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für Radioastronomie

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The Next Generation of Fast Fourier Transform Spectrometers (FFTS)

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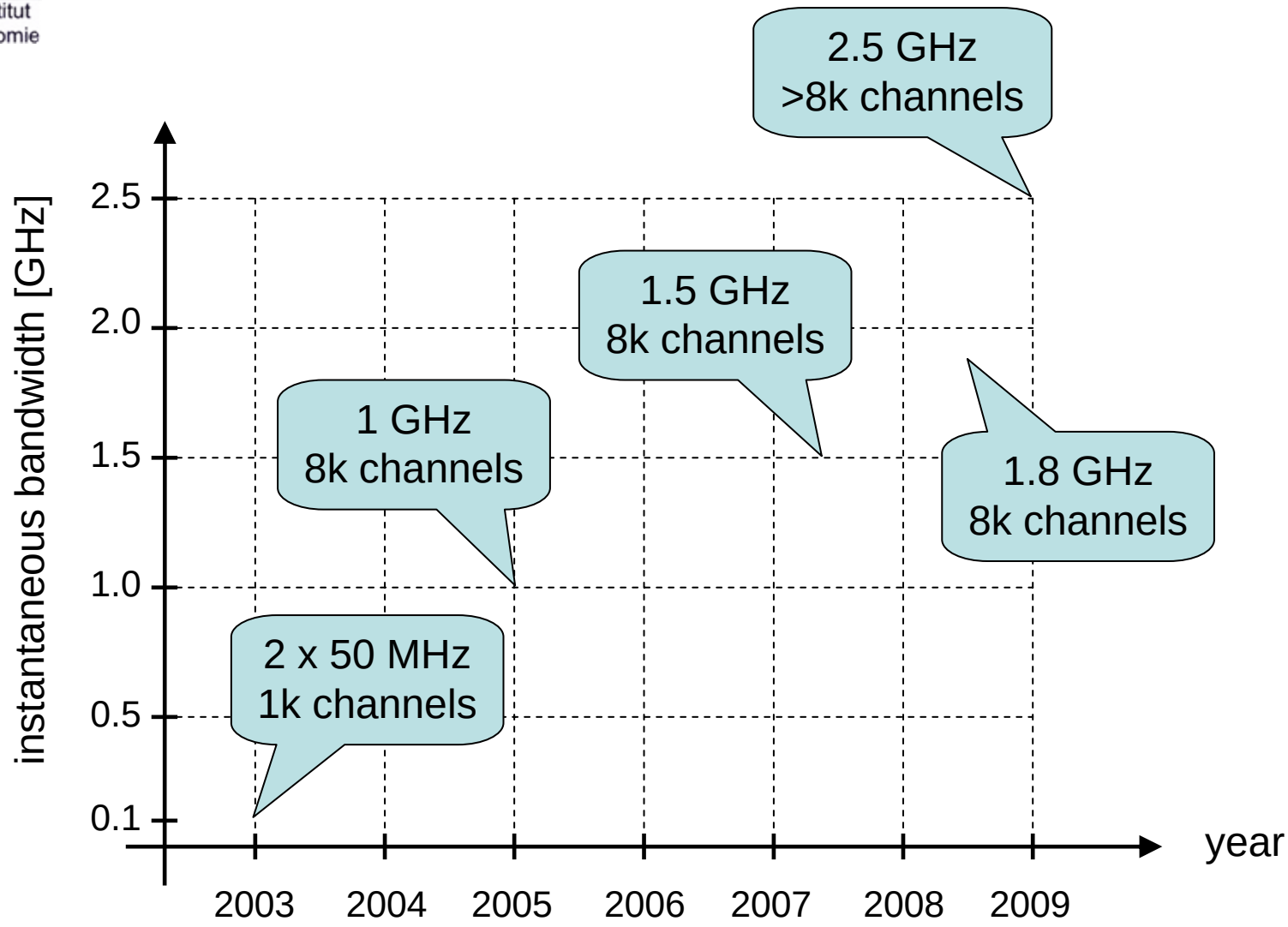
FFTS :: *A short "history" ...*



