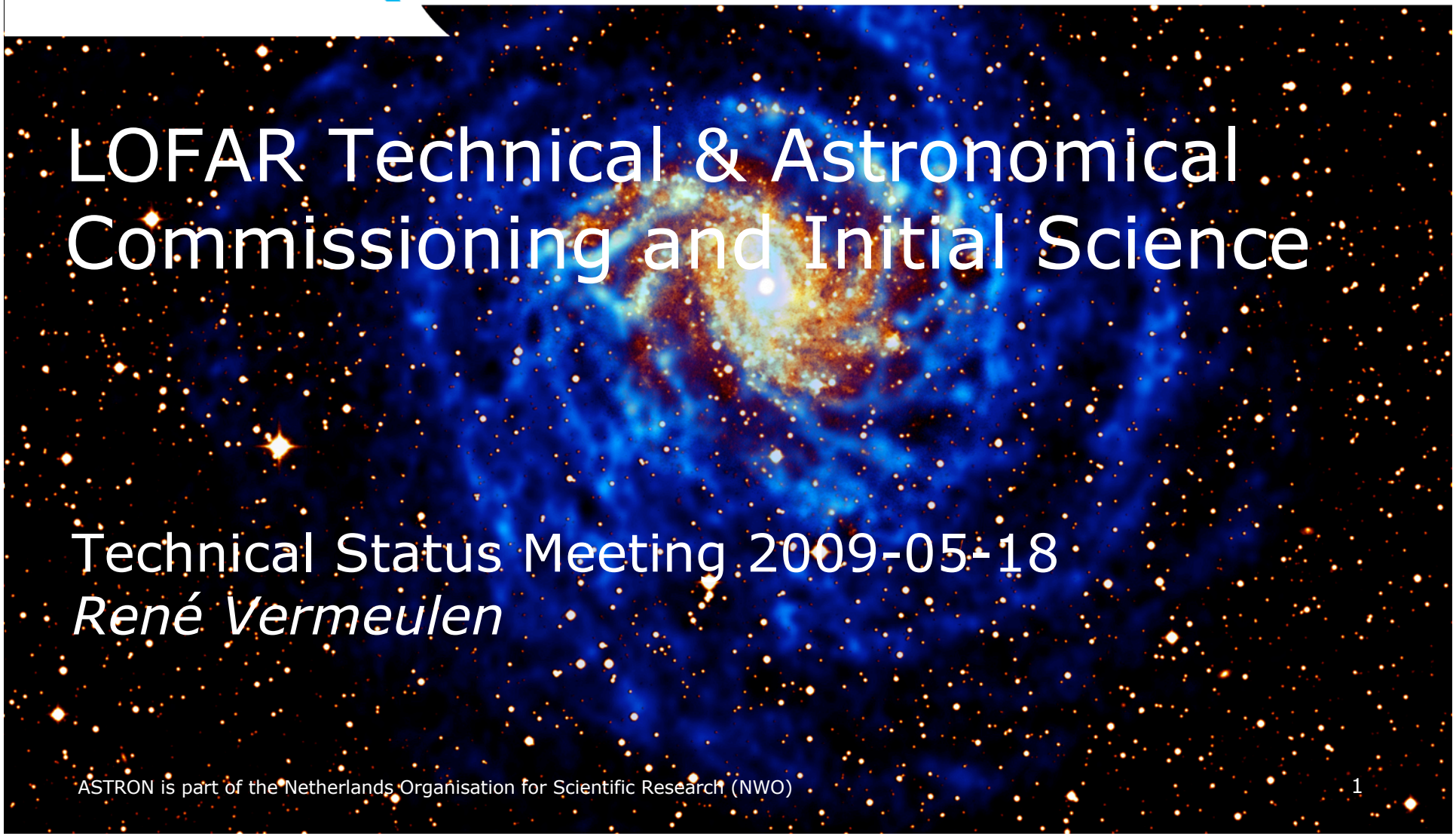
ASTRON

Netherlands Institute for Radio Astronomy



# LOFAR Technical & Astronomical Commissioning and Initial Science

Technical Status Meeting 2009-05-18

*René Vermeulen*

# CS1 and “the Exloo wetlands” in earlier days

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# Building the Superterp

# First full NL Station being installed: LBAs and Cabinet

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# First full NL Station being installed: HBA tiles

