

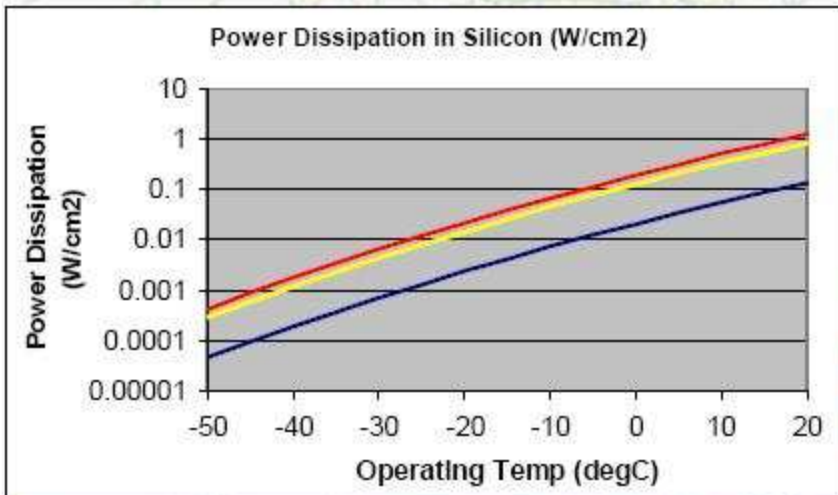
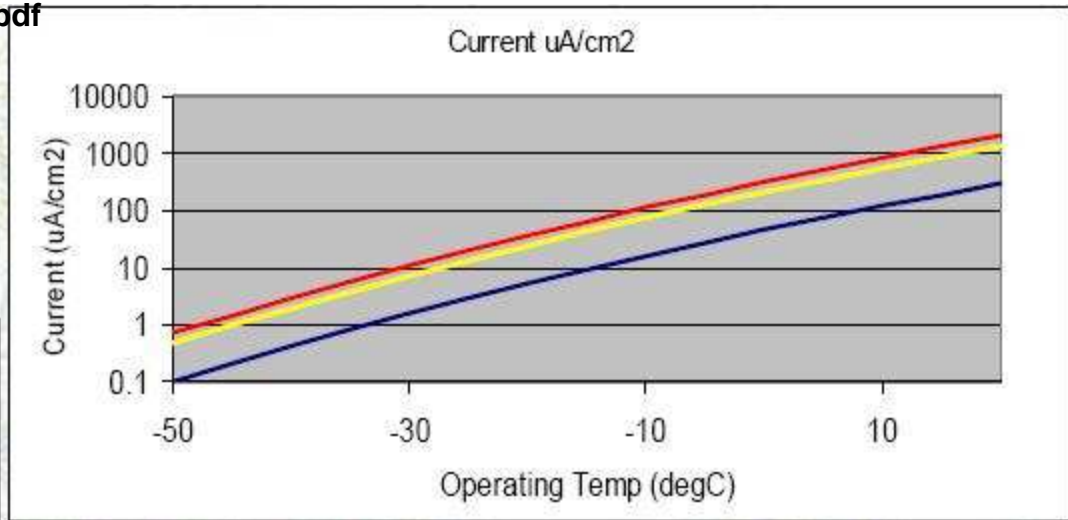
# THERMAL RUNAWAY SIMULATION

# LHC THERMAL RUNAWAY CURVE

hep.ph.liv.ac.uk/~green/silc/talks/AllportAtlasAtSLHC.pdf

## Current & Power Dissipation

Innermost short strip radius:



— LHC: flux =  $2 \times 10^{14}$   $n_{eq}/cm^2$ , bias = 450V, 300 $\mu$ m  
 — SLHC: flux =  $1.4 \times 10^{15}$   $n_{eq}/cm^2$ , bias = 600V, 300 $\mu$ m  
 — SLHC: flux =  $1.4 \times 10^{15}$   $n_{eq}/cm^2$ , bias = 600V, 200 $\mu$ m

