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# Analysis of a Hybrid Broadband Reverberation Chamber Antenna

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08/2015 IEEE/EMC Europe 2015 - WS2 - Modeling of EMC Problems Using CONCEPT-II



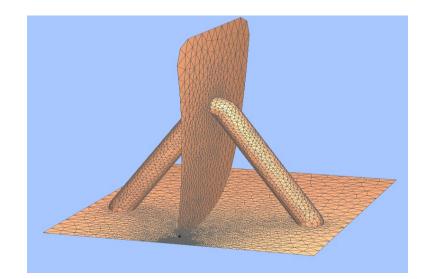
- Our aim was to produce an antenna for use in a reverberation chamber over a wide frequency range.
- Specifically the antenna should be usable in our chamber (4.8m x 3.3m x 2.2m) over the frequency range 200MHz to 20GHz.
- As with any linear structure its frequency range can be adjusted by dimensional scaling

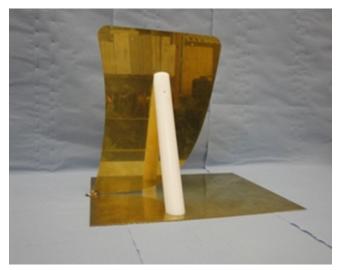


- Frequency range defined by input reflection coefficient:
  - |S11| < 0.316 (-10dB) 200MHz 20GHz
- Radiation pattern:
  - Not specified (isotropic in RC)
- Efficiency:
  - Maximised
- Size:
  - Minimised

### UNIVERSITY of York Solution – Dual Mode Antenna

- A hybrid monopoleexponential taper (Vivaldi) structure.
- Height 305mm.
- Ground plane width 300mm.
- Ground plane length 375mm.





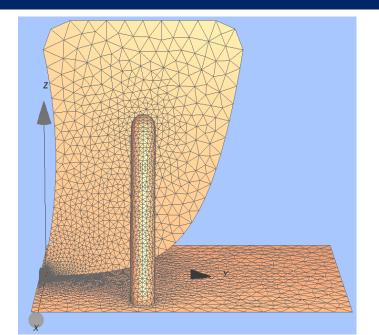
#### Mode of Operation

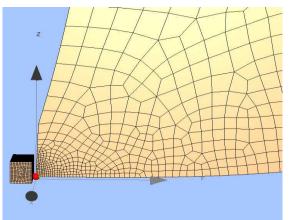
#### Low frequency monopole resonant at ~250 MHz.

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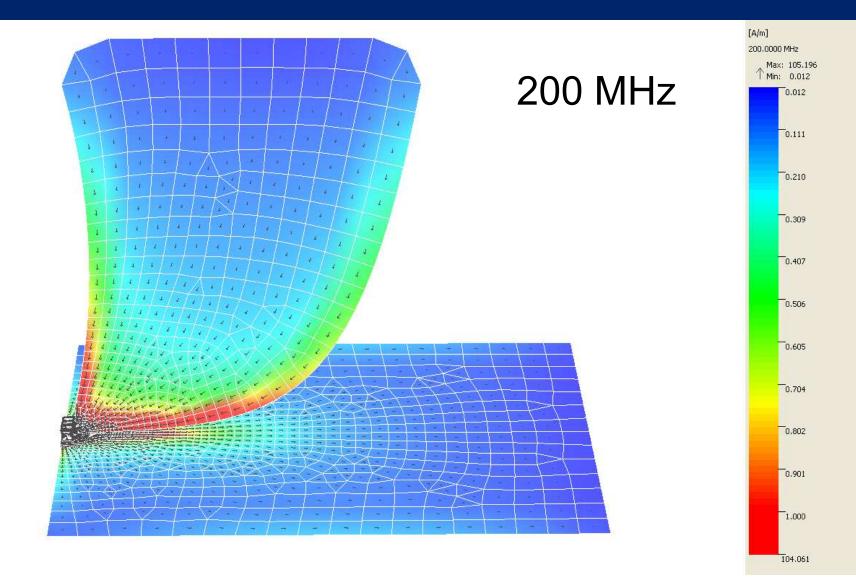
- Determined by the effective minimum length of the monopole defined by the curved edge above the feed point.
- Simple exponential taper from 400 MHz upwards
- The key is that the taper takes over before the λ/2 anti-resonance of the monopole at ~ 500 MHz



