Report of Activities at UK Pilot Locations

By Susana Ochoa, Timothy Darlington and Li-Pen Wang

RainGain Project Meeting, London, 16th April 2013

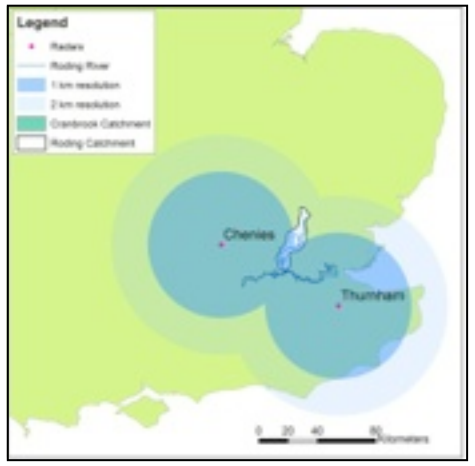
UK pilot locations

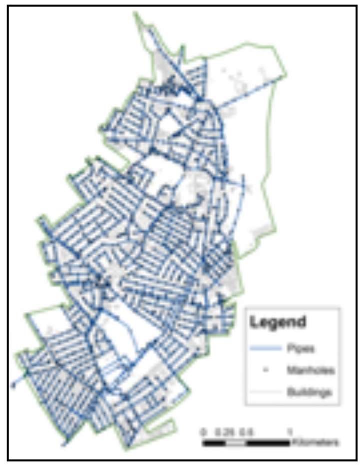
- Cranbrook (London Borough of Redbridge)
- Purley (London Borough of Croydon)
- Torquay City Centre (Torbay, Devon)

Cranbrook

(London Borough of Redbridge)

- **Drainage Area:** aprox. 9 km^2
- **Water course:** 5.75 km (5.69 km are piped/culverted)
- **Characteristics:** Predominantly urban, coincidental fluvial and pluvial flooding
- **Models:** Semi-distributed dual-drainage models have been implemented using InfoWorks CS
- **Sensors available:** C-band and X-band radar, 3 raingauges, 4 level gauges, 1 flow gauge
- **Aims/Expectations:** improved modelling & forecasting of surface flooding to support both urban planning and emergency management
- **Testing in RT:** yes

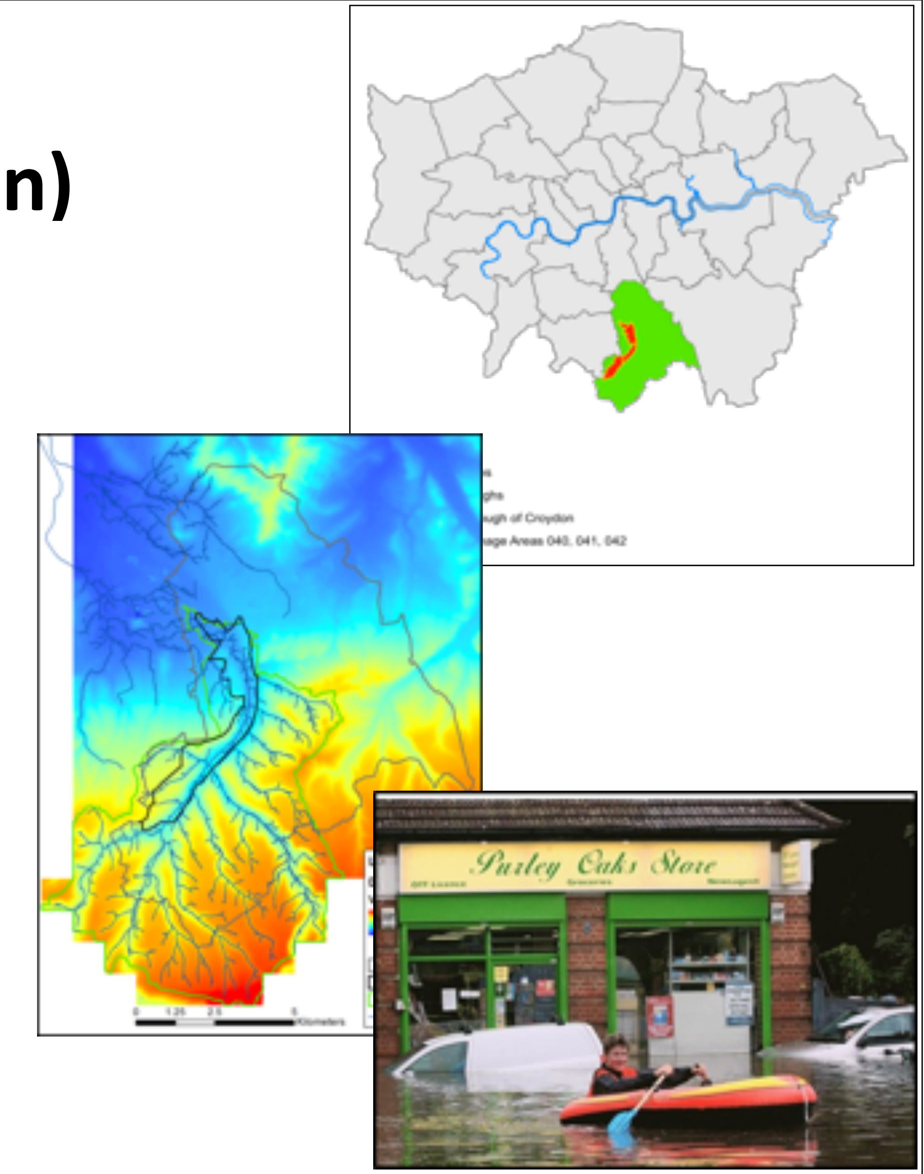





Purley

(London Borough of Croydon)

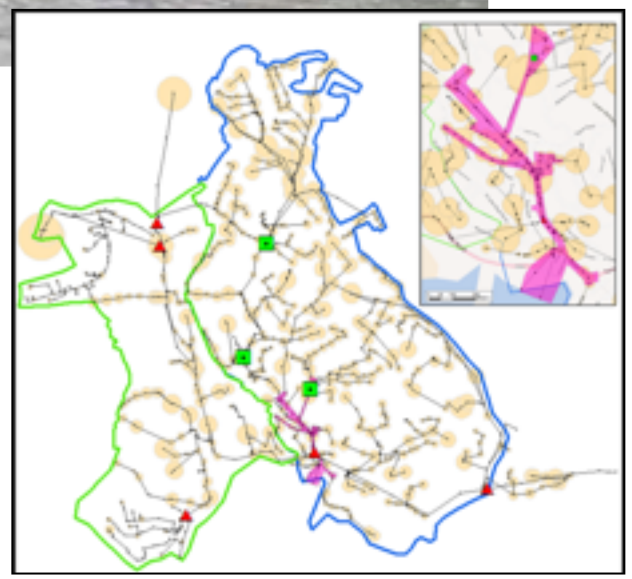
- Croydon is ranked the **4th** settlement in England **most susceptible** to surface water flooding (Defra)
- **Purley area:** highest risk of surface flooding within the Borough (SWMP)
- **Area:** Approx. 6.5 km^2
- Highly urbanised, high density of receptors, slopes drain to natural depression
- **Models:** currently only model of the sewer system in Infoworks. Dual-drainage model is being implemented
- **Sensors:** C-band and X-band radars, 3 raingauges, 10 level gauges (operated by TW)



- **Aims/Expectations:** improved modelling & forecasting of surface flooding to support both urban planning and emergency management
- **Testing in RT:** yes

Torquay City Centre (Torbay, Devon)

- "British Riviera" – tourist place
- Highly urbanised, high density of receptors
- Severe pluvial flooding in the last few years: October 1999, May 1999, October 2004, August 2007
- Tides may generate back water effects
- **Area:** 14.6 km^2
- **Models:** semi-distributed, dual-drainage models in InfoWorks are in place
- **Sensors:** C-band radar, 3 raingauges, 2 level gauges, 1 flow gauge (to be installed soon)
- **Aims/expectations:** mainly flood forecasting, RT control, many control elements!
- **Testing in RT:** yes



In all pilot locations

- Monitoring system has been implemented (or external monitoring data has been acquired)
- Within the coverage of UK Met Office C-band radars

ACTIVITIES WITHIN WP1

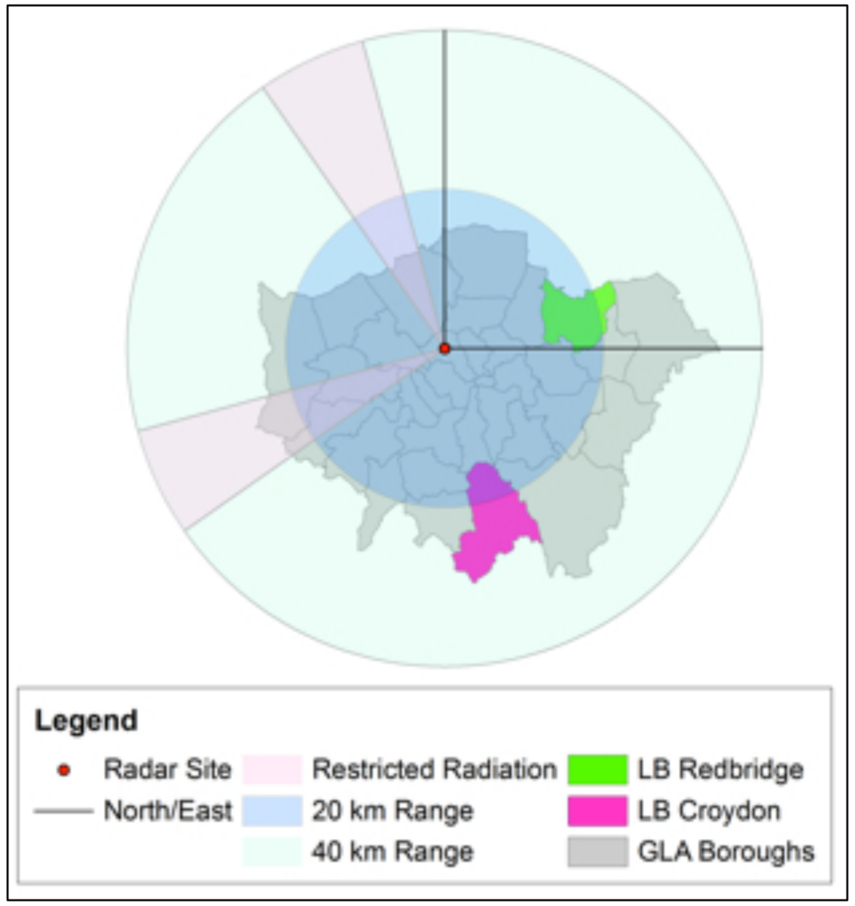
- Installation of X-band radar in London (March – April 2013):
  - Rainscanner on loan from Selex for 6 months
  - Installation of this radar was not initially envisaged (so it is a ‘bonus’!)

