

# CMB Summer School @ UChicago/KICP

Monday Lab - R. Basu Thakur and Z. Pan

## The “Golden- Dewar”

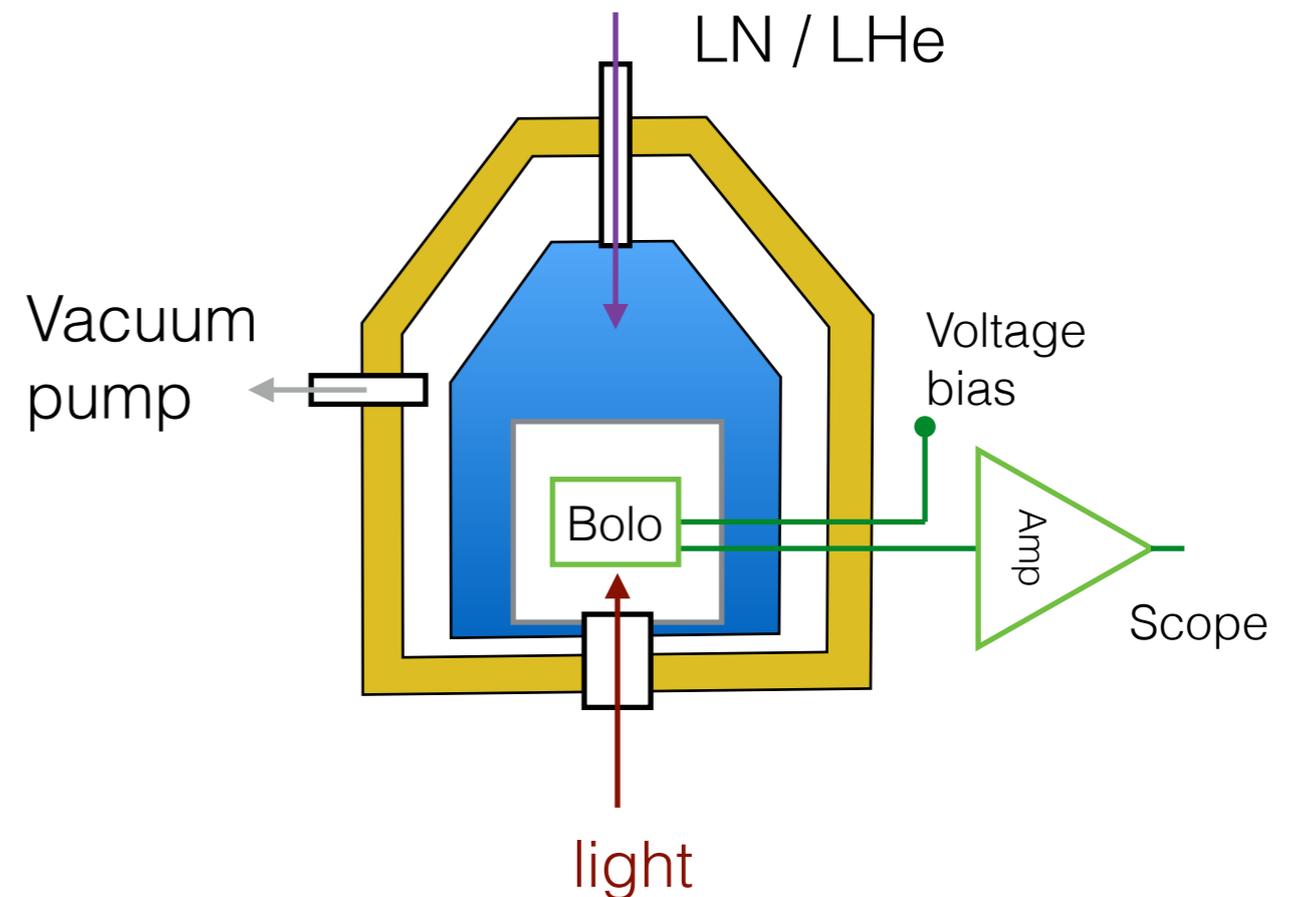
It's our special (historical) wet dewar.

