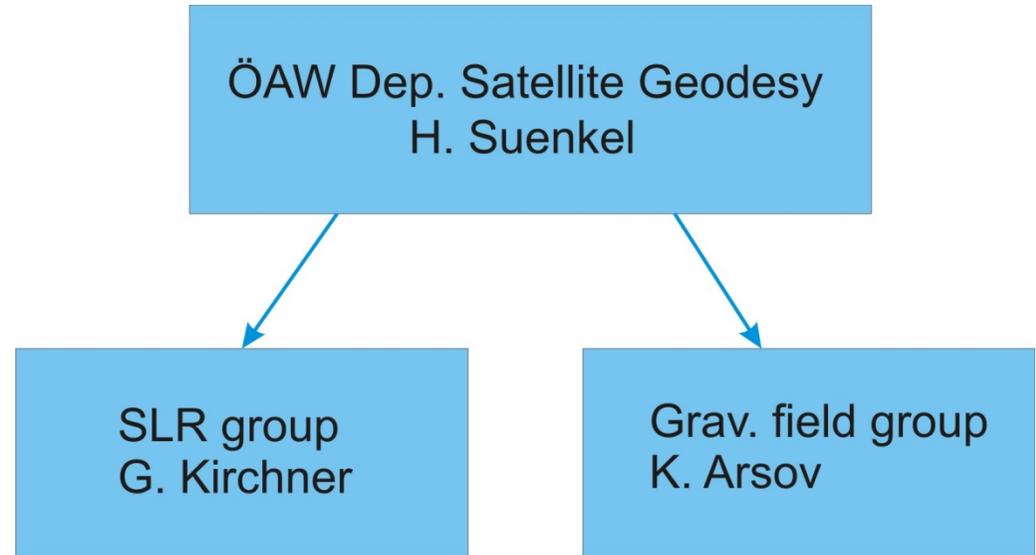


# Towards 2KHz new SLR system in Metsähovi

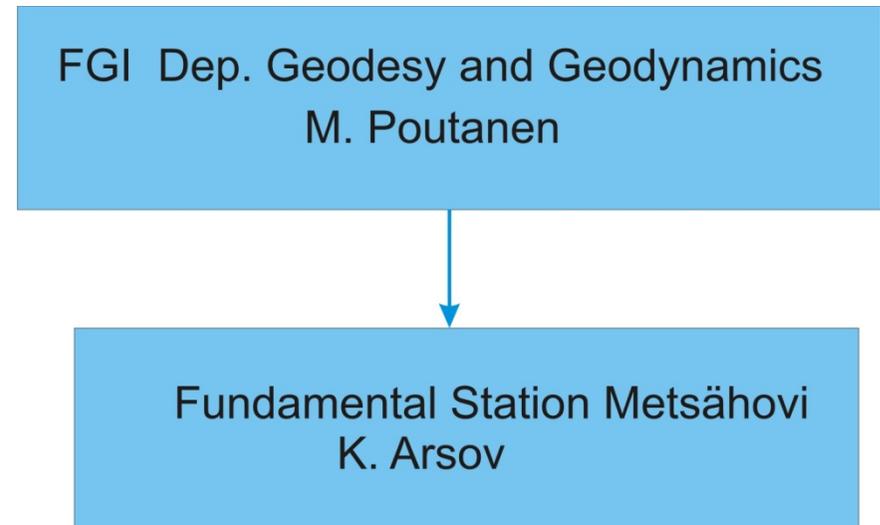
*K.Arsov, A.Raja-Halli, J. Näränen, M.Poutanen  
Finnish Geodetic Institute  
Finland*

# Short Bio

- Before Finland:



- Now:

