Otto-von-Guericke University Magdeburg
Faculty of Electrical Engineering / IGET

Characterization of the Radiation Pattern of Reflector IRAs by Time Domain Measurement Techniques

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1 The IRA built by WIS Munster

O.-v.-G. University Magdeburg [2003]

Qualities:

- Diameter: 92 cm
- Focal length: 33 cm
- Vertical polarization

Accessory parts:

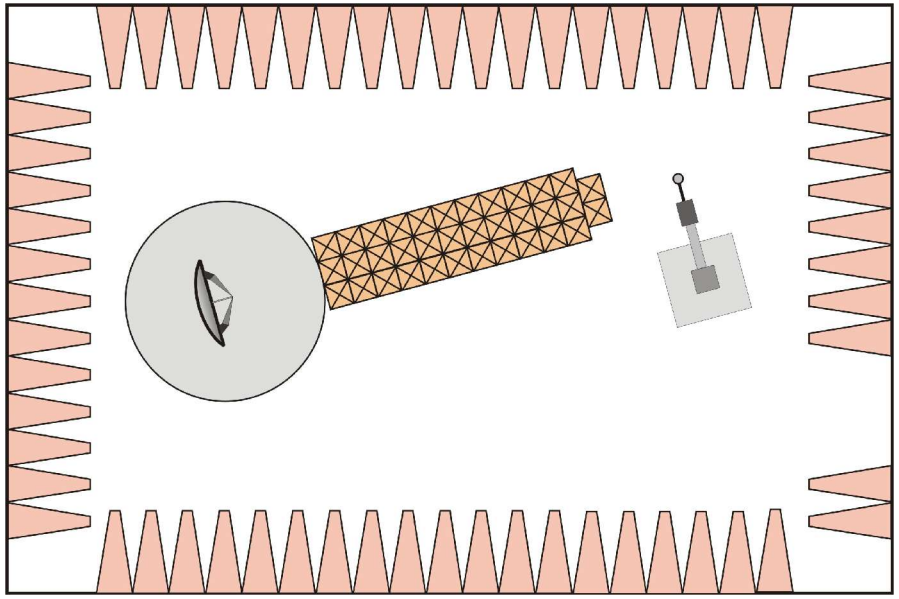
- High-voltage cable
- HN-N adaptor

Kentech pulse generator:
12 kV into 50 Ω, rise time 90 ps, decay time 2 ns, PRF ≤100 Hz

What does the radiated field pattern look like?

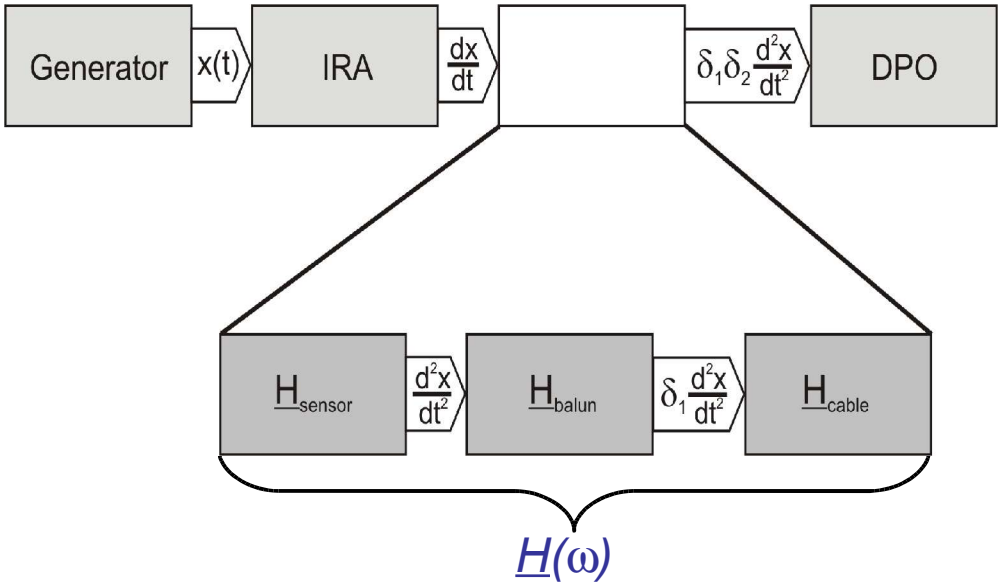
2 Measurements

- Measurement of the vertical component of radiated E field was performed in the university's semi-anechoic chamber.
- 360 angular steps • 31 different hights at each step = 11160 positions
- A passive sensor was used (Prodyn AD-80D) together with a 10GHz balun.
- Sampling and recording was done with Tektronix TDS7404 Digital Phosphor Oscilloscope (4GHz BW).