One bolometer with optical window,  
operated at 4K

Used extensively for filter and material  
transmission measurements and  
understanding FTS performance



Rainer Weiss in his lab in MIT's Building 20 in the late 1970s, working on radiation detectors called bolometers. Massachusetts Institute of Technology



### The “Golden- Dewar”

There are essentially 3 stages under the golden hood:

1. Vacuum jacket for thermal isolation
2. Liquid cryogen tank (the *wet* part)
3. The Bolometer stage

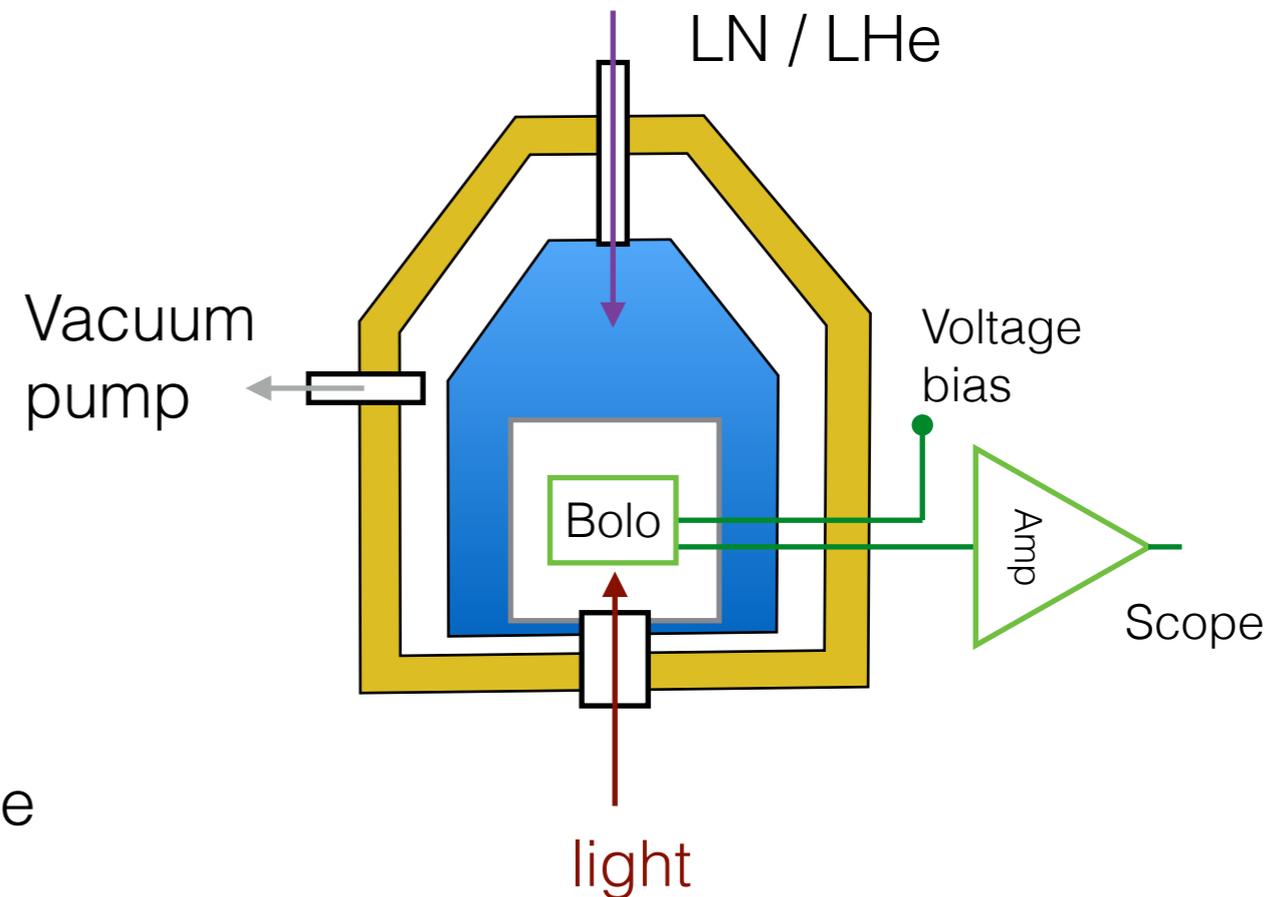
### Setup:

Pump down with roughing pump and evacuate the vacuum jacket ( 6-hours)

Fill the “wet” chamber with liquid nitrogen (LN-77K) overnight

Empty LN, and do liquid helium (LHe-4K) and let the system come to 4K in ~3 hours

9V batteries all at 9.1+V for biasing and reading bolo



### Bolometer

A single monolithic Is bolometer [1] is operated with voltage bias, and the change in resistance with Island temperature ( $T$ ) dictates measured signals

$$R(T) = R_0 \exp[(T_0/T)^{1/2}]$$

Optical power ( $Q$ ) absorption + Joule heating ( $P$ ) leads to increased Island temperature, regulated by the weak thermal link  $G(T)$ .

