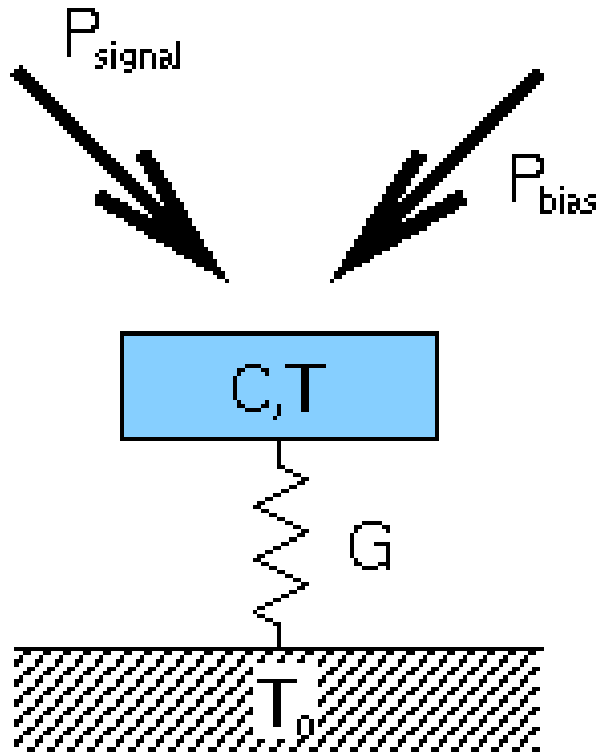


**A Virtual Tour of the  
Microlab:**

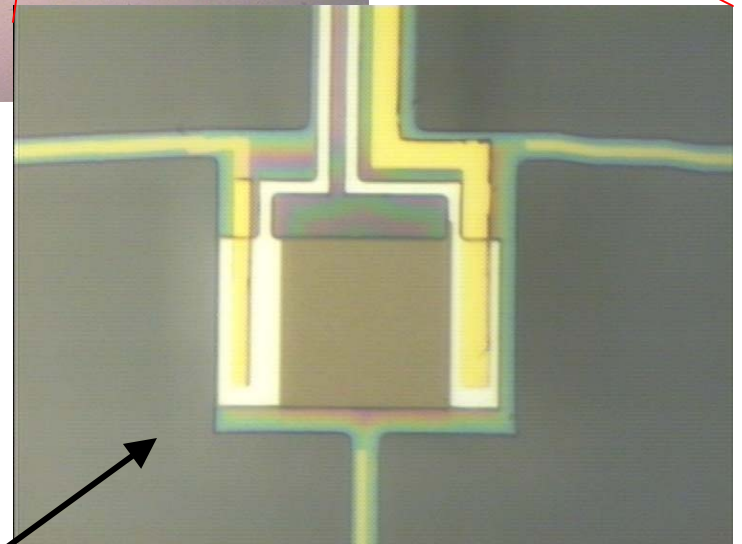
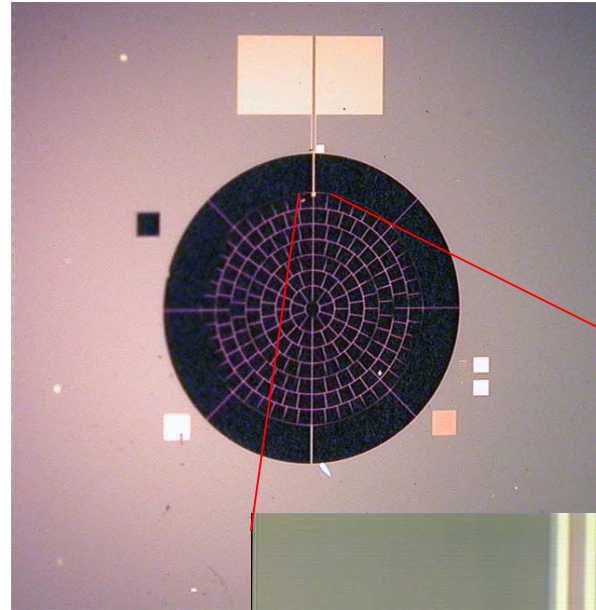
***Spiderweb TES Bolometer  
Fabrication***

**Jared Mehl  
Friday Group Talk  
March 19, 2004**

# Bolometer Basics



**Cartoon Bolo**



**Real Deal**

# Start with blank wafer



- **4 in. Silicon Wafer**
- **Doping unimportant**

**Cross-section**



**Top view**



# Clean Wafers in Sink6

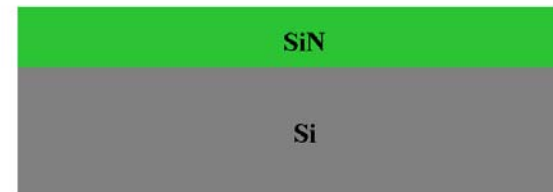


- Piranha bath
- DI water rinse  $R > 10 \text{ M}\Omega$
- Spin dry!

Si

Si

# Grow $\text{Si}_3\text{N}_4$ in Tystar17



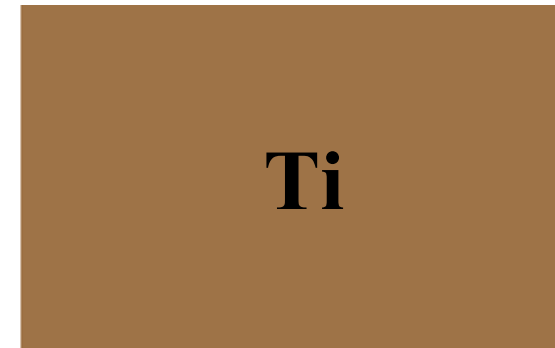
- **Low Stress Nitride Furnace**
- **LPCVD**
- **Deposits  $40 \text{ \AA} / \text{min}$**
- **$\sim 1 \text{ \mu m}$  total film thickness**



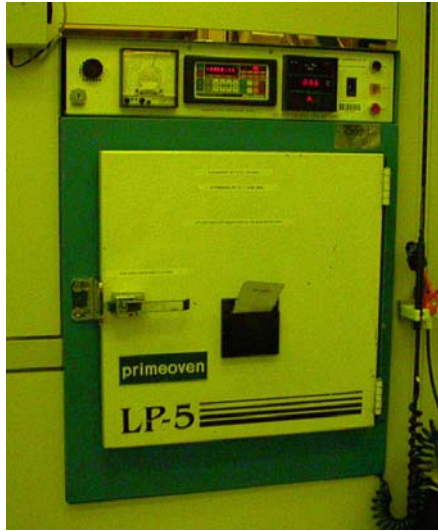
# Sputter Al/Ti Layers in CPA



- 400 Å Al / 800 Å Ti
- Argon DC sputtering
- Base pressure  $\sim 10^{-7}$  Torr



