The Challenges and opportunities for the characterisation and quantification of Stochastic Electromagnetic Fields

Presented by Dave Thomas
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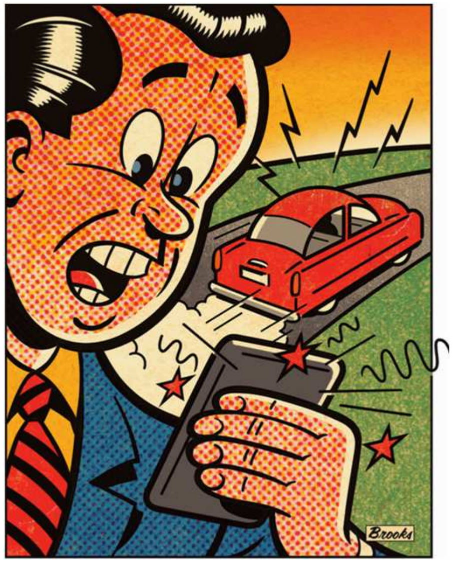
Phone to Fridge:
SHUT UP!
OUR HYPERCONNECTED WORLD NEEDS BETTER PROTECTION AGAINST ELECTRONIC NOISE
By Mark A. McHenry, Dennis Roberson & Robert J. Matheson



IEEE Spectrum
Sep 2015

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Characterisation of the near field EM environment in electronic equipment

- Interoperability
- New paradigm of C2C communications

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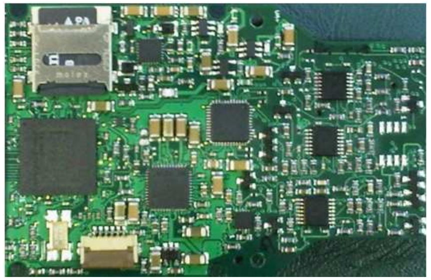

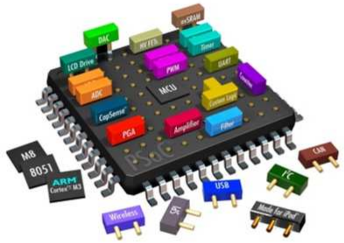

- Society requires more and more functionality in electronic devices increasing their complexity
- Many complex electronics and integrated circuits radiate essentially random noise rather than continuous stationary signals.
- State of the art standards and EMI analysis techniques do not address this.

Wireless C2C communications

- metal interconnects are deficient due to high latency and significant power consumption
- replace multihop wired interconnects with high-bandwidth single-hop long-range millimeter (mm)-wave wireless links.

