SPIRE Large (Scan) Map Mode

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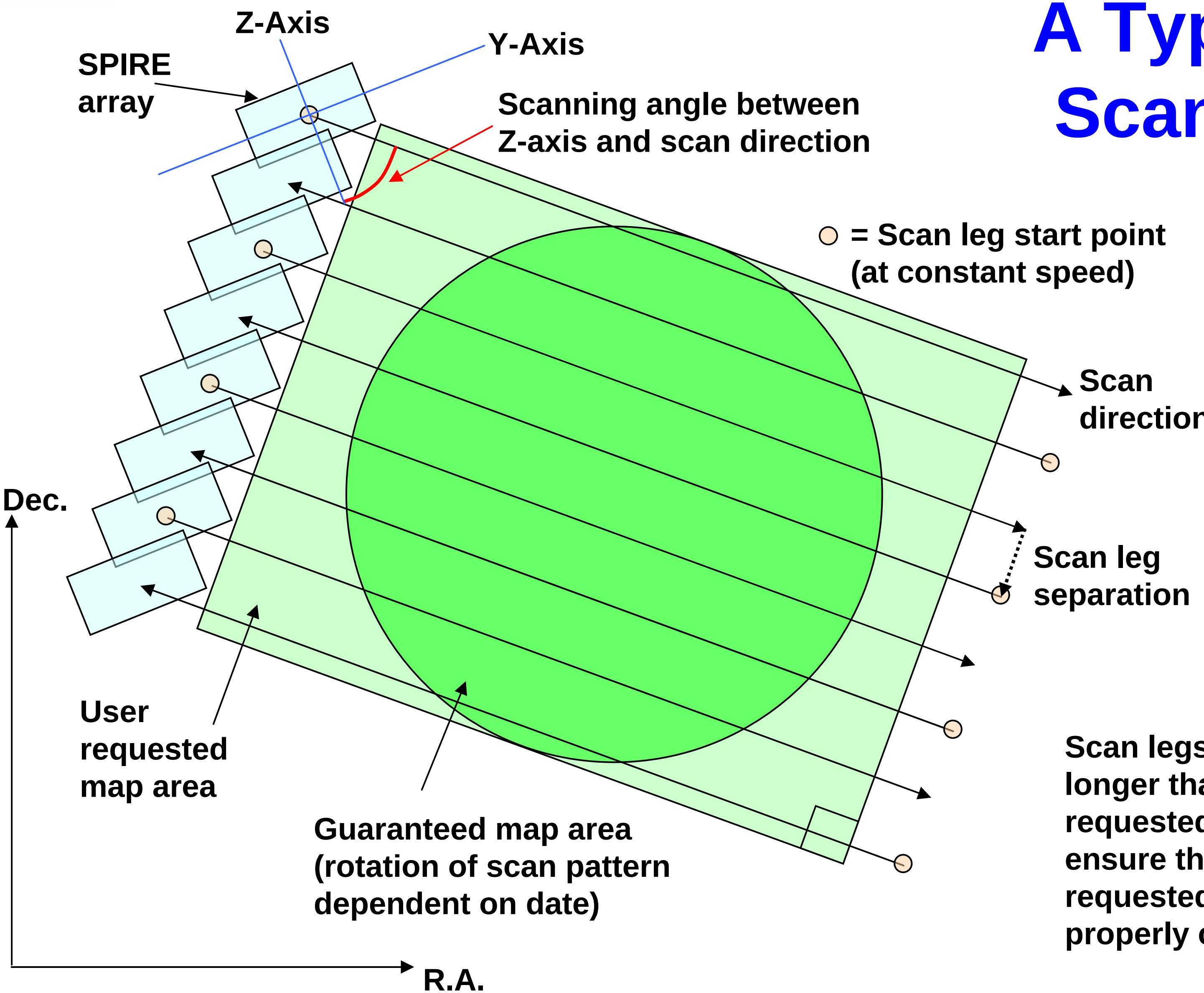
Scan Map Mode - An Introduction (1)

- Otherwise known as ‘Large Map’ in HSpot
- The most efficient mode for large maps
- The current default is to use this mode for any map area larger than a 4’ diameter circle (although this may change slightly)
- The SPIRE arrays cover the map area by building up overlapping strips of data while scanning at a constant speed (without chopping)
- The telescope scans at an angle to the SPIRE array axis, to ensure that the map area is fully sampled by the unfilled arrays
- All three wavelengths are observed simultaneously in the same 4’x8’ FoV

Scan Map Mode - An Introduction (2)

