

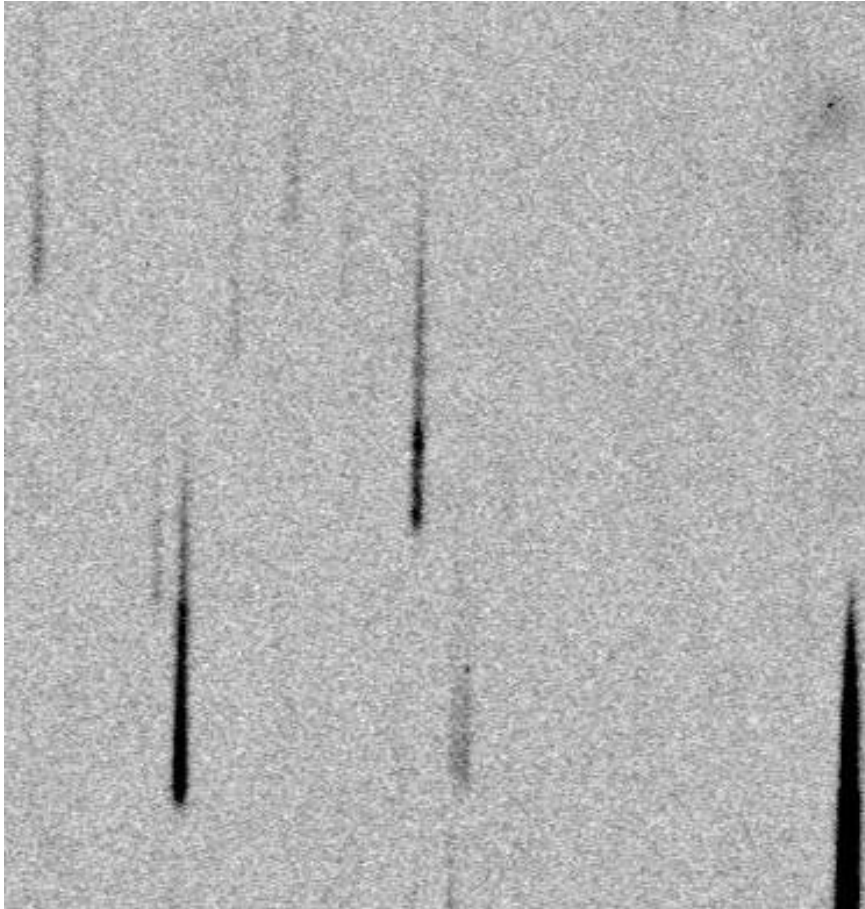
Large surveys with small telescopes:  
Past, Present, and Future (Astroplate III)

Dieter Engels  
Hamburger Sternwarte, Universität Hamburg

## Hamburg Quasar Survey

Bamberg, 13.3.2019

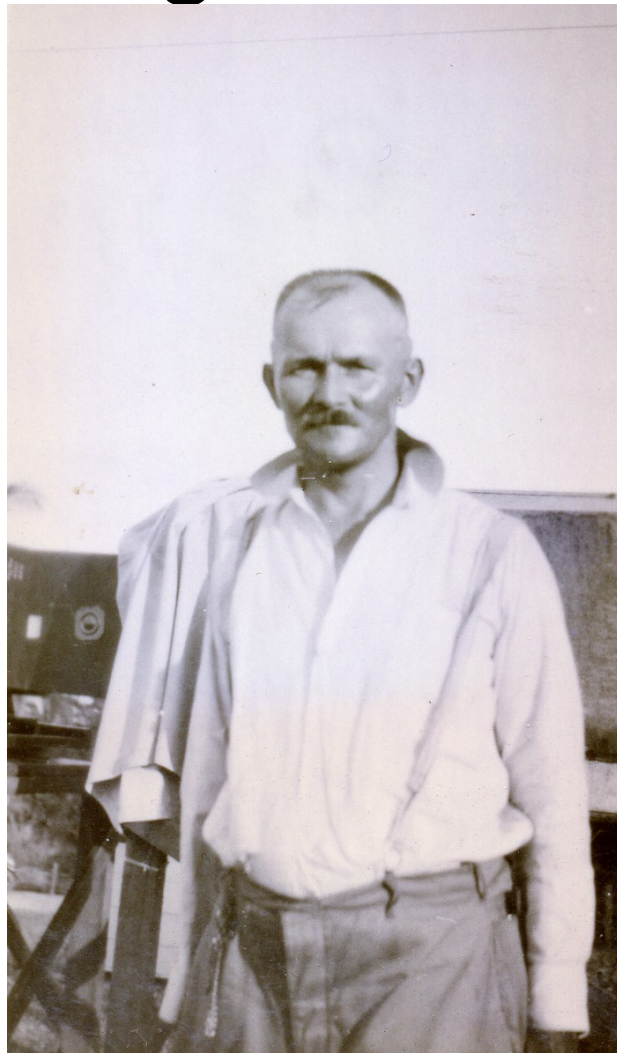
# Hamburg Quasar Survey



HS 1700+6416,  $z=2.72$ ,  $B=16.1$

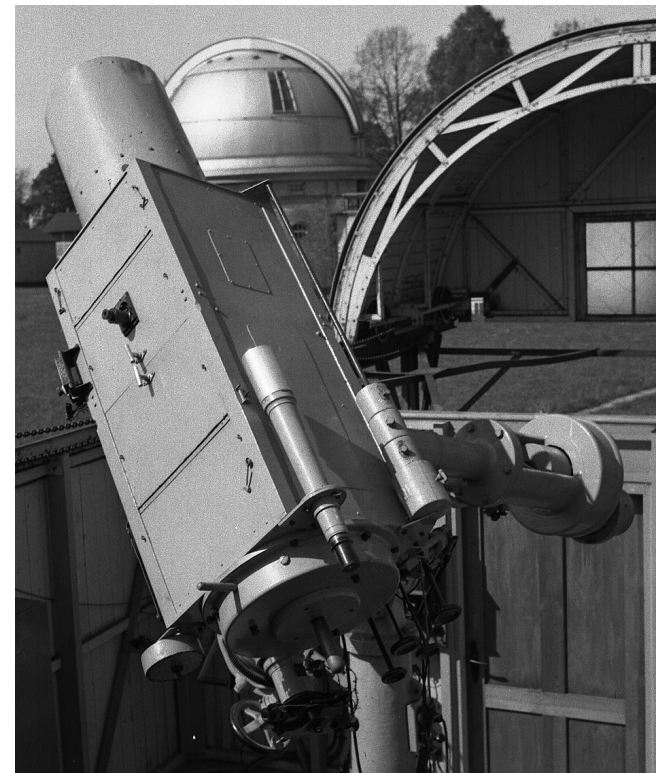
- Objective prism survey of the Northern extragalactic sky
- Hamburg Schmidt Telescope (Calar Alto)
- ~1982 – 2000
  
- Hamburg/ESO Survey – Southern Sky
- ESO – Schmidt telescope (La Silla)
- ~1995 – 2008
  
- First large-scale digitization program

# Original Schmidt-Camera (1932)



Bernhard Schmidt (1879-1935)

