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für Radioastronomie

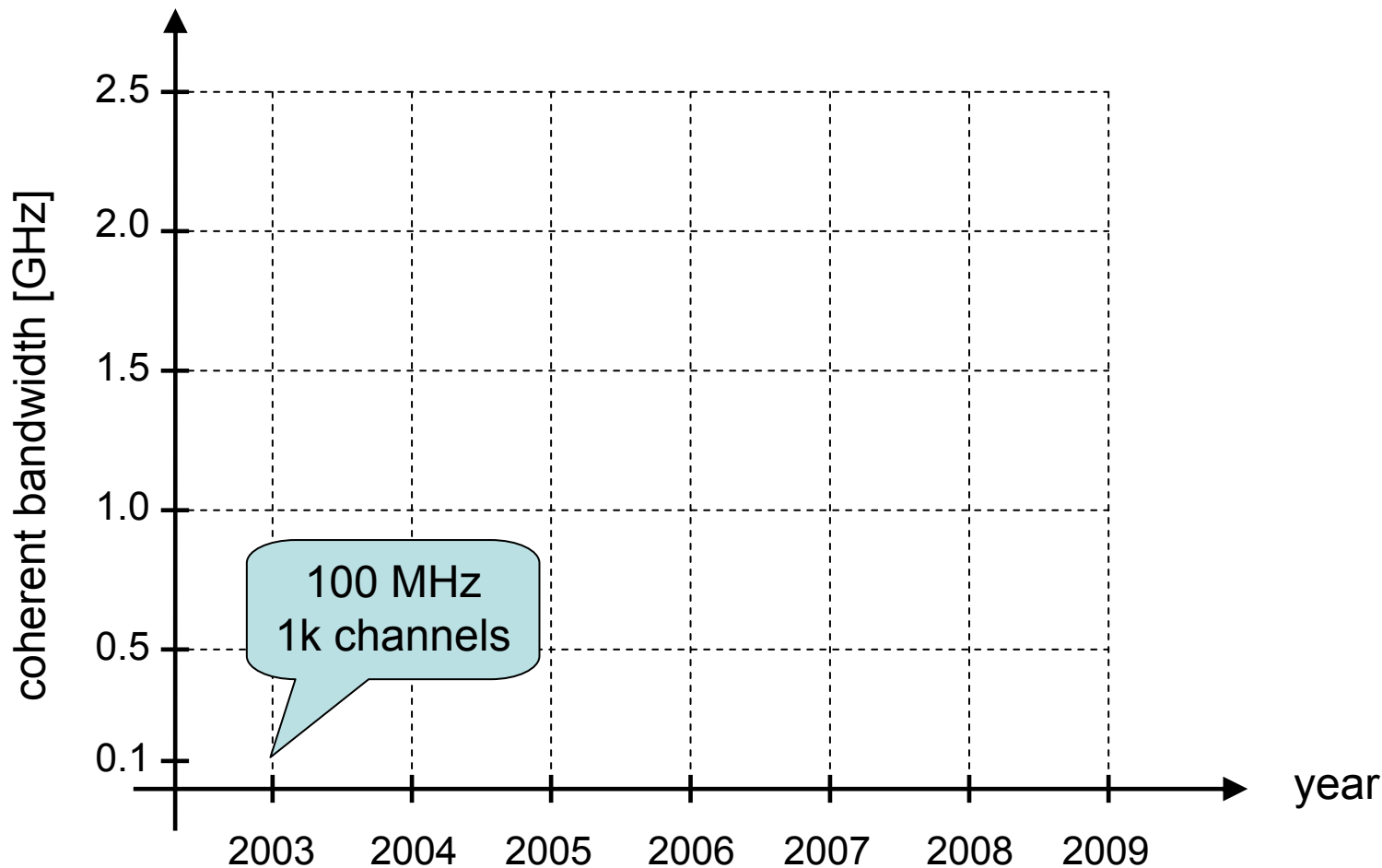
The Next Generation of Fast Fourier Transform Spectrometers (FFTS)