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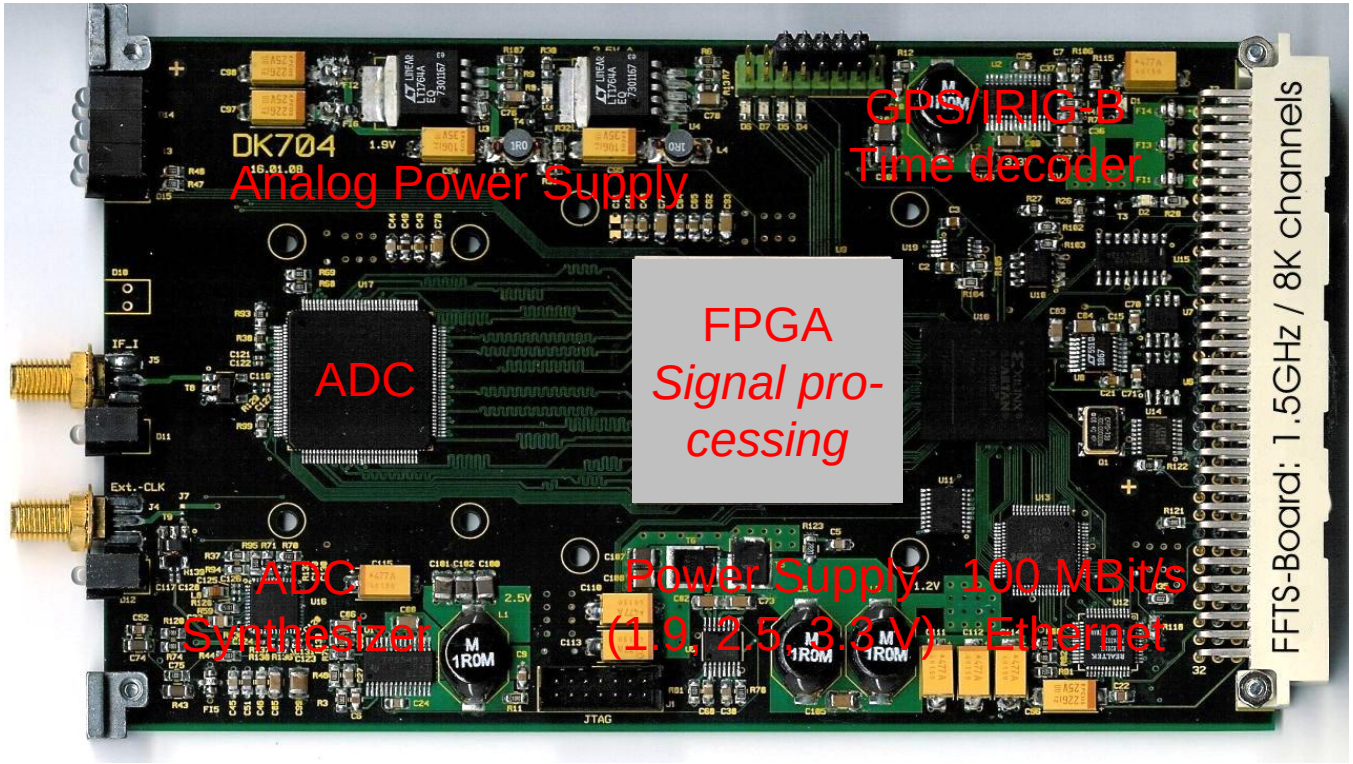
FFTS :: *The MPIfR-Board*

IF input (0 - 3 GHz)



5 Volt

Data

- Instantaneous bandwidth: 0.1 – 1.8 GHz
- Spectral resolution @ 1.5 GHz: 212 kHz
- Stability (spec. Allan Variance): > 1000 sec.
- Calibration- and aging free digital processing

