

RFI Project Plan Updated 30.06.2010 for ALBiUS Management

---

=====  
Date: 16.12.2009 Draft project description for Anton Zensus  
16.04.2010 Goals sharpened, organizational details added

Title: RFI Mitigation  
-----

Start: Q2 2010  
End: Q2 2011

Goals:  
-----

Fulfil our ALBiUS committment to deliver RFI mitigation software

- Multi-rate filtering in DiFX (Roshi & Perley 2003, ASP Conf Ser 306, 109)  
Makes EVN and VLBA spectral-line observations more robust  
against RFI if processed on the DiFX correlator.
- Multi-beam single dish RFI mitigation (Briggs, Bell & Kesteven 2000, AJ)  
Enables EBHIS to extend beyond 2000 km/s, enlarging volume beyond  
local region, by suppressing RFI in the heavily contaminated  
lower frequencies

Additional benefits:  
-----

- The RFI mitigation developed for the 21 cm 7-beam could later be  
applied to a possible checkerboard FPA on Effelsberg, which will have  
a severe RFI environment.

Later, one might compete with ASKAP and APERTIF in deep high-redshift HI  
and OH survey to measure galaxy evolution with redshift out to 1.38 for  
OH or 0.8 for HI using the checkerboard array after this PhD.

- Possible spectral baseline ripple reduction using beam cross-correlation

Context:  
-----

Some methods to mitigate RFI are known to be very effective but  
are not yet implemented at many radio observatories. Sophisticated  
approaches for arrays like the SKA and focal plane arrays  
are still to be fully explored.

This project aims to implement two known effective methods of RFI mitigation  
for VLBI and focal-plane arrays and possibly to explore further approaches  
to RFI mitigation.

The RFI mitigation will be employed to enable extention of the  
EBHIS to higher redshifts and so sample larger volumes of space to  
better study galaxy evolution.

Organization:  
-----

Clients: EU (RadioNet ALBiUS - Cimo/Langevelde)

Project Manager: Alan Roy

Lead Users: All DiFX correlator users  
EBHIS (Kerp)  
EB deep HI survey (Kramer)  
APERTIF (Oosterloo)

Relation to Other Groups:  
-----

The project is conducted in the VLBI group with interaction with other groups.

ALBiUS management (Langevelde and Cimo) asks all ALBiUS contractors  
to have lead users in other institutes/groups to enhance interactions  
and general usefulness of the end products to the community, which is  
satisfied by having lead users as Kerp, Oosterloo and Kramer.

Interaction with Kerp is essential since the OH megamaser survey is based on data mining of the EBHIS cubes, and since RFI mitigation exists in the EBHIS and the ALBiUS work should be planned with advice from Kerp to ensure compatibility with and improvement on the existing system.

All other users of the EBHIS cubes will be assisted by the reduced RFI contamination provided by this project.

APERTIF on Westerbork (Oosterloo) is a lead user. It will survey faster than Effelsberg and to higher redshift where cosmological AGN evolution is strong, though will be ready later. Similarities with the Effelsberg 7-beam receiver are such that algorithms developed there are expected to be portable to APERTIF.

Kramer is moving to install a focal-plane array tile (APERTIF or checkerboard) on Effelsberg, and could use on APERTIF the algorithms developed in this project for the Effelsberg 7 beam 21 cm receiver. Kramer has contact with Oosterloo and can get sampled IF data from the APERTIF prototype, which could be used in this project for early algorithm development.

All users of DiFX including the MPIfR VLBI group will benefit from the RFI mitigation to be introduced in the software correlator.

#### Resources:

-----

#### Multi-rate filtering:

- DiFX and cluster for software development in multi-rate filtering
- Existing ATCA IF-sampled data for demo of RFI mitigation
- Matlab for filter design (existing license)

#### Multi-beam single dish RFI mitigation:

- 21 cm 7-beam receiver on Effelsberg
- Digital receiver from Beam-Park experiments for sampling IF data
- DiFX and cluster for beam cross correlation
- CASA for software development
- APERTIF sampled IF data for early tests during algorithm development

Equipment budget: ?

#### Research and development

-----

#### Multi-Rate Filtering

=====

1. Calculate optimized taper function and understand the computing power requirements
2. Implement multi-rate filtering in the DiFX software correlator
3. Demonstrate the effectiveness with a VLBI experiment, showing the degree of suppression of RFI with and without multi-rate filtering switched on, and showing non-toxicity within the field of view.
4. Documentation of use, performance, and software
5. Deliver software for installation at other DiFX correlators.

#### RFI Mitigation with Focal Plane Arrays

=====

1. Record test data: sampled IF from Effelsberg 21 cm 7-beam receiver
2. Form all auto- and cross- correlation products with software correlator
3. Apply Briggs, Bell & Kesteven (2000) algorithm (in ParselTongue?)  
Document RFI reduction
4. Explore baseline ripple reduction using template spectra
5. If promising, incorporate in Effelsberg HI survey pipeline?
6. Obtain test data from APERTIF(?)
7. Apply same processing
8. Reports

#### Project Milestones

-----

## Major milestone:

milestone	month due	man-months
RFI mitigation software	18 (Dow)	6+

## Minor milestones:

Multi-rate filter design	1	1
Test filter on simulated data	2	1
Software module implementing multi-rate filtering for DiFX	3	1
Test filter on real data	4	1
Documentation for multi-rate filter software	5	1
Focal plane array		
Acquire test data and correlate	6	1
Software to apply Briggs, Bell & Kesteven (2000) algorithm	7	1
Research on baseline ripple reduction	10	3+
Documentation of software and performance	12	2
Median filtering (pieflag port)		
Publish script from Enno to ParselTongue web page	1	0.25
write a report how to use it, some performance notes	6	0.75

## Platform/strategic choices:

## Multi-rate filter:

Platform is DiFX (if public software licensing terms are available)  
 Test data from EVN or ATCA sampled IF data

## Focal plane array:

Platform is CASA  
 (algorithm then available to Uni Bonn HI survey pipeline)  
 Test data from Effelsberg 21 cm 7-beam and possibly APERTIF on westerbork

## Reporting

-----  
 EU Periodic Reporting  
 Software  
 Software documentation