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# Radio Observatory Control Room

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# Recent / ongoing personnel changes in the Radio Observatory

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- Science Support & General Staff:
  - Michael Wise: LOFAR astronomy coordinator (LAD project)
  - Corina Vogt: Internationalisation Liason
  - Antonis Polatidis: Head of Science Support
  - Support scientists:
    - Asgekar, Brentjens, Jozsa, Pradel
    - recruitment ongoing
- Technical Operations:
  - Harm Munk will become Head of Operations on 1 August
  - 3 operators
  - 7 software engineers
  - 5 hardware engineers, 1 more needed
- System engineers:
  - Hanno Holties & Hans van der Marel
  - 2 searches ongoing

# LOFAR: In the beginning...

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- Original science concepts:
  - George Miley & others in NL university community
  - Low-frequency radio surveys: under-explored terrain
- Original technology concepts:
  - Jaap Bregman & others at ASTRON
  - Phased arrays: great promise for the future
- NL subsidies/consortium: multi-disciplinary sensor network
  - Astronomy, geophysics, atmospherics, climatology, agriculture, ...
  - Astronomy / Radio Telescope is dominant application
  - Development & operations for individual applications left to be done in collaboration with the (user) communities
- International interest and collaboration growing rapidly
  - National LOFAR Astronomy Consortium in each country
  - International LOFAR Astronomy Consortium being formed

# LOFAR as a radio telescope

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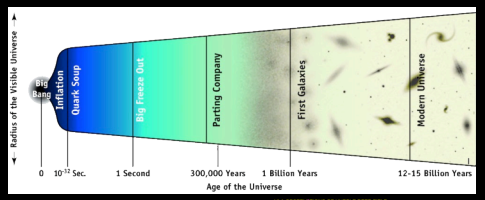
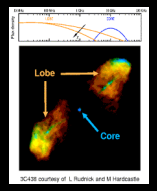
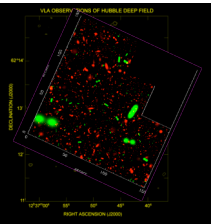
- Applications driving the design, called “key science projects” (KSP)
  - The epoch of re-ionisation
  - Extragalactic surveys
  - Transients and pulsars
  - Cosmic rays, particle astrophysics
  - Cosmic magnetism
  - Solar science, space weather
- For each KSP area, a team of astronomers is involved with ASTRON in realising the required technical capabilities
  - Will be recognised by means of privileged access to observing time
- Capabilities allow very wide range of projects that fall: centrally / periferally / not at all, within the general science areas envisaged by: one / several overlapping, of the KSP teams

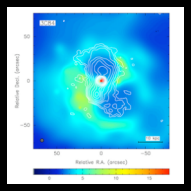
# LOFAR – key science examples

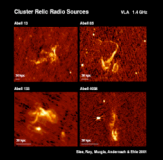
| |
|---|
| Epoch of Reionisation |
| Wide-area Surveys |
| Transients |
| Cosmic Rays |
| Magnetism |
| Sun, Solar System, Space Weather |

