



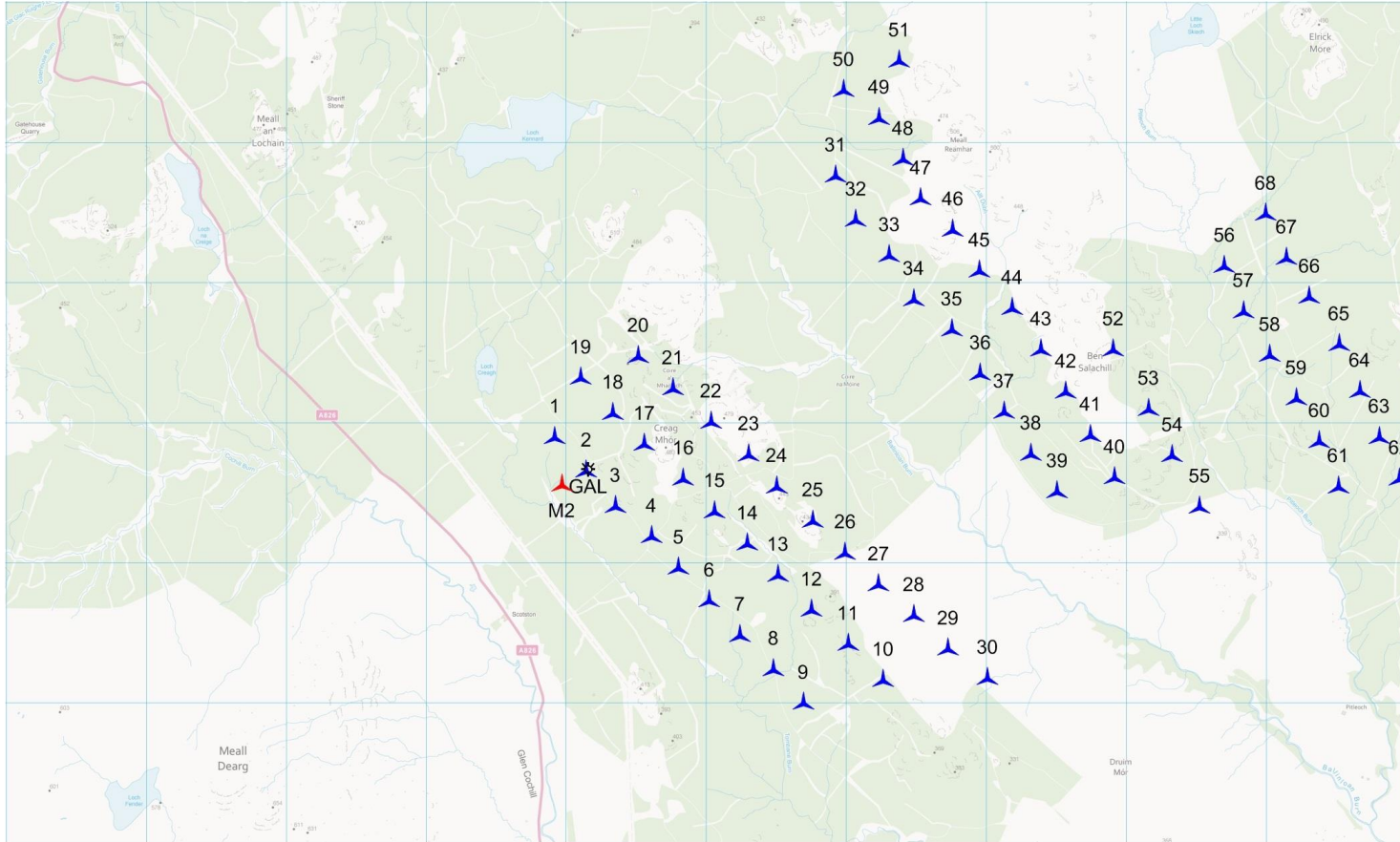
Sustainable Engineering Worldwide

Griffin Power Curve Measurement Campaign

Ralph Torr
Senior Engineer
04 December 2013

Griffin WF - Reference Mast, WTG Mast and Lidar Location

▲ Reference mast ▲ WTGs ✖ Galion Lidar



Griffin WF - Reference Mast, WTG Mast and Lidar Location



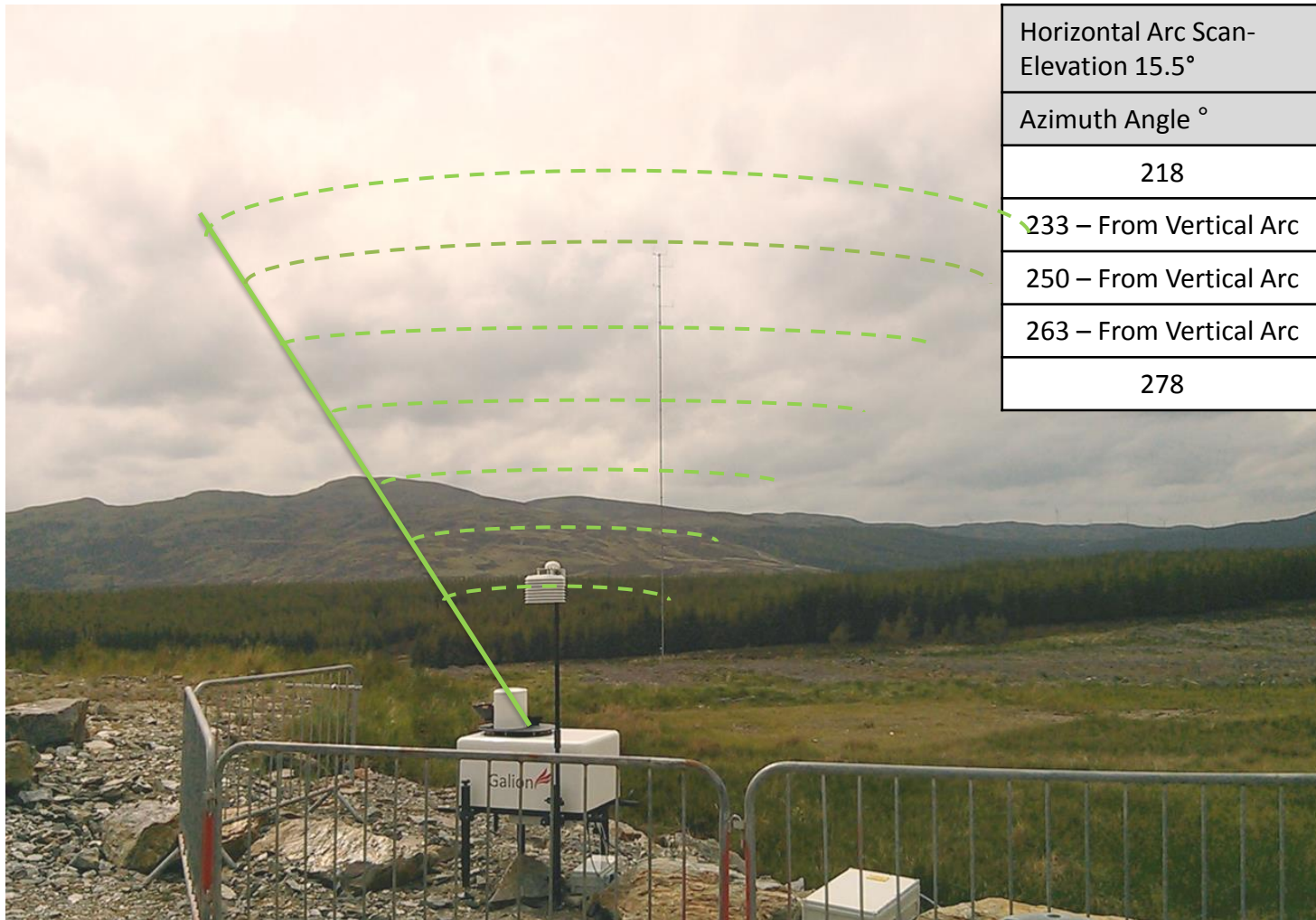
- The reference mast is 2.0 RD away from WTG
- The freestream sector is from 173° to 284°
- The calibrated sector is from 220° to 260°
- Galion is approximately 15 m away from WTG base