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AFFTS :: *Array-FFTS for APEX*

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Atacama Pathfinder EXperiment
APEX

Bandwidth: 32 x 1.5 GHz = 48 GHz (option 58 GHz)
Spec. channels: 32 x 8k = 256k channels @ 212 kHz

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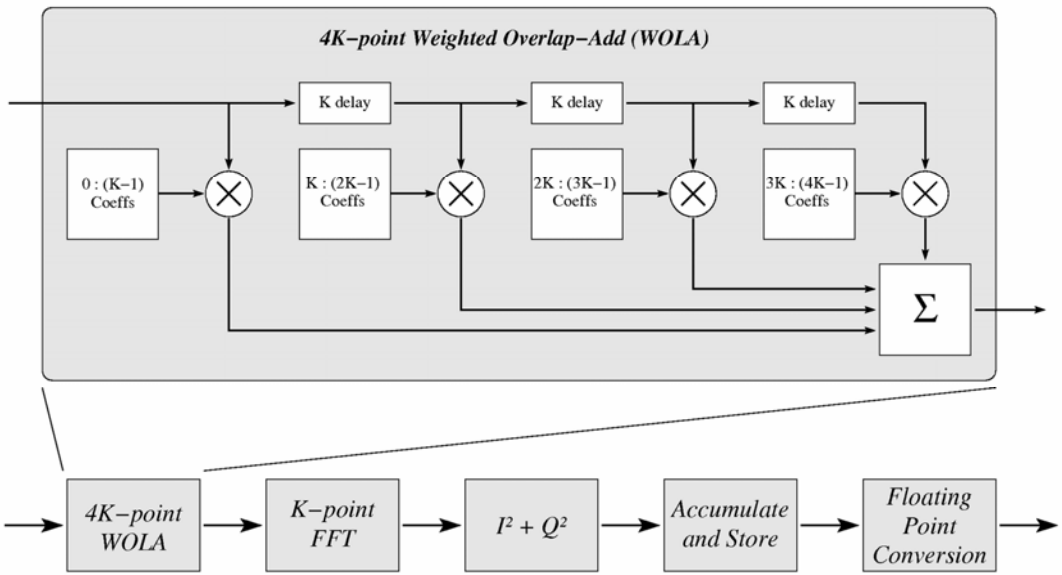
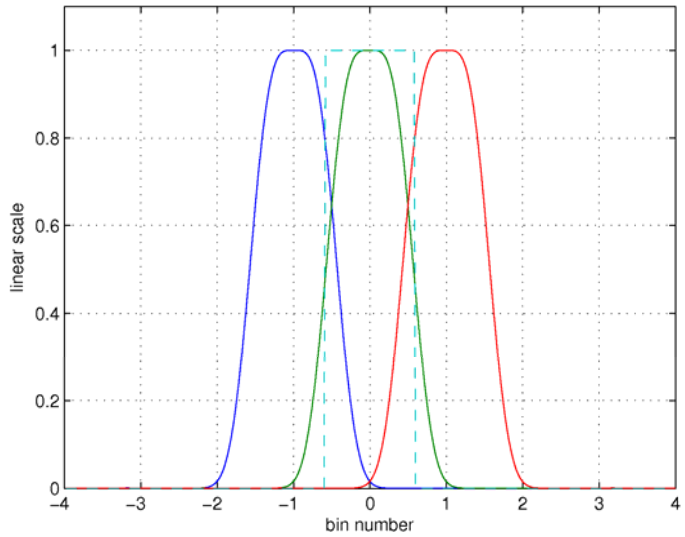
FFTS :: *Signal Processing*

Unlike the conventional windowed-FFT processing, a more efficient polyphase pre-processing algorithm has been developed with significantly reduced frequency scallop, less noise bandwidth expansion, and faster sidelobe fall-off.





