LET Solid-State Detectors

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LET Detector Responsibilities

- **JPL**

Mark Wiedenbeck	overall management
Beverley Eyre	silicon thinning
Robert Radocinski	software support
Jon DePew	hardware support

- **Caltech**

Allan Labrador	detector testing
Sven Geier	detector testing

- **GSFC**

Tycho von Rosenvinge	oversight
Sandy Shuman	mount design
Bert Nahori	detector testing

- **Micron Semiconductor** detector fabrication

LET Detector Designs

- Detector technology: Ion-implanted silicon
- 3 detector designs used in LET

Designation	Sensitive Thickness	Active Area	Elements	Number of Devices (one S/C)
L1	20 μm	2.0 cm^2	3	10
L2	50 μm	13.6 cm^2	10	2
L3	1000 μm	19.7 cm^2	2	2

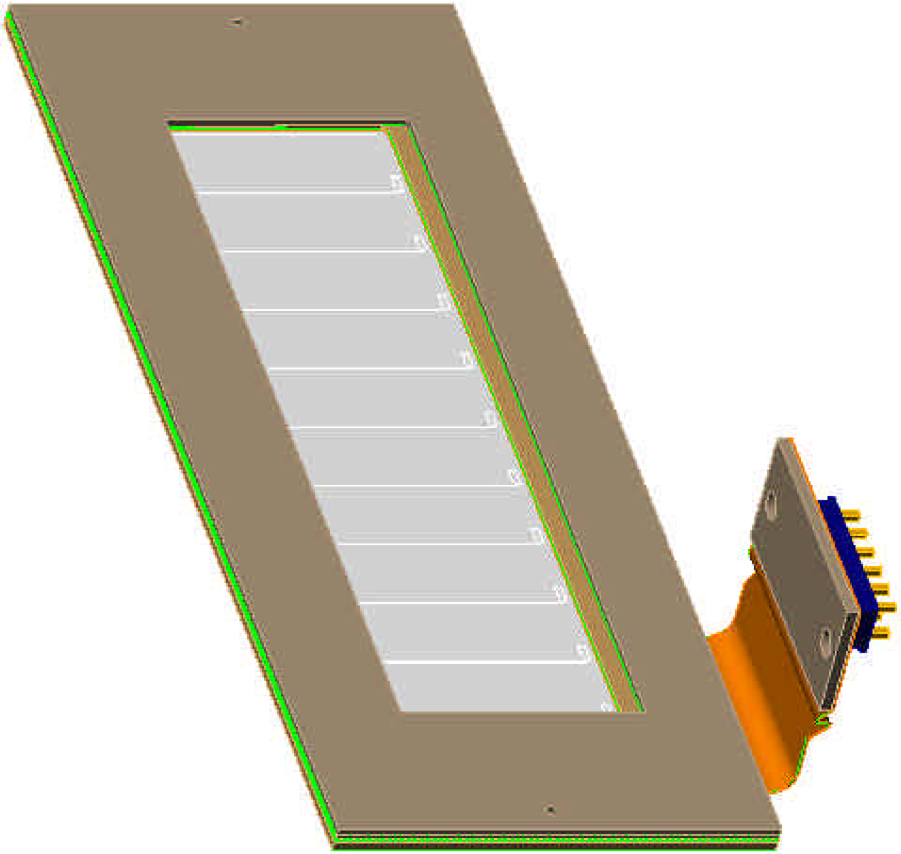
- L2 and L3 are conventional designs and are routine to fabricate
- L1 is a new development (discussed below)

L2 and L3 Detector Specifications

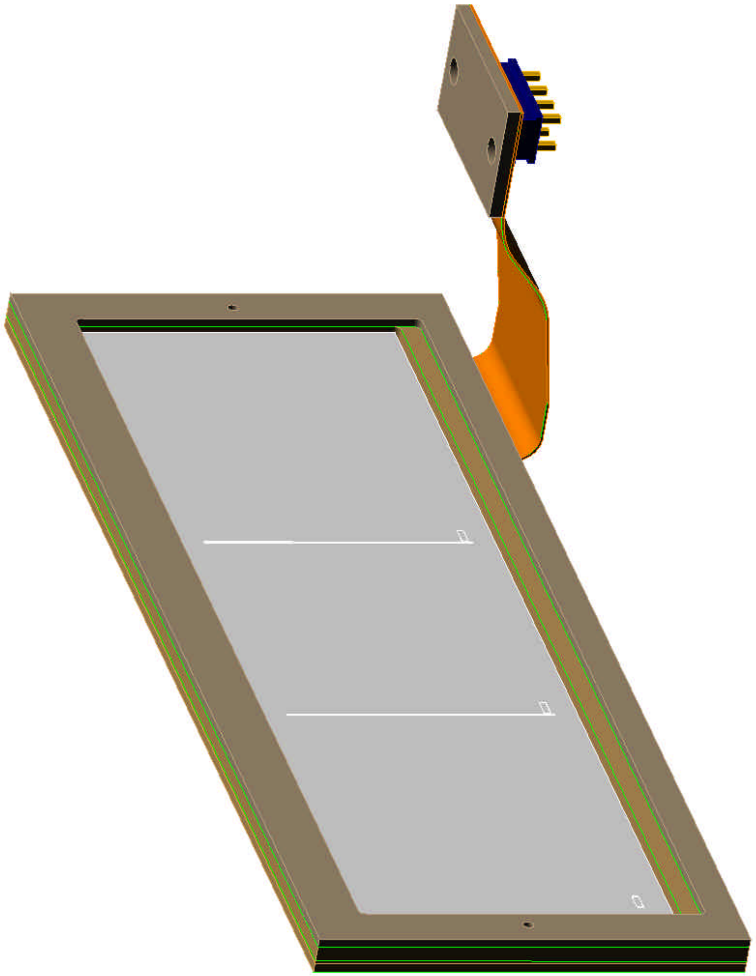
1	Detector Identification	L2	L3
2	Shape	Rectangular	Rectangular
3	Active Area Dimensions (cm)	6.4×1.6	7.8×2.0
4	Overall Area Dimensions (cm)	6.8×2.0	8.2×2.4
5	Average Thickness (μm)	50 ± 5	1000 ± 50
6	Max. Thickness Nonuniformity (μm)	5	25
7	Offcut Min. Dimensions (cm) *	2 each @ 6.4×0.3 2 each @ 1.6×0.3	2 each @ 7.8×0.3 2 each @ 2.0×0.3
8	Active Junction-Surface Contacts	10	3
9	Geometry of Junction-Surface Contacts †	linear array of 10 contacts, each 0.64 cm $\times$ 1.6 cm	linear array of 3 contacts, center contact 2.4 cm long and outer contacts each 2.7 cm long
10	Contact Spacing (μm)	20 ± 5	40 ± 10
11	Junction Surface Connections	wire bonds	wire bonds
12	Ohmic Surface Connections	wire bonds	wire bonds
13	Max. Depletion Voltage (Volts)	20	200
14	Min. Breakdown Voltage (Volts)	50	250
15	Max. Leakage Current (μA)	0.5	2.
16	Max. Alpha Resolution (keV FWHM)	100	100

