Developing Sample Holders for Ultrafast Electron Spin Resonance

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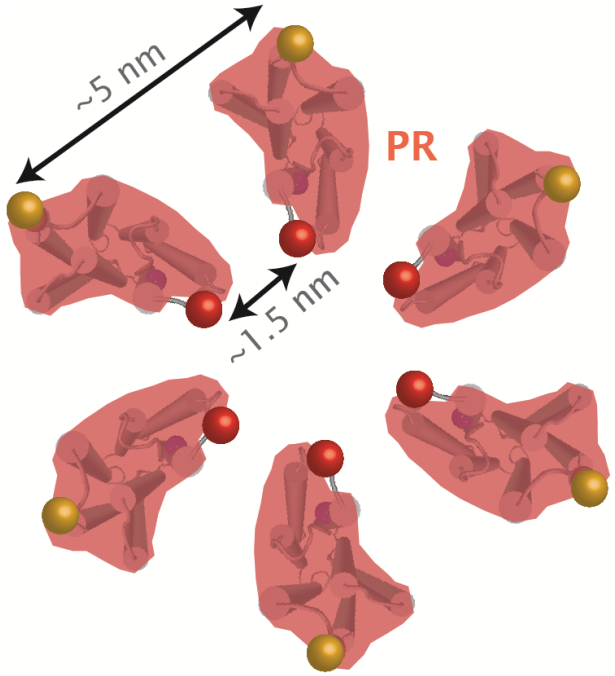
What is ESR Spectroscopy?

- Investigates unpaired electron spins
- Biology: Structures of protein complexes