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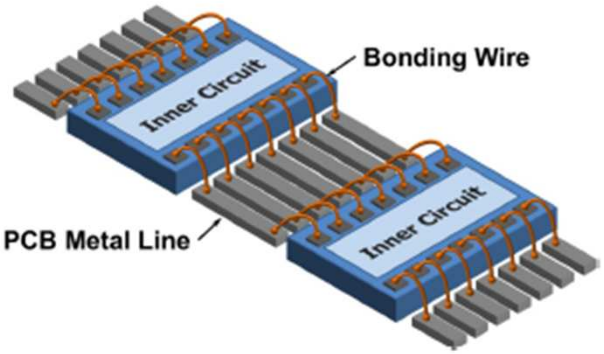
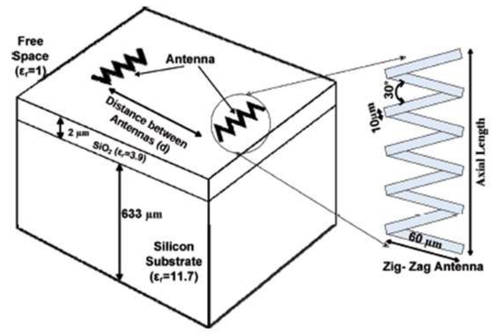
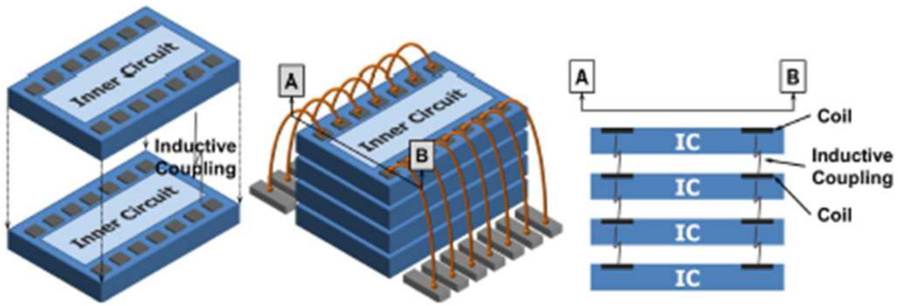
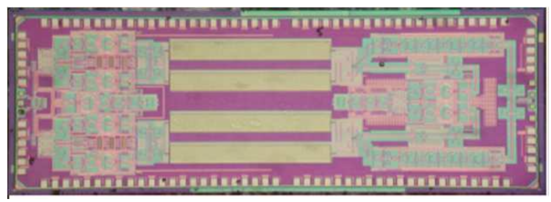
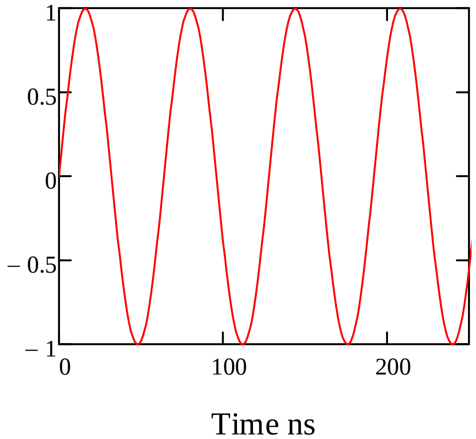
- Wireless C2C communications

