Update of leak current measurement and prediction of SCT barrel modules

SCT Performance meeting

Aug 18, 2011

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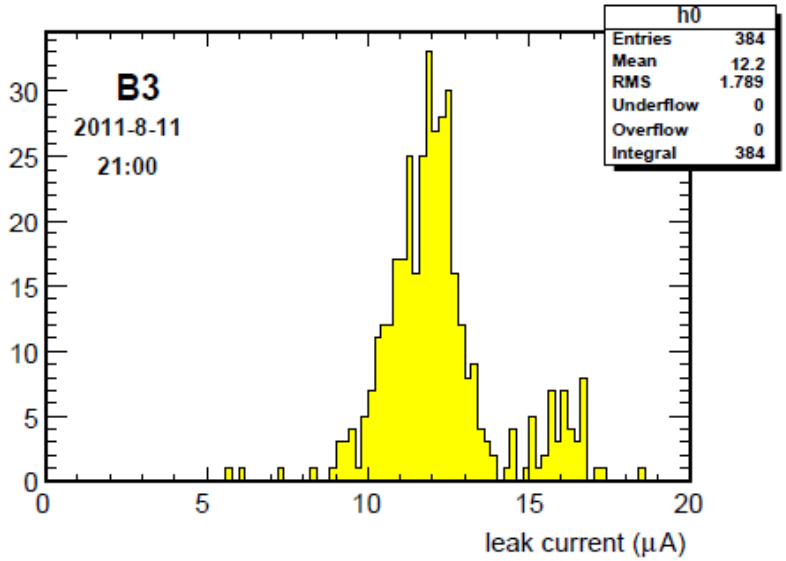
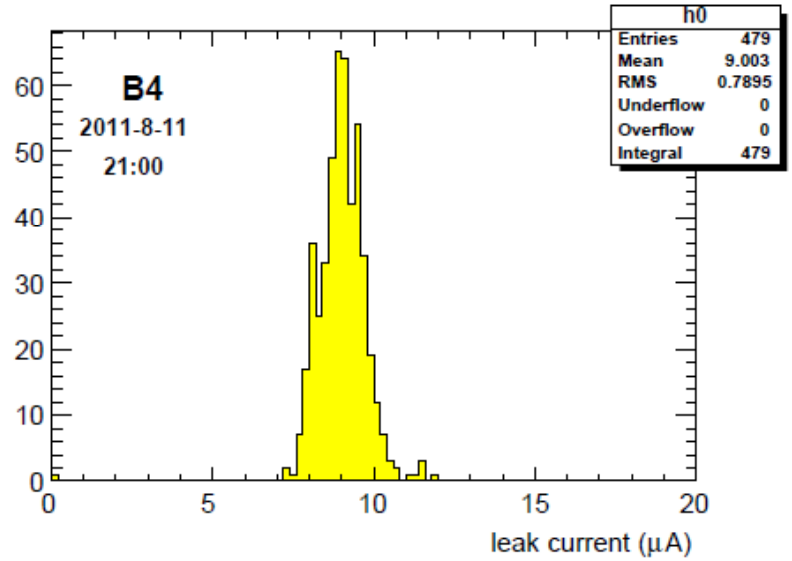
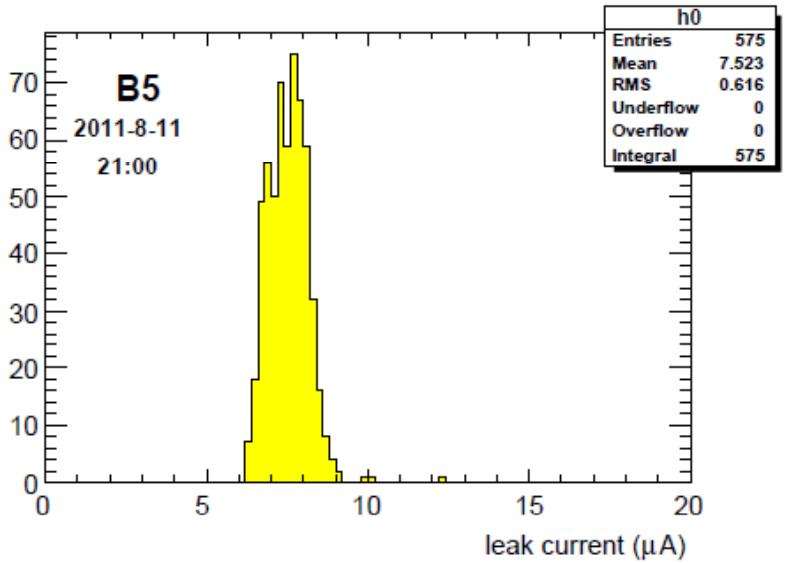
Paul Dervan (University of Liverpool)

