Technical Operations and R&D at JIVE

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What do we do?

- Correlators
  - More capacity, new telescopes, development of AVN
  - New features, new science
- Data recording/playback/transport
  - Real time/near-real time
  - Higher bandwidths, 2 and 4Gbps
- Automated operations
  - Get rid of disk shipping
  - Monitoring, automated fringe checking
  - Triggered observations
- SKA and mm VLBI
  - **User software**, VLBI with CASA
  - Simulations for BHC
  - Fringe checking
- Time and frequency transfer
  - For SKA
  - And on public networks

Correlation

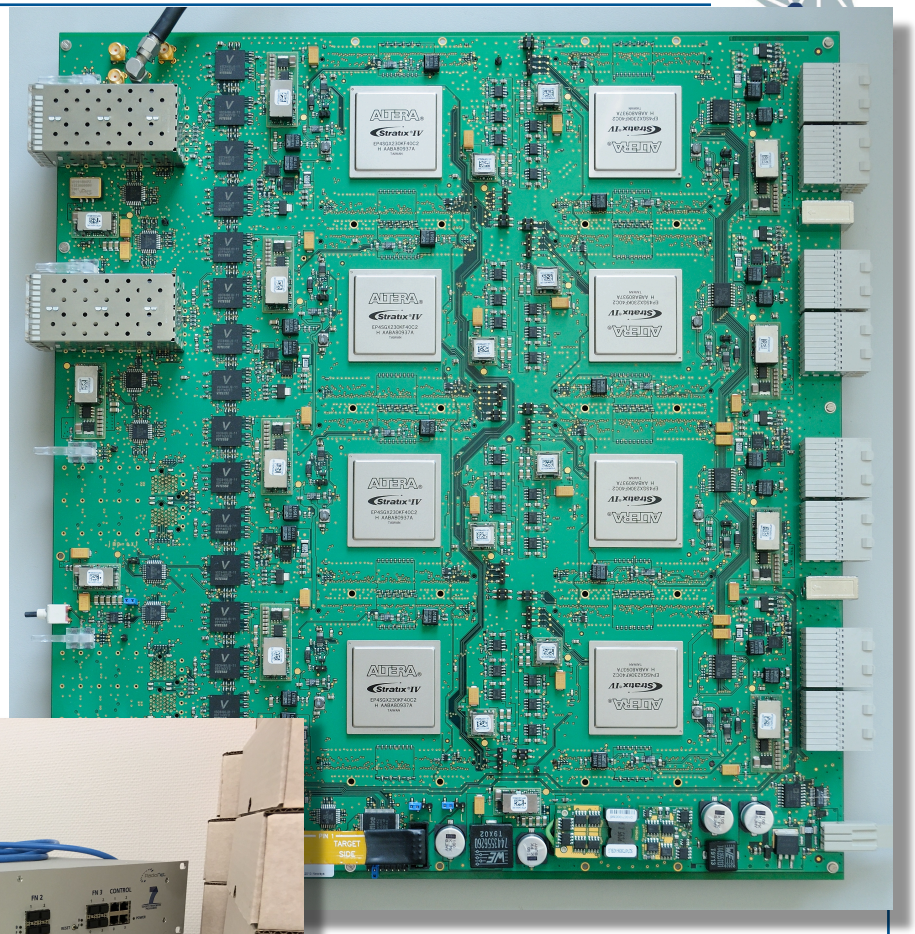
- SFXC software correlator at JIVE:

- 43 nodes; 452 cores
  (Intel Xeon 5500/5600/E5-2600/E5-2630)
- QDR Infiniband interconnect
  (40 Mbit/s)
- 8 nodes with 10 GbE
  (currently limited to 30 Gbit/s total)
- 15-16 stations @1Gbit/s real-time
  (with cross-polarisations)

- All recorded VLBI on SFXC since summer 2012
- First real-time e-VLBI in december 2012
- New SFXC features: talk by Mark Kettenis

JUC (JIVE UniBoard Correlator)

- Developed in RadioNet FP7 (also in RadioNet3)
- As of last week correlator completely integrated in control system (operator-proof) (?)
- 32 MHz sub-bands: last bugs
- Start correlating from Mark5 recordings (again)
- Real-time tests



16 stations at 4 Gbps?

