

KLET OBSERVATORY - KLENOT NEO FOLLOW-UP PROGRAM

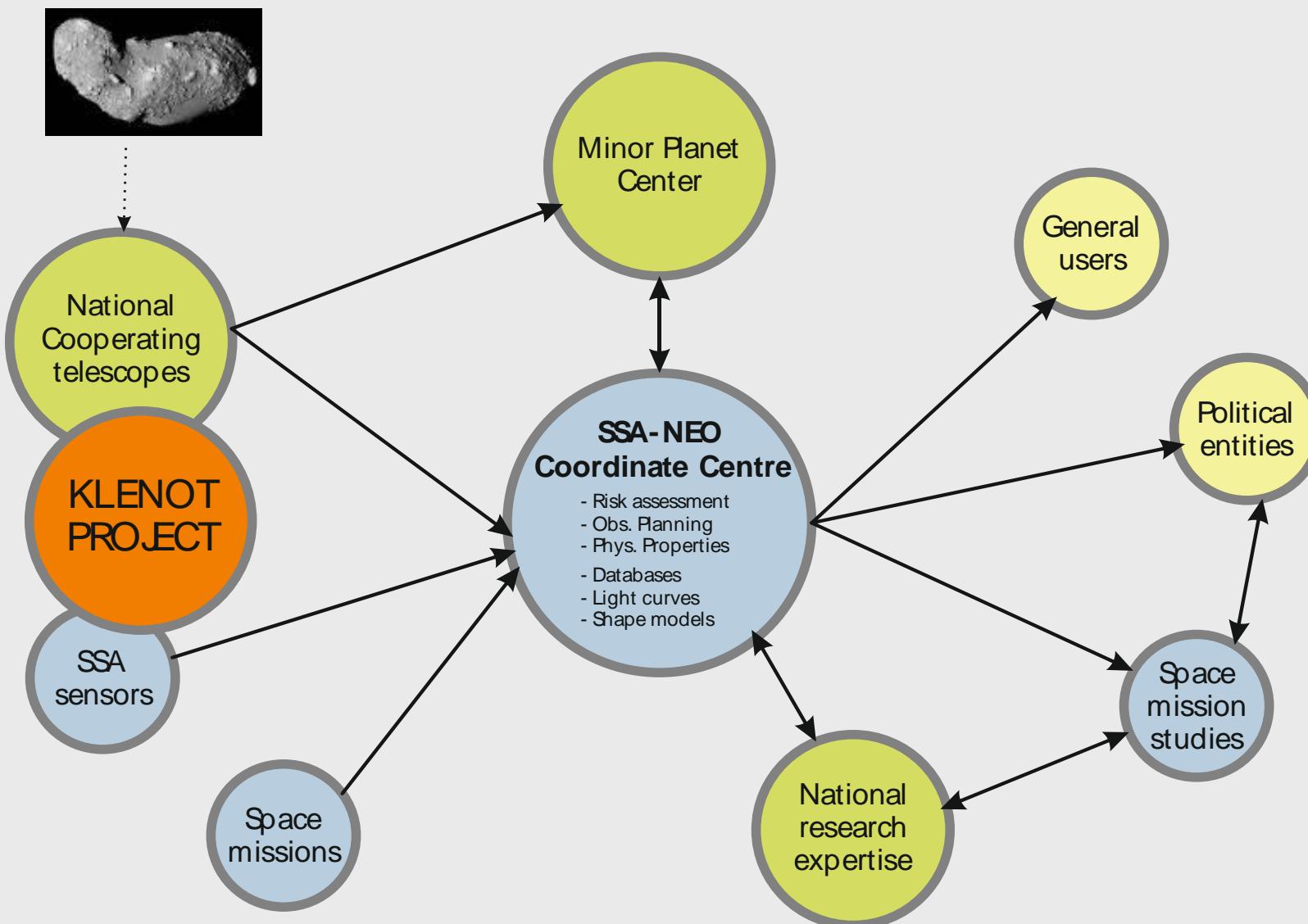
Jana Tichá



THE FIRST EUROPEAN
ASTEROID OBSERVERS
MEETING, 2016 FEB. 1,
ESA/ESRIN, FRASCATI, ITALY

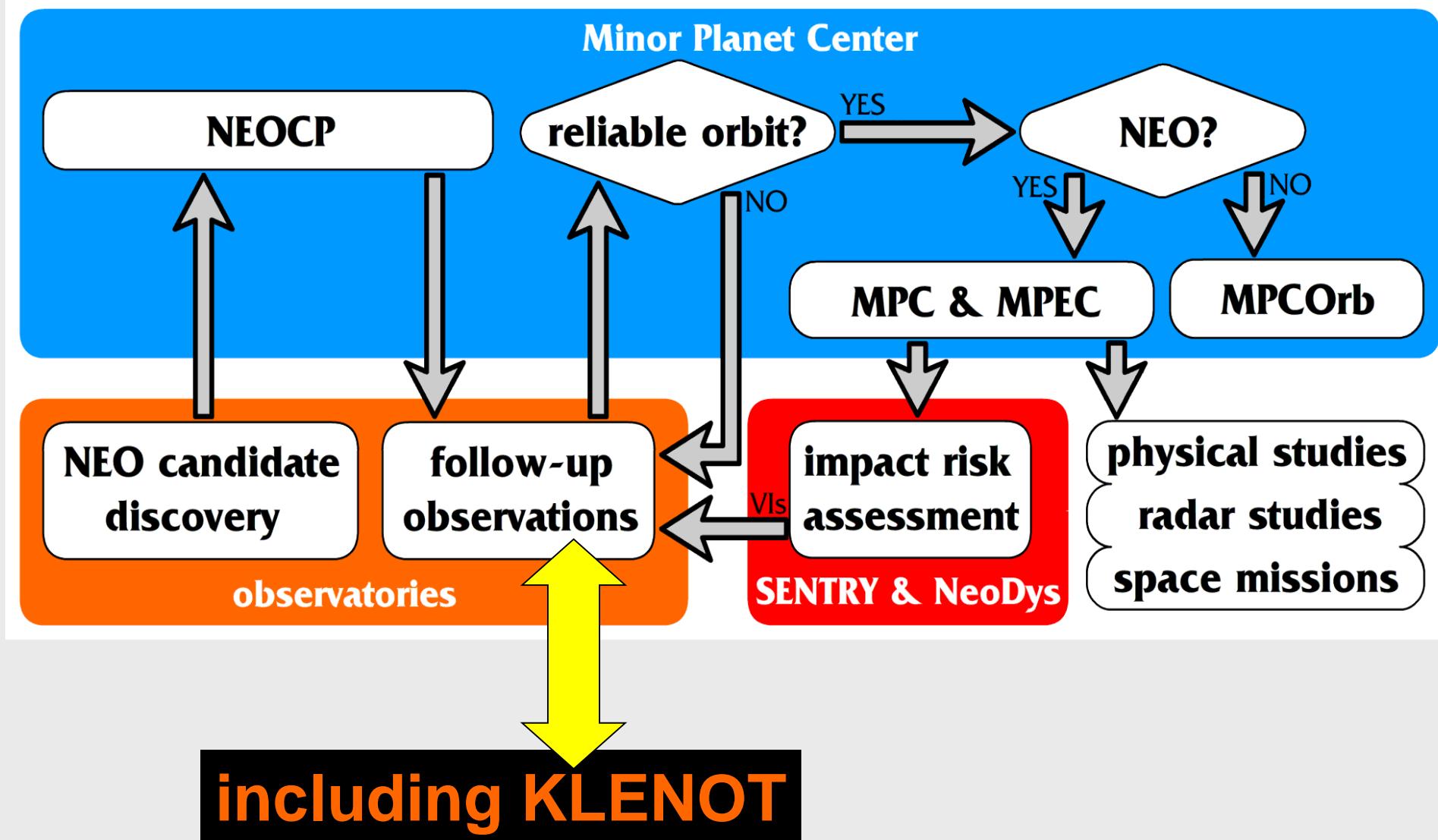


KLET OBSERVATORY
HVĚZDÁRNA KLET



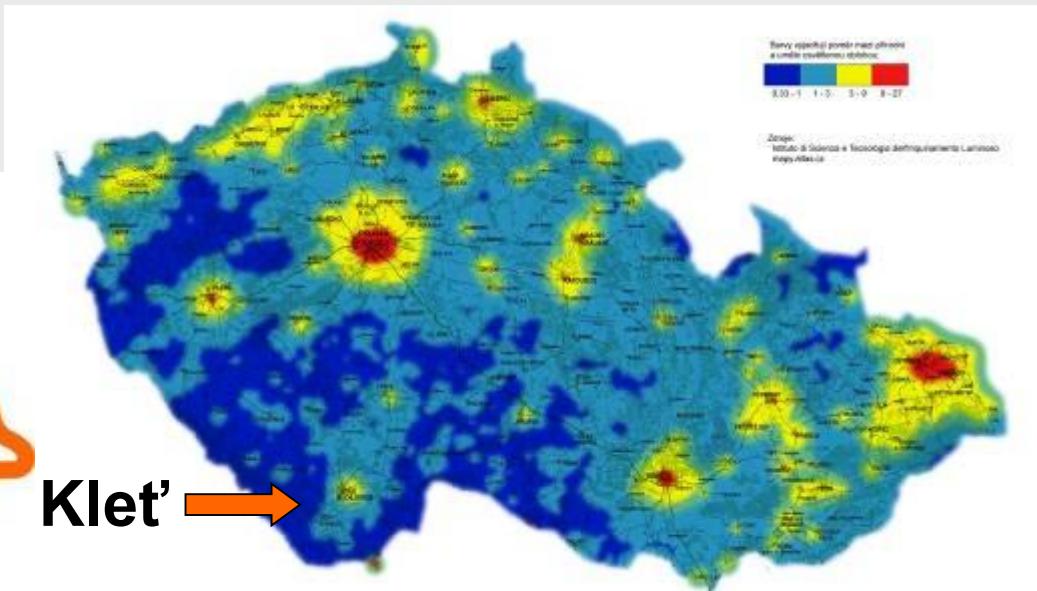