Griffin WF - Lidar and Reference Mast Location



Griffin WF - P1 - Lidar scan geometry

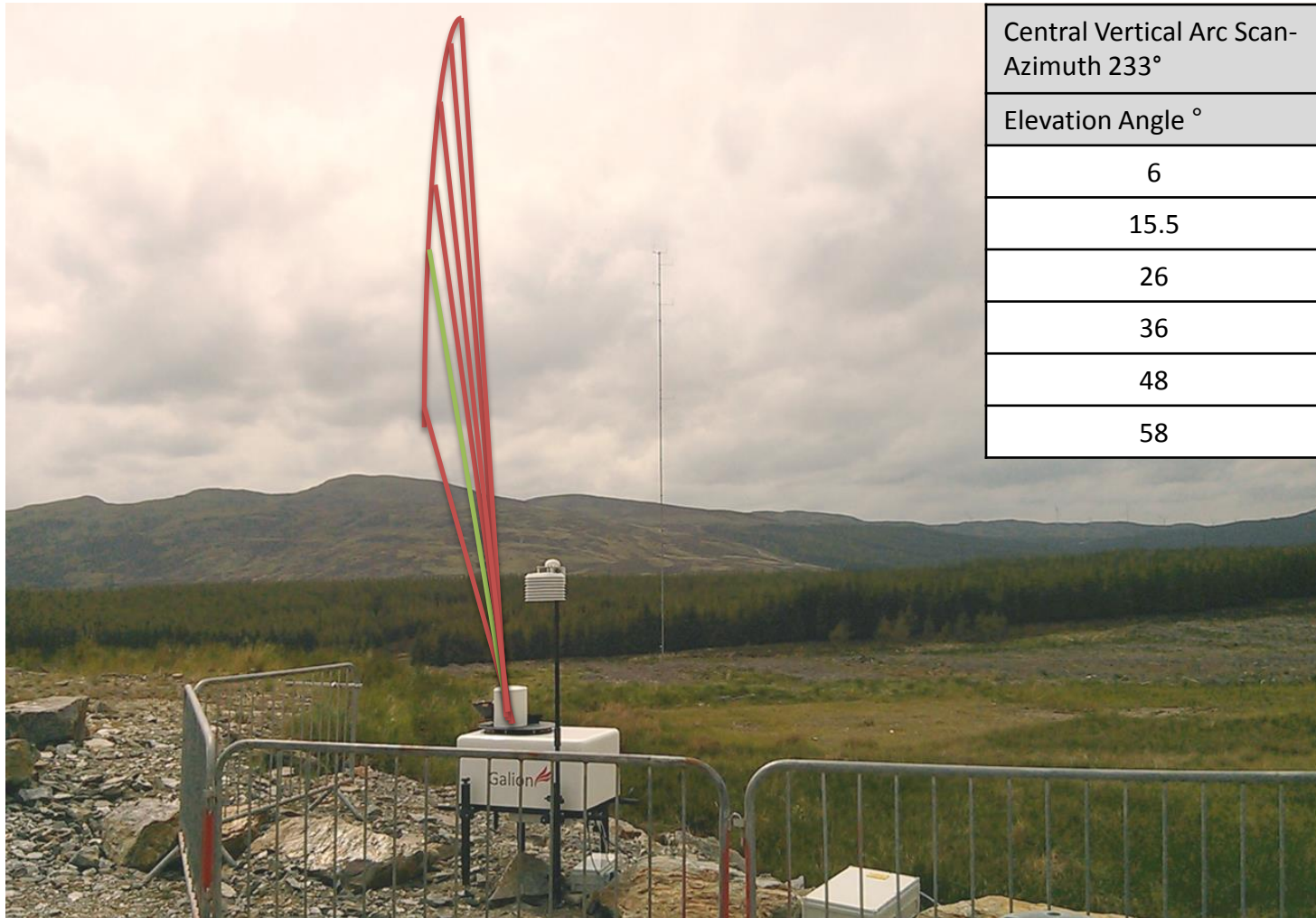


Horizontal Arc Scan- Elevation 15.5°
Azimuth Angle °
218
233 – From Vertical Arc
250 – From Vertical Arc
263 – From Vertical Arc
278

