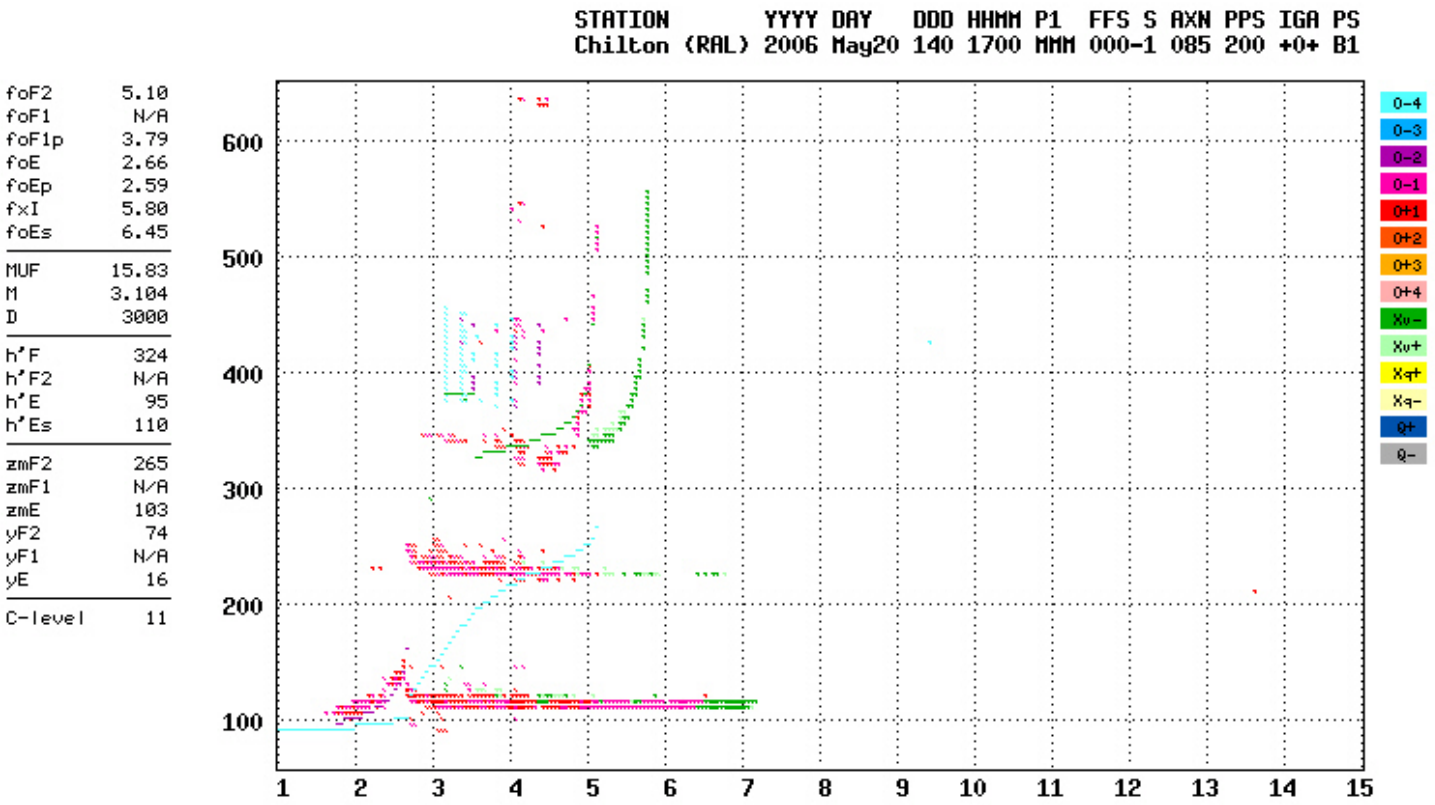
# Practical investigation of the polarisation of 50MHz signals

**Chris Deacon, G4IFX**

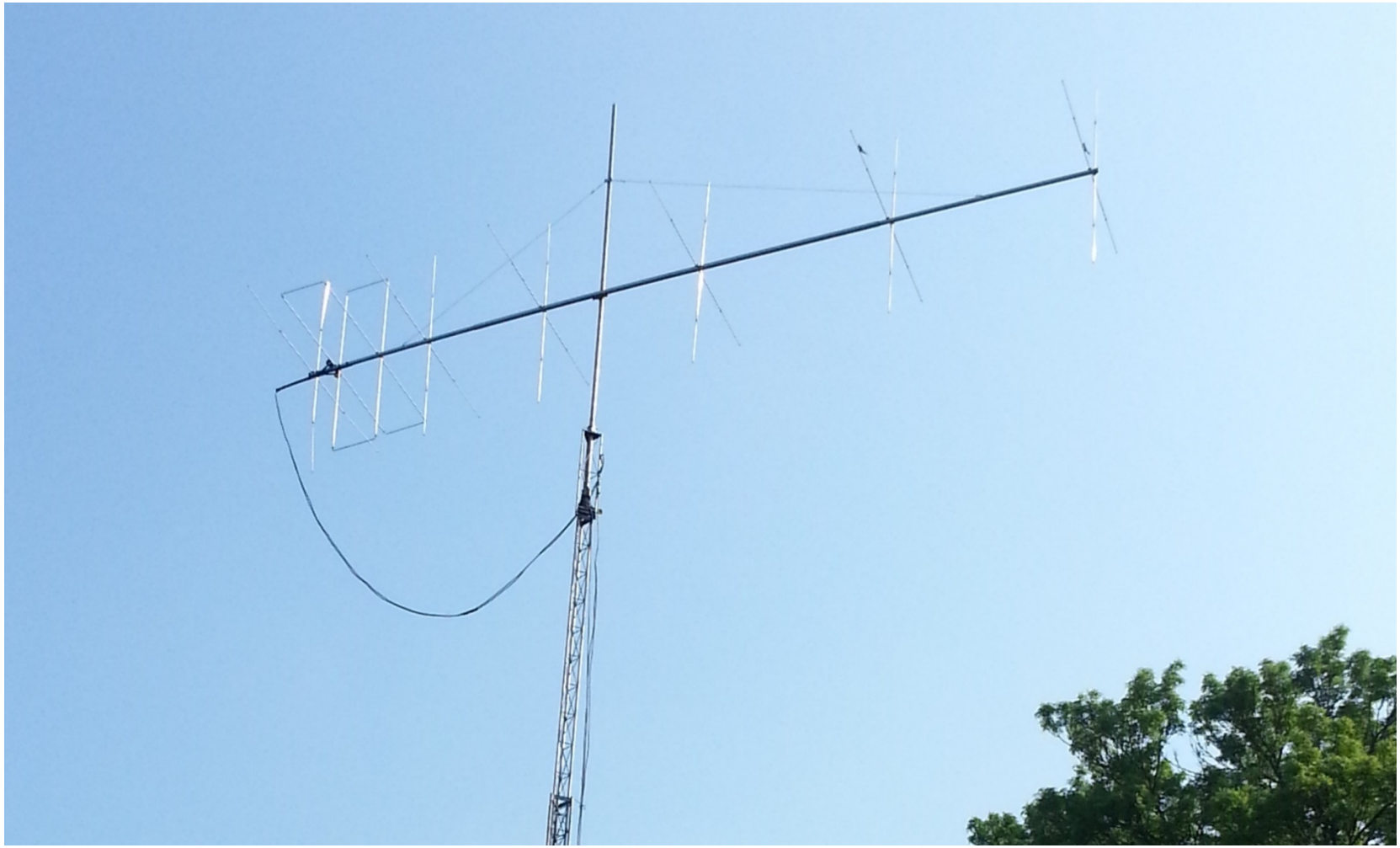
**HAMSCI UK 13th October 2017**

# Is Es similar to F2 in terms of polarisation?




/data/ionosondes/chilton/2006/05/RL052_2006140170000.MMM / 280fx128h 50 kHz 5.0 km 2x3 / DPS-1 (052-052) 51.6 N 358.7 W