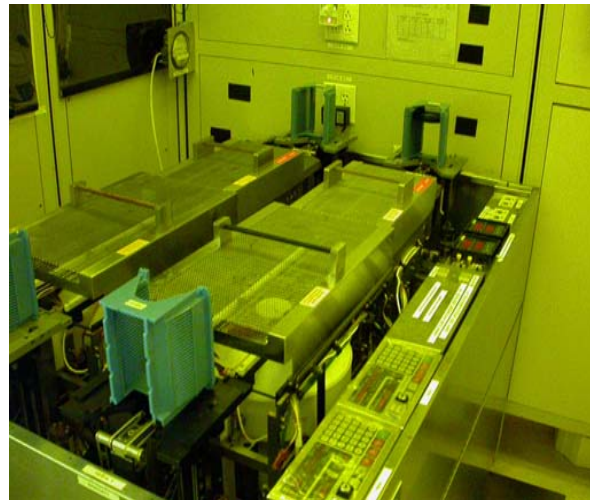
# Lithography 1: Spin Resist



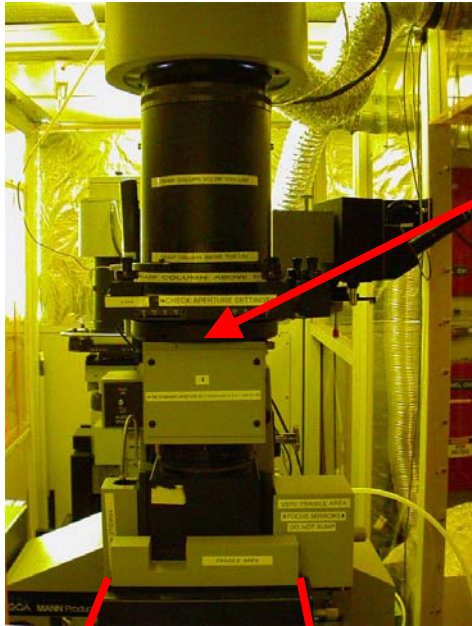
- Primeoven
- Drive off water
- HMDS



- Svgcoat
- 1-2  $\mu\text{m}$  I-line photoresist
- 60 s bake



# Lithography 2: Expose



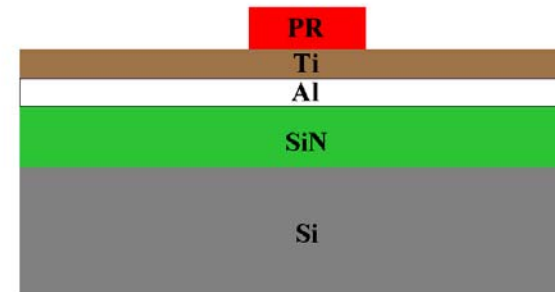
**Masks go  
here**



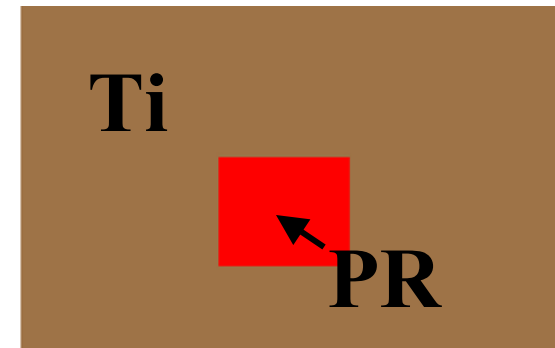
**Wafers  
go here**



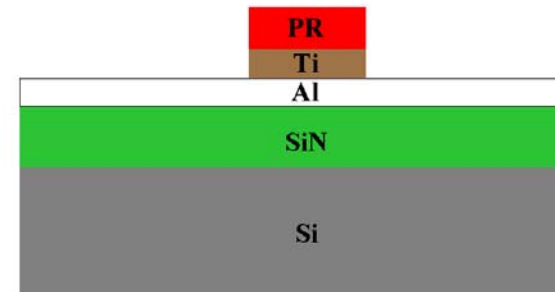
# Lithography 3 : Develop



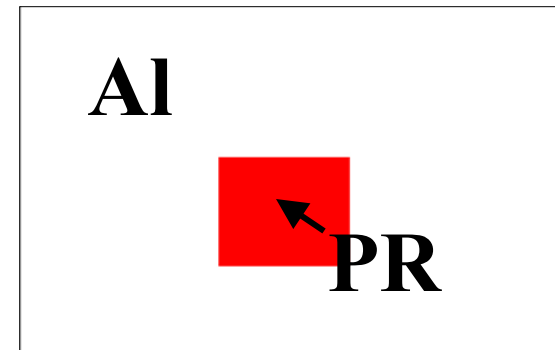
- **svgdev**
- **Post Exposure Bake**
- **Develop 60 s**



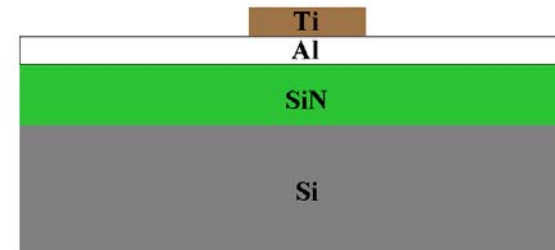
# Etch Ti in Ptherm



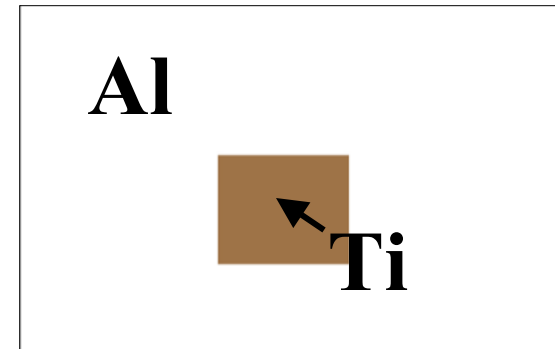
- $\text{SF}_6$  RF plasma 200 W
- Straight wall profile
- Etch stops on underlying Al layer



# Remove Photoresist

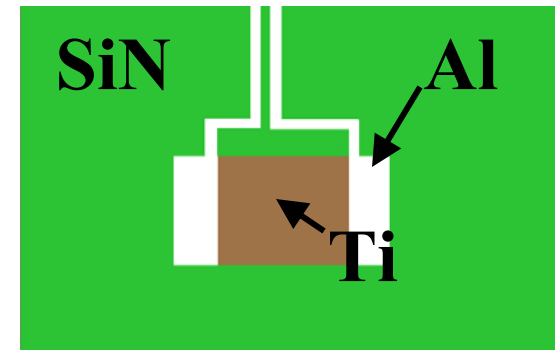
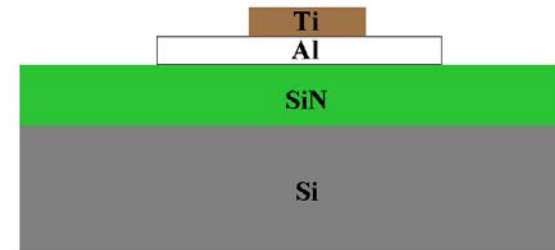
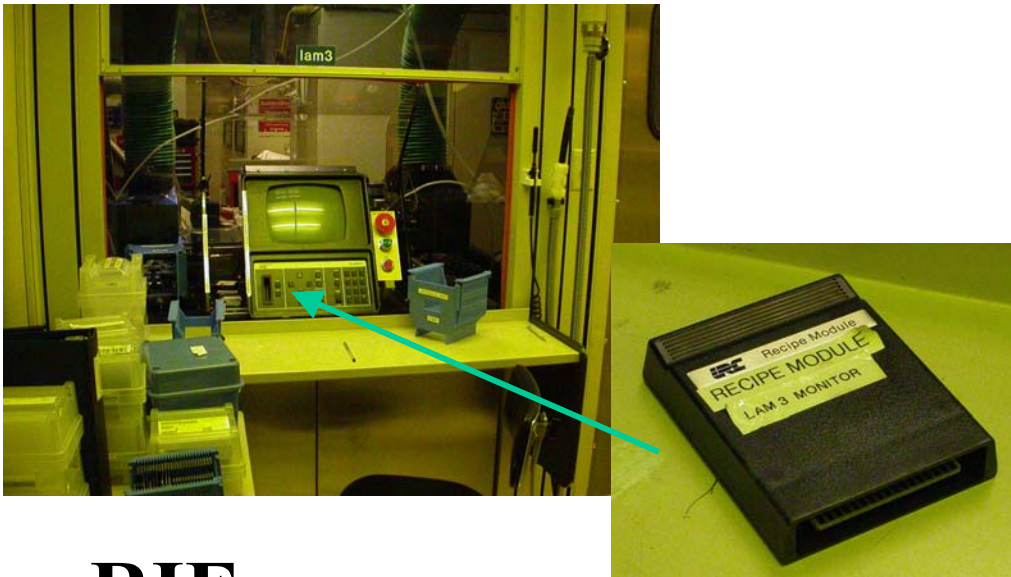


- Soak in acetone
- Rinse in isopropanol
- Rinse in DI water



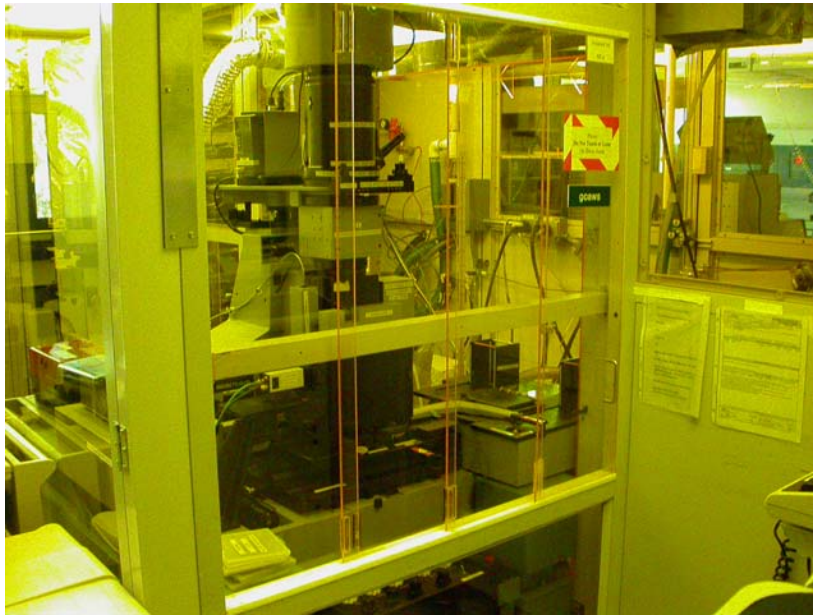
# Etch Al in LAM3

(skipping lithography description from now on)