15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



Griffin WF - P1 - Lidar scan geometry

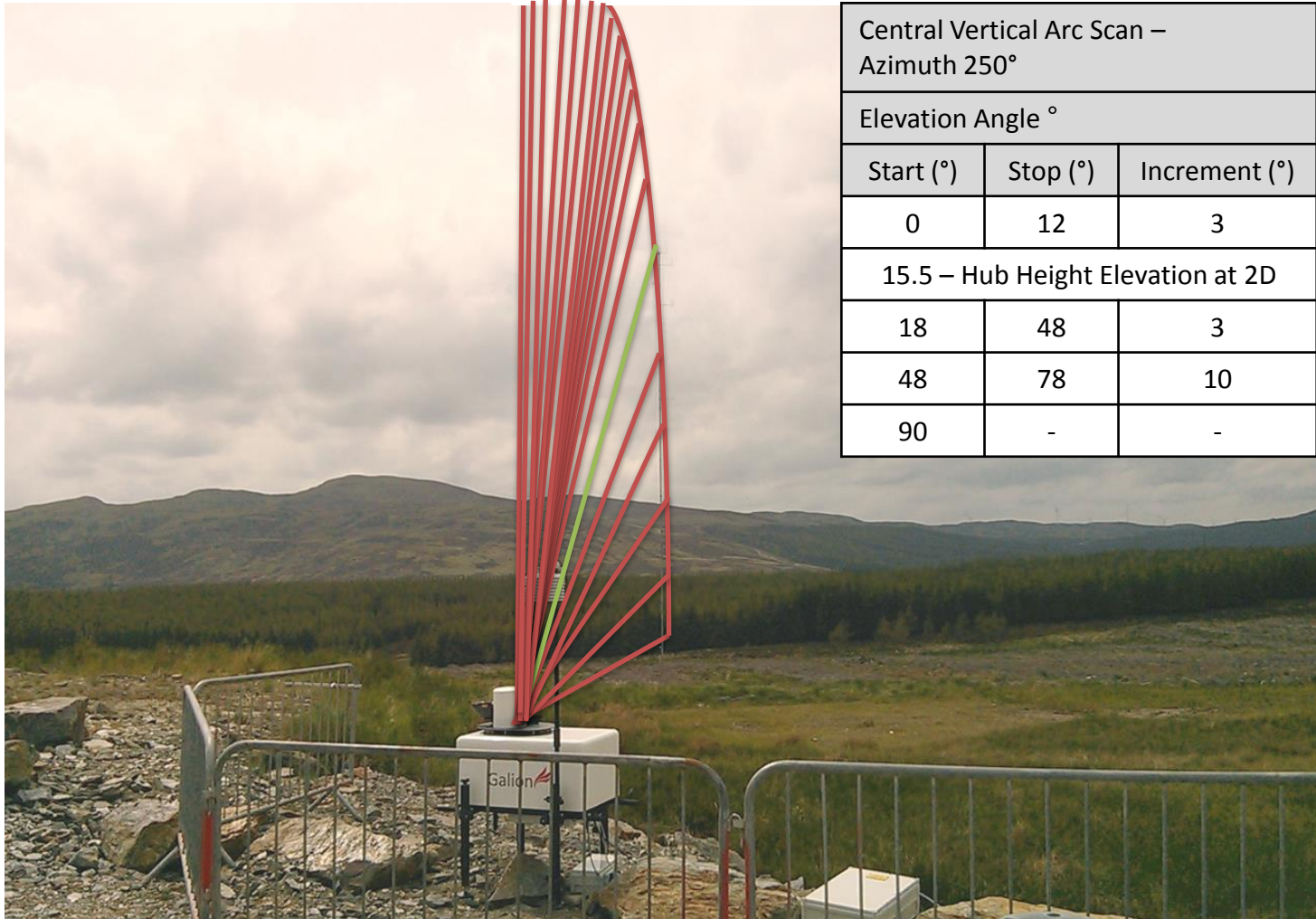


Central Vertical Arc Scan- Azimuth 233°
Elevation Angle °
6
15.5
26
36
48
58

15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



Griffin WF - P1 - Lidar scan geometry



Central Vertical Arc Scan –
Azimuth 250°

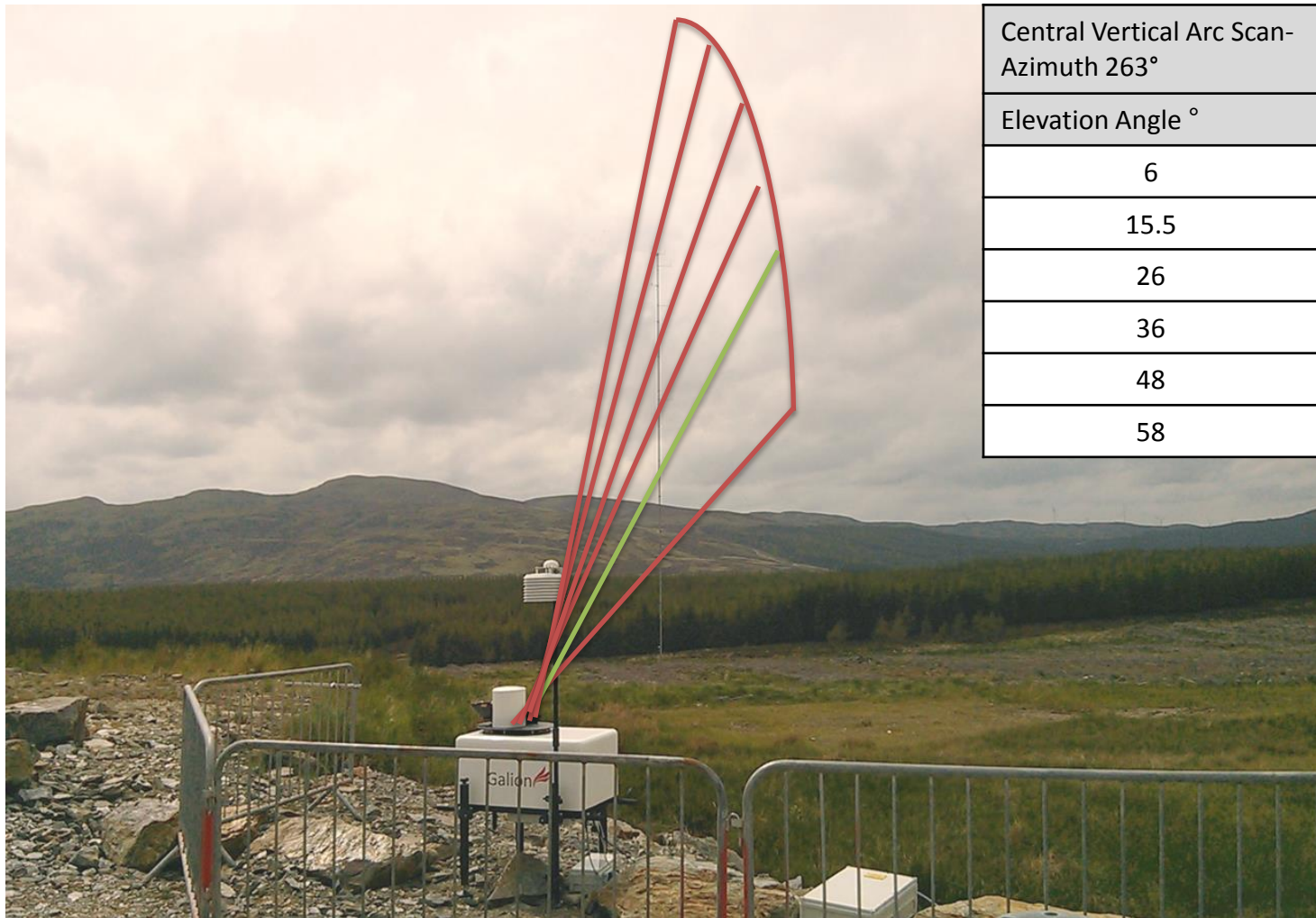
Elevation Angle °

Start (°)	Stop (°)	Increment (°)
0	12	3
15.5 – Hub Height Elevation at 2D		
18	48	3
48	78	10
90	-	-

