New WERA Software Implementation

Klaus-Werner Gurgel

- Automatic frequency adaptation / RFI processing
- CL7 realtime software - continuous mode
- WERA processing software (WGS84)
- Extended Beamforming Capabilities
- Future extensions (To-Do List)

New WERA Software Implementation

1. Automatic frequency adaptation

WeraDesk at Brezellec

Acquisition Mode:	STOP		
Process after Measurement:	☐ sea echos	☐ calibr. data	☐ FM raw data
Time Slot:	Master		
FMICW Mode:	off		
Calibration Power:	000 [dB]	☐ TX off	
Location:	Brezellec		
True North:	344 ° [1 to 360]	**Time Code:**	UTC
Latitude:	48 ° 4.18 ′ N	**Cont. Acqu. Start Time:**	00 [min]
Longitude:	4 ° 39.94 ′ W		
Freq. Management:	12.250 **to** 12.400 MHz	☑ Prescan	☑ Adapt Frequency
Bandwidth Reduction:	2400 m [62.5 kHz] max. allowed Range Cell Depth		
Working Frequency:	12.270 MHz	**Cycle Repetition Time:**	05 [min]
Range Cell Depth:	1000 m [150.0 kHz]	**Number of Range Cells:**	120
Samples per Data Run:	1024	**Maximum Range:**	120 [km]
Chirp Length:	0.260000 [sec]	**Data Acquisiton Time:**	4 : 26 [min:sec]
Range Offset:	300 [m]	**RX Offset:**	0 Hz
Data Path:	/home/wera/data/ kiss/		Open Status Window
File Location ID:	lab [3 characters]		
Comment:	WERA Lab Tests at University of Hamburg. Directory test. 2007-03-09 DIR ntp		

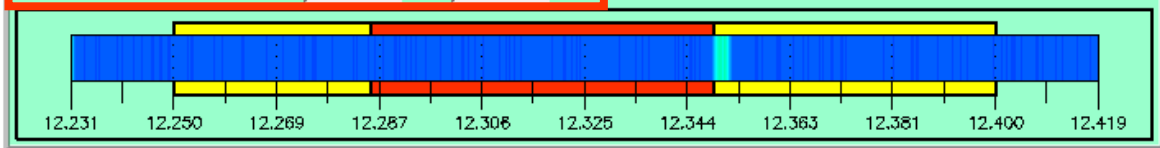
Submit Reset Vers. 2.5.3

New WERA Software Implementation

1. Automatic frequency adaptation

WeraDesk Status at Brezellec 2008-04-24 17:23:55

Acquisition Mode:	STOP				
Process after Measurement:	☐ Sea Echos	☐ Calibr. Data	☐ FM Raw Data		
Time Slot:	Master				
FMICW Mode:	off				
Calibration Power:	00 [dB]	☐ TX off			
Location:	Brezellec				
True North:	344 ° [1 to 360]		Time Code:	UTC	
Latitude:	48 ° 4.18 ' N		Cont. Acqu. Start Time:	00 [min]	
Longitude:	4 ° 39.94 ' W				
Freq. Management:	12.250 to 12.400 [MHz]	☑ Prescan	☑ Adapt Frequency		
Bandwidth Reduction:	1000 to 2400 [m]				



Working Frequency:	12.270 [MHz]	Cycle Repetition Time:	05 [min]
Range Cell Depth:	1000 [m]	Number of Range Cells:	120
Samples per Data Run:	1024	Maximum Range:	120 [km]
Chirp Length:	0.260000 [sec]	Data Acquisiton Time:	4 : 26 [min:sec]
Range Offset:	300 [m]	RX Offset:	0 [Hz]
Data Path:	/home/wera/data/ kiss/		Close This Window
File Location ID:	lab [3 characters]		
Comment:	WERA Lab Tests at University of Hamburg. Directory test. 2007-03-09 DIR ntp		
Status:	Stopped	Automatic Cycles:	Disabled
Available Diskspace on /data: 895G (31%used)			Vers. 2.5.3

New WERA Software Implementation

1. RFI Processing

The new realtime software stores .SORT and .RFI files.
Replace processing programs with new versions:

- wera16_grid → wera16_grid_rfi
- wera16_spec_cwrad → wera16_spec_cwrad_rfi
- plott_wera_sort_rcs_beam → plott_wera_sort_rcs_beam_rfi

You can keep the pocessing without RFI reduction by continuing to use the old programs.
If not required for RFI post-processing, you can delete the .RFI files.