3 Data processing

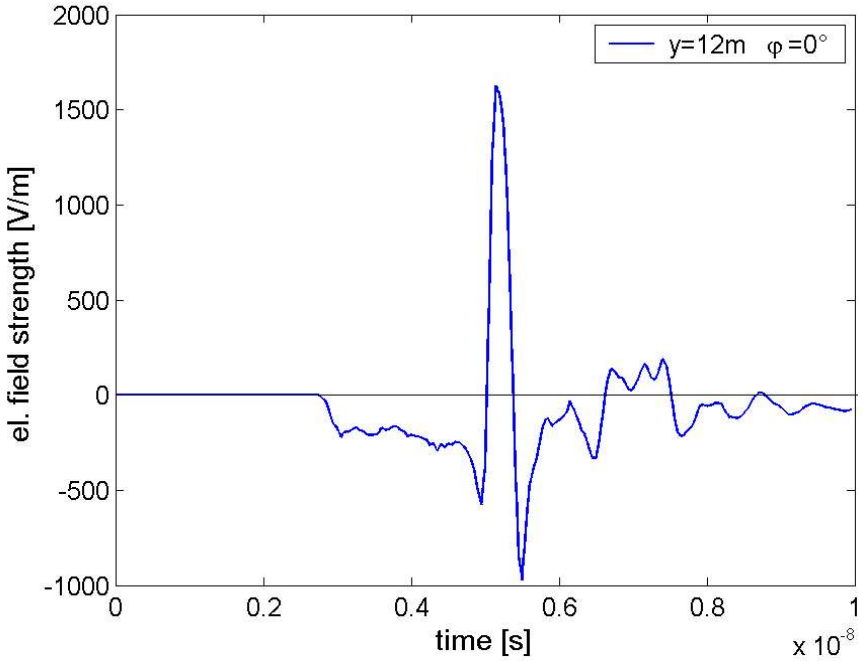
- Use of calibration results (insertion loss) and analytical sensor effective area to determine the electrical field strength.
- Calculation steps were performed in frequency domain.



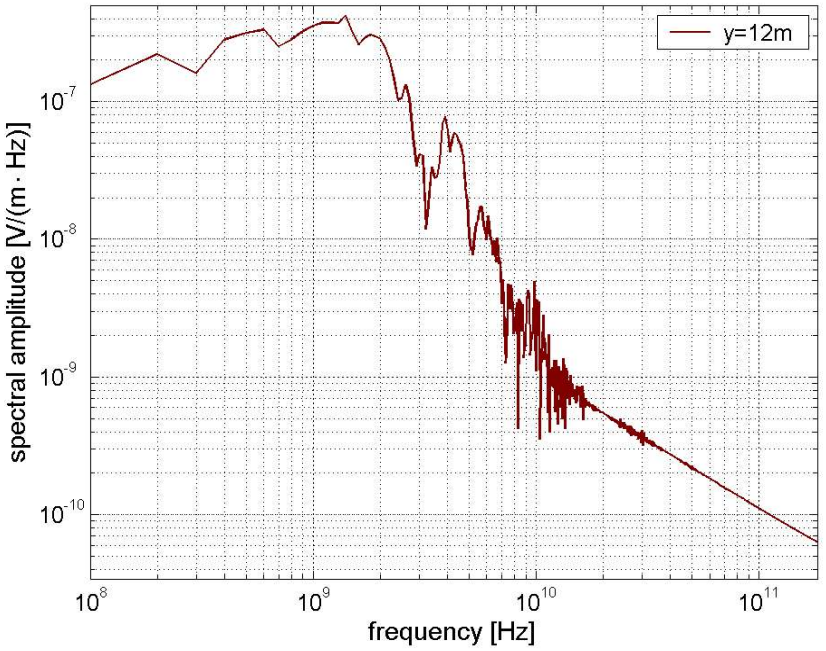
$$\underline{U}_{sens}(\omega) = \frac{\underline{U}_{meas}(\omega)}{\underline{H}(\omega)}$$