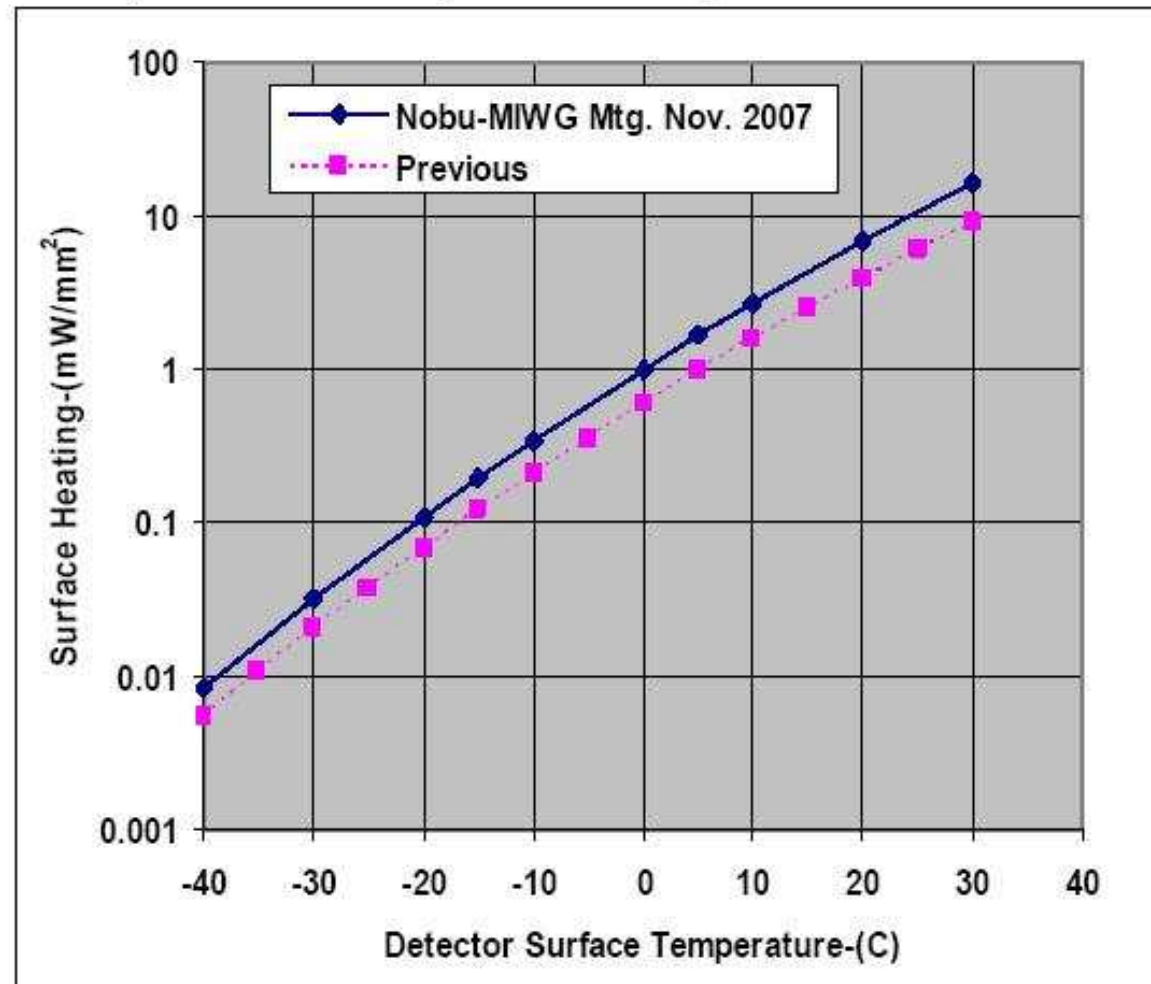
Temperature	-40°C	-30°C	-20°C	-10°C	0°C	10°C	20°C
LHC (mW/cm <sup>2</sup> )	0.19	0.70	2.4	7.2	21	54	135
SLHC (mW/cm <sup>2</sup> )	1.8	6.5	22	67	192	508	1260

Currents:  $\times 7$   
 Power:  $\times 10$

**SLHC: to keep power dissipation same as LHC would need to run  $\sim 20^\circ\text{C}$  colder.**

Note: no longer needed to keep sensors cold outside operation! (At SLHC we will not operate sensors fully depleted, therefore reverse annealing is not a major issue.)