Current NEO data processing system





KLENOT Telescope Location



Klet'

Map of light pollution -
Czech Republic

- the Klet Observatory, South Bohemia, Czech Republic (Central Europe)
- geographical position: latitude $48^{\circ}51'48''N$ longitude $14^{\circ}17'17''E$
- elevation 1068 meters above sea level
- south from the top of the Klet mountain
- a rather dark site in the middle of the Protected Landscape Area Blansky les
- IAU/MPC code 246
- average number of clear nights per year about 120

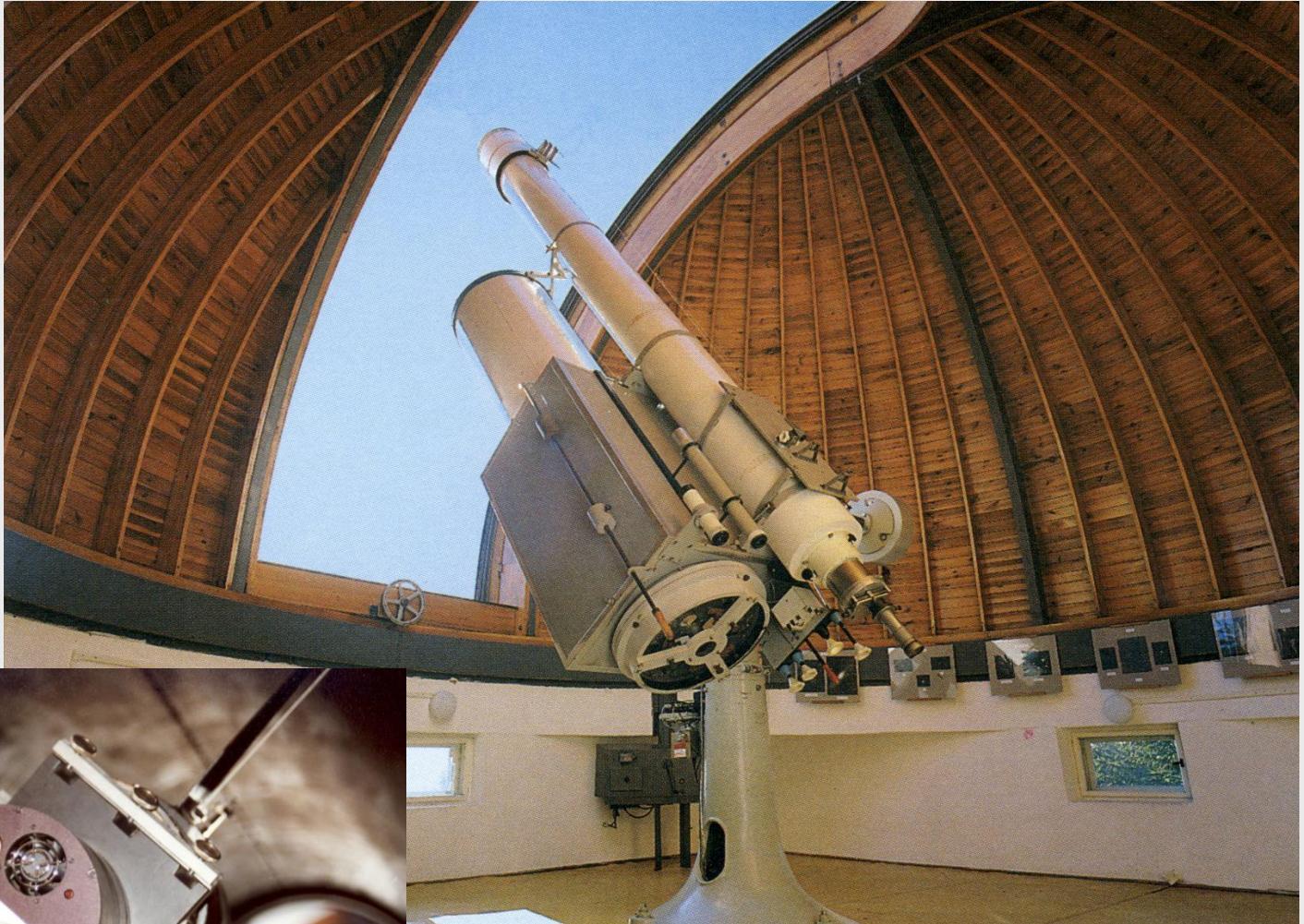


Klet' Mountain, South Bohemia, Czech Republic



Observatoř Klet'

