MARG – MICROWAVE AREAL RAIN GAUGE

a Low Cost Solid State Microwave Areal Precipitation Measurement System

Ferenc Dombai *, MET-ENV, Budapest, Hungary;

H. Paulitsch, TU Graz, Austria;

R. Cremonini, and R. Bechini, ARPA Piemonte, Italy

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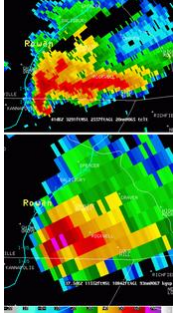


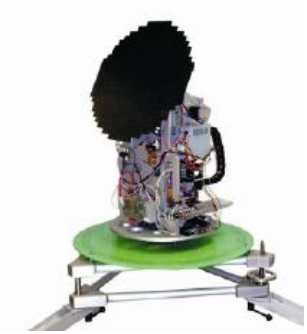
Needs

- New user needs raised for local and regional distribution of precipitation data (urban hydrology, agriculture, flash flood monitoring, etc.)
- Increasing demands for higher spatial and temporal resolution of weather radar measurements,
- Needs for „gap filling" radars for better coverage of the national weather radar networks (USA NSF founding projects – CASA for NEXRAD)
- Numerous projects are targeted on regional hydrological needs (FREMEA, FORALPS, HYDROMET, RAINGAIN, etc.)

Problems

- The widely used exponential formulas for dBZ -> R conversion need too much assumptions which are can not be managed well at long ranges and in most of weather situations
- Reliable rainfall data from operational weather radars are limited in space (about one half of maximum measurement ranges 120 /240 km),
- Latest advances in weather radars (simultan dual-polar, dual wavelength) provide more reliable rainfall data at short ranges but not at long range,
- The range of the reliable radar rainfall measurements will be limited in the future too.
- Multi purpose weather radars with dual polarization need too high investment and operational costs,
- Low cost shipborne based MINI X band radars are limited in their capabilities (attenuation, no Doppler clutter reduction, no met. radar equation),

