SRD1000 Superconductive Reference Devices

Reporting period: mid-2002 - December 2003

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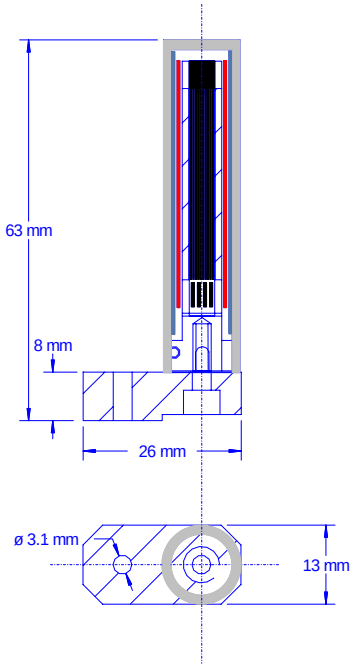
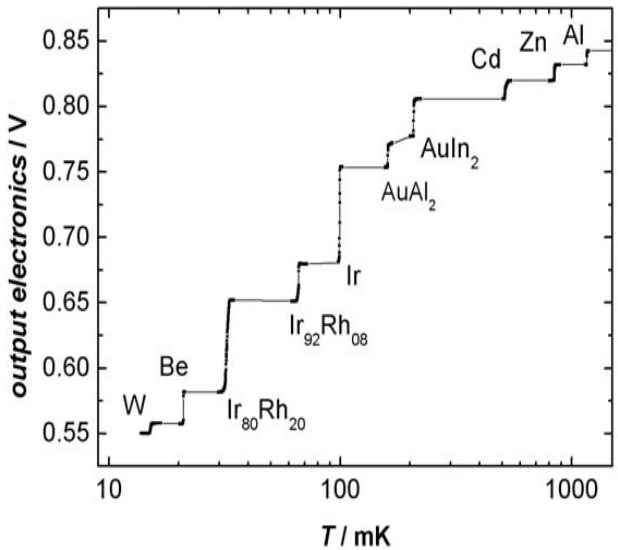
SRD1000 Superconductive Reference Devices

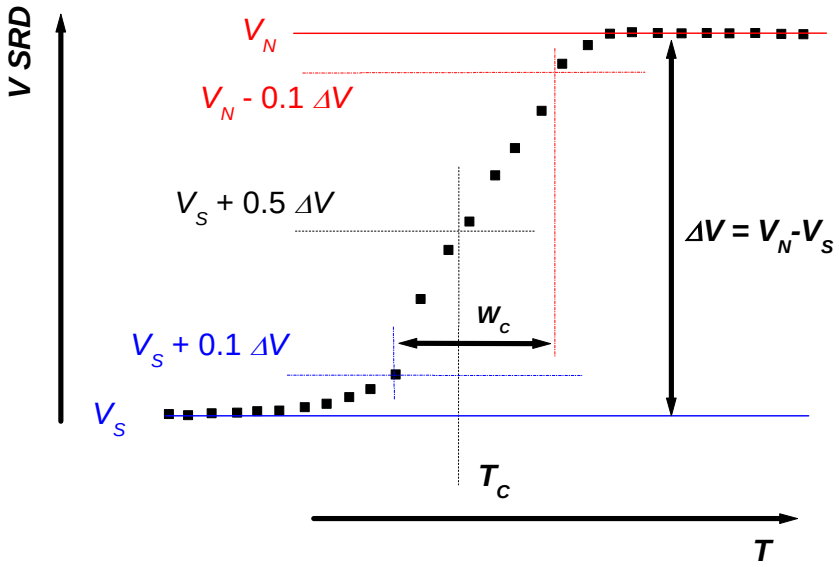
Development	Evaluation
HDL	BNM-INM
LION-KOL	PTB
NMi-VSL	NPL
UT	CNRS / AL

SRD1000 introduction





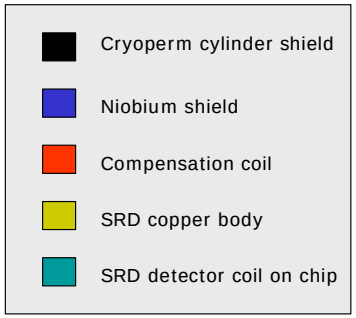
SRD1000 introduction

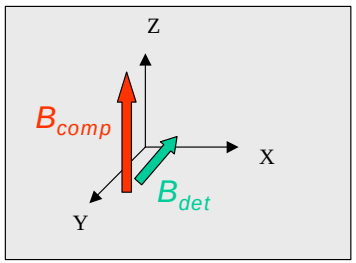


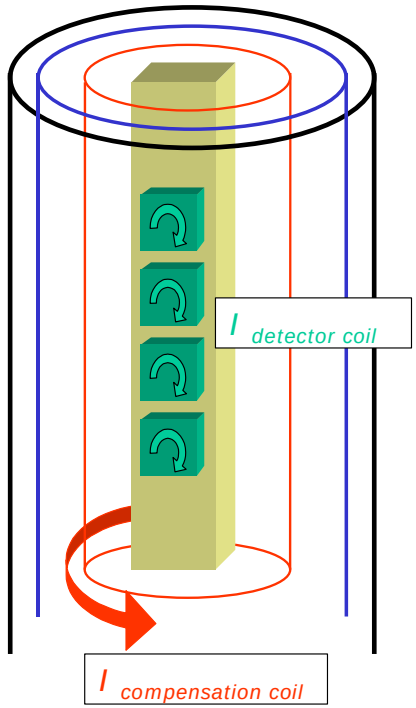
#	material	T_C	W_C	uncert
		[mK]	[mK]	[%]
1	W	15	0.2	0.9
2	Be	21.98	0.08	0.5
3	$Ir_{80}Rh_{20}$	32.32	0.99	0.4
4	$Ir_{92}Rh_{08}$	66.1	0.94	0.2
5	Ir	99.34	0.55	0.1
6	$AuAl_2$	160.89	0.73	0.2
7	$AuIn_2$	207.80	1.56	0.2
8	Cd	516.9	14	0.2
9	Zn	843.7	5.9	0.1
10	Al	1166	4.0	<0.1

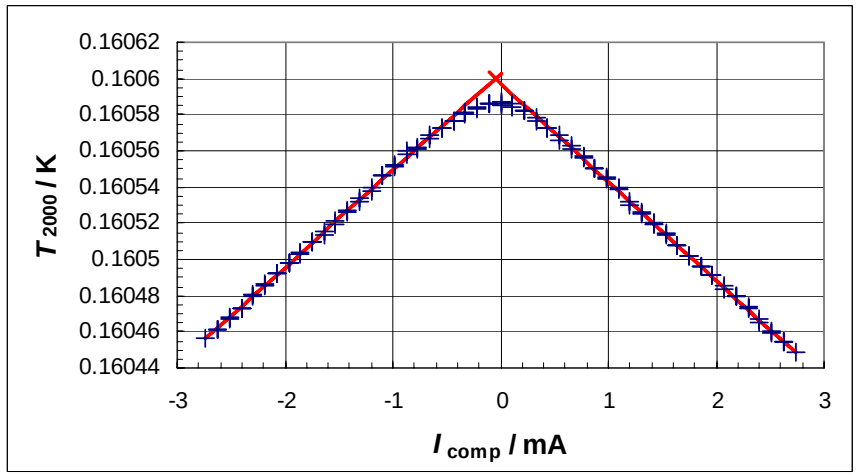
(values found for SRD004)