Notes:
* The number and size of offcuts are to be treated as goals.
† In the multi-contact designs, contact dimensions given include the metallization area plus half the gaps between adjacent contacts.

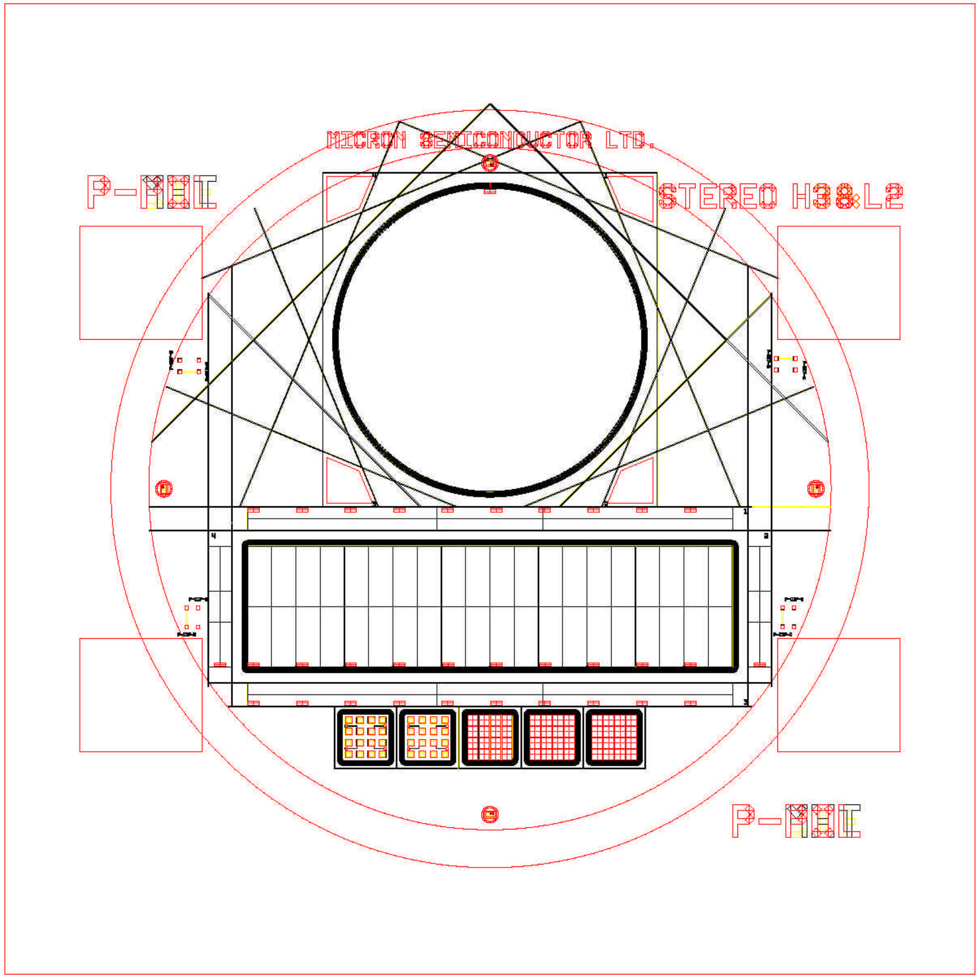
L2 Detector Assembly



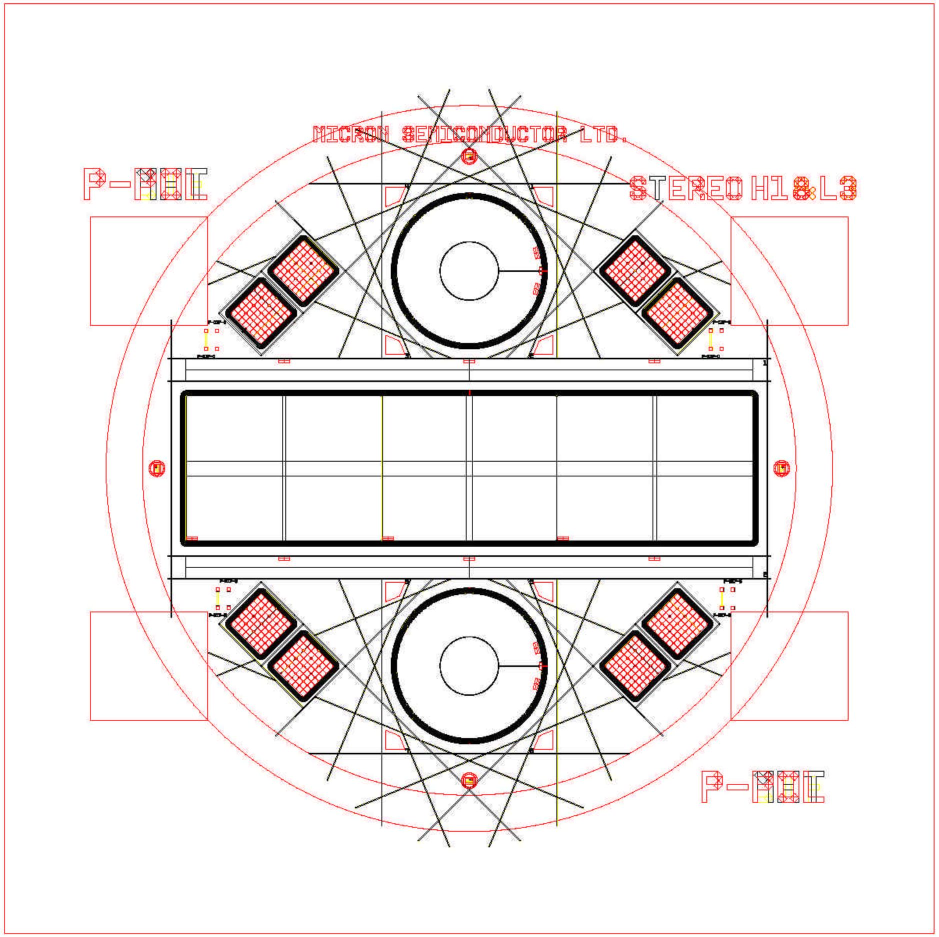
L3 Detector Assembly



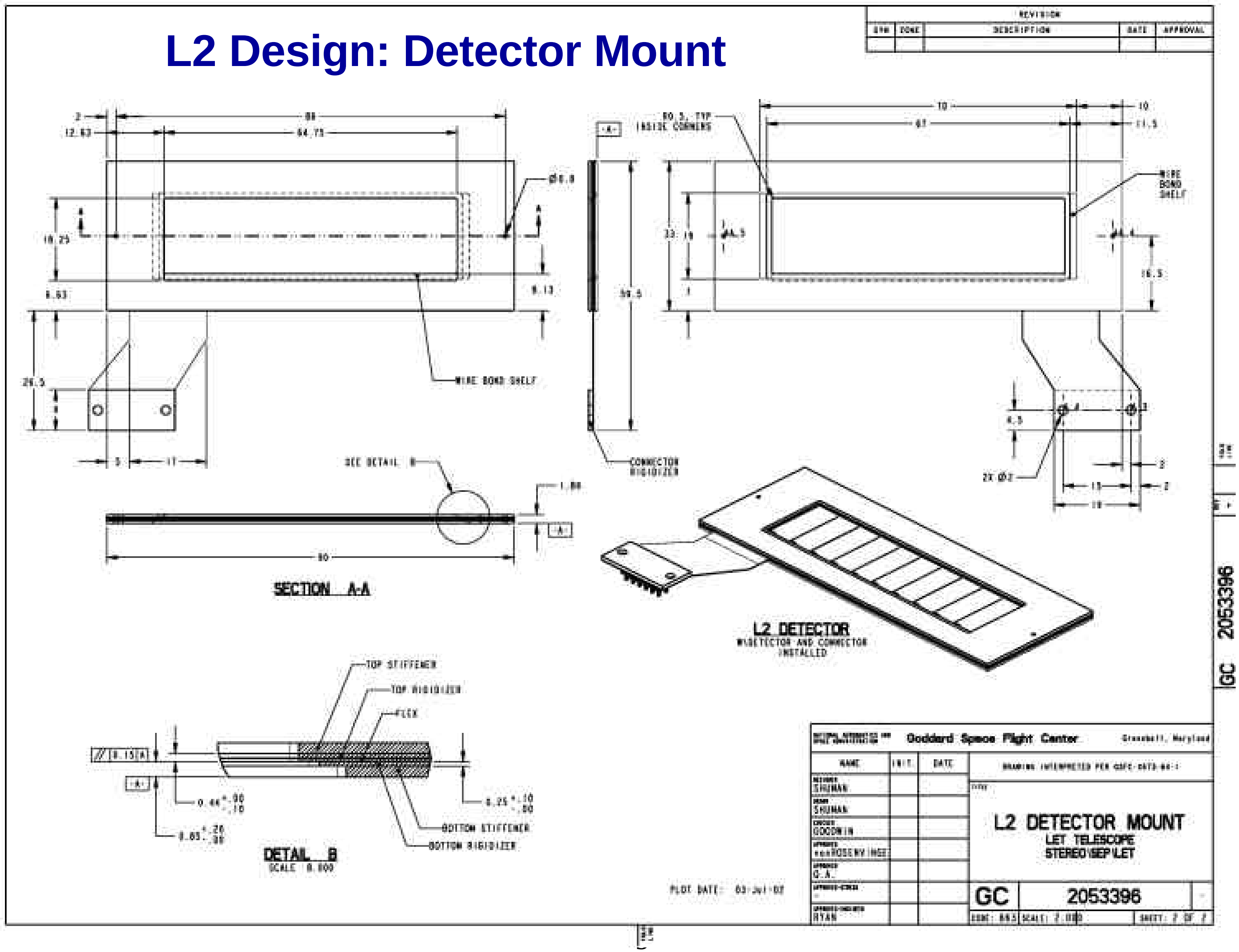
L2 Design: Photolithography (combined with H3)