Present answers - MINI X band weather radars









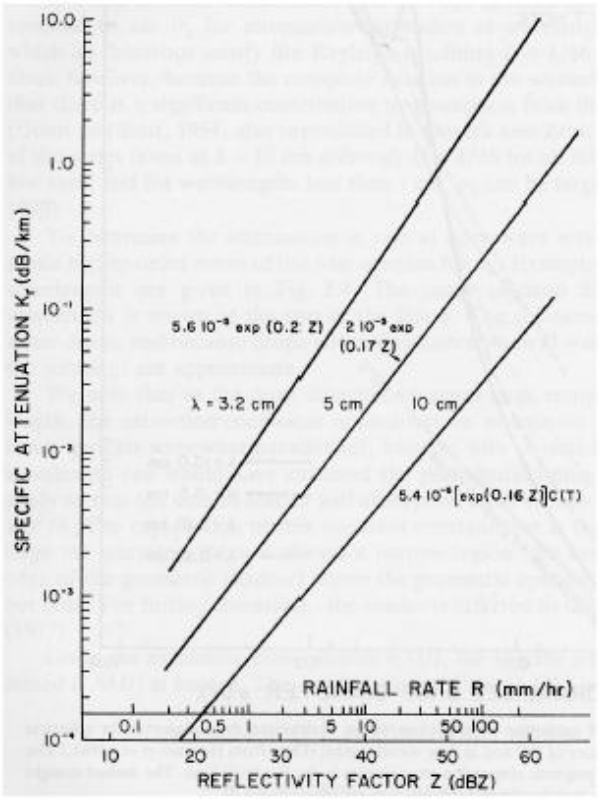


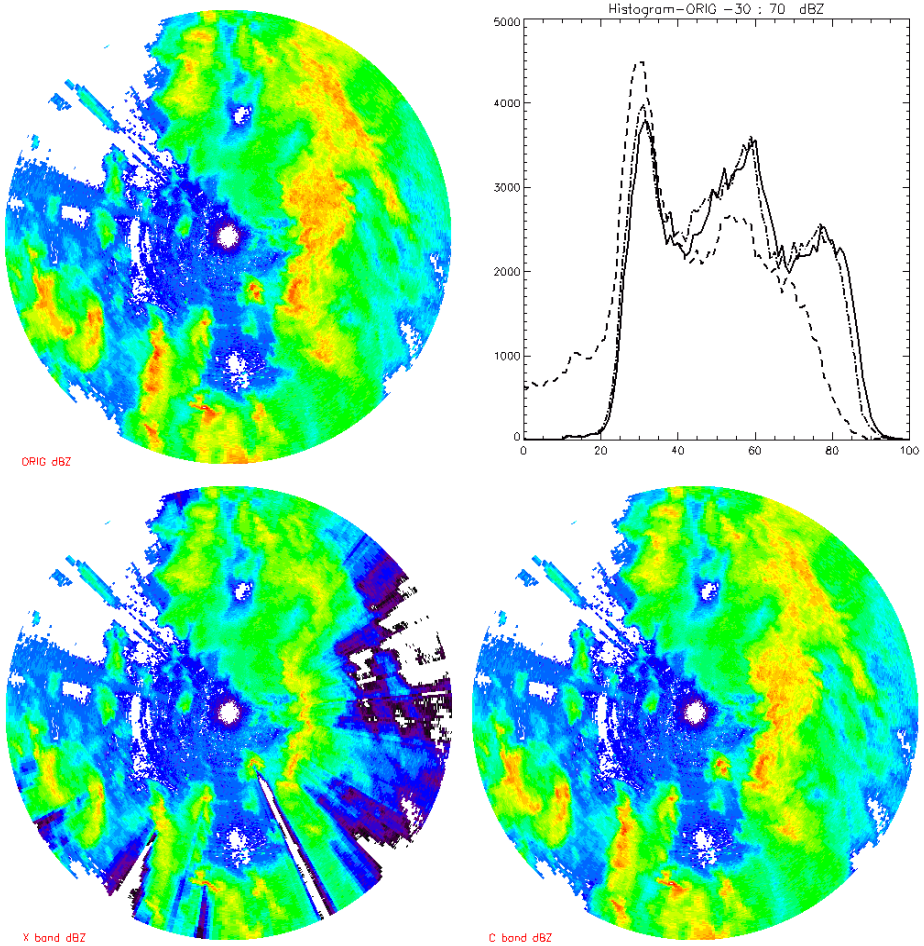

Our answere – MARG concept
Microwave Areal Rain Gage

- Tunable carrier frequency on C band (5.6 cm) to be optimum,
- Doppler FM/CW with Doppler signal processing for ground clutter rejection,
- Two small antenna for transmit and receive – beamwith about 3 degre,
- Only rotating at manually aligned vertical positions,
- One wavelength Z -> R conversion with adjustable parameters using rain types, identification,
- Identification of rain types based on echo structures and/or Doppler spectrum
- High grade clutter rejection,
- Full automatic operation,
- Measurement range up to 15-30 km ranges about 700 -3000 km2,
  (min. det. rainfall 0.2/0.5 mm/h at 15/30 km),
- Accuracy less then 20 % for rain - 0.2- 0.3 dB % in technical,
- Can be associated with disdrometer nearby (optional only),
- Communicate with TCP/IP on WLAN,
- Providing QPE using additional rain gages or disdrometers,
- WEB based user services,

Most operational weather radar systems still use the reflectivity method !