Klet' Observatory, South Bohemia, Czech Republic



**Klet' 0,57-m reflector + CCD
(NEO astrometry since 1993,
MPC code 046)**

KLENOT

KLET

NEO

TNO

KLENOT

**KLEt observatory Near earth
and Other unusual objects
Team and Telescope**



Klet' Observatory





KLENOT Project milestones

- 1995 – **first idea** of KLENOT Project
- 1997 – **start** of KLENOT Project
- 2001 - **first light** of KLENOT Telescope
- 2002 Feb. - **first NEO astrometry** - 2000 DM8
- 2002 Mar. - **MPC code 246** Klet Observatory-KLENOT
- 2002 Jun. – **first NEO discovery** (Apollo 2002 LK)
- 2005/2006 – **new dome** for KLENOT telescope
- 2008-2011 – **new computer controlled mount** for KLENOT Telescope
- 2013 – **new CCD camera** FLI Proline
- 2013 Sep. – first NEO astrometry with **KLENOT Telescope**
Next Generation
- 2014 –**start of ESA contract** as Cooperating Sensor of ESA-SSA-NEO



IAA Planetary Defense Conference 2013, Flagstaff

Professional follow up

- Klenot (Klet Obs.) - 1.1-m f/ 2.7, $V_{lim} \sim 22$.
- Table Mountain Observatory (JPL) - 0.61-m, f/16.
- Mt. John Observatory, New Zealand - 0.64-m
- The MLS (G96) routinely uses ~ 25% of the time to observe NEOCP objects fainter than V=20.
- Spacewatch II (291) is now used exclusively for faint follow up.
- LINEAR will also follow up objects.

IAU Symposium 236, 2006 August 16, Prague



General Assembly 2006
IAU Symposium 236 (NEOs)



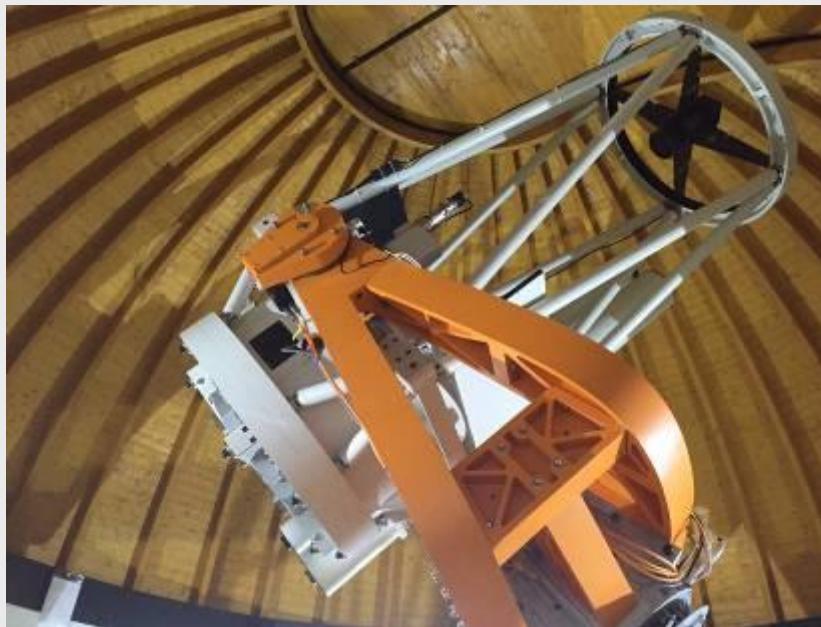
KLENOT Project Goals

- **confirmatory observations of newly discovered fainter NEO candidates**
- **early follow-up of newly discovered NEOs**
- **long-arc follow-up astrometry of NEOs in need of further data**
- **higher priority given to Potentially Hazardous Asteroids (PHAs) and Virtual Impactors (VIs)**
- **recoveries of NEOs in the second opposition**
- **follow-up astrometry of radar/ mission targets, special follow-up requests**
- **follow-up astrometry of other unusual objects (comets, bright TNOs)**
- **analysis of cometary features of suspected bodies**
- **search for new asteroids, especially NEOs as well as other objects having unusual motion**

