Dewar and cryogenics concepts (inc. reliability and maintenance)

Why use cryogenics?

- System cost per dish is very high:
  - Dish cost
  - Infrastructure cost
  - Signal transport cost
  - Signal processing cost
  - Computing cost
- Cryogenic front ends will minimise the number of dishes needed to meet system sensitivity requirements. Hence maximise the system sensitivity per $/€.

Cryogenic technology (1)

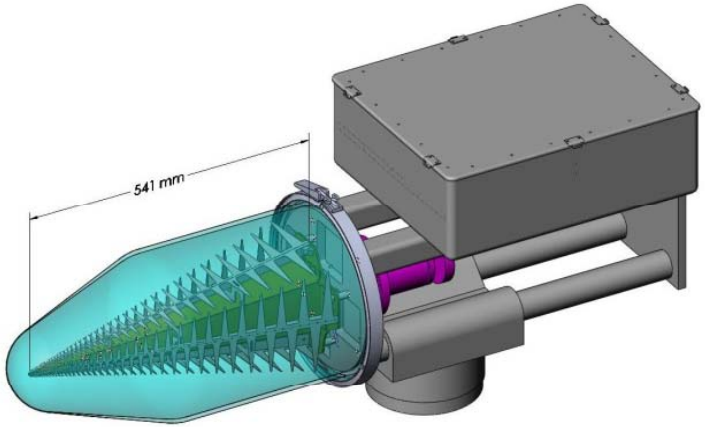
- Radio astronomy traditionally uses GM coolers (15 – 20 K). These require high power and significant maintenance.
- These will be too expensive to operate for SKA.
- SKA needs long life, low power coolers requiring little or no maintenance.

Sandy Weinreb

Cryogenic technology (2)

- Stirling cycle coolers use less power and have long lifetimes; high MTBFs are quoted.
- Temperature: 50 – 70 K
- Vacuum is a problem

(no cryo-pumping above 30 K)



Glass dewar for ATA (Matt Fleming)

Wide band feed with Stirling cooler (Sandy Weinreb)

Cryogenic technology (3)

- Currently there is industry interest in producing maintenance free cryogenic front ends, using solid insulation rather than vacuum, for satcom applications.
- Dewars can be switched off when not in use, to save power and cryo-cooler life. Re-cooling does not need a vacuum pump.

Lifetime, reliability and maintenance

- SKA needs ‘fit and forget’ SPF payloads.
- The number of dishes (250 in SKA1 and potentially ~ 3000 in SKA2) means routine maintenance would be very expensive and high failure rates will result in excessive operating costs as well as loss of array performance.

Dewar and cryogenics in the next phase of SKA

- To date there has been limited SKA-specific development.
- There needs to be substantial development effort in the PEP phase of the SKA.
- Operation and maintenance costs are potentially very high, and these must be minimized in order to maximize SKA science return.

Summary

- Cryogenic front ends are needed to maximize system sensitivity per $/€.
- Traditional radio astronomy cryogenic methods would cost too much.
- Long life, extremely reliable, low power, low (or no) maintenance SPF payloads are needed for the SKA.
- Substantial development work is required in the next phase of the SKA.