

ALBUS

Advanced

Long

Baseline

User

Software

What is ALBUS?



- A **Joint Research Activity** within **RadioNet**
 - EU funded collaboration: R+D, access, networking
 - Contract with obligation to match received funding (ALBUS: ± 11 man year)
- Advanced Long Baseline User Software
 - Opportunity to innovate algorithms & software
 - Advance the capabilities of radio-interferometers
 - Get to other + new science applications
 - To keep up with new hardware (data flood)
 - Opportunity do something in the software arena
 - The EVN has been particularly passive w.r.t. user software
 - Relevant now aips++ will not support VLBI (in the near future)
 - Opportunity to train people in data processing software
 - Not: the answer to data reduction software crisis
 - Not the resources (or desire) to start new package
 - *But, influence the future of data reduction software*
 - *Building up European VLBI software platform*

2 major components



• Part 1: Enhancing the product

• Calibration Transfer (JIVE)

- Antenna Gains
- Phase Cal Tones

• Ionospheric calibration (JIVE)

- Evaluate GPS
- Combine model, vertical structure

• Tropospheric calibration (MPI)

- Using GPS
- Water Vapor Radiometers
- Frequency extrapolation

• Post correlator processing (JIVE)

- Deal with PCInt data flow
- Multiple target selection
- Web portal, user interface

• Part 2: Imaging

• Parallelization (ASTRON)

- evaluation data reduction software
- research algorithms (MIRIAD)

• Wide Band Imaging (JBO)

- using parallel processing
- including self-cal
- may be frequency dependent

• Wide field Imaging (JIVE)

- using parallel processing
- including self-cal
- may be dominated by weak sources

Some 40% from proposal scratched:

- e2e information handling
- Fringe fitting
- Infrastructure software (package)

Initial Activity



- Evaluation of parallel processing
 - Started at **ASTRON** March 2004
 - Looked at possible performance improvements (Miriad)
 - Using better optimized libraries for eg Fourier transforms
 - Multiple processors with shared memory, compiler directives
 - Cluster computing difficult to optimize
 - *IO limited processing not covered by standard parallel libraries*
- Calibration transfer
 - Started at **JIVE** in June 2004
 - Incorporated Tsys, Gain curves, Flag files into FITS product
 - Started on doing the same for Phase Cal detections
- Tropospheric calibration
 - **MPI** moving on existing momentum
 - Software engineer started May 2004
 - Current focus on WVR acquisition

Definition of User Requirements for all work packages...
Discussion on coding platform for future development...

Coding Platform



- Not a clear coding platform for user software
 - Relatively easy when software “behind curtains”
 - Collection of calibration data, incorporated in date
 - But how can we make a uniform software for users?
 - Relevant for future of data reduction in radio–astronomy
- Trying to adopt a uniform approach
 - AIPS: user acceptance, fringe fitting, coding nightmare
 - *Could be revamped, initiative at NRAO*
 - Aips++: no VLBI support, not so easy to code (for astronomers)
 - *performance boost critical for ALMA*
 - MIRIAD: VLBI capable? Relatively easy
 - Difmap: proprietary, no calibration, not scalable
- Discussion with NRAO on interoperability of packages
 - A scripting interface on top of AIPS could be a step in right direction
 - *With interesting features for ALBUS*

Software Forum



- A Networking Activity with RadioNet
 - Chaired by Alan Roy (MPI) and Tom Oosterloo (ASTRON)
 - Opportunity to meet and discuss radio-interferometry software
 - *Travel funds available*
 - Meeting planned for March 2005 at Jodrell Bank
 - *Contact Alan when interested!*
 - Will discuss strategic issues
 - Choice of development platform
 - And review User Requirements ALBUS work packages
 - Relevance of new algorithms, user acceptance, testing
- Stay tuned through the RadioNet web page:
 - At www.radionet-eu.org
 - Wiki page with all proceedings and documents
 - Will start a software forum e-mail exploder

Calibration Transfer



- T_{sys} calibration into correlator product
 - Already in pipeline, principles known
 - And write TY and GC tables to FITS output
 - Use data in quality evaluation
- PhaseCal detection into data product
 - Hardware available and used in other MkIV correlators
 - Algorithms need to be evaluated
 - Some specific ideas by Pogrebenko
 - Same path as TY, but is AIPS ready for JIVE PC tables?

