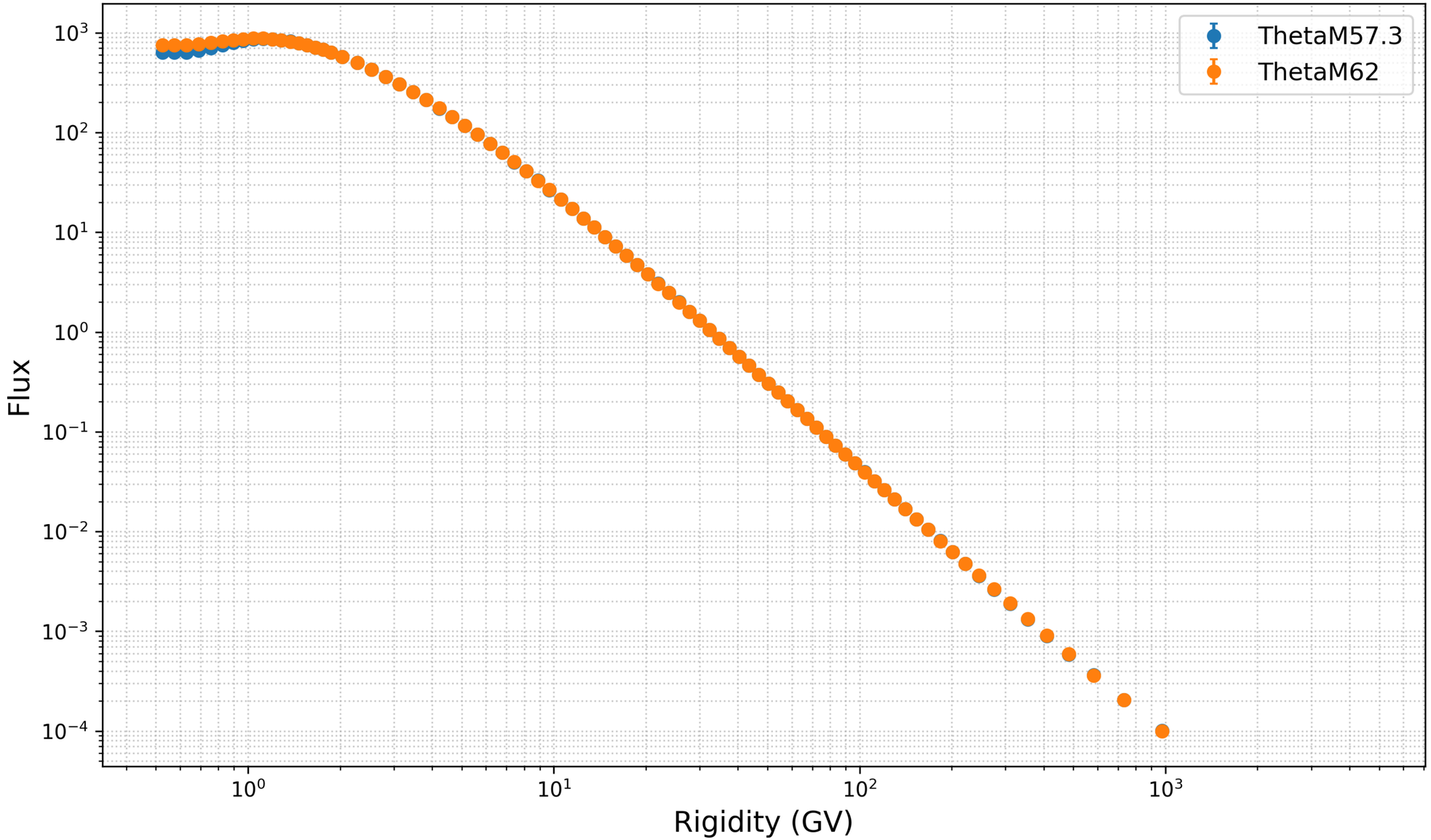

ThetaM 57
11.5 years 20221101
AMS reference flux
RM2 flux ThetaM57.3
×10^3
Flux R^2.7 (m^2 s sr)^-1 GV^1.7
Ratio
R (GV)

PROTON FLUX

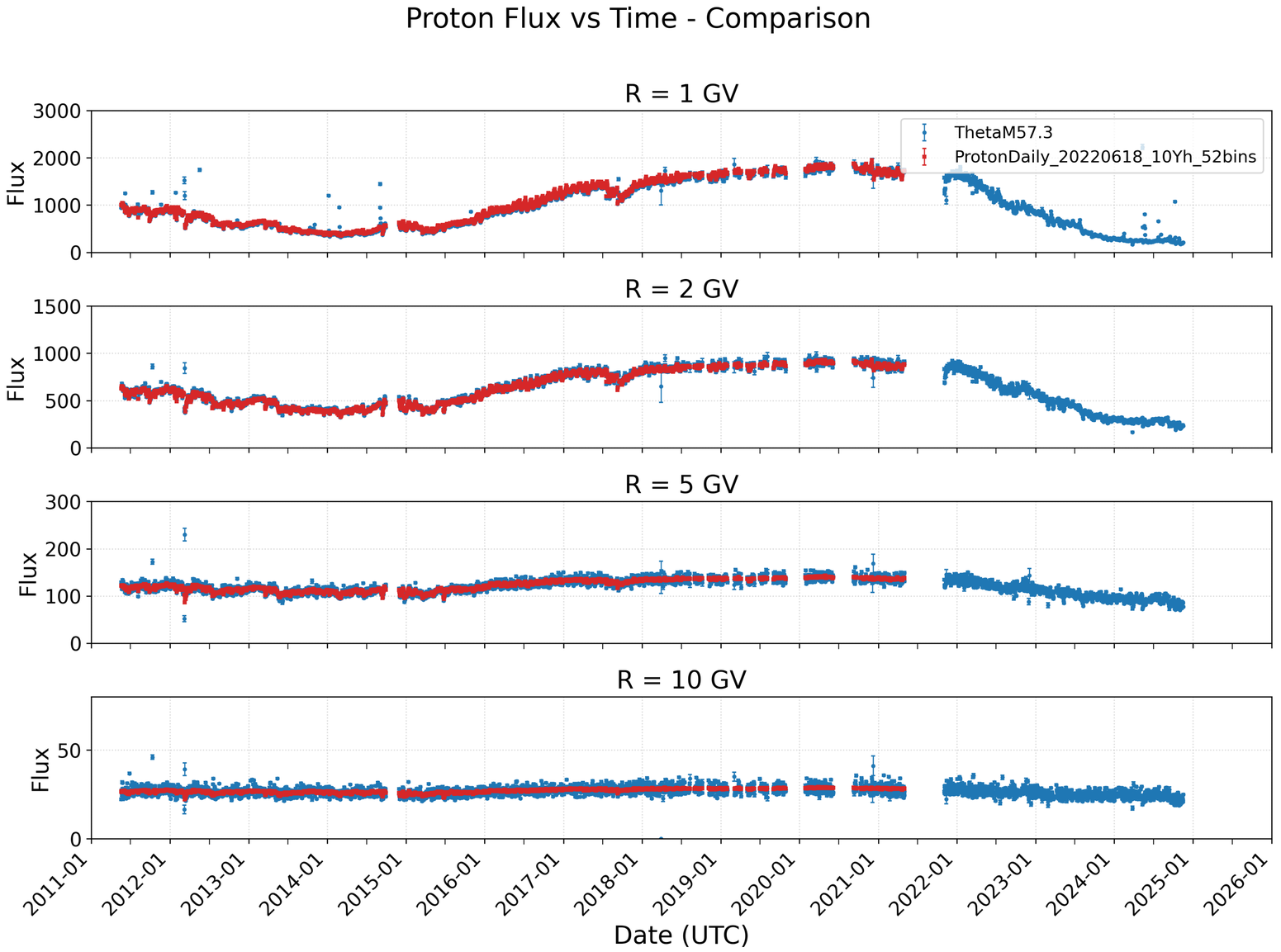

ThetaM 62
11.5 years 20221101
AMS reference flux
RM2 flux ThetaM62
Flux R^2.7 (m^2 s sr)^-1 GV^1.7
×10^3
Ratio
R (GV)

PROTON FLUX

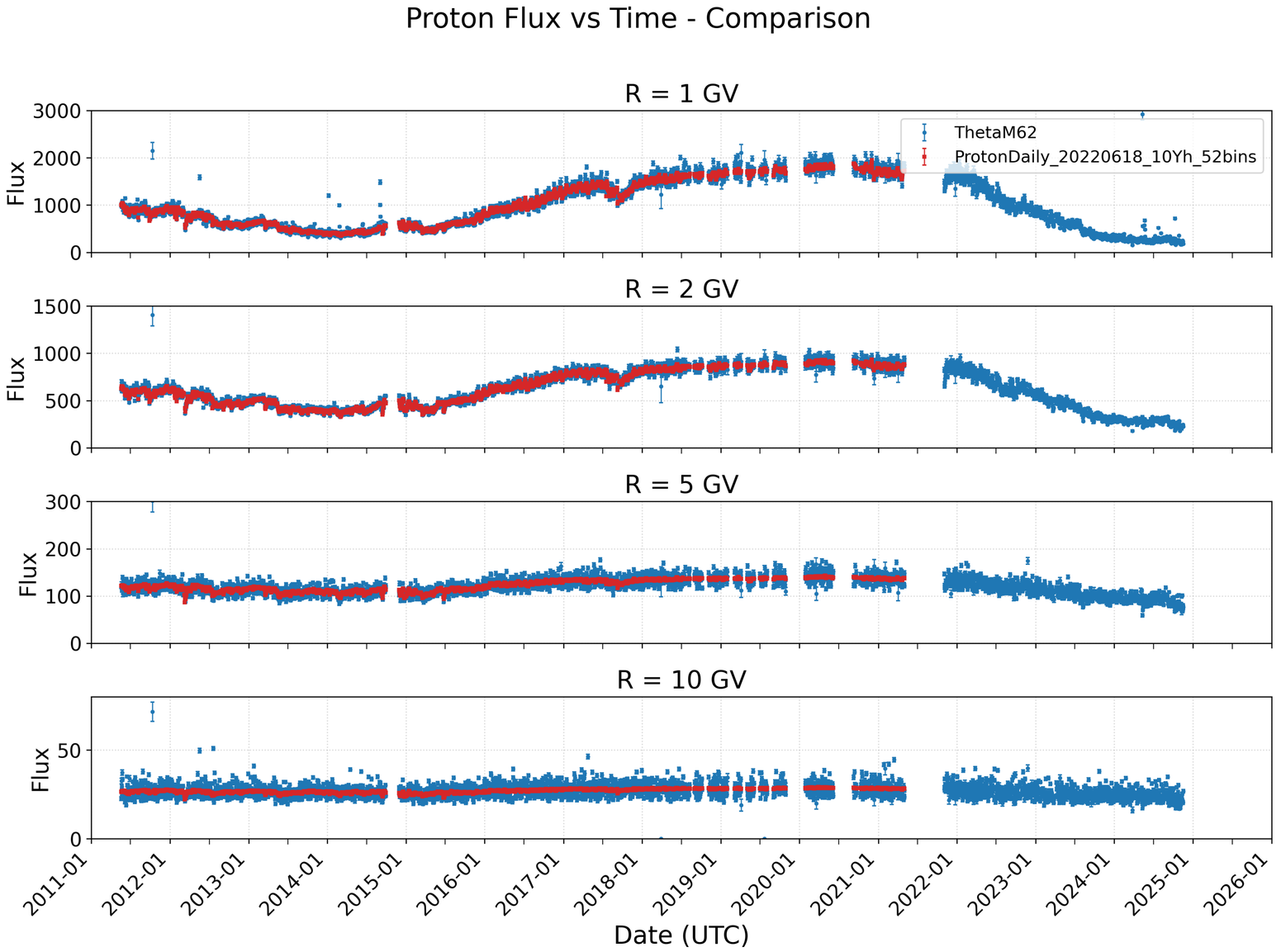
13.5 years (2012-05 to 2024-12)



PROTON FLUX


Proton Flux vs Time - Comparison
R = 1 GV
R = 2 GV
R = 5 GV
R = 10 GV
Flux
ThetaM57.3
ProtonDaily_20220618_10Yh_52bins
3000
2000
1000
0
1500
500
300
200
100
50
2011-01
2012-01
2013-01
2014-01
2015-01
2016-01
2017-01
2018-01
2019-01
2020-01
2021-01
2022-01
2023-01
2024-01
2025-01
2026-01
Date (UTC)

PROTON FLUX

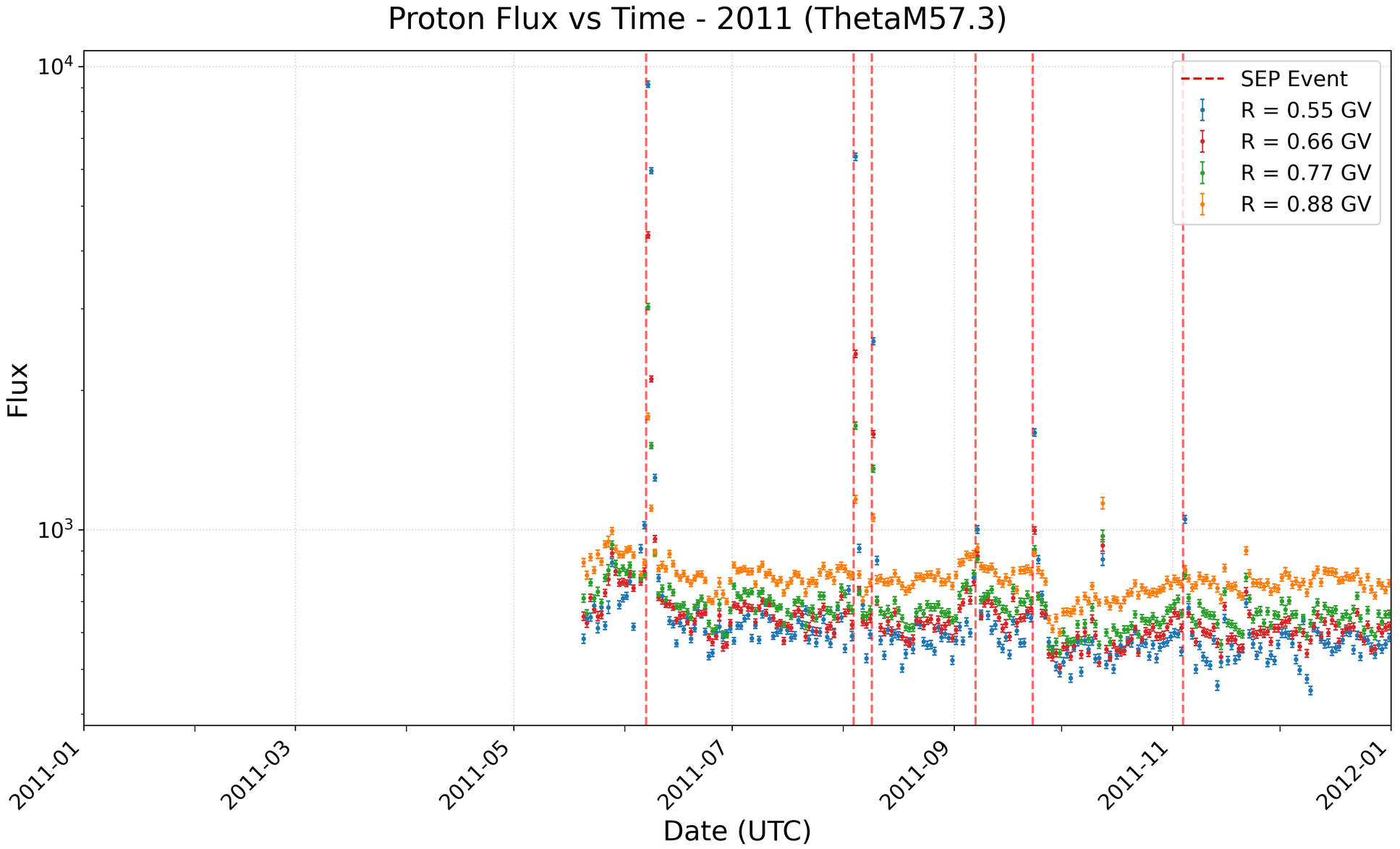

Proton Flux vs Time - Comparison
R = 1 GV
R = 2 GV
R = 5 GV
R = 10 GV
Flux
ThetaM62
ProtonDaily_20220618_10Yh_52bins
3000
2000
1000
0
1500
500
300
200
100
50
2011-01
2012-01
2013-01
2014-01
2015-01
2016-01
2017-01
2018-01
2019-01
2020-01
2021-01
2022-01
2023-01
2024-01
2025-01
2026-01
Date (UTC)

AMS SEP Event List

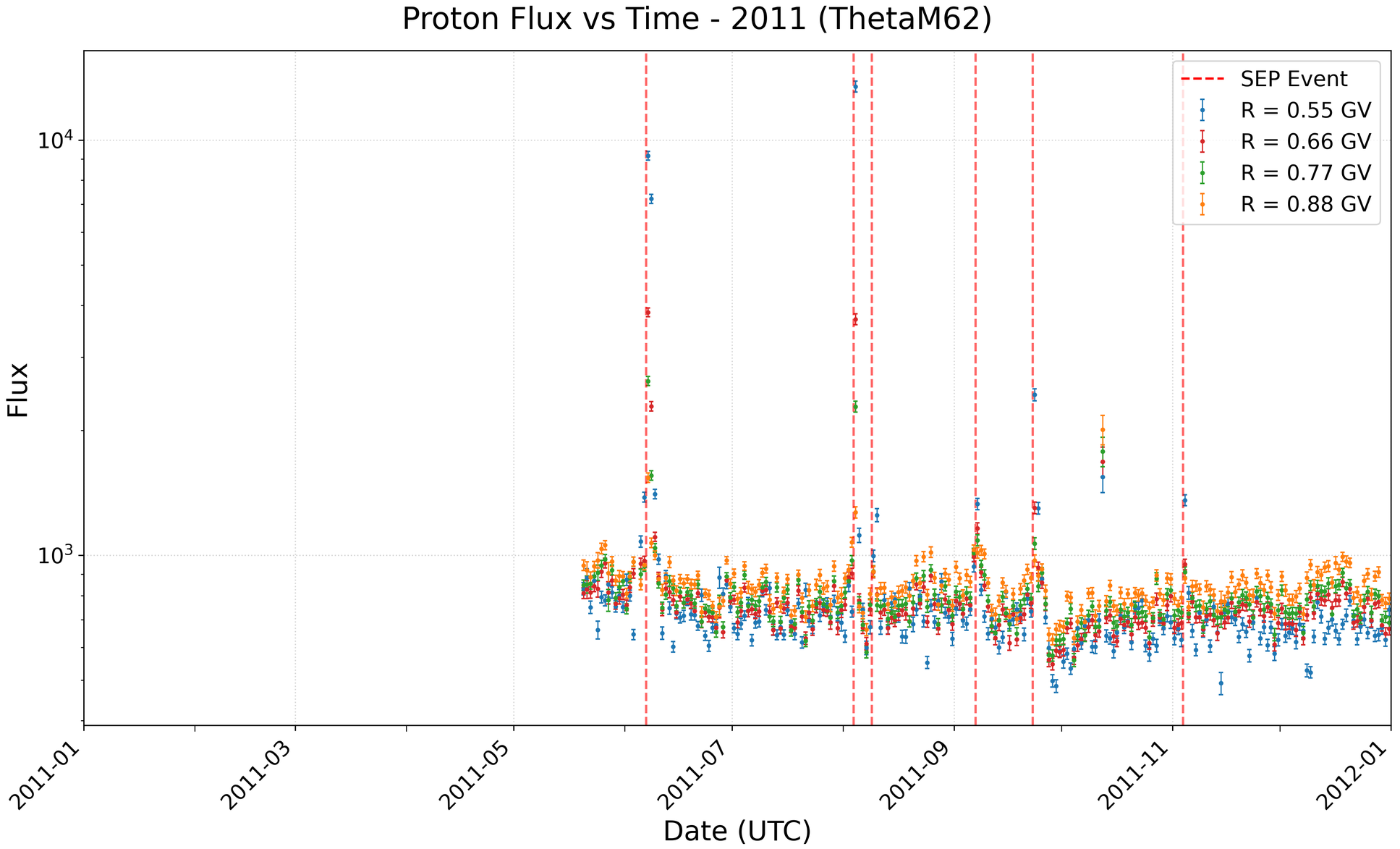
List of 46 SEP events measured by AMS above 0.5 GV and associated with M- and X- class flare and high-speed CMEs

AMS event	Date	Time	Flare Class	Source Location	CME velocity km/s
1	2011/06/07	06:16	M2.5	S22W53	1400
2	2011/08/04	03:41	M9.3	N15W39	1950
3	2011/08/09	07:48	X6.9	N17W69	1175
4	2011/09/06	01:35, 22:12	M5.3, X2.1	N14W04, N14W17	650
5	2011/09/07	22:32	X1.8	N15W31	660
6	2011/09/22	10:29	X1.4	N09E89	1000
7	2012/01/23	03:38	M8.7	N28W20	2211
8	2012/01/27	17:37	X1.8	N31W90	2200
9	2012/03/07	00:02, 01:05	X5.4, X1.3	N18E31, N17E27	1800, 2200
10	2012/03/13	16:21	M7.9	N18W59	2250
11	2012/05/17	00:30	M5.1	N06W90	1500
12	2012/07/07	23:01	X1.1	S17W50	1200
13	2012/07/08	16:23	M6.9	S17W74	1000
14	2012/07/19	04:17	M7.7	S17W91	1200
15	2012/07/23	-	backside	backside	3435
16	2012/11/08	02:09	M1.7	S10E70	1285
17	2013/04/11	06:55	M6.5	N07E13	675
18	2013/04/24	-	-	-	-
19	2013/05/22	12:30	M5.0	N13W75	1756
20	2013/10/11	-	backside	backside	780
21	2013/10/25	07:53, 14:52	X1.7, X2.1	S08E73, S08E65	477, 980
22	2013/10/28	01:41, 04:23	X1.0, M5.1	N07W63, N07W65	650, 750
23	2013/11/02	-	backside	backside	1078
24	2013/12/28	-	backside	backside	796
25	2014/01/06	-	backside	backside	1275
26	2014/01/07	18:02	X1.2	S15W10	2061
27	2014/02/25	00:41	X4.9	S15E77	1847
28	2014/04/18	12:31	M7.3	S18W29	1400
29	2014/09/02	-	backside	backside	1400
30	2014/09/10	17:21	X1.6	N15E05	1400
31	2014/09/25	-	backside	backside	1400
32	2015/10/29	01:03	C1.1	N19W37	402
33	2017/09/10	15:35	X8.2	S08W88	2650
34	2022/02/16	-	backside	backside	2554
35	2022/03/28	10:58	M4.0	N12W01	662
36	2022/03/30	17:21	X1.3	N13W34	808
37	2022/04/02	12:56	M3.9	N15W61	1370
38	2023/03/13	-	backside	backside	2127
39	2023/07/18	23:18, 23:37	M5.0, M5.7	S25W72, S25W72	1388
40	2023/07/28	15:39	M4.1	N25W99	2458
41	2024/02/09	12:53	X3.3	S37W110	2534
42	2024/02/10	22:56	M9.0	S12W13	912
43	2024/02/12	03:23	M5.6	S16W25	457
44	2024/03/23	00:58	X1.1	N25E07	1613
45	2024/05/11	01:27	X5.8	S17W47	1820
46	2024/10/09	01:25	X1.8	N13W08	2112

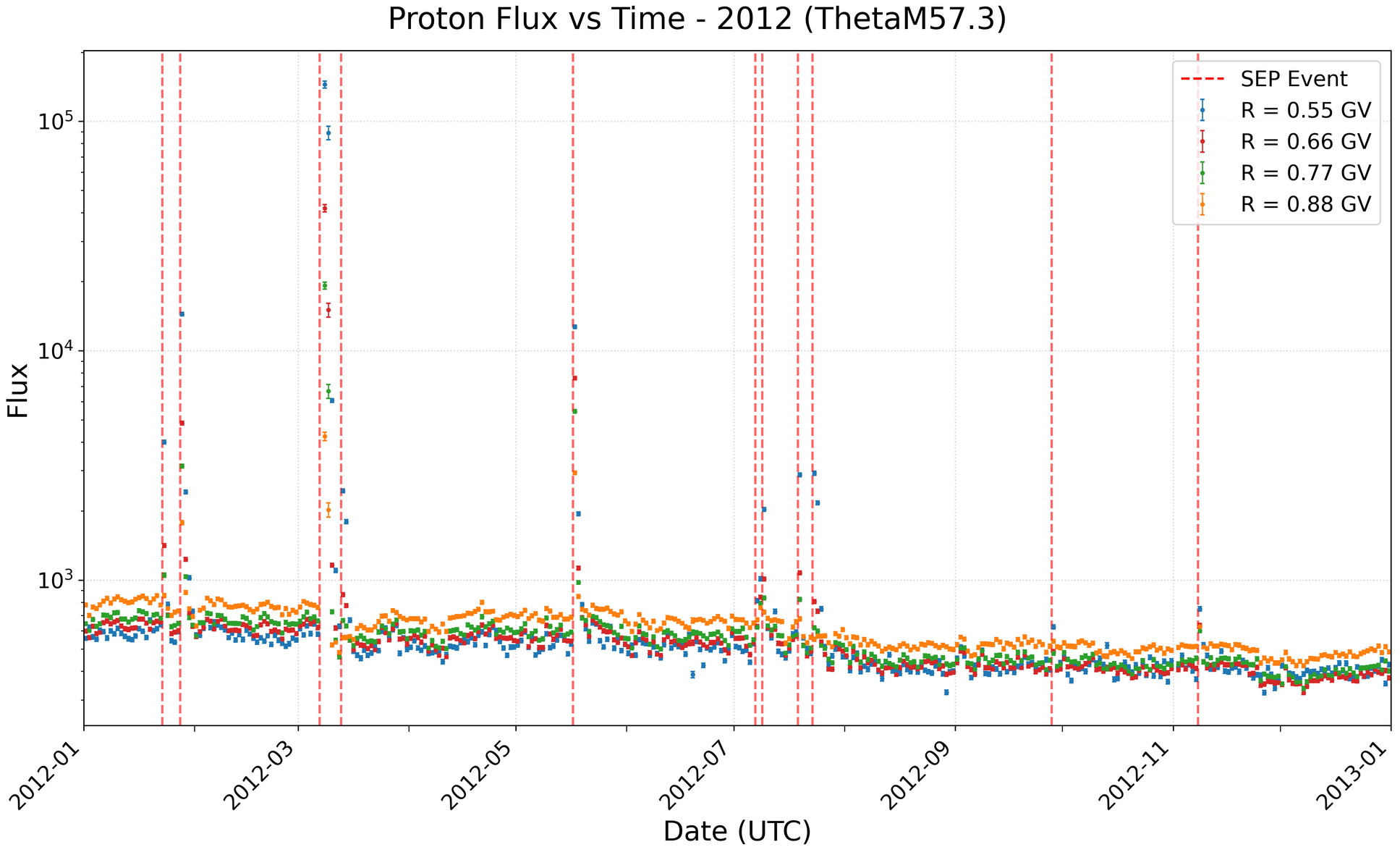
Flare class, source location and CME velocity taken from https://kauai.ccmc.gsfc.nasa.gov/DONKI/search/alerts



2011/06/07
2011/08/04
2011/08/09
2011/09/06
2011/09/07
2011/09/22
2011/11/04

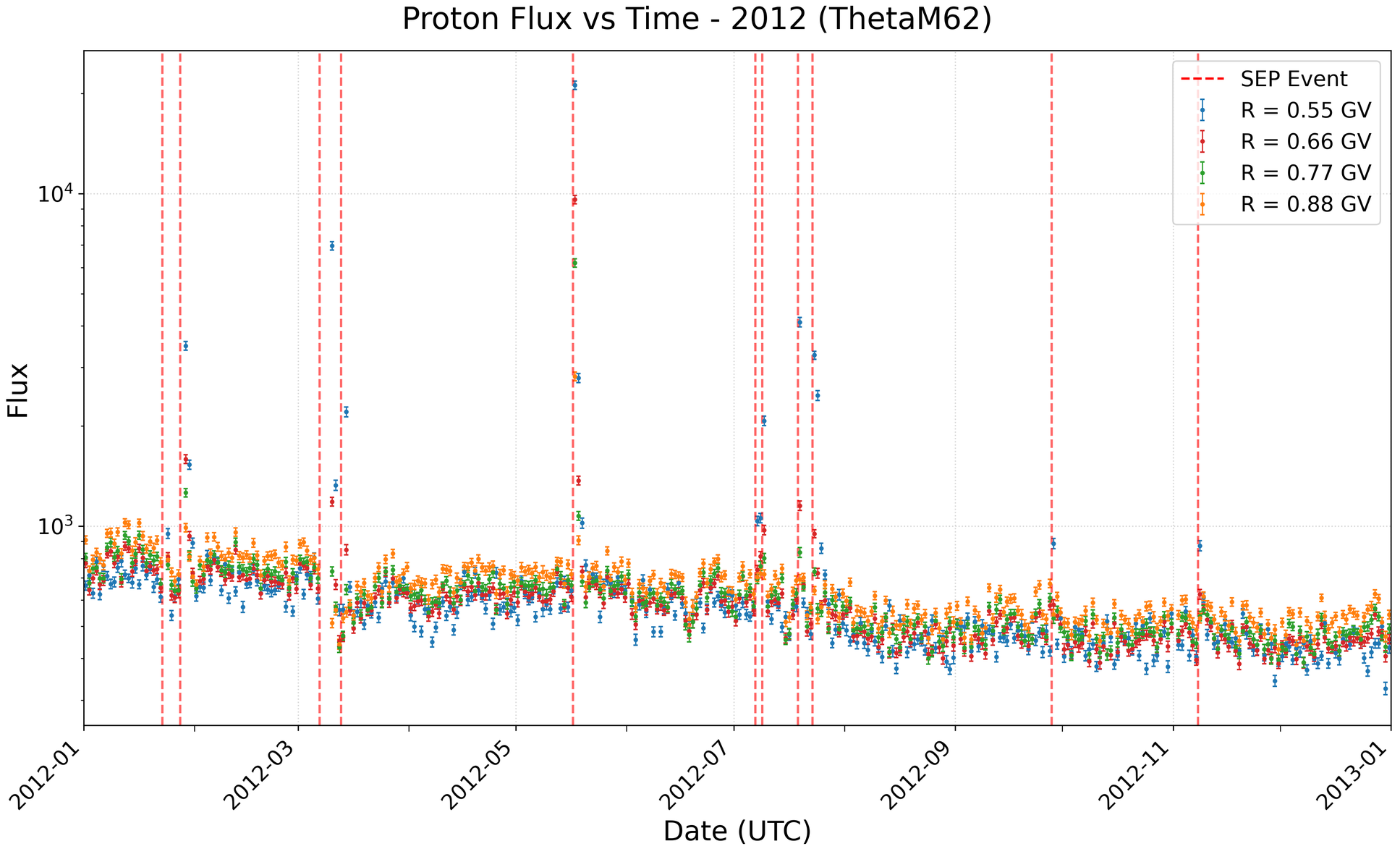


2011/06/07
2011/08/04
2011/08/09
2011/09/06
2011/09/07
2011/09/22
2011/11/04



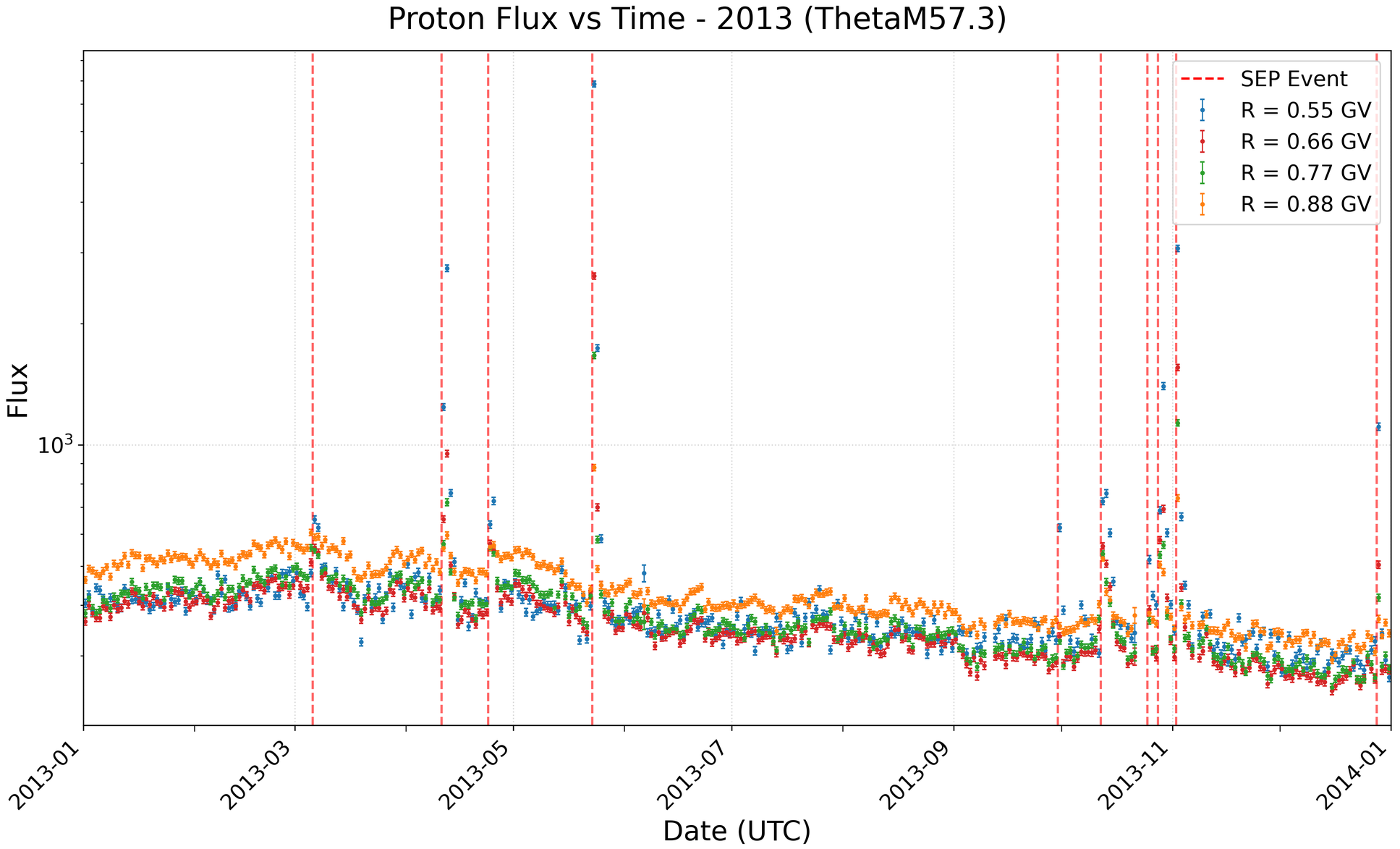
2012/01/23
2012/01/27
2012/03/07
2012/03/13
2012/05/17
2012/07/07
2012/07/08
2012/07/19
2012/07/23
2012/11/08

2012-09-28



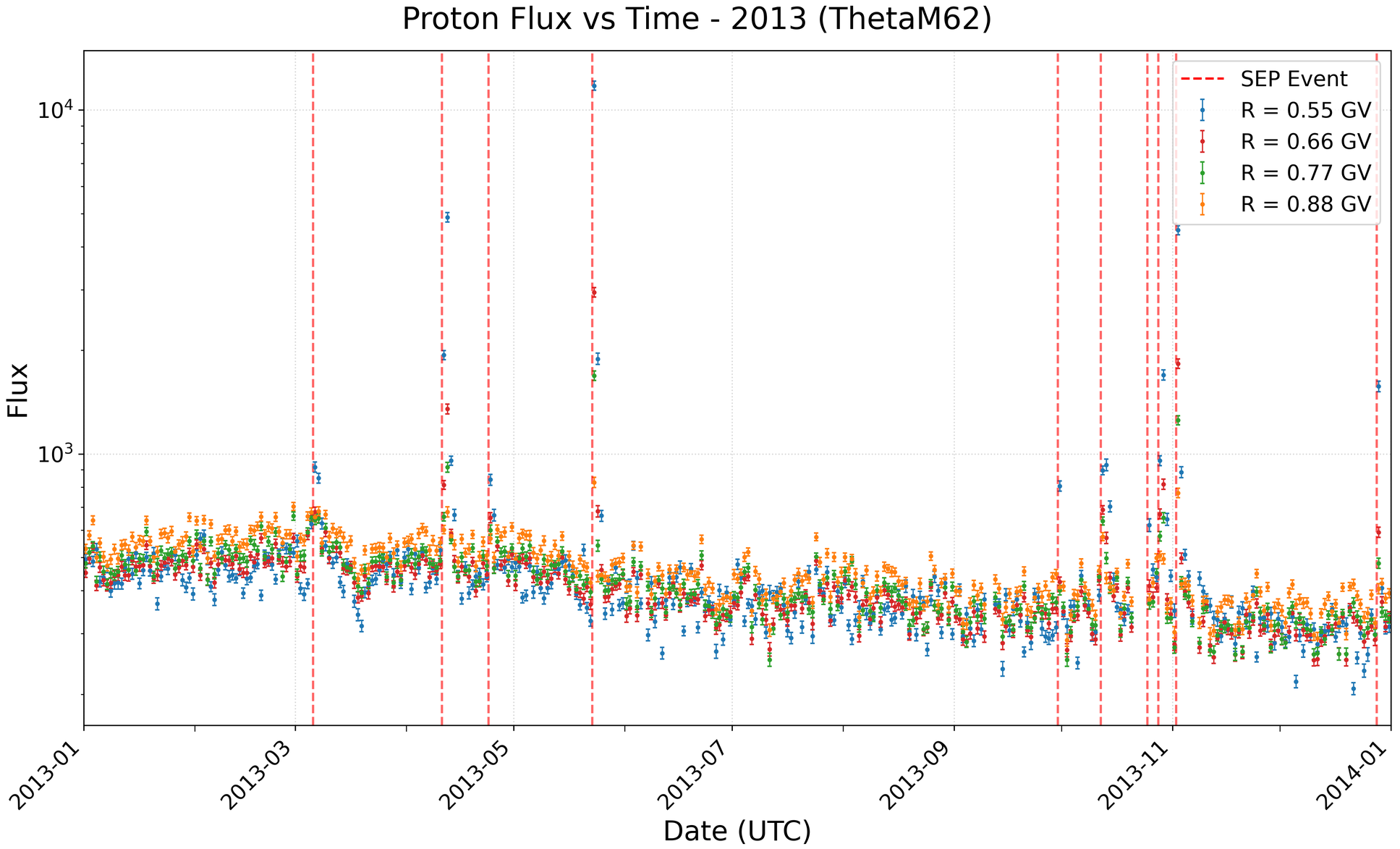
2012/01/23
2012/01/27
2012/03/07
2012/03/13
2012/05/17
2012/07/07
2012/07/08
2012/07/19
2012/07/23
2012/11/08

