

POLARIMETRIC SPECTROMETER FOR ITALIAN RADIOTELESCOPES

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■ Spectrometer developed in the Radioastronomy Laboratory of the Arcetri Observatory

■ Designed for multi-beams receivers to be used on italian radiotelescopes (Medicina, Noto, SRT)

■ Based on boards developed for ALMA correlator.

■ Recently tested for H₂O maser observations in the Medicina Radiotelescope

Devices: Altera Stratix FPGAs
(Field Programmable Gate Arrays)

MODULAR DESIGNS

Components (digital receiver – variable bandwidth filter – polyphase filter – FFT spectrometer)

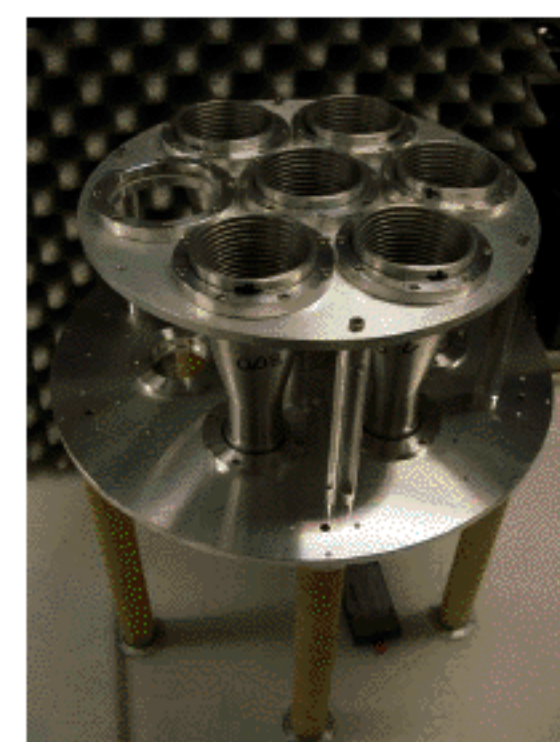
- are described using high level languages
- can be reused on several hardwares

The same hardware can be used to implement several different functions.

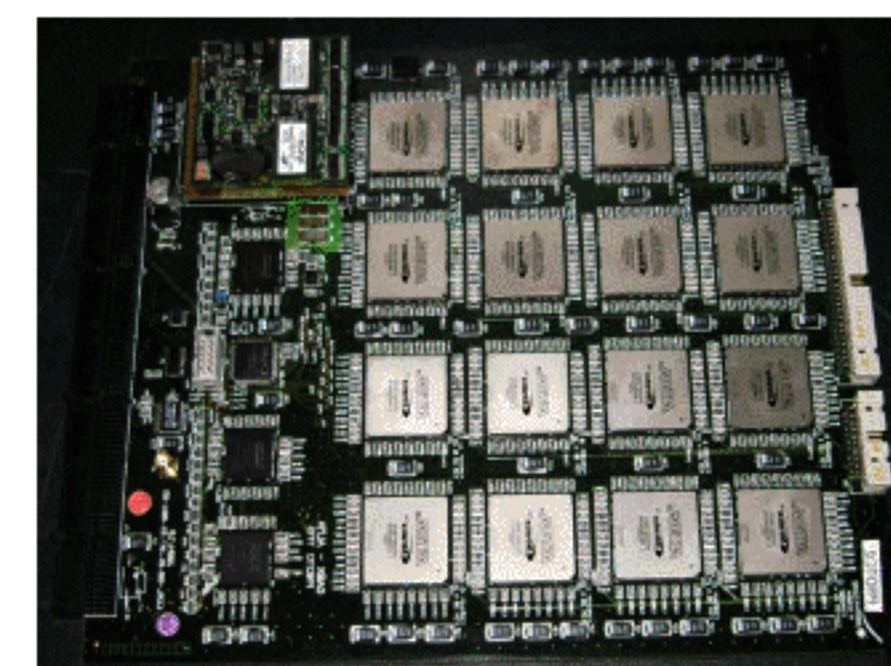
FLEXIBLE INSTRUMENT

Configuration examples:

- polarimeter on 8 receivers with double polarization
- in band synthesis: single channel with 1 GHz bandwidth (8 x 125 MHz)