# Experiments at G4IFX - antenna



Innovantennas 7-ele X-POL antenna @ 20m

*Separate feeders, identical feeder lengths*

# Experiments at G4IFX - receiver


RX1: HORIZONTAL

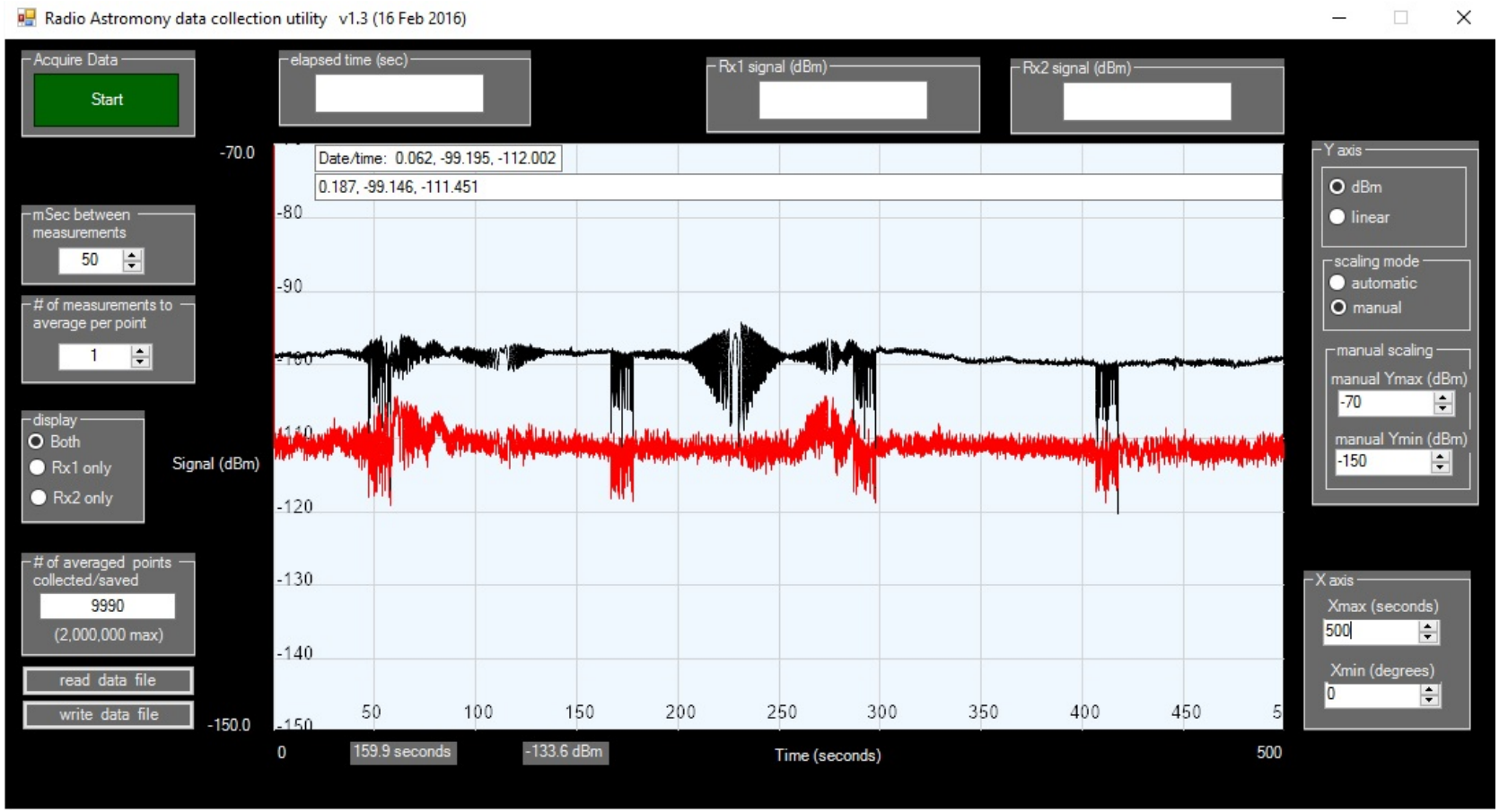
RX2: VERTICAL

GB3BAA

Apache ANAN-100D, dual receivers, OpenHPSDR mRX PS

*(nearly) identical receiver chains – effectively a dual channel spectrum analyser*

# Experiments at G4IFX – data capture




Radio Astronomy data collection utility, OpenHPSDR mRX PS

*GB3RAL 25 March 2016 (propagation: tropo, 58km obstructed path with aircraft scatter)*
*Signal strength in dBm, Black = RX1: horizontal, Red = RX2: vertical*

# An early observation

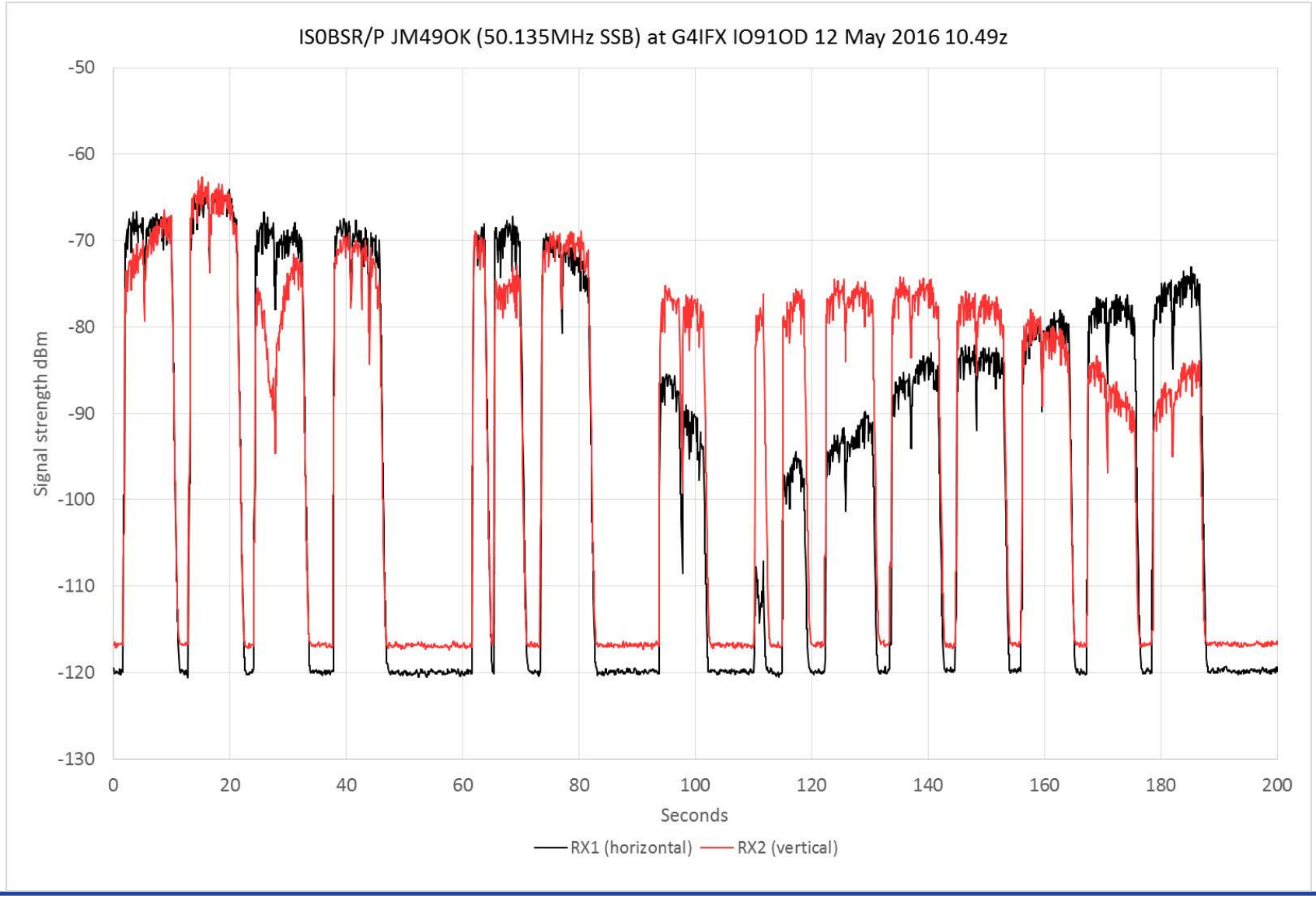
G8BCG (IO70RK) at G4IFX (IO91OD) via aurora 17 March 2015 2105z
RX switching between horizontal (first) and vertical antennas

*"The polarization of auroral echoes is mostly found to be closely identical with the transmitted polarization."*

"Radio Aurora", Bengt Hultqvist and Alv Egeland; Space Science Reviews **3** (1964) 27-78

