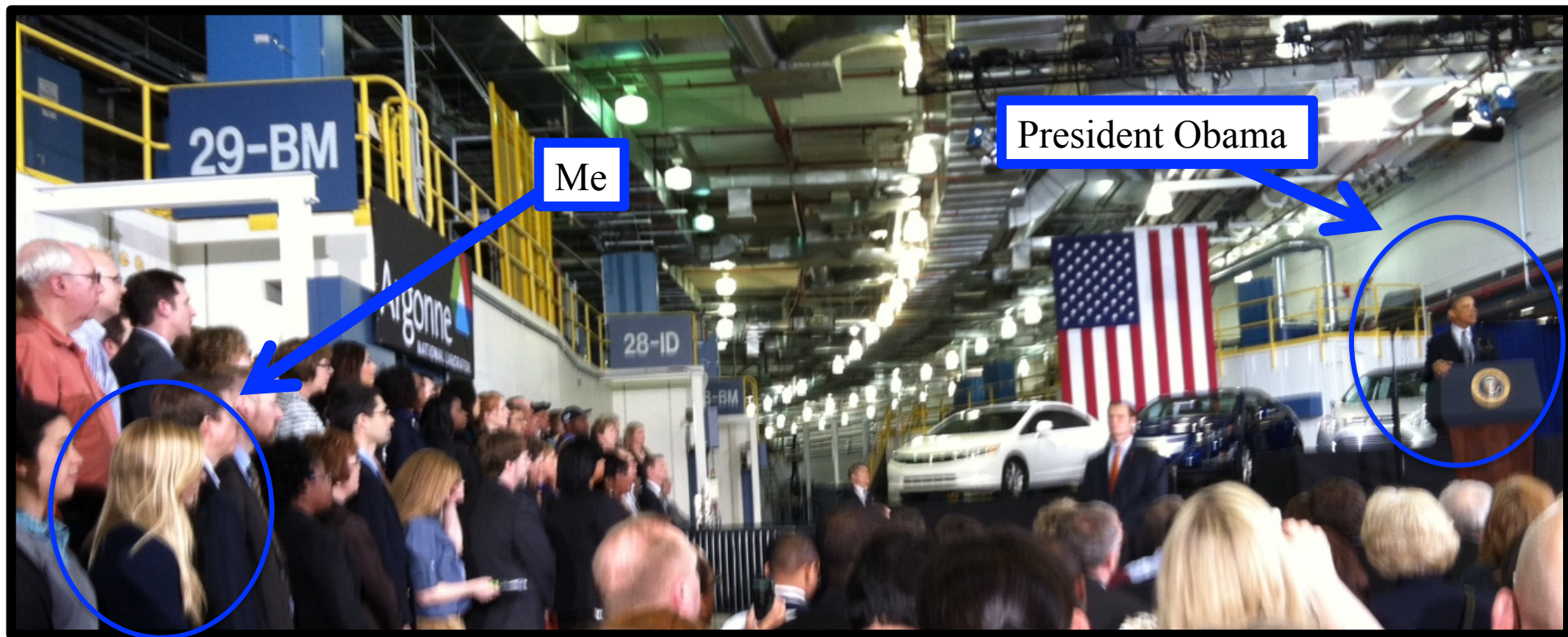


Understanding and optimizing the Li-ion battery cathode material, LiFePO_4



Fiona Strobridge – 4th year PhD student

Supervisor: Professor Clare Grey

