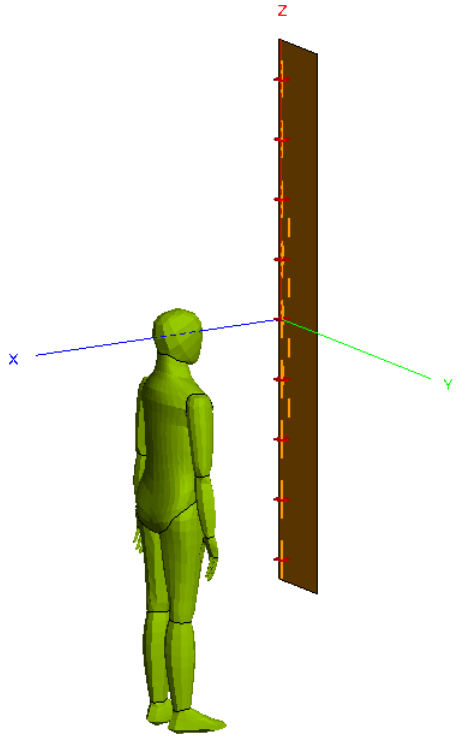
Compliance as a function of assessment method

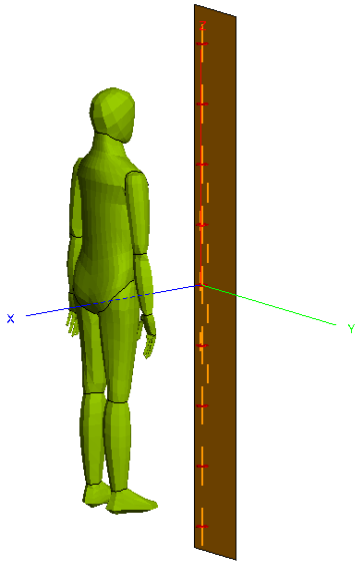
Exposure evaluation in front of a base station panel antenna: 200 W, 900 MHz

FEKO setup

- Panel antenna
  - Panel: 2250 mm x 300 mm
  - 200 W total radiated power
- Homogeneous tissue adult sized phantom
  - $\varepsilon r=55$, $\sigma=1.05$ at 900 MHz
  - ~15,270 dielectric triangles
  - Height=1.75m, mass=64 kg (1000 kg/m^3)
  - Phantom on boresight and off-boresight
- SAR and field strengths calculated
  - Results compared to RPS3 occ. limits



Off-boresight



Boresight

SAR: 900 MHz plane wave exposure

- Comparing whole body average SAR_{wb} in FEKO homogeneous phantom to that in heterogeneous NORMAN (Dimbylow, 2002)

- SAR_{wb} 1 V/m (rms) plane wave, vertical polarisation, incident from front
  - FEKO: 16.6 uW/kg
  - NORMAN (2 mm voxel): 17.0 uW/kg

