TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA
Dipartimento di Fisica

HSERLAB
Human Space Exploration Radiation LAB

# DOSTEL REM LIDAL intercomparison

Livio Narici *on behalf of the DORELI collaboration*

NASA

DLR

ASI

UNIVERSITÀ DI PAVIA

*WRMISS 2023 Rome (IT) – Telespazio*

Cross calibrations and comparisons of detector measurements is mandatory to exploit the single detector results but also to fully extract information from the space radiation environment

***This is still difficult to perform but …***

J. Space Weather Space Clim., **7**, A18 (2017)
DOI: 10.1051/swsc/2017016


SWSC

RESEARCH ARTICLE OPEN ACCESS

## Exploiting different active silicon detectors in the International Space Station: ALTEA and DOSTEL galactic cosmic radiation (GCR) measurements

Livo Narici[1,2,*], Thomas Berger[2], Sönke Burmeister[3], Luca Di Fino[1], Alessandro Rizzo[1], Daniel Matthiä[2], and Günther Reitz[2]

Space Weather

Accepted article online 11 FEB 2019

RESEARCH ARTICLE
10.1029/2018SW002103

**Key Points:**
- We report comparisons of energetic particle spectra taken in low-Earth

## Comparisons of High-Linear Energy Transfer Spectra on the ISS and in Deep Space

C. Zeitlin[1], L. Narici[2,3], R. R. Rios[1], A. Rizzo[2], N. Stoffle[1], D. M. Hassler[4], B. Ehresmann[4], R. F. Wimmer-Schweingruber[5], J. Guo[5], N. A. Schwadron[6], and H. E. Spence[6]

J. Space Weather Space Clim. 2020, **10**, 34

https://doi.org/10.1051/swsc/2020028

JSWSC

Available online at:
www.swsc-journal.org

RESEARCH ARTICLE OPEN ACCESS

## Long term variations of galactic cosmic radiation on board the International Space Station, on the Moon and on the surface of Mars

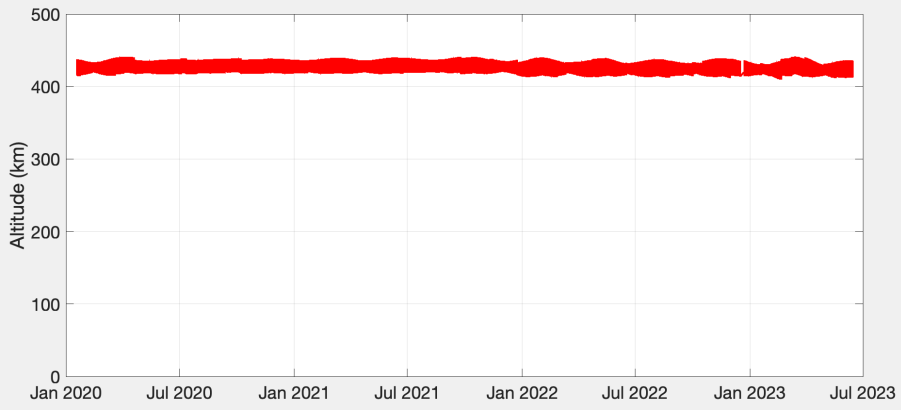
Thomas Berger[1,*], Daniel Matthiä[1], Sönke Burmeister[2], Cary Zeitlin[3], Ryan Rios[3], Nicholas Stoffle[3], Nathan A. Schwadron[4], Harlan E. Spence[4], Donald M. Hassler[5], Bent Ehresmann[5], and Robert F. Wimmer-Schweingruber[2]

# When



Measurement times

- LIDAL from January 19th 2020
- DOSTEL from Jan 1st 2020
- REM from Sept 17 2021




Altitude would not be an issue during the considered period

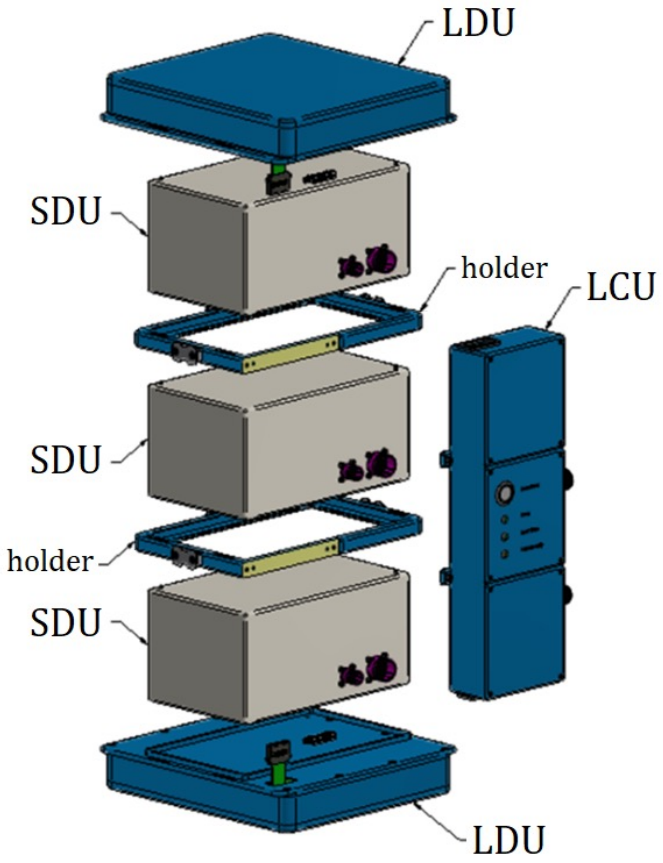
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | January | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| | February | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | | |
| | March | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 |
| | April | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | |
| | May | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 |
| | June | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | |
| | July | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 |
| | August | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 |
| | September | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | |
| | October | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 |
| | November | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | |
| | December | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 |
| 2021 | January | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| | February | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | | | |
| | March | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| | April | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | |
| | May | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 |
| | June | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | |
| | July | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 |
| | August | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 |
| | September | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | |
| | October | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 |
| | November | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | |
| | December | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 |
| 2022 | January | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| | February | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | | | |
| | March | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| | April | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | |
| | May | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 |
| | June | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | |
| | July | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 |
| | August | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 |
| | September | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | |
| | October | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 |
| | November | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | |
| | December | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 |
| 2023 | January | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| | February | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | | | |
| | March | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| | April | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | |
| | May | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 |
| | June | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | |
| | July | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 |
| | August | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 |
| | September | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | |
| | October | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 |
| | November | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | |
| | December | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 |

| Legenda |
|---|
| OFF (Nominal) |
| OFF |
| Z Direction |
| Y Direction |
| X Direction |

# What: LIDAL



49 cm




18 Si planes: [0.038 x (2 x 8) x 8] $cm^3$

2 Scint. planes.: [0.4 x (8 x 2) x 8] $cm^3$

GF: 15.32 $cm^2\ sr$ (bi-directional)

# What: REM



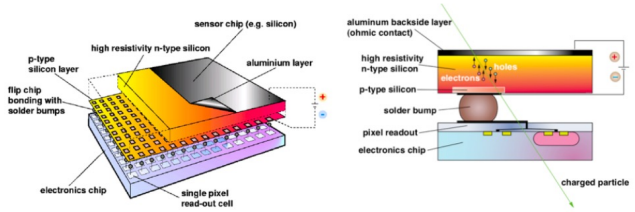
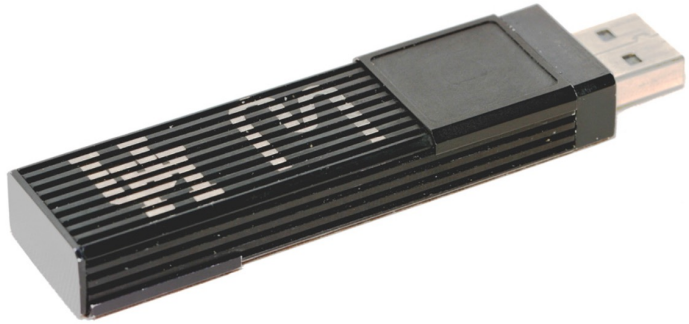


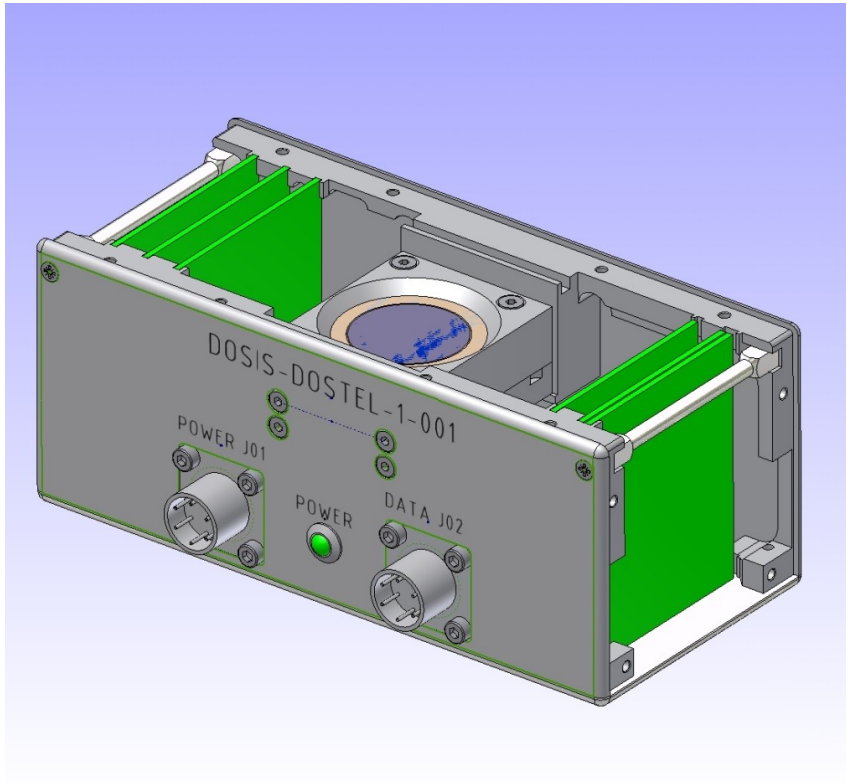

Figure 1: Medipix2 chip and Timepix assembly. (Source: CERN/Medipix.)

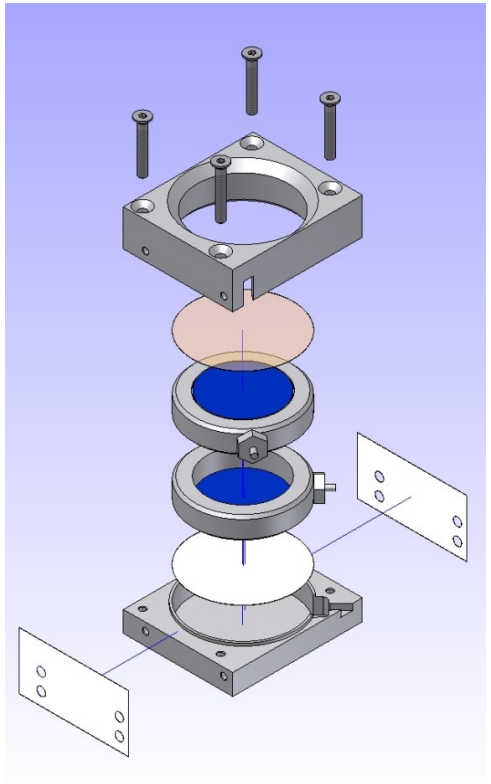


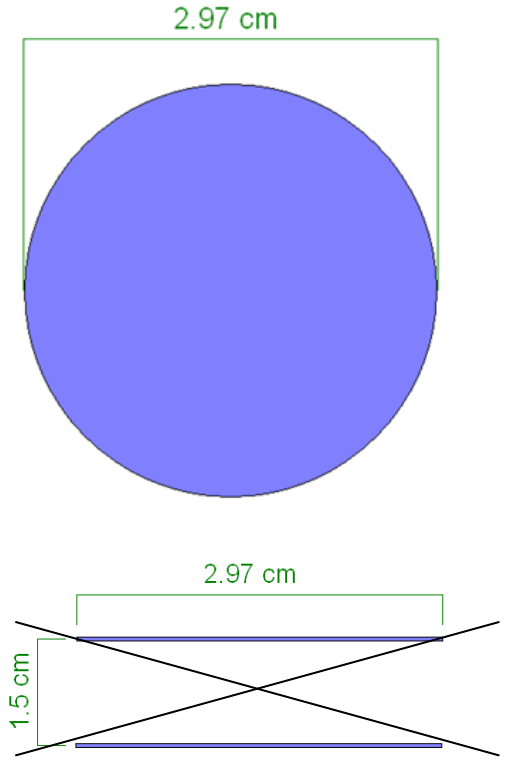
- Hybrid silicon pixel detector utilizing Medipix2/Timepix technology from CERN (medipix.cern.ch).
  - 256×256 pixels, each with a 55μm pitch (1.982cm$^2$).
  - Opening angle: $4\pi$.
- Low mass/power/cost make it an ideal technology for space applications.

# What: DOSTEL





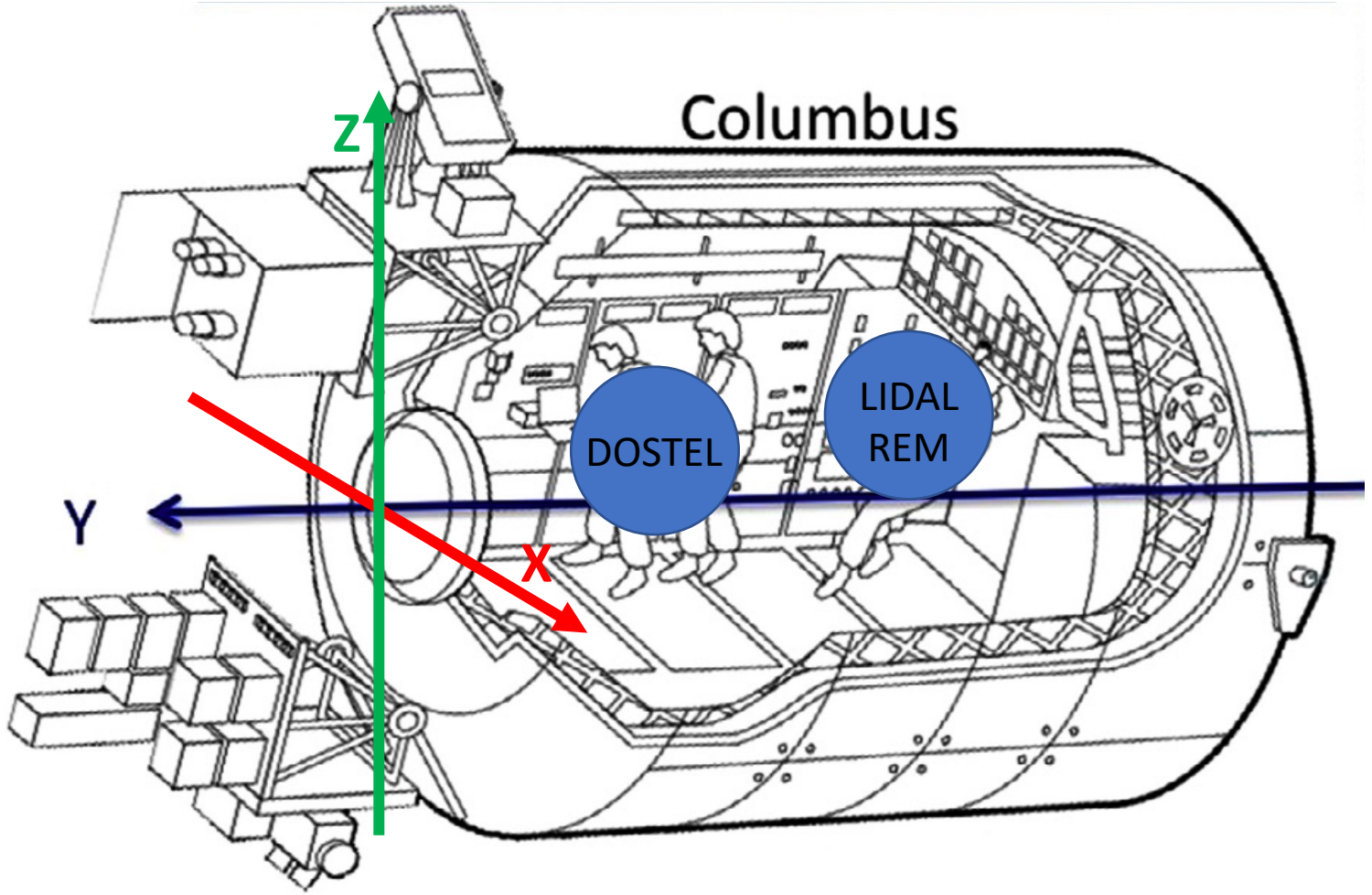






Each DOSTEL consits of two Canberra PIPS (Passivated Implanted Planar Silicon) detectors forming a telescope.
Each detector has a thickness of 315 µm and an active area of 6.93 $cm^2$.
The distance between the two detecots of 1.5 cm defines an opening angle of 120°.