2012-09-28



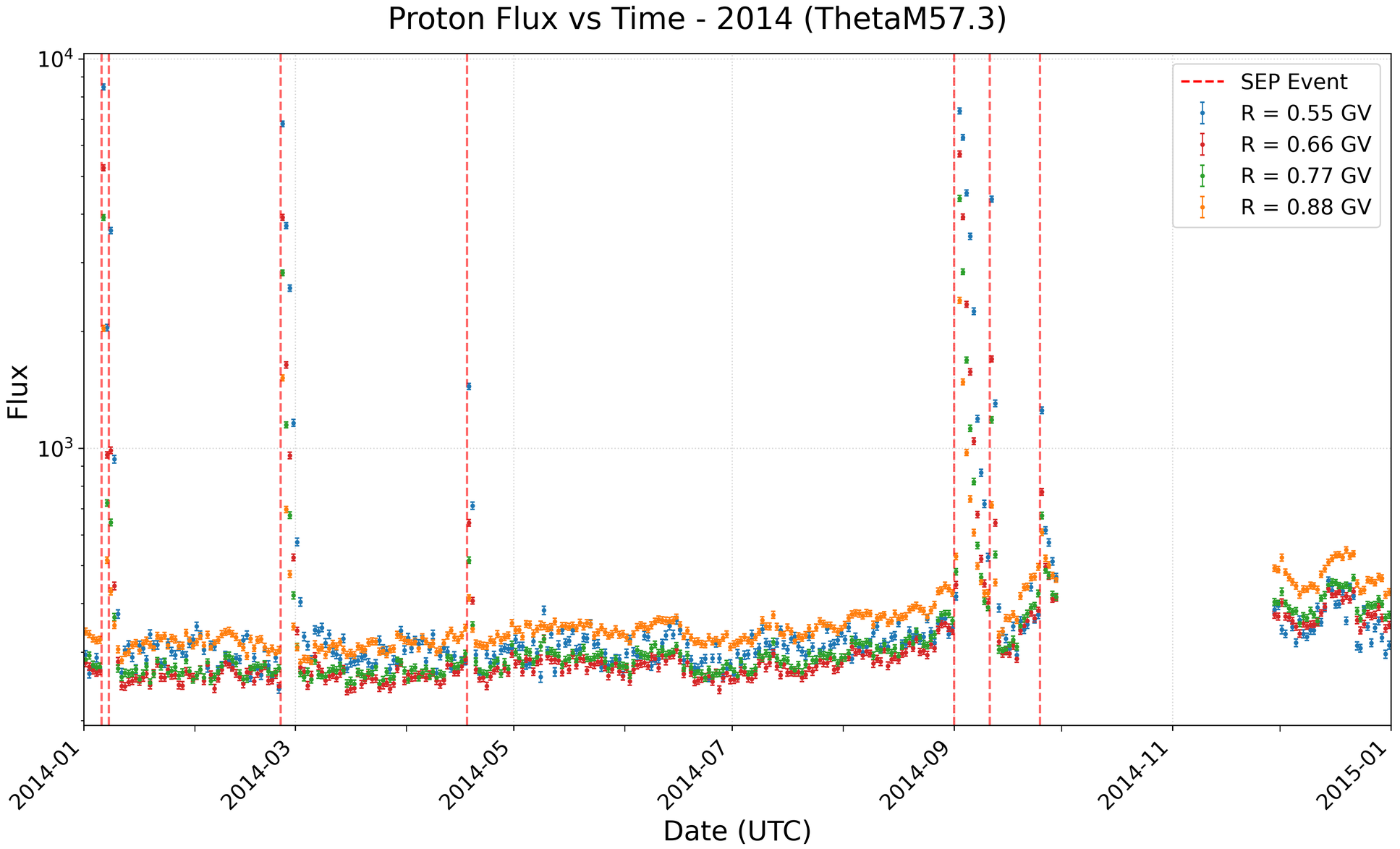
2013/04/11
2013/04/24
2013/05/22
2013/10/11
2013/10/25
2013/10/28
2013/11/02
2013/12/28

2013-03-06
2013-09-30

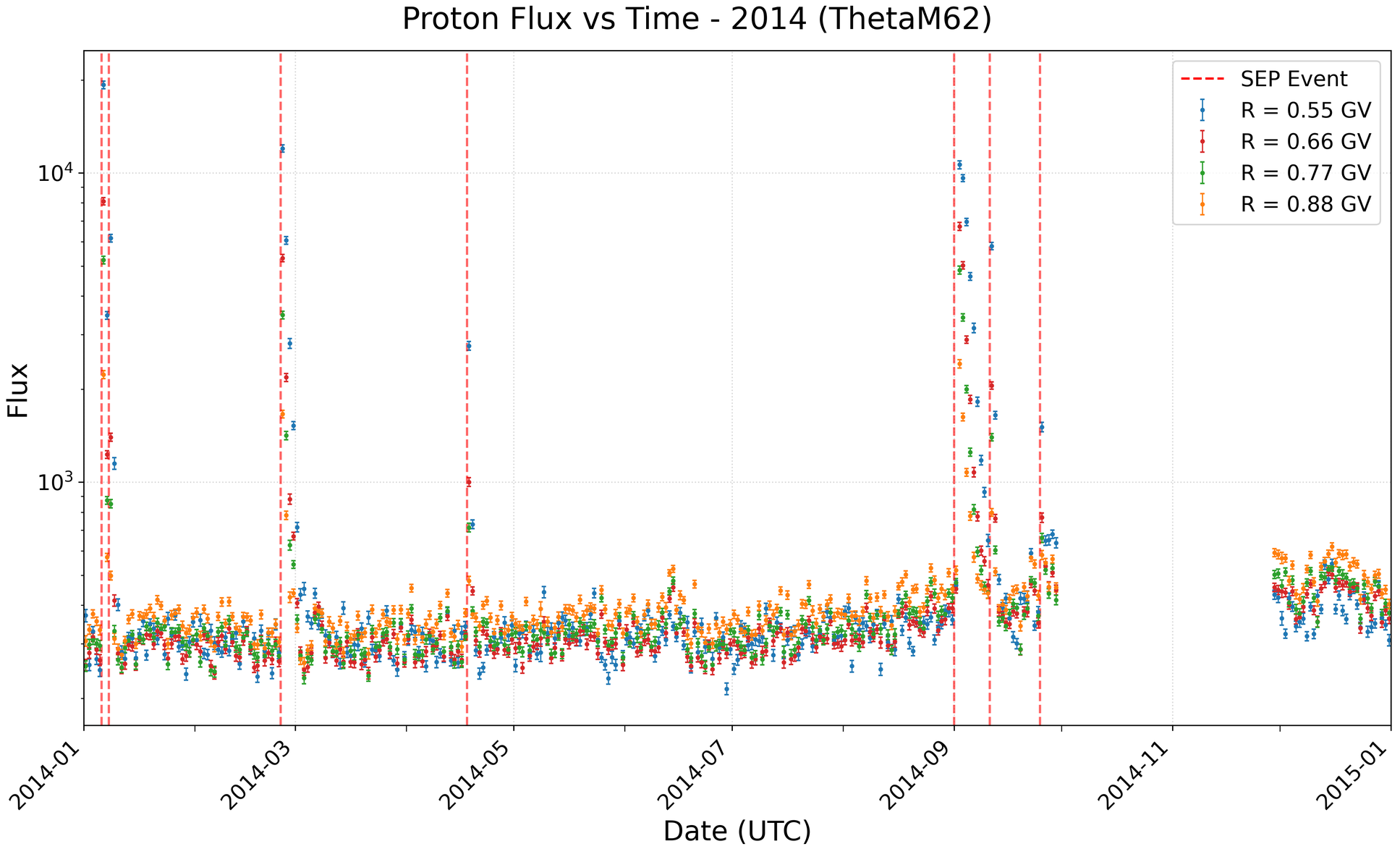


2013/04/11
2013/04/24
2013/05/22
2013/10/11
2013/10/25
2013/10/28
2013/11/02
2013/12/28

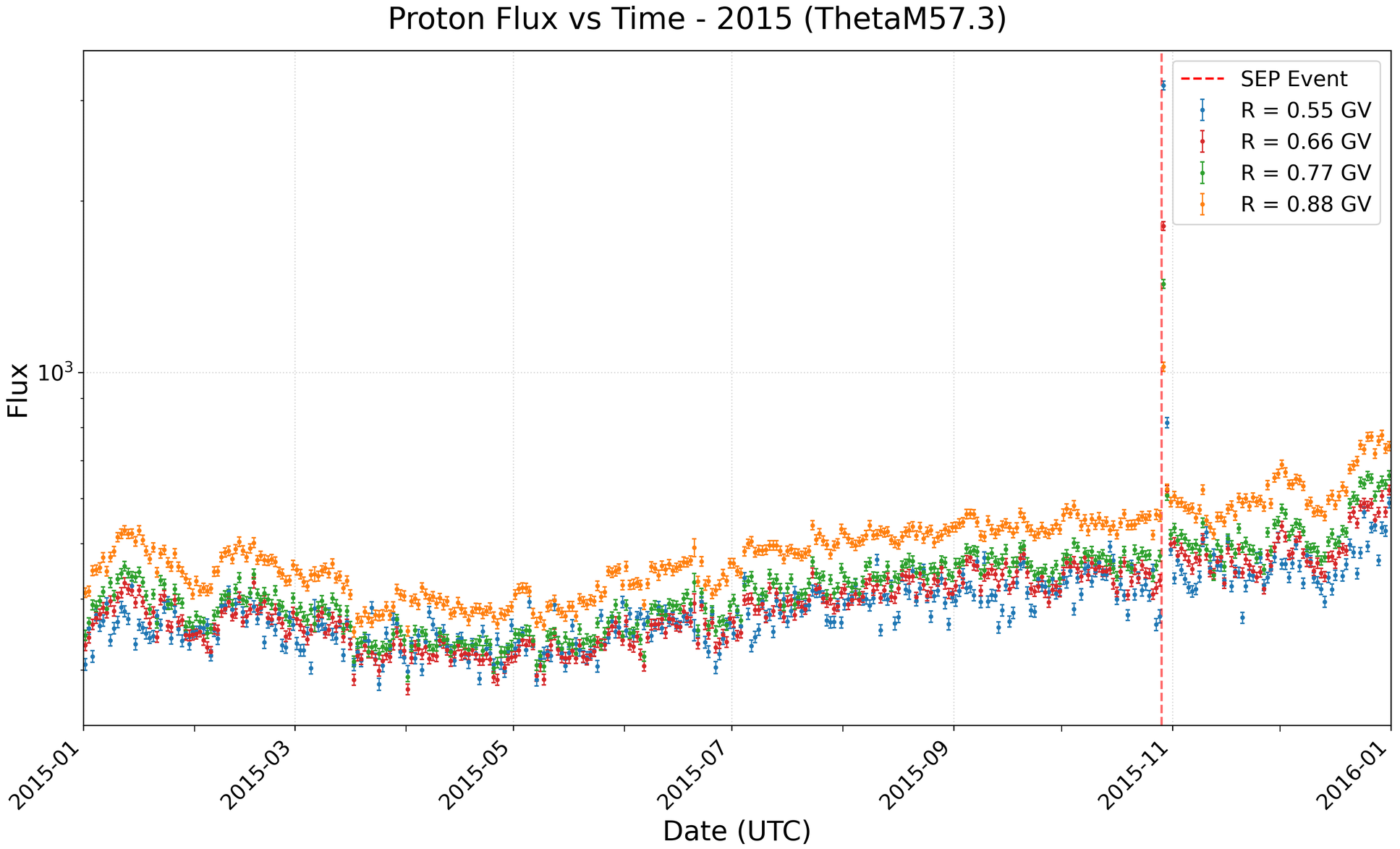
2013-03-06
2013-09-30



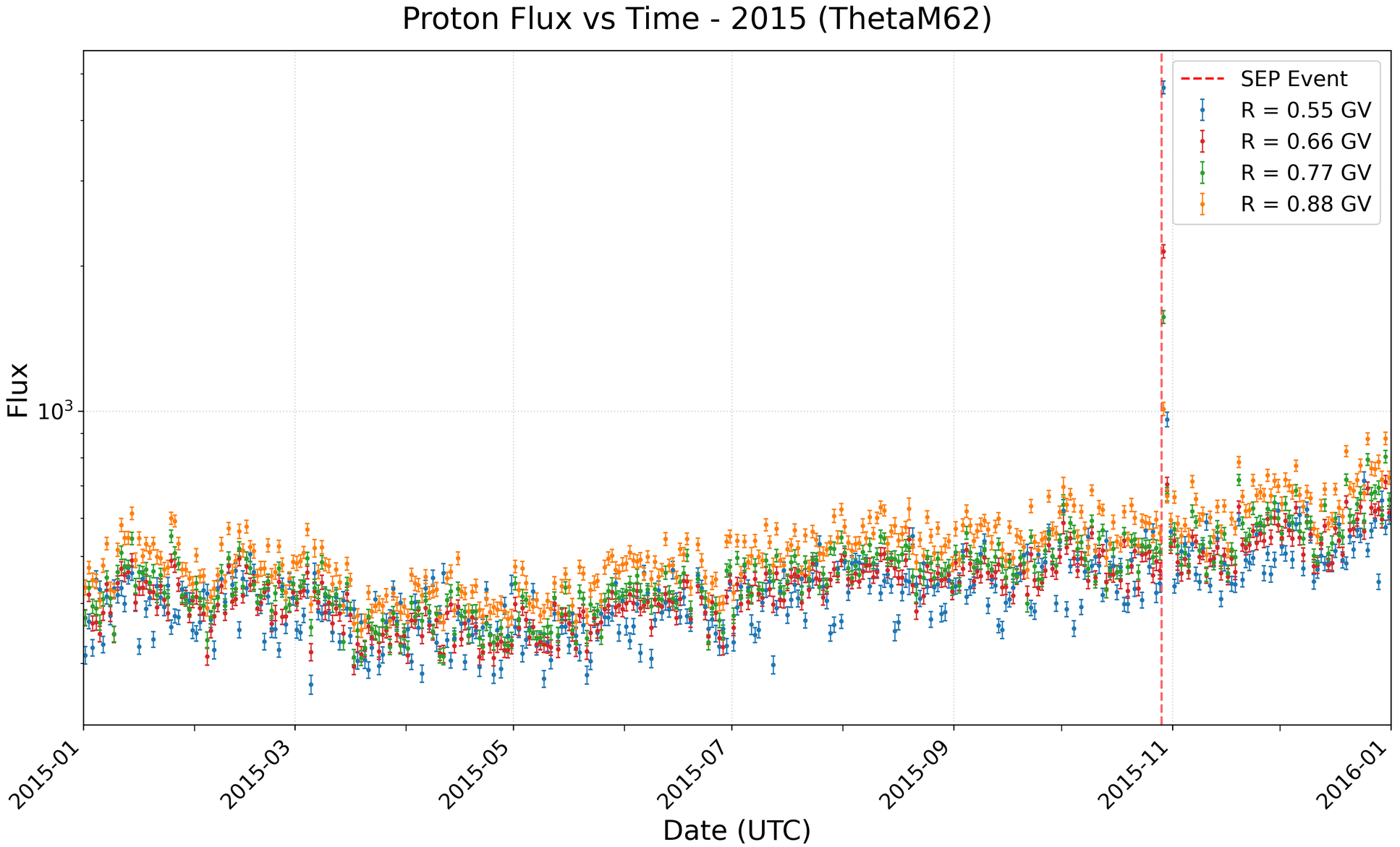
2014/01/06
2014/01/07
2014/02/25
2014/04/18
2014/09/02
2014/09/10
2014/09/25



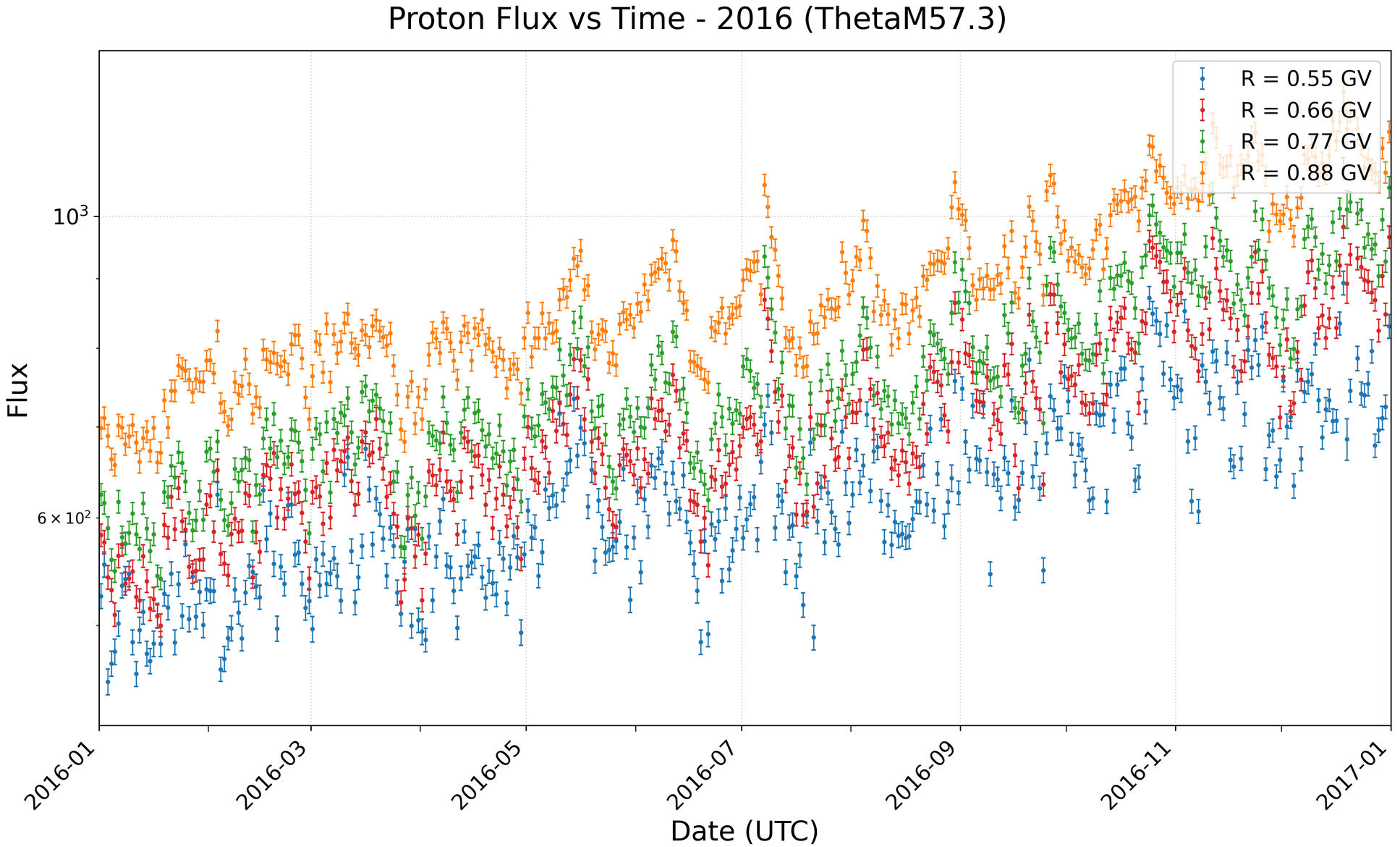
2014/01/06
2014/01/07
2014/02/25
2014/04/18
2014/09/02
2014/09/10
2014/09/25

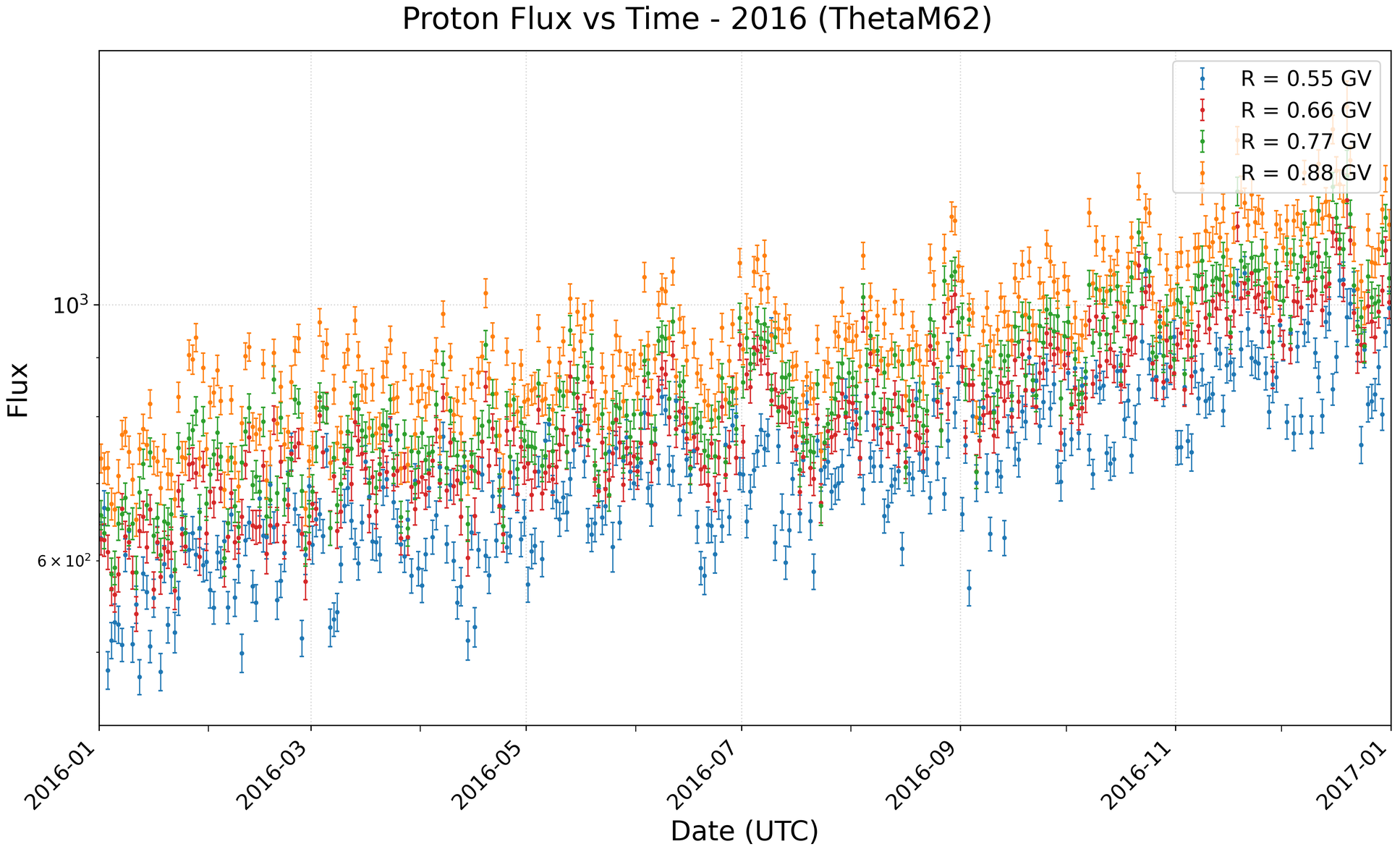

Proton Flux vs Time - 2015 (ThetaM57.3)
SEP Event
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
10^3
2015-01
2015-03
2015-05
2015-07
2015-09
2015-11
2016-01
Date (UTC)

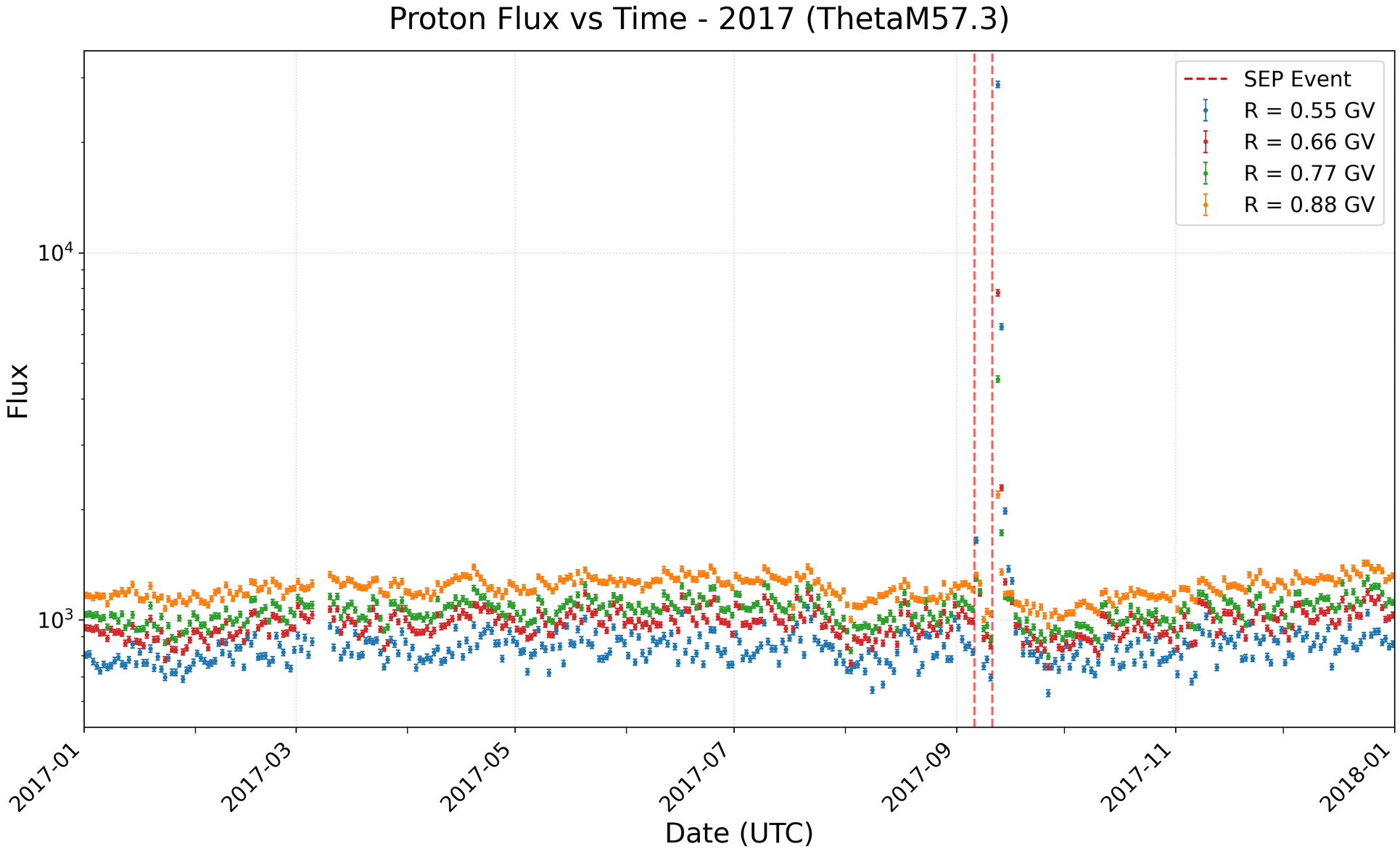
2015/10/29


Proton Flux vs Time - 2015 (ThetaM62)
SEP Event
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
10^3
2015-01
2015-03
2015-05
2015-07
2015-09
2015-11
2016-01
Date (UTC)

2015/10/29

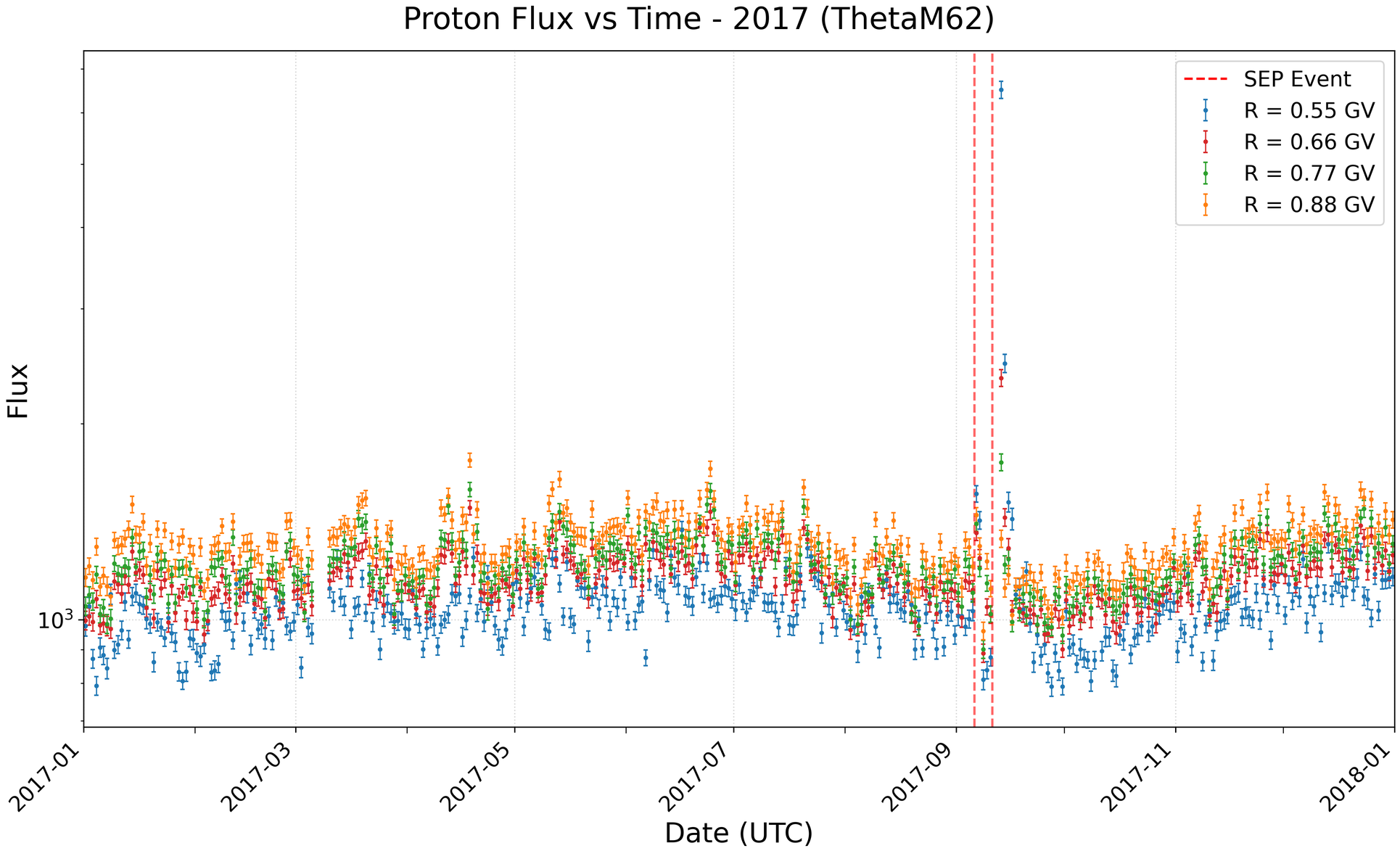

Proton Flux vs Time - 2016 (ThetaM57.3)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
10^3
6×10^2
2016-01
2016-03
2016-05
2016-07
2016-09
2016-11
2017-01
Date (UTC)


Proton Flux vs Time - 2016 (ThetaM62)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
10^3
6×10^2
2016-01
2016-03
2016-05
2016-07
2016-09
2016-11
2017-01
Date (UTC)