Panel antenna

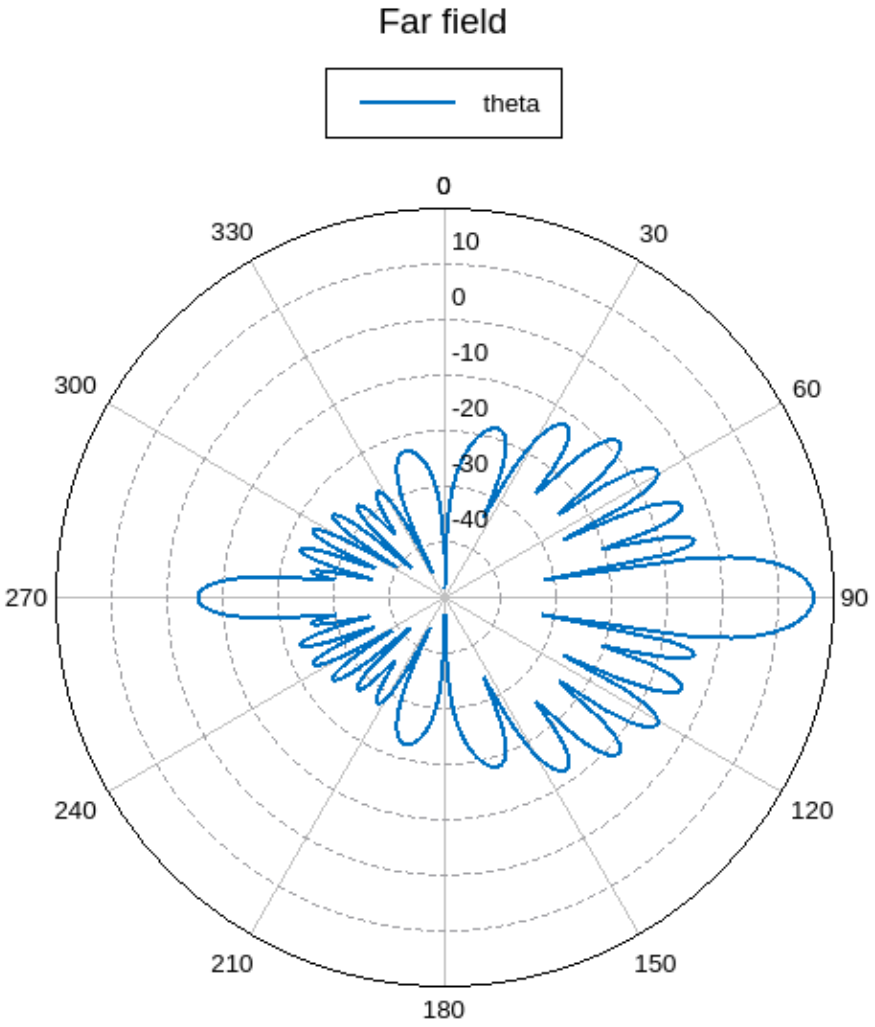
- Dual frequency 900/1800 MHz panel antenna
  - Vertical polarisation

- Two arrays of vertically stacked half wave dipoles
  - 9 dipoles at 900 MHz and 7 dipoles at 1800 MHz
  - Overall antenna dimensions: 2250mm x 300mm

- **Only 900 MHz array active in this example**
  - Active 1800 MHz will be included in a future example

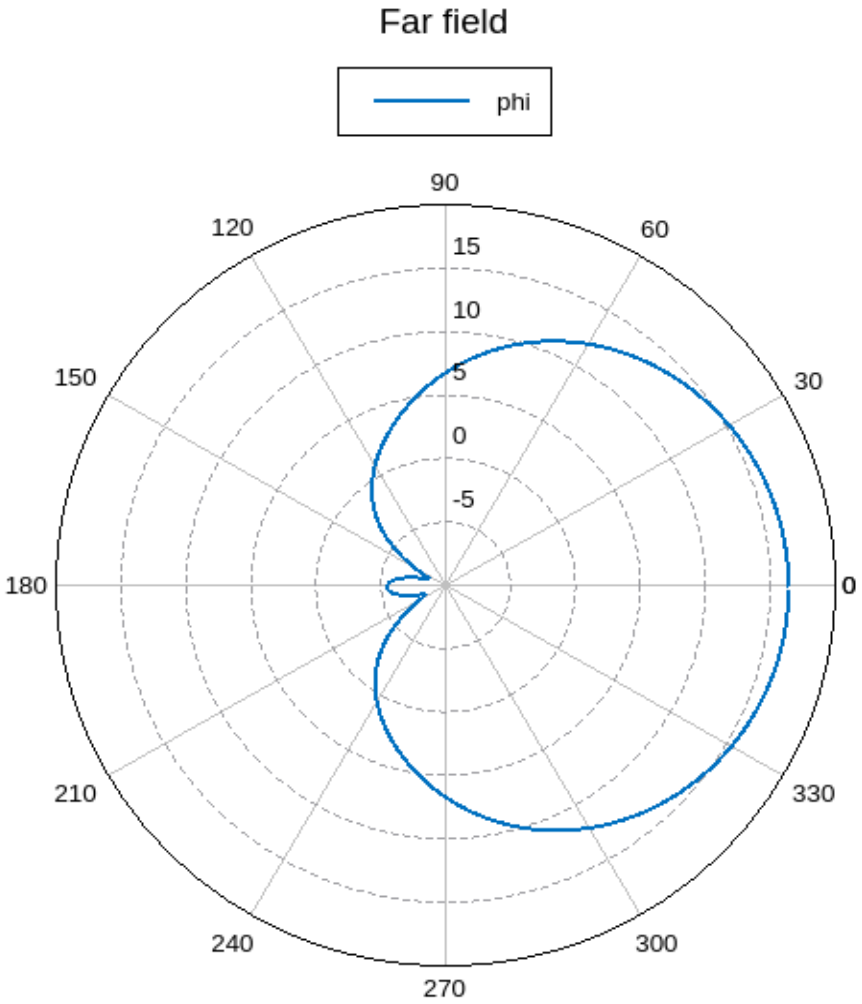
- Specifications at 900 MHz
  - 9 half wave dipoles
  - Maximum gain: 16.4 dBi
  - Half power horizontal beamwidth: 98°
  - Total radiated power: 200 W