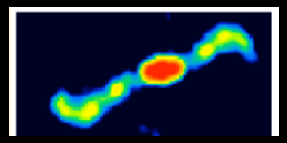


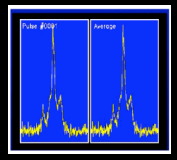



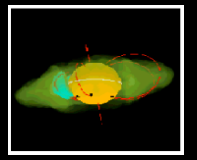



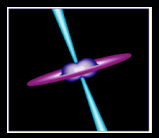


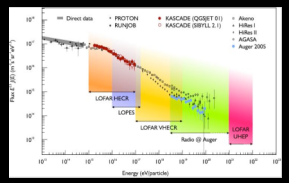


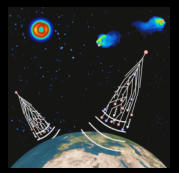


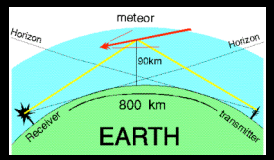


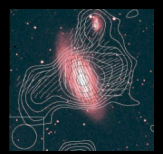


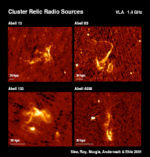


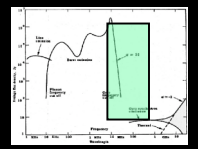


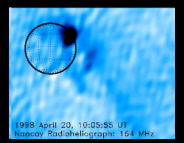


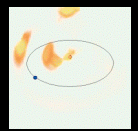


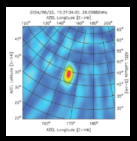











# LOFAR: a broad common-user Observatory

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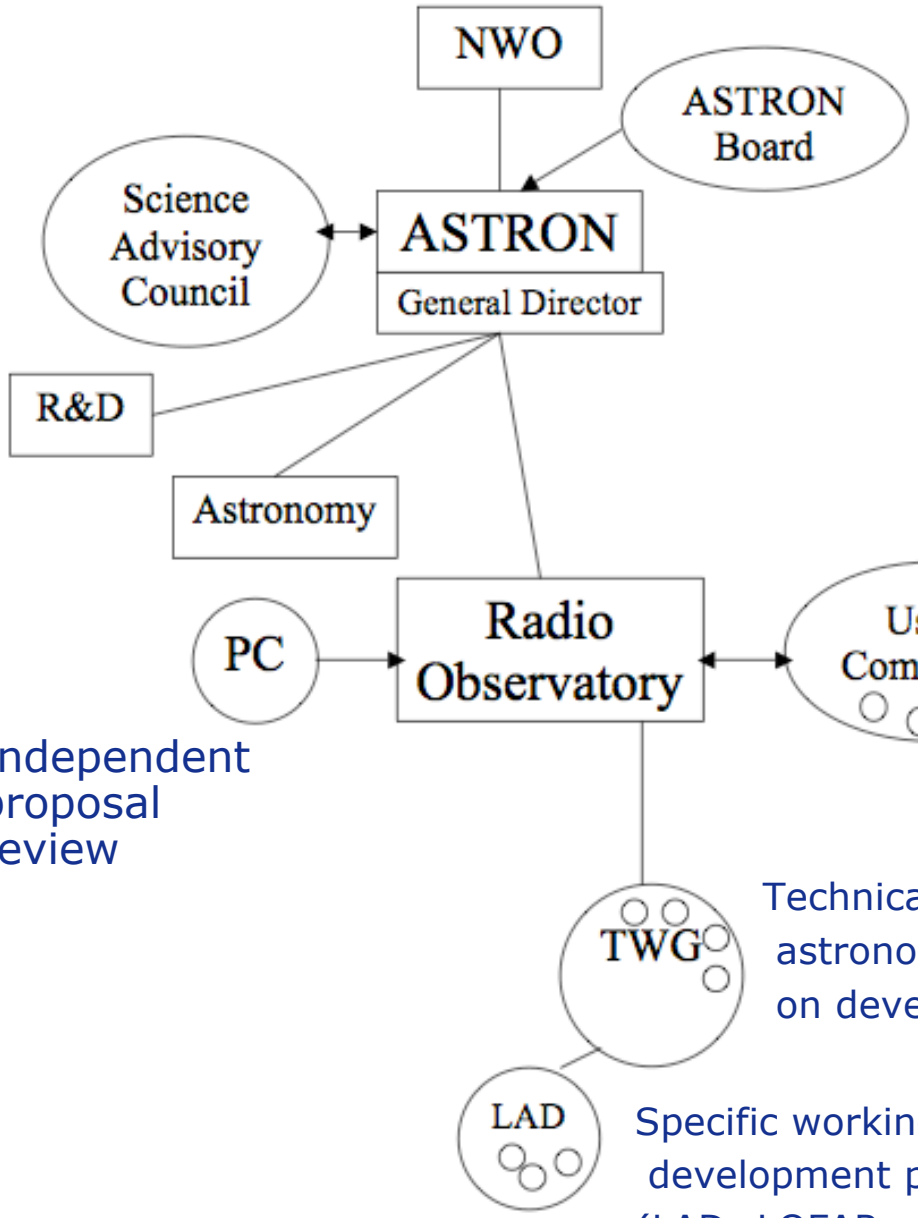
- LOFAR scope has gone from “project” to “observatory”
- Observatory aims at maximal, long-term overall scientific output
  - Integrated operations via ASTRON/Radio Observatory
  - Intensive partnership with user groups
  - National consortia participate: International Astronomy Consortium
- Rapidly growing Open Skies portion
- Many individual user groups
  - Each focusing on maximal yield in their specific research topic(s)
  - In individual collaborations that fit specific science and style
- Substantial contributions are rewarded with privileged access
  - Development, commissioning of common, integrated infrastructure
  - Participation in integrated operations