Bernd Klein

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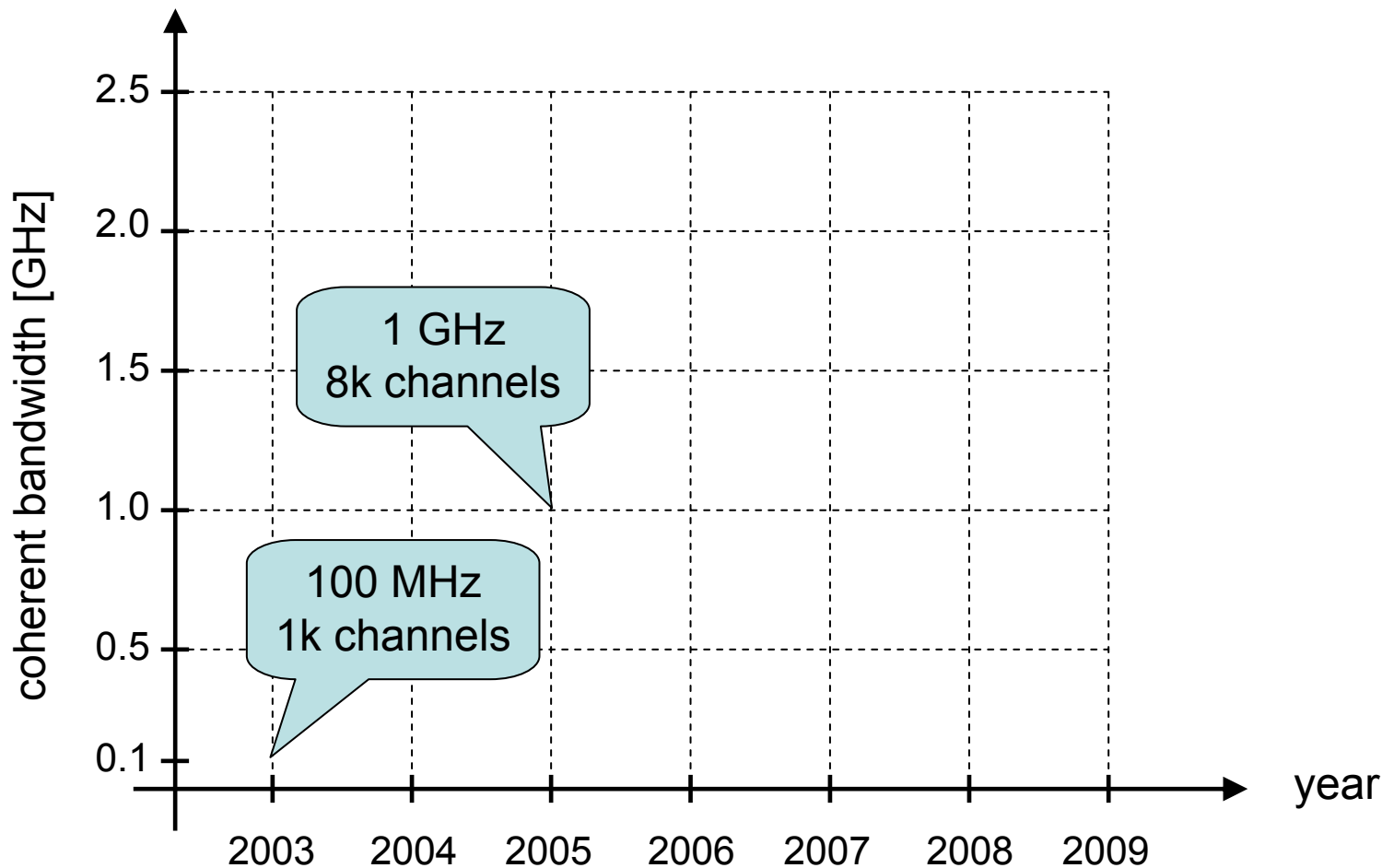


FFTS :: A short "history" ...