Residual field measurement and compensation





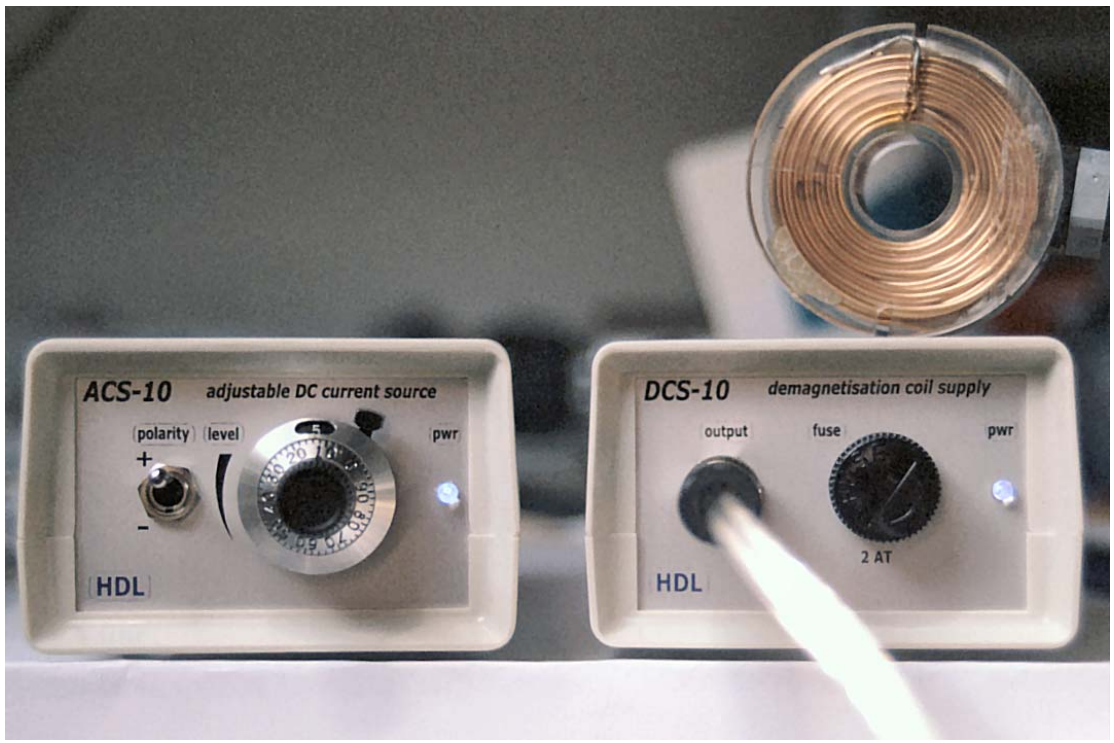




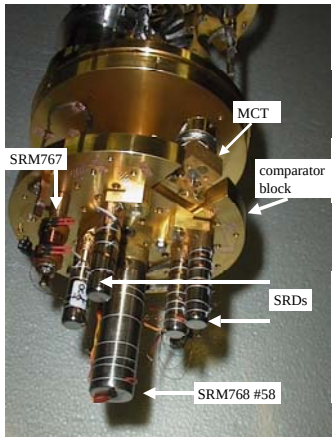
T_C of $AuAl_2$ versus I_{comp} of SRD004, as measured by PTB.

Residual field measurement and compensation

- ACS-10 adjustable DC current source
- Optional input on MIDS-10 preamp for compensation field in X,Y plane
- DCS-10 degauss tool for the Cryoperm shield



Calibration of prototypes at NMi-VSL

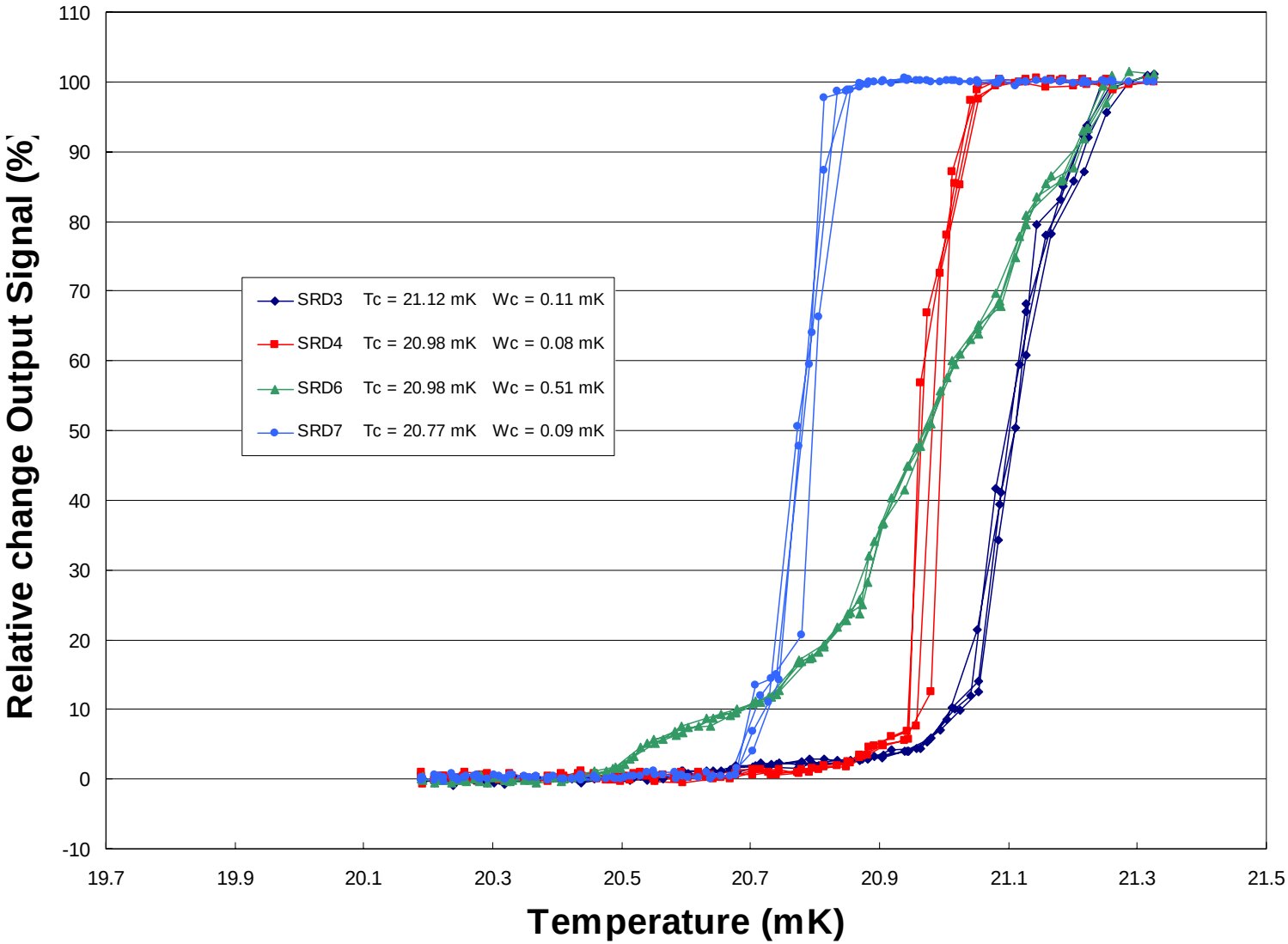


- run 10 (June 2002): SRD003 / 004 / 005
  - SRD003 / 004: new samples and detectors required
  - SRD005: sent to BNM-INM for evaluation

