



GEMATRONIK

Weather Radar Systems

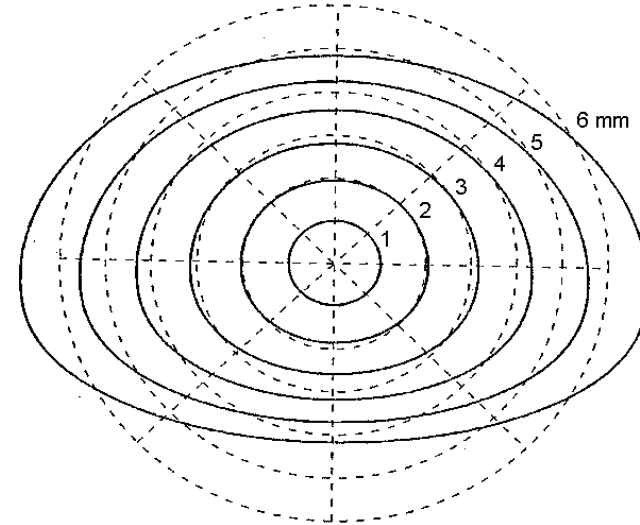
Precipitation Measurement Techniques

Nordic Weather Radar Workshop
3-4 October 2002 – FMI, Helsinki



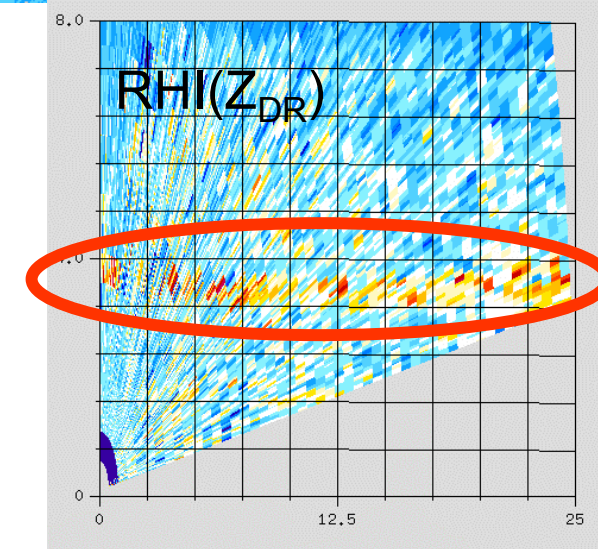
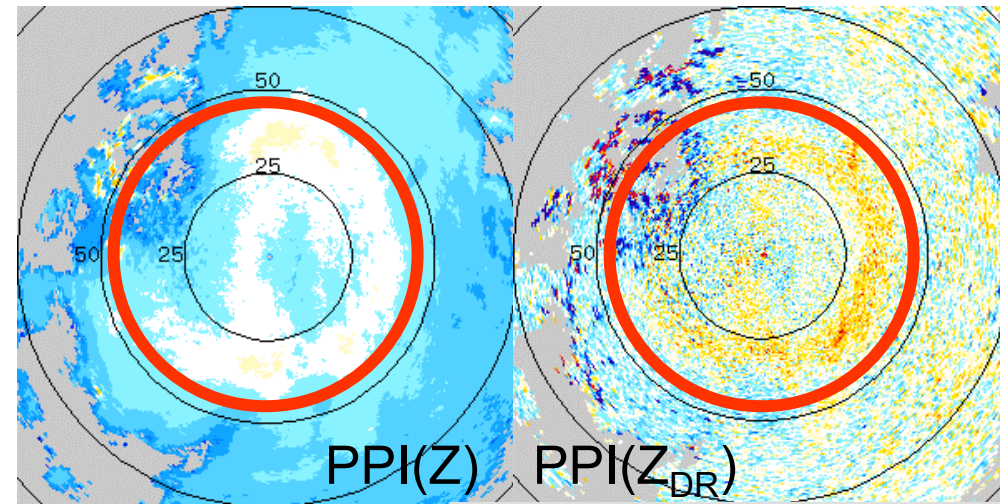
Z_{DR} – Differential Reflectivity

- Oblate Objects
- Hail detection
- **Melting Layer**



Z_{DR} – Differential Reflectivity

- Oblate Objects
- Hail detection
- **Melting Layer**

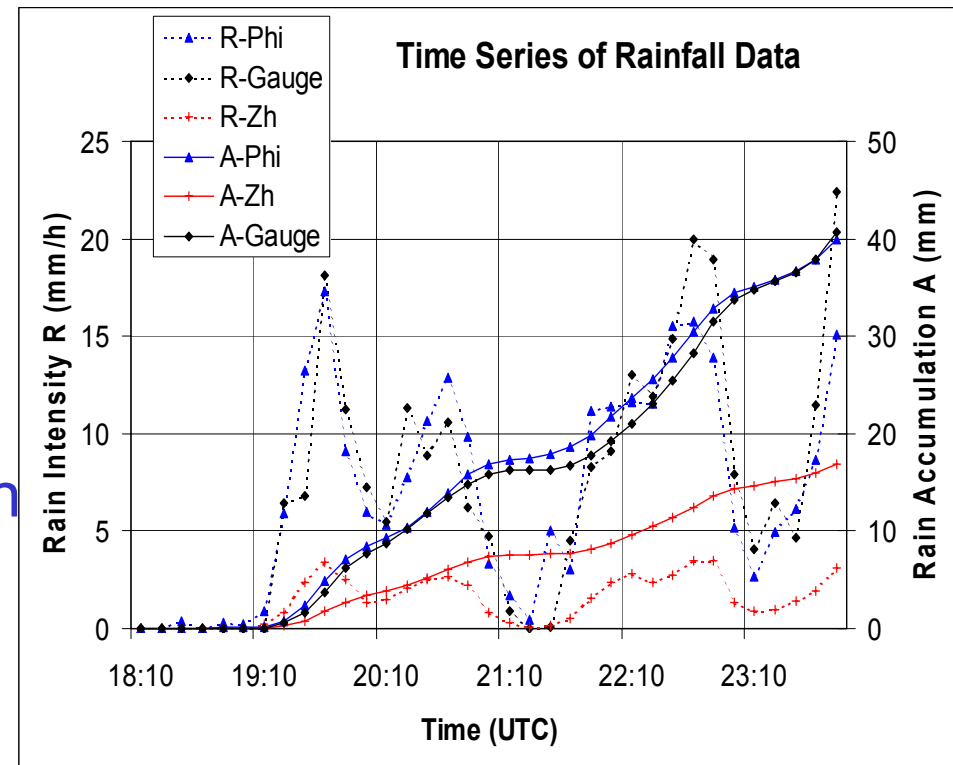


Z_{DR} – Differential Reflectivity

- Oblate Objects
- Hail detection
- **Melting Layer**

Φ_{DP} – Differential Phase Shift

- Integrated Rain Intensity
- Independent on RX calibration attenuation, beam blocking