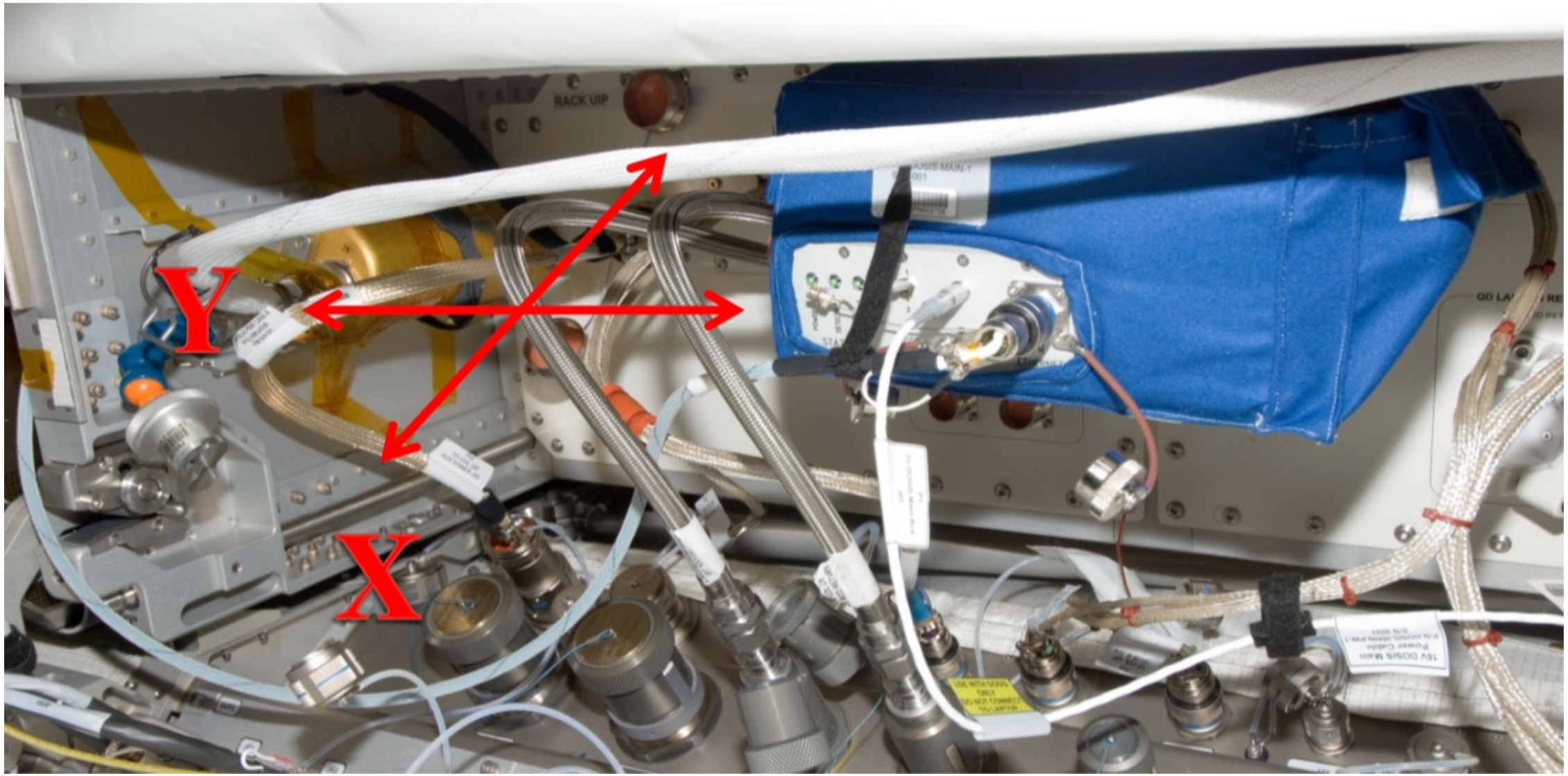
# Where





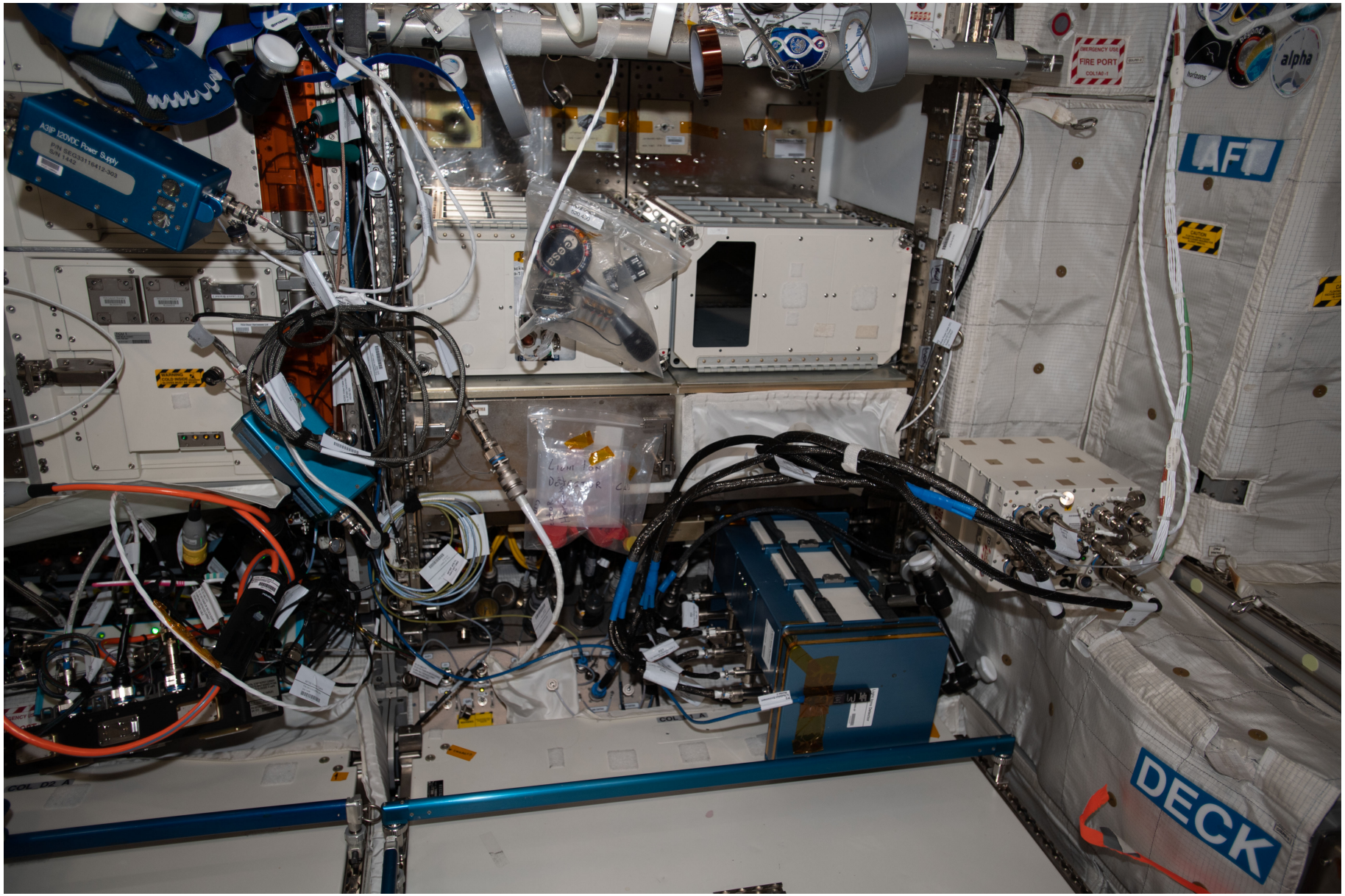
# Where: DOSTEL site (fixed)





