# The Ultra Broad Band Receiver (BEACON) Project

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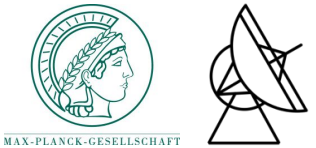
# BEACON




- **Project funded in 2011 by ERC Staring Grant n. 279702 to Paulo Freire.**

- **This grant is funding the construction and exploitation of a ultra-broad-band receiver for pulsar timing observations in order to rule out alternative theories of gravity.**

# BEACON: Expected results

- Unique experimental data in gravitational physics

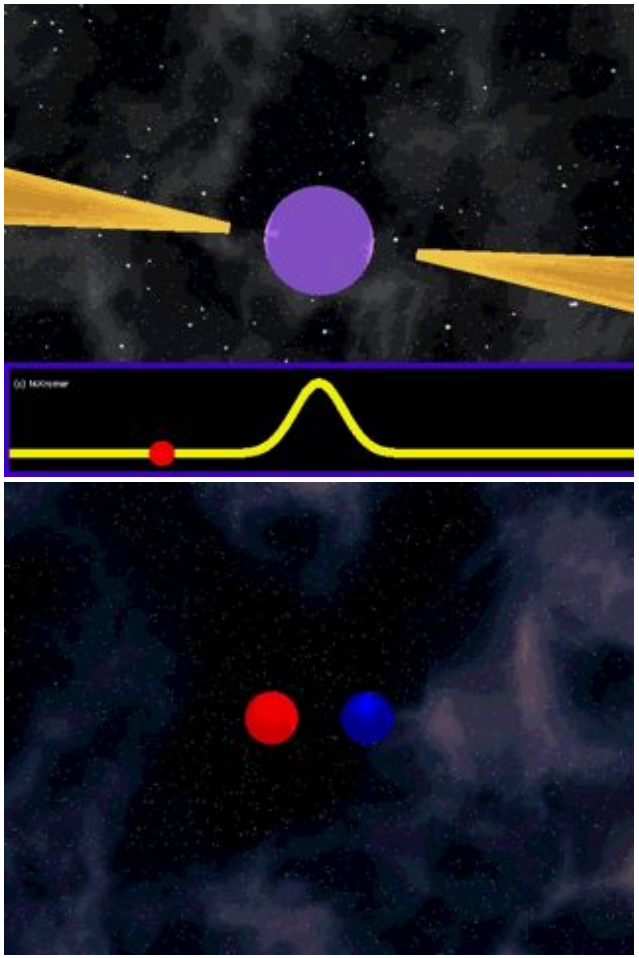
- *Definite answers on GR and alternative theories of gravity*.

*Rule out alternative theories of gravity*
(e.g. TeVeS)
*Make a strong case for Dark Matter*

*Show the existence of phenomena beyond general relativity!*

# How?

- A clean and simple experiment:

