Broadband Imaging of Coherent Radiation as a Single-Shot Bunch Length Monitor with Femtosecond Resolution

J. Wolfenden, E. Kukstas, C. P. Welsch, University of Liverpool/Cockcroft Institute, Liverpool, UK

B. Kyle, E. Mansten, M. Brandin, S. Thorin, MAX IV, Lund, Sweden

T. H. Pacey, ASTeC, Warrington, UK

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The Cockcroft Institute of Accelerator Science and Technology

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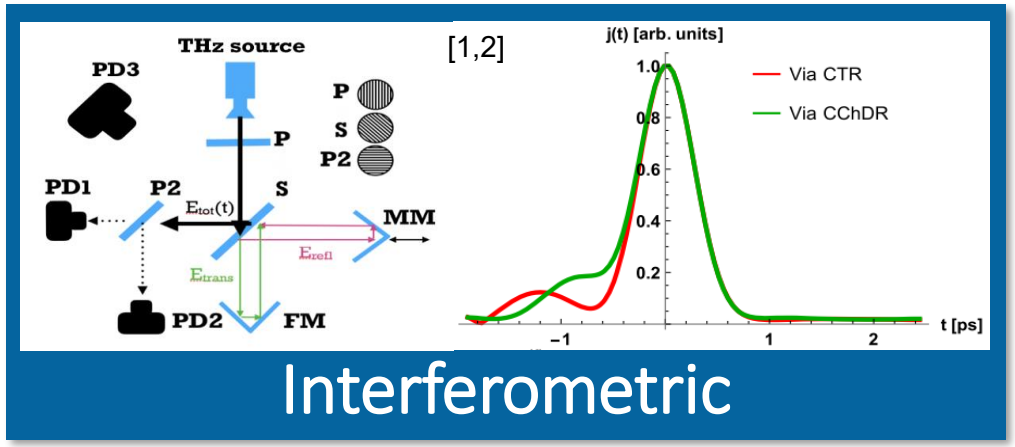
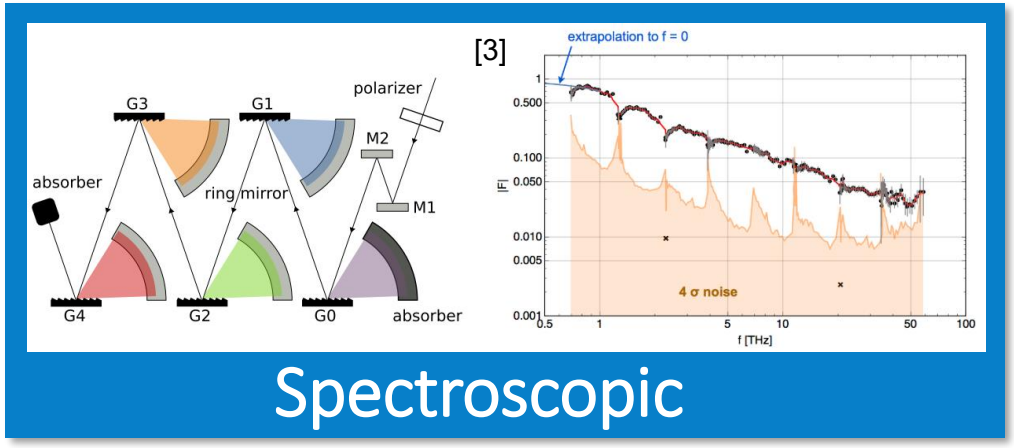
Motivation