Pulse on boresight

Pulse at distance 12m on boresight



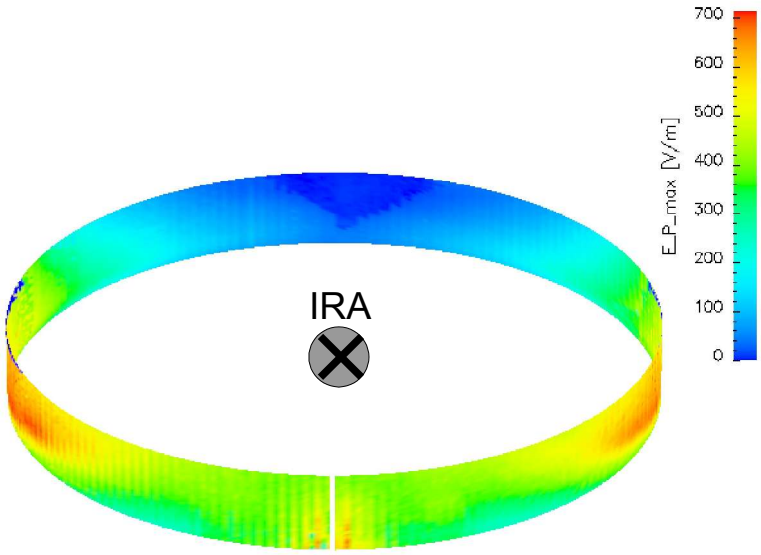
Amplitude spectrum of left pulse



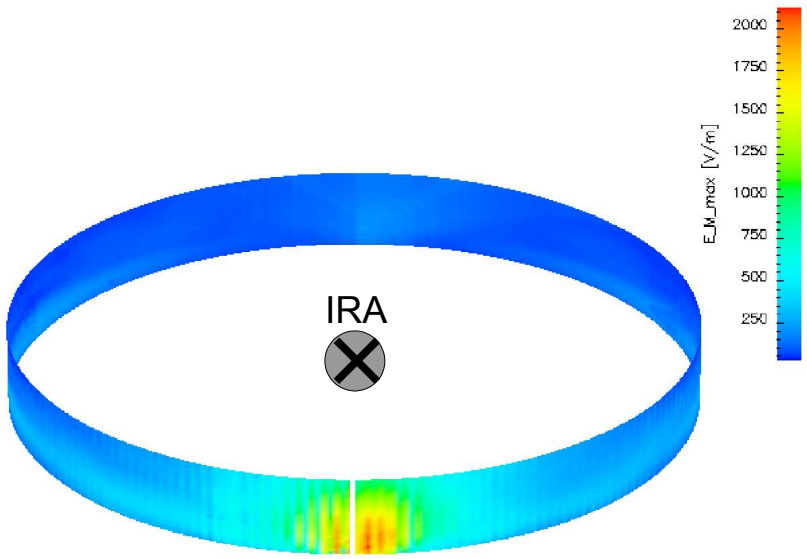
Equation proposed by D.V. Giri :

$$r_{far} \geq \frac{D^2}{2ct_r} = 11\,m$$

5 Peaks of prepulse and impulse



Maximum field strength of prepulse at a distance of 12m

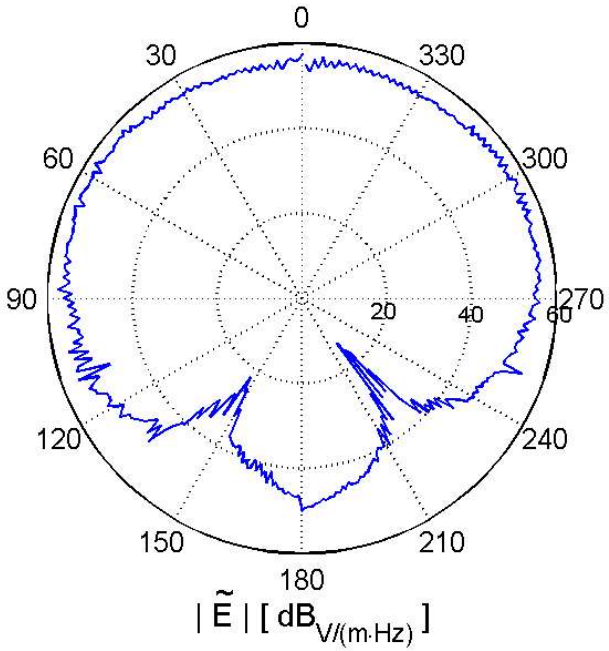


Maximum field strength of impulse at a distance of 12m

Radiated field pattern at LF

f = 100 MHz
(horizontal plane)