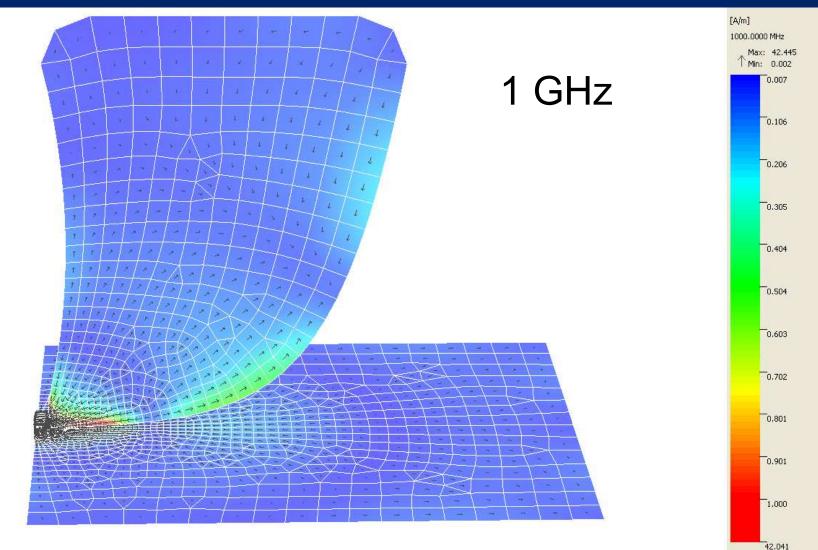




#### Monopole Mode

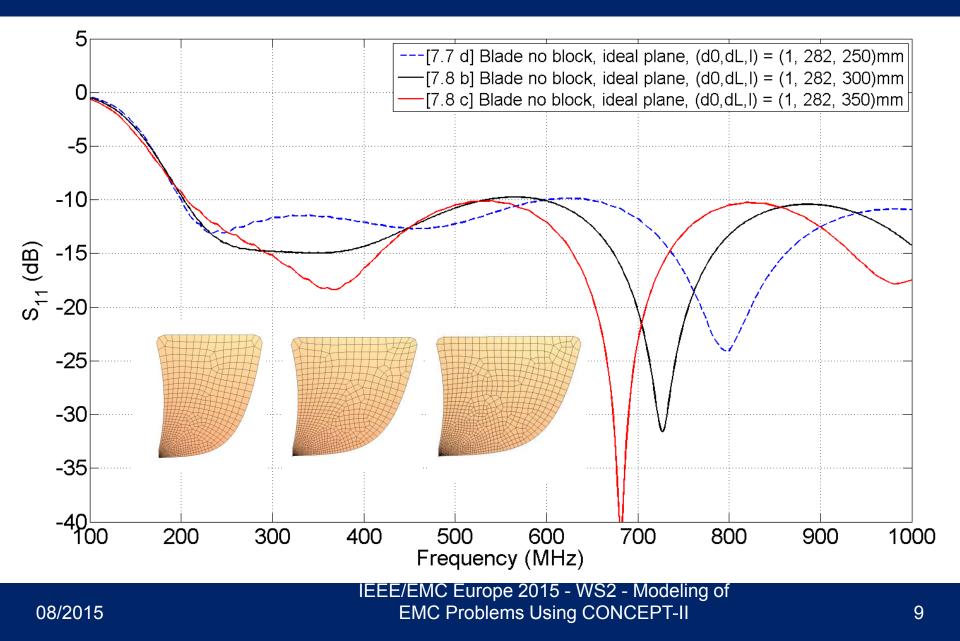


#### Vivaldi Mode

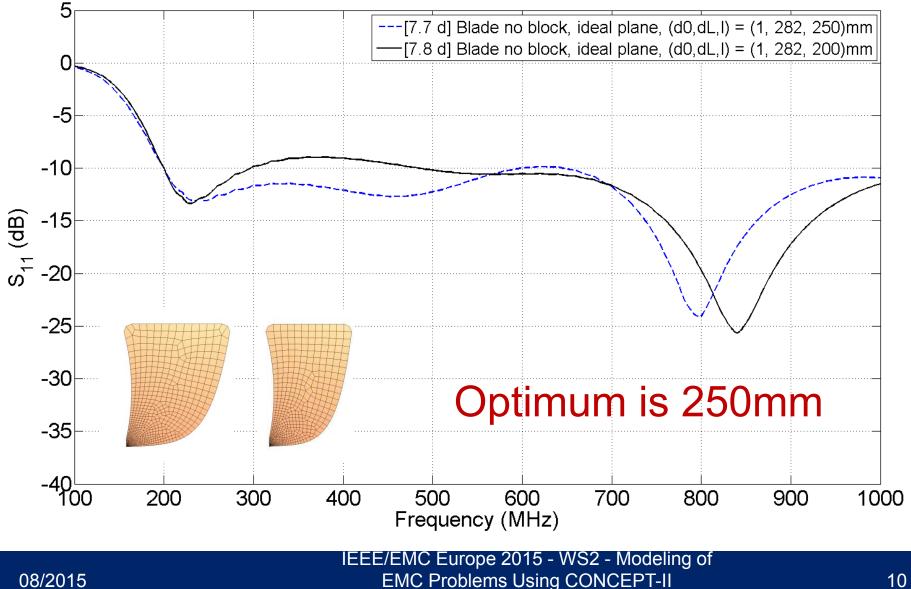


- Modelled with CONCEPT II and Gmsh
- Target: S<sub>11</sub> < -10dB from 200 1000 MHz
- Radiation pattern less important for use in reverberation chamber
- Vary parameters including length and shape of exponential taper, and size of feed block
- Mesh size ~1 cm at edges away from feed and ~0.5mm near feed

