Examining radially localized, poloidal ExB flows

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Examining radially localized, poloidal ExB flows

- Self-generated, $k_{\square} \approx 0$ poloidal flows thought to play an important role in suppressing turbulence
- Expected poloidal flows: $v_{\square} \approx v_{ExB} \leq 0.01 \times v_{thi}$
- For edge parameters, $v_{thi} \approx 3 \times 10^{7}$ cm/sec, need to measure small fraction of $v_{ExB} \approx 3 \times 10^{5}$ cm/sec
- Fluctuation autocorrelation frequency for flows of interest is $\square\square^{ZF} \approx 5$ kHz, considerably faster than CXRS diagnostic data acquisition rate

Required capabilities

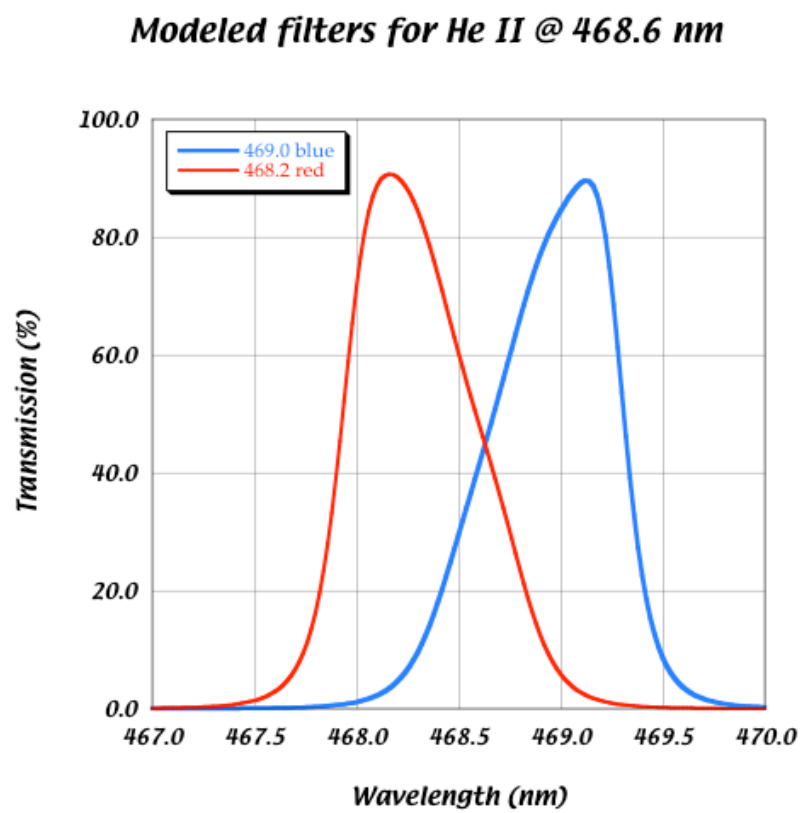
- Need light level adequate to detect poloidal velocity with resolution of < 0.1 km/sec at 10 kHz

- Radial localization of modes is $k_r \rho_i \approx 0.1$, so radial resolution must be finer than 40-60ρ_i or 1-2 cm

- To compare to ambient fluctuation levels, need capability to measure up to 500 kHz

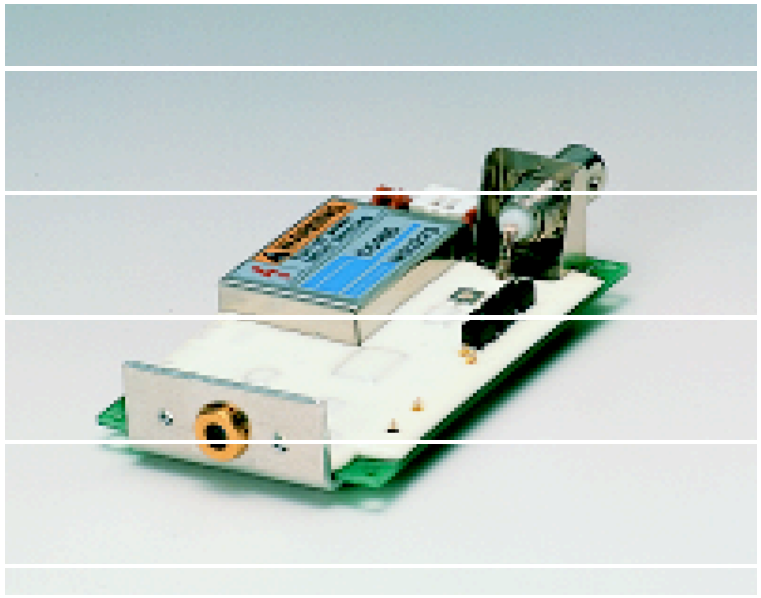
Crossed interference filters
($3K each from Barr Associates)