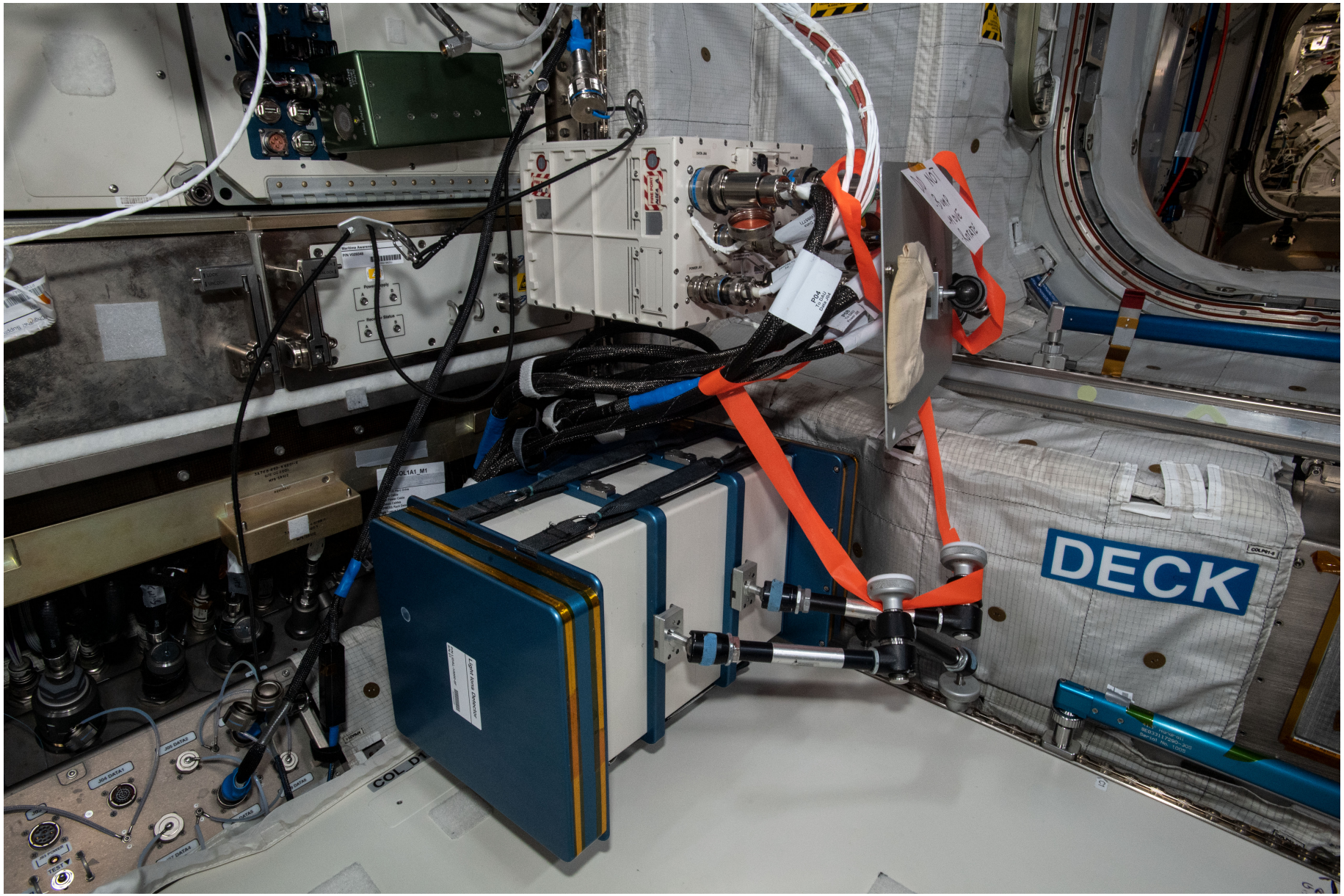
# Where: LIDAL X / REM





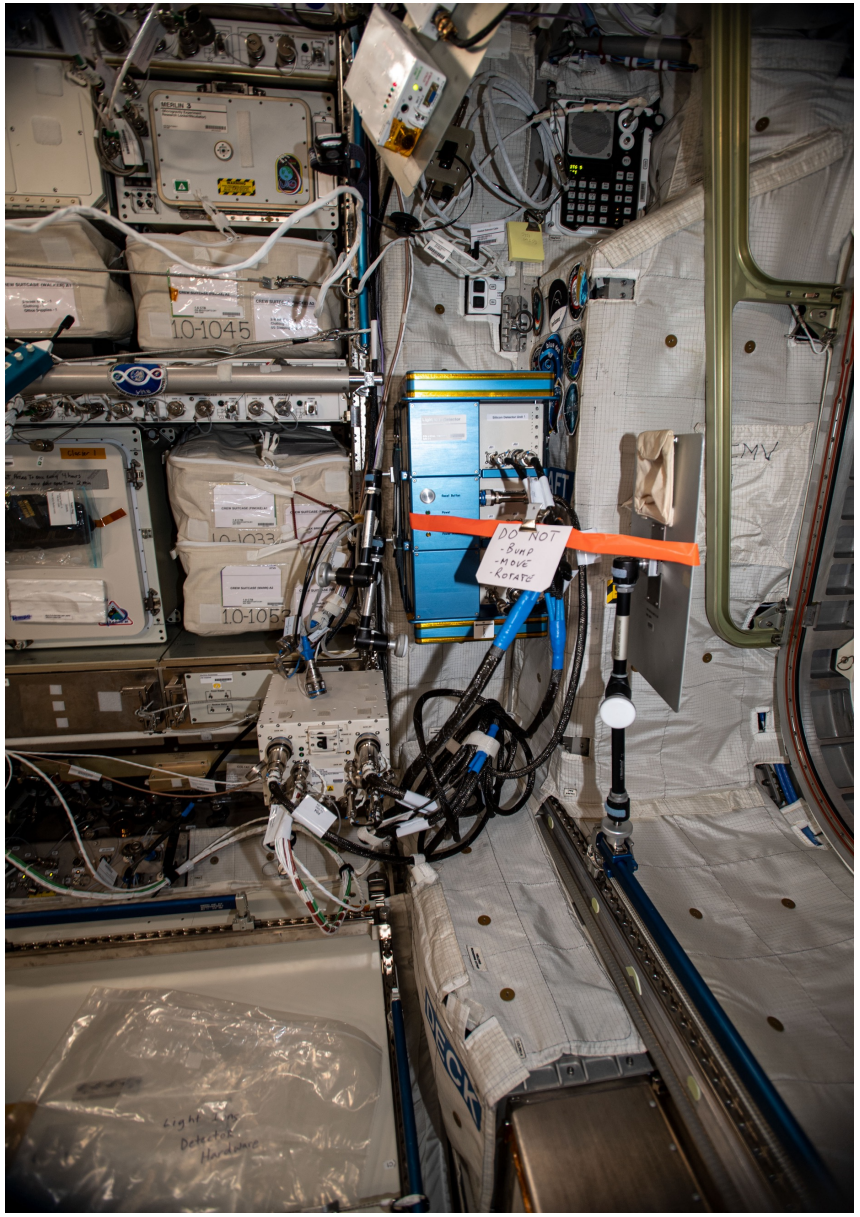
# Where: LIDAL Y





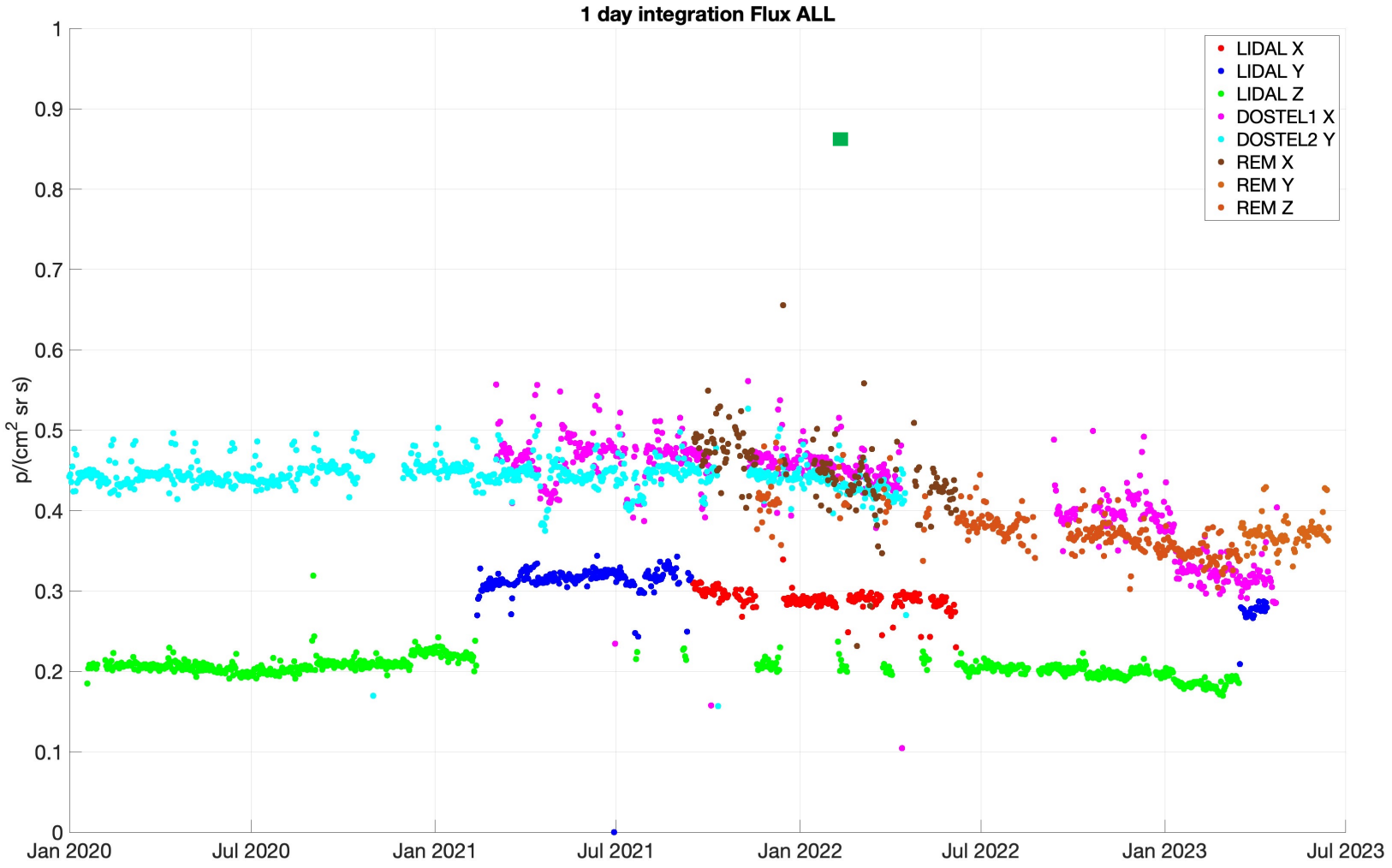
# Where: LIDAL Z/REM





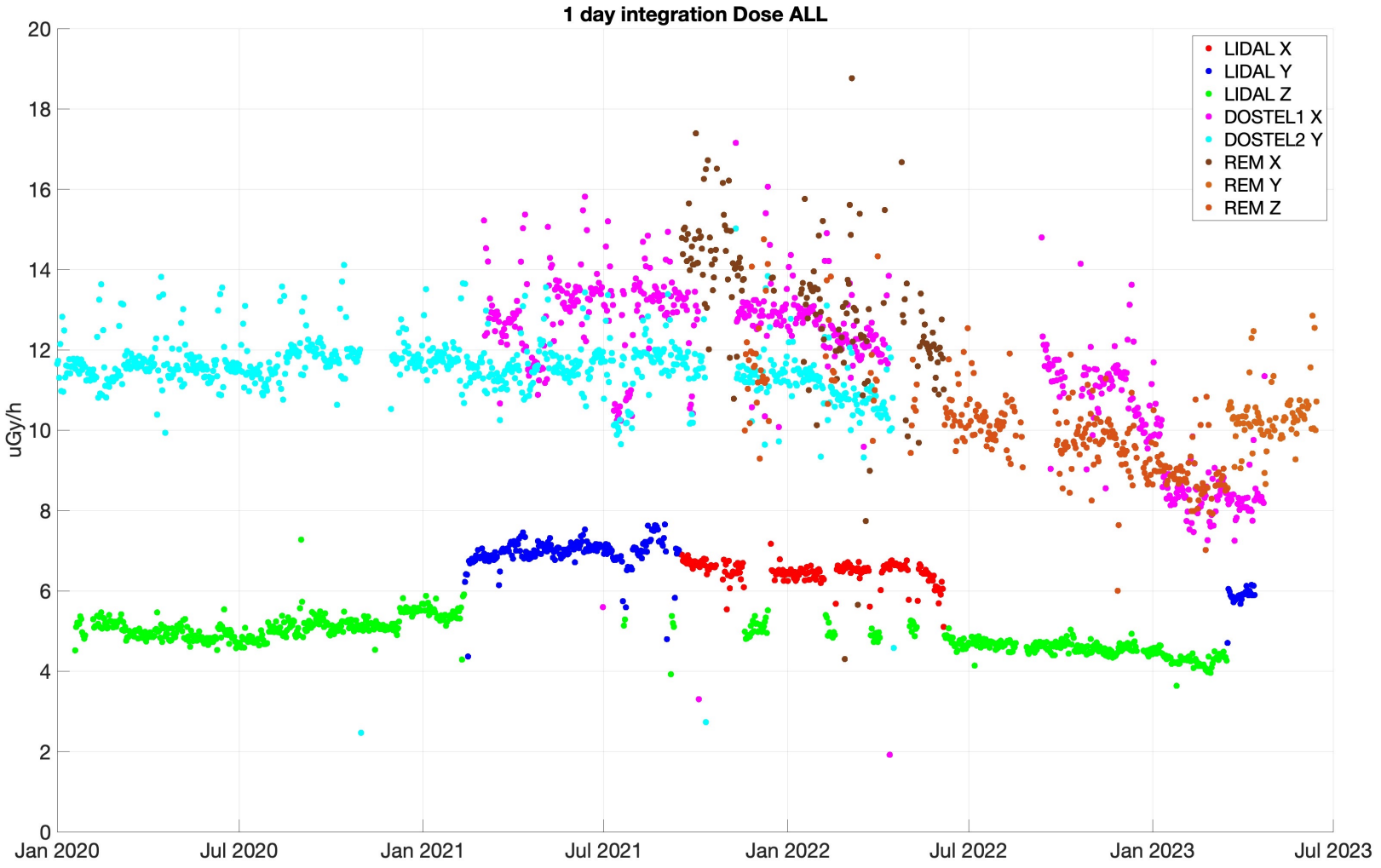

# Flux rate 1 day





# Dose rate 1 day



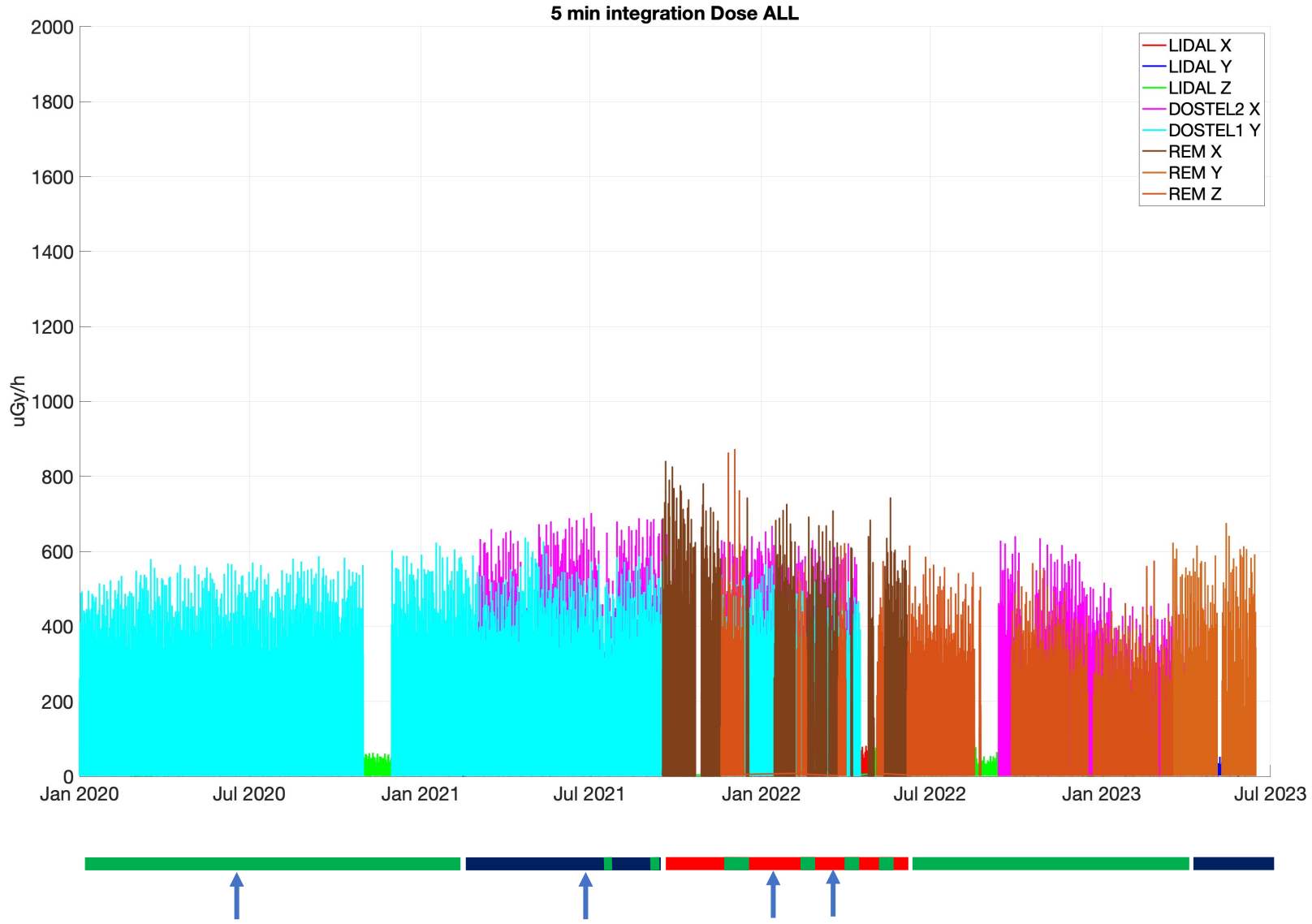


# Flux rate 5 min



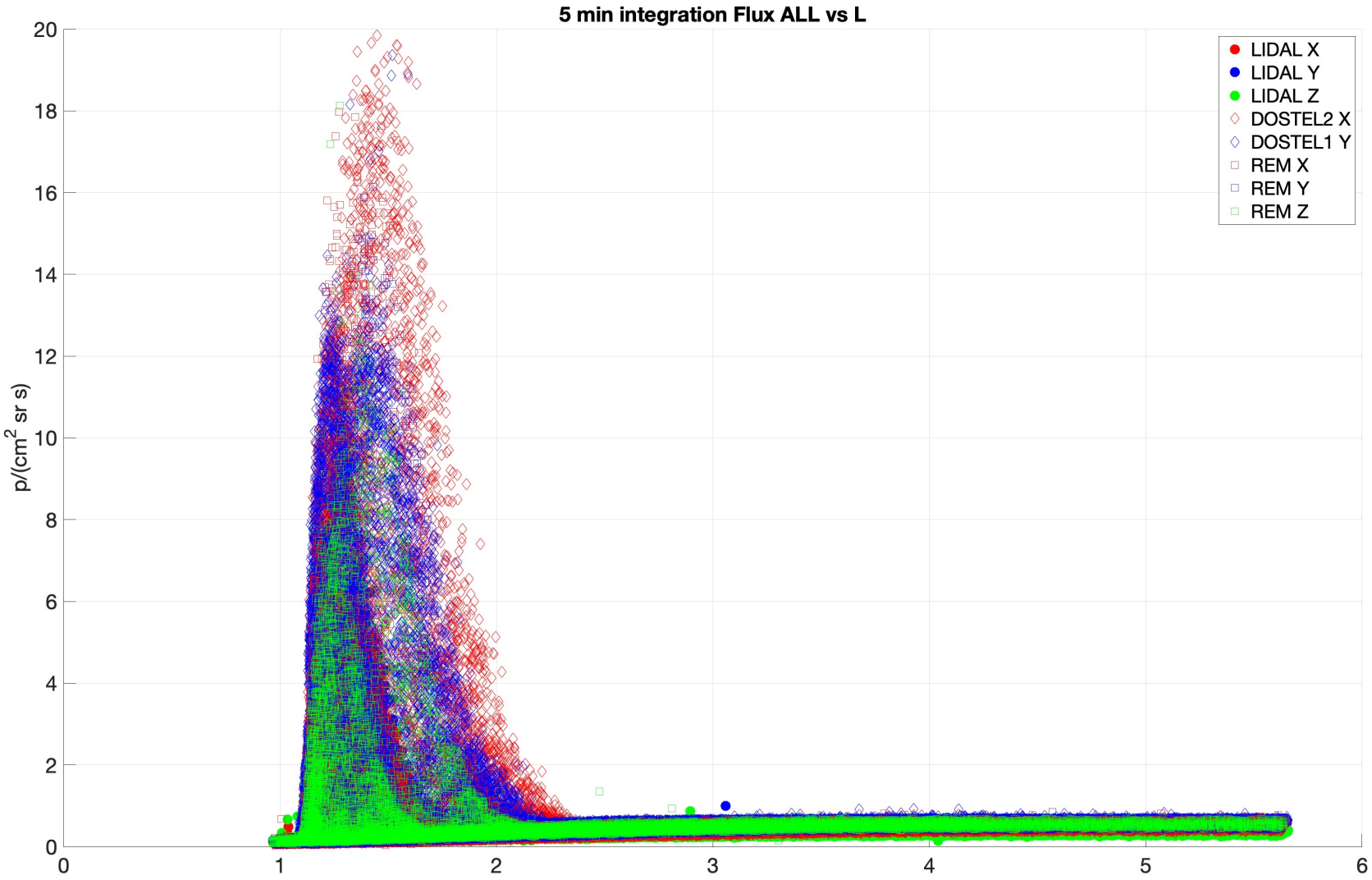
# Dose rate 5 min





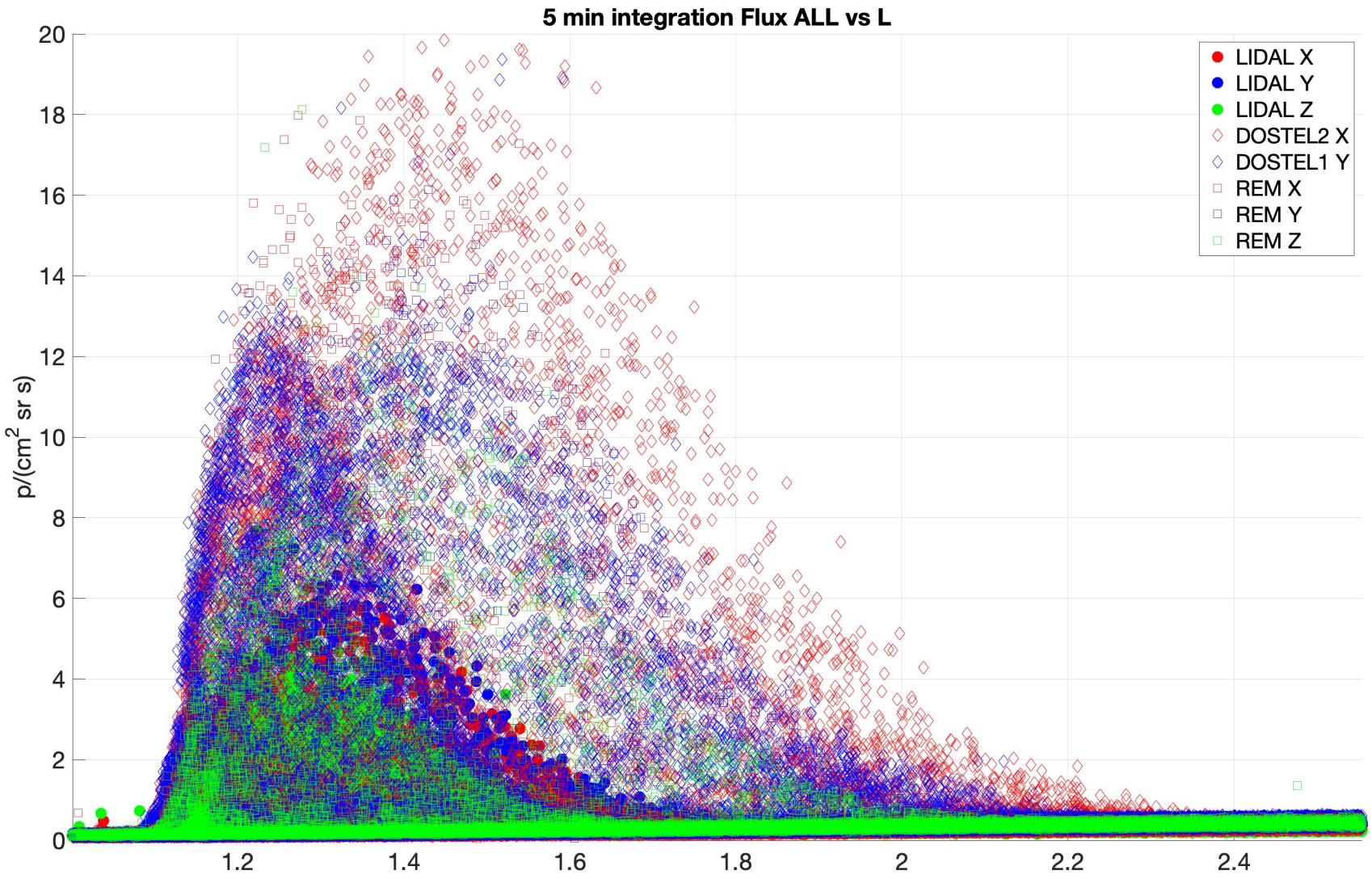