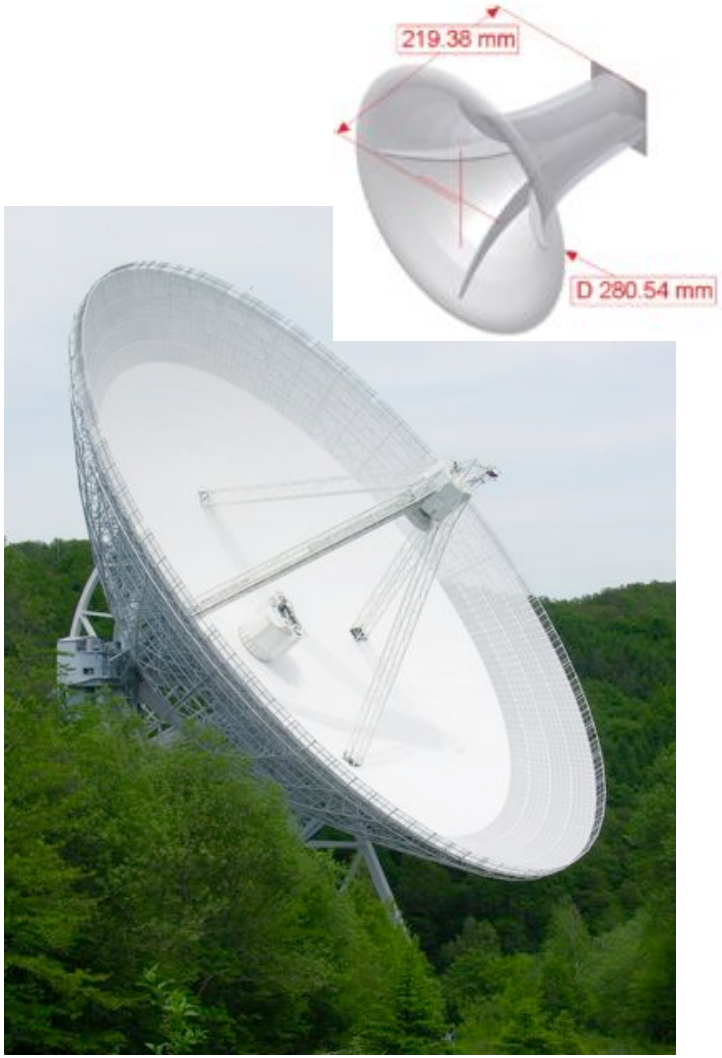


*Pulsar timing:* Measure pulsar motion by timing arrival of radio pulsars at telescope.

**Different theories predict different orbital dynamics for these systems!**

*Binary pulsars:* ~200 out of the total of ~2000 known pulsars have binary companions. Pulsar's momevent probes space-time around companion star!

# What do we need to do?




- To differentiate between GR and alternatives, ***we must improve pulsar timing precision***!
- *Limitations*:
  - *telescope sensitivity*
  - *effects of the interstellar medium*.
- Solution:
  - ***ultra-broad-band receiver*** (0.6 - 3 GHz),
  - ***Beyond state-of-the-art spectrometer***