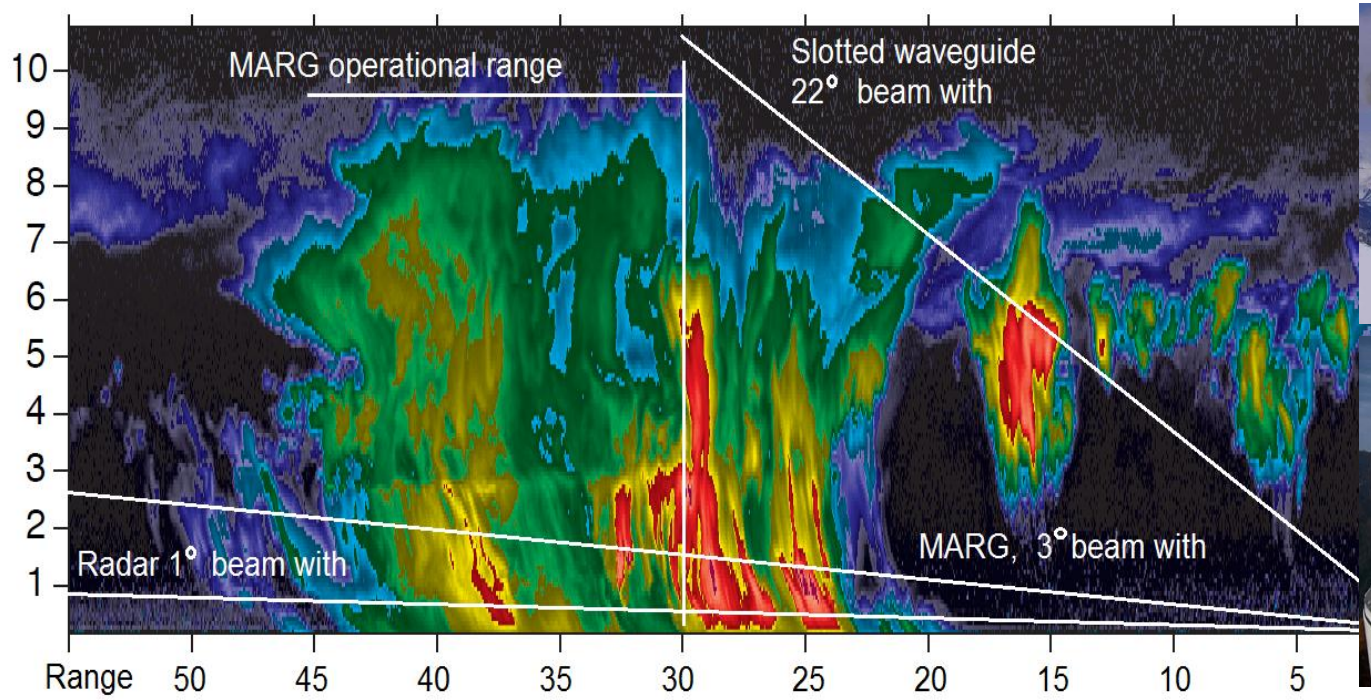
Selection of wavelength





The impact of the attenuation calculated for X band (left bellow) and C band (right below) using a reference dBZ distribution (upper left) with 50-55 dBZ cells. Max range is 30 km.

Selection of Antenna Type and Beamwith



Radar counts or

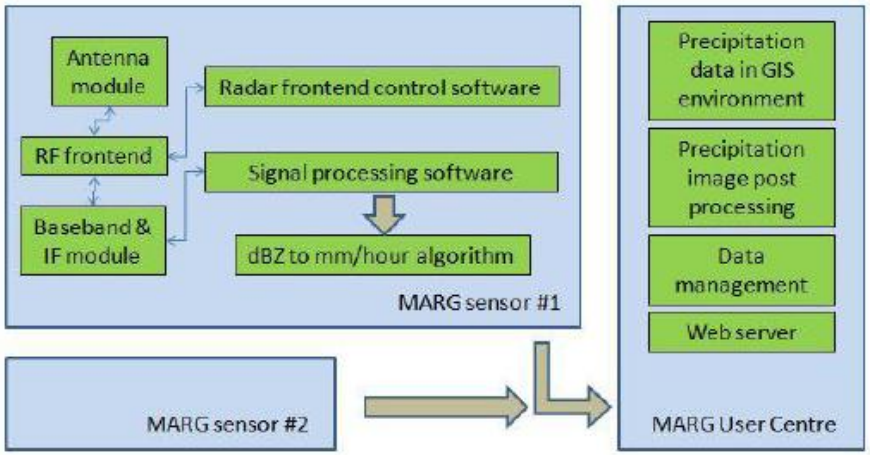
Met. Radar equation
dBZ ?

