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MONITORING EXOPLANETS FROM ANTARCTICA WITH ICE-T

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Abstract. The International Concordia Explorer Telescope (ICE-T) is a f/1.1 Schmidt telescope, 61 cm aperture, with two tubes equipped with identical CCD 10.3×10.3k, 9μ ultra-wide-field with a total FOV of 65 square degrees. Its aim is to operate at Dome C, the French-Italian Antarctic Station, taking advantage of the long winter night for continuous observations. It is optimized for high precision photometry in two separate filters Sloan g and Sloan i ranging from 100μmag to 10 mmag (9-16 mag). Among the scientific tasks there are the detection of hot Jupiters and Super Earths with the transit method, and related magnetic activity of the hosting stars. The 4m Radom for ICE-T together with 3 foundation pillars and the cables bundle have been already successfully installed in January 2009.

1. MOTIVATION

ICE-T is an international consortium led by the Leibniz Institut für Astrophysik Potsdam foreseen to be located at the French Italian Concordia Station at Dome C (72°06'04" S, 123°20'52" E, 3233 m altitude). Dome C is well known to be one of the best sites in the world for observations because of sky transparency in most of the atmospheric windows, low sky background (typically from 3 to 5 times lower than at mid latitudes), very good seeing (0.27 arcsec above 30 m), higher isoplanatic angle (5.7 arcsec), longer coherence time (7.9 ms), even better than at South Pole (Agabi et al. 2005), and low scintillation noise which permits to reach a photometric precision of 200μmag.

The prime envisioned scientific targets are extra-solar planets as well as stellar magnetic activity and non-radial pulsations in the structure of the host star, their inner dynamics and dynamo activity too (Strassmeier et al. 2008). Long term observations with high precision are necessary to detect planets and to analyze starspots and flares. We need two separate bandpasses, Sloan g (402-552 nm) and i (691-818 nm) operating simultaneously in order to discriminate a transit from spot and plages associated to rotation (Carpano et al. 2003). Optical afterglows of gamma-ray bursts and micro-lensing effects are also pursued among the required targets. ICE-T will stare at one single field for each campaign. Once it is pointed, the telescope is supposed to keep on tracking the very same field in a fixed position along RA for the whole season. Two optimal fields have been selected taking into account the diurnal air mass and refraction variations, solar, lunar interference, interstellar absorption,