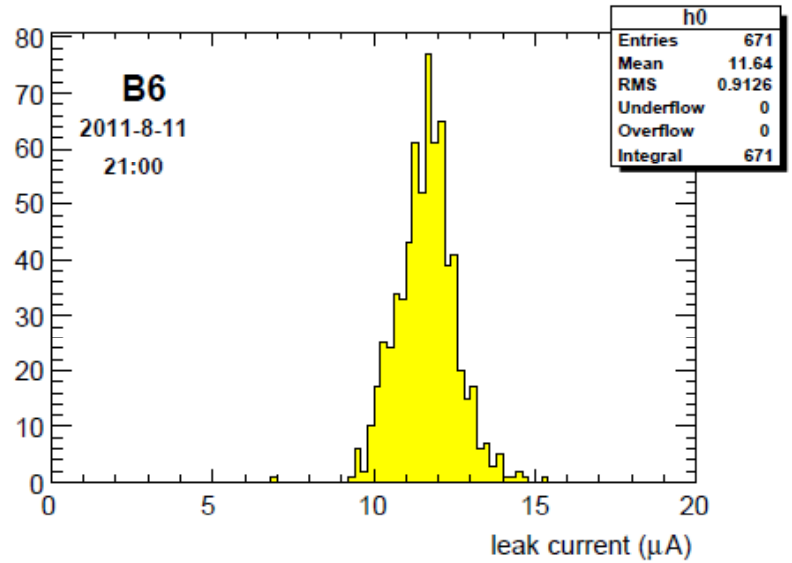
Leak current distribution of barrel modules