Frequency response of the optimized FFT signal processing pipeline

Equivalent noise bandwidth = 1.16 x frequency spacing

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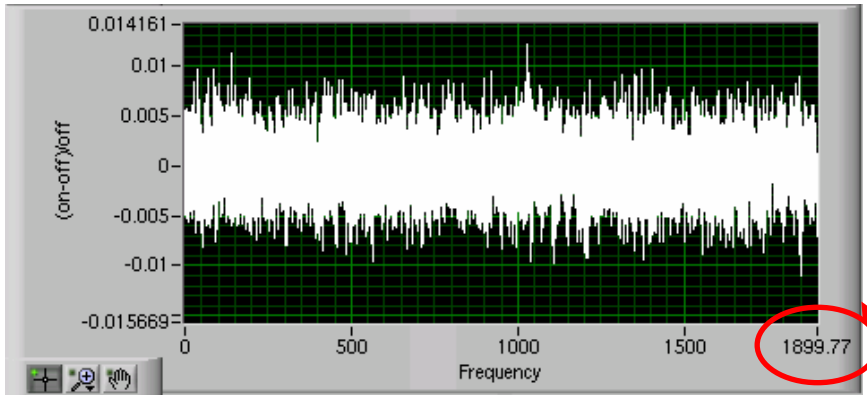
FFTS :: *FPGA configurations*

Today, implemented FFTS board / FPGA configurations are:

- 1 x 1.5 GHz bandwidth, 1 x 8192 spectral channels, ENBW: 212 kHz (default core)
- 1 x 1.8 GHz bandwidth, 1 x 8192 spectral channels, ENBW: 255 kHz



1.9 GHz is possible by using selected FPGAs with highest speed grades!

- 1 x 750 MHz bandwidth, 1 x 16382 spectral channels, ENBW: 53 kHz
- 1 x 500 MHz bandwidth, 1 x 16384 spectral channels, ENBW: 35 kHz
- 1 x 100 MHz bandwidth, 1 x 16384 spectral channels, ENBW: 7 kHz (in lab test)
- 2 x 500 MHz bandwidth, 2 x 8192 spectral channels, ENBW: 71 kHz (in lab test)

The Equivalent Noise Bandwidth (ENBW) is the width of a fictitious rectangular filter such that the power in that rectangular band is equal to the (integrated) response of the actual filter.