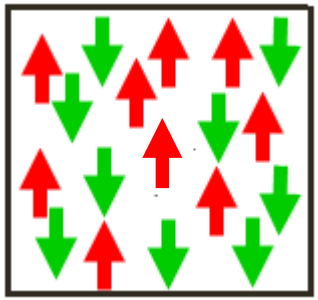


ProteoRhodopsin

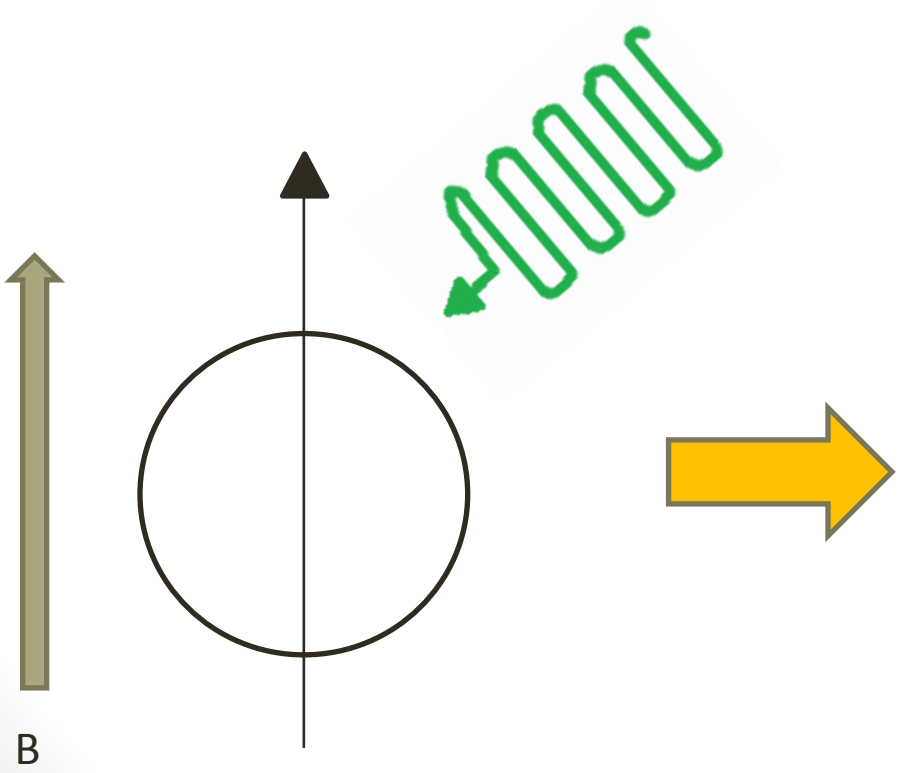
Hexamer

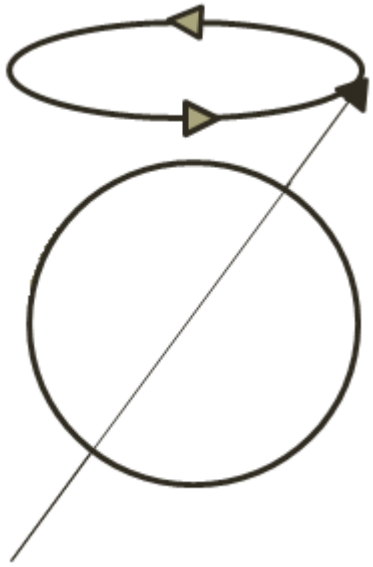
Electron Spin Resonance

- Electrons spin-up or spin-down
- Excitation causes precession



Spin-up and spin-down electrons

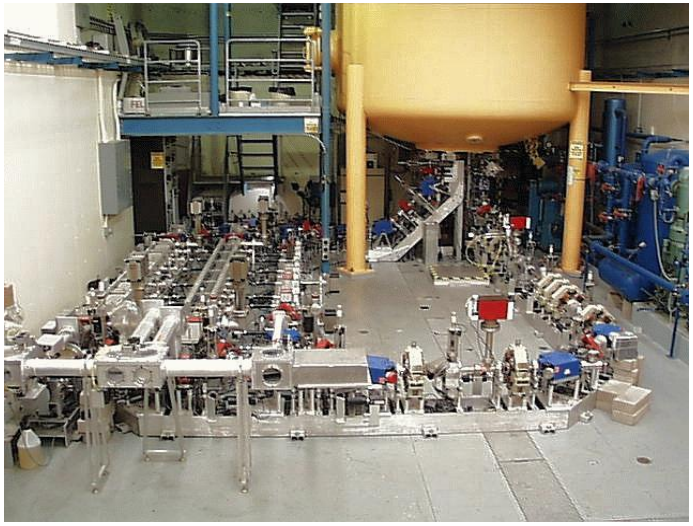




What Makes ESR at UCSB Unique?