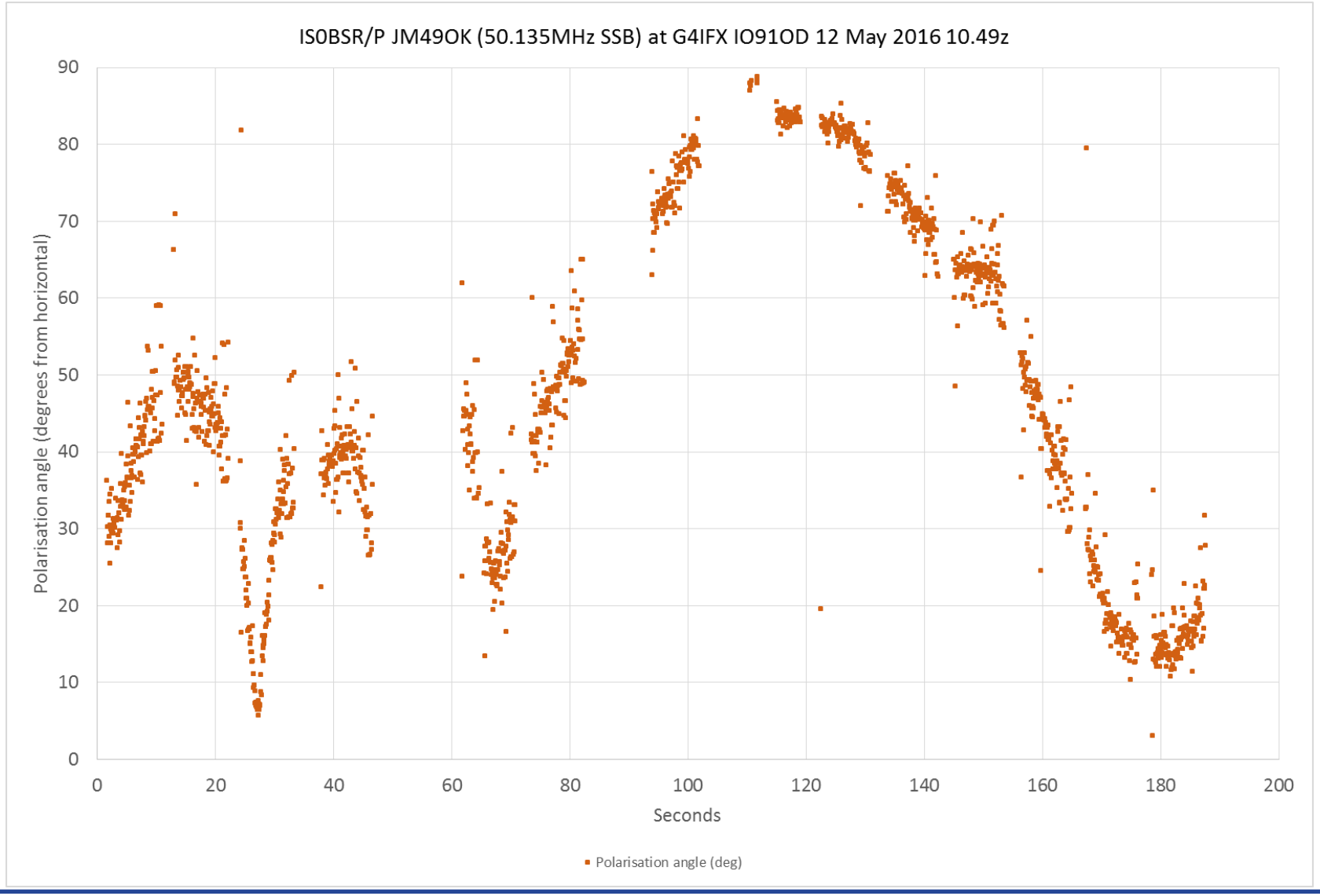
# Sporadic–E single-hop

*Transmitted polarisation: horizontal*
*Range: 1515km*



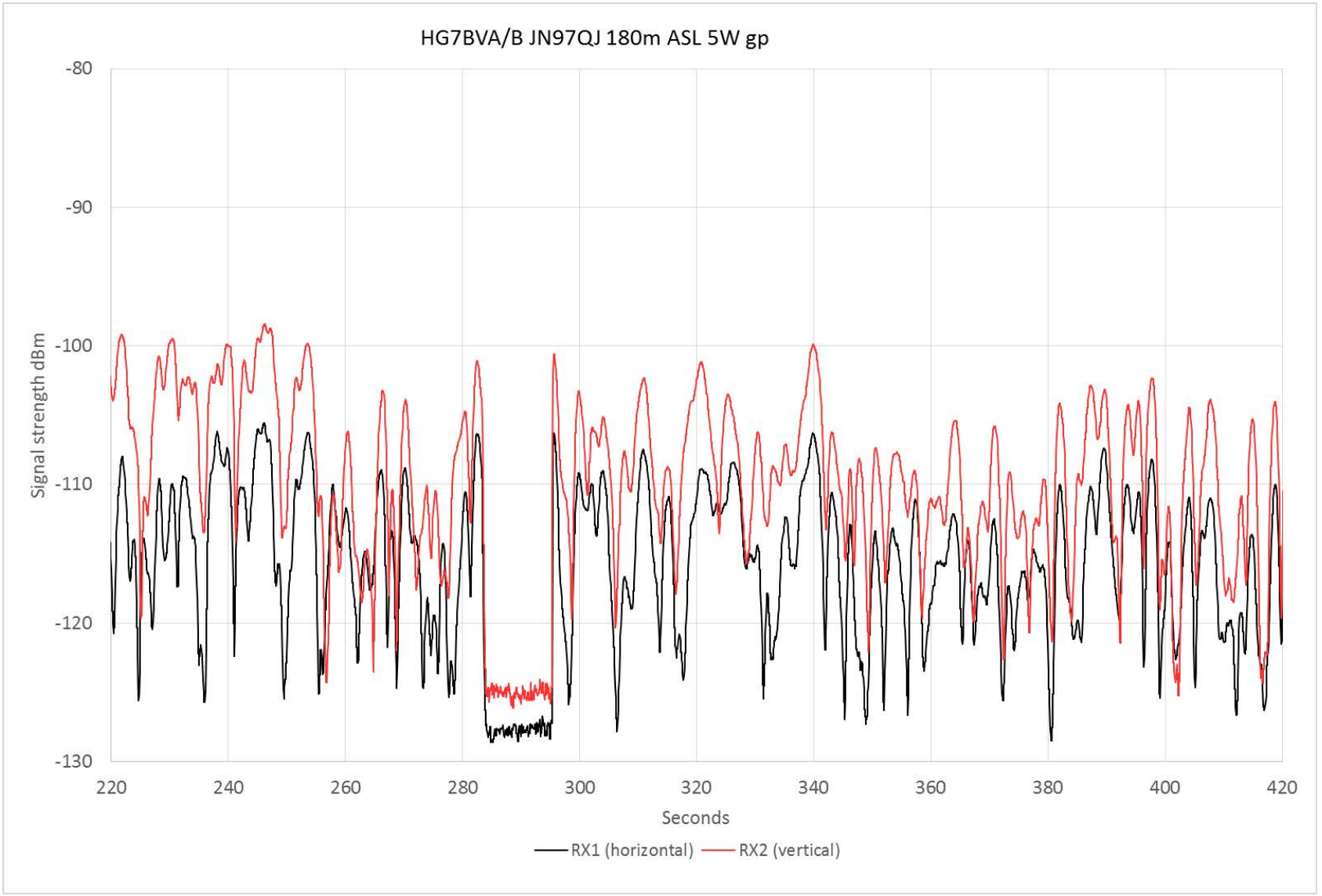
# Calculated polarisation angle

*Transmitted polarisation: horizontal*
*Range: 1515km*



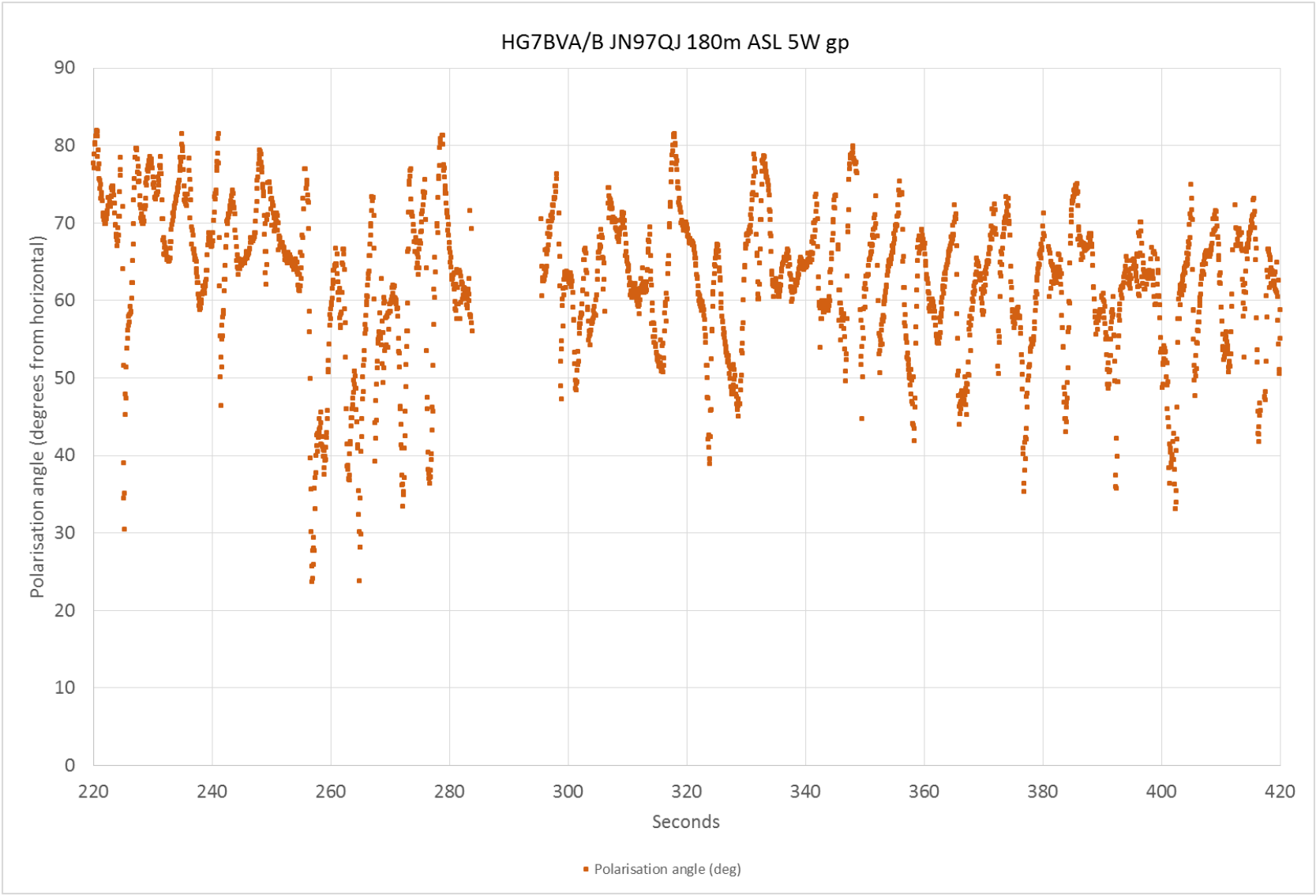
# Sporadic–E single-hop

*Transmitted polarisation: vertical*
*Range: 1515km*



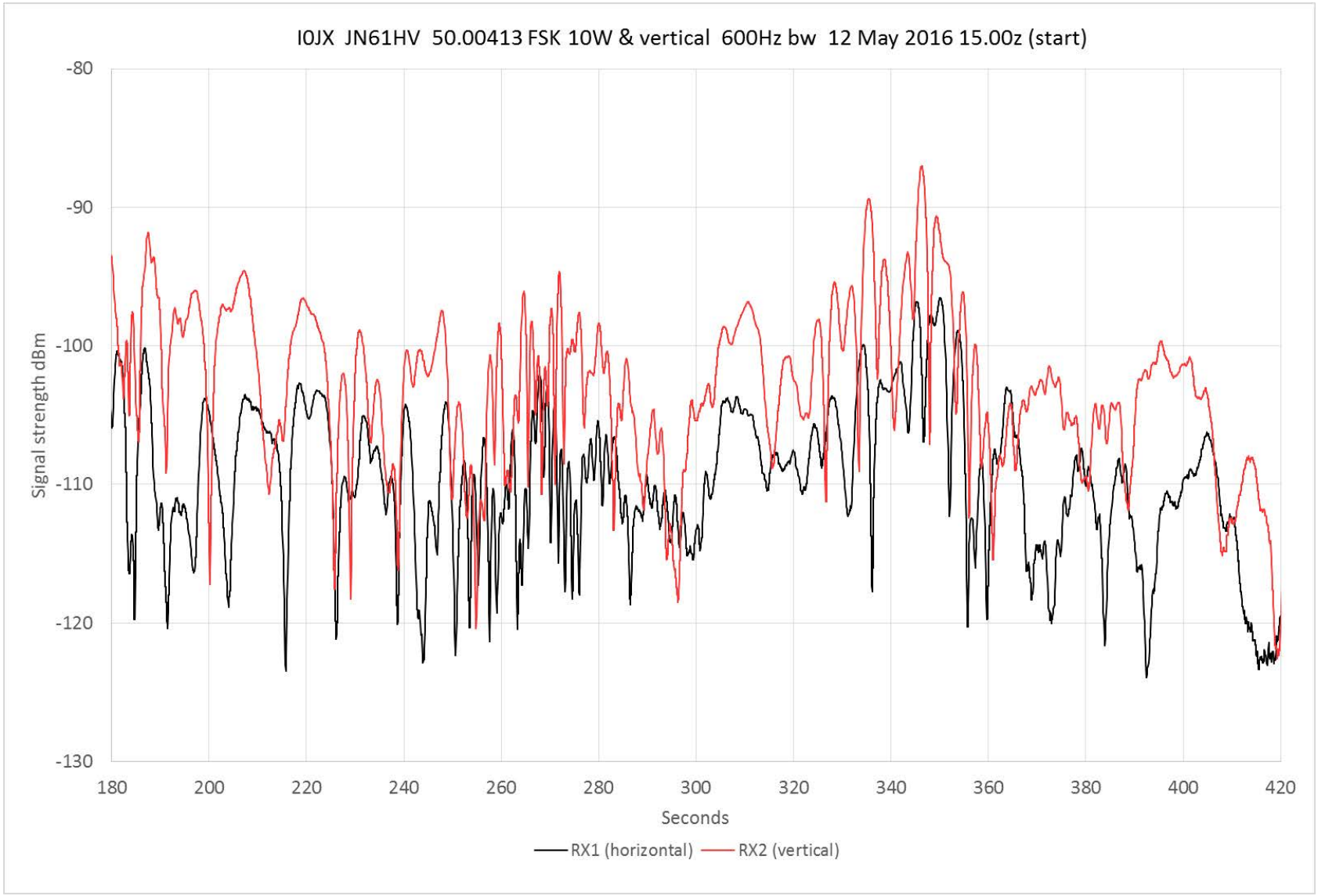