- Since 1926 freelanced member of staff at Hamburger Sternwarte
- 1929/30 invents the corrector plate



44cm mirror diameter, 36cm aperture

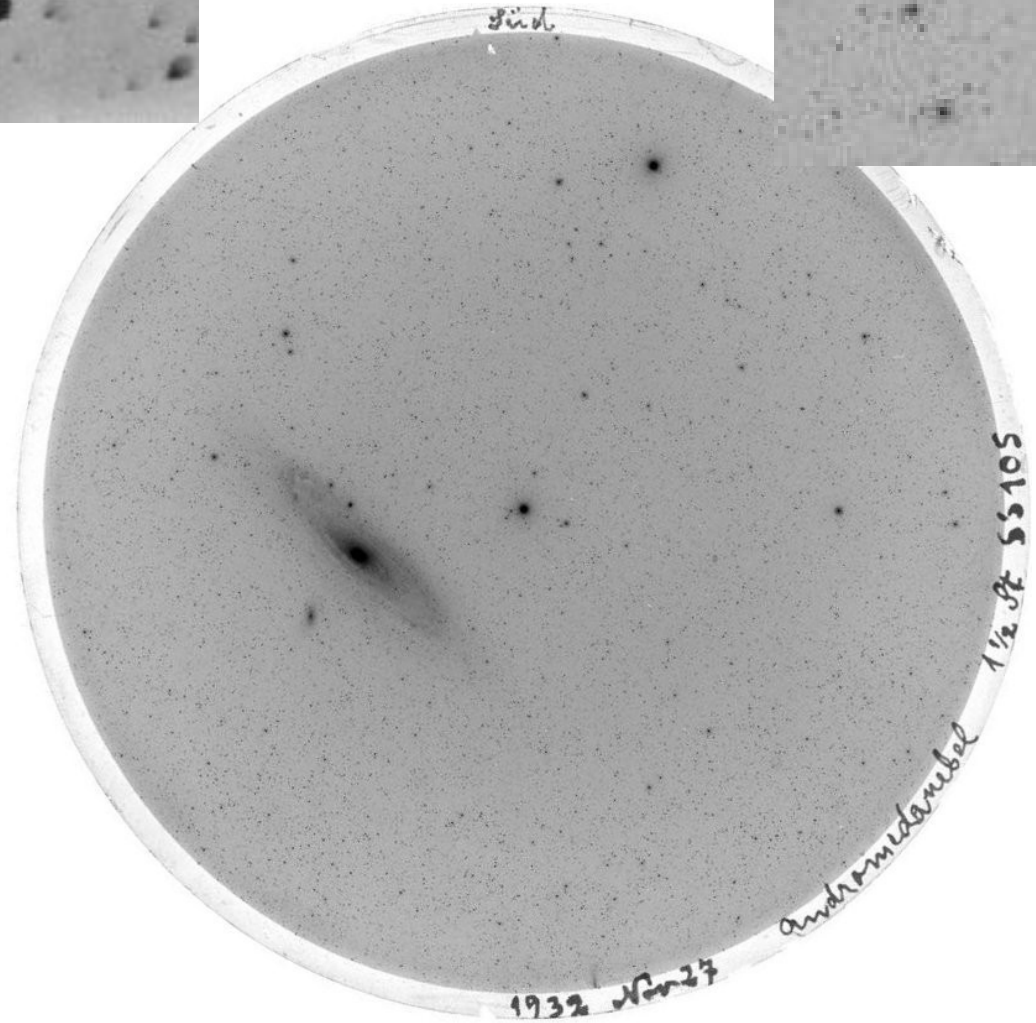
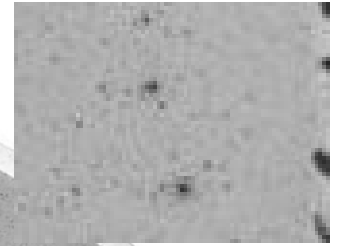
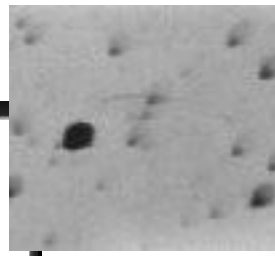
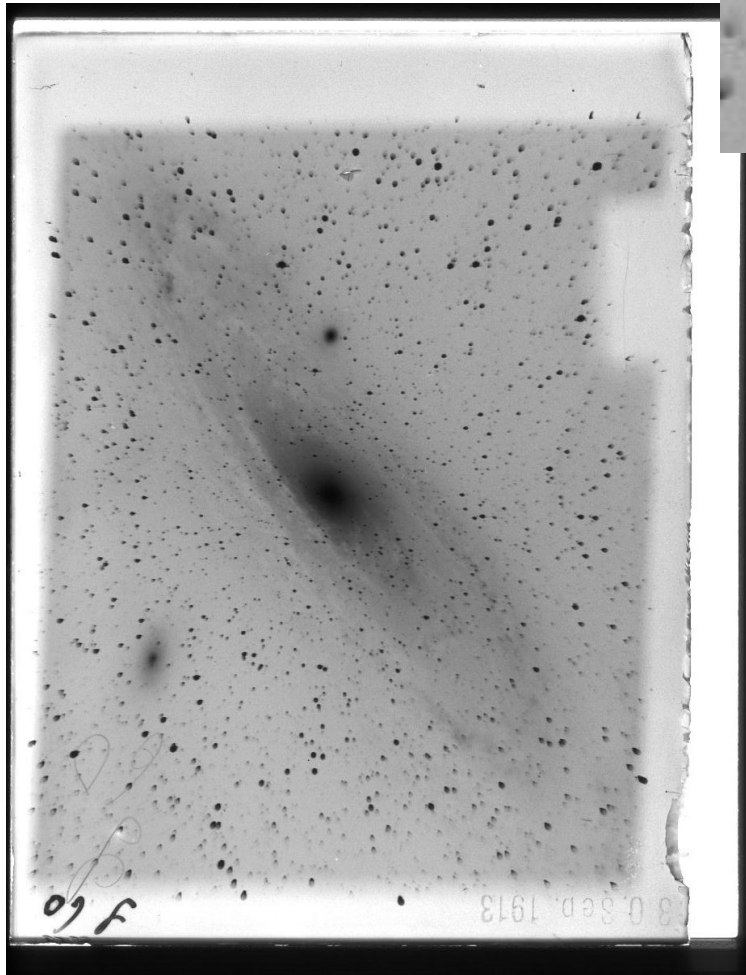
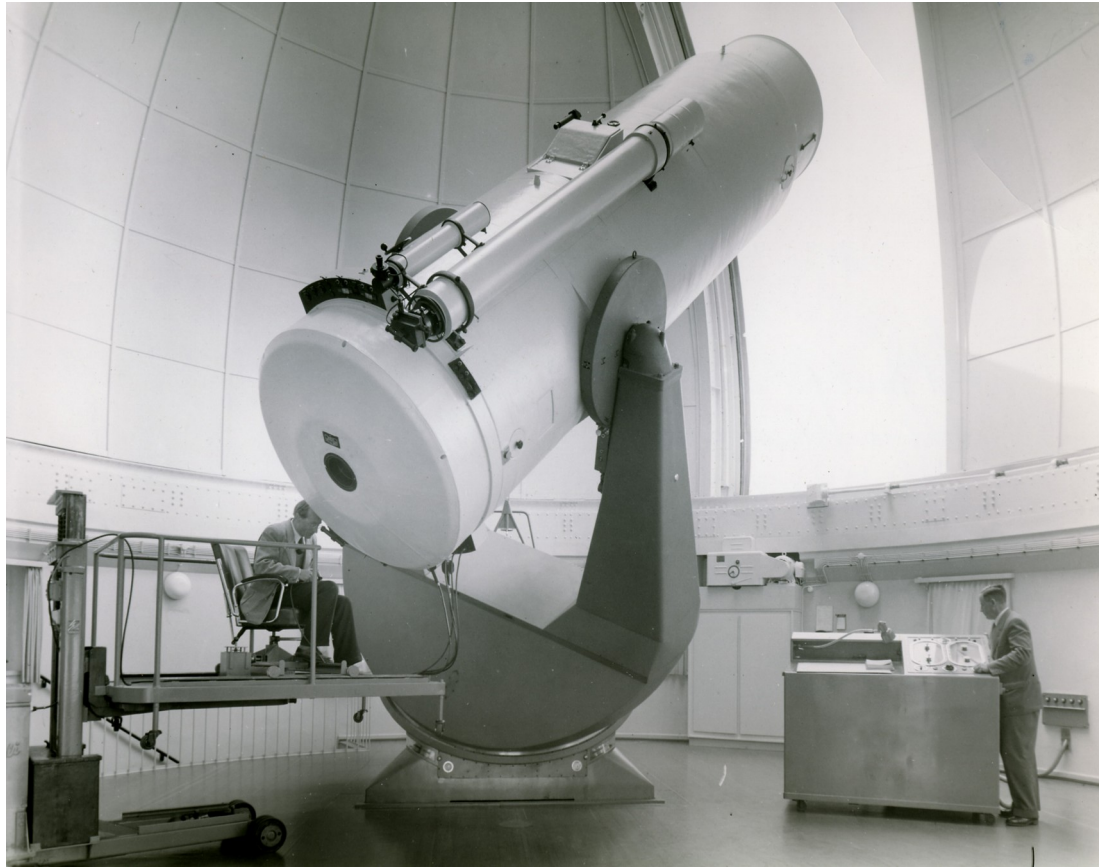