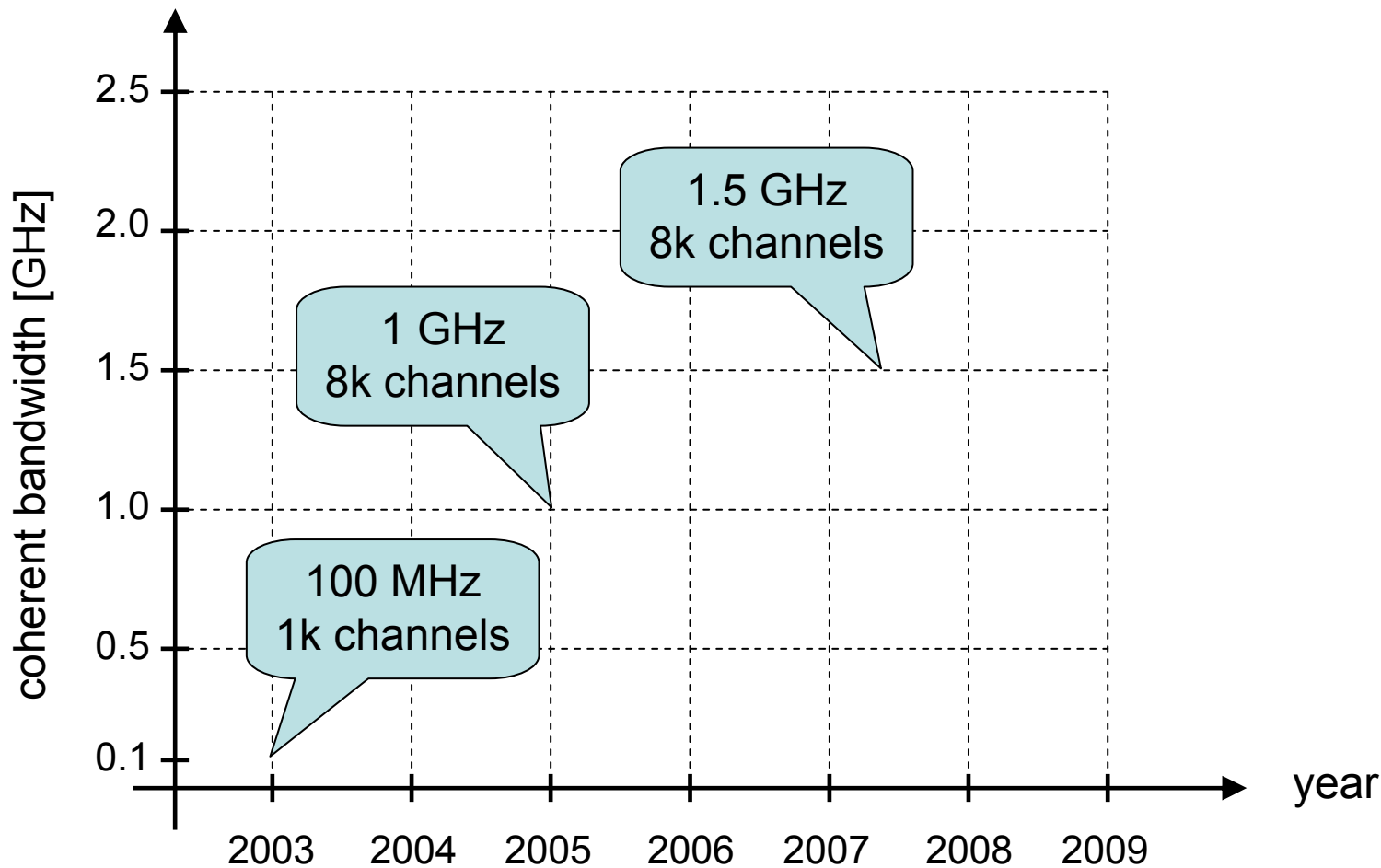


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