

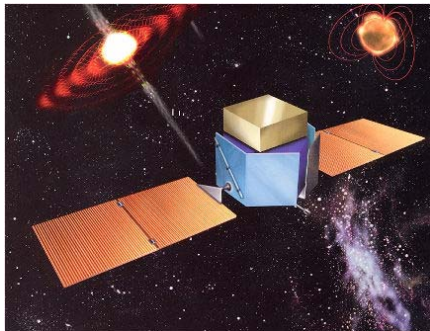


**Stefano Ciprini**  
 Tuorla Astronomical Observatory  
 University of Turku - Piikkiö, Finland  
 (EC Research Training Network ENIGMA)

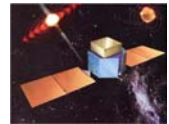


# The possible contribution of the Tuorla Observatory Team

AGILE MULTIWAVELENGTH GROUP (AMG) Meeting  
 Feb. 3, 2005 - INAF-IASF-RM, Roma



## Tuorla-Metsahovi teams interested to high energy AGN research

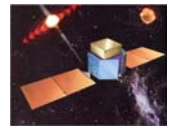


- Tuorla and Metsahovi AGN research groups are strictly linked. Both have asked (jointly to the Space-Research-Lab. Turku Univ.) to form a Center of Excellence in Finland.
- **Tuorla Observatory group:** A. Sillanpää, L.O. Takalo, E. Valtaoja, S. Ciprini, E. Lindfors, K. Nilsson, M. Pasanen, T. Savolainen, J. Virtanen, T. Pursimo, and other...  
 (+ people involved partially or in similar topic: A. Berdyugin, M. Hanski, T. Hyvönen, J. Kotilainen, M. Lainela, H. Lehto, E. Rastorgueva, M. Valtonen, K. Wiik, E. Örndahl.....)
- **Metsahovi Radio Observatory group:** M. Tornikoski, A. Lähteenmäki, M. Parviainen, H. Talvikki, H. Teräsraanta, I. Tornainen, M. Tröller, and other...



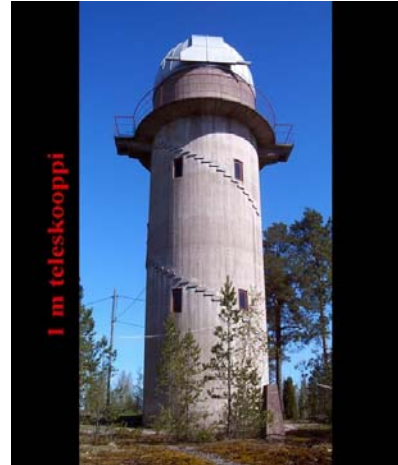
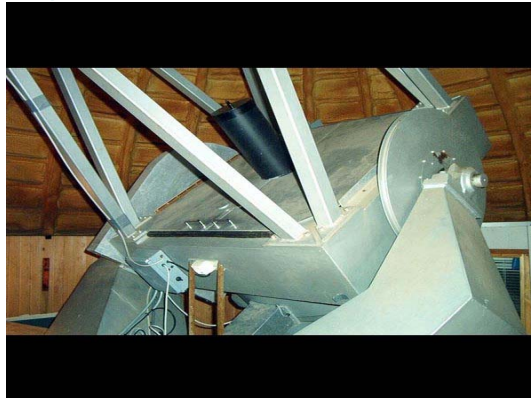
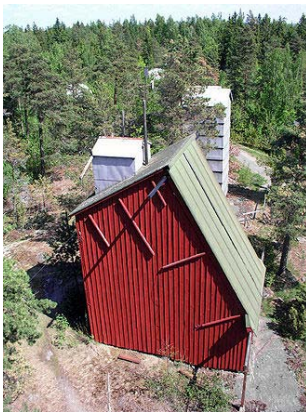


# Tuorla blazar optical monitoring: 1-m telescope



• Tuorla monitoring program of potential gamma-ray (GeV-TeV) blazars (since 2002), extracted from the list of Costamante & Ghisellini (2002). Observations mostly done with Tuorla 1m telescope (therefore only objects with dec. > 20°). KVA 0.6m telescope on La Palma is also used now to monitoring these and other sources.