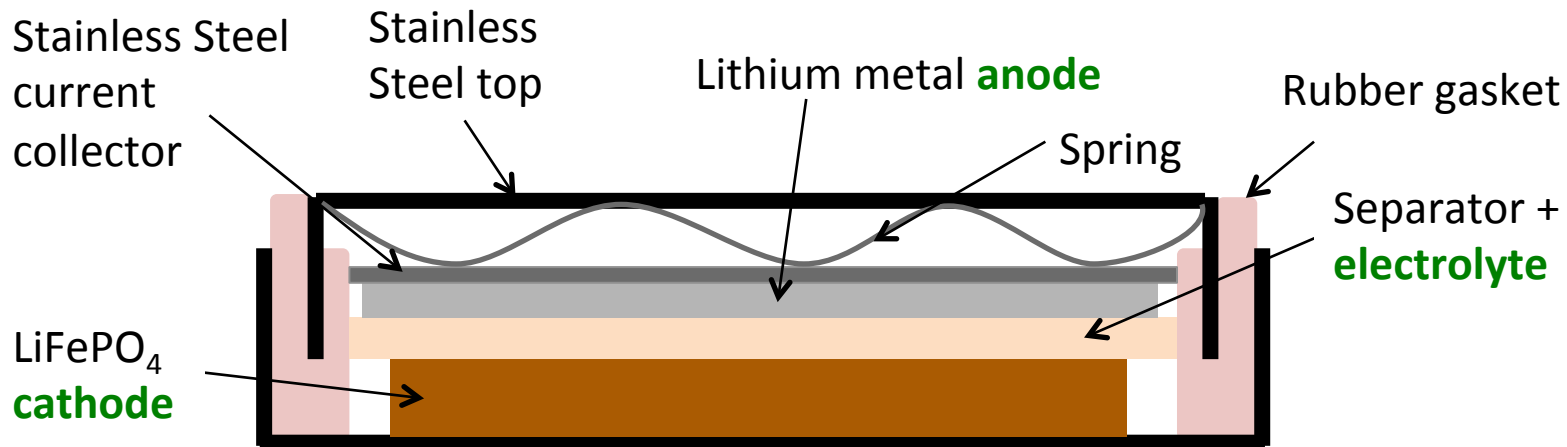
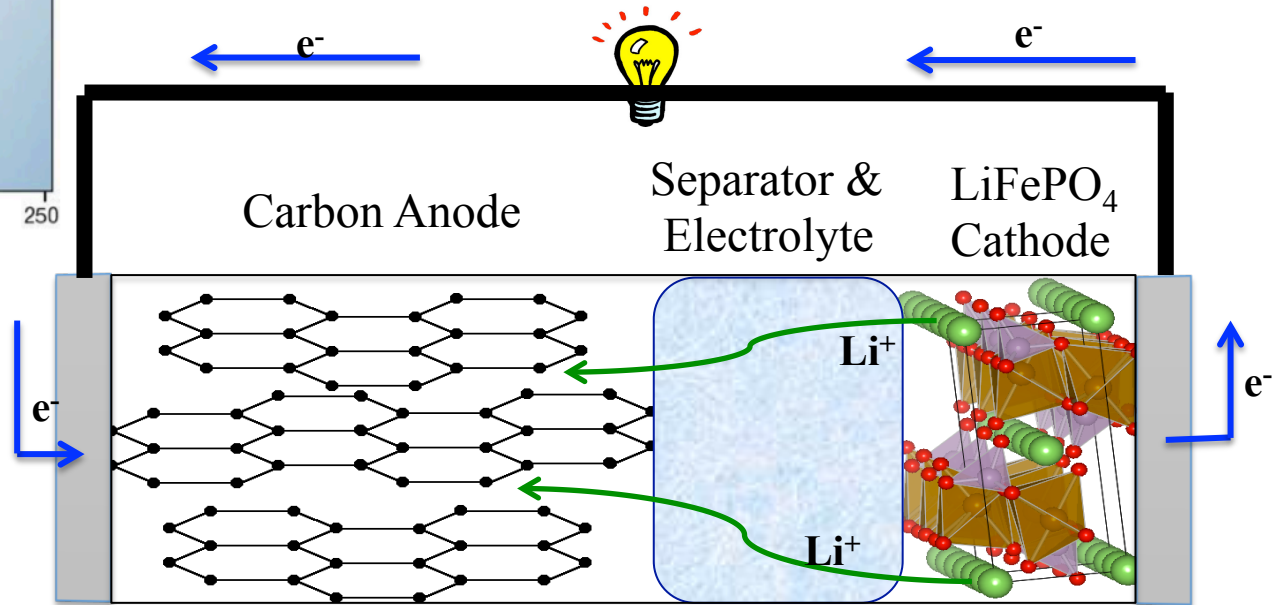
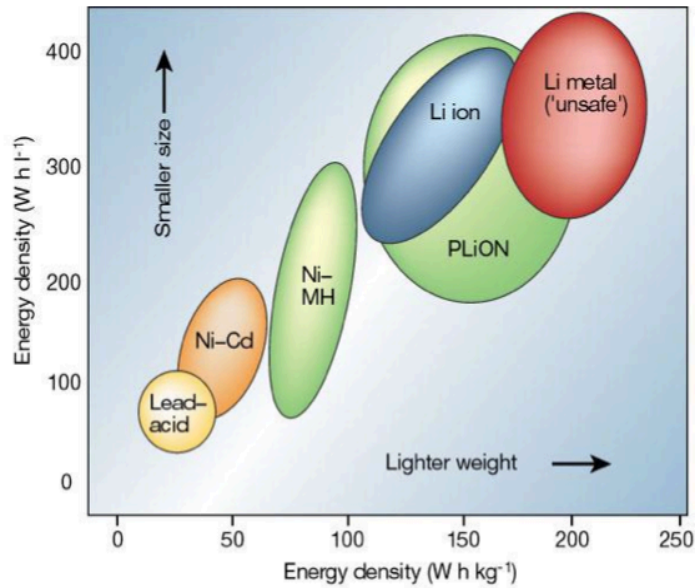
University of Cambridge, Department of Chemistry

Cambridge Society for the Application of Research (CSAR)