# Sporadic–E single-hop

*Transmitted polarisation: vertical*
*Range: 1515km*



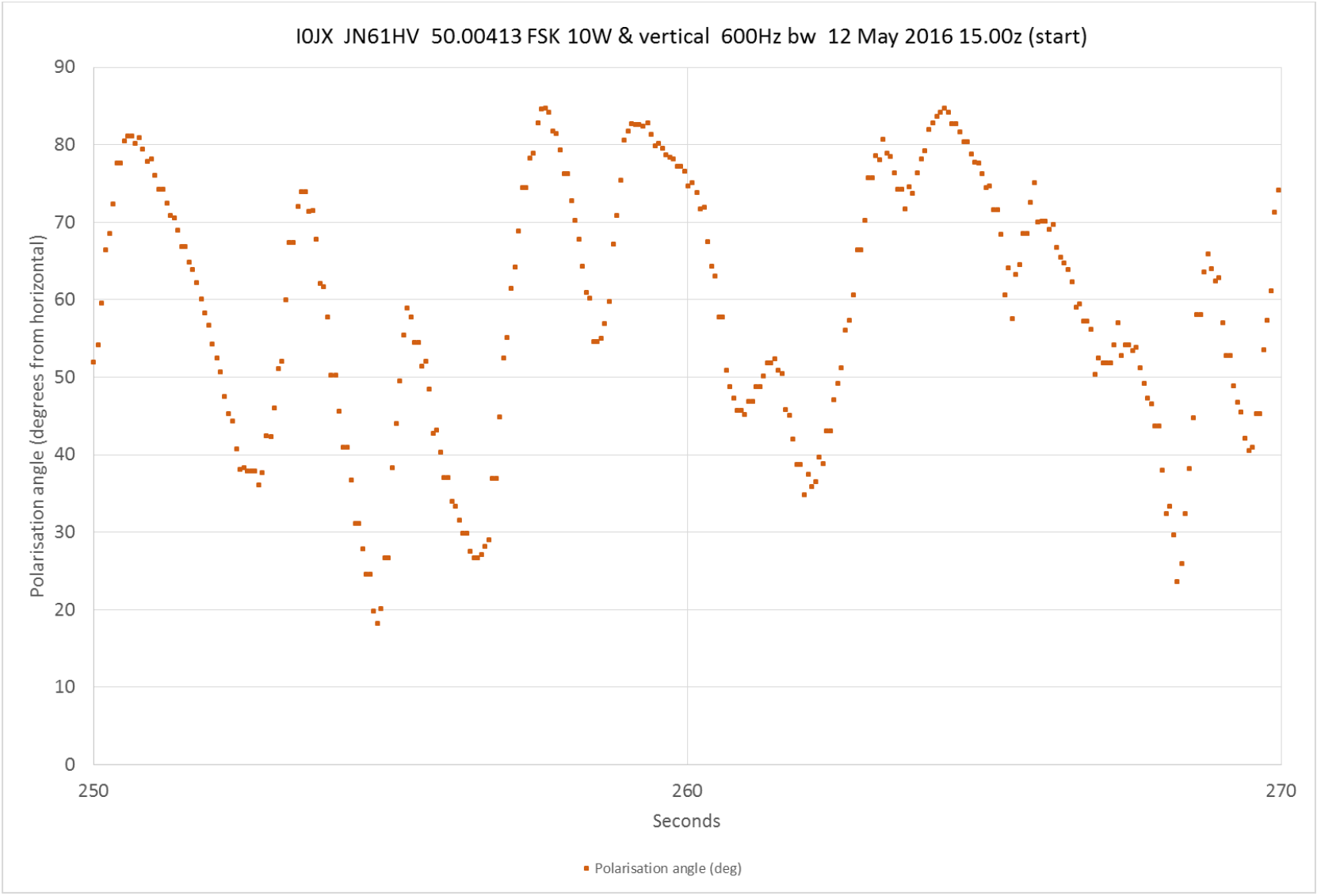
# Sporadic–E single-hop

*Transmitted polarisation: vertical*
*Range: 1448km*

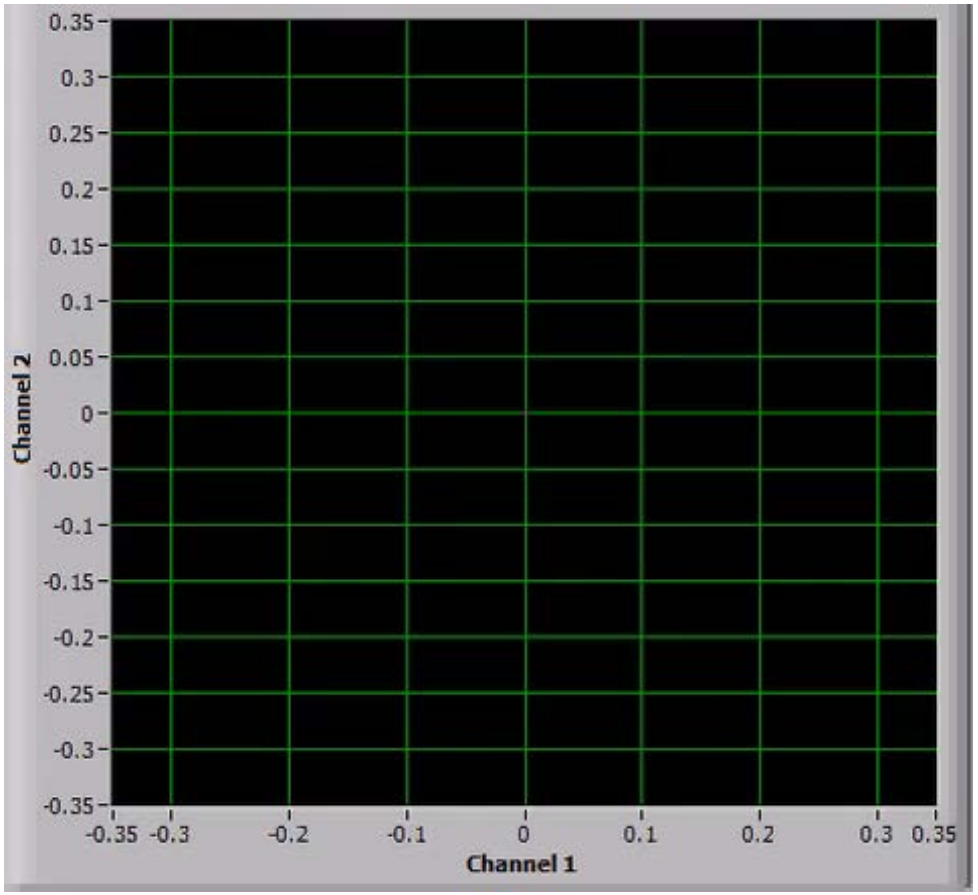


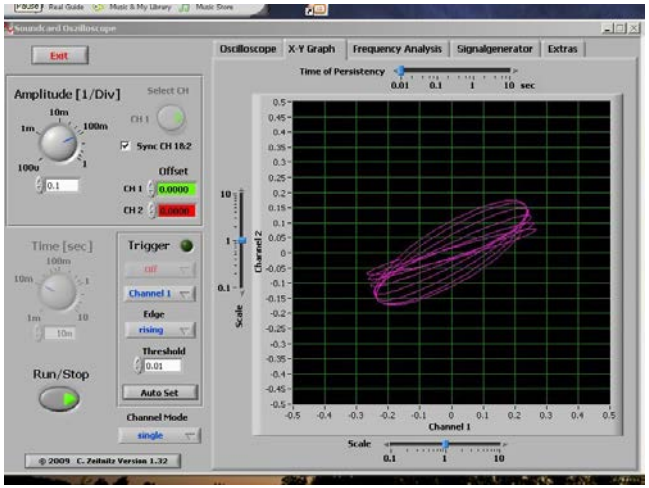
# Sporadic–E single-hop

*Transmitted polarisation: vertical*
*Range: 1448km*



# What's really happening?
## Prior work by Graham Kimbell, G3TCT




GB3LER 5 August 2010 via sporadic-E, range 1059km

*See Graham's website (http://g3tct.co.uk/diversity.html) for an extensive set of 50MHz diversity recordings*

# BBC research report 1975

BBC RD 1975/17

BBC

RESEARCH DEPARTMENT

REPORT

## Ionospheric propagation in v.h.f. television Band I

L.F. Tagholm, M.B.E., F.I.E.E.
C.P. Bell, B.Sc.(Eng.)
P. Knight, M.A., Ph.D., M.I.E.E.