- run 11 (October 2002): SRD003 / 004 / 006 / 007
  - T_{base} > 16 mK, no W calibration possible
  - occasionally the MCT blocks
  - temperature stabilisation problematic around 1 K
  - RhFe thermometer is not working properly
  - SRD003: $AuAl_2$ is not visible, repair detector before evaluation
  - SRD004: sent to PTB for evaluation
  - SRD006/007: $AuIn_2$ has long tail, new sample before evaluation

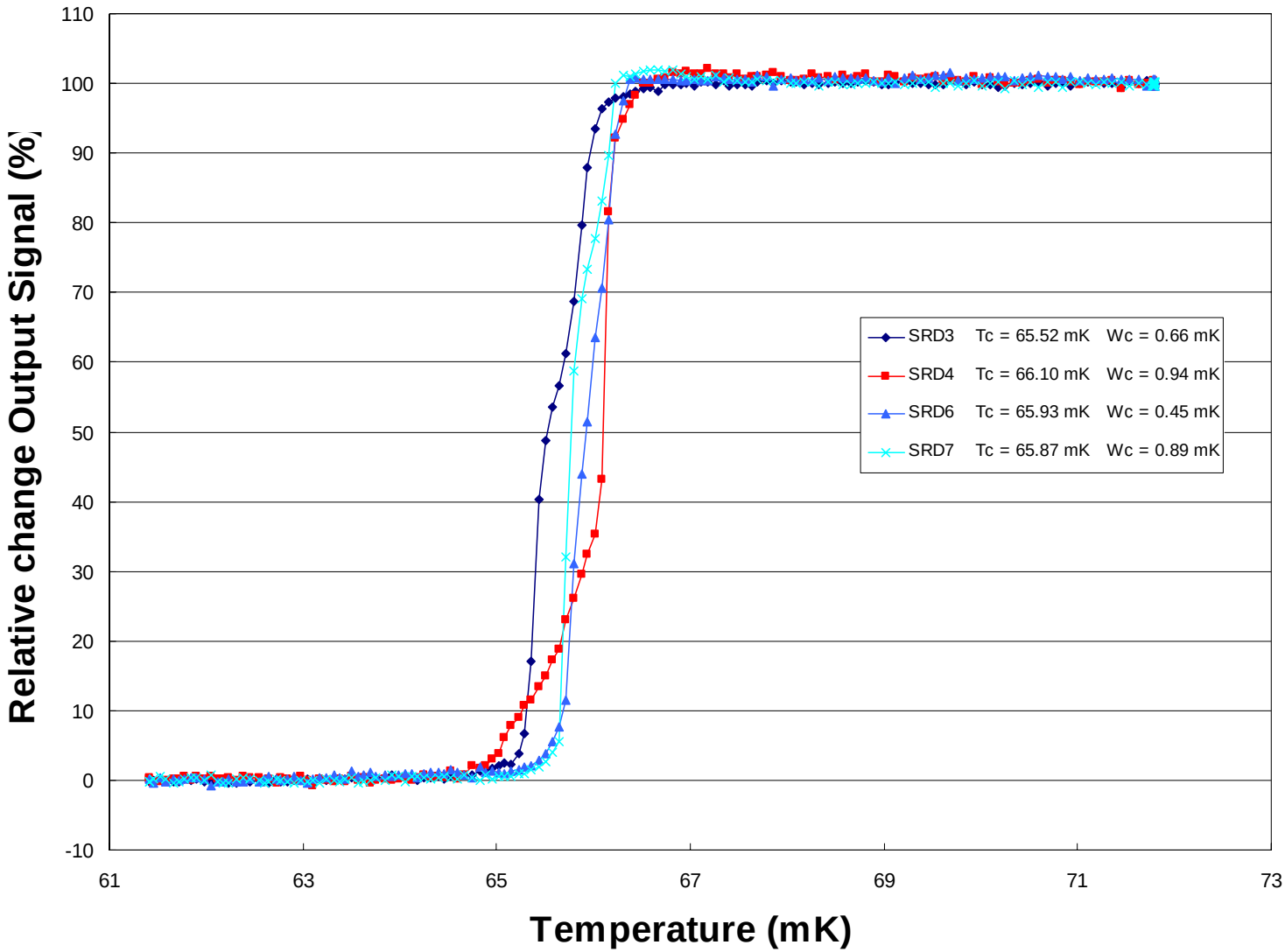
Calibration of prototypes at NMi-VSL

Berillium (run 11)