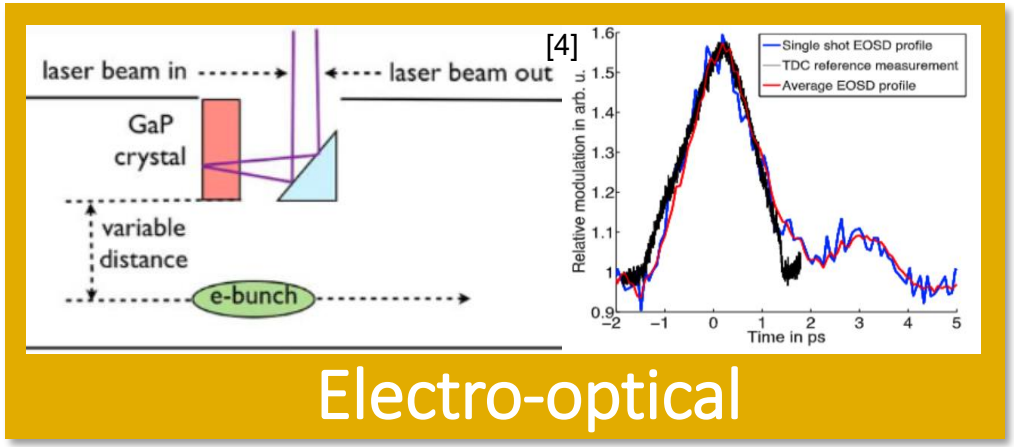
[1] K. Fedorov et al., JINST (2020) 15 C06008
[2] A. Curcio et al., Phys. Rev. Accel. Beams (2020) 23 022802
[3] B. Schmidt et al., *Phys. Rev. Accel. Beams* (2020) **23** 062801
[4] A. Borysenko et al., *Physics Procedia* (2015) **77** 3-8



Interferometric



Spectroscopic



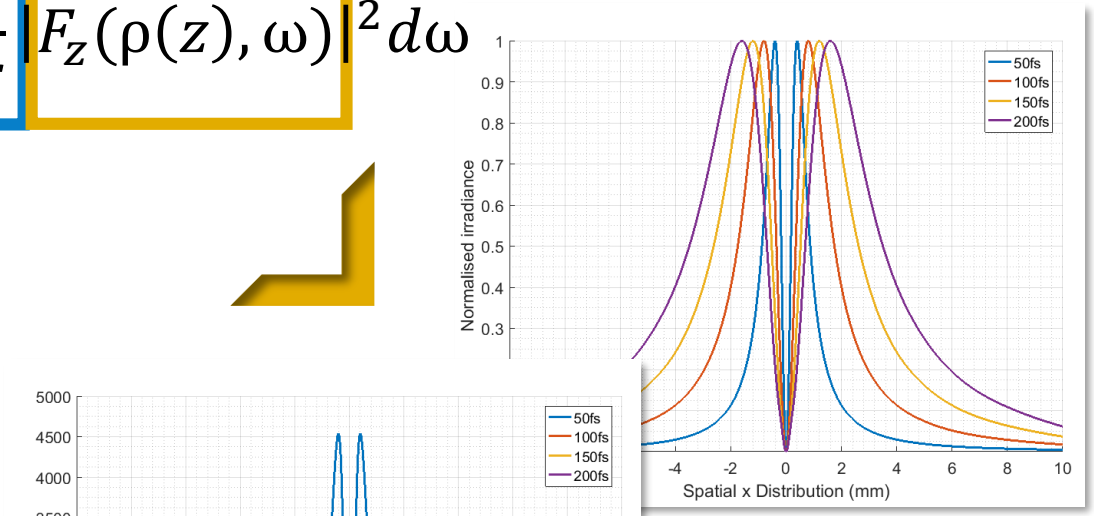
Electro-optical

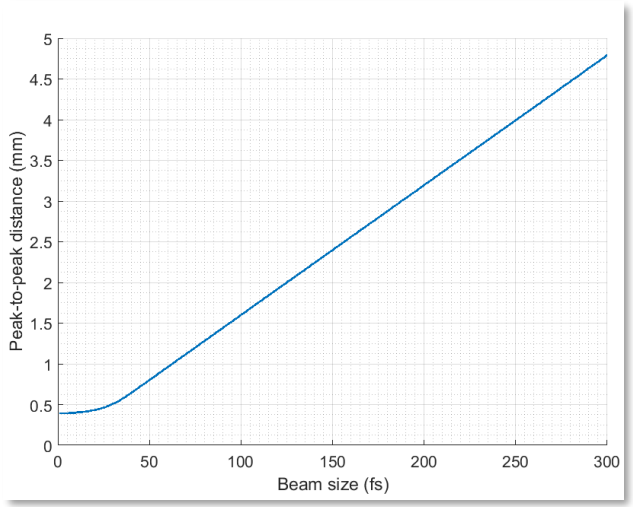
J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)
IPAC 21 Virtual Edition, Campinas, Brazil
@JoeWolfWolf