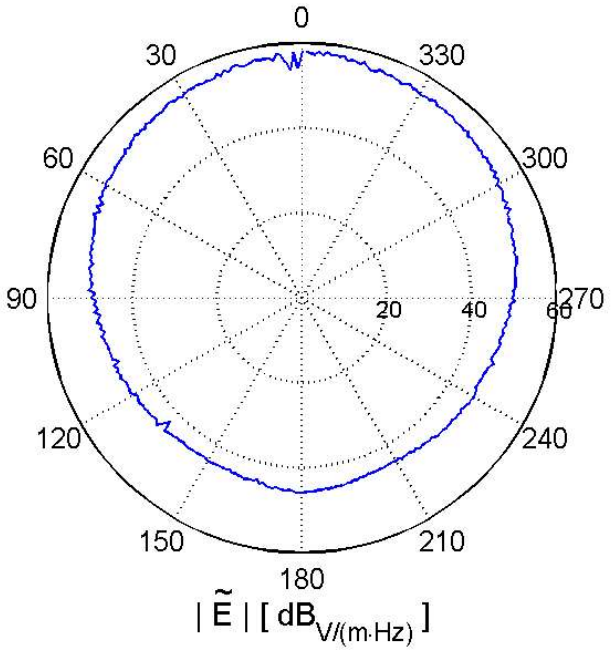
$D/\lambda = 0.3$



Cardioid-like shape

f = 200 MHz
(horizontal plane)