Z_{DR} – Differential Reflectivity

- Oblate Objects
- Hail detection
- **Melting Layer**

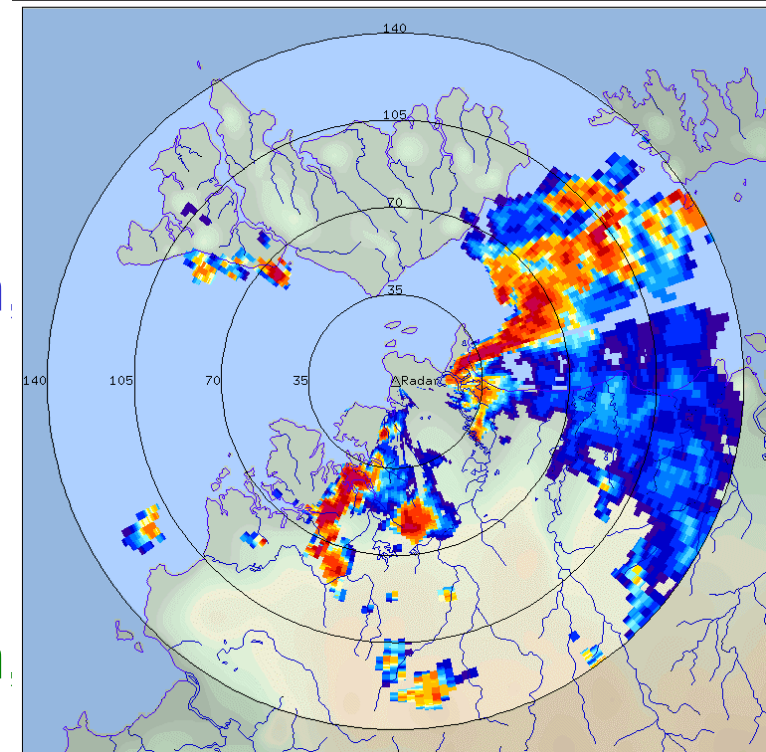
Φ_{DP} – Differential Phase Shift

- Integrated Rain Intensity
- Independent on RX calibration, attenuation, beam blocking

K_{DP} – Specific Differential Phase

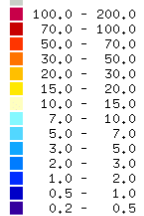
- Rain Intensity
- Independent on RX calibration, attenuation, beam blocking

File : 2000020307200800.ppi_RDP
Type : PPI R(Z,ZDR,KDP)



3 Feb 2000
07:20:08

R [mm/h]



Radar: BMRC C-Pol
Scan R : 140.0 km
Scan Res: 0.3 km
Disp R : 150.0 km
Disp Res: 0.4 km
PPI Ele : 0.7 deg

Data source :
(C) BMRC Australia

Rainbow (C)
by GEMATRONIK

ρ_{HV} – Polarimetric Correlation Coefficient

- (Ir)regularity, shape, canting angle of hydrometeors

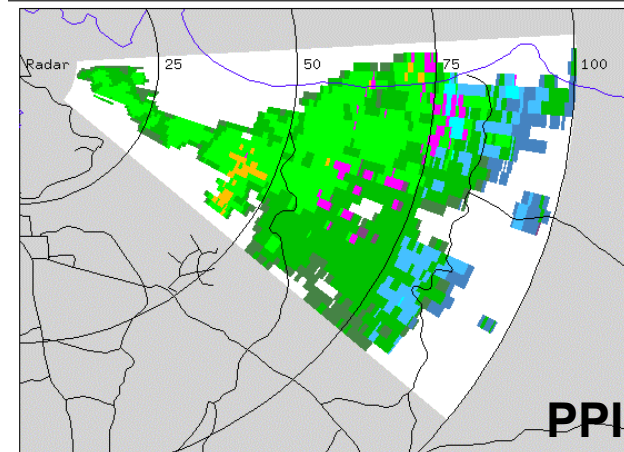
LDR – Linear Depolarisation Ratio

- (Ir)regularity, shape, canting angle of hydrometeors

Z , Z_{DR} , Φ_{DP} , K_{DP} , ρ_{HV} [, LDR]

- Hydrometeor classification (Fuzzy Logic scheme)

File : 1999012112000001.ppi_Hyd
Type : PPI Hydro Classification



21 Jan 1999
12:00:00

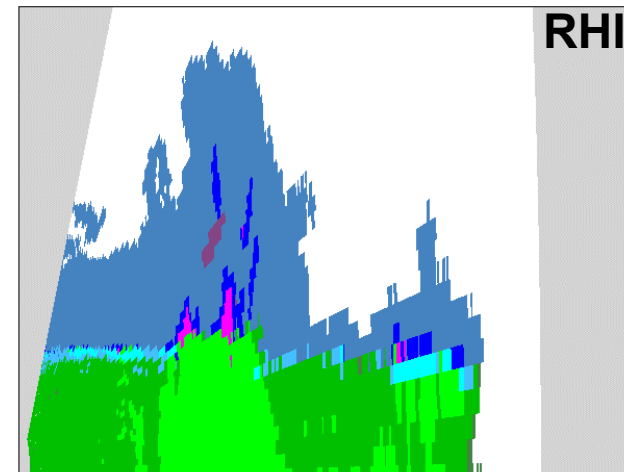
Hydro Type

- strong rain + hail
- rain and hail
- strong large hail
- large hail
- graupel or hail
- weak graupel
- dry snow
- weak dry snow
- wet snow
- weak wet snow
- rain
- weak rain
- drizzle
- weak drizzle

Radar: EMRC C-Pol
Location: Darwin
Scan R : 100.0 km
Scan Res: 0.3 km
Disp X : 110.0 km
Disp Y : 80.0 km
Disp Res: 0.2 km
PPI Ele : 2.7 deg