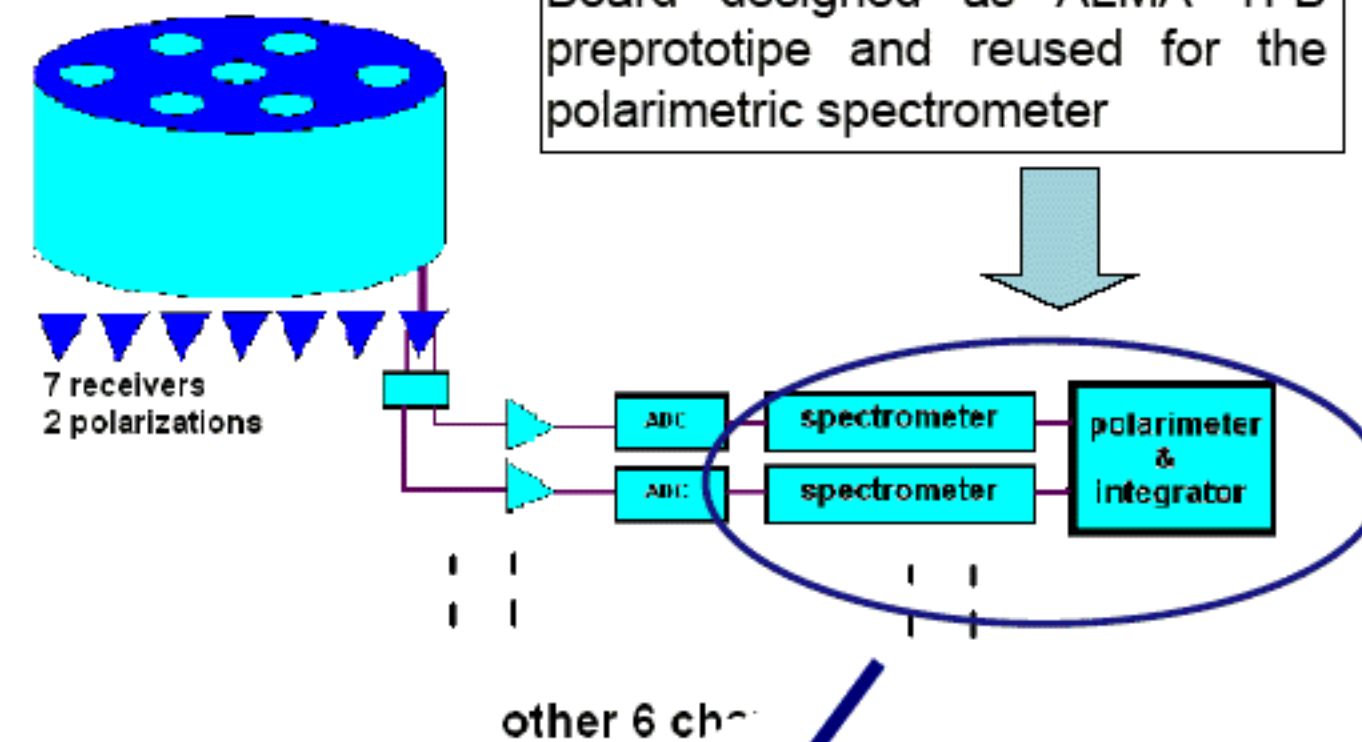
7 beams double polarization radio receiver for the band 18–26 GHz



