Detector Questions and Options

Not including questions discussed earlier in this meeting:

- Dark squids and dark TES counts/plans.
- Wafer dimensions, fab area, bond pad details.
- How many sides to wire to for low-density wafers.

John Ruhl
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Detector "Parameter" Requirements
Major Open Issues

- **Detector stability**
  - "Science TES" : readout bandwidth, taus, tau requirements
  - "High-Tc TEs" : taus via fab choices about C, n, Tc, etc
  - gain and tau stability requirements (eg under changing loading)

- **Crosstalk requirements**
  - impact of crosstalk depends on wiring decisions

Current PBD - 7 wafer types

SATs

Tube name	LF		MF1		MF2		UHF	
Band Centers (GHz)	27	39	85	145	95	155	225	278
Pixels/Wafer	12		147		147		469	
Wafers	24		72		72		48	

HEX
RHOMB

LATs

Tube name	ULF	LF		MF		UHF	
Band Centers (GHz)	20	27	39	93	145	225	278
Pixels/Wafer	27	48		432		432	
Total in LATs	4	25		162		64	

Want to move ~200 wafers from "rhomb" to "hex"

Q1: Should there be only one type of SAT MF wafer, with mixed bands on it?

Pros:

- Only one wafer type.
- Relative (rather than absolute) shifts in bands easier on one wafer. *However, if we're not hitting bands within a couple GHz, we have bigger problems.*

Cons:

- Potential biasing issue, different required P_electricals for 85/95 or 145/155.
- Horn/OMT optimization and AR coatings broader band, and therefore more difficult.

Suggested recommendation:

Cons outweigh pros, keep wafer types separate,

=> no homework.

Q2: Can the SATs adopt LAT frequency bands at 30/40 and 220/270 GHz?

(my previous table assumes this is so.)

Pros:

- easier for fabs to move from one wafer type to the other.

Suggested homework:

- [Bischoff/Buza] Need to validate SAT foreground subtraction… (ie Fisher to r)
- ? (anything else?)

Current PBD - 7 wafer types

48 Hex, 423 Rhomb

SATs

Tube name	LF		MF1		MF2		UHF	
Band Centers (GHz)	27	39	85	145	95	155	225	278
Pixels/Wafer	12		147		147		469	
Wafers	24		72		72		48	

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LATs

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Total in LATs	4	25		162		64	

To balance the number of hex and rhomb wafers, we would need to move ~200 wafers from "rhomb" to "hex"

1. LAT MF is already developed by NIST, so is a poor candidate for change.
2. LAT UHF would make it nearly identical to SAT UHF, could share horns and interface wafers, and benefits from increase in mapping speed. Good candidate for change.
3. SAT wafers have edge taper requirements, so changing horn size is a complicated trade. MF worth checking.
4. LF wafers hex vs. rhomb options have big fractional jumps in N_pixels and horn size, => complicated.

Q3: Can the LAT UHF change to a HEX(469) layout?

(switches 64 wafers from Rhomb to Hex)

=> (Hex: 112, Rhomb: 359)

SATs

Tube name	LF		MF1		MF2		UHF	
Band Centers (GHz)	27	39	85	145	95	155	225	278
Pixels/Wafer	12		147		147		469	
Wafers	24		72		72		48	

HEX

RHOMB

LATs

Tube name	ULF	LF		MF		UHF	
Band Centers (GHz)	20	27	39	93	145	225	278
Pixels/Wafer	27	48		432		432	
Total in LATs	4	25		162		64	

Rhombus layout pixel count possibilities					HCP layout pixel count possibilities					
Number of Rings	Pixels/wafer	Horn diameter (mm)	Horn diameter (mm)	Used in	Pixels on side of hex	Pixels across diameter	Pixels/ wafer	Horn diameter (mm)	Horn diameter (mm)	Used in
Active wafer area diameter		130.00	134.00					130.00	134.00	
2	12	30.20	31.10	SAT 30/40GHz	1	1	1	130.00	134.00	
3	27	20.70	21.10	LAT 20GHz	2	3	7	43.33	44.67	
4	48	15.70	16.10	LAT 30/40GHz	3	5	19	26.00	26.80	
5	75	12.70	13.0		4	7	37	18.57	19.14	
6	108	10.60	10.90		5	9	61	14.44	14.89	
7	147	9.10	9.40	SAT 85/145, 95/155	6	11	91	11.82	12.18	
8	192	8.00	8.20		7	13	127	10.00	10.31	
9	243	7.10	7.30		8	15	169	8.67	8.93	
10	300	6.40	6.60		9	17	217	7.65	7.88	
11	363	5.80	6.0		10	19	271	6.84	7.05	
12	432	5.30	5.50	LAT 90/150, 220/280	11	21	331	6.19	6.38	
13	507	4.95	5.10		12	23	397	5.65	5.83	
14	588	4.60	4.70		13	25	469	5.20	5.36	SAT 220/280

Q3: Can the LAT UHF change to a HEX(469) layout?

Pros:

- Helps equalize HEX-Rhomb workload.
- Same horn array, interface wafers as SAT UHF, if bands are the same (see Q2).

Suggested Homework:

- [JR] Calculate MS impact on LAT UHF. Should improve, ie no performance downside.
- ? (anything else?)

Q4: Can the SAT MF's change to a HEX layout?