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION June 1975

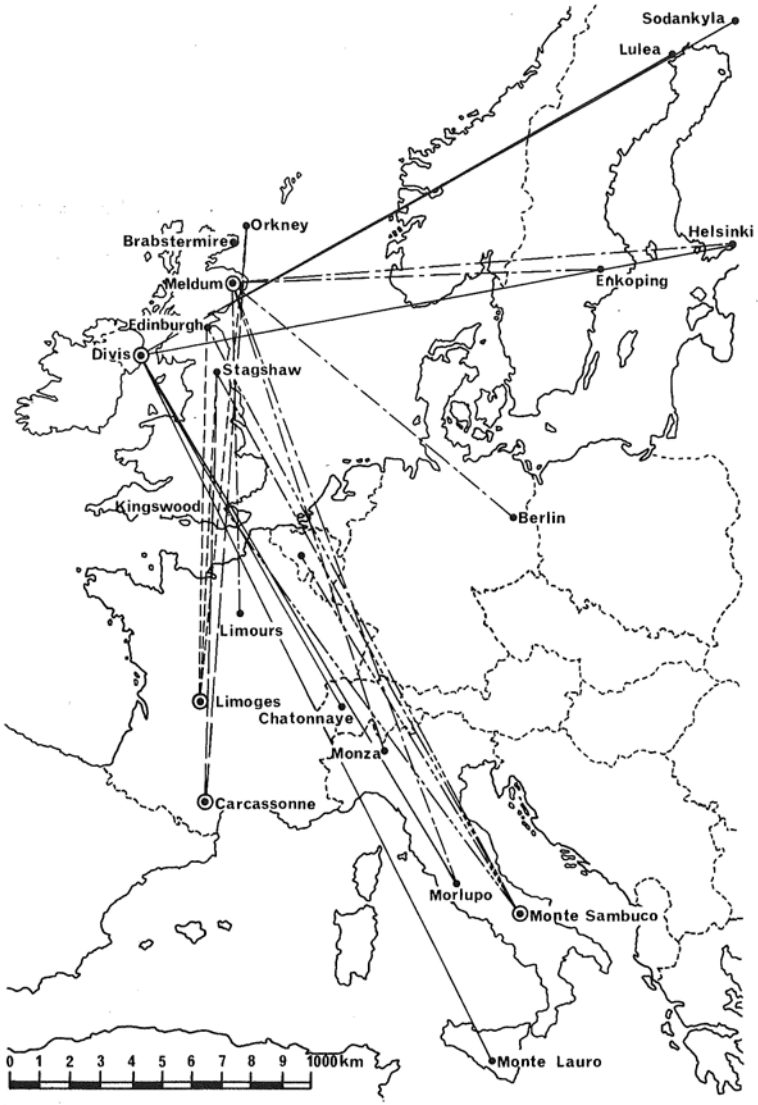



*Fig. 1 - Propagation paths*

*Transmitting stations* ● *Receiving stations*

# BBC research report 1975

Average received vs transmitted polarisation:

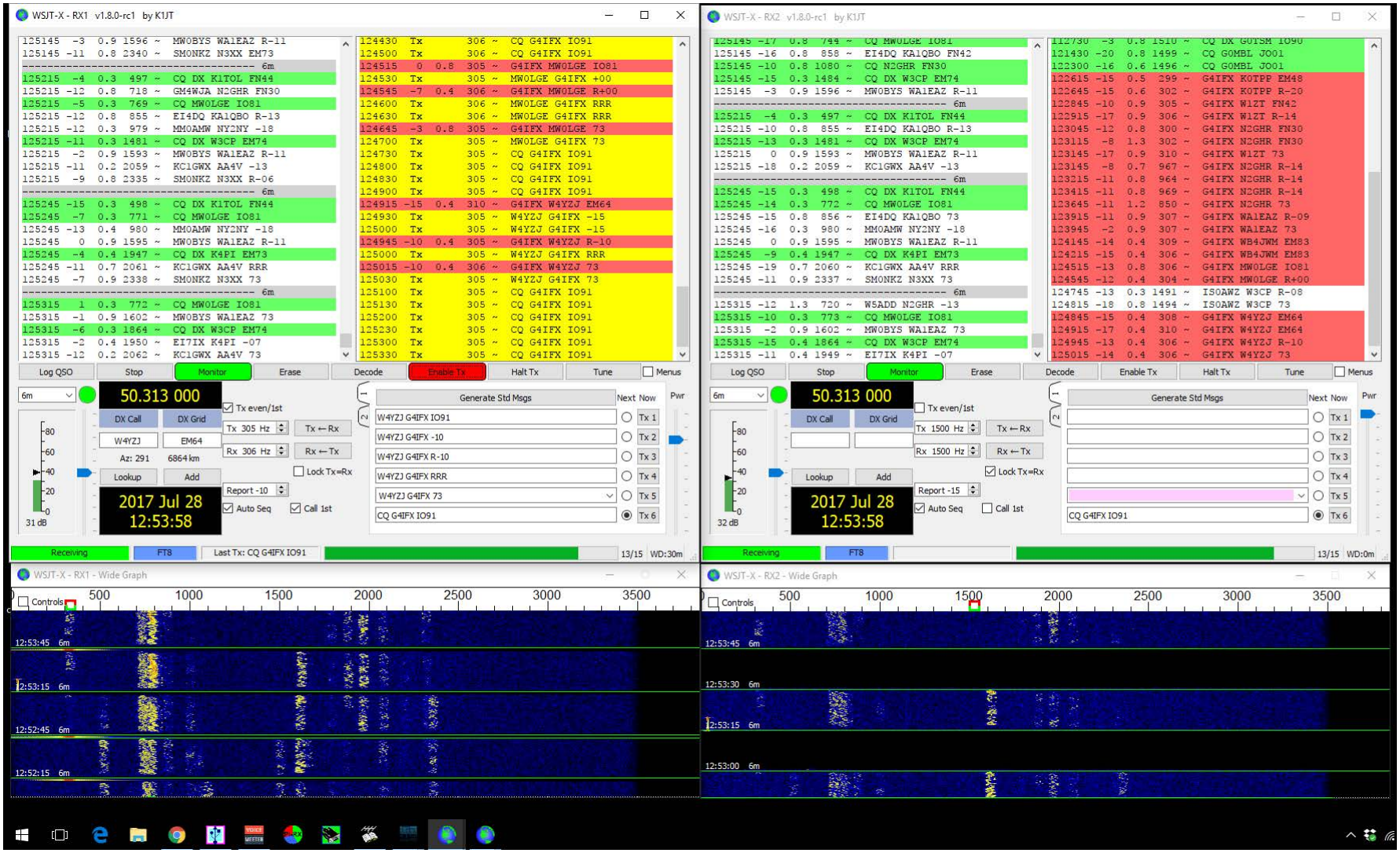
*Table 4*

*Polarization Ratio*

| Transmitter Frequency and Polarization | Receiver | Radiation angle, degrees | Year | Polarization ratio, dB | Average Polarization ratio, dB |
|---|---|---|---|---|---|
| Limoges<br>41·28 MHz<br>H | Orkney | 4·7 | 1970<br>1971 | 6·7<br>8·6 | 7·4 |
| Divis<br>41·465 MHz<br>H | Helsinki | 2·0 | 1968<br>1969<br>1970<br>1971<br>1972 | –0·9<br>–0·3<br>0·1<br>0·4<br>0·3 | –0·1 |
| Monte Sambuco<br>49·30 MHz<br>H | Kingswood | 4·0 | 1966<br>1967 | 5·8<br>3·5 | 5·0 |
| Carcassonne<br>54·43 MHz | Kingswood | 11·0 | 1966<br>1967 | 2·2<br>3·6 | 3·0 |
| V | Orkney | 3·0 | 1970 | 4·6 | 4·6 |
| Meldrum<br>58·215 MHz<br>H | Helsinki | 4·0 | 1970<br>1971<br>1972 | 3·4<br>4·2<br>7·1 | 4·4 |

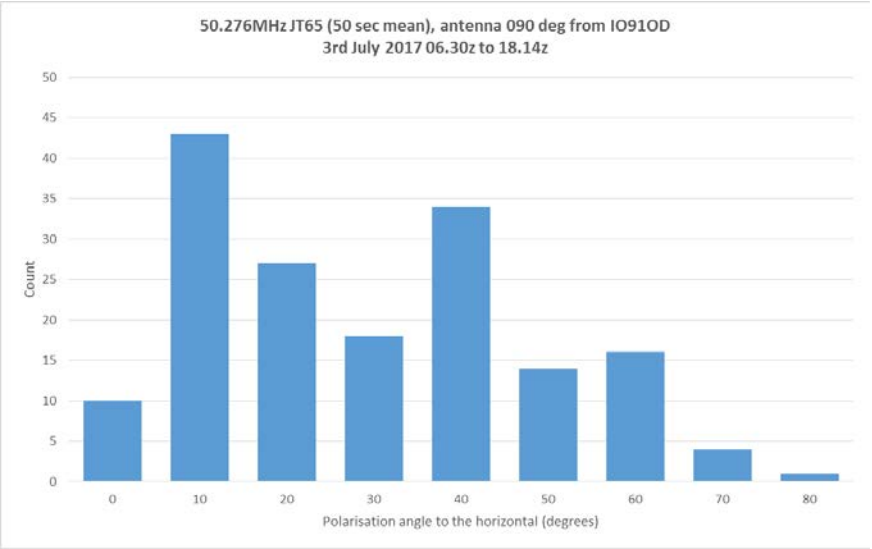
Polarisation ratio = the ratio of the signal strength for the transmitted polarisation to the signal strength for the orthogonal polarisation (dB)