15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



Griffin WF - P1 - Lidar scan geometry



Central Vertical Arc Scan-
Azimuth 263°

Elevation Angle °

6

15.5

26

36

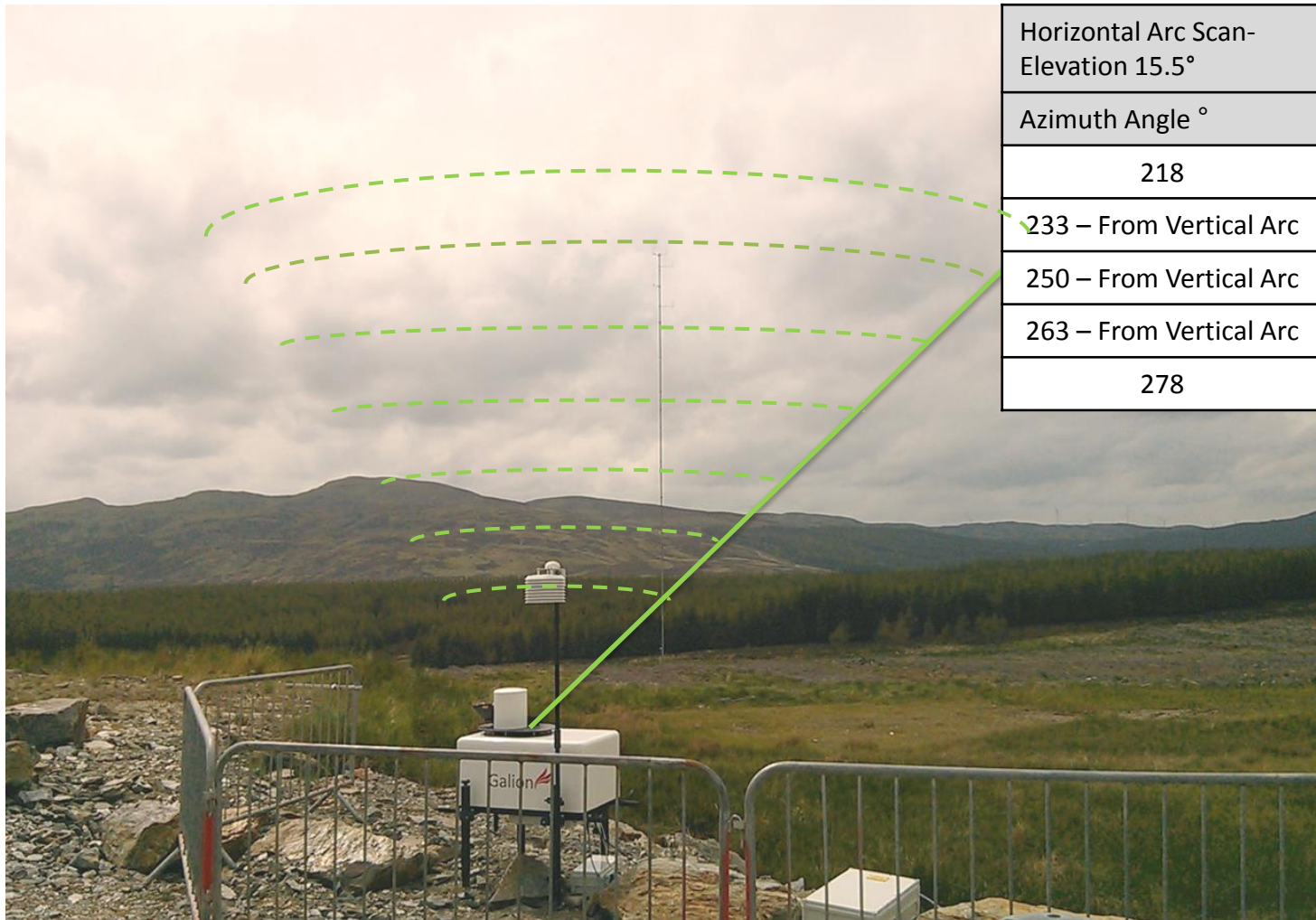
48

58

15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



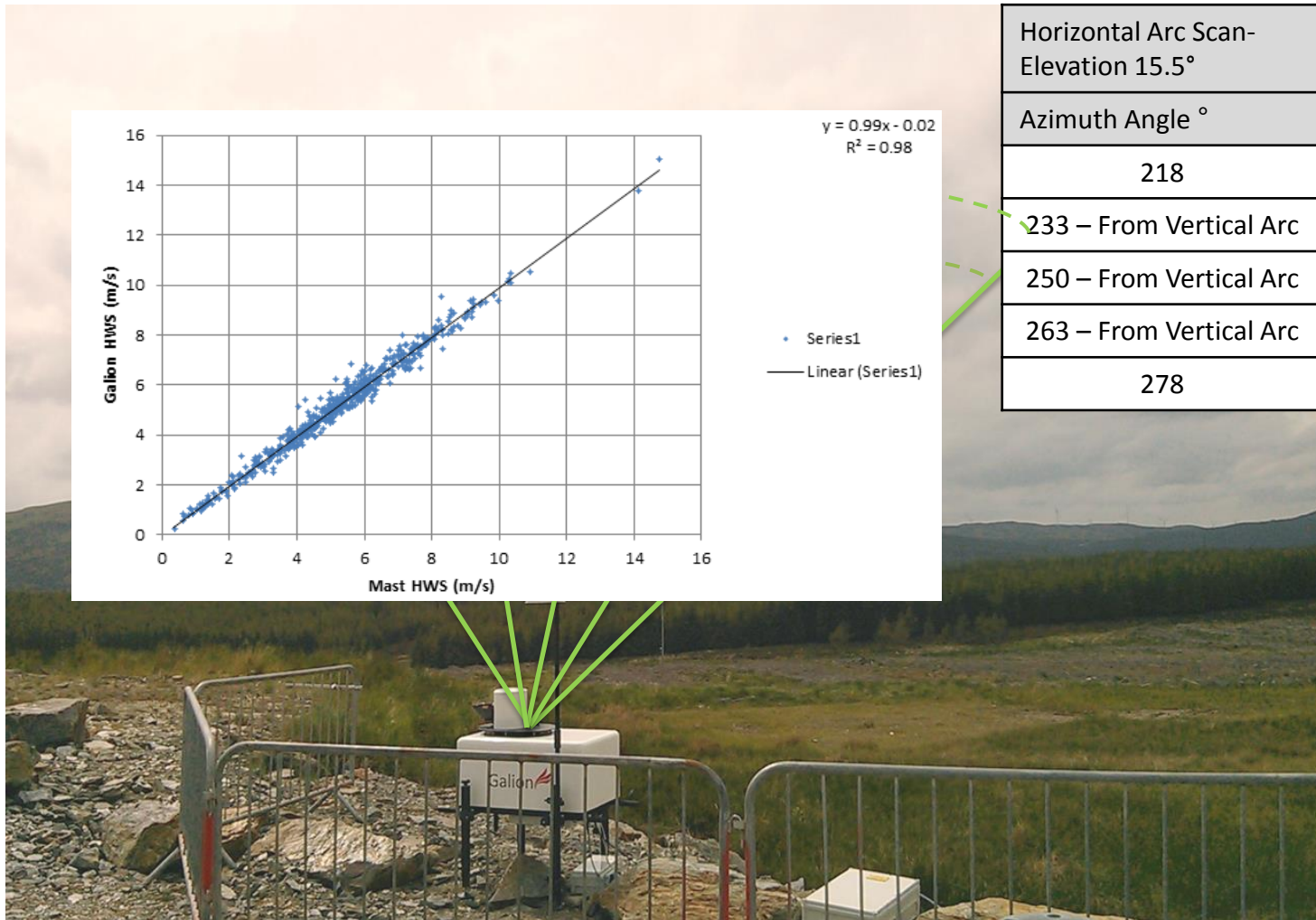
Griffin WF - P1 - Lidar scan geometry