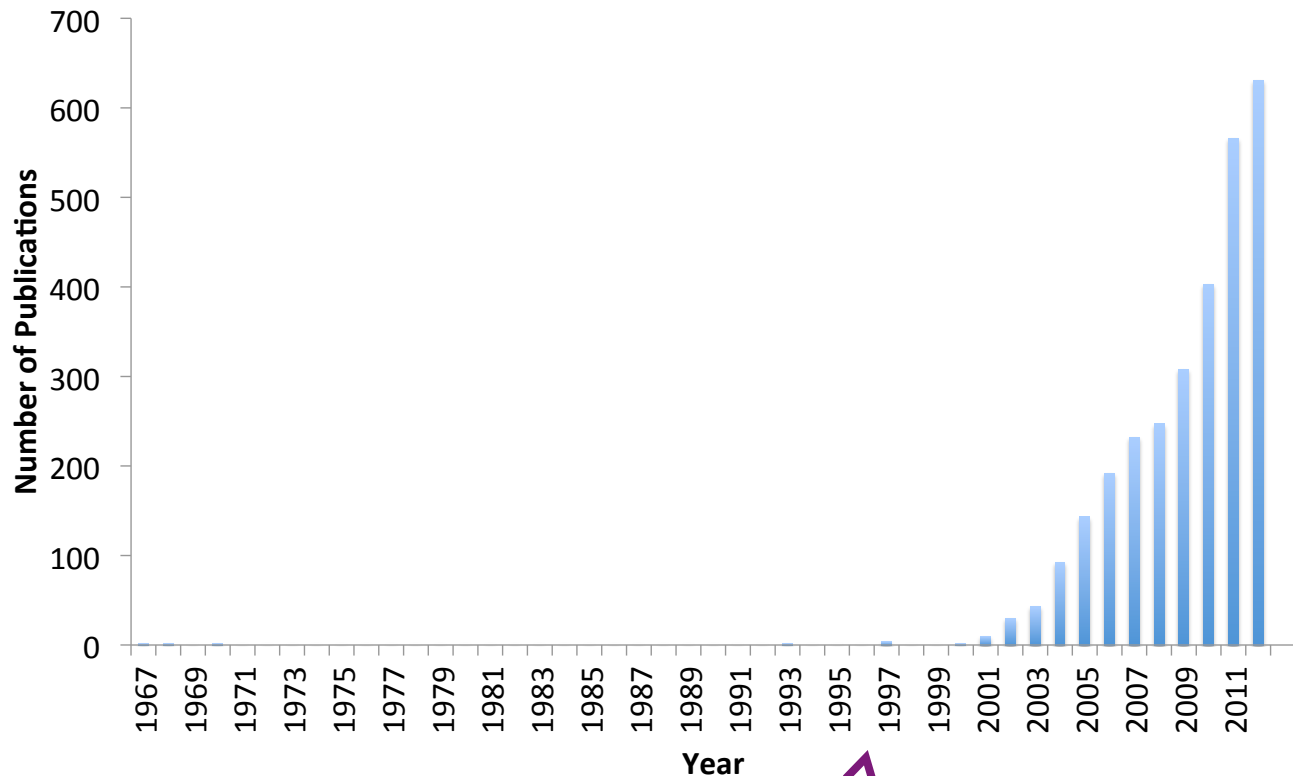
Monday 21st October 2013



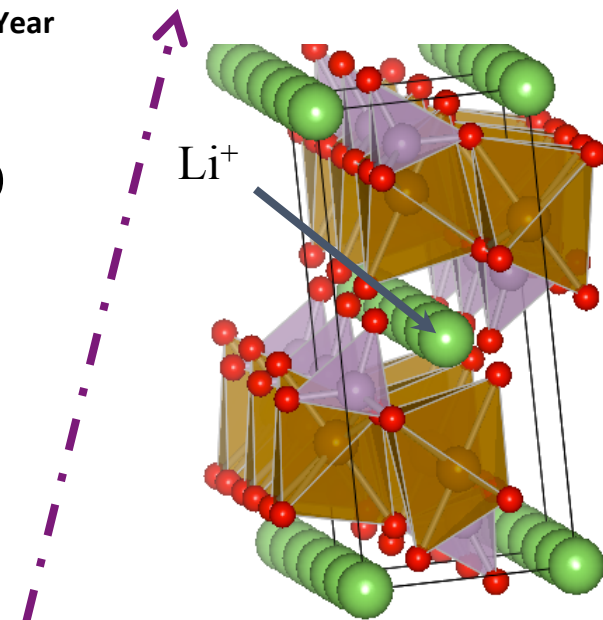
What is a battery?



Lithium Iron Phosphate, LiFePO_4



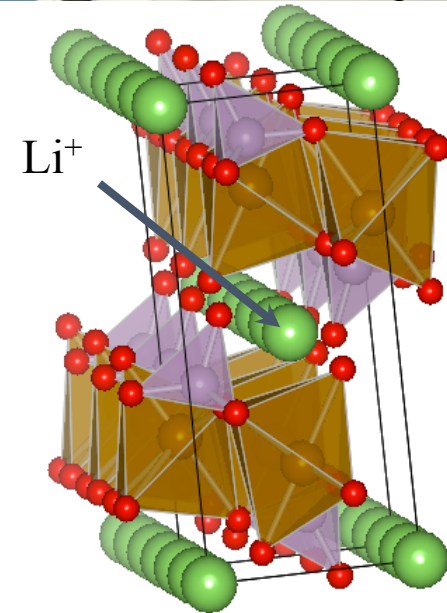
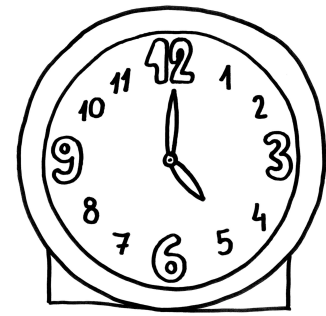
- ✓ 1D diffusion channels \Rightarrow Topotactic phase transition
- ✓ High reversible capacity (170 mAh/g compared with 140 mAh/g in LiCoO_2 , widespread in laptops and phones)
- ✓ **High-rate material, when nano-sized**
- ✓ Low toxicity
- ✓ High thermal stability
- ✓ Safe operating voltage