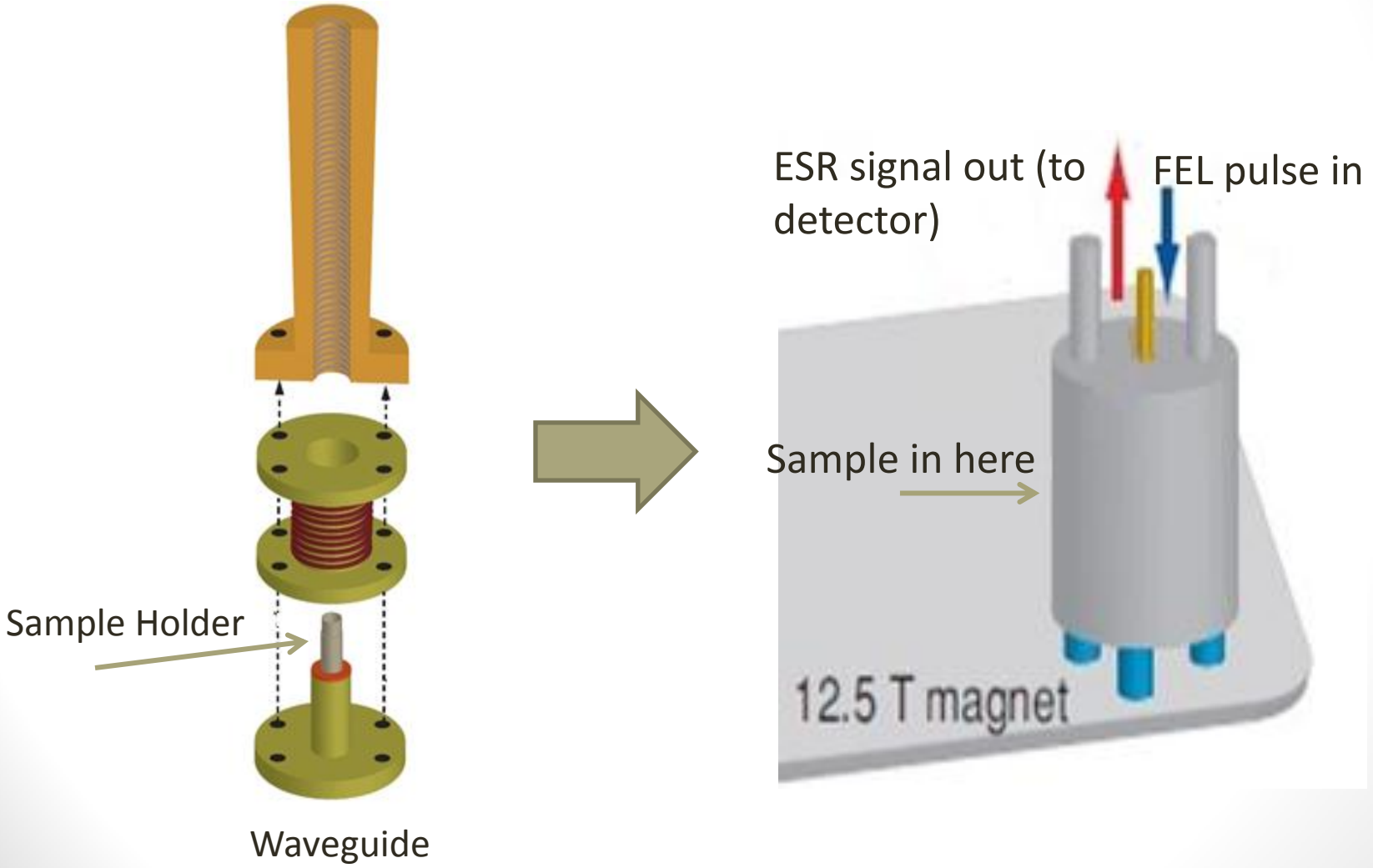
- Powered by Free Electron Laser (FEL)
  - Power 100,000x greater than a typical ESR experiment
  - Frequencies above 100 GHz
- Strong Magnet
  - 12.5 Tesla = 200,000x magnetic field of the earth