Standing Committee
plus annual public Users Meeting
Interface with users:
- performance, gripes, desires
- overview of capabilities & results

Independent proposal review

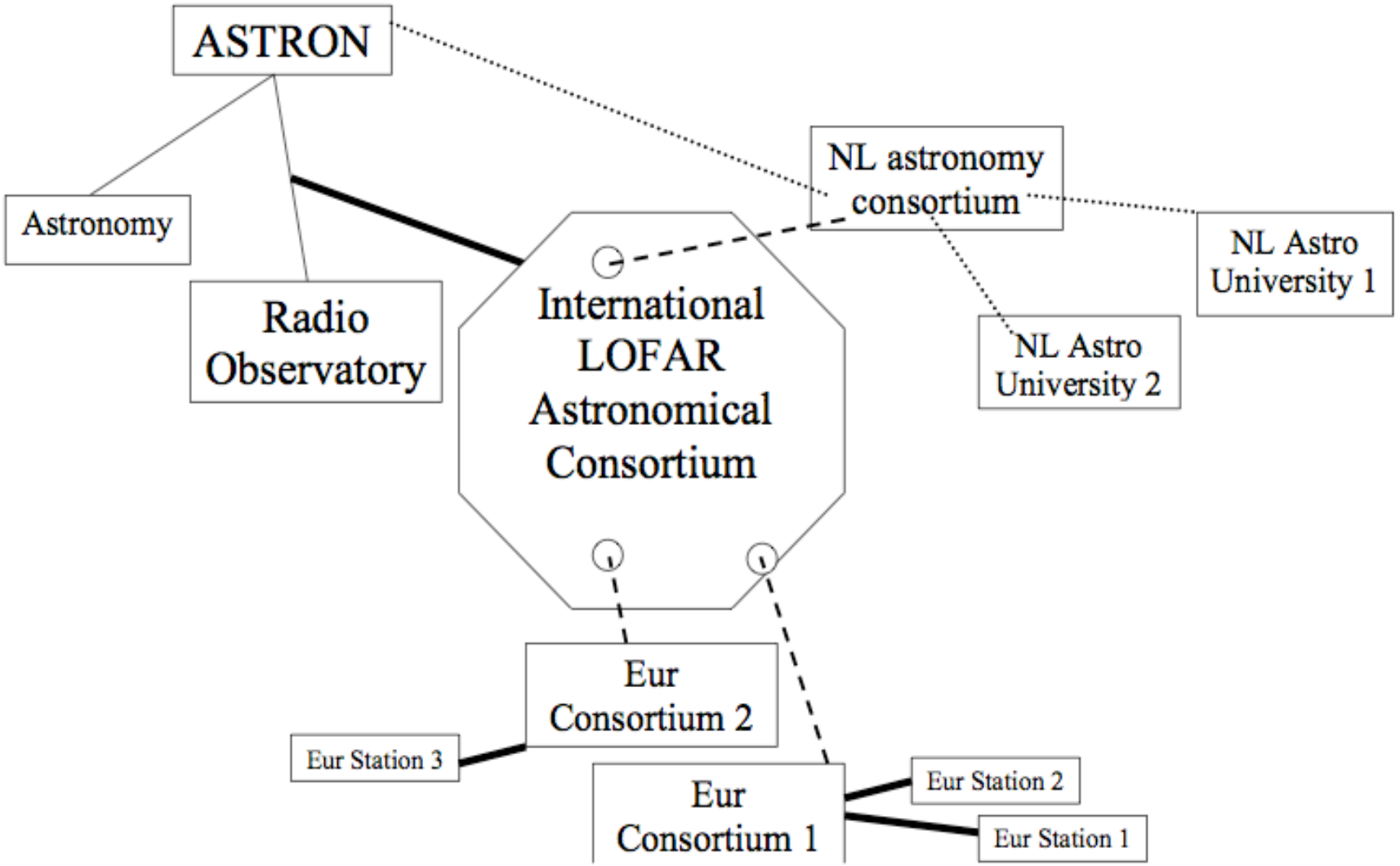
Technical interface between
astronomers and System Engineers
on development/design issues