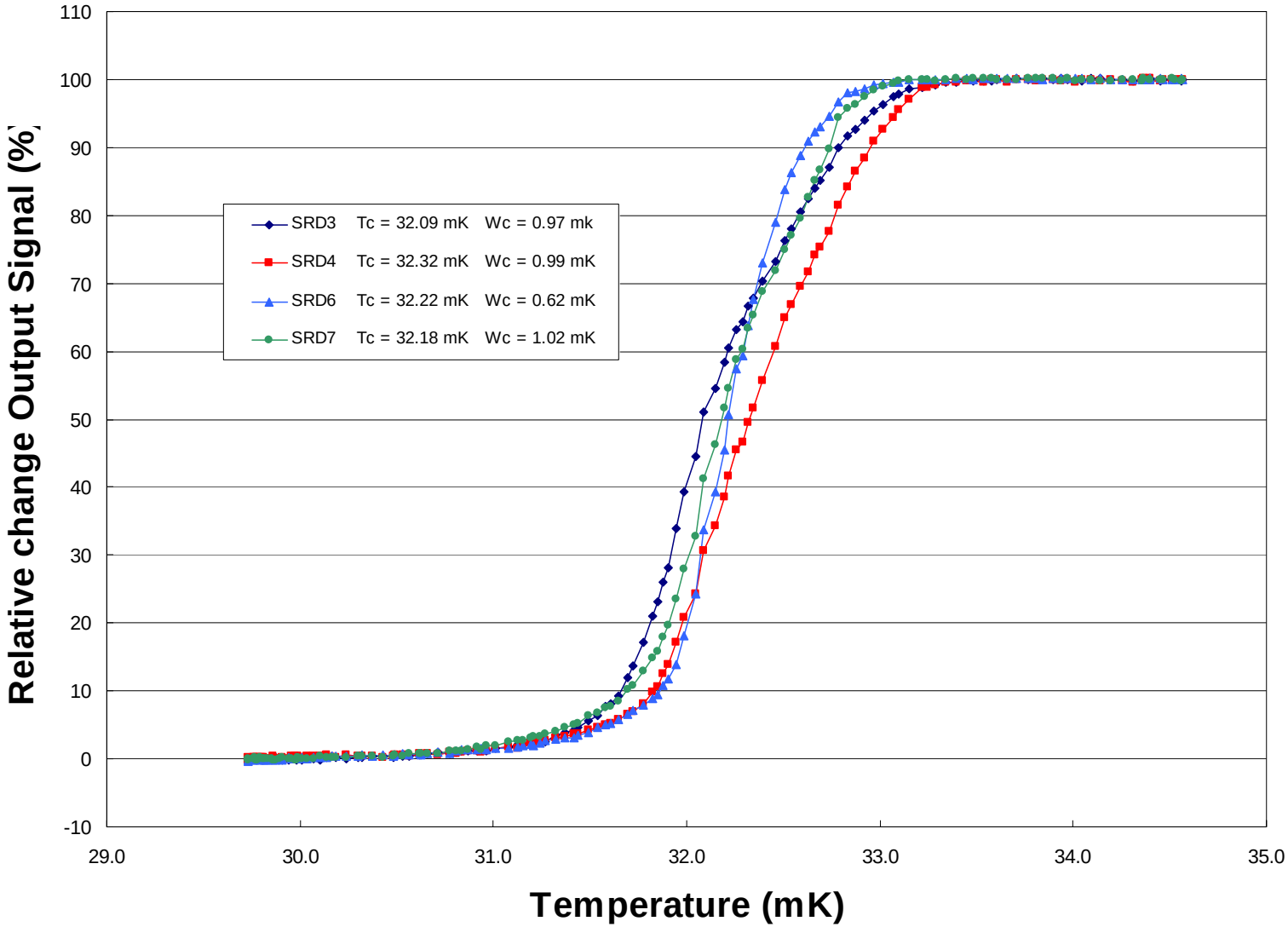
Calibration of prototypes at NMi-VSL

Ir92Rh08 (run 11)



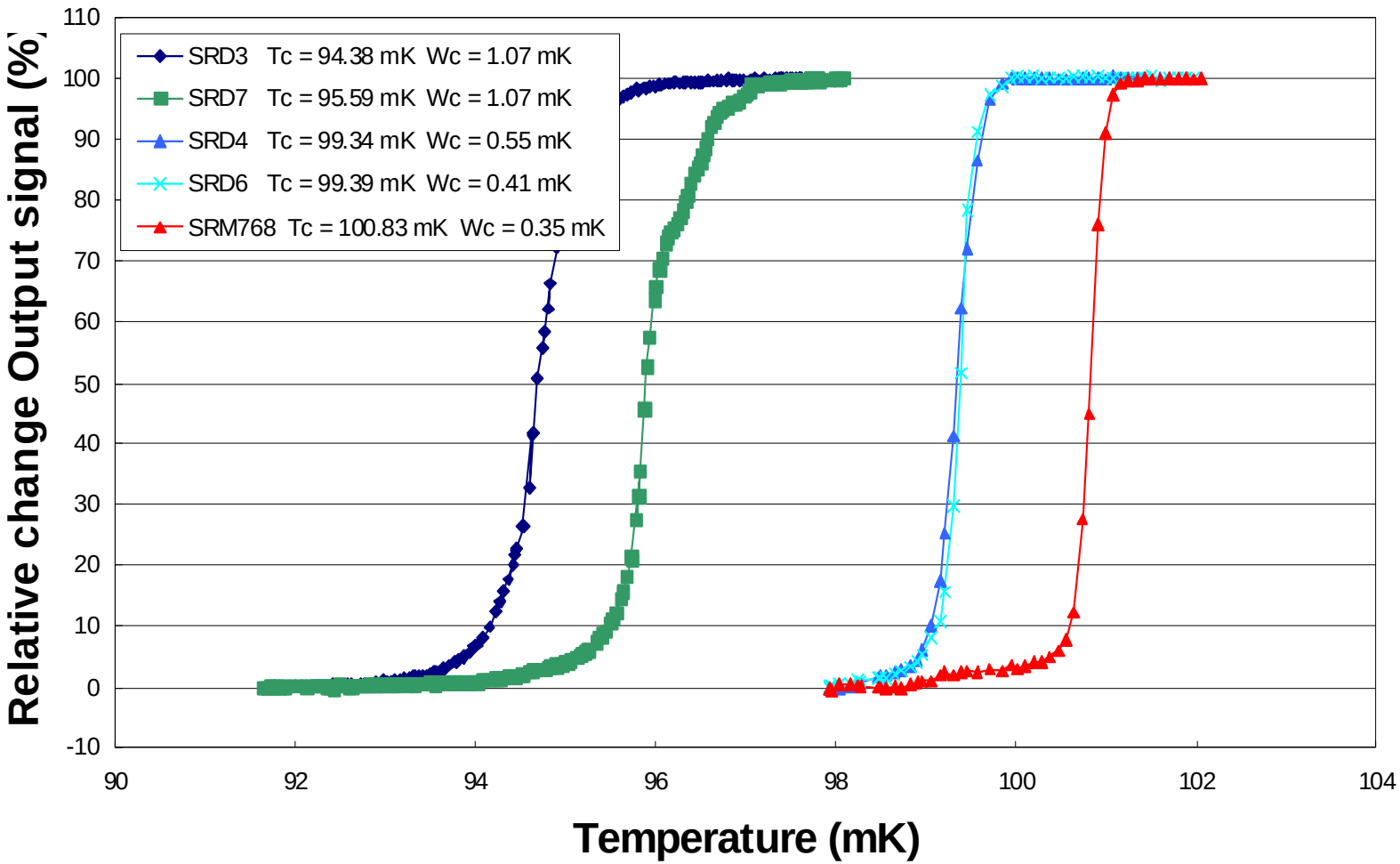
Calibration of prototypes at NMi-VSL

Ir80Rh20 (run 11)