Aug. 11, 2011



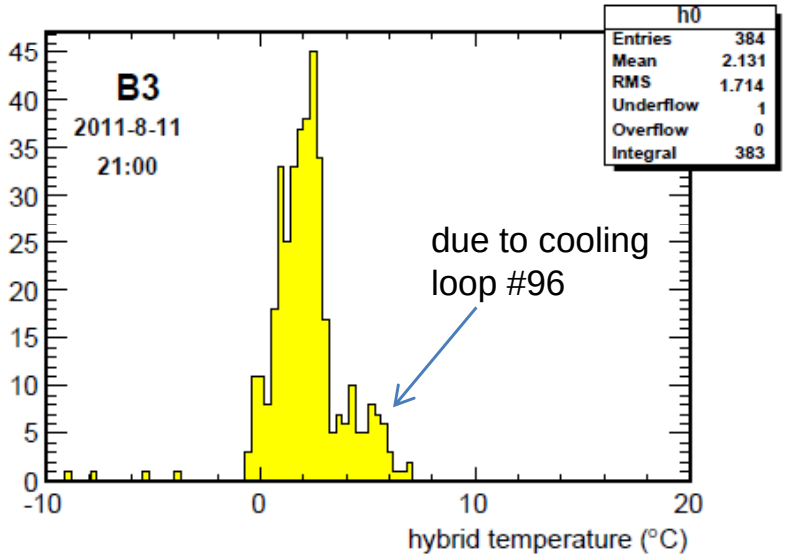


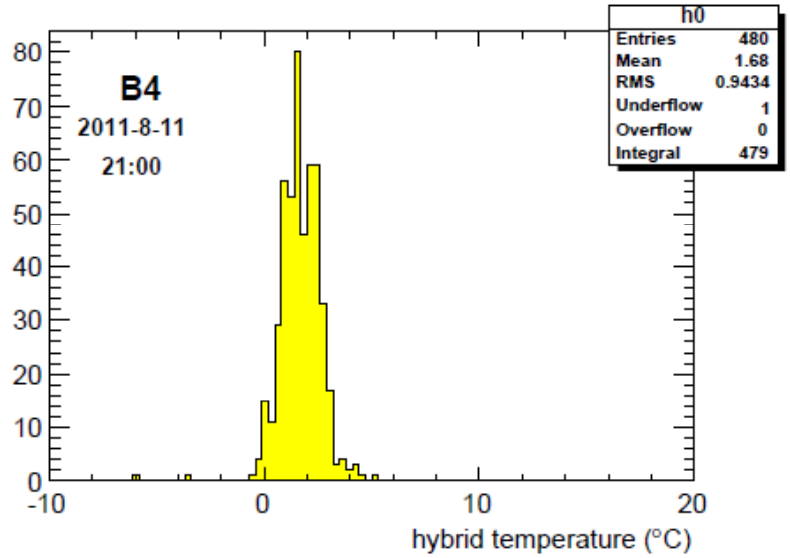


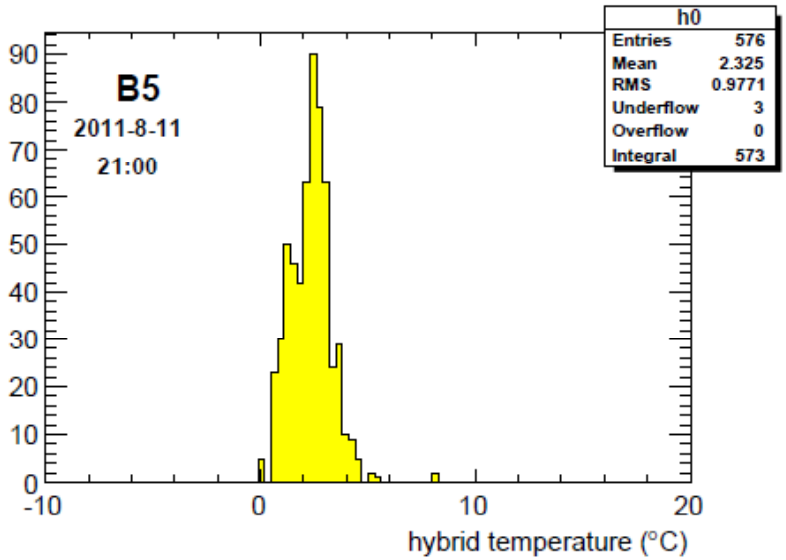


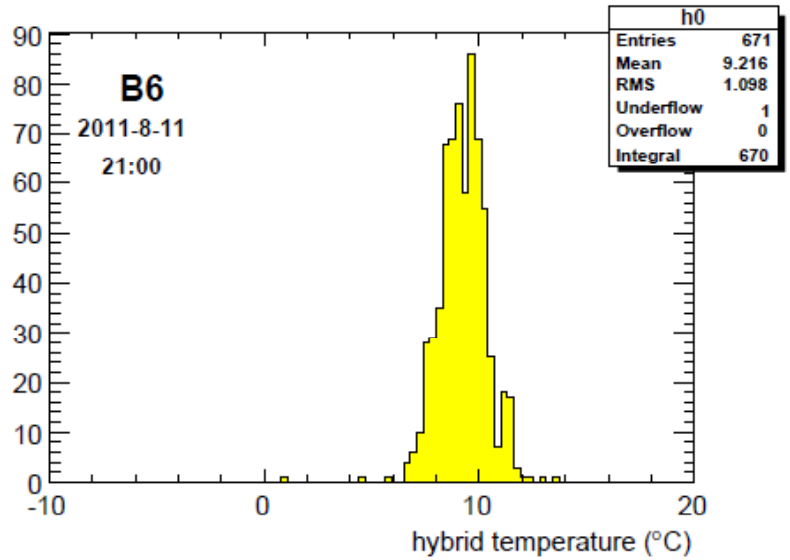
Temperature distribution of the hybrid = $(T_{link0}+T_{link1})/2$