Data source :
(C) EMRC Australia
Rainbow (C)
by GEMATRONIK

File : 1998051812000001.rhi_Hyd
Type : RHI Hydro Classification



18 May 1998
12:00:00

Hydro Type

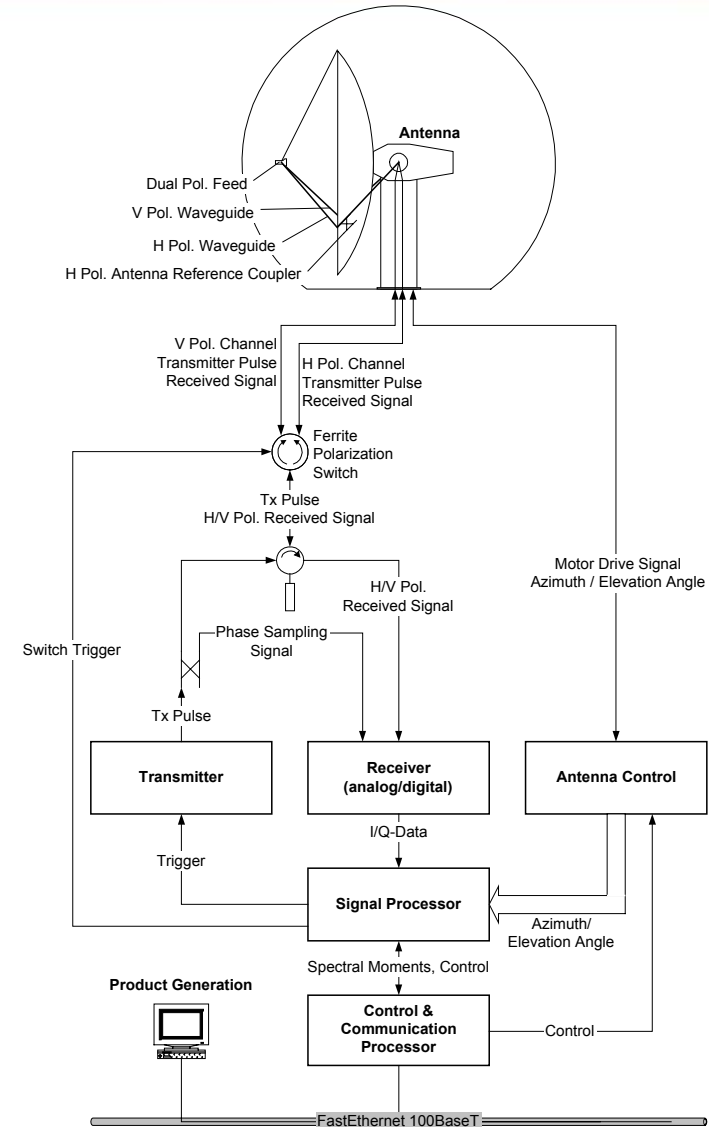
- strong rain + hail
- rain and hail
- strong large hail
- large hail
- graupel or hail
- weak graupel
- dry snow
- weak dry snow
- wet snow
- weak wet snow
- rain
- weak rain
- drizzle
- weak drizzle

Radar: EMRC C-Pol
Location: Darwin
Scan R : 120.0 km
Scan Res: 0.3 km
Disp R : 120.0 km
Disp Hgt: 18.0 km