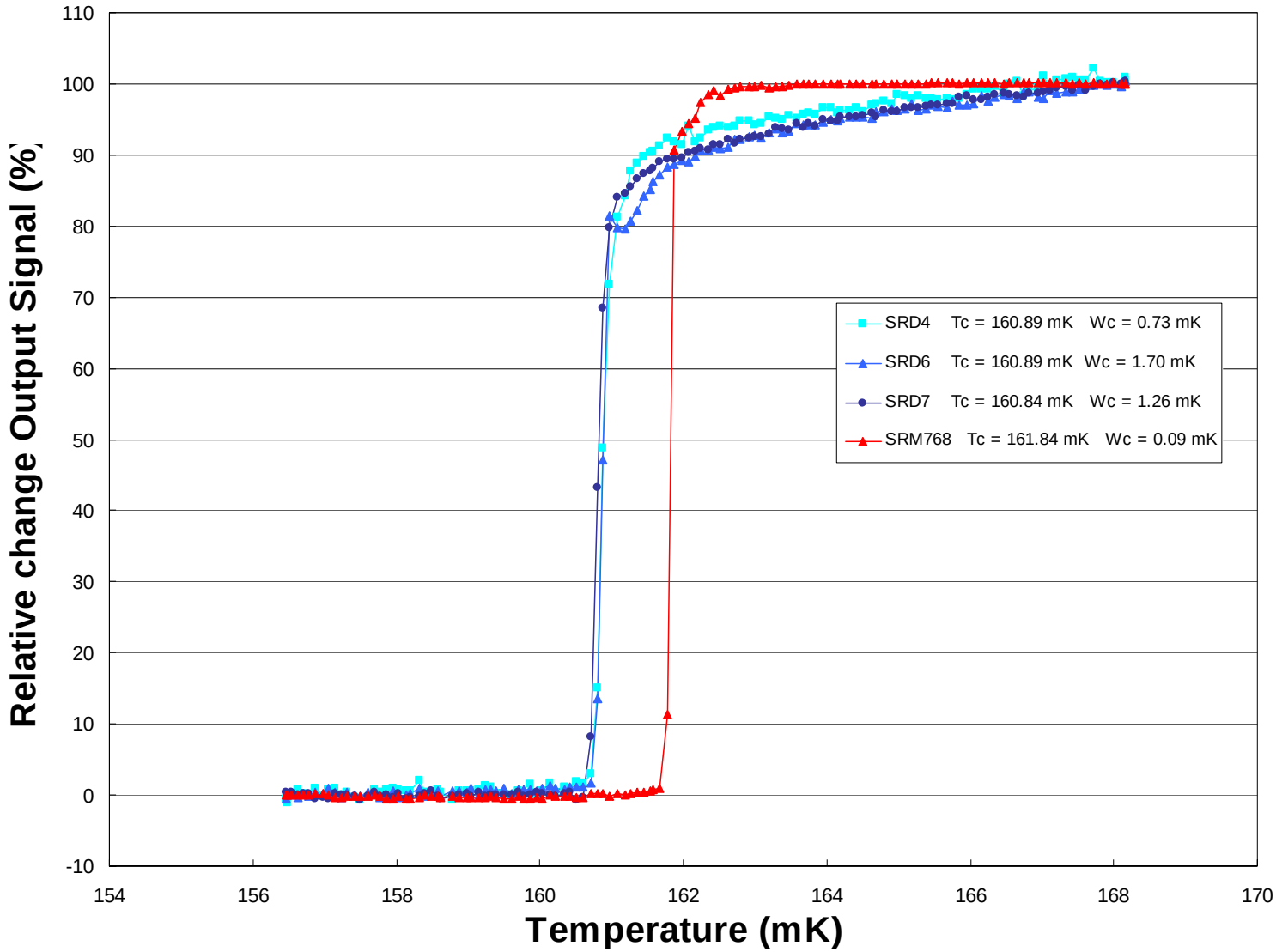
Calibration of prototypes at NMi-VSL

Iridium (run 11)



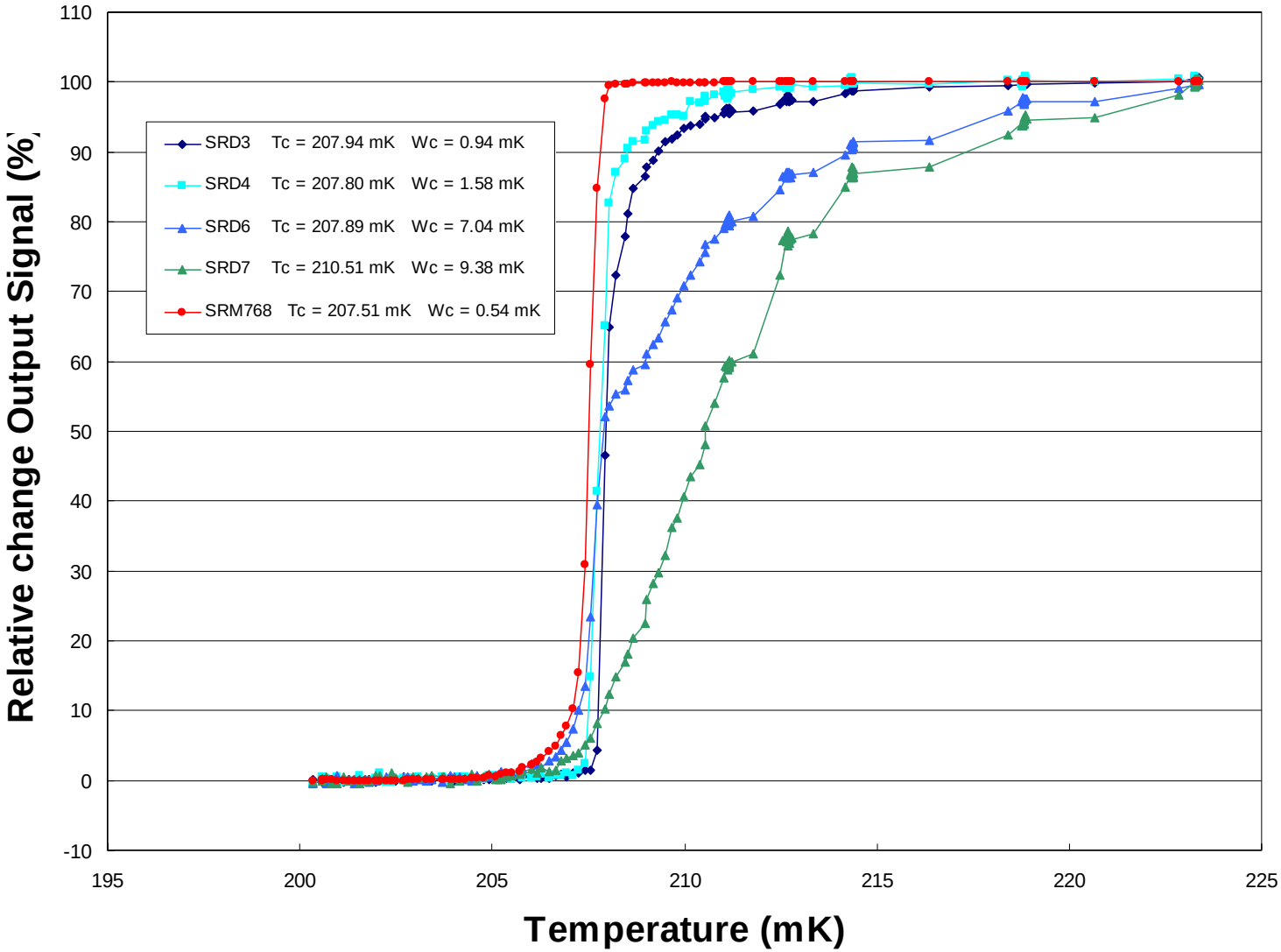
Calibration of prototypes at NMi-VSL

AuAl2 (run 11)