Broadband Imaging Method

$$\frac{dI^i_{bunch}}{dr} \approx N_e^2 \int_{\Delta\omega} \frac{d^2 I^i_e}{d\omega dr} |F_z(\rho(z),\omega)|^2 d\omega$$

- Bunch Image
- No. of e⁻
- Bandwidth
- Single e⁻ Spectral Image
- Bunch Form Factor



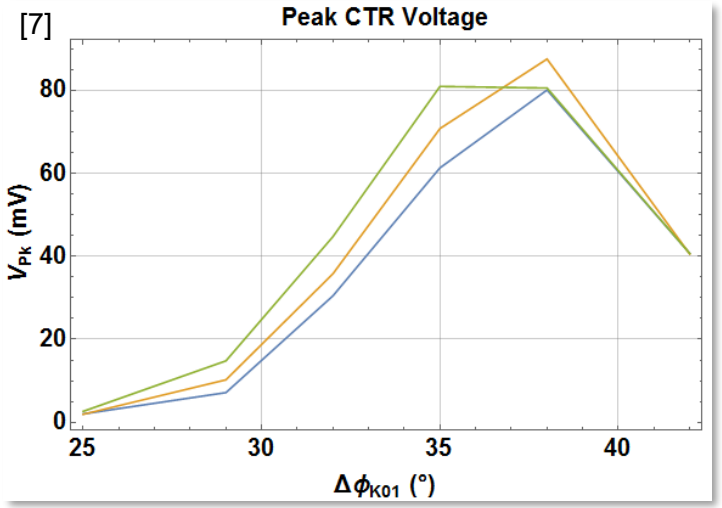


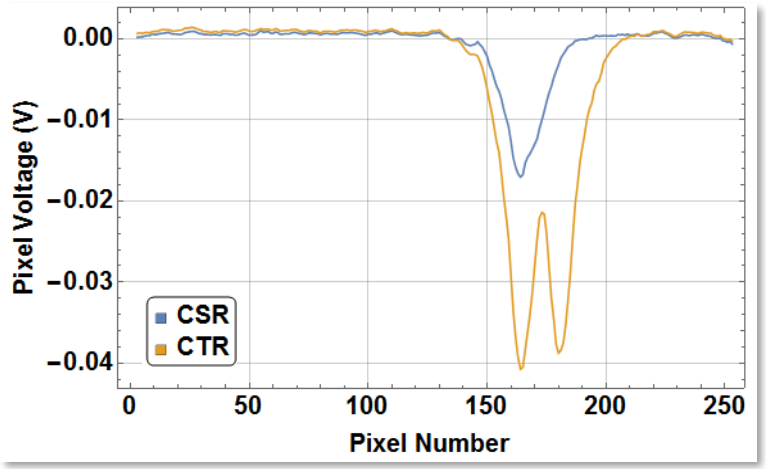
J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)
IPAC 21 Virtual Edition, Campinas, Brazil
@JoeWolfWolf

Previous Results

[5] S. Thorin et al., *Proc. IPAC2017*, TUPAB099
[6] J. Wolfenden et al. *Proc. IPAC2019,* WEPGW095
[7] B. Kyle et al., *Proc. IPAC2019,* MOPRB061

[7]