Plate: 1m-Telescope, 30.9.1913

Plate: Schmidt-Camera, 27.11.1932

The Hamburg Plate Archive contains 1800 plates taken in the years 1932 - 1955

# “Großer Schmidt-Spiegel”



*In the OLT-Dome in Hamburg*

- 1937 Senate of Hamburg approves construction of a **BIG** Schmidt-Telescope
- 1951 Start constructions
- 1954 “First light”
- 5771 Plates until 1974

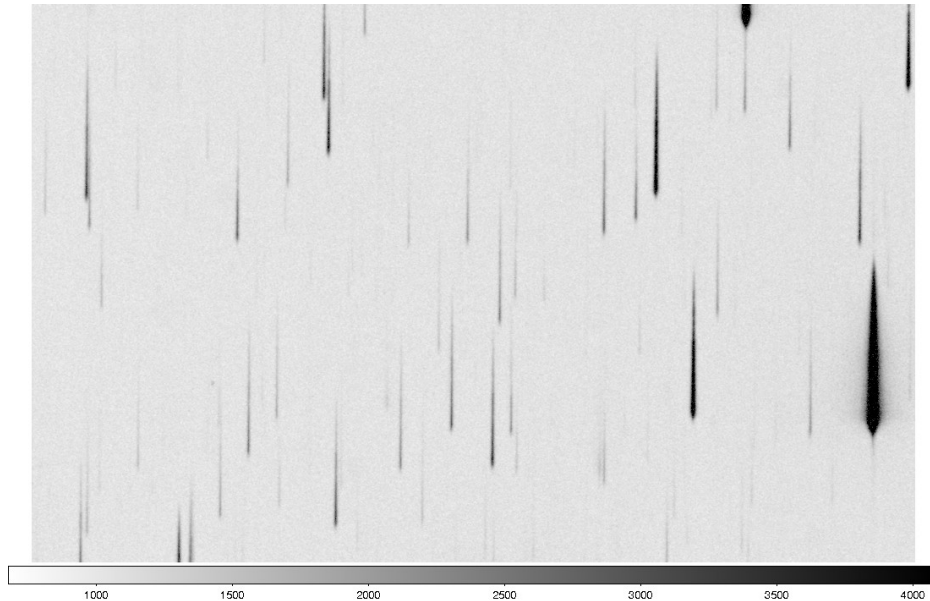


# On Calar Alto (Spain)



- 1960+: Plans for a German - Spanish Observatory on Calar Alto (Spain)
- Classical configuration: 1.23m, 2.2m, 3.5m + Schmidt as object provider
- Relocation: 1975 – 1979 (on loan)
- 1980 Start observations
- Since 1981: First extragalactic plates taken by Prof. U. Haug (1929-1992)
- Searching visually for quasars on the objective-prism plates