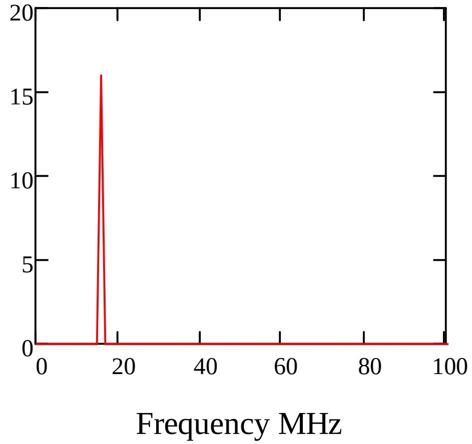




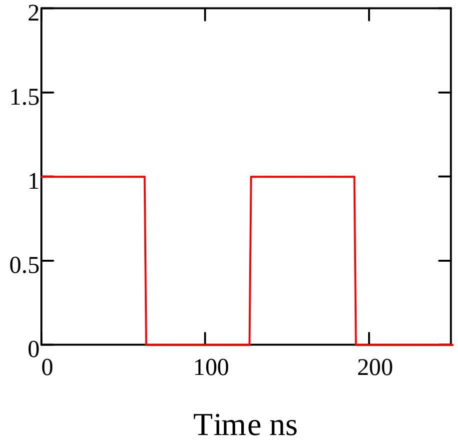


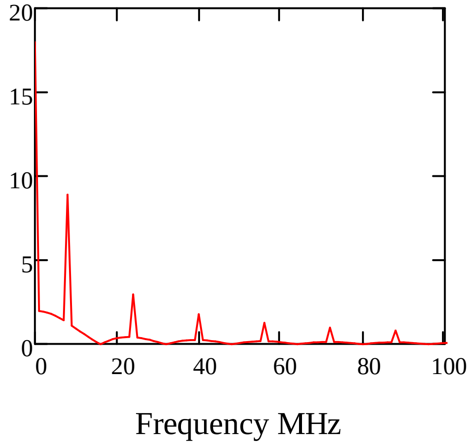




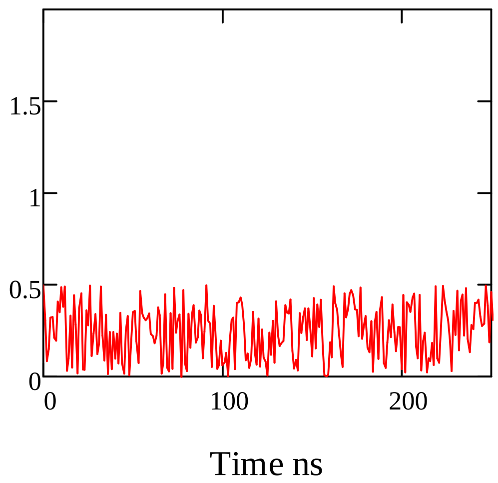


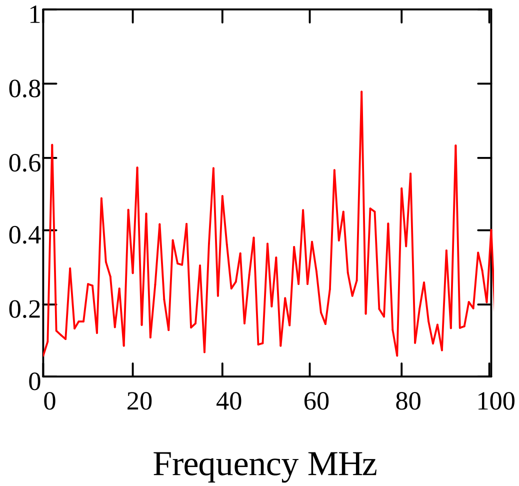
Orpheus like beauty

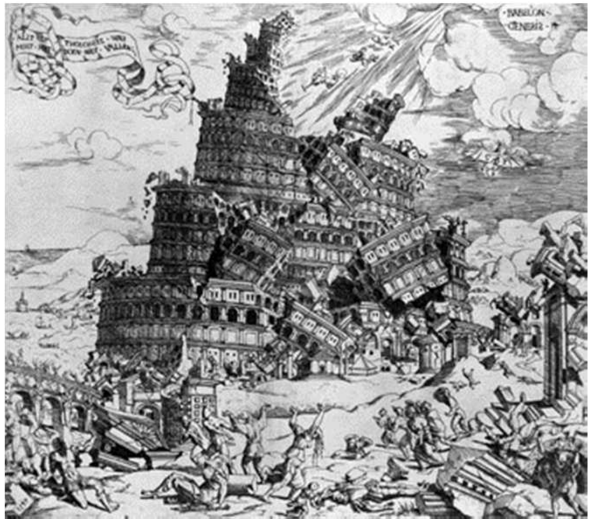




The problem addressed







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Advanced Characterisation and Classification of Radiated Emissions in Densely Integrated Technologies

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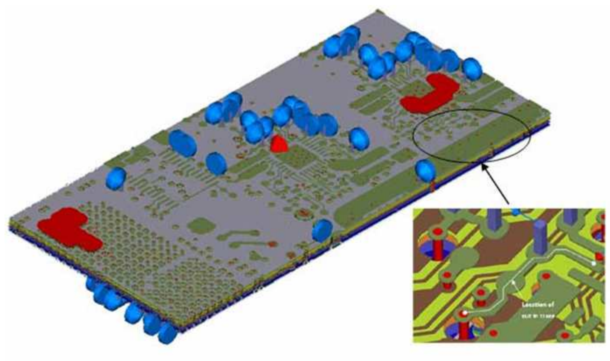
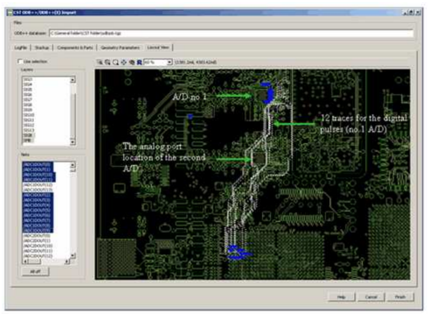
Through a series of networking activities it will provide coherent solutions and full understanding of the opportunities and relative merit of the international and inter-sectoral work on *stochastic* emissions.