London’s X-Band Radar

	Selex RainScanner RS90
Radar type	X-band
Polarisation	Single-polarisation
Doppler (yes/no)	No
Antenna	Parabolic, pencil beam antenna
Beamwidth	[illegible]
Frequency range	8 to 12 GHz
Wave length	2.5 – 4 cm
Range resolution	30 m
Pulse length (m)	Approx. 100 m
Temporal resolution	1 min
[illegible]	2

Can detect:

- Light rain: within 35-40 km range
- Moderate rain: within 60-70 km range
- Heavy rain: within 70-100 km range



Technical Specifications

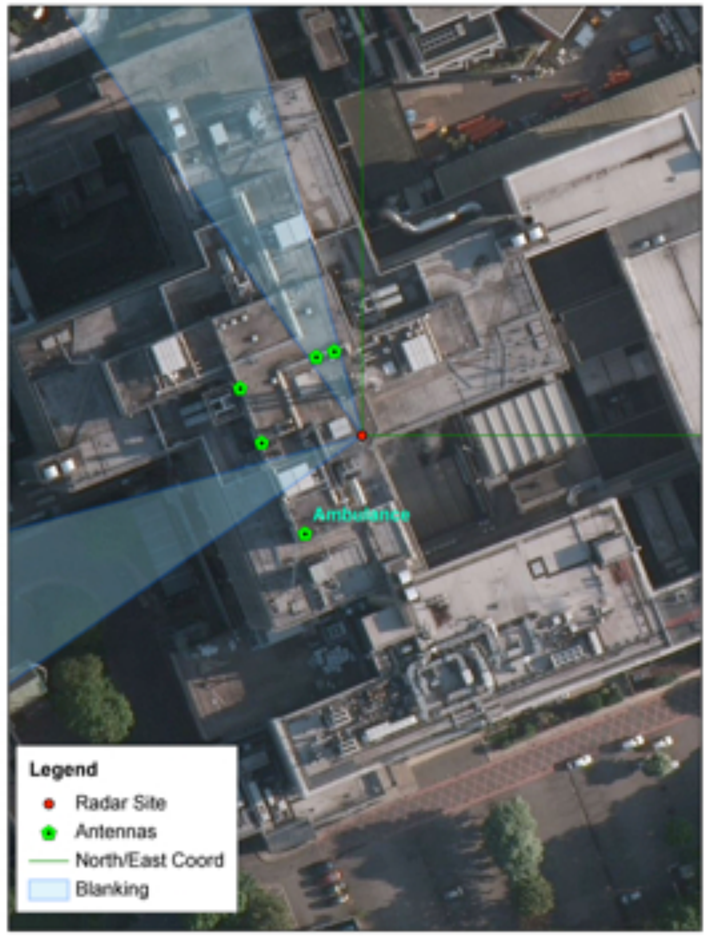
	RS60	RS90	RS120
Antenna			
- Diameter	0.6 m	0.9 m	1.2 m
- Gain	32 dB	37,5 dB	38.5 dB
- Elevation Sidelobe	-20 dBc	-26 dBc	-27 dBc
- Azimuth Beam Width	4°	2.5°	2°
- Elevation Beam Width	4°	2.5°	2°
- Rotation Rate	12 rpm	12 rpm	12 rpm
- Azimuth Accuracy	± 0.5°	± 0.5°	± 0.5°
Transmitter			
- Peak Power	25 KW		
- Frequency	9375 or 9410 (± 30 MHz)		
- PRF	833 – 1500 Hz		
- Pulse Duration	500 – 1200 ns		
- Pulse Length (Resolution)	75 – 180 m		
Receiver			
- Bandwidth (1200ns / 500 ns)	3 MHz / 7 MHz		
- Minimum Detectable Signal	-100 dBm		
- Dynamic Range	70 dB		
- Noise Figure	6 dB		
Signal Processor			
- CPU	Intel Pentium Dual Core		
- Operating System	LINUX		
- Memory (RAM)	2 GB		
- Hard Disk	Min. 30 GB, extended temperature range		
- Interfaces	COM1, COM2, Parallel, 4x USB 2.0, PS2		
- Network Interface	Fast Ethernet 100 Mb/s		
- Radar A/D Converter	14 bit, 20 MS/s		

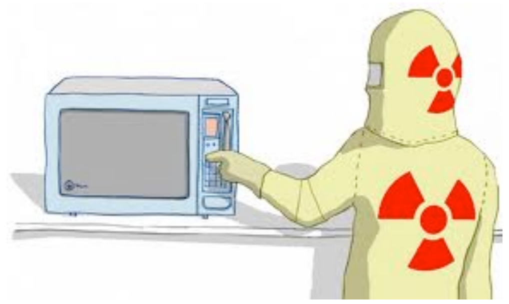
Investing in Opportunities
This project has received European Regional Development Funding through INTERREG IV B.
nwe INTERREG IVB

INSTALLATION WAS DONE IN THREE PHASES

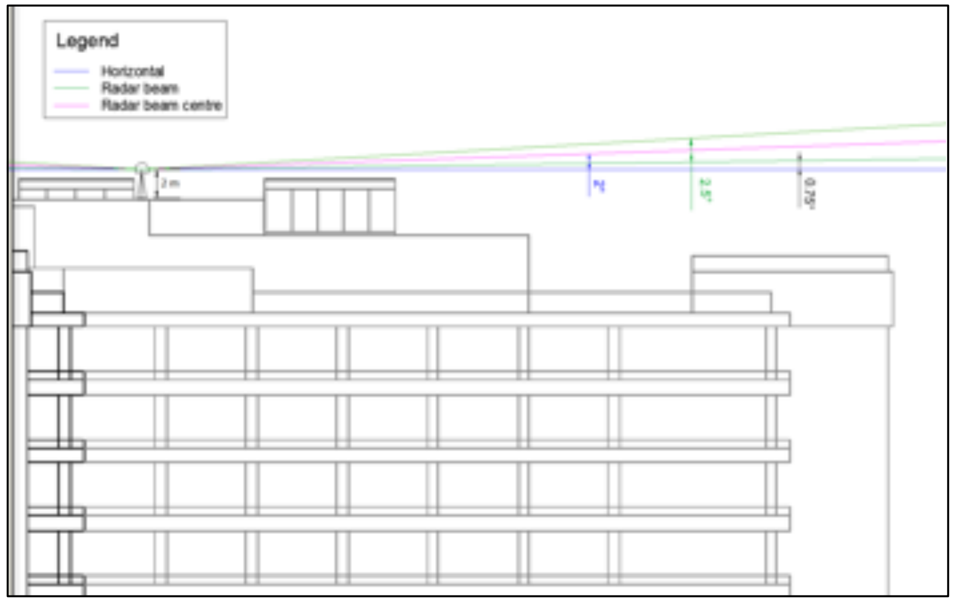
PHASE 1 – 9TH MARCH 2013

BUT… No antenna **and** hospital worried about risk of interference and radiation in case of inadvertent access to the roof…





Solution: Comprehensive risk assessment + warning signs + change in protocol to access roof + need to raise the antenna 2 m above the ground



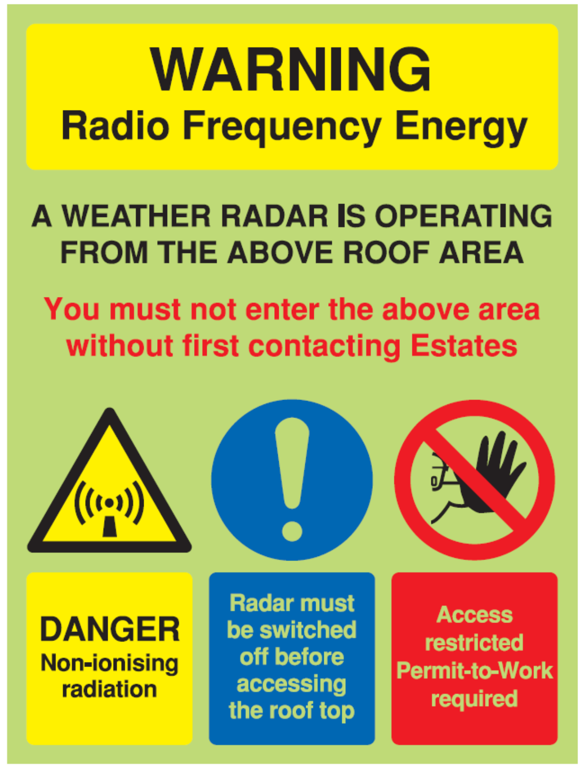
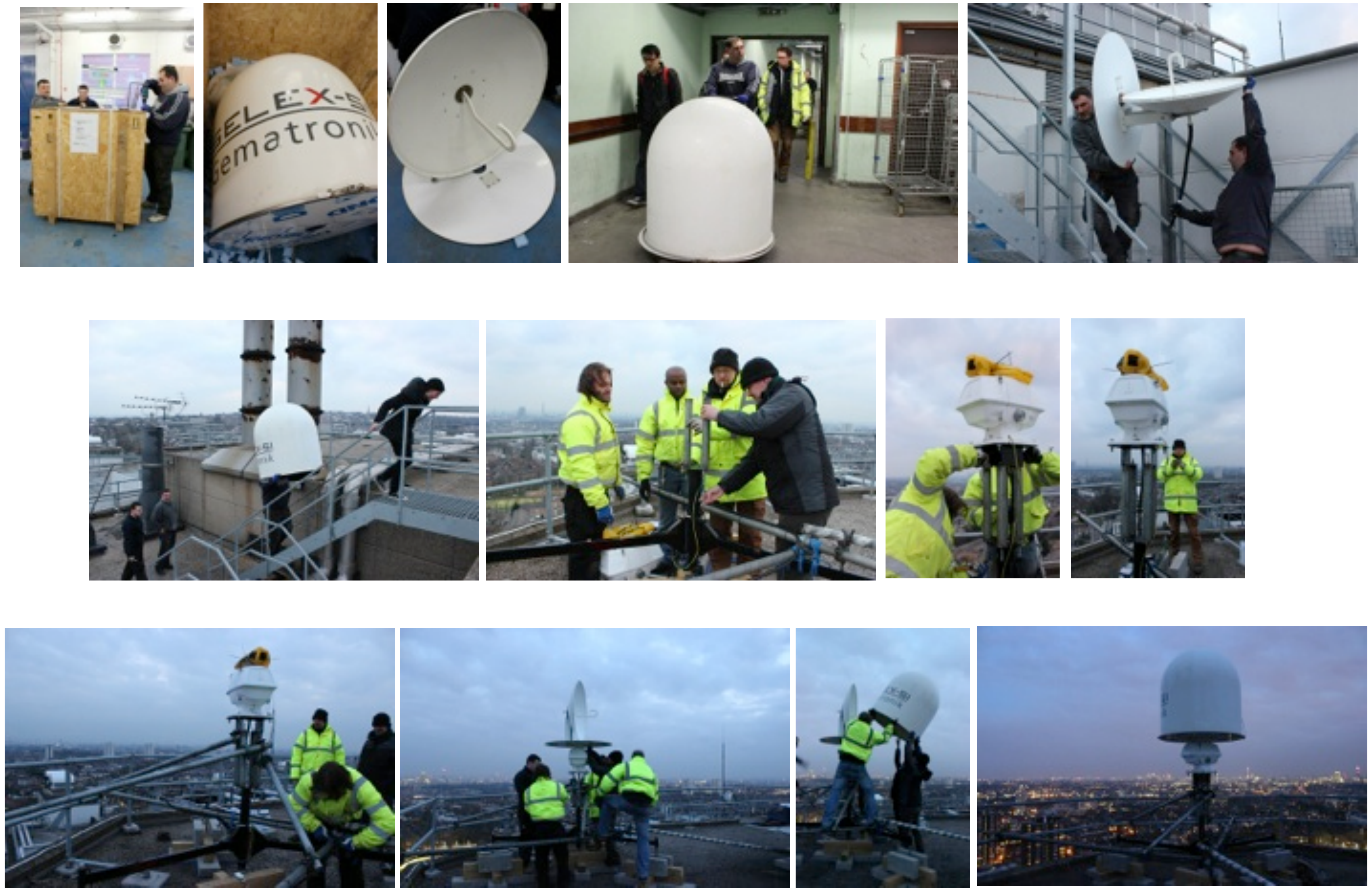