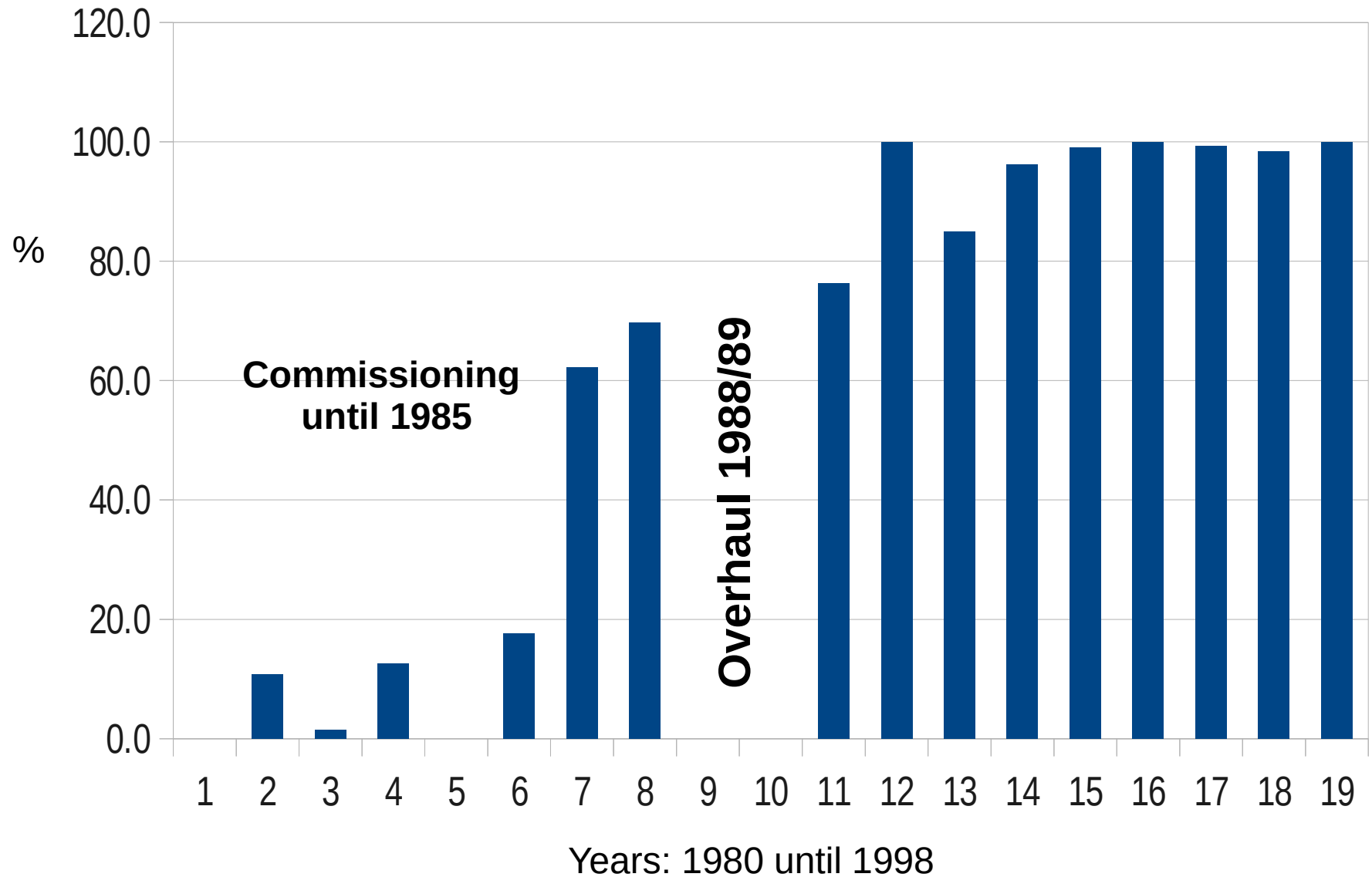
# The beginnings of the HQS



- Prism plates on KODAK IIIa-J
- Limit  $\sim B=19$  mag
- 3400-5400 Å

- 1980: Prof. D. Reimers starts at the Observatory
- University purchases PDS 1010G Densitometer
- Aim: Digitize plates, semi-automatic quasar survey
- Set-up of a working group until 1985:  
initially D. Groote, H.-J. Hagen, D. Engels ...

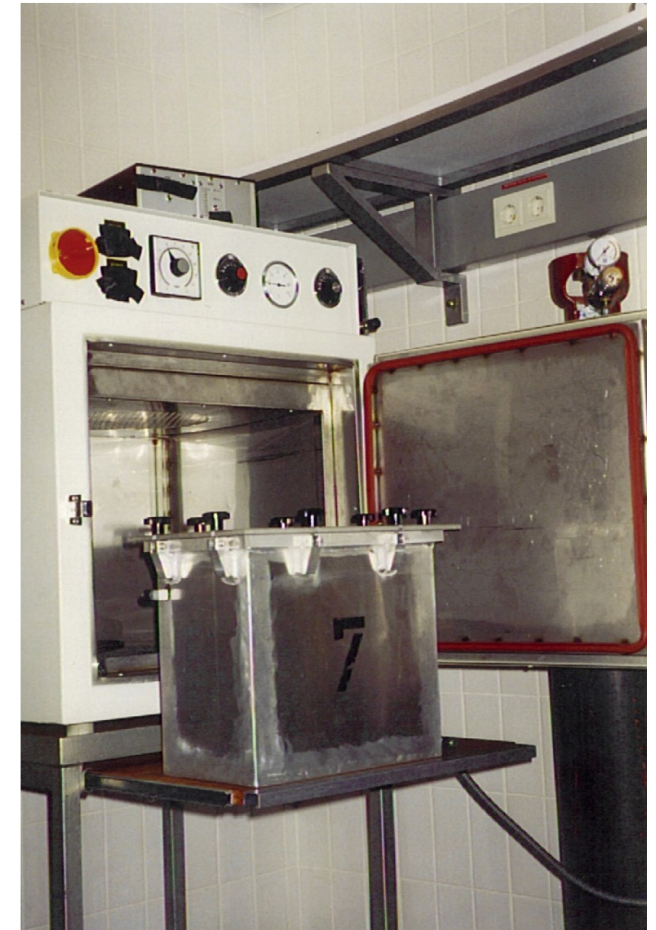
# HQS-Use of the Schmidt-Telescope





# A Schmidt Observing Night

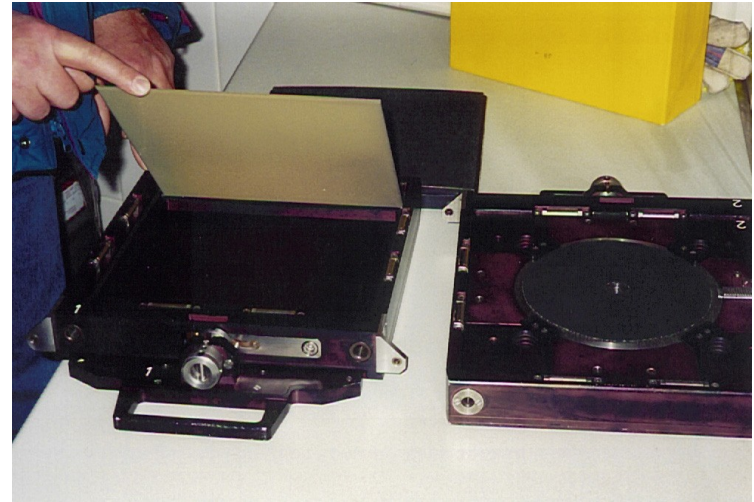
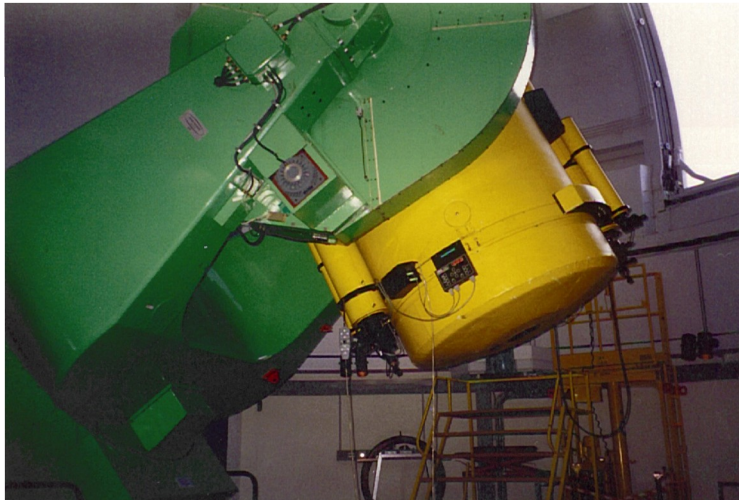
- Plate sensitization (“Baking”)
- 16 hours in nitrogen ( $T=69^{\circ}\text{C}$ )
- 2-4 hours in “forming gas” ( $>1987$ )



