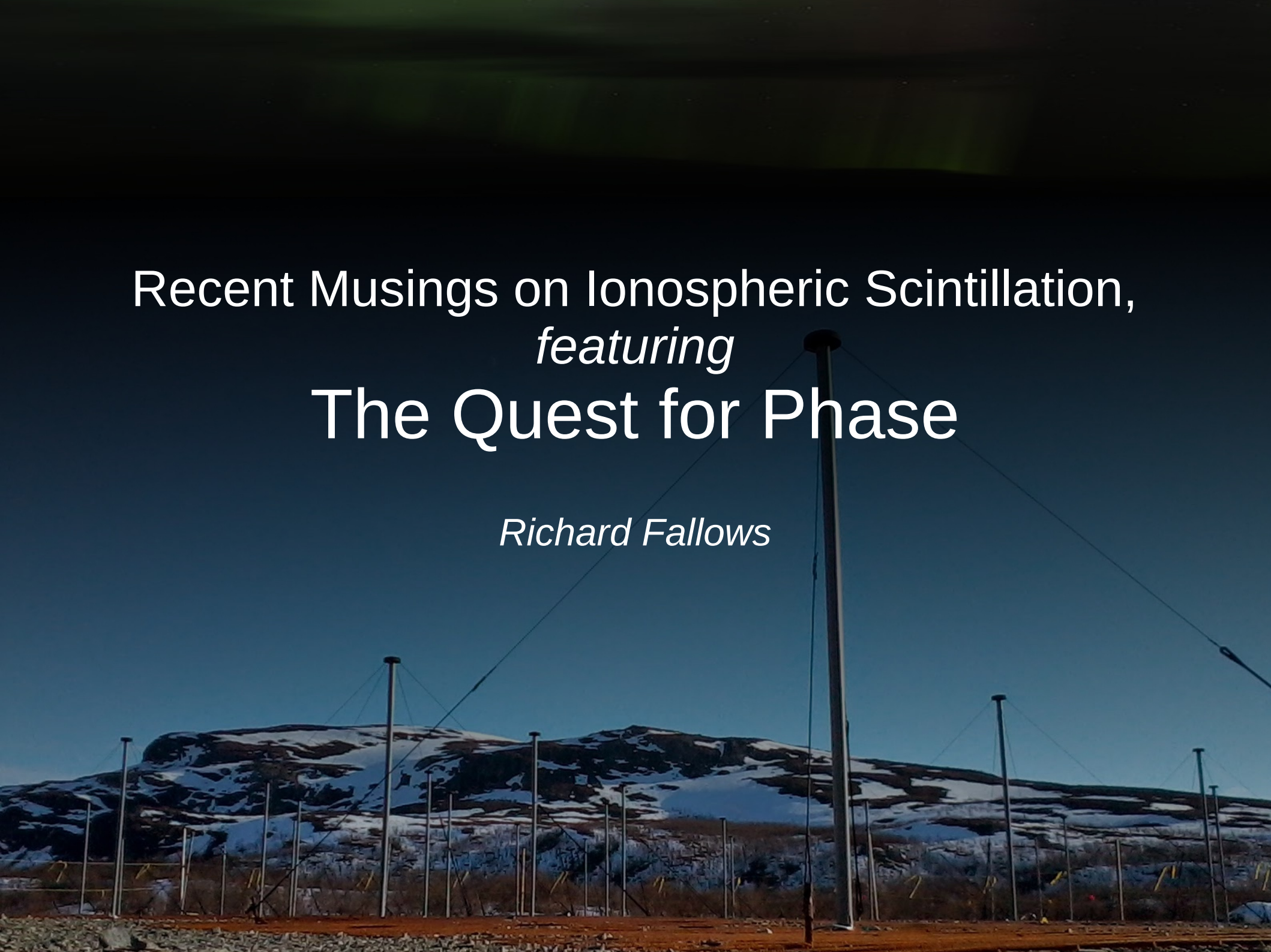


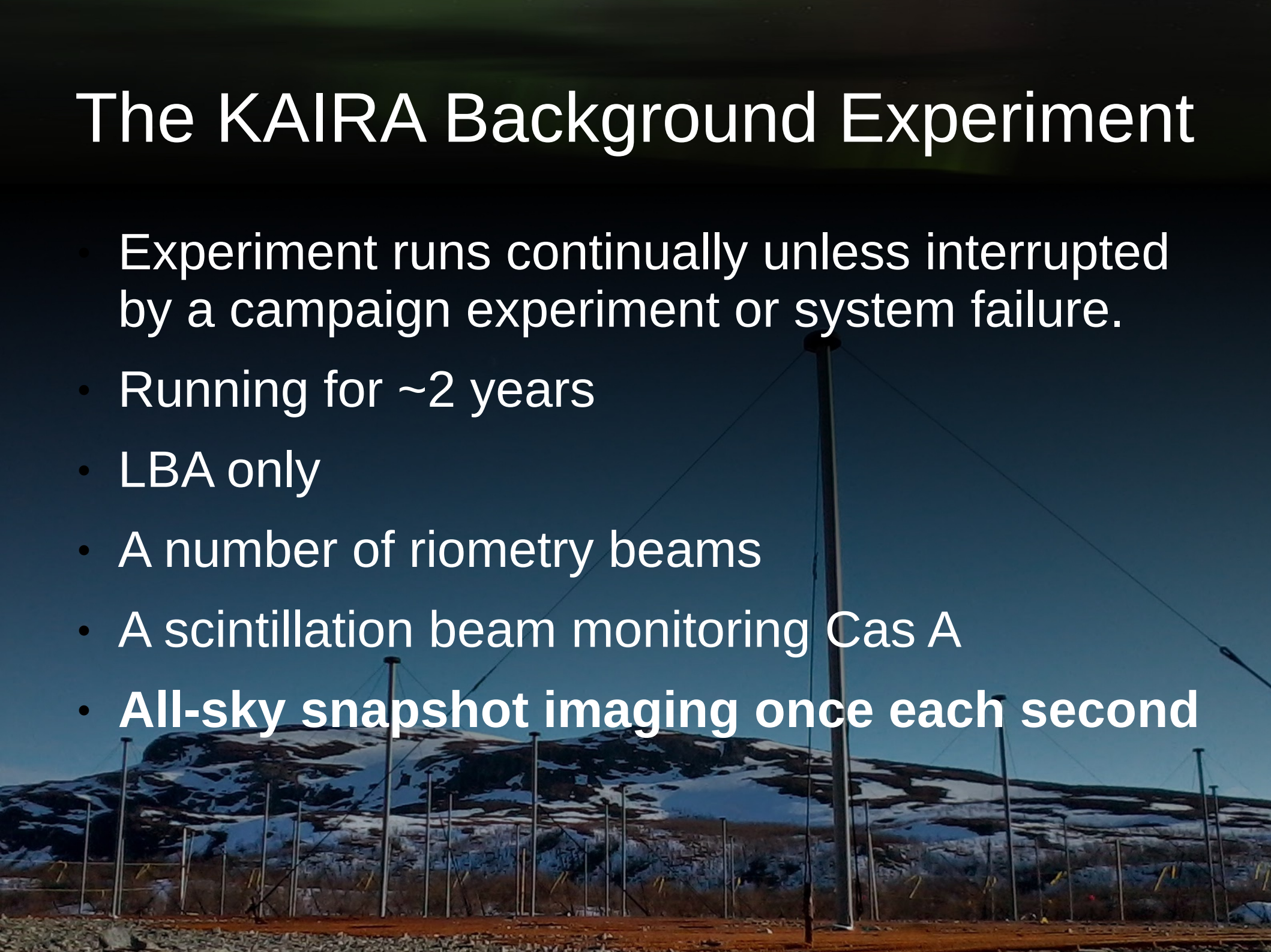
Recent Musings on Ionospheric Scintillation, *featuring* The Quest for Phase