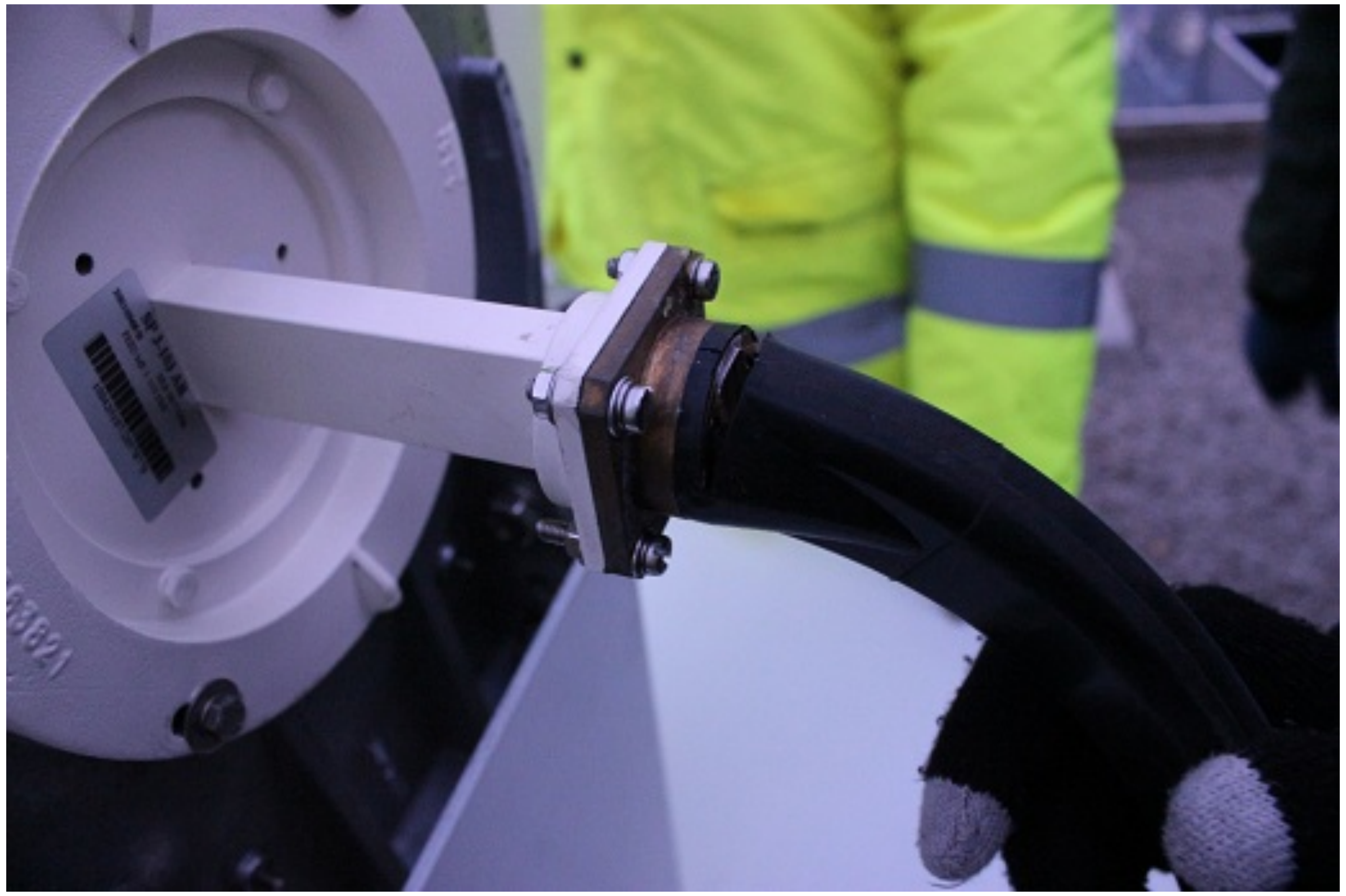
Table A.3: Risk grading matrix

Likelihood	Consequence				
	None	Minor	Moderate	Major	Catastrophic
Rare	Very low	Very low	low	moderate	High
Unlikely	Very low	Very low	low	moderate	High
Possible	Very low	Low	Moderate	High	High
Likely	Low	Low	Moderate	High	High
Almost certain	Low	Low	Moderate	High	High

PHASE 2 – 26TH MARCH 2013

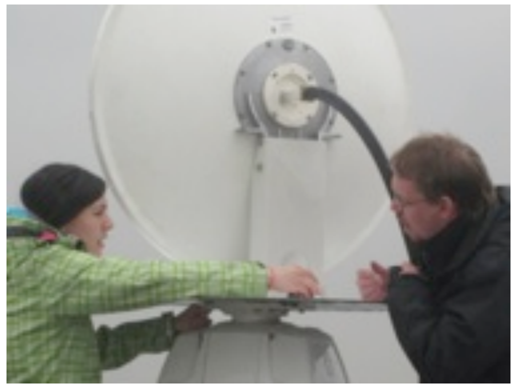


BUT… Broken waveguide and protocols for roof access not ready yet

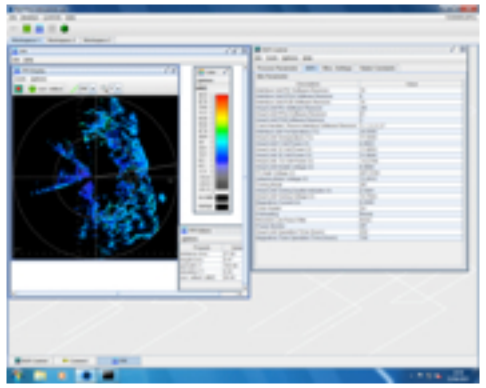


PHASE 3 – 11TH APRIL 2013







Need to get licence for software, will start collecting data soon!

Next Steps

- Quality control and calibration will be done using raingauge data from pilot locations
- Website for dissemination of results is under development and will be operational even after the radar has been decommissioned

Interactions/Collaboration with Project Partners

- The experiences of the Belgian partners with the installation of their X-band gave us insights about the requirements for installing a similar radar in London (e.g. protocol for accessing roof, data transmission, etc.).
- Useful discussion with project partners and communication officer regarding how to handle the general public (e.g. should the installation of the radar be made public or should we keep it secret? How to present the risk of radiation to the public?).
- Useful discussion with project partners about dissemination of results. In the future, we may share the code of our radar website with partners.

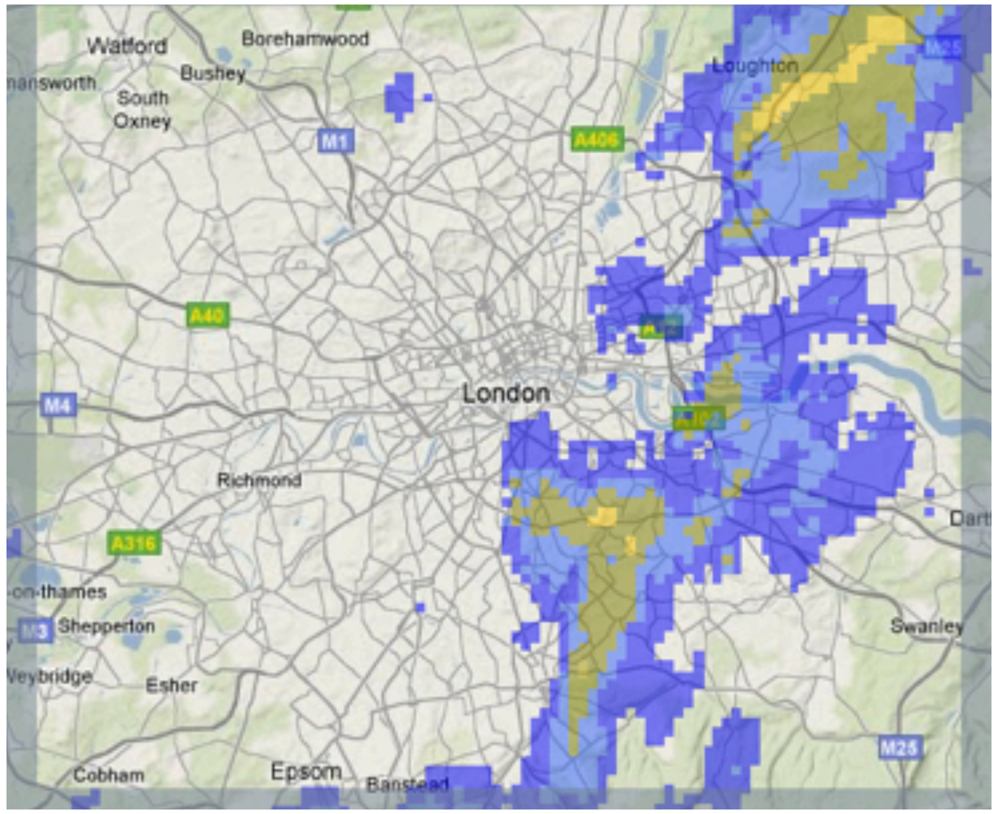
ACTIVITIES WITHIN WP2

- Progress on C-Band radar signal processing for obtaining high resolution radar rainfall estimates
- Analysis of the possibility of improving QPFs through dynamic gauge-based adjustment of radar rainfall estimates (with mean field bias and KED adjustment methods)