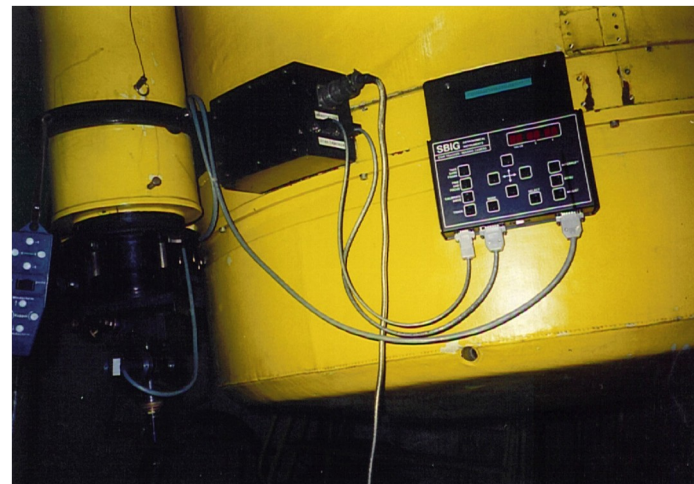
Left: Lightproof steel box with plate holder (N=8)

# A Schmidt Observing Night

- Integration times 50-60 minutes (prism)
- ~45 min. (direct)



*Plate - cartridges*

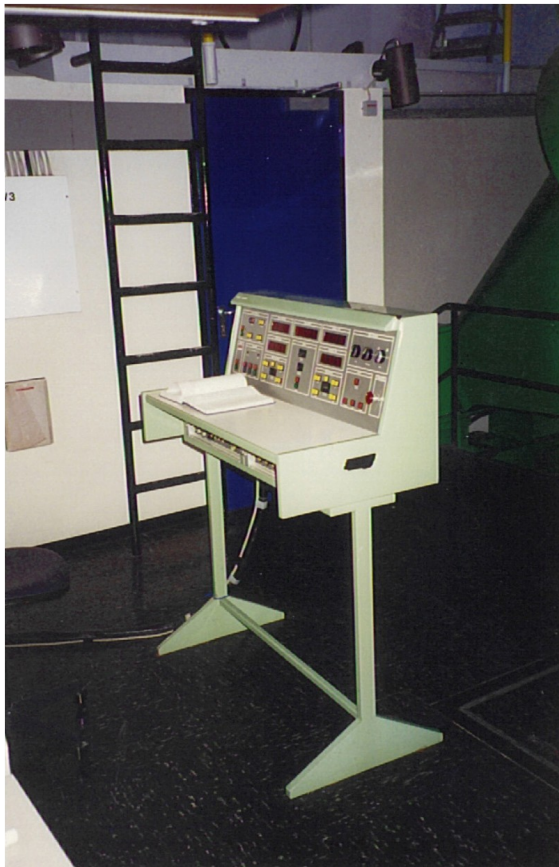


*Autoguider (installed 1991)*



# A Schmidt Observing Night

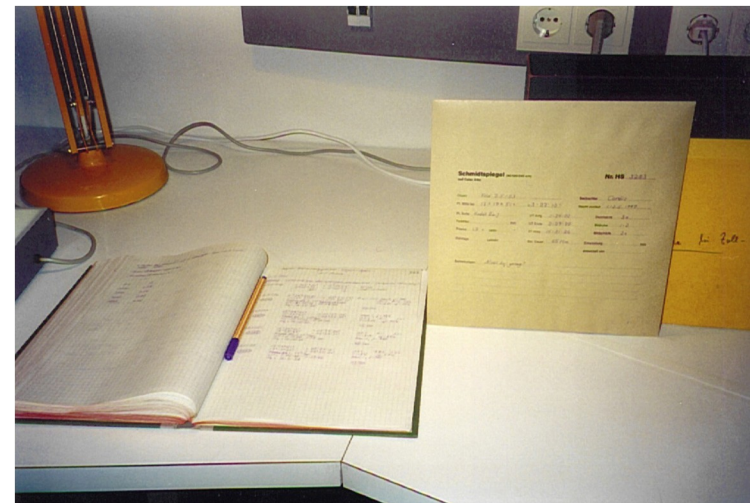
- Plate processing in pairs
- ~30 min. developing + fixation
- 60 min. watering
- ~2 hours drying



*Control desk*



*Darkroom*



*Logging / Packaging*

# Users 1985 - 1998

## Observing nights at the Schmidt-Telescope

567 observing fields with  $|b| > 20^\circ$

Aims (per field):

2 prism plates

1 direct plate

Only moonless nights

No observations during summer

Losses due to weather 40-60%

Personnel:

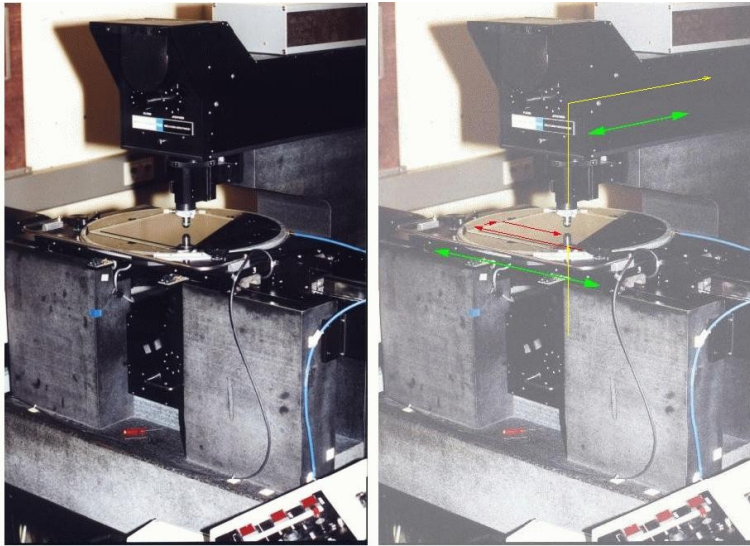
6 principal observers,

25 assistants (Diploma and graduate students, technical and scientific staff of the Observatory).

Name	Nights	Years
Livia Cordis	343	1990-97
Pava Halilhodzic	200	1990-96
Dieter Engels	193	1986-98
Detlef Groote	163	1985-96
Ulrich Haug	130	1981-91
Hans-J. Hagen	90	1986-96
<b>Sum</b>	<b>1119</b>	

(= 3 years every night observing)

# Digitization



PDS 1010G Microdensitometer

Software: H.J. Hagen

Scans:

-- 2006: HQS-working group,  
A. Müller

2014-2015: D. Groote et al.