Wireless near field chip to chip communications requires a better understanding and characterisation of the noisy near field environment

Direct modelling or Equivalent methods

3D EM simulation of mixed analog / digital PCB





modeling time	running time	memory required
1 week	10 h	3 GB

Difficulties

- unrealistic computational resources and time due to increasingly complex circuit structure
- unknown characteristics of the circuit
- confidential reasons

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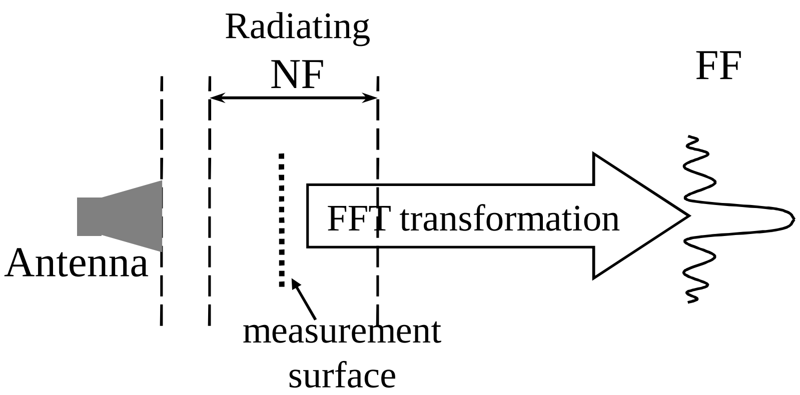
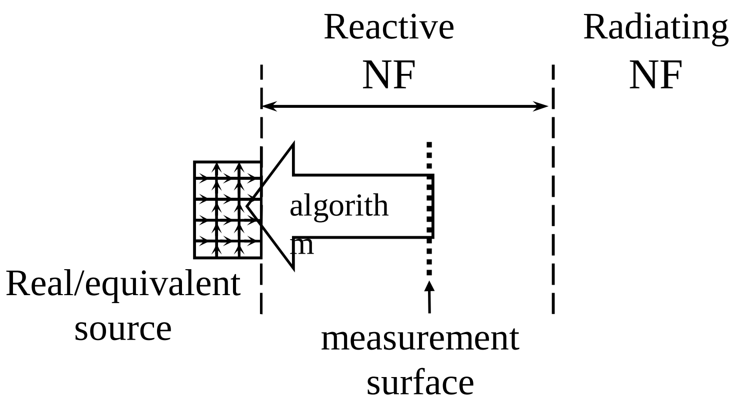
Popular technique for providing EM fields closely surrounding DUTs



NF – FF transformation



Source model from NF

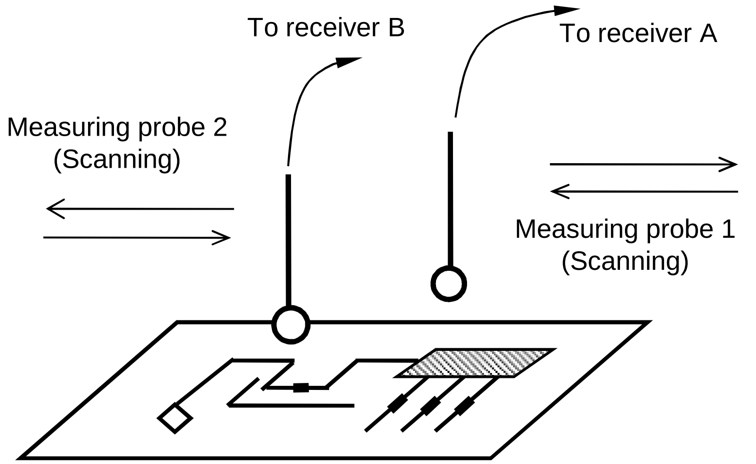
Correlation spectrum

$$\Gamma_H(x_1, x_2, \omega) = \int_{-\infty}^{\infty} c_h(x_1, x_2, \tau)\, e^{-j\omega\tau} d\tau = \lim_{T\to\infty} \frac{1}{2T} \left\langle \boldsymbol{H}_T(x_1, \omega)\, \boldsymbol{H}_T^*(x_2, \omega) \right\rangle$$

The spectral magnetic energy density is then

$$W_H(x, \omega) = \frac{\mu}{2} \Gamma_H(x, x, \omega)$$

Experimentally we obtain $\Gamma_H\left(\boldsymbol{r},\boldsymbol{r},\omega\right)$ using the two probe arrangement below,