Specific working group on important
development project
(LAD: LOFAR software, pipelines)

# Strengthening the International Institutional Ties

ASTRON

- International Working Group has been formed
  - Ties in directly to Radio Observatory/ASTRON
  - Gives appropriate role for institutional partners
  - Gives international partners symmetry w.r.t. NL
- Dual goals:
  - Preparation for a formal International LOFAR Astronomy Consortium of partners sharing in LOFAR exploitation
  - Dealing with management and policy issues in the institutional relationships with ASTRON/RO as they arise


ASTRON
Astronomy
Radio Observatory
NL astronomy consortium
NL Astro University 1
NL Astro University 2
International LOFAR Astronomical Consortium
Eur Consortium 2
Eur Station 3
Eur Consortium 1
Eur Station 2
Eur Station 1

# LOFAR Commissioning: interaction and coordination

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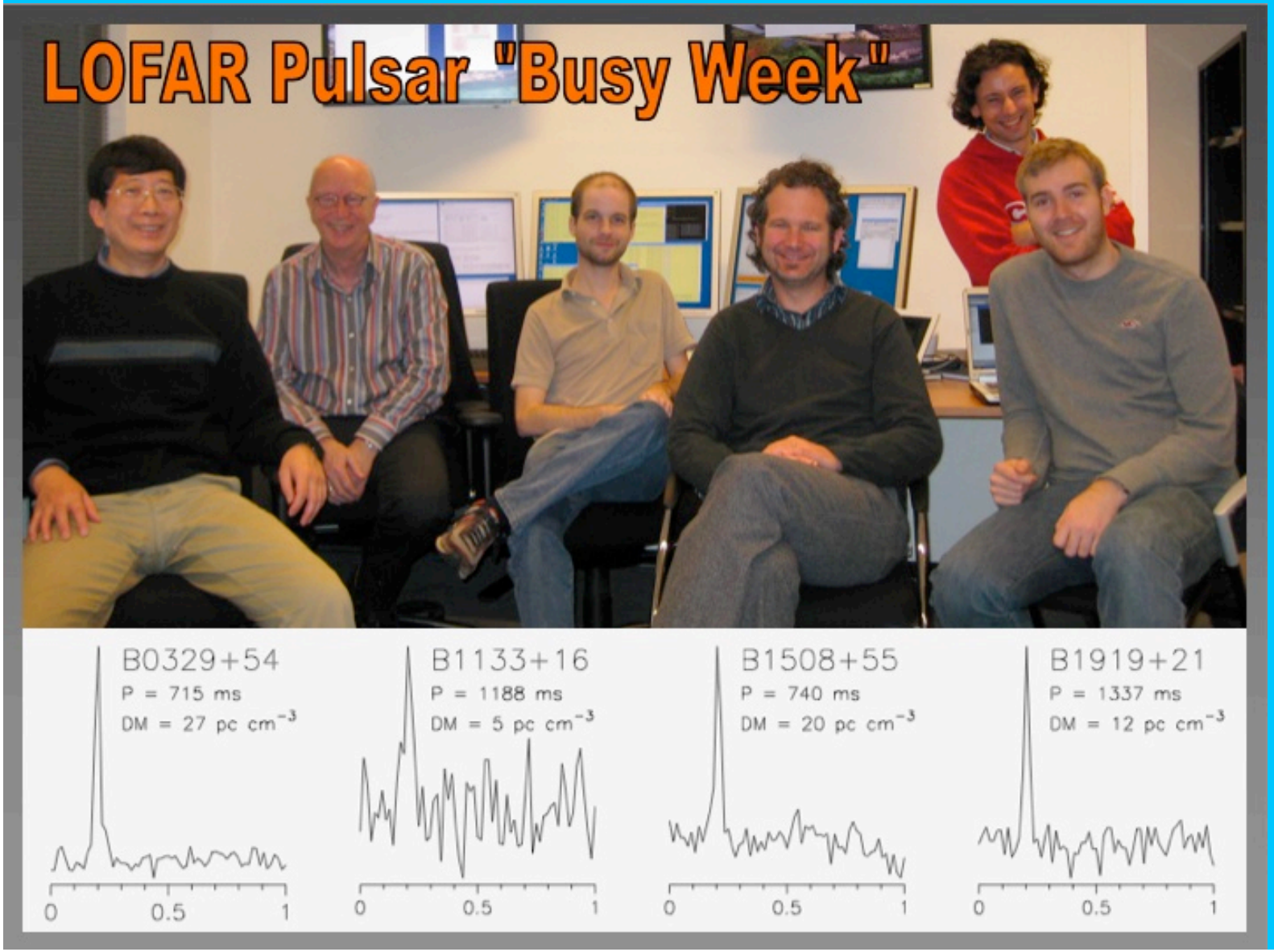

# LOFAR commissioning

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Commissioning phase requires intensive partnerships, coordination

- With users and user groups (YOU; THIS MEETING!)
  - Technical design/development issues: the TWG
  - Software development, astronomical commissioning: the LAD
  - Users Committee will be set up for operations phase

- With national consortia (Internationalisation Working Group)
  - Handle management/policy issues as they arise
  - Prepare appropriate consortium for operational phase

# The commissioning effort in summer 2009

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- Very limited observing resources:
  - Gradual expansion of available hardware (stations, CEP) & software
  - Operational & control tools also still in delivery/commissioning
  - Simultaneous debugging of many components
  - On high part of maintenance "bathtub curve"
- Observing requests by commissioning teams; web tool
- Scheduling priorities set by observatory & development team
  - Based on rollout, checkout, & technical commissioning needs
  - Changes on short timescale
  - No guarantees for any time
  - No formal data archive yet; temporary storage/access routes

# The commissioning plan until the end of hardware rollout (well into 2010)

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- Hardware rollout (stations, CEP, archive) gradually completes
- Operations tools & data archive gradually mature
- Astronomical modes (pipelines) gradually available for commissioning
- PLANNED STEPS for technical and generic commissioning of astronomical functionality take precedence on claiming observing resources and commissioning manpower
  - E.g. MSSS optimised to obtain GSM for generic calibration
  - Plans determined by rollout, observatory & commissioning teams; the LAD project !
  - Important chance for input/iteration at this workshop now
  - Feel free to join in and contribute to the coordinated efforts !

