ECAL Thermal status

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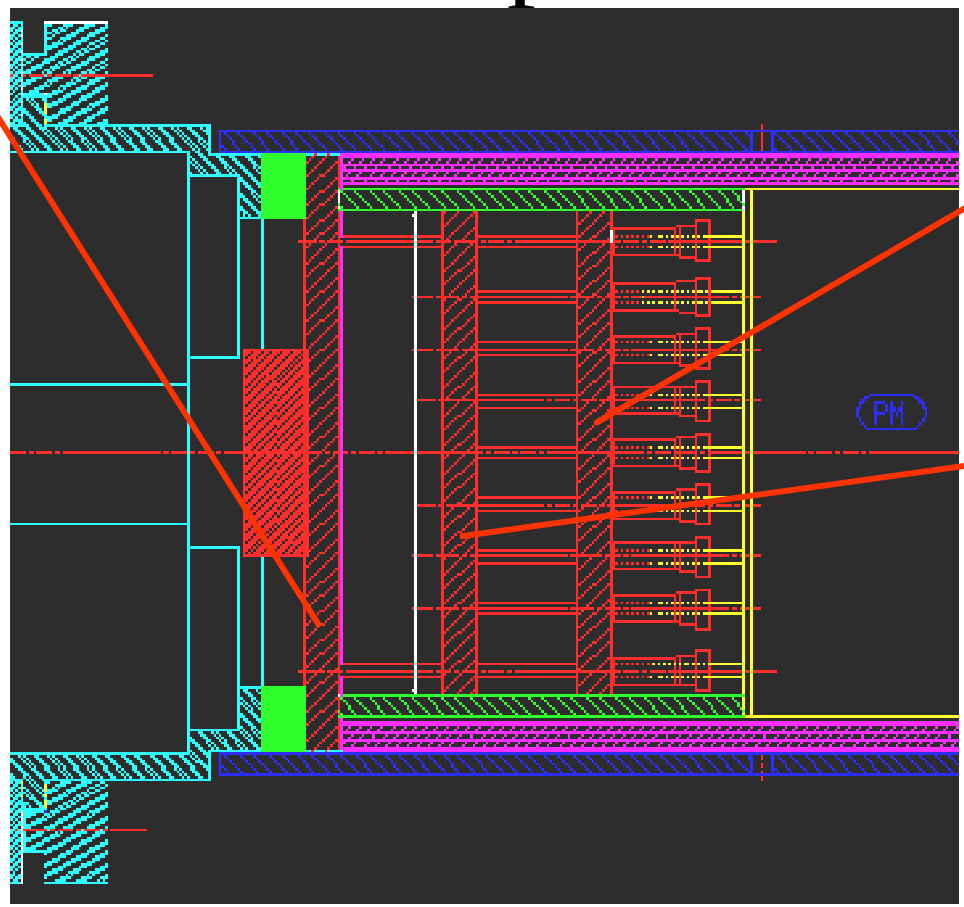
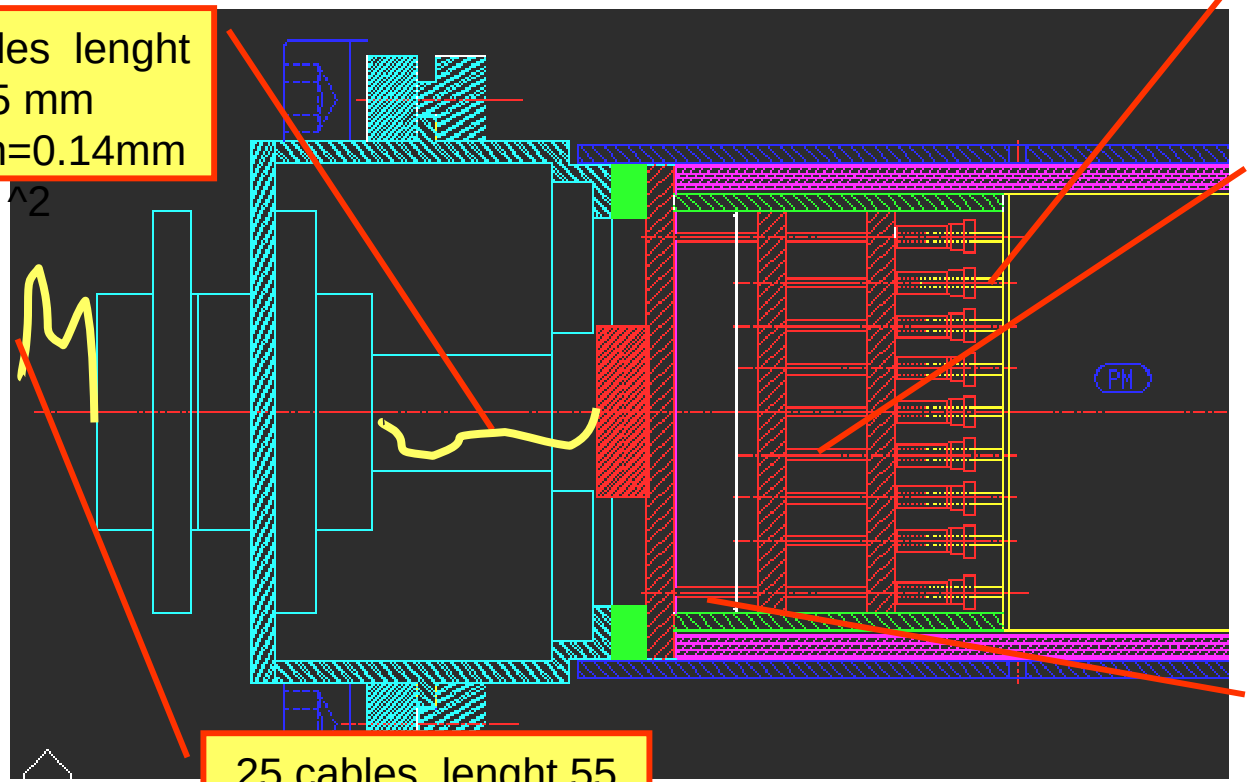
Model improvements