- **Default scan speed is 30”/s**
- **Maximum scan length is 1189’ = 19.82°**
- **Maximum cross-scan length is 240’ = 4°**
- **Scan legs follow great circles on the sky**
- ***Current* default is to use ‘long’ axis scanning (see later slides)**
- **User will have no control over the scan angle or scan speed (these have been fixed for optimum observing for most cases)**
- **Cross-linked observations are not currently implemented but will be at some point**
- **Sensitive to all spatial scales, up to the size of the map itself**

A Typical Scan Map



Scan legs are slightly longer than the user requested length, to ensure the user requested area is properly covered

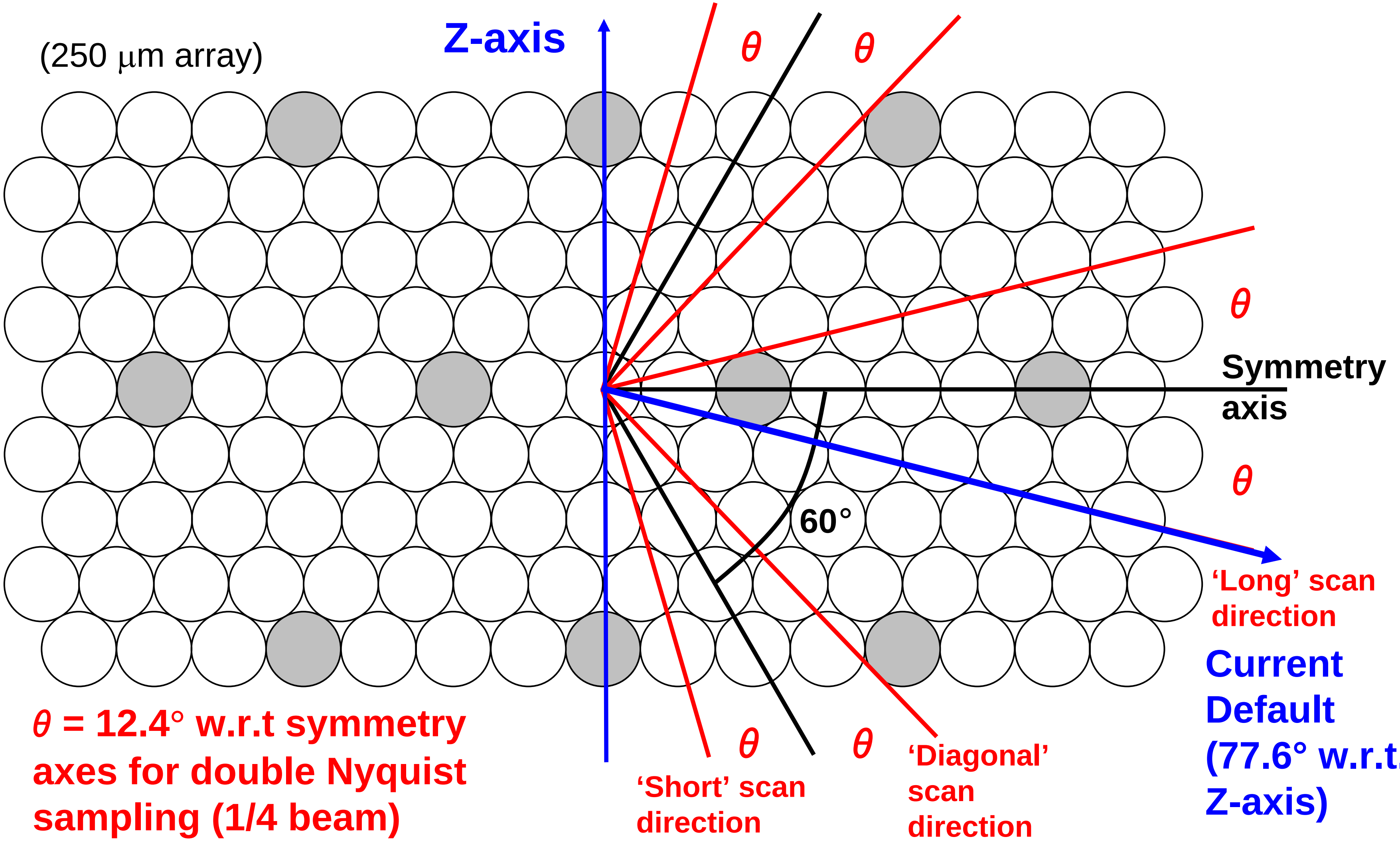
Some Points to Note

- 'On-source integration time' in HSpot refers to the total time it takes to observe the map area (excluding overheads)
- This quantity does NOT determine the sensitivity
- Sensitivity is governed by the number of 'map repeats'
- No matter how big or small a map is, a single map repeat has the same 'effective integration time' on the sky and so the same sensitivity (which is roughly uniform across the map area)
- This leads to discrete sensitivity levels as map repeats are added to the observation ($\Delta S \propto N^{-0.5}$)
- For rectangular maps it is more efficient for the scan leg length to be > the cross-scan length (less turn around overhead) - Although this will be irrelevant once cross-linked observations are implemented