# The commissioning plan until the end of hardware rollout (well into 2010)

ASTRON

- The generic coordinated commissioning (LAD) plan:
  - Will be documented/tracked online
  - Focus on pushing ahead commissioning, no science goals
  - This commissioning may nevertheless lead to some quick initial science
  - Papers (technical, scientific) published collectively by the Builders List (e.g. up to Validation step I incl. MSSS)
- An Announcement of Opportunity to extend from this:
  - Extended commissioning for more specific science capabilities, pilots for large future projects
  - Specific initial science projects requiring modest further observing or extended data analysis
  - All on shared-risks basis, Open Skies fraction small, commissioning participation required

=> Also required to jump-start proposal process for operations

# Special Initial Announcement of Opportunity: Dual Purpose

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- Stimulate and organise community-wide participation in astronomical commissioning period
  - Modestly sized shared-risks projects
  - Starting towards end 2009 or in the first half of 2010.
- Effectuate orderly jump-start of project review and allocation of resources
  - Novel telescope. Census needed of range of:
    - Specific science goals envisaged
    - Detailed observing resources desired
  - Offer timely feedback on appropriate scopes and scales
  - Allow revised proposals prior to any allocations for the operational period

# Allocation of Observing Resources

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- Traditionally: Allocation of Telescope Time

- Additional aspects and resources for LOFAR include:
  - Instantaneous bandwidth
  - Instantaneous beams
  - Data transport capacity
  - Data processing capacity
  - Data storage capacity
  - Interrupt privileges
  - Piggyback privileges
  - Archive processing, proprietary rights
  - Support scientist, data analyst, or operator assistance

- Need an integrated Programme Committee for independent scientific assessment of all projects
- Need pre-arranged shares of “time” to recognise contributions

# Allocation of Observing Resources

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- Scarce/distinct resources to be allocated:
  - Telescope time, i.e. opportunity to determine setup/configuration
  - Data storage capacity and throughput
  - (Post)processing capacity and throughput
  - Access privileges to data / archive access, for specific science purposes, piggyback use

# LOFAR "time" allocation

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- 3-tiered allocation mechanism with pre-arranged fractions to various communities and "rights holders"
  - Open Skies (fosters broad user base)
    - Starts modestly (10% avg 2010?) and on shared risks basis
    - Will rise rapidly (in 5 years to 65%?)
  - Contributors (recognises past and present contributions)
    - chiefly the KSP groups & (international) station owners
    - consolidated in national consortia
    - will be assured of a high fraction initially (80% in 2010 ?)
    - but will find their reserved share dwindling in later years
  - Operators (rewards sustained operational involvement)
    - Significant, slowly rising fraction (10-35% ?)

# Sponsoring through National Consortia

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Under IWG discussion:

- Rights accumulated by National Consortia:
  - Contributions of all adhering members added
- National Consortia then distribute their acquired rights:
  - To any/all of their favourite (large) projects
  - Well suited for projects with cross-national membership !
- Scientists are free to set up projects and collaborations for maximal efficiency:
  - Propose per project, with relevant group of collaborators
  - Seek collaborations for greater observing efficiency
  - Large projects may obtain (multiple) national sponsorships
  - (Initially) (smaller) projects use Open Time

# The first Announcement of Opportunity for LOFAR observing

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Text to be finalised at IWG meeting on June 10

- Submission deadline in (early ?) September 2009
- Period starts in late 2009, runs well into 2010
- Proposals can be for specific stages of operational readiness (milestones tbd, input/feedback at this meeting)
- Online documentation on new ASTRON/RO website
  - Configuration, basic principles, basic modes & numbers
  - Resource estimator and sensitivity calculators
  - Quick guides/recipes
  - Example observations/results (regularly updated)
- This workshop is also a tutorial on the initial LOFAR capabilities