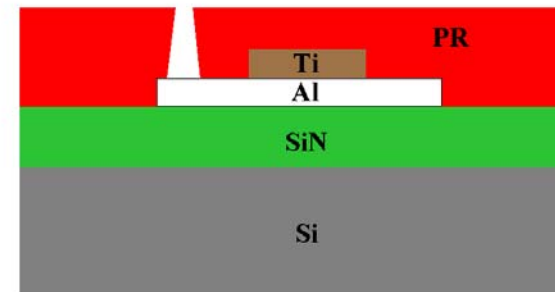


- **RIE**
- **$\text{BCl}_3$ ,  $\text{Cl}_2$ ,  $\text{CHCl}_3$ ,  $\text{N}_2$**
- **Etch 25 s, don't oxidize Al**

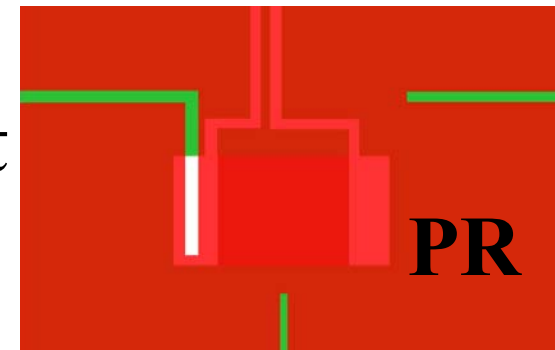
# Liftoff 1: Apply/Dev PR



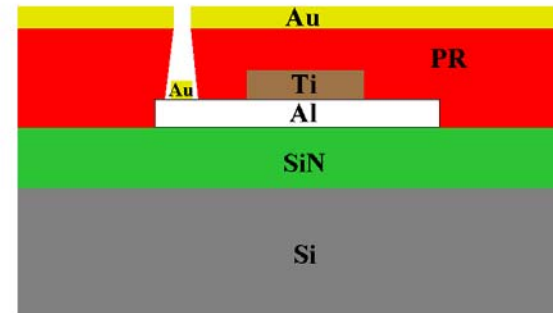
(for gold Spiderweb absorber)



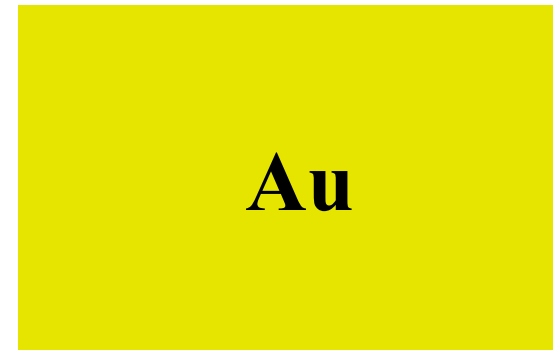
- Soak in developer before exposure to harden PR crust
- Uses negative masks



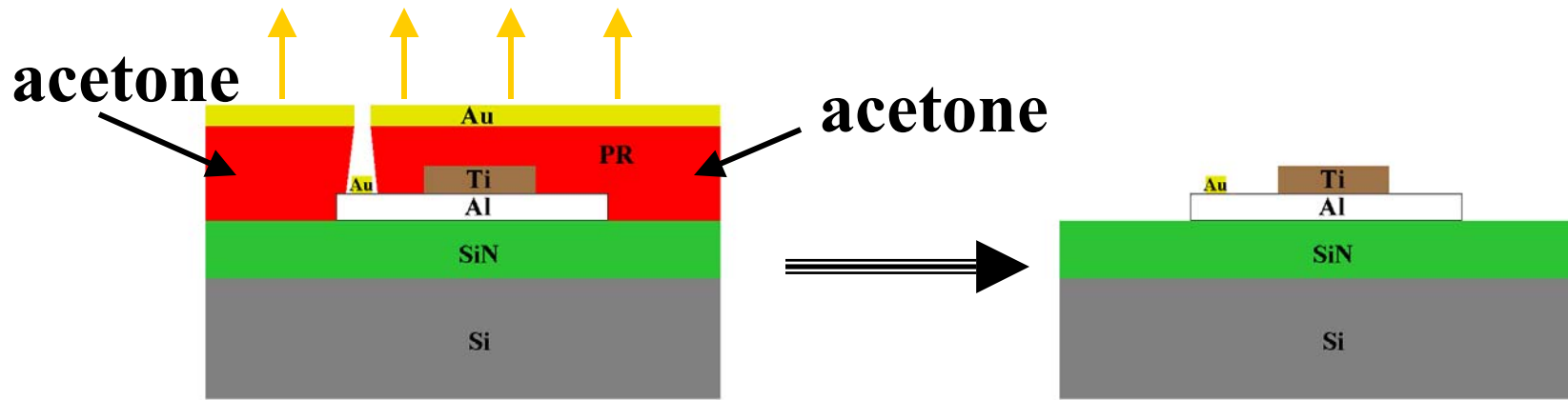
# Liftoff 2: Evaporate Au



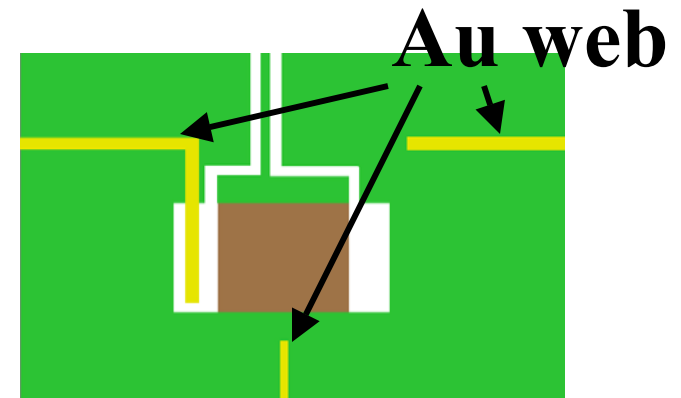
- in Veeco (v401)
- 20 Å Ti to improve adhesion
- 250 Å Au for web



# Liftoff 3: Liftoff!

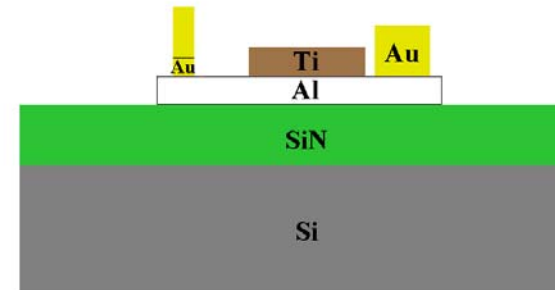


- Soak in acetone, overnight if possible
- Ultrasound bath

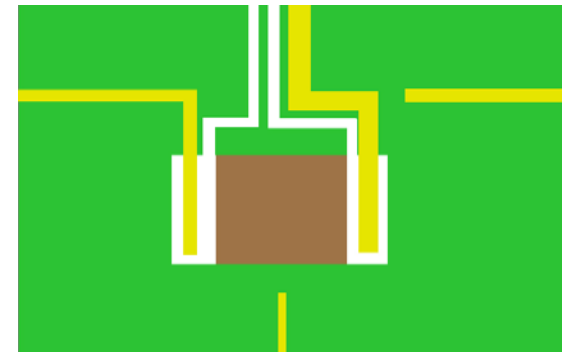


# Apply Gold finger in Veeco

(another liftoff process...)

