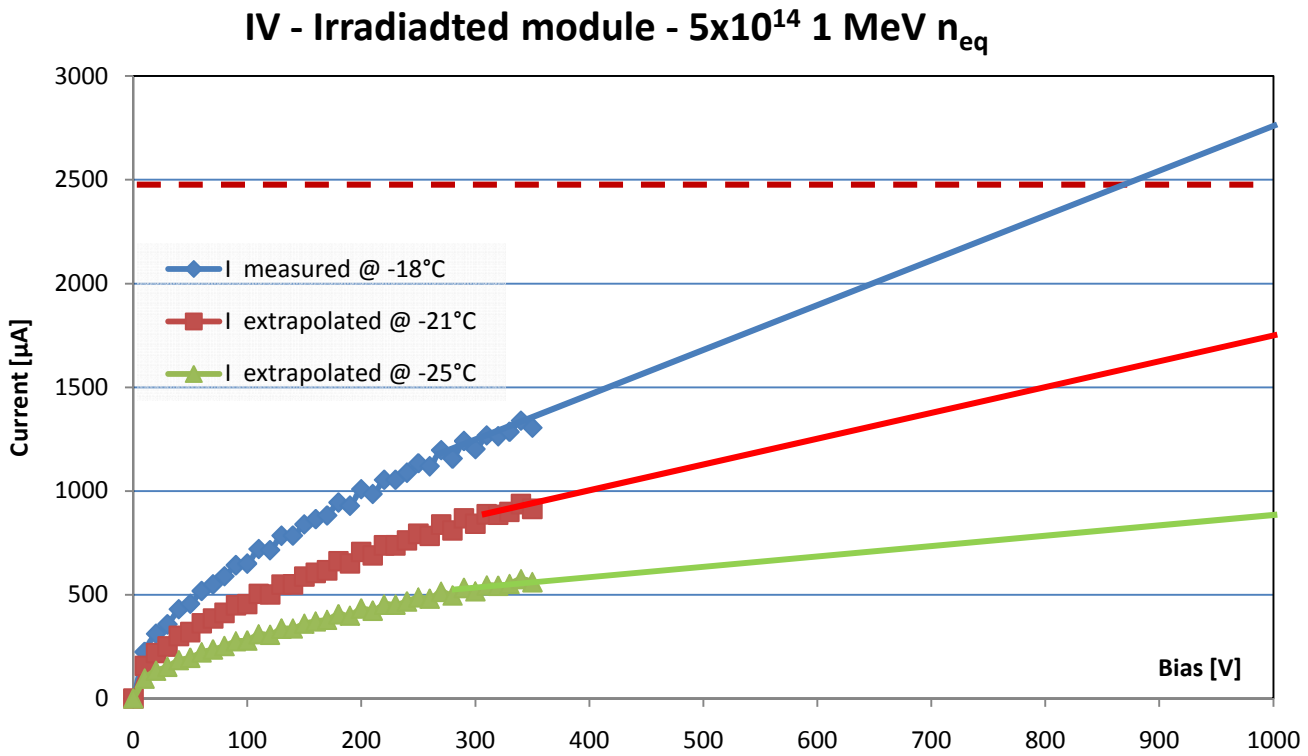
# Chiller range choice for the irradiated module

## Inputs and facts:

-Si-detector current increased by 5 to 6 order of magnitude
- FE power increased by few %
- HV filter resistors of 10kΩ are limited to 0.0625W → so max current on Si is 2.5 mA
- Measured delta T between hybrid and silicon: 10°C
- Extrapolated delta T between module block and hybrid when fully powered clocked and configured: 21°C
- Thermal runaway extracted from simulation: around 40W on the Si for -21°C on the silicon
- Measured inefficiency between chiller bath temperature and the module box (see next page)
- Current Huber chiller - Min reachable temperature -25°C → Cooling block temperature extrapolated at -18°C
- In order to be in Upgrade condition one need to reach -30°C on the cooling block
  → Can be achieved with a chiller bath going below -42°C (cf page 3)