Overheads (wake up in 1 min)

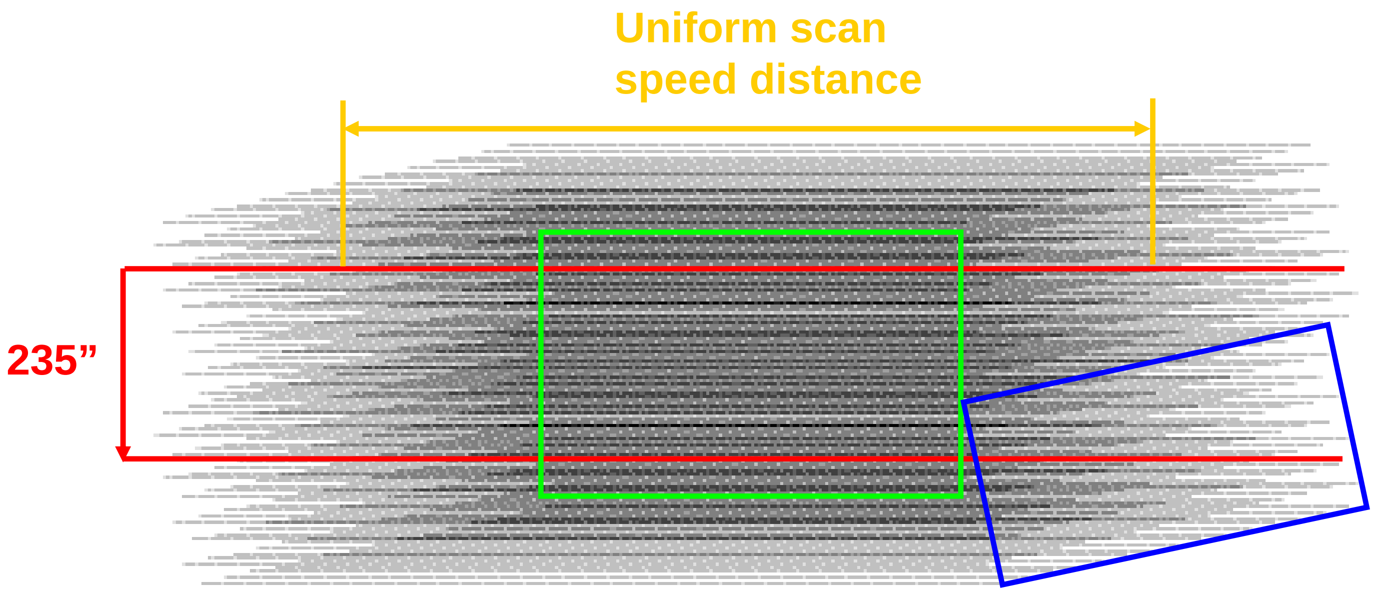
- Before each scan leg the Herschel spacecraft must accelerate up to the nominal scan speed (30”/s) and coast until the pointing accuracy has stabilised
- Currently this coast time is very large but we are working to reduce it (no guarantees)
- After each scan leg the spacecraft decelerates and traverses to an off map point before accelerating again for the next scan leg
- PCal calibration flashes are done about once per hour to keep track of the relative sensitivity of the detectors
- The larger the map the more efficient the observation

Possible Scan Directions



θ = 12.4° w.r.t symmetry axes for double Nyquist sampling (1/4 beam)

‘Long’ Axis Scanning - current default (77.6° w.r.t. Z-axis)