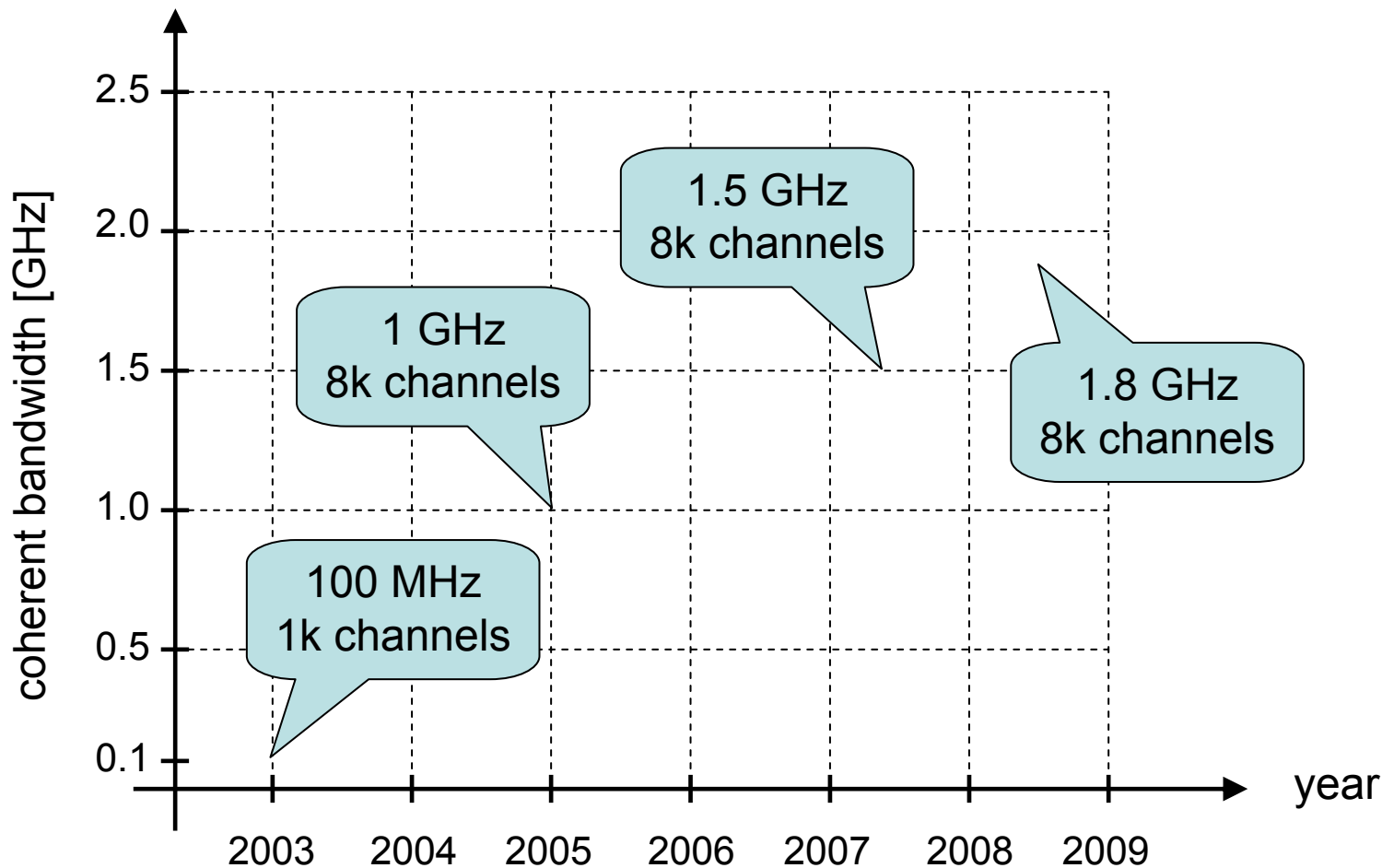


FFTS :: A short "history" ...