Advantage: High power allows measurements of very rapid decaying spins



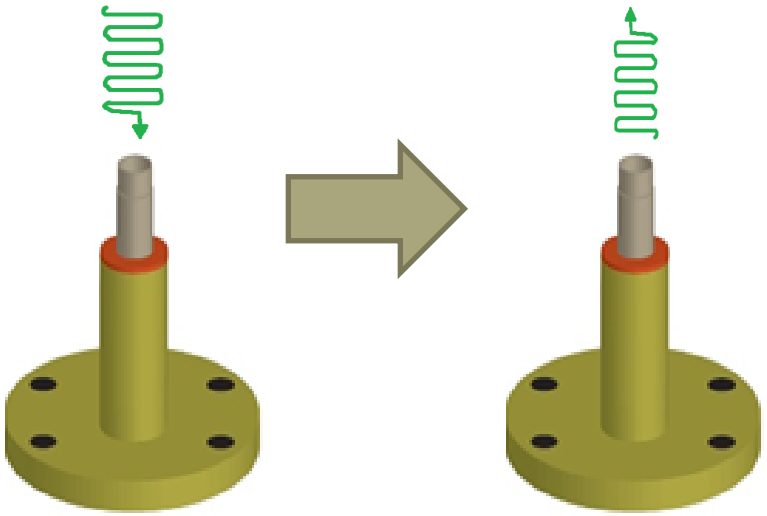
UCSB FEL

Studying Biological Samples

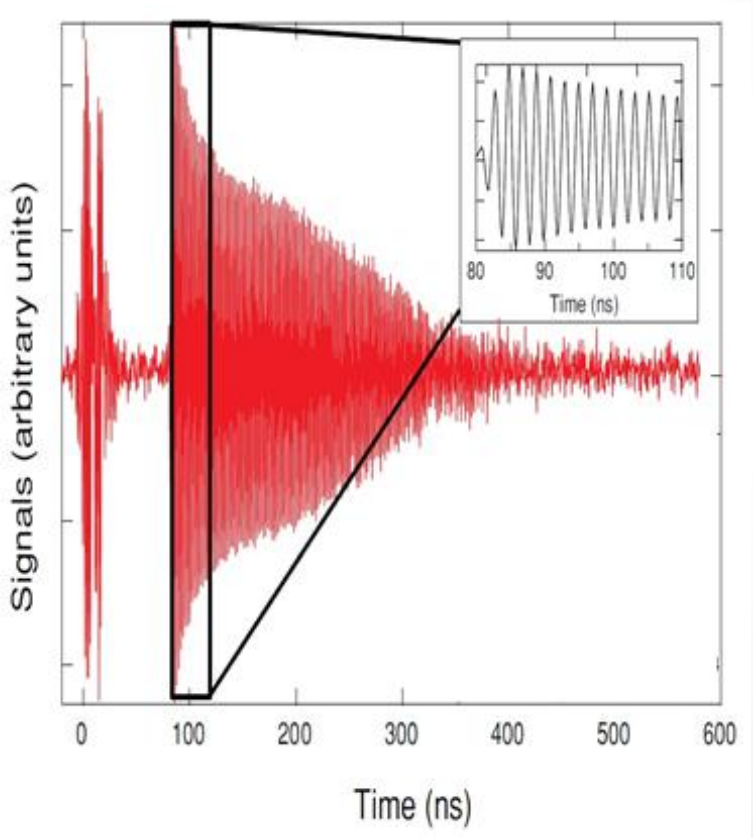


Sample Holders Reflect Pulse

- Reflections interfere with decaying spin signal
- Must turn detector on 80 ns after pulse shot
- Goal: Reduce “dead-time”

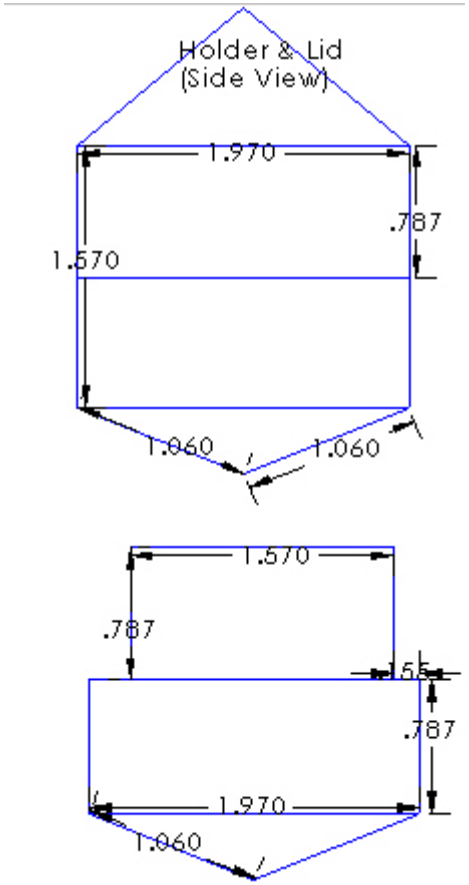


Free Induction Decay
(ESR signal)