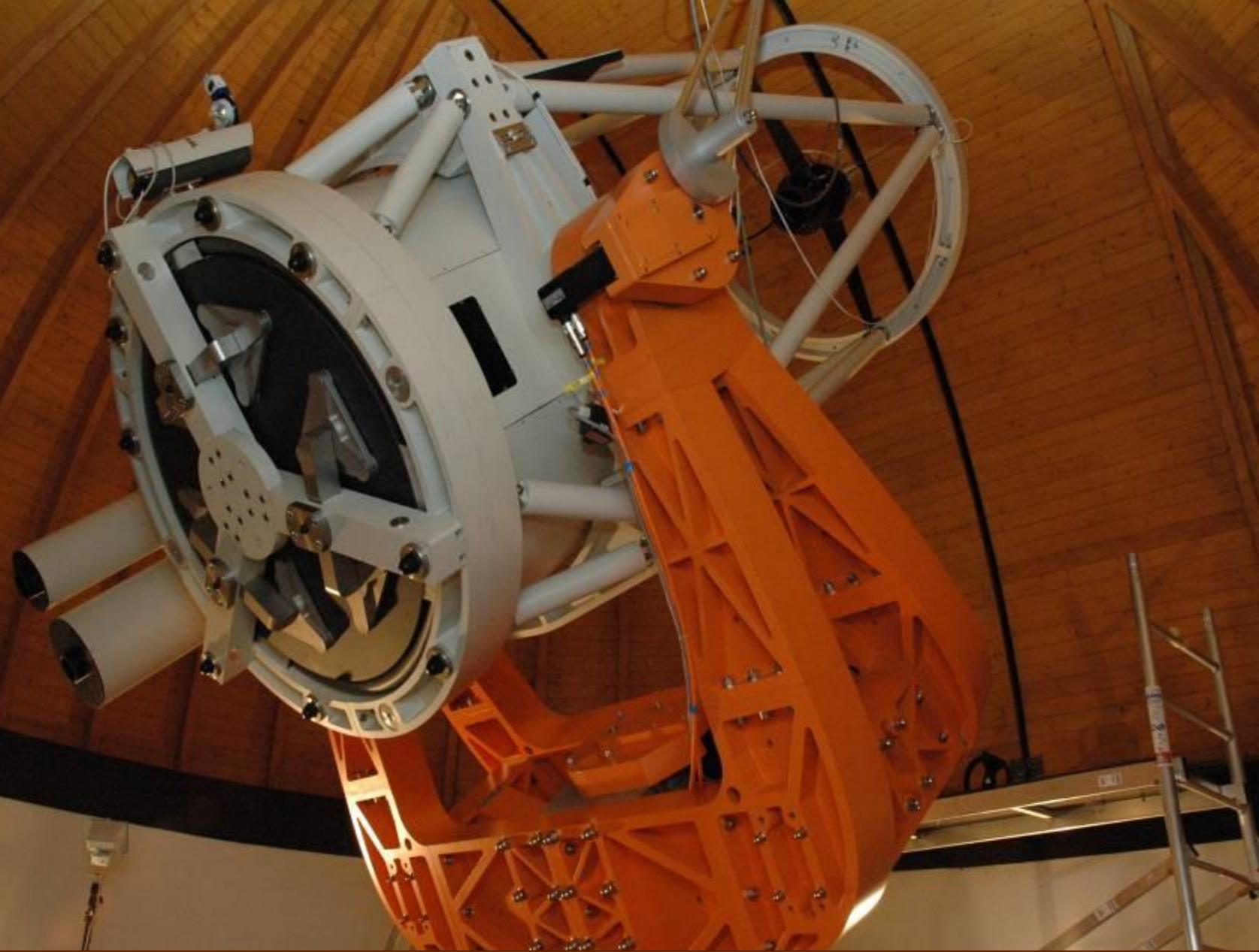


KLENOT Telescope

- **1.06-m f/3 mirror (Zeiss GmbH – Sital glass)**
- **4-lenses optical corector (SINCON + Charles University, Prague)**
- **CCD camera FLI ProLine PL230** (chip e2v, 2048 x 2048 pixels, pixel size 15 microns, electronic cooling-Peltiers)