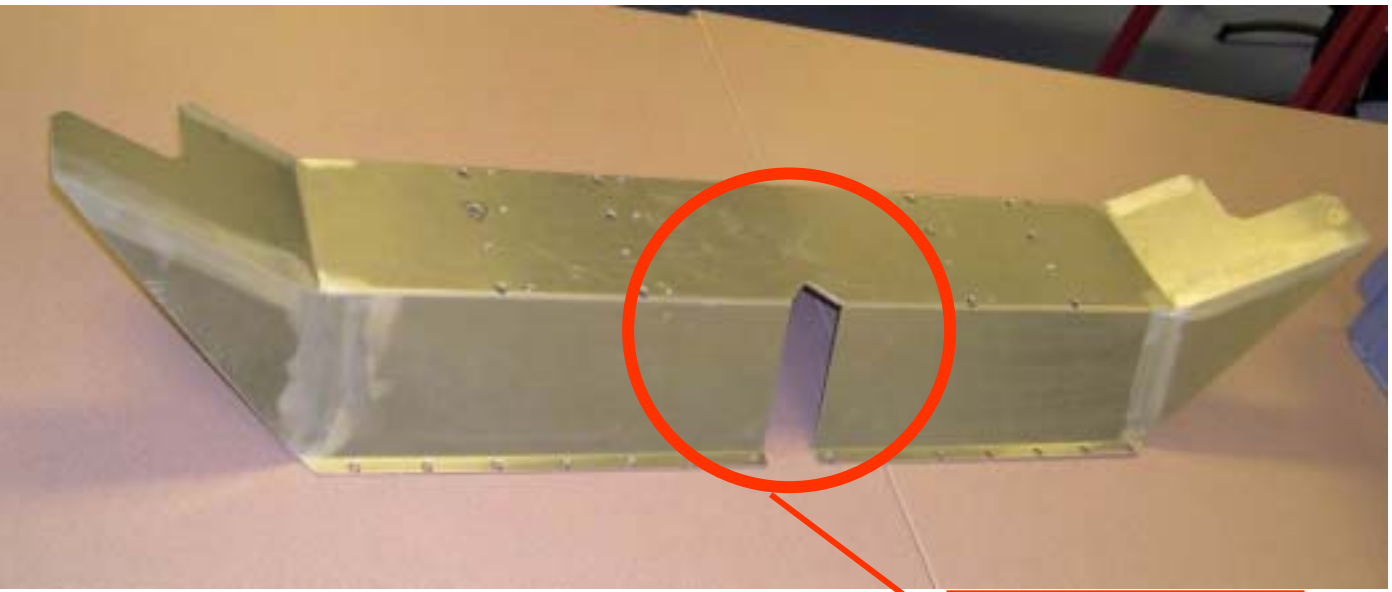
Power dissipation (defined by LAPP, meeting on 05-06 February 2004)