Data source :
(C) EMRC Australia
Rainbow (C)
by GEMATRONIK

Single Channel, Switched

- Alternating Pulses H-V-H-V
- One Receiver

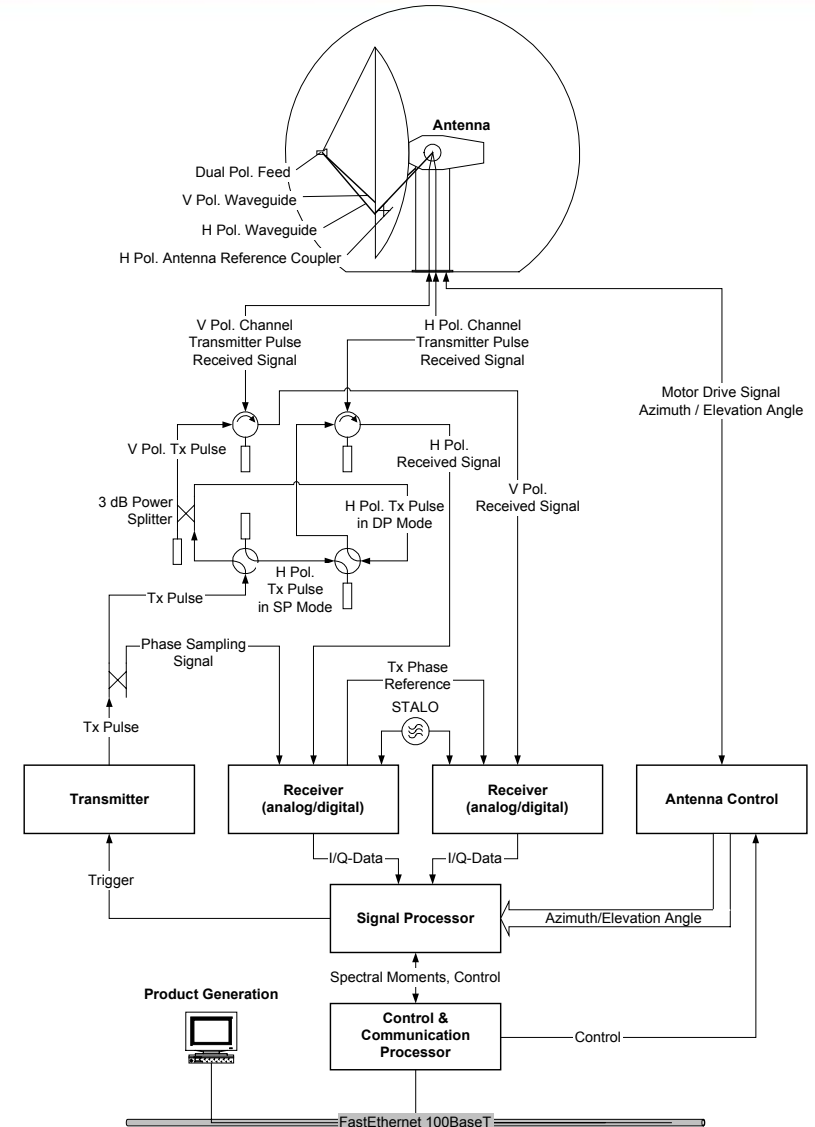


Single Channel, Switched

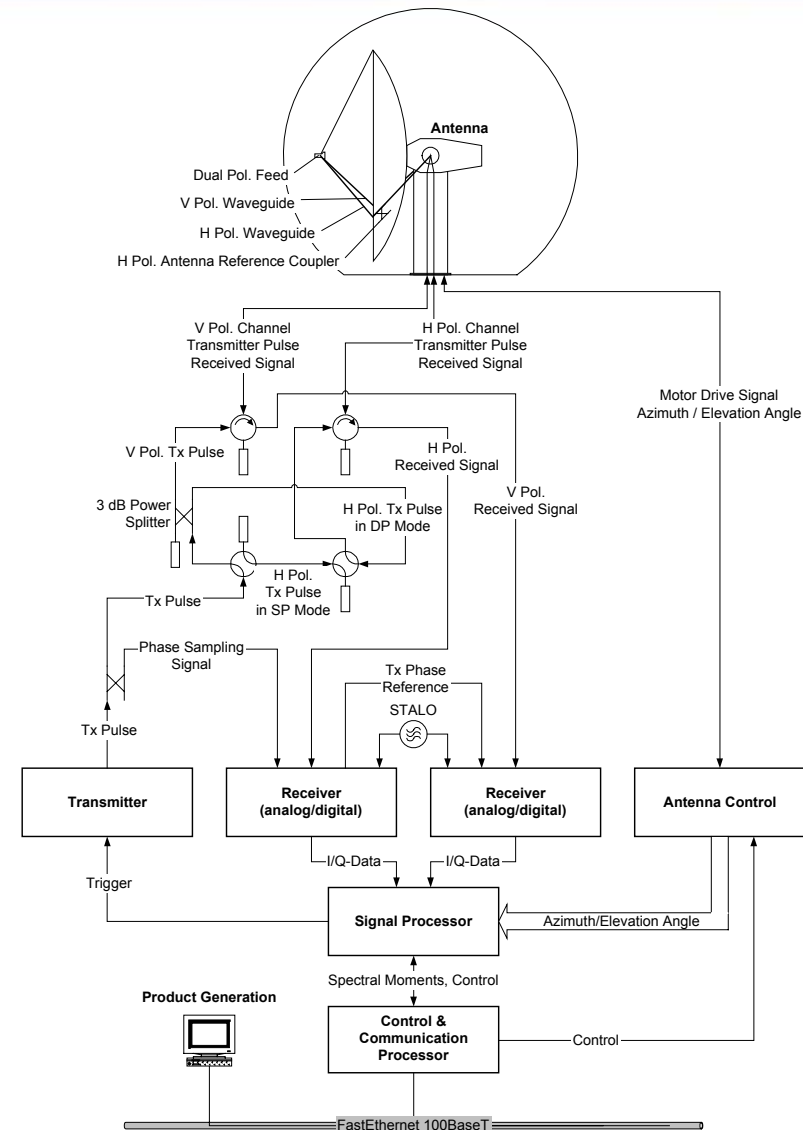
- Alternating Pulses H-V-H-V
- One Receiver

Dual Channel Configuration

- Transmit H and V together
- Two Receivers

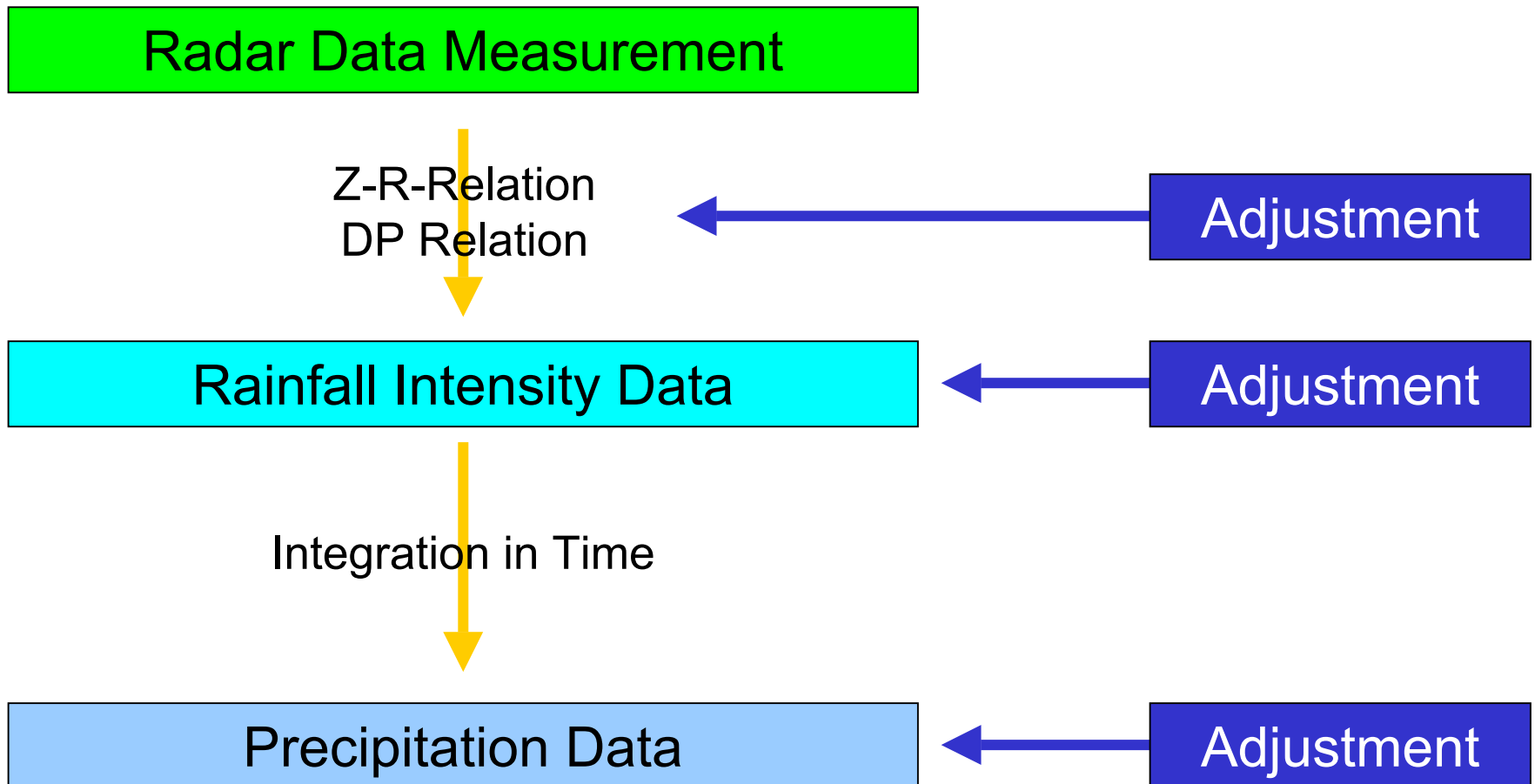


Polarimetric Operation: Hardware (1)