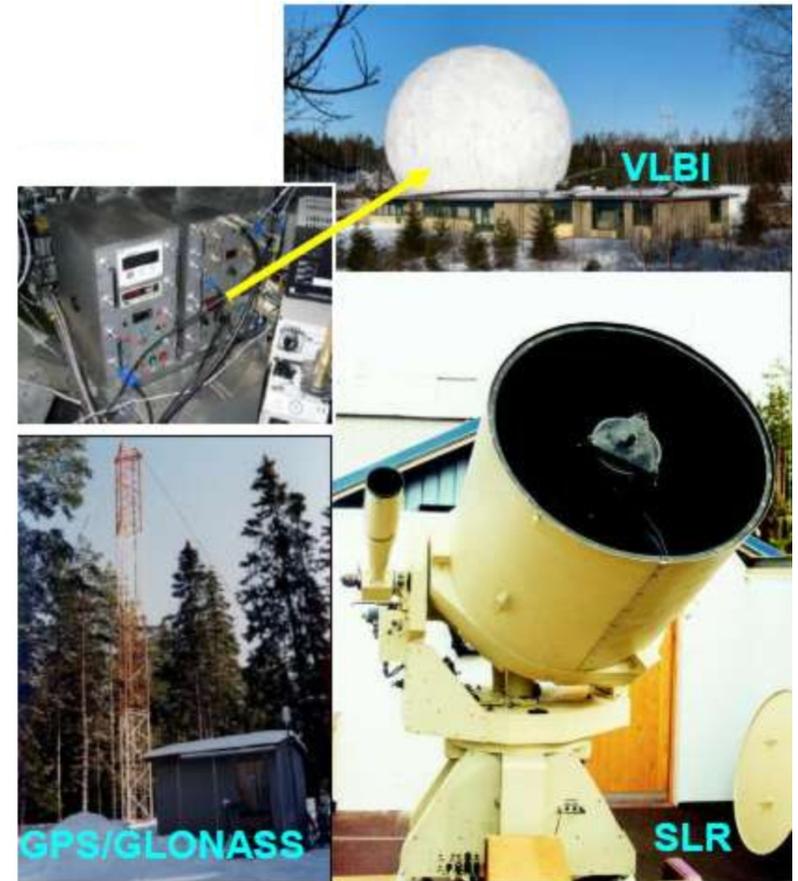


# Some Department Tasks

- EUREF and its realization in Finland (EUREF-FIN), connection to the international frames;
- Vertical datums, precise levelling, and new Finnish height system, participation in the creation of new European vertical datum;
- Participation on IAG services (IGS, IVS, ILRS, IDS) and other international permanent geodetic networks (EPN, GGP, NGOS, GGOS ...), especially using FinnRef and the instrumentation in Metsähovi;
- Promotion, education and consultation on new reference frames in Finland;

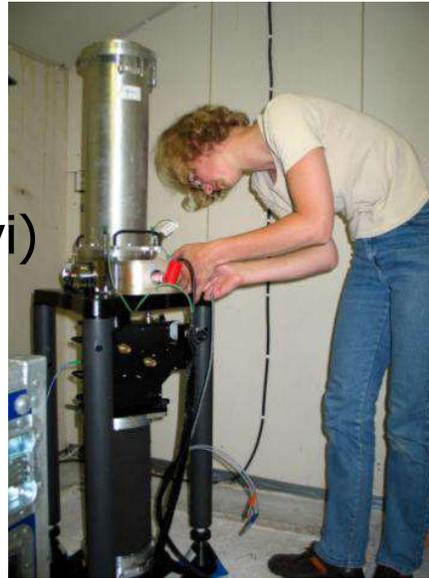
# Metsähovi instrumentation

- GPS (IGS station since 1992)
- GPS/GLONASS
- SLR (1978-)
- geo-VLBI (2004-)
- DORIS
- SCG
- Abs. Gravity
- (Seismometer)



# Absolute Gravity

- NGOS
- Intercomparisons /(Metsähovi)
- Measurements abroad



# Superconducting Gravity

- Study on the environmental effects and loading on the gravity; Earth free oscillations
- Loading studies combined with other methods like GPS and gravity satellites, as well as other geodynamic-related work
- Participation on GGP (Global Geodynamics Project)



# VLBI

- 6-8 sessions per year
- Cooperation with HUT
- E-VLBI experiments  
8Gb data transfer



# SLR - General

- The system was not operational from second half of 2005
- Old 1Hz system, maintenance become more and more difficult, most of the equipment obsolete and not working
- Personnel change; in late 2006 decision to completely renovate the system, and started in apr 2007.
- New laser late 2006, HighQ 2KHz, Nd:VAN solid state laser., pulse 12.3ps 830mW, 0.425mJ @532nm
- Purchase of A032-ET for 2KHz timing
- For RGG Graz fpga board
- UTC timing; GPS time + frequency receiver from CNSSYS (used frequently in VLBI); It serves also as NTP time server, all computers synchronized with this via LAN
- Meteo server; Vaisala PTU200 (in the station at the moment 5 barometers present)