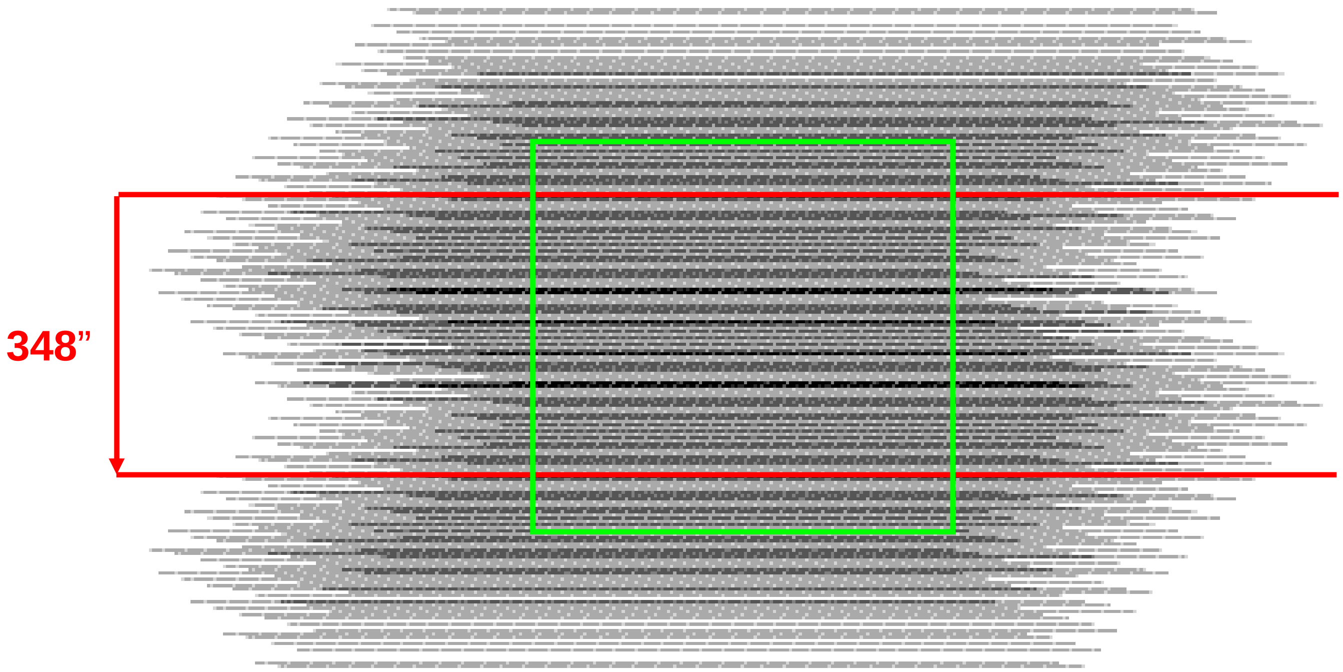


Scan leg

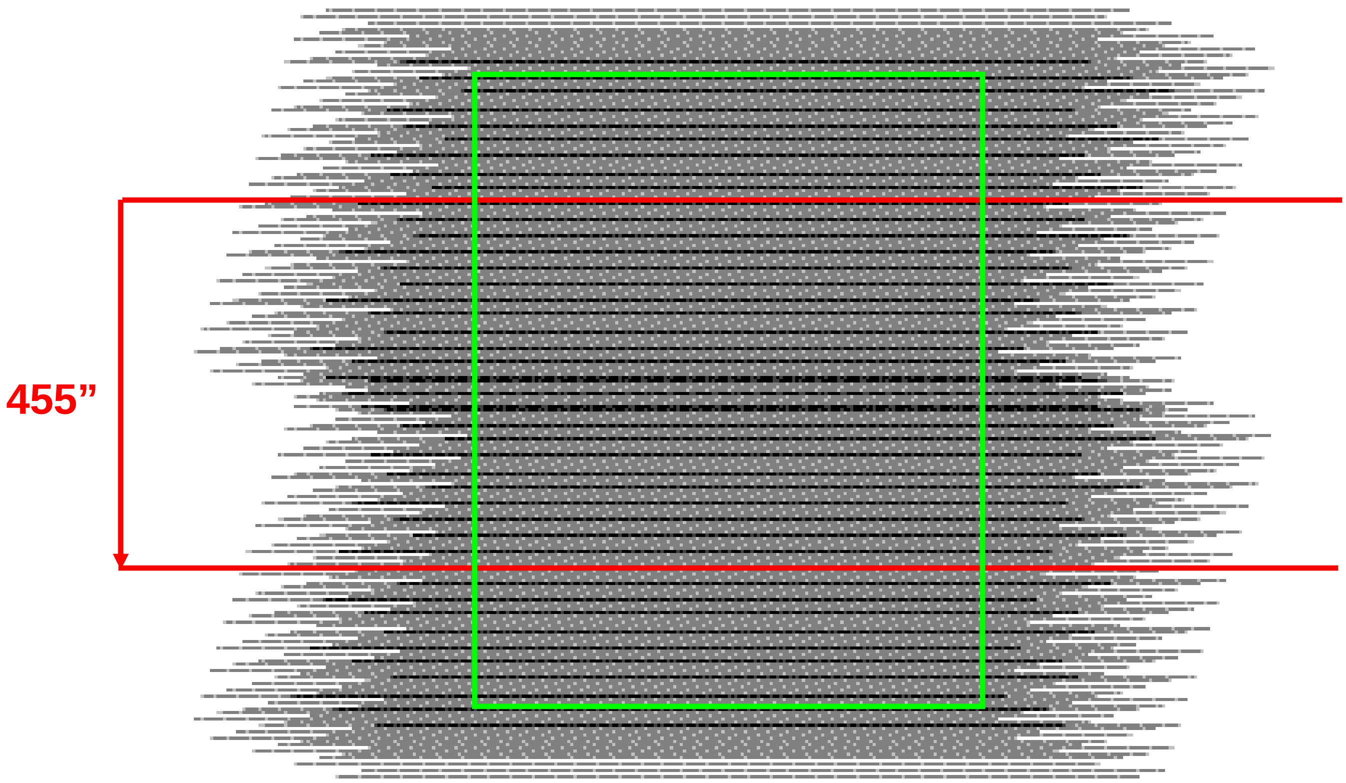
Map area covered to uniform sensitivity

SPIRE 250 μm array size

‘Diagonal’ Axis Scanning - for comparison (42.4° w.r.t. Z-axis)



‘Short’ Axis Scanning - for comparison (17.6° w.r.t. Z-axis)



Current HSpot Sensitivities*