Aug. 11, 2011

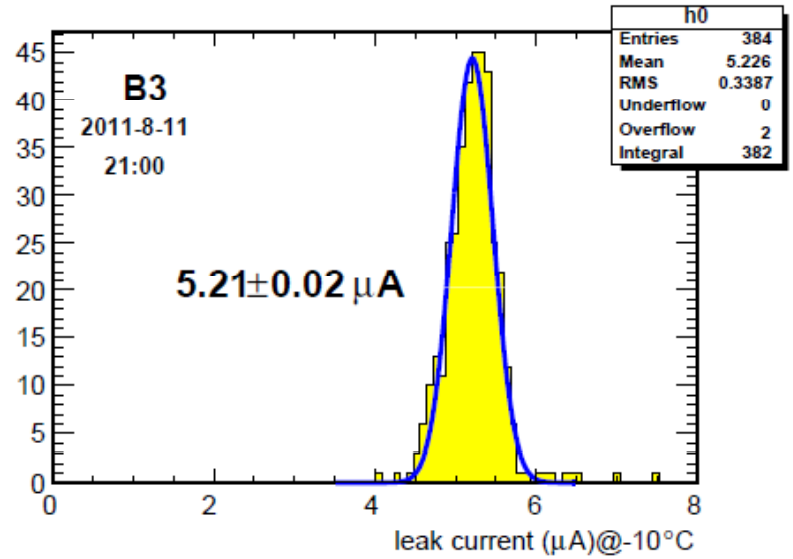


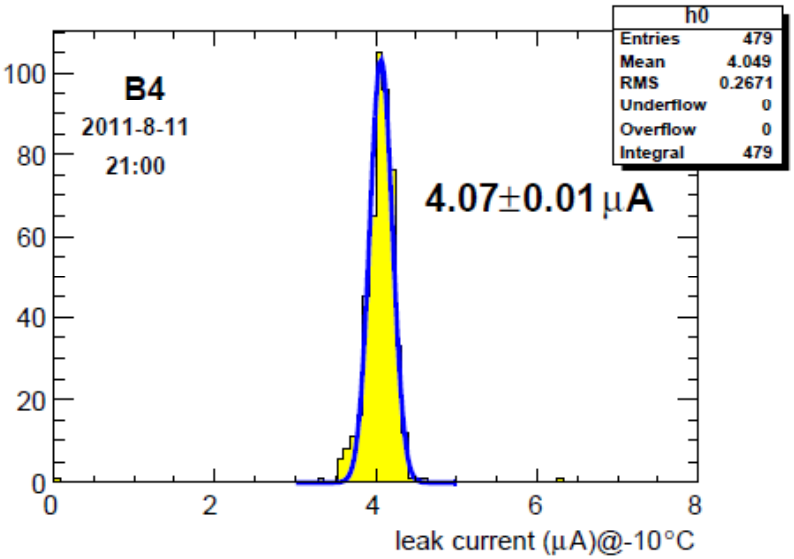


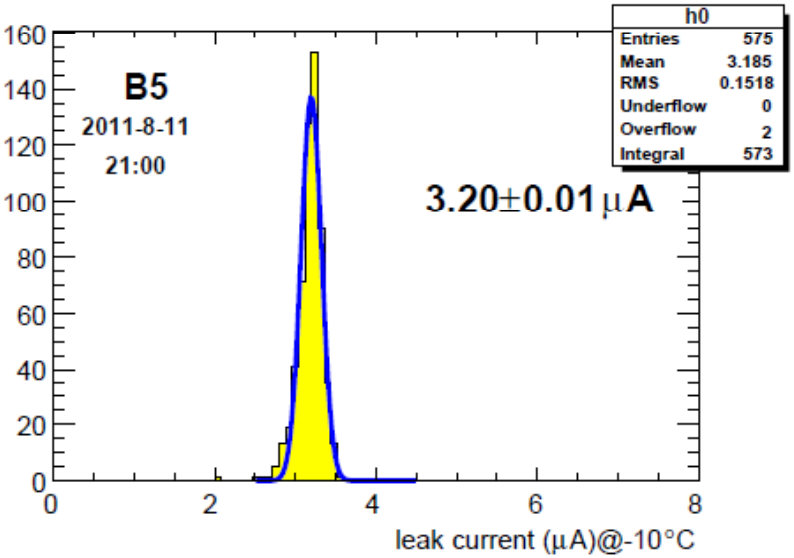


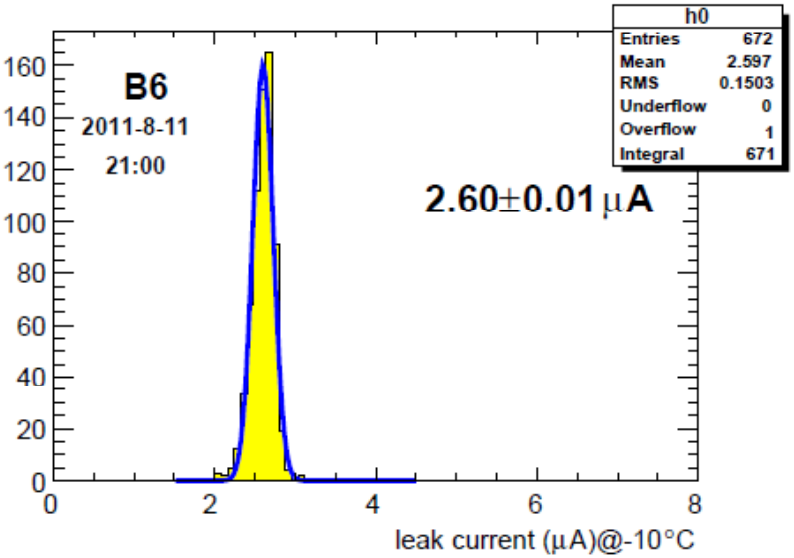


Transfer to leak current at -10°C and fitting









Note: Fitted values are slightly different (0.15-0.3μA) from those by Paul. Investigating.