# SLR-General

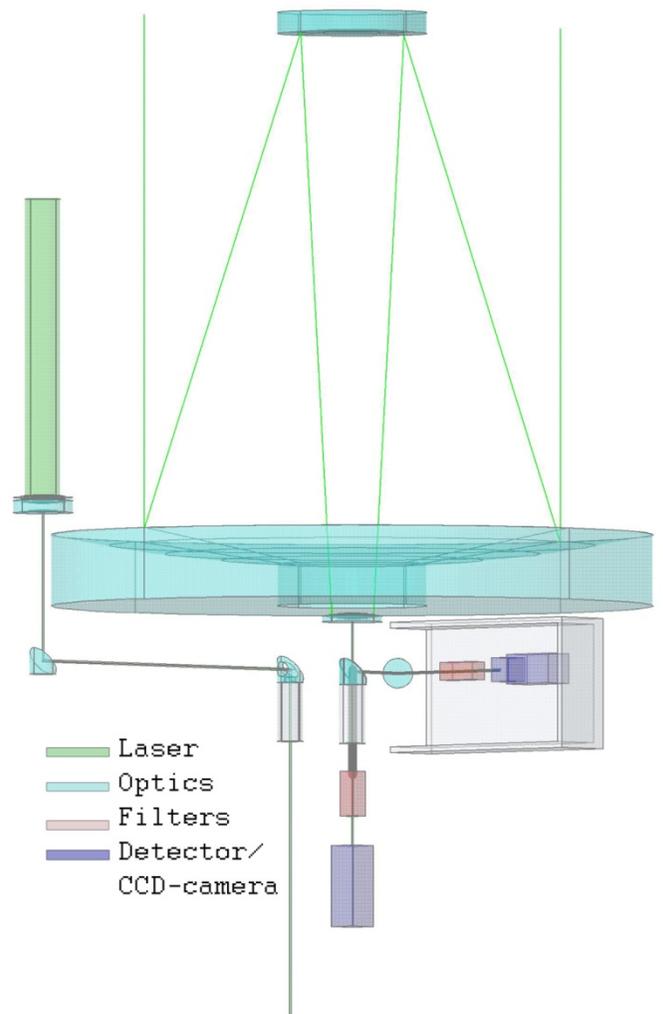
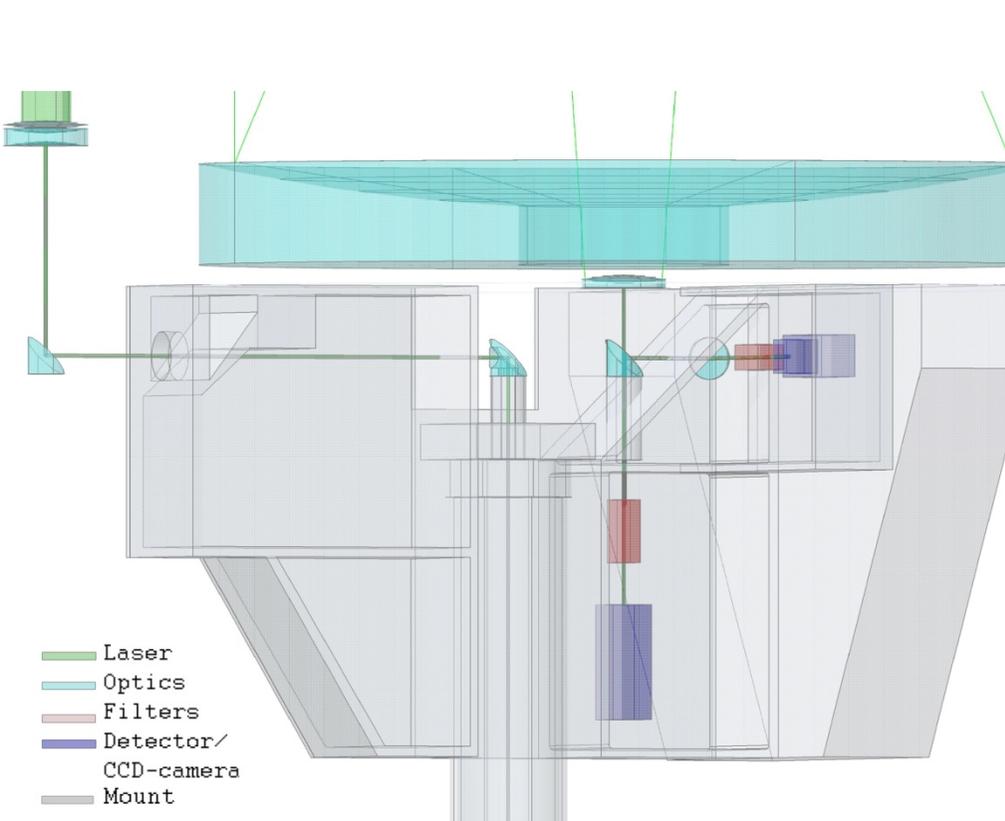
- New photodetector C-SPAD replaced the old PMT
- Couple of pulse distributors
- Timing signal from H. Maser
- New encoders for the telescope together with motors, complete renovation of the telescope is undergoing
- New room for SLR instrumentation
- New operational software from scratch to suit the new 2KHz SLR ongoing
- Primary telescope mirror recoated
- Mechanical/optical solution for the separate beam path under implementation
- Seeking funding for a new telescope and a dome to host the new SLR observatory building in the future

