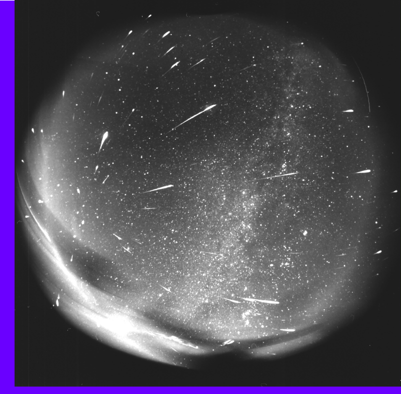
Distributions of spin/shape parameters of asteroid families and targeted photometry by ProjectSoft robotic observatory

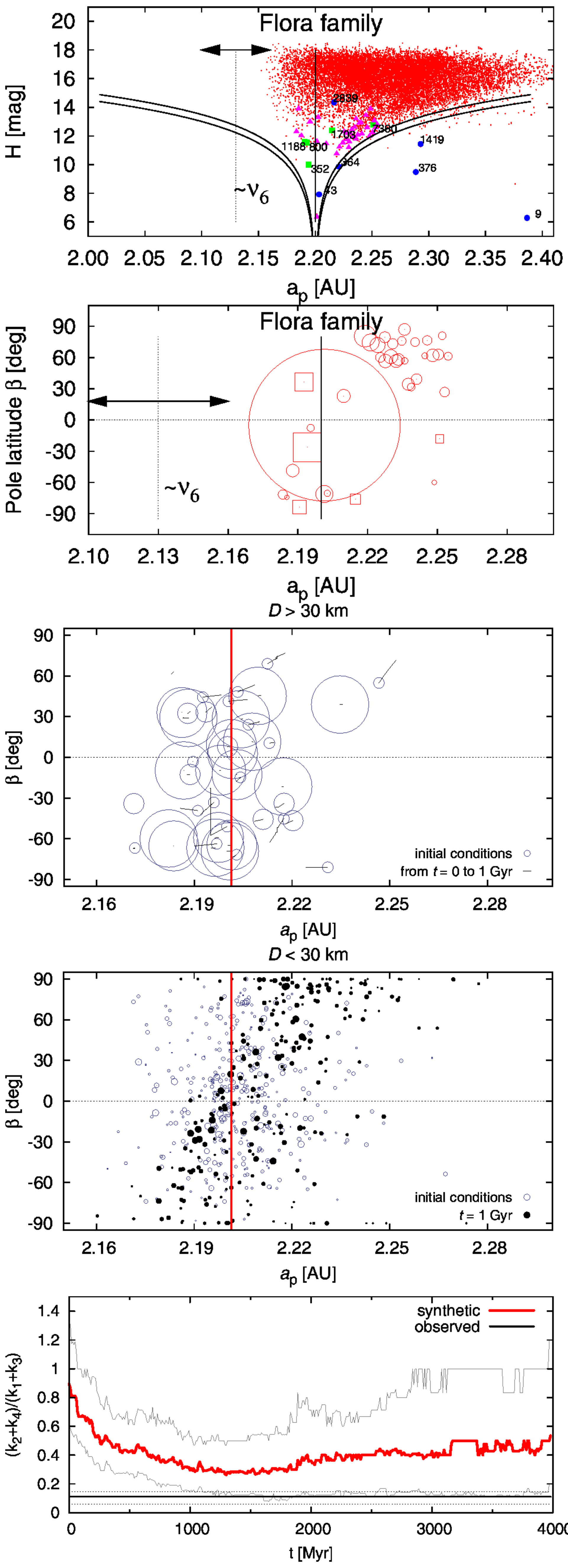


Miroslav Brož, Josef Ďurech, Josef Hanuš, Martin Lehký - Charles University in Prague, V Holešovičkách 2, 18000 Prague, Czech Republic, email: mira@sirrah.troja.mff.cuni.cz

Abstract: In our recent work (Hanuš et al. 2013, A&A 559, A134) we studied dynamics of asteroid families constrained by the distribution of pole latitudes vs semimajor axis. The model contained the following ingredients: (i) the Yarkovsky semimajor-axis drift, (ii) secular spin evolution due to the YORP effect, (iii) collisional reorientations, (iv) a simple treatment of spin-orbit resonances and (v) mass shedding. The major limitation of our model stems from the fact that the number of observed family members with known pole latitudes is limited.