New WERA Software Implementation

2. CL7 realtime software - continuous mode

WeraDesk at Brezellec

Acquisition Mode:	STOP		
Process after Measurement:	☐ sea echos	☐ calibr. data	☐ FM raw data
Time Slot:	Master		
FMICW Mode:	off		
Calibration Power:	000 [dB]	☐ TX off	
Location:	Brezellec		
True North:	344 ° [1 to 360]	**Time Code:**	UTC
Latitude:	48 ° 4.18 ' N	**Cont. Acqu. Start Time:**	00 [min]
Longitude:	4 ° 39.94 ' W		
Freq. Management:	12.250 **to** 12.400 MHz	☑ **Prescan**	☑ **Adapt Frequency**
Bandwidth Reduction:	2400 m [62.5 kHz]	max. allowed Range Cell Depth	
Working Frequency:	12.270 MHz	**Cycle Repetition Time:**	05 [min]
Range Cell Depth:	1000 m [150.0 kHz]		
Samples per Data Run:	13312		
Chirp Length:	0.260000 [sec]	**Data Acquisiton Time:**	57 : 41 [min:sec]
Range Offset:	300 [m]	**RX Offset:**	0 Hz
Data Path:	/home/wera/data/ kiss/		Open Status Window
File Location ID:	lab [3 characters]		
Comment:	WERA Lab Tests at University of Hamburg. Directory test. 2007-03-09 DIR ntp		

Submit Reset Vers. 2.5.3

Stores .USORT/.URFI every 128 samples

New WERA Software Implementation

3. WERA processing software (WGS84)

WERA HF Radar WGS84 Coordinates

As of December 2007, the WERA processing software takes the locations of the sites, angle and range, as well as the grid points defined by Make_Grid to be given in WGS84 coordinates. This is the coordinate reference system used by the GPS (Global Positioning System) in most cases. The Fortran code used for the WGS84 calculations has been derived from source coded hosted by the National Geodetic Survey [look for 'INVERSE/FORWARD3D (Version 2.0)']. The code is based on a paper by Vincenty [1975].

New WERA Software Implementation

3. WERA processing software (WGS84)

Advantages of WGS84 Use

There are several advantages if the results of WERA current maps, ocean wave spectra, and wind direction is directly given in WGS84 coordinates: There is no deviation between the location given by WERA and the location of ships or moored instruments, which usually have been located using GPS. The electromagnetic wave is travelling along great circles on the earth's surface and not following straight lines in Mercator-like maps. The propagation physics of the EM waves is now taken into account in a more accurate way. And finally, the data supplied to the US coastal radar network are required to be based on WGS84 coordinates.

New WERA Software Implementation

3. WERA processing software (WGS84)

Compatibility with pre-WGS84 Results

The coordinates of the WERA sites and the measurement grid points are now interpreted to be in the WGS84 reference system. With increasing range, the deviation between WERA's old reference system and WGS84 also increases. For distances of ~200 km a deviation in the order of a few kilometres can occur. It is impossible to convert an "old" measurement grid to WGS84 coordinates in a general way. It can only be done using one WERA location as a reference point. The transformation would be from the old carthesian measurement grid to a radial grid originated at the WERA site using the old Mercator-like transformation. From this radial grid, the new WGS84-based carthesian grid can be calculated using the WGS84 transformation. Obviously, the resulting WGS84-based grid coordinates depend on the WERA site location and can not be calculated in a general way. If significant deviations are observed when processing pre-WGS84 and WGS84 data sets together, the best way is to reprocess the old .SORT data as required.

New WERA Software Implementation

3. WERA processing software (WGS84)

Modified Processing Programs

The following programs have been modified to use the WGS84 reference system:
wera16_grid / wera16_grid_rfi
rad2uv
wrad2uv
Please check the program source code for comments on the modifications.