# SLR-Telescope Renovation

- Recoating of the main 1m mirror  
Jan 2009 (Zeiss -> 4H eng. )
- Separate laser beam channels
- New encoders
- New telescope motors
- New optical setup in development
- Recoating of the secondary mirror
- Change the telescope focus
- Receiver box (C-Spad etc)
- Justification calibration, colimation



# SLR-Telescope Channels



# SLR-Software

- Writing everything from scratch tailored to 2KHz system
  - Use C++ as main language and whenever possible Assembler
- 2 Computers concept: Real time DOS for RGG (fpga); Master Windows computer for session planning, SLR measurement, Graphics, comm. with DOS via PCI-DIO-96 fast and reliable; 1Gb LAN as backup and time server readings.
  - Soon hit the wall of DOS incapacibilities;
  - Now reliable DOS
  - Everything is 32bit, computations in 32bit protected mode CWSDPMI server, DOS extender inside DOS, program runs on top of DOS in protected mode
  - Full PCI usage (32 bits) and GbLAN
  - 4GB RAM for use (normally DOS lets only 1MB)

# SLR-Software

- When OS tasks needed, switch back via A20 gate ( $1\mu\text{s}$ )
- DJGPP (gpp for DOS) compiler ported DJ Delorie
- Windows Master computer
  - Use of C++ and MFC libraries (Assembler where possible)
  - As automatic as possible; Own control of all windows messages
  - Module for session planning, satellites manipulation, ftp orbits downloading etc
  - Module for meteo and timing data management
  - Module for DOS communication, A032-ET timer reading, etc
  - Graphics was critical item; solved with DirectX 10 and powerfull Graphics board; part of the software is implemented as PC video game.
  - Can handle SLR measurements up to 7KHz without problem
  - Can filter residuals up to 1% (0.1% still in test phase)
  - Auto Range Gate setting, TB, RB (in development phase)