15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



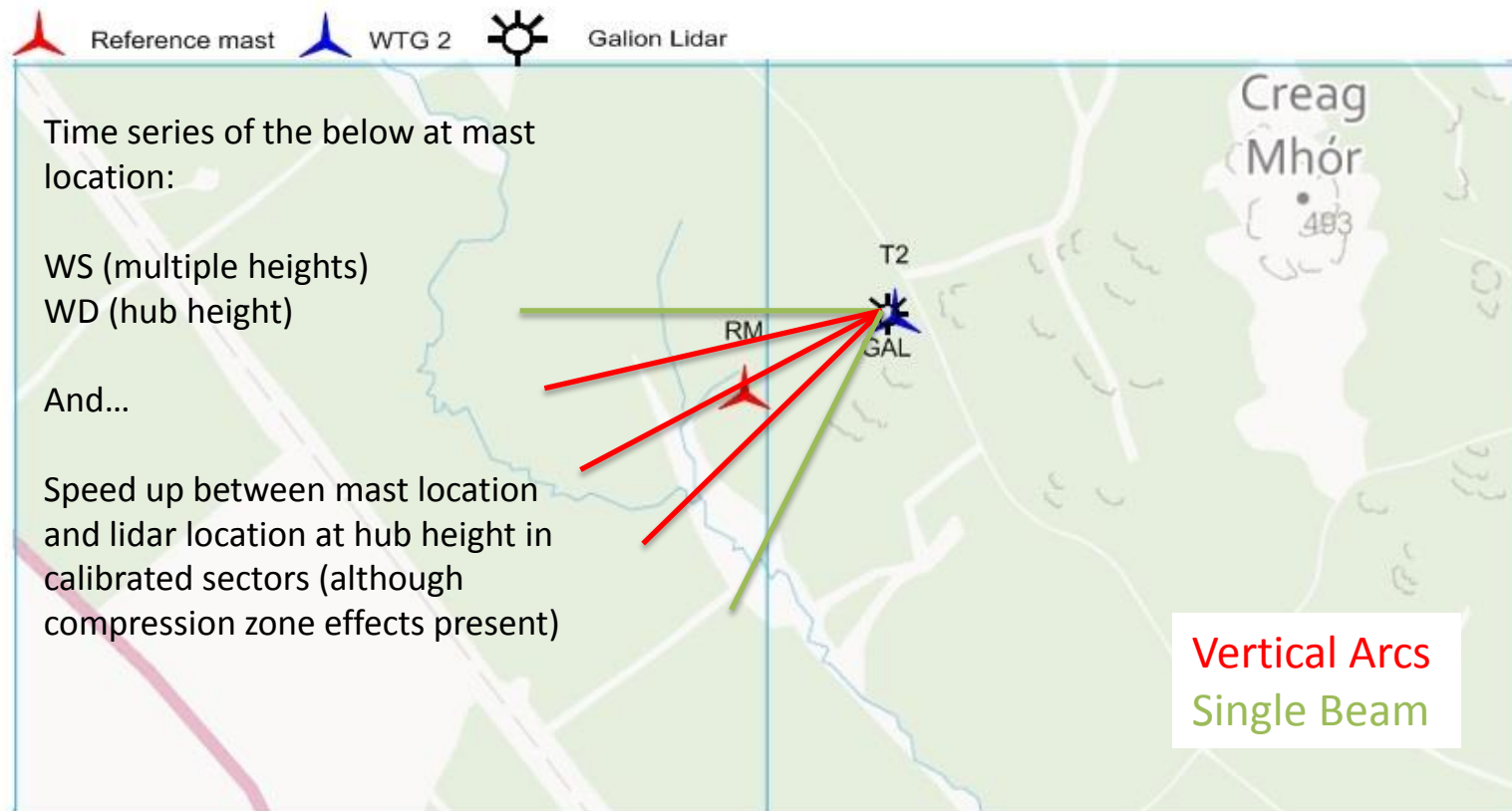
Griffin WF - P1 - Lidar scan geometry



15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



Griffin WF - P1 - Lidar scan geometry



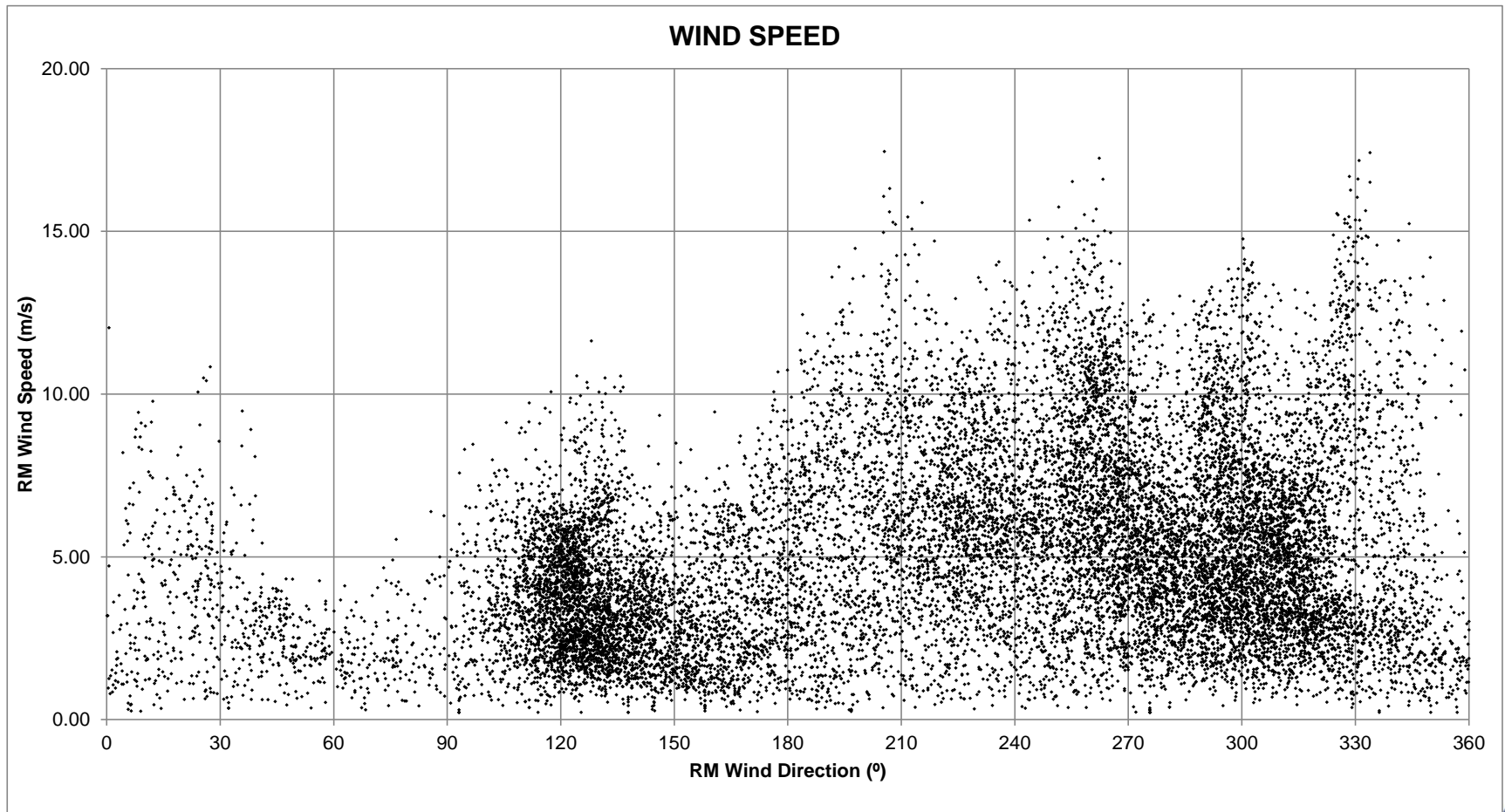
15 July 2013 and 13 September 2013 – 10 x scans per 10 minute