Scale up =>
Energy density –
mileage



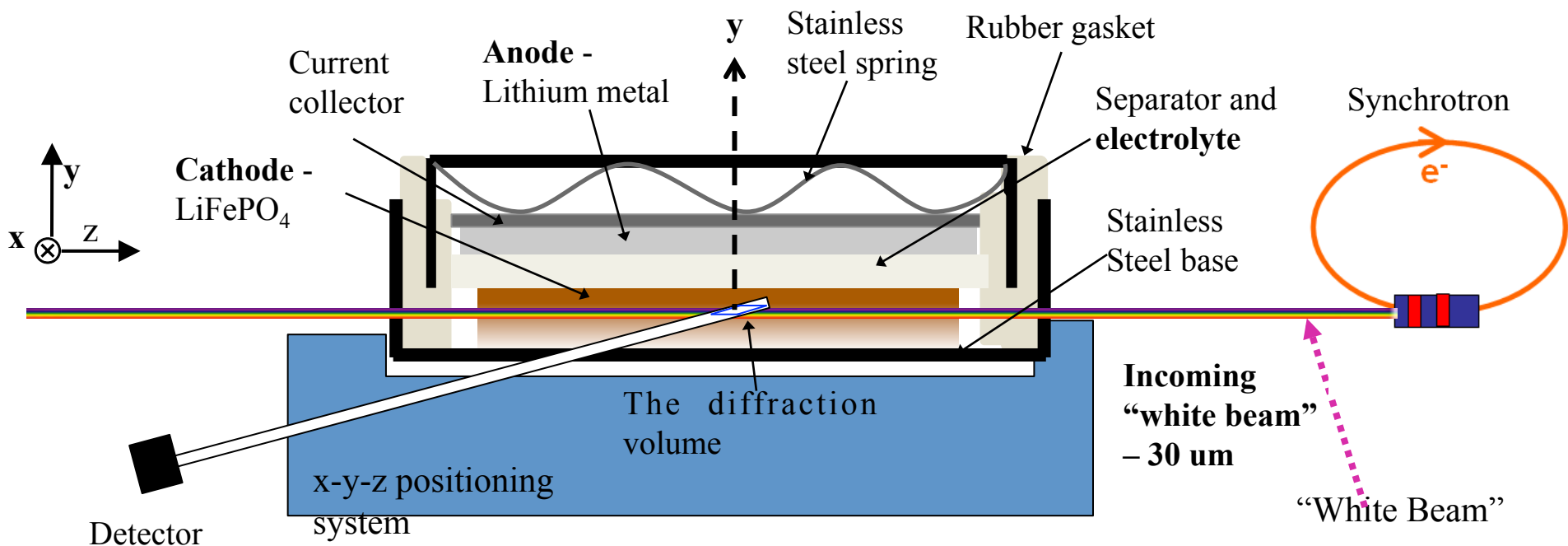
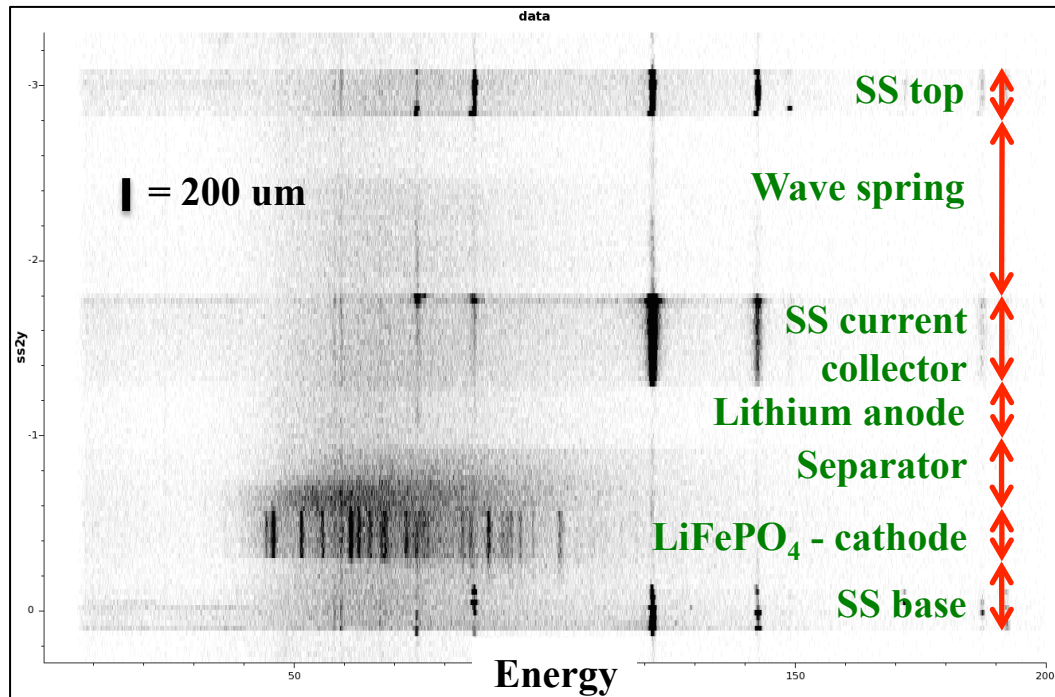
Charging
times