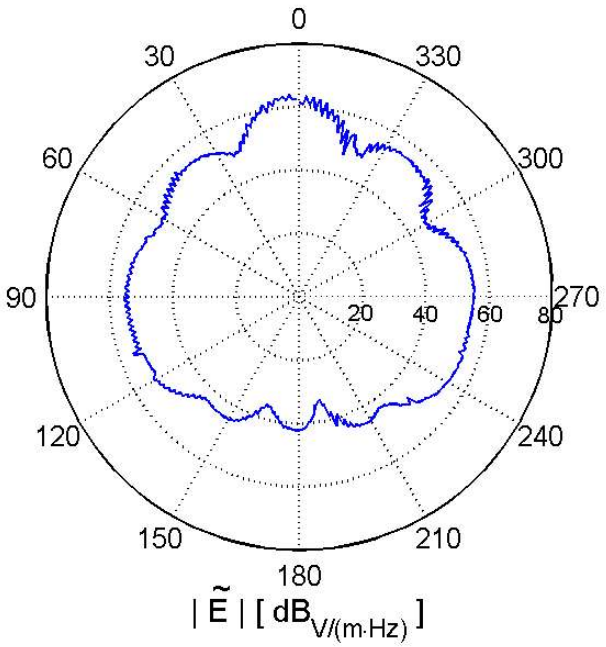
$D/\lambda = 0.6$



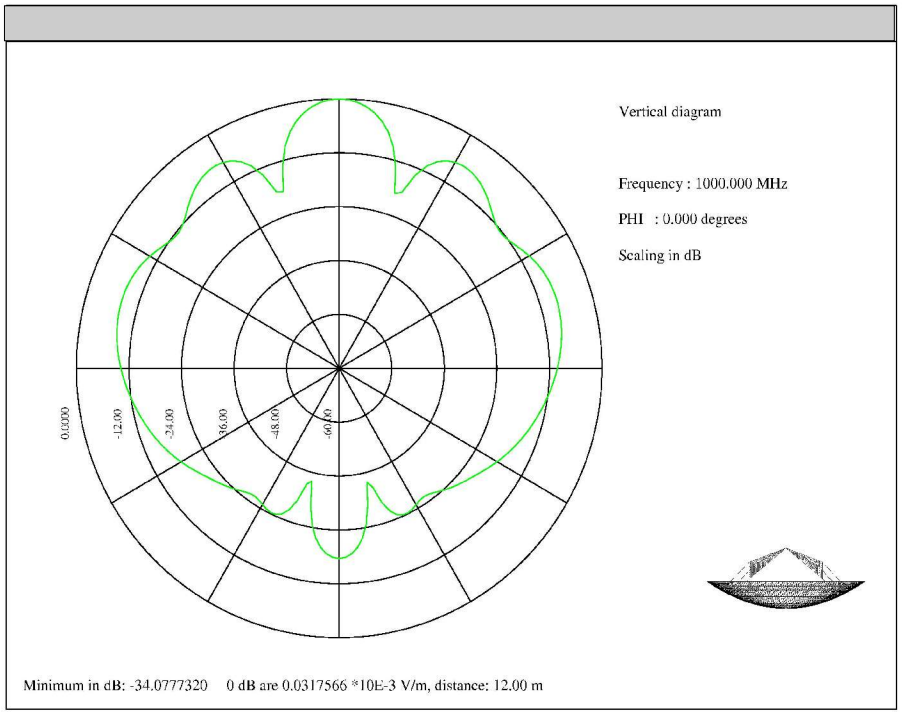
Very regular distribution

Radiated field pattern at 1 GHz

$D/\lambda = 3$



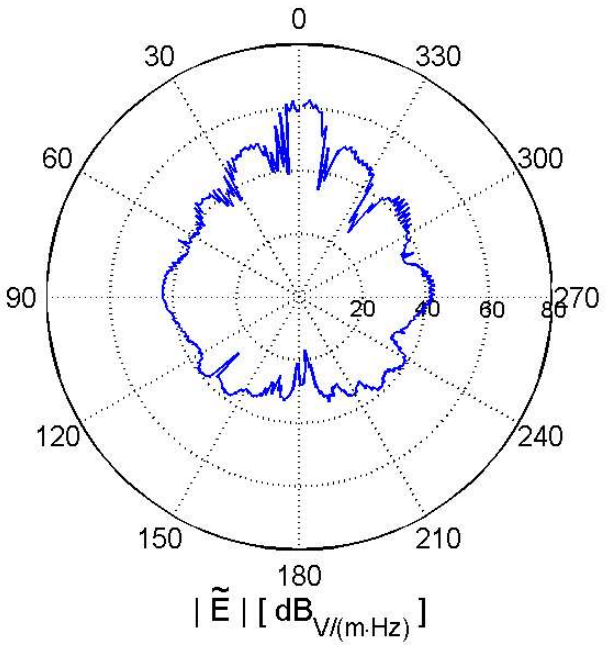
CONCEPT simulation result



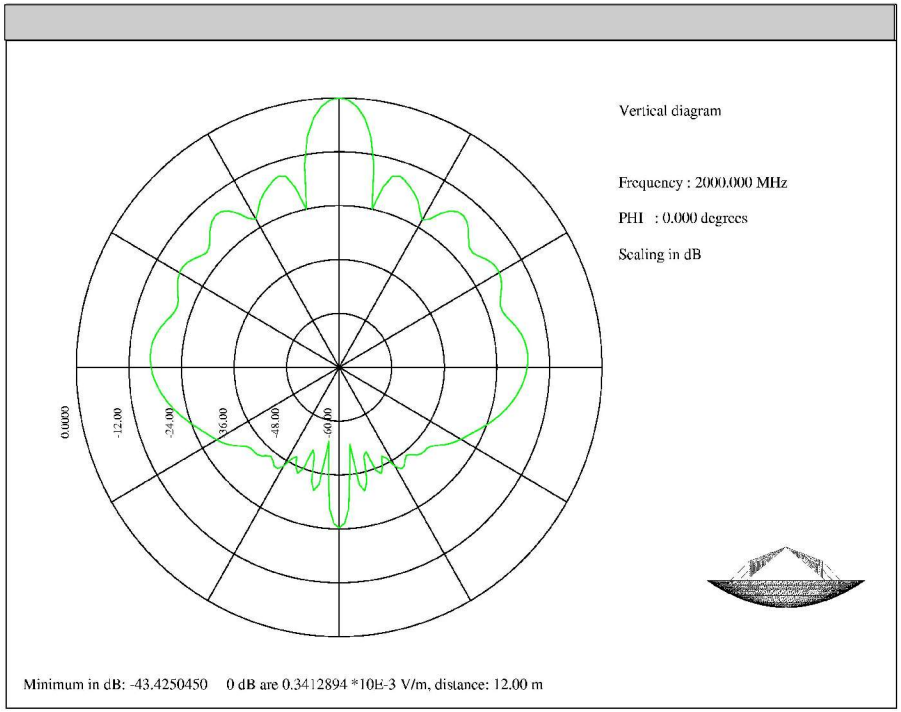