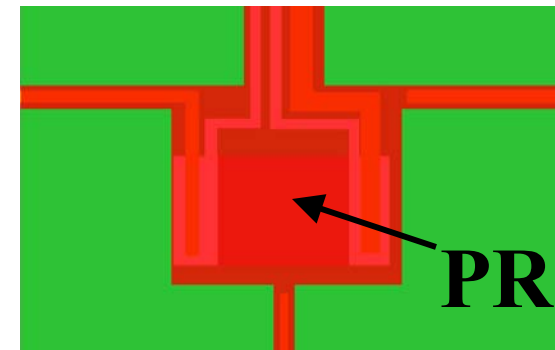
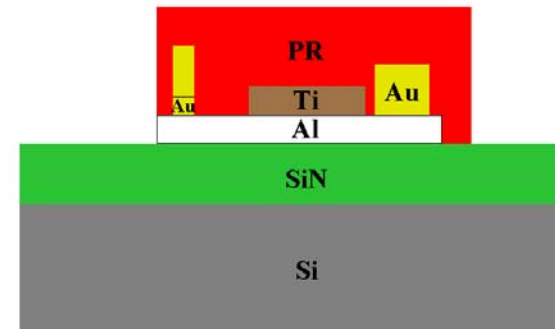


- Evaporate  $\sim 600 \text{ \AA}$  Gold
- Tunes G value

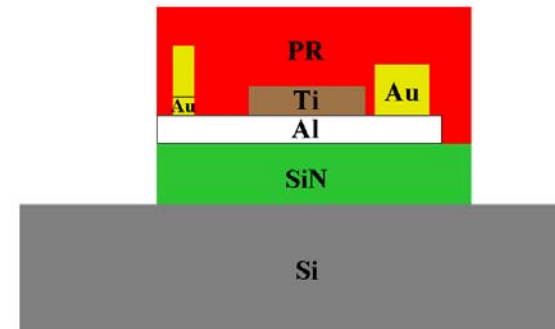


# Nitride Web Lithography

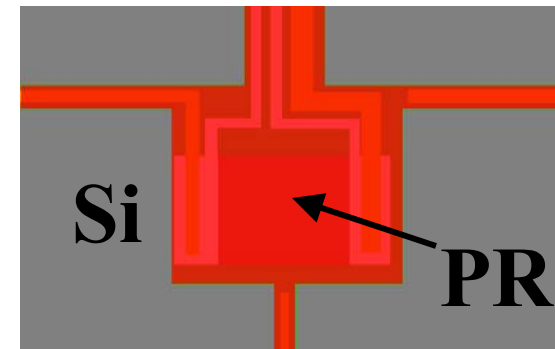
**Need to leave extra thick ( $\sim 2 \mu\text{m}$ ) of photoresist to protect TES and gold layers during wafer dicing and release.**



# Etch Nitride Web in Ptherm

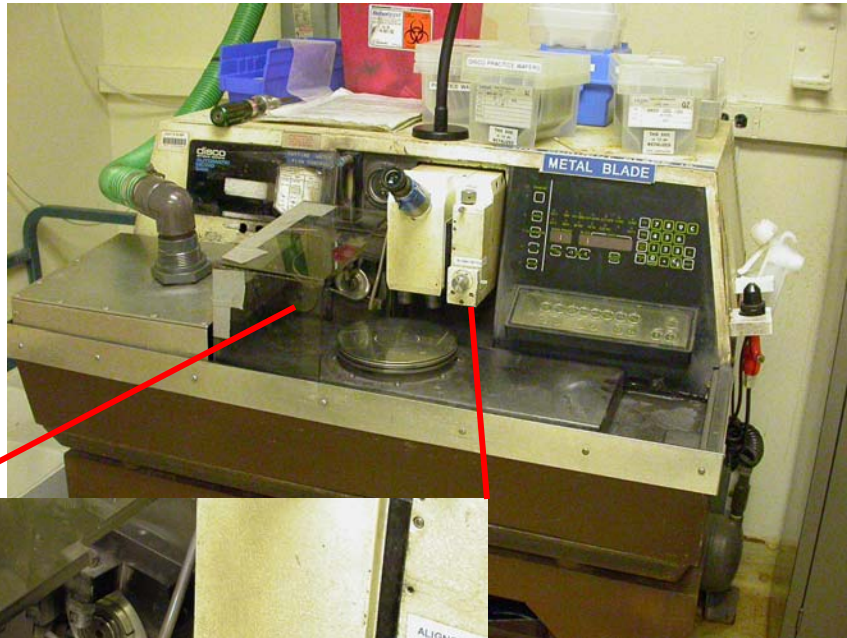


- Nitride etch rate 1000 Å per min
- Leave PR on after etch

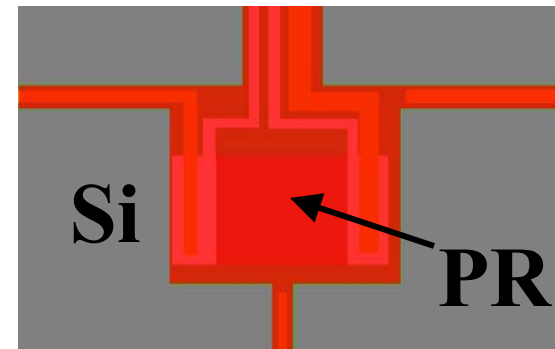
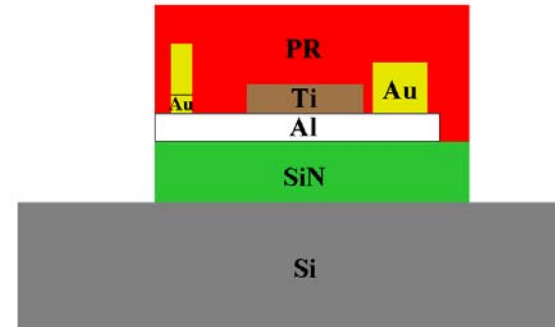




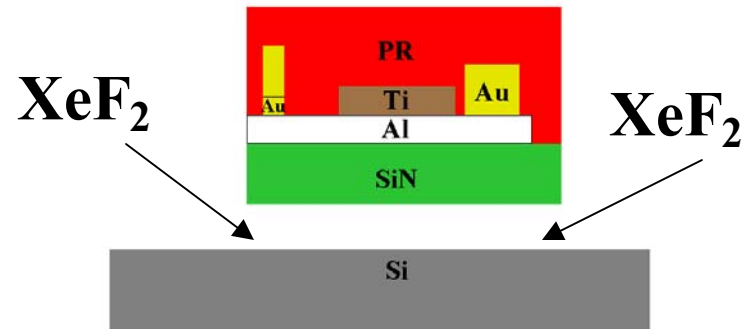
# Dice wafer in Disco



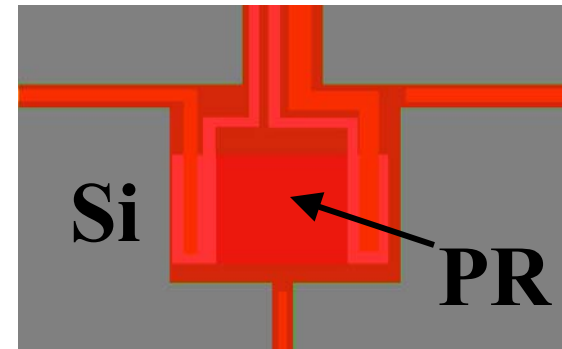
**Scary blade!**



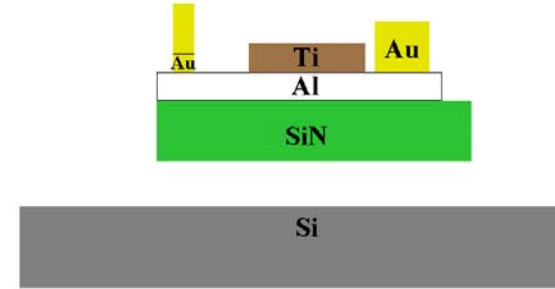
# Release Web in Xetch



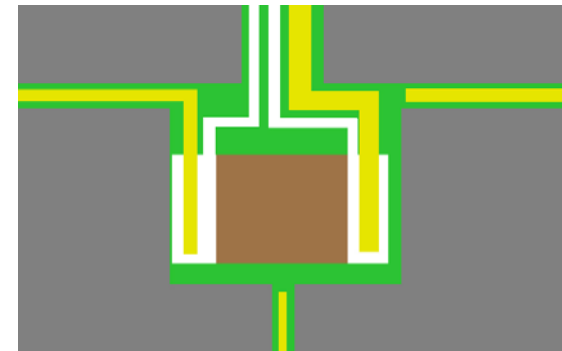
- **Isotropic  $\text{XeF}_2$  gas etch**
- **~ 40 minutes / die**
- **~ 5 hours / wafer**