wp1.1
JIVE

Ionospheric Calibration



- Goal to attach good estimate of TEC to data
 - Based on GPS (exists in AIPS for US)
 - Combined with modeling (some in aips++)
 - And ionosonde to get vertical structure
- First step: scientific evaluation
 - Exists a single best approach?
 - Worth the extra effort over GPS?
- Data collection outside data reduction software
 - Probably still need to be portable
 - For expert users or special cases
- Put TE tables to correlator product
 - Similar to TY, PC
 - Can always be replaced by better estimates by user

wp1.2
JIVE

Troposphere



- GPS based Tropospheric calibration
 - EVN has 8 co-located GPS receivers
 - EUREF archive, 2 hour updates, $2.5^\circ \times 5^\circ$ grid
 - Scientific evaluation
 - faster updates, effect of distance to GPS station
 - Operational Implementation
 - Download GPS data, pipeline, generate SN tables
 - Undo troposphere in correlator model?
- WVRs at Ef, On, Pv, PdB, Haystack
 - Calibrated sky temperature spectra at Ef:
 - validation of opacity, zenith delay, ϕ -correction
 - move to focus cabin for better beam overlap
 - Refine atmosphere model
 - Make operational and accessible
 - web-based real-time monitor & display
 - archive sky spectra in Bologna
 - script to incorporate corrections after correlator
- Dual-Frequency phase cal (eg, 15/43 GHz, 15/86 GHz)
 - Demonstrated to work on VLBA (Middelberg)

wp1.3
MPI

Post-Correlator processing



- PCInt project allows large FoV archive on-line
 - Up to 120 MB/s output rate
 - Several TByte per experiment
- Want to make user products available on request
 - Always run correlator at maximum sustainable rate
 - Derive reasonably sized user product on request
 - By phase rotation and averaging in time and frequency
 - Must come with calibration info attached
- Web interface for these requests
- Must define new output format and archive
 - Backwards compatibility issues
 - Averaging step can be coded in several places
 - Raw data, aips++, FITS, VO-tables

wp1.4
JIVE

EVN User meeting
Yebes
13 Oct 2004
11/6

PCInt backend is here!



Evaluation parallel software



- Evaluate parallel approaches for existing software packages
 - First main interest in imaging and self-cal steps
 - gridding
 - subtract models from uv data
 - selfcal solutions
 - Wide-band and wide-field deconvolution
 - other VLBI specific algorithms...
- Examine **data** parallelisation
 - Test scalability
- At ASTRON MIRIAD first choice for testing
 - Evaluate different algorithms in MIRIAD
 - How suitable is MIRIAD for VLBI applications
 - Investigate performance of AIPS & aips++
- Deliverable is a report
 - Maybe some prototype applications

wp 2.1
ASTRON

Wide-band imaging



- Deal with $\Delta\nu/\nu = 0.3$ to 1 at 1.5, 5 GHz
 - Contiguous frequency coverage
 - Completely fills uv plane
 - Cannot ignore spectral problems
 - Expect artifacts at 1% level even for $\Delta\alpha=0.1$
 - And Primary beam effects
- Algorithms well-known (Conway, Sault)
 - ATCA have used 30% b/w with 14 x 25 channels
 - Need optimizing for 8k channel case
 - Gridding may be key step
 - Self-calibration issues: need source model $f(\nu)$
 - Wide-band source subtraction
- Requires a parallel processing approach

wp 2.2
JBO

Wide field imaging



- Data available for wide field application
 - From PCInt output, also eMERLIN correlator
 - Searching many weak sources near target source
 - Deep fields
 - Imaging masers over extended star forming regions
 - Must port the computations to parallel computing
- Requires some new algorithms
 - Self-cal of many, many weak sources
 - Imaging, accurate coordinates
 - Display large images
- Access to cluster computing by users
 - Run data reduction remotely
 - Virtual Observatory, Grid computing

wp 2.3
JIVE

RadioNet



- Funded by the EC, FP6, 12 M€
 - 20 partners to advance radio–astronomy in Europe
 - Started January 2004
 - Details on www.radionet-eu.org
- Trans National Access to a number of facilities
 - EVN, WSRT, MERLIN, JCMT, IRAM, OSO, MPIfR
- 8 Network activities to strengthen communication
 - Engineering, software, science, ALMA, future of radio–astronomy
- 3 Joint Research Activities
 - AMSTAR: about millimeter receivers
 - PHAROS: focal plane array receivers
 - Jan Geralt bij de Vaate
 - ALBUS: advanced algorithms & software for long baseline interferometry