# Flux vs L




5 min integration Flux ALL vs L
p/(cm$^2$ sr s)
LIDAL X
LIDAL Y
LIDAL Z
DOSTEL2 X
DOSTEL1 Y
REM X
REM Y
REM Z
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5
6

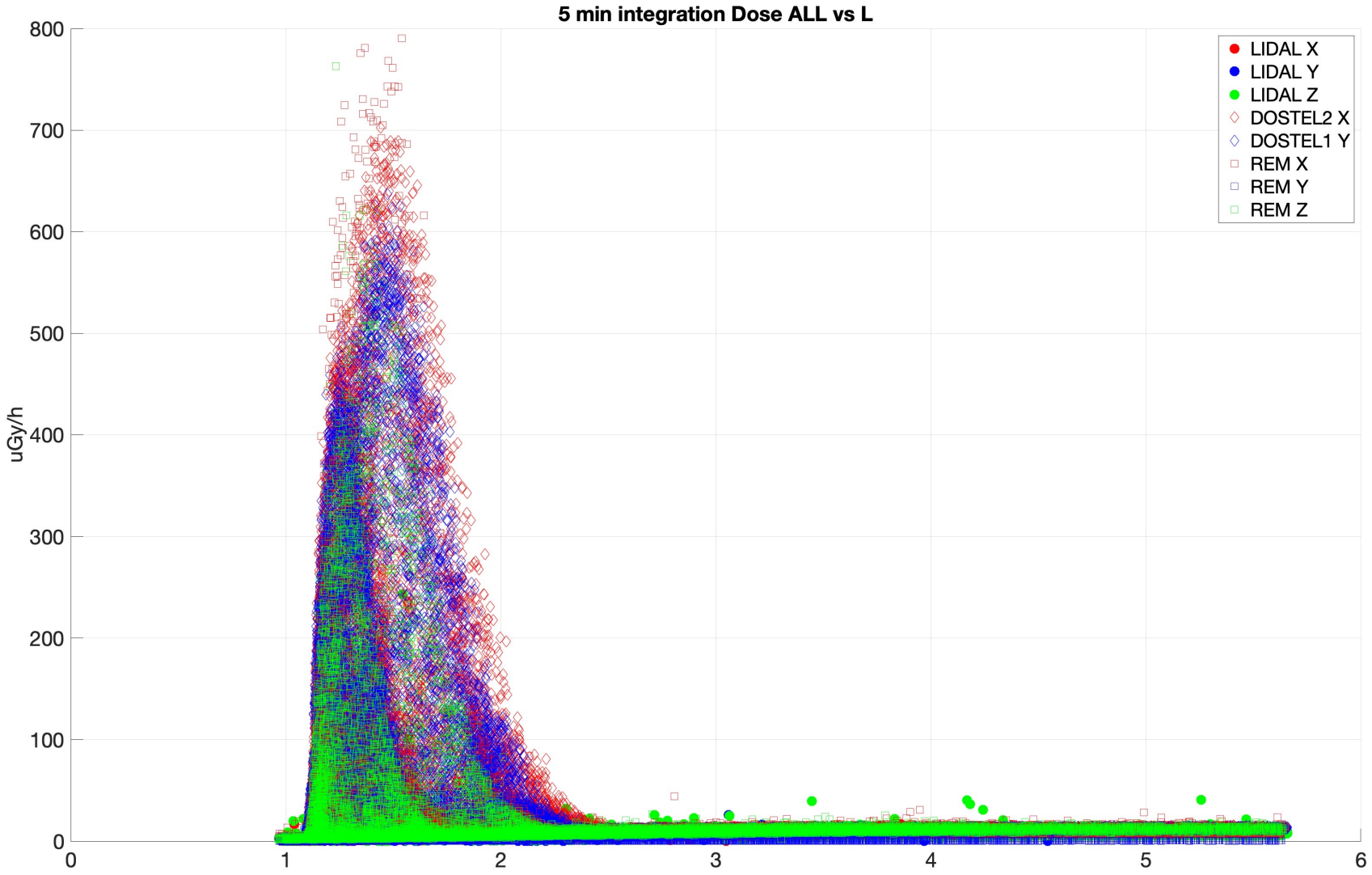
# Flux vs L expanded





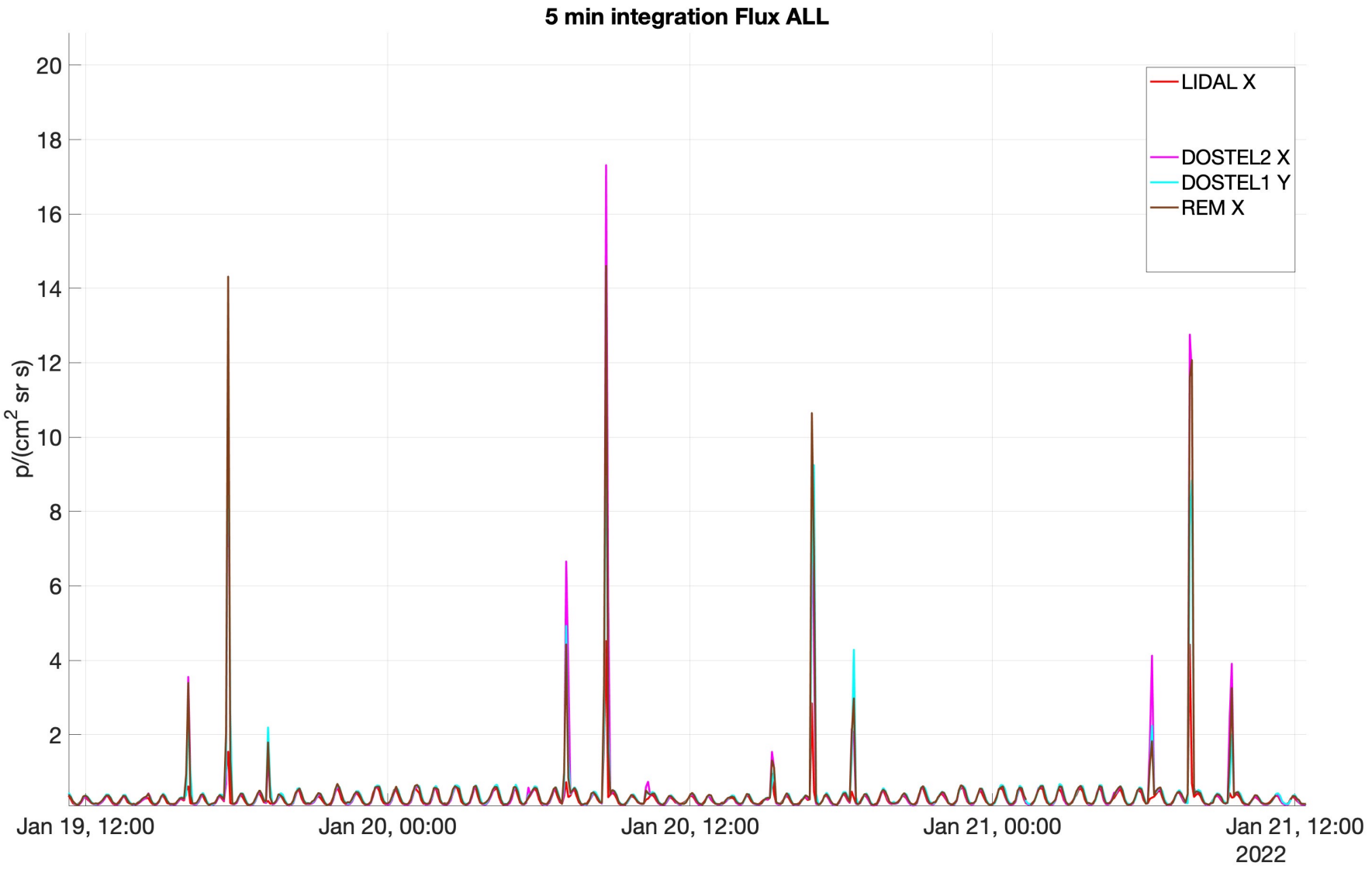
# Dose vs L




5 min integration Dose ALL vs L
uGy/h
0
100
200
300
400
500
600
700
800
0
1
2
3
4
5
6
LIDAL X
LIDAL Y
LIDAL Z
DOSTEL2 X
DOSTEL1 Y
REM X
REM Y
REM Z