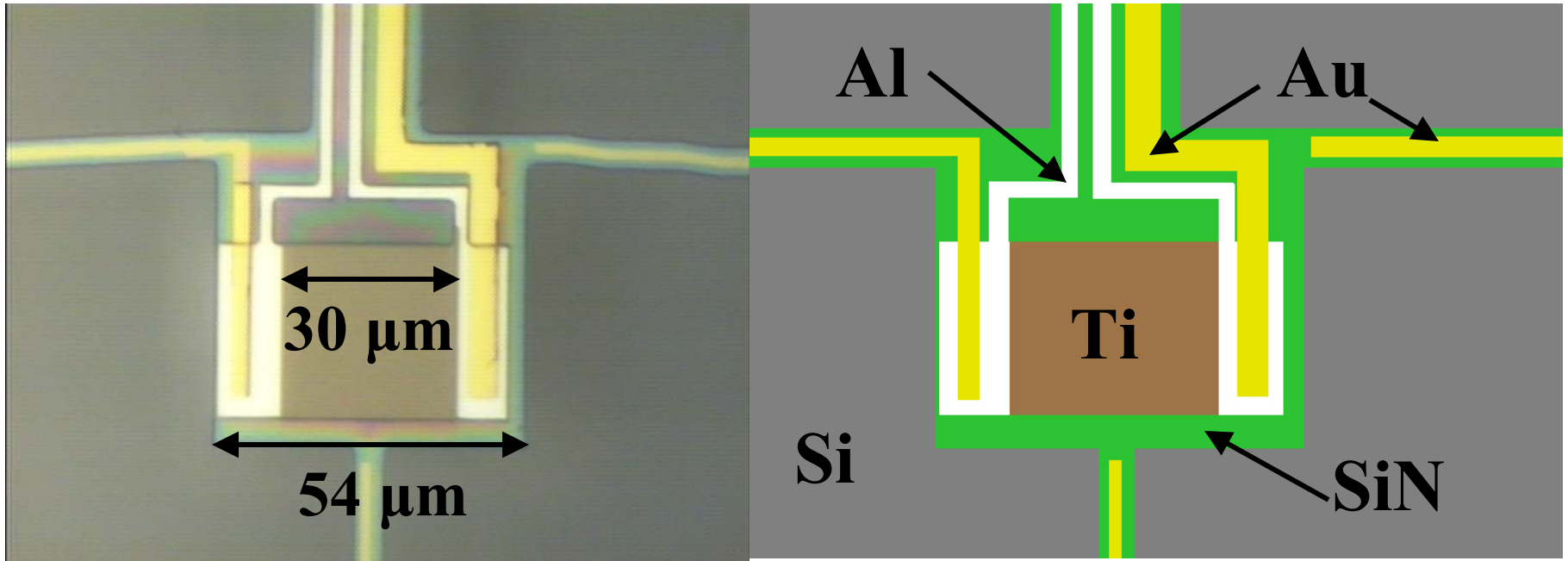
# Ash PR in Ptherm



- $O_2$  RF plasma, 200 W
- PR too hard for Acetone removal