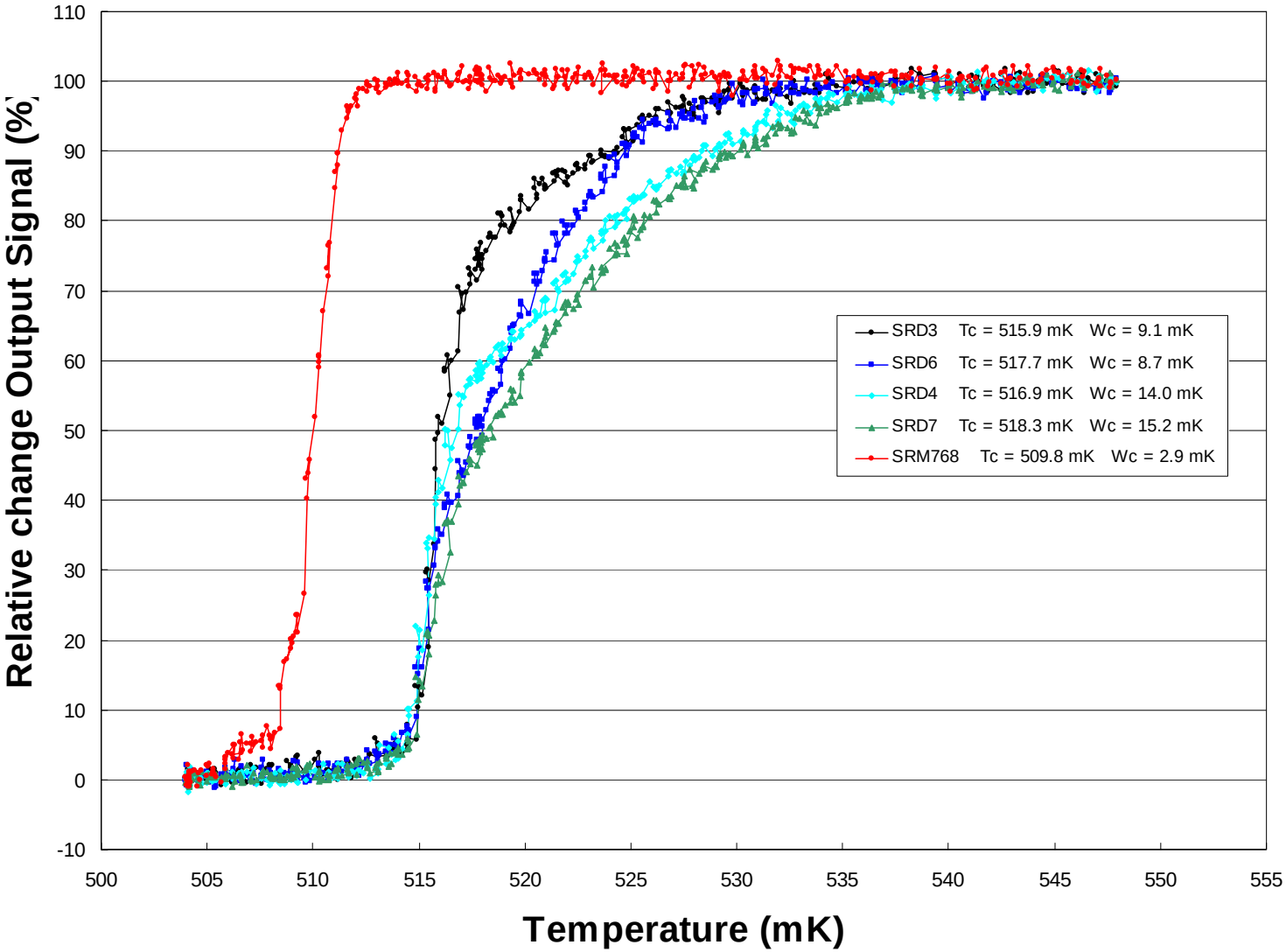
Calibration of prototypes at NMi-VSL

AuIn2 (run 11)



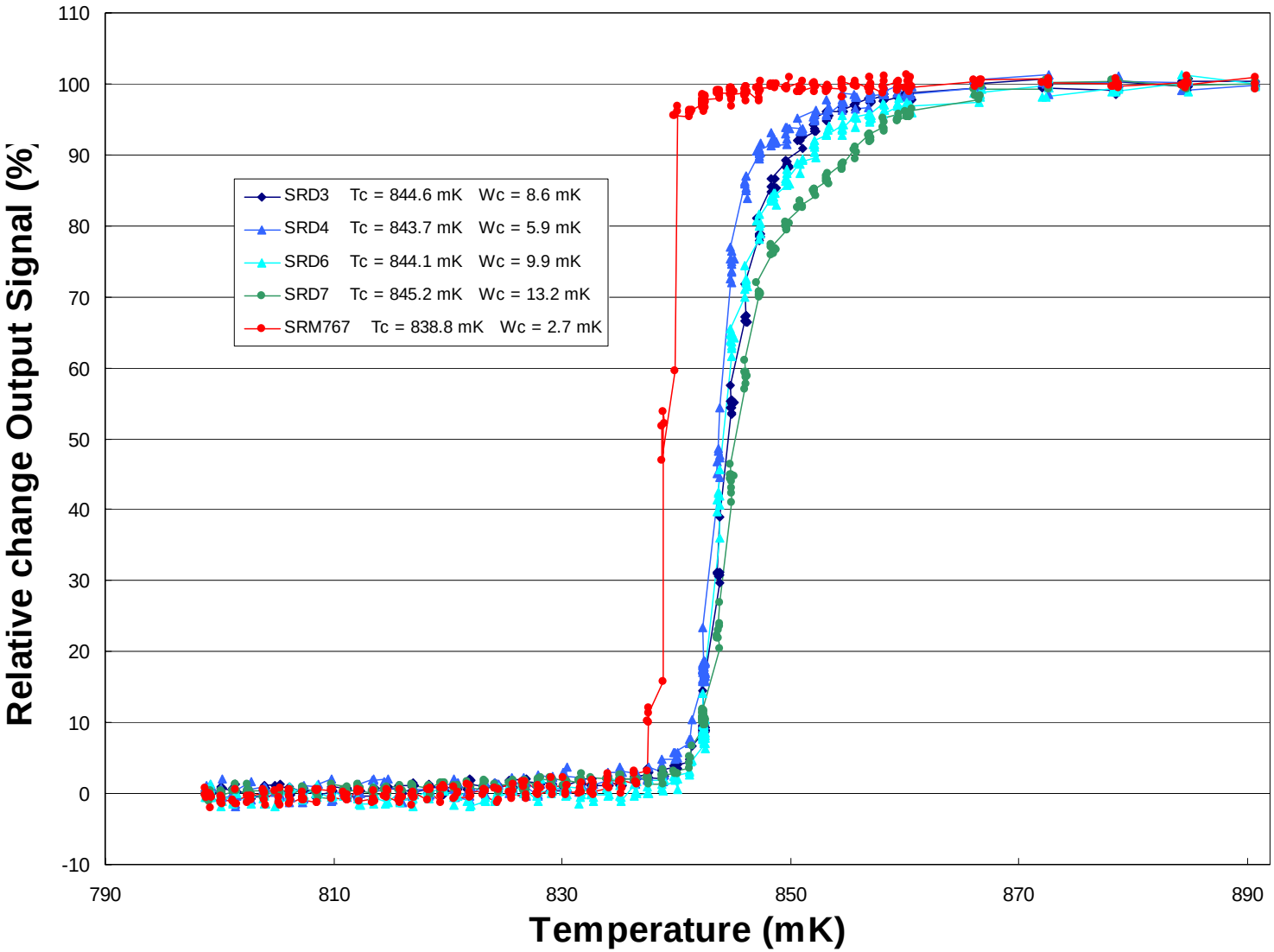
Calibration of prototypes at NMi-VSL

Cadmium (run 11)