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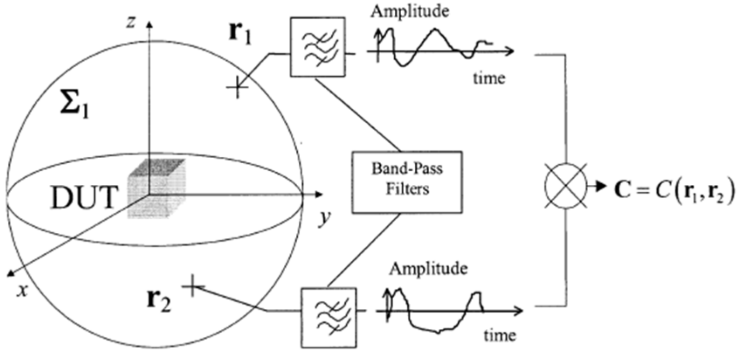
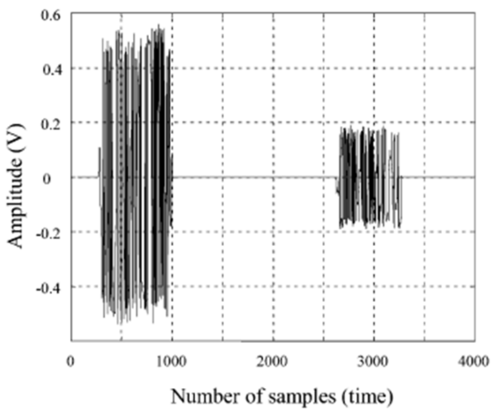
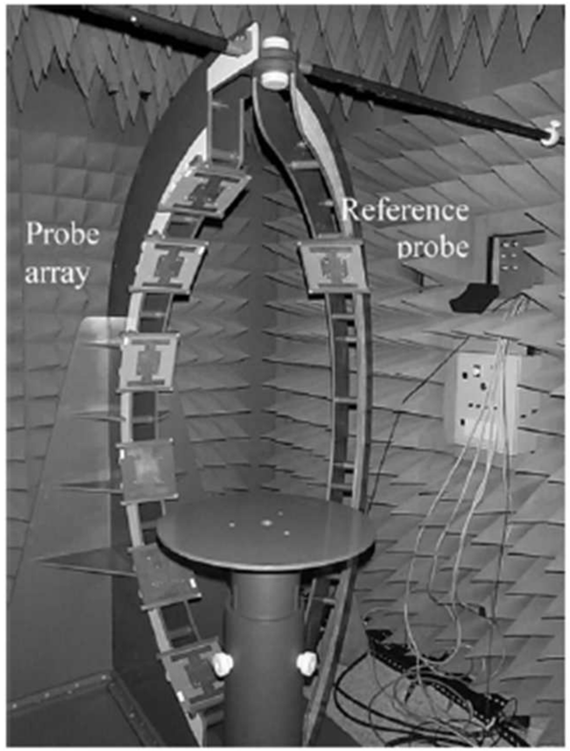
Antenna measurements