# SLR- RT Session Animation

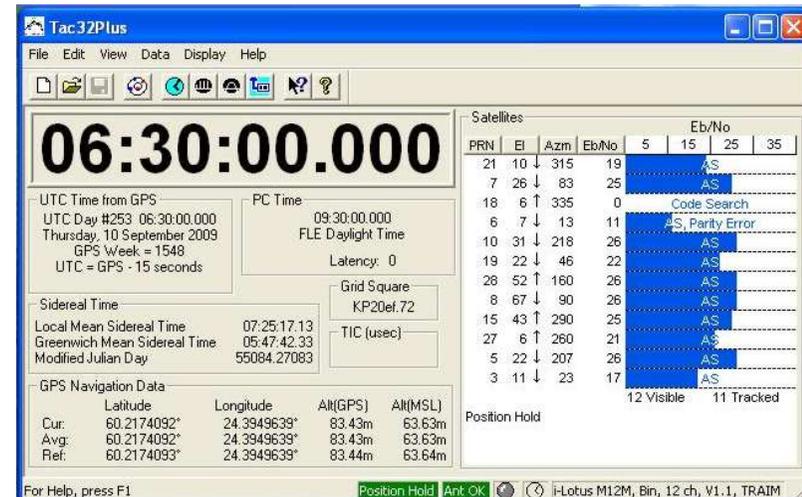
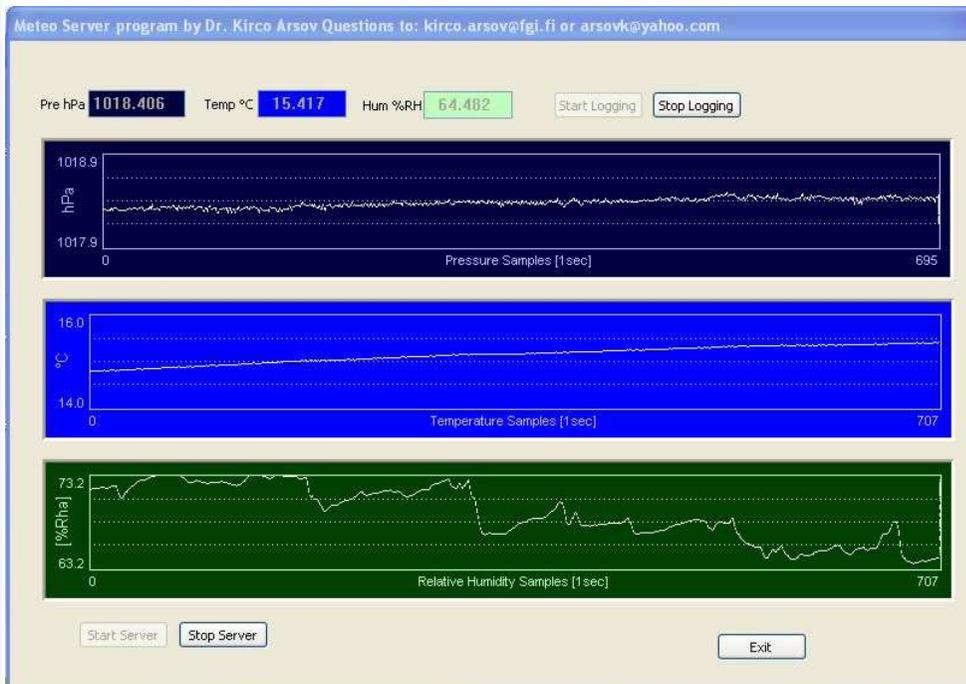


- Directx 10
- Render with DEM
- Refresh 60 fps

- Animate the orbit with the terrain
- Introduce lighting and shading + camera moving
- Everything within the board (no CPU usage)
- Not Nr. 1 priority

# SLR-Software Meteo+UTC

- Own program for meteo data
- CNS Clock II used for UTC offset



# SLR-SW future work

- PCIe FPGA reprogramming with ROACH board
- Smart satellite search, RB, TB determination in real time
- Auto RG\_WID setting
- Kalman to aid in filtering ?
- More clever session planning, real time visibility and sat plot
- Post processing module (use Graz version for starting)
- Telescope control module
- Work on higher rates ?
- More automation
- Virtual observation animation

# SLR Software Demo

Metsähovi SLR Operational Software by Dr. Kirco Arsov

Home Slr Session DOS Commands A032-ET Settings Program Style

Cut Copy Paste Select All Clipboard View Status bar Caption bar

Session

Target	Start	Stop	Duration	Pass Rise	Rise El.	Ris
--------	-------	------	----------	-----------	----------	-----

Start ET  
Init PCI  
Set Cur. Arc  
Del. Cur. Arc

Dos Log Window

Metsähovi SLR OS Document: Ready Pane 1



**Thanks for your attention**

# A032-ET overlapping

The screenshot displays the 'Metsähovi SLR Operational Software by Dr. Kirco Arsov' interface. The 'A032-ET' tab is active, showing a session configuration table for 'Etalon1'.