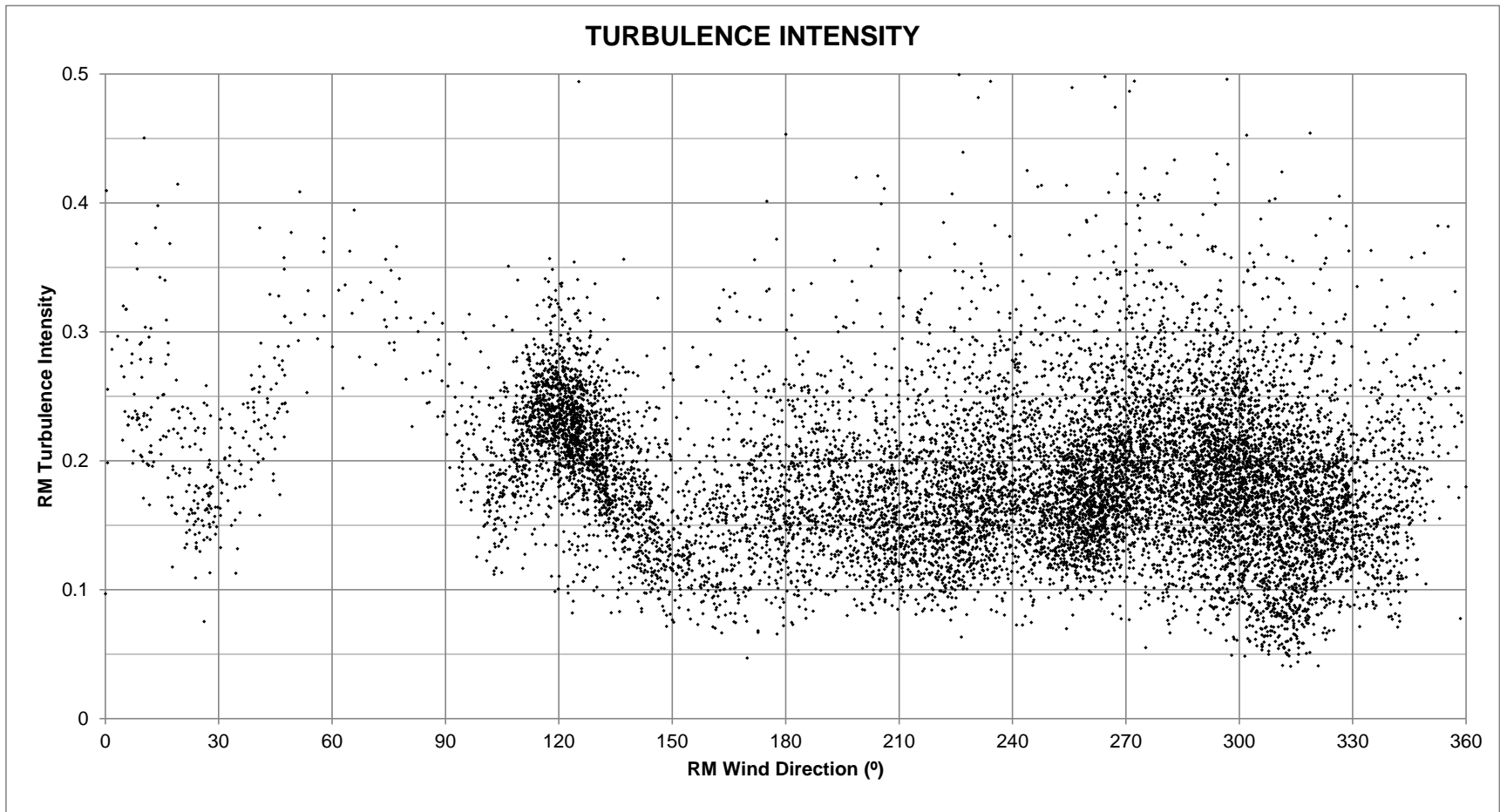
Annex



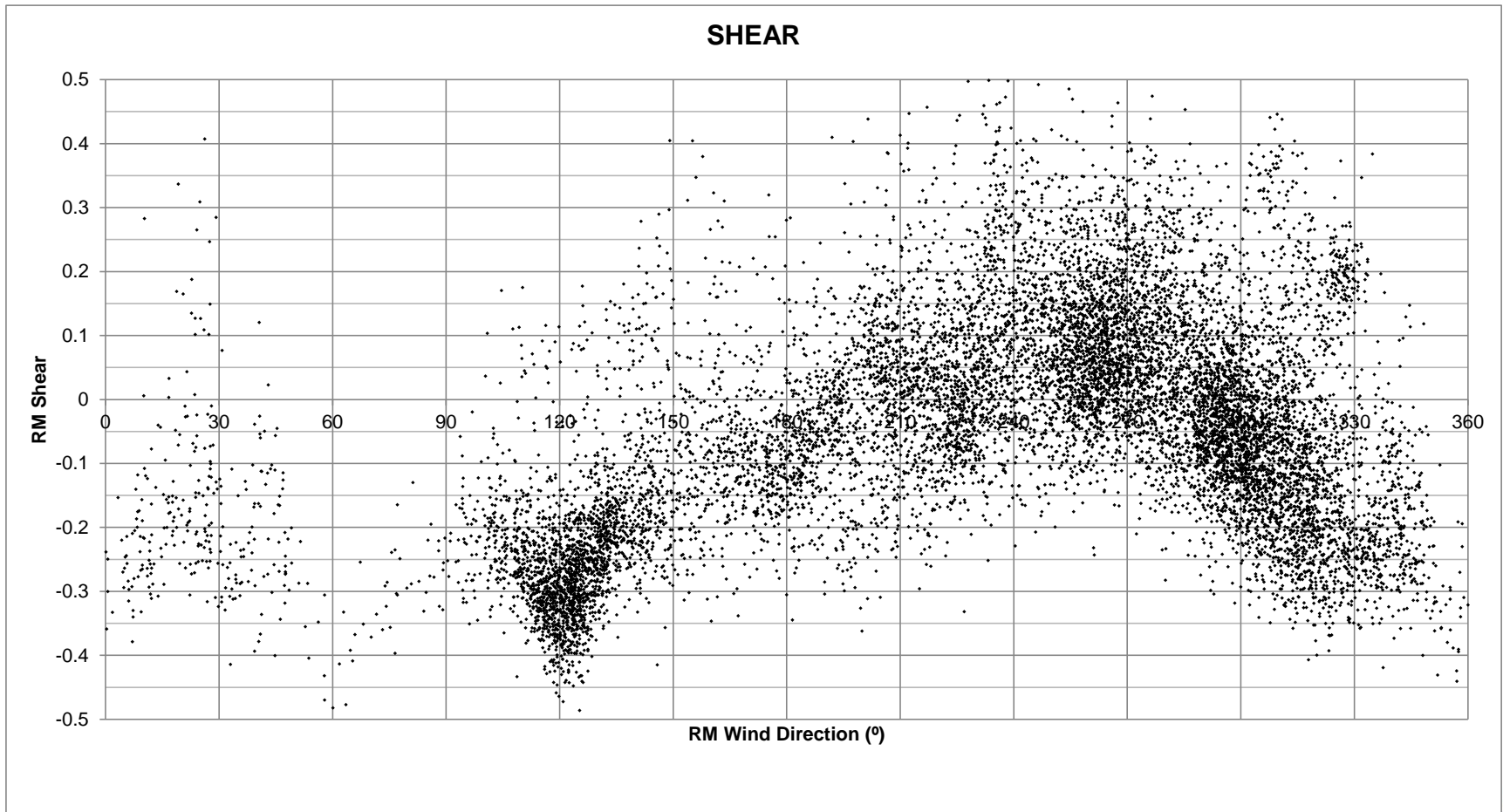
Griffin WF - Wind Speed at Reference Mast