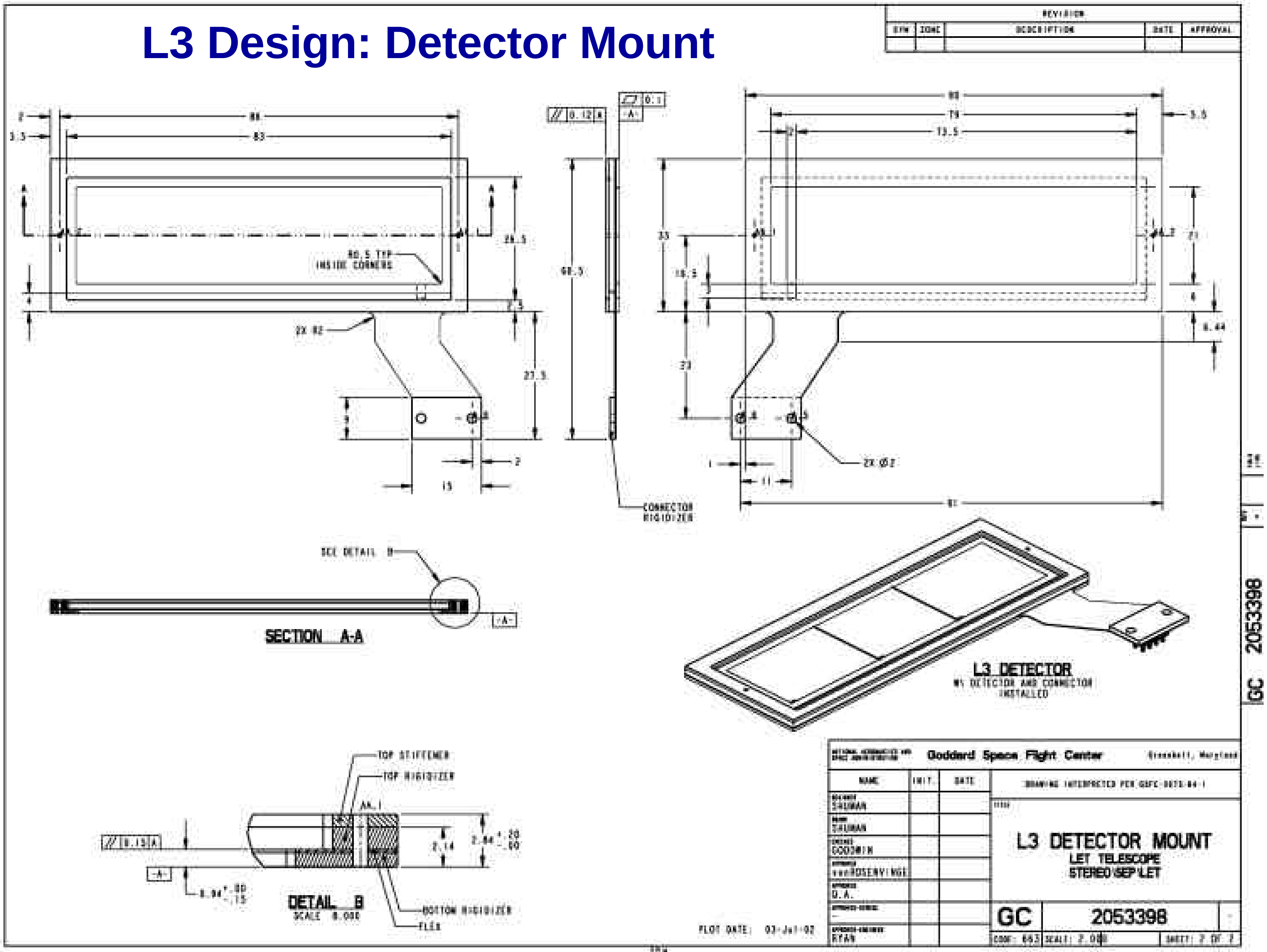
L3 Design: Photolithography (combined with H1)