### UNIVERSITY of York Taper length 250, 300, 350 mm

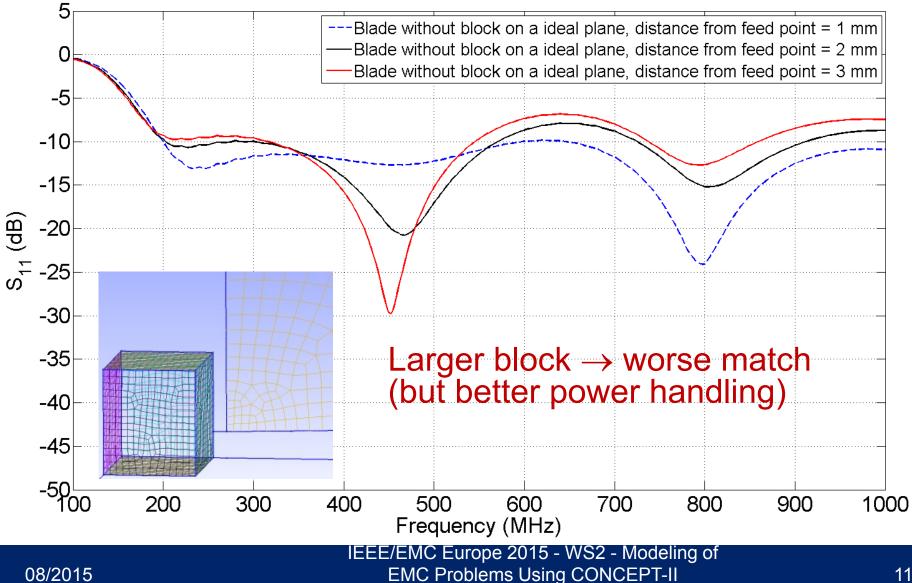


#### Taper length 250, 200 mm



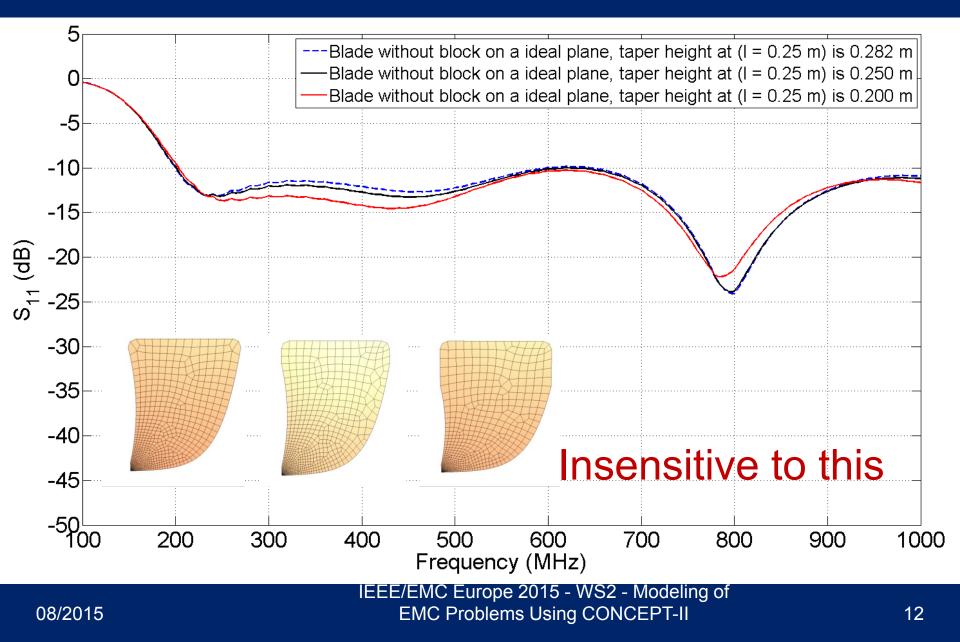
#### UNIVERSITY of mk

#### Feed point 1, 2, 3 mm



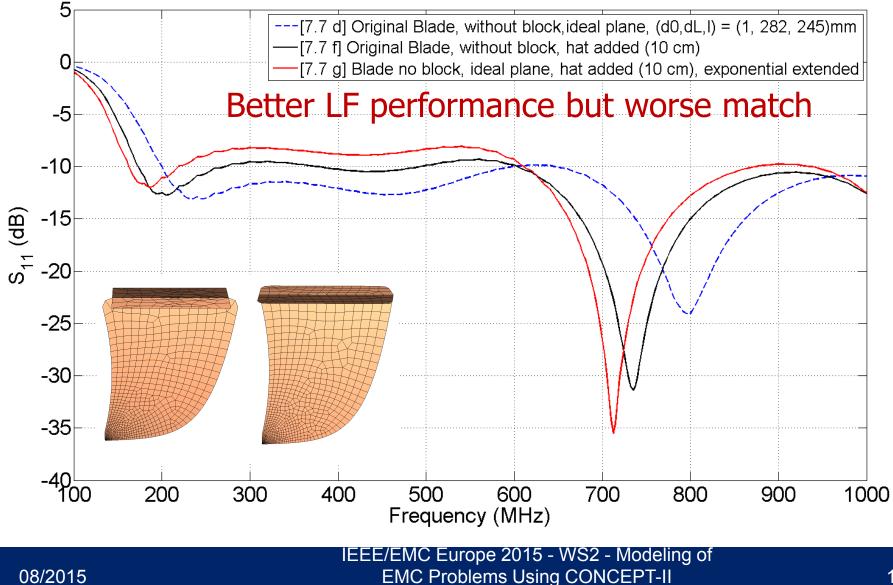
#### Shape of taper







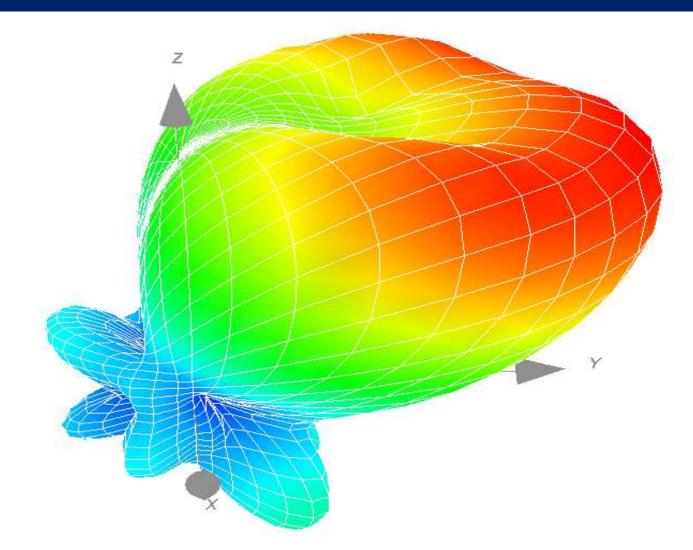
#### Top loading



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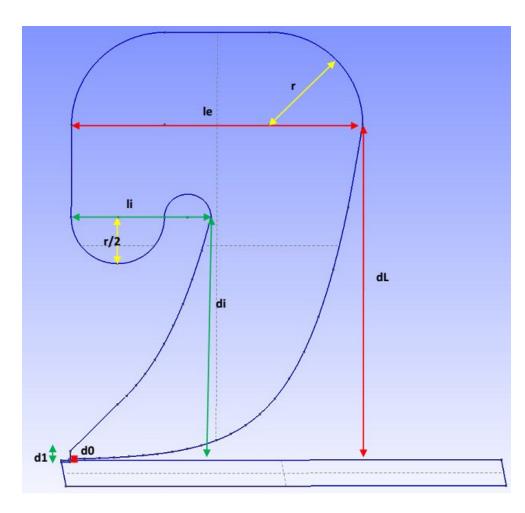
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#### Radiation pattern at 1 GHz



