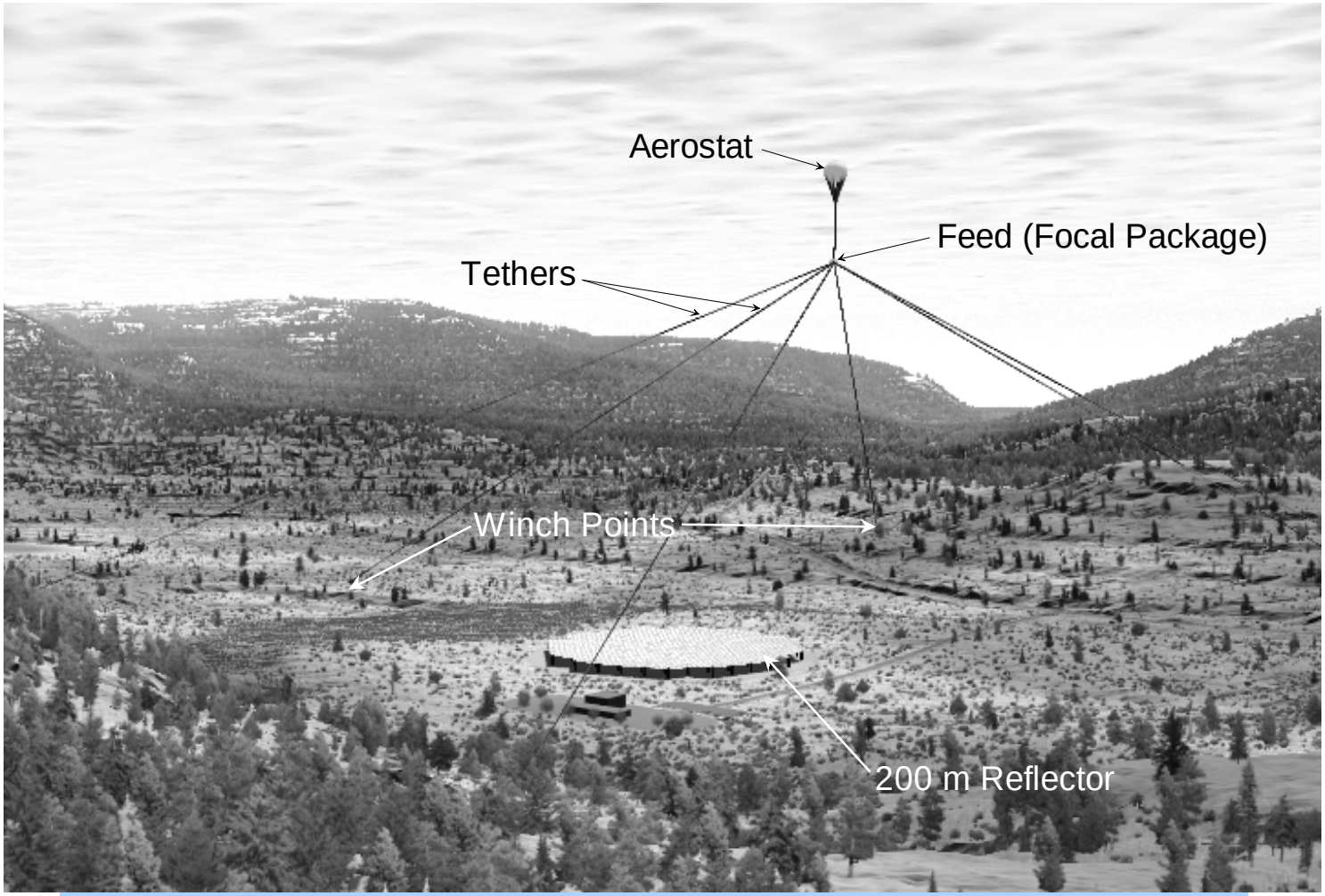
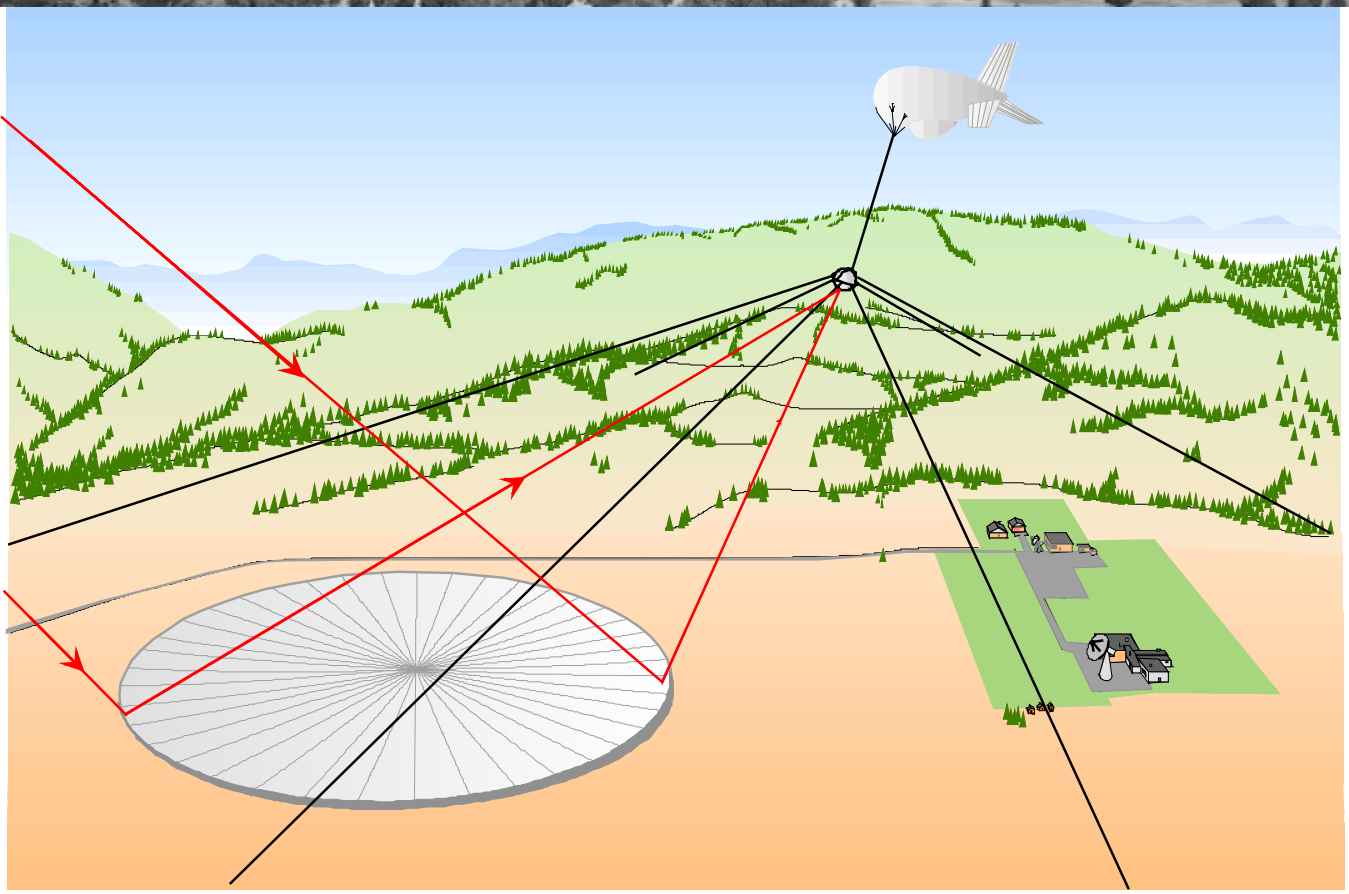
SKA Report – Canadian Activity
Manchester SKA meeting