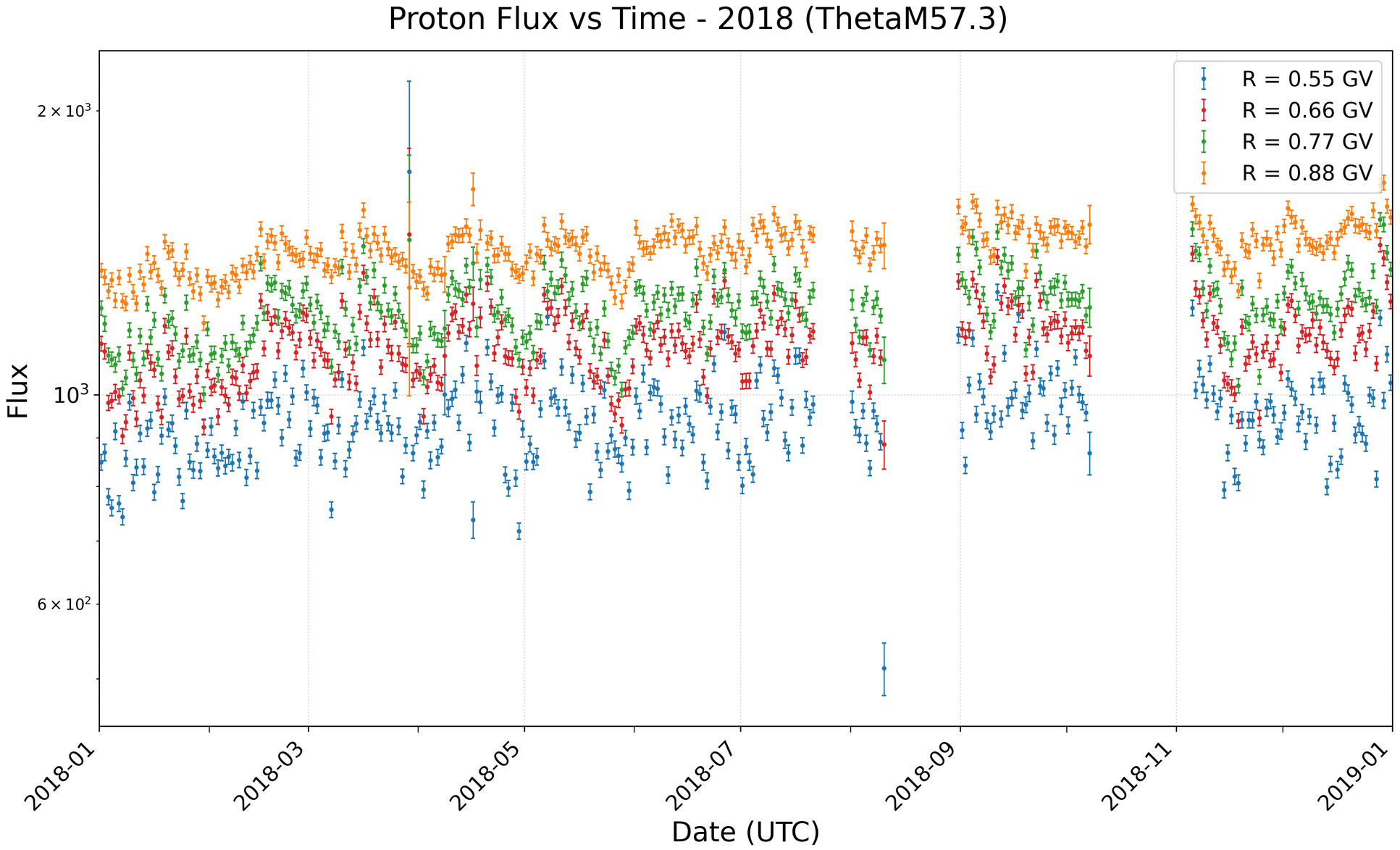
2017/09/10

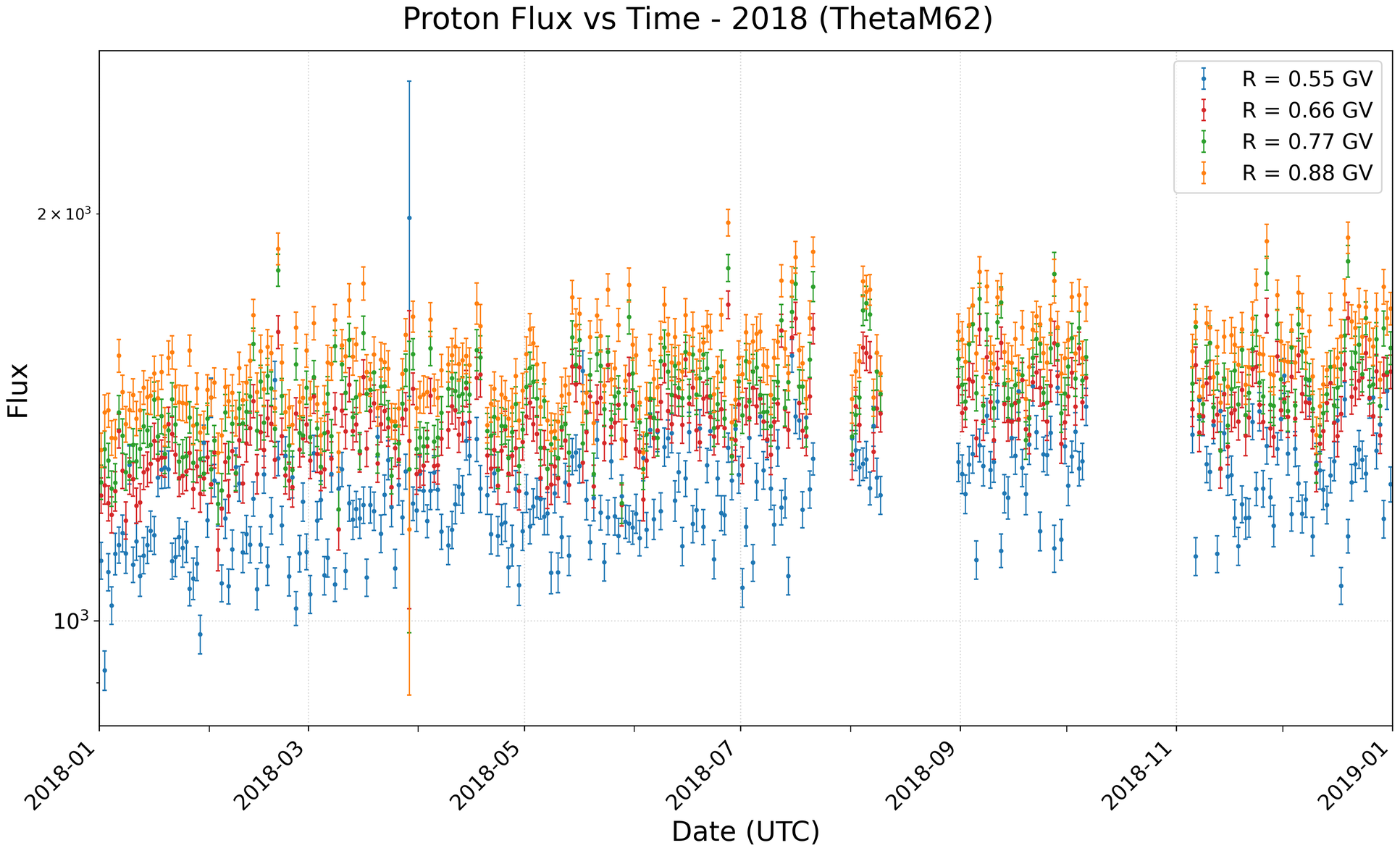
2017-09-06

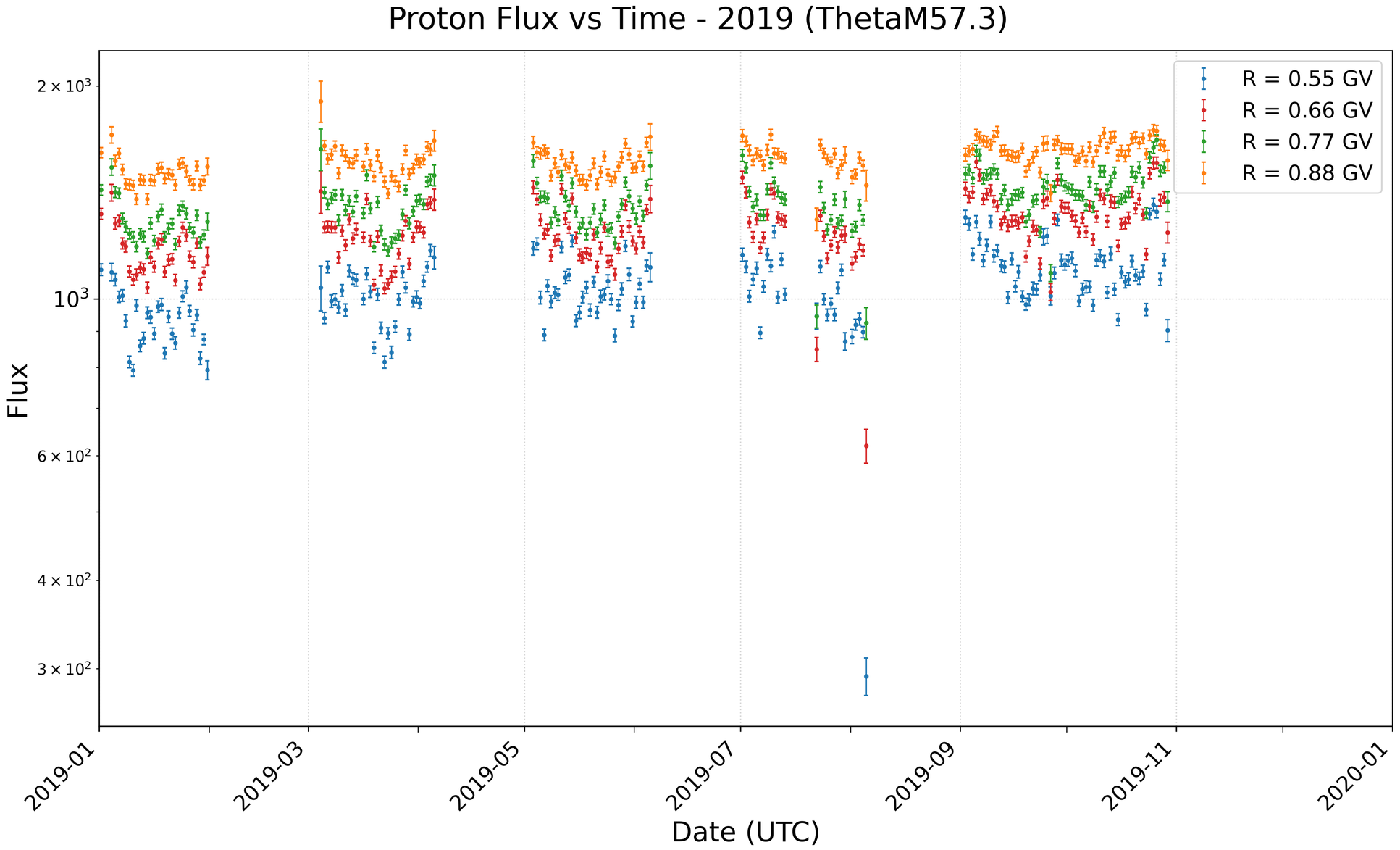


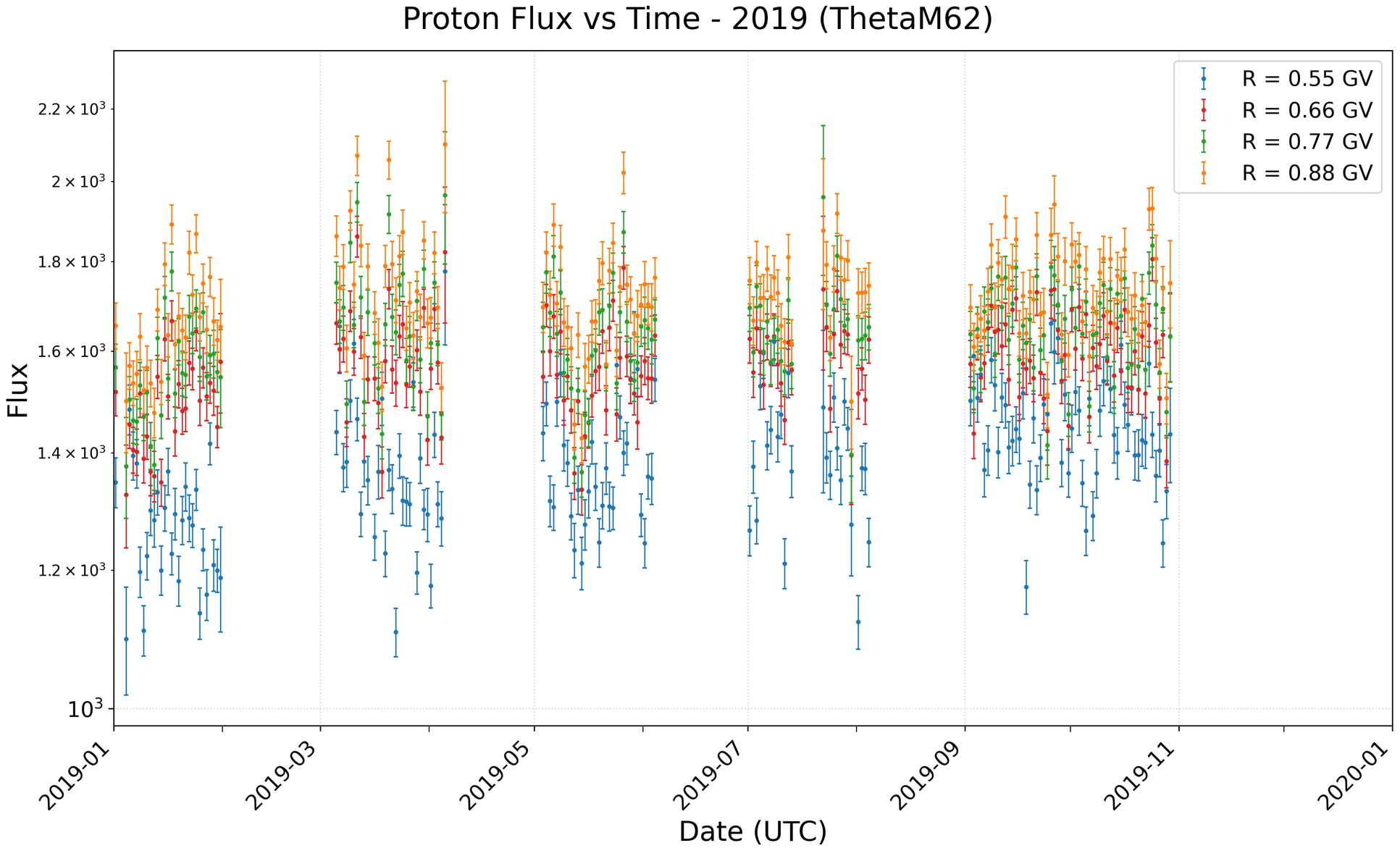
2017/09/10

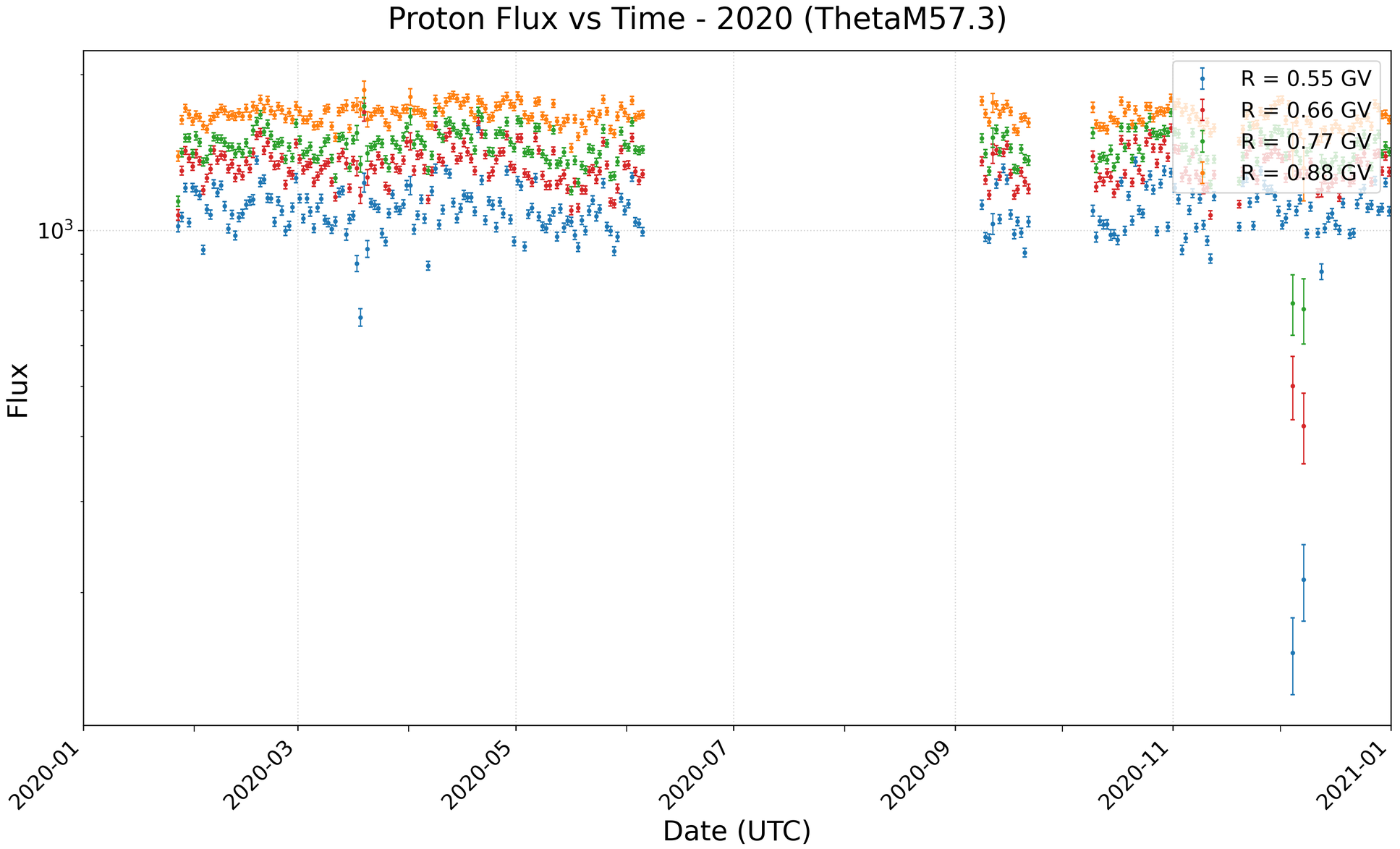
2017-09-06

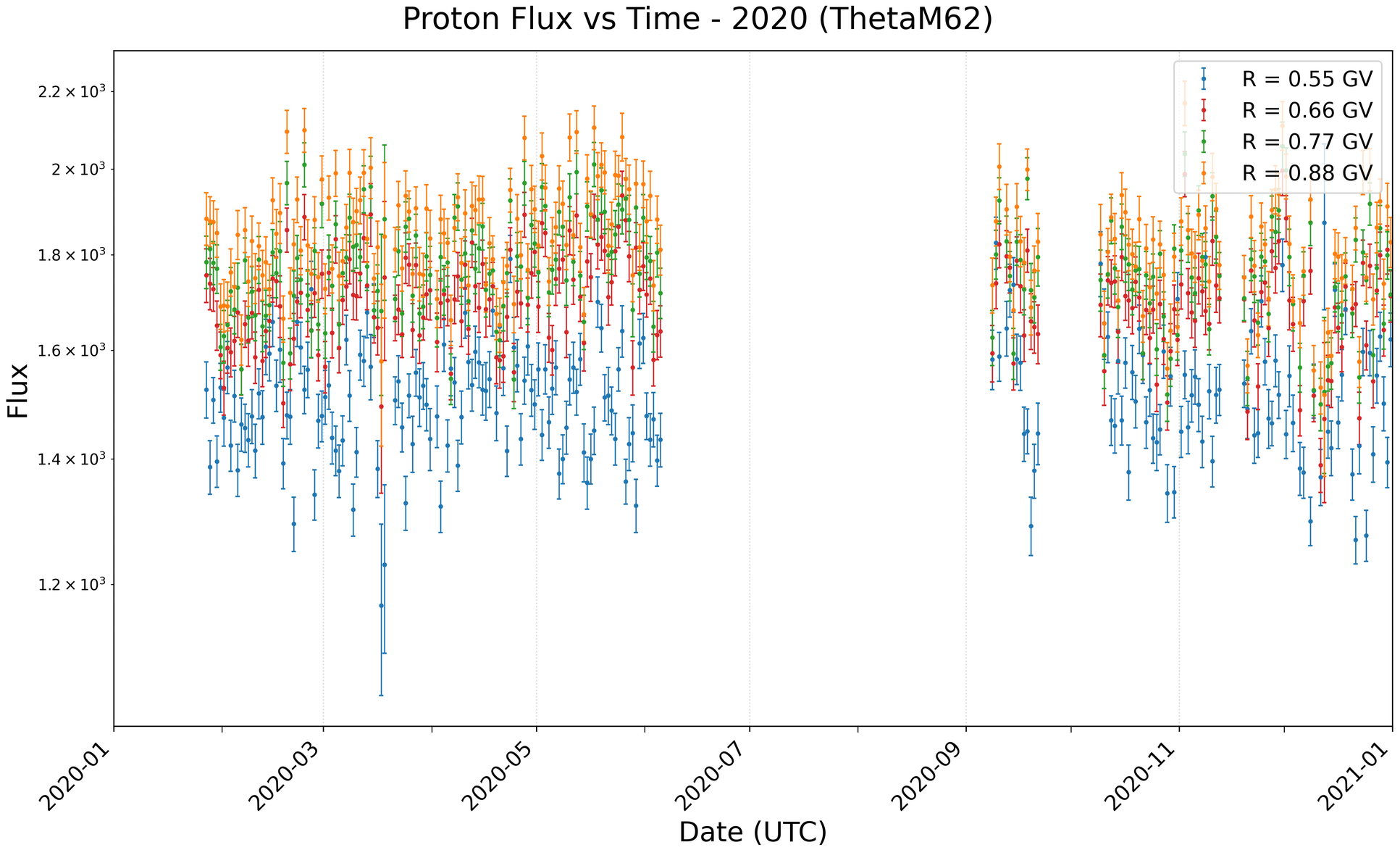

Proton Flux vs Time - 2018 (ThetaM57.3)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
2×10^3
10^3
6×10^2
2018-01
2018-03
2018-05
2018-07
2018-09
2018-11
2019-01
Date (UTC)

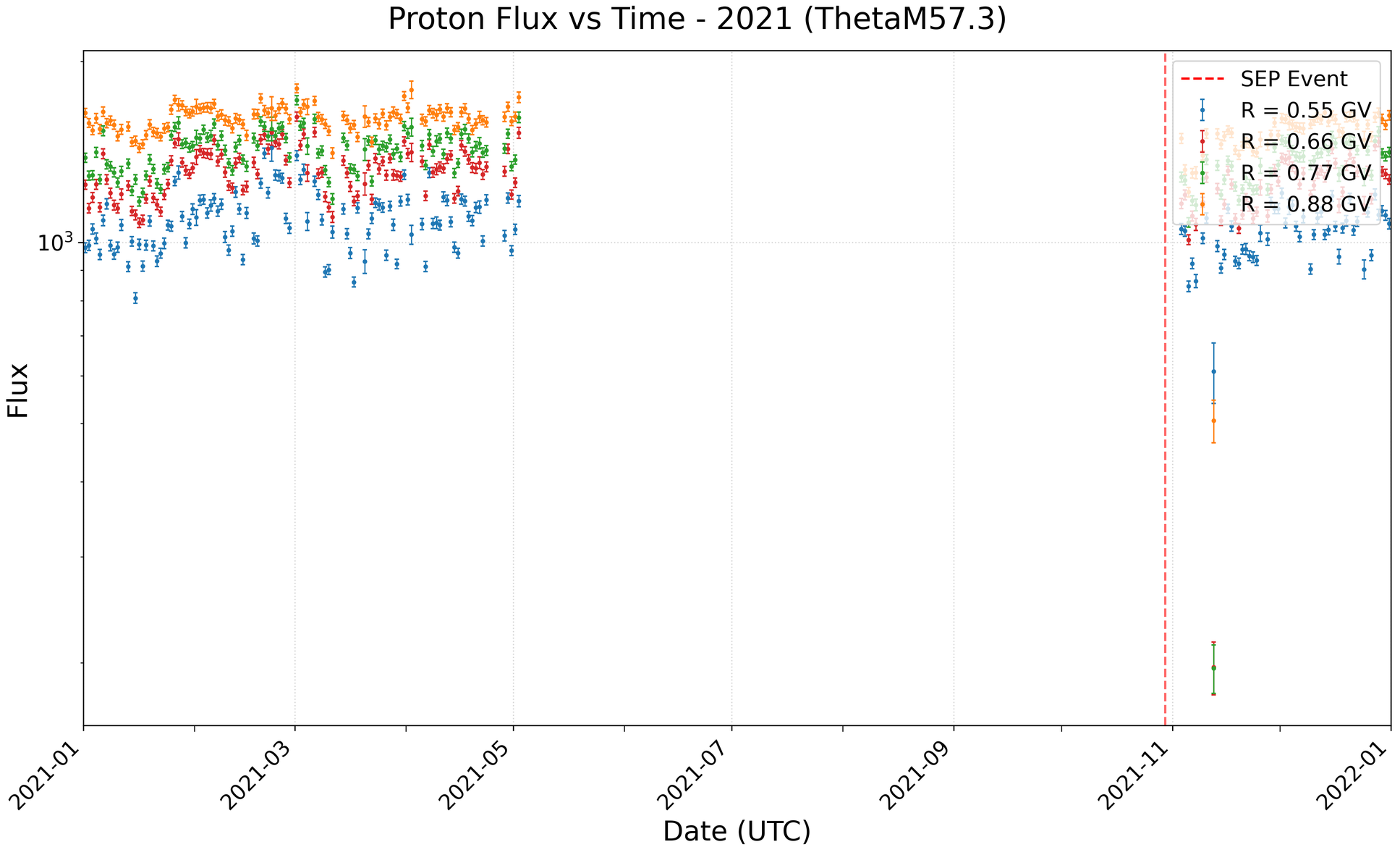

Proton Flux vs Time - 2018 (ThetaM62)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
2×10^3
10^3
2018-01
2018-03
2018-05
2018-07
2018-09
2018-11
2019-01
Date (UTC)

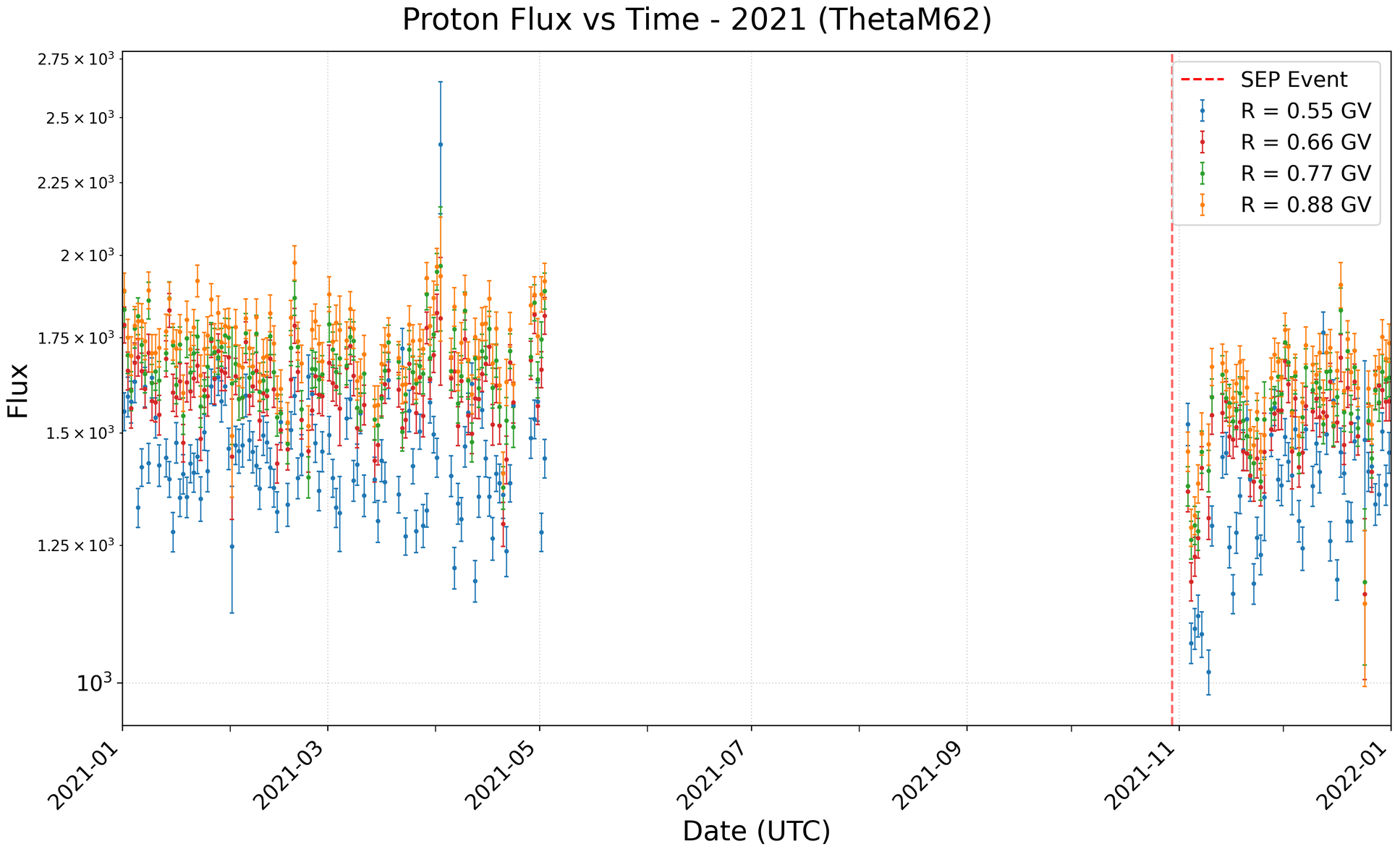

Proton Flux vs Time - 2019 (ThetaM57.3)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
2×10^3
10^3
6×10^2
4×10^2
3×10^2
2019-01
2019-03
2019-05
2019-07
2019-09
2019-11
2020-01
Date (UTC)

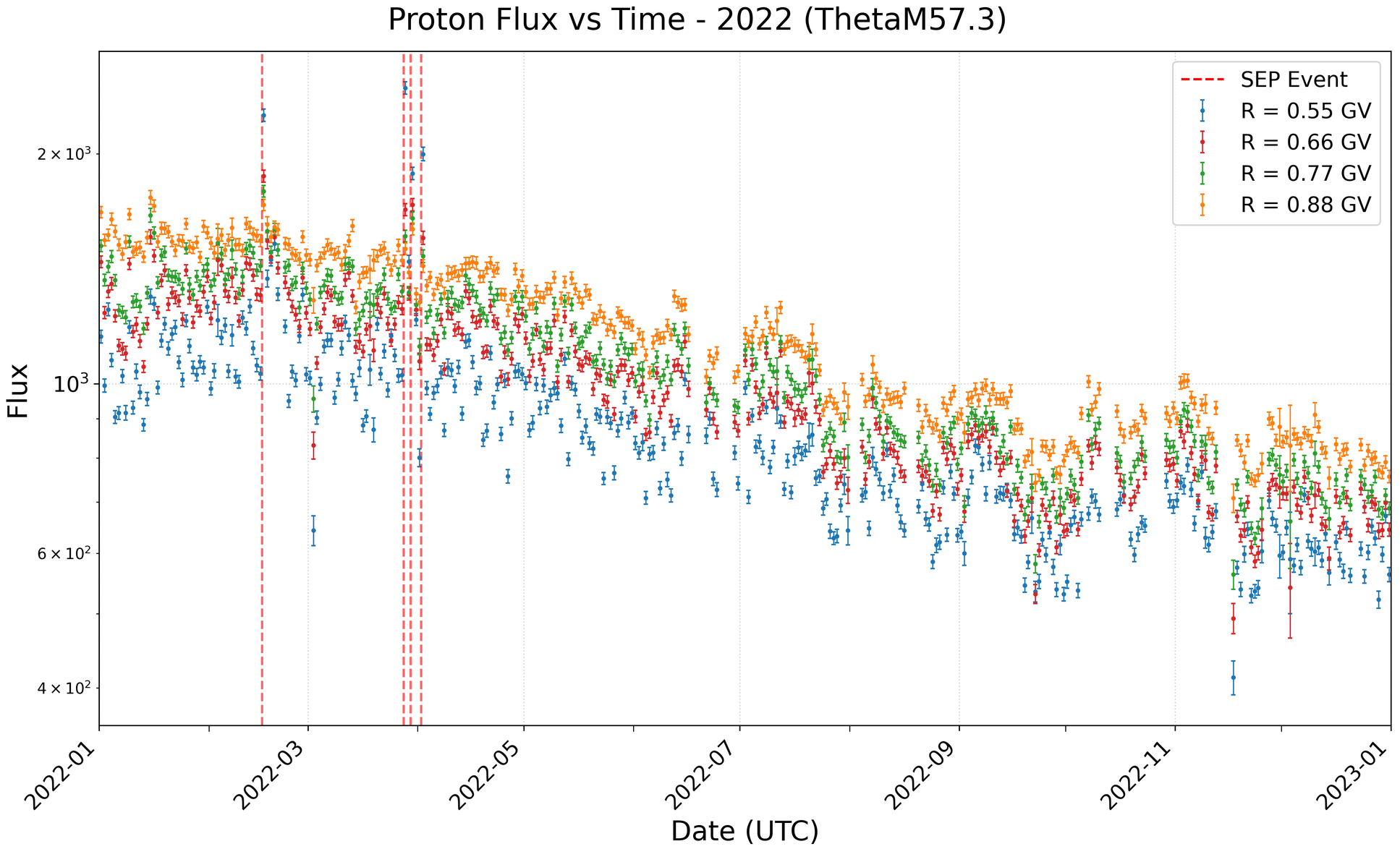

Proton Flux vs Time - 2019 (ThetaM62)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
2.2×10^3
2×10^3
1.8×10^3
1.6×10^3
1.4×10^3
1.2×10^3
10^3
2019-01
2019-03
2019-05
2019-07
2019-09
2019-11
2020-01
Date (UTC)


Proton Flux vs Time - 2020 (ThetaM57.3)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
10^3
Flux
2020-01
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01
Date (UTC)

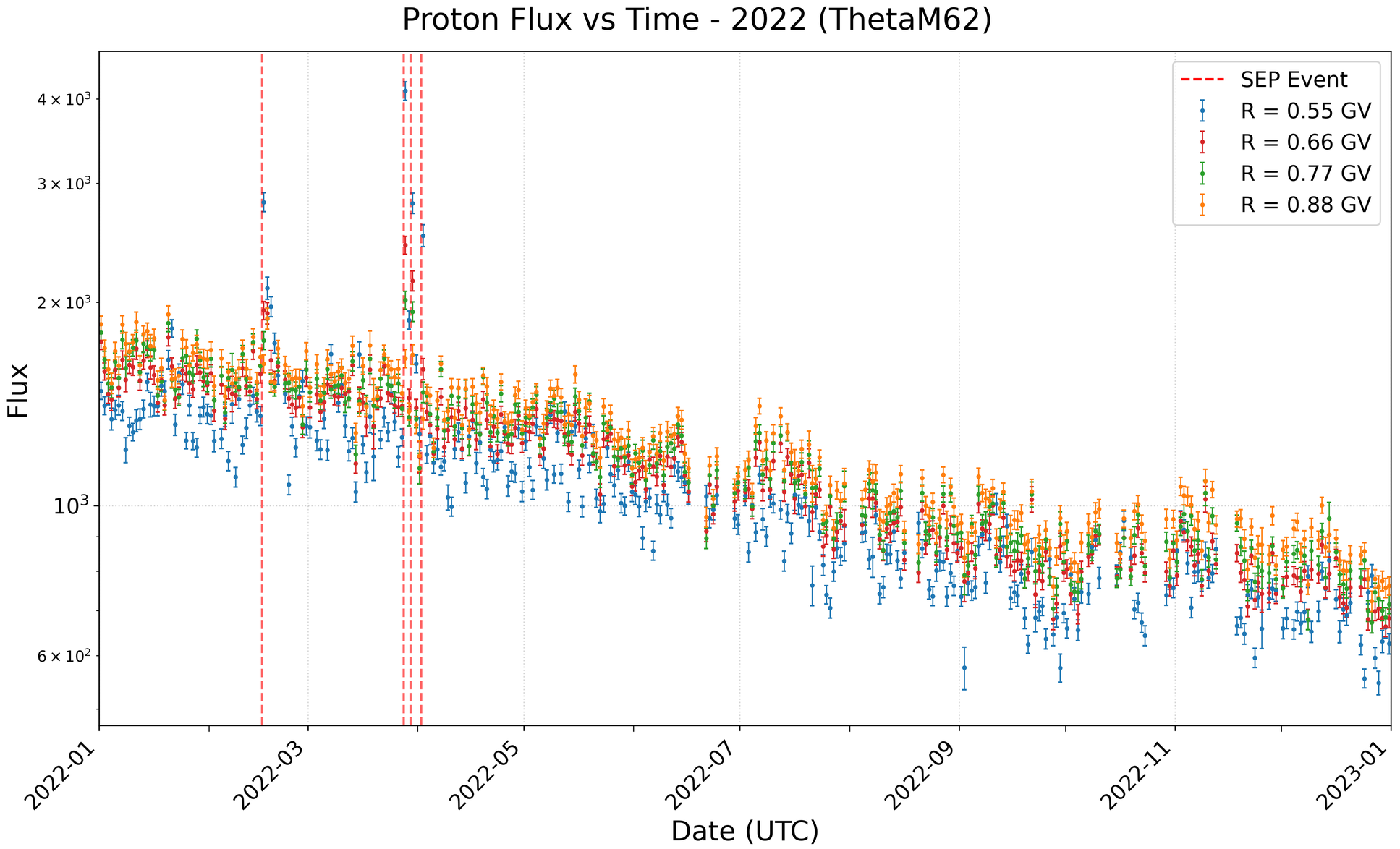

Proton Flux vs Time - 2020 (ThetaM62)
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
Flux
2.2 × 10^3
2 × 10^3
1.8 × 10^3
1.6 × 10^3
1.4 × 10^3
1.2 × 10^3
2020-01
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01
Date (UTC)


Proton Flux vs Time - 2021 (ThetaM57.3)
SEP Event
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
10^3
Flux
2021-01
2021-03
2021-05
2021-07
2021-09
2021-11
2022-01
Date (UTC)

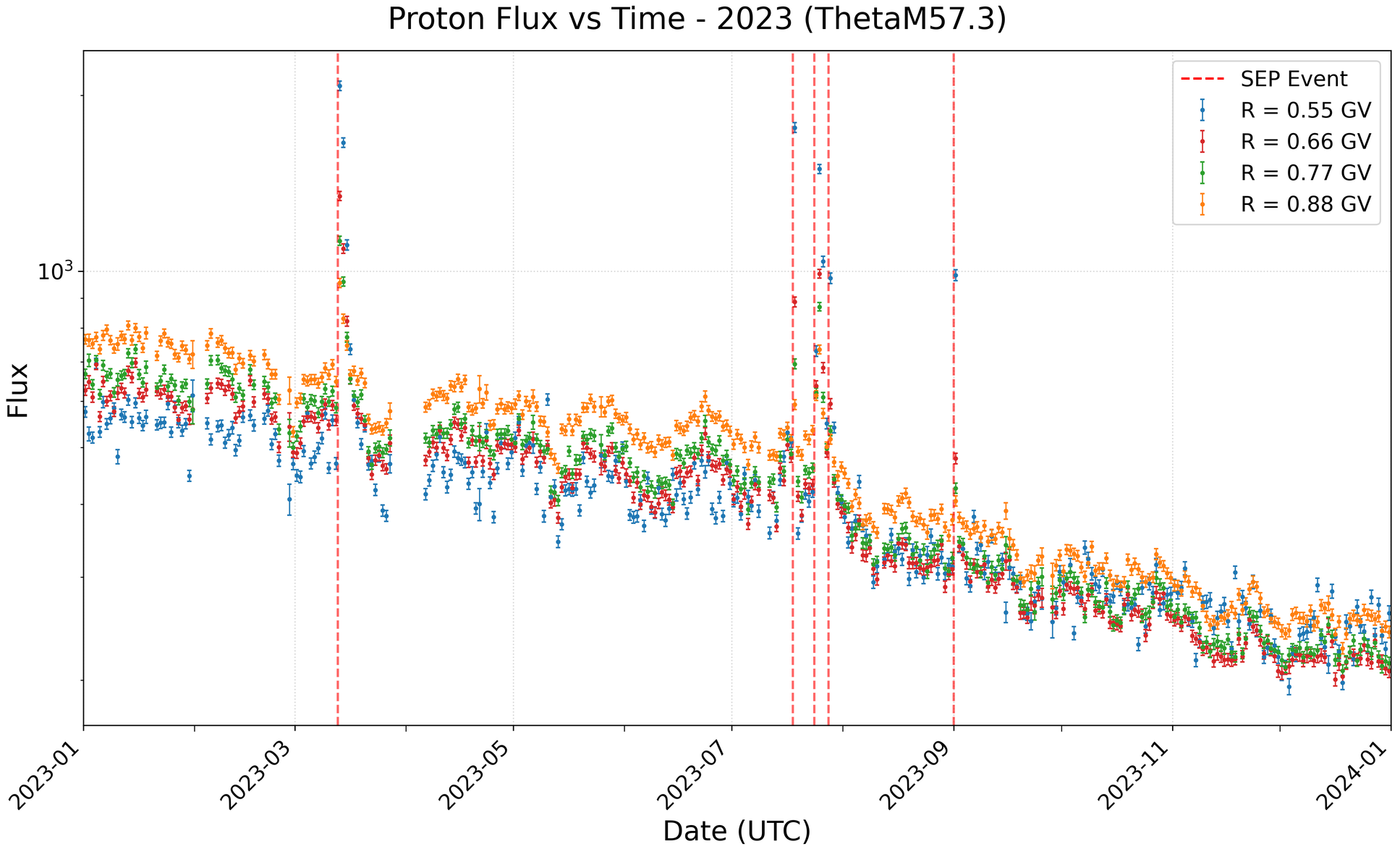

Proton Flux vs Time - 2021 (ThetaM62)
Flux
Date (UTC)
SEP Event
R = 0.55 GV
R = 0.66 GV
R = 0.77 GV
R = 0.88 GV
2.75 × 10^3
2.5 × 10^3
2.25 × 10^3
2 × 10^3
1.75 × 10^3
1.5 × 10^3
1.25 × 10^3
10^3
2021-01
2021-03
2021-05
2021-07
2021-09
2021-11
2022-01