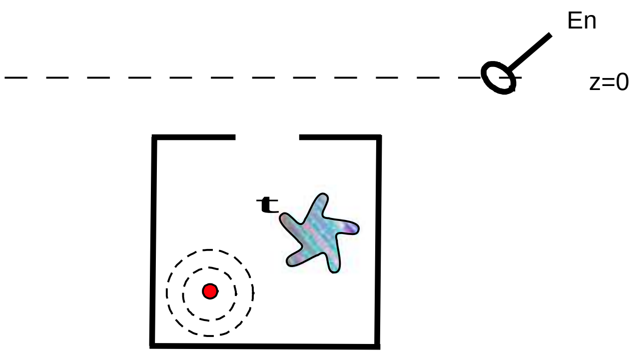


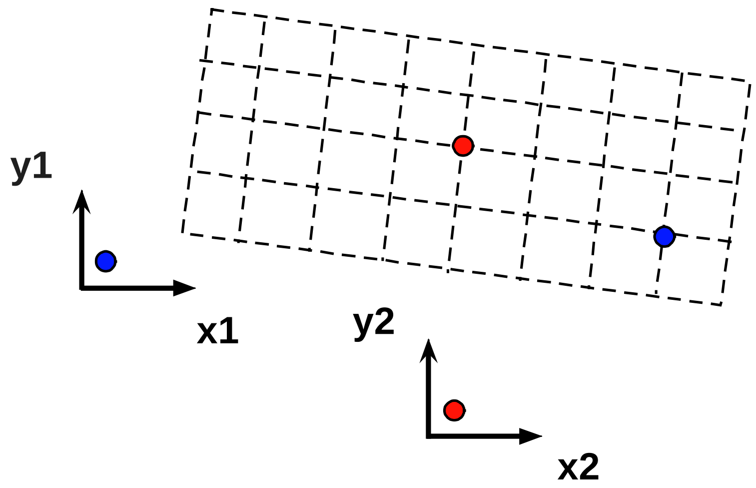
Bolomey's group



Experiments with a cavity backed aperture

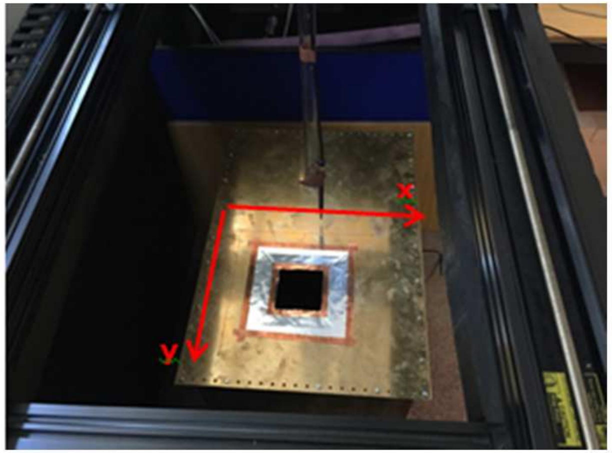
Consider an open mode-stirred enclosure as a source of random emissions:

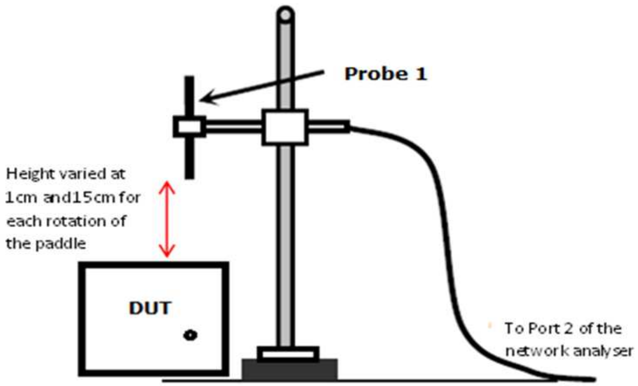




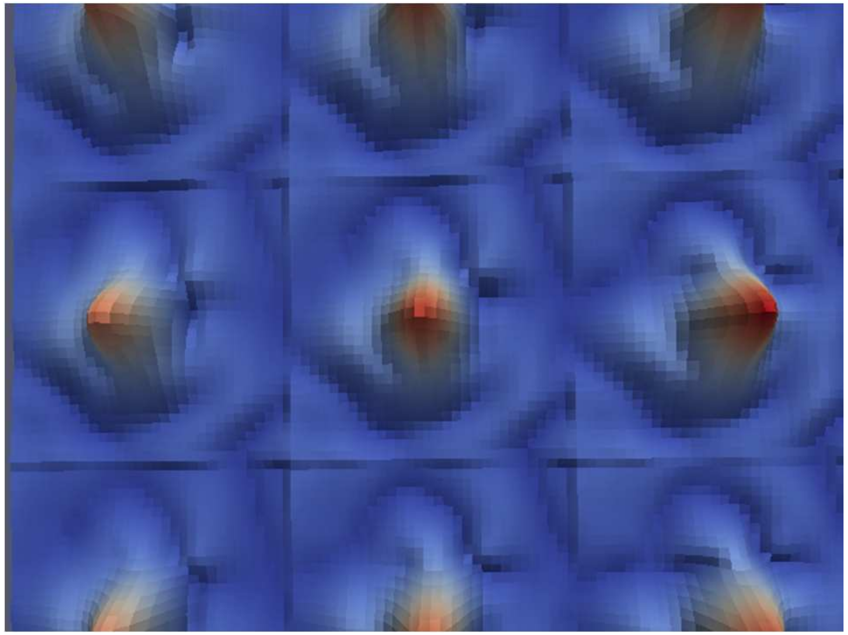
$$\Gamma^{ab}\left(x_1, y_1, x_1', y_1'; x_2, y_2\right) = \left\langle E_a(x_1, y_1; x_2, y_2) E_b^{*}\left(x_1', y_1'; x_2, y_2\right)\right\rangle_t$$