L2 Design: Detector Mount



L3 Design: Detector Mount



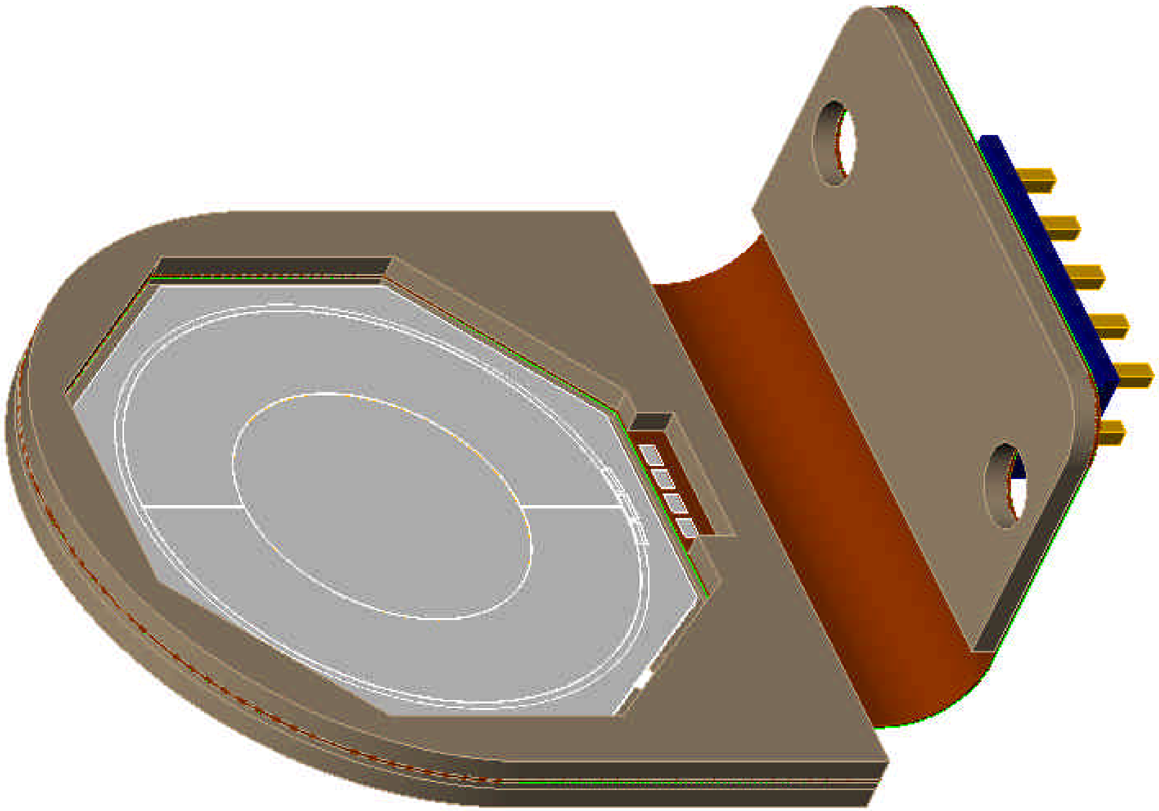
L2 & L3 Prototype Development Status (6 Nov 2002)

- **All mask sets fabricated**
- **Wafers with prototype detectors fabricated and probe tested**
- **Mounts being fabricated and inspected**
- **Detectors being cut out and mounted in preparation for testing by Micron**
- **Delivery expected November/December 2002**

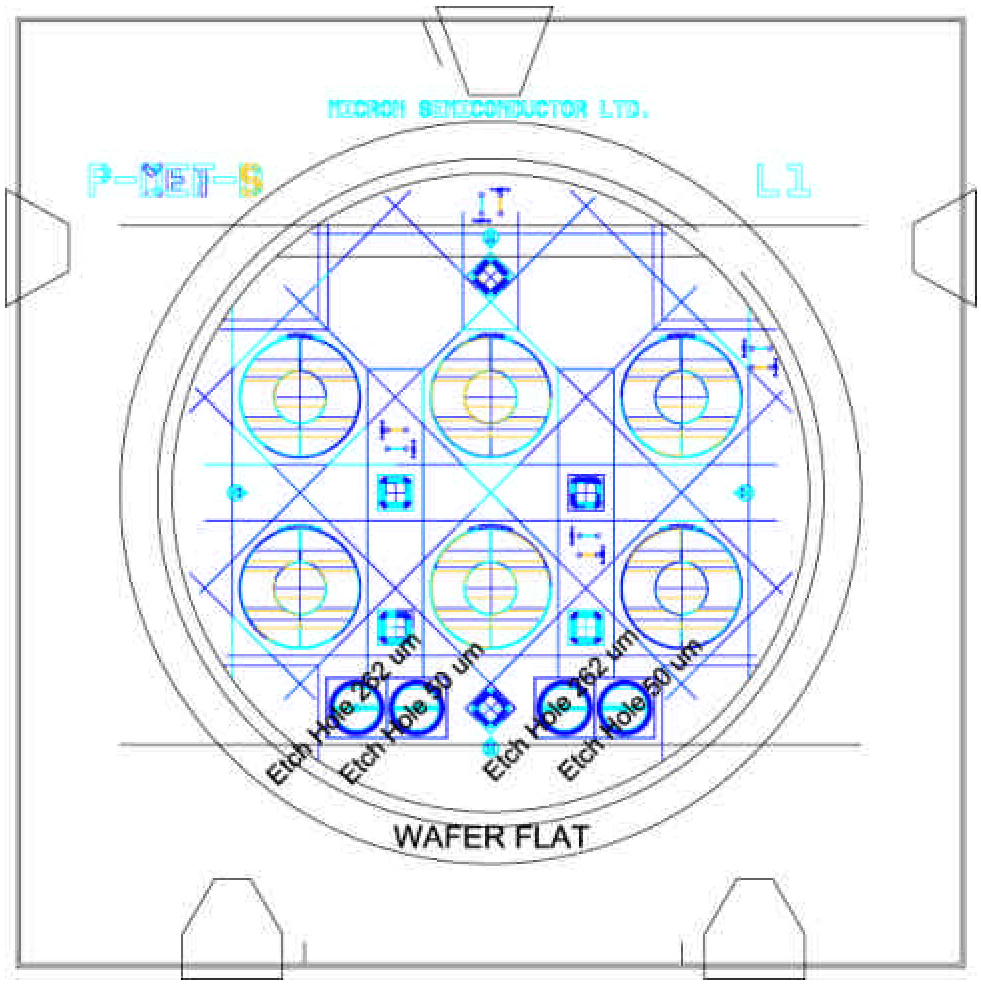
LET L1 Detectors - Key Requirements

- **Very thin to allow low energy threshold for instrument**
- **Thickness uniformity sufficient for measuring He isotopes**
- **Segmented readout to accommodate high rate and reduce noise**