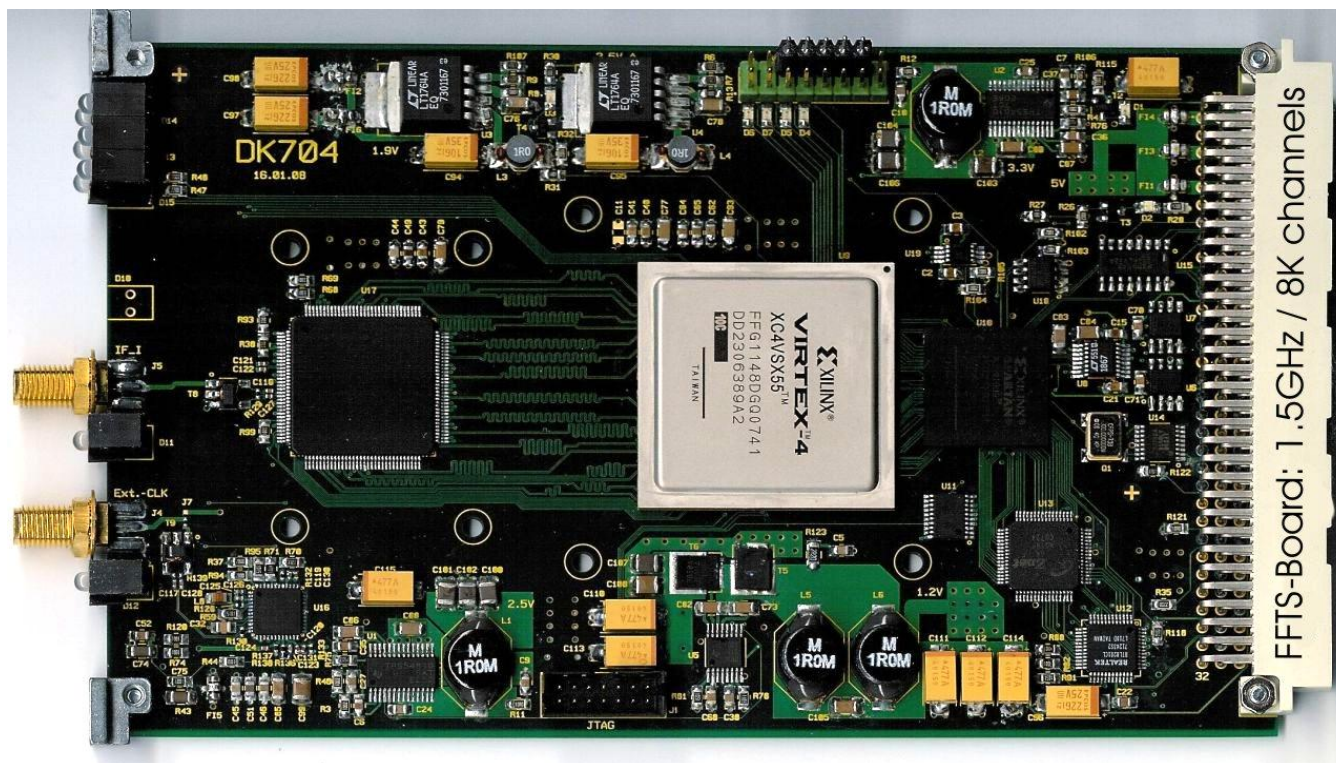
FFTS :: A short "history" ...





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FFTS :: The MPIfR-Board



IF input
(0 - 3 GHz)