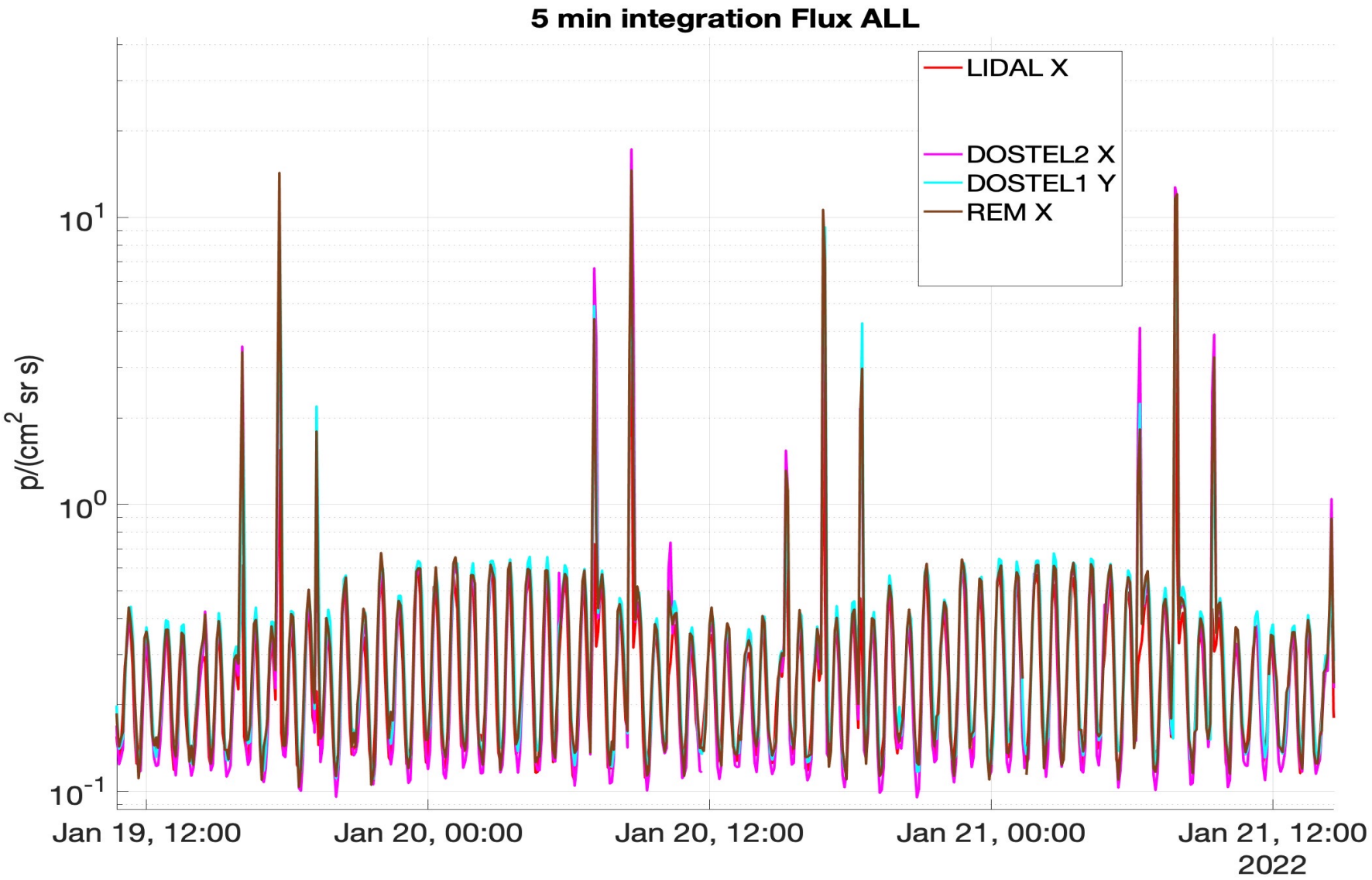
# Flux rate 5 min, 2022 Jan 19th





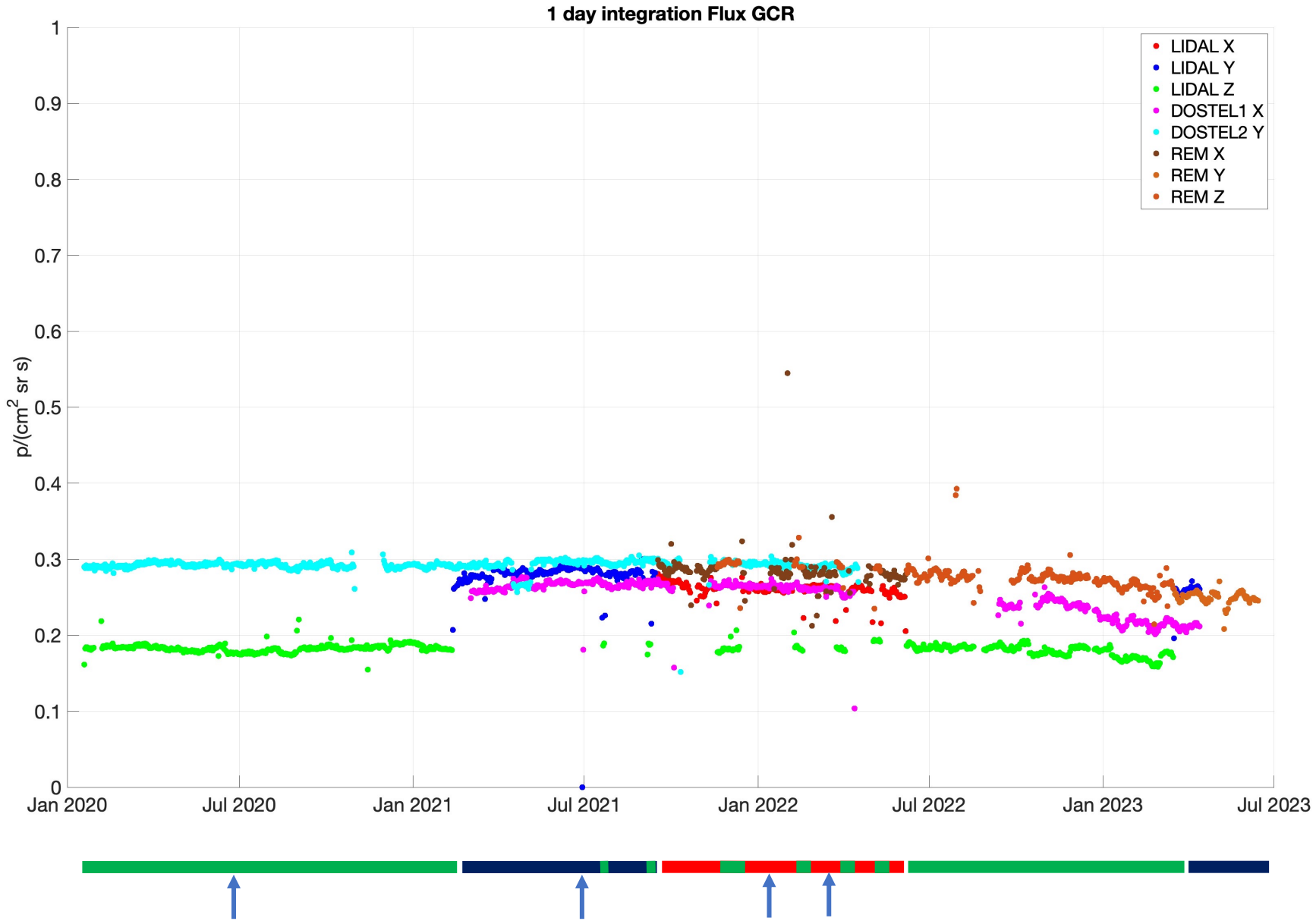
# Flux rate 5 min, 2022 Jan 19th





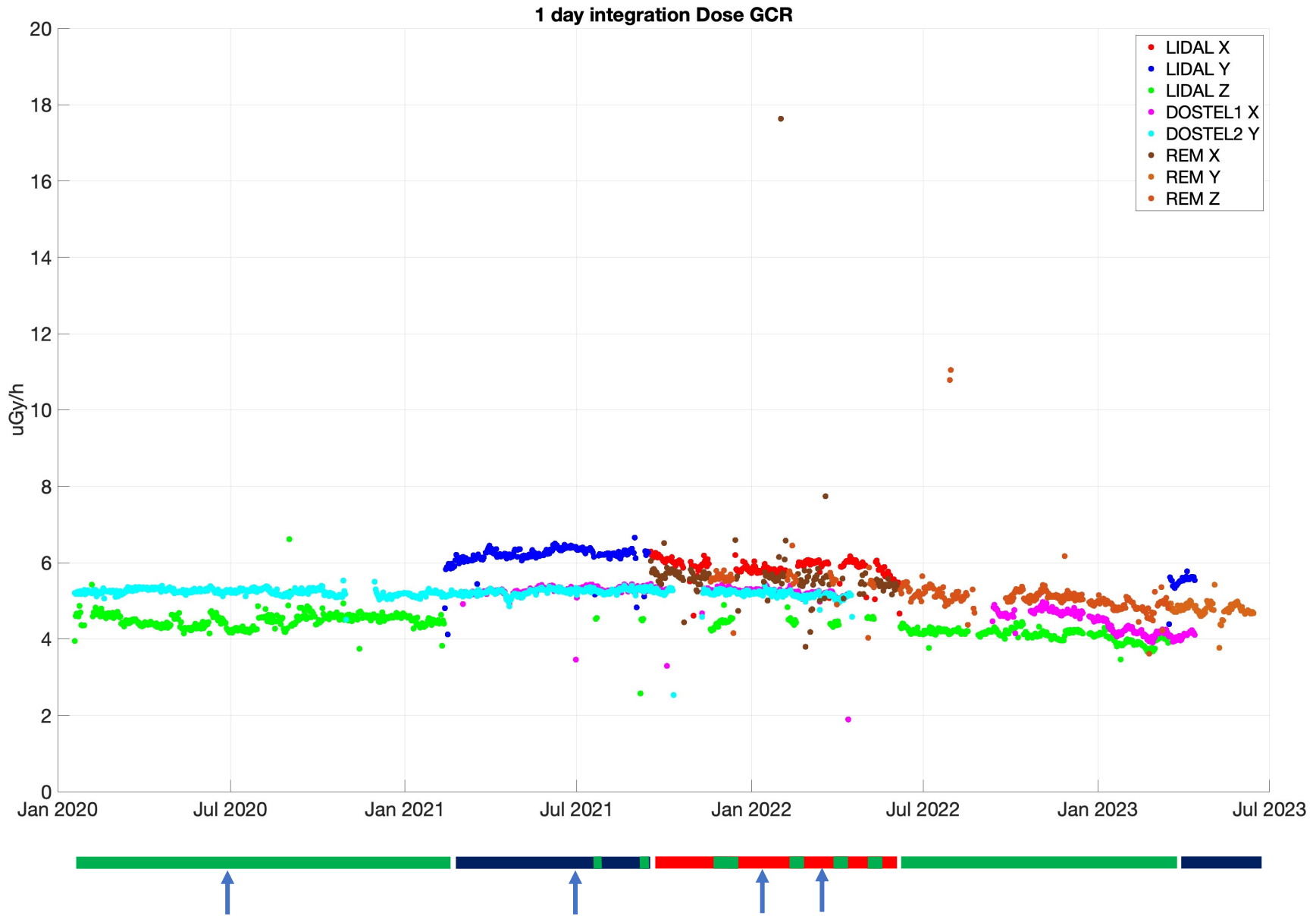
# Flux rate 1 day only GCR





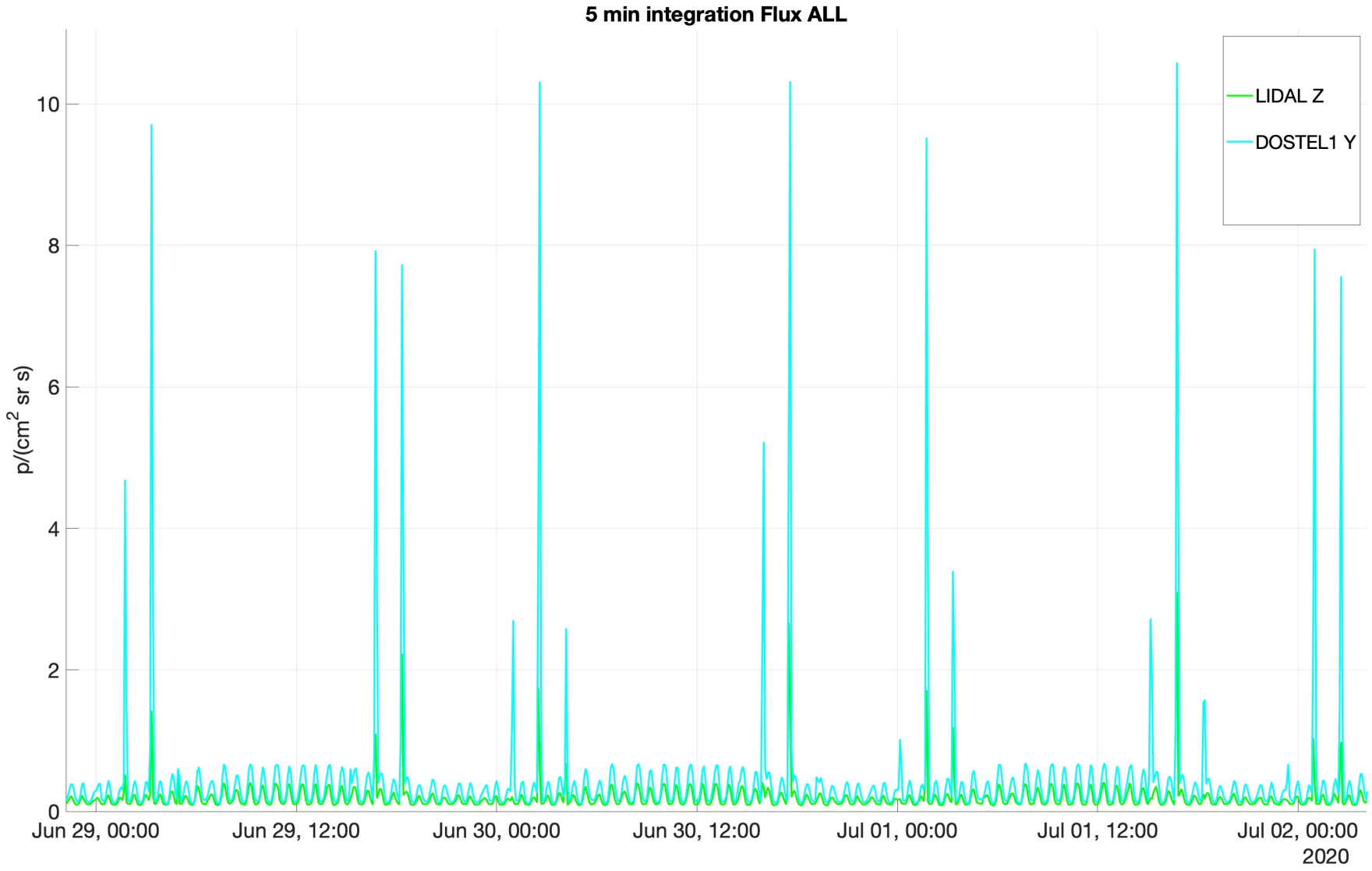
# Dose rate 1 day only GCR





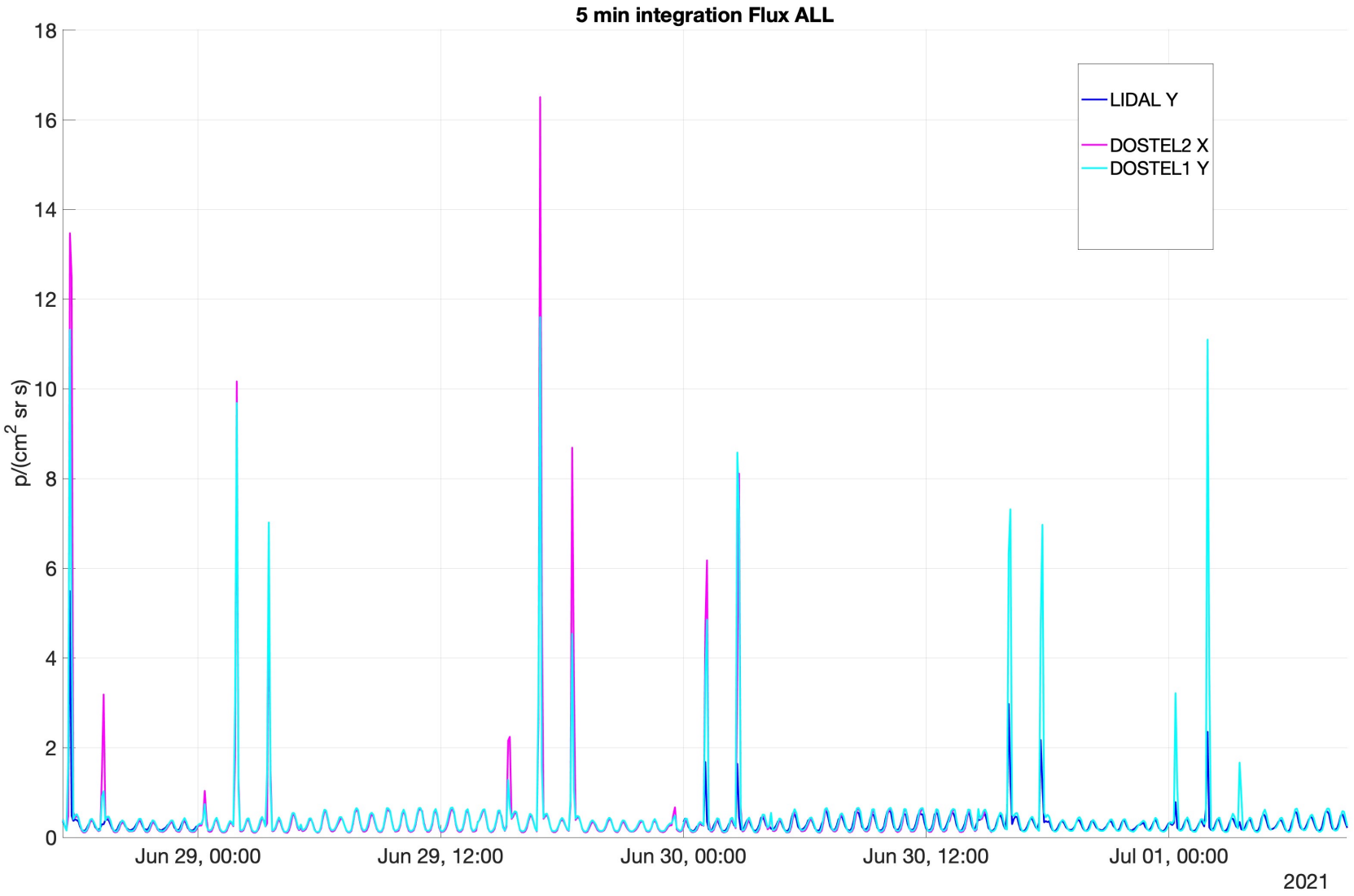
# Flux rate 5 min, 2020 Jun 29th





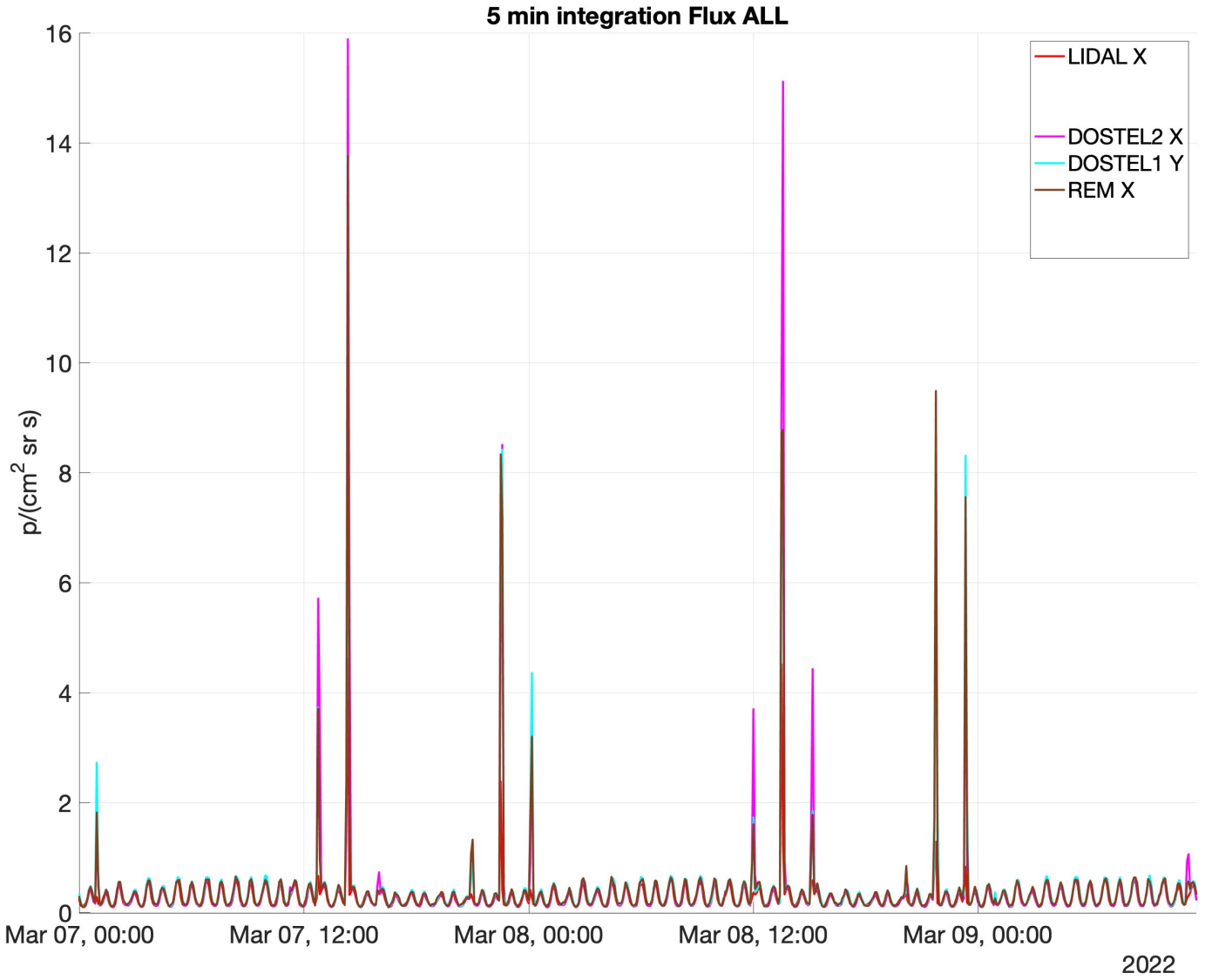
# Flux rate 5 min, 2021 Jun 29th





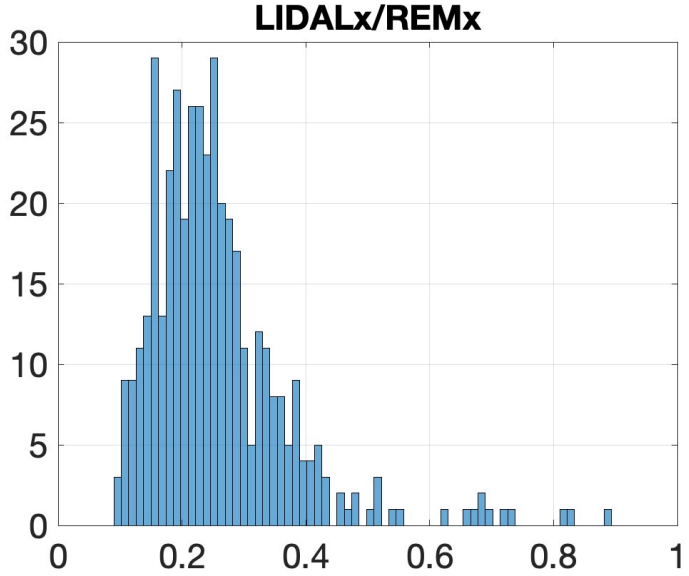
# Flux rate 5 min, 2022 Mar 07th

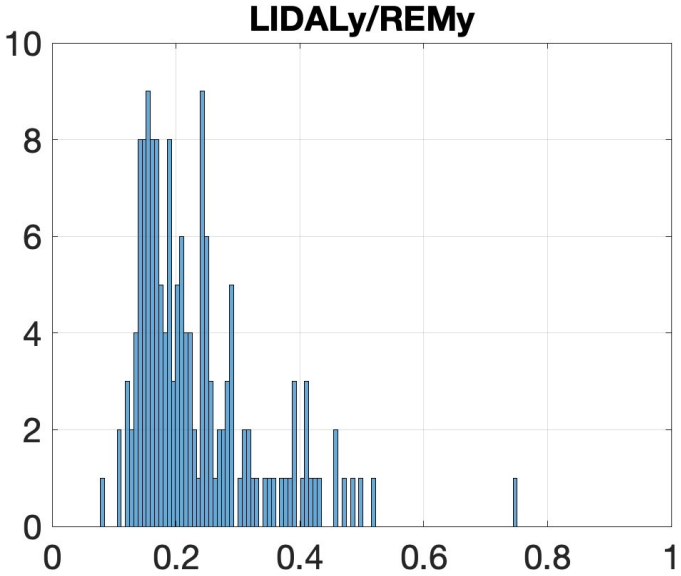