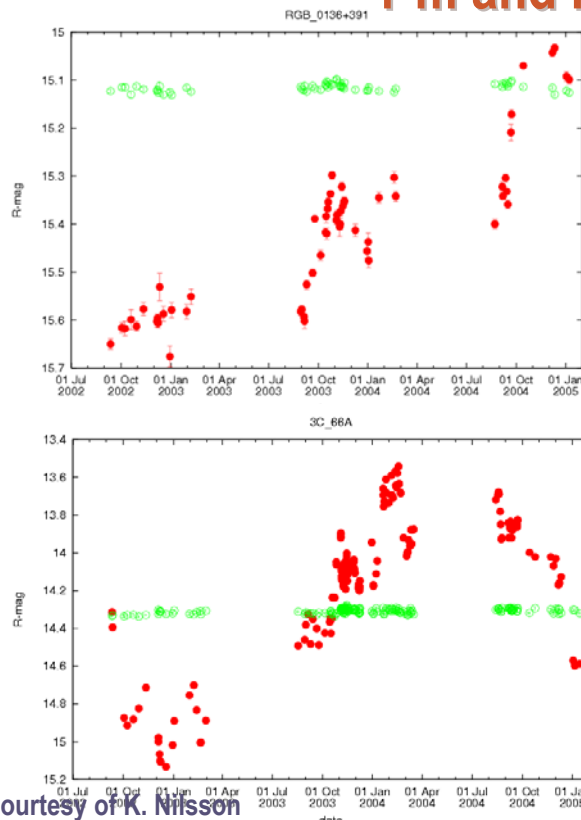
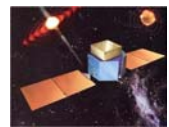
• For some of the selected targets no previous optical photometry exists (ongoing calibration sequences for several fields). The aim is to measure their variability properties and select possible interesting targets for follow-up studies, possibly involving also **gamma-ray observations**.



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# Tuorla blazar optical monitoring: 1-m and KVA observations



- |              |               |
|--------------|---------------|
| 1ES 0033+595 | 1ES 1218+304  |
| 1ES 0120+340 | RGB 1417+257  |
| RGB 0136+391 | 1ES 1426+428  |
| RGB 0214+517 | 1ES 1544+820  |
| 3C 66A       | Mkn 501       |
| 1ES 0647+250 | OT 546        |
| 1ES 0806+524 | 1ES 1959+650  |
| OJ 287       | BL Lac        |
| 1ES 1011+496 | 1ES 2344+514  |
| 1ES 1028+511 | HB89 0317+185 |
| Mkn 421      | 1ES 0323+022  |
| RGB 1117+202 | AO 0235+164   |
| Mkn 180      | S5 0716+714   |
| RGB 1136+676 | PKS 0735+178  |
| ON 325       | 3C 279        |
|              | PKS 2155-304  |

• data preview:

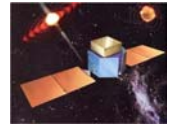
<http://users.utu.fi/kani/1m/index.html>

Courtesy of K. Nilsson

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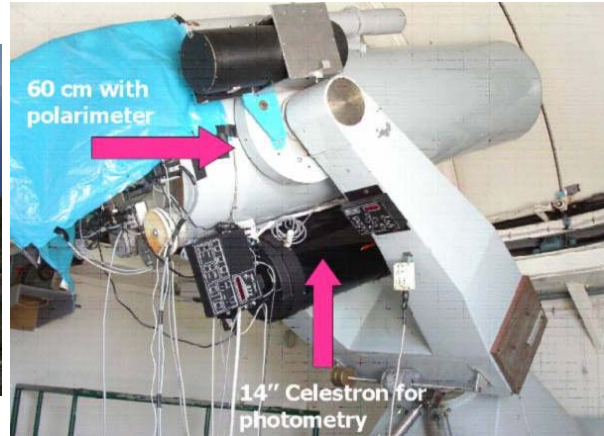


# KVA remote optical telescope



- The 60 cm telescope on La Palma (Canary Island) is used remotely from Tuorla Observatory (Finland). **BVR optical photometry + optical polarization**. Primary function: follow-up for MAGIC targets, but also successful participation to MW-campaigns (e.g. last HESS MW campaign on PKS 2155-304, INTEGRAL MW campaign on S5 0716+71, RXTE MW campaign on 3C 66A, XMM MW campaign on AO 0235+164, etc.).

