Scientific Justification: K2 opens a new avenue for the detailed study of pulsations and their possible relationship to dust formation in R Coronae Borealis (RCB) stars (Clayton et al. 2012, JAAVSO, 40, 539). These observations are key to understanding the evolution of the RCB stars because their masses cannot be accurately estimated by other means. Only one RCB star, V1157 Sgr, has been observed during the Field 1-8 campaigns. It is being observed now in Campaign 7 so no data are yet available. Field 9 contains eight additional RCB stars. The ~75 days of near continuous, high-precision observations will provide an opportunity to use Kepler to observe the brightness variations of RCB stars. These observations will be at least two orders of magnitude more precise than the existing ground-based photometry, typically with a cadence of once per night and uncertainties $\gtrsim$ 0.01 mag. These observations will provide the first detailed look at the pulsation mechanisms and modes in a sample of RCB stars. It is also likely that one or more of the stars will form dust during the campaign which would be of great interest because a correlation between pulsation phase and the timing of dust formation has been found in several RCB stars (Crause et al. 2007, MNRAS, 375, 301).

R Coronae Borealis (R CrB) is the prototype for its eponymous class of stars, which are very rare and have many unusual characteristics including extreme hydrogen deficiency and large, sudden declines in brightness of 8 magnitudes or more due to dust forming near the stellar atmosphere (Clayton et al. 2012). Only about 100 RCB stars are known in the Galaxy. The dust forms near the surface of the RCB star due to density and temperature perturbations caused by the stellar pulsations (Woitke et al. 1996, A&A, 313, 217). RCB stars typically show small amplitude regular or semi-regular pulsation periods in the 40-100 d range (Lawson et al. 1990, MNRAS, 247, 91). Two scenarios have been suggested for the evolution of an RCB star: the double-degenerate model, where an RCB star is the result of merger between a CO- and a He-white dwarf (WD), and the final flash model, where a star evolving into a WD undergoes a final helium-shell flash and expands to supergiant size (Saio & Jeffery 2002, MNRAS, 333, 121).

Trimble (1972, MNRAS, 156, 411) suggested the existence of an instability strip for helium stars and used the RCB stars as examples, inferring masses of ~2 $M_\odot$. Their possible relationship to type Ia supernovae was pointed out by Wheeler (1978, ApJ, 225, 212) who emphasized the possibility of determining accurate masses of the RCB stars using pulsation modeling. The pulsations in these stars, occuring in a hydrogen-deficient star, are extremely non-adiabatic and may include strange modes and non-radial pulsations which occur in stars with high luminosity where radiation pressure dominates (Glatzel & Gautschy 1992, MNRAS, 256, 209). The pulsations in RCB stars were studied using a non-linear hydrodynamic code which found that the stellar masses are likely to be <1 $M_\odot$ (Saio & Wheeler 1985, ApJ, 295, 38). Models of radial and non–radial pulsations excited in the luminous hydrogen–deficient star WD merger models for RCB stars are shown in Figure 1 (Saio 2008, ASP Conf. Ser., 391, 69). Three RCB stars, R CrB, RY Sgr, and UW Cen were modeled.

The new proposed K2 data will provide new much more accurate constraints on stellar pulsation models which are essential to estimate the RCB star masses. The maximum light magnitudes of

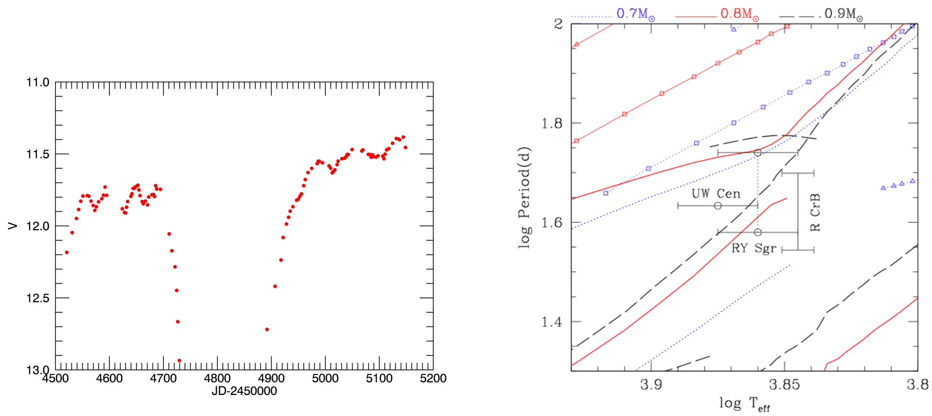

Fig. 1.— Left: The lightcurve of V1157 Sgr showing a sudden decline in brightness due to dust and low amplitude pulsations. Right: Estimates of stellar masses using periods of radial and non–radial pulsations excited in RCB star models plotted versus effective temperature. Lines with and without symbols are for non-radial and radial pulsations of RCB stars, respectively. Lines with triangles are for non–radial l = 1 modes, and lines with squares are for non–radial l = 2 modes (Saio 2008).

the stars are listed in the Target Table. But it is not possible to predict what the brightness of the sample stars will be when Field 9 is observed since dust formation occurs at iregular intervals. At V=14, the precision in a 30 minute exposure will be 0.0004 mag. The duration of the K2 monitoring is useful since it will cover almost two complete pulsation cycles for a typical RCB star. RCB stars are thought to be ∼0.8-0.9 $M_\odot$ from previous stellar pulsation modeling, as shown in Figure 1. These estimated masses agree well with the predicted masses of the merger products of a CO- and a He-WD (Han 1998, MNRAS, 296, 1019). Final-flash stars, since they are single white dwarfs, should typically have masses of 0.55-0.6 $M_\odot$. These mass estimates if confirmed are of great importance in distinguishing between the two proposed evolutionary paths for the RCB stars. We plan to analyze the pulsations using the methods described above and in our previous studies of RCB star pulsations (Saio & Jeffery 1988, ApJ, 328, 714;Saio 2008). No cool RCB star, with T(eff) = 5000-7000 K, is known to be a binary so mass estimates from the stellar pulsations are necessary to understanding the evolution of these enigmatic stars.

Why a DDT Proposal?: RCB stars are extremely rare and form a Bulge population (Tisserand et al. 2013, A&A, 551, A77). The previous K2 campaigns, Fields 1-8, contained a total of one RCB star, V1157 Sgr, which is being observed as part of Field 7. Field 9 contains eight additional RCB stars and so offers the promise of providing a statistically useful sample for the study of RCB star pulsations and dust formation. Regular proposals for Field 9 were not allowed.

Long-Term Legacy Value: As described above, only one RCB star was included in Fields 1-8. This proposal provides a unique opportunity to obtain K2 data on a number of RCB stars so that a useful sample exists to study the differences that may exist from star to star. Pulsation modeling is the only way to estimate the masses of these rare and unusual WD merger products.