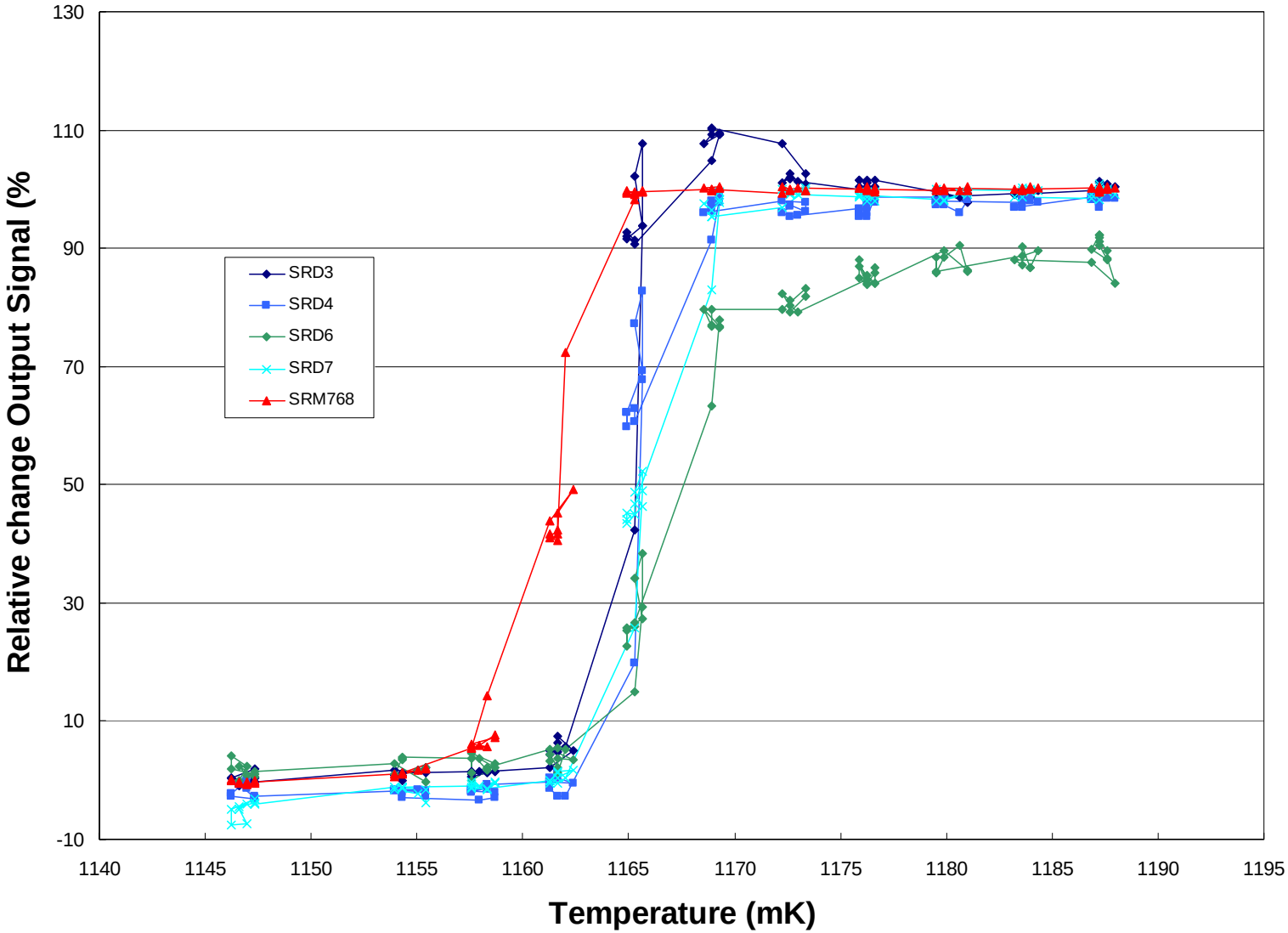
Calibration of prototypes at NMi-VSL

Zinc (run 11)



Calibration of prototypes at NMi-VSL

Aluminium (run 11)



Improvements to samples after run 11

$AuAl_2$ - annealing, pretest samples before mounting in prototypes
- new samples were mounted in SRD003 and SRD006

$AuIn_2$ - other batch produces better samples, pretest samples
- new sample was mounted in SRD006

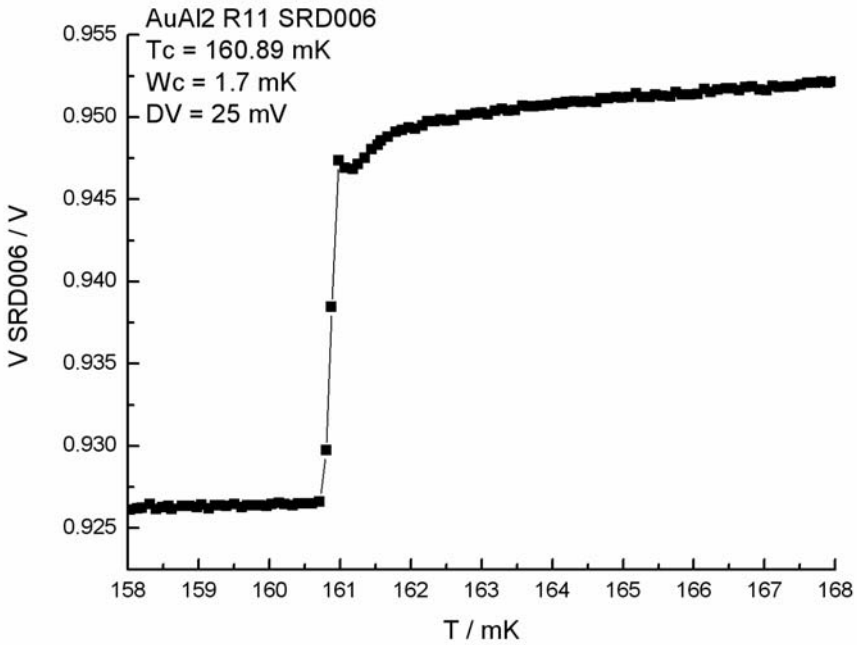
Cd - etching the surface reduces *Wc* by factor 3