## - 1998: Two-stage scan method

- Low-resolution scan:  $100 \times 20 \mu\text{m}$   
Scan time: 3 hours
- Automatic color selection of UV-bright spectra
- Follow-up high-resolution scan of selected spectra, few hundred objects, scan time:  $\sim 2$  hours  
(Hagen et al. 1995)
- Visual classification, follow-up spectroscopy

- 1239 prism, 578 direct plates
- **1999-2006: Complete plate scan with the PDS ( $20 \times 20 \mu\text{m}$  slit)**
- Scan time: 9 hours
- **7/2014–2/2015 Scanner**
- Scan time:  $2 \times 7$  minutes





# Access to prism spectra

<https://plate-archive.hs.uni-hamburg.de/>

## Hamburger Sternwarte - Research

### Hamburg Objective Prism Sky Surveys - Online Access

The server handling the Hamburg Objective Prism Sky Surveys gives access to the digitized data of the Hamburg Quasar Survey and of the Hamburg/ESO Survey (HES). The server provides two-dimensional images in FITS-, JPEG, Postscript and PDF-Format.

The area currently covered by the digitized HQS is restricted in declination to  $0 < \delta < 80^\circ$  and in galactic latitude to  $|b| > 20^\circ$ . In case that the chosen region appears on several plates compressed images are displayed, from which a high-resolution image can be selected. For the HES similar restrictions apply.

Please enter a position and an image size. The image size is restricted to 15 arc min (4.4 Mb). Because of the length of a spectrum a minimum size of 240 arc sec (HQS) and 480 arc sec (HES) is recommended.

**Coordinates:**

**R.A. :** (hh mm ss)

**Dec. :** ( $\pm dd mm ss$ )

**Coordinate System:**

J2000  B1950

**Image Size:**

**Size** (arcseconds)

**Survey**

**Output format:**



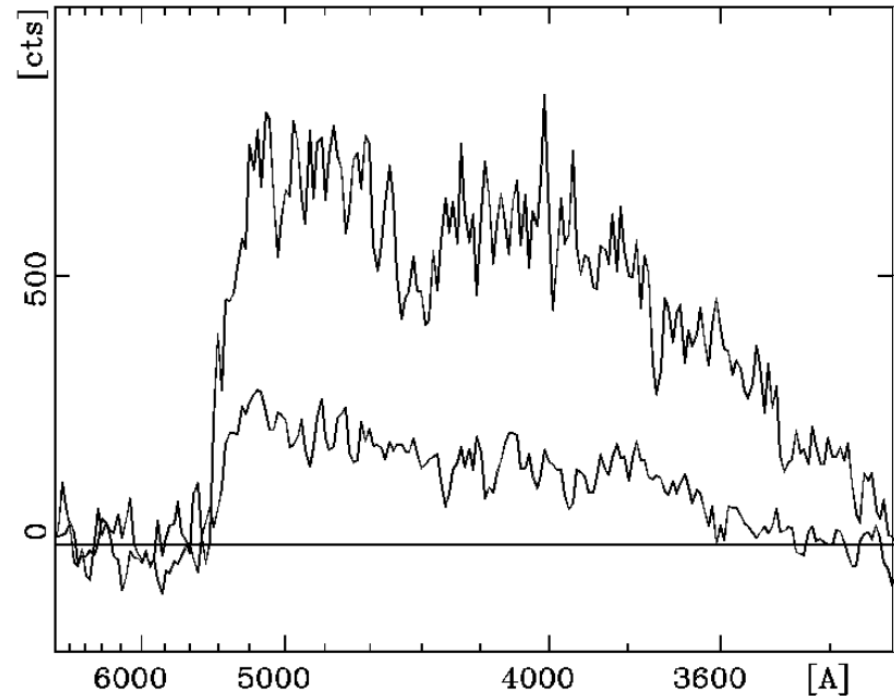
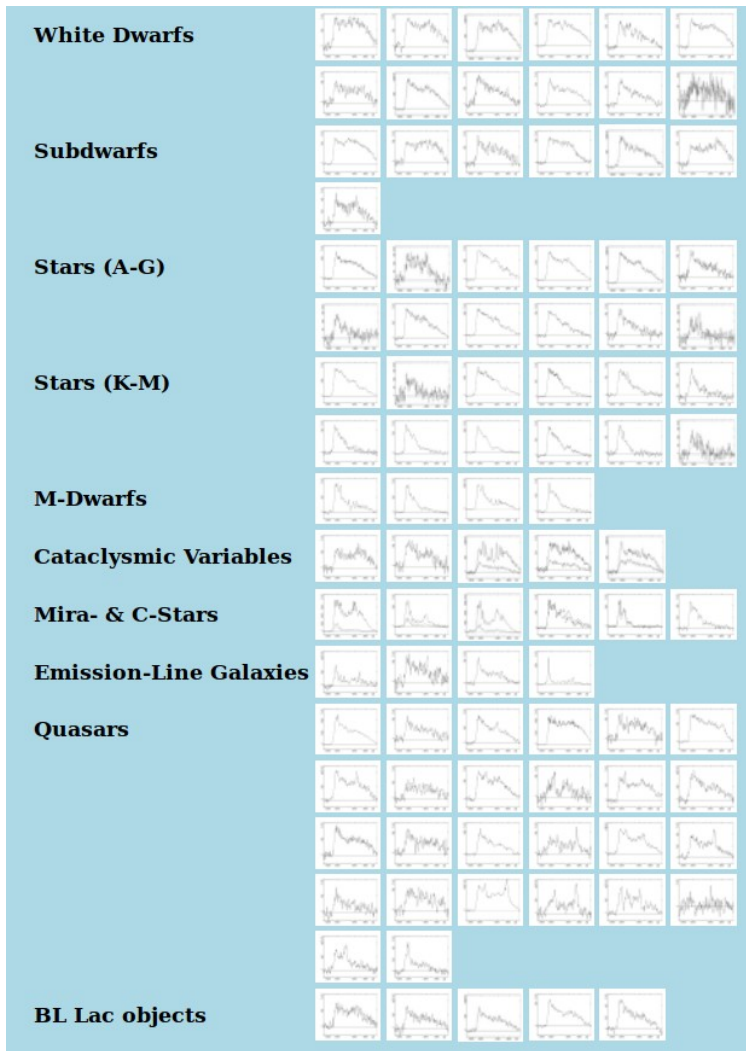

Catalogue of [template objective prism spectra](#) (HQS only)

Collaborators: [N. Christlieb](#), [D. Engels](#), [D. Groote](#), [H.-J. Hagen](#), [D. Reimers](#), [L. Wisotzki](#).