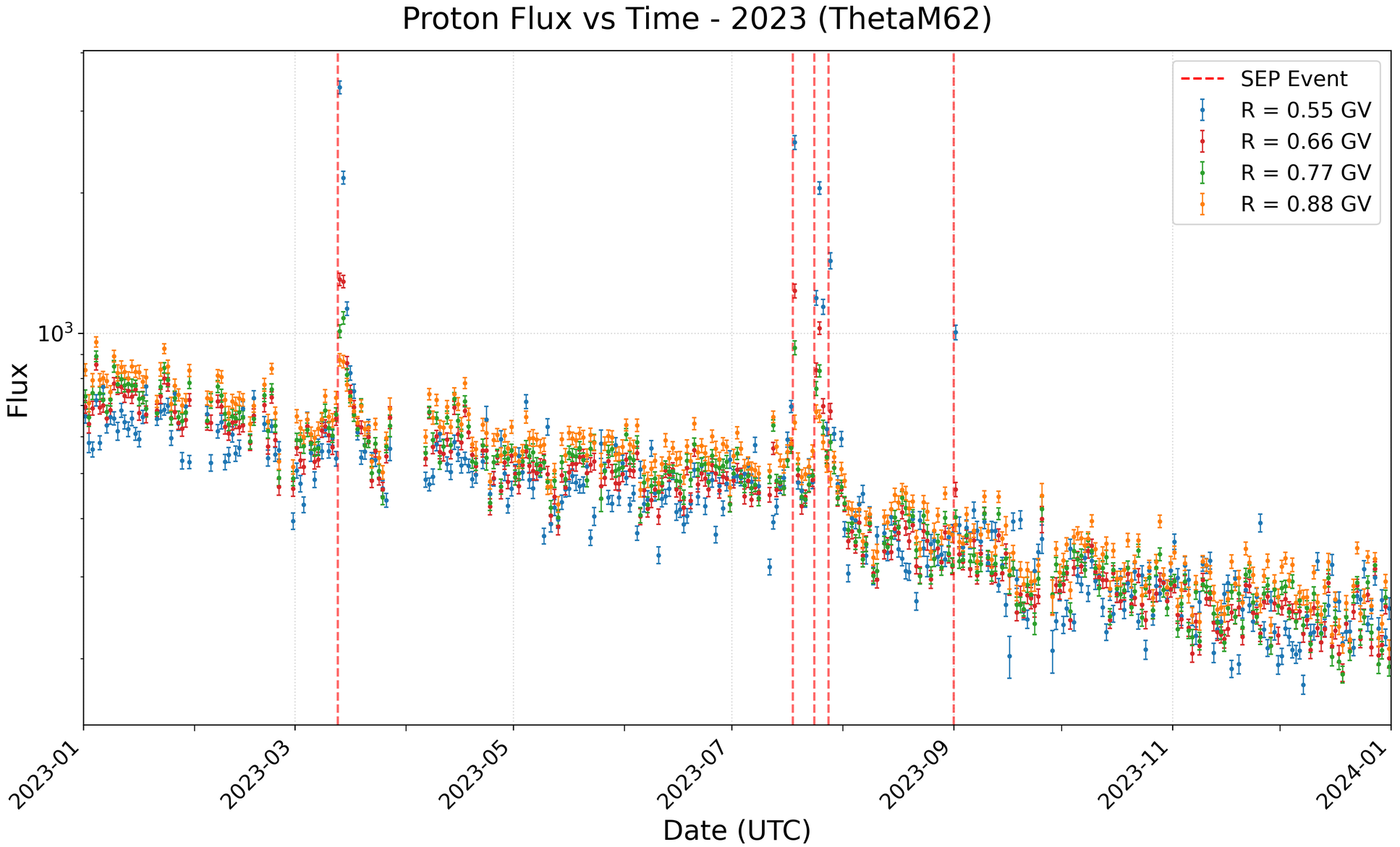
2022/02/16
2022/03/28
2022/03/30
2022/04/02



2022/02/16
2022/03/28
2022/03/30
2022/04/02



2023/03/13
2023/07/18
2023/07/28
2023-07-24
2023-09-01



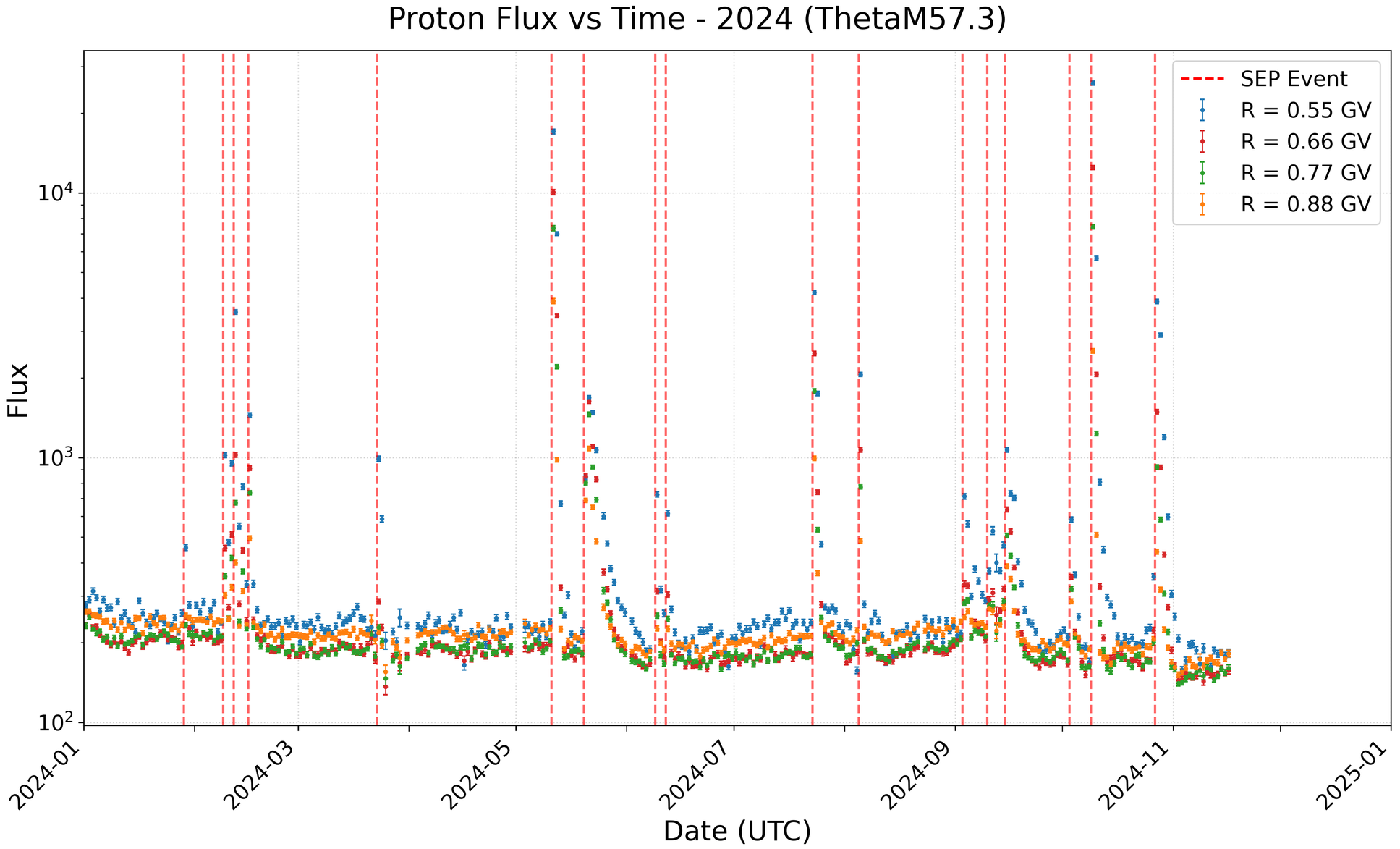
2023/03/13

2023/07/18

2023/07/28

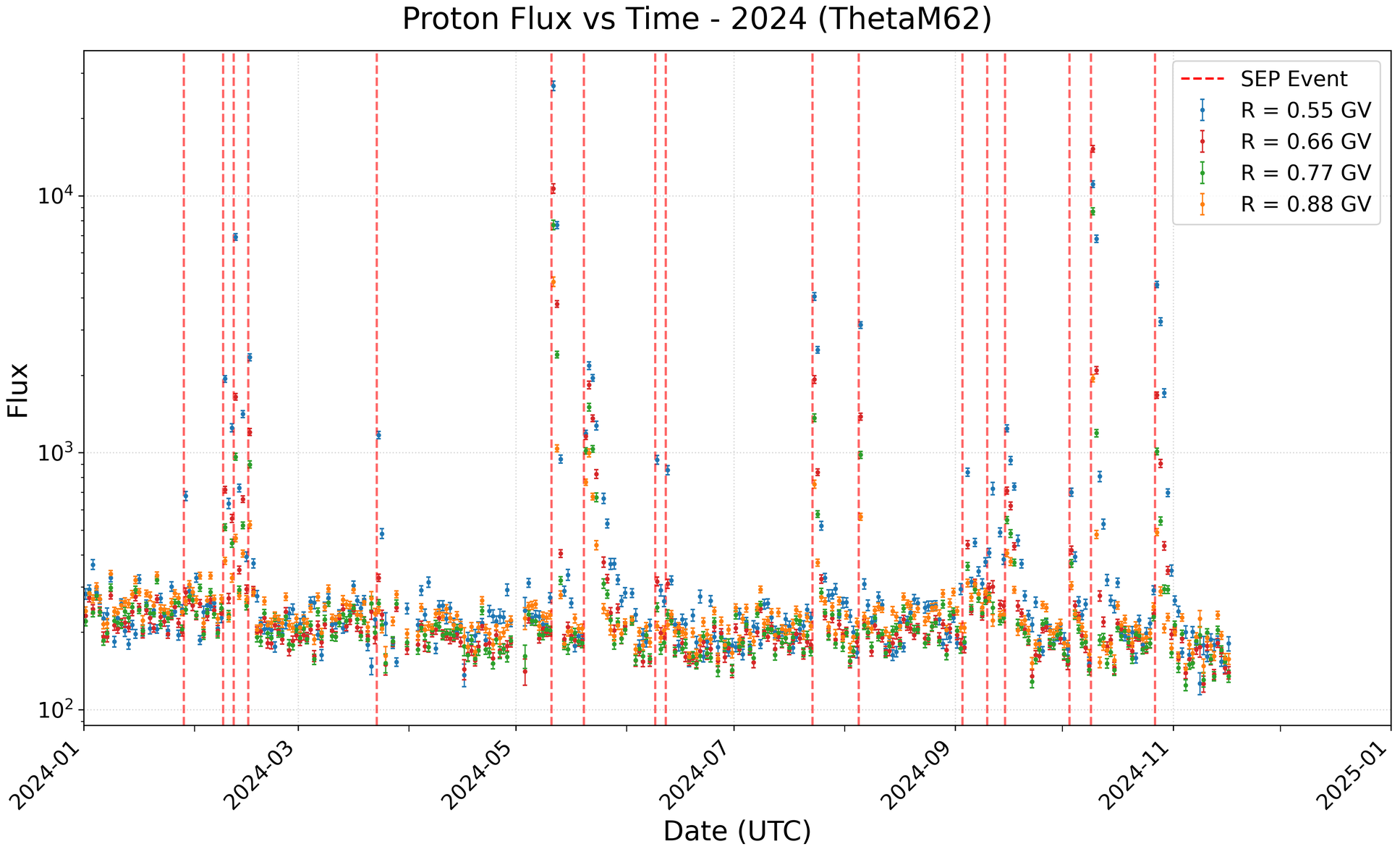
2023-07-24

2023-09-01



2024/02/09
2024/02/10
2024/02/12
2024/03/23
2024/05/11
2024/10/09

2024-01-29
2024-02-16
2024-05-20
2024-06-09
2024-06-12
2024-07-23
2024-08-05
2024-09-03
2024-09-10
2024-09-15
2024-10-03
2024-10-27



2024/02/09
2024/02/10
2024/02/12
2024/03/23
2024/05/11
2024/10/09

2024-01-29
2024-02-16
2024-05-20
2024-06-09
2024-06-12
2024-07-23
2024-08-05
2024-09-03
2024-09-10
2024-09-15
2024-10-03
2024-10-27

SEP list

2011/06/07
2011/08/04
2011/08/09
2011/09/06
2011/09/07
2011/09/22
2011/11/04

2012/01/23
2012/01/27
2012/03/07
2012/03/13
2012/05/17
2012/07/07
2012/07/08
2012/07/19
2012/07/23
2012/11/08
2011/11/04

2013/04/11
2013/04/24
2013/05/22
2013/10/11
2013/10/25
2013/10/28
2013/11/02
2013/12/28
2012-09-28

2014/01/06
2014/01/07
2014/02/25
2014/04/18
2014/09/02
2014/09/10
2014/09/25
2013-03-06
2013-09-30

2015/10/29

2017/09/10
2017-09-06

2022/02/16
2022/03/28
2022/03/30
2022/04/02

2023/03/13
2023/07/18
2023/07/28
2023-07-24
2023-09-01

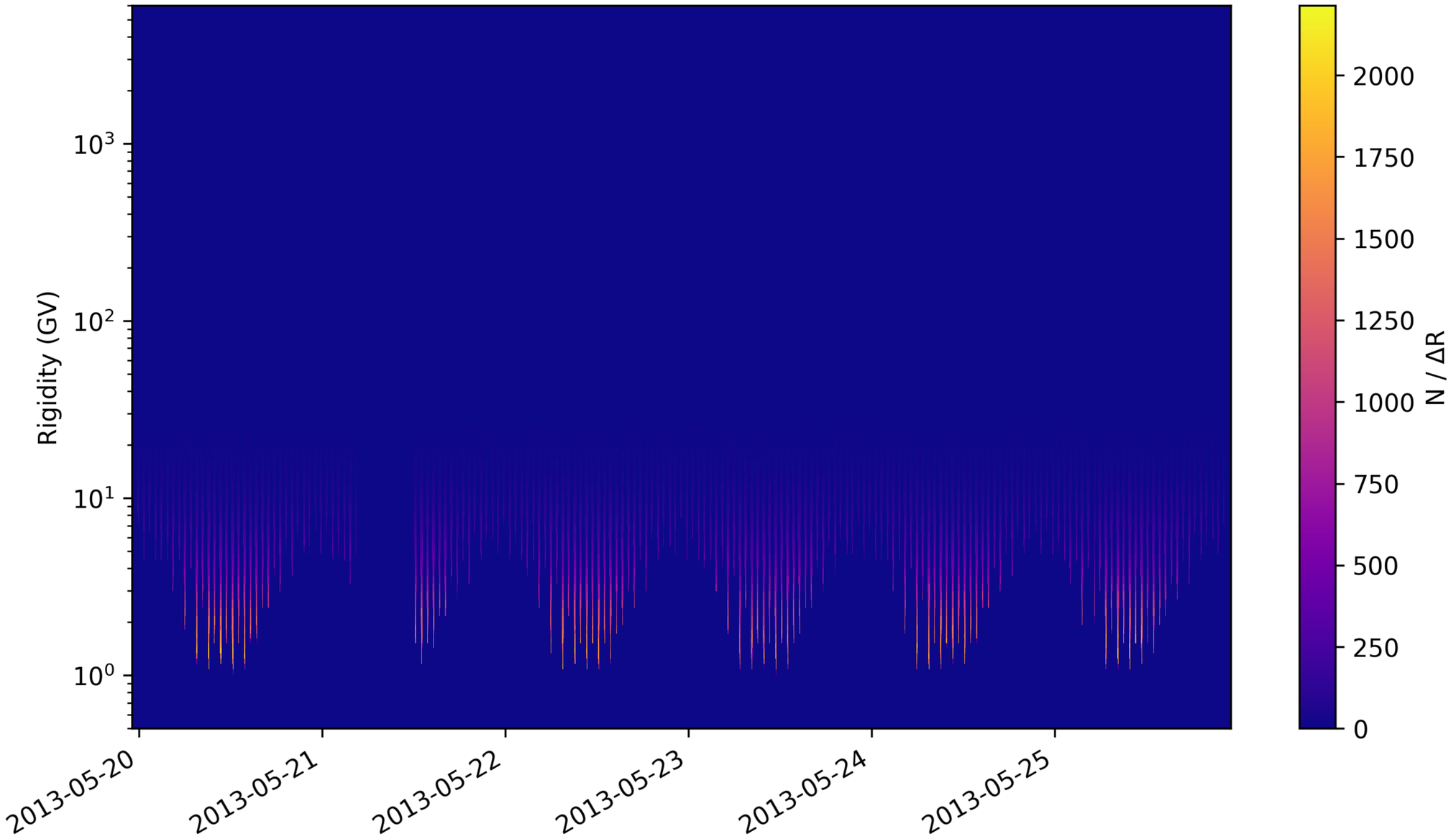
2024/02/09
2024/02/10
2024/02/12
2024/03/23
2024/05/11
2024/10/09
2024-01-29
2024-02-16
2024-05-20
2024-06-09
2024-06-12
2024-07-23
2024-08-05
2024-09-03
2024-09-10
2024-09-15
2024-10-03
2024-10-27

In total: 66

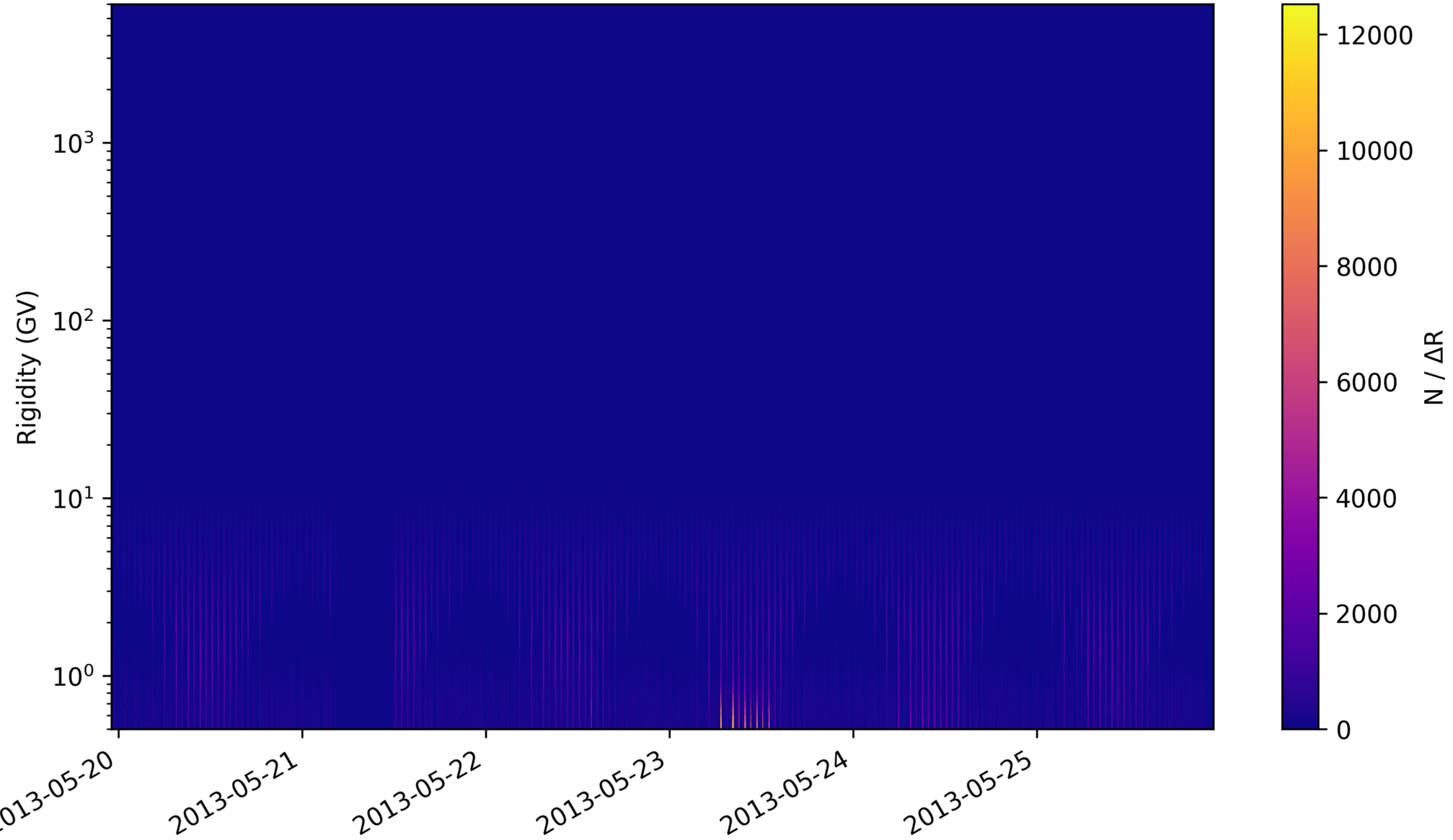
- SEP Proton flux

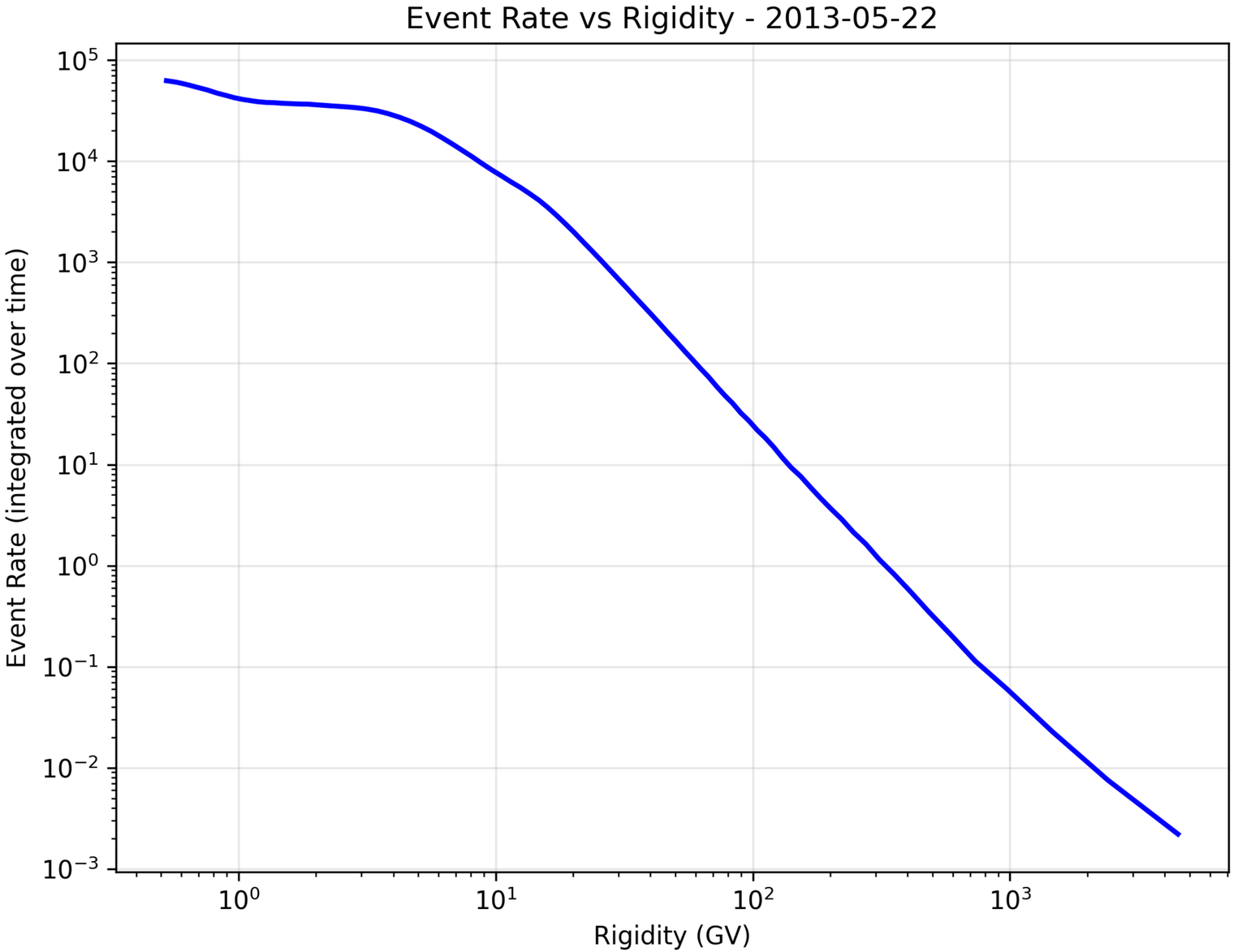
SEP event: 2013-05-23

EventNum/ΔR WithCutoff

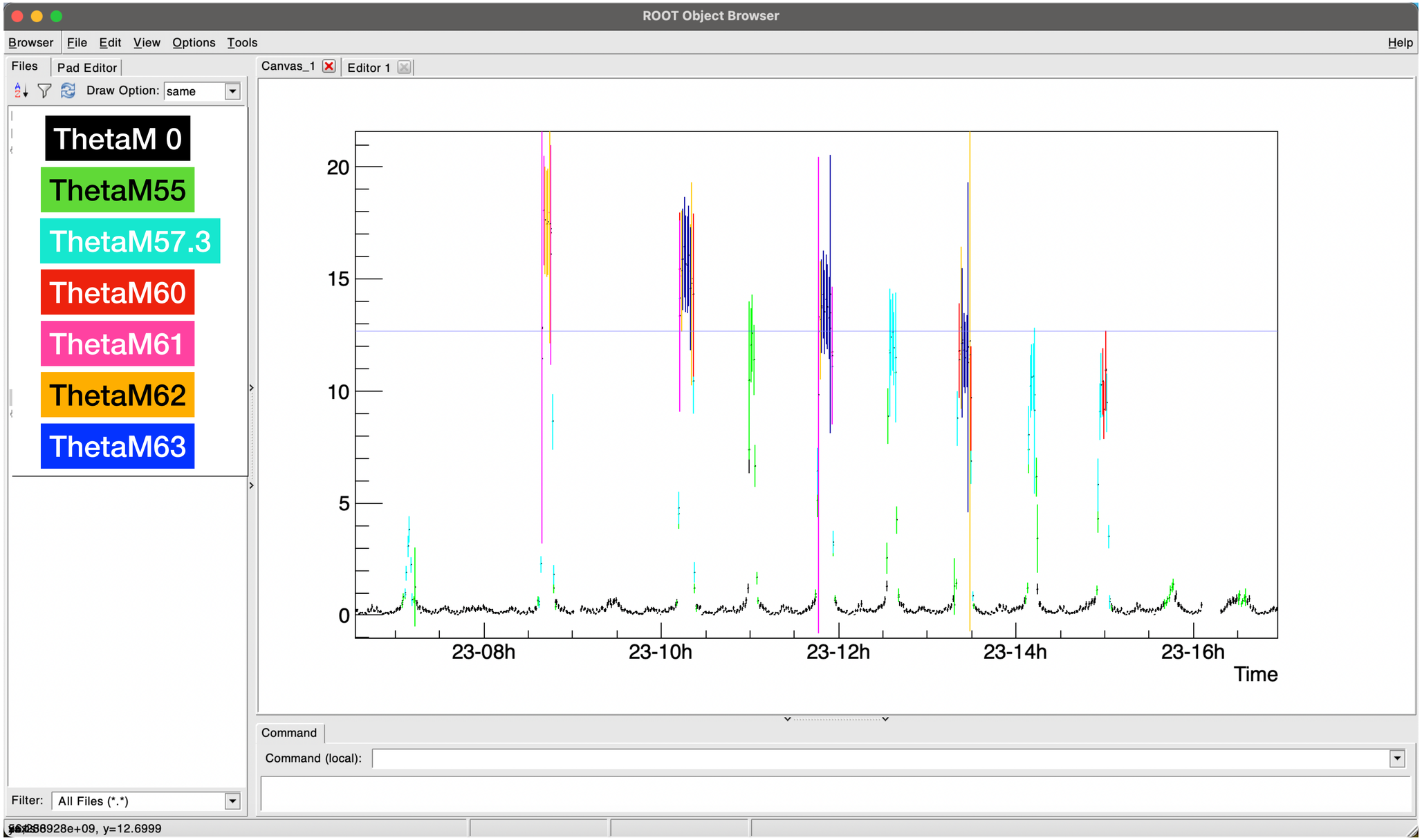


EventNum/ΔR WithoutCutoff

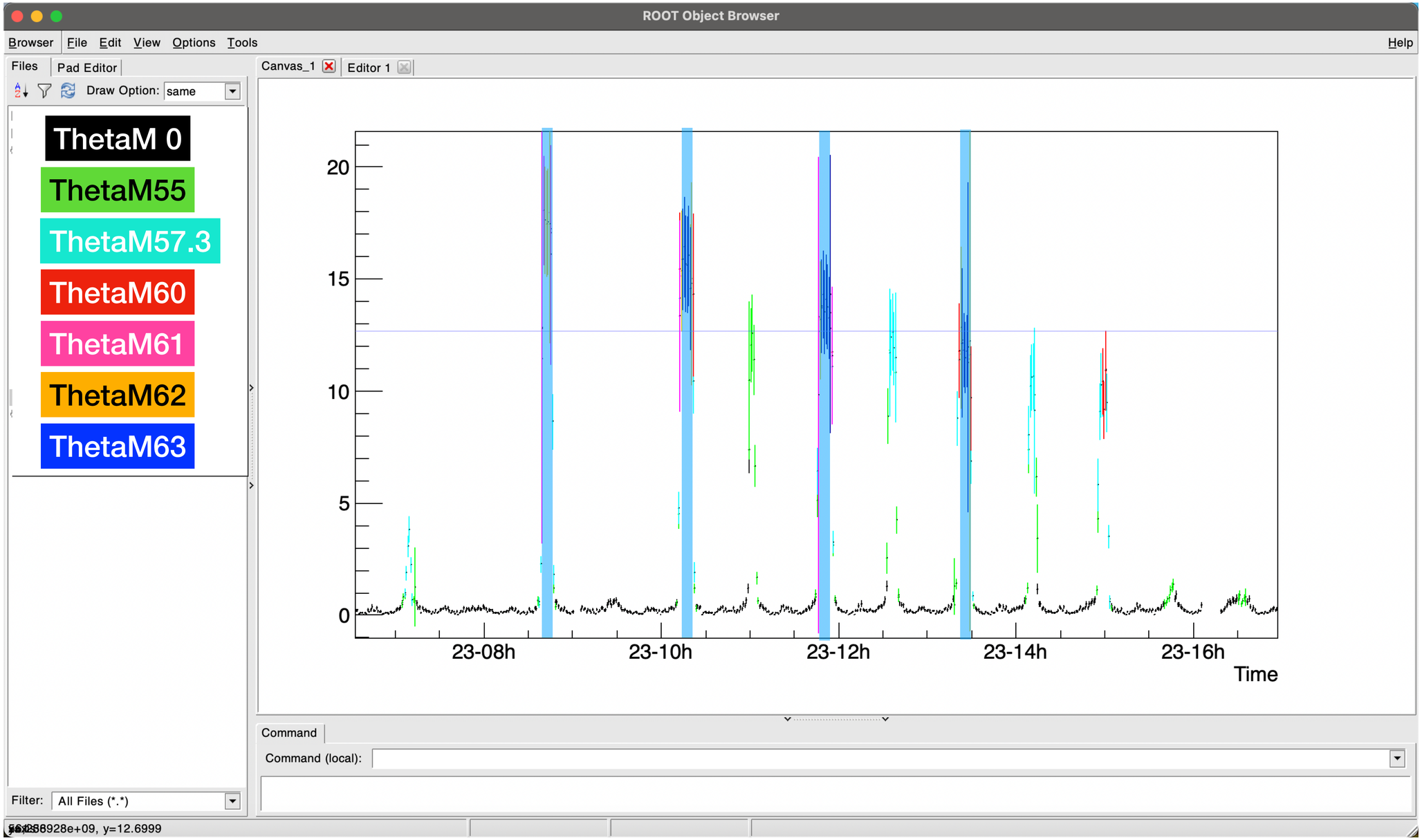



Event Rate vs Rigidity - 2013-05-22
Event Rate (integrated over time)
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{0}
10^{1}
10^{2}
10^{3}
Rigidity (GV)

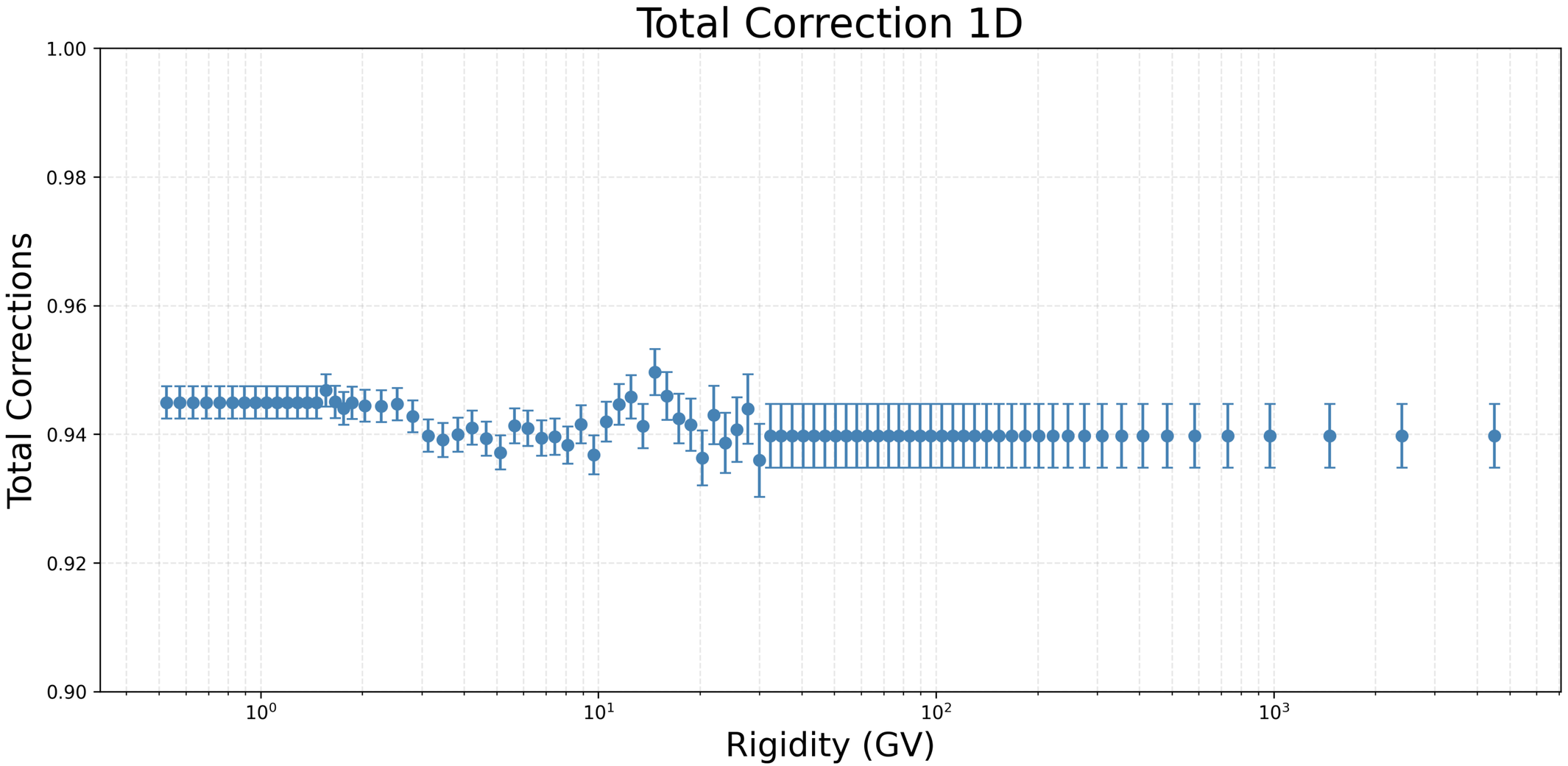
Event rate

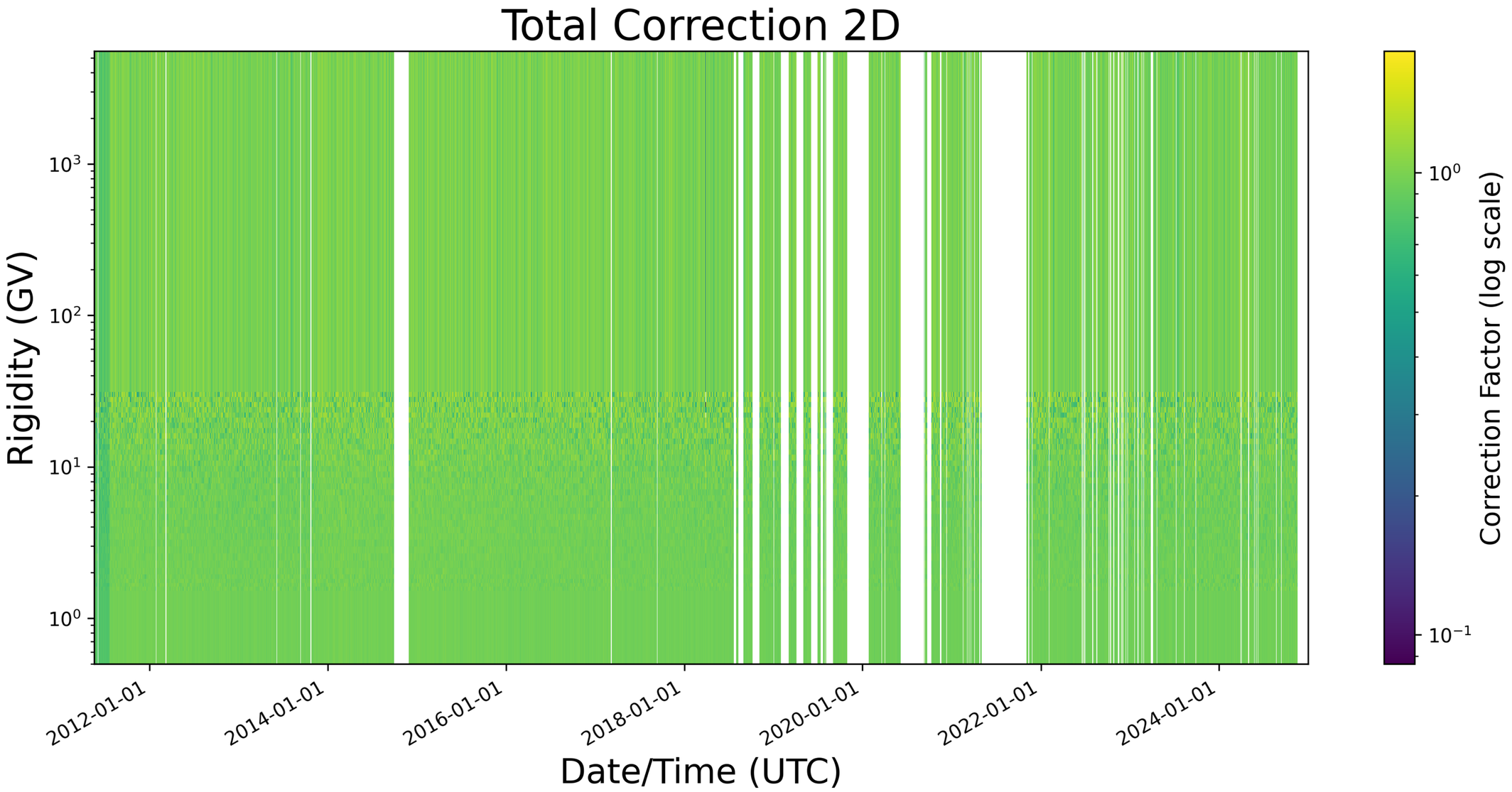

ROOT Object Browser
Browser
File
Edit
View
Options
Tools
Help
Files
Pad Editor
Draw Option:
same
ThetaM 0
ThetaM55
ThetaM57.3
ThetaM60
ThetaM61
ThetaM62
ThetaM63
Filter:
All Files (*.*)
Canvas_1
Editor 1
20
15
10
5
0
23-08h
23-10h
23-12h
23-14h
23-16h
Time
Command
Command (local):
y=12.6999