Making New Sample Holders

CAD 2D Sketches



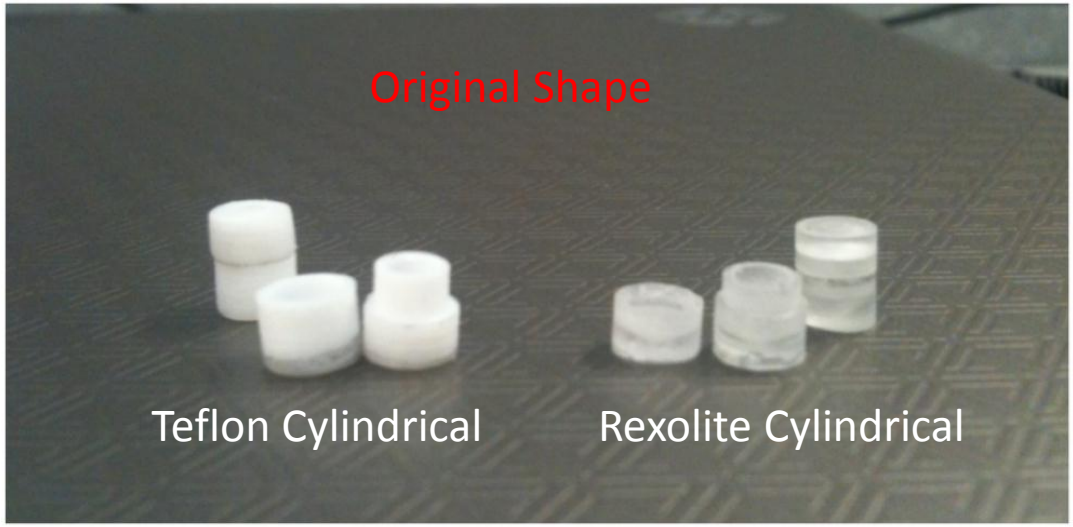
Labels in inches x10

Machine Shop

Lathe

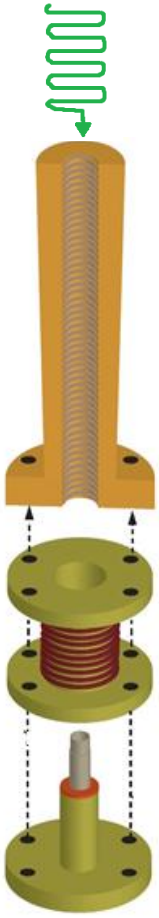
Teflon and Rexolite rods

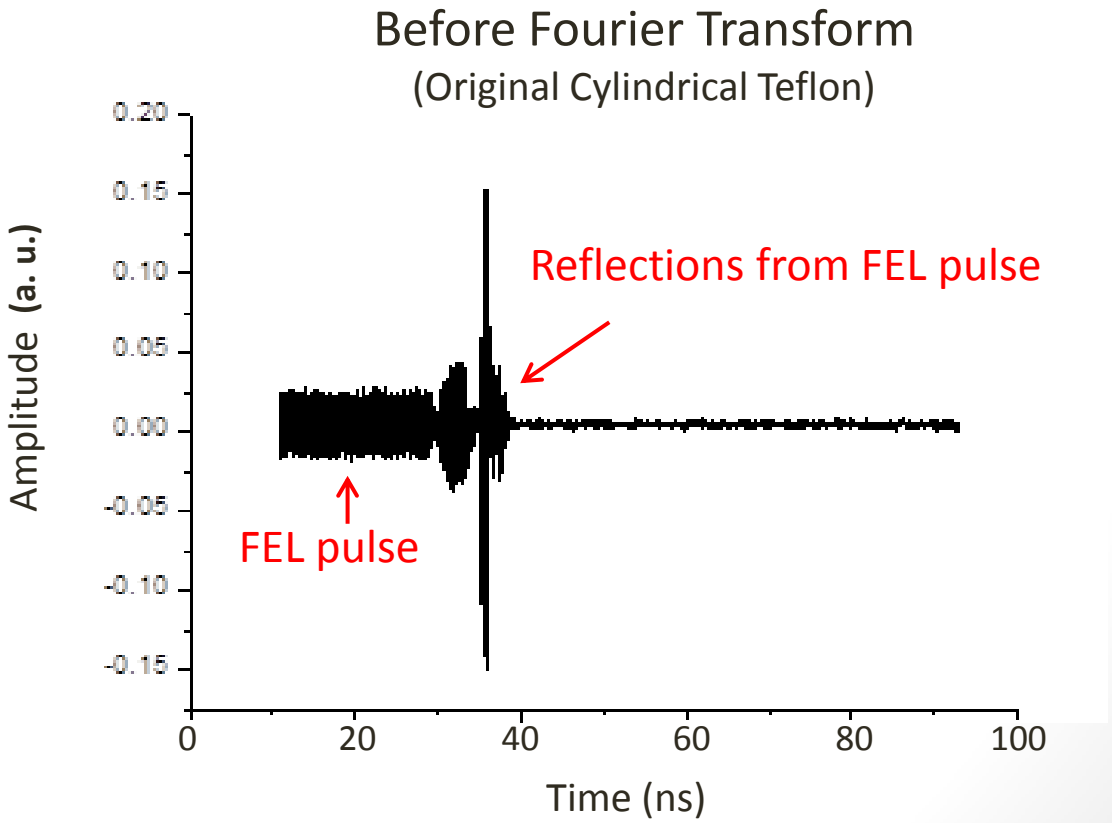