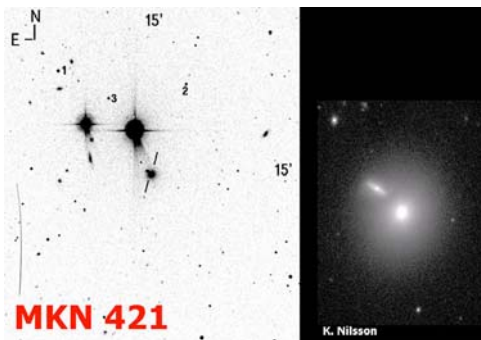
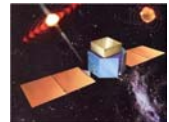
- Work on upgrading the telescope and the system and making the telescope from remote to fully automatic is in progress. **KVA available also for AGILE target follow-up and simultaneous optical flux/polarization monitoring** (also "slight-southern" AGN).



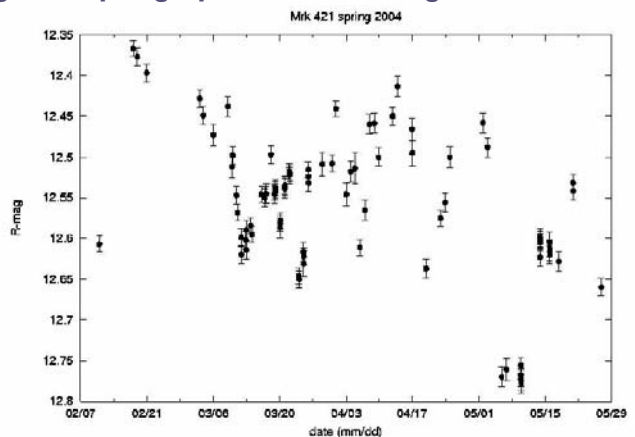
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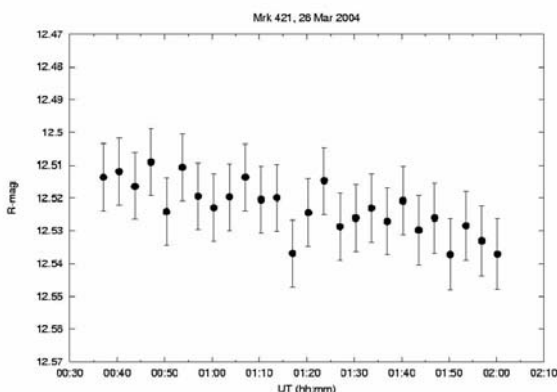
# KVA observations: an example