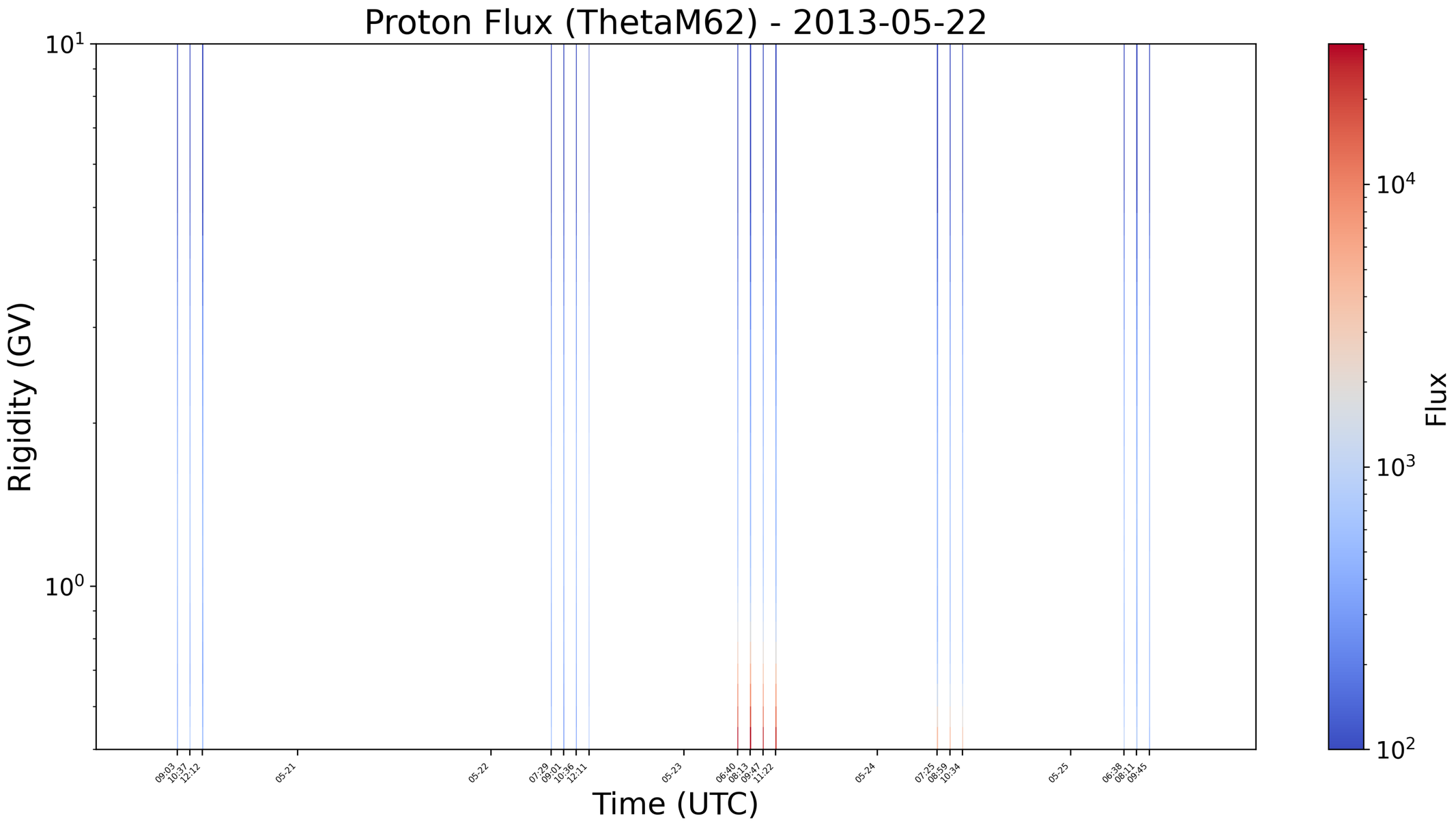
Event rate

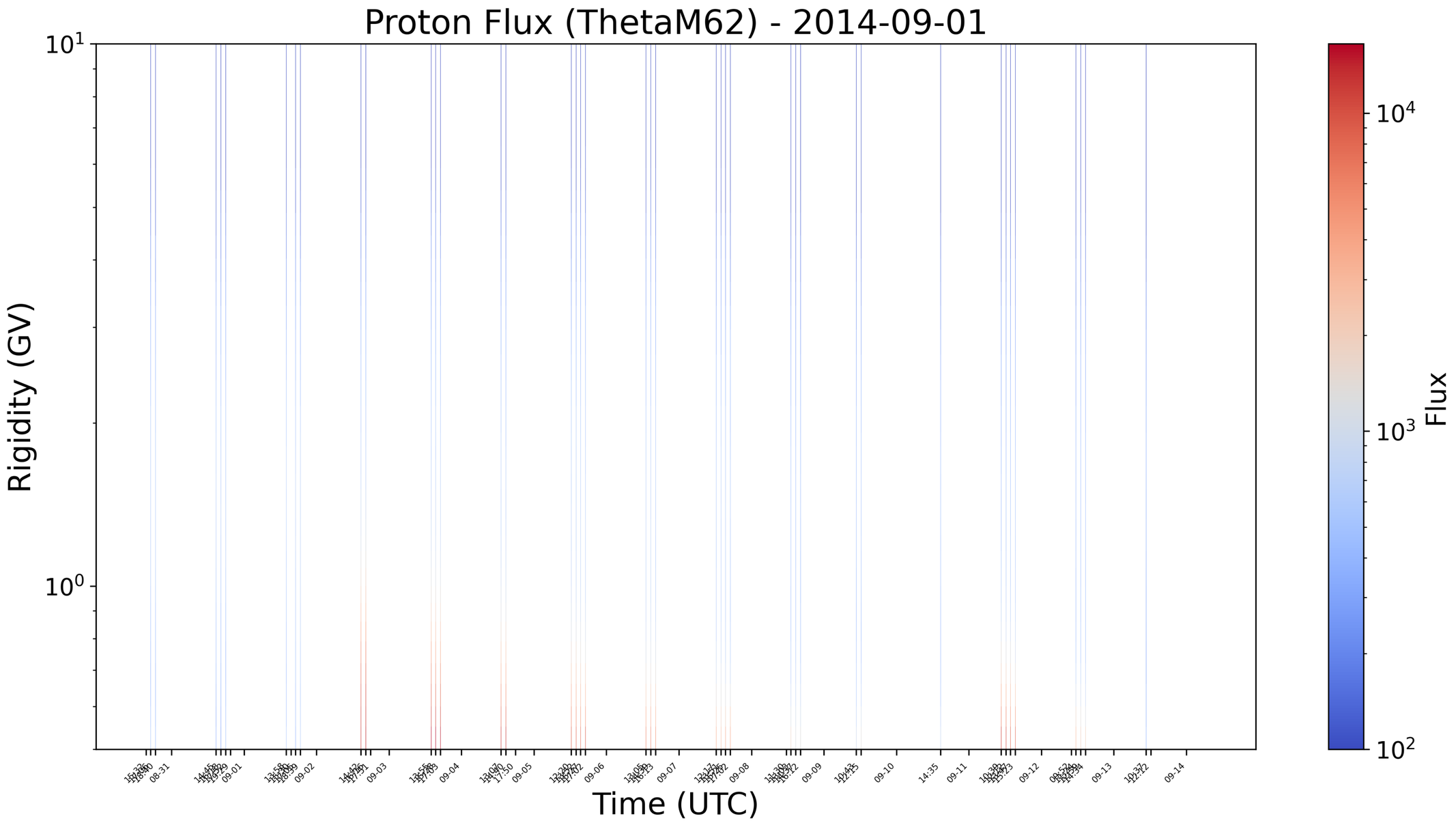

ROOT Object Browser
Browser
File
Edit
View
Options
Tools
Help
Files
Pad Editor
Draw Option:
same
ThetaM 0
ThetaM55
ThetaM57.3
ThetaM60
ThetaM61
ThetaM62
ThetaM63
Filter:
All Files (*.*)
Canvas_1
Editor 1
20
15
10
5
0
23-08h
23-10h
23-12h
23-14h
23-16h
Time
Command
Command (local):
y=12.6999

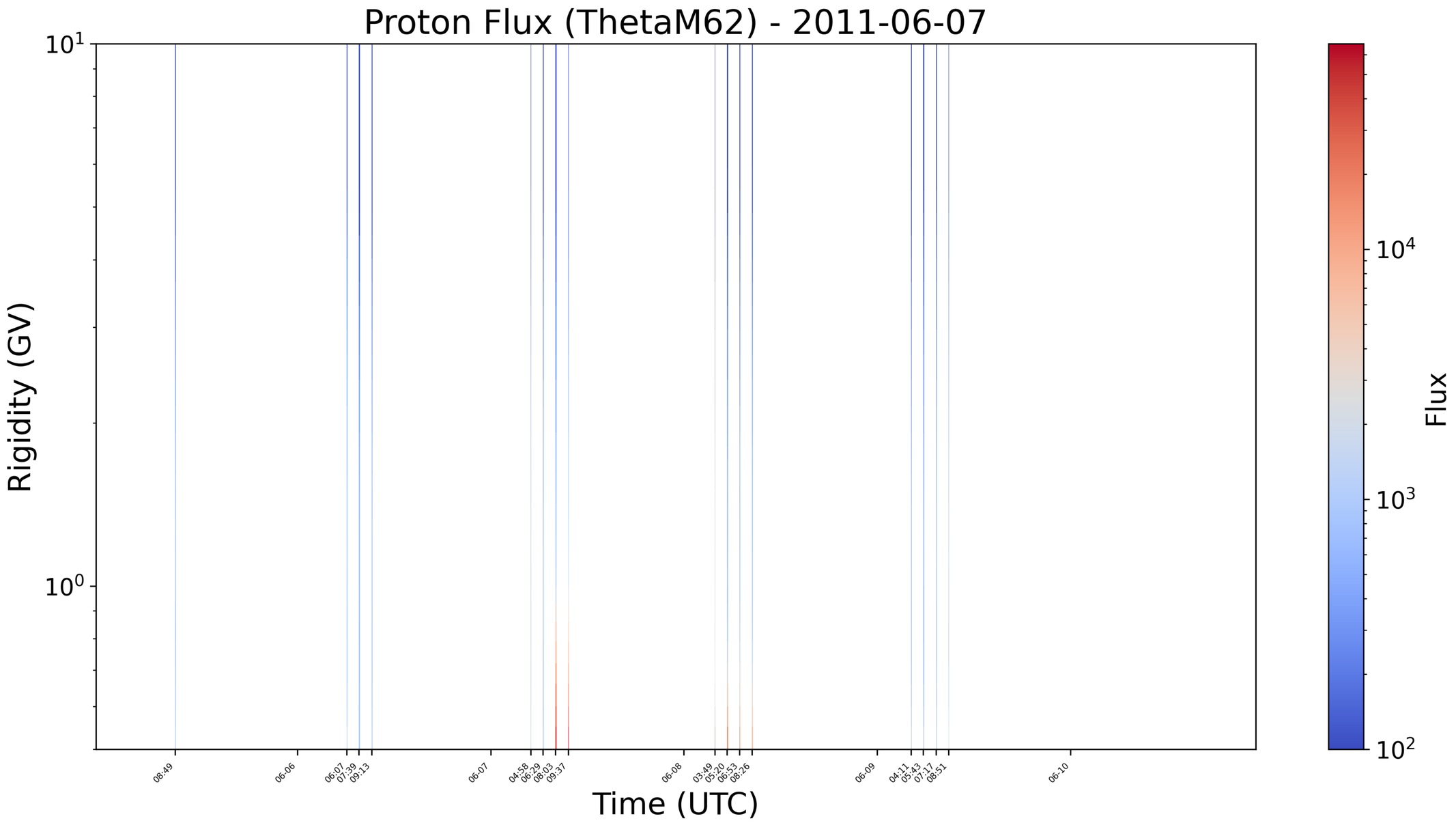
Only select ThetaM>62, and with stable event rate

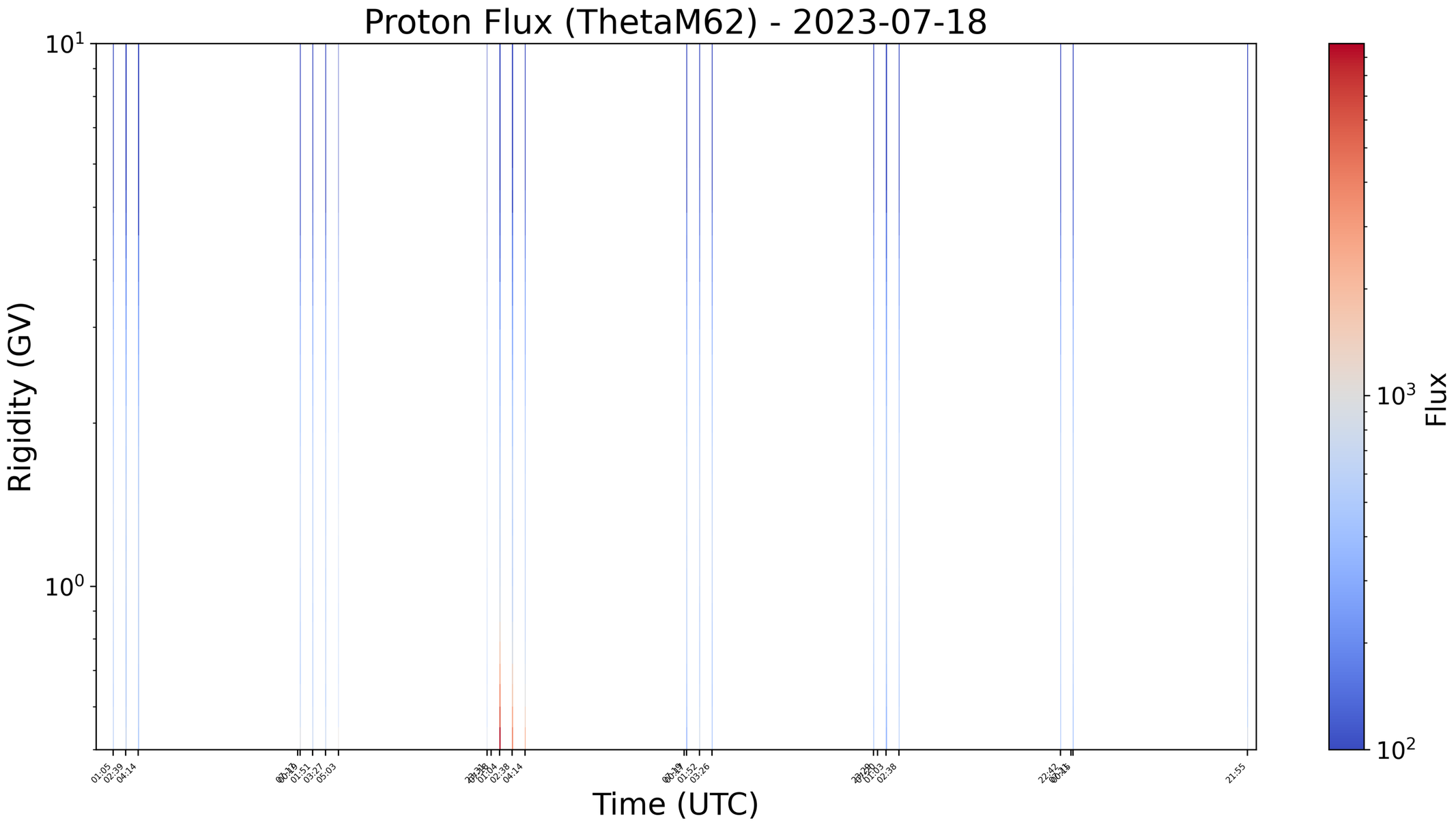

Total Correction 1D
Total Corrections
1.00
0.98
0.96
0.94
0.92
0.90
10^0
10^1
10^2
10^3
Rigidity (GV)


Total Correction 2D
Rigidity (GV)
10^3
10^2
10^1
10^0
2012-01-01
2014-01-01
2016-01-01
2018-01-01
2020-01-01
2022-01-01
2024-01-01
Date/Time (UTC)
10^0
10^{-1}
Correction Factor (log scale)

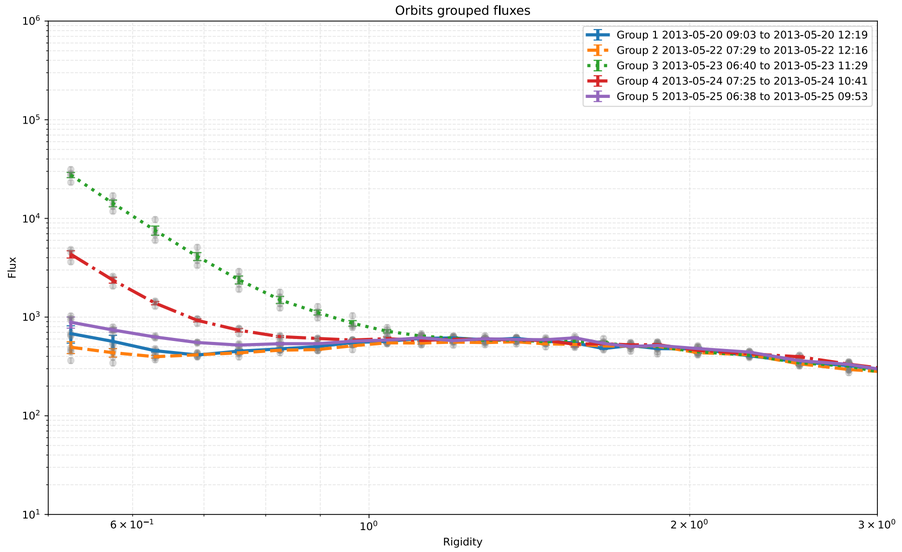

Proton Flux (ThetaM62) - 2013-05-22
Rigidity (GV)
10^1
10^0
09:03
10:37
12:12
05-21
05-22
07:29
09:01
10:36
12:11
05-23
06:40
08:13
09:47
11:22
05-24
07:25
08:59
10:34
05-25
06:38
08:11
09:45
Time (UTC)
Flux
10^4
10^3
10^2

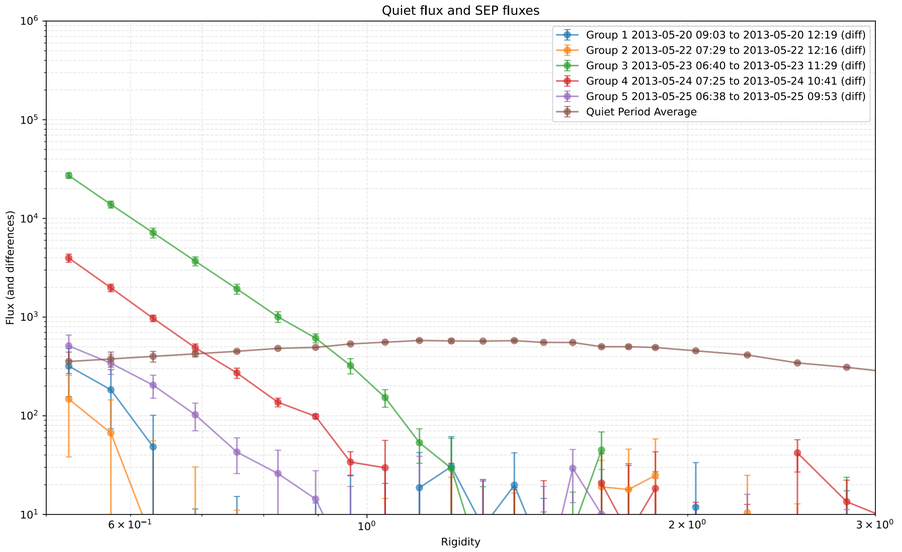

Proton Flux (ThetaM62) - 2014-09-01
Rigidity (GV)
10^1
10^0
Time (UTC)
08-31
09-01
09-02
09-03
09-04
09-05
09-06
09-07
09-08
09-09
09-10
09-11
09-12
09-13
09-14
Flux
10^4
10^3
10^2

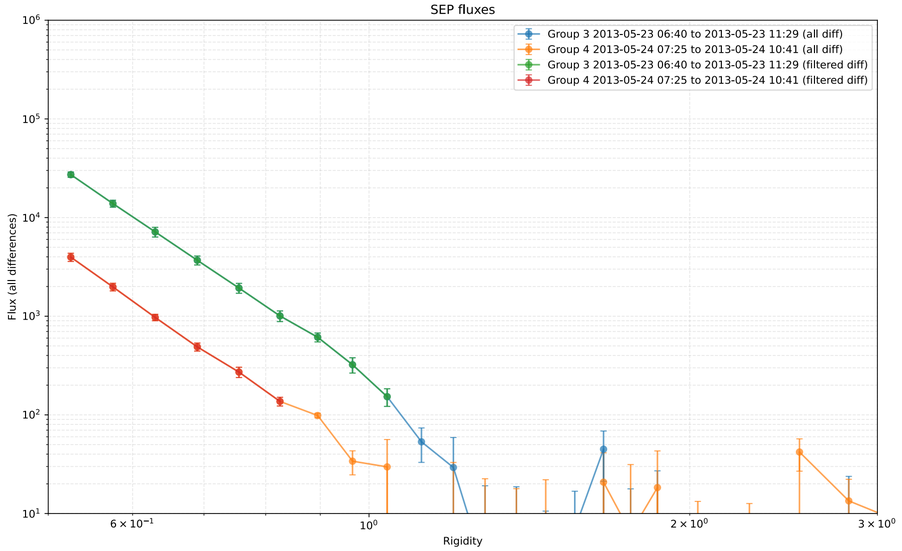

Proton Flux (ThetaM62) - 2011-06-07
Rigidity (GV)
10^1
10^0
08:49
06-06
06:07
07:39
09:13
06-07
04:58
06:29
08:03
09:37
06-08
03:49
05:20
06:53
08:26
06-09
04:11
05:43
07:17
08:51
06-10
Time (UTC)
Flux
10^4
10^3
10^2

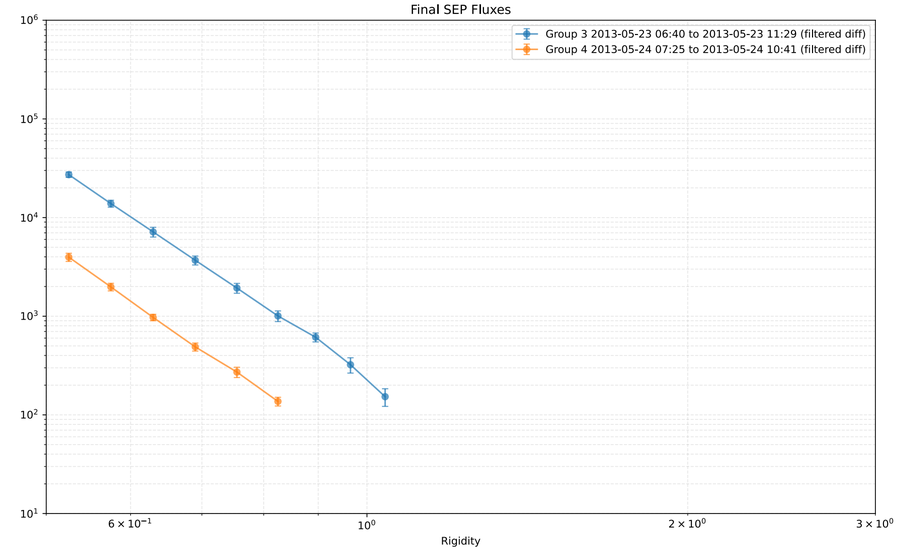

Proton Flux (ThetaM62) - 2023-07-18
Rigidity (GV)
10^1
10^0
Time (UTC)
01:05
02:39
04:14
01:51
03:27
05:03
01:52
03:26
02:38
04:14
02:38
21:55
Flux
10^3
10^2

Rigidity Series for 2013-05-22 (Rigidity < 3)

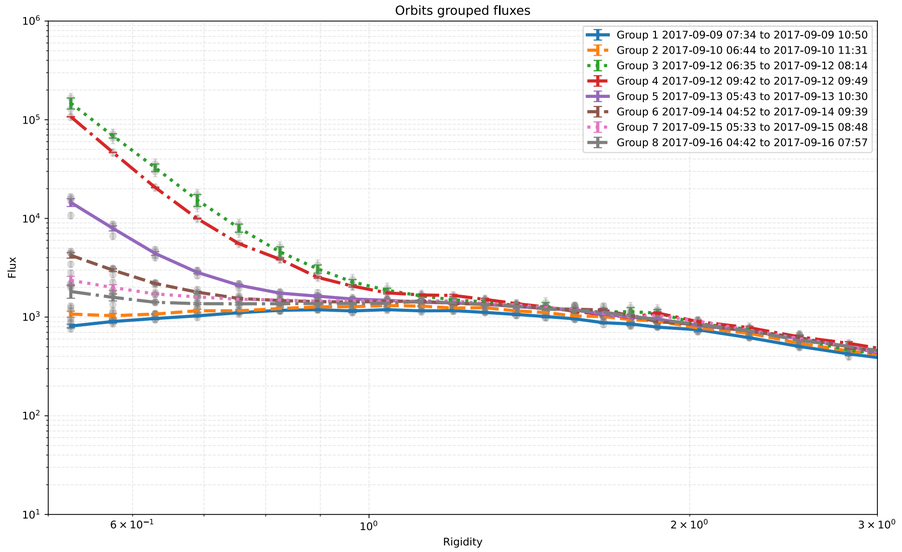


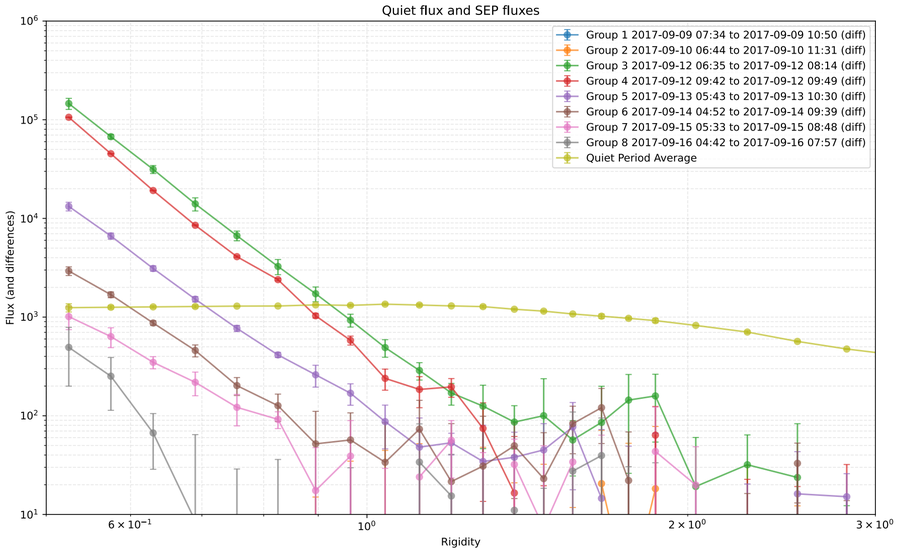


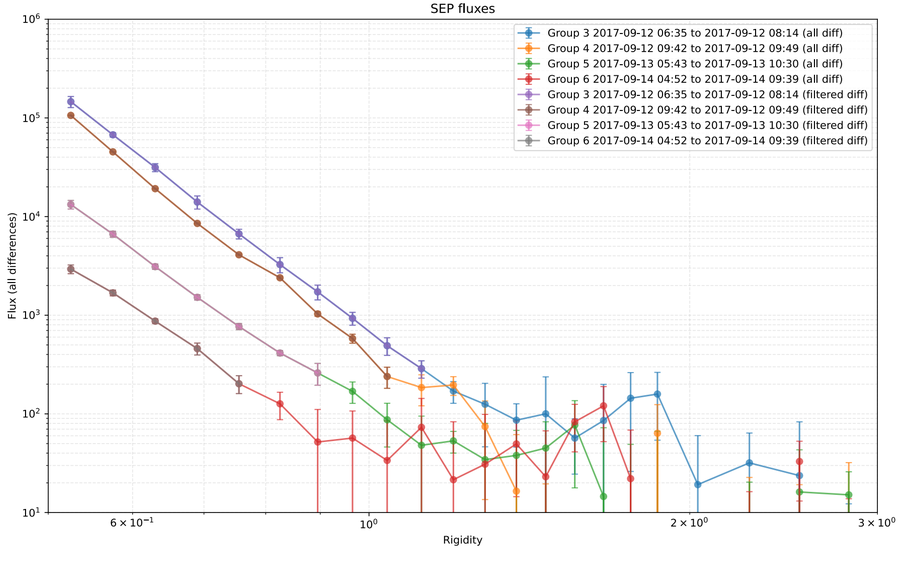


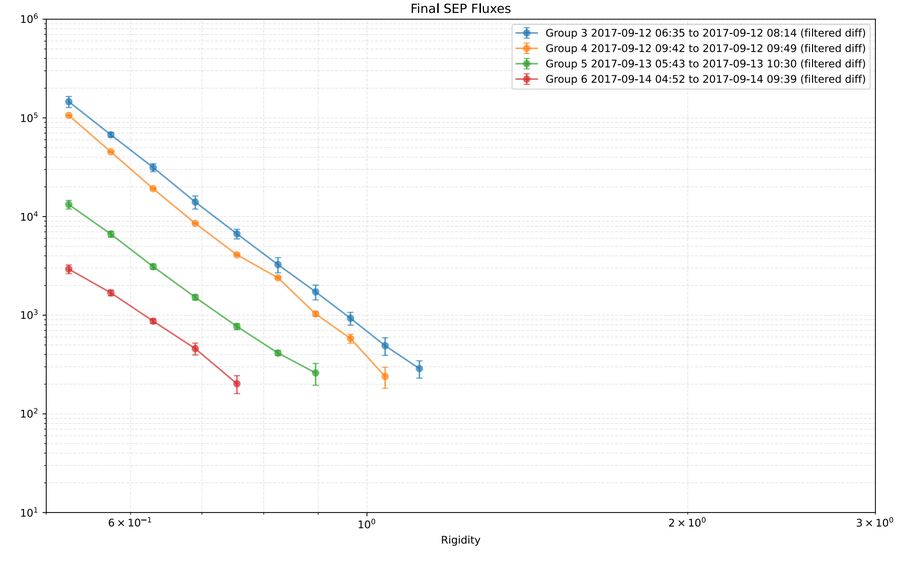


Rigidity Series for 2017-09-11 (Rigidity < 3)



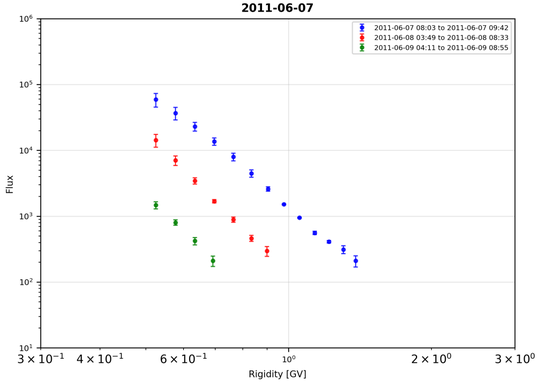




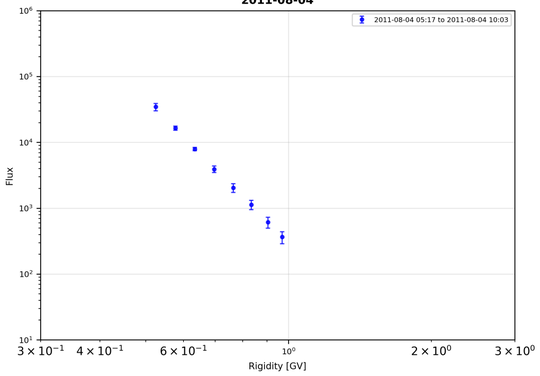


SEP Events Analysis - Group 1
Days 1-9 of 51

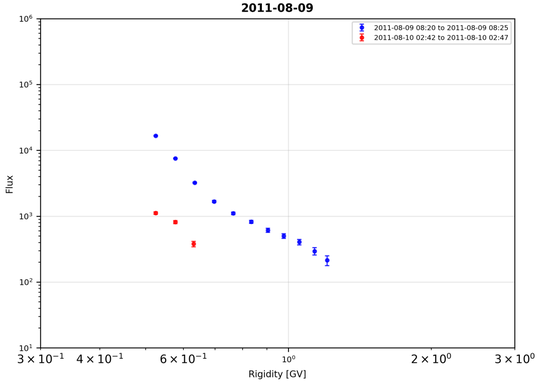
2011-06-07



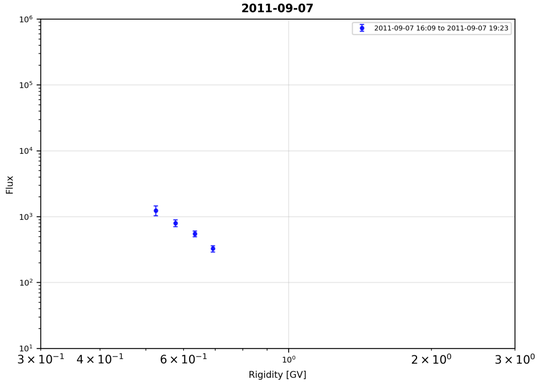
2011-08-04



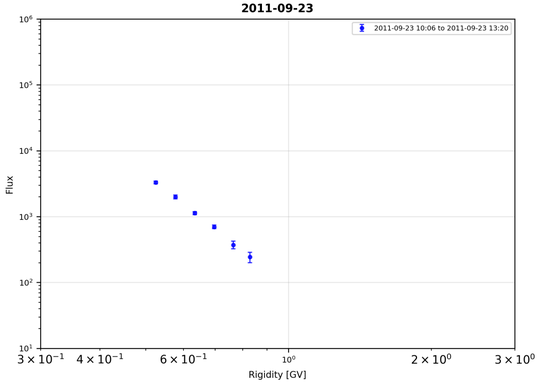
2011-08-09



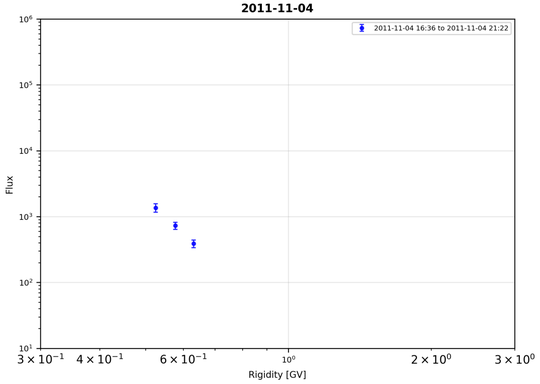
2011-09-07



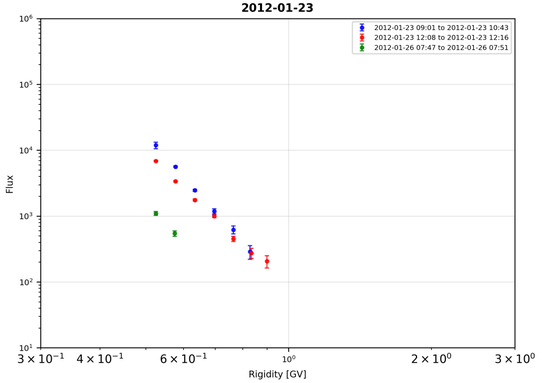
2011-09-23



2011-11-04



2012-01-23



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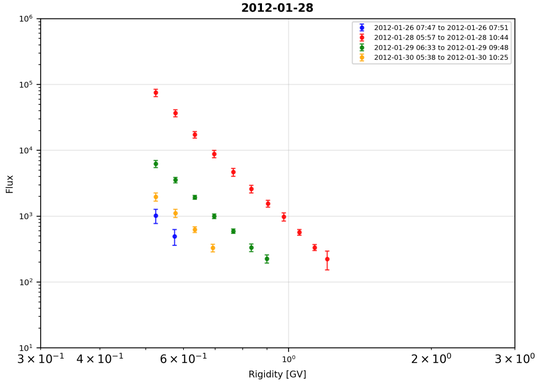