# Bolometer Finished



# Bolometer Tests

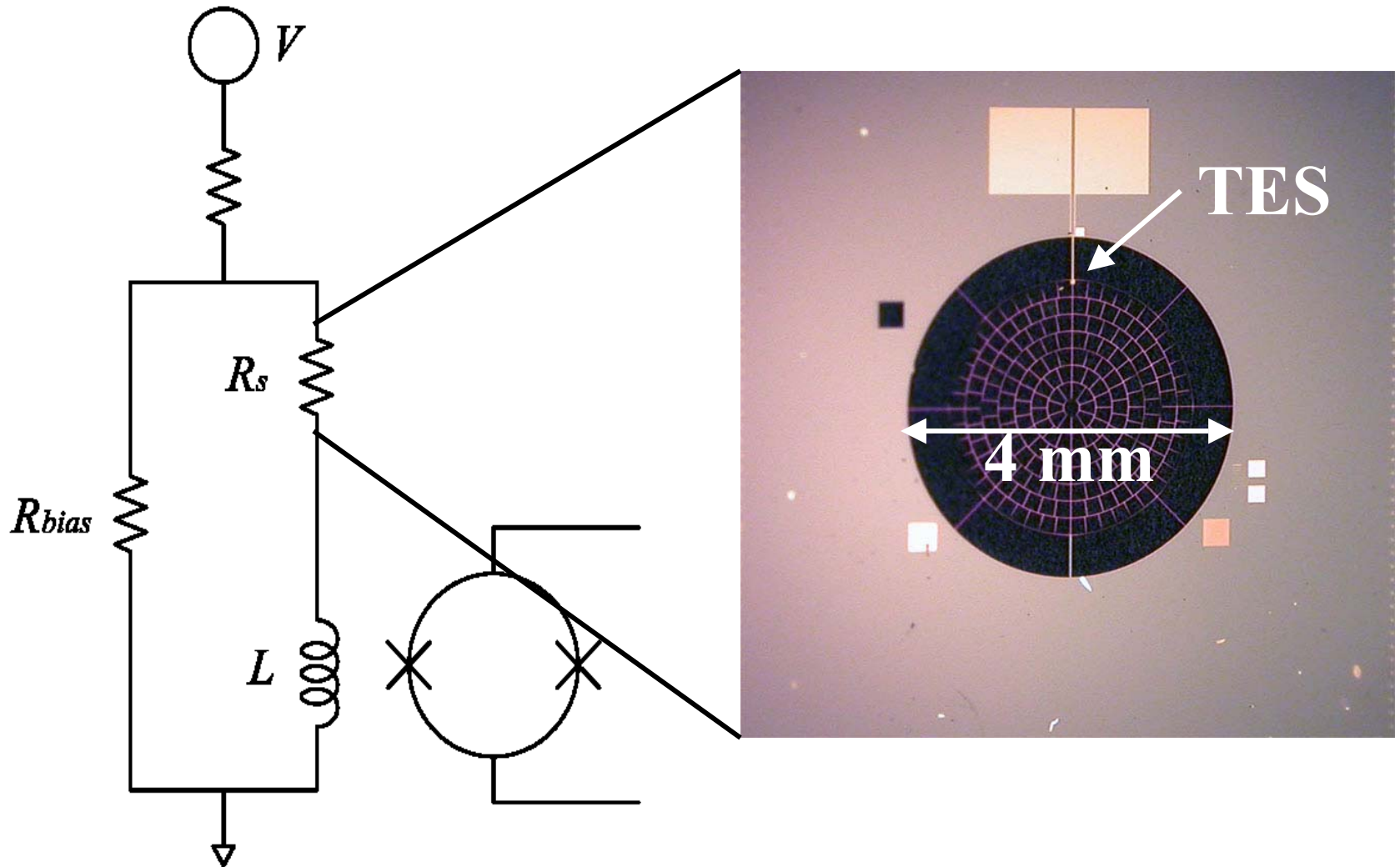
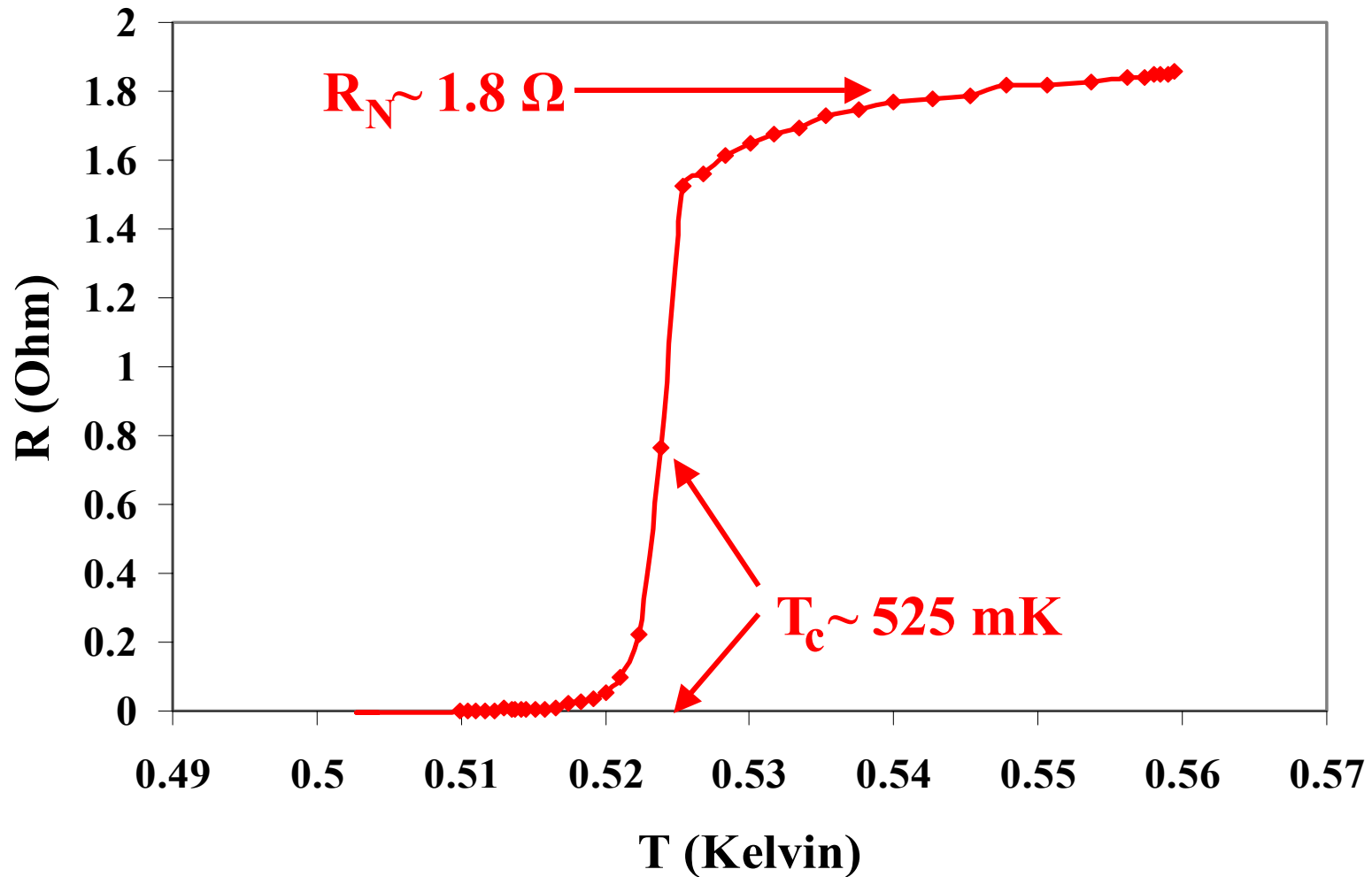
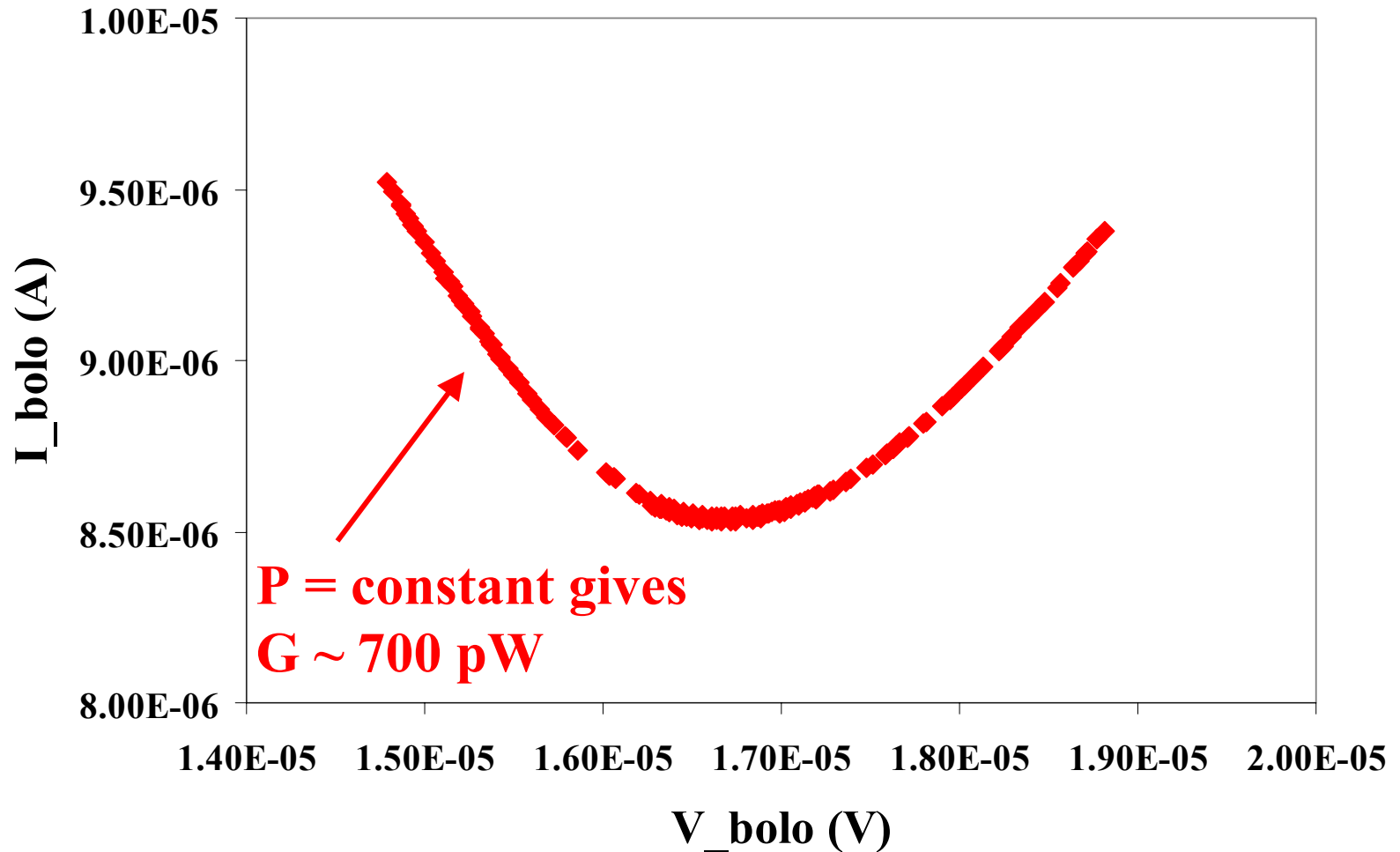