- ~13 stations on current SFXC cluster at 1 Gbps
- 16 stations at 4 Gbps: factor of ~5 more hardware needed

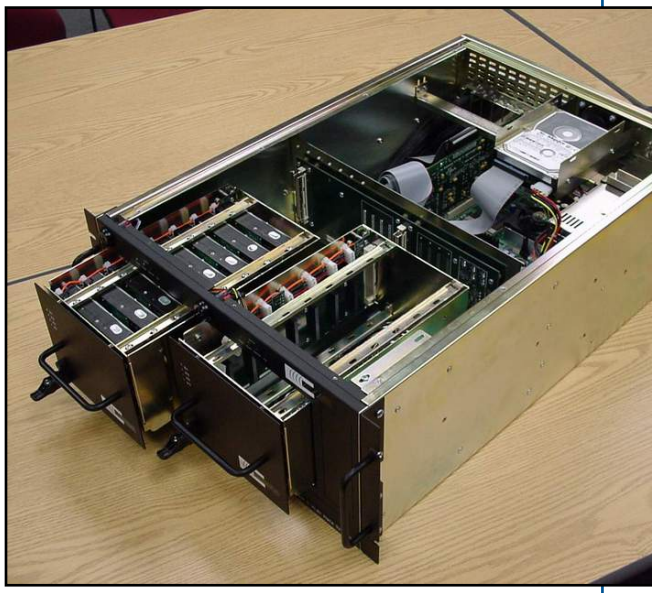
- 16 stations on 2 available UniBoards at 2 Gbps
- 4 Gbps: factor 2

platform	power consumption (kW)	investment (keuro)
SFXC	30	550
UniBoard	1	30

- Somewhat incomplete comparison
  - Software: fantastically flexible, easy to modify, HW getting cheaper as we go along
  - Firmware: very power efficient, once it goes, it goes, but not nearly as flexible, ideal for “simple” things

Data recording/transport: Jive5AB

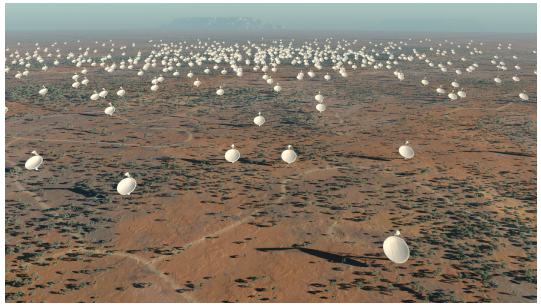
- Original control code not adequate for needs of EVN
  - Full re-write of Mark5 control code
  - Used for all EVN operations, gaining traction in geo community as well
  - Incorporates full Mark5 command set, supports Mark5, Mark6, FlexBuff…
  - Many features; “Swiss army knife of (e)VLBI”
    - Channel dropping, on-the-fly corner turning, sending different chunks of data to different destinations, full VDIF support
  - Made e-VLBI possible at all
  - Enabled semi-automated fringe tests
  - M5Copy: transport any data from anything to anything
    - Choice between TCP, UDP, UDT
  - Essential for automated shipping
  - Future developments in ASTERICS
  - Talk by Harro Verkouter