Illustration of different beam with on a virtual RHI section. The background picture was taken from presentation I. Zawadzki (2008)

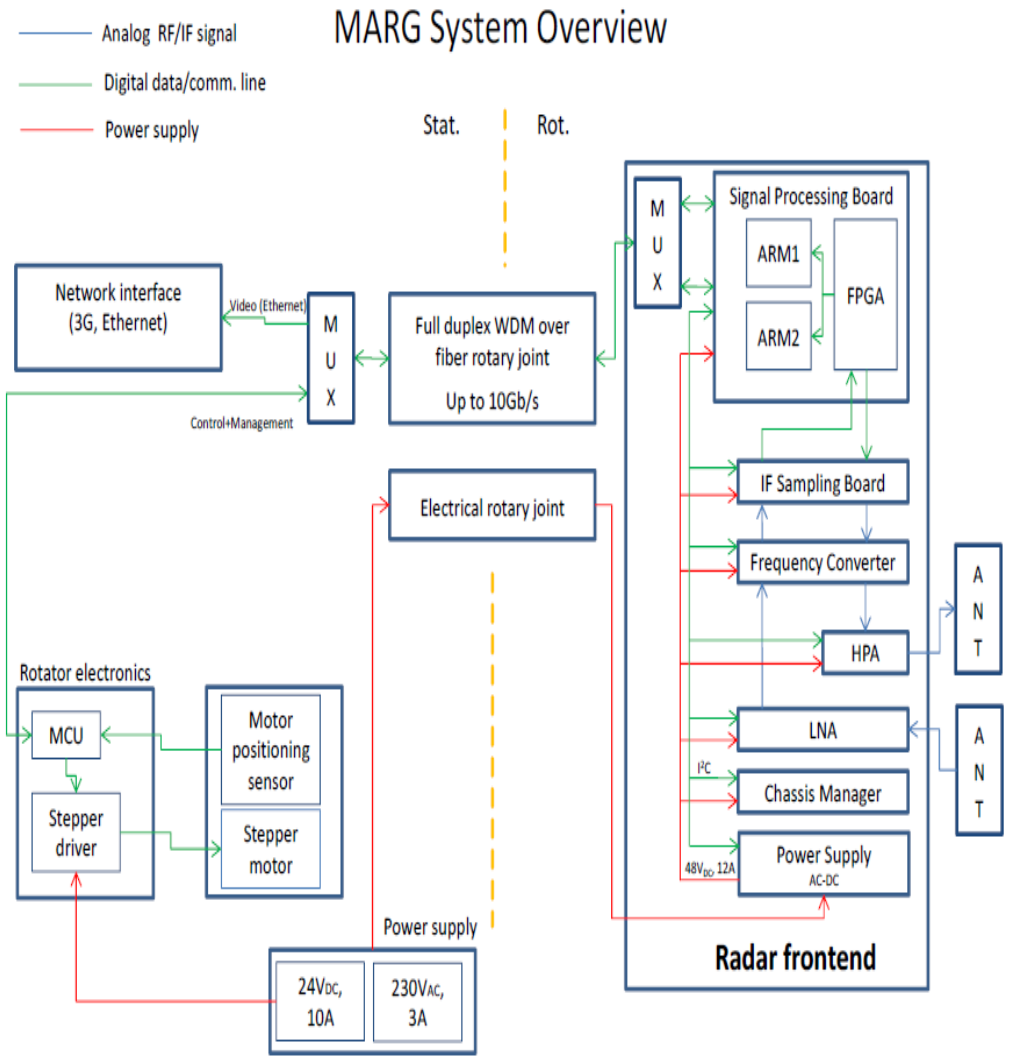
The MARG Project

- Based on the MARG concept a Consortium was organized and a Project proposal was formulated for development a high resolution, low cost, short range precipitation measurement system.
- The Project proposal has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 315296.
- Start date: November 1, 2012
- Duration: 24 months
- Funding Scheme: FP7 Research for the Benefit of SMEs
- Website: www.marg-project.eu
- Consortium members:
  - RTD partners: TU GRAZ, ARPA Piemonte, MFKK
  - SME partners: BHE, ON-AIR, MET-ENV, GEOGRAPHICA, PESSL,