#### **GA Driven Optimisation**

- Automatic optimisation
- Octave/MATLAB program
- Parametric CAD Gmsh
- MATLAB GA toolbox or in-house Octave GA
- MATLAB/Octave functions to write CONCEPT input files

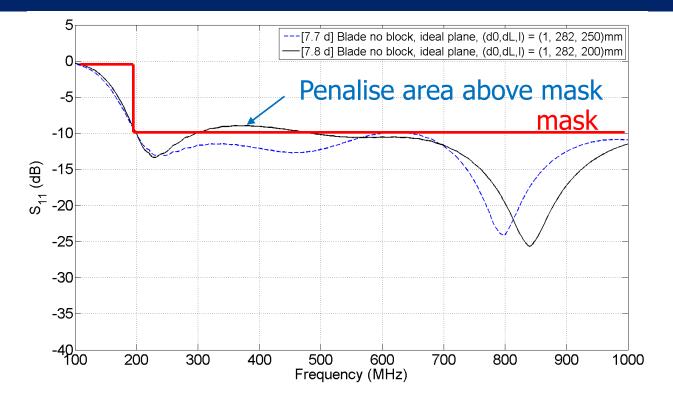




- Decode genotype -> parameters
- Create Gmsh (.geo) file with required parameters
- Create mesh using Gmsh
- Create CONCEPT input files from templates
- Run CONCEPT
- Post- process to get input impedance
- Evaluate cost function as area between |S11| and upper mask