$$P + Q = \int_{T_B}^{T_D} G(T) dT = G_0(T_D^4 - T_B^4)/4.$$

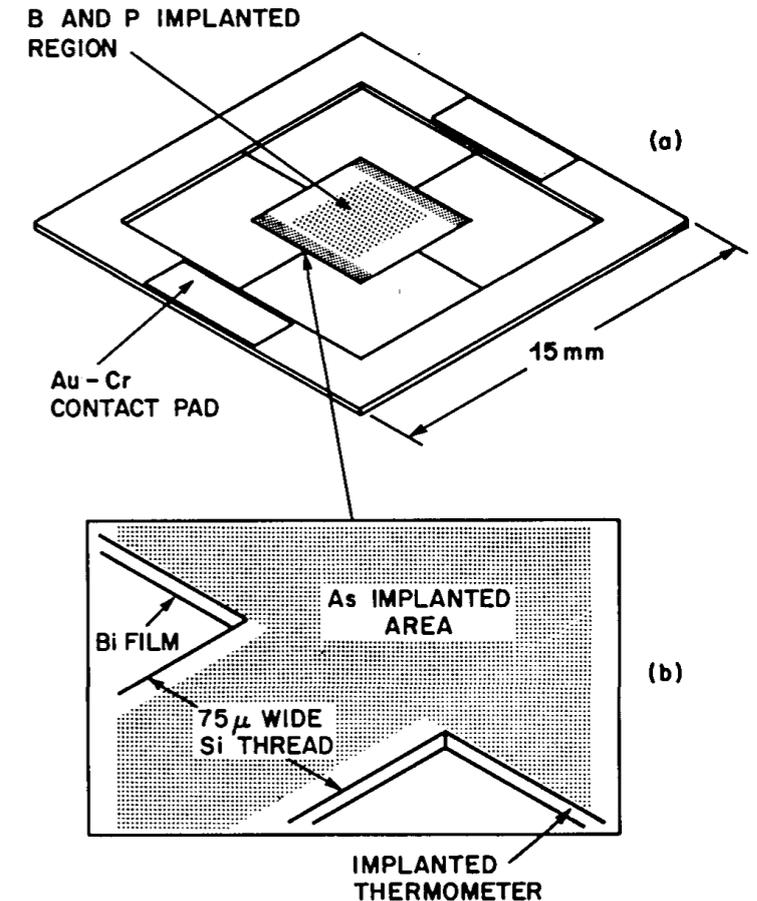
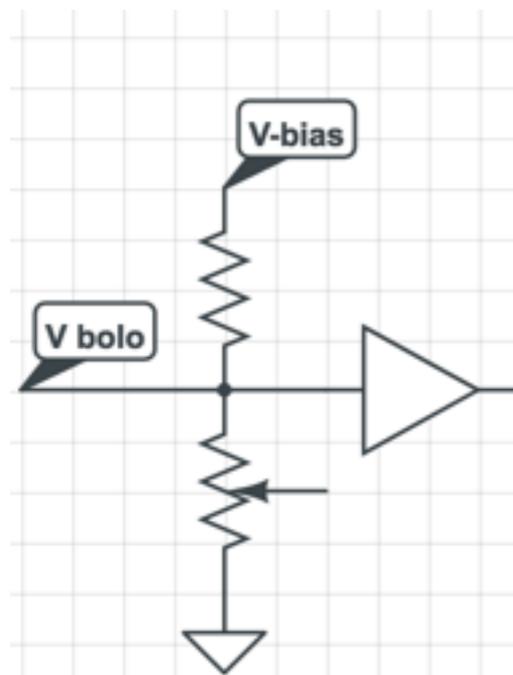
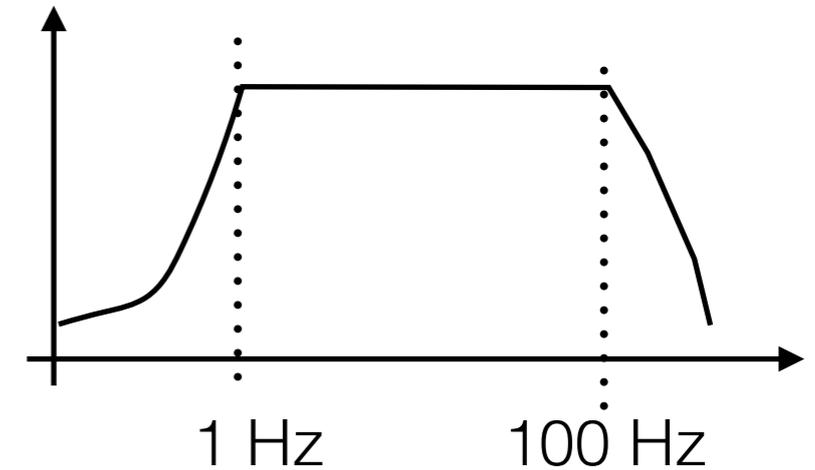


Fig. 1. (a) Illustration of the front side of the monolithic silicon bolometer; (b) detail of an As implanted thread and the detecting element.