Richard Fallows

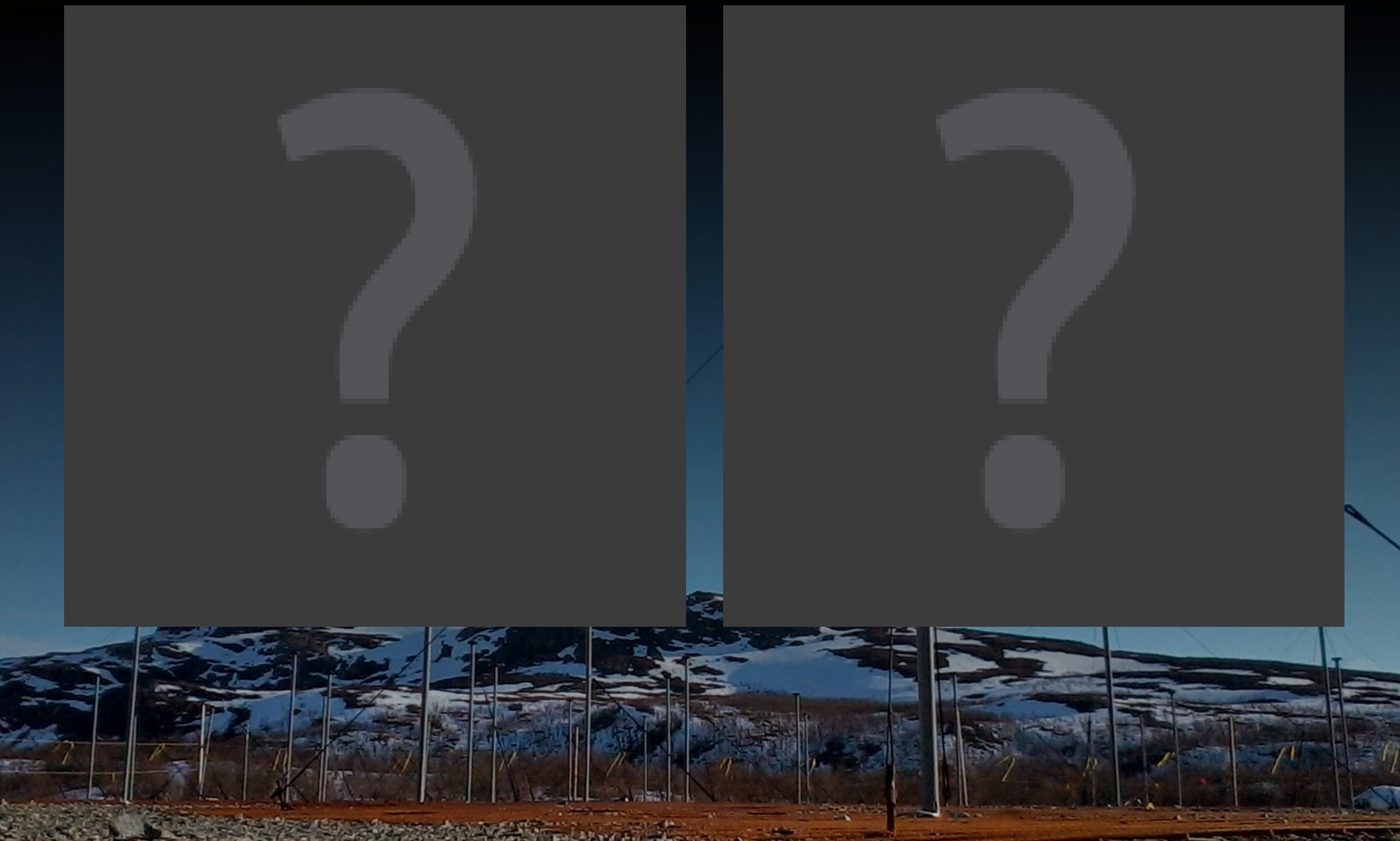
KAIRA – Kilpisjärvi Atmospheric Imaging Receiver Array

The KAIRA Background Experiment

- Experiment runs continually unless interrupted by a campaign experiment or system failure.
- Running for ~2 years
- LBA only
- A number of riometry beams
- A scintillation beam monitoring Cas A
- **All-sky snapshot imaging once each second**



KAIRA: Christmas Day 2013



Phase Scintillation!

Radio source moving around in a series of images can be directly translated as a phase shift of the incoming signal.

Rapid movement indicates rapid changes in phase – phase scintillation.

Unlike amplitude scintillation, it does not depend on interference between waves to “build up” an interference pattern.

It is a more direct measure of the scattering and allows probing of larger scale density structures than amplitude scintillation.