Results on Barrel modules on recent 5 measurements:

Updated

date	2011.1.25	2011.2.15	2011.5.9	2011.6.11	2011.8.11
Integrated L	51.2 pb^{-1}	51.2 pb^{-1}	325.0 pb^{-1}	1010.2 pb^{-1}	2430.1 pb^{-1}
B3 average	88.0 nA	79.6 nA	769.5 nA	2315 nA	5480.7 nA
B4 average	67.7 nA	61.1 nA	593.3 nA	1794 nA	4250.2 nA
B5 average	56.4 nA	47.4 nA	463.4 nA	1396 nA	3340.7 nA
B6 average	47.8 nA	42.7 nA	374.9 nA	1088 nA	2734.7 nA

Same as before

Note:

(1) Leak current results at -10°C were provided by Paul.

(2) Integrated Luminosity is now total delivered 7TeV collisions at Point-1 including non-Stable beam collisions, thanks to Eric Torrence [1].

[1] /afs/cern.ch/atlas/www/GROUPS/DATAPREPARATION/DataSummary/
The quantity "lhcall_7 tev <delivered> " in the file daylist.xml is used.

Same as before

- Radiation fluences in ID part at 7 TeV pp collision have been calculated by Ian Dawson et al. using FLUKA [1].

Layer	Fluence at 1 pb^{-1} pp 7TeV
B3	$1.65 \cdot 10^8$ n_{eq}/cm^2
B4	$1.29 \cdot 10^8$ n_{eq}/cm^2
B5	$1.07 \cdot 10^8$ n_{eq}/cm^2
B6	$9.00 \cdot 10^7$ n_{eq}/cm^2

- Sensor Temperature
  - When cooled, it is estimated from the average Temperature [2] of two thermistors on the module hybrid by subtracting 3.6°C, the delta-T obtained by FEA [3].
  - When the cooling is off, the environmental temperature (17.5°C during the last winter shutdown) is used.

[1] https://twiki.cern.ch/twiki/bin/viewauth/Atlas/BenchmarkingAtTheLHC
[2] https://pc-sct-www01.cern.ch/CalibMonitor/
[3] https://indico.cern.ch/getFile.py/access?contribId=4&resId=0&materialId=0&confId=47816

Same as before

- Leak current formula by R. Haper [1] is used for prediction.