(for long axis scanning at 30"/s)

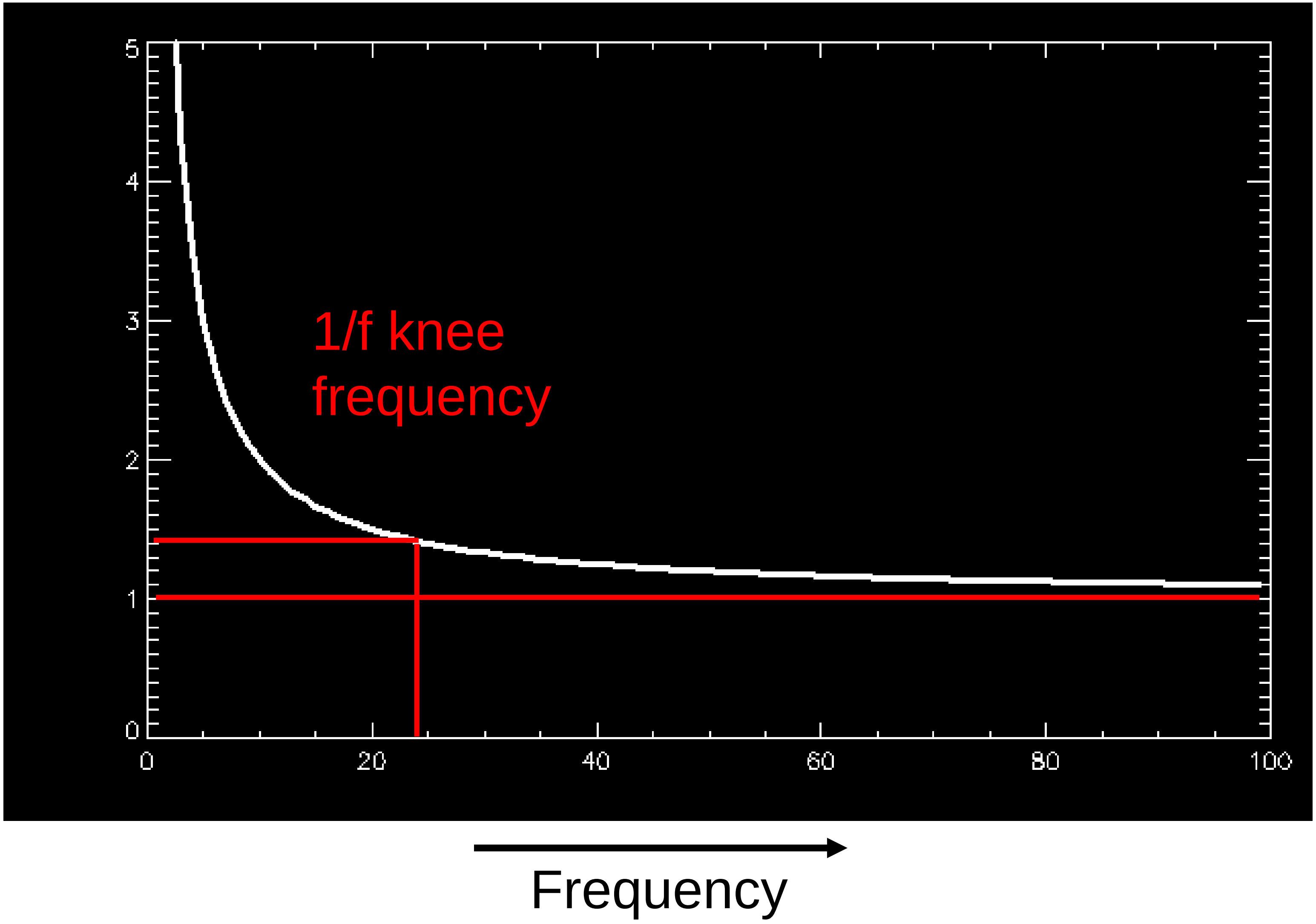
Array	250 μm	350 μm	500 μm
Effective integration time per map repeat (s)	16.6	17.8	18.2
ΔS (5 σ) for one map repeat (mJy)	55	75	65
Time to map 1 deg^2 to 3 mJy rms (hrs, excluding overheads)	8.6	15.3	11.7
Number of map repeats needed to reach 3 mJy rms	14	25	19