New WERA Software Implementation

3. WERA processing software (NOAA .ruv)

https://ifmaxp1.ifm.zmaw.de/weradocs/Wera_NOAA.shtml

WERA HF Radar NOAA .ruv File

As of December 2007, the WERA processing software is able to write NOAA .ruv files, which are required to pass WERA measurements to the US coastal radar network. For a description of the data format see below.

Modified Processing Programs

The following programs have been modified to generate or display NOAA .ruv files:

wera16_spec_cwrad / wera16_spec_cwrad_rfi
Plott_UV
List_Radial_NOAA

To activate writing of .ruv files include **NOAA_File = .TRUE.** In params*.cfg

New WERA Software Implementation

3. WERA processing software (NOAA .ruv)

NOAA Data Format Example

%CTF: 1.00
%FileType: LLUV rdls
%Manufacturer: Helzel Messtechnik GmbH, WERA.
%LLUVSpec: 1.00 2007 12 06
%Site: cdn "Crandon "
%TimeStamp: 2005 11 29 08 00 00
%TimeZone: "UTC" +0.00 0
%TimeCoverage: 266.23999023 Seconds
%Origin: 25.713333 -80.150833
%GreatCircle: "WGS84" 6378137.000 298.257223562997
%GeodVersion: "NGS-Vincenty" 2.0 2002 10 01
%RangeResolutionKMeters: 1.200
%TransmitCenterFreqMHz: 16.0640
%DopplerResolutionHzPerBin: 0.003756010
%CurrentVelocityLimit: 370.0
%MergedCount: 0001
%TransmitSweepRateHz: 0.26000
%TransmitBandwidthKHz: 124.914
%SpectraRangeCells: 120
%SpectraDopplerCells: 01024
%TableType: LLUV RDL1
%TableColumns: 12
%TableColumnTypes: LOND LATD VELU VELV EVAR EACC XDST YDST RNGE BEAR VELO HEAD
%TableRows: 8661
%TableStart:

%% Longitude (deg)	Latitude (deg)	U comp (cm/s)	V comp (cm/s)	Variance (cm/s)	Accuracy (cm/s)	X Distance (km)	Y Distance (km)	Range (km)	Bearing (deg NCW)	Velocity (cm/s)	Direction (deg NCW)
-80.1641749	25.2804153	3.005	107.629	29.215	4.132	-1.3438	-47.9587	47.978	181.6	107.671	1.6
-80.1641749	25.2714165	2.906	106.236	29.973	4.239	-1.3439	-48.9556	48.974	181.6	106.275	1.6
-80.1641749	25.1544256	2.342	108.310	26.168	3.701	-1.3452	-61.9154	61.930	181.2	108.336	1.2
-80.1542302	25.2894157	0.785	108.133	29.953	4.236	-0.3421	-46.9618	46.963	180.4	108.136	0.4
< ----- snip ---- >											
-79.0696098	25.4604010	7.502	-1.968	26.620	5.324	108.7385	-27.5765	112.181	104.2	-7.755	284.7
-79.0696098	25.4514022	8.230	-2.234	27.068	5.414	108.7466	-28.5734	112.438	104.7	-8.528	285.2
-79.0596650	25.4963978	5.593	-1.250	28.200	5.640	109.7059	-23.5805	112.211	102.1	-5.731	282.6