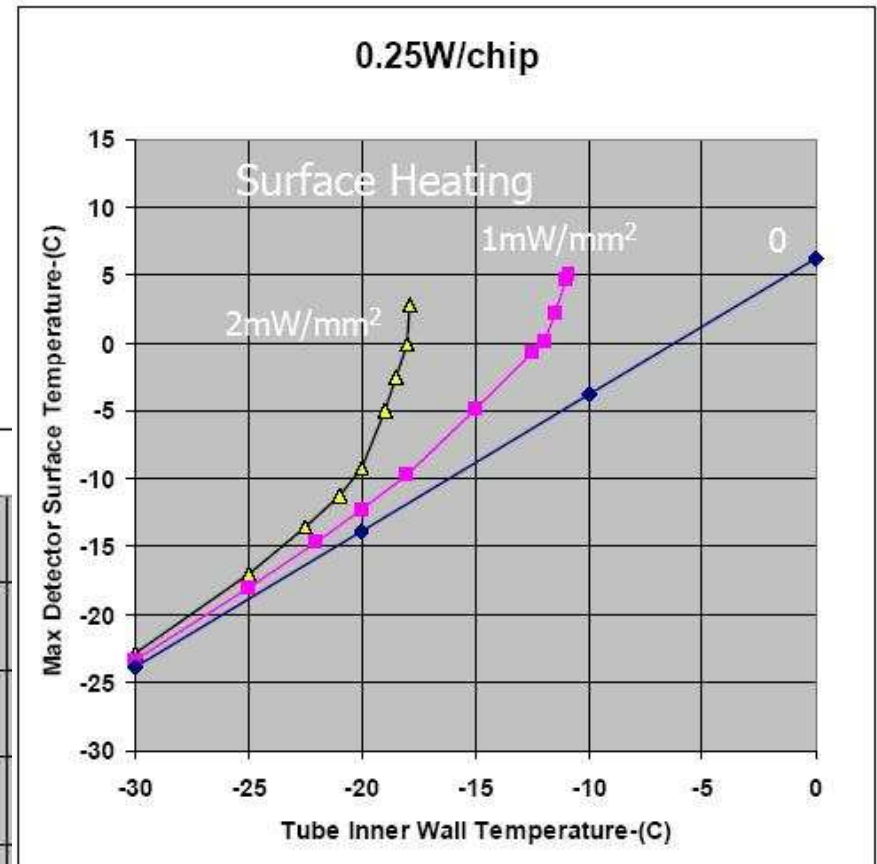
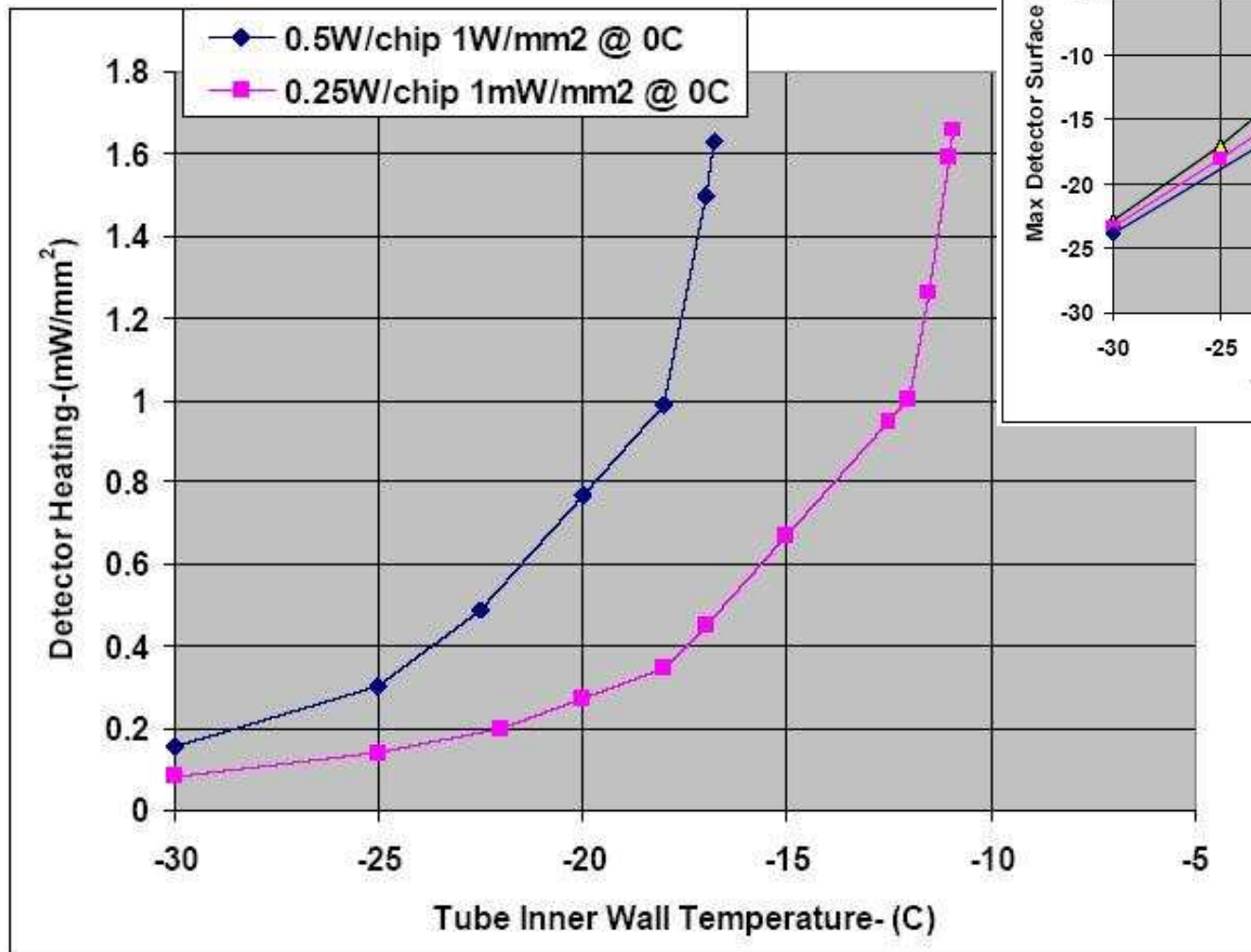
New curve based on 1mW/mm<sup>2</sup> at 0°C (Nobu-MIWG Nov. 2007) and exponential temperature dependence