Dual Channel compared to Single Channel Switched Configuration:

- ☹ Power Separation → Sensitivity Loss 2–3 dB
- ☹ LDR: Separate Scan needed (in H-Mode)
- 😊 2x more Processed Pulses → Better Data, Faster Scan
- 😊 Doppler Clutter Filter possible
- 😊 Unfolding by Staggering possible



$$A = \sum_i R_i \cdot \Delta t_i$$

A Precipitation amount

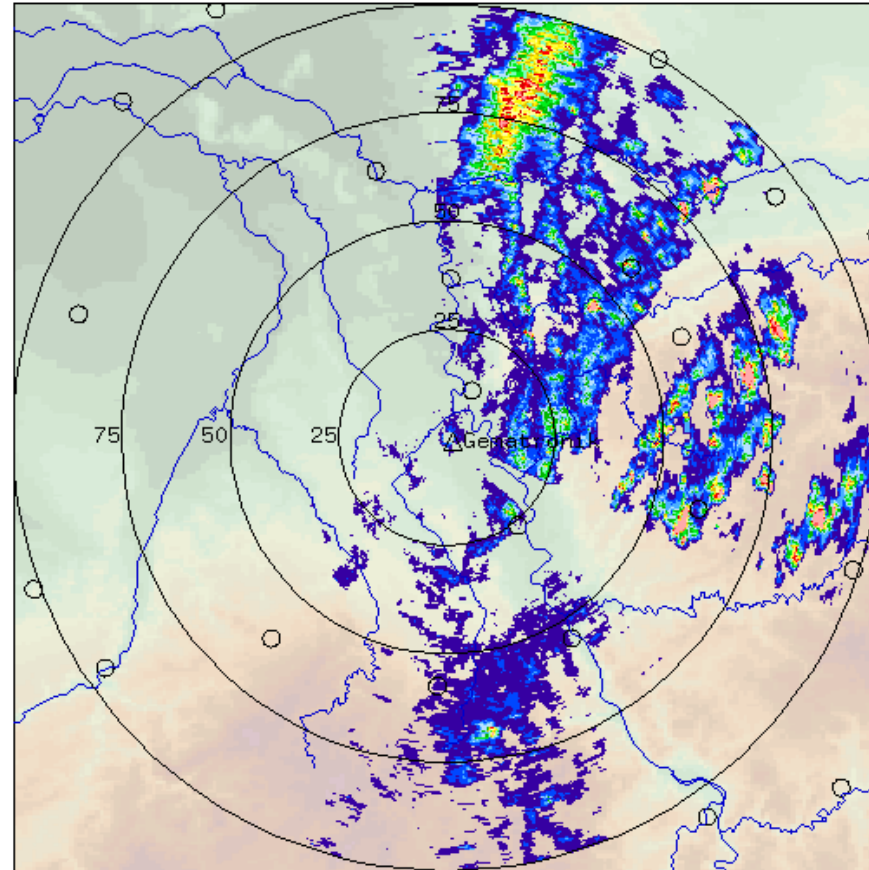
R_i Rainfall intensity (at t_i)

Δt_i Time step

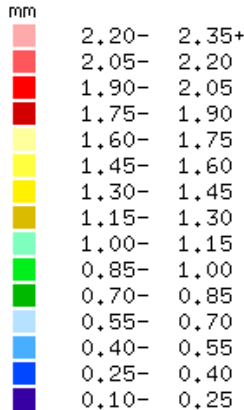
Important goal:
Minimise Δt_i

Solutions:
a) Scan Strategy

File : 2001081616142015.pac
Type : PAC
Range: 100,0 km



16.08.2001
16:14:20



Neuss_Germany
PCNT:6
DD/HH:MM: 0/3:0
START/STOP TIME:
16.08.2001/14:58
16.08.2001/16:14

Rainbow (C)
by GEMATRONIK

15 min
normal

$$A = \sum_i R_i \cdot \Delta t_i$$

A Precipitation amount

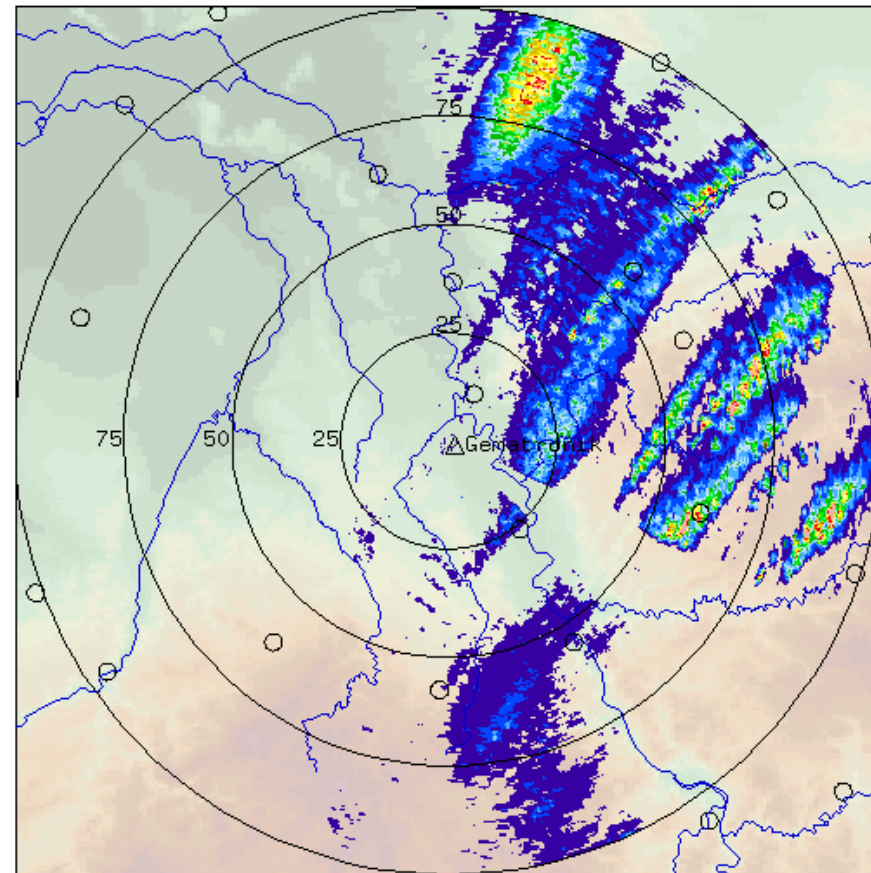
R_i Rainfall intensity (at t_i)