Canadian Long Range Planning Activities

- *Long Range Planning Panel* established in mid-1998 by the National Research Council (NRC) & the Natural Sciences and Engineering Research Council (NSERC) to recommend how to proceed with major astronomy activities funded by these agencies over the next decade.
- Report published Jan, 2000.
- Recommended doubling the yearly total spending on astronomy from $C 22M per yr.
- High priorities:
  - Major Projects: ALMA, NGST
  - Moderate Projects/ Facilities: *SKA (LAR studies)*, VLOT studies, and enhanced development of receiver and correlator technologies for radio astronomy.
  - People at HIA, universities.
  - Increased funding for archiving, data mining, and computational activities.
- Funding has not appeared for any of these initiatives so far, but the Canadian government's reaction is expected in the Feb, 2001 budget.


Aerostat
Feed (Focal Package)
Tethers
Winch Points
200 m Reflector



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Funding Applications - Large Adaptive Reflector (LAR)

This has been a large fraction of the "progress" in Canada on the SKA in the last year. The applications require enormous effort on the part of many researchers and are very heavy with paperwork.

- Canada Foundation for Innovation (CfI)
  - A group of engineering and science researchers at the University of Victoria and NRC applied for "infrastructure" funding, a wide-ranging funding application for radio and optical astronomy.
  - Includes funding for equipment for a scaled model of multi-tethered aerostat.
  - Funding announcement made about 1 week ago.

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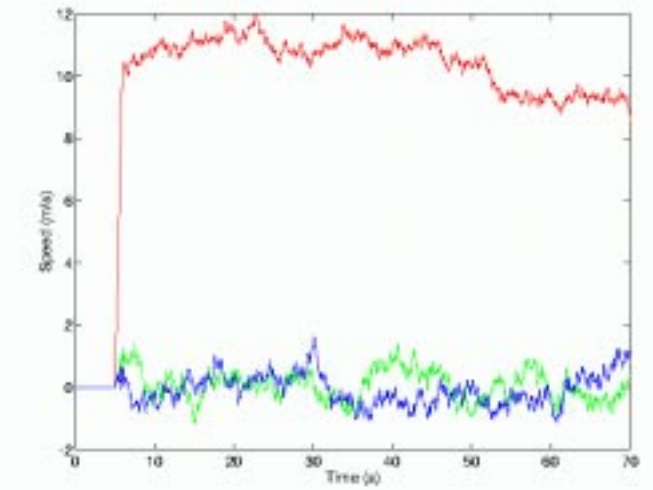
Engineering Progress – (LAR)

(For Overview – see SPIE paper – Carlson et al.)

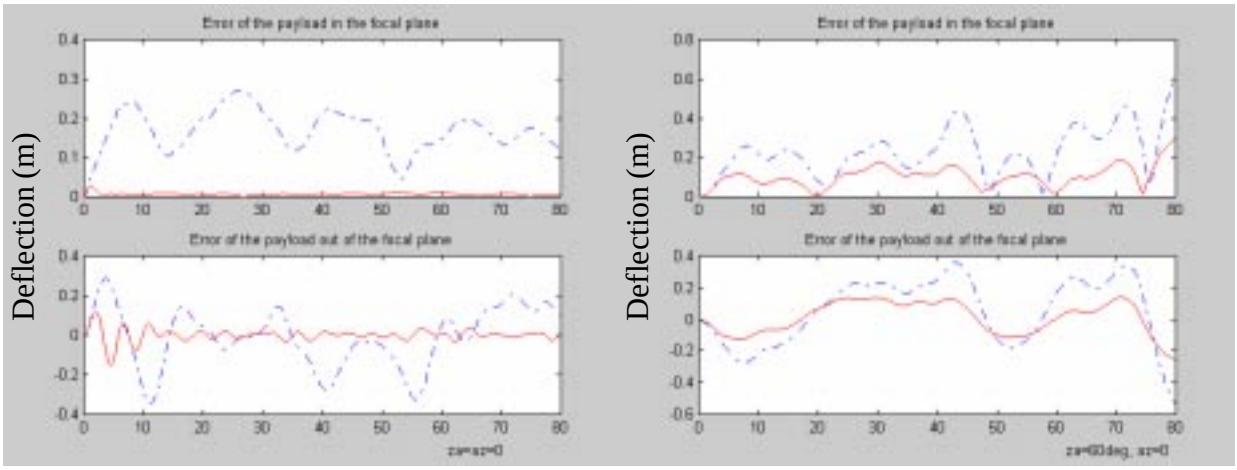
- Aerodynamics calculations and computer simulations
  - *Static Solutions* (SPIE paper). Fitzsimmons, Veidt and Dewdney are working on a write-up on the steady-state behaviour of three and six tethered systems. A bit more work is needed in exploring "parameter space" with the computer models developed.
  - *Dynamical simulations* are steadily improving (Nahon and Zhou). Aerodynamic equations for streamlined aerostats have been incorporated. Various optimization methods are in place to resolve the indeterminacy of solutions with >3 tethers. Simple winch control systems, incorporated into the models, have been found to be quite effective.
  - Field trials (1/3 scale) will begin as soon as we can get organized.