C-Band Radar Signal Processing

Timothy Darlington and Li-Pen Wang

High-resolution processing

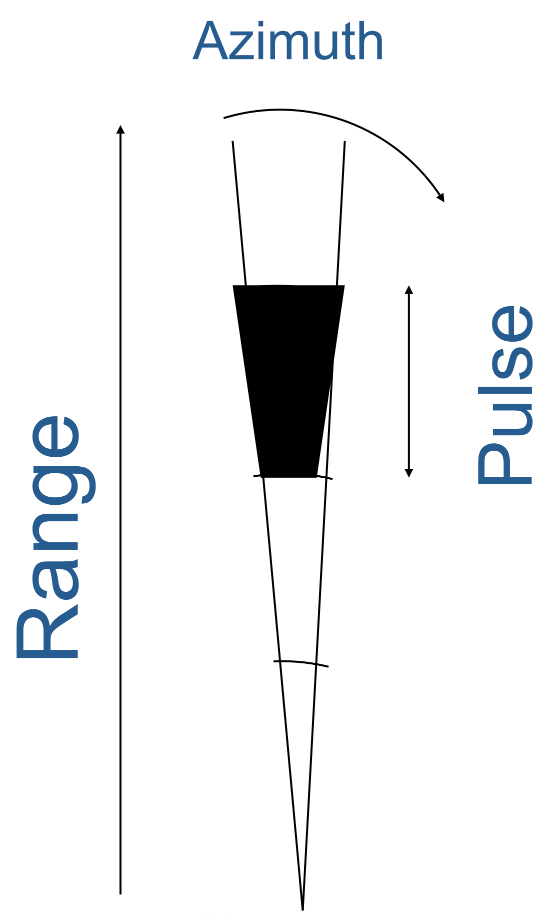


500m data on Invent

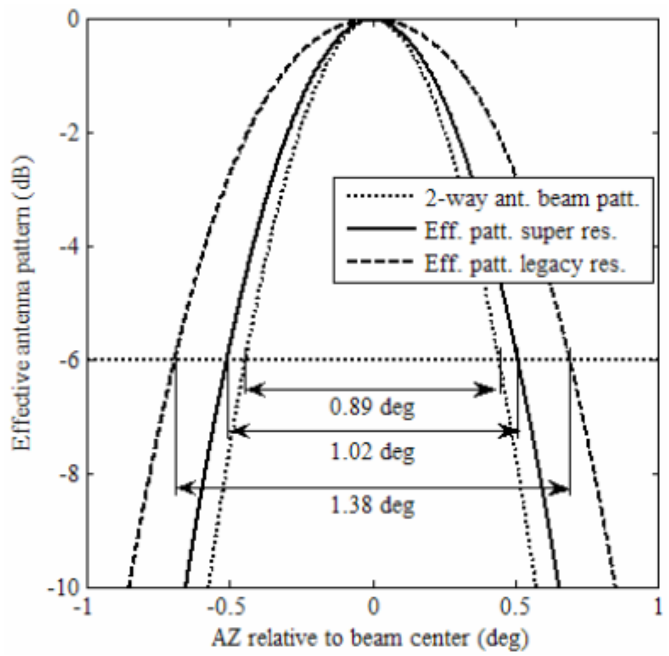
- Can we refine resolution of the rainfall estimates for urban catchments? (While maintaining / improving quality)
- **Our goal: 100m or better resolution over central London by 2014**

Fine scale resolution – limiting factors

- Weather radar measurements are collected in polar coordinates i.e. range gates per degrees
- Range gate resolution is limited by the transmitted pulse length
- The angular resolution is mostly limited by the beam width of the antenna at the transmission wavelength



High-resolution processing Progress: Azimuth Improvements

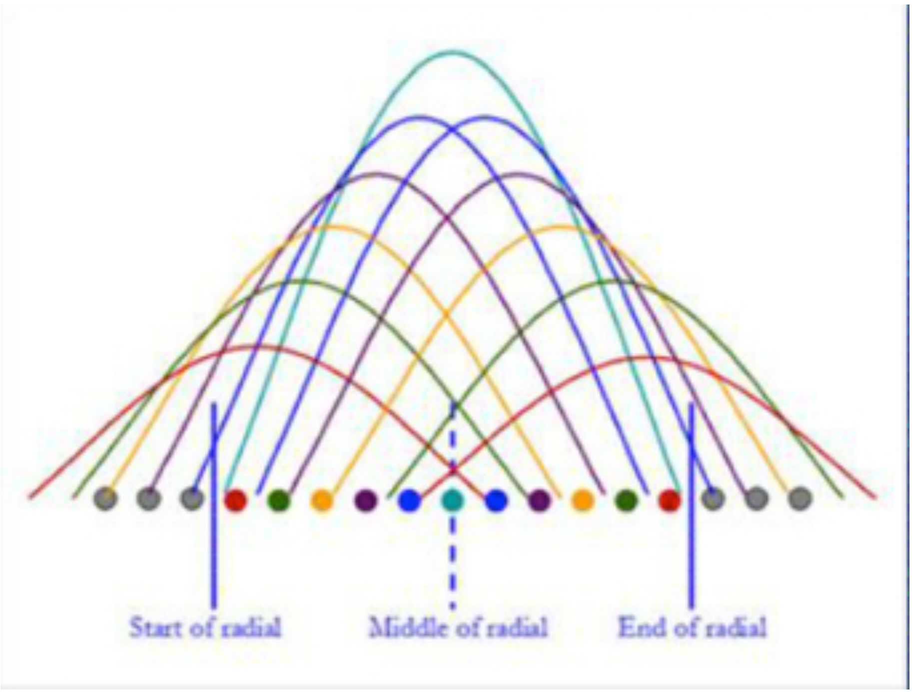


Effective antenna patterns corresponding to legacy- and super-resolution processing for a Gaussian intrinsic antenna beam pattern with a two-way 6-dB beam width of 0.89 deg. *

- Based on work in the US
- Beam width usually degraded by scanning motion of antenna

* Design considerations for improved tornado detection using super-resolution data on the NEXRAD network
Sebastian Torres, Christopher Curtis