Comparable results

Radiated field pattern at 2 GHz

$D/\lambda = 6$



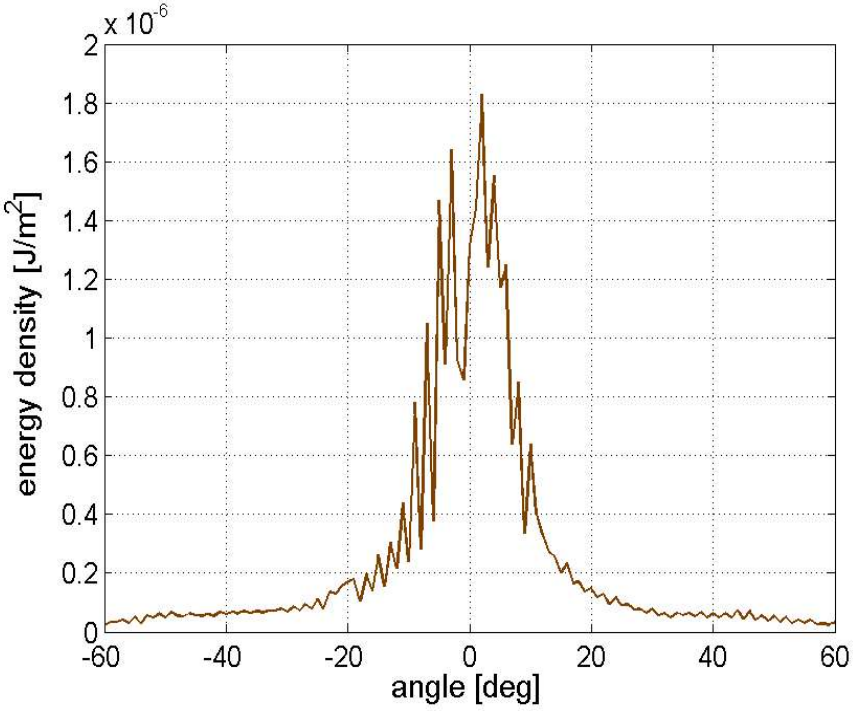
CONCEPT simulation result



Comparable results

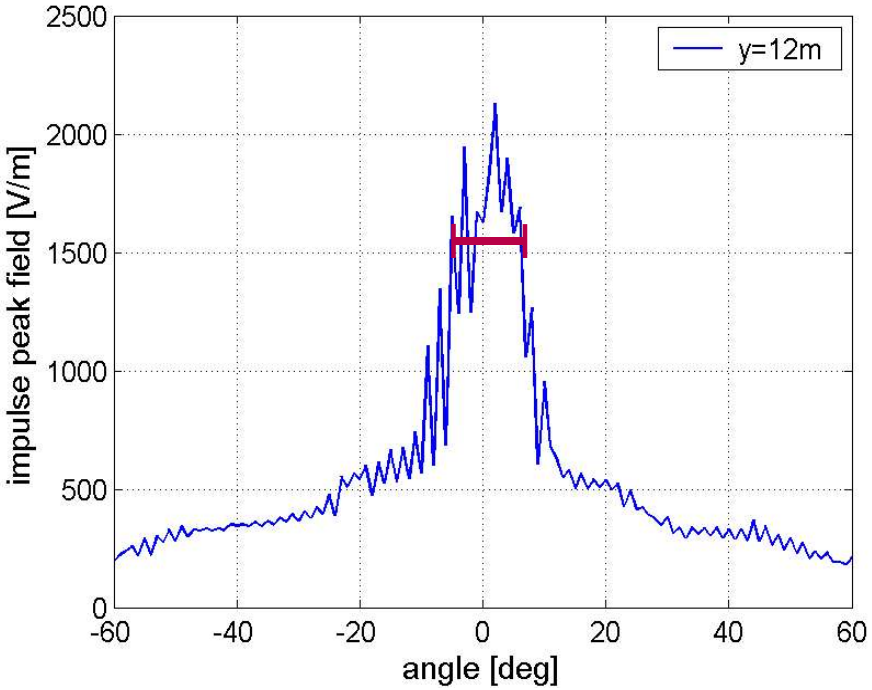
Pulse parameters off axis

Energy density calculated from impulse (horizontal plane)