Pins and cables dimensions (defined by LAPP)



Radiator



This hole will be eliminated in the flight model (LAPP)

- External coating is “Silvered Teflon adhesive tape” ; **CGS will define required surface treatment for optimal tape adhesion.**
- Internal coating: **CGS will define required coating.**

LAPP Meeting actions

- Preliminary calculations highlight that the critical conductive path is between END CAP and BACK PANEL; a conductive paste (silicone) will improve heat path towards radiators. **LAPP will ask Lockheed Martin for material suggestion and approval**.
  - **STATUS: CLOSED by LAPP, approved**

- Taking into account this action, preliminary calculations highlight that in worst hot condition, PMT temperature will be about 50-55°C. Mathematical model update and new simulation to validate these data will be performed and results circulated. Final result of this activity will be a “Thermal Analysis Report” issued by CGS
  - **STATUS: ongoing, preliminary results in this presentation**

Thermal analysis

REQUIREMENTS

- PMT requirements (INFN Pisa):
  - **Operational: -20 +40 °C** (for physics/mechanical reasons)
  - Non Op: -40 +40 °C
- Hamamatsu range:
  - Op/non Op: **-30** +50 °C (to avoid breaking)
- From LAPP: no particular requirements for thermal expansion coeff, T ~ 50°C is ok
- From physics: -0.3 % /°C gain loss:
  - @50°C gain is 10% lower than @20°C UNACCEPTABLE

Operational time

- To prevent overheating, during a maximum period of 5% of the mission time it is allowed to switch off the detector

Cases Selection

- Reduced model → 196 cases analyzed (beta angle, attitude)
  - Worst cases determination
- Complete model of AMS→ detailed analysis on the 10 worst cases
  - I/F data generation
- Detailed ECal Model
  - Temperature results

Analysis results

Extreme hot case: beta –75, YPR=-15,+15,0.

- Maximum Solar constant
- Maximum Albedo
- Maximum Earth temperature
- Minumum altitude
- Degraded optical properties
- Worst attitude
- Always in Sun, with worst orientation

•Power on, maximum dissipation (125+25 mW per PMT)

Analysis results

STARBOARD

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	56	56	56	56	57	57	57	57	57	57	57	57	56	56	56	56	56	56
2	57	57	57	57	58	58	58	58	58	58	58	58	57	57	57	57	57	56
3	57	57	57	57	58	58	58	58	58	58	58	58	57	58	57	57	57	56
4	56	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	56
5	55	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	55	55

	2	3	4	5
1	53	54	54	53
2	53	54	54	53
3	53	54	54	53
4	53	54	54	53
5	53	54	54	53
6	53	54	53	53
7	52	53	53	53
8	52	53	53	53
9	52	53	53	53
10	52	53	53	52
11	52	53	53	52
12	52	53	53	52
13	52	53	53	52
14	52	53	52	52
15	51	52	52	52
16	51	52	52	52
17	51	52	52	51
18	50	51	51	51