# The first Announcement of Opportunity for LOFAR observing

ASTRON

- Validation/consolidation of commissioning period
- Orderly initial / pilot science observing
- Jump-start of large proposal allocation process
  - No allocations for operational period made yet
  - For all intended large projects the preparations (commissioning, pilots, initial science) are to be framed in the context of the projects to run in the first few operational years
  - Full project specifics: science, observing & analysis plans
  - Find range of specific planned science and pressures on resources
  - Allows iteration: equitable balance & realistic expectations
    - Bottlenecks w.r.t. resources
    - Specific large science projects tackled by specific groups
    - Ramp-up of Open Time

# Programme Committee assessment for all

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## Single, independent Programme Committee

- Composed of independent international experts
- Uniform assessment of all projects (new & progress reports)
  - Scientific merit
  - Technical feasibility
  - Project plan: timelines, people, data analysis resources
  - Scope, focus, demarcation
    - Cannot "reserve" technique, sky area, "umbrella science",...
    - Piggy-back & archive use allowed/encouraged
  - Suitability for privileged ("large programme") support
- All groups can then tune and focus their large-scale projects without losing any observing opportunities

# Collaborations and interactions

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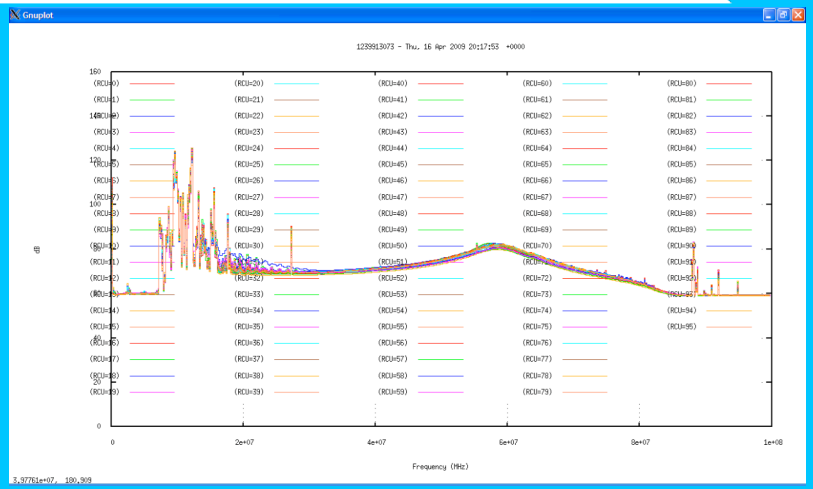
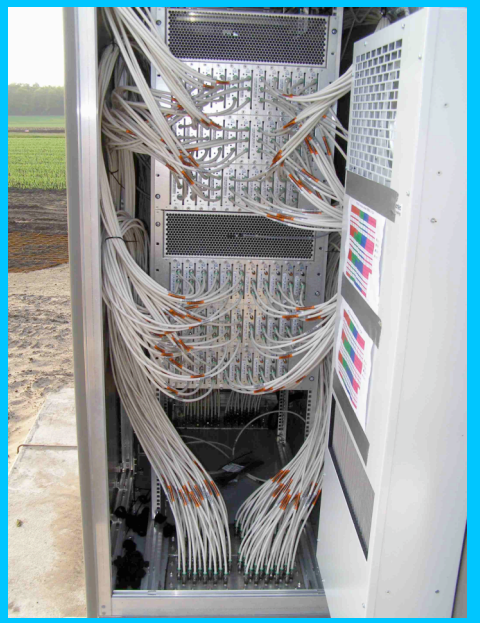
- Overall science output from the LOFAR Observatory will benefit from:
  - Breadth of the user community
  - Healthy competition
  - Focused research carried out by dedicated research groups
  - Coordinated and broad participation in commissioning

- Astronomers should set up project scope and collaborations in the way that best suits science, interests, style of work, and the finite amount of their time and of telescope resources
  - Within a large conglomerate or with a small group or on their own
  - A grand-design programme or a very focused project
  - Requesting observing time or data access rights

- LOFAR SCIENCE WILL BE EXCITING AND MULTI-FACETED !!

# RS302 now being checked, in preparation for handover to Radio Observatory



# Watch progress via www.astron.nl