Antenna pattern data - elevation



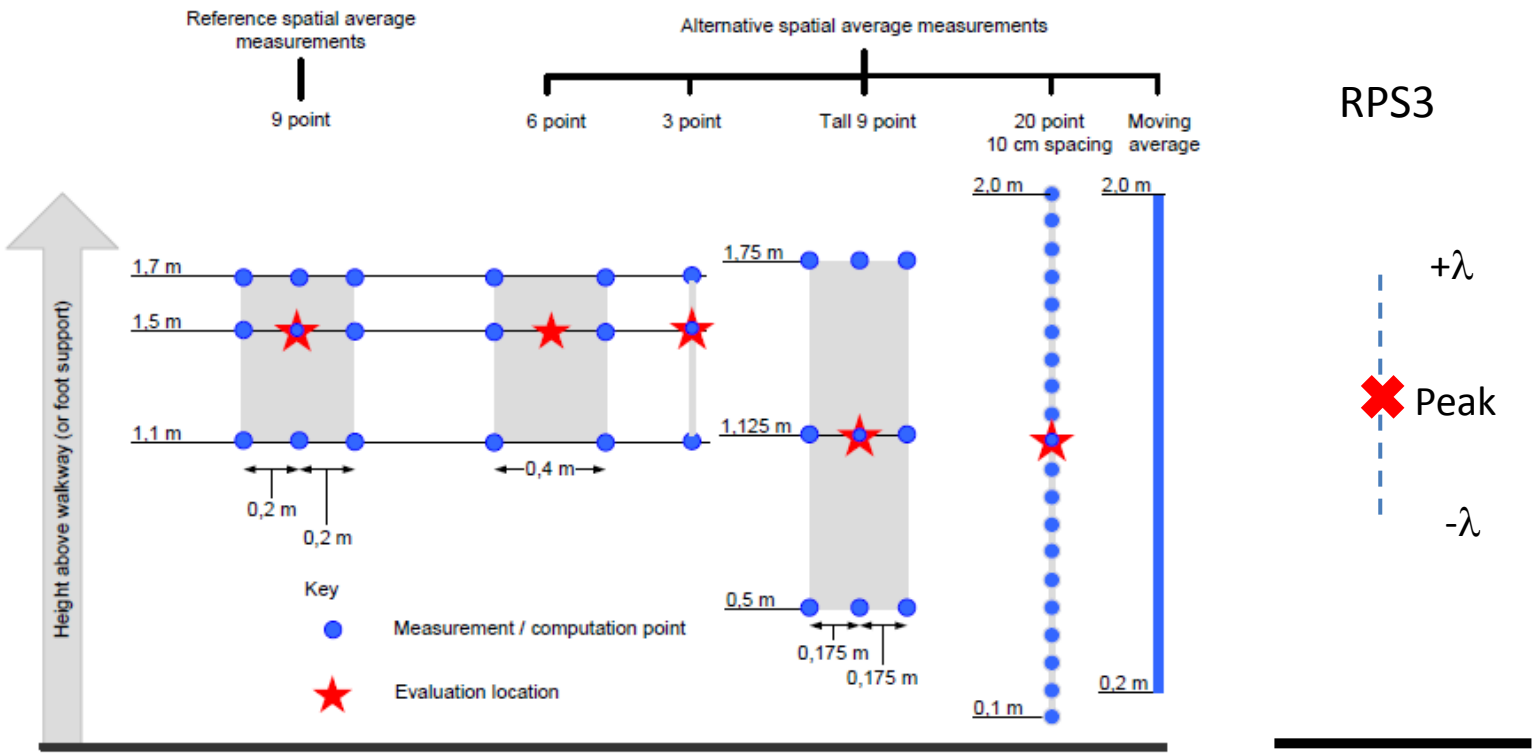
Total Gain [dBi] (Frequency = 900 MHz; Phi = 0 deg) - BSmodel_full_900_1800_offset_900srcsON_patterndata