	1	2	3	4
1	50	50	50	50
2	50	50	50	49
3	49	50	50	49
4	49	50	50	49
5	49	50	50	49
6	49	49	49	49
7	49	49	49	48
8	49	49	49	48
9	49	49	49	48
10	48	49	49	48
11	48	49	49	48
12	48	49	49	48
13	48	48	48	48
14	48	48	48	48
15	48	48	48	47
16	48	48	48	47
17	47	48	48	47
18	47	47	47	47

56.8

52.6

48.6

48.2

WAKE

RAM

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	48	48	48	48	48	48	48	48	48	48	48	47	47	47	47	47	47	46
2	49	49	49	49	49	49	49	49	49	49	49	49	48	48	48	48	48	47
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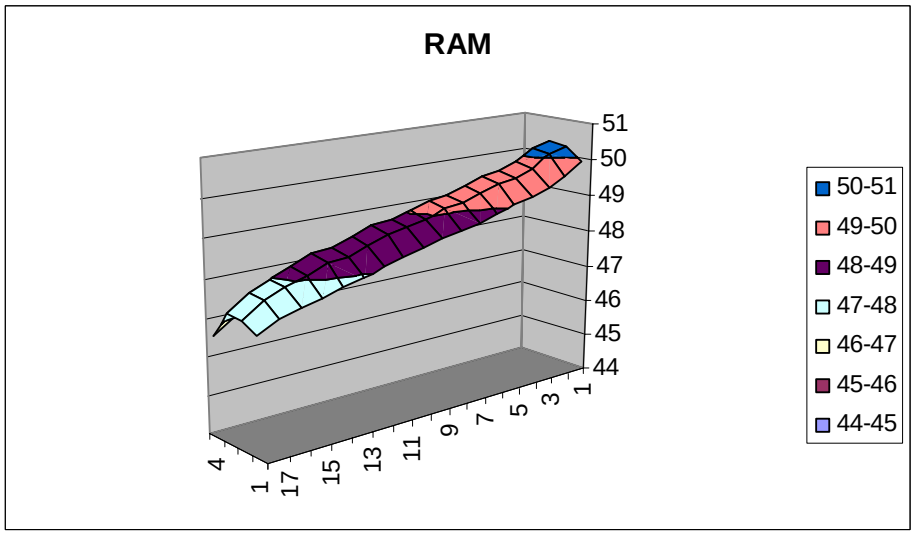
5	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	47	47	47

PORT

PMTs Temperatures.

Worst case


RAM
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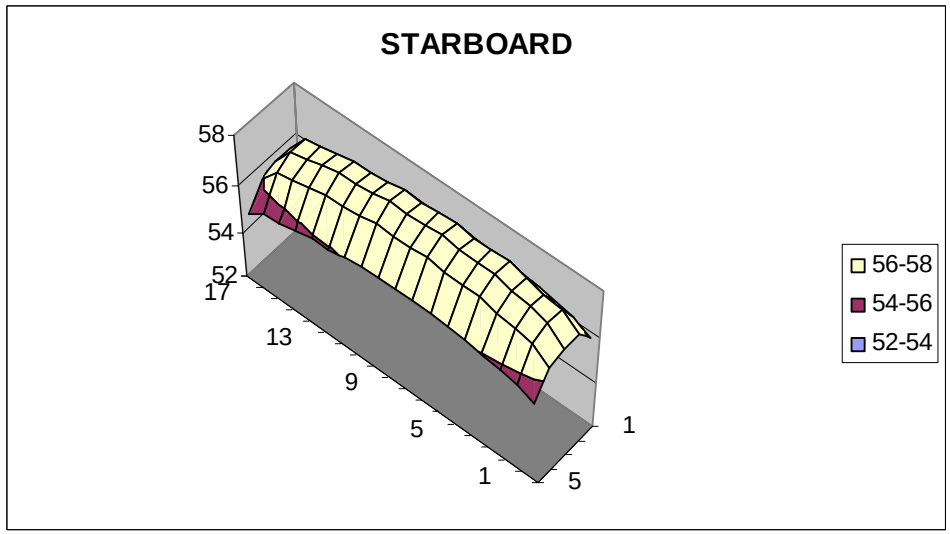
49-50
48-49
47-48
46-47
45-46
44-45