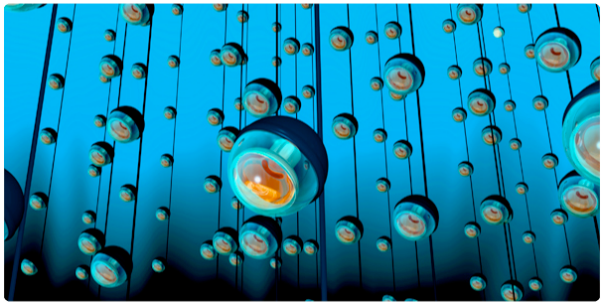


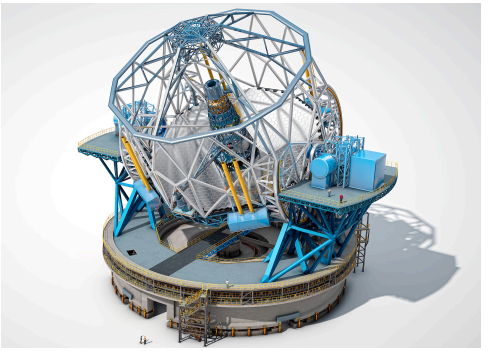
Addressing Cross-Cutting Synergies and Common Challenges for the Next Decade Astronomy Facilities

What is ASTERICS ?

- Astronomy ESFRI Research Infrastructure CluSter (ASTERICS)
- Topic: Implementation of cross-cutting solutions for clusters of ESFRI research infrastructures and ERICs
- ASTERICS represents the first major European collaboration Astronomy/Astrophysics/Astroparticle Physics
- 23 partners funded by EC Horizon2020 at 15 M€ for 4 years







ASTERICS Work Packages

WP2 – DECS: Dissemination, **E**ngagement and **C**itizen **S**cience

WP3 - OBELICS: Observatory **E**-environments **Li**nked by **C**ommon challenge**S**

- Software interoperability
- Training in parallel programming and big data frameworks
- Adapt and optimise extremely large database systems for ESFRIs
- Data mining tools and statistical analysis techniques on petabyte data sets

WP4 - DADI: Data **A**ccess, **D**iscovery and **I**nteroperability

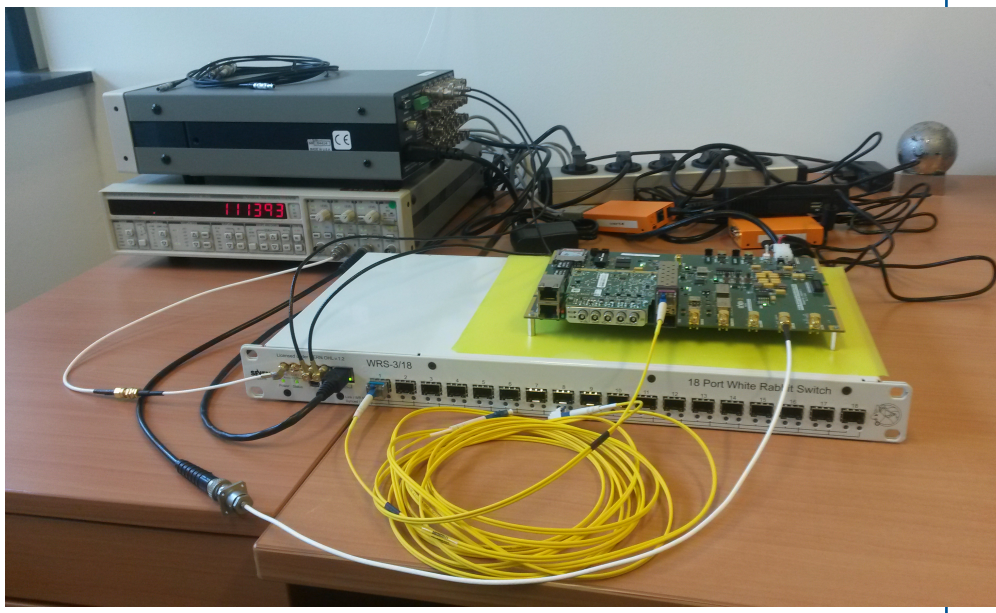
- Training and support for the scientific use of VO in general
- Train and support staff of ESFRI projects
- Adapt VO framework and tools to ESFRI projects needs

WP5 - CLEOPATRA: Connecting **L**ocations of **E**SFRI **O**bservatories and **P**artners in **A**stronomy for **T**iming and **R**eal-time **A**lerts

- Time and frequency transfer
- relaying alerts (warning system for transient events, also in EVN)
- data streaming software (builds on Jive5ab experience)
- advanced scheduling algorithms for complex, large arrays (mainly for SKA, CTA)