✓ High-rate material, when nano-sized

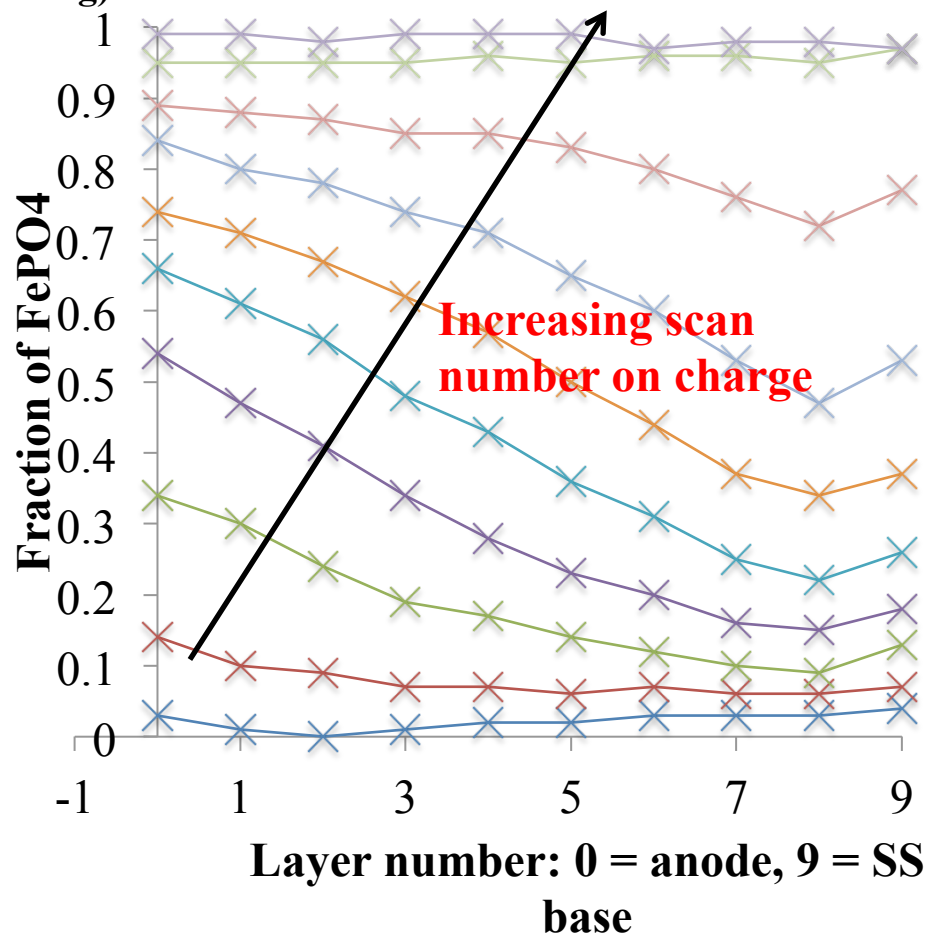
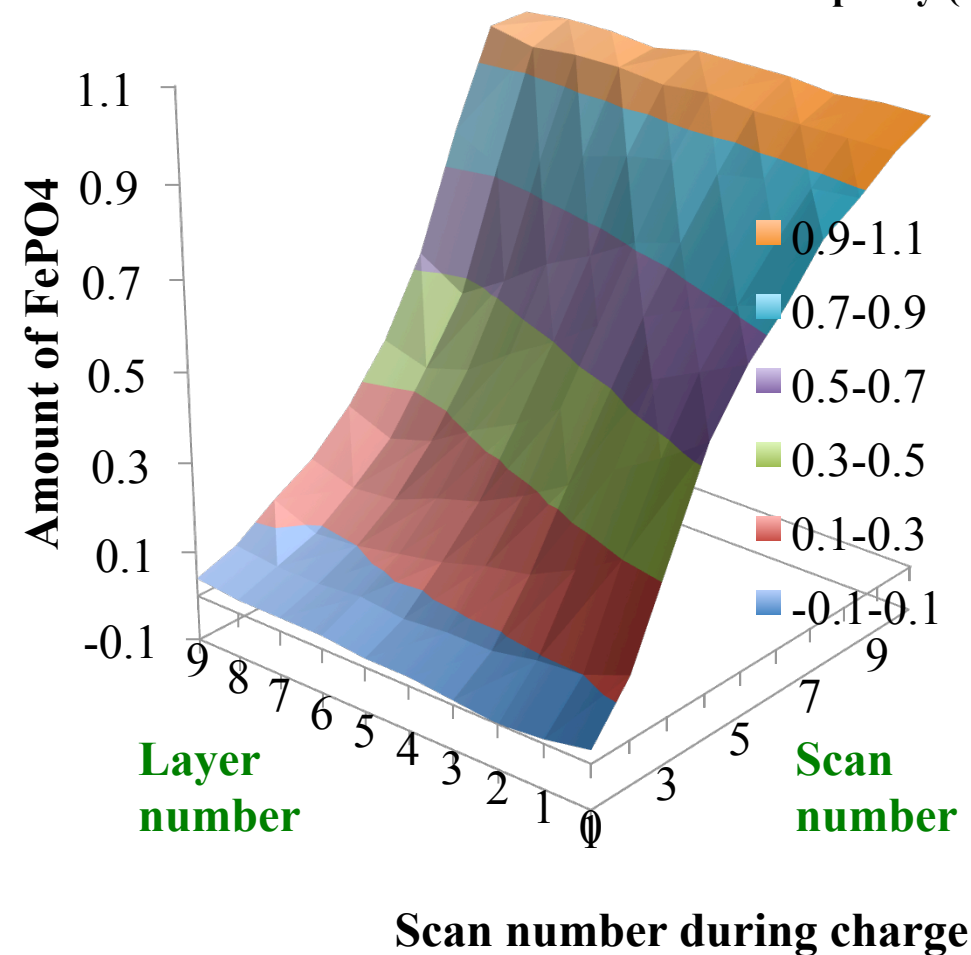
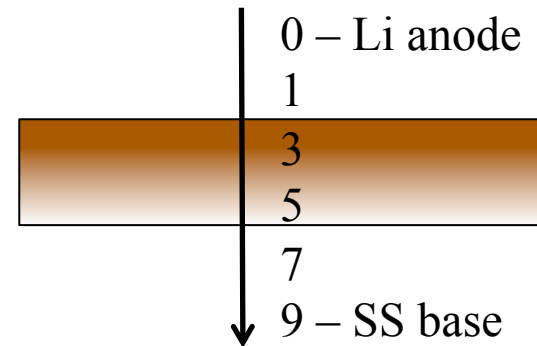
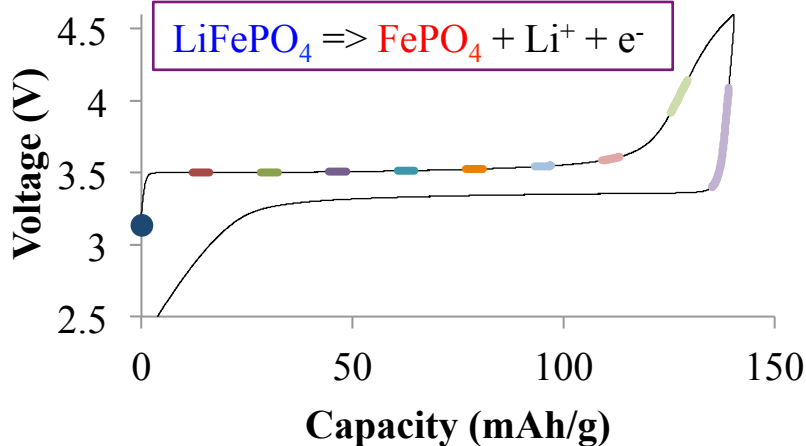
In situ energy dispersive X-ray diffraction (EDXRD) of a coin cell