Antenna pattern data - azimuth



Total Gain [dBi] (Frequency = 900 MHz; Theta = 90 deg) - BSmodel_full_900_1800_offset_900srcsON_patterndata

Scanning and spatial averaging



These schemes used >> ☑ ☑ ☑ ☑ ☑

Process

- FEKO calculated SAR (whole body average and 10g) at different separation distances directly front of the antenna
  - At 0.5m and then from 1m to 15 m in 1m increments
  - Boresight and off-boresight alignment of phantom facing the panel antenna

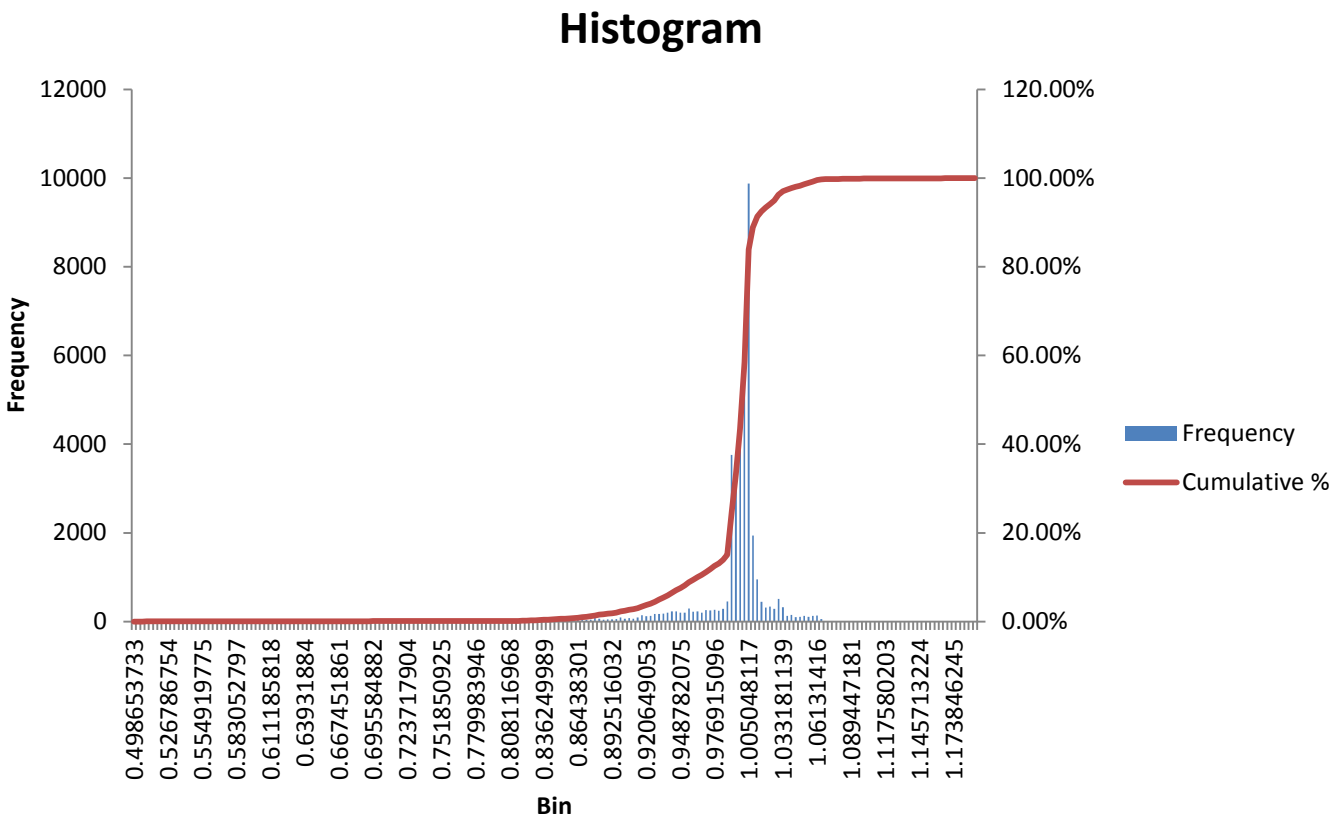
- At each separation distance, and without the phantom present, performed a scan over a vertical plane to determine the maximum (peak) equivalent power flux density S_{eq}. Additionally, performed spatial averaging using the schemes shown on the previous slide
  - $S_{eq}=E_t^2/377$ and E_t is the total field electric strength = $\sqrt{(|E_x|^2+|E_y|^2+|E_z|^2)}$ at a point in space
  - Spatial average=$(S_{eq-1}+S_{eq-2}+ .. + S_{eq-N})/N$ where N is the number of points
  - N = 3, 6 , 9 and 20 point schemes
  - the difference between using E_t or H_t field to calculate S_{eq} is explored on the next slide