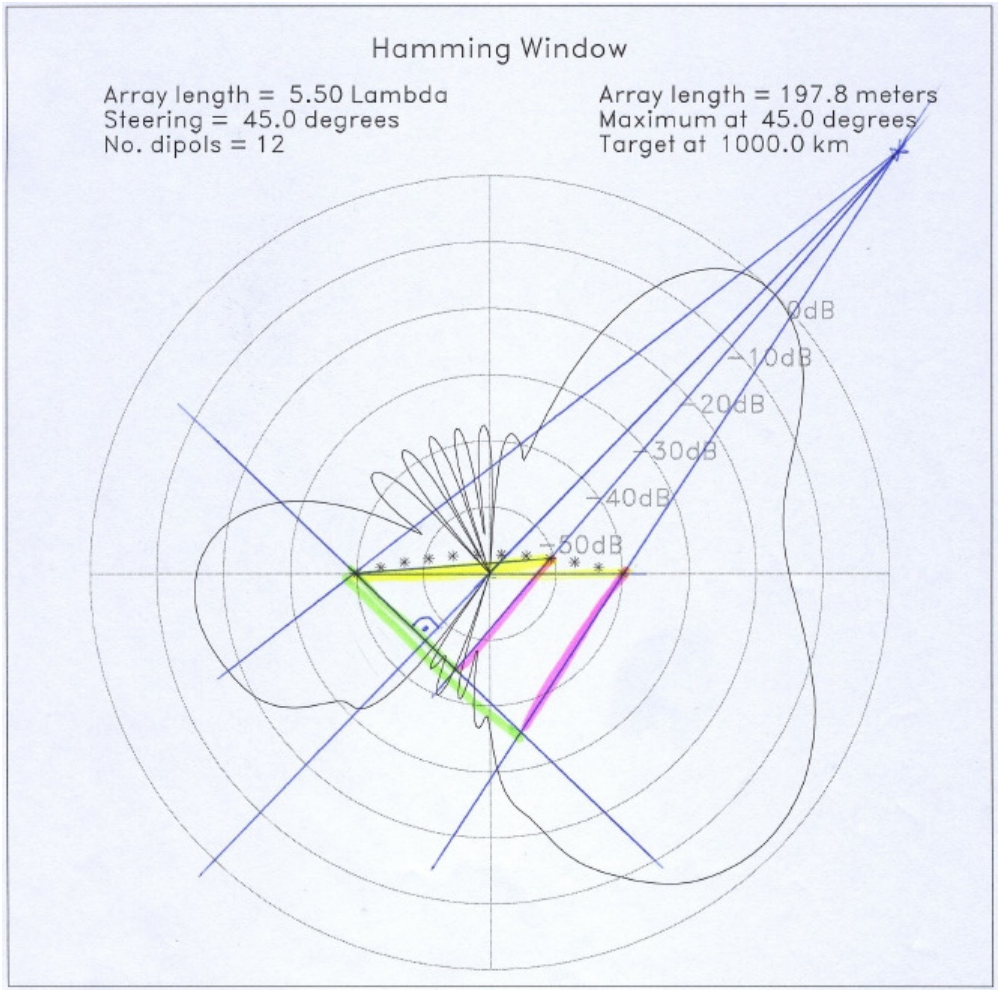
%TableEnd:
%End:

New WERA Software Implementation

4. Extended Beamforming Capabilities

1. Receive antenna locations now given by LAT / LON.
2. Phases for beam steering are calculated from the distance antenna to target location in spherical coordinates.
3. Window function is derived from projected spacing (green line).

The antenna locations are freely selectable following the area‘s restrictions. Antenna spacing must be < 0.5 lambda



New WERA Software Implementation

4. Extended Beamforming Capabilities

Compatibility with the old approach in params_xxx.cfg:

1. No ARRD_nnn → Spacing is 0.5 lambda
2. ARRD_nnn = 10.90 → Spacing is 10.9 m
3. DIST_nnn = ‘antdist_site.asc‘ (Spacing in meters)
4. APOS_nnn = ‘antpos_site.asc‘ (LAT / LON)

For cases 1-3, antpos_site.asc is calculated from the site‘s location and TRUE_NORTH from the measurement header.

Beamforming always uses ‘antpos_site.asc’. If you use one of the old approaches and change ARRD_nnn or DIST_nnn (spacing, ‘antdist_site.asc’), delete ‘antpos_site.asc’ to have the antenna locations re-calculated.

New WERA Software Implementation

4. Extended Beamforming Capabilities

- Before beamforming, the antenna gains of the single antennas are normalized by summing up the energy of the 1st-oder Bragg lines.

- To select a window function for beamforming define
  AWIN_nnn = ‘h‘ ! Hamming
  AWIN_nnn = ‘u’ ! Ultra Spherical

New WERA Software Implementation

5. Future Software Extensions

- Define a new data format for the .SPEC files
- Extend processing software for currents and waves to read the new .USORT/.URFI data format (continuous operation)
  Make integration times for current and wave processing selectable
- Implement Internal FullCal
- Auto-select master clock frequencies 90.7421538 MHz or 90.0 MHz; 90.0 MHz is required for GPS time synchronization
- Implement multi-static operation
- Next archives will be encrypted by GnuPG. Please supply your public key