MARG Technical Specification



- Wavelength: C band
- Beam width : 3 degre
- TX power: 20 W (43 dBm)
- Antenna gain G = 36 dB (1.5 m)
- Noise figure 3-4 dB
- Rain rate: 0.5 and 100 mm/h
- Reflectivity: min 18 and 55 dBZ (using a standard Z-R relationship)
- Distances from 100 m up to 30 km and for derived parameters
- Range resolution 100 m
- Dynamic range (from distance and reflectivity) ~ 85 dB
- Doppler processing for ground clutter cancellation and radial wind



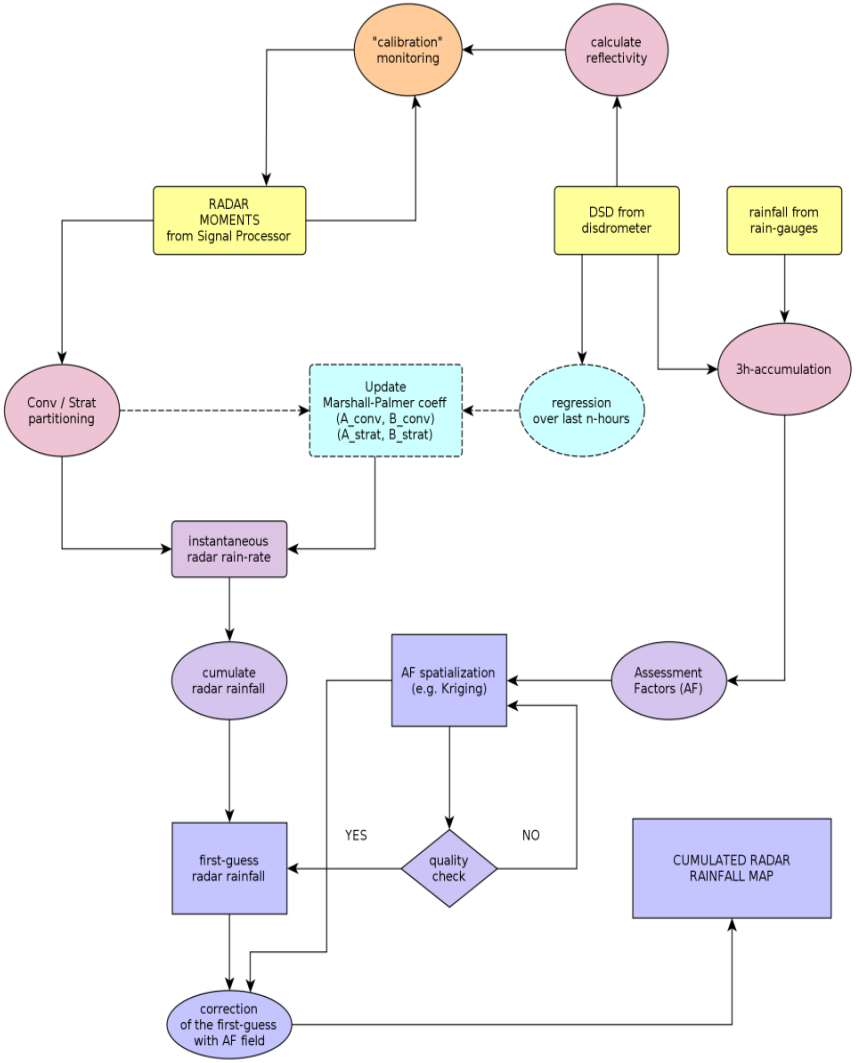
Software defined waveform, linear FMCW, Configurable FMCW parameters (sweep duration, frequency span, range resolution, number of range bins, number of sweeps for integration, unambiguous radial velocity)

Bandwidth: 3 MHz for a range gate of 50 m
Digital generation of IF signal, digital TX and RX IF
Direct IF receiver with digital baseband conversion and I-Q-demodulation
IF conversion : Single stage RF to IF with image rejection mixer
IF frequency: 60 – 70 MHz, but can be modified
Image rejection : > 50 dB
Radar frontend control on integrated ARM CPU
System integrity monitoring, built-in test equipment