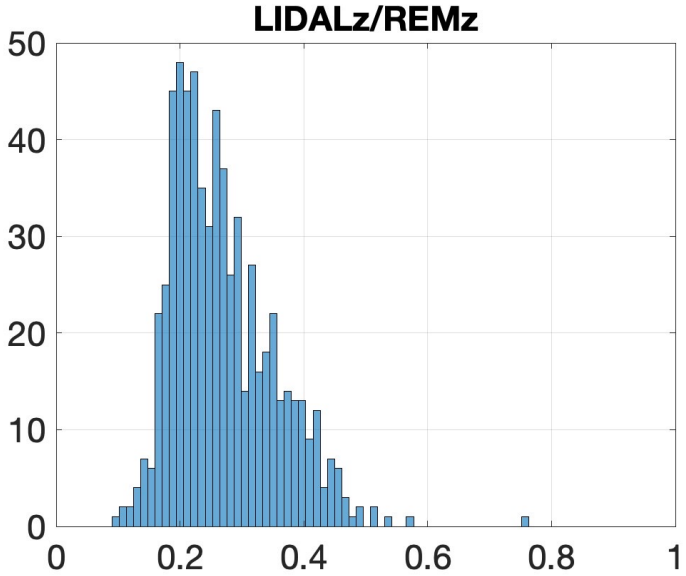


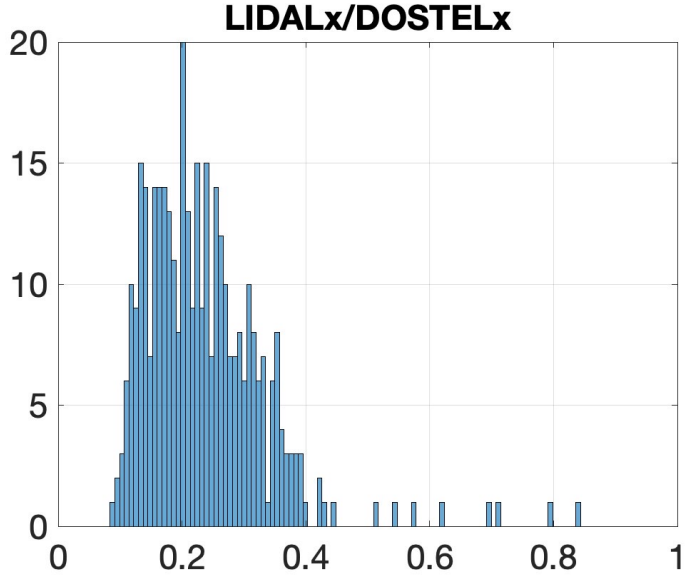
# Flux amplitude peak ratios in the SAA

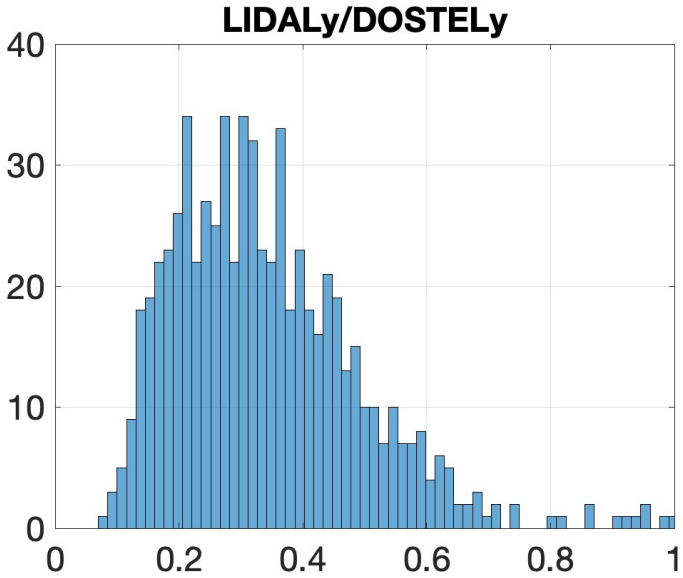


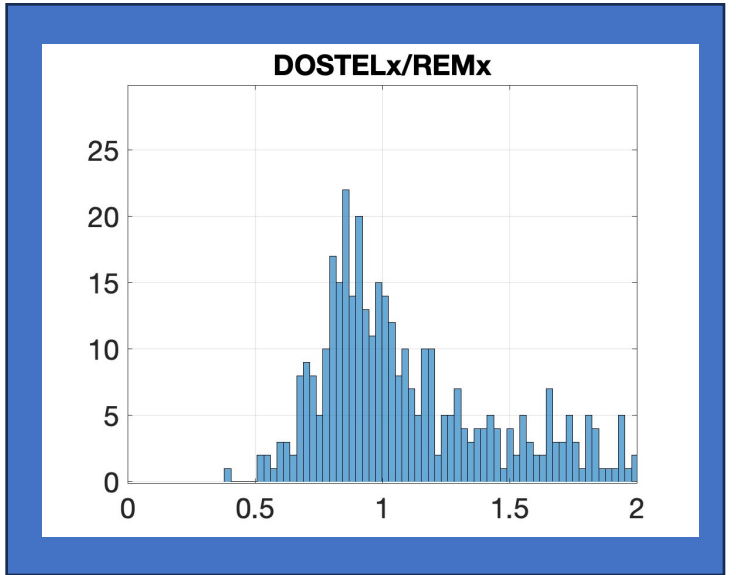


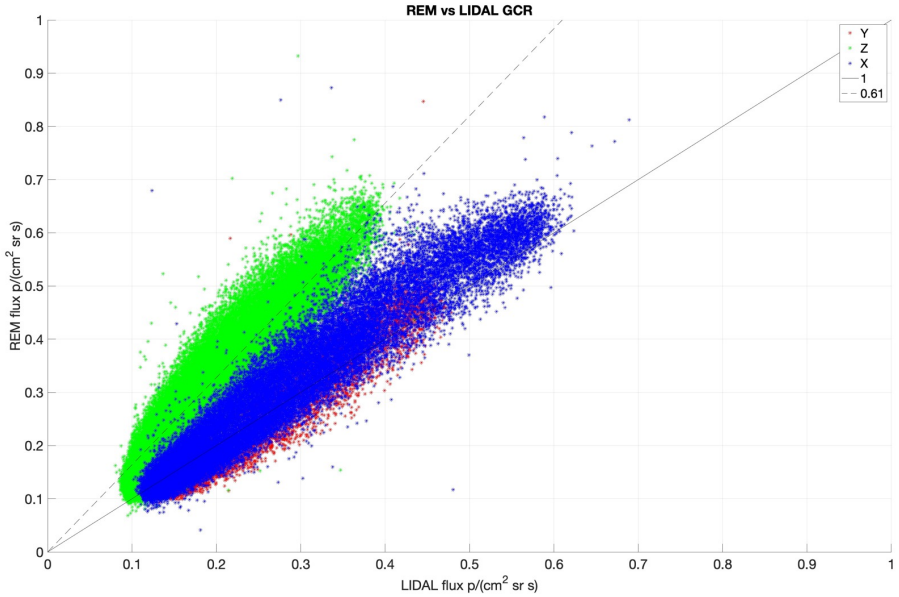



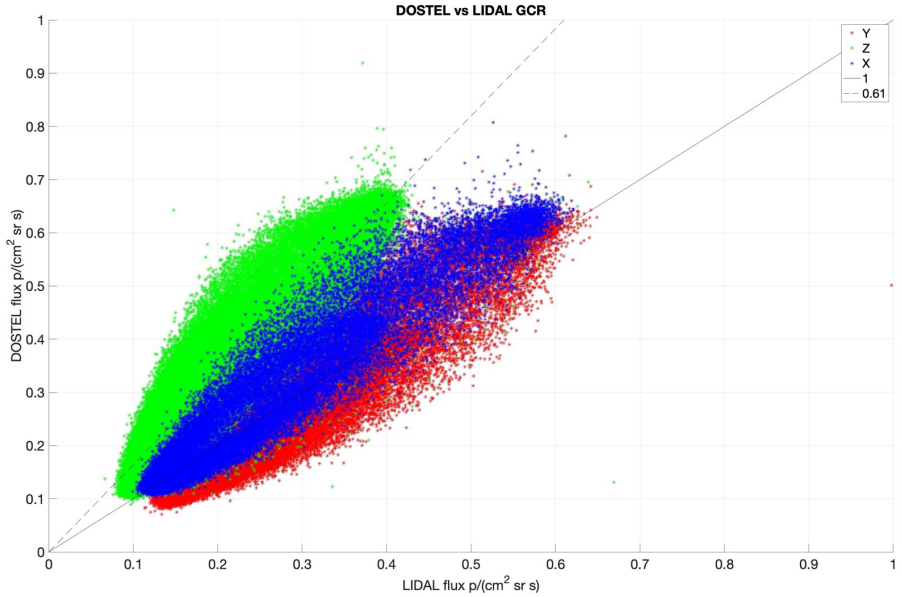



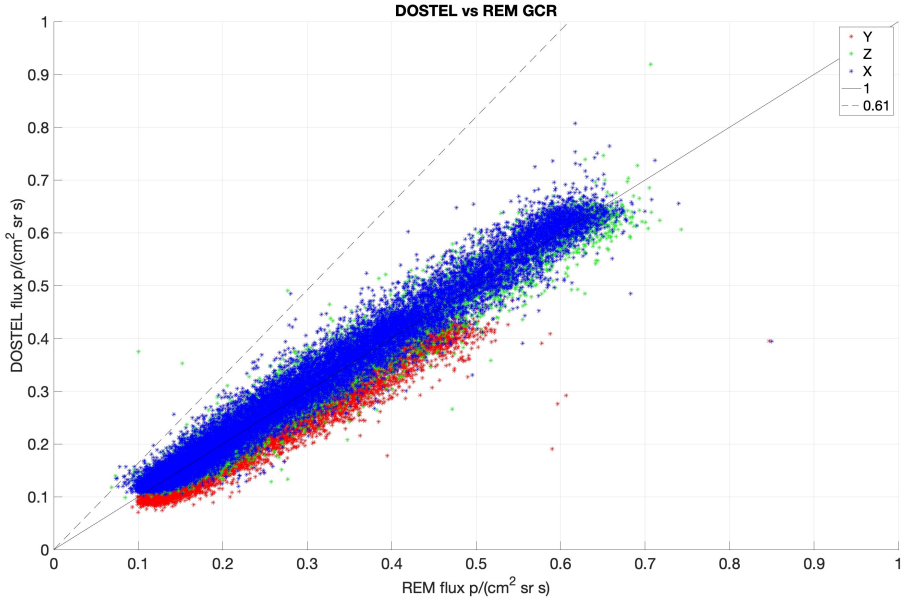



# Flux comparison (5 min)





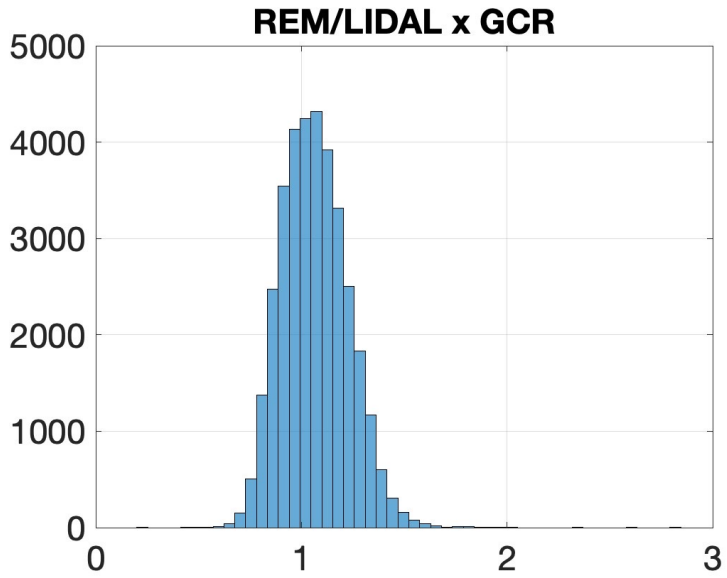



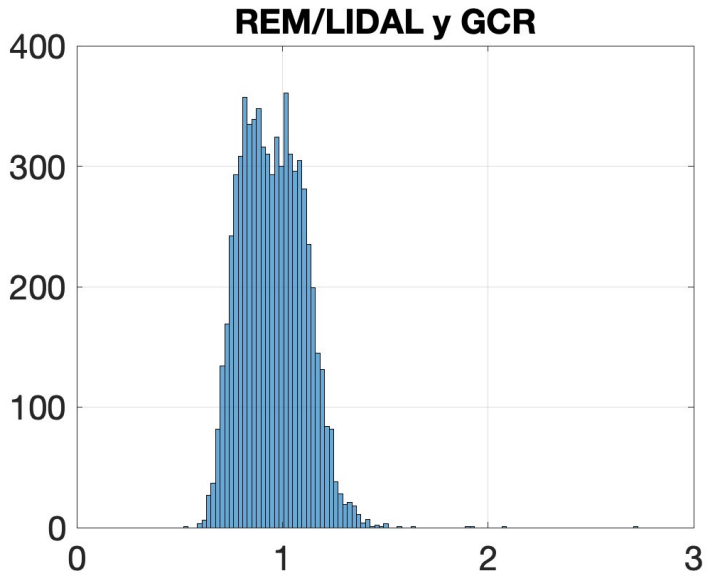

The continuous line is the bisector (Identity)