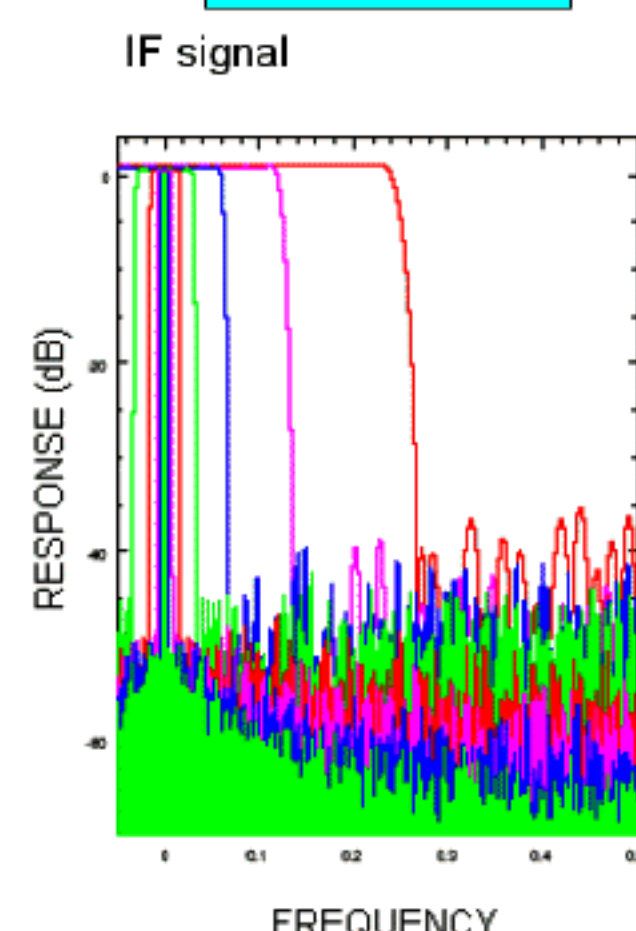
Board designed as ALMA TFB preprototype and reused for the polarimetric spectrometer

Receiver parameters:

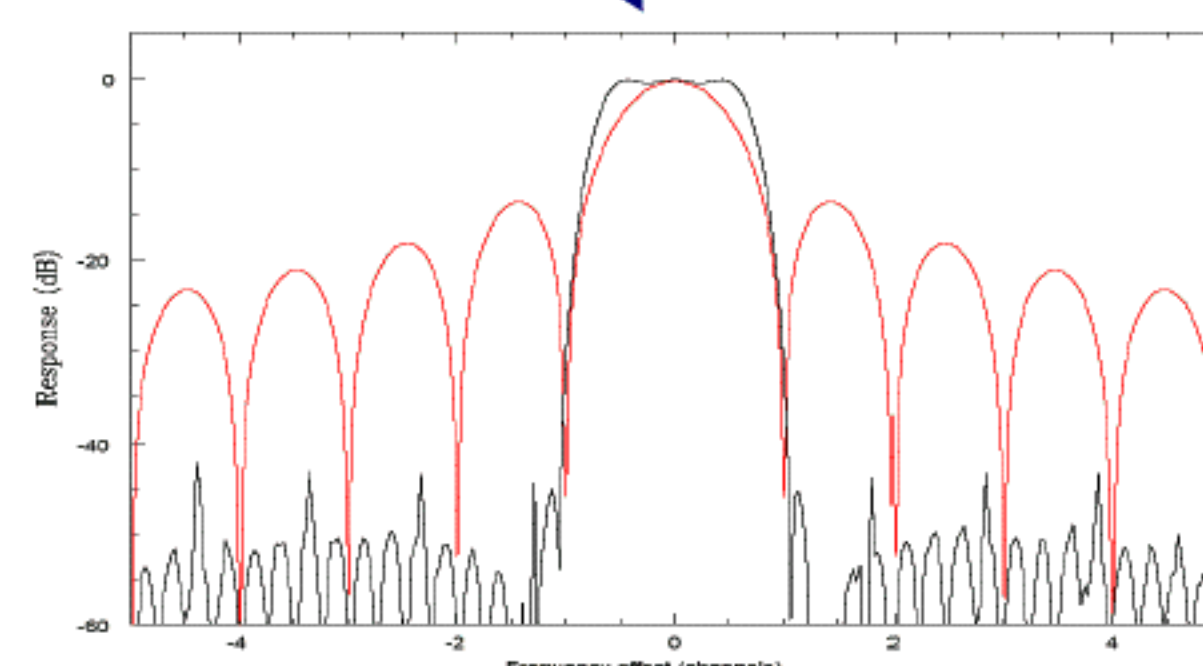
- Observable band 18 – 26 GHz (transitions H₂O, NH₃, HC₃N)
- 7 beams with double polarization outputs
- instantaneous bandwidth 2 GHz
- InP receivers, Tsys = 50 K



Single channel structure



Band shape of the digital filter for decimation factors between 2 and 256.



polyphasic filtering: channels insulation with polyphasic filter and without it.