Δt_i Time step

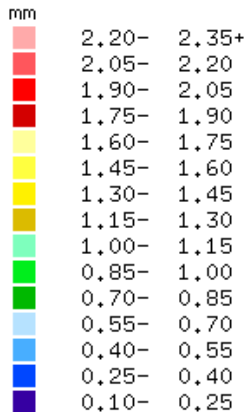
Important goal:
Minimise Δt_i

Solutions:
a) Scan Strategy

File : 2001081616142006.pac
Type : PAC
Range : 100,0 km



16.08.2001
16:14:20



Neuss_Germany
PCNT:14
DD/HH:MM: 0/3:0
START/STOP TIME:
16.08.2001/14:58
16.08.2001/16:14

Rainbow (C)
by GEMATRONIK

6 min
normal

$$A = \sum_i R_i \cdot \Delta t_i$$

A Precipitation amount

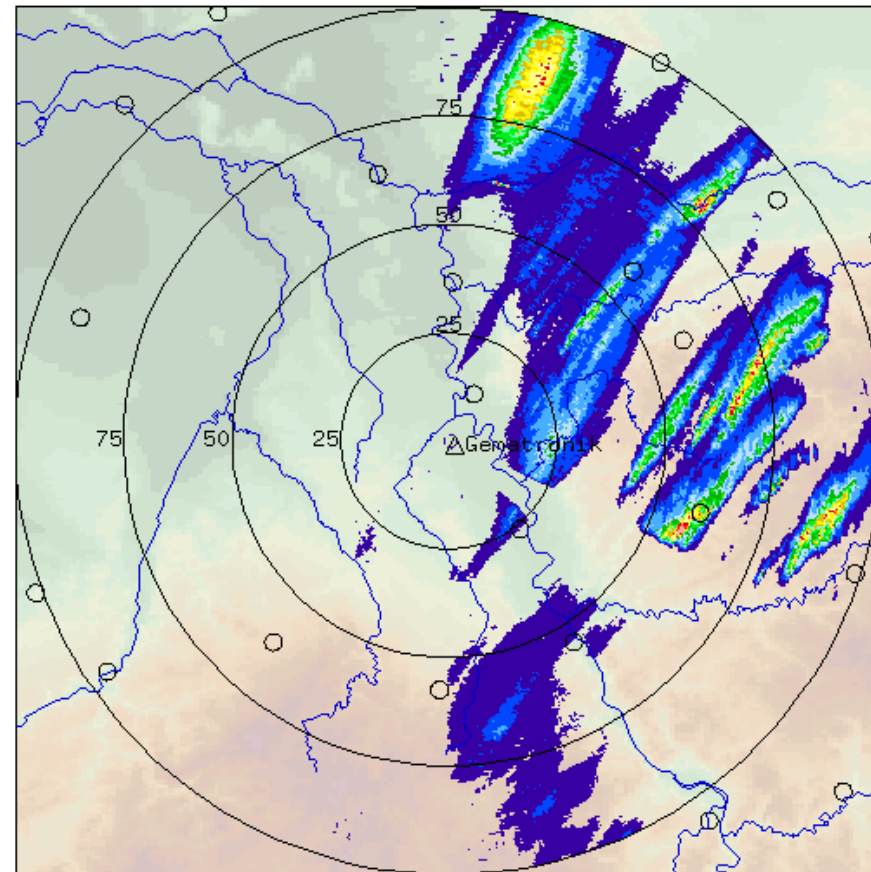
R_i Rainfall intensity (at t_i)

Δt_i Time step

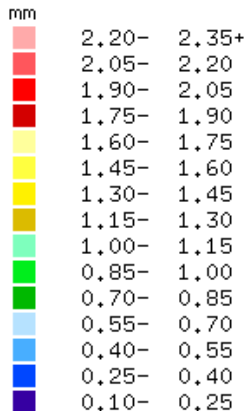
Important goal:
Minimise Δt_i

Solutions:
a) Scan Strategy

File : 2001081616142001.pac
Type : PAC
Range : 100.0 km



16.08.2001
16:14:20



Neuss_Germany
PCNT:52
DD/HH:MM: 0/3:0
START/STOP TIME:
16.08.2001/14:58
16.08.2001/16:14

Rainbow (C)
by GEMATRONIK

1.5 min
normal

$$A = \sum_i R_i \cdot \Delta t_i$$

A Precipitation amount

R_i Rainfall intensity (at t_i)