Target	Start	Stop	Duration	Pass Rise	Rise El.	Ris
Etalon1	01.09.2009 05:15:00	01.09.2009 09:45:00	04:30:00	01.09.2009 05:15:00		

Below the table, a plot shows two overlapping signals (yellow and green) on a dark background, illustrating the 'A032-ET overlapping' mentioned in the title. The plot shows a horizontal line of data points with some vertical spikes.

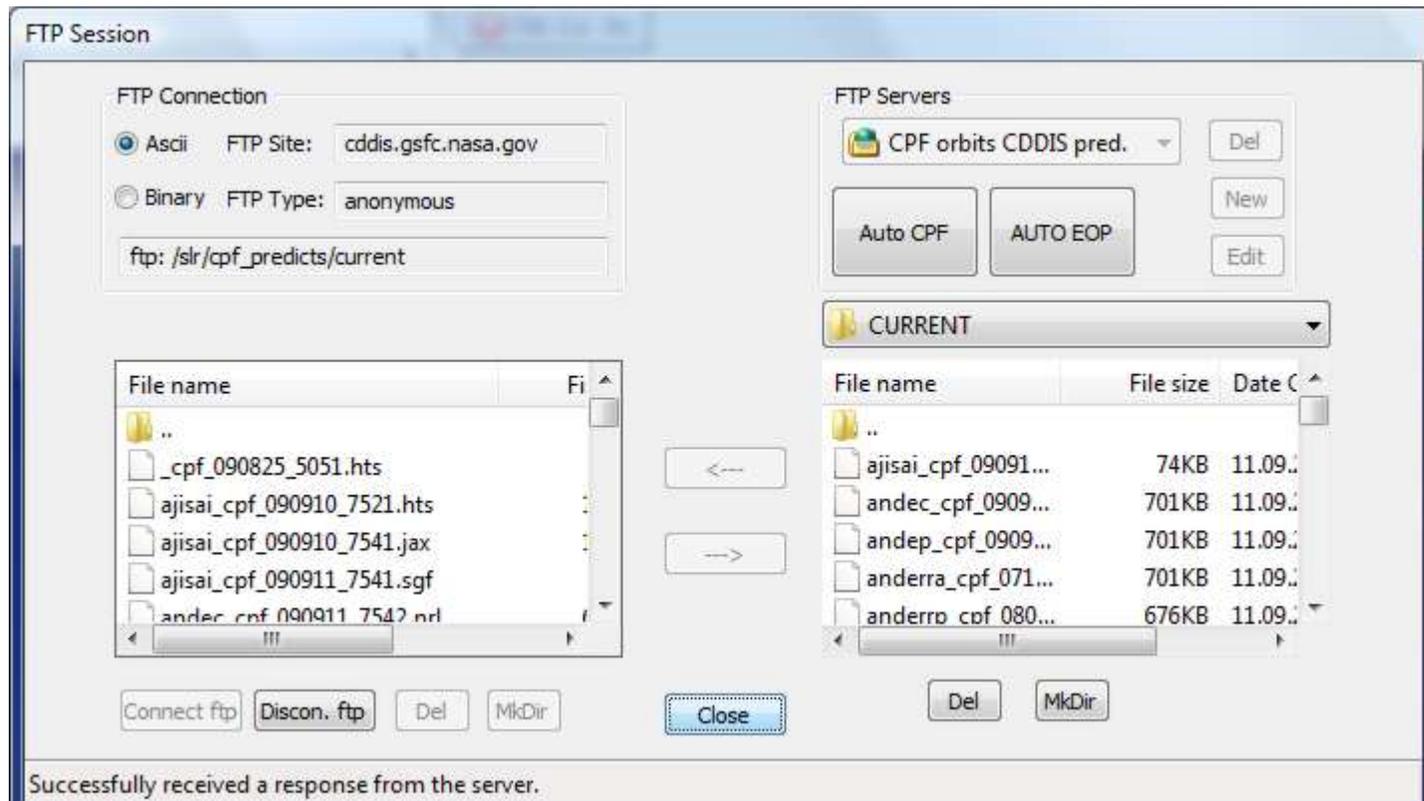
The interface also includes a 'Session' section with buttons for 'Start ET', 'Release PCI', 'Set Cur. Arc', and 'Del. Cur. Arc'. A status bar at the bottom indicates 'SLR Session Finished'.