The incoming “white beam” can penetrate the stainless steel casing of a standard “coin cell” and record diffraction patterns at different layers of the cathode.

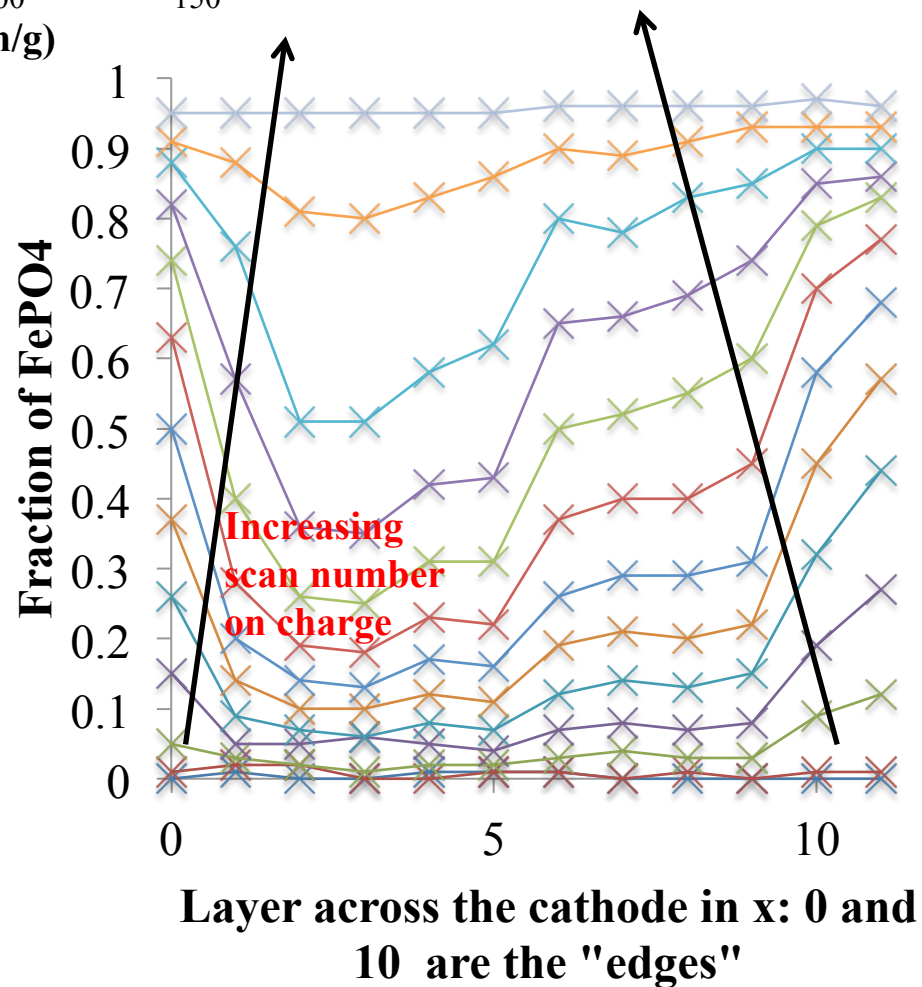
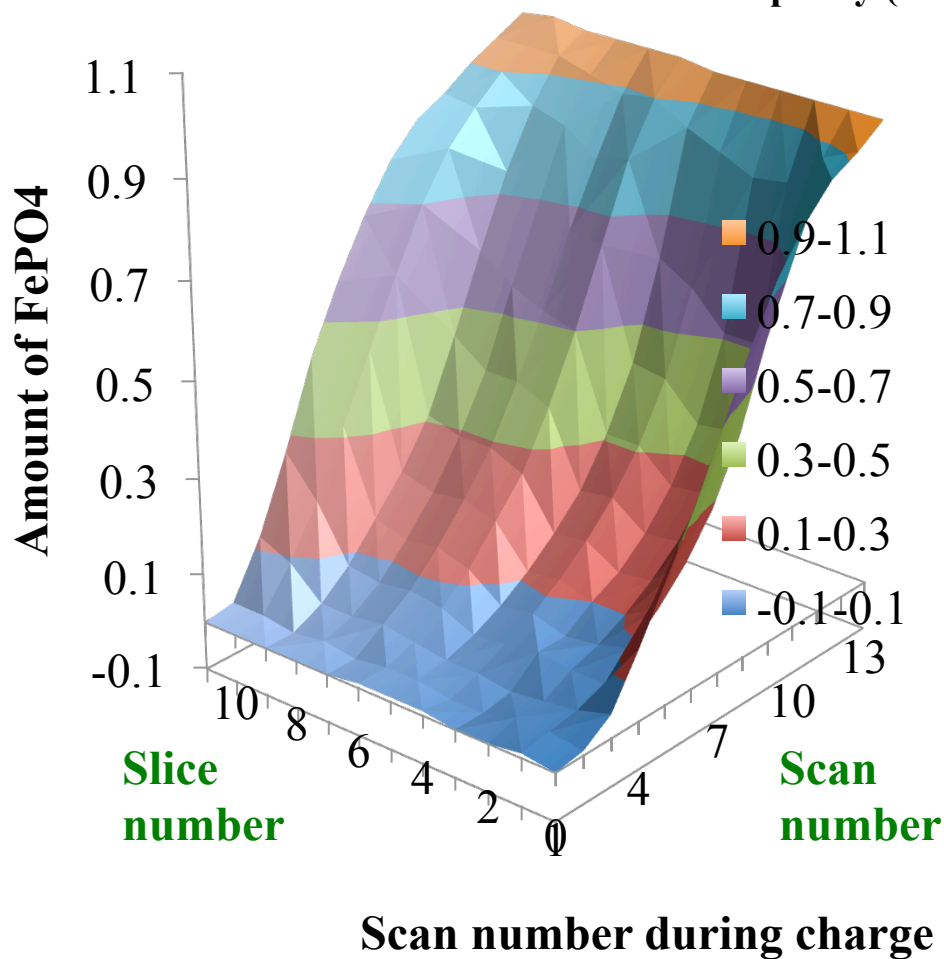
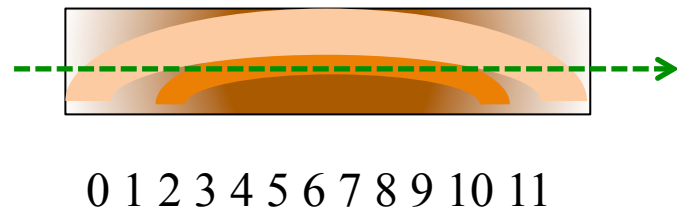
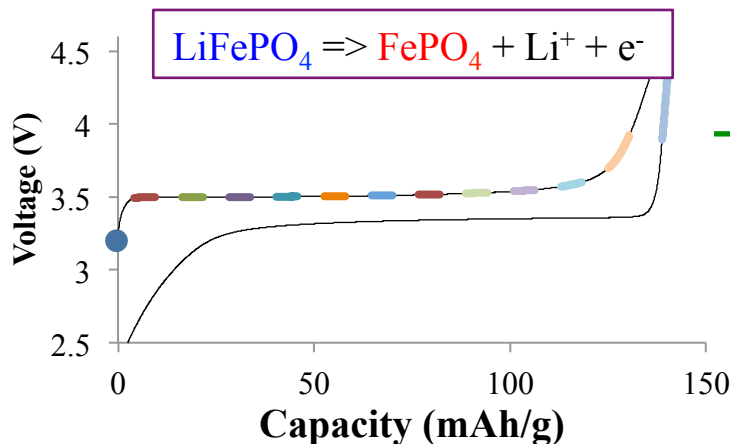