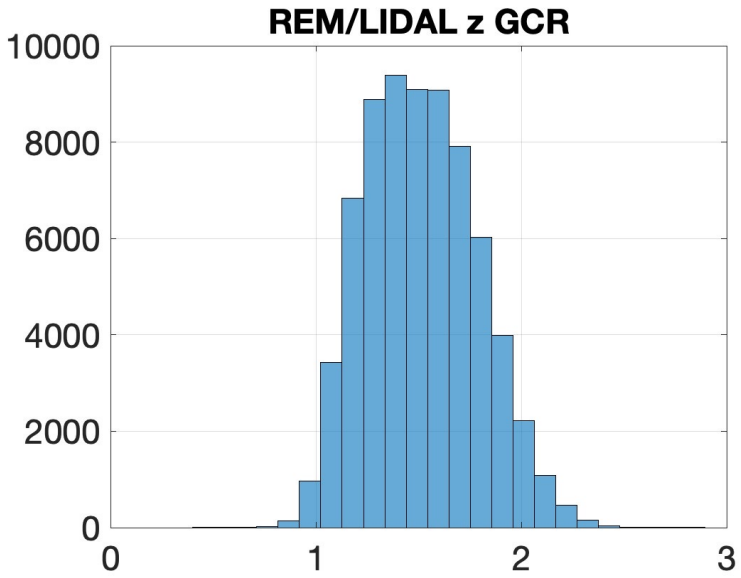
The dashed line considers a 39% geometrical shadow from the Earth

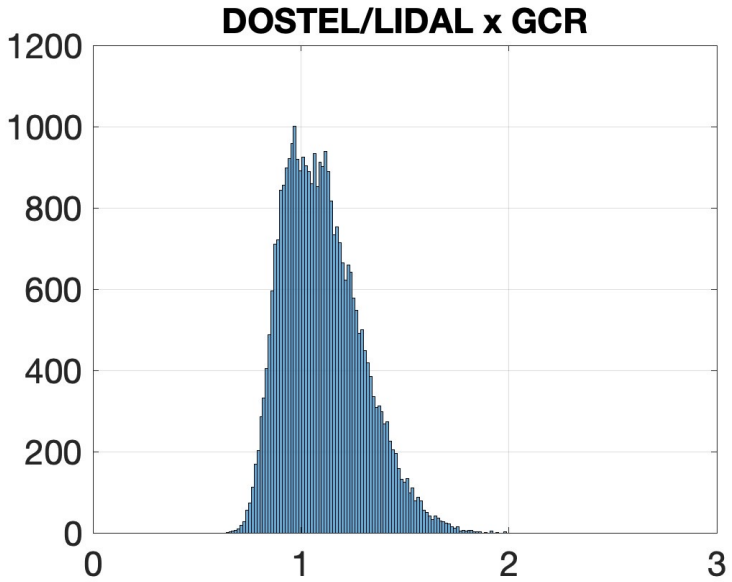
# Flux amplitude ratios in GCR

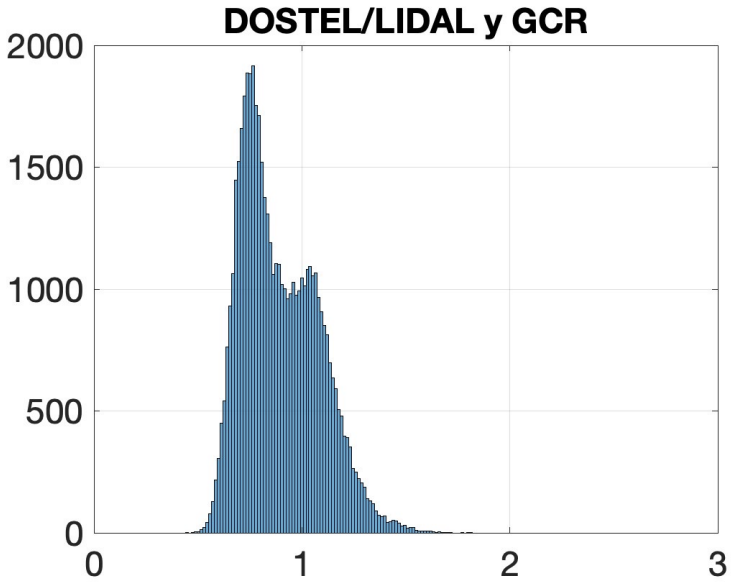




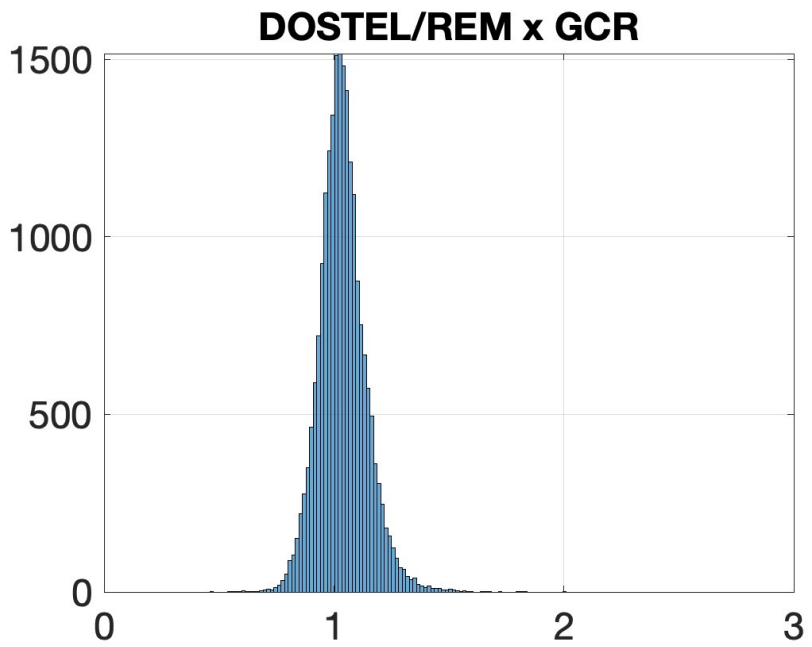



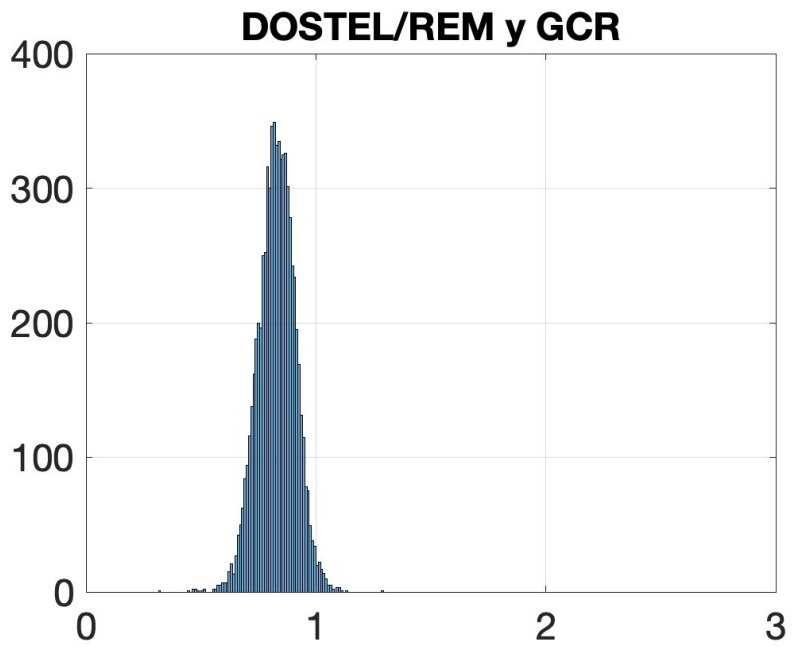



# Flux amplitude ratios in GCR

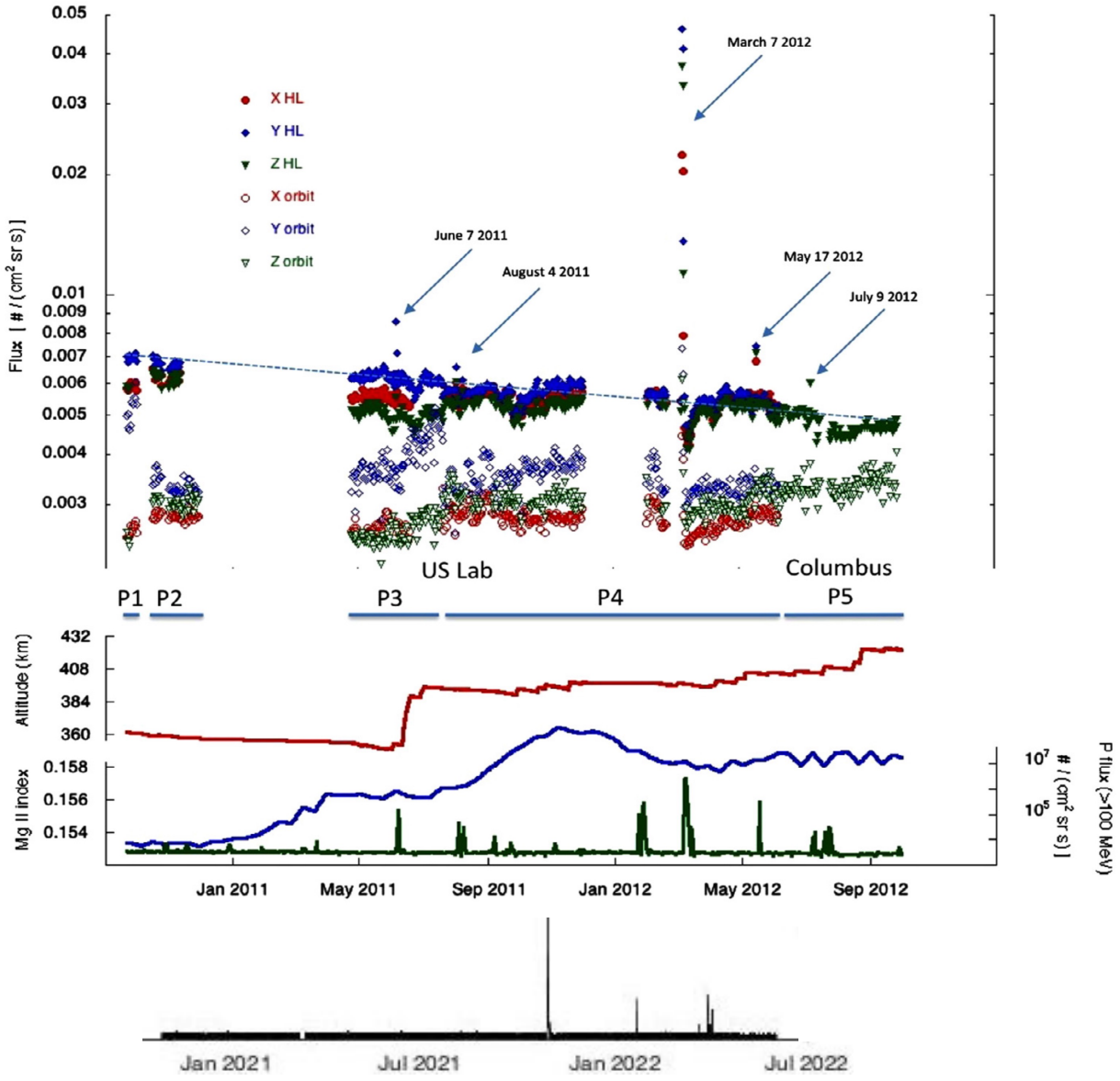




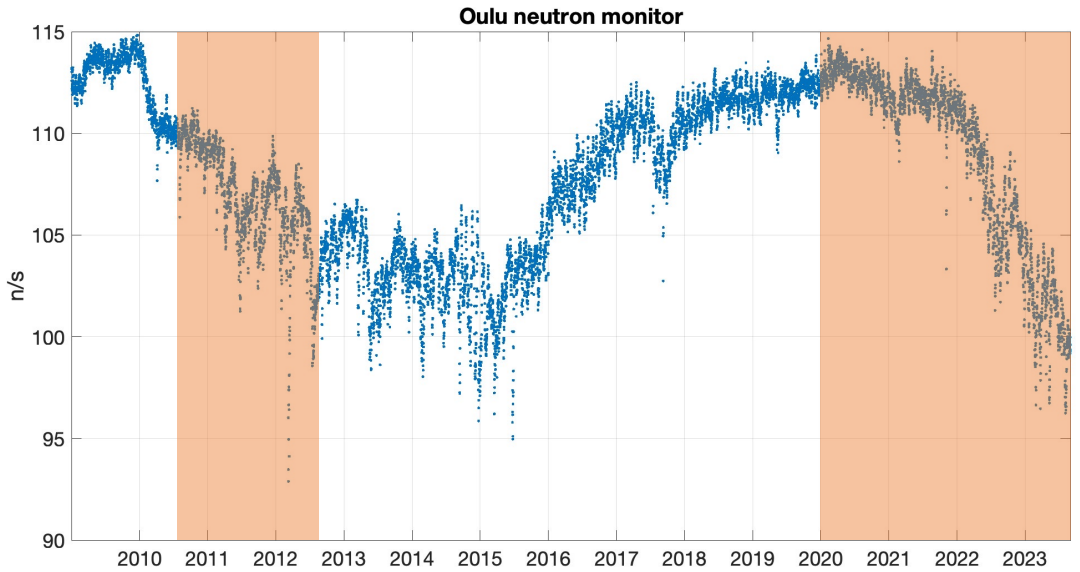



# SPEs old and new



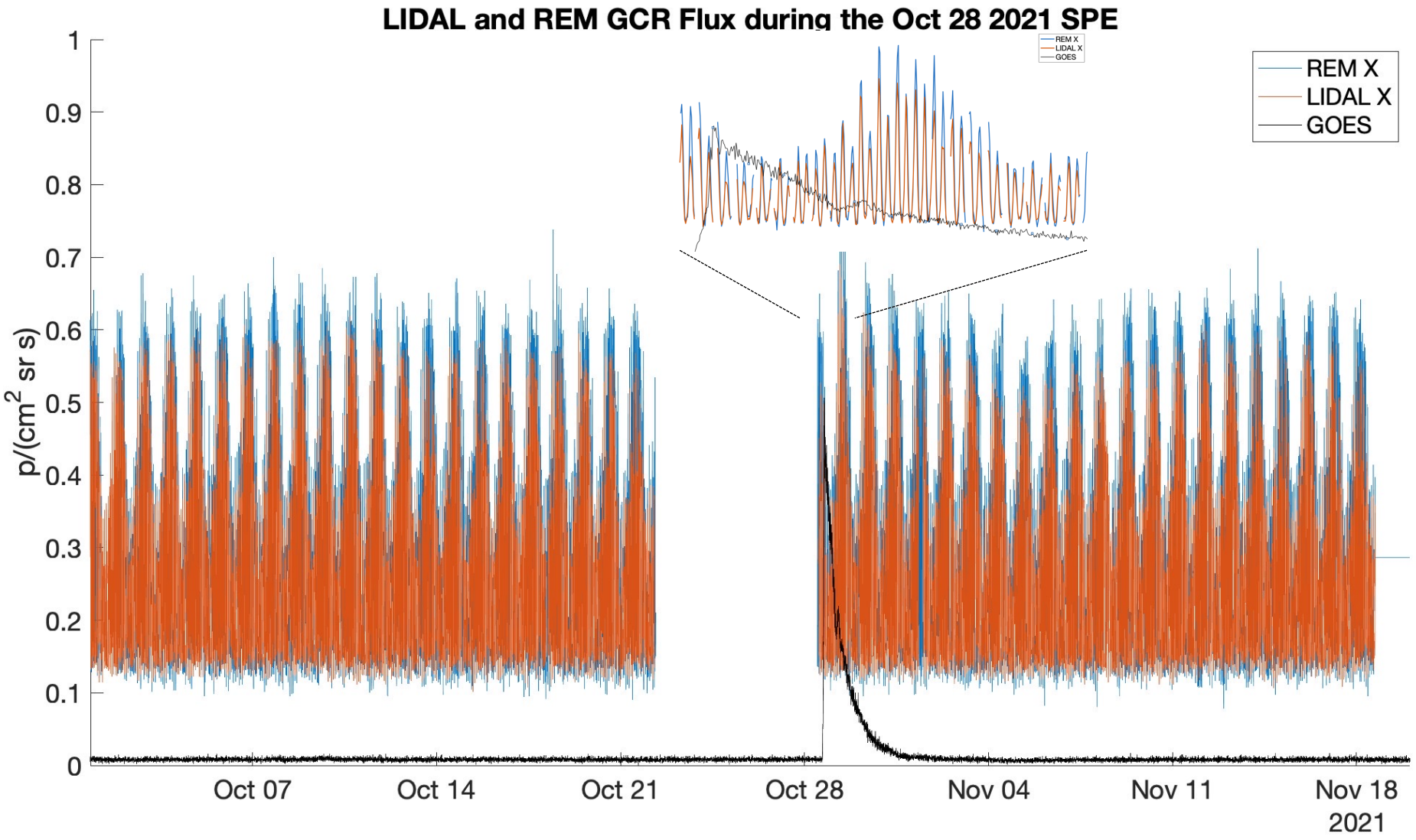



With respect with one solar cycle ago fewer SPEs and almost none in a period to be measured inside the ISS