On the left side of the desktop, there is a vertical list of numerical values from 400000 to 800000 in increments of 20000, and a 'c:\arsov' directory path.

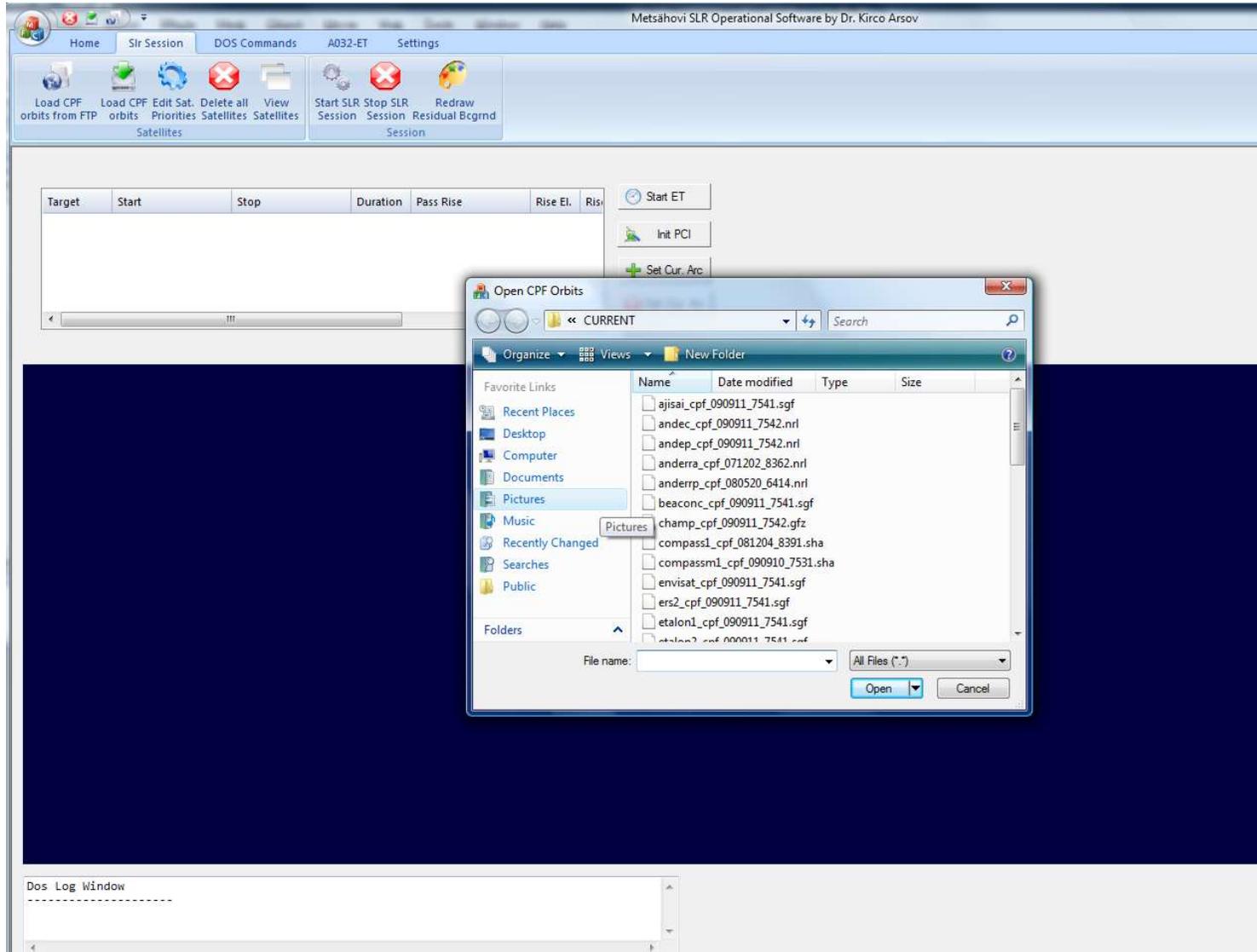
The taskbar at the bottom shows several open applications: Welcome Center, Metsähovi SLR..., OrbTests, Debug, Administrator..., UltraEdit-32..., Source files, SquirrelMail 1.4..., Metsähovi SLR..., and Satellites View. The system clock shows 11:39.