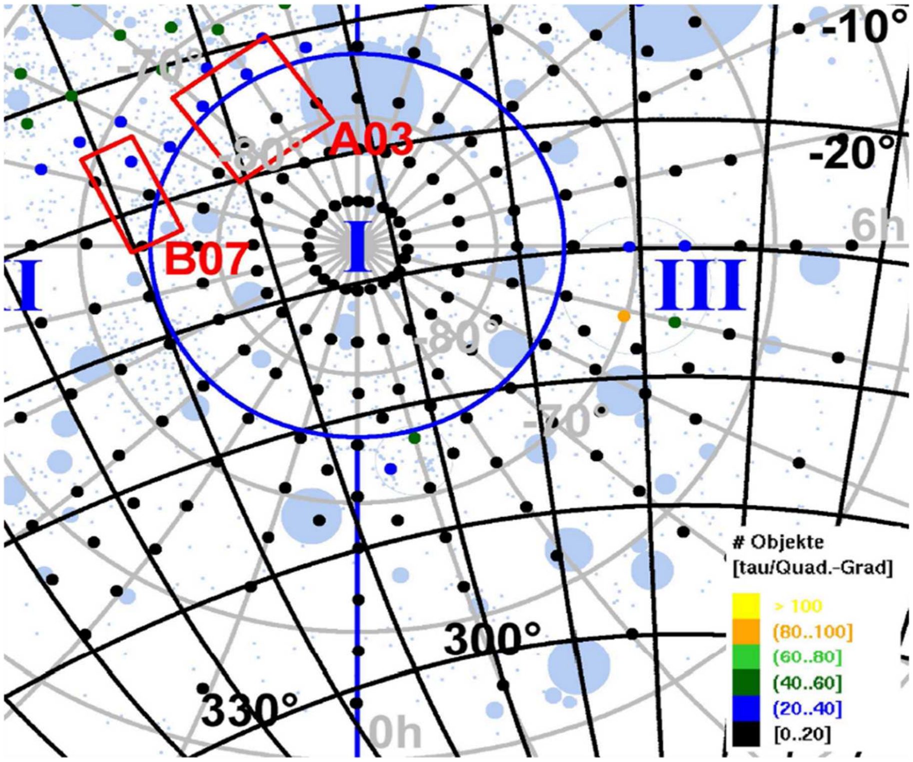

Figure 1: Position of the two optimal fields A03 (in equatorial coordinates α=14^h20^m, δ=-77.0°) and B07 (α=17^h04^m, δ=-73.3°). Black dots represent the number of stars in a square degree down to 18.5 mag. The light blue areas are either star-forming regions, dark clouds or open clusters. The small blue dots are known variable stars taken from the catalogue GCVS. Regions enclosed by I are located close to zenith with declination lower than the geographical latitude of Dome C. Fields contained by region II are affected by full moon, and those in region III are in the direction of the sun (Fügner et al. 2008).

overexposing of bright stars and ghosts, crowding by background stars, and the ratio of dwarf to giant stars in the field. A03 and B07 are respectively the best full-frame and half frame fields (8.1°×8.1° and 8.1°×4.05°), so that open clusters, dark clouds, star-birth regions and variable stars are minimized within this areas (see Figure 1). Fields in II are in the direction of full moon, while sector III is perturbed by twilight stars. Stars in region I are permanently close to zenith or at most 30° away. Figure 2 represents the position of the two optimal fields in the sky, with respect to the stars hosting so far discovered planetary systems (source: exoplanets.org).

2. OPTICS

The optical system includes a double achromatic Schmidt plate of N-BK7 and N-F2, fast f/1.125, with a 61 cm clear aperture, 20 mm air gap. The main mirror

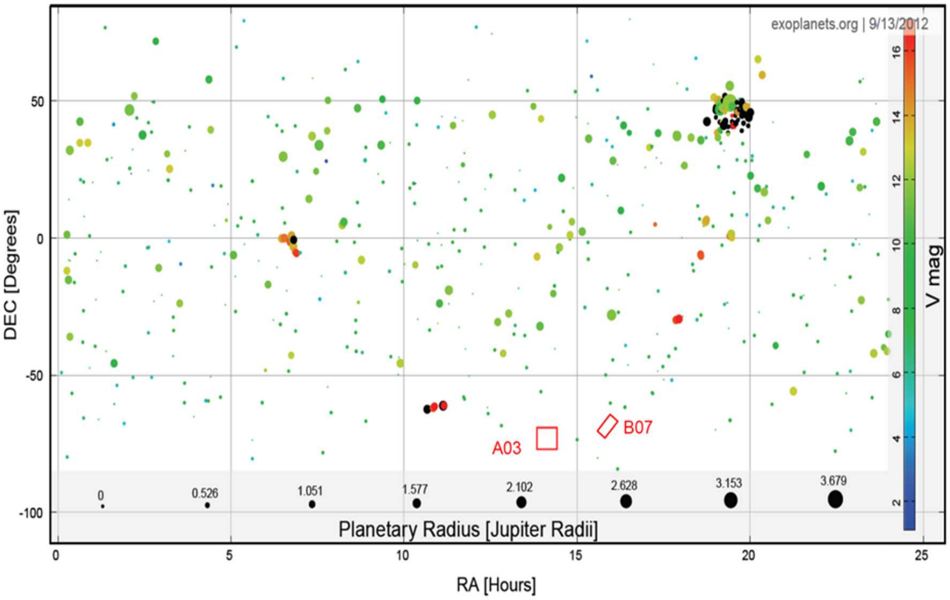

Figure 2: Location of the two optimal fields in the sky, where the dots represent the size of the so far discovered planet (September 2012) in the V-band. Notice that in these regions there is still a lack of information.

made of Zerodur is spherical, Ø82 cm, with a central hole of 15 cm and radius of curvature of 1414.5 mm. A field flattener lens diffracts approximately 16% of the entrance aperture. The triplet lenses, made of BK7 have spherical surfaces with slightly different parameters for Sloan g and Sloan i filters. They are made of N-BK7 glass, as no transmission in UV is required.