- Primary Actuators
  - Detailed design of the primary actuators has begun, partly because of interest from the private sector, and in optical telescopes.
  - A working model of these actuators is expected.

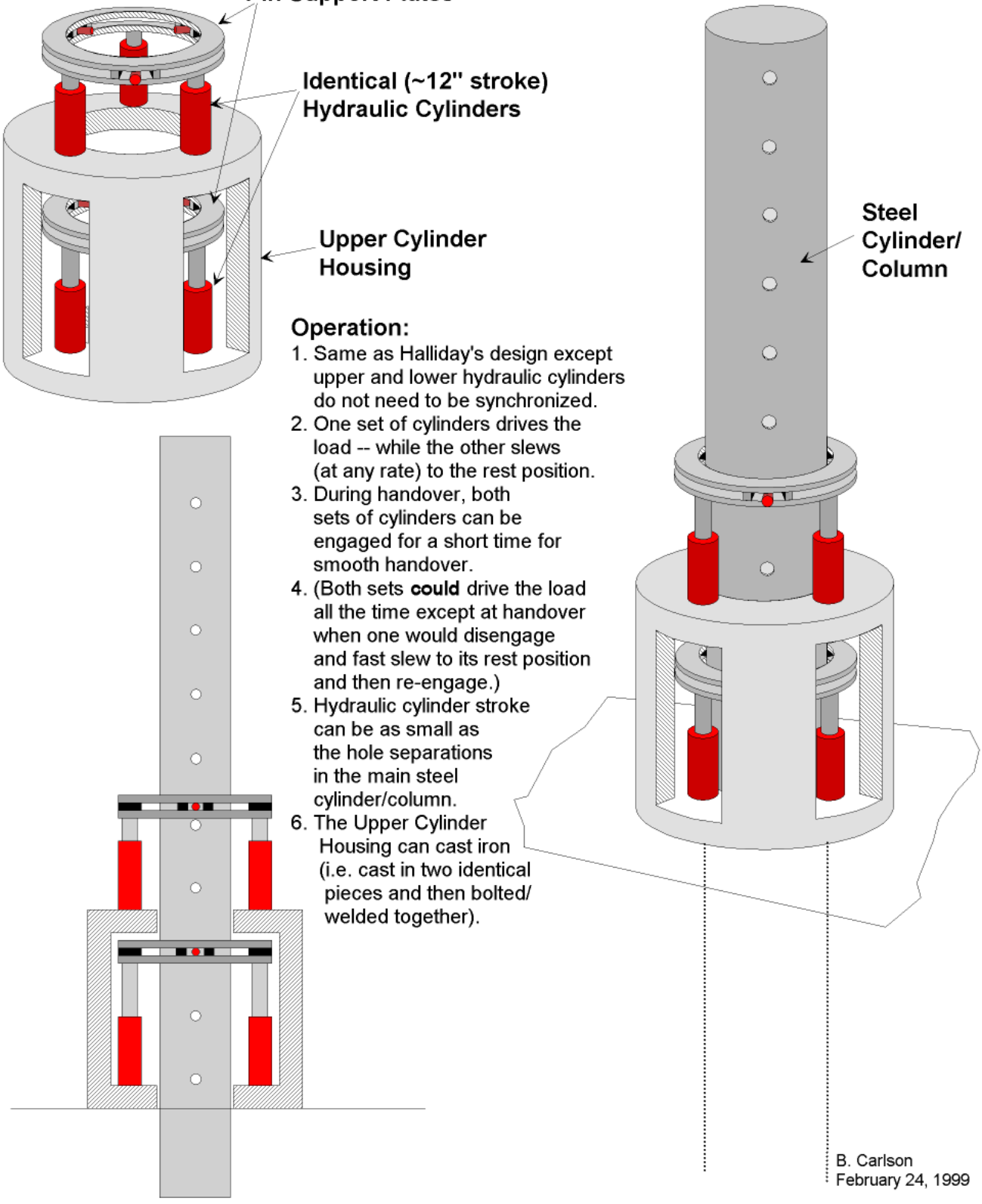


Preliminary Results: Tethered Aerostat Simulations

Left: Simulated wind velocity in the x, y, and z directions (red, blue, green respectively). The mean wind speed at 500-600 m altitude is 10 m s^{-1}.
Bottom Left: Aerostat deflections in the focal plane (open loop - dotted blue; closed loop - solid red) at the Zenith.
Bottom Right: Aerostat deflections at a Zenith Angle of 60 degrees.