# SLR-Master cmp



# SLR-Master cmp



# SLR-Master cmp

The screenshot displays the 'Metsähovi SLR Operational Software by Dr. Kirco Arsov' interface. The main window has a menu bar with 'Home', 'Slr Session', 'DOS Commands', 'A032-ET', and 'Settings'. Below the menu bar is a toolbar with icons for 'Load orbits from FTP', 'Load orbits', 'Edit Sat. Priorities', 'Delete all Satellites', 'View Satellites', 'Start SLR Session', 'Stop SLR Session', and 'Redraw Residual Bcgrnd Session'.

The 'Session' section contains a table with the following data:

Target	Start	Stop	Duration	Pass Rise	Rise El.	Ris
goce	11.09.2009 07:57:00	11.09.2009 08:03:00	00:06:00	11.09.2009 07:57:00		
terrasarx	11.09.2009 08:35:45	11.09.2009 08:43:45	00:08:00	11.09.2009 08:35:45		
Envisat	11.09.2009 09:36:00	11.09.2009 09:48:00	00:12:00	11.09.2009 09:36:00		
terrasarx	11.09.2009 10:09:45	11.09.2009 10:15:45	00:06:00	11.09.2009 10:09:45		
Envisat	11.09.2009 11:15:00	11.09.2009 11:30:00	00:15:00	11.09.2009 11:15:00		

Overlaid on the bottom right is the 'Satellites Priorities edit dialog' box. It features a list of satellites with their priority levels, each with a checkbox:

- 01 graceb
- 01 gracea
- 02 champ
- 03 terrasarx
- 03 goce
- 04 envisat
- 05 ers2
- 06 jason1
- 07 jason2
- 08 oicets
- 09 larets
- 10 starlette
- 11 stella
- 12 ajsai
- 13 lageos2
- 14 lageos1
- 15 hearncr

The dialog box includes an 'Add Sat.' button, 'OK' and 'Cancel' buttons, and instructions: 'Double click a row to edit' and 'Select row(s) and hit del key to delete'.

# SLR-Master cmp

The screenshot displays the 'Metsähovi SLR Operational Software by Dr. Kirco Arsov' interface. The main window is titled 'Satellites View' and contains a 'Session' table and a satellite activity chart.

**Session Table:**

Target	Start	Stop
goce	11.09.2009 07:57:00	11.09.2009 11:15:00
terrasarx	11.09.2009 08:35:45	11.09.2009 11:09:00
Envisat	11.09.2009 09:36:00	11.09.2009 11:09:00
terrasarx	11.09.2009 10:09:45	11.09.2009 11:09:00
Envisat	11.09.2009 11:15:00	11.09.2009 11:09:00

**Satellite Activity Chart:**

The chart shows activity for various satellites from 05:00 to 12:00. The y-axis lists satellites: gracea, graceb, champ, goce, terrasarx, Envisat, ERS2, Jason1, Jason2, Larets, Starlette, Stella, Ajisai, Lageos2, Lageos1, BeaconC, Etalon1, and Etalon2. Blue bars indicate active periods. A red bar is visible for 'goce' around 06:30.

**Time Axis settings:**

Spacing: 1 Hrs, 0 Min. (Set)  
Start with: 0 Hrs, 0 Min. (Set)

**Session Time Window:**

Start Time: 10.09.2009 00:15:00  
End Time: 15.09.2009 22:31:45

**Satellite: goce details:**

Date	Time	Azim	Elev
11.09.2009	06:30:00	342.0°	14.5°
11.09.2009	06:36:00	238.7°	5.2°

Arc length [hh:mm:ss] 00:06:00  
Dt [s] 180 Nr. Pts 3 Prior 3

**Elevation Plot:**

A polar plot showing elevation (0 to 180 degrees) versus azimuth (0 to 360 degrees). A yellow curve indicates the satellite's path, starting at approximately 342 degrees azimuth and 14.5 degrees elevation, and ending at 238.7 degrees azimuth and 5.2 degrees elevation.

**Dos Log Window:**

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Metsähovi SLR OS Document: Ready