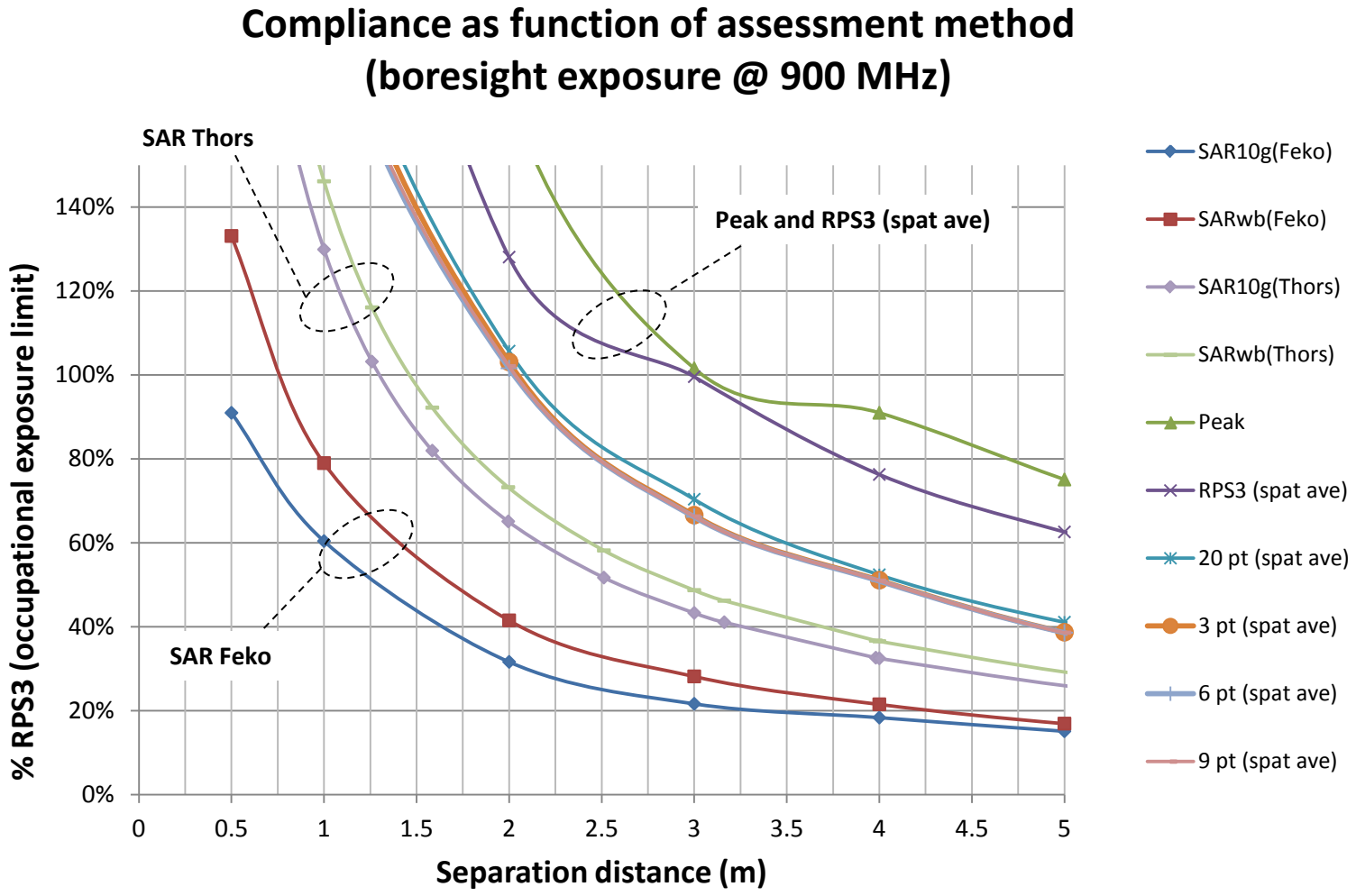
- Calculated SAR (whole body and 10g) using formulas published by Thors et al (2008)