# The Ultra-Broad-Band (UBB) Receiver

- Design goals: - sensitive = cooled

  - linear = robust to RFI

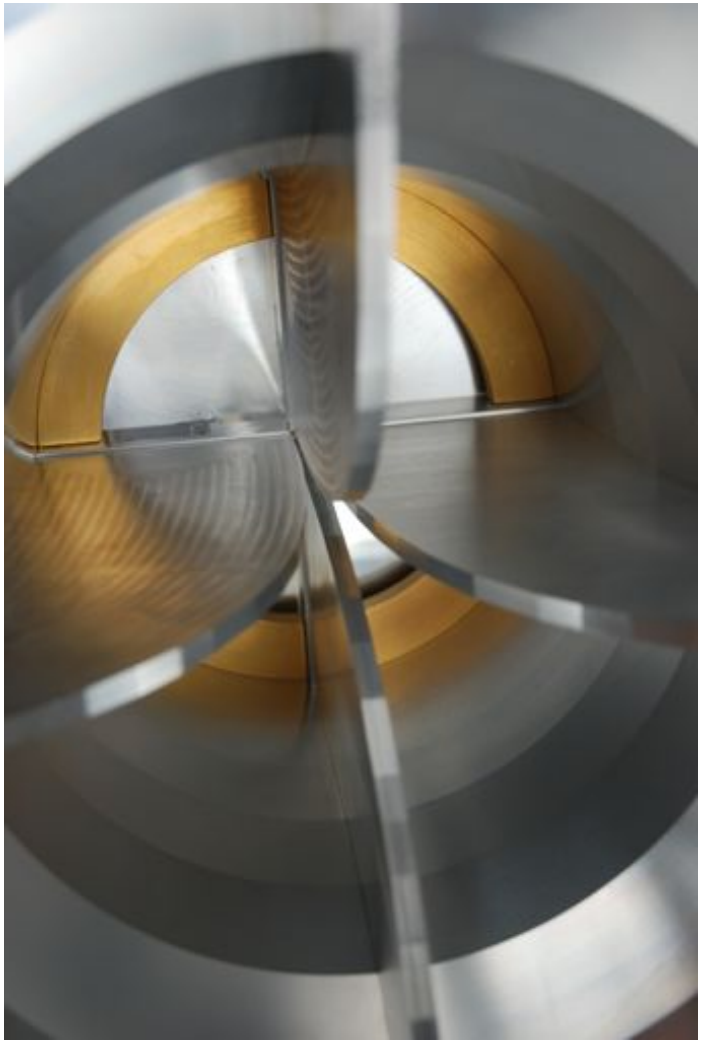
  - fully coherent dedispersed

- Using “quadridge feed” as designed by Sandy Weinreb (JPL) within the TDP

- Direct digitization, i.e. no mixing to IF

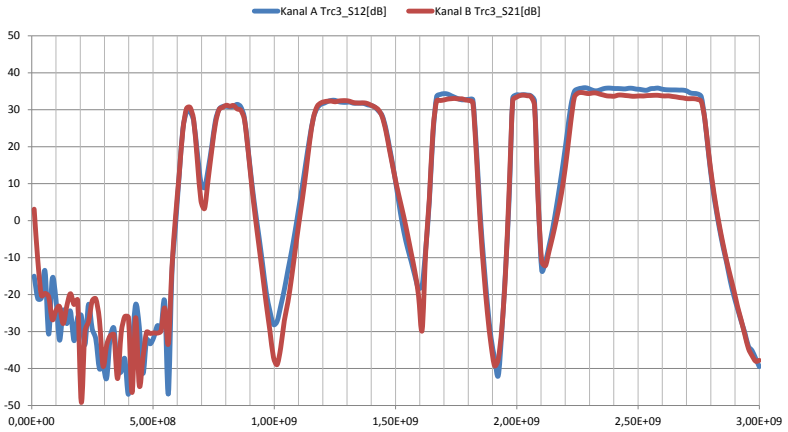
- Coherent dispersion of 3 GHz via GPUs

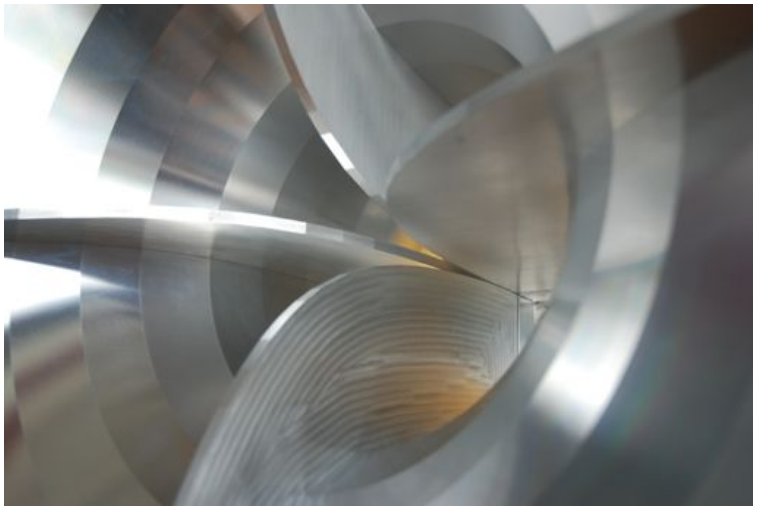
- From first idea, funding, design and commissioning in under two years!