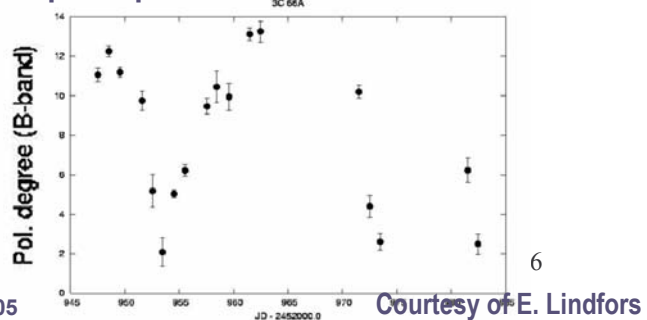
- high-sampling optical monitoring



- intra-night optical observations



- optical polarization observations

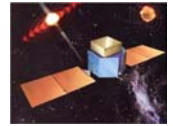


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Courtesy of E. Lindfors



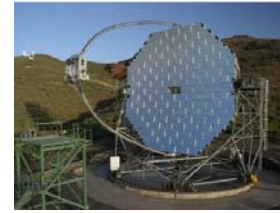
## Tuorla collaboration to MAGIC



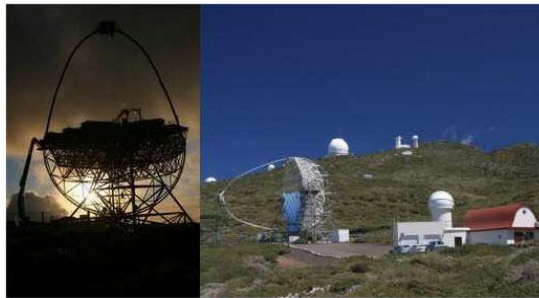
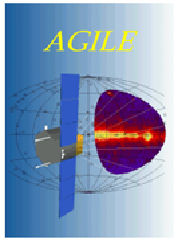
- **MAGIC: 17-m imaging Cherenkov telescope** designed to detect cosmic gamma-ray photons ( $E = 30 \text{ GeV} - 1 \text{ TeV}$ ), located on La Palma (Canary Islands). MAGIC-collaboration: 18 (mostly European) institutes.



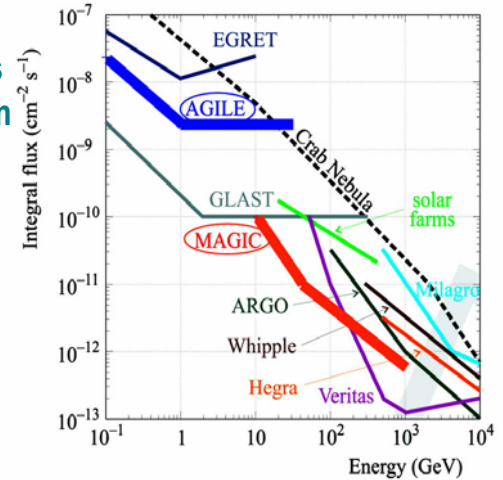
- **Main contribution of Tuorla Observatory collaboration:** use of the 60 cm KVA telescope in connection with MAGIC. Truly simultaneous optical and gamma-ray observations, and access to some MAGIC data.



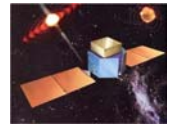
- **Possible joint MAGIC-AGILE gamma-ray observations (proposals).** Almost all the gamma-ray energy spectrum covered!



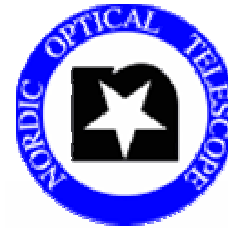
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## Optical and near-IR observations with NOT



- **Nordic Optical Telescope (NOT, 2.5 m telescope):** instrumentation: UBVRI optical photometry and imaging, JHK near-IR photometry, optical and near-IR spectroscopy, optical linear and circular polarimetry.



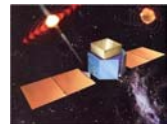
- **Possible deep optical-IR imaging and polarimetry observation of some AGILE AGN (proposals).**



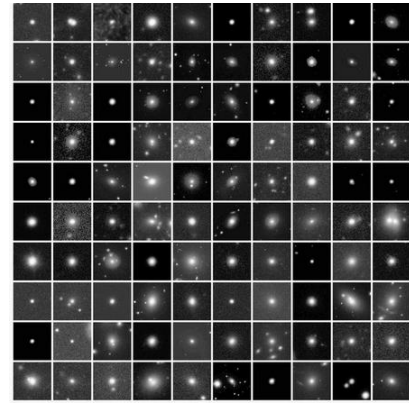
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# NOT observations: example