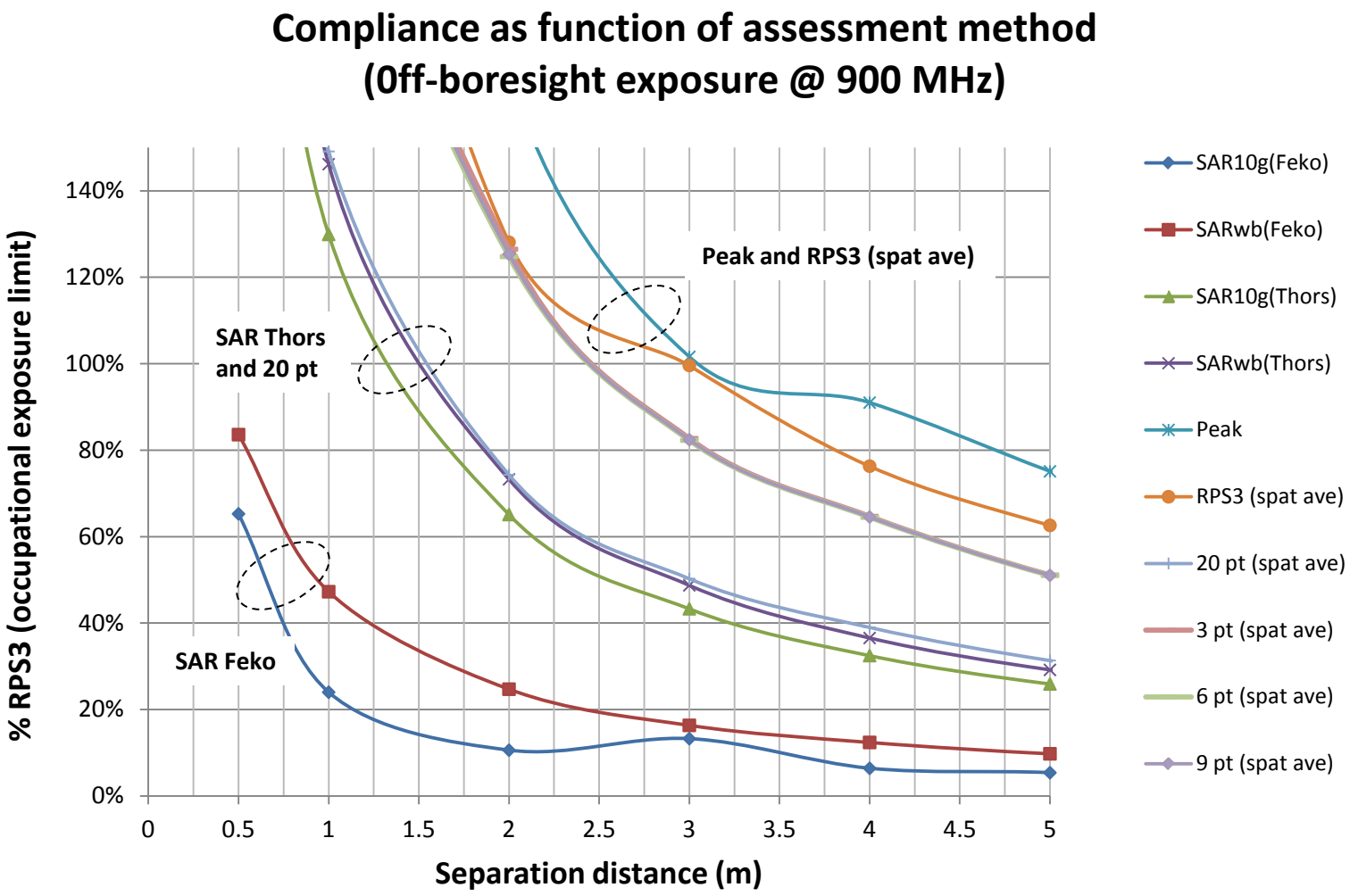
- Compared results with RPS3 occupational exposure limits