We thus outline an ongoing construction of the ProjectSoft robotic observatory called "Blue Eye 600", which will support our efforts to complete the sample of shapes for a substantial fraction of (large) family members. Dense photometry will be targeted in such a way to maximize a possibility to derive a new pole/shape model. Other possible applications of the observatory include: (i) fast resolved observations of fireballs (thanks to a fast-motion capability, **up to 90 degrees/second**), or (ii) an automatic survey of objects (MBAs, NEAs, variable stars, novae, monitoring of flares on solar-type stars, optical counterparts of GRBs, stellar occultations, ...).

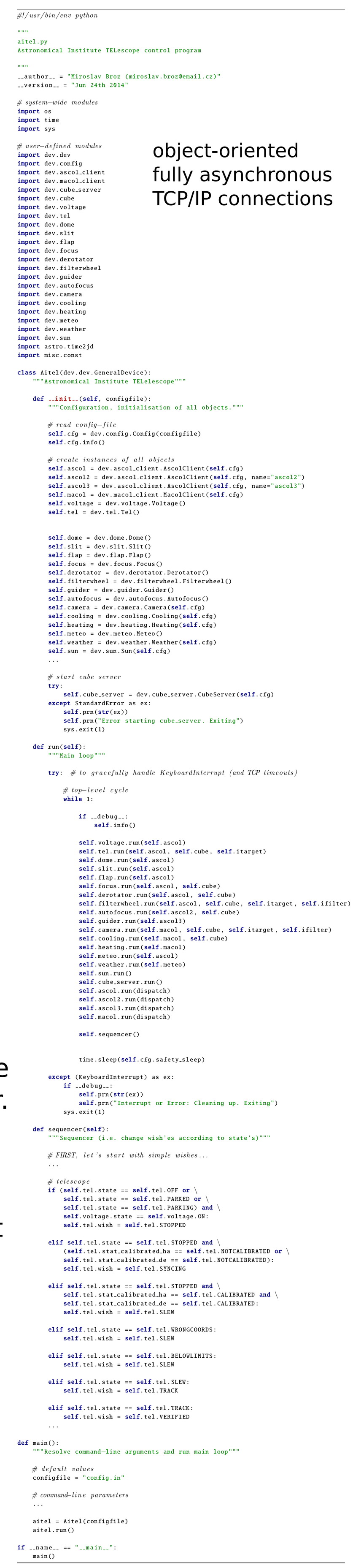
We also suggest to use a different (complementary) approach, based on distribution functions of shape parameters. Based on **>1000** old and new convex-hull shape models, we will be able to construct the distributions of suitable quantities (ellipticity, normalized facet areas, etc.) and we shall discuss a significance of differences among asteroid populations. A check for outlier points may then serve as a possible identification of (large) interlopers among "real" family members. This has also implications for SPH models of asteroid disruptions which can be possibly further constrained by the shape models of resulting fragments. Up to now, the observed size-frequency distribution and velocity field were used as constraints, sometimes allowing for a removal of interlopers (Michel et al. 2011, Icarus 211, 535).



DAMIT: Database of Asteroid Models from Inversion Techniques (http://astro.troja.mff.cuni.cz/projects/asteroids3D) now contains models for **381** asteroids. Most of the models were derived from disk-integrated photometry by the lightcurve inversion, some of them were scaled or refined by adaptive optics disk-resolved images, thermal infrared data, or data from stellar occultations. We plan to use DAMIT and models obtained in the framework of the distributed computing project **Asteroids@home** (http://asteroidsathome.net).