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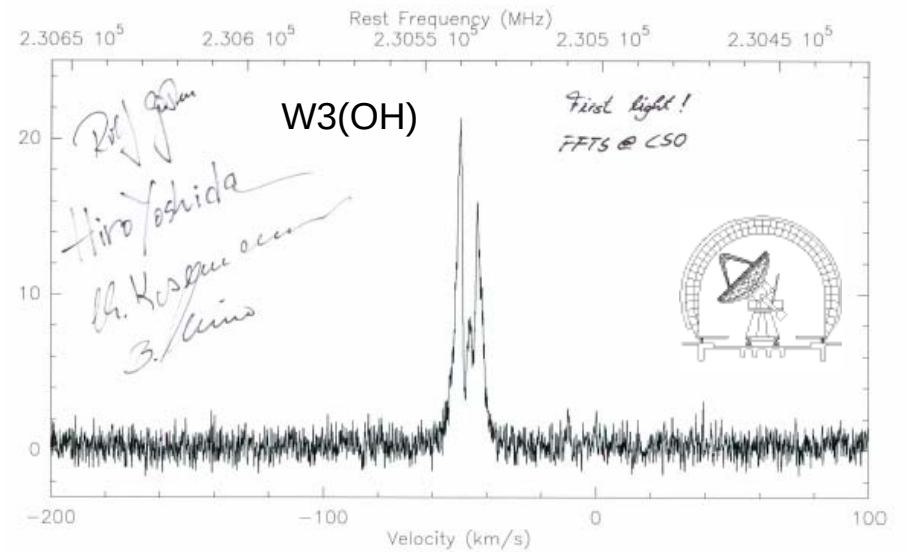
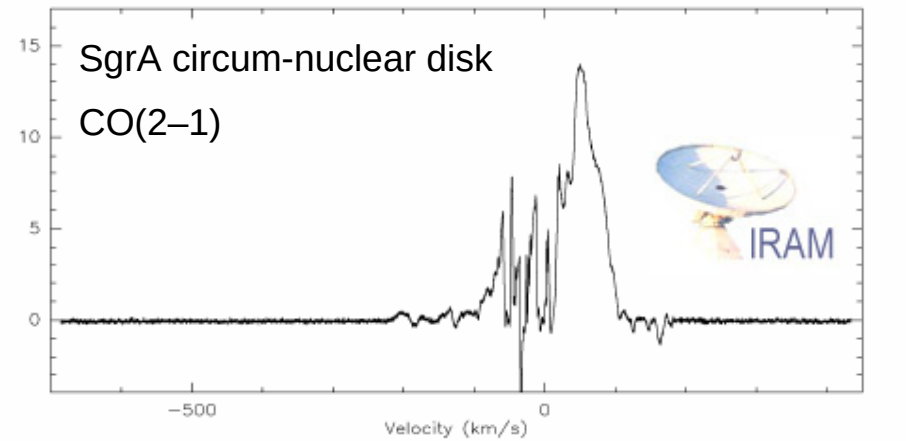
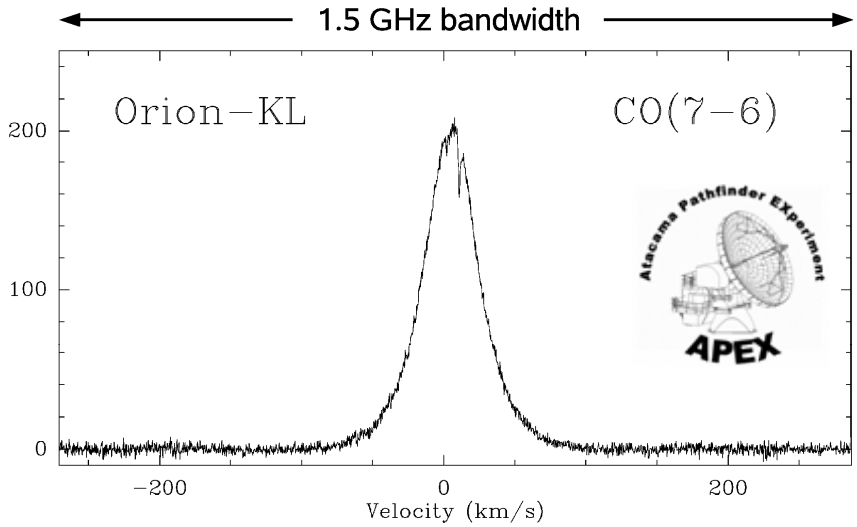
FFTS :: *in world-wide use*

The superior performance, high sensitivity and reliability of MPIfR FFT spectrometers has now been demonstrated at many telescopes world-wide.







Spectrum towards Orion-KL. The high-excitation CO(7-6) transition at 806 GHz was observed with the central pixel of the CHAMP+ array.