The van Cittert – Zernike Relation

$$V(u,v) = \int I(l,m)\, e^{-2\pi i (ul + mv)}\, dl\, dm$$

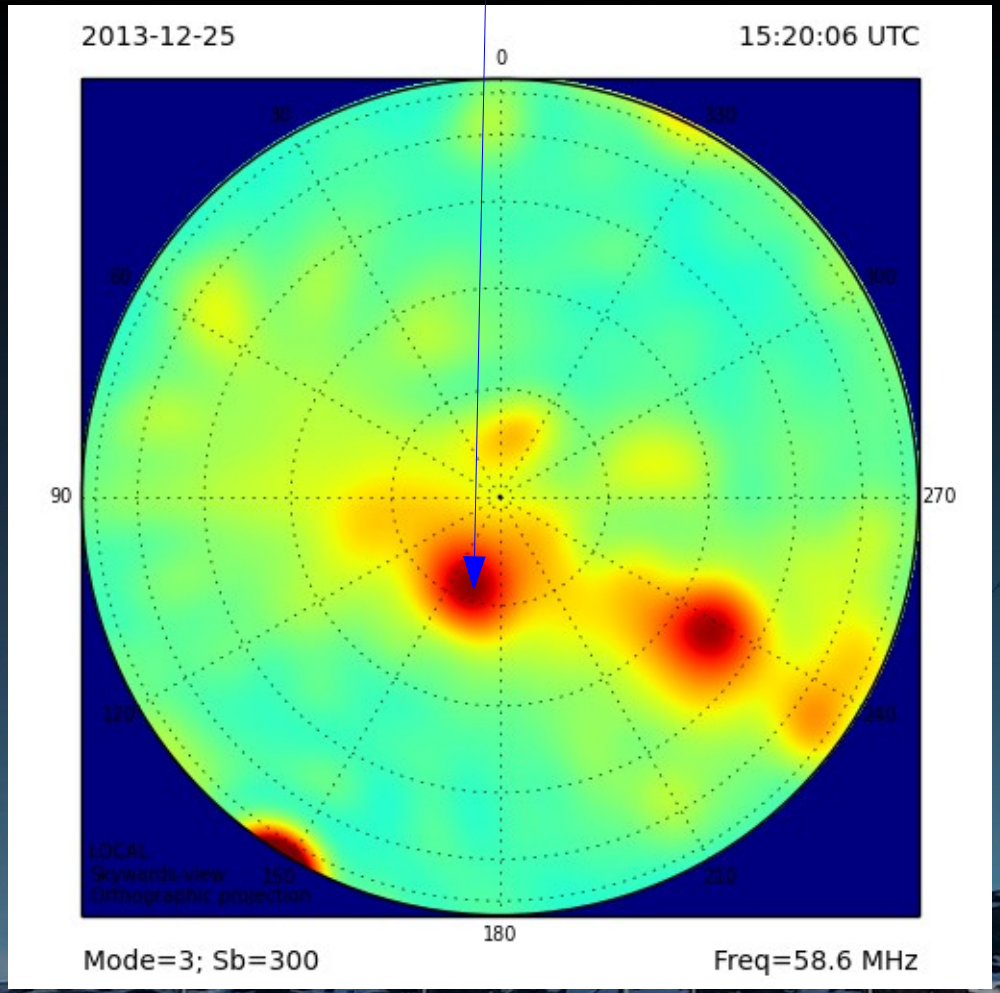
Complex “visibility”: cross-correlation of signal between two antennas with baseline u,v

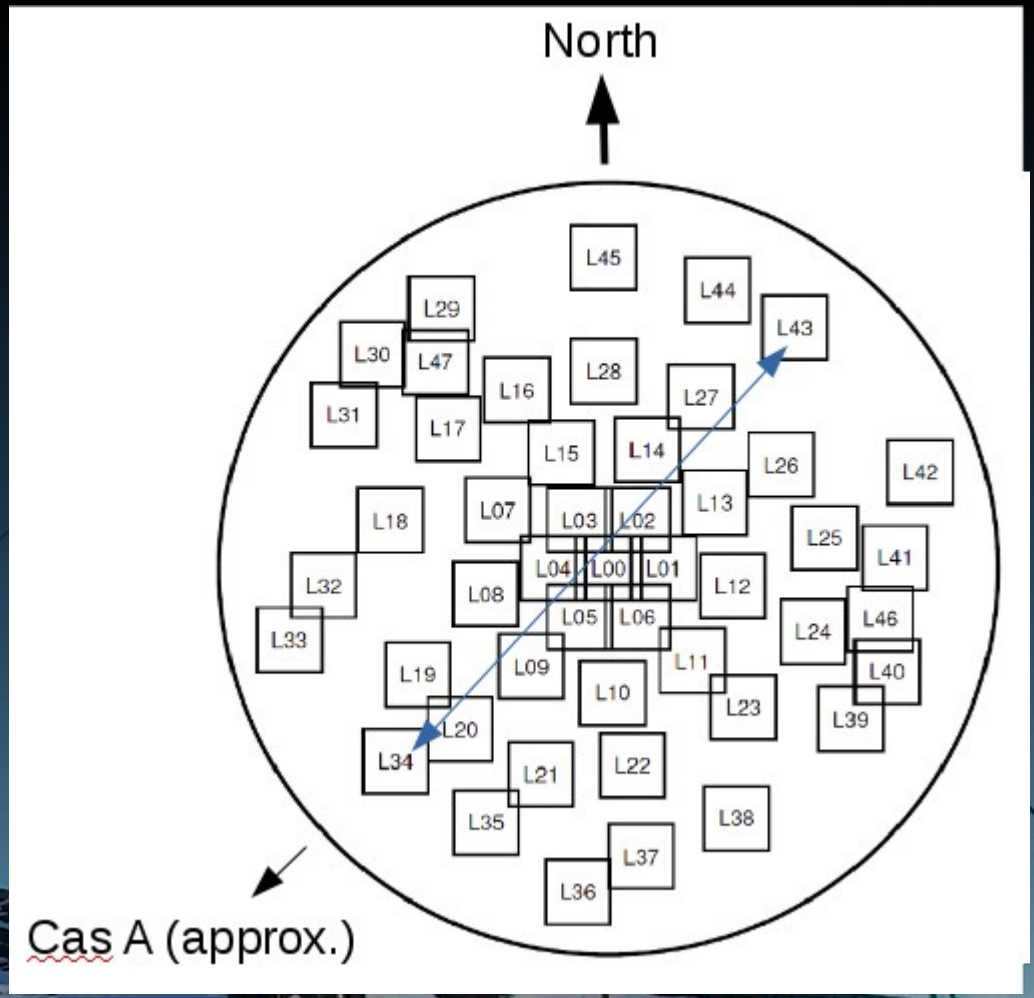
Image intensity: Pixel co-ordinates l,m correspond to baseline co-ordinates u,v