STARBOARD
58
56
54
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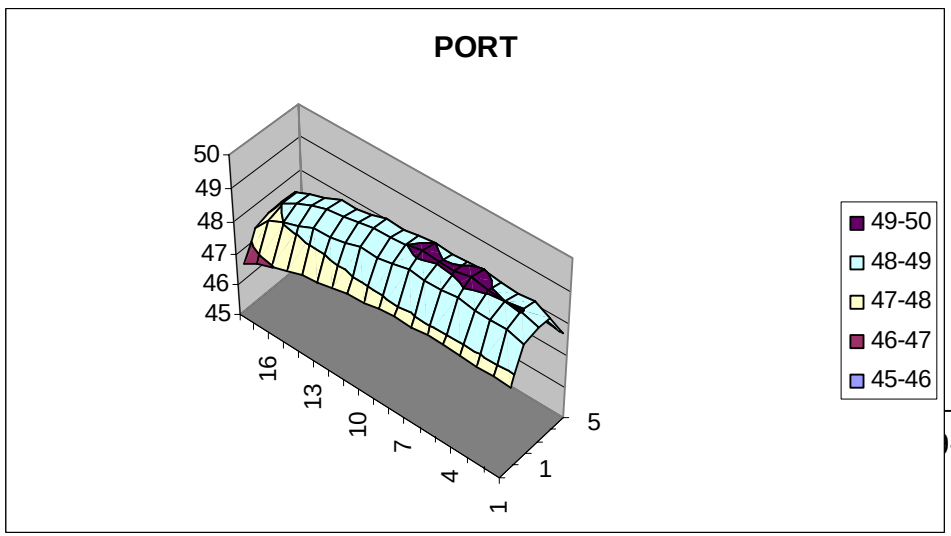
56-58
54-56
52-54