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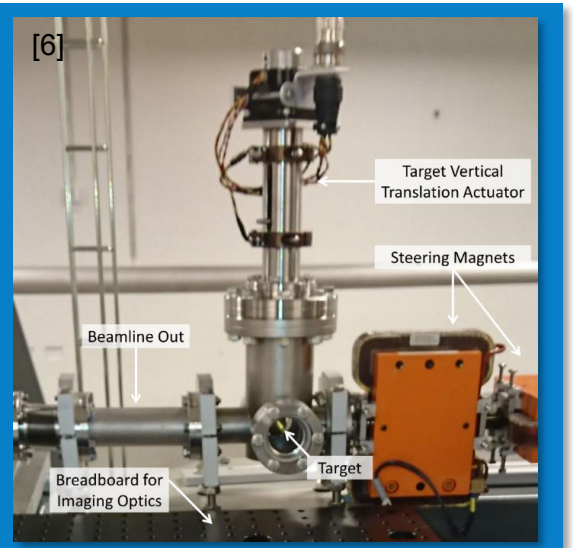
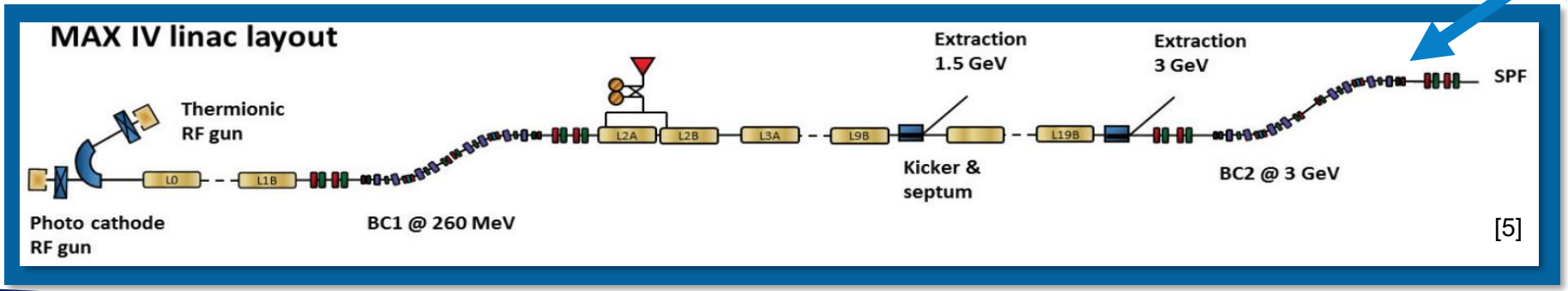
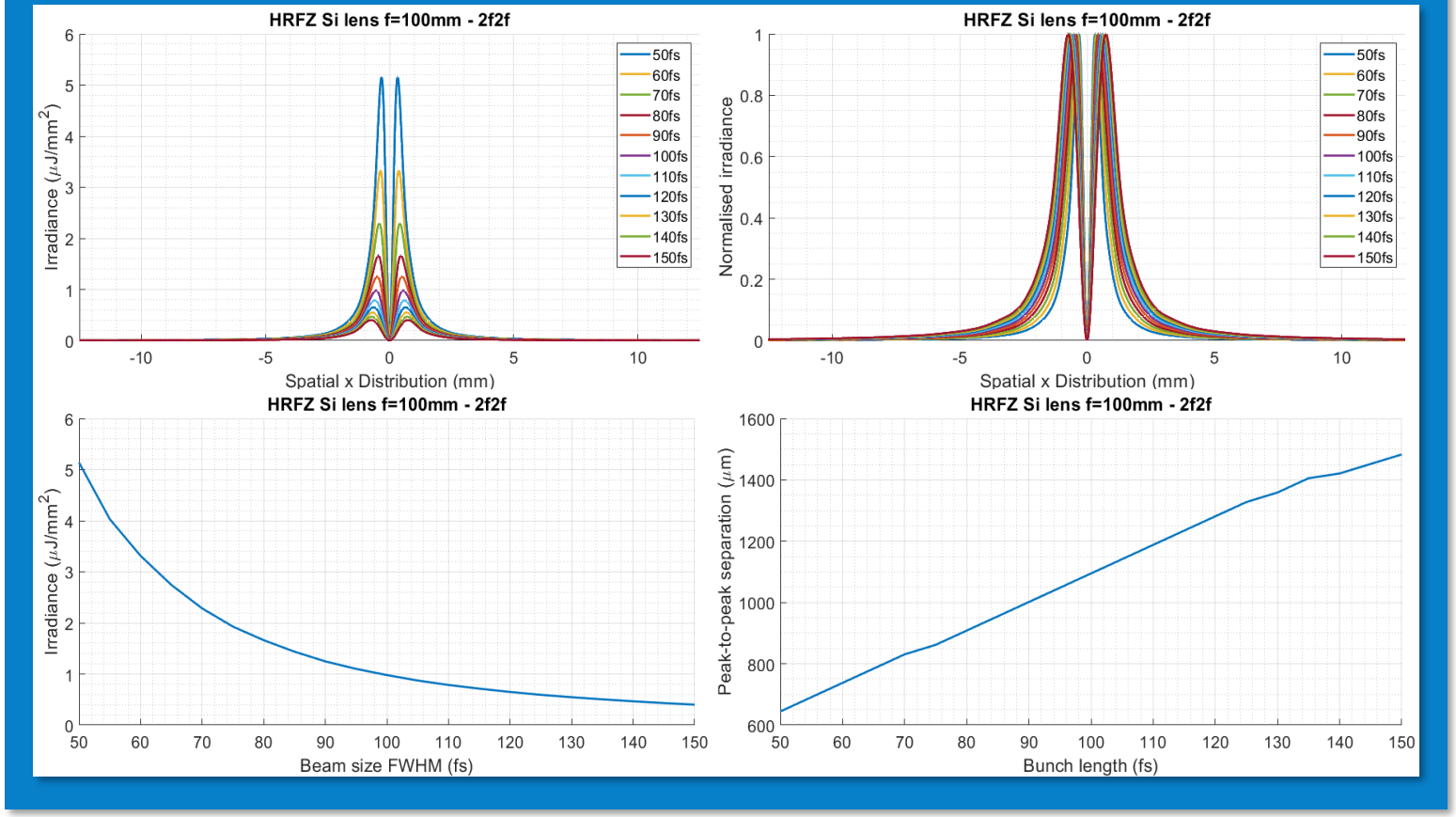