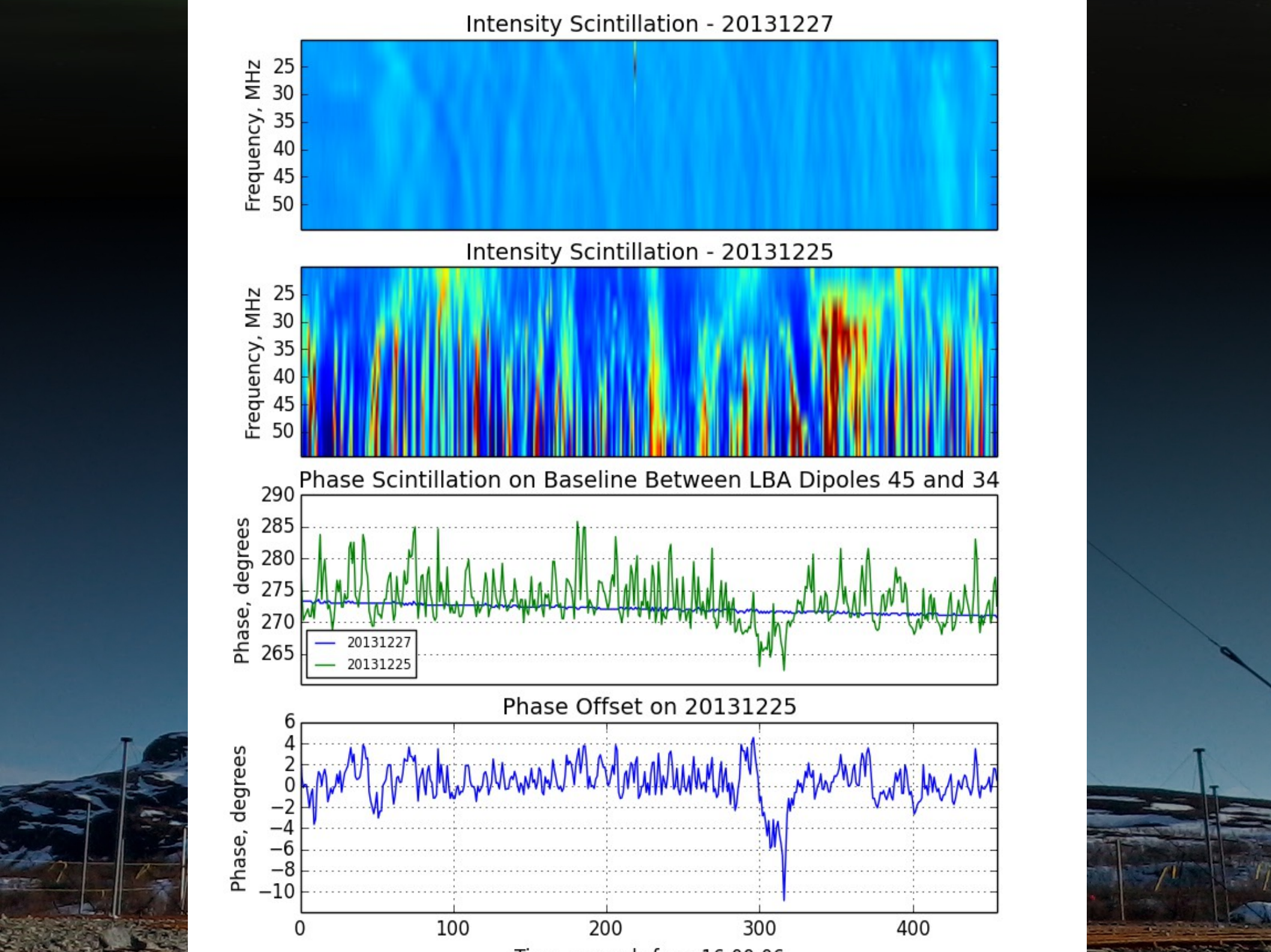
Phase term for given pixel co-ordinates and baseline