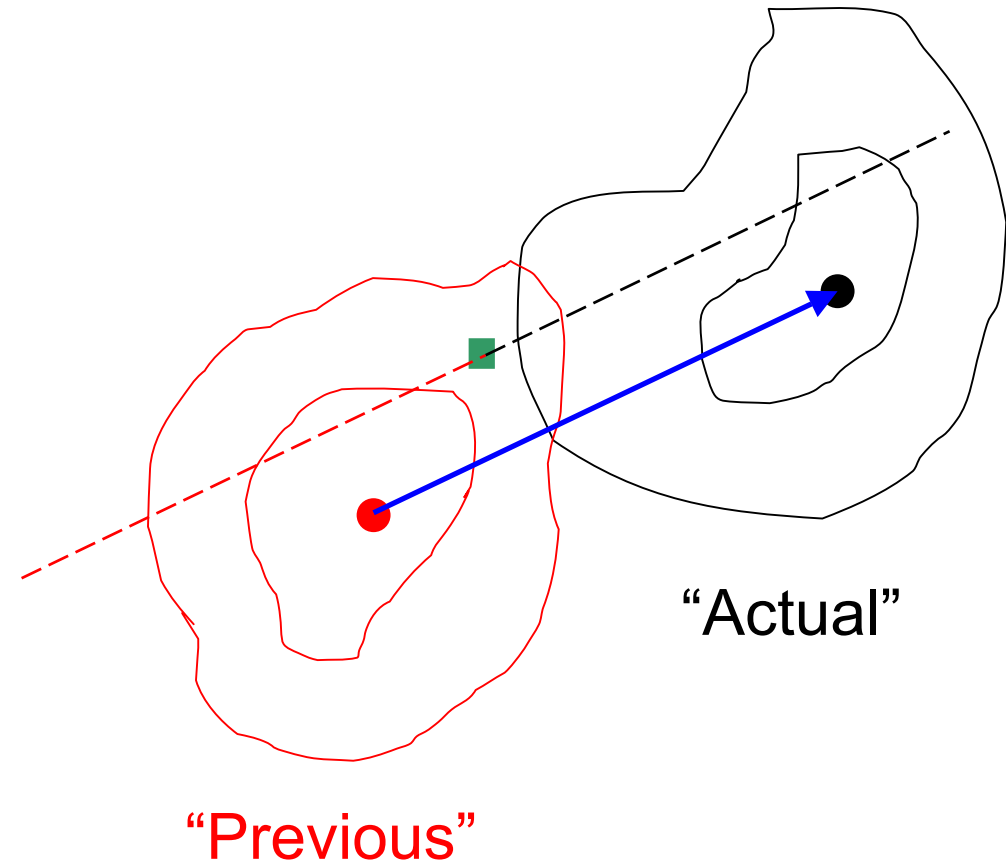
Δt_i Time step

Important goal:
Minimise Δt_i

Solutions:

a) Scan Strategy

b) Tracking methods



$$A = \sum_i R_i \cdot \Delta t_i$$

A Precipitation amount

R_i Rainfall intensity (at t_i)

Δt_i Time step

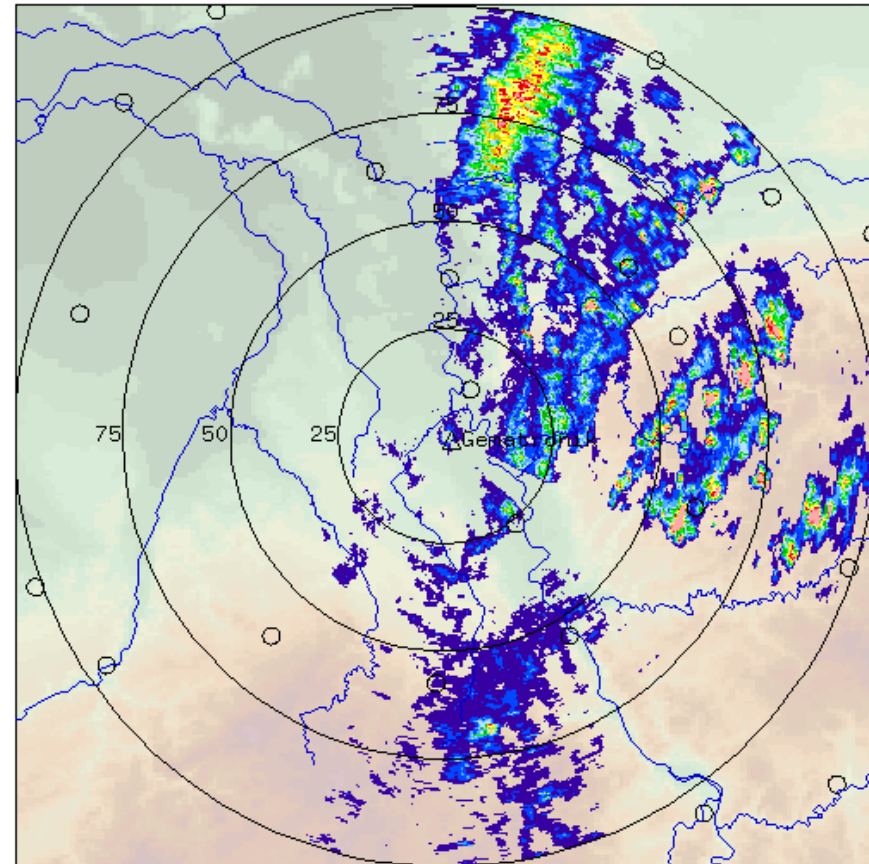
Important goal:
Minimise Δt_i

Solutions:

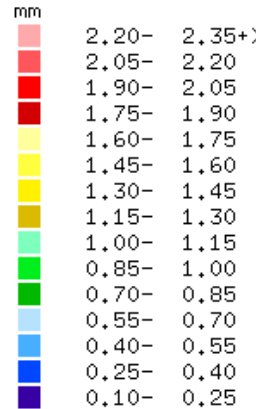
a) Scan Strategy

b) Tracking methods

File : 2001081616142015.pac
Type : PAC
Range: 100.0 km



16.08.2001
16:14:20



Neuss_Germany
PCNT:6
DD/HH:MM: 0/3:0
START/STOP TIME:
16.08.2001/14:58
16.08.2001/16:14

Rainbow (C)
by GEMATRONIK

15 min
normal

$$A = \sum_i R_i \cdot \Delta t_i$$

A Precipitation amount

R_i Rainfall intensity (at t_i)