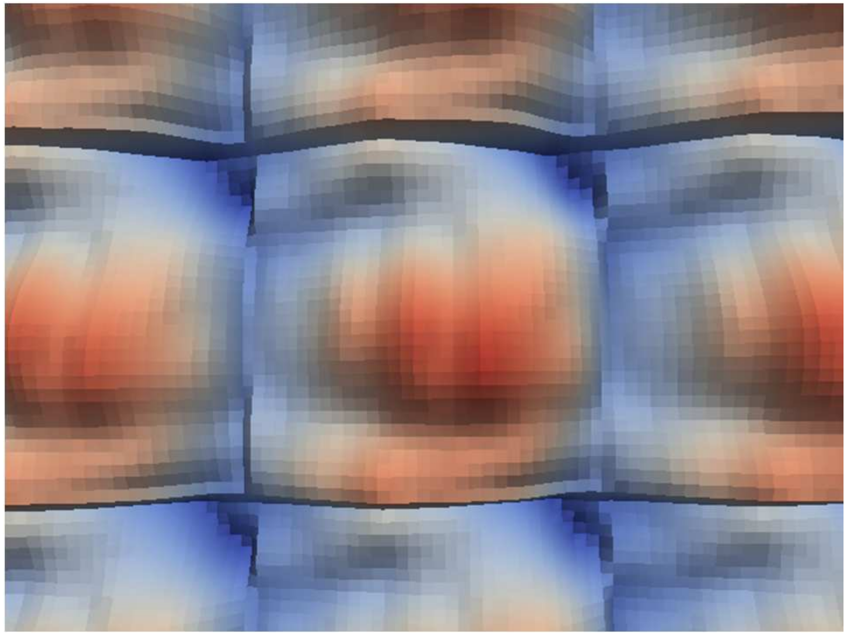
C Smartt, D W P Thomas



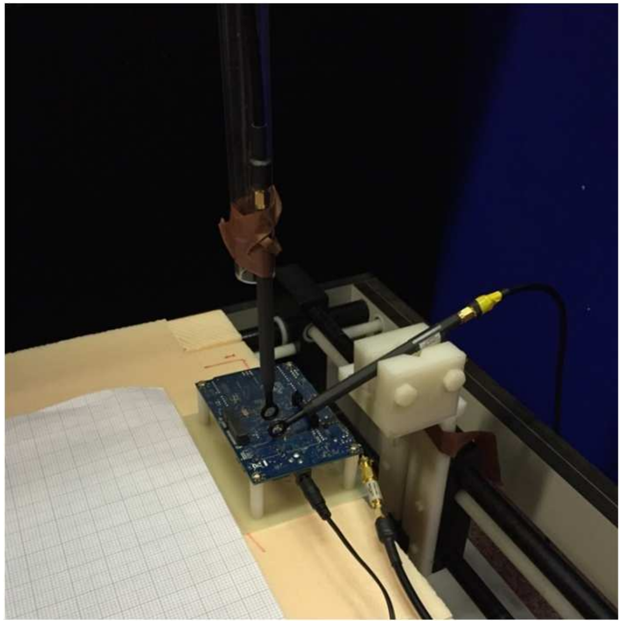


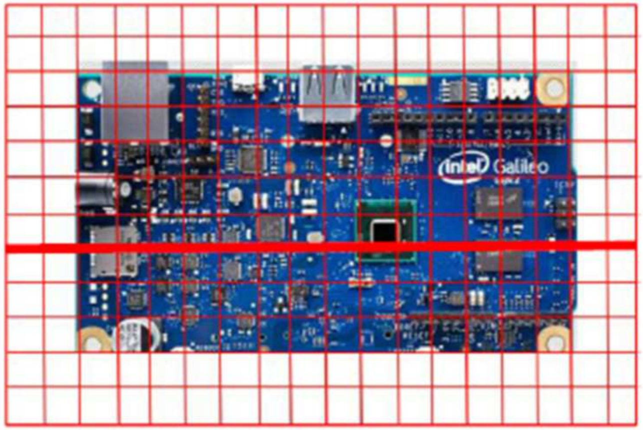
- The H-field data are measured for the frequency of 1-3GHz
- Do a scan over a plane in near field above the aperture of mode stirred chamber