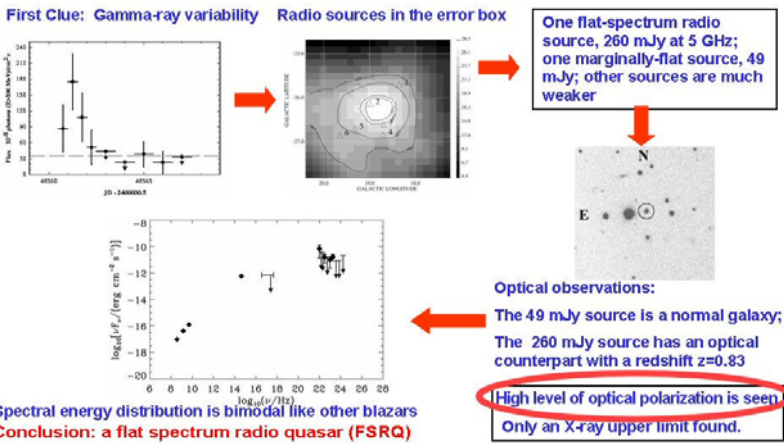


- R-band imaging of 100 BL Lac host galaxies from the RGB catalog of intermediate blazars (Laurent-Muehleisen et. al . 1999) observed at NOT.
- Near-IR spectroscopy, study of the cosmic evolution of quasar host galaxies, central black hole masses, etc.
- Optical polarization surveys for confirmations of new BL Lac and new EGRET identification.

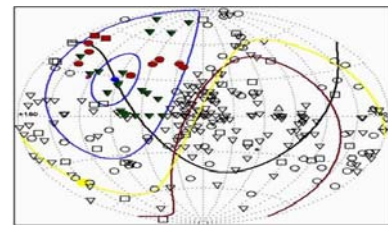


Courtesy of K. Nilsson

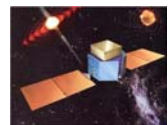
## Blazar Identification Example: 3EG J2006-2321



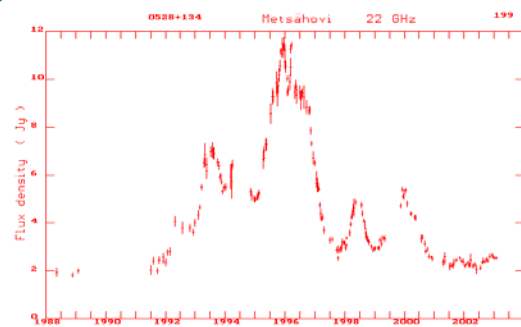
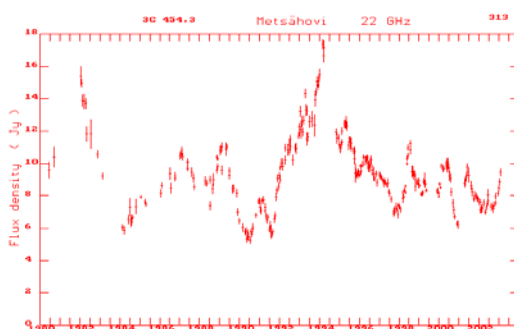
- Possible NOT optical polarization observation of new AGILE gamma-ray blazar candidates



# Metsähovi AGN radio monitoring

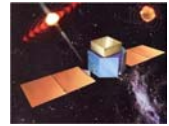


- Metsähovi 14-m radio telescope: most of the observing time is dedicated to the monitoring of quasars/FSRQ/AGN/inverted spectrum radiogalaxies (frequencies 22, 37 and 90 GHz) since 1980. Main sample of 85 sources.
- Swedish-ESO Submillimetre Telescope (SEST) on ESO (Chile): 90 and 230 GHz historical data available.
- Foreground AGN research with the PLANK satellite collaboration.
- Metsahovi radio telescope available also for AGILE target follow-up and simultaneous radio flux monitoring (AGN/radio-jets – gamma-ray emission connection). PLANK-AGILE connection.

