**Impact of window temperature changes on ITER toroidal interferometer and polarimeter (TIP) measurements**

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The Toroidal Interferometer and Polarimeter (TIP) is the primary electron density diagnostic on ITER. For long pulse operation, the interferometer is challenged by phase offsets due to environmental changes such as temperature, humidity, etc. [1,2]. To improve measurement accuracy and provide reliable electron density data to fueling control, it will be essential to minimize and monitor ambient environmental changes. A key element of this will be consideration of temperature changes in window and transmissive optics materials since the index of refraction depends on the temperature.

In TIP, BaF2 and ZnSe are used for vacuum and secondary windows, as well as lens and beam splitter/combiners [1]. Though previously published data on the dependence of the index of refraction on the temperature [3] exists for these materials, the quoted error bars are too large to accurately predict the expected phase drifts in ITER. Hence, the TIP prototype, operating at 10.59 and 5.22 microns, was used to directly measure the phase shifts induced by temperature changes of BaF2 and ZnSe for reliable extrapolation to ITER. 3 cm-long BaF2 and ZnSe specimens were placed in an oven in the TIP beam path and the temperature increased up to > 80 °C (ITER vacuum window temperature ~ 70 °C). The temperature dependent vibration compensated phase shifts of BaF2 and ZnSe are +0.012 and -0.27 deg./°C/cm, respectively. The measured phase shift is the sum of two terms: the index of refraction change and the thermal expansion. While signs of these two terms are opposite in BaF2, they are the same in ZnSe. Hence the phase shifts in BaF2 are largely cancelled resulting in smaller temperature dependent vibration compensated phase shift errors.

The primary vacuum window material for TIP is planned to be ZnSe, which has been chosen over BaF2 because it can meet ITER’s strict vacuum window requirements; ZnSe has better resistance to steam ingress and satisfies the mechanical strength required for the helicoflex vacuum sealing. Due to double passage of double 1.4 cm-thickness windows, the total path length of TIP beams in ZnSe is 5.6 cm. Allocating 1 deg. error budget to the vacuum window (10% of TIP’s total error budget), a temperature change of <0.7 °C during a discharge will be required. For temperature changes beyond that value, careful monitoring of the window temperature would be required to remove phase offsets.

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