**final optical system 1.06-m f/2.7
field of view 39 x 39 arcminutes, 1.2"/pixel**



**1,06-m KLENOT Telescope + CCD + Computer Controlled
Paralactic Mount (NEO astrometry, MPC code 246)**



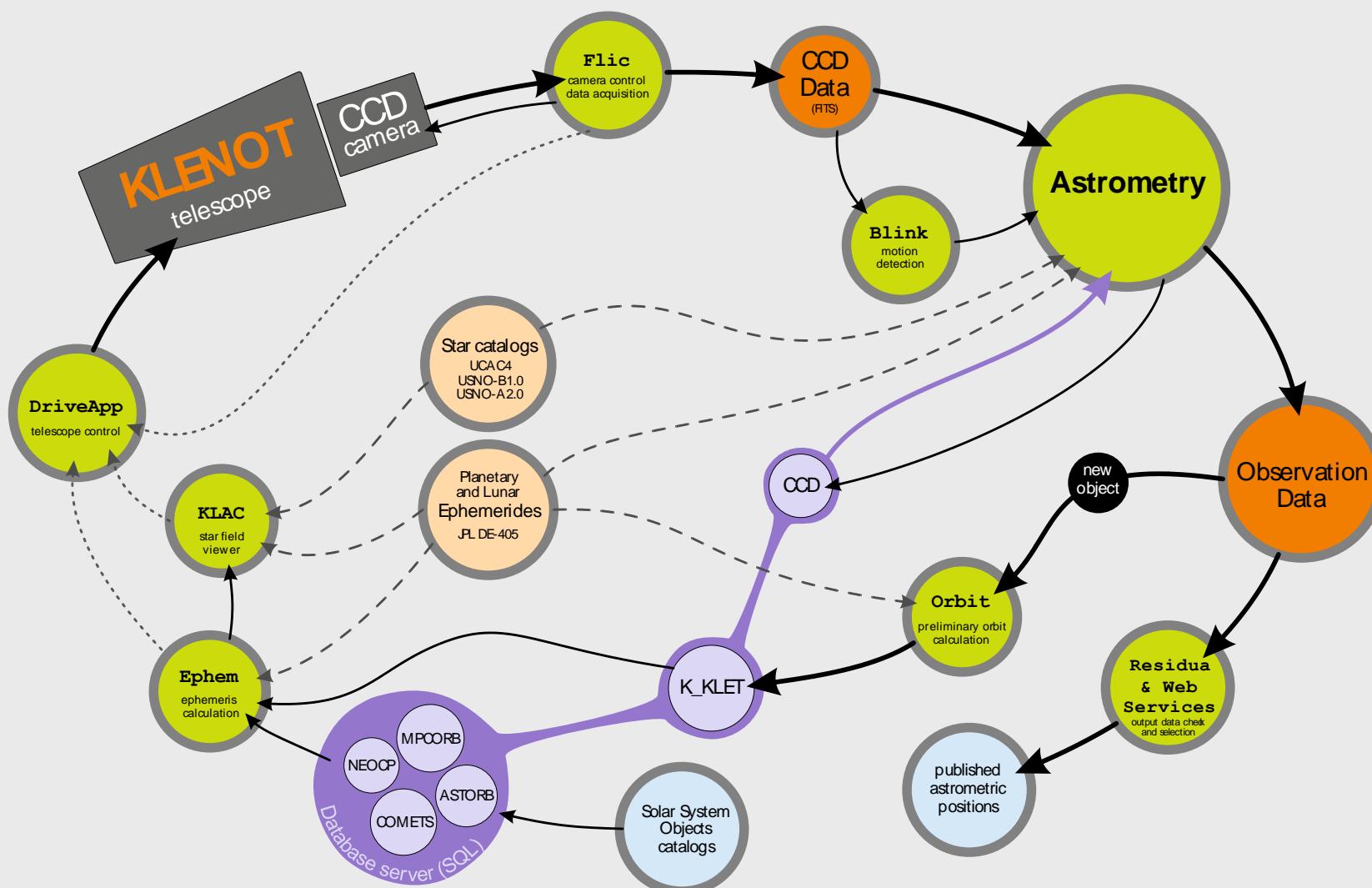
CCD detector for KLENOT Project

FLI ProLine PL230 (since 2013)