Expected result

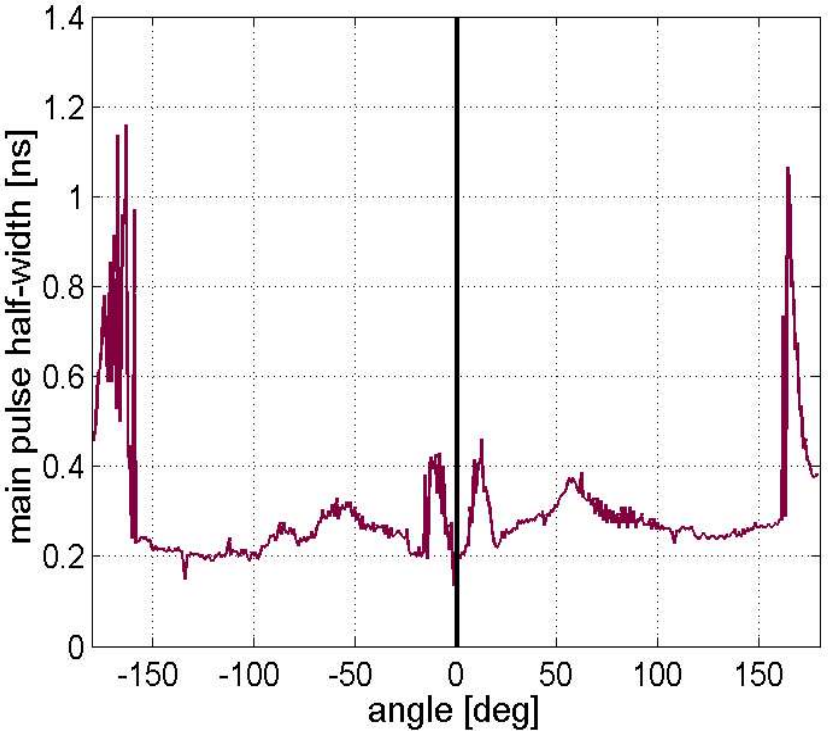
Impulse peak field value (horizontal plane)



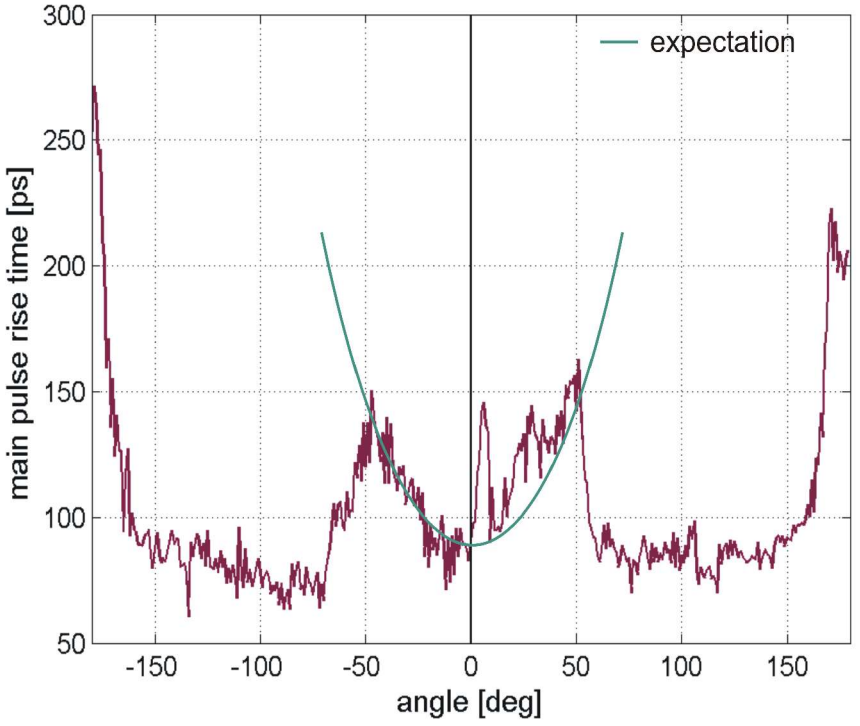
„Beamwidth“ ~ 12°

Temporal parameters

Impulse half-width
(horizontal plane, 12m)