5 Volt
←

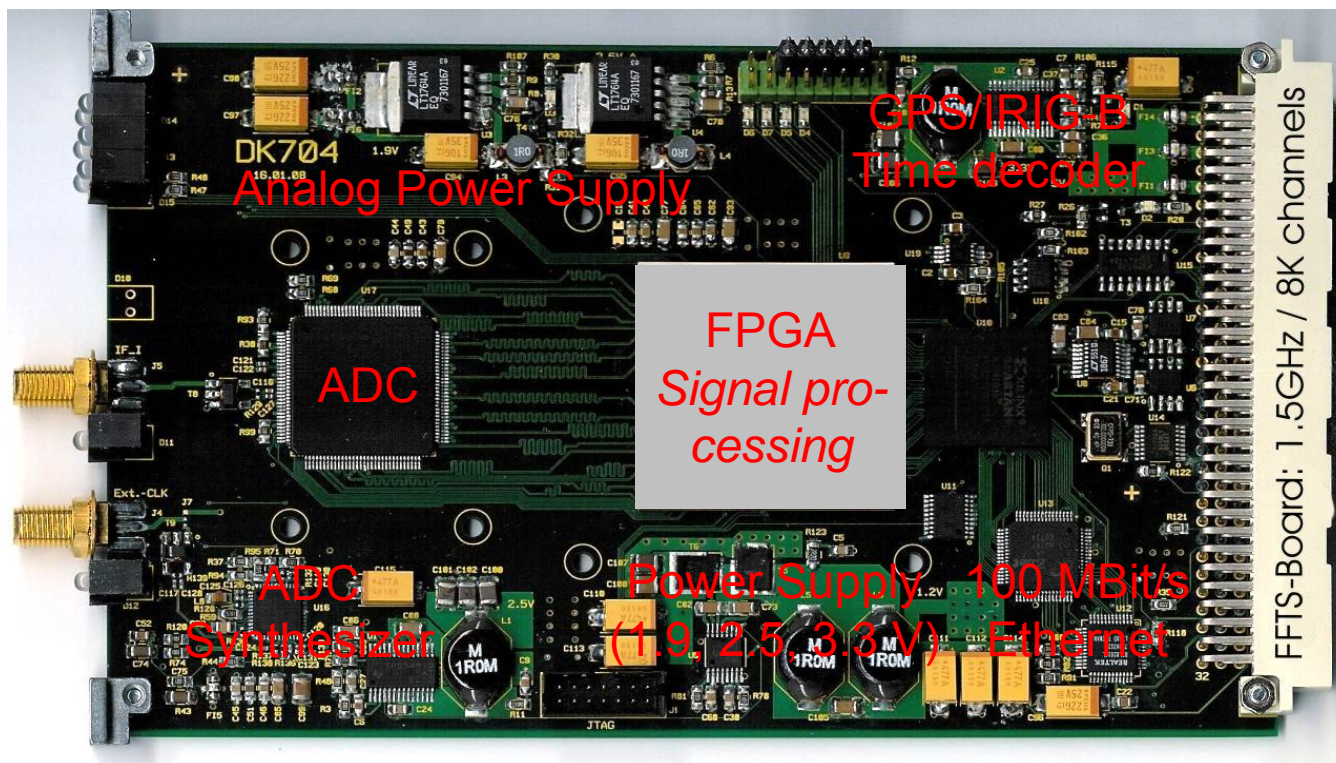
Data
→

- Monolithic 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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FFTS :: Array-FFTS for APEX



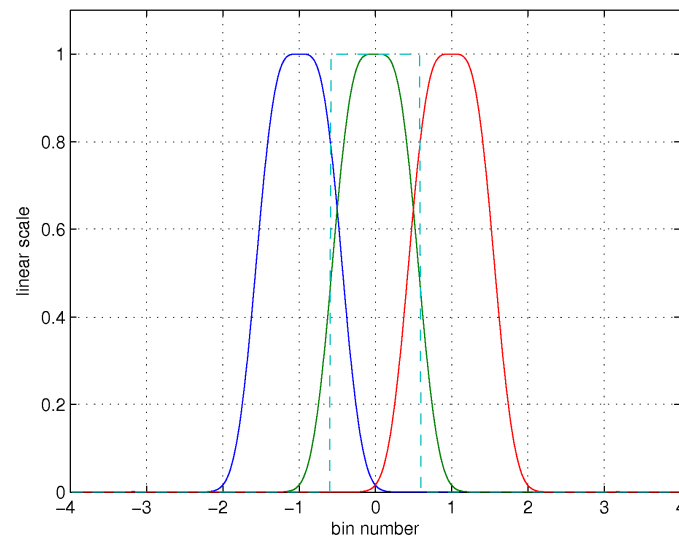
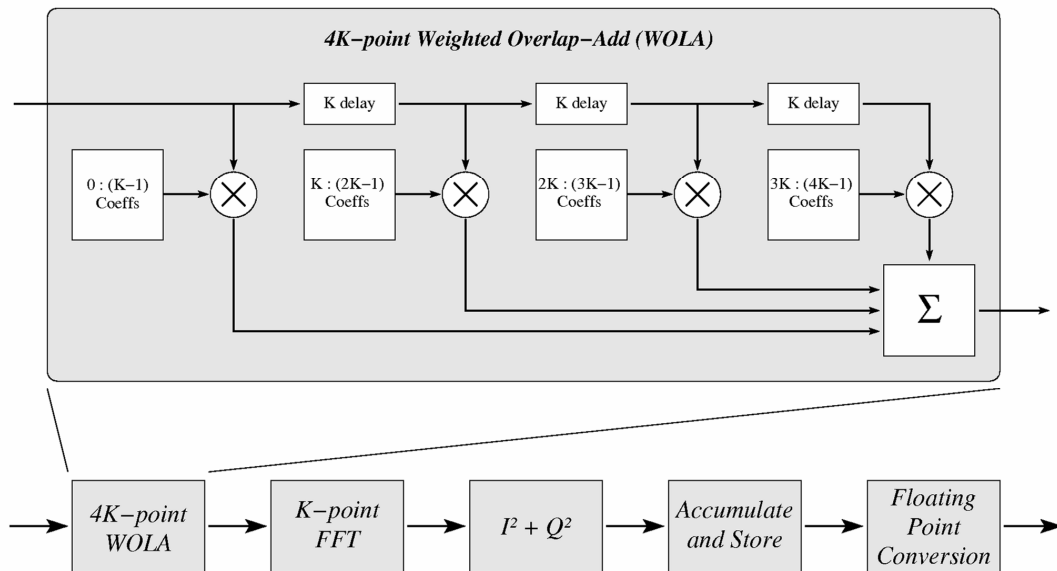
Bandwidth: $32 \times 1.5 \text{ GHz} = 48 \text{ GHz}$ (option 58 GHz)
Spec. channels: $32 \times 8\text{k} = 256\text{k}$ channels @ 212 kHz