Δt_i Time step

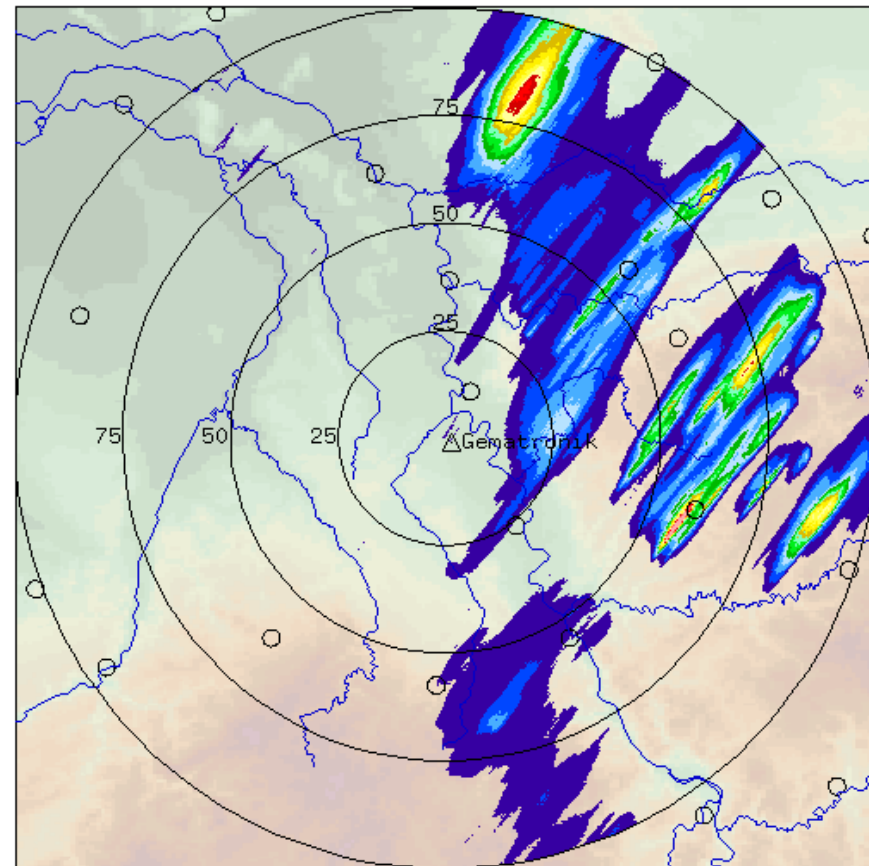
Important goal:
Minimise Δt_i

Solutions:

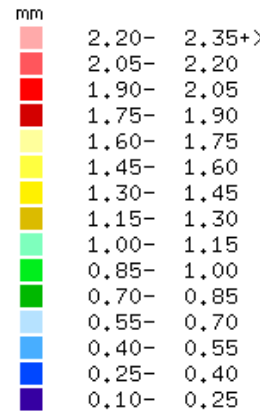
a) Scan Strategy

b) Tracking methods

File : 2001081616142015r.pac
Type : PAC
Range: 100.0 km



16.08.2001
16:14:20



Neuss_Germany
PCNT:6
DD/HH:MM: 0/3:0
START/STOP TIME:
16.08.2001/14:58
16.08.2001/16:14

Rainbow (C)
by GEMATRONIK

15 min
Cross-Corr

Adjustment step

Method

Z-R-Relation



Mechanical Disdrometer

Optical Disdrometer

Rainfall Intensity



Disdrometer

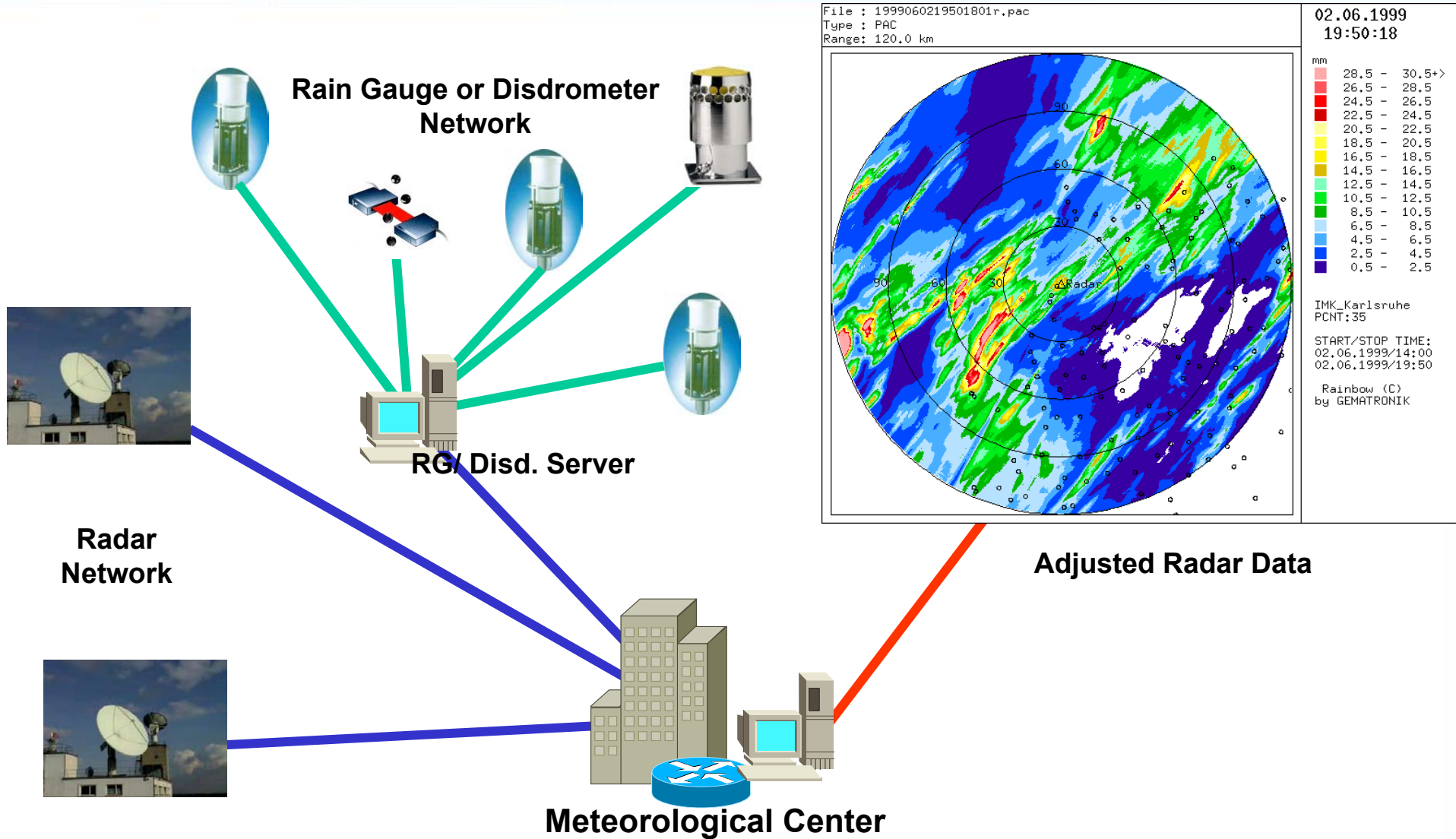
Rain Gauge

Rainfall Accumulation



Rain Gauge

Adjustment: Network Solutions



MUSIC – **M**ulti **S**ensor Precipitation Measurements Integration, Calibration and Flood Forecasting

Objectives:

- Improvement of Precipitation Measurements
- Improvement of Flood Forecasts

Methods:

- Combine Radar, Rain Gauge and Satellite Data
- Block Kriging, Bayesian Combination
- Consider Data Errors and Uncertainties
- New Visual User Interfaces

Results:

- Multi-Sensor Precipitation Estimator
- Flood Forecasting Decision Support System

More Information: <http://www.geomin.unibo.it/orgv/hydro/music/>