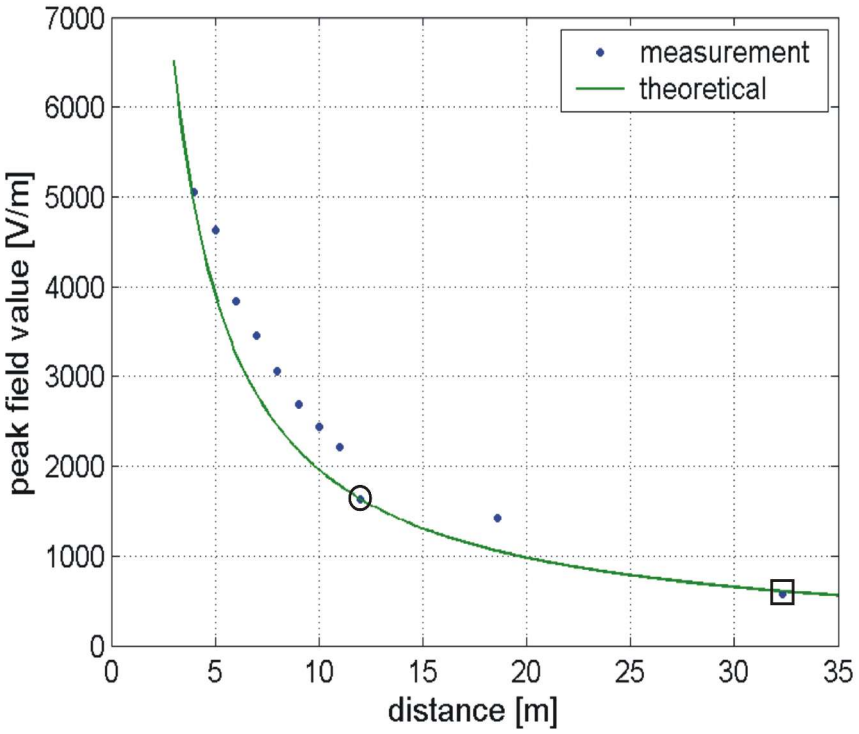
Maximum rate of rise for impulse
(horizontal plane, 12m)



Automation process is valid up to 50°

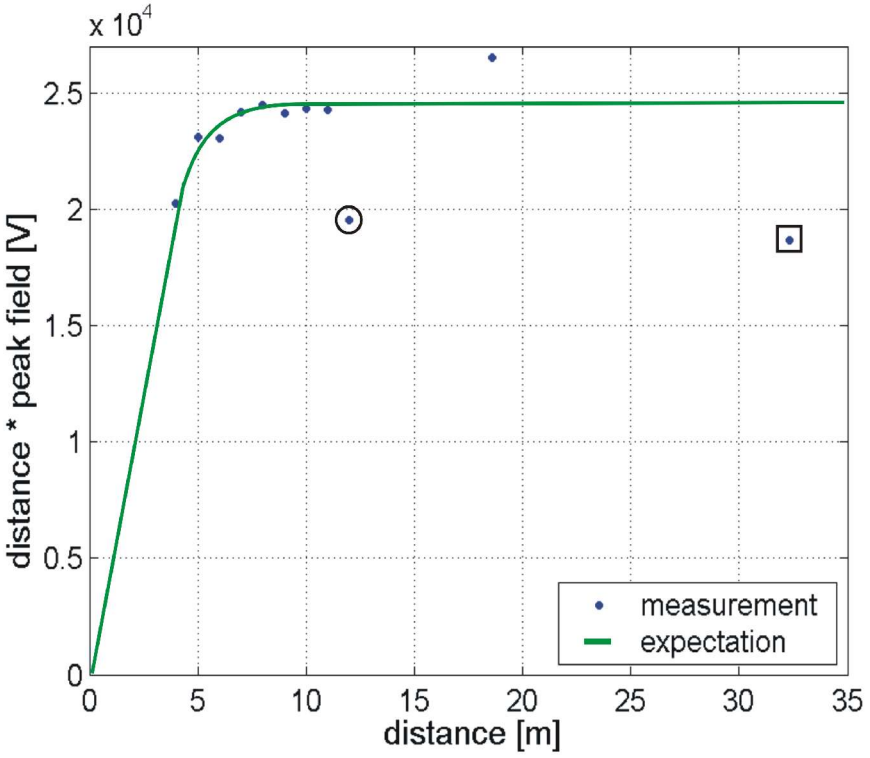
Measurements on axis

Peak field value on axis



Double exponential source voltage assumed

Peak field • distance



V_{far} ~ 24kV // „gain“ ~ 1.9

Summary

- Automated measurements as well as data processing can now be performed with the reflector IRA at this university.
- Now we have the most complete radiation pattern of an IRA both in time and spectral domain.
- About 10% of the field is radiated to the back and to the side of the antenna.
- There are still unknown effects with the angular dependent temporal parameters like maximum rate of rise or half-width of the impulse.
- An extended numerical model for the input voltage shape could possibly explain these effects, which is left to examine.