LAR Primary Actuator - Variation of D. Halliday's Design



Operation:

1. Same as Halliday's design except upper and lower hydraulic cylinders do not need to be synchronized.
2. One set of cylinders drives the load -- while the other slews (at any rate) to the rest position.
3. During handover, both sets of cylinders can be engaged for a short time for smooth handover.
4. (Both sets **could** drive the load all the time except at handover when one would disengage and fast slew to its rest position and then re-engage.)
5. Hydraulic cylinder stroke can be as small as the hole separations in the main steel cylinder/column.
6. The Upper Cylinder Housing can cast iron (i.e. cast in two identical pieces and then bolted/ welded together).

B. Carlson
February 24, 1999

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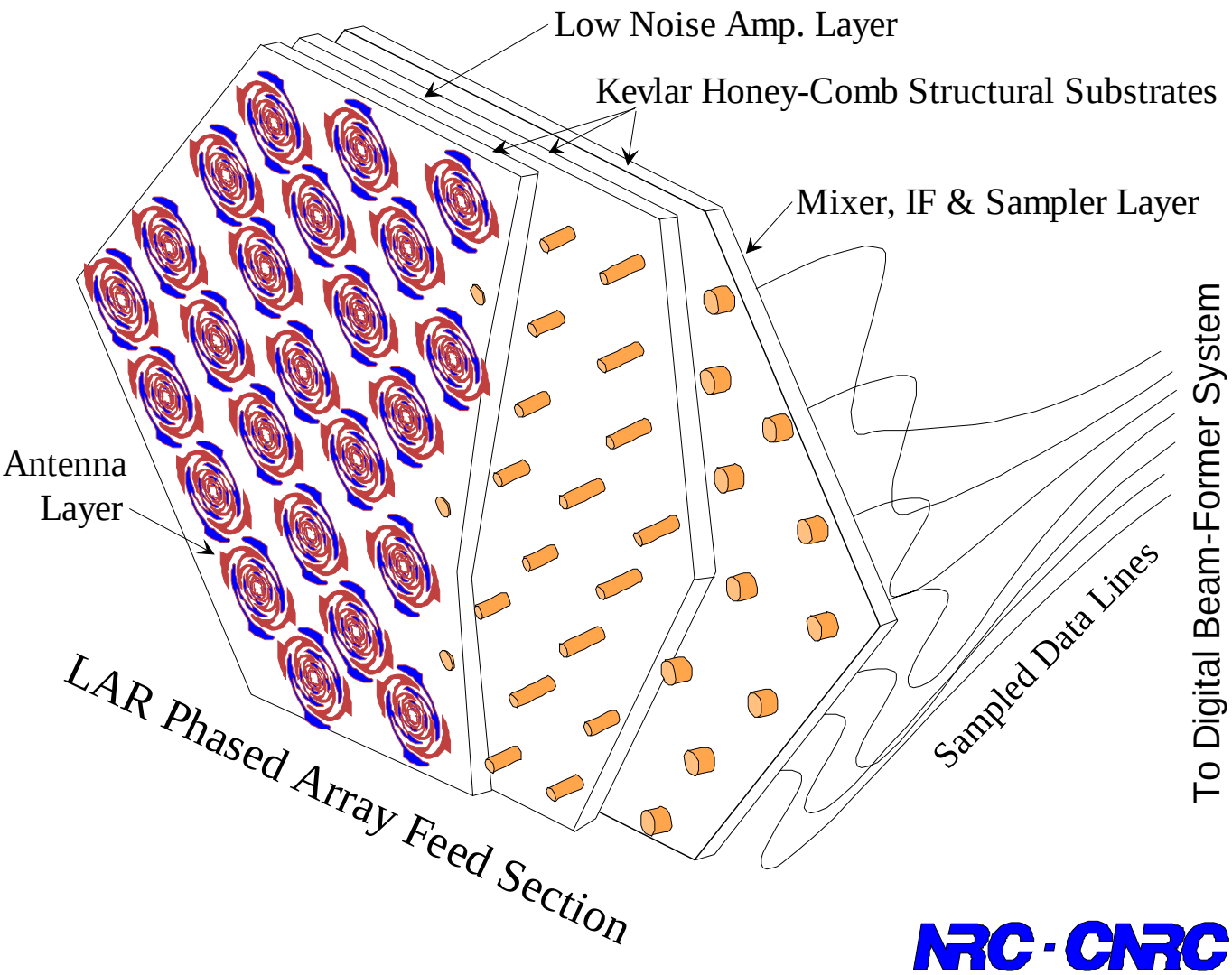
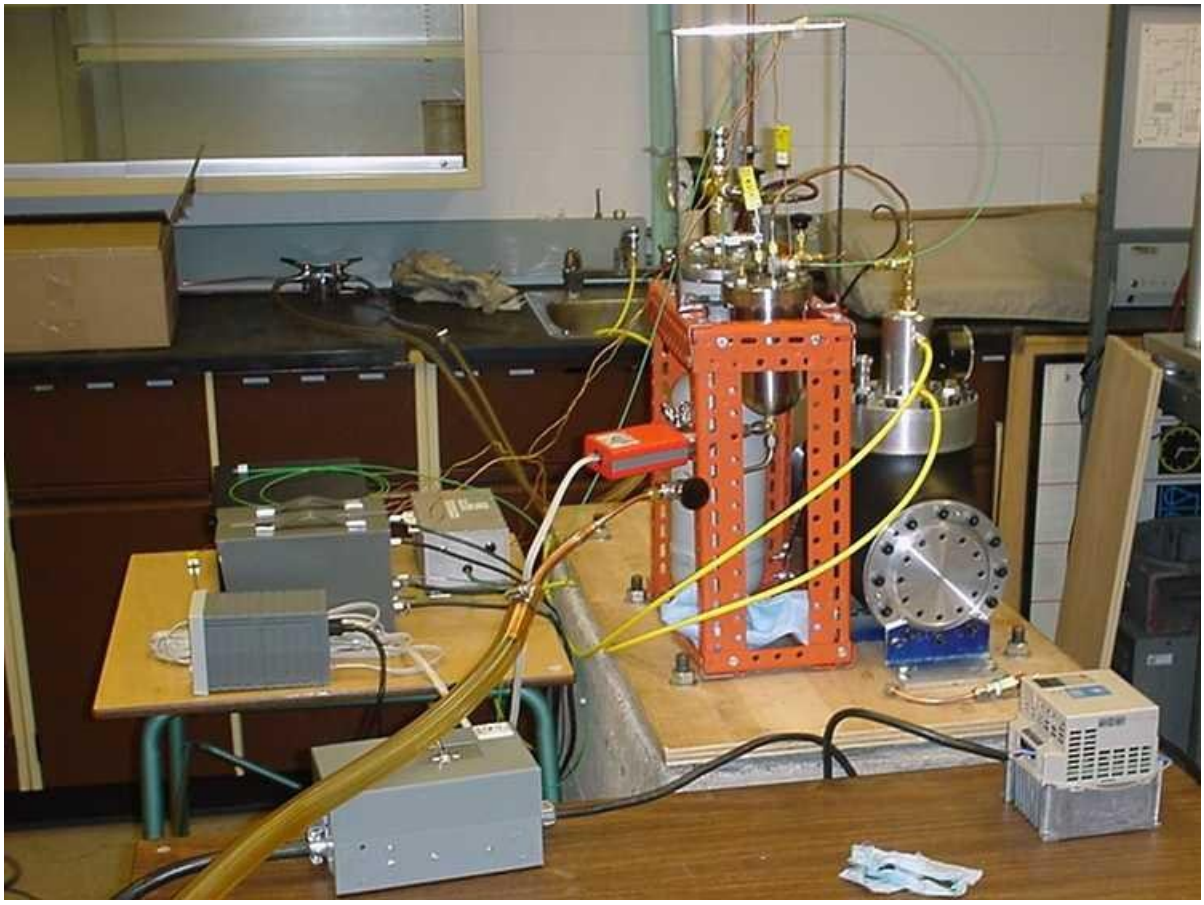
Engineering Progress