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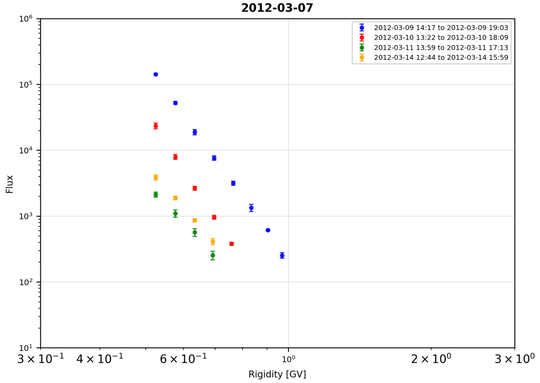
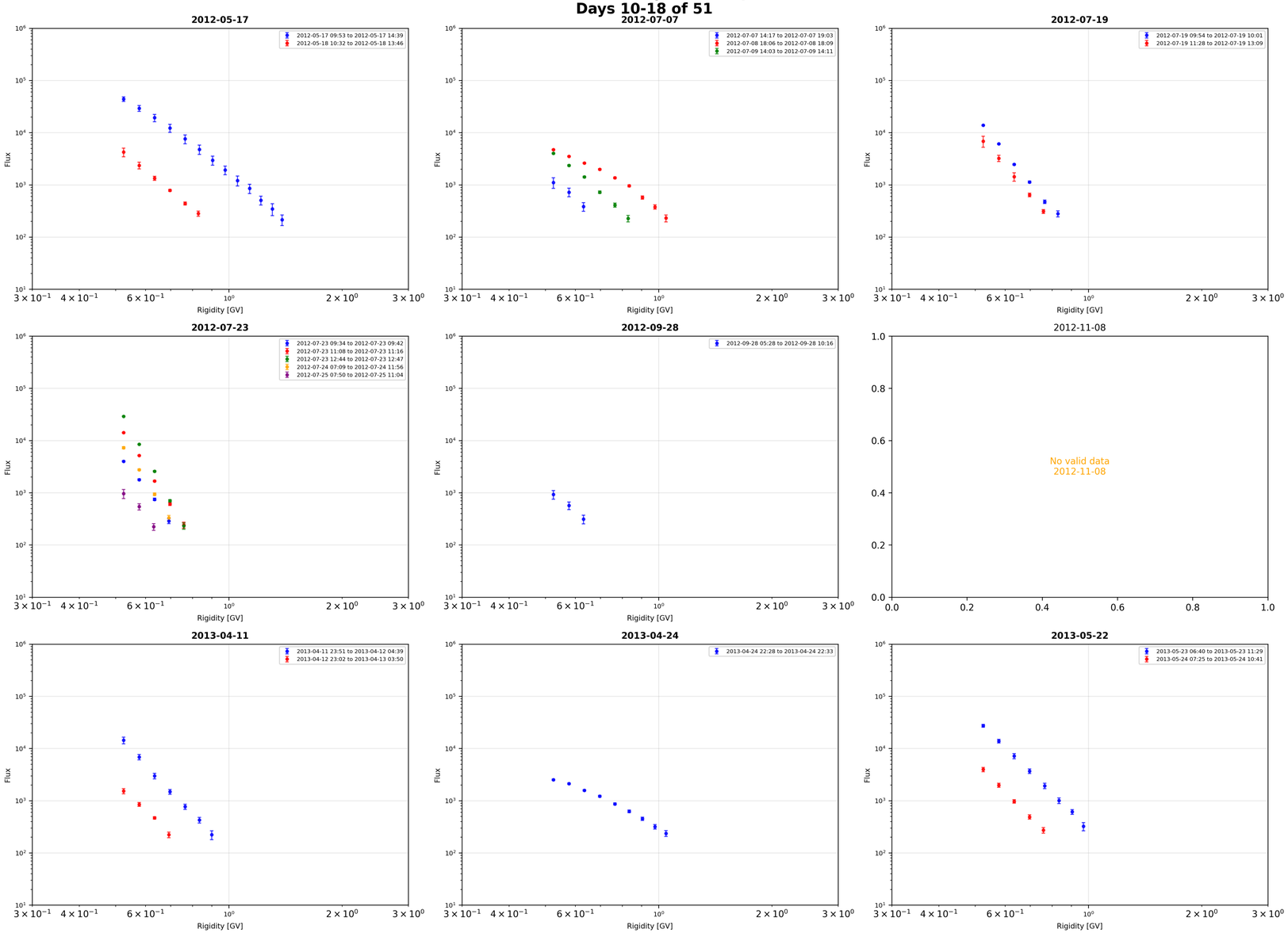
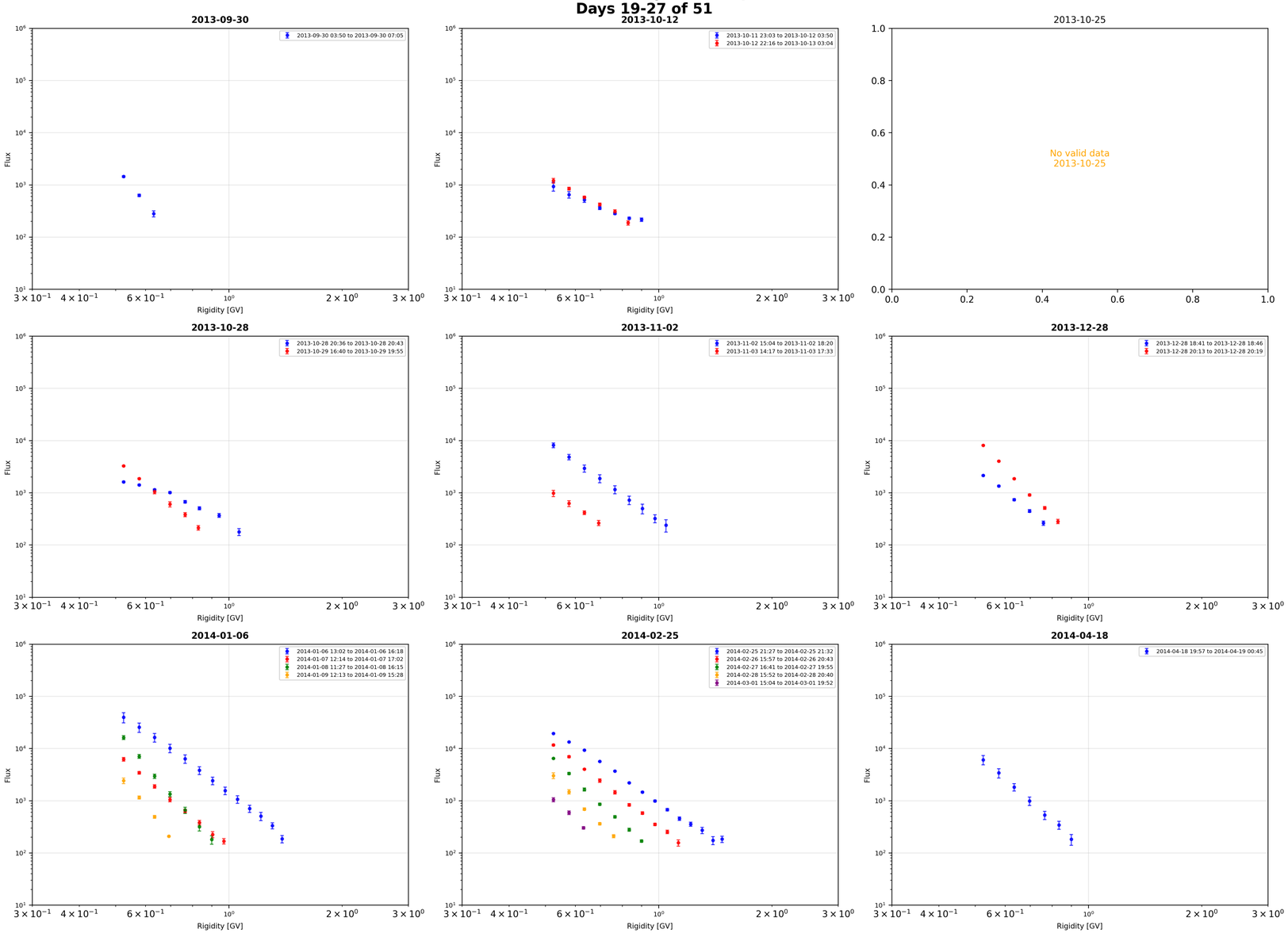


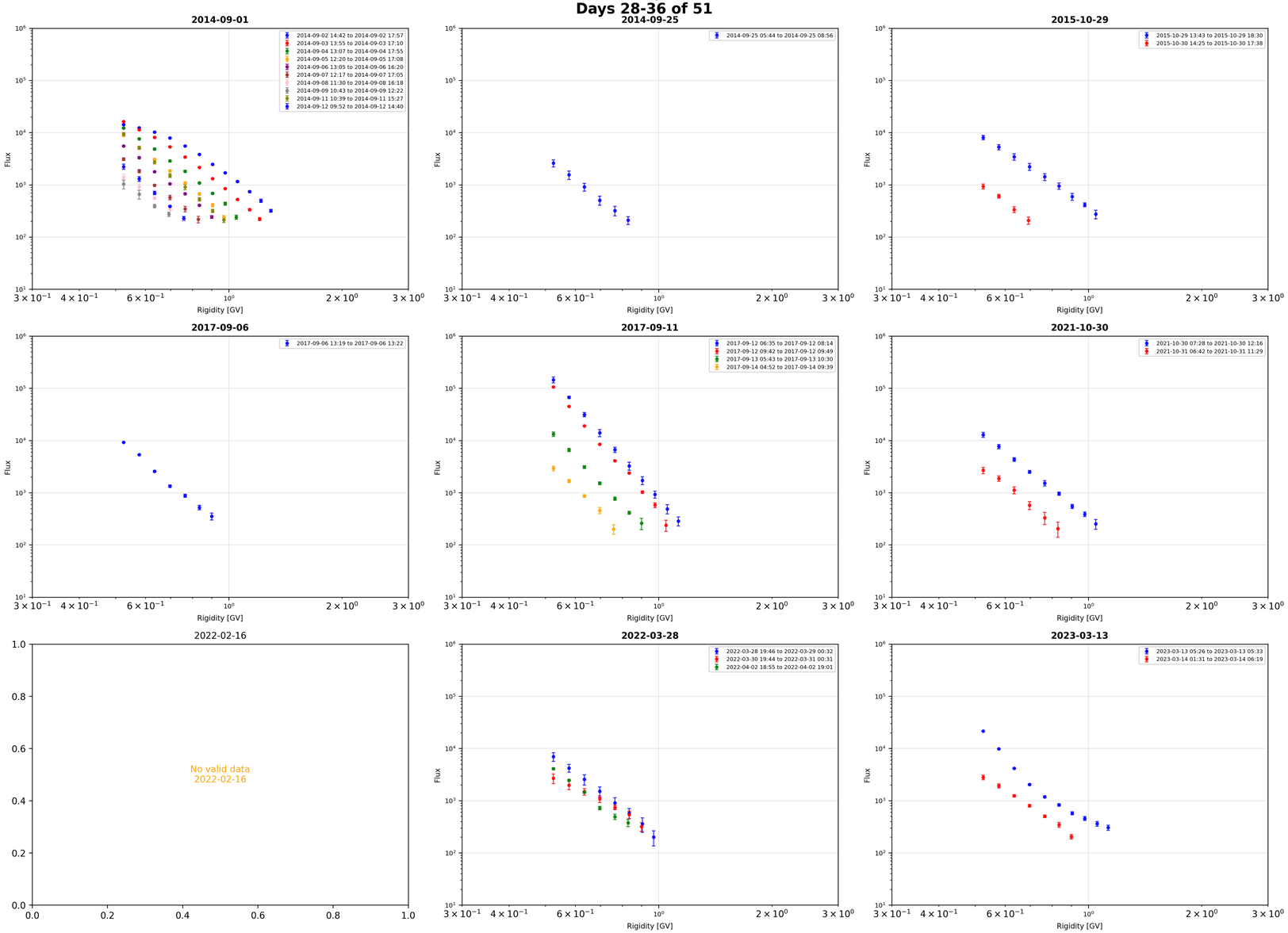
SEP Events Analysis - Group 2
Days 10-18 of 51



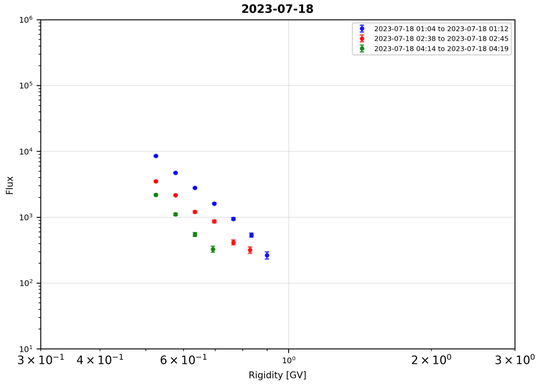
SEP Events Analysis - Group 3
Days 19-27 of 51

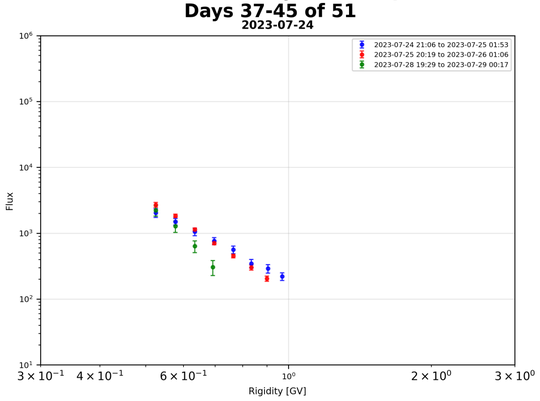


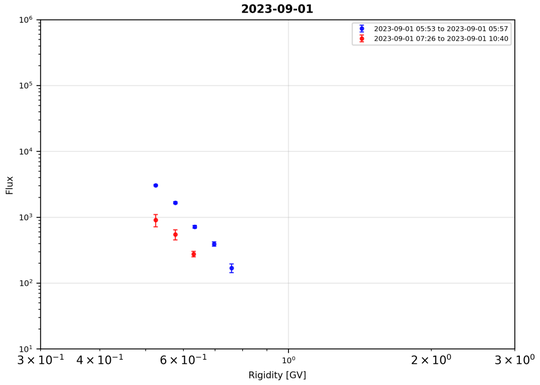
SEP Events Analysis - Group 4
Days 28-36 of 51

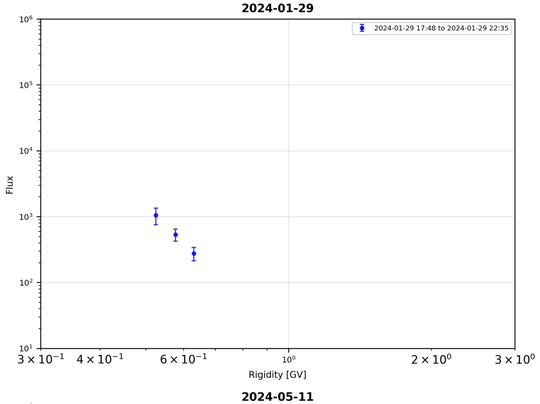


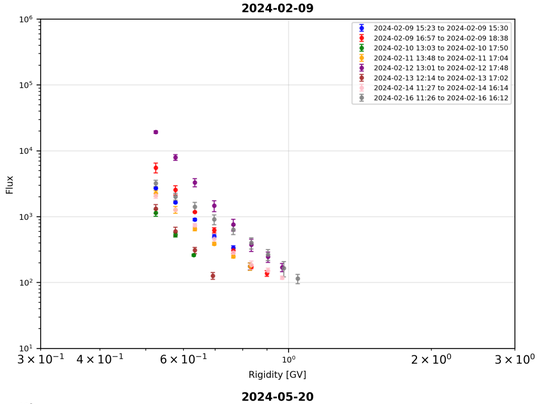
SEP Events Analysis - Group 5
Days 37-45 of 51

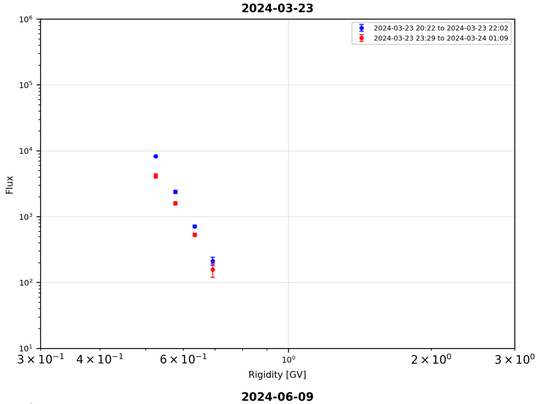


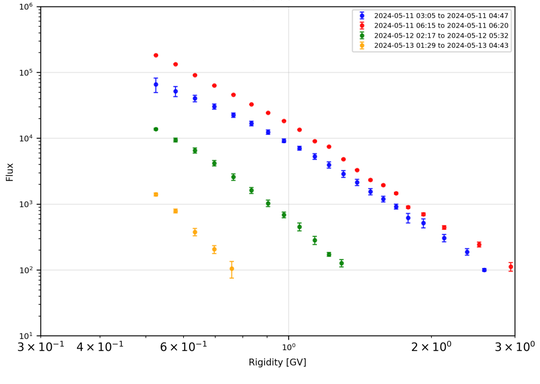


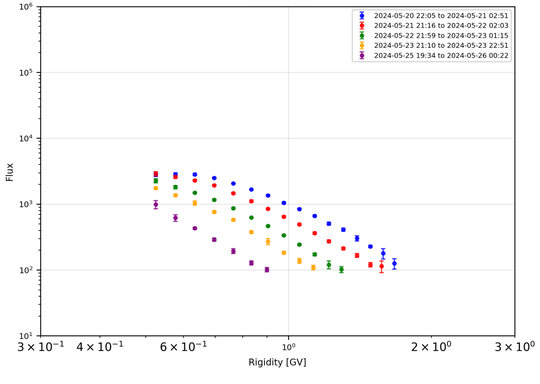


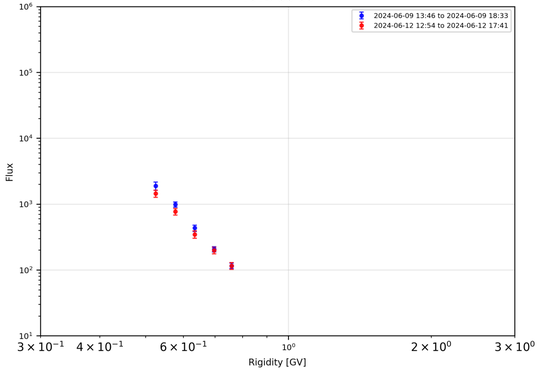




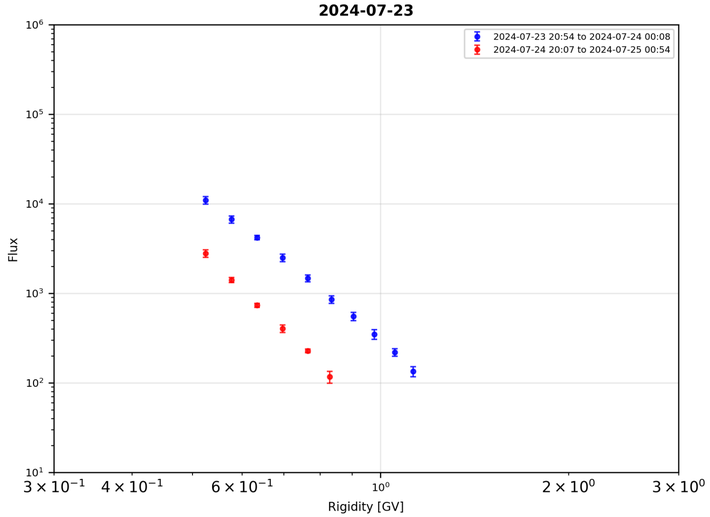


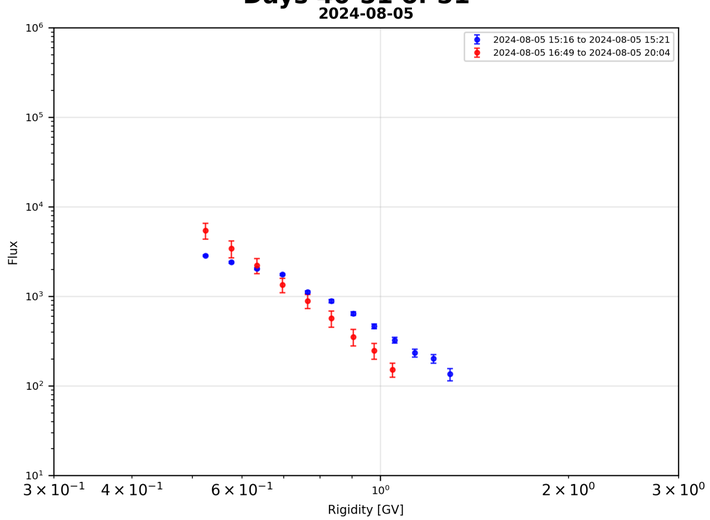


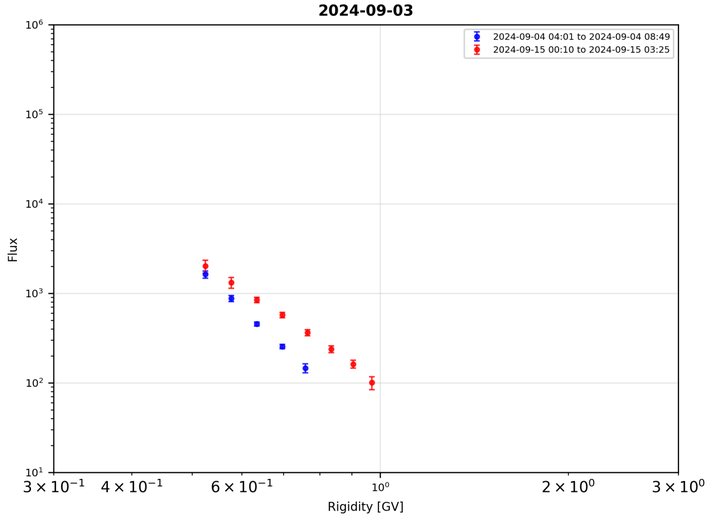


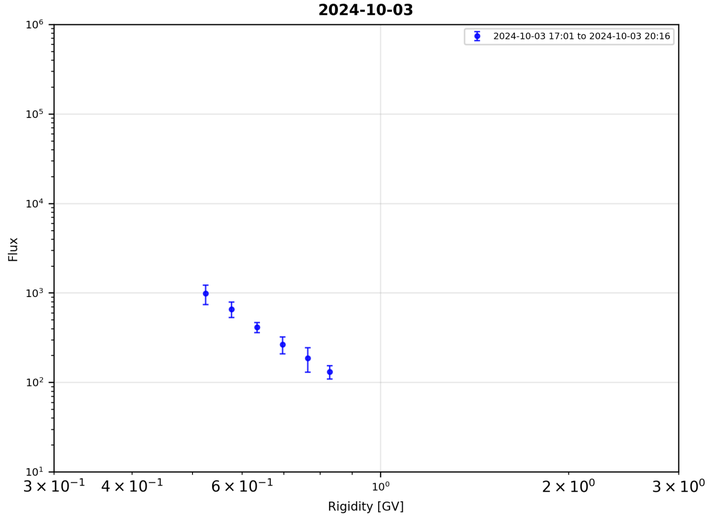


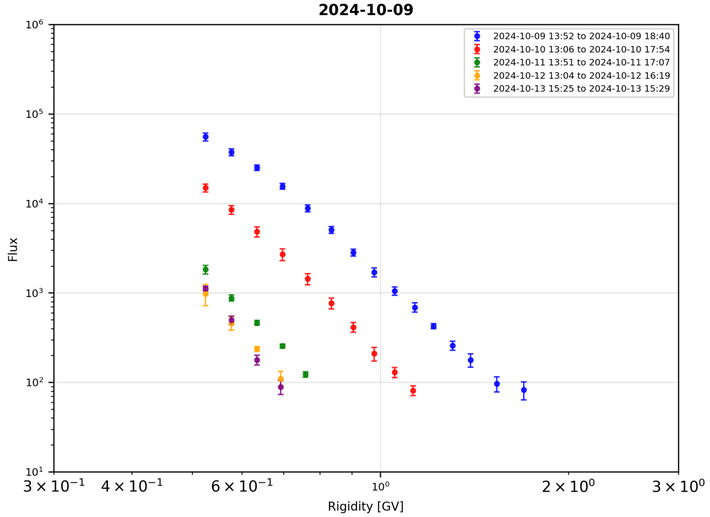
SEP Events Analysis - Group 6
Days 46-51 of 51

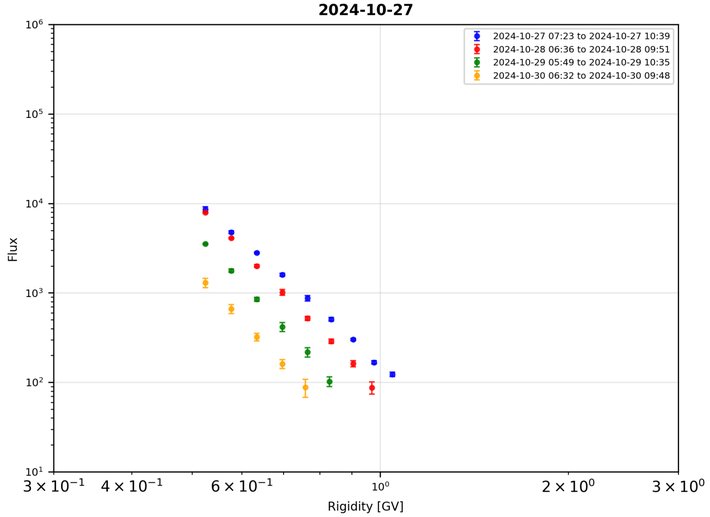




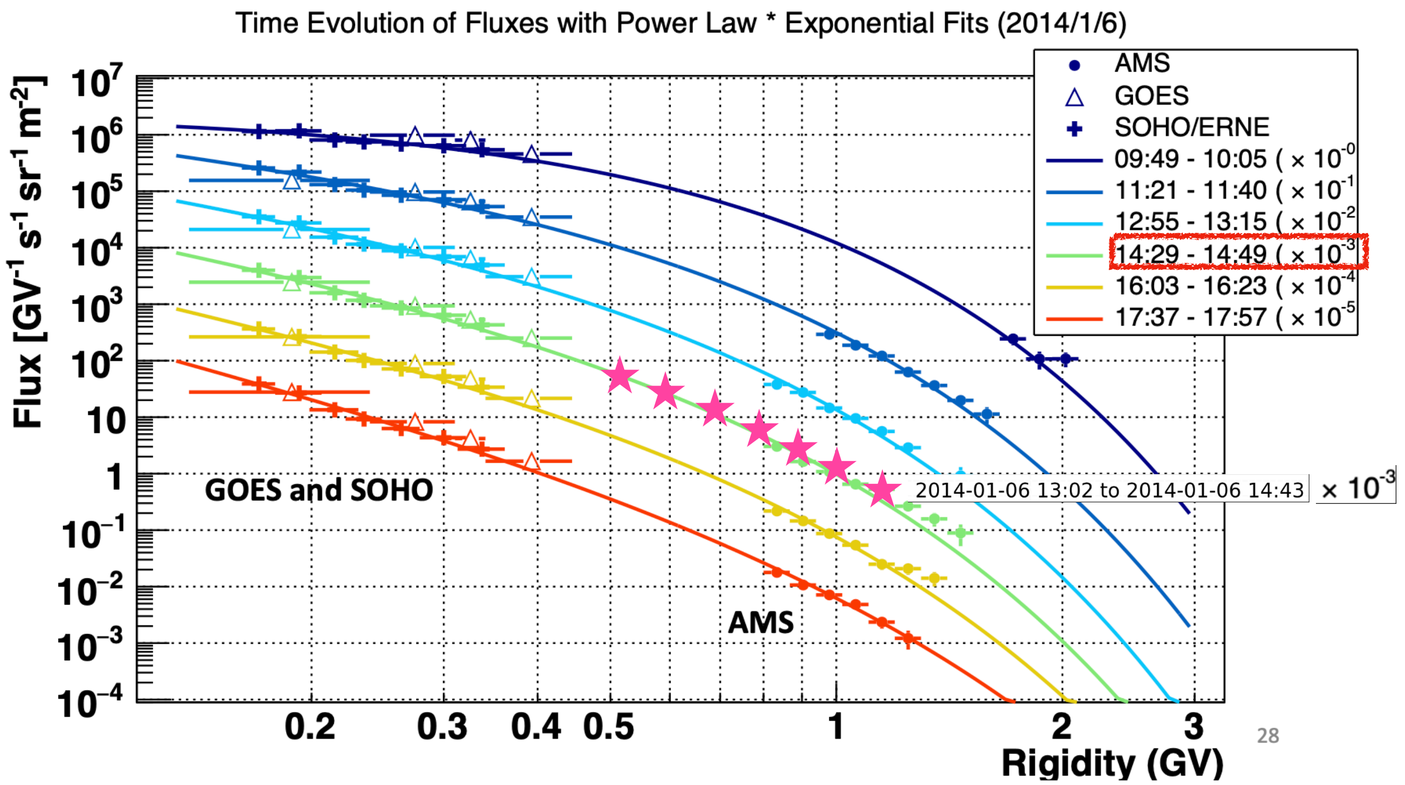






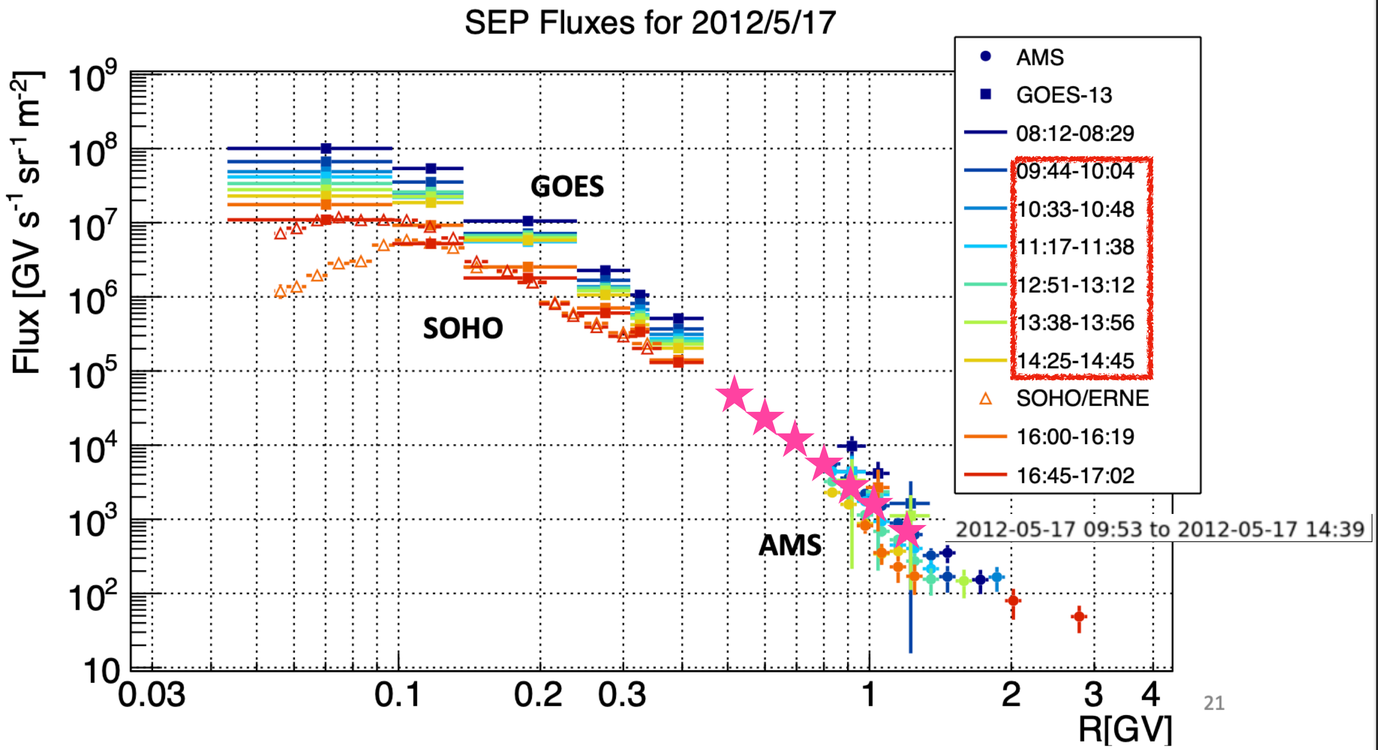


Time Evolution of Spectra – Power Law * Exponential
January 6, 2014



28

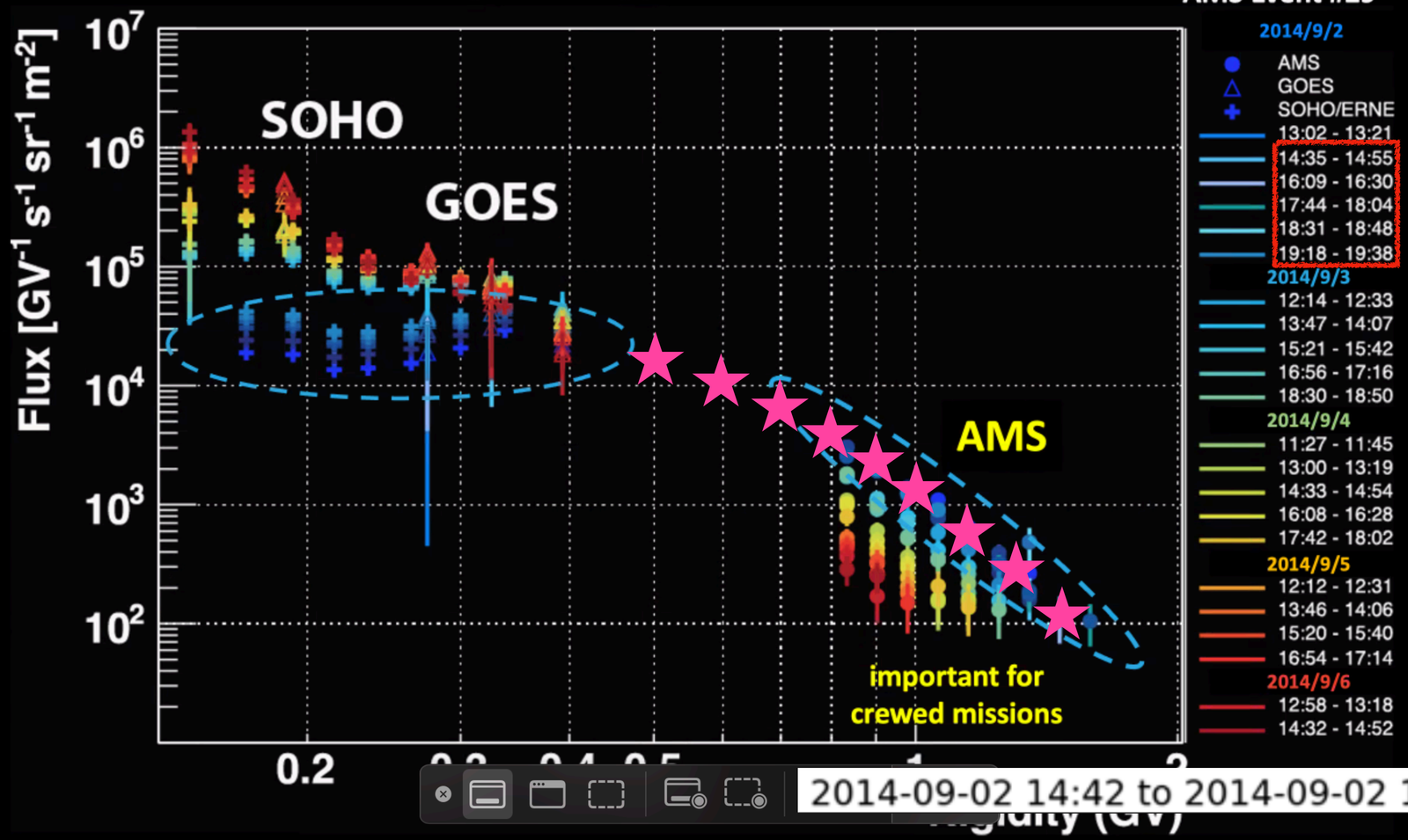
SOHO,GOES and AMS Background Subtracted SEP Proton Fluxes



21

Talking: Samuel Ting

SEP time evolution over 5 days in two different rigidity ranges: Low-energy measurements by SOHO and GOES are not connected with the high-energy measurements from AMS