ProjectSoft: The company specializes in renovation of existing astronomical telescopes, domes, spectrographs and other astronomical instruments, requiring computer control, robotic and automatic operations. We are able to guarantee quick implementation including all turn-key deliveries. We use only commercial off-the-shelf solutions and components which significantly increase lifetime of the modernized system. Moreover, this solves the essential problem of astronomical devices which is the availability of spare parts and maintenance. This way they are world-wide available regardless of the supplier.

ESO - the Danish 1,54m telescope robotization at La Silla Chile
ESA - OGS 1m telescope robotization at Tenerife
four out of five (!) 2m telescopes made by **Carl Zeiss Jena** were robotized by ProjectSoft
→ we use this experience to construct a fully robotized observatory **Blue Eye 600**



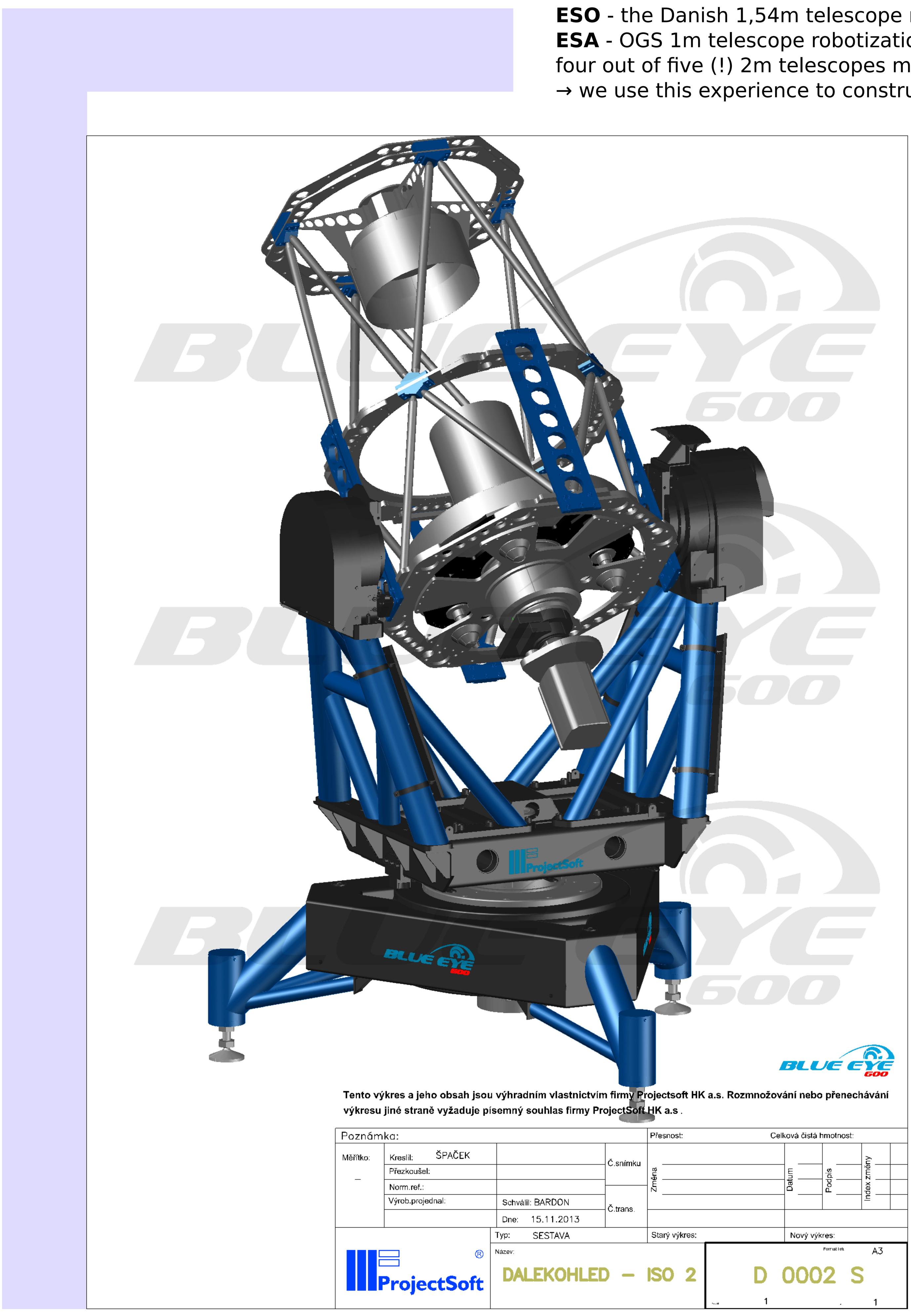
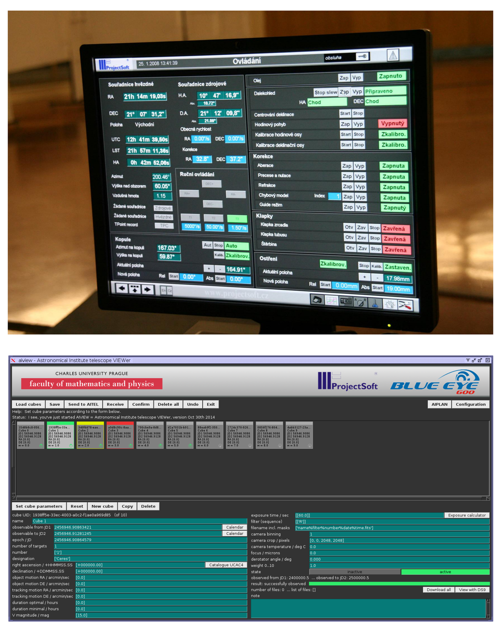
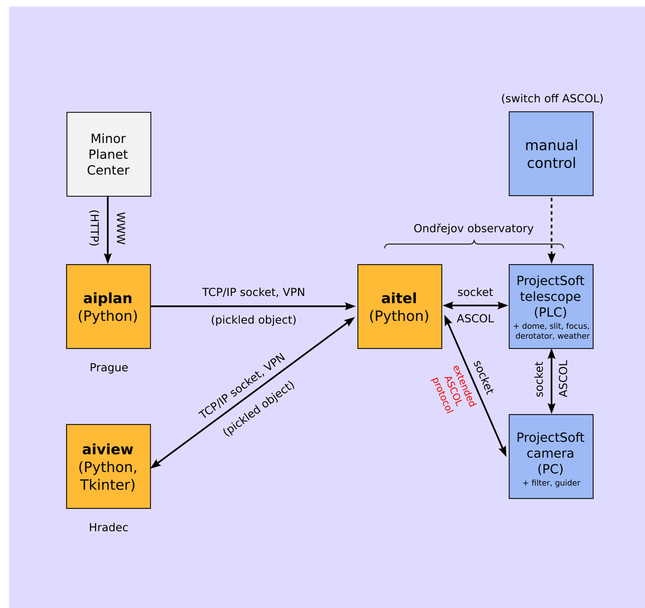
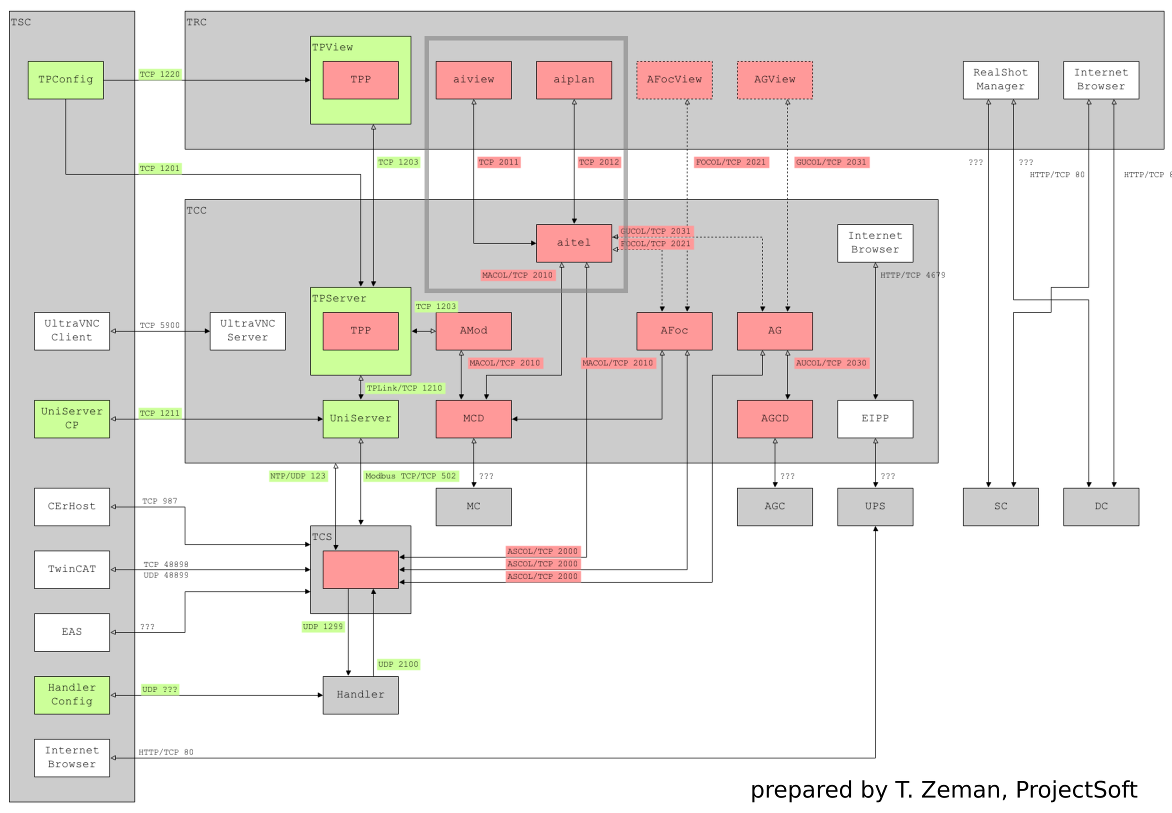


