The First Year After First Light

Report from Astropeiler Operations

First Light

On February 26th, 2011, the main components of our receiving chain had been put together and the telescope was steerable under manual control. On that day, we moved the dish to an area in the Milky Way and looked for the HI emission with our Fast Fourier Transform Spectrometer (FFTS).
And sure enough, a clear signal was received. We consider this as our “first light” after restoration of the instrument:

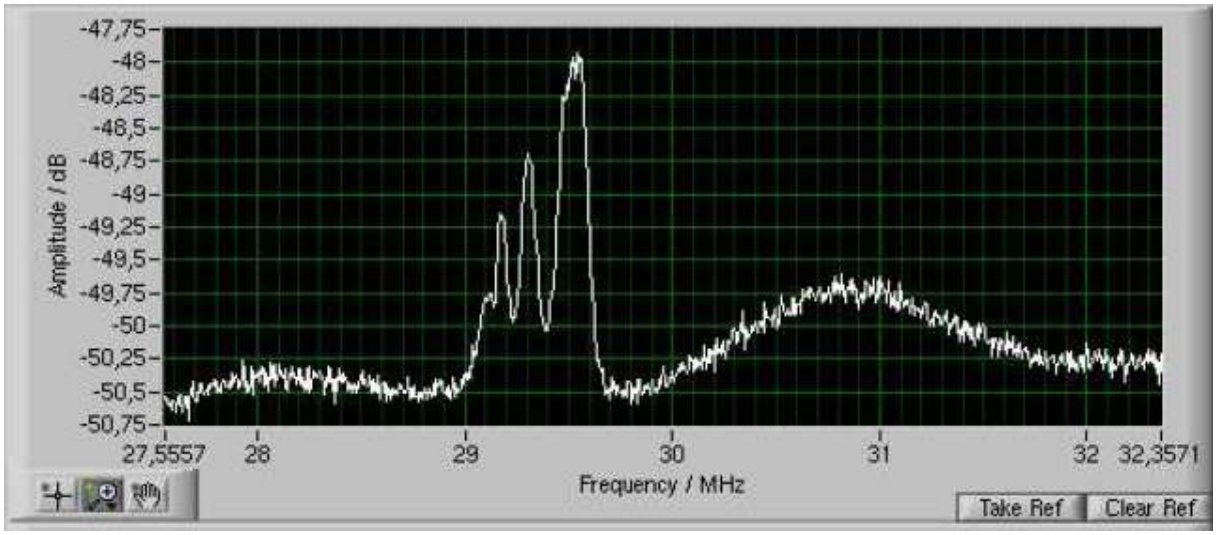

Figure 1: First light signal on the spectrometer (Sky frequency is 1450MHz – frequency as denoted in the figure)

Development of instrument control

Encouraged by the first light, we spent a lot of effort to develop the computer control of the instrument both for steering and data acquisition.
As of today, the instrument is now capable to go to targets and track them automatically. Scans are possible using terrestrial, celestial and galactic coordinates. Data acquisition and post processing for continuum, spectral and pulsar measurements are available.
This enables the Astropeiler to support various measurement tasks.
The “Astropeiler Stockert Software System” for telescope control and data acquisition is based on a development performed by the members of the “Förderverein”. Doing this “from scratch” rather than relying on the adaption from software of other parties was a difficult decision. This, however, should enable us to continually enhance and maintain this software system and making the most efficient use of the specific characteristics of the Astropeiler.
The post processing is typically done by software provided by the radio astronomy community (such as CLASS and sigproc).

Measurements

As the bits and pieces came together we started doing measurements with the intention to learn as much as possible about the characteristics of the instrument. We looked at radio astronomy textbooks and publications and then tried to replicate the phenomena described therein.
In doing so, we were able to do identify and record a substantial variety of radio signals from various sources:

Continuum signals observed from galactic sources:

- *Super nova remnants (SNR):* Cassiopeia A, Taurus A (Crab nebula), Tycho, 3C157

- *H II Regions*: Orion nebula, North America nebula, Omega nebula, 3C400, Heart nebula, Rosetta nebula, Trifid nebula, Gamma Cygnus nebula

- Galactic centre (Sagittarius A)