  ϕ : n_{eq} fluence, V: volume

$$I = g(\Theta(T_A)t_{ir}, \Theta(T_A)t')\alpha\phi V$$

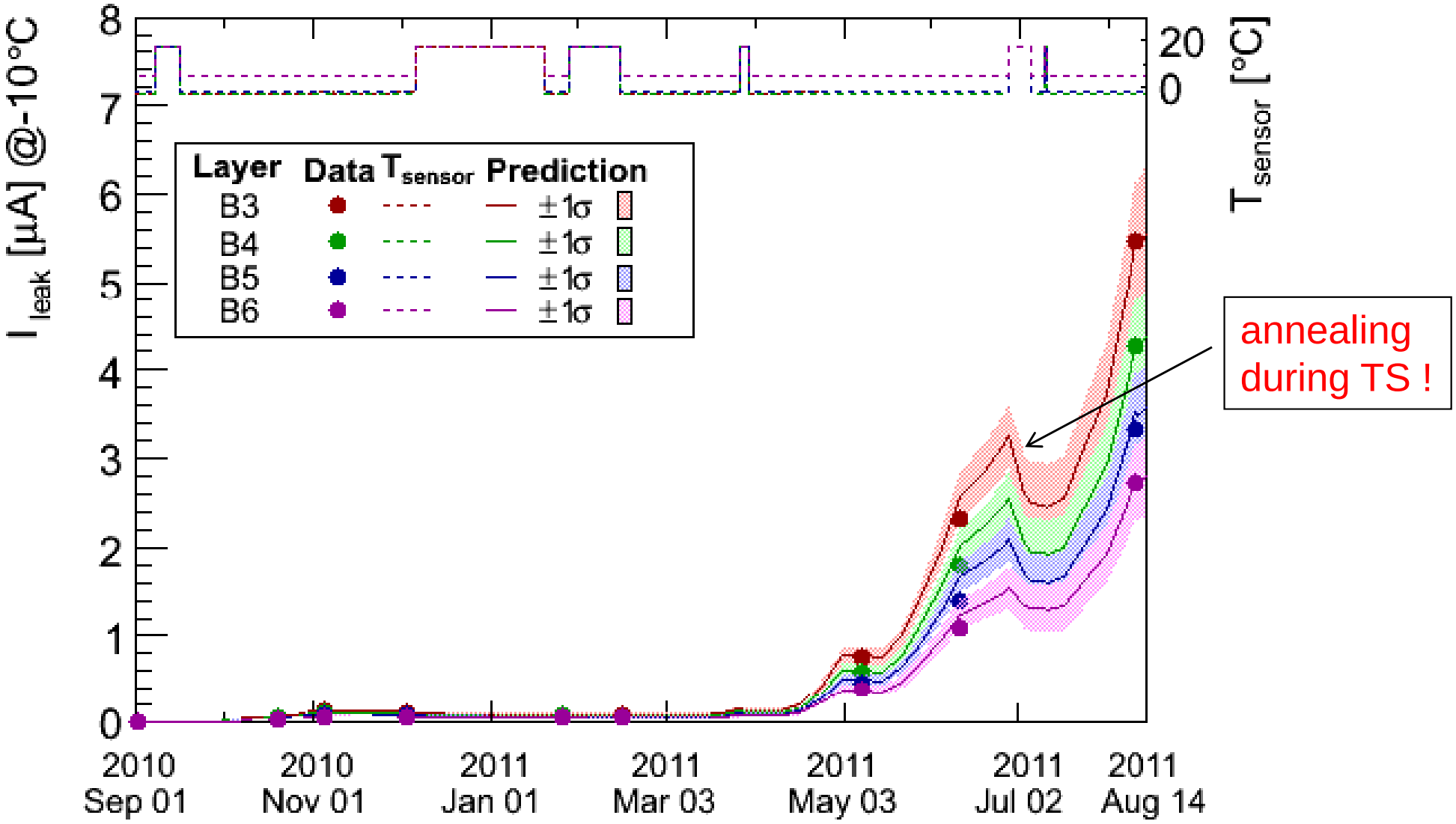
$$g(\Theta(T_A)t_{ir}, \Theta(T_A)t') = \sum_{i=1}^{n}\left\{A_i \frac{\tau_i}{\Theta(T_A)t_{ir}}\left[1-\exp\left(-\frac{\Theta(T_A)t_{ir}}{\tau_i}\right)\right]\exp\left(-\frac{\Theta(T_A)t'}{\tau_i}\right)\right\}$$

$$\Theta(T_A) = \exp\left(\frac{E_I}{k_B}\left[\frac{1}{T_R}-\frac{1}{T_A}\right]\right)$$