Source location plus offset from expected

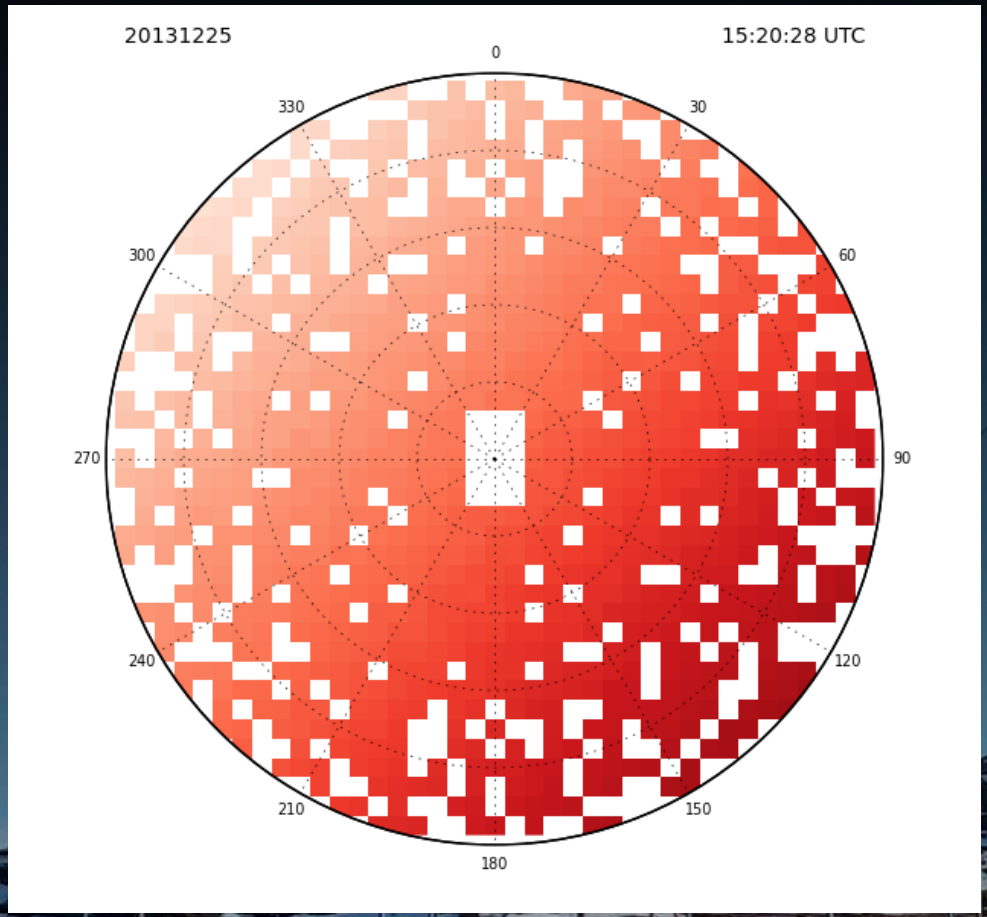
Antenna baseline

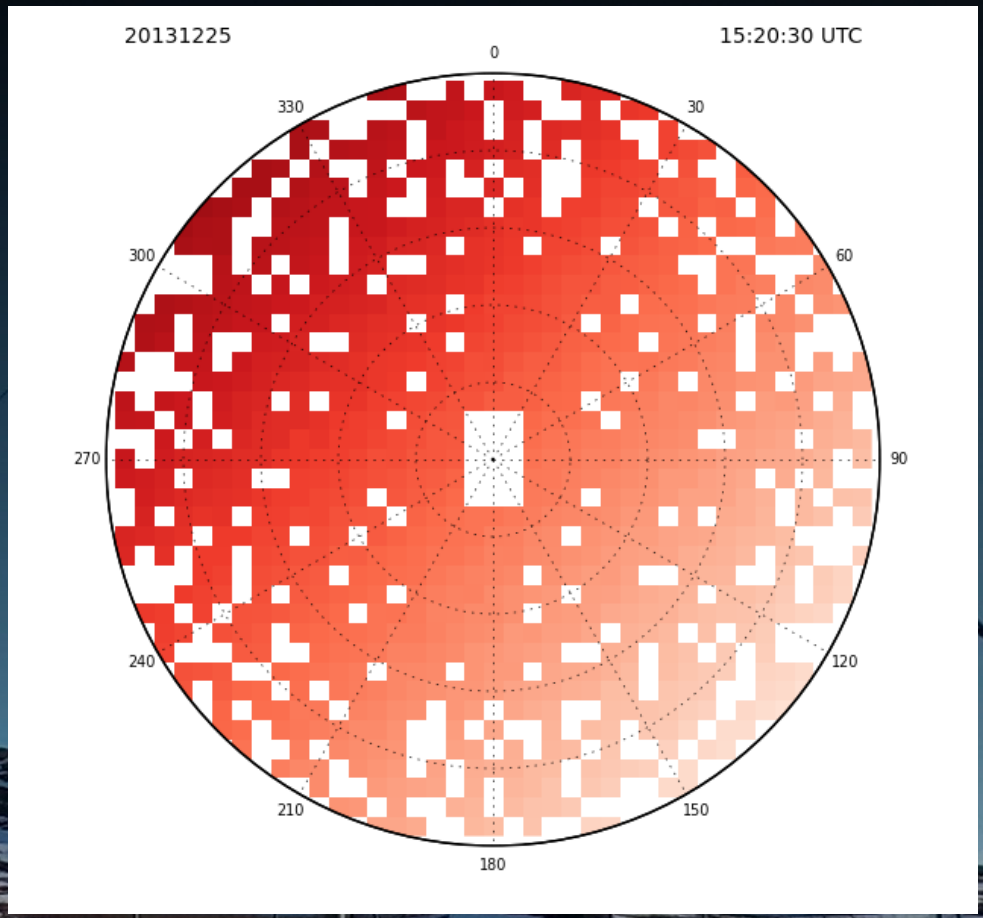




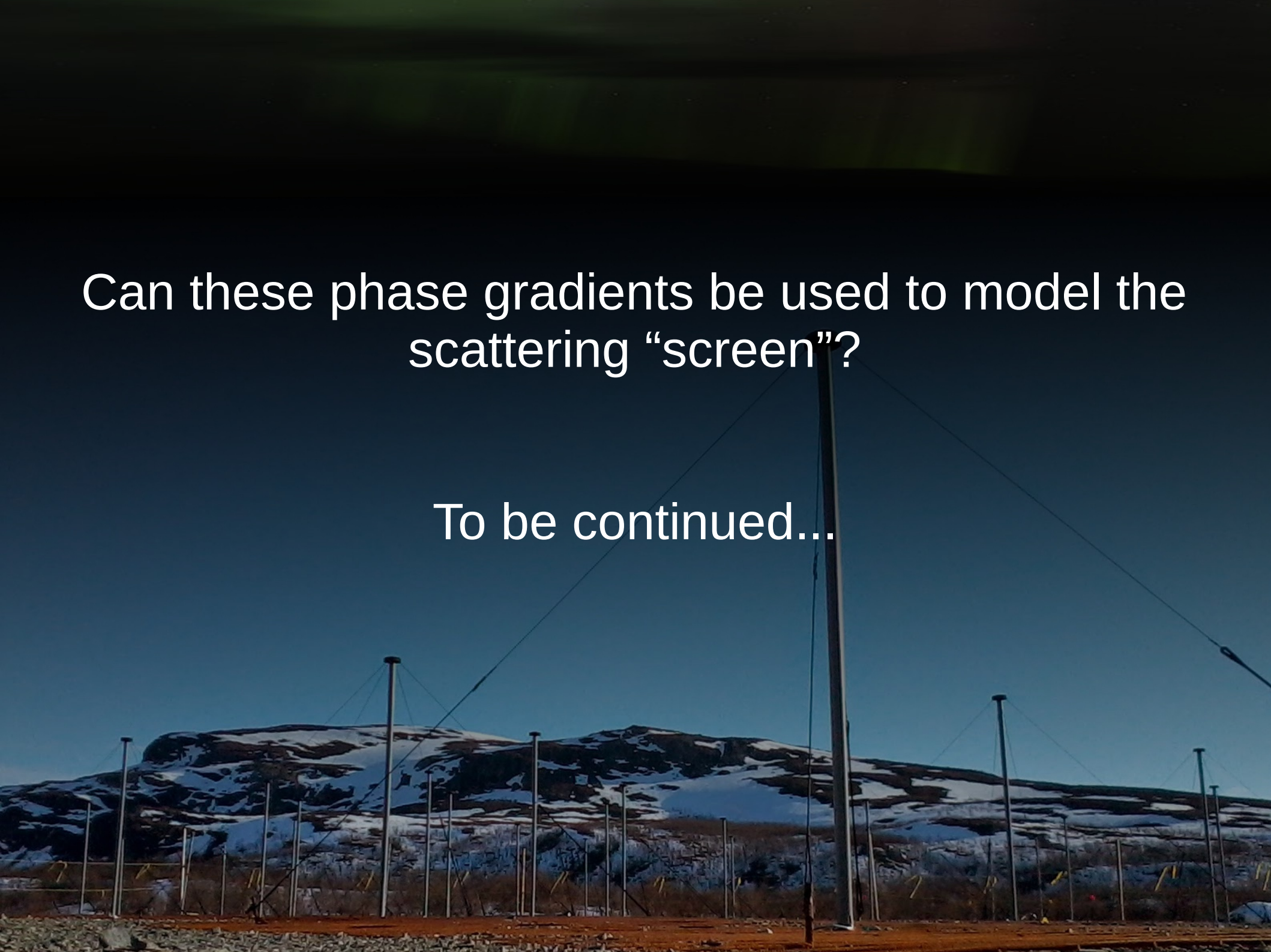

Intensity Scintillation - 20131227
Frequency, MHz
25
30
35
40
45
50
Intensity Scintillation - 20131225
Frequency, MHz
25
30
35
40
45
50
Phase Scintillation on Baseline Between LBA Dipoles 45 and 34
Phase, degrees
290
285
280
275
270
265
20131227
20131225
Phase Offset on 20131225
Phase, degrees
6
4
2
0
−2
−4
−6
−8
−10
0
100
200
300
400

Calculate phase gradient across array by subtracting phases for every baseline for expected source position from phases for measured source position.