Figure courtesy T. Lanting

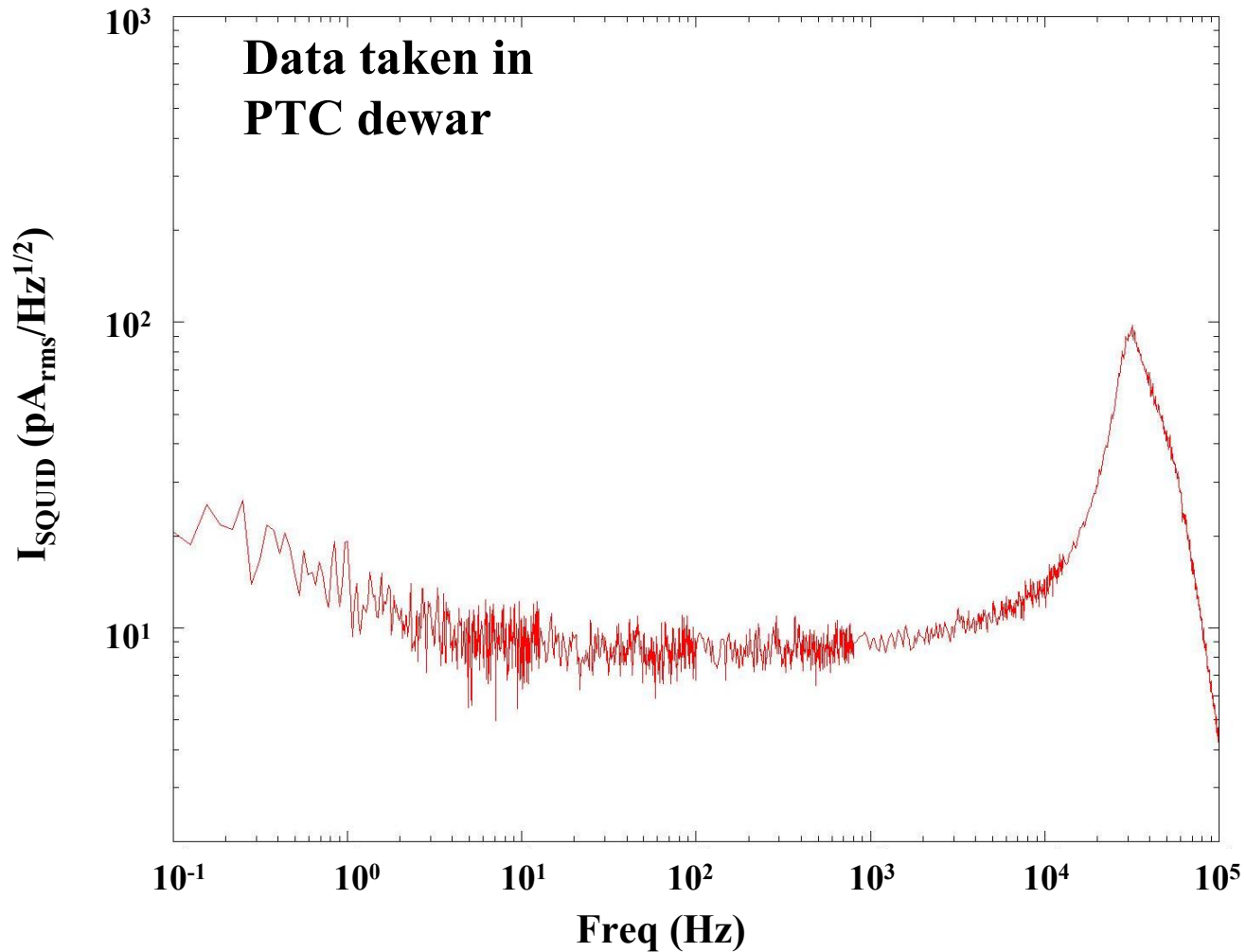
# Bolometer Tests: $T_c$ , $R_N$



# Bolometer Tests: IV



# Bolometer Tests: Noise

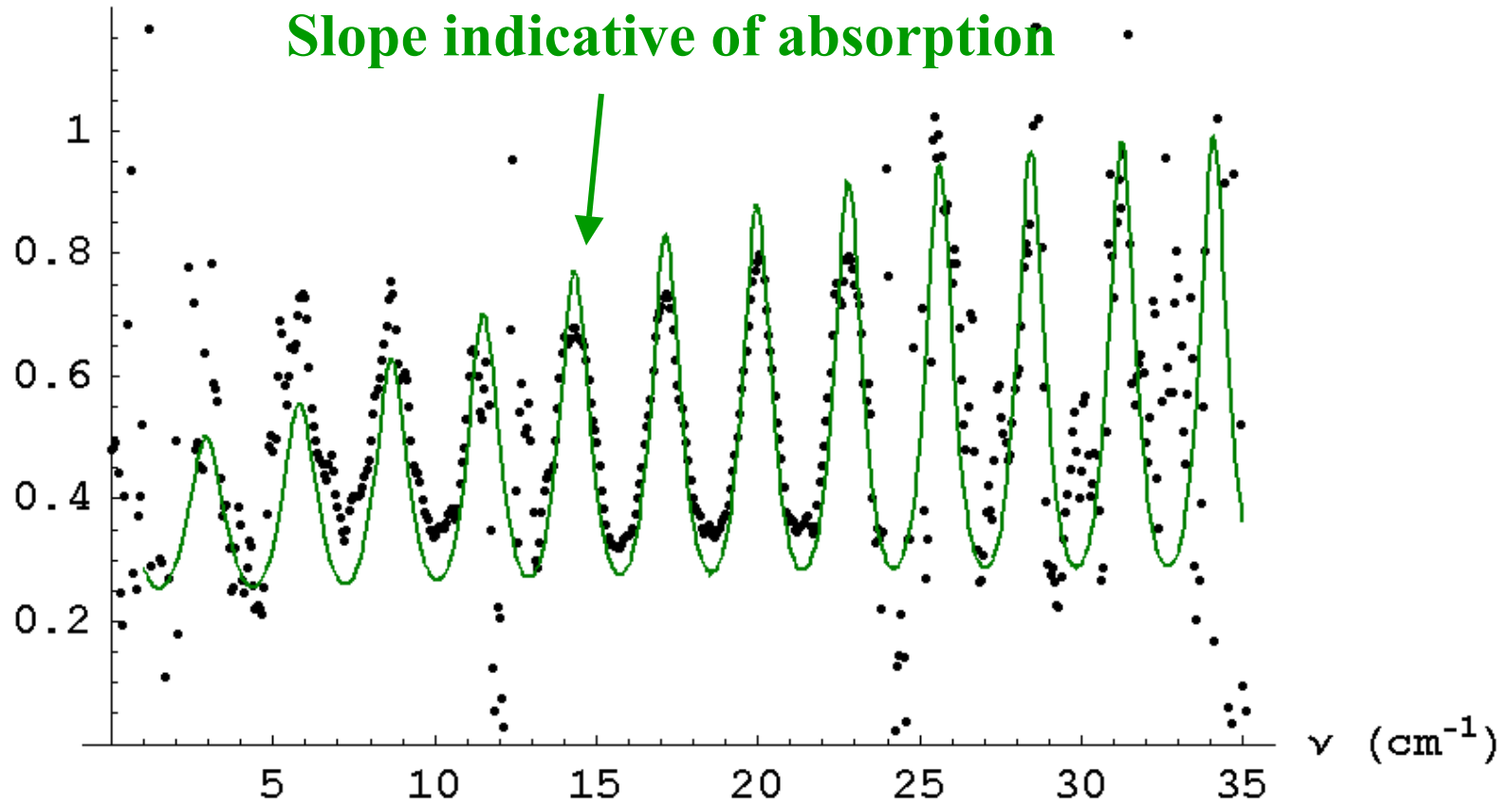


*Figure courtesy of T. Plagge*

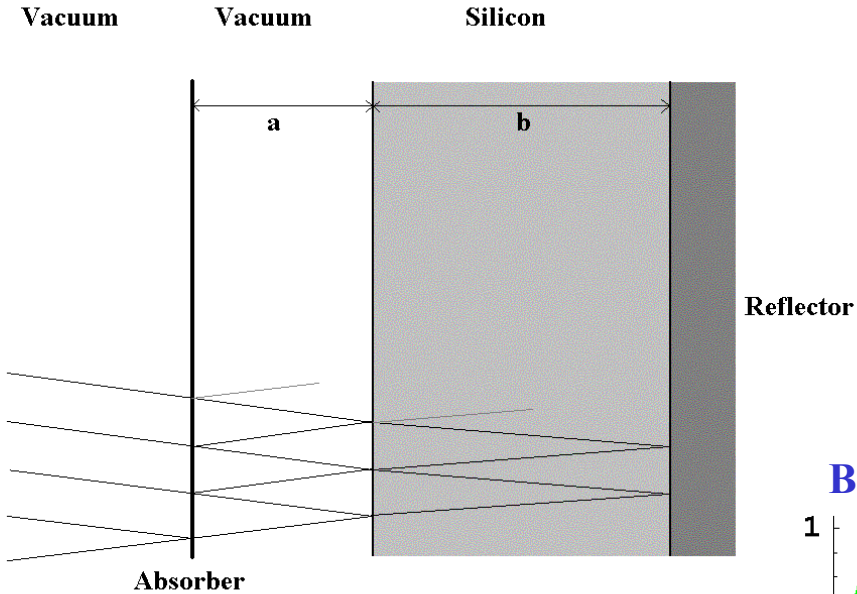
# Bolometer Tests: Au Abs

Data taken in FTS

Transmittance

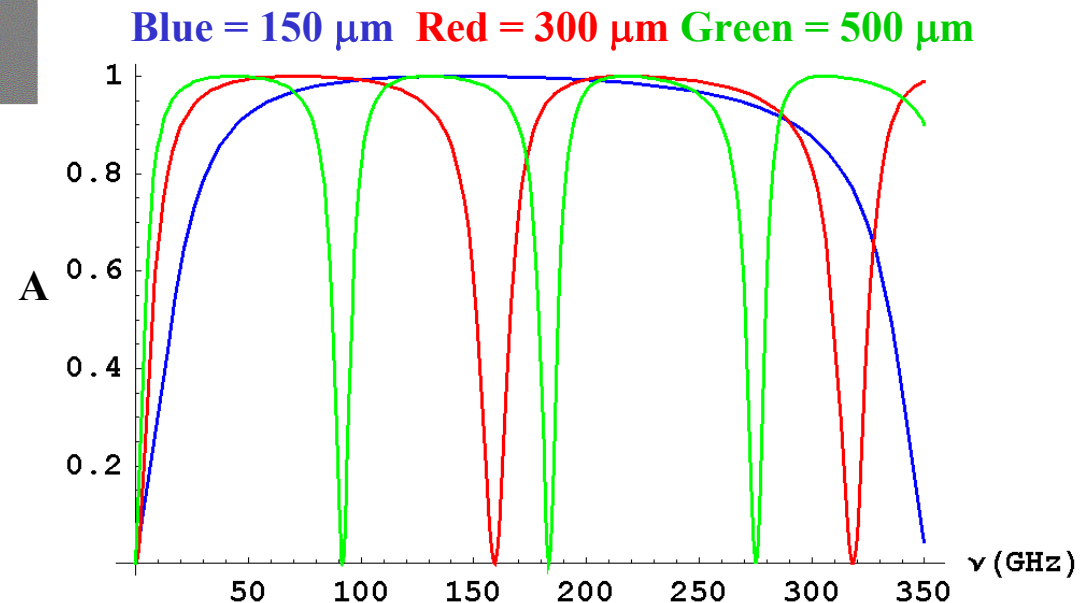


# Backshort Design



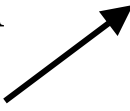
**150  $\mu\text{m}$  wafer thickness  
best for bands around  
150 GHz and 217 GHz**