$$P/P(0) = (T+273.15)^2 \exp(-E_g/2k(273.15+T)) / (273.15^2 \exp(-E_g/(2k(273.15))))$$

$$E_g = 1.2 \text{ eV} , k = 8,5e-5 \text{ eV/}^\circ\text{K}$$

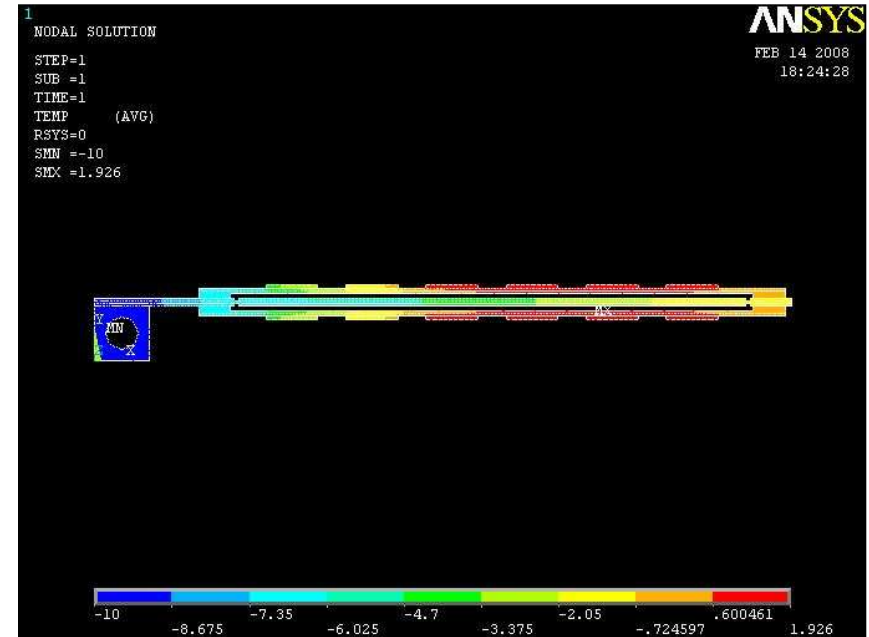
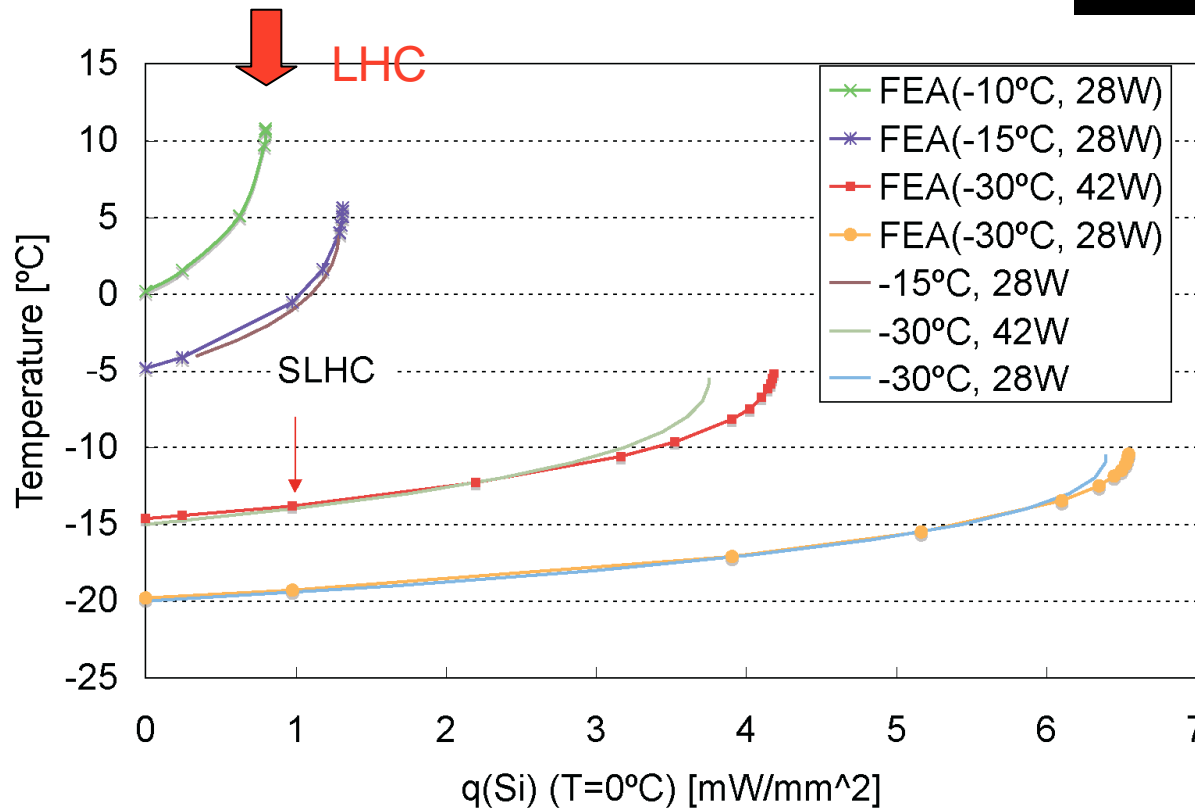
# TWO WAYS TO GRAPH THERMAL RUNAWAY



# SUSUMU TERADA TAKASHI KOHRIKI

*T. Kohriki "Nuclear instr. & methods..." A 579 (2007)*

2D, 64x128x0.3mm<sup>3</sup>, Single-Side cooling



- Model
  - LHC SCT barrel module
  - **Full area baseboard=2D**
- Silicon
  - w=64mm, t=300µm, 2-sides
- Baseboard:
  - TPG1400, t=400µm
  - k=1400 W/m/K
- Hybrid:
  - CC bridge, t=300µm
  - k=650 W/m/K
- Electronics heat
  - **4 rows of ASIC's**
  - **28W/12cm**
- Cooling
  - Single-side cooling
  - Sensor to Coolant:ΔT=10 °C (@28W)

# RESULTS RUNAWAY LHC

FACTOR	-40°C	-30°C	-20°C	-10°C	0°C	10°C	20°C	Tdet.
x1	1.9	7	24	72	210	540	1350	0.183°C
x3	5.7	21	72	216	630	1620	4050	3.925°C
x4	7.6	28	96	288	840	2160	5400	9.5°C
x5	9.5	35	120	360	1050	2700	6750	-----
x4.5	8.55	31.5	108	324	945	2430	6075	-----
x4.2	7.98	29.4	100.8	302.4	882	2268	5670	-----
x4.1	7.79	28.7	98.4	295.2	861	2214	5535	-----
x4.05	7.7	28.35	97.2	291.6	850.5	2187	5467.5	10.104°C

W/m<sup>2</sup>