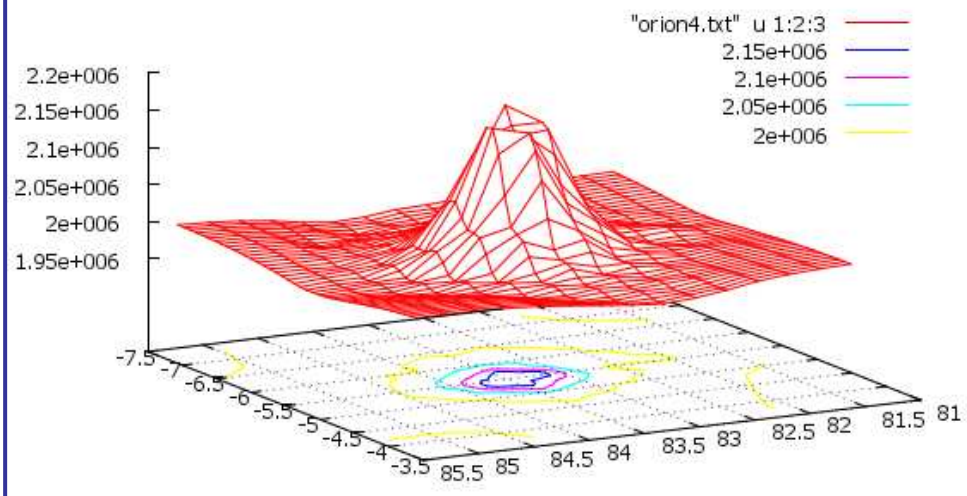

Figure 2: Example of a cross scan: Orion nebula, vertical scale: intensity in arbitrary units

Spectral measurements towards galactic sources:

- HI emission spectrum in the galactic plane from l= 0° to 240° and at various other locations
- HI absorption towards CAS, TAU A, Trifid nebuala, Sagittarius A
- HI emission from high velocity clouds at various locations
- Hα166, 167, 169 recombination lines towards Orion nebula
- Hα166, 167, 168 recombination lines towards Omega nebula
- Hα166 recombination lines towards Trifid nebula

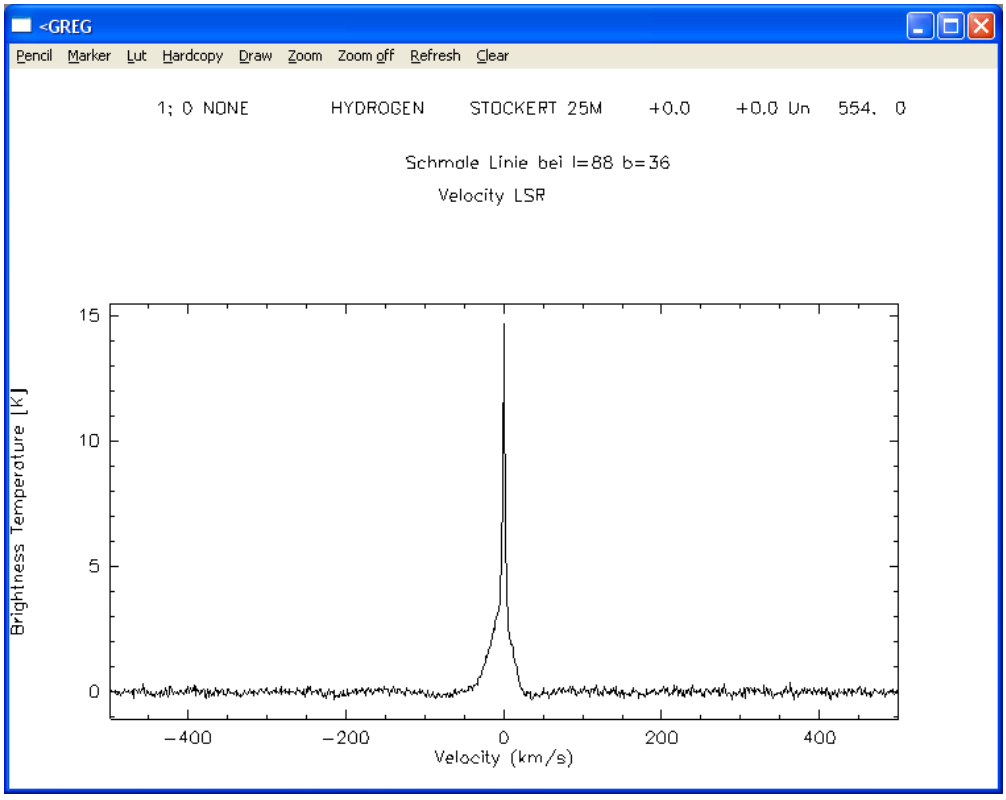

Figure 3: Example of a spectral Measurement: HI emission line from a “cold cloud” outside the galactic plane