#### **GA** Cost Function

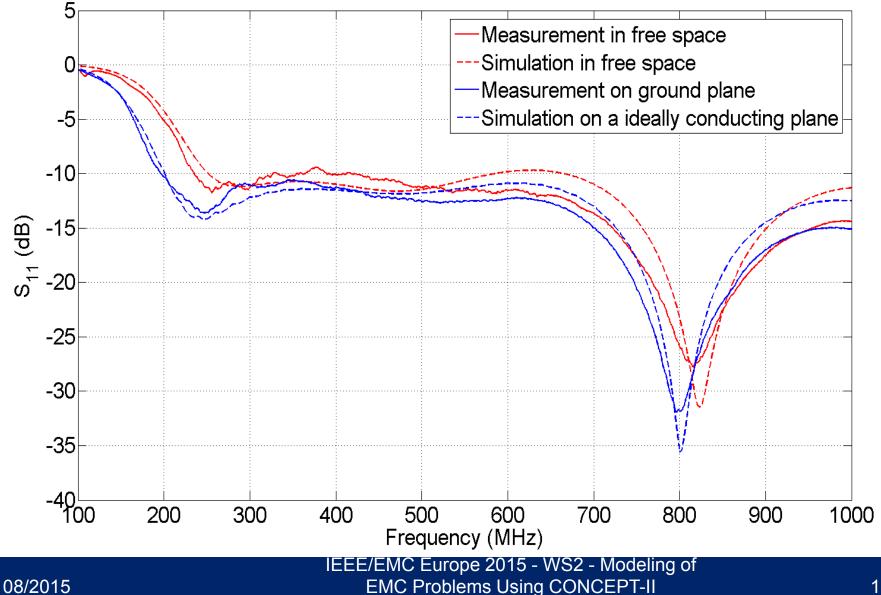




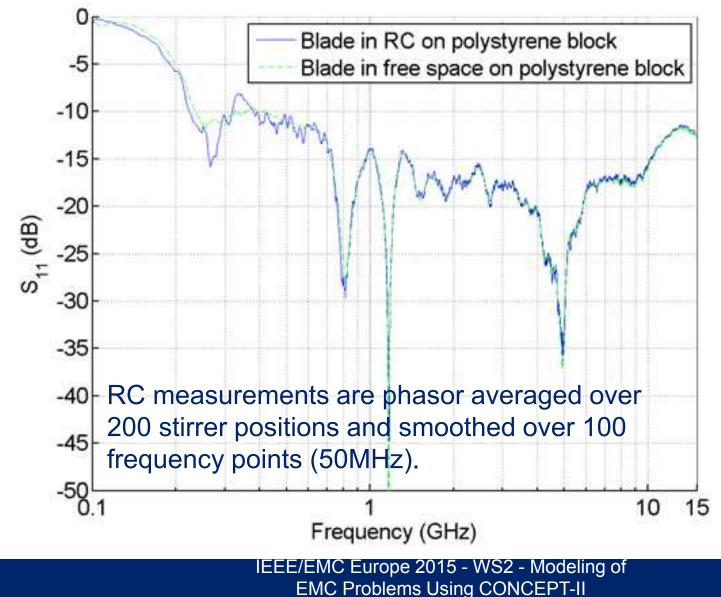
Optimise cross-over region (monopole-> taper)

 Cost function is area between S11 amplitude mask and simulated |S11|.

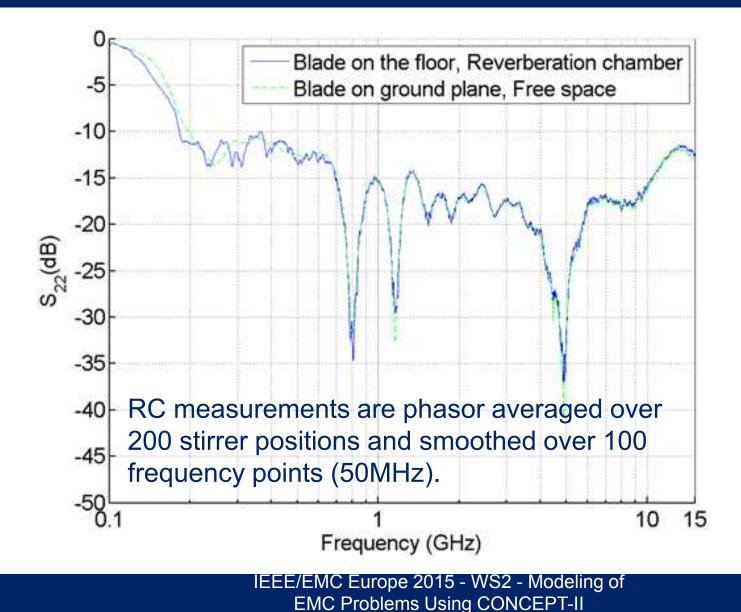
#### Validation of model



## UNIVERSITY of fork High frequency behaviour in RC



## UNIVERSITY of fork High frequency behaviour in RC





- Successful transition between antenna modes
- Initial design was close to optimal!
- Trade-offs:
  - Feed point: S<sub>11</sub> against power handling
  - Top loading: S<sub>11</sub> against LF performance
- Final antennas have acceptable performance from 200 MHz to 25 GHz (maybe higher)