Super angular resolution



- By weighting values in azimuth we can recover some of the angular resolution

- Downside
  - Loss of information
    - Higher variance measurements

Results: Implementation at

Looking at Ground Clutter

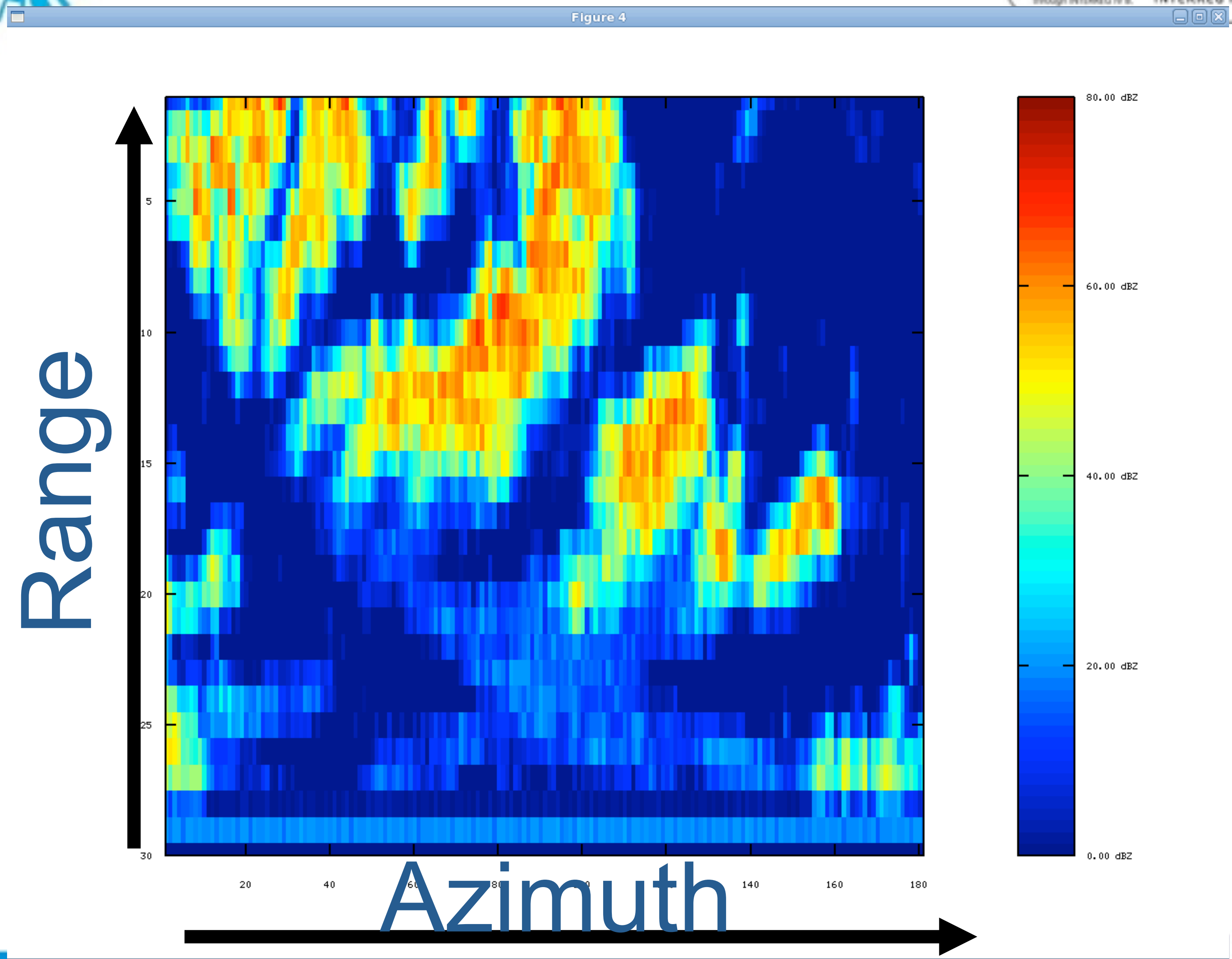
•Provides known repeatable targets

300m range conventional azimuth data

Polar

Data

Plot



300m range

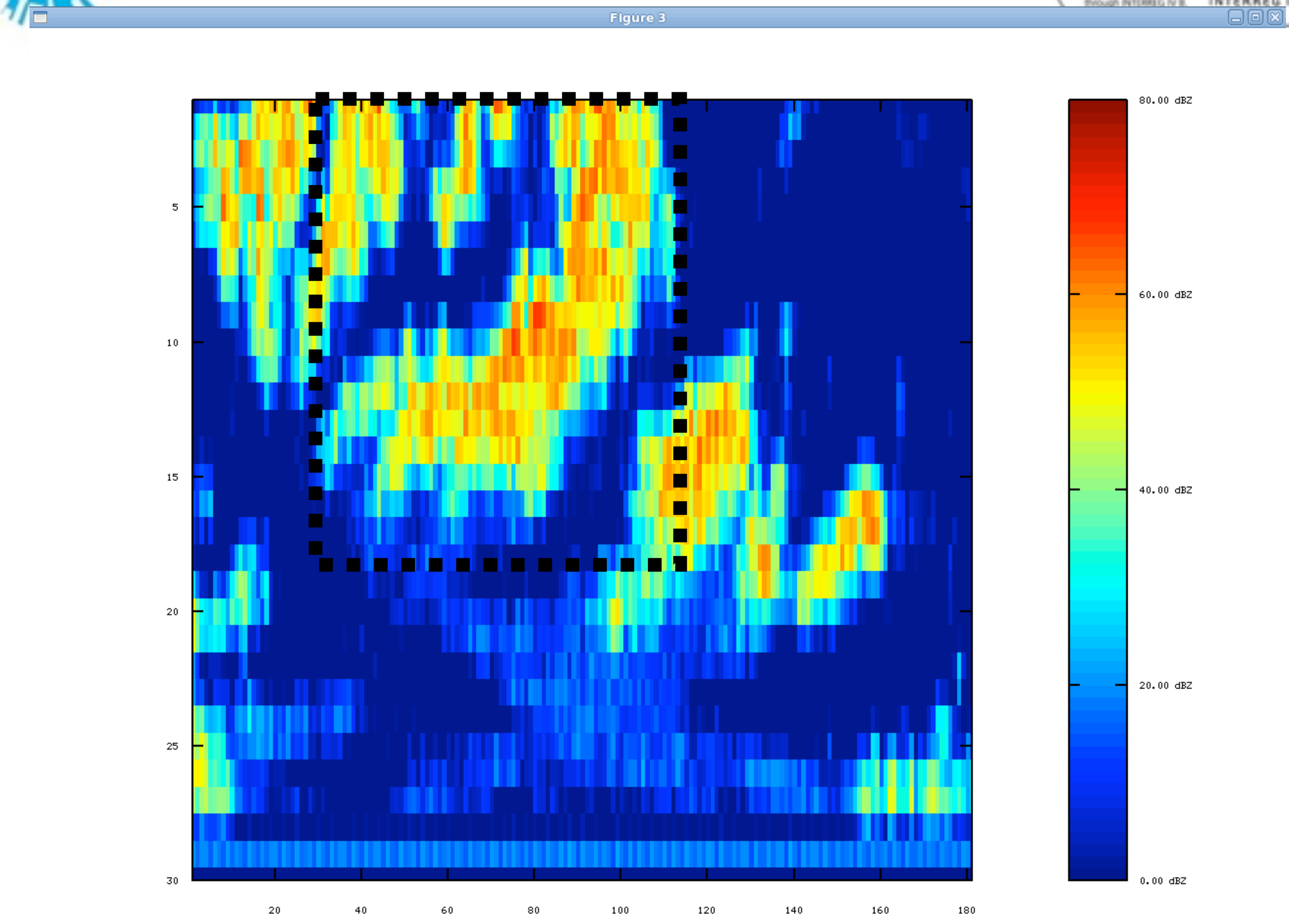


Figure 3
80.00 dBZ
60.00 dBZ
40.00 dBZ
20.00 dBZ
0.00 dBZ
5
10
15
20
25
30
20
40
60
80
100
120
140
160
180

Does sharpening work?

- The question:
  - After sharpening is it possible to resolve two targets that were previously seen as one?

300m range

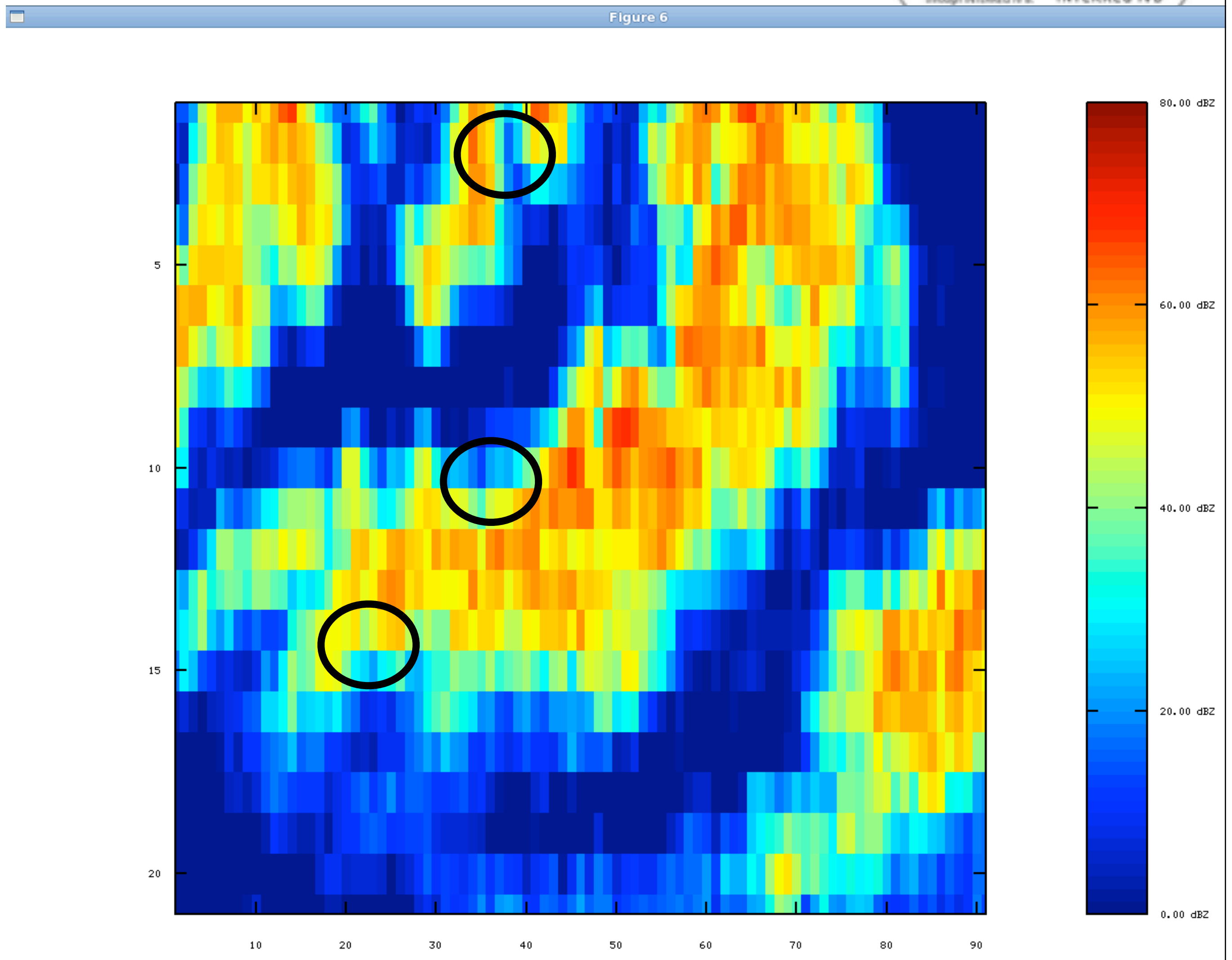


Figure 6
5
10
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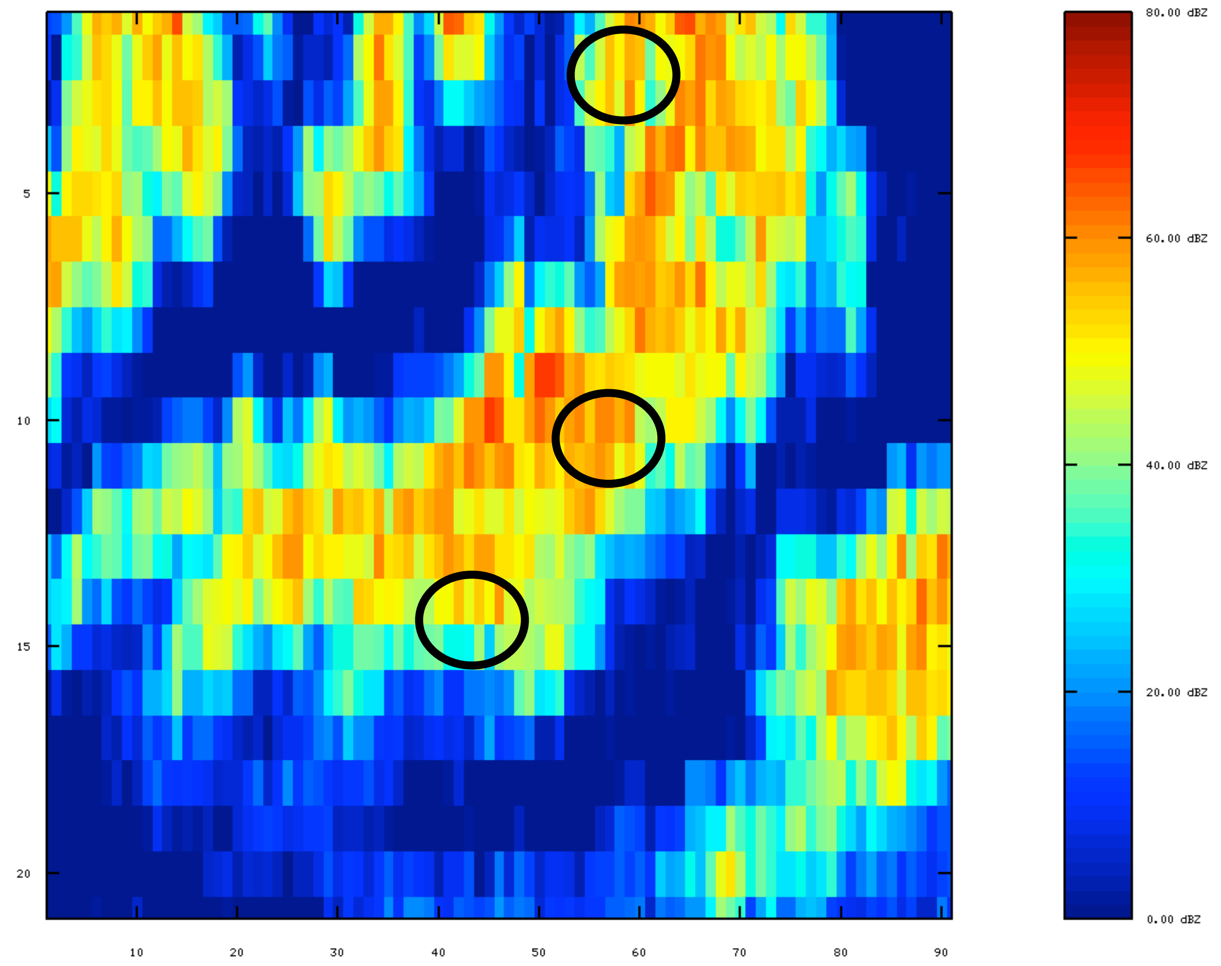
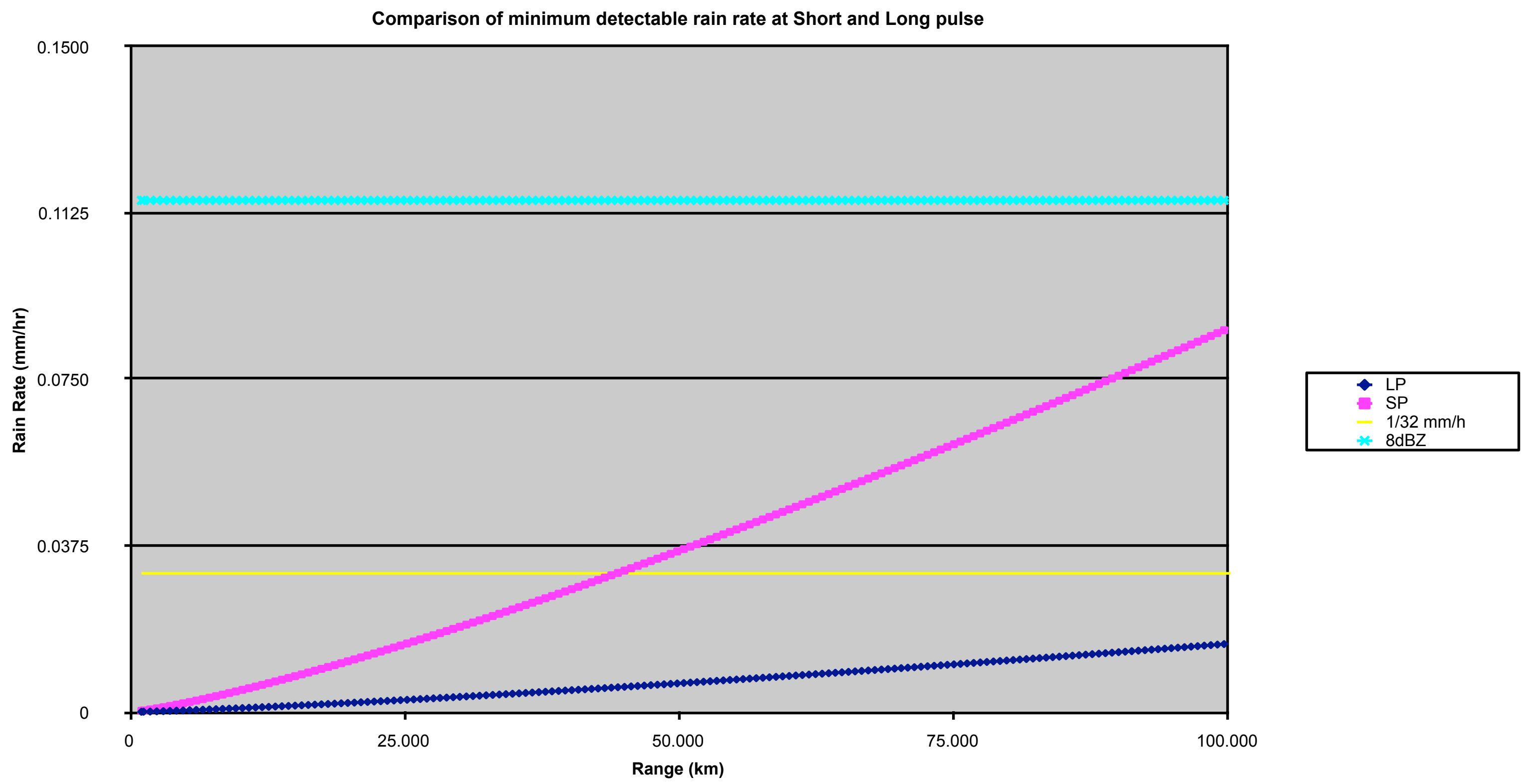
90
80.00 dBZ
60.00 dBZ
40.00 dBZ
20.00 dBZ
0.00 dBZ