Y-profiling

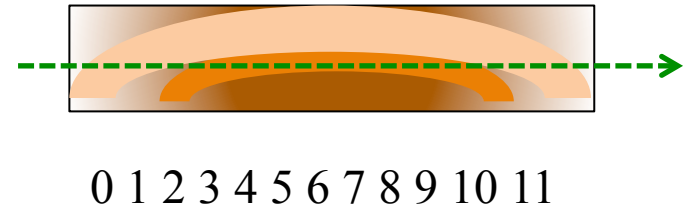
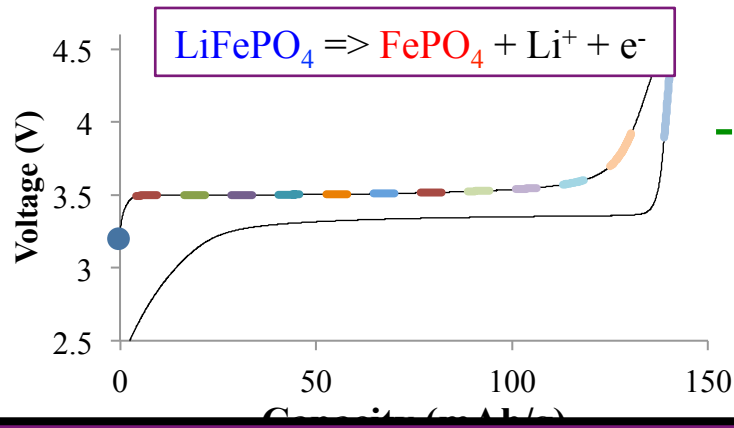
Previously proposed mechanism: reaction occurring preferentially closer to the anode (Li metal)