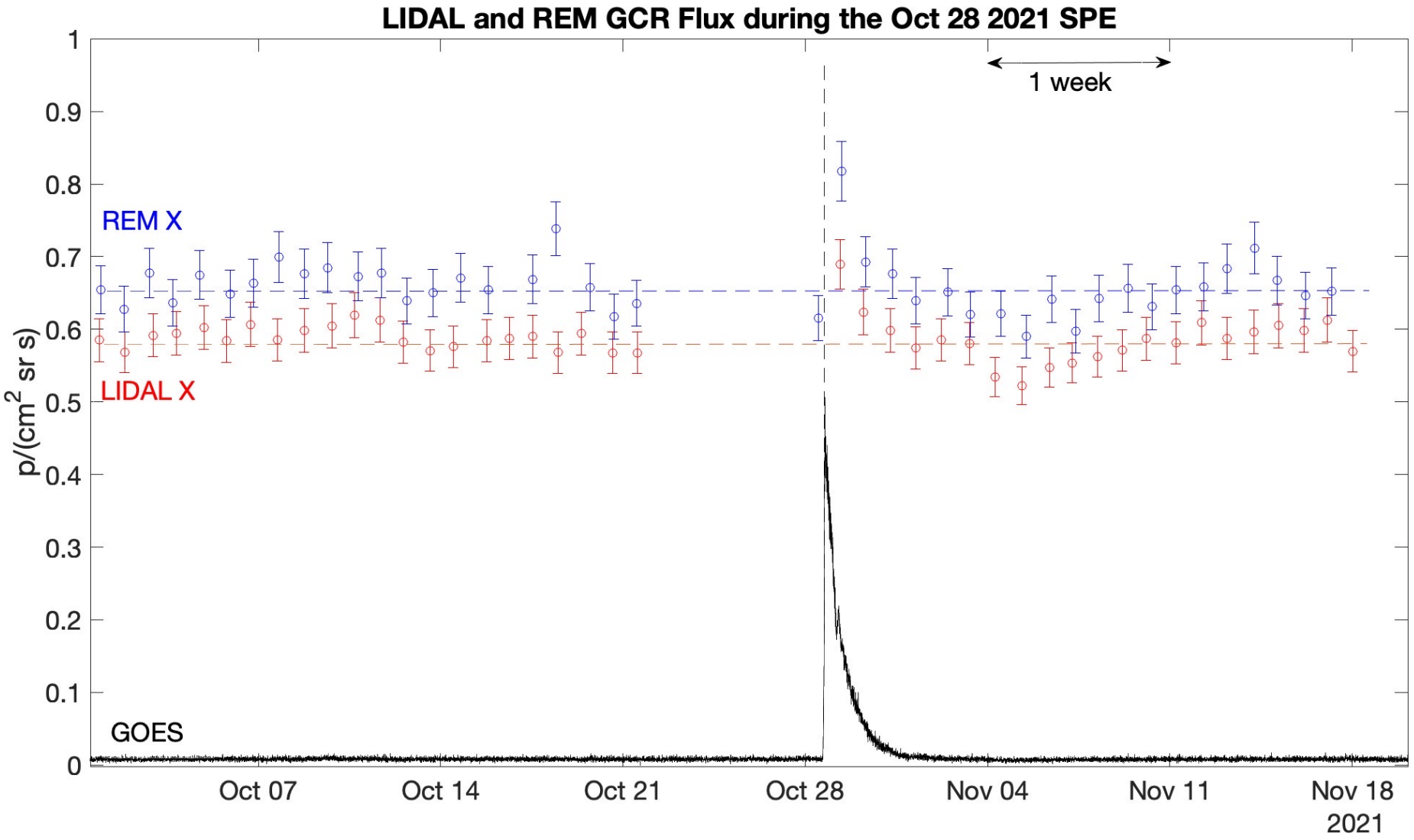
# SPE October 28th 2021





# SPE October 28th 2021





# Remarks



**The DORELI intercomparison had effects on**

→ Data refinements
→ Calibration refinements
→ SAA studies
→ SPE evaluations

**The major detector characteristics leading to differences in measurements:**

- Differences in geometrical acceptance of the detectors
  → difference in the shielding within view angle
  → difference in measuring non-isotropic radiation

- Differences in the triggering modes (energy acceptance)

- Reconstruction algorithms (especially for LIDAL and REM)
- How to consider the Earth shadow

# Take home messages and TDL



**Trivial things ←→ lengthy process:**

- Measurement units
- Date units
- Not availability of data for some periods (‘holes’)
- Ancillary data (Alt Lon Lat B L) {…. are all ancillary data OK?} - how to get them fast and correct
- GOES (or similar) availability

**Obvious messages ←→ good to repeat**

- Metadata are important: how to collect them in the most efficient way

**Initial proposal for a To Do List**

- Effort to **write** metadata and procedure (algorithms) in a usable (for all) and comparable way
- Work on the same set of cleaned data
- understand the differences to exploit the detectors
- Set up a ‘fast cycle’ analysis group

**Further**

- Spectra
- ‘Real time’
- Etc …

# DORELI take home messages and TDL



**Trivial things ←→ lengthy process:**

- Measurement units
- Date units
- Not availability of data for some periods (‘holes’)
- Ancillary data (Alt Lon Lat B L) {…. are all ancillary data OK?} - how to get them fast and correct
- GOES (or similar) availability

**Obvious messages ←→ good to repeat**

- Metadata are important: how to collect them in the most efficient way

**Initial proposal for a To Do List**

- Metadata and procedure (algorithms) in a usable (for all) and comparable way
- Use the same set of cleaned data
- understand the differences to exploit the detectors
- **Set up a ‘fast cycle’ analysis group**

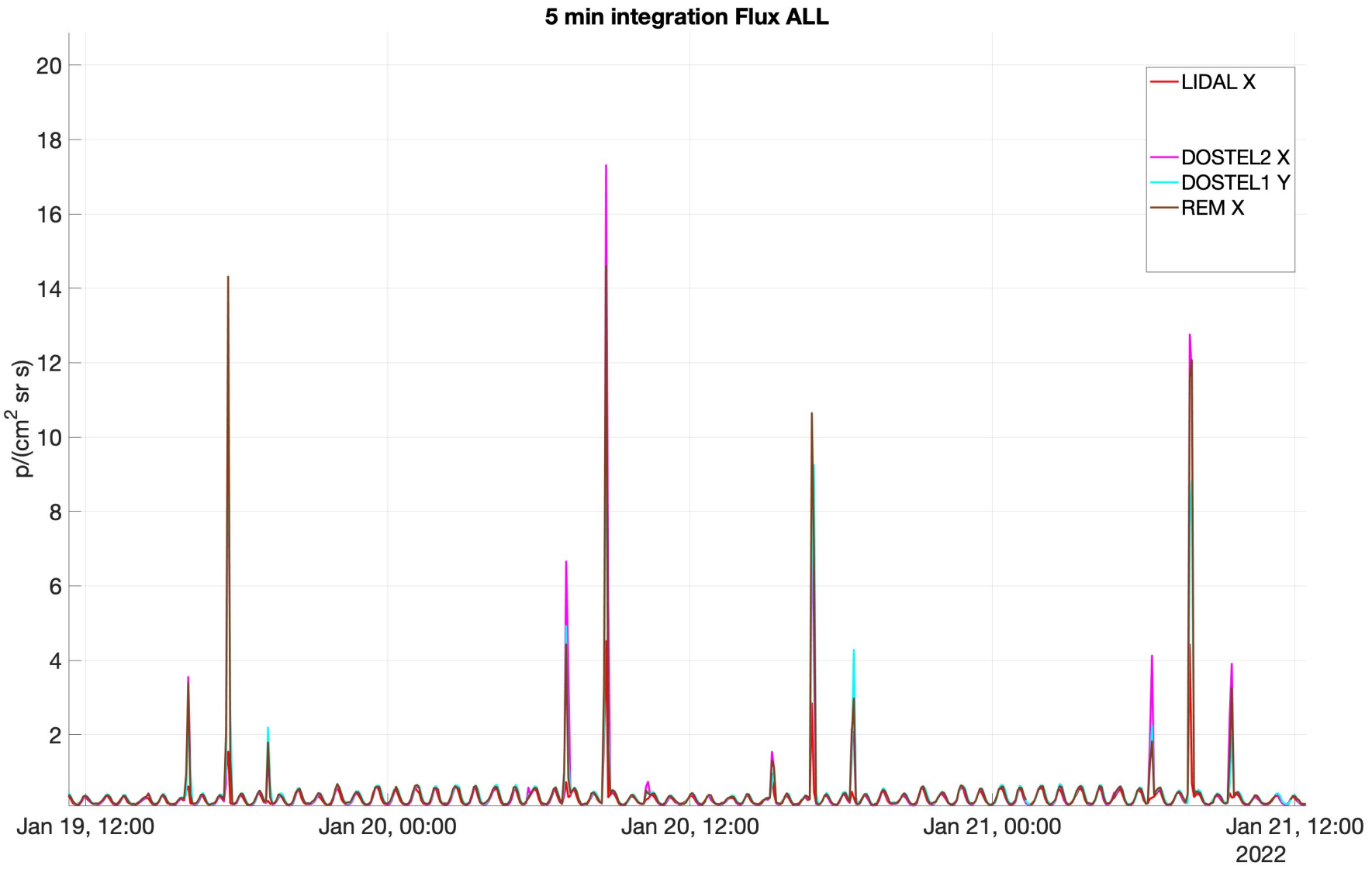
**Further**

- Spectra
- ‘Real time’
- Etc …

IN GREEN THE ISSUES THAT CAN BE SOLVED BY RadLab

# Flux rate 5 min, 2022 Jan 19th

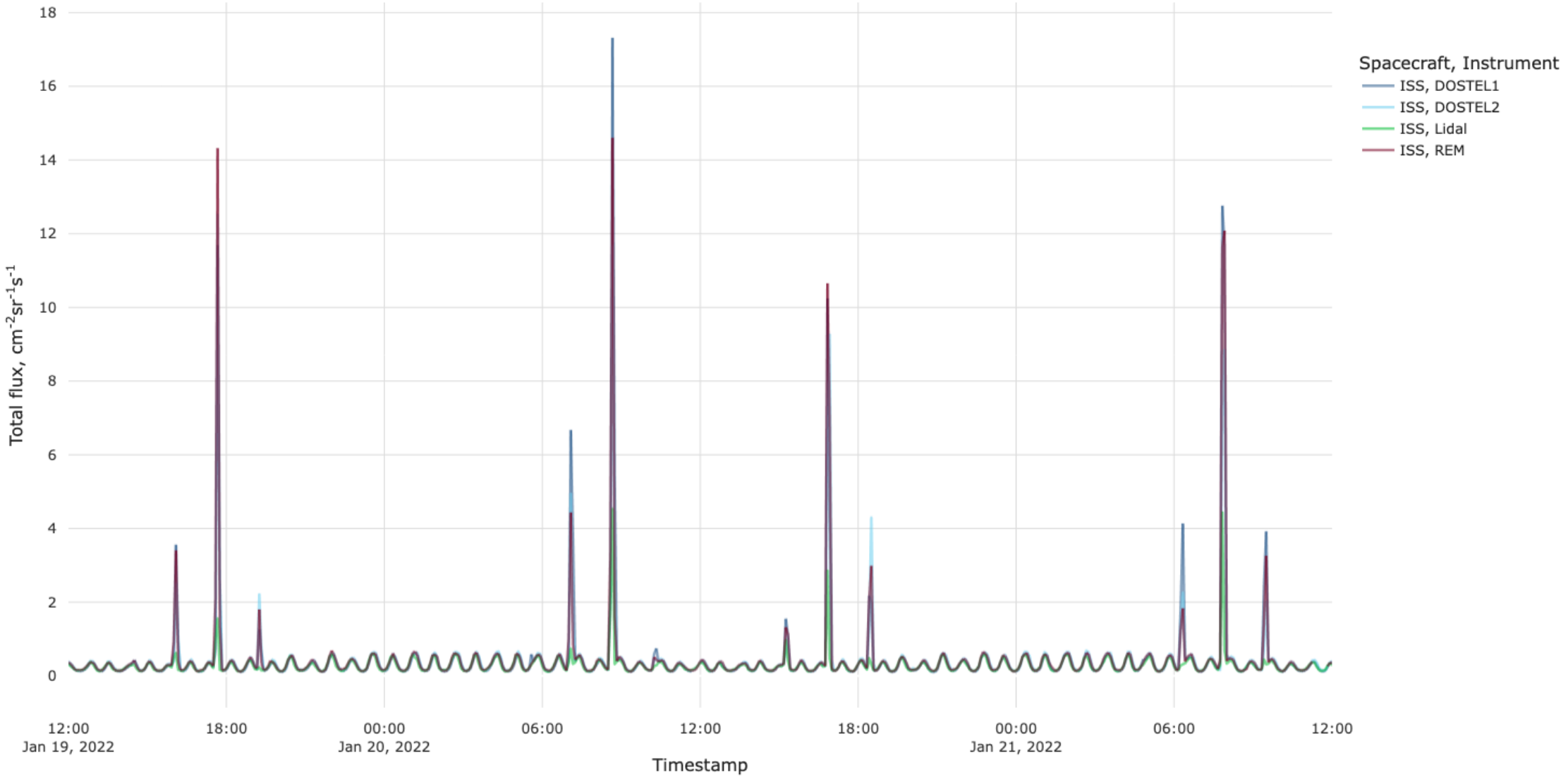




# Flux rate 5 min, 2022 Jan 19th



With RadLab:




http://osdr-visualization-stage-1.smce.nasa.gov/radlab/, https://forms.gle/3y2sAHLqPbf62hQ79

TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA
Dipartimento di Fisica

# The DORELI collaboration

HSERLAB
Human Space Exploration Radiation LAB

**LIDAL team**

Livio Narici
Virginia Boretti
Luca Lunati
Giulia Romoli*
Giorgia Santi Amantini
Luca Di Fino
Giorgio Baiocco
Alice Mentana

**REM team**

Kerry Lee*
Nic Stoffle
George Stuart
Tom Campbell-Ricketts
Andy Castro

**DOSTEL team**

Thomas Berger
Daniel Matthiae
Bartos Przybyla
Sönke Burmeister

*Thank you for your attention*

*and … please*

# COMMENTS! QUESTIONS!!