PORT
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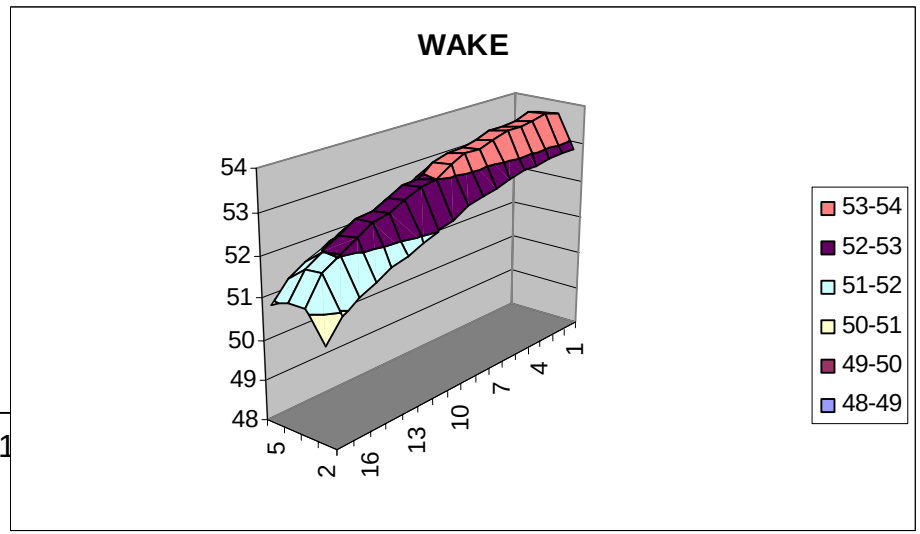
WAKE
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4
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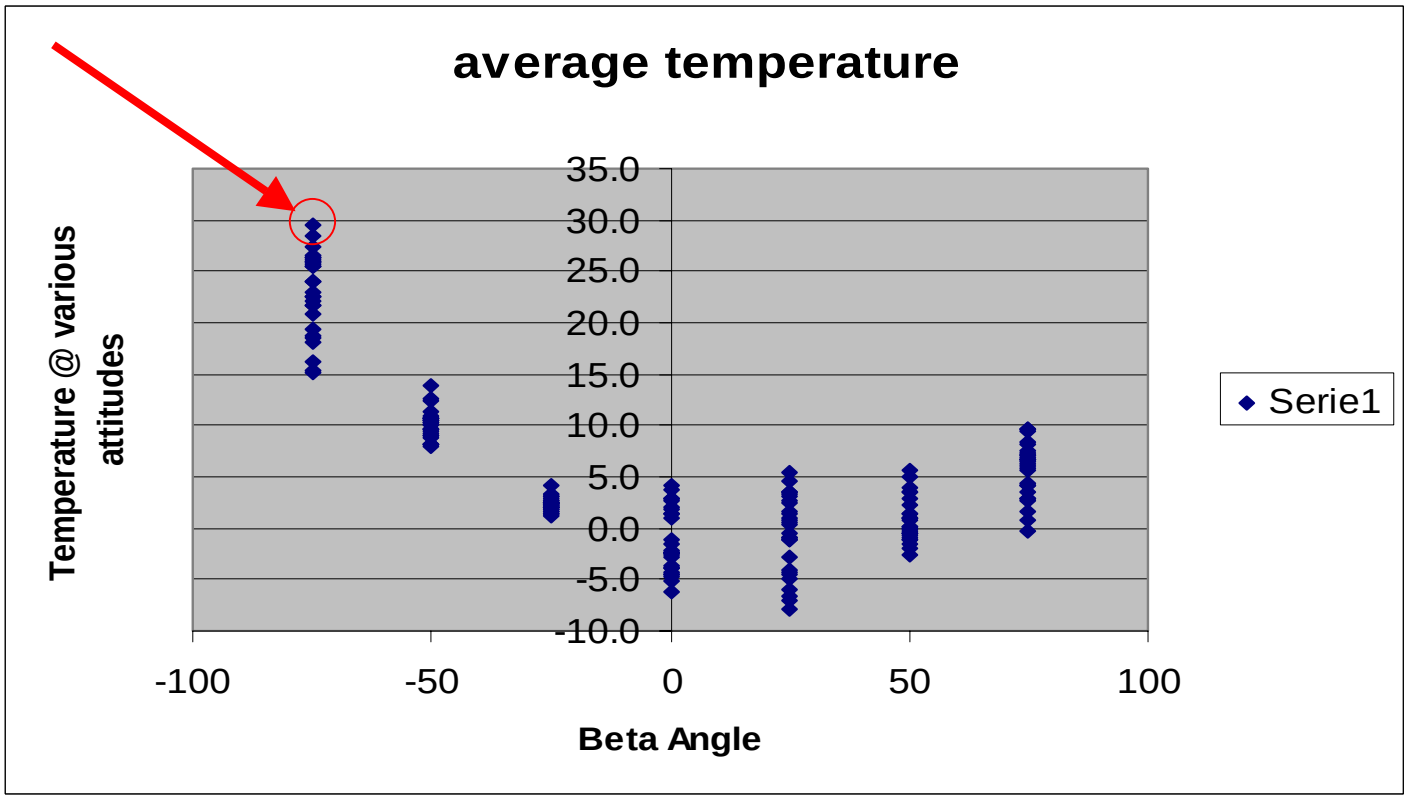
53-54
52-53
51-52
50-51
49-50
48-49

Where is the worst case?