(switches 144 wafers from Rhomb to Hex)
=> (Cumulative with LAT UHF: Hex: 256, Rhomb: 215)

SATs

Tube name	LF		MF1		MF2		UHF	
Band Centers (GHz)	27	39	85	145	95	155	225	278
Pixels/Wafer	12		147		147		469	
Wafers	24		72		72		48	

HEX
RHOMB

LATs

Tube name	ULF	LF		MF		UHF	
Band Centers (GHz)	20	27	39	93	145	225	278
Pixels/Wafer	27	48		432		432	
Total in LATs	4	25		162		64	

Rhombus layout pixel count possibilities					HCP layout pixel count possibilities					
Number of Rings	Pixels/wafer	Horn diameter (mm)	Horn diameter (mm)	Used in	Pixels on side of hex	Pixels across diameter	Pixels/ wafer	Horn diameter (mm)	Horn diameter (mm)	Used in
Active wafer area diameter		130.00	134.00					130.00	134.00	
2	12	30.20	31.10	SAT 30/40GHz	1	1	1	130.00	134.00	
3	27	20.70	21.10	LAT 20GHz	2	3	7	43.33	44.67	
4	48	15.70	16.10	LAT 30/40GHz	3	5	19	26.00	26.80	
5	75	12.70	13.0		4	7	37	18.57	19.14	
6	108	10.60	10.90		5	9	61	14.44	14.89	
7	147	9.10	9.40	SAT 85/145, 95/155	6	11	91	11.82	12.18	
8	192	8.00	8.20		7	13	127	10.00	10.31	
9	243	7.10	7.30		8	15	169	8.67	8.93	
10	300	6.40	6.60		9	17	217	7.65	7.88	
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12	432	5.30	5.50	LAT 90/150, 220/280	11	21	331	6.19	6.38	
13	507	4.95	5.10		12	23	397	5.65	5.83	
14	588	4.60	4.70		13	25	469	5.20	5.36	SAT 220/280

Q4: Can the SAT MF's change to a HEX layout?

Issues

- Change in pixel count => change in sensitivity, mapping speed.
  - mapping speed approximately proportional to pixel count.
    - Fewer, larger horns: 127/147 = 0.86
    - More, smaller horns: 169/147 = 1.15
  - Homework: [JR] check bolo-calc estimates of NET to verify this.

- Change in horn diameter
  - smaller horn diameter => more illumination of stop => more diffraction, potentially more sidelobes. [8.9mm/9.4mm = 0.95]
  - Homework: See next page.

		30	40	85	145	95	155	220	270
	Totals	LF		MF1		MF2		UHF	
Horn diameter (mm)		31.1		9.4		9.4		5.2	
Edge taper at cold stop (dB)		-9.3	<-15	-6.2	<-15	-8.4	<-15	-13.4	<-15

Q4: Can the SAT MF's change to a HEX layout?

Homework

1. **[AA?] Take a careful look at pixel pitch and horn diameter for the possible Rhomb and Hex layouts.**
   a. Include effect of horn array diameter possibly exceeding useful-wafer-hex size, ie "horn overhang", made possible by active pixel area being smaller than pixel pitch.
2. **[?] Decide on SAT horn optimization metrics.**
   a. ellipticity, aperture efficiency, edge taper. Need to know how to weight tradeoffs, whether there are hard bounds.
   b. note: we don't have specs written down for these specific things.
3. **[SS] Given horn diameter and optimization metrics, find "best horn" and report results.**
   a. Each run (cchorn + hfss + analysis) takes ~weeks, so we need a good initial set of optimization metrics, can't iterate many times.
4. **[JK?] Work on how to decide what edge taper is tolerable.**

Q5: Can the LAT and SAT LF's change to a HEX layout?

Rhombus layout pixel count possibilities				
Number of Rings	Pixels/wafer	Horn diameter (mm)	Horn diameter (mm)	Used in
Active wafer area diameter		130.00	134.00	
2	12	30.20	31.10	SAT 30/40GHz
3	27	20.70	21.10	LAT 20GHz
4	48	15.70	16.10	LAT 30/40GHz
5	75	12.70	13.0	
6	108	10.60	10.90	
7	147	9.10	9.40	SAT 85/145, 95/155
8	192	8.00	8.20	
9	243	7.10	7.30	
10	300	6.40	6.60	
11	363	5.80	6.0	
12	432	5.30	5.50	LAT 90/150, 220/280
13	507	4.95	5.10	
14	588	4.60	4.70	

HCP layout pixel count possibilities					
Pixels on side of hex	Pixels across diameter	Pixels/wafer	Horn diameter (mm)	Horn diameter (mm)	Used in
			130.00	134.00	
1	1	1	130.00	134.00	
2	3	7	43.33	44.67	
3	5	19	26.00	26.80	
4	7	37	18.57	19.14	
5	9	61	14.44	14.89	
6	11	91	11.82	12.18	
7	13	127	10.00	10.31	
8	15	169	8.67	8.93	
9	17	217	7.65	7.88	
10	19	271	6.84	7.05	
11	21	331	6.19	6.38	
12	23	397	5.65	5.83	
13	25	469	5.20	5.36	SAT 220/280

Q5: Can the LAT and SAT LF's change to a HEX layout?

Issues

- Fractional changes in pixel count between options are large. "More smaller horns" is the only options that makes sense.
  - SAT LF has same mapping-speed/edge-taper tradeoff issues as SAT MF, but starts from a better edge-taper.
    - 26.8mm/31.1mm = 0.86 (same ratio as MF)
    - 19/12 = 1.58 (big increase in horn count)
  - LAT LF may have some improvement in mapping speed due to already-high spillover (unlike SATs).
    - 14.44mm/15.70mm = 0.92
    - 61/48 = 1.27 **[Homework: JR bolo-calc MS change]**

Suggestion: Don't consider SAT-LF until SAT-MF exercise is done, as it will be gated by our ability to push horn calculations.