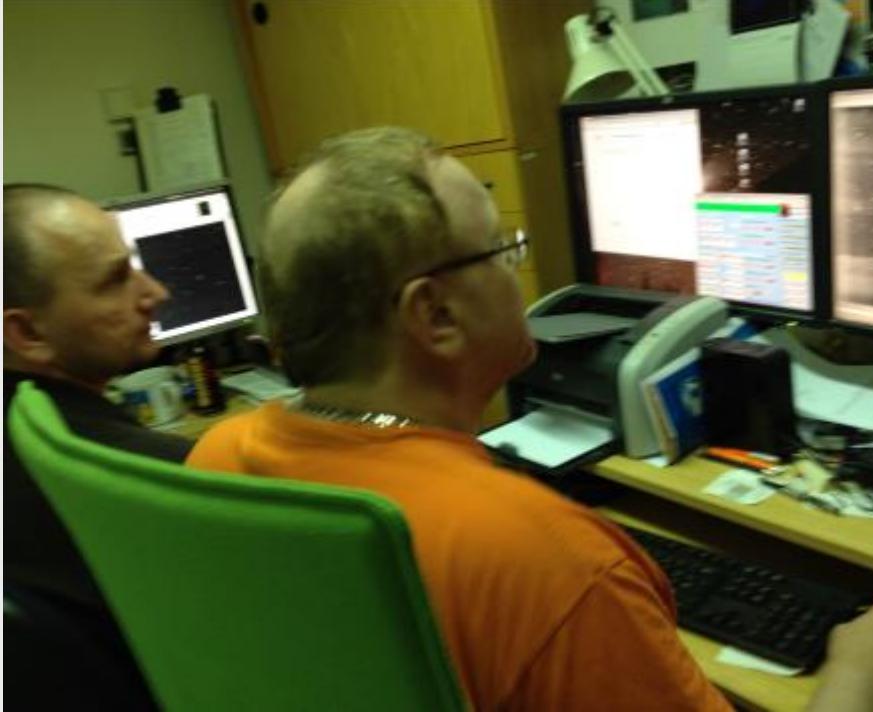
KLENOT Project software/hardware





KLENOT PROJECT ADVANTAGES

- full observing time is dedicated to the KLENOT team
- quick changes in an observing plan possible, even during an observing night
- long-term NEO activities at Klet (since 1992)
- experienced observers/measurers visually validate each moving object candidate
- real-time processing of targeted objects





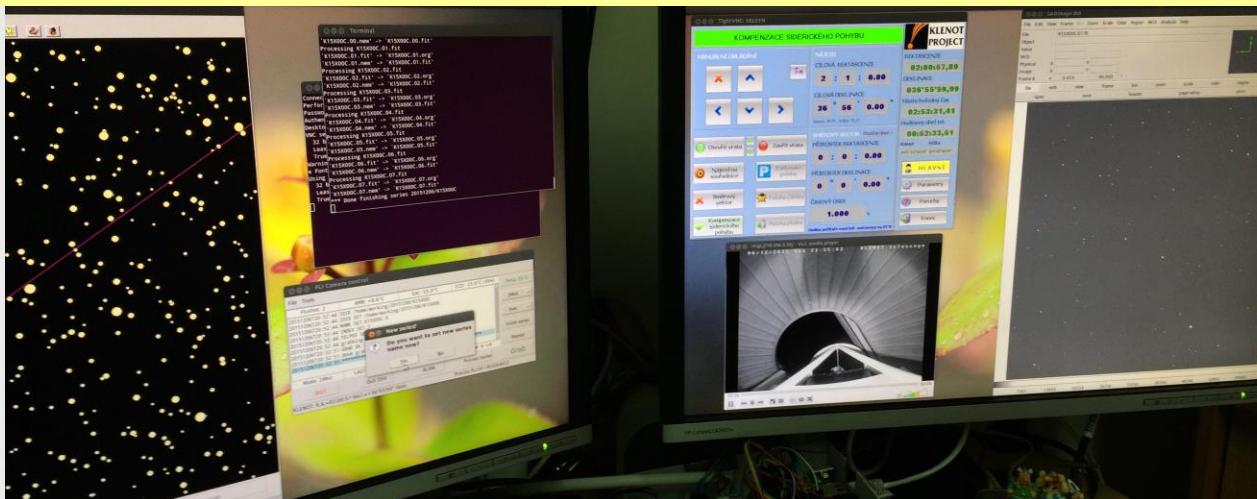
KLENOT Project First Phase Results (2002-2008)

- total of 52,658 astrometric measurements of 5,867 bodies,
it contains:
- 13,342 astrometric measurements of 1,369 NEAs (MPC,NEODys)
- confirmation and astrometry of 623 NEAs from NEOCP (MPECs)
- recoveries of 4 comets and 16 NEAs (including 196P/Tichý)
- astrometry of 157 Virtual Impactors (CLOMON, SENTRY)
- detection of cometary features of 34 bodies (IAUCs)
- astrometry of Centaurs, TNOs and SDOs
- discovery of splitting of comet C/2004 S1 (Van Ness)
- independent discovery of 4 fragments of comet 73P/S-W 3
- asteroid discoveries - 750 bodies
- 3 NEOs - Apollo 2002 LK, Aten 2003 UT55, Apollo 2006 XR4
- 1 JFA – 2004 RT109