- **$a = 30 \mu\text{m}$**
- **$n_{\text{Si}} = 3.46$**
- **$R_{\square} = 377 \Omega$**



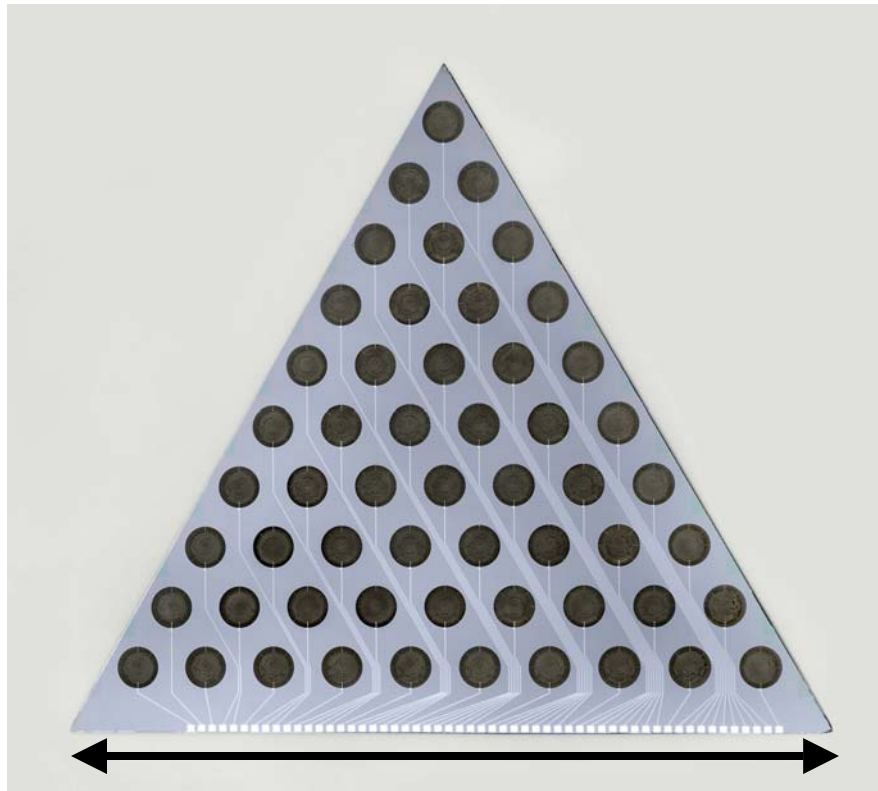
# Prototype Array Fab

**Differences from  
single pixel:**

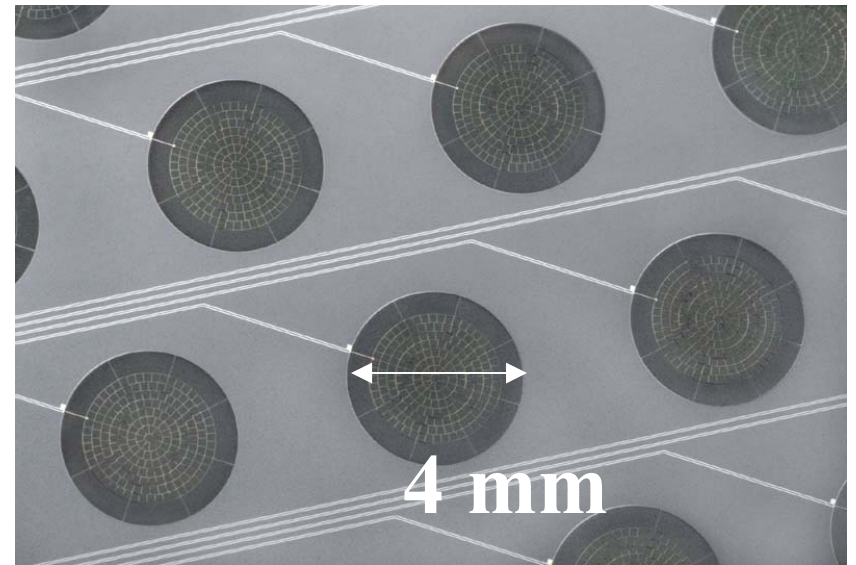
- **Process on thin  
(150  $\mu\text{m}$ ) wafer for  
backshort**
- **Contact print Al  
leads in ksaligner** 



# Prototype Array 55 Sensors

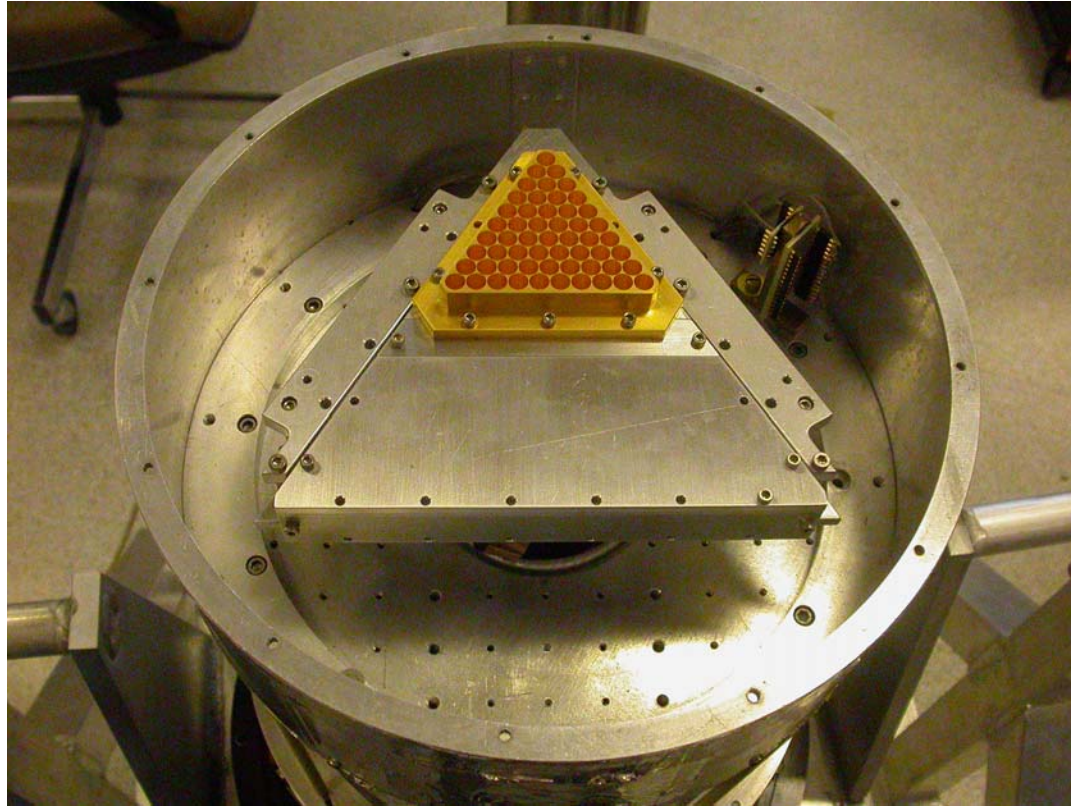


**73.45 mm**



**4 mm**

# Prototype Array Tests



**Test dewar (still!) under construction**