300m range



Range improvement?

- Quick test – use a shorter pulse – 300m vs 75m
- Down side : Lower detection Limit



300m range

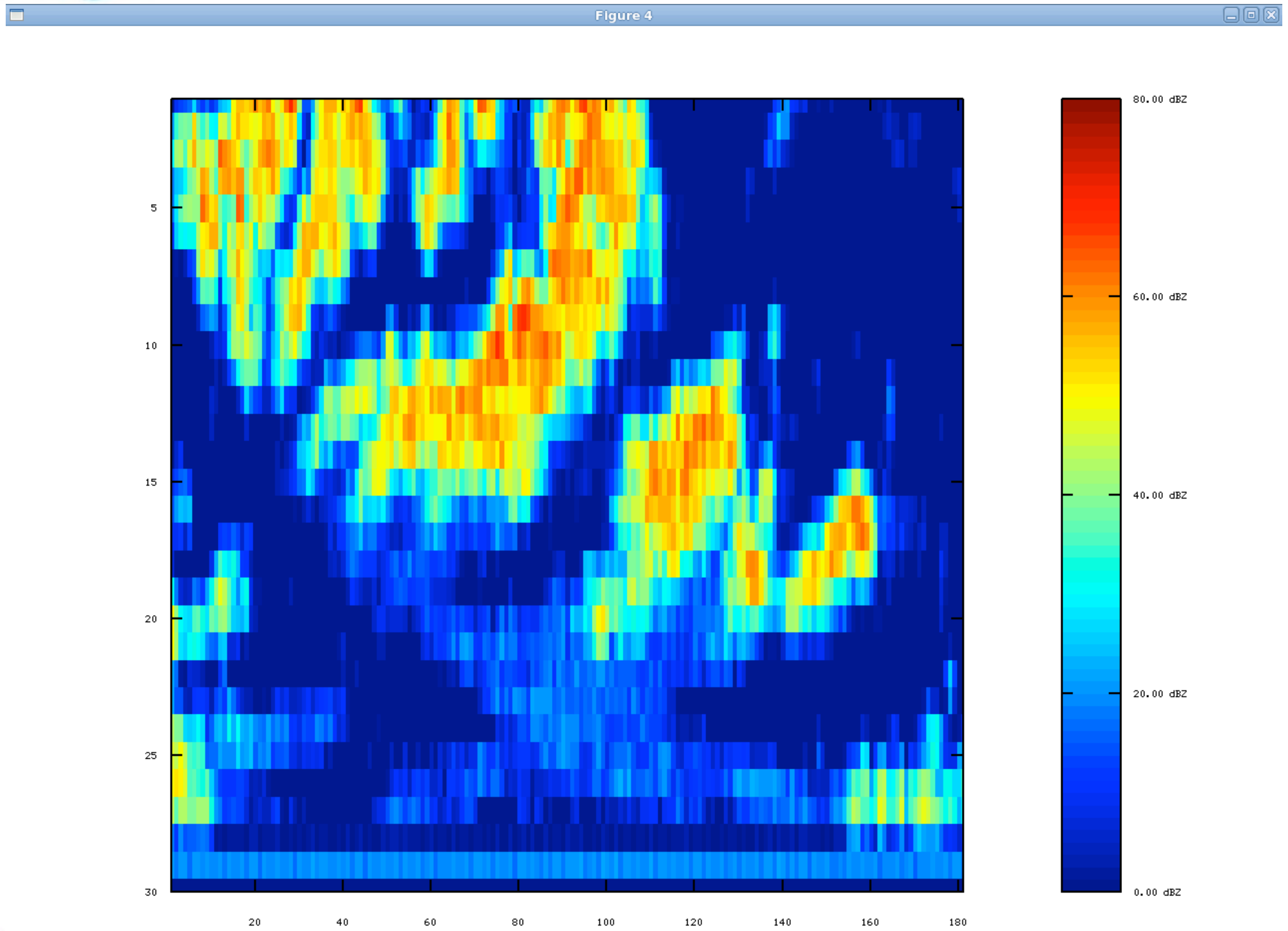


Figure 4
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180
80.00 dBZ
60.00 dBZ
40.00 dBZ
20.00 dBZ
0.00 dBZ