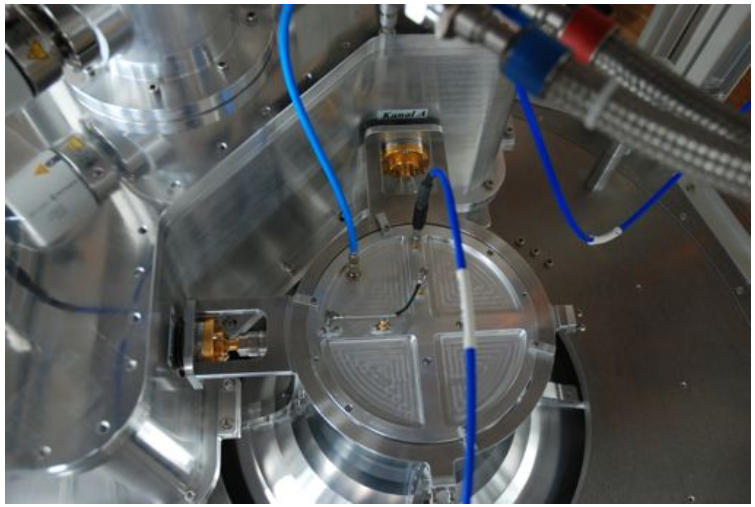


# The Ultra-Broad-Band (UBB) Receiver

- Receiver completed May 2012
- System temperature < 25 K
- Flexible RFI filters (post-LNA)
- Biggest problem: still, RFI!





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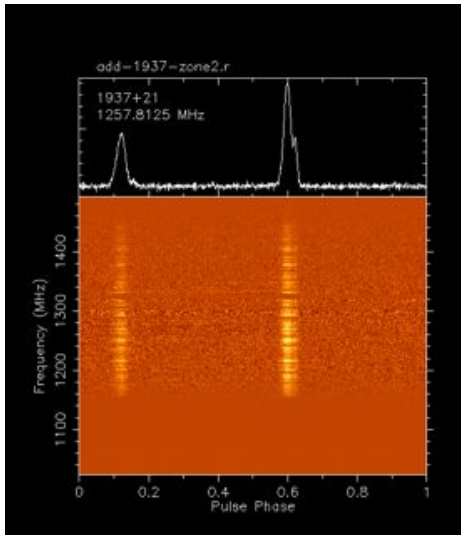
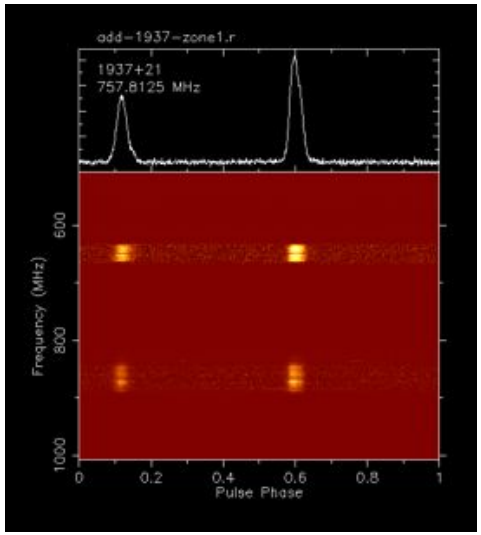
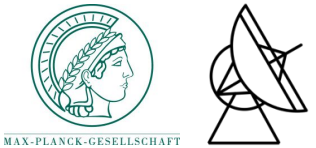


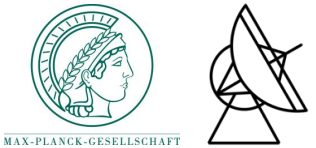




# The Ultra-Broad-Band (UBB) Backend



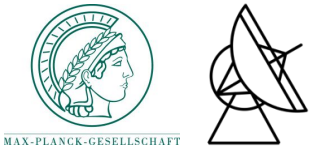

- Complete Nyquist-sampling of whole band 0.6-3 GHz (both pol.)
- Currently, ROACH based system with limited bandwidth
- From early 2013:  Tektronics Sampler + UNIBOARD + GPU
- Coherent on-line dedispersion, coherent filterbank, incoherent filterbank
- Full Stokes information
- May also be used also as backend at other receivers

# Summary & Outlook




- Receiver had first light and is performing well
- Sensitivity currently limited by RFI – need to filter that to gauge overall sensitivity
- Various options are being explored, incl.
  - mechanical shielding
  - super-conducting filter
- Full bandwidth available in early 2013
- Further science application in addition to pulsar timing

# More information:




http://www3.mpifr-bonn.mpg.de/staff/pfreire/BEACON.html