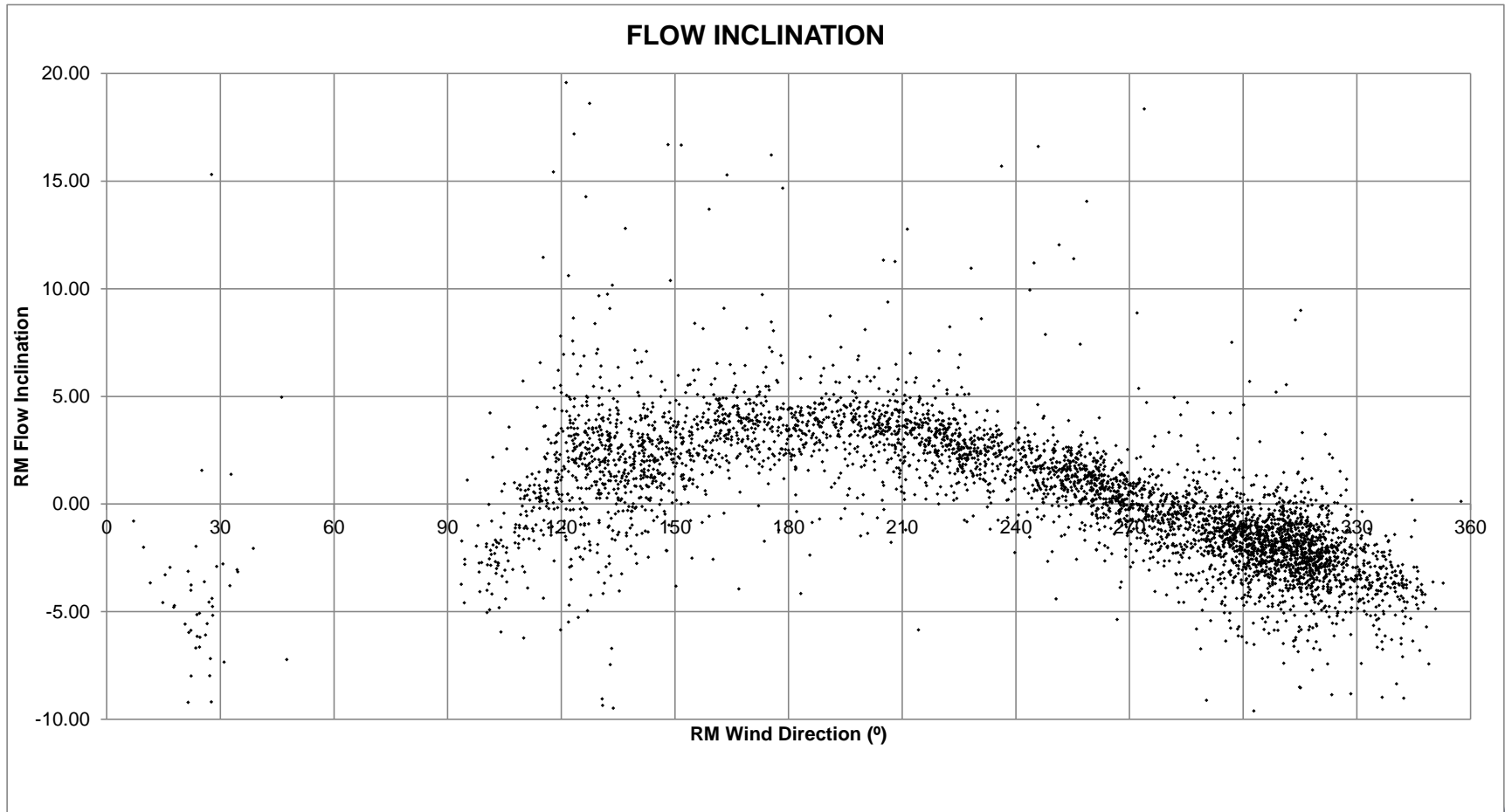
Griffin WF - TI at Reference Mast (wind speed >3 m/s)



Griffin WF - Shear at Reference Mast (wind speed >3 m/s)



Griffin WF - Inflow at Reference Mast (wind speed >3 m/s)