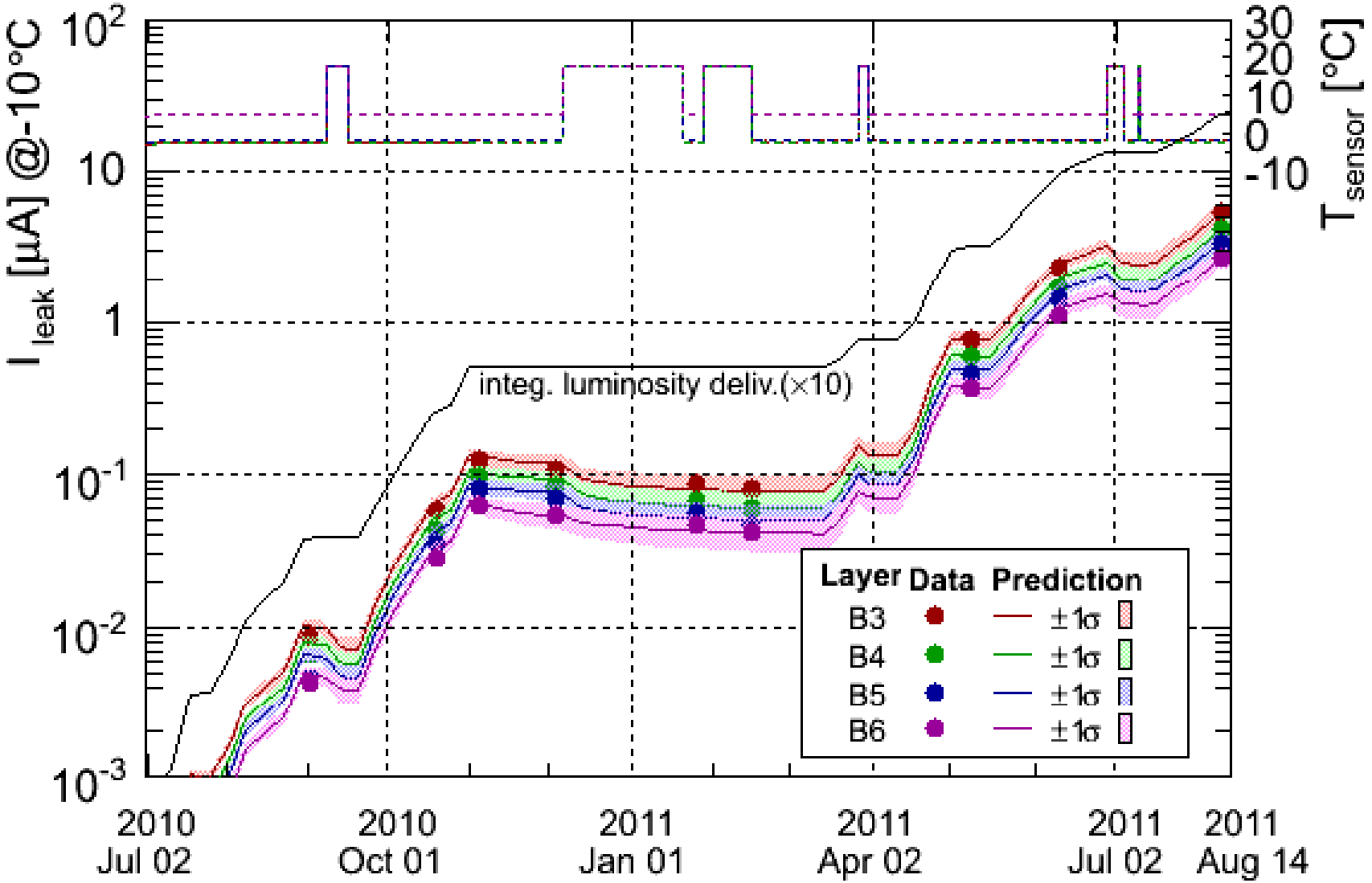
$$\alpha_{eq}(-7°C) = (6.90 \pm 0.20)\times 10^{-18}\ \mathrm{A\cdot cm^{-1}}$$

i	τ_i (min)	A_i
1	$(1.2\pm0.2)\times10^{6}$	0.42 ± 0.11
2	$(4.1\pm0.6)\times10^{4}$	0.10 ± 0.01
3	$(3.7\pm0.3)\times10^{3}$	0.23 ± 0.02
4	124 ± 25	0.21 ± 0.02
5	8 ± 5	0.04 ± 0.03

[1] R. Harper, Thesis of University of Sheffield, Oct. 2001



The errors do not include ~50% uncertainties in the fluence simulation using FLUKA and min. bias EG.


I_{leak} [μA] @-10°C
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
30
20
10
0
-10
T_{sensor} [°C]
integ. luminosity deliv.(×10)
Layer Data Prediction
B3 ±1σ
B4 ±1σ
B5 ±1σ
B6 ±1σ
2010 Jul 02
2010 Oct 01
2011 Jan 01
2011 Apr 02
2011 Jul 02
2011 Aug 14

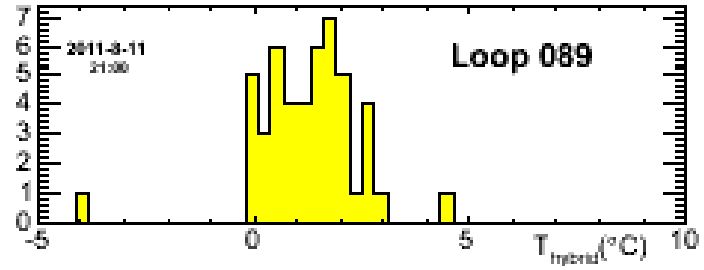
Summary

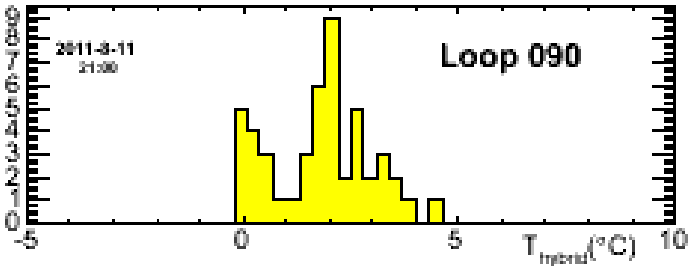
- Leak current of SCT Barrel was measured on 2011 Aug. 11
- Excellent agreement between measurement and prediction.
- Modules of the B3 cooling loop #96 showed systematically higher temperature (about 3^{o}C).