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

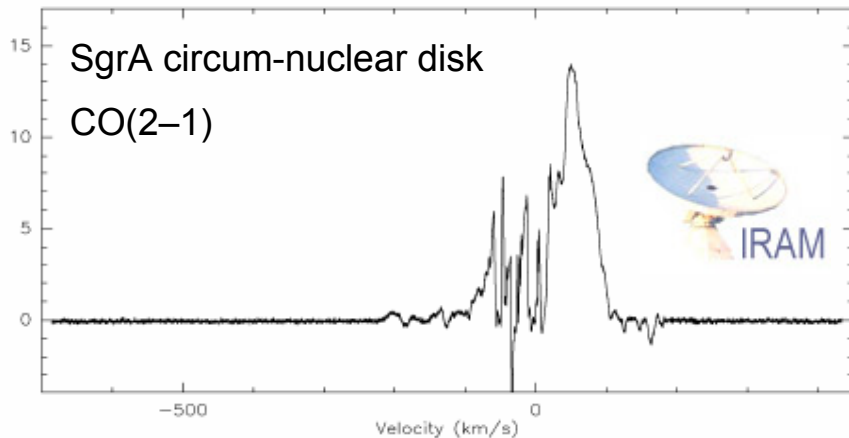
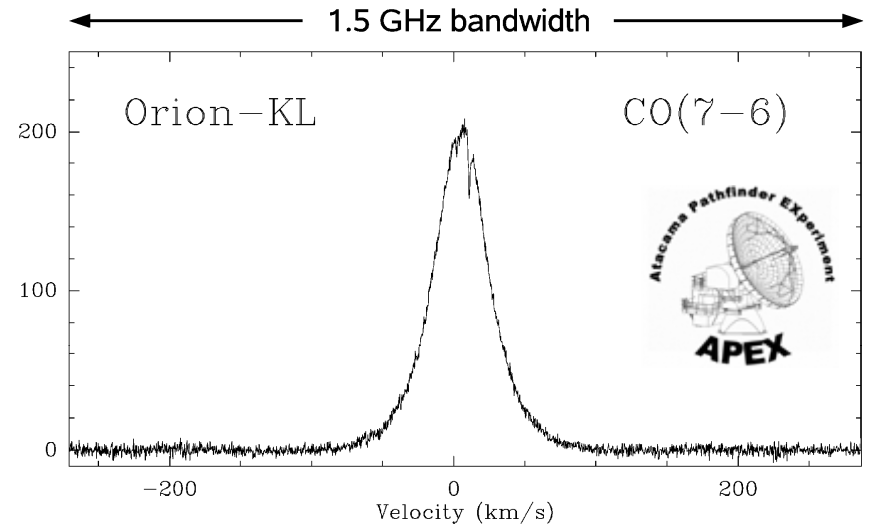
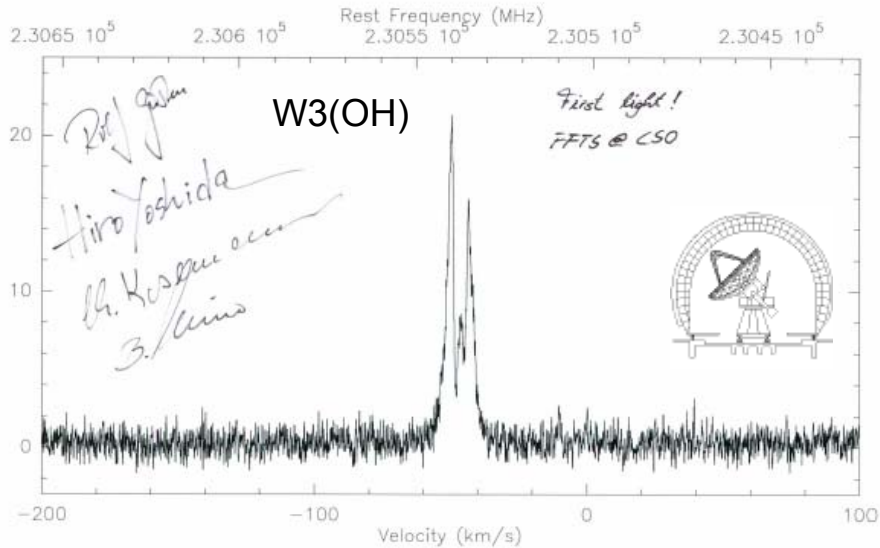
Equivalent noise bandwidth = 1.16 x frequency spacing