Time and frequency transport: White Rabbit

- CLEOPATRA:
  - Verify/demonstrate achieved 10^-13 stability (1s) and 1ns timing performance
    - by showing fringes between WSRT and Dwingeloo dish
  - Transfer of H-Maser signal from the WSRT to Dwingeloo



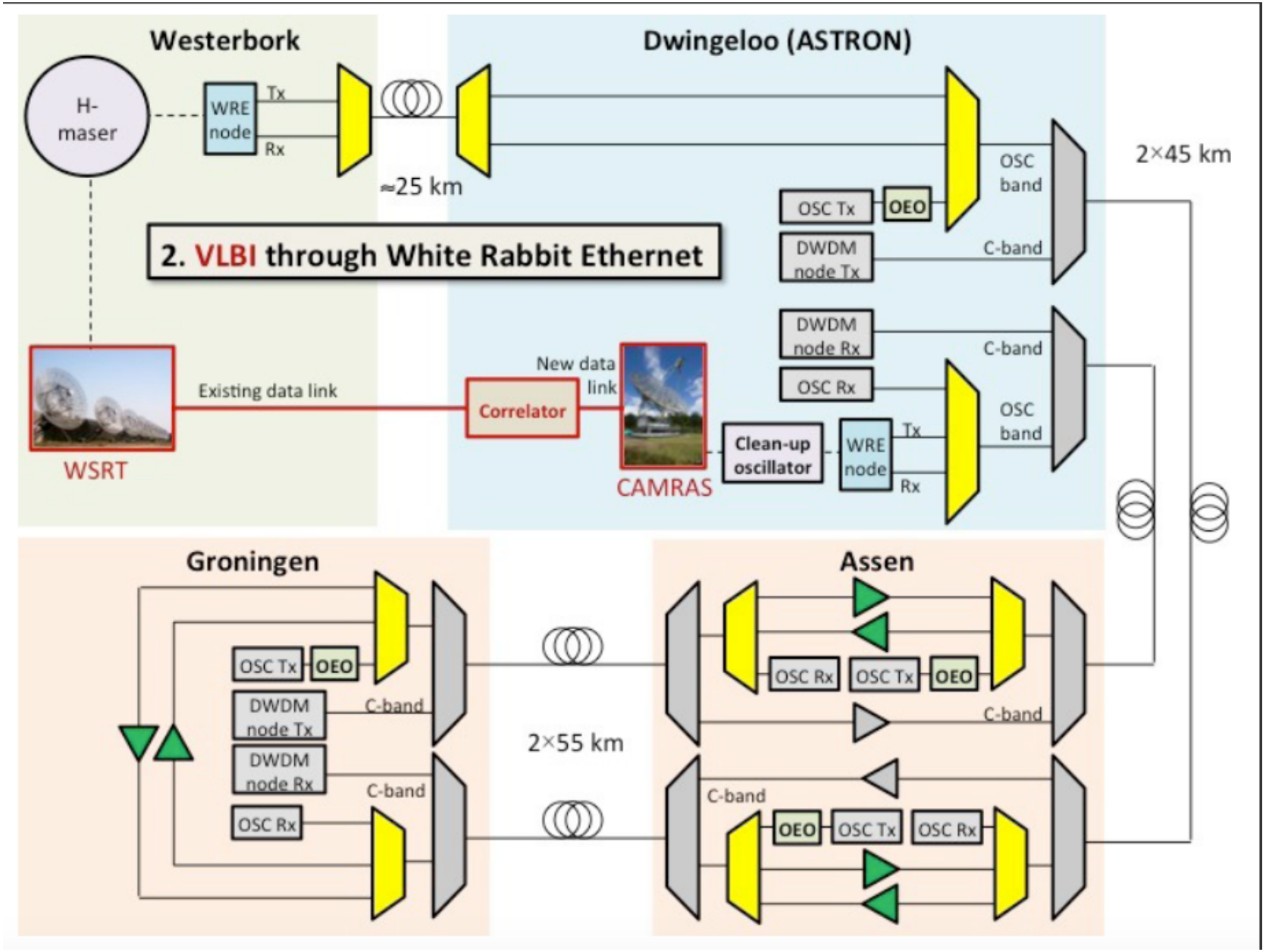
- But also used for SKA:
  - Measure timing performance with WR-ZEN board
  - Test with 10km fibre in climate chamber
  - Tests done on overhead fibres in SA
  - Tests planned on e-Merlin fibre

JIVE

What is White Rabbit?