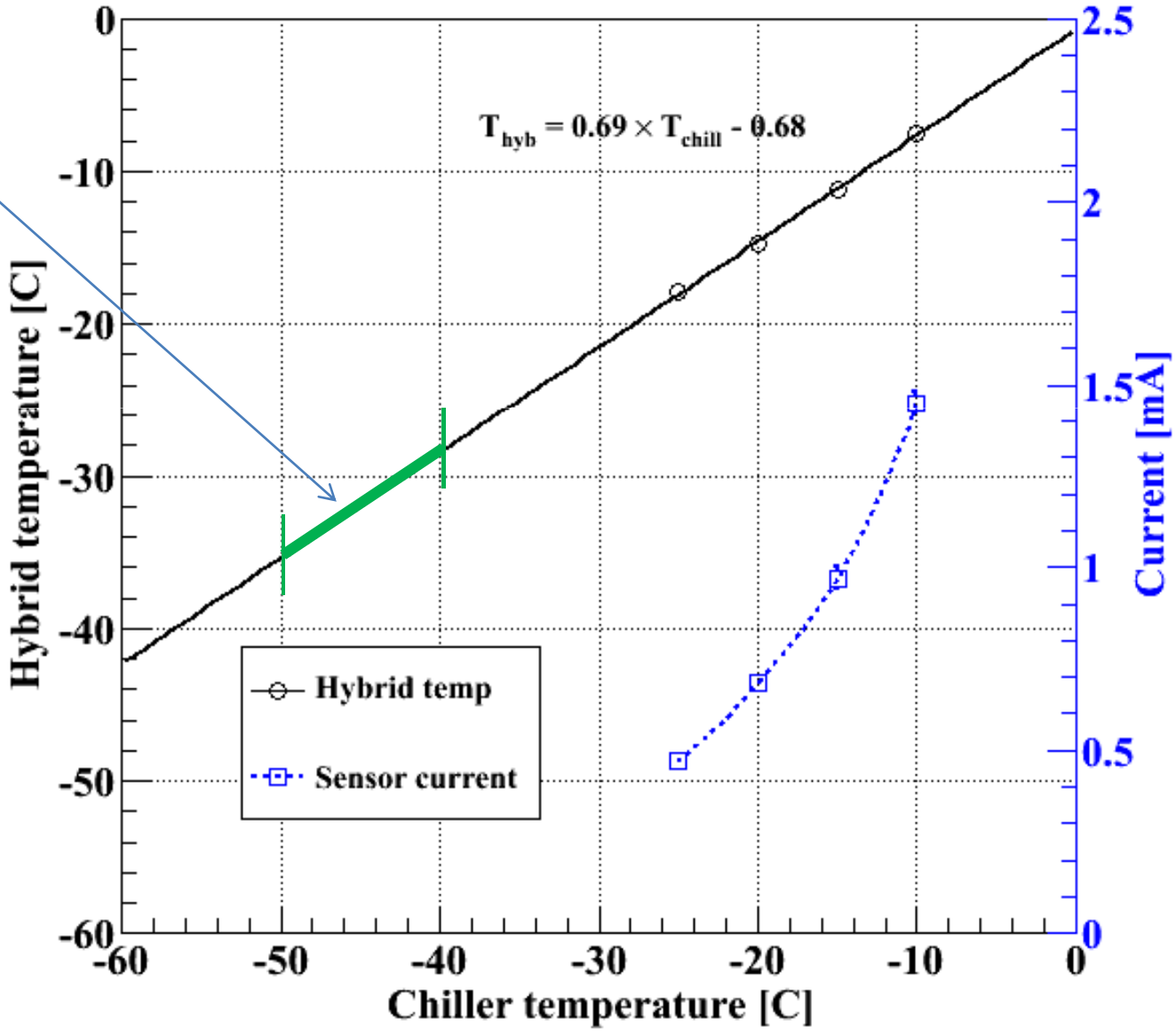
# IV – Measured at -18°C and extrapolated



## Module Temperature versus Chiller Temperature

Slope shows (≠1) due to thermal losses in the box and the pipes

Extrapolation for chiller bath from -40 down to -50°C



## Summary and conclusions

Proposal is to use Huber chiller with wider range:

- CC3-505wl (-50...200C), 150W at -40C, 230V, air cooled ~ 6kEuros
- Unistat 705 (-75 … 250°C), 300W at -60°C, 230V, air cooled ~ 15kEuros
- For both it is recommended to use thermo-oil (10 liters) ~ 1kEuros

**Summary:**

-The chiller bath temperature to have less than -30°C on the cooling blocks should be < -43°C

This can be achieved by the 2 chiller types above

-This will allow to have less than -19°C on the silicon when the hybrids are fully powered, clocked and configured

- Assuming less then -19°C → Module can reach 1KV with current less than 2.5mA
- This means 2.5W on the module which is far from the 40W estimation for the runaway
- If the module is irradiated to $1.5 \times 10^{15}$ 1 MeV neq (3 times the fluence reached today) it means that the current will increase by a factor of 3

-Not a problem for the runaway

- Model CC3-505 when at -50°C will allow to have ~ -24°C on the silicon and IV may be limited to 800V

**Conclusions:**

**-** Model CC3-505 is suitable for up to an additional fluence of $1 \times 10^{15}$ 1 MeV neq

**-** If the price is not an issue the model Unistat 705 give more margin for extended fluences!