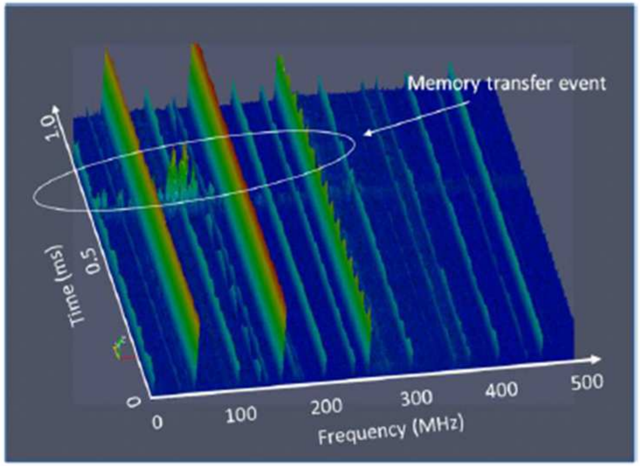


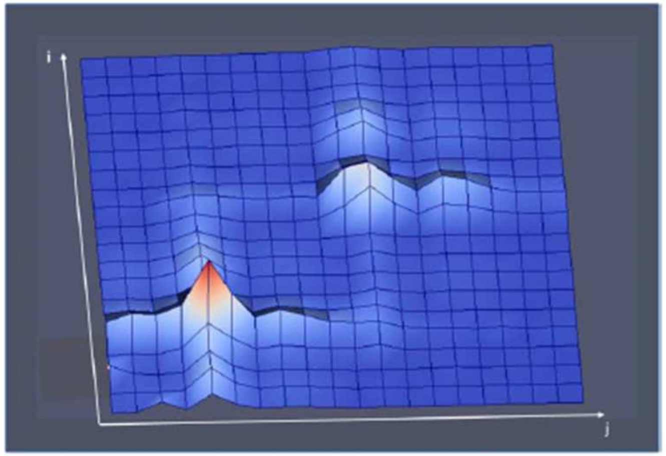


Two probe measurement




intel Galileo


Memory transfer event
Time (ms)
1.0
0.5
0
Frequency (MHz)
0
100
200
300
400
500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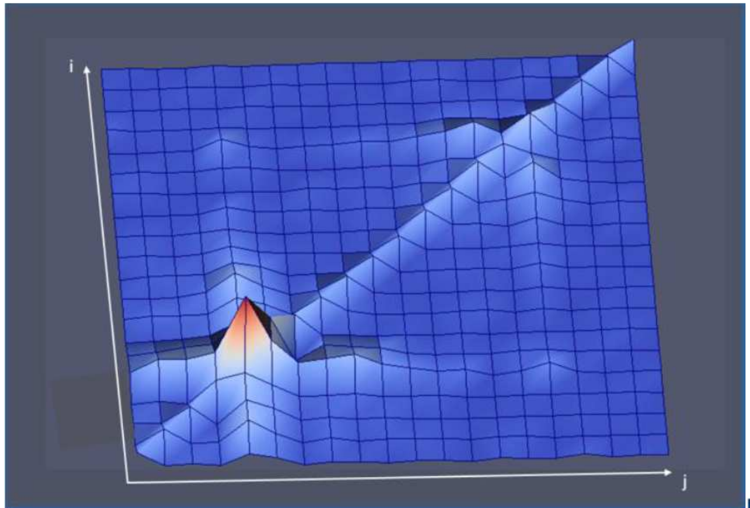
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- Problem of radiation from complex sources
- Experimental measurements confirm the properties of the propagation of correlation spectrum
- Future work will look at optimising the measurement of real systems

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Questions?