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FFTS :: *in world-wide use*

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



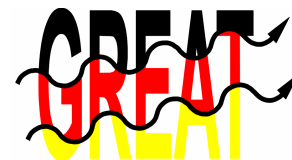
Spectrum towards Orion-KL. The high-excitation CO(7-6) transition at 806 GHz was observed with the central pixel of the CHAMP+ array.



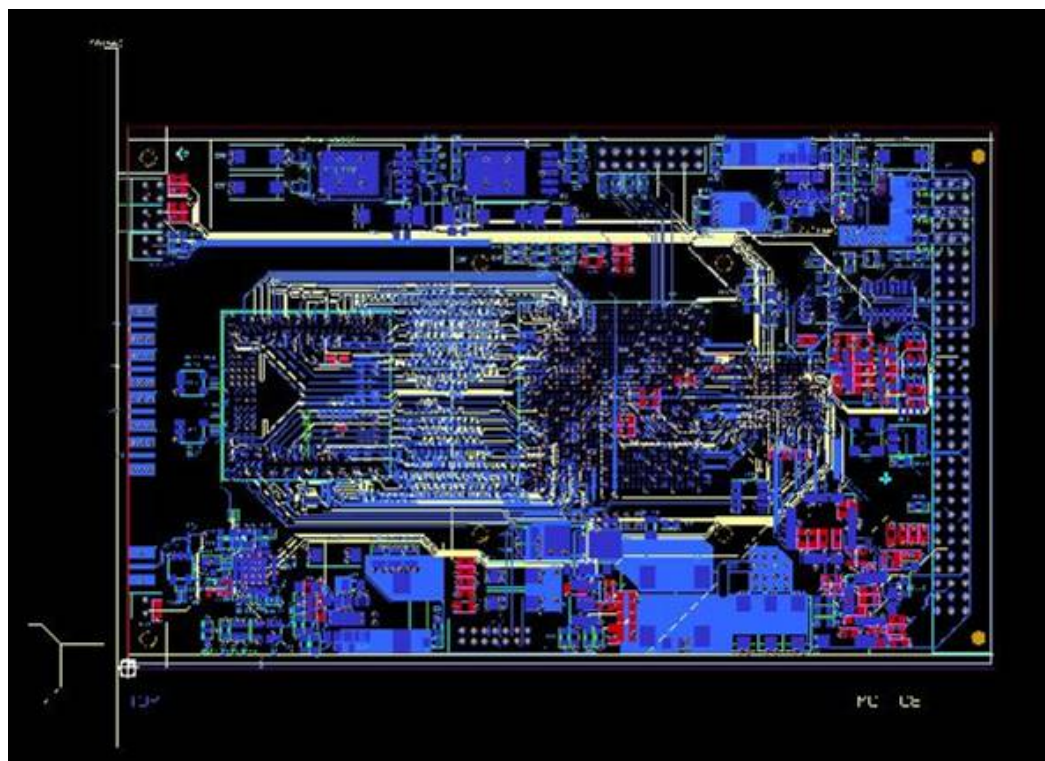
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FFTS :: *The 2.5 GHz development*

DIGITALLABOR
www.digitallabor.de



Currently in development: The 2.5 GHz bandwidth FFTS for GREAT



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

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MPIfR FFTS :: *Summary*

Advantages of our new generation of compact FFT spectrometers:

- ✓ FFTS provide high coherent bandwidth (1.5 GHz demonstrated in field tests, 1.8 GHz achieved in lab tests) with many thousands frequency channels, thus offering wide-band 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 ~4000 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, future developments and applications, please contact Rolf Güsten (rguesten@mpifr.de) or Bernd Klein (bklein@mpifr.de) at the Max-Planck-Institut für Radioastronomie in Bonn, Germany.



Distribution:



<http://www.radiometer-physics.de>