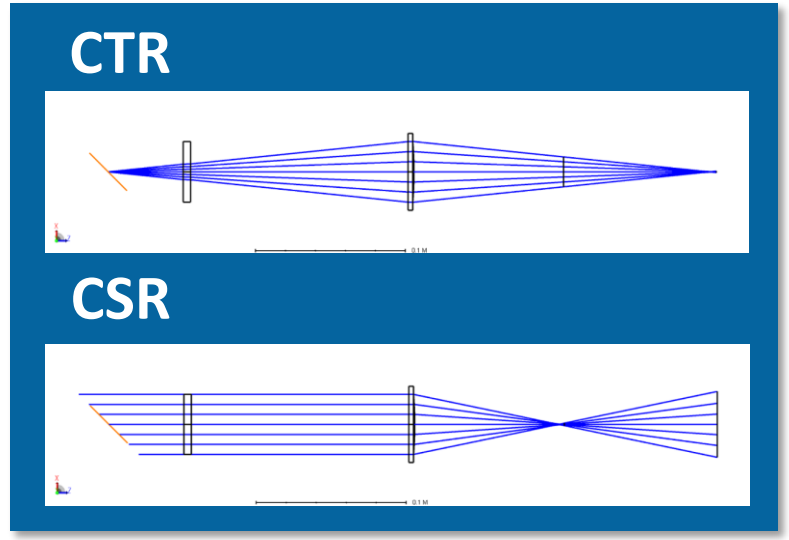


[5]

J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)
IPAC 21 Virtual Edition, Campinas, Brazil
@JoeWolfWolf