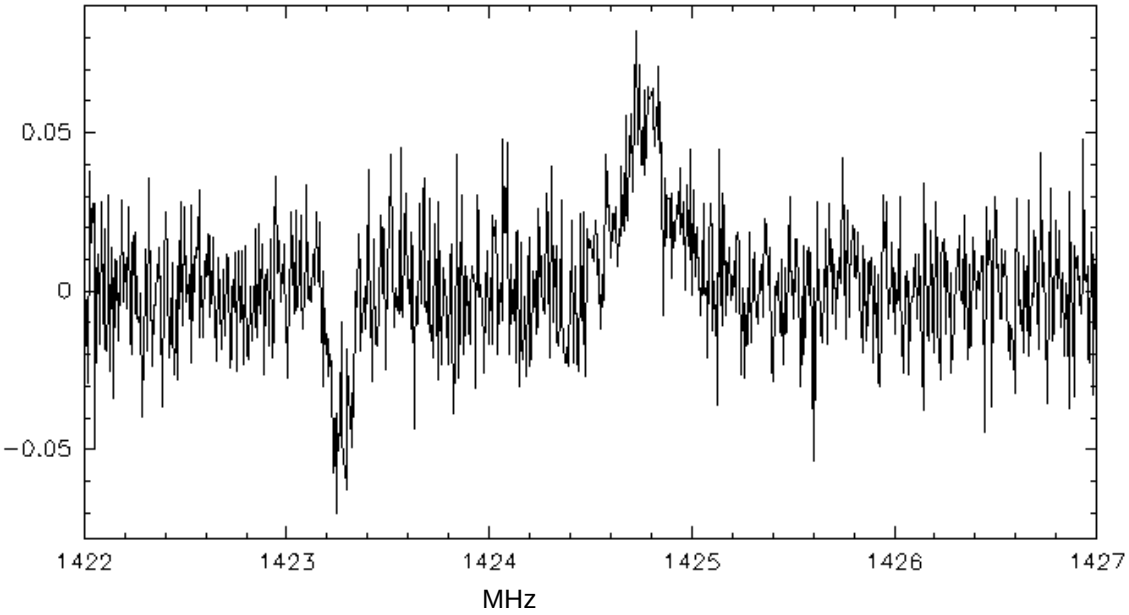

Figure 4: Example of a radio recombination line: H α 166 from Orion nebula using frequency switching detection (hence both positive and negative signal); vertical scale: brightness temperature

Pulsar detection:

The pulsar mode of our FFTS spectrometer enabled us to detect and record pulsar signals:

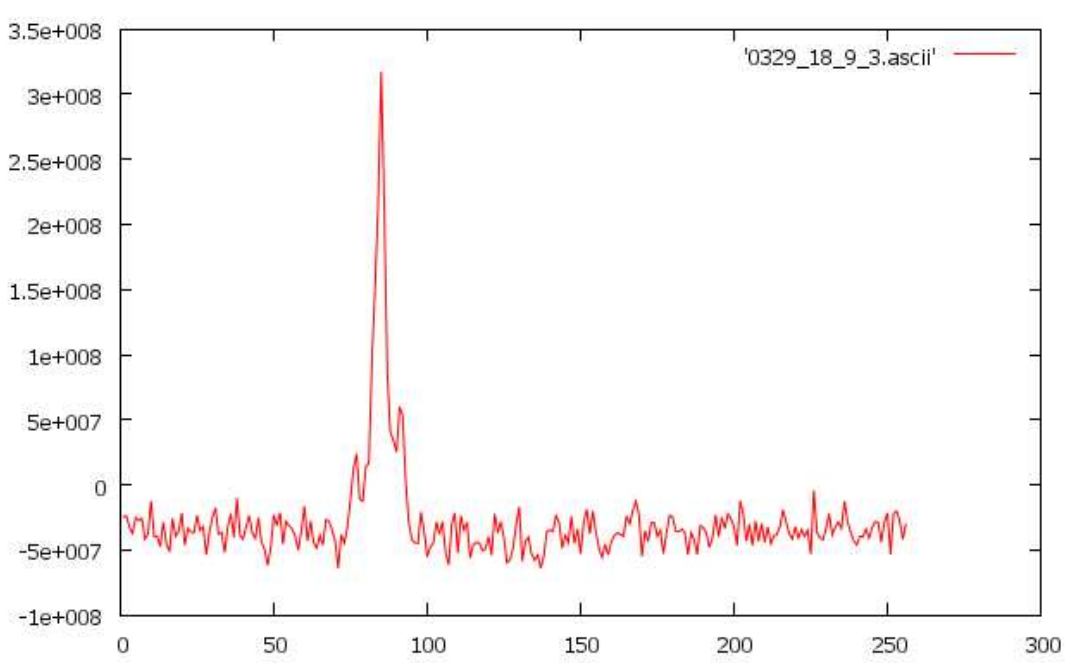

Figure 5: Pulsar signal from 0329+54

Extragalactic sources:

Nearby galaxies could be recorded by their hydrogen emission spectrum. The galaxies detected this way were:

- Andromeda, Triangulum, Holmberg II, UGC3851, M 82, UGC 718

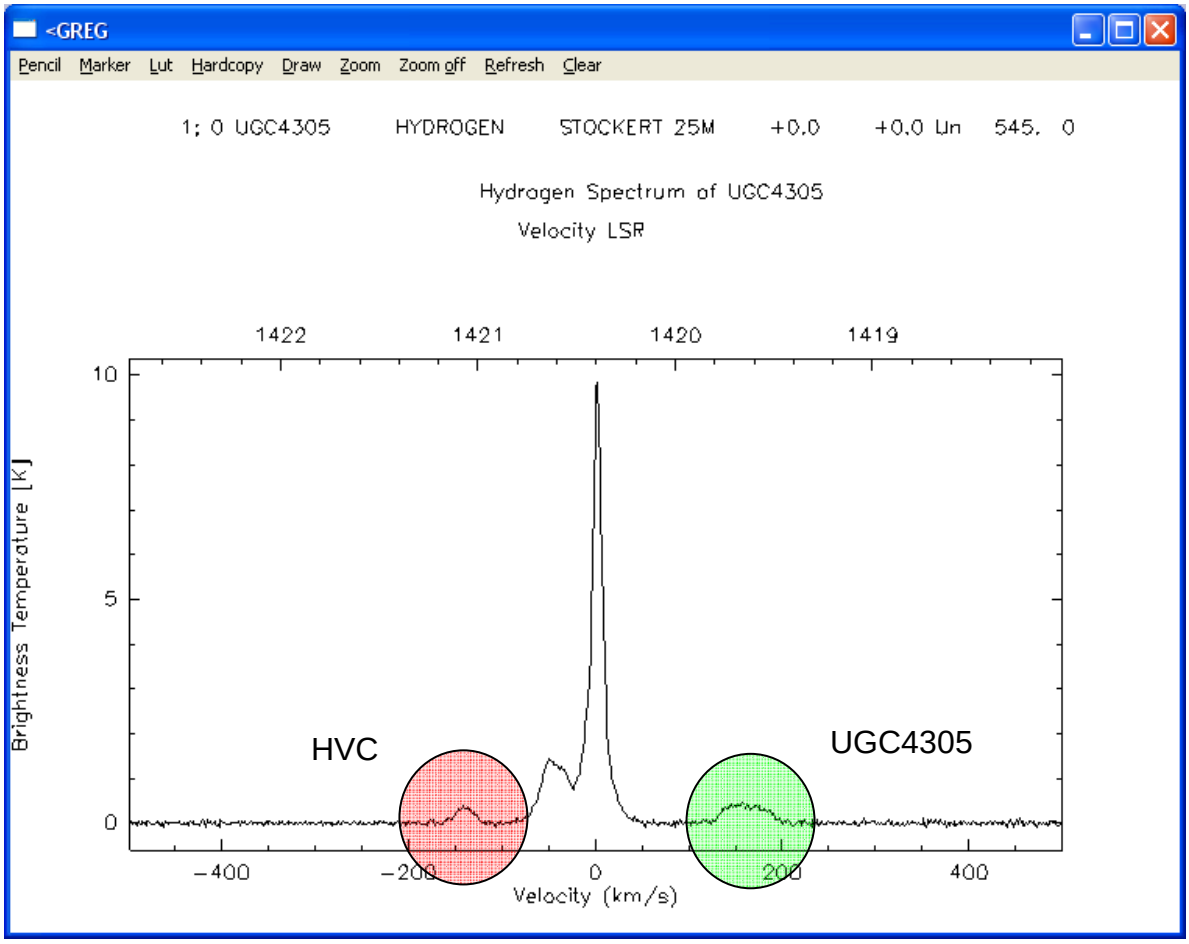

Figure 6: Example: Hydrogen emission from UGC4305 (Holmberg II), also showing the emission from a high velocity cloud and the “normal” galactic hydrogen emission

Continuum emission was observed from various galaxies with an active galactic nucleus (AGN):

- Cygnus A, Virgo A, Perseus A, 3C353, Herkules A, 3C273, 3C123, 3C438, 3C295, 3C147, 3C286, 3C196, 3C309.1