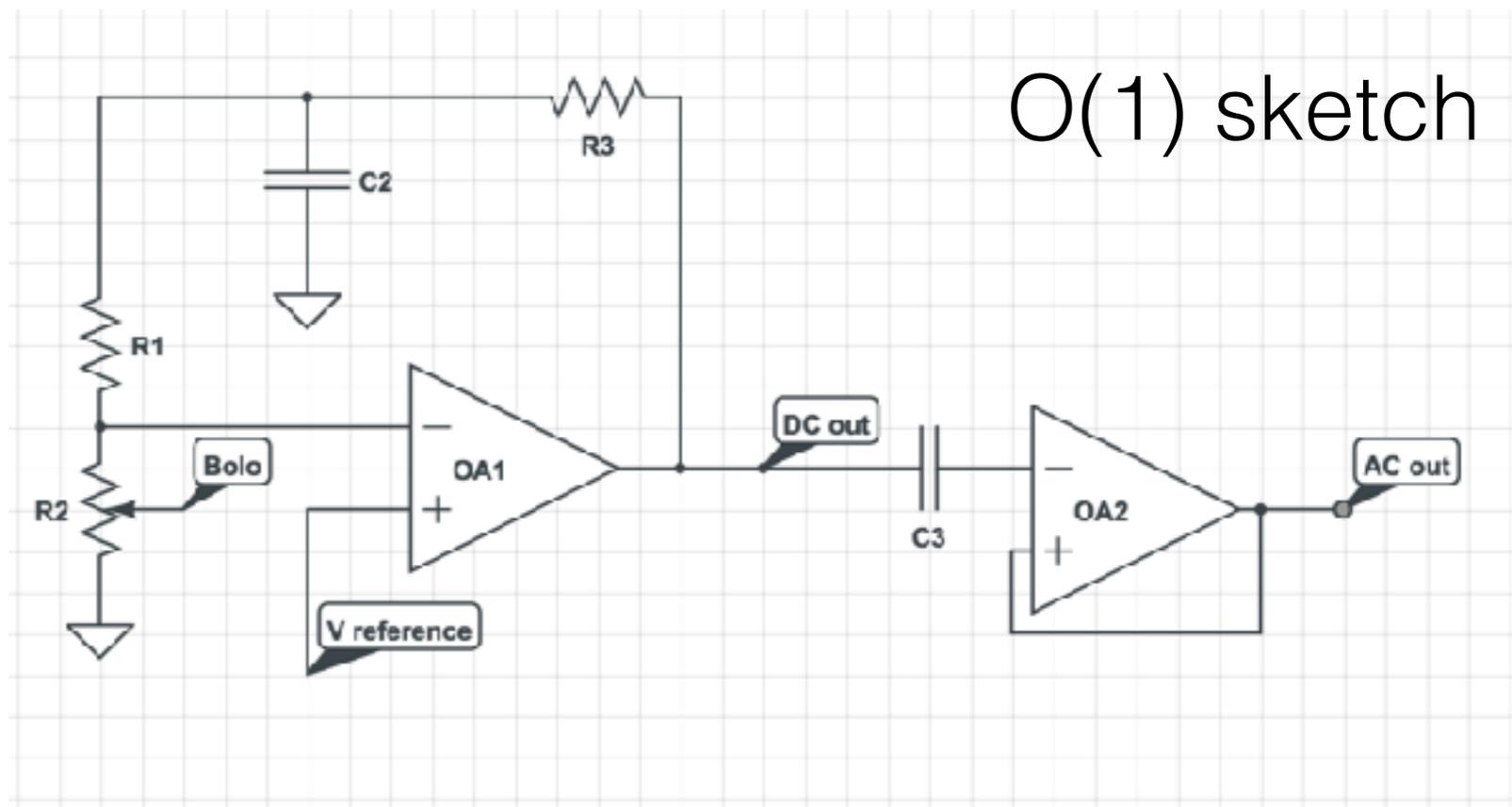
### Read-out electronics

Change in resistance is measured as voltage differential wrt a reference voltage.

The signal is read out via an amplifier in feed-back with both DC and AC gain and band-pass-filtering



O(0) sketch



O(1) sketch

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## Today's tests:

Optical coupling set up: How to bring light to the bolometer ?

- A simple version microwave telescope optics, i.e., how to let the cosmic microwave photons (and preferably none other) in

Chopper response: How to measure change in brightness ?

- A simple version of getting at power / brightness calibration, i.e., how does a 1uK signal show up on the bolo time-streams

Time-constant: Find how fast the bolometer can respond to changing brightness ?

- A simple version of scan-strategizing, i.e., how quickly can you scan to see small spatial features at a decent signal-to-noise/