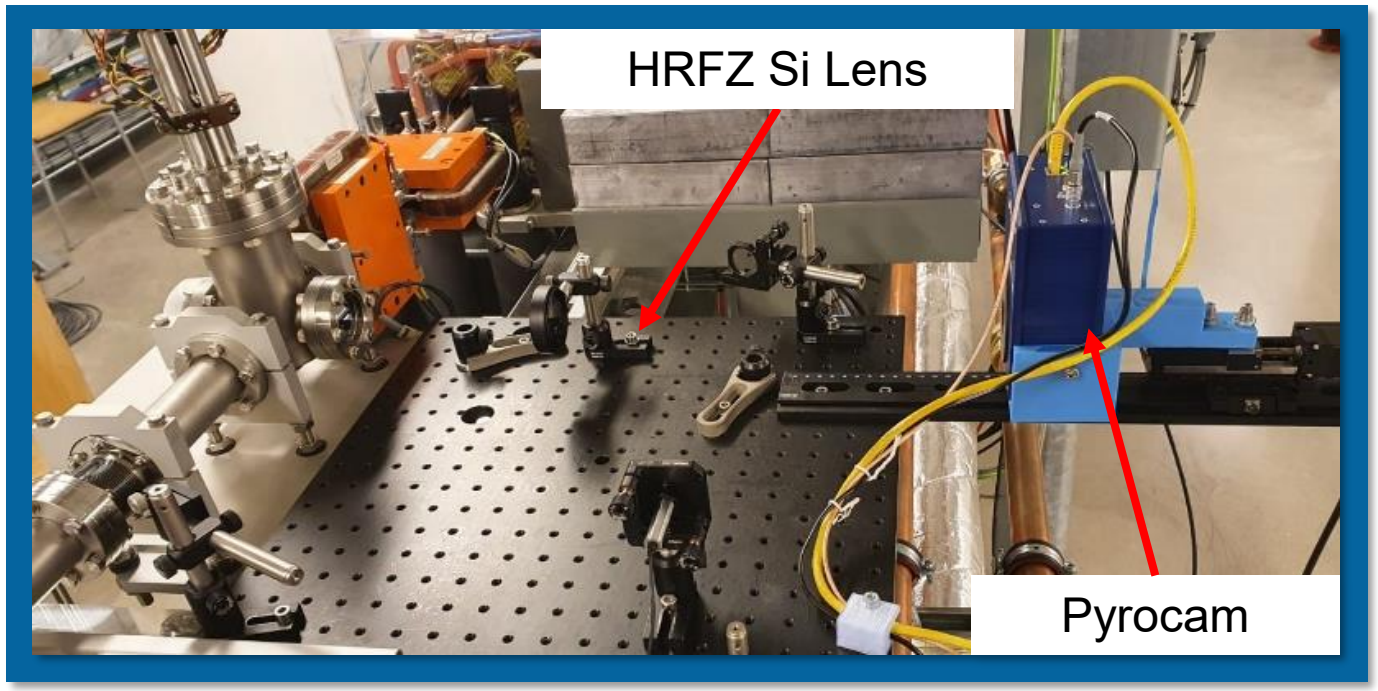
Current Work & Future Plans: Simulation





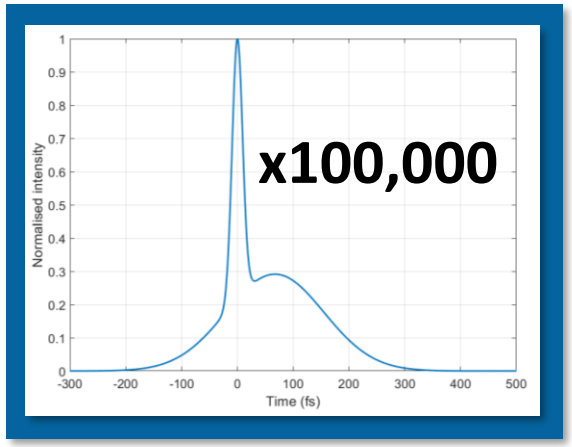
J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)
IPAC 21 Virtual Edition, Campinas, Brazil
@JoeWolfWolf

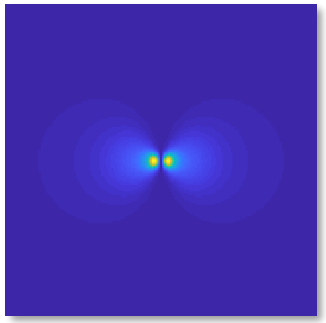
Current Work & Future Plans: Measurement