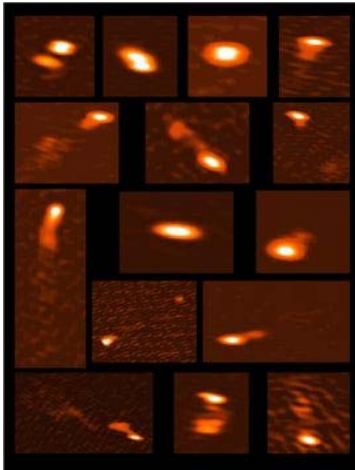




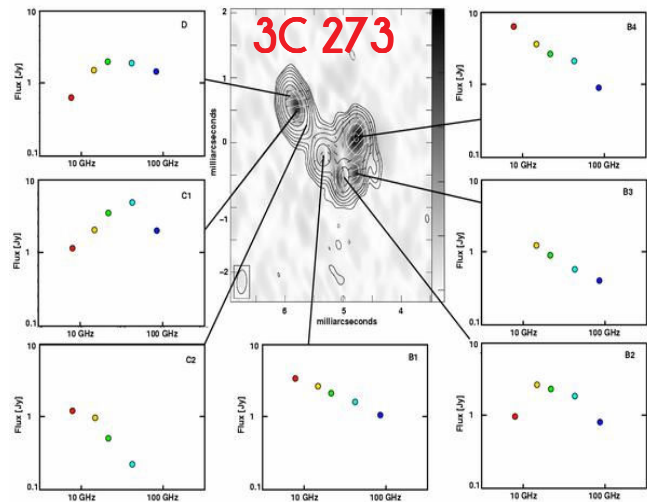
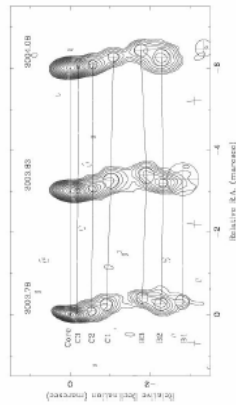
# VLBA and VLBI radio observations



- Metsähovi is a member of the European VLBI Network. They participated in several VLBI sessions. One of the main research topics: study of the correlations between VLBI-structure at different frequencies and the radio-mm flux.
- Possible simultaneous VLBI structure and polarization measures of some AGILE AGN (proposals), and study of the correlations between the multiband radio structure and polarization of radio jets (high resolution and dynamic range) and the gamma-ray flares.



Courtesy of K. Wiik

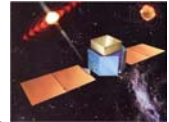


Courtesy of T. Savolainen

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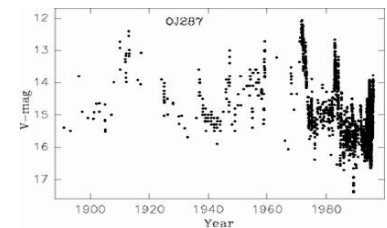
## Conclusions



- 2 groups (Tuorla- Metsähovi) devoted to AGN study-observation: interested in a collaboration to the Agile MW Group (AMG).

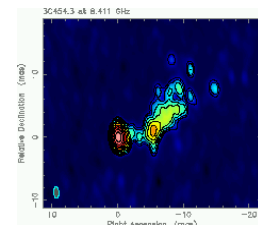
<http://www.astro.utu.fi/tuorla/new>      <http://korp-www.hut.fi>

- Follow-up of AGILE gamma-ray AGNs: radio optical flux and polarization simultaneous monitoring (Tuorla-KVA-Metsahovi).



- VLBI, NOT, MAGIC, PLANK observation of some AGILE sources (proposals), through the Tuorla- Metsähovi group.

- Large database of past radio--optical data (the oldest optical monitoring program in Europe).



- Theoretical framework: e.g. superluminal radio jets and gamma-ray connection, pc scale radio structure high energy emission, relativistic outflows, jets and shock acceleration models, blazar variability models, dynamical models (OJ 287), host galaxies and central SMBH characteristics, cosmologic host evolution, etc. ...).

- Collaboration with other projects, telescopes, satellites: VLT, ENO, VLBI, WEBT,<sup>2</sup> INTEGRAL, MAGIC, PLANK, HERSCHEL...