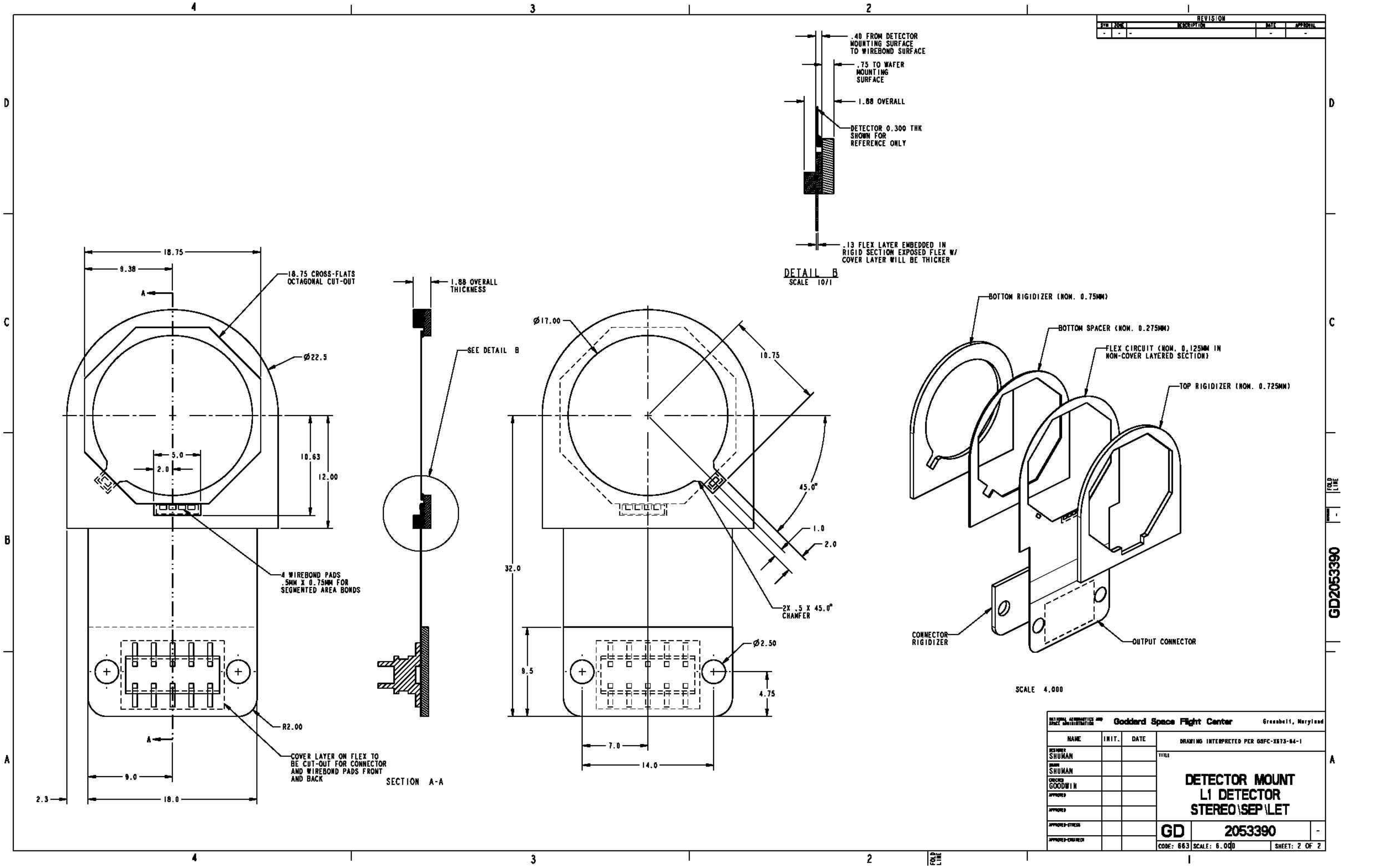
L1 Detector Assembly



L1 Design: Photolithography



L1 Design: Detector Mount



LET L1 Detectors: Possible Fabrication Approaches

Designation	Detector Thickness	Initial Wafer Thick-ness	Thinning Approach	Primary Advantages	Primary Disadvantages
Plan A	20 mm	140-300 mm	etch active areas in KOH	relatively rugged, best uniformity	unproven approach, more handling during fab
Plan B	20 mm	20 mm	lap & polish full wafer	similar to Micron conventional fab	fragile - uncertain yield, marginal uniformity
Plan A'	20 mm	140-300 mm	etch active areas in TMAH	relatively rugged, approach has been used, can all be done by Micron	marginal uniformity
Plan B’	30 mm	30 mm	lap & polish full wafer	proven technology, better resolution	higher instrument threshold

LET L1 Detectors: Prototyping Status

Details of R&D work in Document "Thin Silicon R&D Summary" (STEREO-CIT-014.A)

All Plans

- mounts fabricated and delivered to Micron

Plan A

- masks have been fabricated
- front-side patterning of wafers has been done
- etch tests of unprocessed wafers successfully completed
- etching of front-side-patterned wafers in progress
- problems of etch attacking front-side pattern being addressed

Plan B

- masks have been fabricated
- wafers with prototype detectors fabricated and probe tested
- two prototypes delivered – tests are in progress

LET L1 Detectors: Prototyping Status (cont.)