- LAR Feed System (Veidt, NRC – see paper at this meeting)
  - It is now clear that the best method of feeding the LAR is a *"simplified" phased array*.
  - Only way to simultaneously control the level of spillover noise, as well as to provide "beams" over a wide field of view.
  - A design concept for an array with octave bandwidth has been developed. This is a major step in a long process.
  - Concepts for receiver designs and for combining networks are now being explored. Laboratory receiver arrays are planned for the coming year.
  - WIDAR design is important aspect of signal combining network.

- Cryogenic Cooling Systems for the LAR (University of Calgary)
  - NSERC-funded project (Bauwens *et al.*) at the University of Calgary (Mech. Eng.).
  - Concentrating on improving the efficiency of small-to-medium sized pulse-tube cryo-coolers.
  - Constructed a laboratory model, paired with a theoretical code for its behaviour. The lab model works to 90 K now.
  - One post-doc, two Master's students involved.
  - Reached the half-way point in the funding.


Low Noise Amp. Layer
Kevlar Honey-Comb Structural Substrates
Mixer, IF & Sampler Layer
Antenna Layer
To Digital Beam-Former System
Sampled Data Lines
LAR Phased Array Feed Section

NRC · CNRC



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- Expanded Very Large Array (EVLA) Correlator Project (NRC)
  - *Relevance to SKA* – provides new options for correlation and for beam-forming, where wide-band, high spectral resolution is needed (see paper - Carlson at this meeting).
  - Will be used for wide-band LAR beam-forming.
  - WIDAR systems contains several features:
    - method for avoiding aliasing when using digital filters and reduced sample-rate data streams.
    - improved reliability and accuracy of digital delay.
    - increased spectral dynamic range.
    - efficient use of resources for high spectral resolution.
  - Extensive testing of concept carried out by Carlson.
  - Considerable progress on EVLA correlator design – goal is detailed proposal in Autumn, 2000.
  - Provisional patent registered for WIDAR technology.


The EVLA - WIDAR Correlator Project
NRC·CNRC

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- Dynamic Range Studies (Willis & Gray, NRC)
  - Initially, the AIPS^{++} framework was being used as a platform for development of high dynamic range imaging algorithms, using arrays of LAR antennas.
  - However, AIPS^{++} is not yet fully capable of the task, nor is any other radio imaging package. Parts of AIPS^{++}, AIPS, Miriad, and DRAO packages have been used.
  - Turning out to be a stringent test of imaging packages.
  - Fundamental task will be to incorporate time-variable field-of-view (primary antenna beam) function into imaging. This capability is needed by any SKA technology that does electronic beam forming from arrays or contains foreshortened elements.
  - Simulations suggest that the LAR is inherently capable of sufficient dynamic range for the SKA. Clean optics and individual beam-arrays (3.5 arcmin at λ21 cm) on the sky contribute to dynamic range performance.
  - This work will continue:
    - Speed up software packages, and continue to point out and/or repair problems.
    - Study array configurations.
    - Incorporate time-variable primary beam capability into packages (likely AIPS^{++}).

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Engineering Progress

- Structural Design of Focus Platform (UBC & U. Stuttgart)
  - The structure that contains the focus equipment is subject to large forces.
  - Bildstein (Visiting student from U. Stuttgart to University of BC) and Stiemer (UBC) are carrying out a first-level engineering design of the frame that links the tethers together with the aerostat, and supports the focus equipment.
  - Much work remaining here.

- Focus Distance Measurement (University of Alberta & NRC)
  - Prototype system designed and built to transfer a Local Oscillator signal to the focus, and to simultaneously measure the distance from the reflector to the focus in real time (Belostotski & Landecker).
  - Subject of thesis (now complete) at University of Alberta.
  - Measurements not affected by cloud.
  - Makes innovative use of Chinese Remainder Theorem to resolve ambiquities.
  - May have additional applications in distance measurement, if developed further.
  - To be published soon.