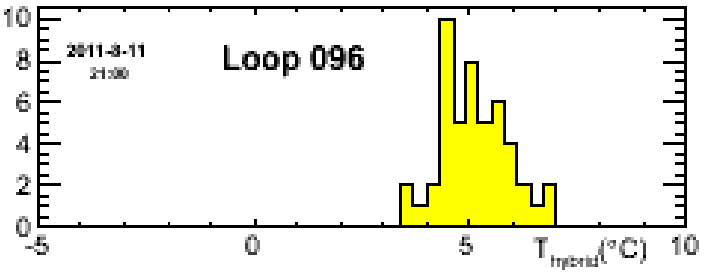
Backup slides

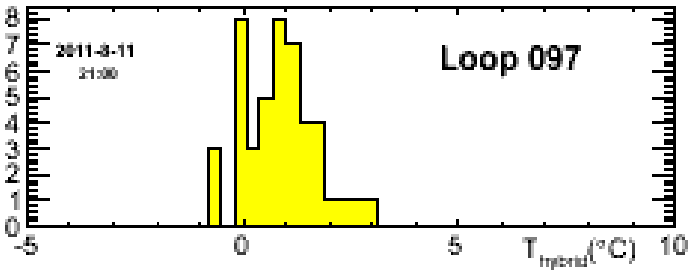
(added on Aug.19,2011)

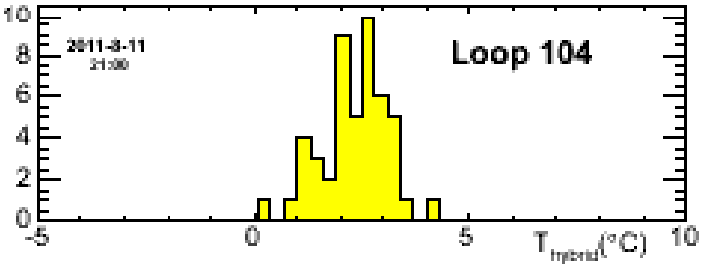
Dependence of B3 hybrid temperature on cooling loops

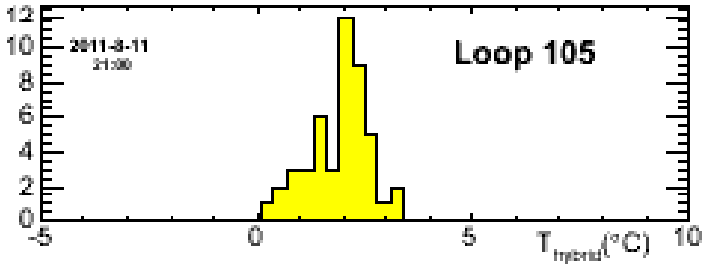


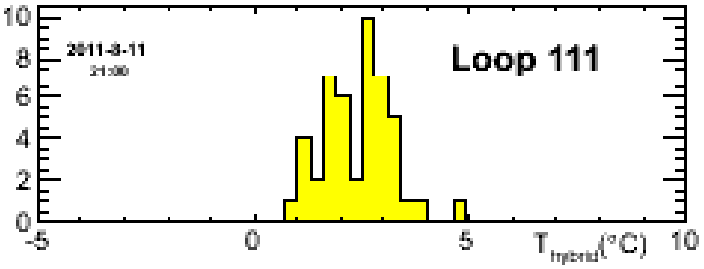


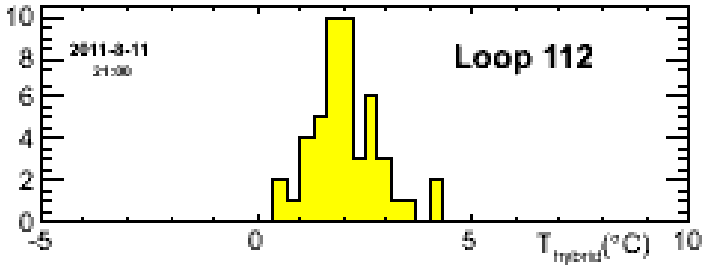












Dependence of B3 leak current at -10ºC on cooling loops