Machined Sample Holders



Testing with the FEL

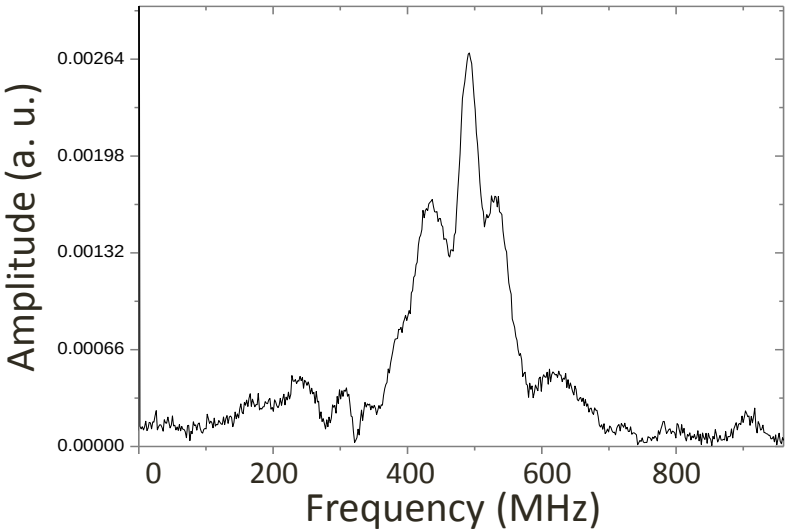
- Raw data: Amp. v. time
- Fourier Transform data to look at prominent frequencies
- FEL frequency = 500 MHz (mixed down)