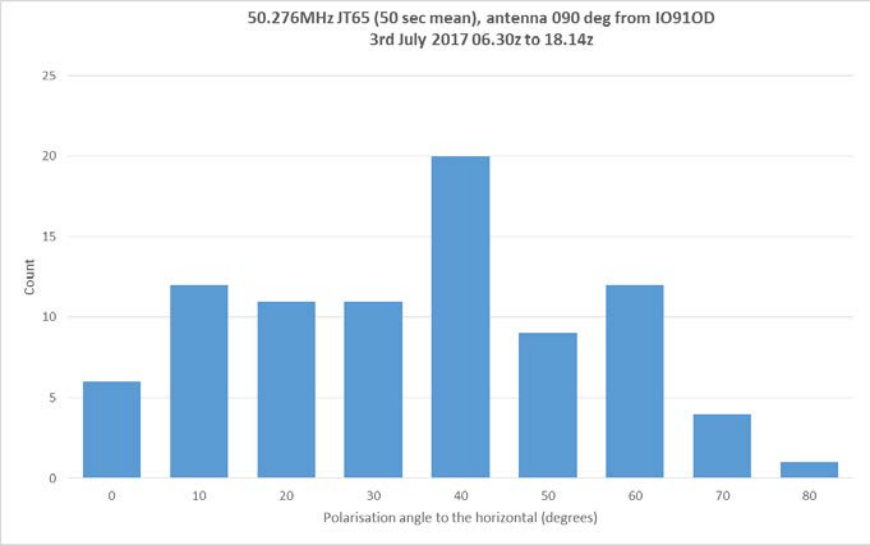
# Using WSJT-X for bulk data collection



# Initial results using JT65

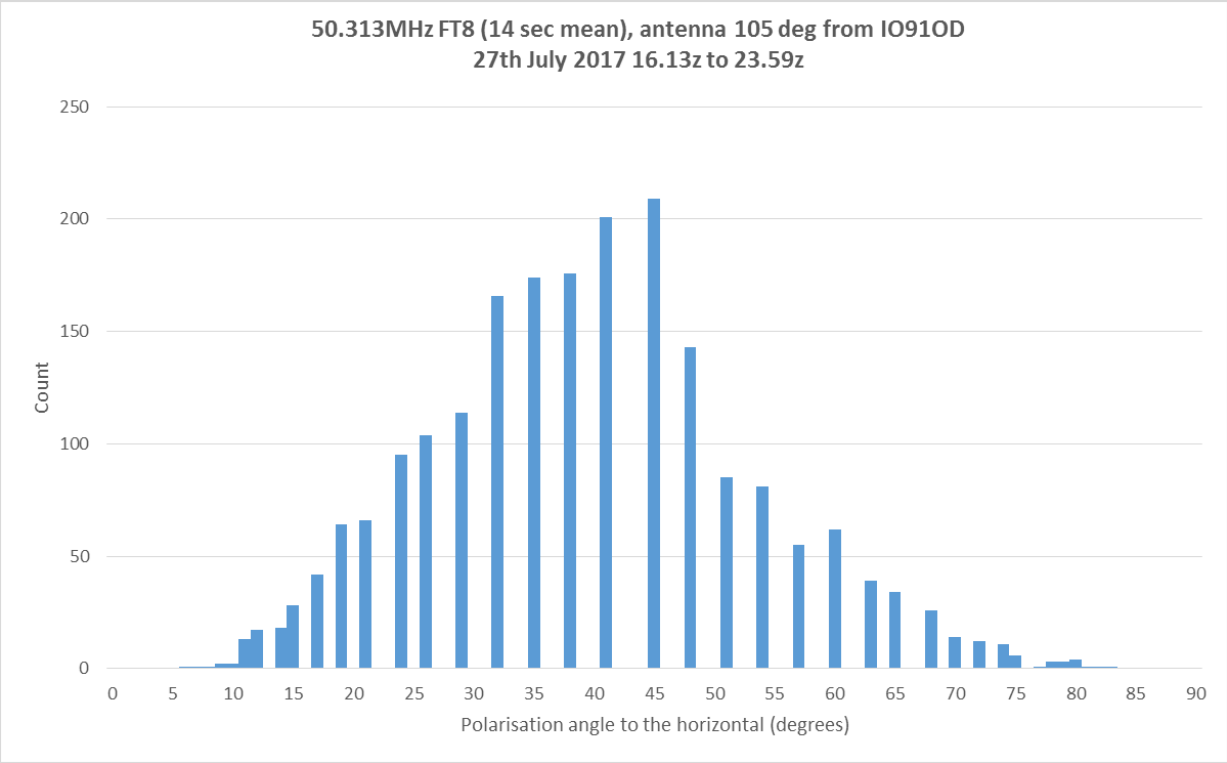
As logged ->




< - Minus the tropo

# Polarisation distribution using FT8

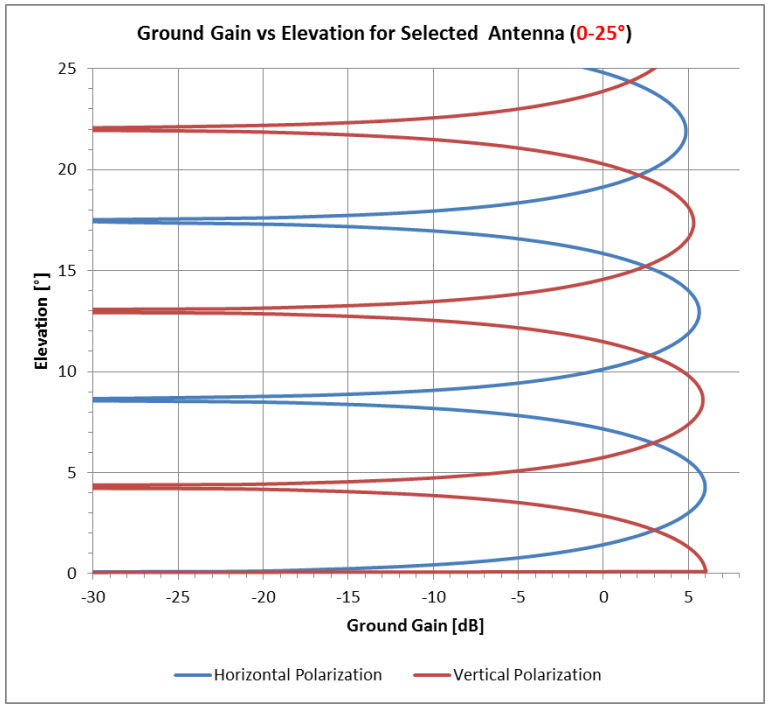



**Polarisation Angle**
Mean = 39.8
Median = 38.5
Std Dev = 14.2

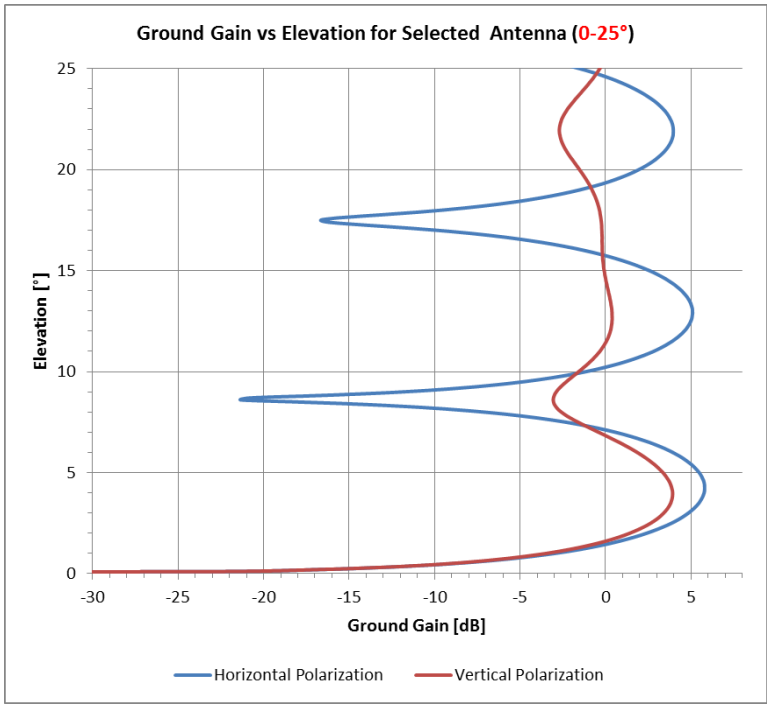
Single-hop sporadic-E only, 750km -2500km range