75m pulse

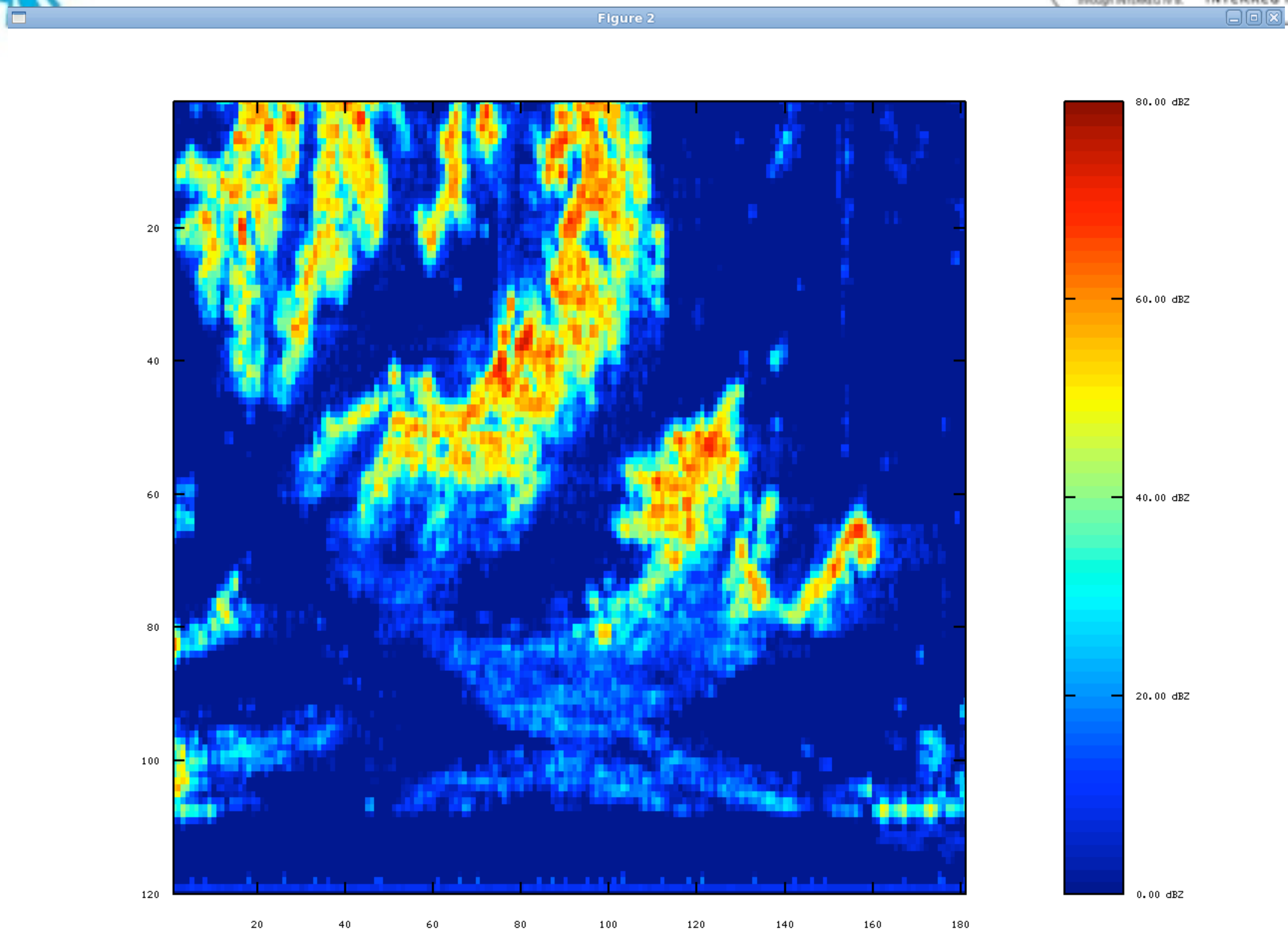

Figure 2
20
40
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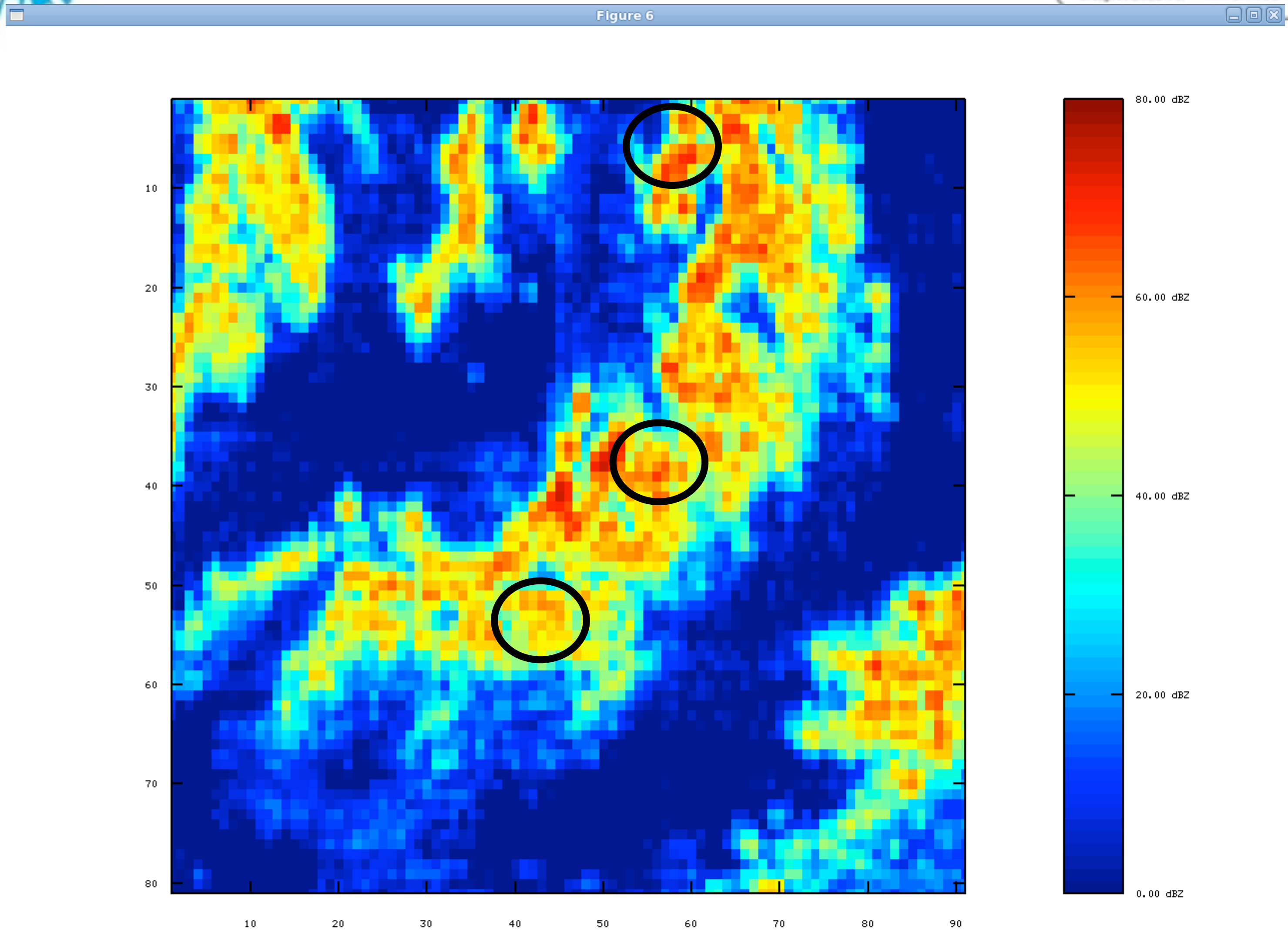
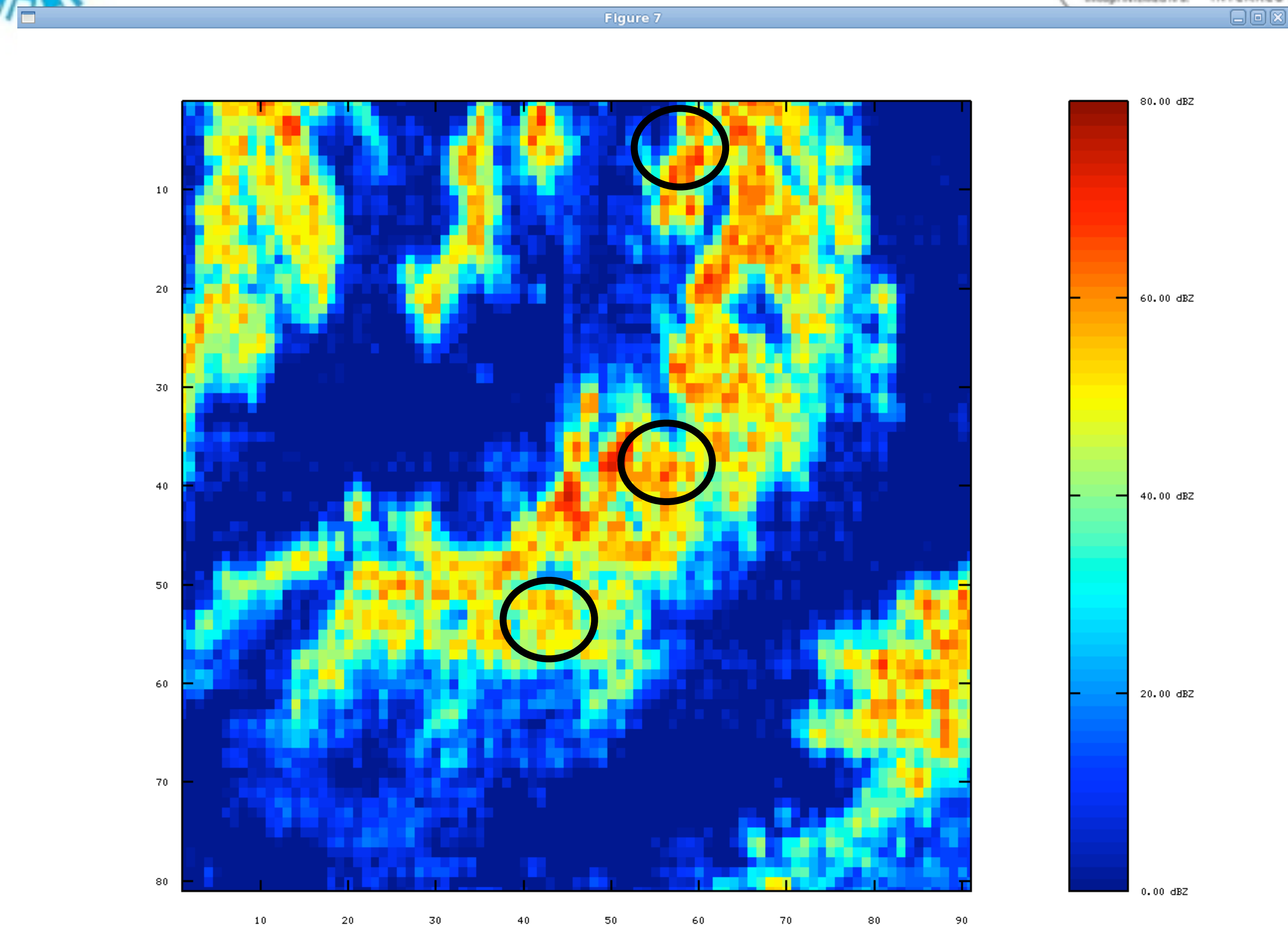
100
120
140
160
180
80.00 dBZ
60.00 dBZ
40.00 dBZ
20.00 dBZ
0.00 dBZ

