An update on the HIPER project – sub-nanosecond pulse ESR

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The HIPER project is an attempt to create a step-change in performance in pulsed ESR by constructing a 94GHz pulsed ESR spectrometer with sub-nanosecond $\pi/2$ pulses combined with sub-nanosecond deadtime. Such a spectrometer would significantly increase sensitivity and resolution for pulsed ESR measurements of systems with broad lines commonly found in spin labels, biological radicals, metal centres and defects in semiconductors and insulators. In particular, it promises to dramatically increase the sensitivity for pulsed ELDOR measurements to the point where it may be possible to extract broad distance distributions in real time, on ms timescales, in site-directed spin label studies. Such a system also promises greater time resolution, where the current limitations on Fourier Transform ESR (associated with deadtime and excitation bandwidth) would largely be eliminated thus making FT-ESR a viable technique for many of the common spin systems studied today.

However, these specifications are extremely challenging and can only realistically be achieved by moving to high frequencies (W-band and above) and exploiting the recent availability of new high power amplifiers. Even then, key components are simply not available commercially and in some cases dramatic increases in performance are required. The power handling of mm-wave switches needs to be increased by several orders of magnitude. The return loss of mm-wave circulators and loads needs to be increased by six orders of magnitude (!) compared to commercially available components. The bandwidth of both (pulse) excitation and detection schemes also needs to be substantially increased compared to present state-of-the-art.

This program has now been running for nine months and in this talk I will describe the substantial progress that has been made in achieving these goals and outline the vision for the whole project.