Characteristics of the individual channel

■ **ADC:**
 Input bandwidth 125 MHz [125 : 250 MHz]
 Sampling frequency 250 MHz

■ **DIGITAL RECEIVER & FILTER:**
 Bandwidth : 0.5 MHz ± 125 MHz
 Tunable

■ **SPECTROMETER:**
 Polyphasic filtering
 channels insulation > 50 dB
 FFT computation
 4096 spectral points resolution

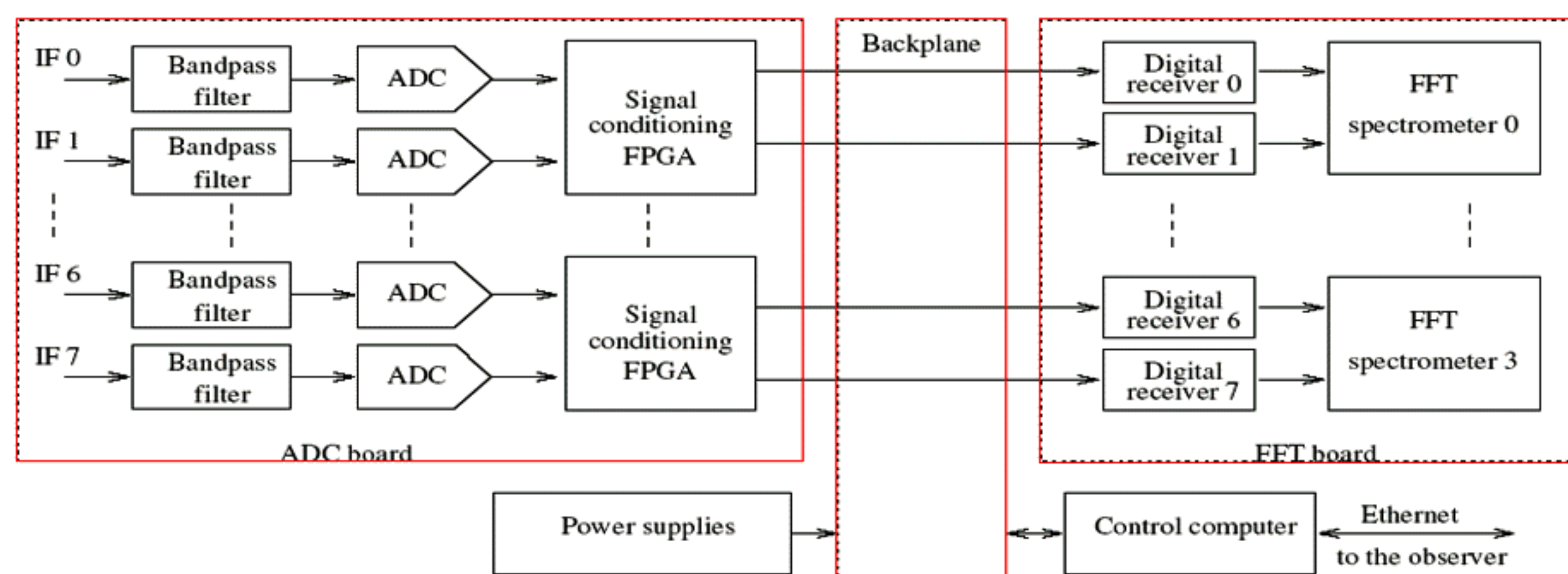
First implementation:

- one ADC at 125 MS/s
- selectable bandwidth between 0.5 and 62.5 MHz
- tested in Medicina Radiotelescope: H₂O maser observations
- board initially designed as ALMA TFB pre-prototype



Final implementation:

- 8 ADC at 250 MS/s
- selectable bandwidth between 0.5 and 125 MHz
- complete back end for the 7 beams double polarization receiver



SFR ON1
 Bandwidth: 15.625 MHz
 Spectral resolution: 4096 points

H₂O masers
 $f = 22.223$ GHz
 Medicina radiotelescope

SFR W3(OH)
 Bandwidth: 15.625 MHz
 Spectral resolution: composite, 2x4096 points overlapping spectra