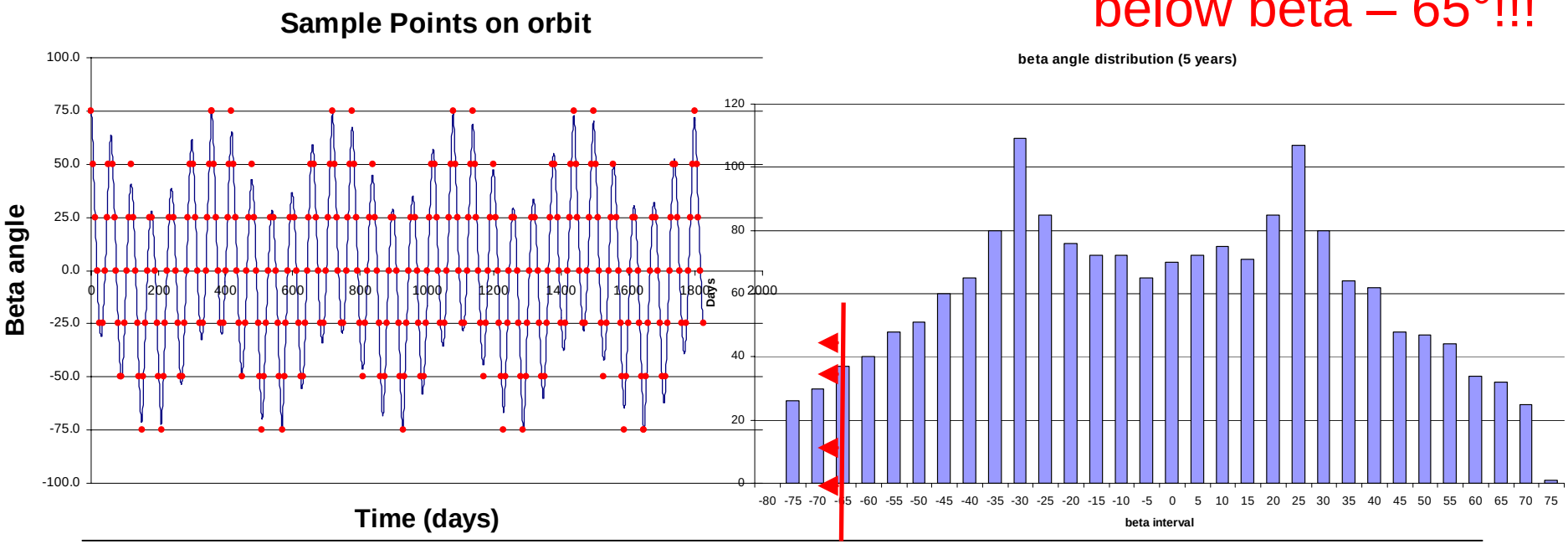


Note: the temperature scale is arbitrary

Nominal behaviour

- Beta angle distribution
  - Only beta –75° are dangerous

Only 3% of time below beta – 65°!!!