For more information please contact: [D. Engels](#)

since 2001

# 'Training' sample



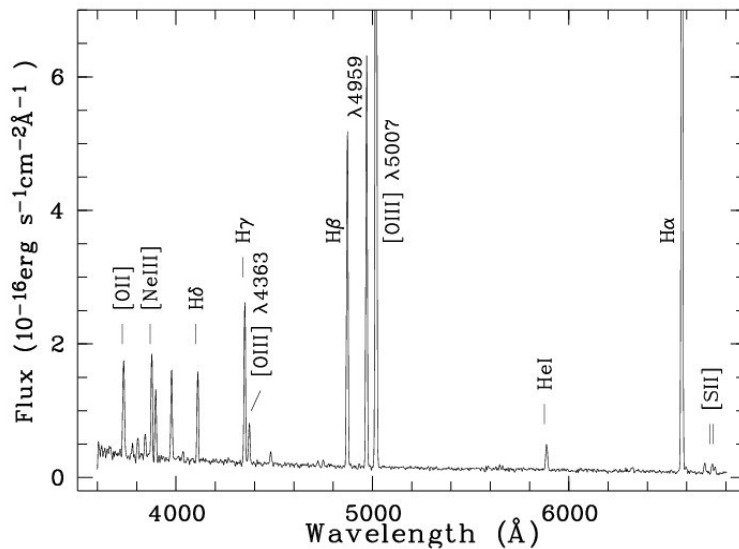
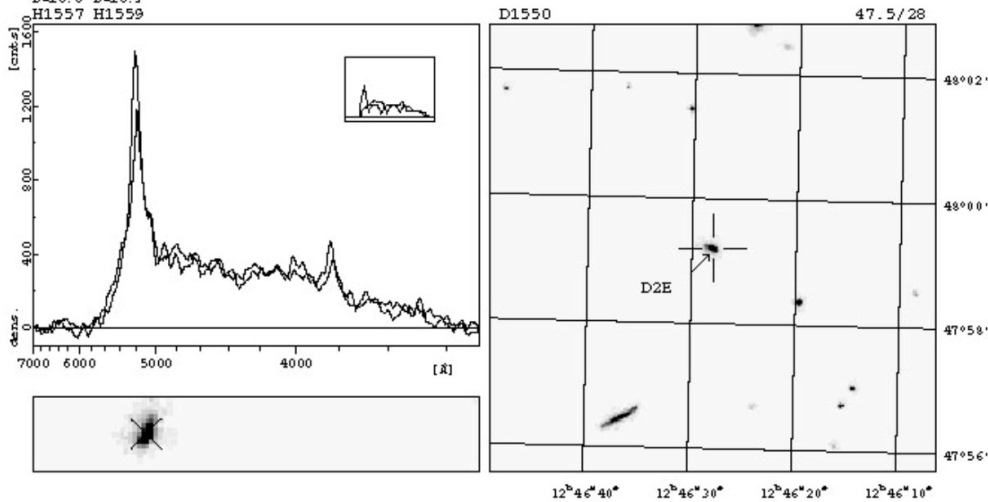
Cataclysmic variable, B = 16.0 mag

# HQS contributions

- UV-bright quasars
- Gravitational lenses
- Emission-Line Galaxies (with Munich, SAO/Russia)
- White dwarfs, Subdwarfs (with Kiel, Bamberg)
- Cataclysmic Variables (with Göttingen)
- Identification of ROSAT X-ray sources (with MPE Garching)

# Emission-line Galaxies

HS\*1246+4759 N. EMISS B = 16.9  
 D2E : MARK 229 m=17.0  
 12<sup>h</sup>46<sup>m</sup>28.<sup>s</sup>0 +47°59'13" (1950)  
 B=16.8 B=16.9  
 H1557 H1559



- Hamburg/SAO Survey for Emission-Line Galaxies (HSS)
- Follow-up spectroscopy with Telescopes in Russia, Spain and U.S.
- 547 galaxies
- Highlight: HS 0822+3540, Dwarf galaxy
- Extremely metal poor (Kniazev et al. 2000)

# Identifications ROSAT-Sources



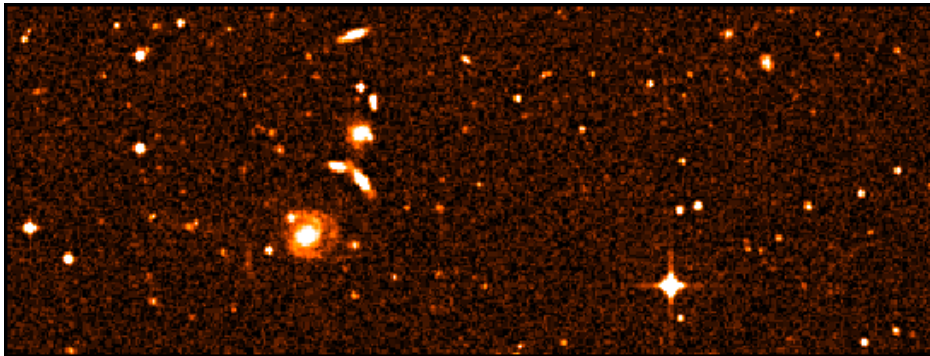
Result: ~ 45% of BSC-sources  
are AGN candidates.

Zickgraf et al. (2003)

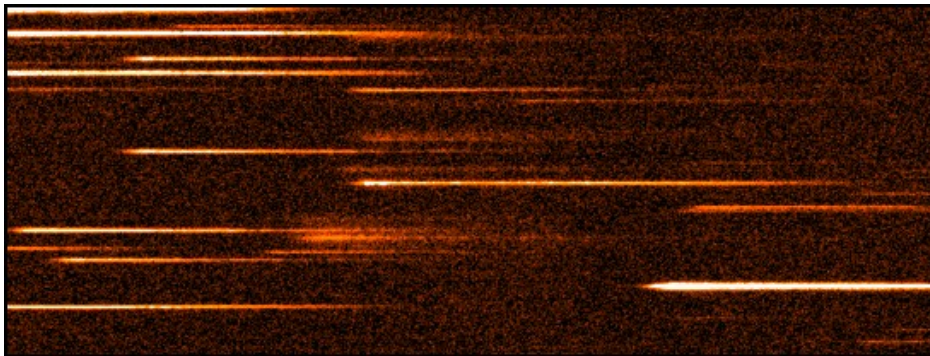
- ROSAT Satellite
- 1990-1999
- All-Sky Survey at 0.1-2.4 keV
- 125000 sources
- 18811 in Bright-Source Catalog (all-sky)
- 5341 identified on HQS plates ( $|b| > 20^\circ$ ;  $\delta > 0^\circ$ )