The MARG system overview - C band FMCW Doppler radar

MARG OPTIMAL QPE

- Rainfall rate *is* derived from the radar reflectivity *Z* using a Z-R relationship
- M-P parameters will depend on the rainfall types as stratiform or convective algorithm by *Steiner (1995)*
- Monitoring & calibration – using disdrometer (mean field bias correction)
- Accumulation of rainfal,1-3-24 hour ,
- Range-dependent adjustment – RDA,
- Assesment factor spatialization (Kriging) when more ,

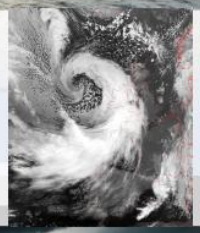


MARG

Microwave Areal Rain Gauge

The Need

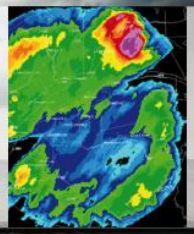
In Europe annual investments of € 9.5 billion in meteorological, including rainfall data leads to € 68 billion return in economic value.[1] The real-time hydrologic applications of rain data contributes to € 58 million turnover for the water industry.The estimation and quality of recorded rainfall play a vital role in the performance of sewer systems, water treatment plants, irrigation requirements and advanced recognition of a developing flood threat. Heavy rain frequently overwhelms urban sewage systems, which cause rapid flooding in cities. In the UK, precipitation results the collapse of up to 5000 sewage systems each year. The 20% of all EU-funded infrastructure investments are used to maintain and upgrade sewer systems. The unnecessary use of water for irrigation on farms increases costs significantly.



Accurate, local level rainfall data is critical for customers of weather data service providers, multimillion euros can be saved on rainfall related investment for improving these systems.

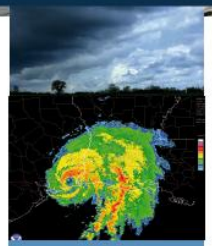
The Goal

The proposed product will provide reliable rainfall measurement data to supply the needs of end-users. It will couple **unique accuracy** in **optimal range** for localised measurement of rain intensity and spatial distribution. The MARG system will combine state-of-the-art **solid-state microwave technology**, digital signal processing, and **GIS technology** with **novel precipitation measurement algorithms**.



The value for the customers will be increased safety and better production with reduced costs. MARG has the potential to provide reliable data for private **water sector operators and municipalities** that are responsible for the optimal operation of distributed water systems, sewages and treatment plants which can cost billions of euros. By helping the better schedule of watering and applying fertilizers it can potentially to save 25% for **agricultural holdings** in farming costs. The system can further support hydropower companies to optimize production capacity, insurance companies in investigating whether claims, and leisure planners to protect people and goods from damages.

Project Objectives



- To realize a relatively lower commercial price than current solutions
- To realize a pre-competitive product that will enable participants to reach the targeted return on investments
- To identify rain type events using Doppler spectrum data;
- To identify rain type events using morphological information of the radar rainfall maps;
- To develop high grade clutter cancellation algorithm in order to eliminate scattering data on stationary objects in the area;
- To train SMEs on functionality, operability, troubleshooting, maintenance, etc. of the system
- To disseminate the project at commercial, scientific, certification and on public platforms, and to compile a European Best Practices Guild.
- To prepare Exploitation Plan to determine routs for protection and exploitation of Foreground in line with post-project exploitation plans

www.marg-project.eu

Members of the Consortium:
Project Coordinator: MFKK Invention And Research Center Services Company Ltd.
Project Partners: BHE BONN HUNGARY Elektronikai Kft. | ON AIR Elektronikai Gyártó és Javító Kft. | Geografia Aplicada Sl. | PESSL INSTRUMENTS GmbH. | Centina D'Alfonso Del Sordo Srl. | Technische Universität Graz | Agenzia Regionale Per La Protezione Ambientale Del Piemonte | MET-ENV Fejlesztő és Szolgáltató Bt.

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MFKK | TU Graz | MET-ENV | Pessl | BHE | geographica | ON AIR

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Q & A

Thank you for your attention !

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