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Development of single-filter polychromator for cost-effective Thomson scattering system

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A novel single-filter type polychromator for Thomson scattering system has been developed by use of varied angle of incidence (AOI) to an interference filter. This polychromator needs only one filter for multiple wavelength channels but uses sets of collimation lenses and mirrors to reflect light back into the filter at different AOIs, as shown in Figure 1.

An 1059nm bandpass filter was used for the interference filter, and an optic fiber for the input. The light was focused at the filter surface with a lens, and entered the filter with large AOI to prioritize sensitivity at shorter wavelengths. The light that reflected off the filter was redirected back with smaller AOIs with the use of a lens and a mirror 2 times for a total of 3 channels. The channels were designed with the AOI of 17°, 9°, and 4° each. The light that transmitted through the filter was focused onto avalanche photodiodes (APDs).

After assembly, light from a monochromator has been used as incident light to the polychromator for the purpose of testing its performance. Figure 2 shows the measured transmittance of each channel across wavelengths below 1064nm. Their values were normalized by the raw power distribution of the incident light in the absence of an interference filter. The three curves indicate successful separation of wavelengths (1041m, 1052nm, and 1058nm) as well as comparable transmittance (0.56, 0.46, and 0.48). The first channel with high AOI showed light loss inherent to the interference filter, but the subsequent channels showed further decrease of transmittance suggesting light loss from elsewhere.

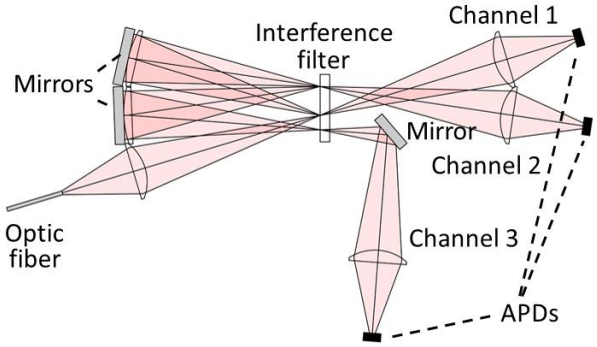

Figure 1. Schematic of the single-filter polychromator. Light is introduced via optic fiber (bottom left) and cascades between the interference filter and mirrors.

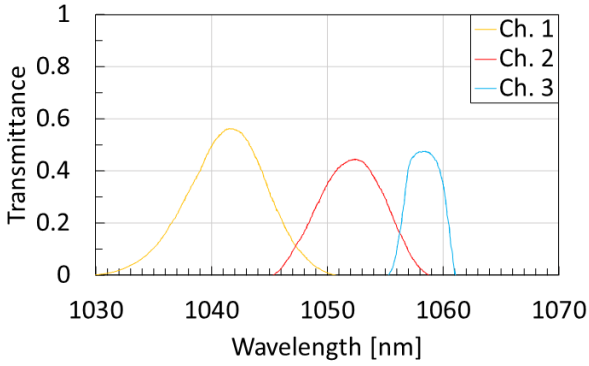

Figure 2. Transmittance of each channel of the polychromator.