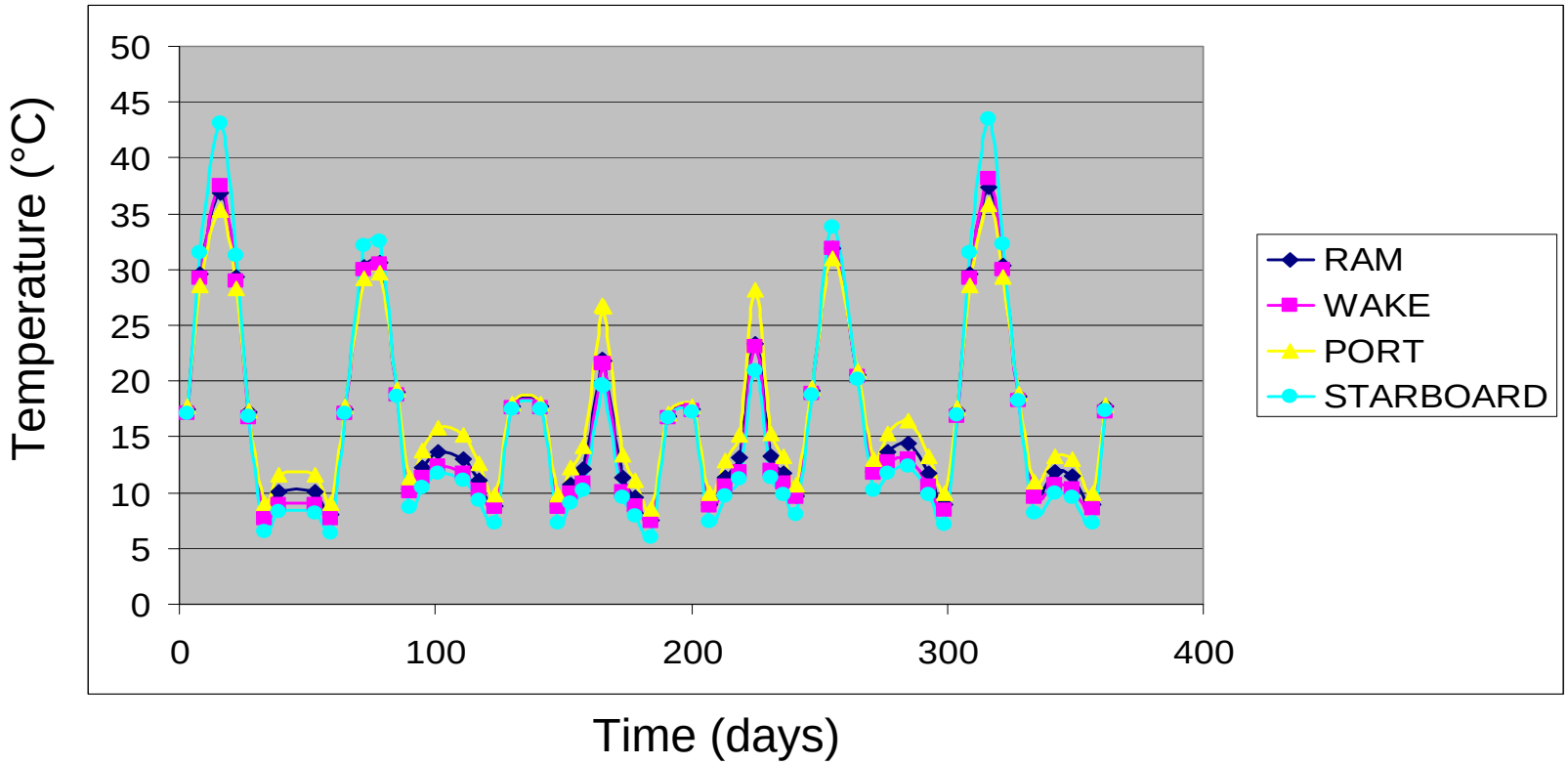


Environmental parameters

- Solar constant is deterministic
- Albedo and Earth Temperature are usually in counter-phase, and oscillation range is narrower
- Average altitude
- MPA ATTITUDE is the most likely for the ISS

=> Need of a realistic picture

Expected behavior (PMT)



Averaged temperatures along the 4 sides; typical gradients of +/- 2 °C are expected along the same side.

Assumptions

- In the previous graph:
  - MPA attitude
  - Measured T_earth, Albedo
  - Average altitude
  - End Of Life t/o properties

Conclusions

- In nominal conditions, the calorimeter is always working, except at beta –75 (less than 2% of total time above 40°C)
- What happens in worst orbit, when detector is switched off?

ECAL switched off:

- Worst case, ECAL power on:
  - MAX temperature on PMT: 58°C
- Worst case, High Voltage off:
  - MAX temperature on PMT: 48°C
- Worst case, HV off, EIB off, ADC off:
  - ONGOING ANALISYS

COLD CASES

- ANALYSIS in PROGRESS; preliminary data (with the old model) show temperatures always above –30°C.
- New runs with improved model needed, to confirm these data.

Temperature sensors

- Temperature sensors are needed to monitor the PMT.
  - To allow offline temperature data correction
  - To prevent overheating (thermal switch)
- Where and how many?
  - Reasonably, at least 10-15 per side, positioned on the END CAP, behind back panel (if possible)
  - Other sensors on the back panels/radiators/EIB (10 per side) for model correlation
  - Total: about 80-90 sensors

Additional margins

- PMT power set at maximum (800V, 125 mW), while expected working point is 650V
  - (this doesn't help in the worst hot case)
- The "switch off" hot case still had some components ON
  - (this should lower temperature by some degrees, TBC)