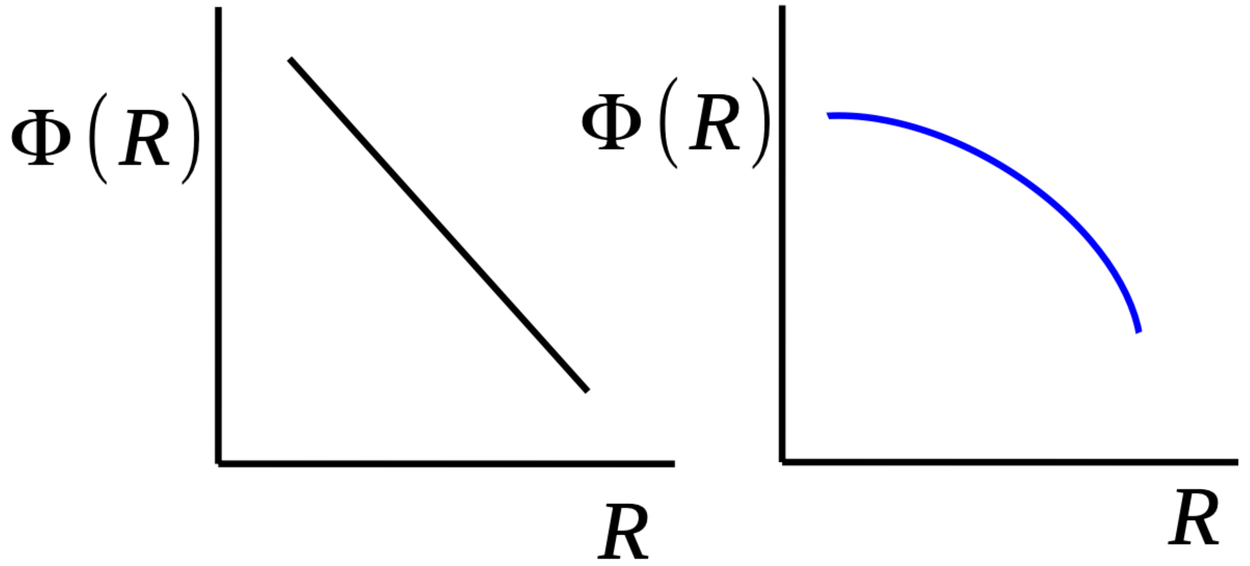
SEP Spectral Shape Analysis

Modified power law with exponential variation in log.10 of rigidity

$$\Phi(R) = A\left(\frac{R}{R_0}\right)^{-[\gamma+\delta\log(R/R_0)]}$$

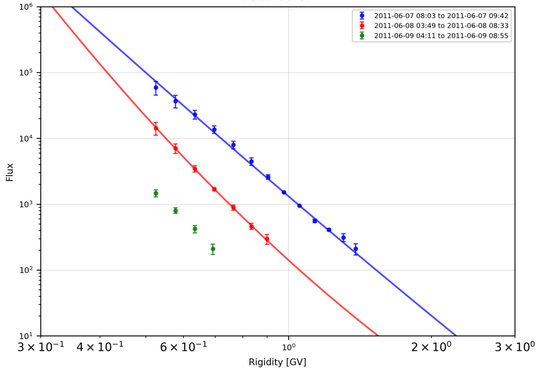
$R_0 = 0.5[GV]$

$\delta \simeq 0$ **Single power law** $\delta > 0$ **Rolling behavior**

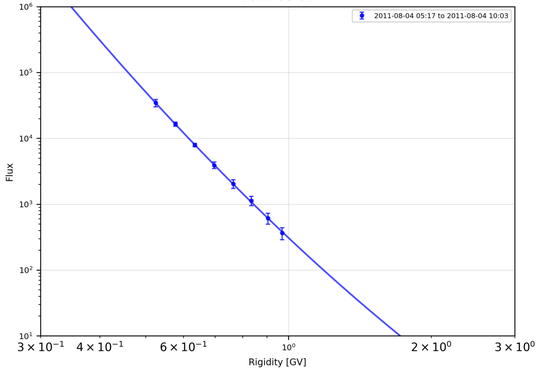


SEP Events Analysis - Group 1
Days 1-9 of 51

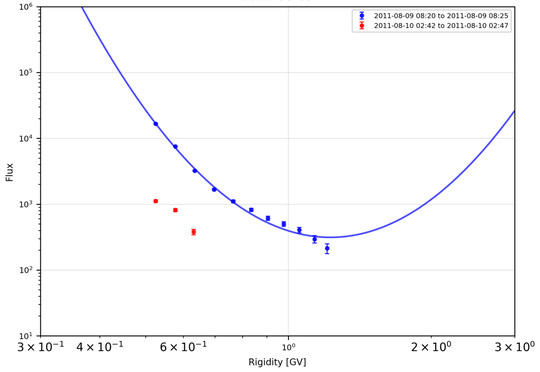
2011-06-07



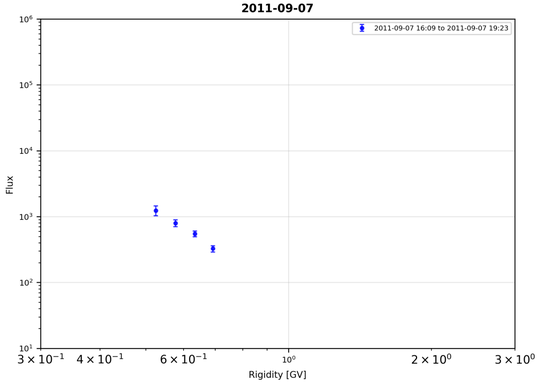
2011-08-04



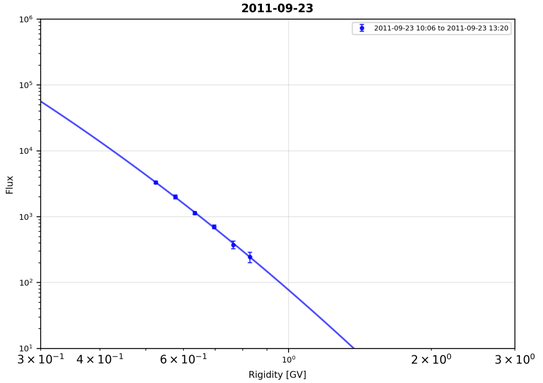
2011-08-09



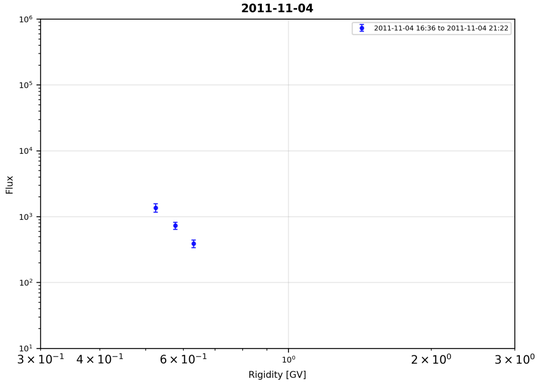
2011-09-07



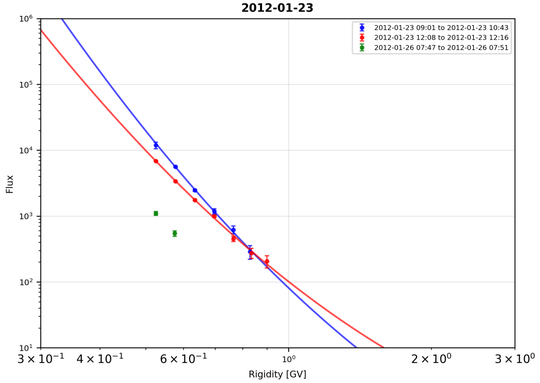
2011-09-23



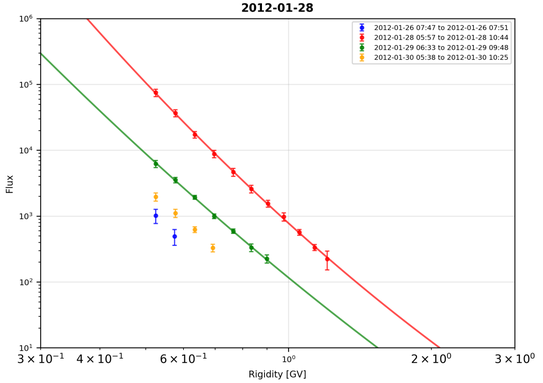
2011-11-04



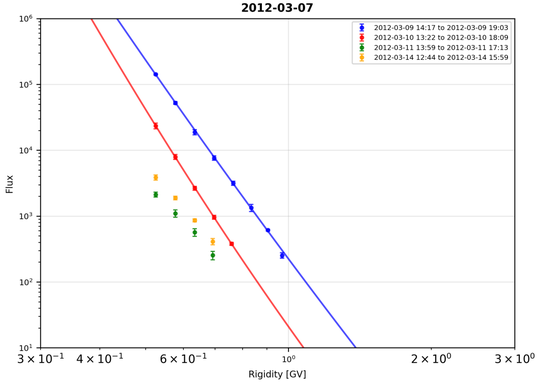
2012-01-23

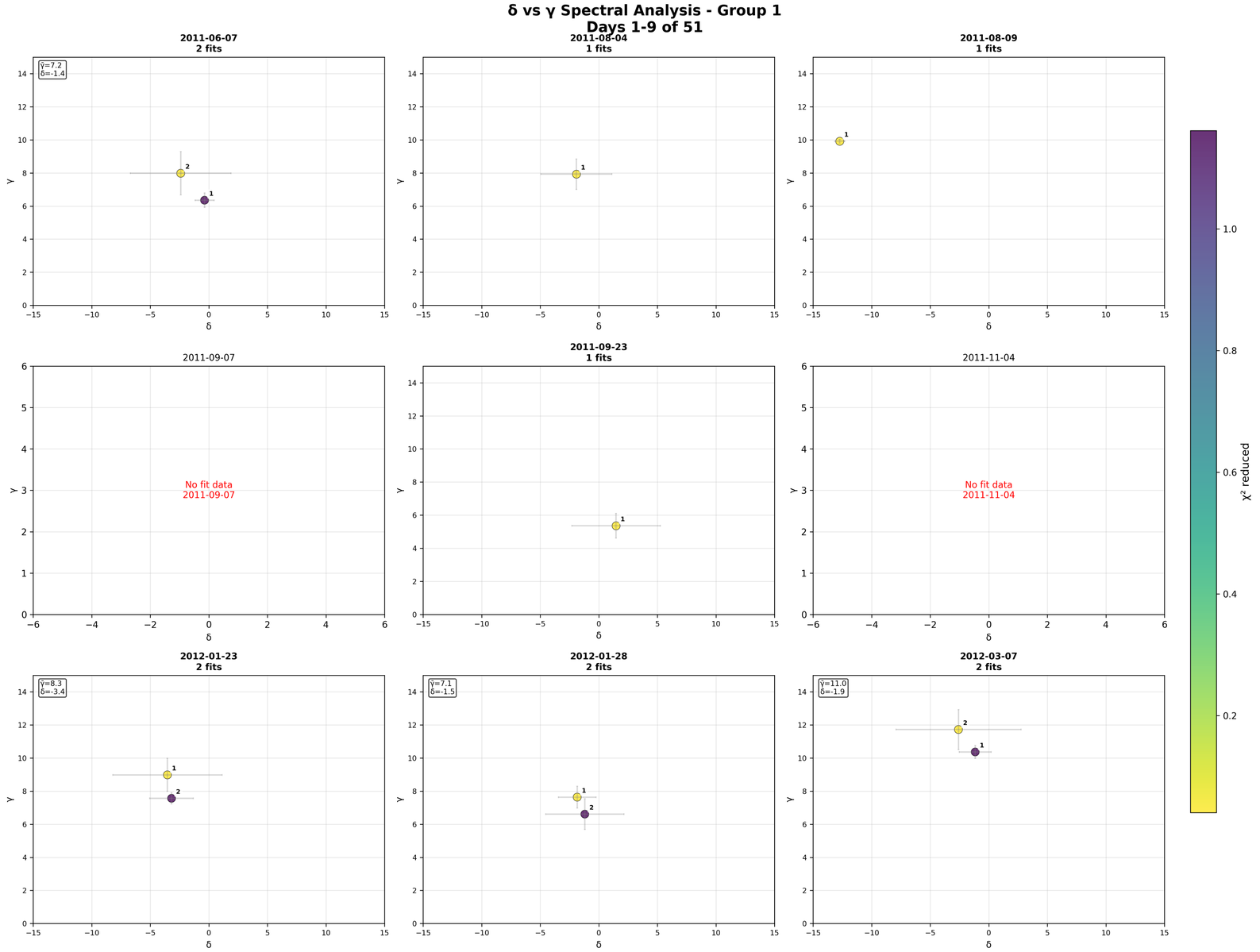


2012-01-28

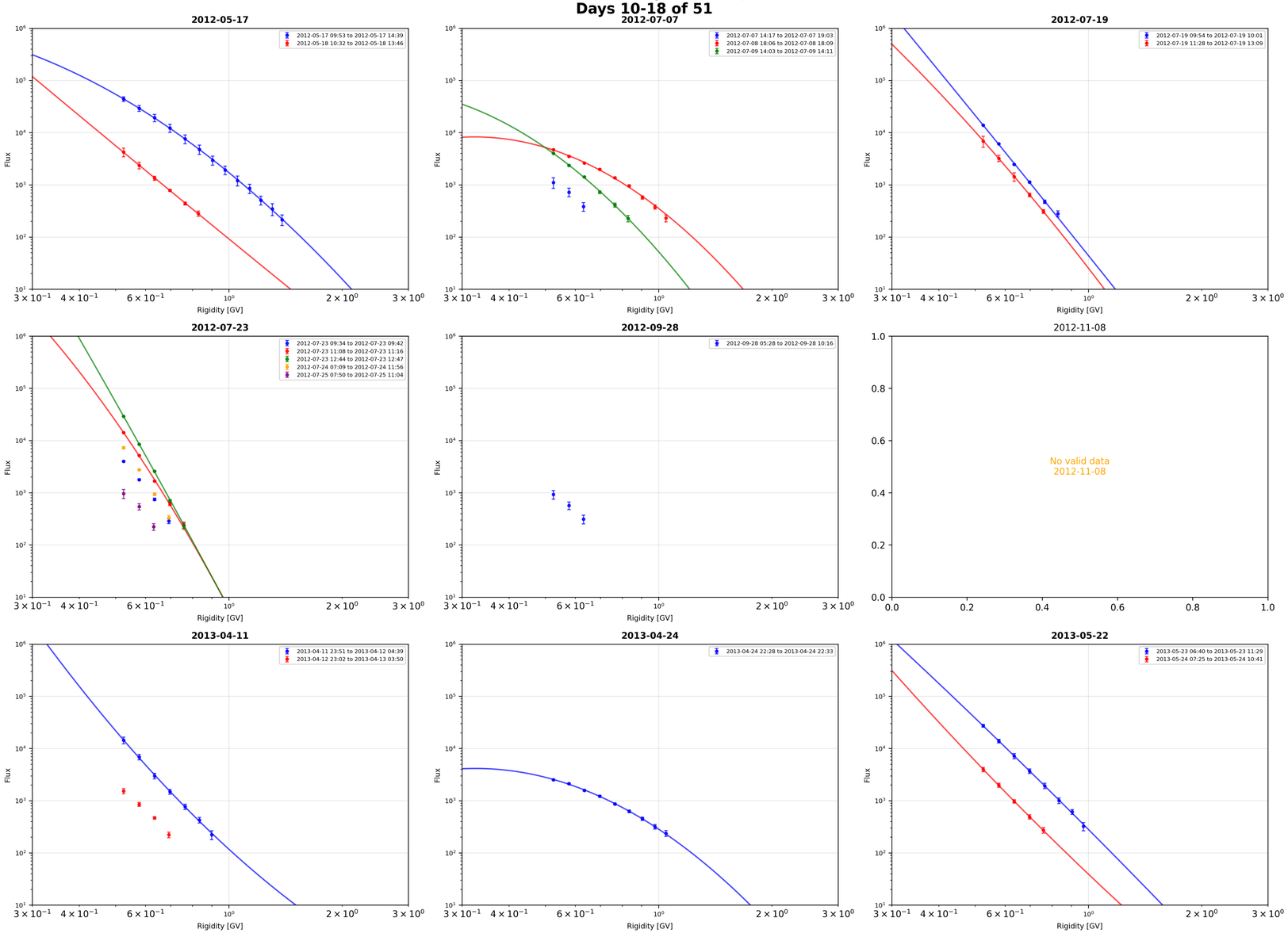


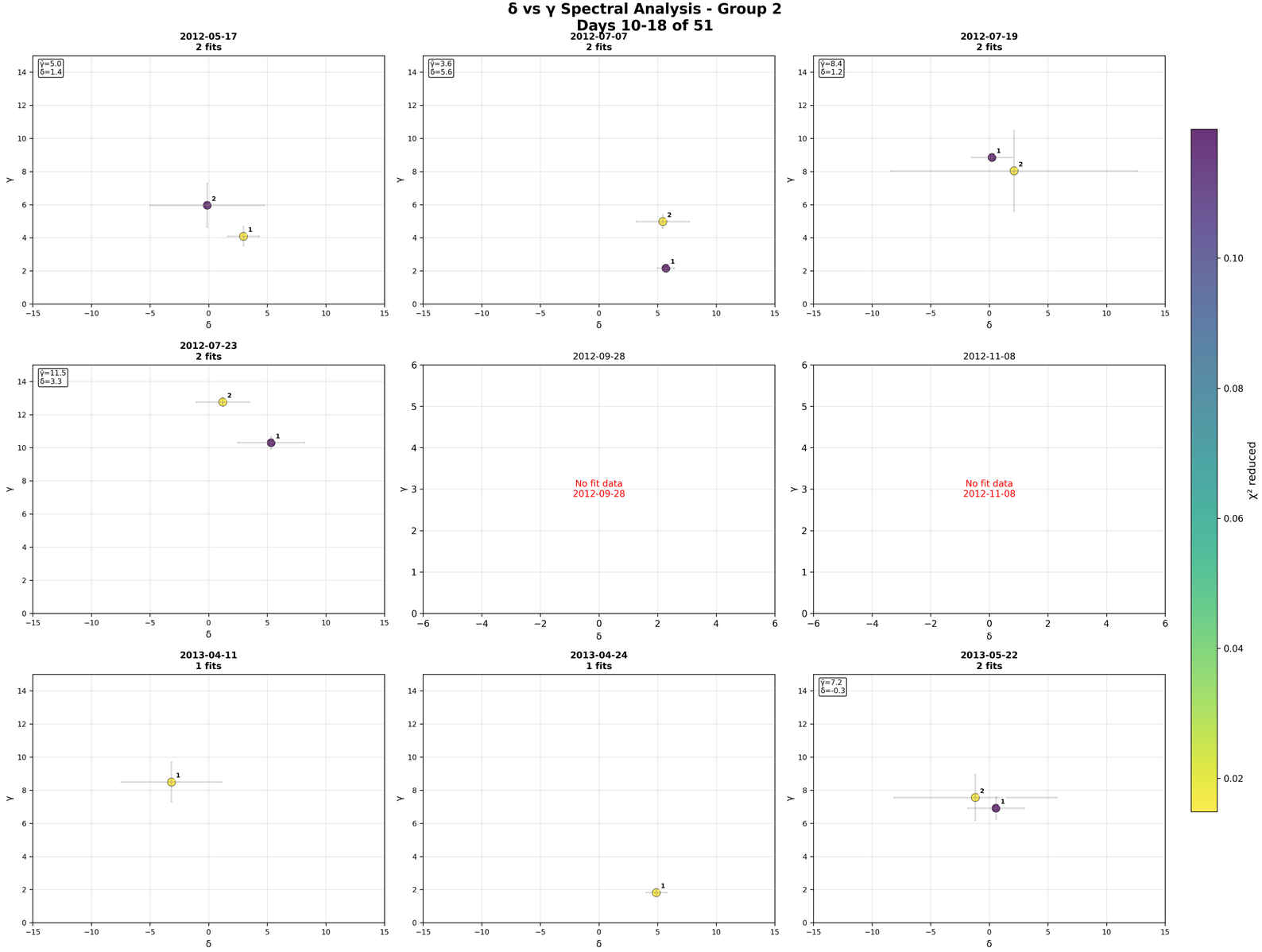
2012-03-07



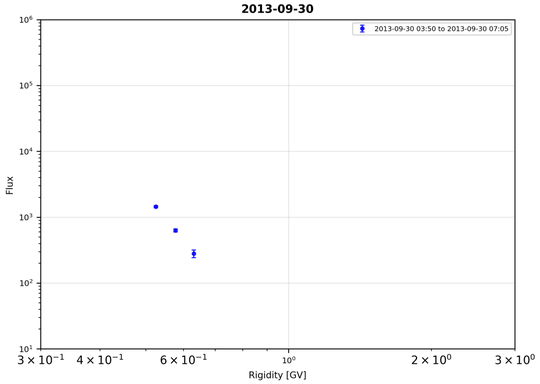

δ vs γ Spectral Analysis - Group 1
Days 1-9 of 51
2011-06-07
2 fits
γ̄=7.2
δ̄=-1.4
2011-08-04
1 fits
2011-08-09
1 fits
2011-09-07
No fit data
2011-09-07
2011-09-23
1 fits
2011-11-04
No fit data
2011-11-04
2012-01-23
2 fits
γ̄=8.3
δ̄=-3.4
2012-01-28
2 fits
γ̄=7.1
δ̄=-1.5
2012-03-07
2 fits
γ̄=11.0
δ̄=-1.9
γ
δ
χ² reduced

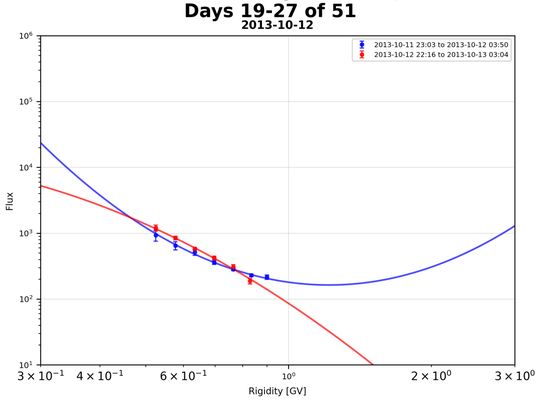
SEP Events Analysis - Group 2
Days 10-18 of 51

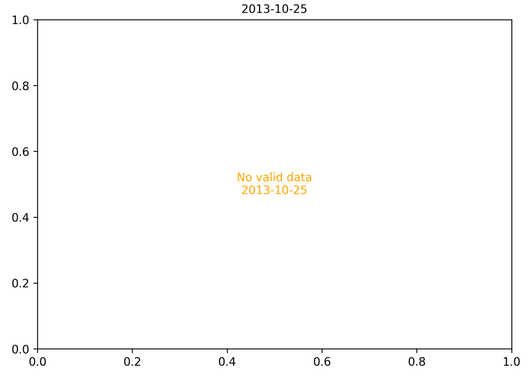


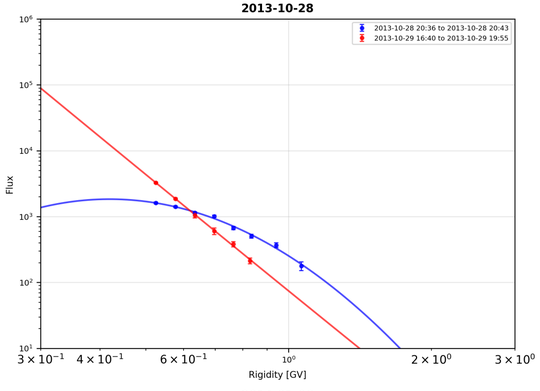

δ vs γ Spectral Analysis - Group 2
Days 10-18 of 51
2012-05-17
2 fits
γ̄=5.0
δ̄=1.4
2012-07-07
2 fits
γ̄=3.6
δ̄=5.6
2012-07-19
2 fits
γ̄=8.4
δ̄=1.2
2012-07-23
2 fits
γ̄=11.5
δ̄=3.3
2012-09-28
No fit data
2012-09-28
2012-11-08
No fit data
2012-11-08
2013-04-11
1 fits
2013-04-24
1 fits
2013-05-22
2 fits
γ̄=7.2
δ̄=-0.3
γ
δ
χ² reduced

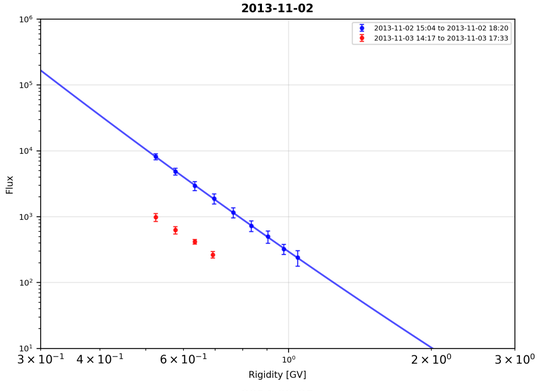
SEP Events Analysis - Group 3
Days 19-27 of 51

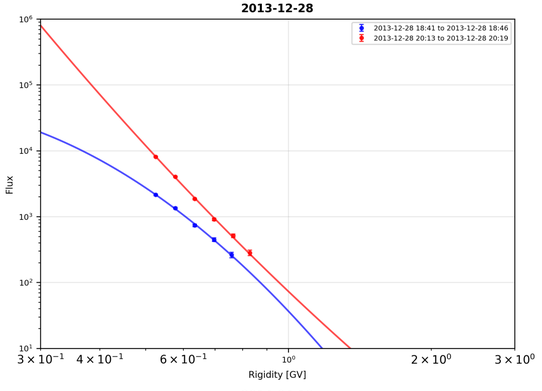


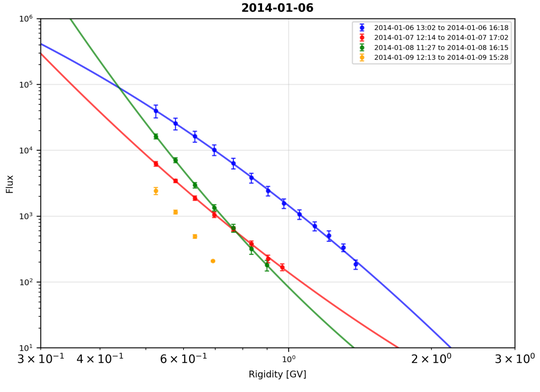


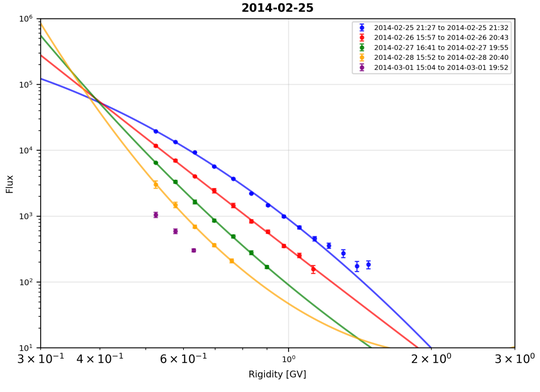


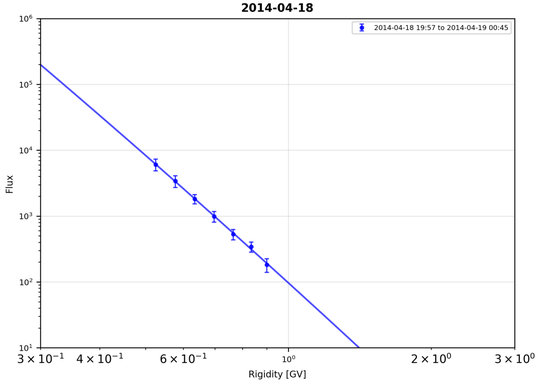


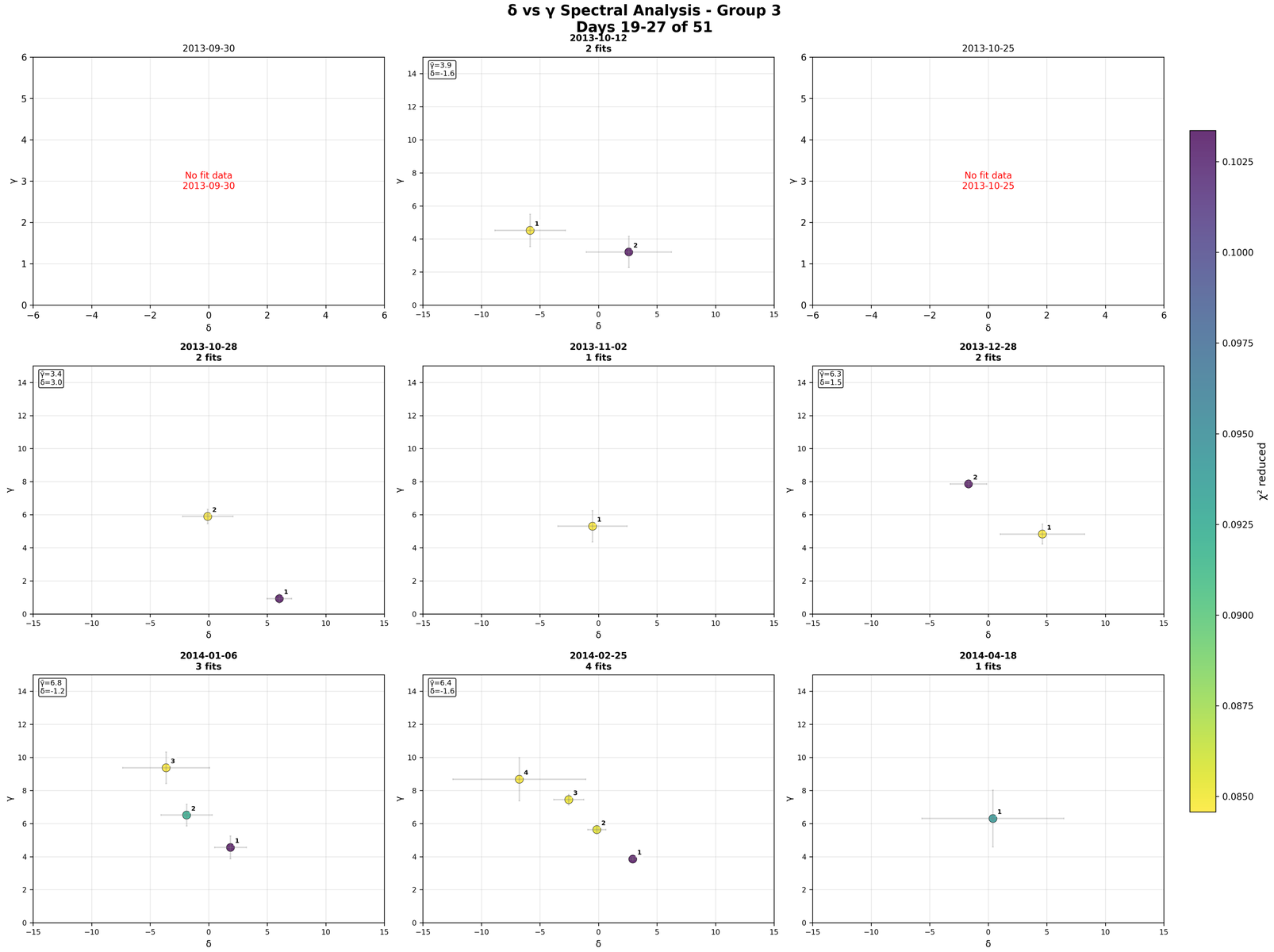




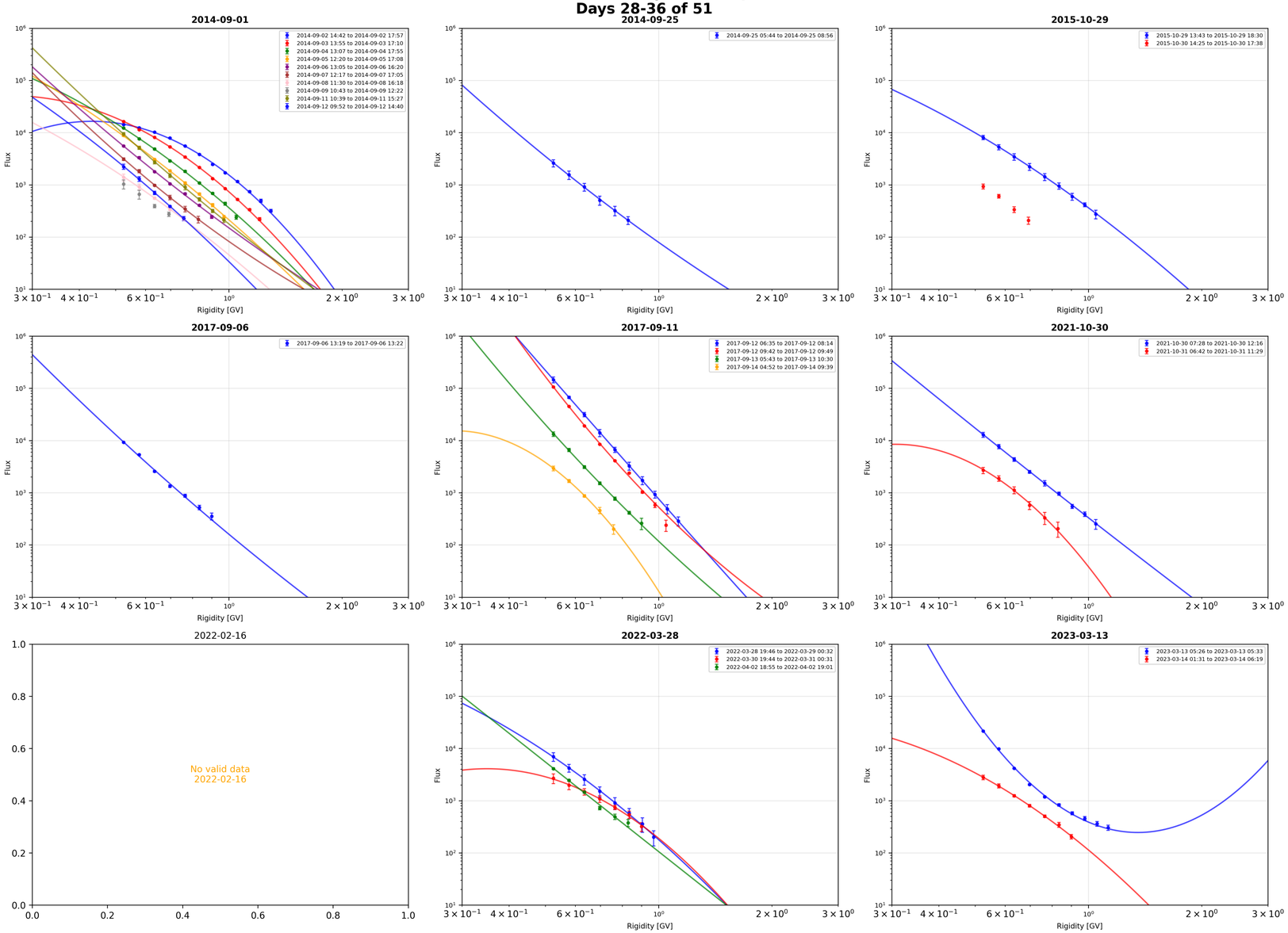


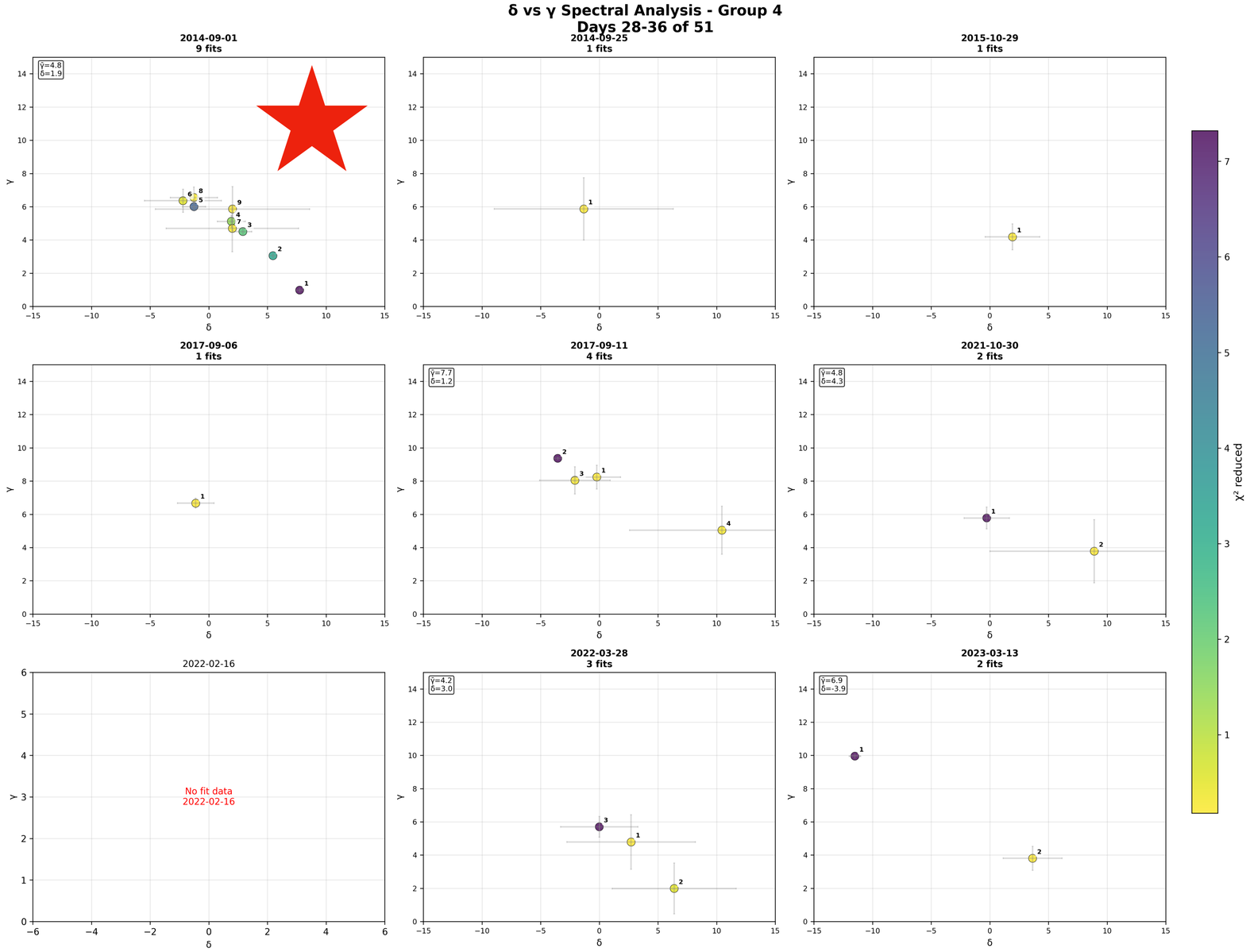




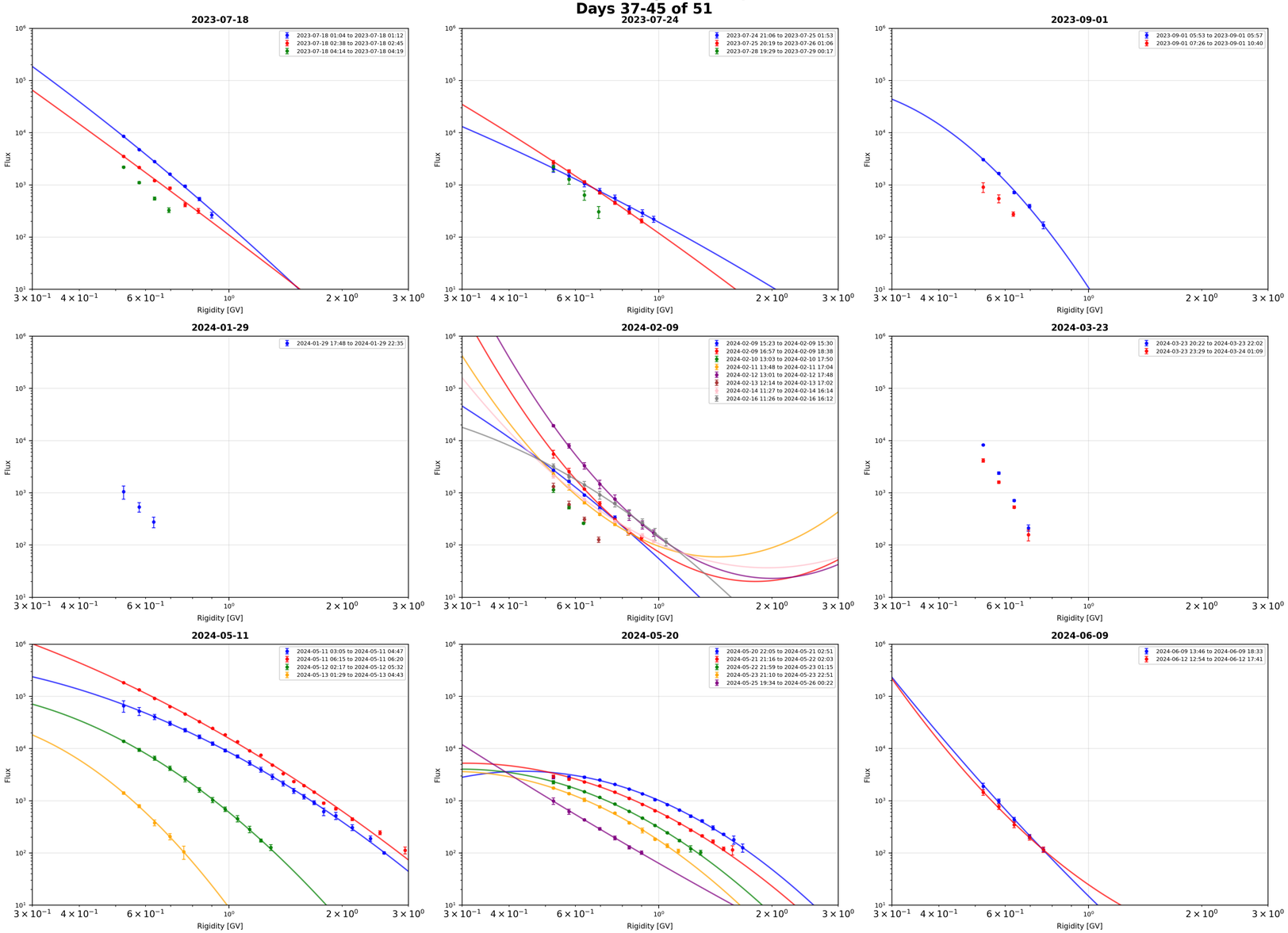

δ vs γ Spectral Analysis - Group 3
Days 19-27 of 51
2013-09-30
No fit data
2013-09-30
2013-10-12
2 fits
γ̄=3.9
δ̄=-1.6
2013-10-25
No fit data
2013-10-25
2013-10-28
2 fits
γ̄=3.4
δ̄=3.0
2013-11-02
1 fits
2013-12-28
2 fits
γ̄=6.3
δ̄=1.5
2014-01-06
3 fits
γ̄=6.8
δ̄=-1.2
2014-02-25
4 fits
γ̄=6.4
δ̄=-1.6
2014-04-18
1 fits
γ
δ
χ² reduced