# Hamburg-ESO Survey (HES)



*Direct plate (Digitized Sky Survey)*

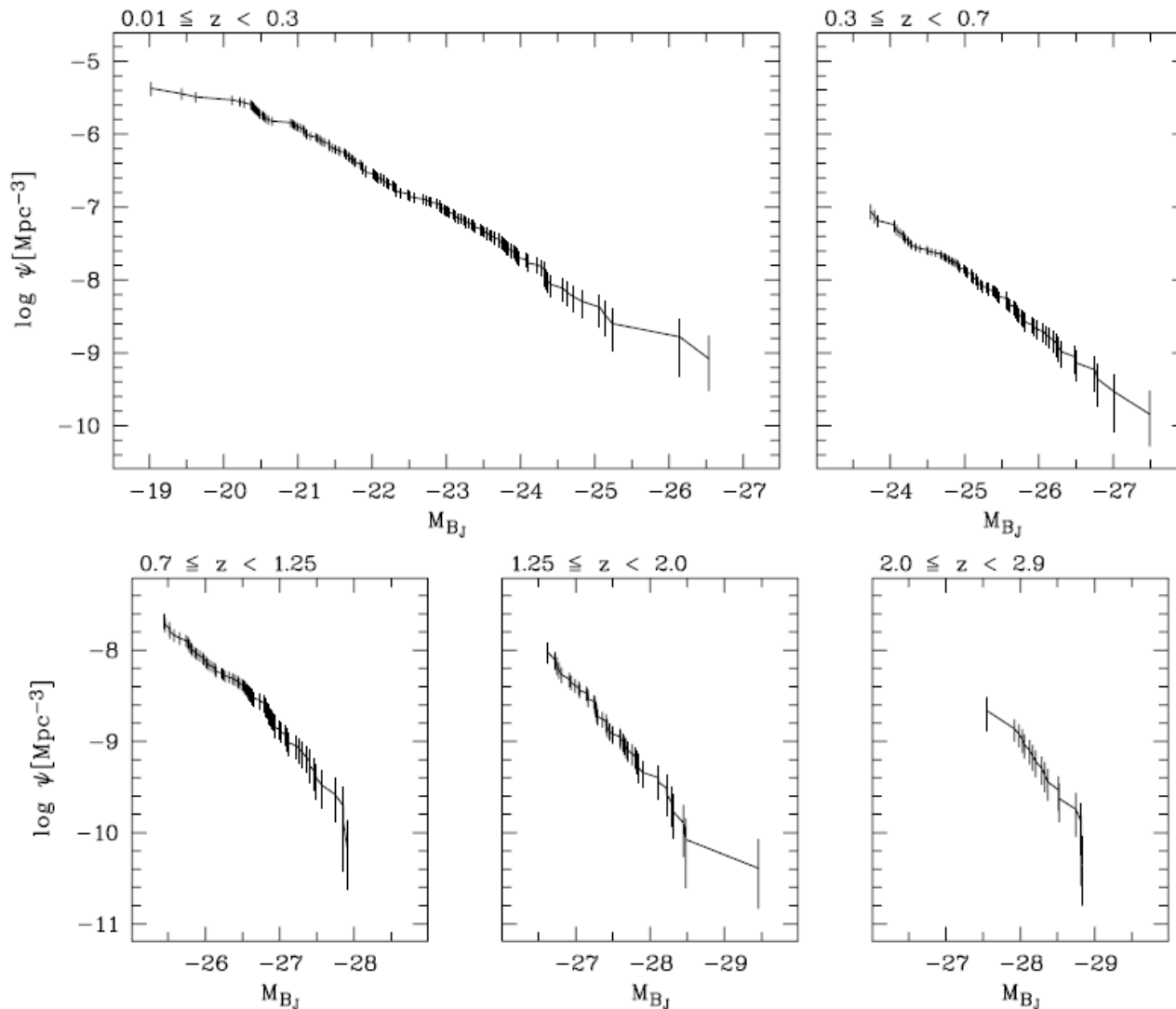


*Spectral plate (Hamburg-ESO Survey)*

- Extension to Southern sky
- 1m ESO-Schmidt
- 428 fields with  $\delta < 0^\circ$
- 1 prism plate/field
- Service-Mode Obs.
- $B < 18$  mag

*Participants:* N. Christlieb, H.-J. Hagen, T. Köhler, D. Reimers, L. Wisotzki a.o.

# Quasar luminosity function $\phi$

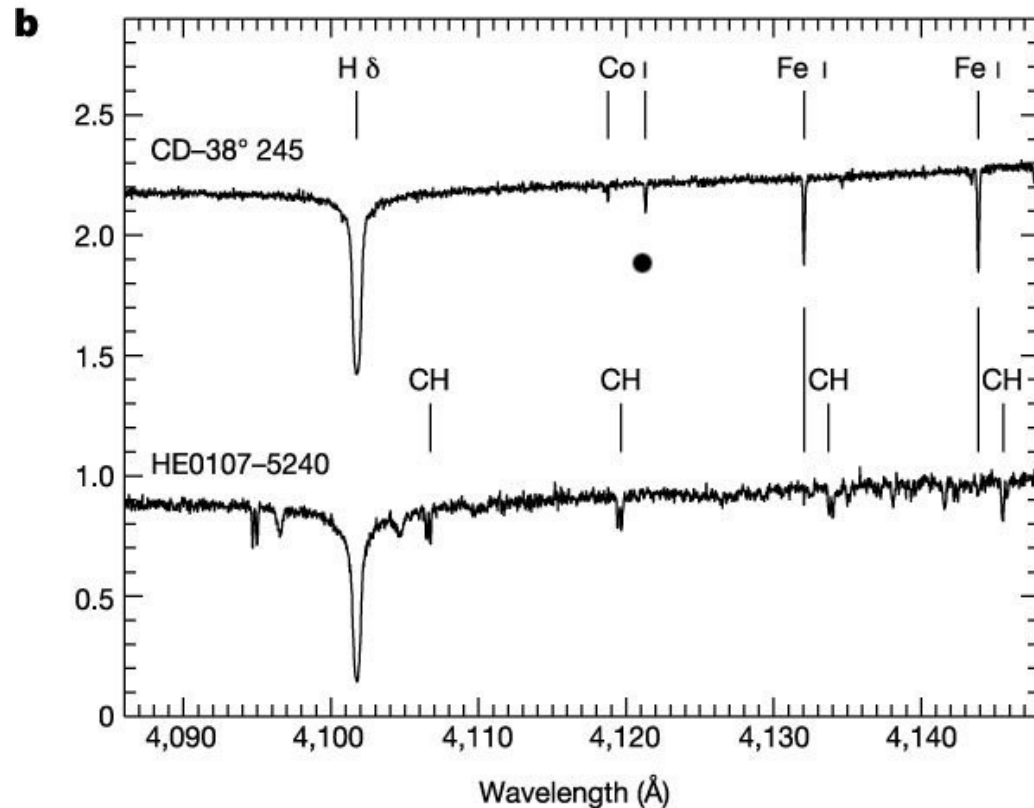


- 415 Quasars
- Completeness
- $B_J < 17.5$
- $z < 3.2$

**HES Highlight**

*Wisotzki et al. (2000)*

# Metal poor stars



*Christlieb et al. (2002)*

- HE 0107-5240
- The most metal poor star in the Milky Way
- Fe-abundance: 1/200000 solar
- CD-38°245: Fe-abundance: 1/10000

**HES Highlight**

# Outlook

- **Available:** Homogeneous spectroscopic coverage of the extragalactic sky (epoch 1992+/-6 years)
- **Available:** Web access to cut-outs of the plates available since 2001
- **Science case:** Time Domain Astronomy
- **Missing:** Catalog of spectra
- **Requires:**
  - Cut-out of the spectra
  - Resample on a linear wavelength scale
  - unfold from characteristic curve
  - store in database
  - (calibrate photometrically, automated classification)
- **Wishlist:**
  - a spectroscopic APPLAUSE

# References

- Christlieb et al. 2002, Nature 419, 904
- Hagen et al. 1995, A&AS 111, 195
- Kniazev et al. 2000, A&A 357, 101
- Wisotzki et al. 2000, A&A 353, 853
- Zickgraf et al. 2003, A&A 406, 535

Hamburg Plate Archive:

<https://plate-archive.hs.uni-hamburg.de/index.php/en/>

Hamburg Quasar Survey – Online Access

<https://www.hs.uni-hamburg.de/DE/For/Exg/Sur/hqs/online/index.html>

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