* likely to change by the time OT observations are performed but not by much

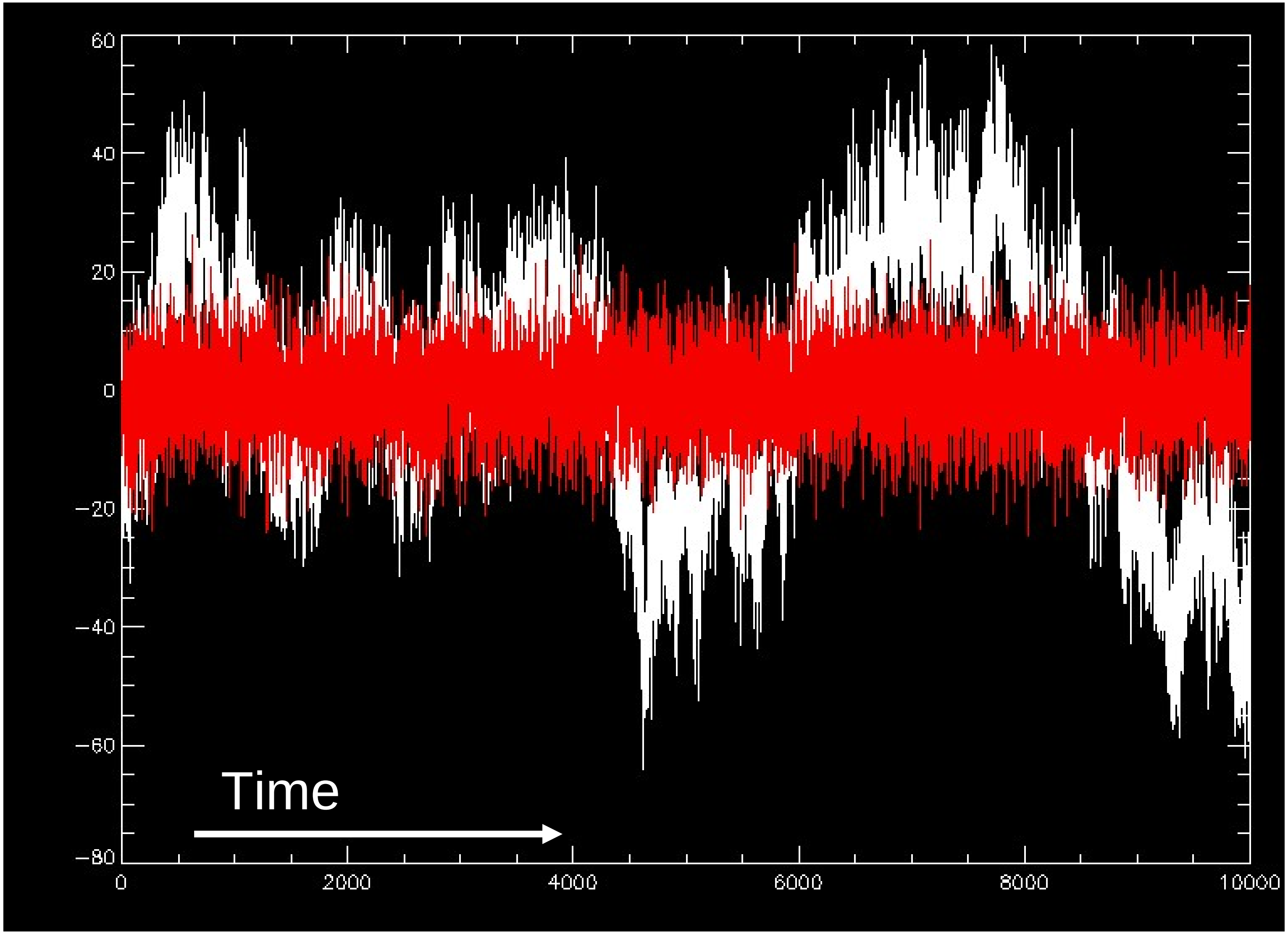
1/f Noise

- **Scan map mode is susceptible to 1/f noise, unlike jiggle map mode**
- **Both correlated and uncorrelated 1/f noise will be present**
- **Correlated 1/f noise can (will) be removed by the SPIRE data processing pipeline**
- **If left untreated 1/f noise can appear like large scale structure in the map (and can affect point source detection)**
- **Uncorrelated 1/f noise can be dealt with (to a lesser or greater degree) by performing cross-linked observations**
- **The SPIRE pipeline will include a map making stage that can take advantage of cross-linked observations to help reduce the effects of 1/f noise (based on the CMB code MADmap)**
- **Cross-linked observations are NOT currently possible in a single AOT but we are working to get this implemented**

