The Building of EMBRACE

G.W. Kant
& the EMBRACE team
EMBRACE Architecture overview
Site at Westerbork

Radome: 17m x 17m x 4.7m
### EMBRACE Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Frequency range</td>
<td>500 MHz - 1500 MHz.</td>
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<tr>
<td>Polarisation</td>
<td>Single polarisation</td>
</tr>
<tr>
<td>Physical Collecting area</td>
<td>~300 m WSRT / 100 m Nançay</td>
</tr>
<tr>
<td>Aperture Efficiency</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>Electronic Scan Range</td>
<td>+/-45 deg</td>
</tr>
<tr>
<td>T</td>
<td>&lt;100K @ 1GHz (aim for 50K)</td>
</tr>
<tr>
<td>Element phase control accuracy</td>
<td>3 bit (also time delays)</td>
</tr>
<tr>
<td>Instantaneous bandwidth</td>
<td>40 MHz (Achieved &gt;200 MHz)</td>
</tr>
<tr>
<td>Dynamic range A/D Converter</td>
<td>60dB (effective # of bits ~10)</td>
</tr>
<tr>
<td>Number of independent FoV (RF beams)</td>
<td>2</td>
</tr>
<tr>
<td>No of digital beams</td>
<td>8+</td>
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Back end processing
Building the platform infrastructure
Building the platform infrastructure
Platform Specifications

- Platform @ WSRT installed wk 21
- Between RT4 and RT5
- Platform 20x22 m²
- Additional platform for back-end 4x8 m²
Radome and Array
Detail image of array elements
EMBRACE signal flow overview

Radome

Analogue beam former

Down Convertor

ADC

Digital beam former

Image processing

Front-end

Back-end
Block diagram signal flow
Architecture with numbers – WSRT station

Beam A
One full FoV RF beam without combiner option in CDC

Beam B
RF beam with combiner option in CDC
Antenna development

- Mechanics evolved toward trustworthy and producible antenna element.
Embrace antenna feed connector

HFSS Model

Test PCB

Measured S parameter in 70Ω
Array simulation and measurements

Simulated

Measured

\[ F = F_{\text{min}} + \frac{4 \cdot r_n \cdot |\Gamma_s - \Gamma_{\text{opt}}|^2}{(1 - |\Gamma_s|^2) \cdot |1 + \Gamma_{\text{opt}}|^2} \]

8 × 8 array

\( \Gamma_{\text{act}} \) of centre element

500 < f < 1500 MHz

\( \theta < 45 \) deg
Mechanical break down of EMBRACE array
Assembling the final tile
Hex-Board

- 12 analog RF channels; phase and amplitude controllable
- Bias conversion and distribution
- Temperature monitoring
- Time delay
Centre-Board

- Time delay
- Bias distribution
- Ethernet control
Control & Down Conversion Unit

48V DC Bias  |  Control  |  Filter  |  Down conversion
Conclusion

- EMBRACE testing is ramping up
- Half station hardware installed (Westerbork)
- 40 tiles are ready to be shipped to Nancay
- First results show the full signal chain is functional
- EMBRACE will deliver a phased array with more than 10000 elements
- A movie on the building of EMBRACE will be shown during the break