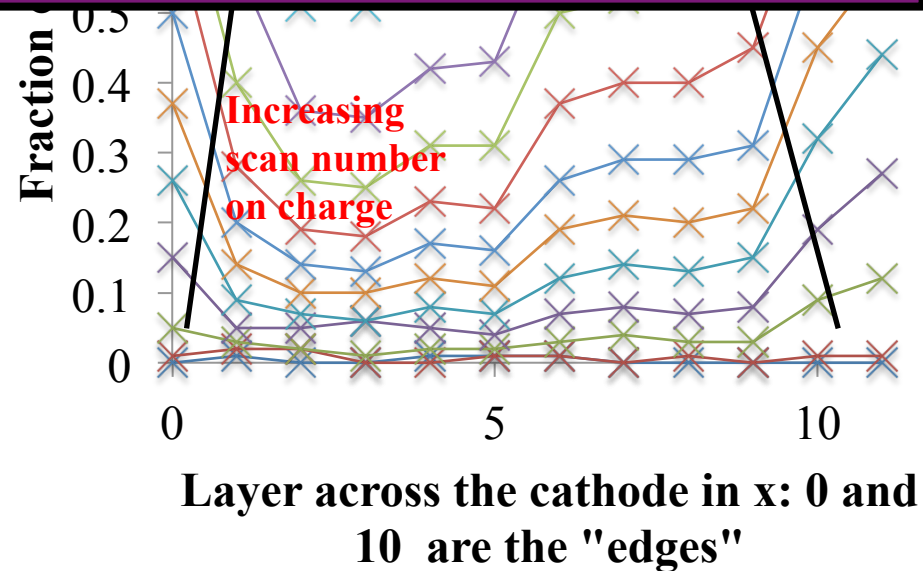
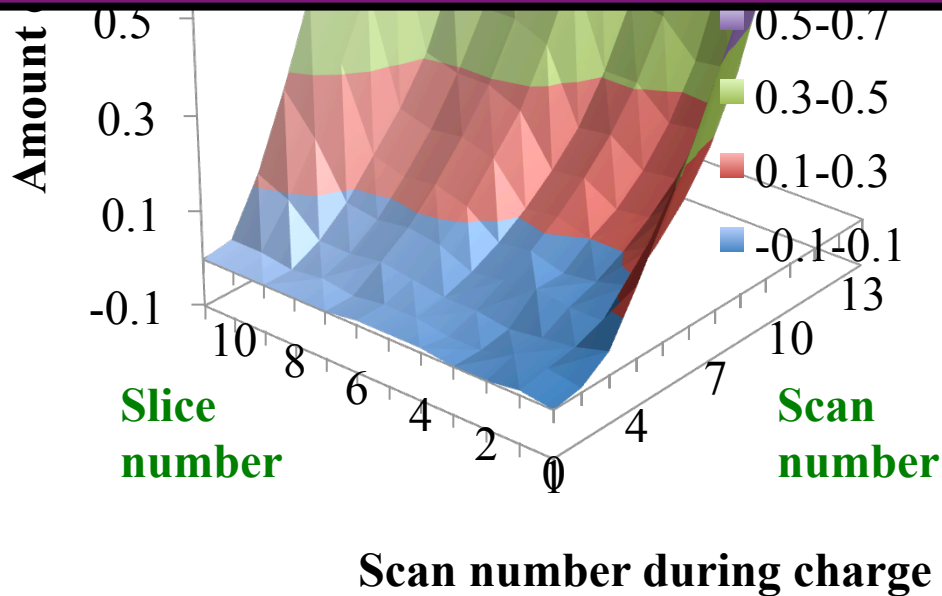
X-profiling



X-profiling



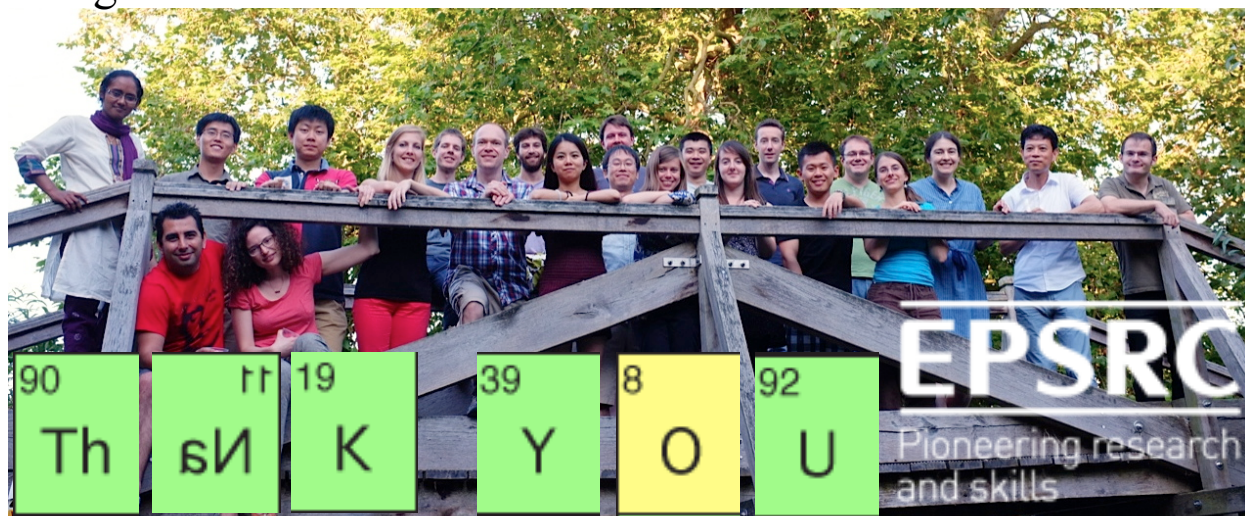
Propose a new mechanism – reaction front moves in a hemi-spherical way.
 Scanning x, we see the sides react first and the middle of the cell to react last



Conclusions & Acknowledgements

- We have successfully developed a technique which can monitor the $\text{LiFePO}_4/\text{FePO}_4$ reaction front moving through the electrode in a standard battery.
- Successfully proven that there is an inhomogeneous reaction occurring. Preferential reaction closer to the anode and on the edges of the cathode.

CSAR



- Professor Clare Grey
- Dr. Rosa Robert
- All of the Grey group
- Engineering and physical sciences research council (EPSRC) and a DTA Award for funding my work
- CSAR for the bursary

- Mark Croft, Rutgers University
- Beamline scientist Professor Zhong Zhong (NSLS, Brookhaven National Lab)
- Beamline scientists Dr. Thomas Connelly and Dr. Michael Drakolpolus (Diamond Light Source)