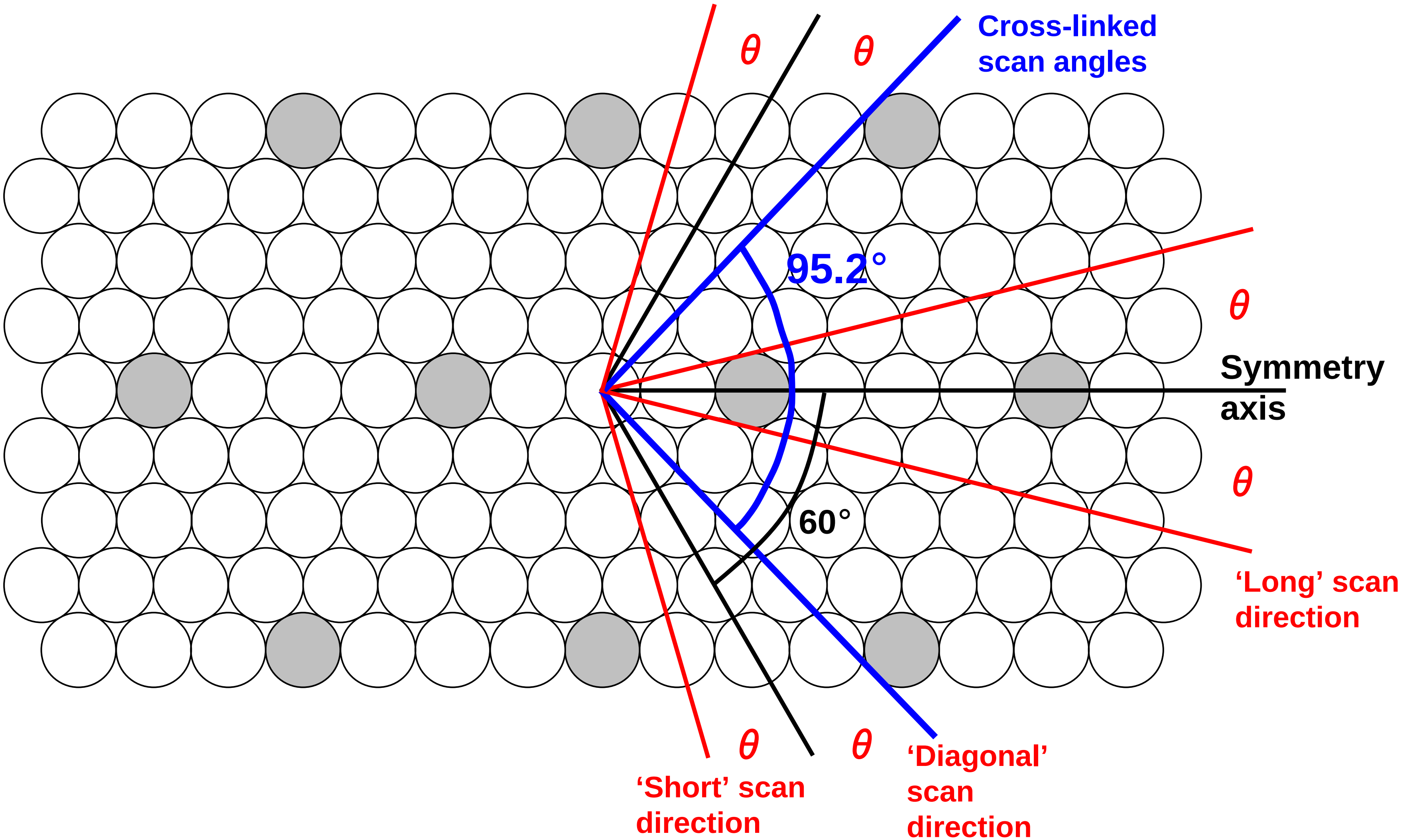
1/f Noise



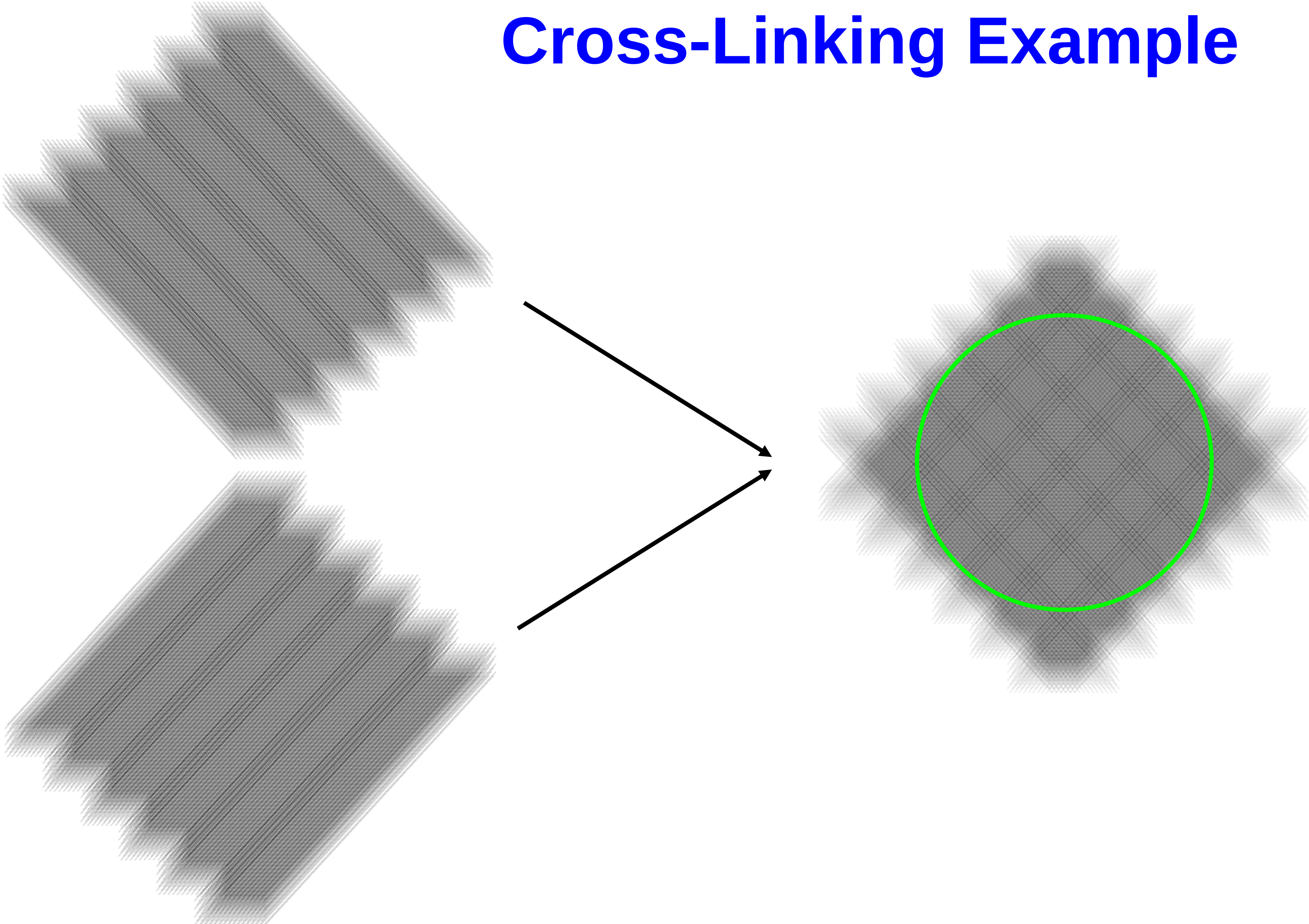
1/f Noise



Intended Cross-Linked Scan Directions



Cross-Linking Example



More Details

- **Refer to the AO for more details, including HSpot examples and how to implement a Large Map observation:**
- **http://herschel.esac.esa.int/Docs/SPIRE/html/spire_om.html**

- **Specifically:**
- **Chapter 3,** Chapter 3 ("*General Performance*")
- **Chapter 4,** Section 4.1 ("*Photometer AOT Modes*")
- **Chapter 6,** Sections 6.3 and 6.5 ("*HSpot Components for Setting up a SPIRE Photometer Observation*" and Example Photometer Observations)