- 3-cavity filters; 1 nm bandwidth
- Linear over 0.6 nm
- T_{peak} > 60%
- Tune center by tilting
- Temperature controlled to < 0.1° C
- Rejects O II at 469.9 nm



Blue enhanced APD module
(from Hamamatsu - $740)

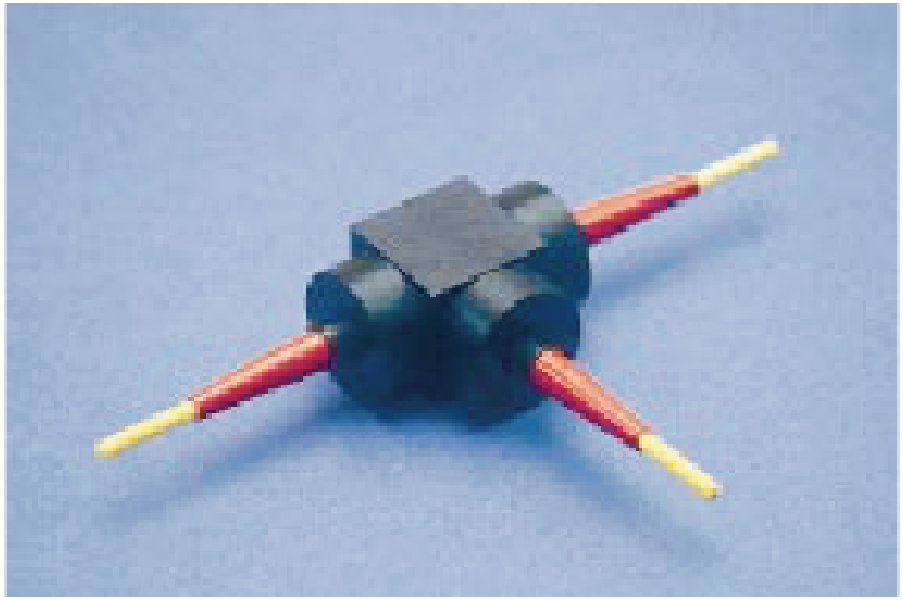
- S5343 1mm dia APD and low noise circuitry mounted on a PC board
- 65% quantum efficiency
- Frequency response from DC to 100 kHz
- NEP of only 15 fW/Hz$^{1/2}$
- Gain is continuously compensated for changes in temperature



Beam splitter -- $900

- *Insertion loss < 1.5 dB*
- *< 0.1% splitting ratio over 3 nm*
- *No sensitivity to polarization*
- *Accommodates up to 600 micron dia. fiber*
- *Optimized for 488 nm*

OZ OPTICS LTD.



So how much can be measured?

- Light flux measured by poloidal CHERS indicates He II light flux from a single 0.6 mm fiber is 7×10^4 photons/μsec
- With losses from filter transmission and splitter efficiency (35% each) and a 65% detector QE, and $G_{APD} = 50$ the photocurrent is 3×10^5 elec/μsec
- Detection noise is nearly 2×10^3 pe /μsec (for a 100μsec time integration)
- End result: can measure S/N of 250:1
- Translates to 0.5 km/sec @ 10 kHz, about 10% of the poloidal velocity

Light emission from plasma edge

- Light flux measured by poloidal CHERS indicates He II light flux from a single 0.6 mm fiber is 7×10^4 photons/μsec
- With losses from filter transmission and splitter efficiency (35% each) and a 65% detector QE, the photocurrent is 5×10^3 photoelectrons/μsec