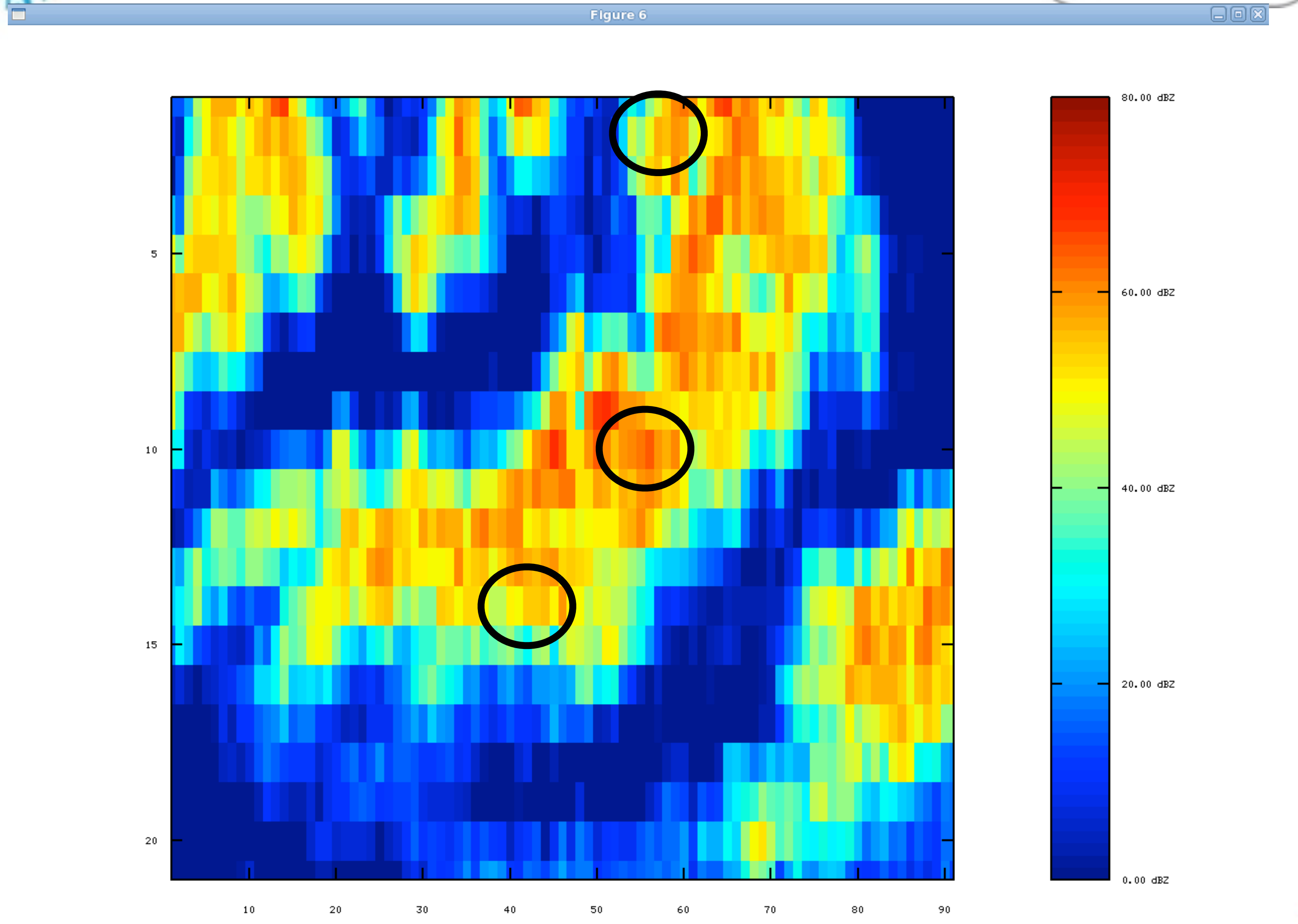
75m pulse conventional



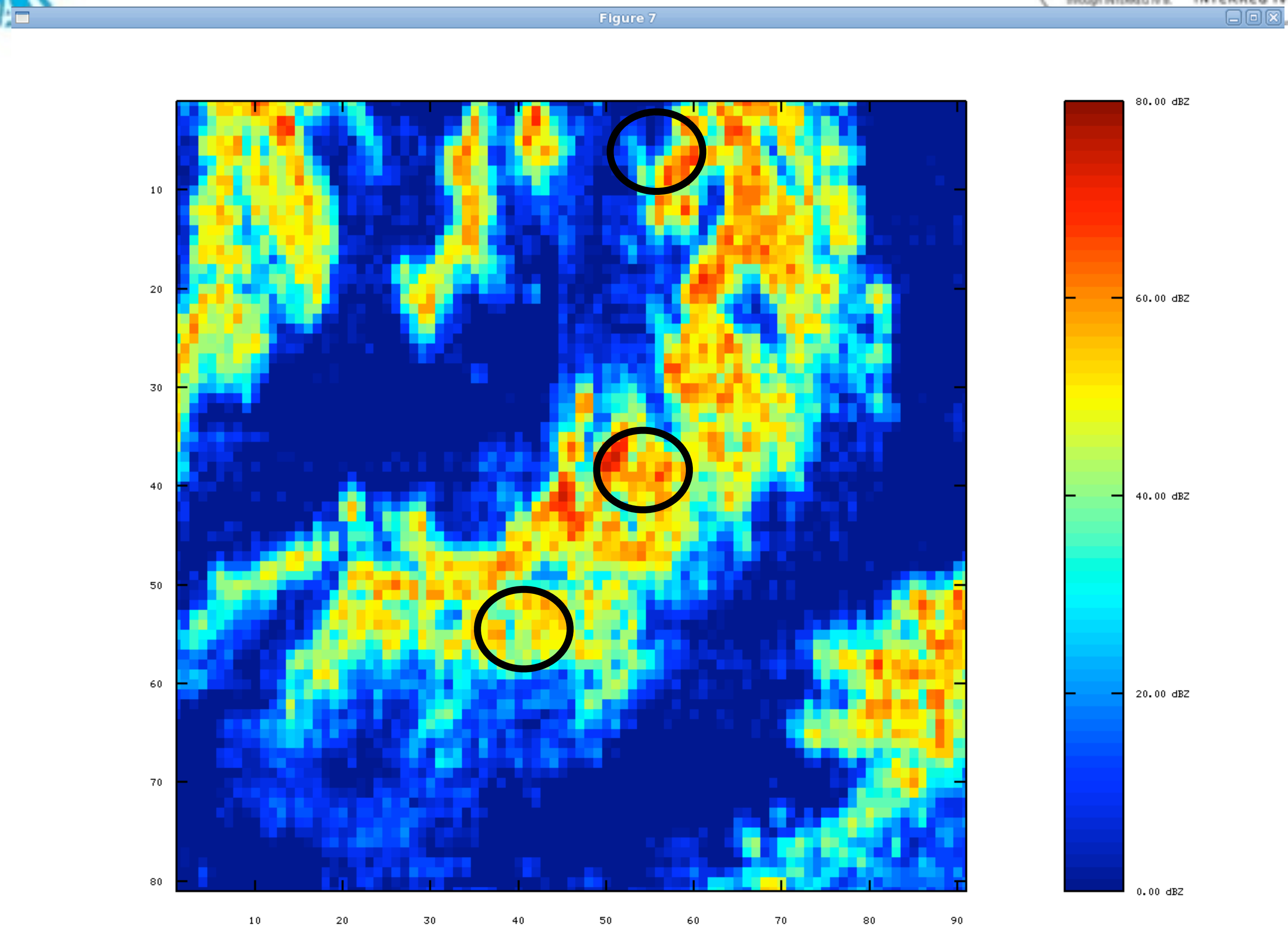
75m pulse zoomed in



From LP 300m normal to

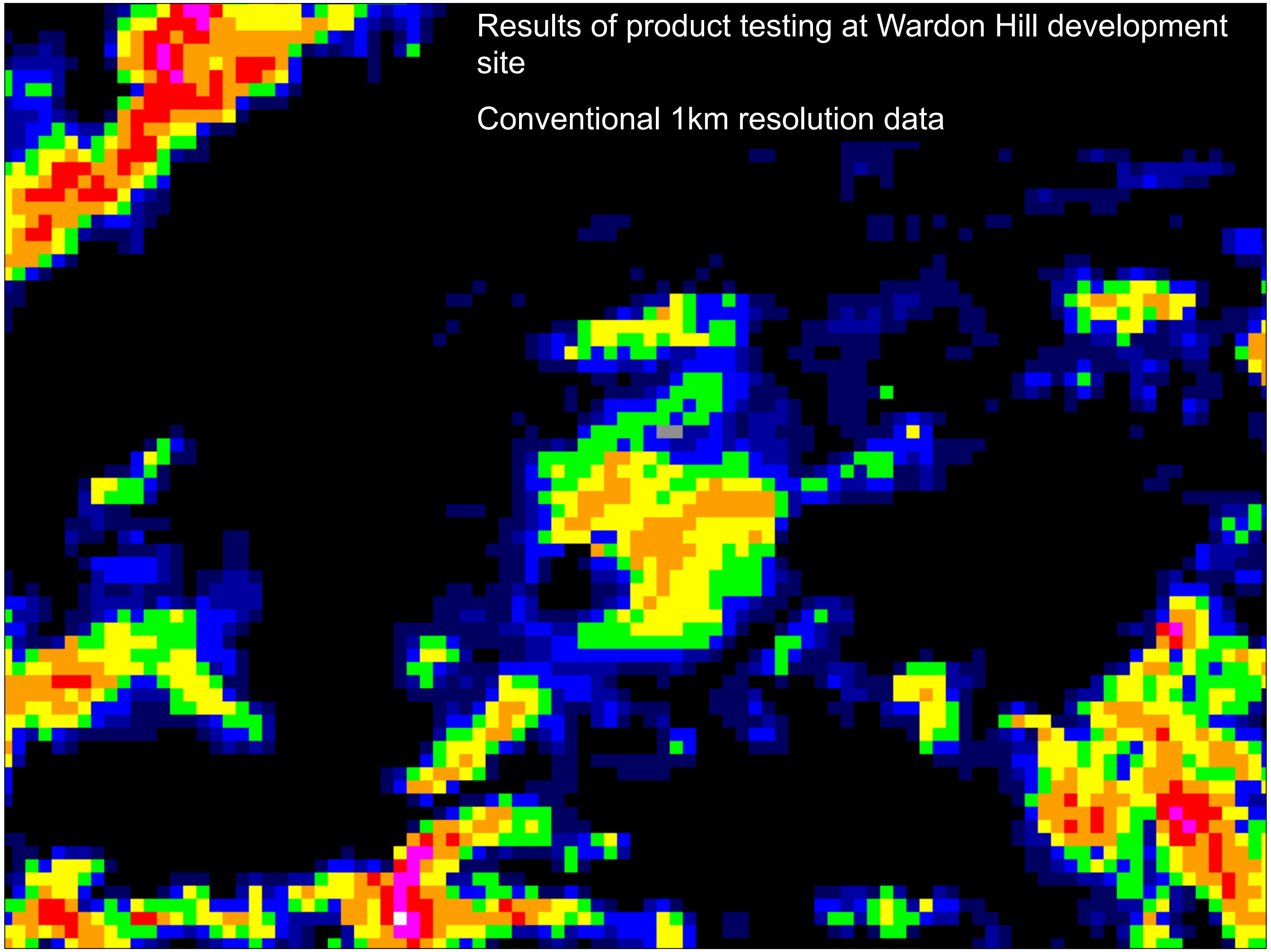


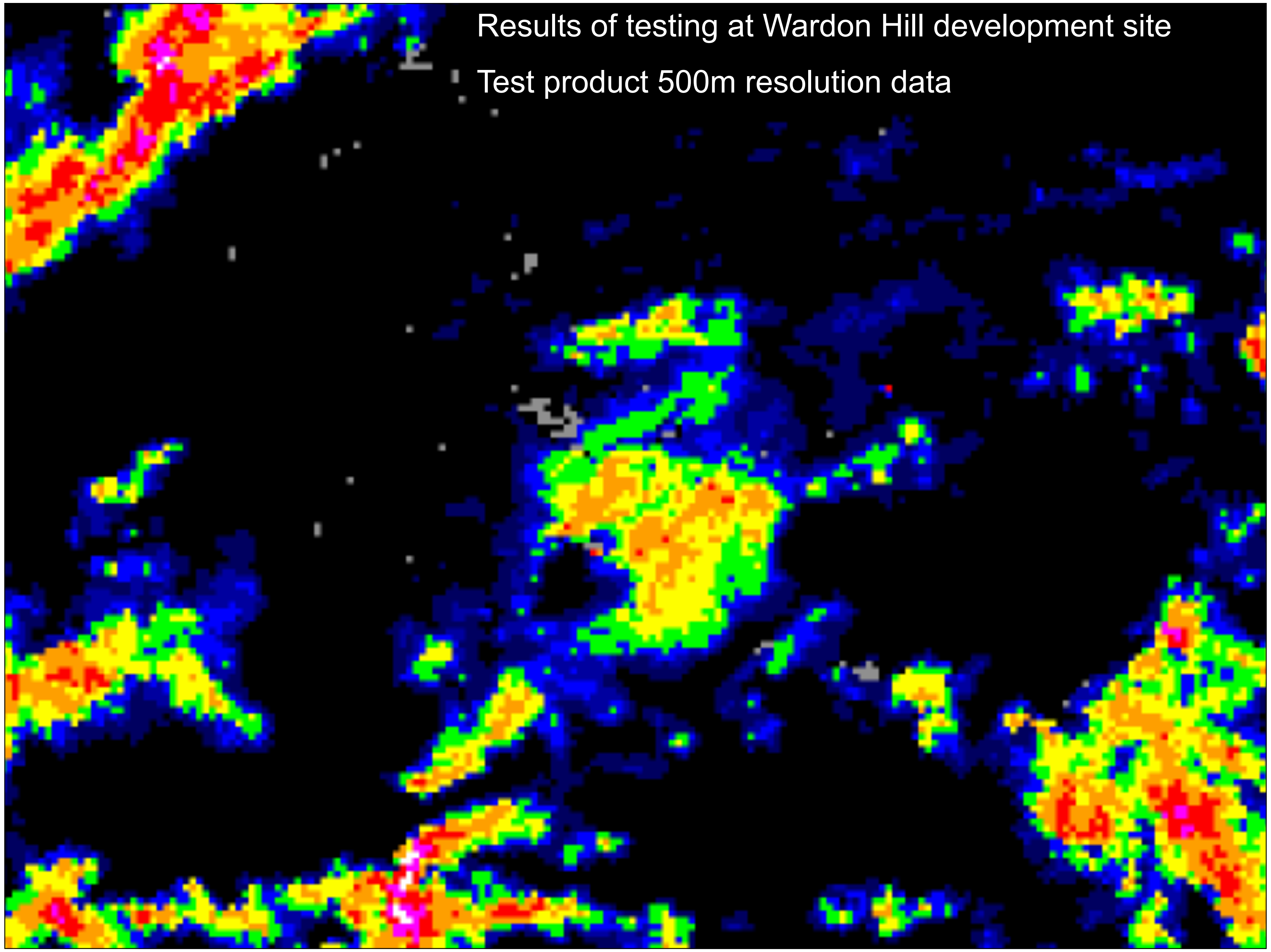
75m pulse sharpened



Effect on Cartesian data

- Very preliminary results


Results of product testing at Wardon Hill development site
Conventional 1km resolution data


Results of testing at Wardon Hill development site
Test product 500m resolution data