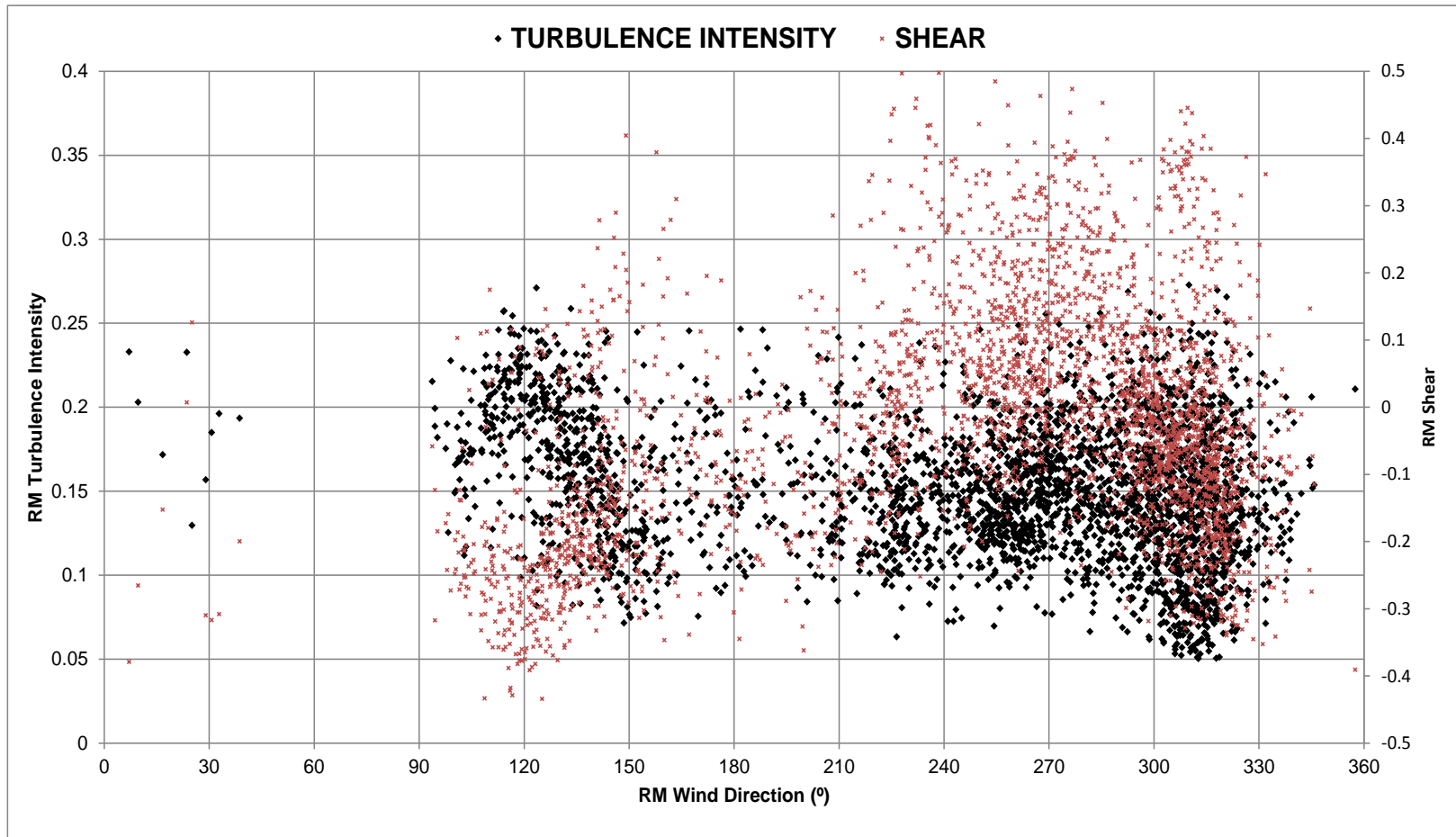


Griffin WF - TI and Shear at Reference Mast –

After filtering (wind speed >3 m/s)

Flow inclination: -3° to $+3^\circ$

$0.05 < TI < 0.1 \cdot (0.8 \cdot V_{hub} + 6 \text{ m/s}) / V_{hub}$

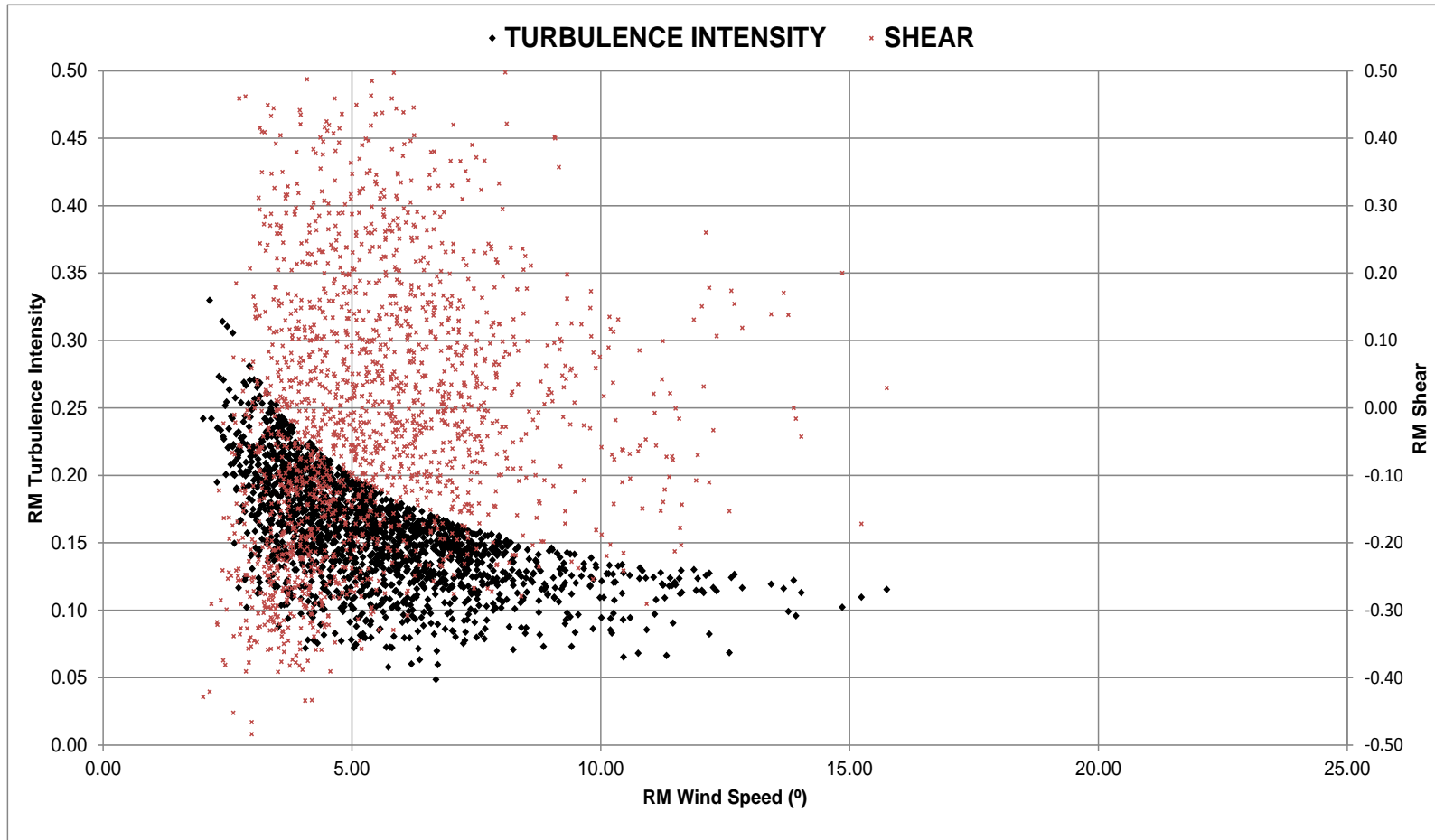


Griffin WF - TI and Shear at Reference Mast-

After filtering (wind speed >3 m/s)

Flow inclination: -3° to $+3^\circ$

$$0.05 < TI < 0.1 * (0.8 * V_{hub} + 6 \text{ m/s}) / V_{hub}$$



Griffin WF - Impact of TI and Shear Filters at Reference Mast Location

Data remaining after filtering					
Sector	Raw data	Turbine Status (OK, Connected, Not curtailed)	Flow inclination (-3° to +3°)	Turbulence intensity $(0.05 < TI < 0.1 * (0.8 * V_{hub} + 6m/s) / V_{hub})$	TI + Flow inclination
220°-260°	407 hours	72 %	45%	34%	24%