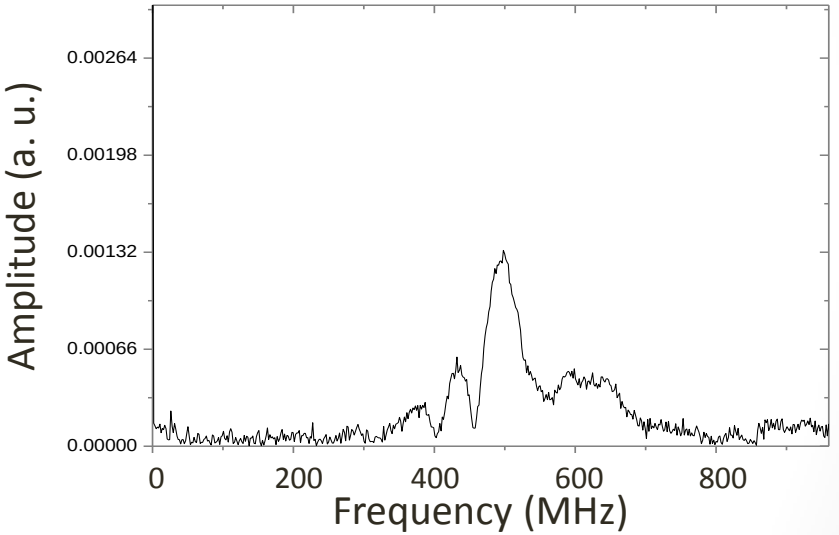


Comparing FEL Pulse Reflections

- Teflon reflects much more than Rexolite



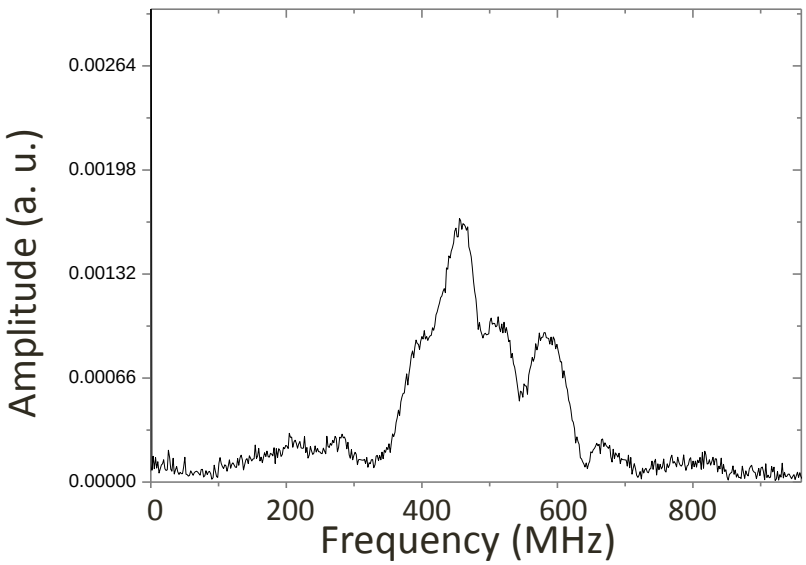
Original Cylindrical Teflon



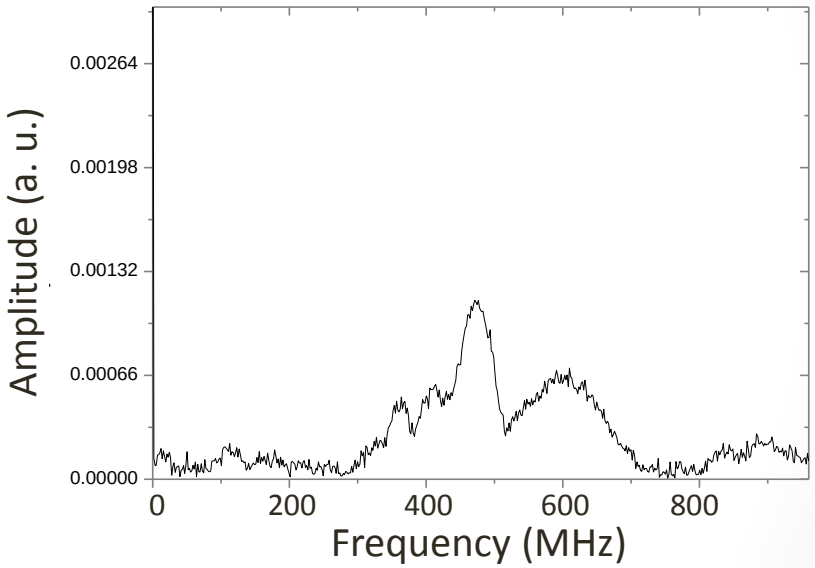
Original Cylindrical Rexolite

Reflections from the Double Cone

- Two prominent peaks
- Rexolite looks somewhat better



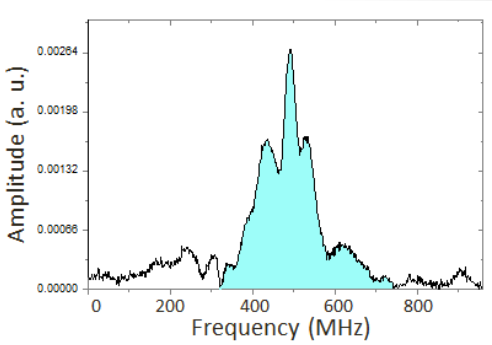
Double Cone Teflon



Double Cone Rexolite

Comparing Reflections from all Four Holders

- Integrate peaks