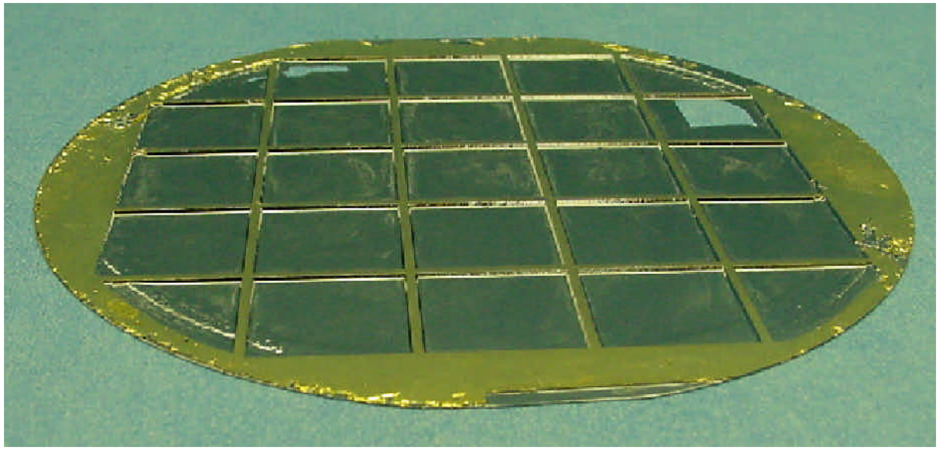
Plan A'

- being tried by Micron with company resources
- thinned wafers with prototype detectors fabricated and probe tested
- six prototypes delivered – too thick, poor uniformity

Plan B'

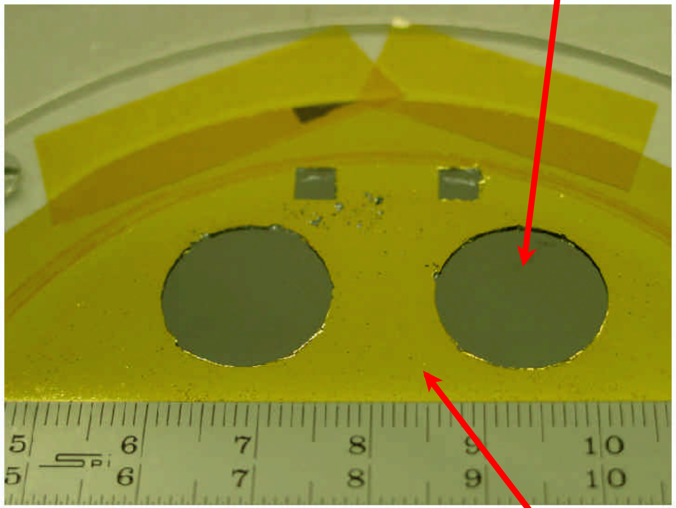
- not presently being pursued
- no additional masking, fixturing, or mounts required
- available as a fall back

Etching of 4" Silicon Wafers: Test Sample (left) & L1 (right)



300 mm wafer thinned to ~16 mm

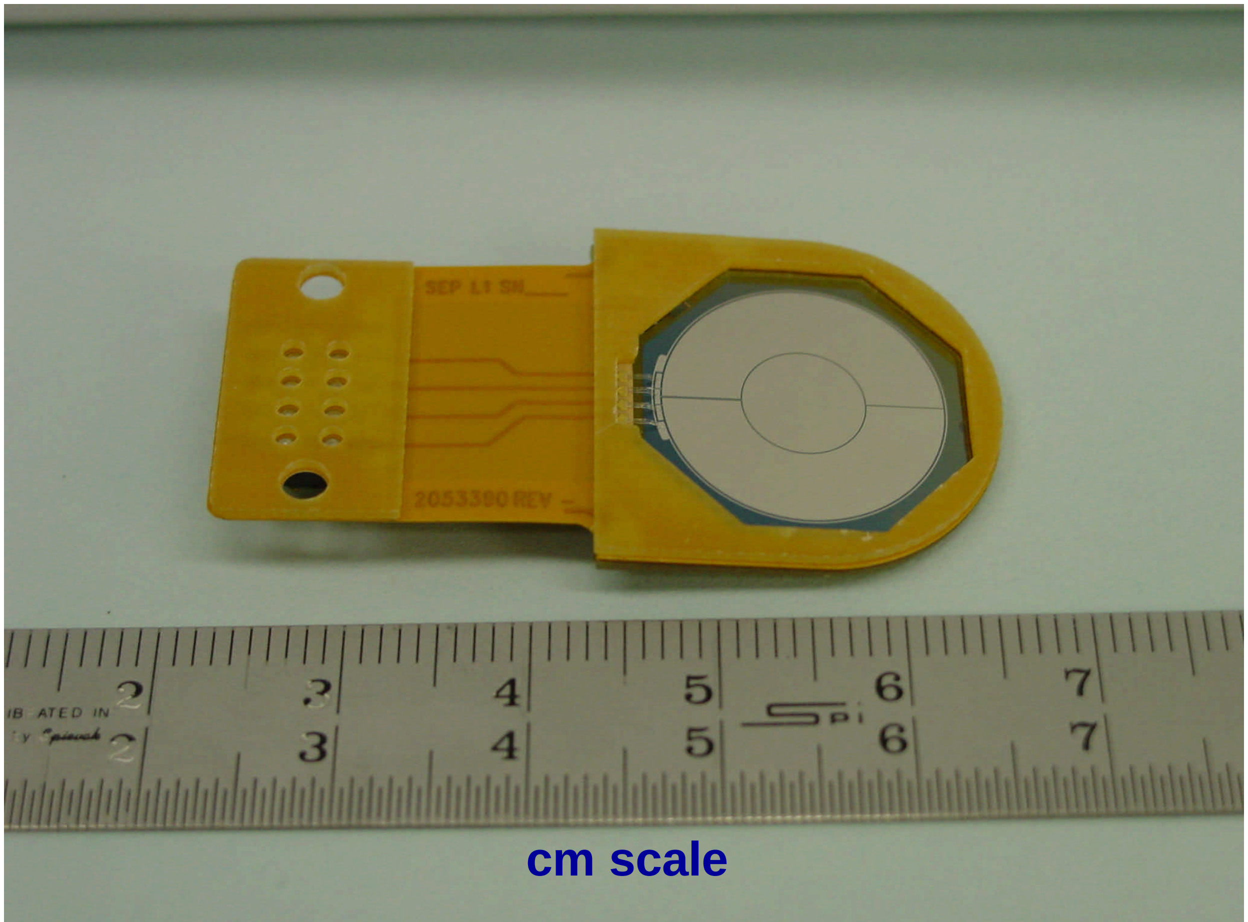
Etched 20 µm membrane
For L1 fab (6 per wafer)