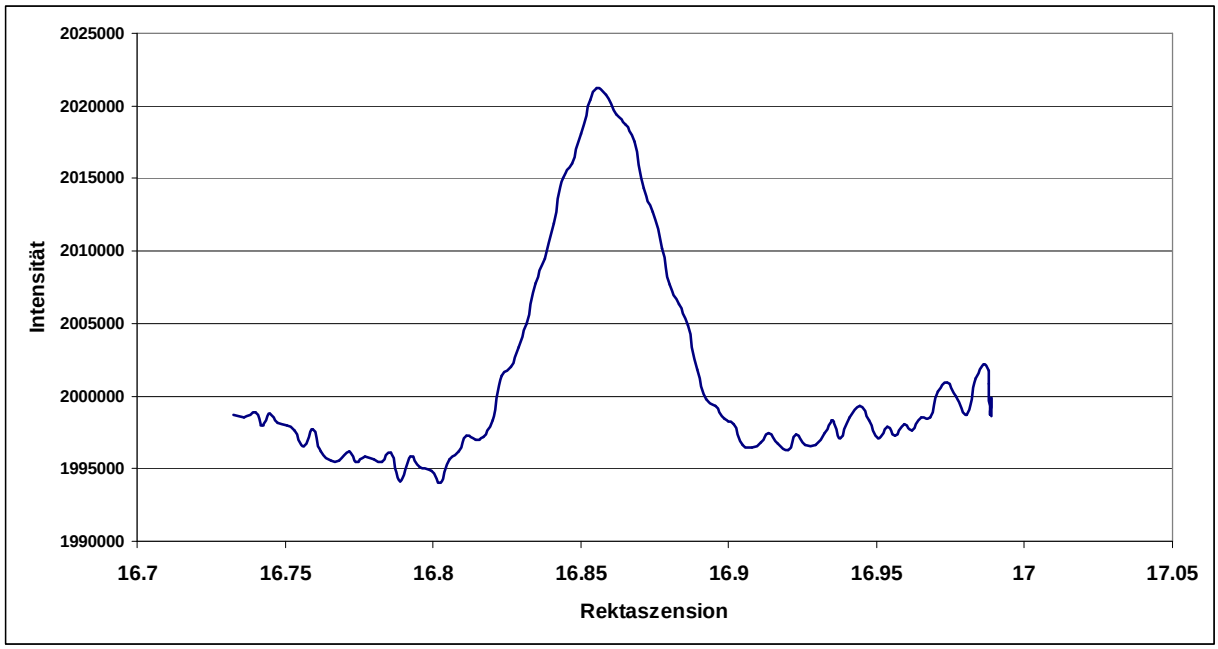

Figure 7: Example: Rectascension scan of the Hercules A galaxy, vertical scale arbitrary units

Findings

The measurements have demonstrated that the instrument is capable of detecting a great variety of radio astronomy phenomena. We also identified a number of areas which give room for improvement. The most prominent issue is the receiver stability where a deficiency was detected. This will be dealt with during the last weeks of 2011 when the receiver will be taken out from the prime focus for review.

Outlook

We are looking forward to a number of events during the coming year 2012. We will have students from universities who will get hands on experience with radio astronomy observations. Schools will be visiting and there will be advanced teacher training.
Focus of the operations team will be further development of the software and improvement of the sensitivity, stability and resolution of the instrument.
The scientific community is starting to get interested in the capabilities of the Astropeiler, and if all goes well we may be seeing some first scientific usage of this old lady again after a long period of hibernation.

Acknowledgements

All this would not have been possible without the support from various organizations and individuals.
We are deeply grateful to the Nordrhein-Westfalen Stiftung for the substantial financial efforts and the continuous support and encouragement which kept the “Förderverein Astropeiler e.V.” going. Without the courageous decision of the foundation to invest in this beautiful monument of science and technology nothing would have been accomplished.
We received invaluable support in technology, advice and practical help from the Max-Planck Institute for Radioastronomy (MPIfR), the Fraunhofer Gesellschaft für Hochfrequenztechnik (FHR), the Argelander Institute for Astronomy of the University of Bonn and the Hochschule Bonn-Rhein-Sieg.
The Arbeitgeberverband Gesamtmetall and many individuals have supported us through generous donations.
Finally, all the members of the Förderverein did their best in dealing with all the big and little things which all need to come together in order to revitalize this old, but very capable instrument.

Förderverein Astropeiler Stockert e.V., November 2011
Wolfgang Herrmann