- Greater area = more reflections



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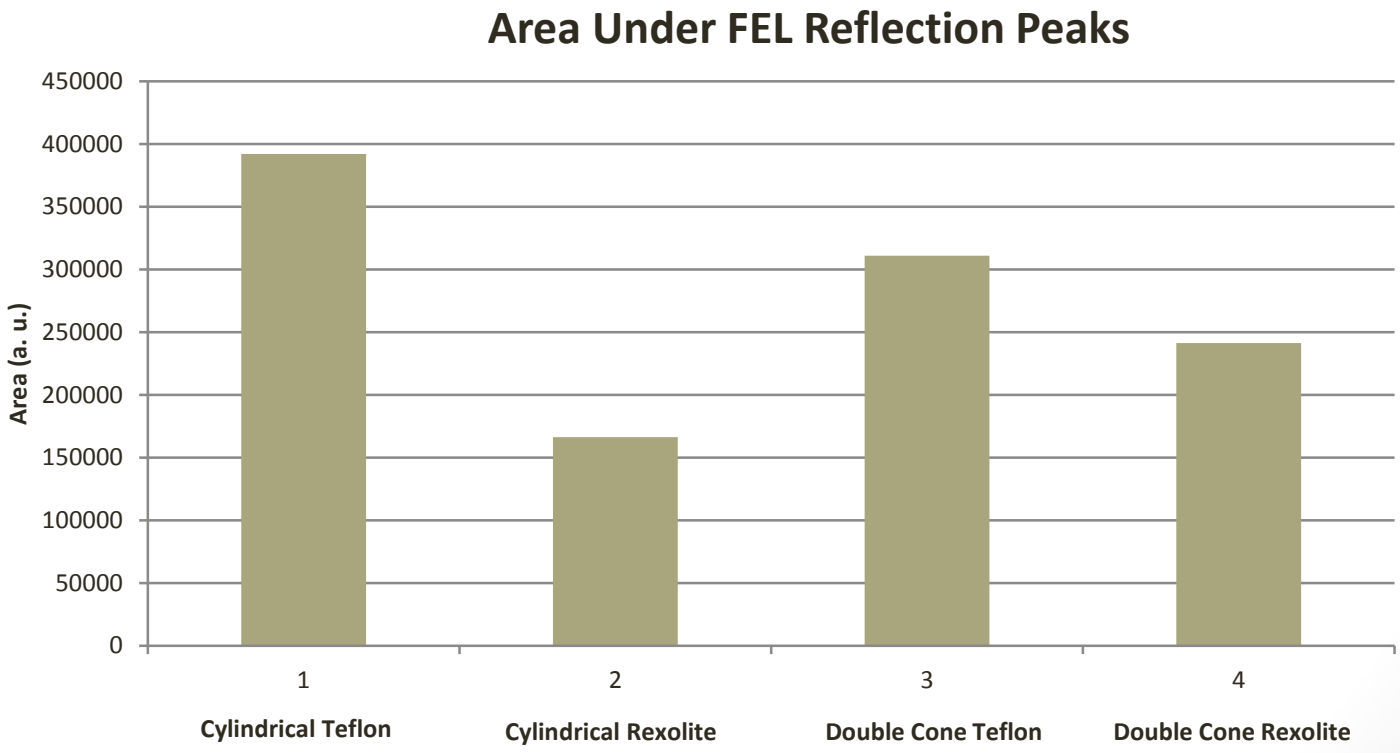


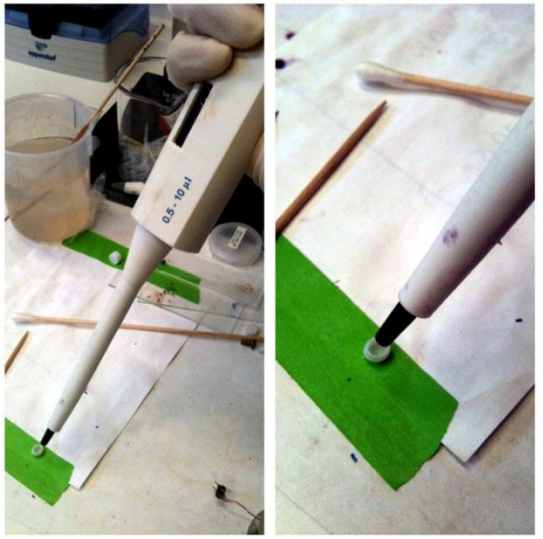
Conclusions and Future Tests

Conclusions:

- Rexolite is a better material than Teflon
- Continue using the cylindrical design for now

Further Testing:

- Add sample to the holders, measure decay of spins
- Look for a decrease in “dead-time”



Acknowledgements

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