- Sub-ns accurate synchronization network
- Open Hardware design, project started at CERN
- Based on:
  - PTP (IEEE1588v2)
  - Bidirectional (BiDi) SFPs
  - SyncE: Syntonization of 125 MHz clock
  - 1 Gb/s Ethernet
- In use in several accelerators and astronomy instruments around the world

Frequency transfer demo in CLEOPATRA



On the spot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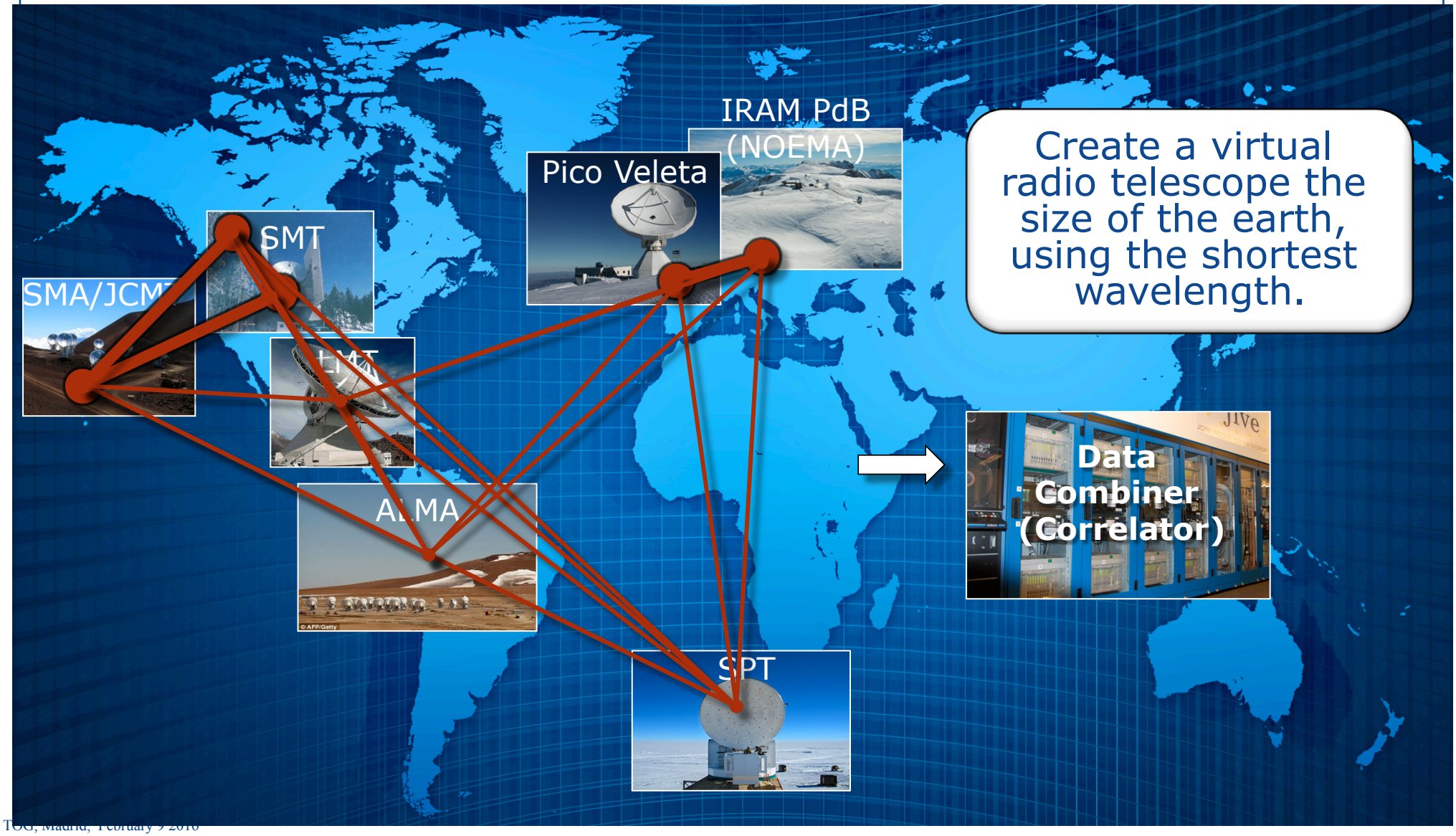
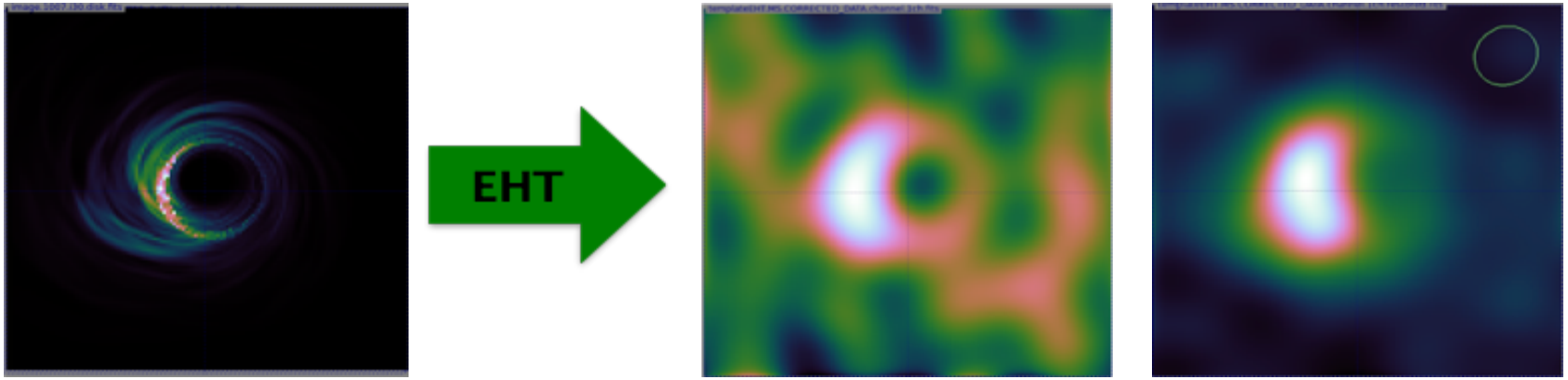
Desolation and overhead fibres