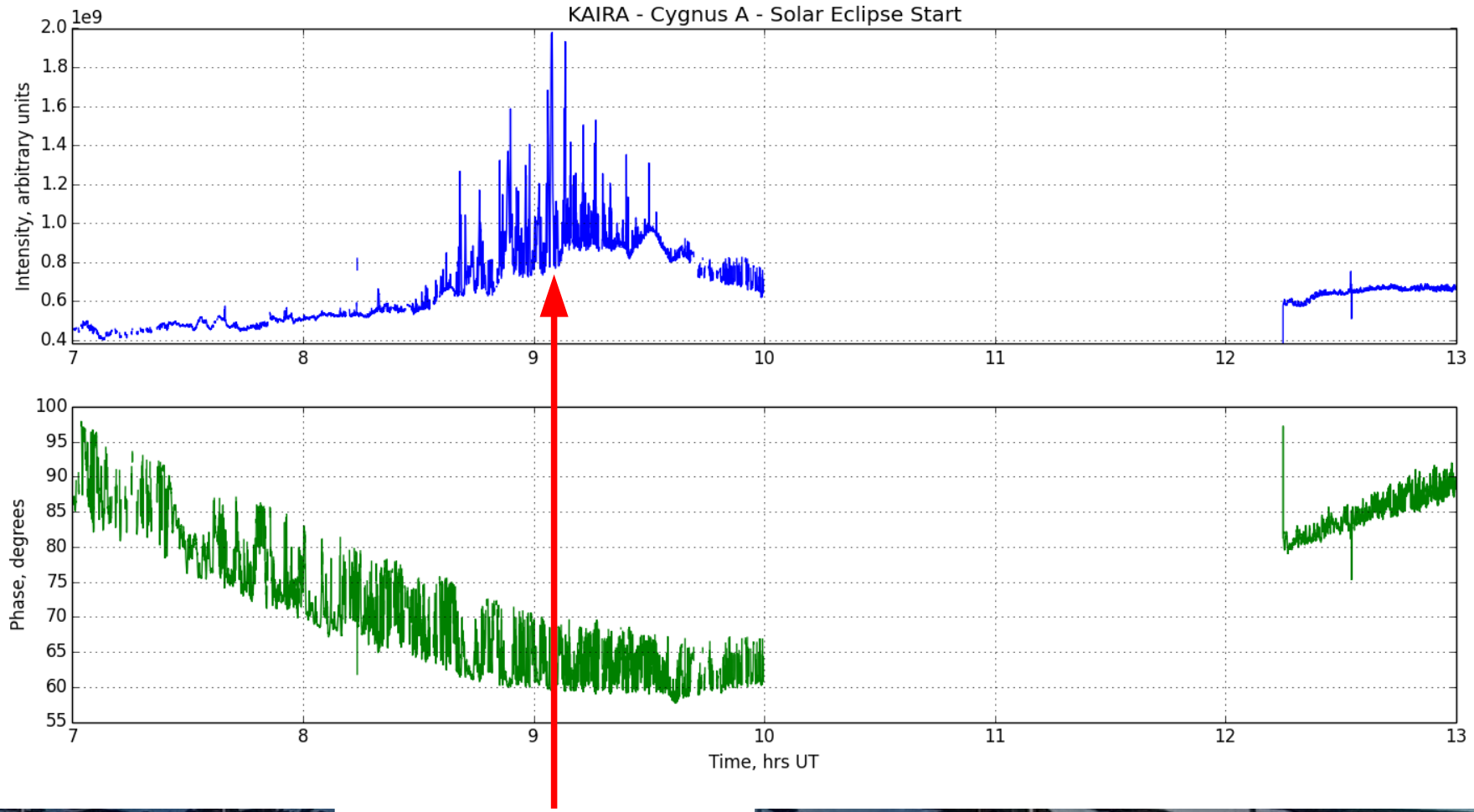


Images are two seconds apart


Can these phase gradients be used to model the scattering “screen”?
To be continued...

The Solar Eclipse from KAIRA

The Solar Eclipse from KAIRA



Start of visible eclipse


Coffee Time...