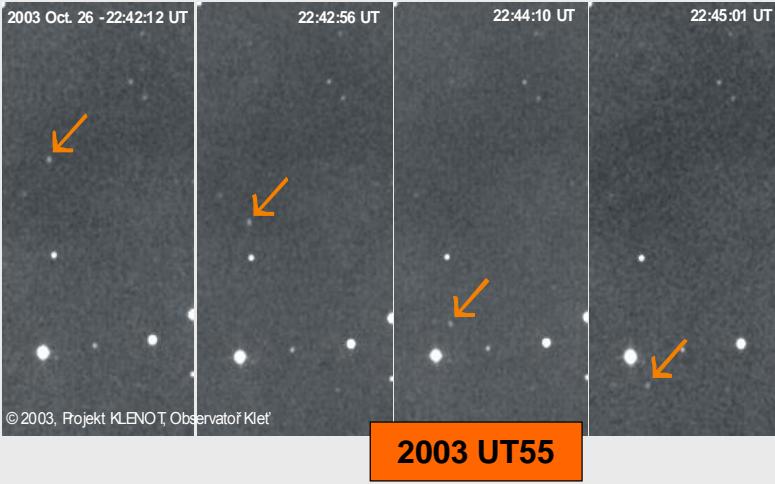
KLENOT Project ESA-SSA Results (Oct. 2014-Dec. 2015)

- total of 10,016 astrometric measurements of 1,285 bodies, it contains:
- 2,649 astrometric measurements of 259 NEAs (24 Atens, 136 Apollos, 99 Amors)
- astrometry of 148 objects from the NEO Confirmation Page
- follow-up astrometry of 5 Virtual Impactors
- detection of cometary features of 5 bodies





KLENOT images...





KLENOT images...



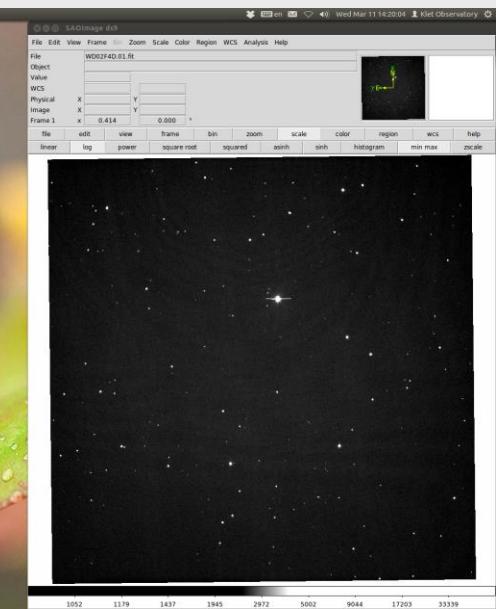
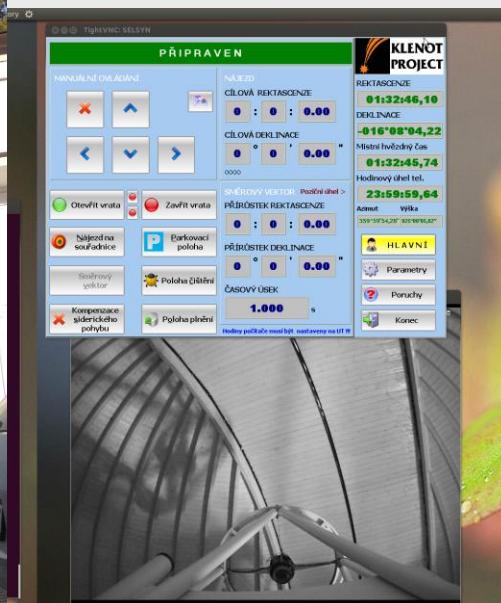
The collage consists of five windows from the KLENOT software:

- KLENOT Atlas**: A map showing numerous stars and a grid overlay.
- ITI Camera control**: A window showing camera settings: Mode 24Hz, LAST--01:32:46, Serie WD04452, Frame: 1 ->2. It includes buttons for QUIT, BLINK, Process Series, and Grab.
- TightVNC: SELSYN**: A configuration window titled "PŘIPRAVEN" (Prepared) showing coordinates (RA 01:32:46.10, Dec -01° 08' 04.22), field size (0.0000), and a "Hodinový úsek" (Hourly segment) set to 23:59:59, 04. It lists various telescope controls like "Otevřít vrata" (Open door), "Parkovací poloha" (Parking position), and "Poloha čidla" (Sensor position).
- SAOImage ds9**: A astronomical image viewer showing a dark field with several stars. It has a menu bar with File, Edit, View, Frame, Zoom, Scale, Color, Region, WCS, Analysis, Help.
- Console Window**: A terminal window displaying log output for file processing, including fields like RA, Dec, and various status messages.





KLENOT images...





ACKNOWLEDGEMENT

- The Southbohemian Region (since 2003) 
- The NEO Shoemaker Grant of the Planetary Society (2000)
- ESA Contract No. 4000112347/14/D/MRP
**SSA-P2-NEO-IV Observations with Cooperating Sensors
(since 2014)**

<http://www.klet.org>