A Robust, Fully Automated Algorithm to Collect High Quality OPA Tuning Curves

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Motorized optical parametric amplifiers (OPAs) are increasingly common, but frequency domain experiments remain difficult, due in part to unreliable and irreproducible OPA tuning curves. We have developed an automated OPA tuning routine that produces robust, high quality tuning curves quickly.

Frequency domain experiments in which motorized optical parametric amplifiers (OPAs) are scanned as experimental axes remain relatively uncommon in multidimensional spectroscopy despite their promise [1]. One reason for their relative rarity is the practical difficulty in reproducibly setting OPA color while maintaining good output power. OPA tuning curves (the recorded correspondence between OPA motor positions and output color) are sensitive to laboratory conditions and upstream laser drift. Those who wish to scan their OPAs` output color must work hard to maintain ideal tuning curves. Making a tuning curve 'by hand' may take a full day, and the resulting curves may not be stable for more than a week in average laboratory conditions. In addition, simple tuning procedures that optimize output power may give unexpected results or poor OPA behavior, especially for femtosecond OPAs. These challenges have limited the utility of motorized OPAs: many still work up and use output colors one at a time, while others spend a large amount of time tuning their OPAs or suffer with poor OPA performance.

We have developed a fully automated procedure to quickly collect high quality OPA tuning curves. The procedure relies upon measurement of the OPA output at a series of OPA motor positions. Equivalent measurements are possible to achieve with any computer-controlled OPA, monochromator, and detector. Array detection speeds up the acquisition, but is not needed. The measured outputs and motor positions are passed through an algorithm which fits the acquired data and returns a high-quality tuning curve and plot that shows the behavior of the OPA (example shown in Figure 1). This algorithm has been made open source and is generally available. Here we discuss this procedure as applied to both picosecond and femtosecond OPAs. With our acquisition hardware, it takes less than thirty minutes per OPA to generate high quality tuning curves that interpolate better than curves generated 'by hand'.

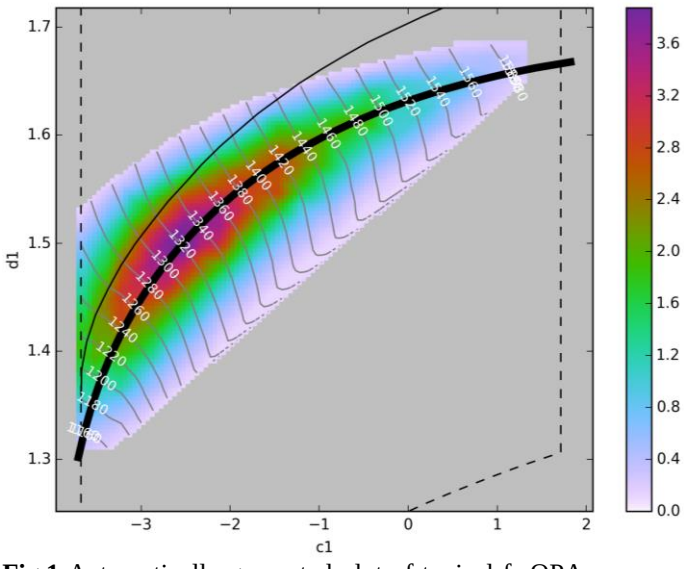

Fig.1 Automatically generated plot of typical fs OPA preamp tuning acquisition. Axes are OPA motor positions, with dotted lines indicating scanned motor position range. At each motor position the spectral OPA output is fit to a Gaussian. After filtering for good fits, the amplitude (colorbar) and central color (grey contours) of the fit outputs are plotted. Also shown: the previous tuning curve (thin black line) and generated tuning curve (thick black line).

[1] A.V. Pakoulev *et al.*, ACR **42,** 1310 (2009).