J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)
IPAC 21 Virtual Edition, Campinas, Brazil
@JoeWolfWolf

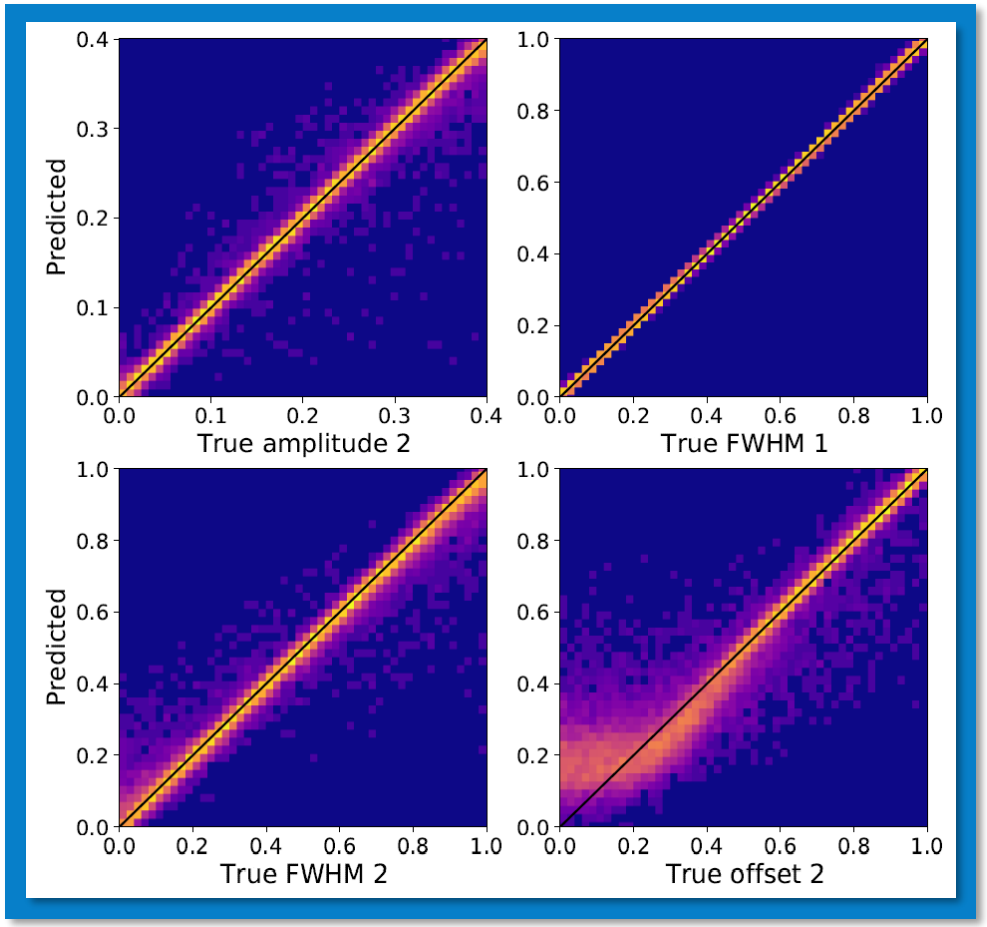
Current Work & Future Plans: Machine Learning Analysis





6.7% RMSE

6.2% RMSE



1.0% RMSE

17.2% RMSE

J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)
IPAC 21 Virtual Edition, Campinas, Brazil
@JoeWolfWolf

Conclusion

- Neural network based analysis provided promising results
- Began work on bunch length diagnostic
- Proof-of-principle for broadband imaging of coherent radiation

J. Wolfenden (joseph.wolfenden@Cockcroft.ac.uk)

Thank you for your attention!
Questions?

Live Sessions: Tuesday 25th May (or at University of Liverpool Booth)

Email: joseph.wolfenden@cockcroft.ac.uk

Twitter: @JoeWolfWolf

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