E_t or H_t to calculate S_{eq} ?

- Histogram: ratio $r=S_{eq}(H_t)/S_{eq}(E_t)$
- ~95% of values lie between r=0.90 (2.43%) and r=1.04 (97.41%)
- Used E_t in calcs




Compliance as function of assessment method
(boresight exposure @ 900 MHz)
SAR Thors
Peak and RPS3 (spat ave)
SAR Feko
% RPS3 (occupational exposure limit)
140%
120%
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Separation distance (m)
SAR10g(Feko)
SARwb(Feko)
SAR10g(Thors)
SARwb(Thors)
Peak
RPS3 (spat ave)
20 pt (spat ave)
3 pt (spat ave)
6 pt (spat ave)
9 pt (spat ave)


Compliance as function of assessment method
(0ff-boresight exposure @ 900 MHz)
% RPS3 (occupational exposure limit)
140%
120%
100%
80%
60%
40%
20%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Separation distance (m)
SAR Thors
and 20 pt
SAR Feko
Peak and RPS3 (spat ave)
SAR10g(Feko)
SARwb(Feko)
SAR10g(Thors)
SARwb(Thors)
Peak
RPS3 (spat ave)
20 pt (spat ave)
3 pt (spat ave)
6 pt (spat ave)
9 pt (spat ave)

Summary

- Feko SAR calcs show compliance with RPS3 can be achieved with a separation distance of ~0.75m for boresight and off-boresight alignment of phantom

- Thors SAR estimation formulas are conservative compared to Feko SAR calcs
  - RPS3 compliance can be achieved with a separation distance of 1.5m

- Most conservative compliance estimation occurs when using Peak field strength. Next most conservative is RPS3 spatial averaging
  - RPS3 compliance can be achieved with a separation distance of ~3m.