BlackHoleCam and the Event Horizon Telescope



JIVE BHCam involvement

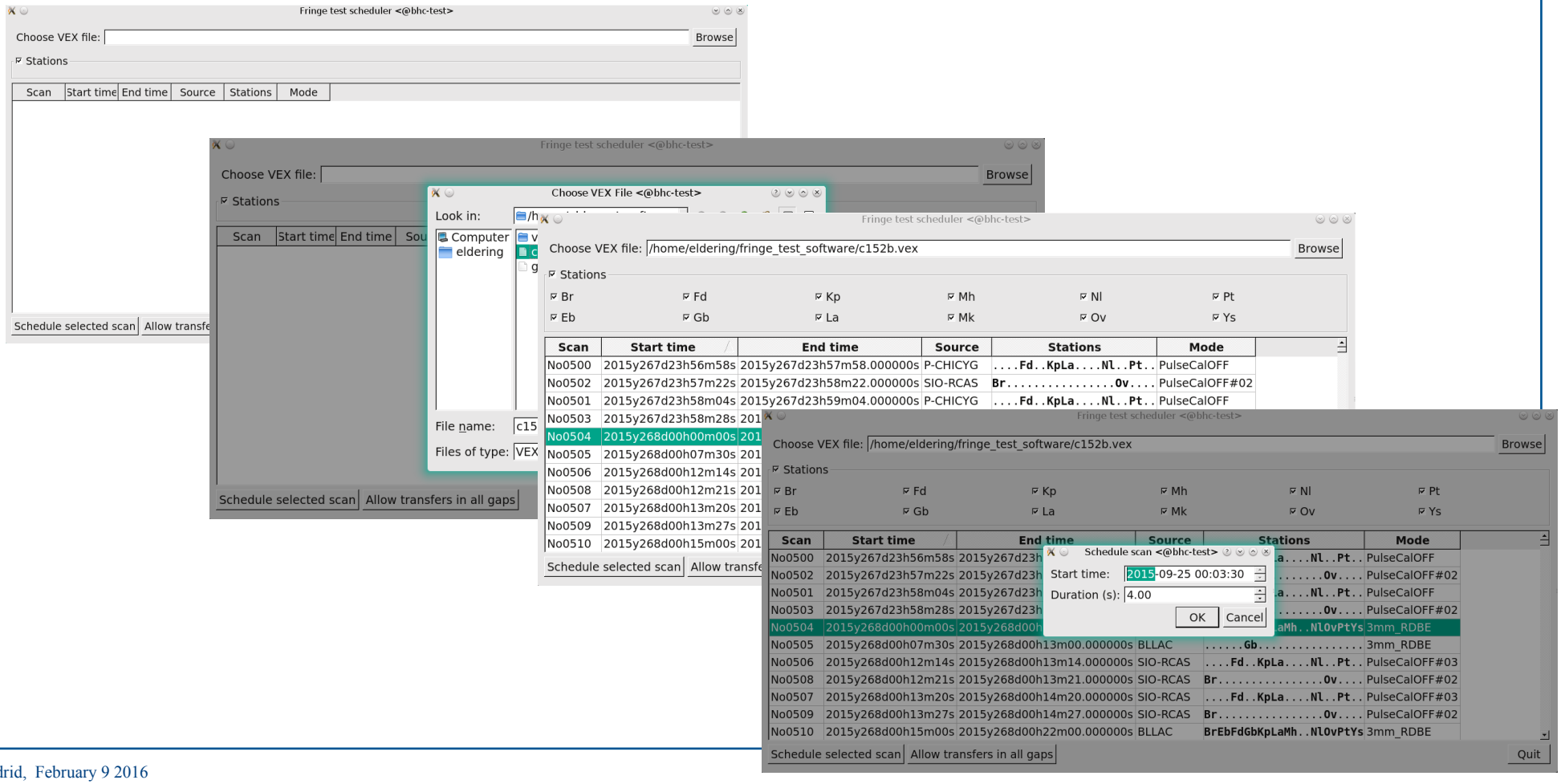
- Software pipeline [JIVE]
  - CASA-based fringe-fitter for VLBI
  - End-to-end VLBI reduction in CASA now possible (thanks to many hacks)
- Array simulation [JIVE, Radboud, Rhodes]
- Robust turn-key VLBI operation [MPIfR, JIVE]
  - “real-time-ish” fringe check mechanism in place (based on jive5ab)
  - Interface being implemented, gets info from observing schedule
  - Uses dead time between scans, continues data transfer over many intervals
  - No interference with recording in any way



Courtesy: Monika Moscibrodzka, Roger Deane

mm-VLBI fringe checking

- Based on experiment schedule
- Select scans, gaps for transfer



What's next…

- Working on an H2020 proposal
  - Aimed specifically at ESFRI, ERICs

- **BUMPING UP JIVE**:
  - Bringing Users More Power - Interferometry's Next Global Usage Perspective by JIVE
- Objectives:
  - Solidify JIVE's presence in Europe's radio astronomy community
  - Raising the public awareness of JIVE and the EVN
  - Expand the scope of the ERIC (ILT?)
  - Further integration of new telescopes
  - Develop geodetic and astrometric capabilities of JIVE/EVN
  - Aim for a global VLBI facility
  - Operational interface issues: remote monitoring/control, SCHED?
  - large-scale exchange programme for researchers and technicians EVN-AVN