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The Effelsberg FFTS

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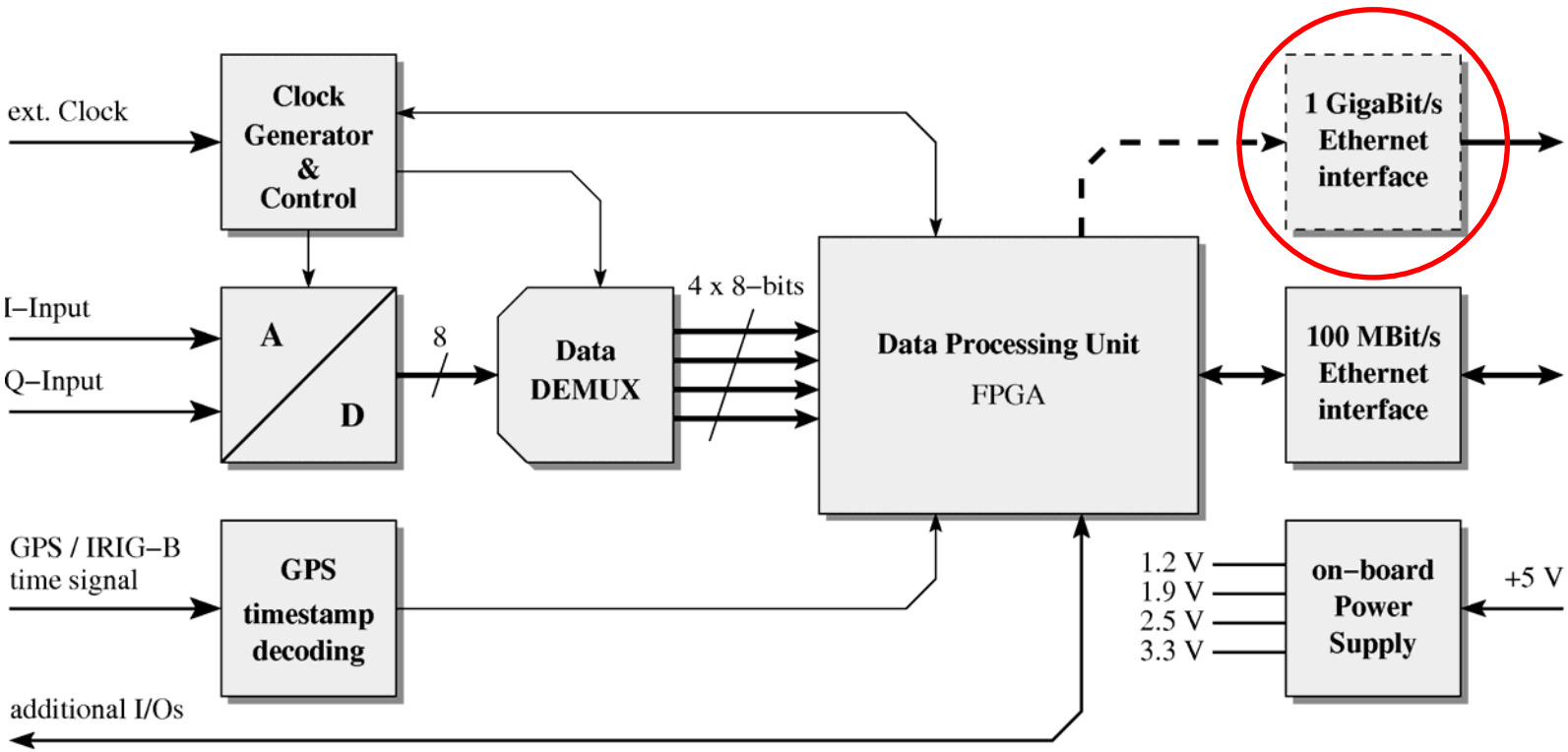
Applications:

- Spectroscopy :: 16 x 100 - 500 MHz bandwidth, 8192 and 16384 channels
- Pulsar Search :: 16 x 250 MHz bandwidth, 512 channels, 64µs dumping



Installation & Commissioning: August this year!

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FFTS :: *The 2.5 GHz development*