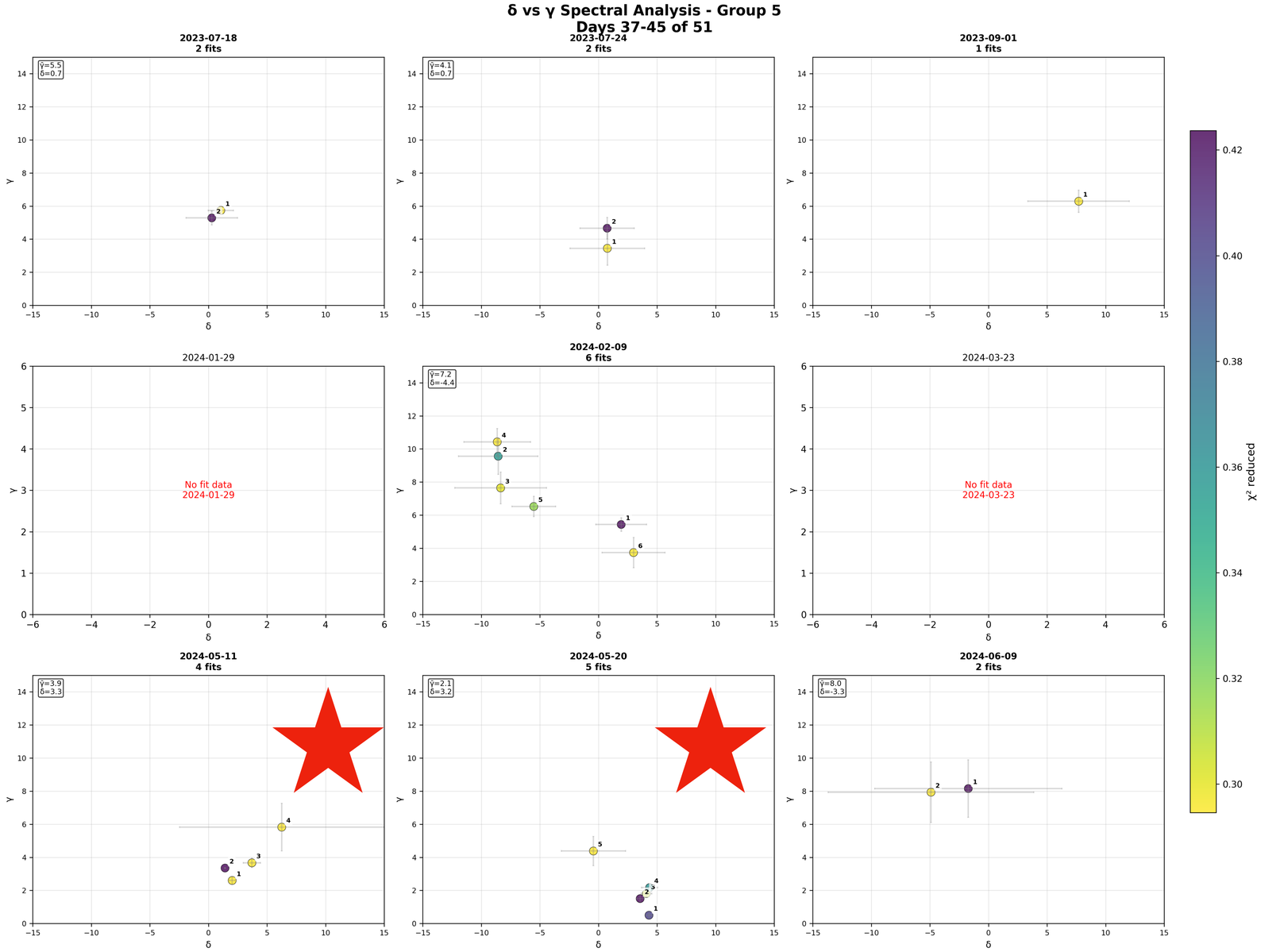
SEP Events Analysis - Group 4
Days 28-36 of 51



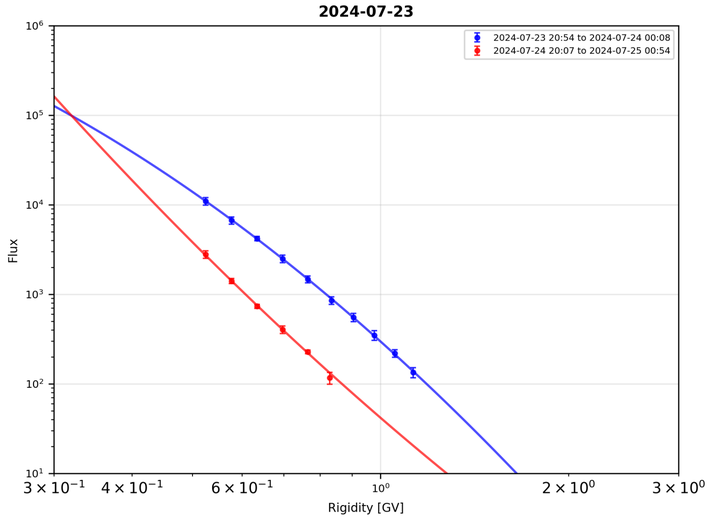

δ vs γ Spectral Analysis - Group 4
Days 28-36 of 51
2014-09-01
9 fits
γ̄=4.8
δ̄=1.9
2014-09-25
1 fits
2015-10-29
1 fits
2017-09-06
1 fits
2017-09-11
4 fits
γ̄=7.7
δ̄=1.2
2021-10-30
2 fits
γ̄=4.8
δ̄=4.3
2022-02-16
No fit data
2022-02-16
2022-03-28
3 fits
γ̄=4.2
δ̄=3.0
2023-03-13
2 fits
γ̄=6.9
δ̄=-3.9
γ
δ
χ² reduced

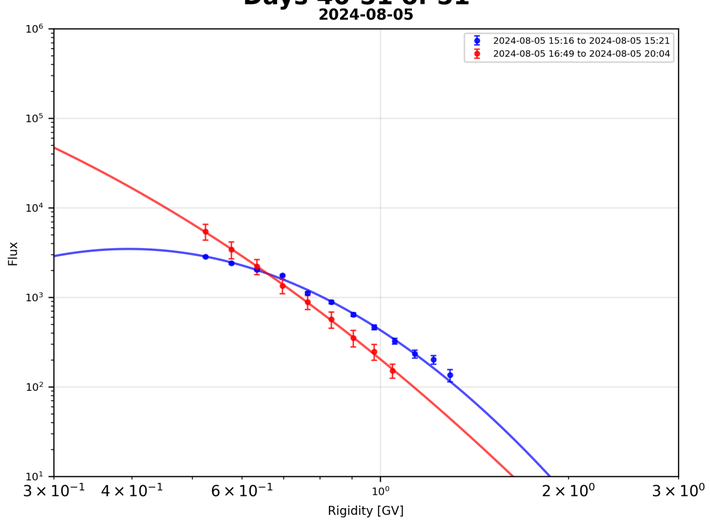
SEP Events Analysis - Group 5
Days 37-45 of 51

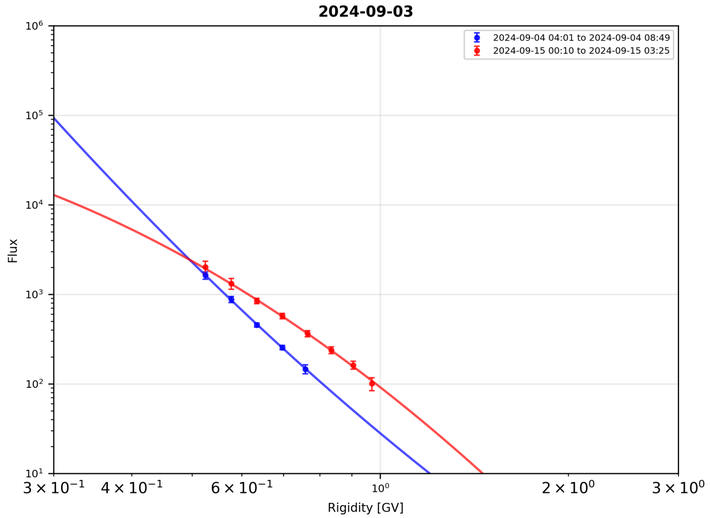


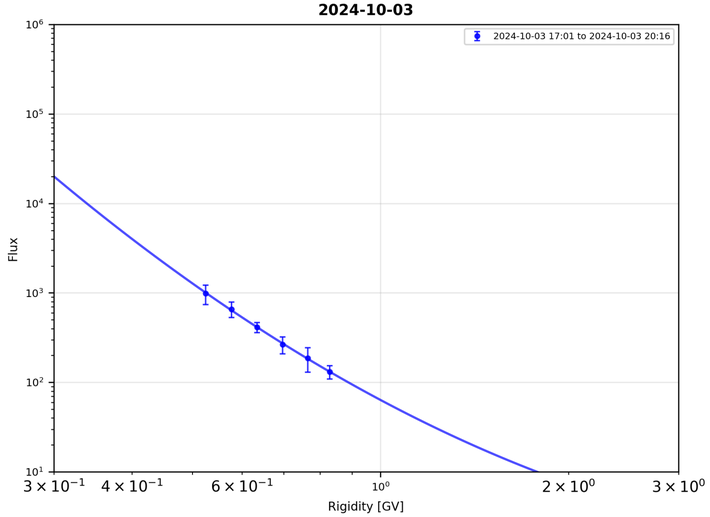

δ vs γ Spectral Analysis - Group 5
Days 37-45 of 51
2023-07-18
2 fits
γ̄=5.5
δ̄=0.7
2023-07-24
2 fits
γ̄=4.1
δ̄=0.7
2023-09-01
1 fits
2024-01-29
No fit data
2024-01-29
2024-02-09
6 fits
γ̄=7.2
δ̄=-4.4
2024-03-23
No fit data
2024-03-23
2024-05-11
4 fits
γ̄=3.9
δ̄=3.3
2024-05-20
5 fits
γ̄=2.1
δ̄=3.2
2024-06-09
2 fits
γ̄=8.0
δ̄=-3.3
γ
δ
χ² reduced

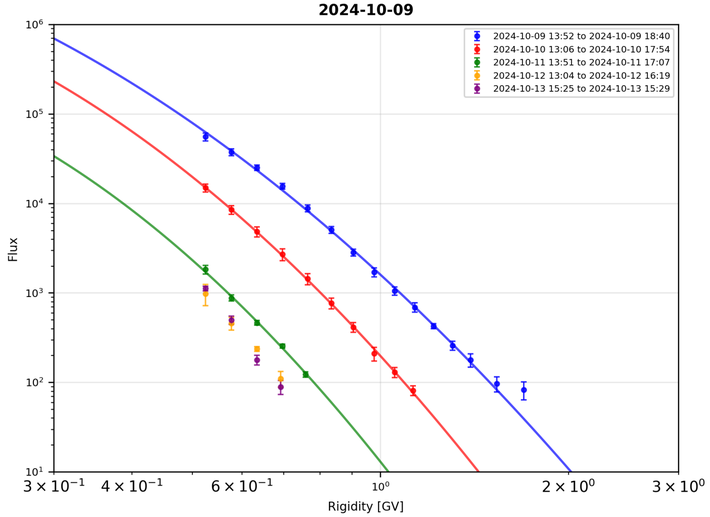
SEP Events Analysis - Group 6
Days 46-51 of 51

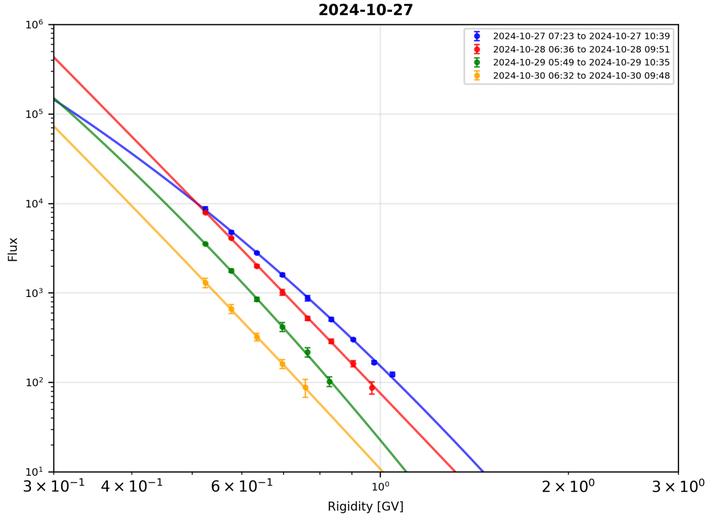


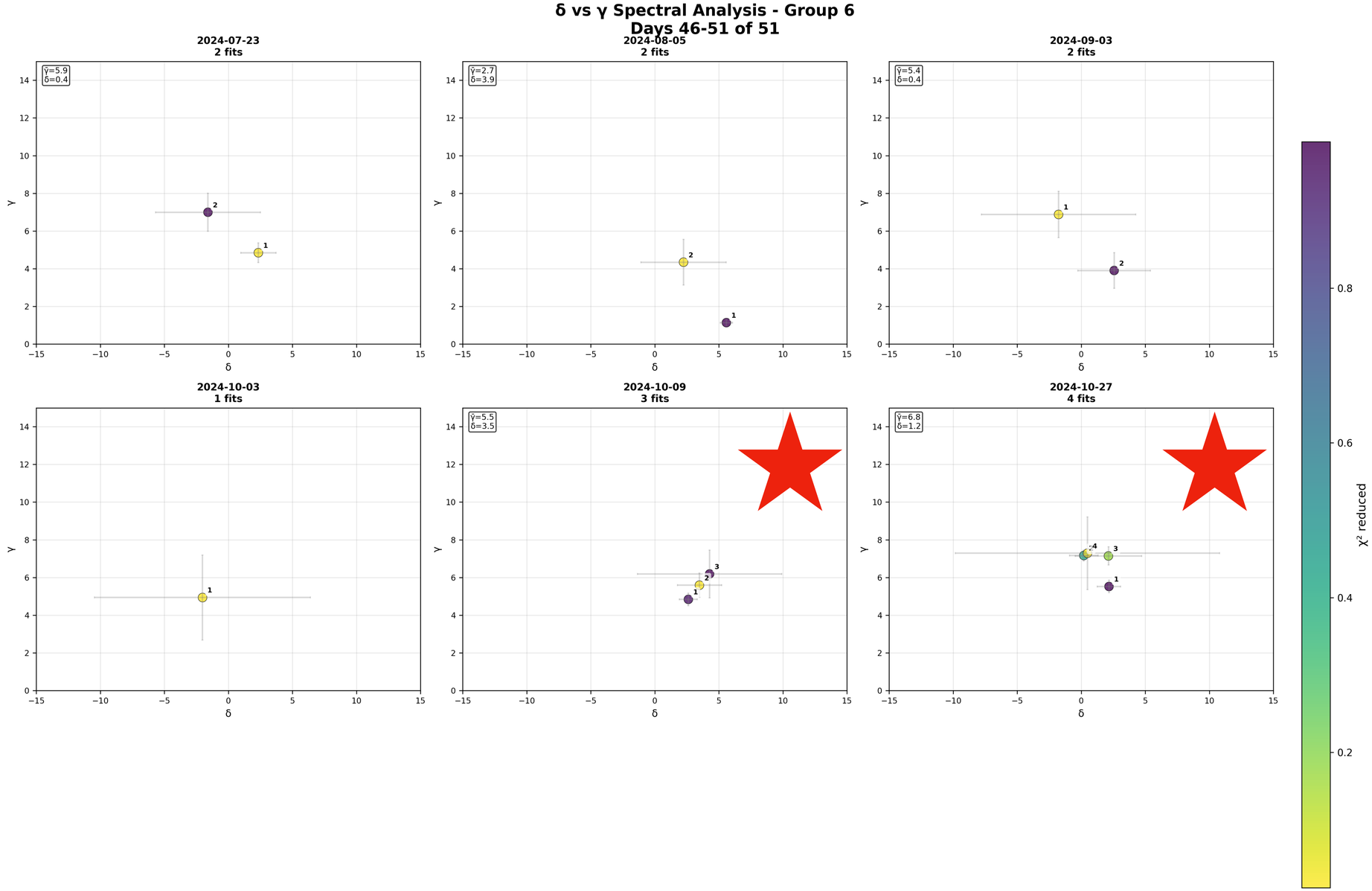


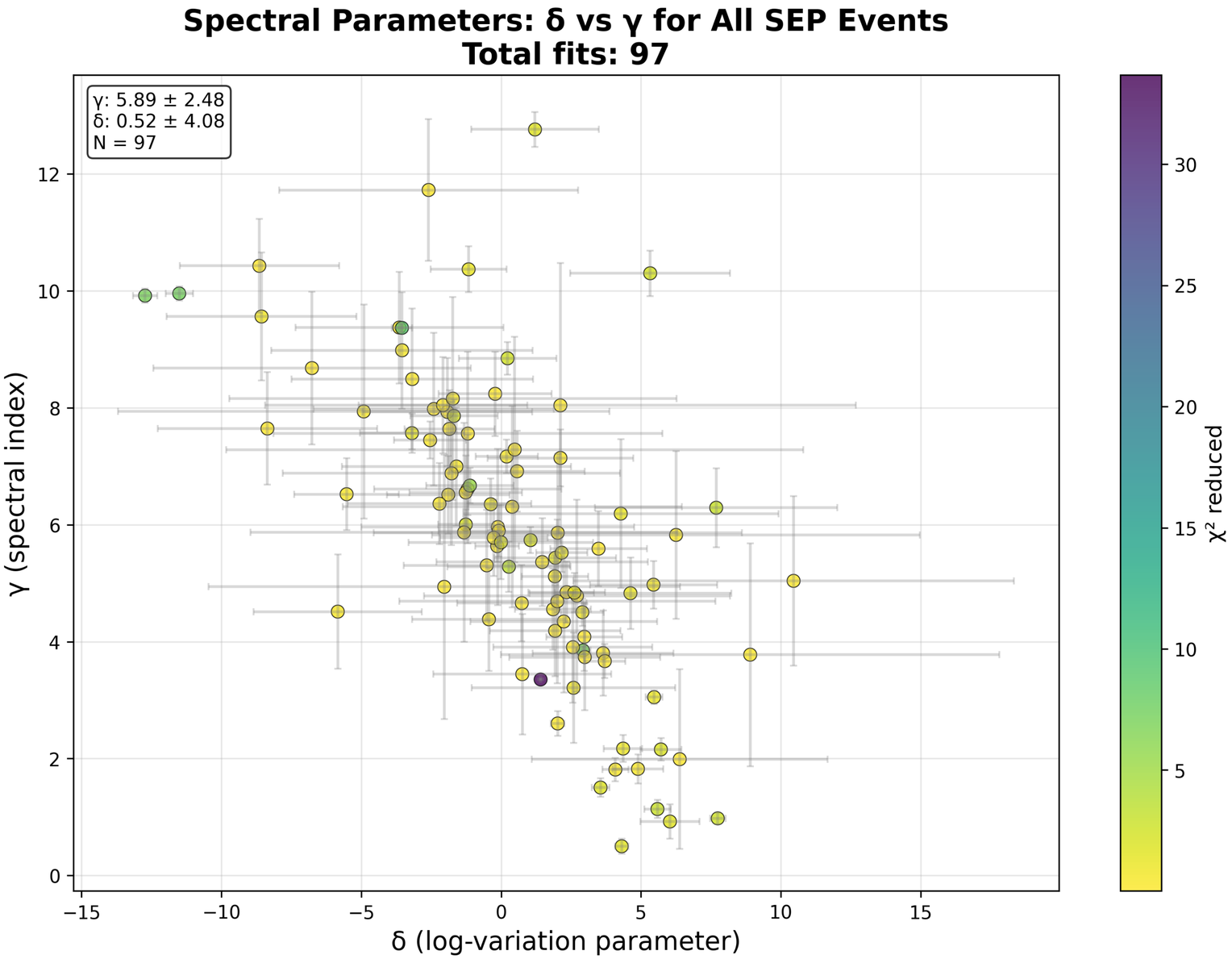


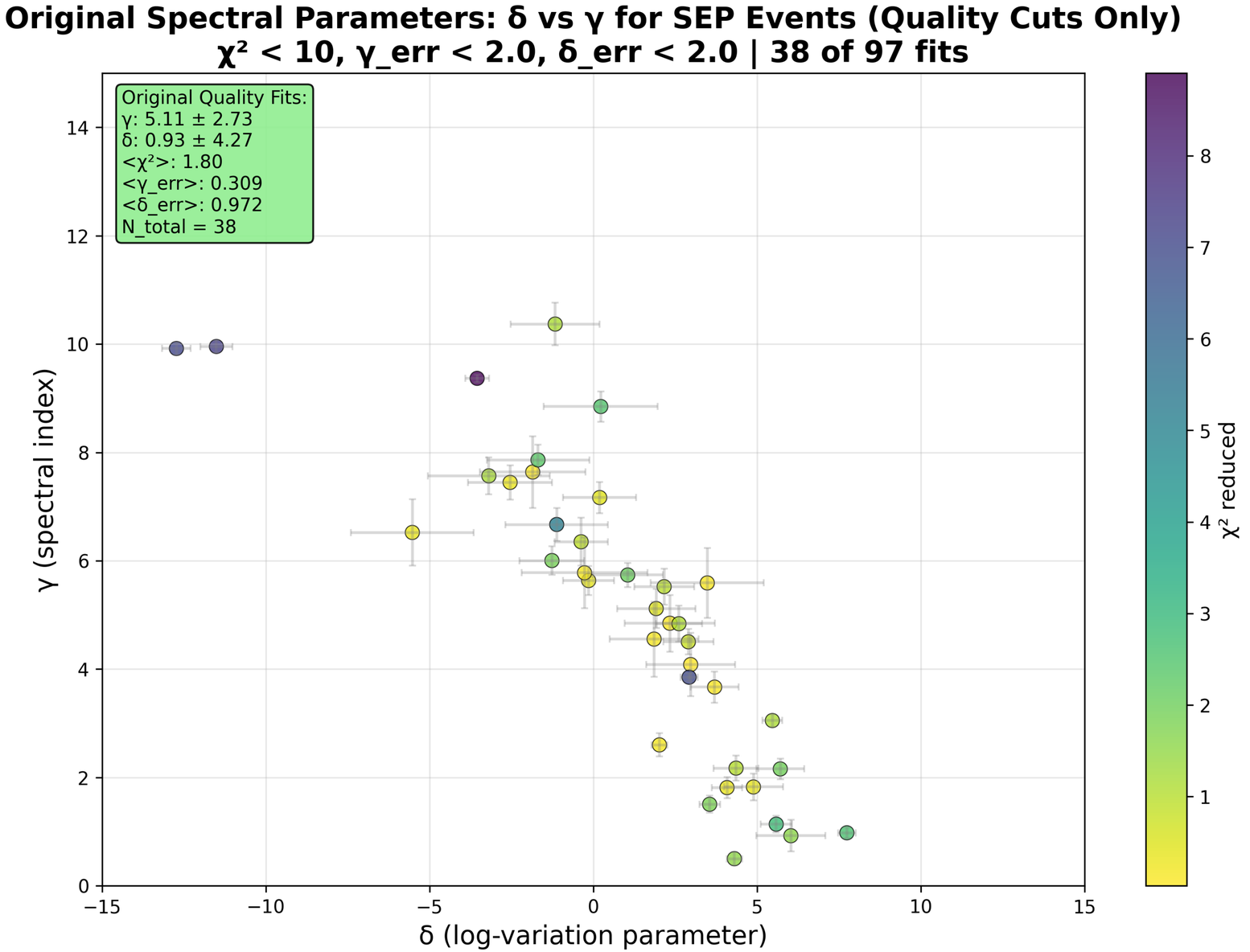




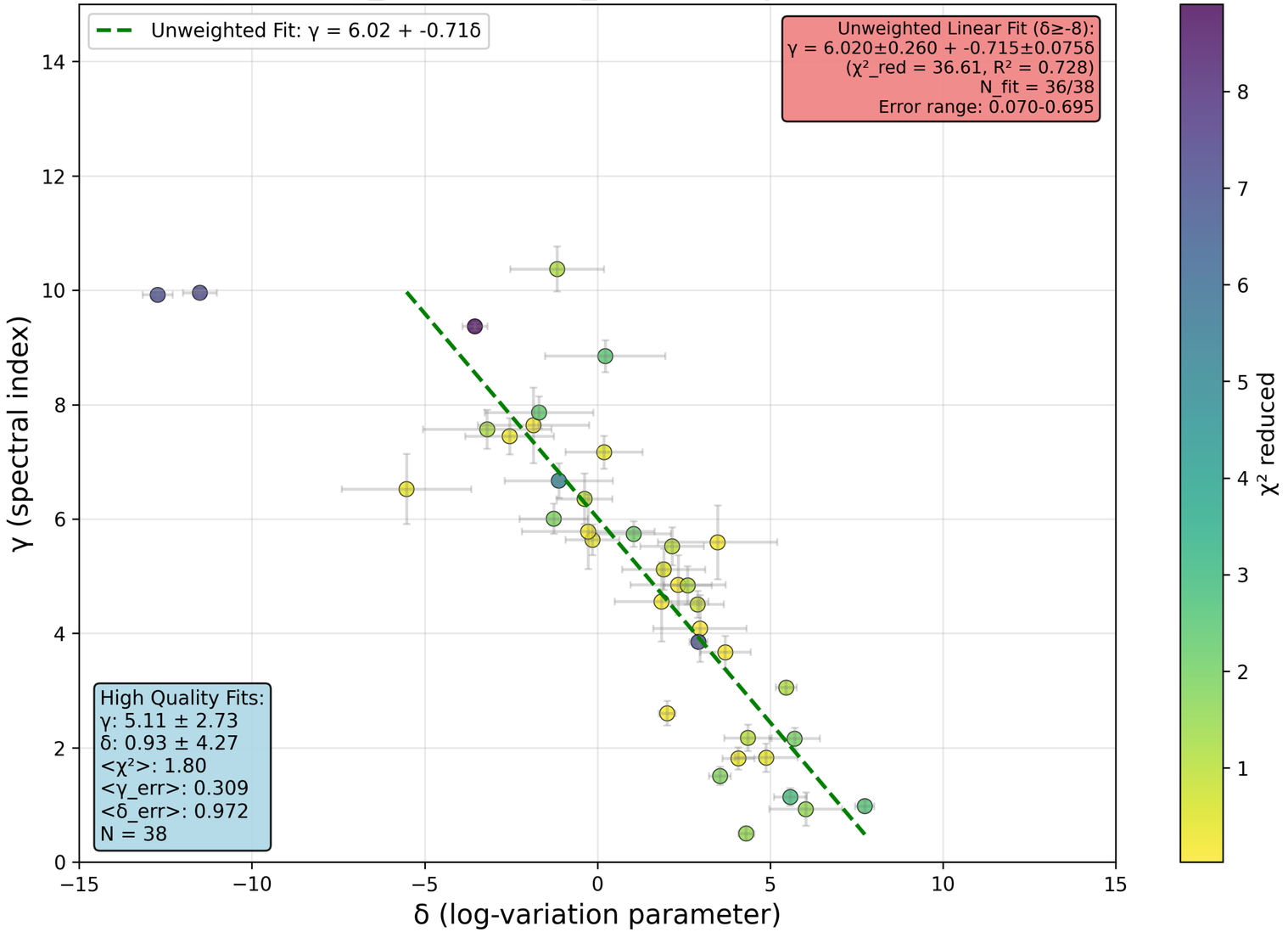


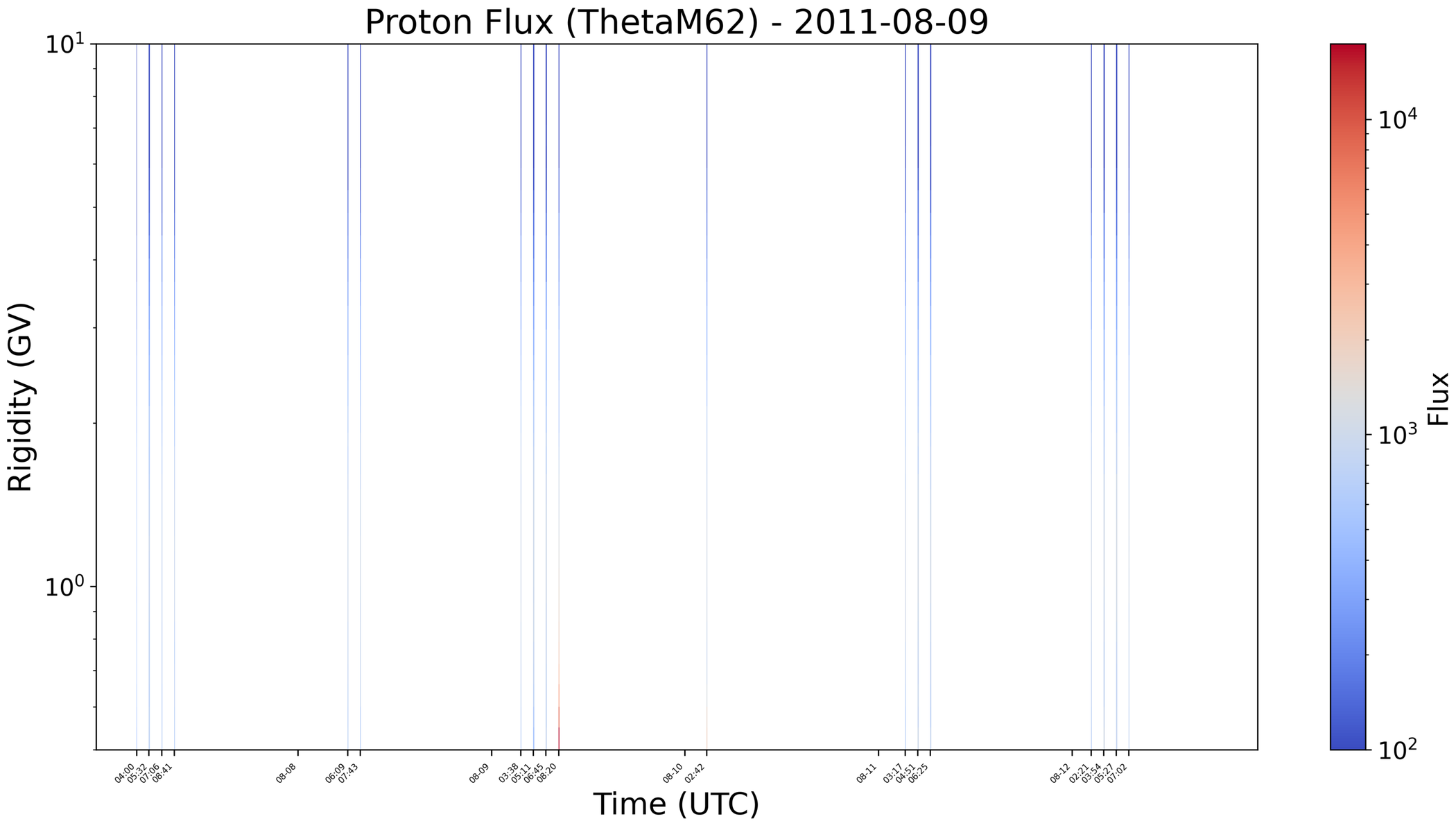

δ vs γ Spectral Analysis - Group 6
Days 46-51 of 51
2024-07-23
2 fits
γ̄=5.9
δ̄=0.4
2024-08-05
2 fits
γ̄=2.7
δ̄=3.9
2024-09-03
2 fits
γ̄=5.4
δ̄=0.4
2024-10-03
1 fits
2024-10-09
3 fits
γ̄=5.5
δ̄=3.5
2024-10-27
4 fits
γ̄=6.8
δ̄=1.2
γ
δ
χ² reduced

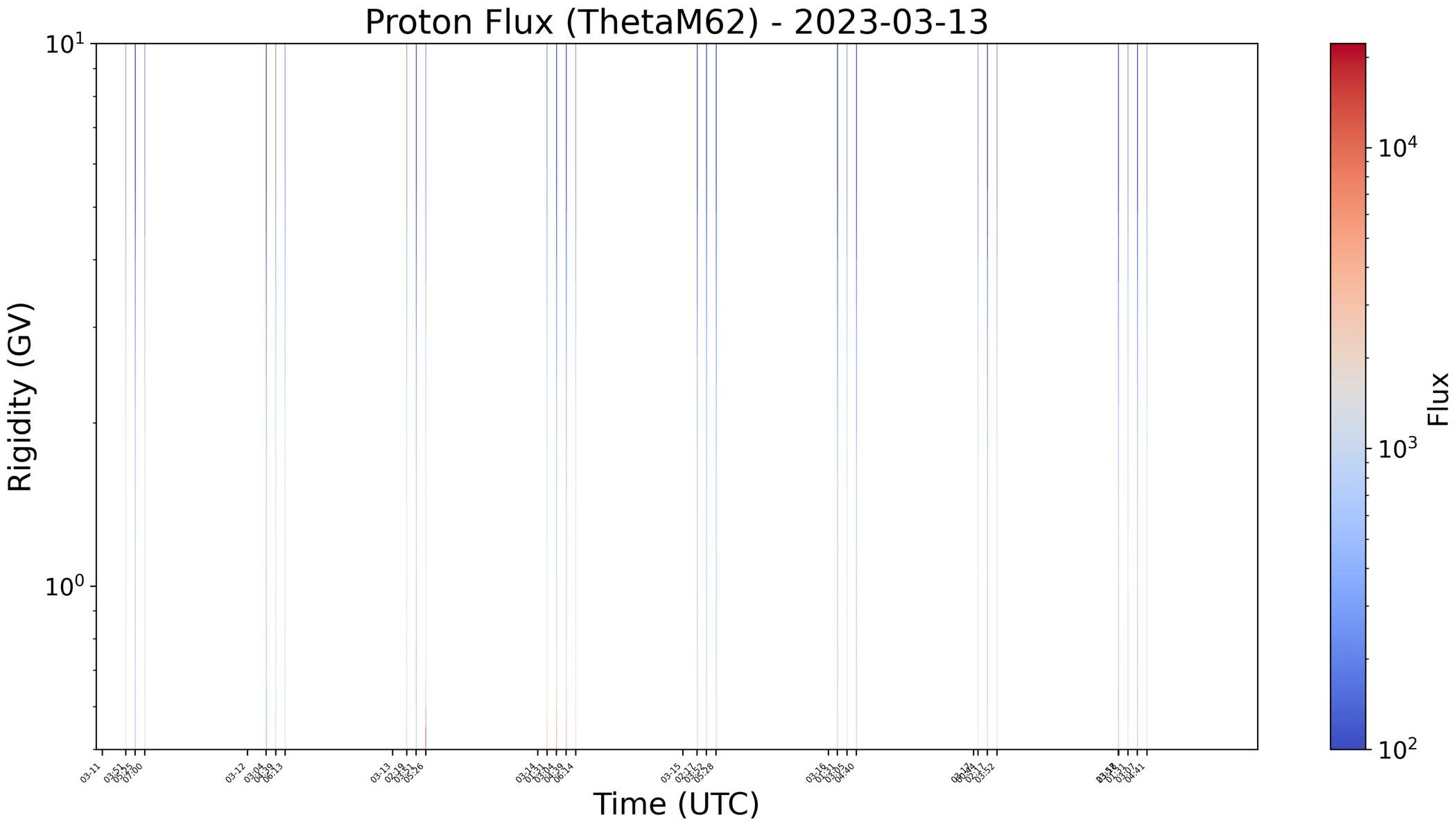

Spectral Parameters: δ vs γ for All SEP Events
Total fits: 97
γ: 5.89 ± 2.48
δ: 0.52 ± 4.08
N = 97
γ (spectral index)
δ (log-variation parameter)
χ² reduced
0
2
4
6
8
10
12
−15
−10
−5
0
5
10
15
5
10
15
20
25
30


Original Spectral Parameters: δ vs γ for SEP Events (Quality Cuts Only)
χ² < 10, γ_err < 2.0, δ_err < 2.0 | 38 of 97 fits
Original Quality Fits:
γ: 5.11 ± 2.73
δ: 0.93 ± 4.27
<χ²>: 1.80
<γ_err>: 0.309
<δ_err>: 0.972
N_total = 38
γ (spectral index)
δ (log-variation parameter)
χ² reduced

Spectral Parameters: δ vs γ for SEP Events (Unweighted Fit, Quality + Small Error Cut)
χ² < 10, γ_err < 2.0, δ_err < 2.0 | 38 of 97 fits




Proton Flux (ThetaM62) - 2011-08-09
Rigidity (GV)
10^1
10^0
Time (UTC)
04:00
05:32
07:06
08:41
08-08
06:09
07:43
08-09
03:38
05:11
06:45
08:20
08-10
02:42
08-11
03:17
04:51
06:25
08-12
02:21
03:54
05:27
07:02
Flux
10^4
10^3
10^2


Proton Flux (ThetaM62) - 2023-03-13
Rigidity (GV)
10^1
10^0
Time (UTC)
Flux
10^4
10^3
10^2

We are trying to study the feature of the SEP flux at their highest rigidity.

Fitting the SEP fluxes by a modified power law with exponential variation which qualifies the rolling behaviour :

$$\Phi(R) = A\left(\frac{R}{R_0}\right)^{-[\gamma + \delta \log(R/R_0)]}$$

Preliminary result shows there is a linear relationship:

$$\gamma = 6.02 + -0.71\delta$$

$$\gamma = 6.020 \pm 0.260 + -0.715 \pm 0.075\delta$$

Smaller spectra index, is more likely to has rolling behaviour.

For a SEP event, from the beginning to the end, the spectra index is more likely to increase, while the rolling behaviour is vanishing as time.

More checks need to be done.

End