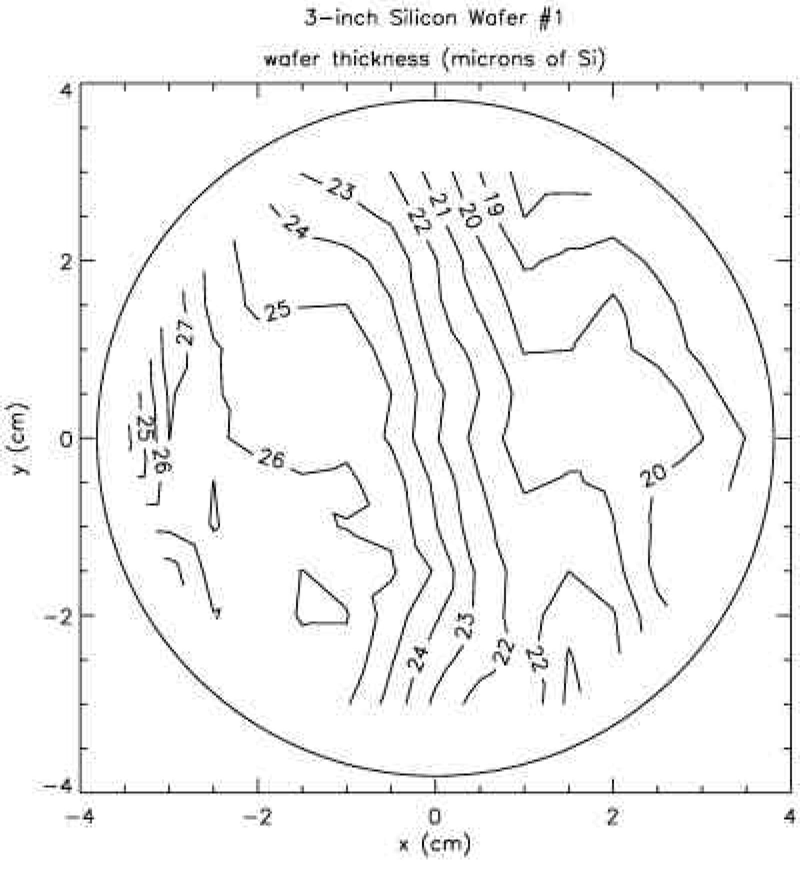
cm scale

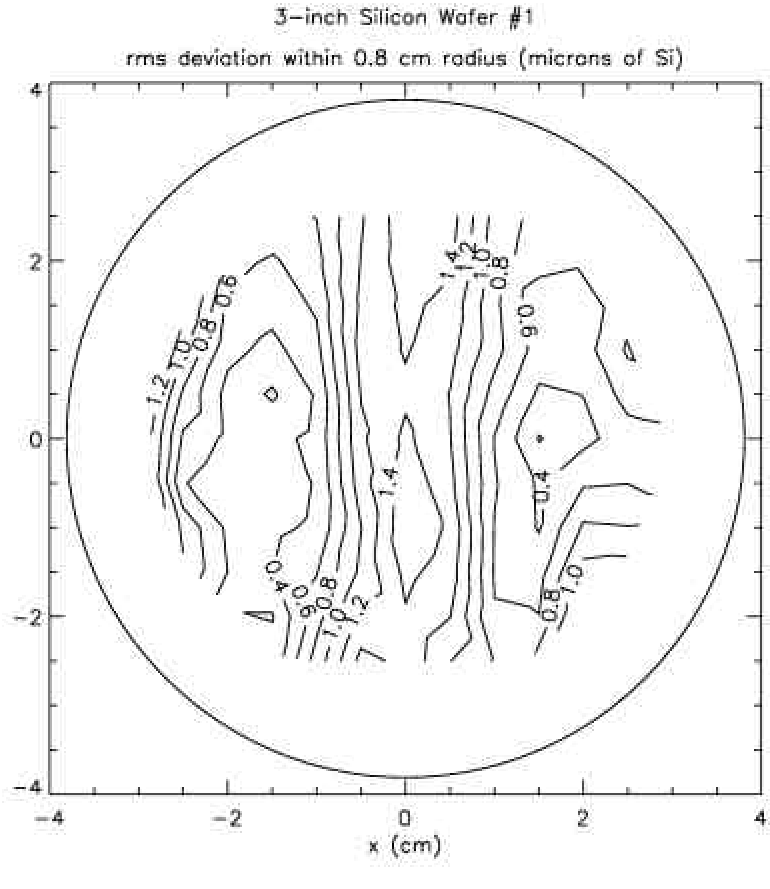
300 µm wafer
Masked w/gold

Prototype L1 Detector: 20 mm x 2 cm^2



Plan B Wafer Thickness Maps





Thickness Distribution of L1 Prototype