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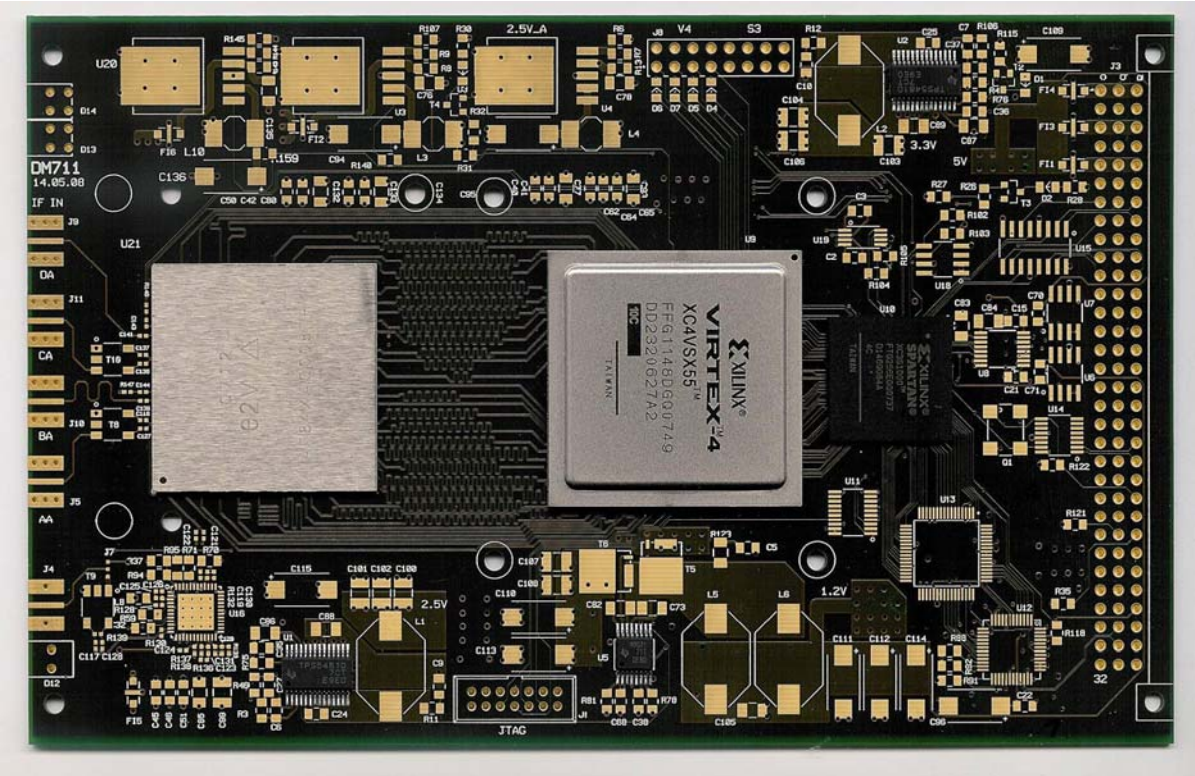
GREAT

Currently in development: **The 2.5 GHz bandwidth FFTS for GREAT**



Goal: 2.5 GHz instantaneous bandwidth with adequate spectral resolution (~100 kHz), to be operational in time for SOFIA's early science flights in summer 2009!

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MPIfR FFTS :: *Summary*

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Advantages of our new generation of compact FFT spectrometers:

- ✓ FFTS provide high instantaneous bandwidth (1.5 GHz demonstrated in field tests, 1.8 GHz achieved in lab tests) with many thousands frequency channels, thus offering wideband observations with high spectral resolution without the complexity of the IF processing in a hybrid configuration.
- ✓ They provide very high stability by exclusive digital signal processing. Allan stability times of > 1000 seconds have been demonstrated routinely.
- ✓ Field-operations of our FFTS over the last 3 years have proven to be very reliable, with calibration- and aging-free digital processing boards, which are swiftly re-configurable by Ethernet for special observation modes.
- ✓ Low space and power requirements – thus safe to use at high altitude (e.g. APEX at 5100-m) as well as (potentially) on spacecrafts and satellites.
- ✓ Production cost are low compared to traditional spectrometers through use of only commercial components.

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FFTS :: *Contact, Distribution*

Contact:

For further information about the MPIfR FFT spectrometer technology,
future developments and applications, please contact
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Rolf Güsten (rguesten@mpifr.de) at the
Max-Planck-Institut für Radioastronomie in Bonn, Germany.

Distribution of standard FFT spectrometer (1.5 GHz / 8192 channels) by:

NEW!

Radiometer Physics GmbH

http://www.radiometer-physics.de

NEW!