Figure 4: **TomPack view** (a manual control), **aiview** (an interactive planner), a communication scheme of the robotic observatory with **aiplan** (an automated planner). Right column: a small part of the **aitel** source code written in Python (i.e. the major user-level application which includes a sequencer controlling observations).







prepared by T. Zeman, ProjectSoft

Figure 2: A sketch of the Blue Eye 600 robotic observatory (or its parts, respectively, telescope and alt-azimuth mount). The dome is not shown.

Figure 5: A technological/software scheme of the robotic observatory: TCC = Telescope Control Computer, TRS = Telescope Remote Computer, TSC = Telescope Service Computer, TCS = Telescope Control System (a PLC HW), MCD = Main Camera Driver, aitel = Astronomical Institute TELescope control program, ...

Figure 1: An example of the Flora family spin-orbital evolution; (a) the observed proper semimajor axis a_p vs the absolute magnitude H; (b) a_p vs pole latitude β, with sizes D denotes by symbols; (c) the same for a simulation of large asteroids (D > 30 km); and (d) small asteroids. Finally, (e) a sort of χ^2 metric vs time t.

Figure 3: An optimisation of the alt-azimuth mount during the development phase. The final mount equipped with Officina Stellare RiLA 600 f/5 reflector and a sensitive CCD camera (E2V chip 42-20-BI, >90% QE, FOV 0.52 deg). The complete autonomous observatory is now located in Ondřejov, Czech Republic. The first-light image (M31)!

Technology Agency of the Czech Republic
ProjectSoft
Charles University Prague, faculty of mathematics and physics

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