# Ground gain v/s polarisation

Calculated ground gain, five-element yagi at 20m , perfect ground




Calculated ground gain, five-element yagi at 20m , average ground




Ground Gain in Theory and Practice By Gaëtan Horlin, ON4KHG
Dubus 3/2011 (September 2011)

# BBC research report 1975 (again)

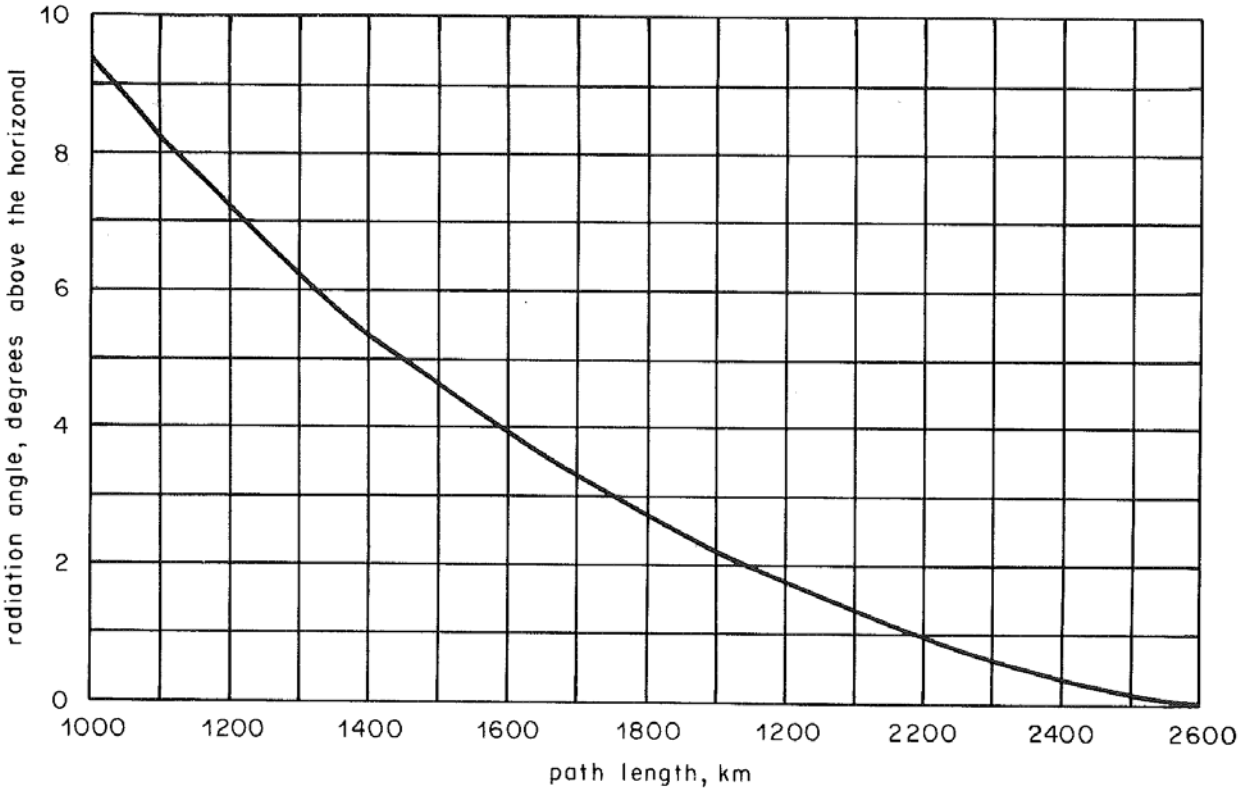
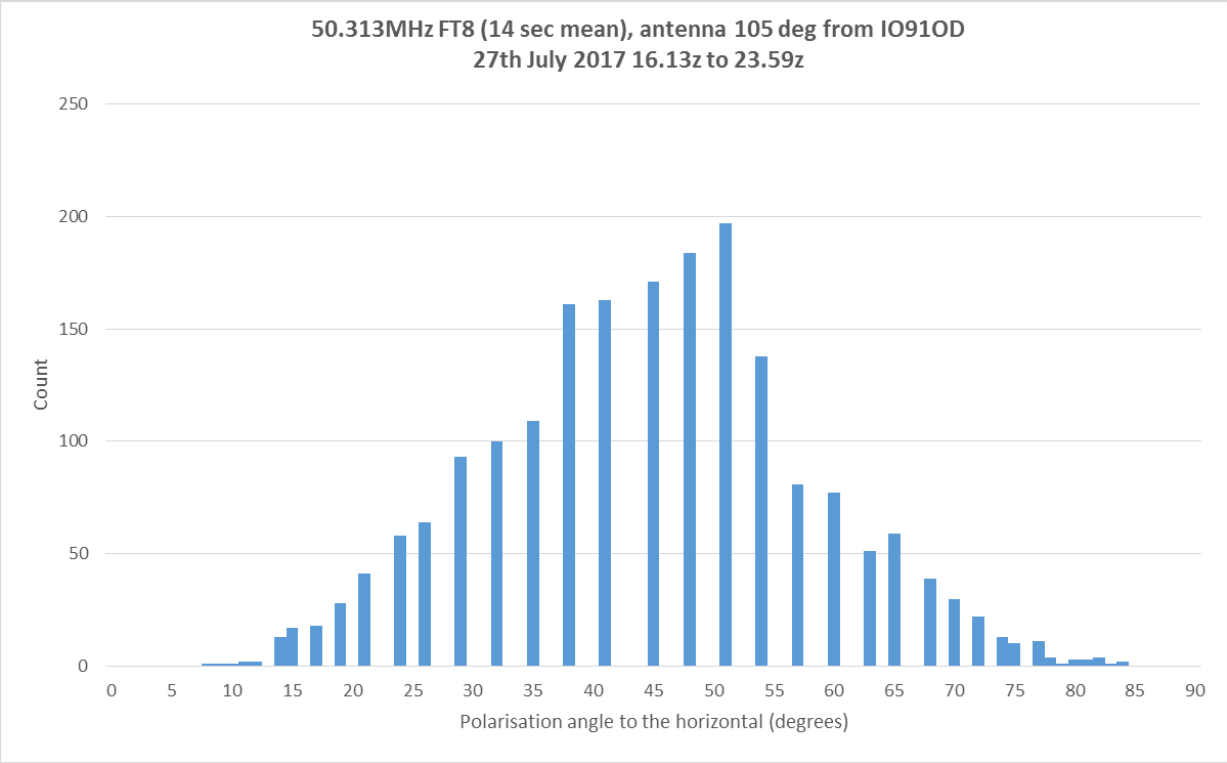



*Fig. 11 - Median radiation angle for propagation via the sporadic-E layer*

# Polarisation distribution, corrected for ground gain




**Polarisation Angle**
Mean = 45.3
Median = 45.0
Std Dev = 14.4

Single-hop sporadic-E only, 1200km -2500km range
Ground gain correction = +2dB on vertical

# Conclusions so far

- Sporadic-E signals, on a short timescale, tend to have a strong net polarisation which rotates over periods of seconds to minutes
- This polarisation rotation is observable in single-hop, two-hop and three-hop Es
- Averaged over longer periods, average polarisation tends to 45 degrees once differential ground gain is compensated for
- But the frequent short-term variation seems to indicate that the incident wave is at the very least strongly elliptically polarised - otherwise such wide short-term variations in net polarisation would not be observed
- Less formal observation shows that it's not uncommon for an Es signal transmitted from a horizontal antenna to arrive more or less vertically polarised for long periods of time (and vice versa)
  - Sometimes signals from a given direction will *all* be tilted the same way
- Auroral signals seem generally to retain their original polarisation
- The received polarisation of tropo signals is frequently far from 'pure' horizontal or vertical

# Find out more…


**g4ifx@uksmg.org**

**www.uksmg.org**

**http://rsgb.org/main/about-us/committees/propagation-studies-committee/**

**www.rsgb.org**