The best spot diagram size simulated is 9μ at 400nm. Among five offers from several vendors we have considered only the one from GOAL (General Optics Asia Limited) affordable. The proposal includes manufacturing within 0.5λ P-V and 0.05λ rms tolerances, polishing, light weighting of the primary, coating and delivery. For the primary mirror a surface quality over clear aperture of 0.25λ P-V (λ=632.8 nm), 0.07λ rms can be achieved, via Al+SiO_2 coating. The specification for Antireflection Coating is Single Layer MgF_2. In order to get good adhesion, the substrates are maintained at 300°C during coating. At such elevated temperature, the substrate permanently deforms (degrading optical surface quality beyond acceptable limits). The deformation is enhanced by increasing the aspect ratio (diameter-center thickness).

As the corrector plates have adverse aspect ratio (610/30=20.3), the coating needs to be done at lower substrate temperature. Therefore a multilayer (SiO_2 + Ti_3O_5) AR coating has been proposed.

3. CCDs

We intend to use two CCDs without shutter, i.e. in frame-transfer mode as was foreseen for ESA's Eddington mission. Read-out is then retrieved during exposure,

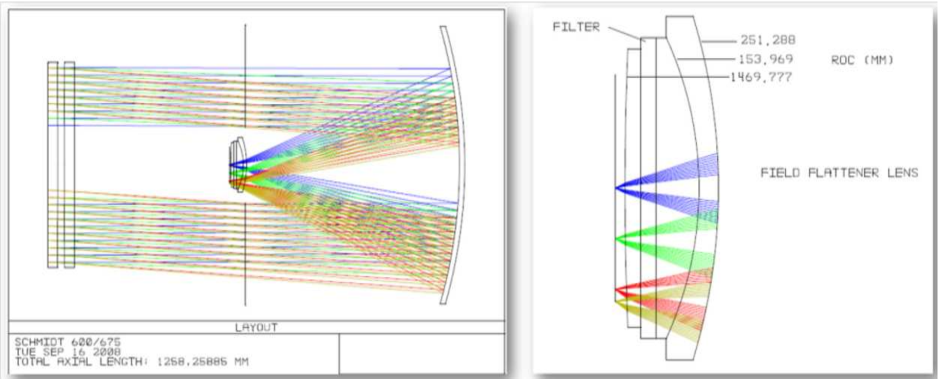

Figure 3: Left: Optical layout in Sloan *g*. Right: Triplet lens Ø180 mm, constituting the field flattener, with the filter inserted inside the positive lens, and the last lens being the dewar entrance window.

which sets the time resolution nearly to the exposure time. The total unvignetted FOV is matched to the 95 mm×95 mm thinned STA1600A CCD. A FOV of 8.1°×8.1° with 10600^2 pixels correspond to 2.75 arcsec/pixel. The architecture of the STA1600A CCDs includes a total of 16 amplifiers, 8 on each adjacent side. The read-out-noise of the STA device with an ARC Gen-II controller is expected to be similar to the first PEPSI STA 10k device at 200 kpix/port/s (≈ 7 e^-). Frame transfer operation will relax the controller requirements to ≈ 350 kpix/port/s for a 10s integration without a waiting period (Strassmeier et al. 2010).

4. THE DOME STRUCTURE

The Rader dome, built by *Baader Planetarium*, whose inner diameter is 3.4 m, can be fully opened. It is bolted on a wooden platform, with an elevation of 1 m above the ground. The platform has a central aperture of Ø1.8 m to host three Ø600 mm concrete piers, on which the weight of the telescope is distributed. Overall weight is estimated to be at most 3 tons. The piers have a length of 4m of which 3m are plunged into the ice. The Dome and the platform have been successfully installed at Dome C at the beginning of 2009 and site access has been granted by French polar agency IPEV since October 2010.

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