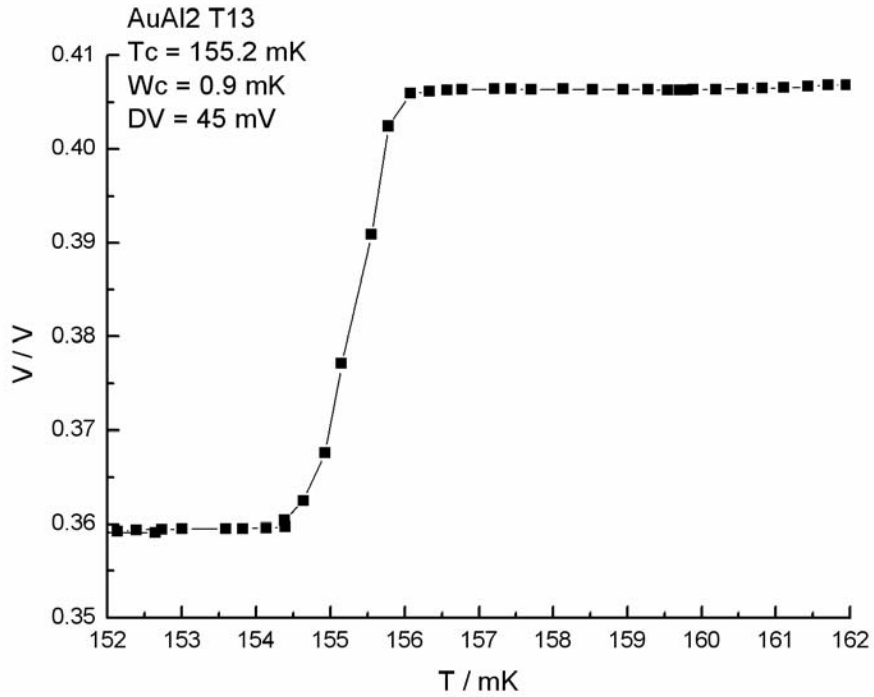
Zn - etching gives no improvement

Al - annealed wire replaces foil to reduce upturn effect bond wires
- new samples were mounted in SRD003 and SRD006

Improvements to samples after run 11

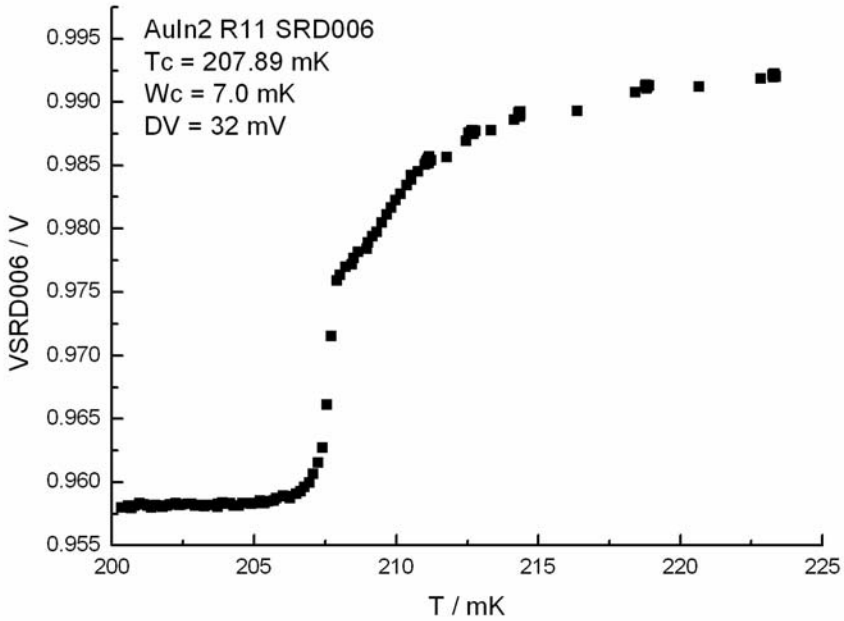
$AuAl_2$

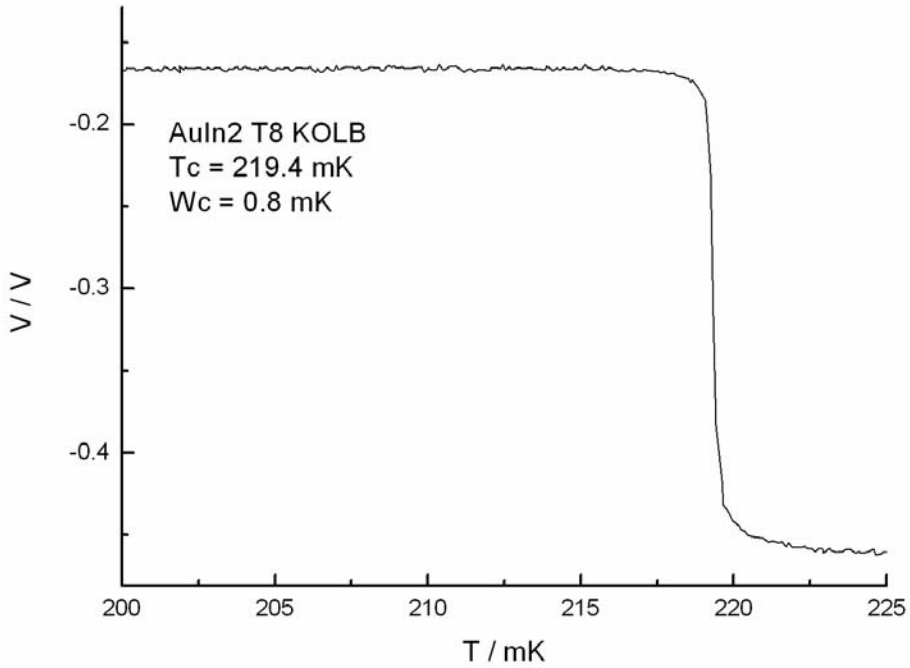




Improvements to samples after run 11

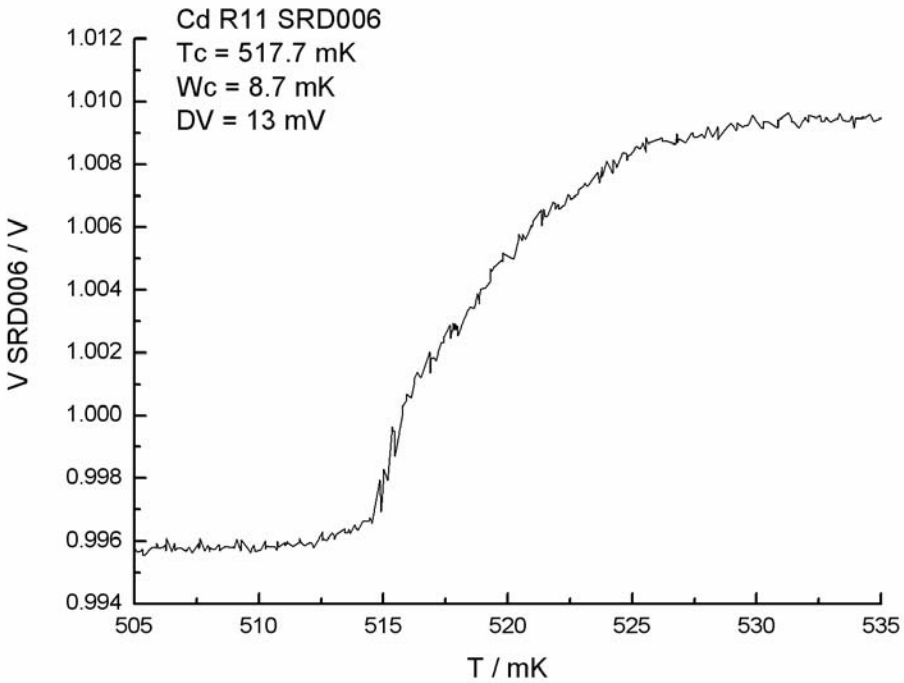
$AuIn_2$

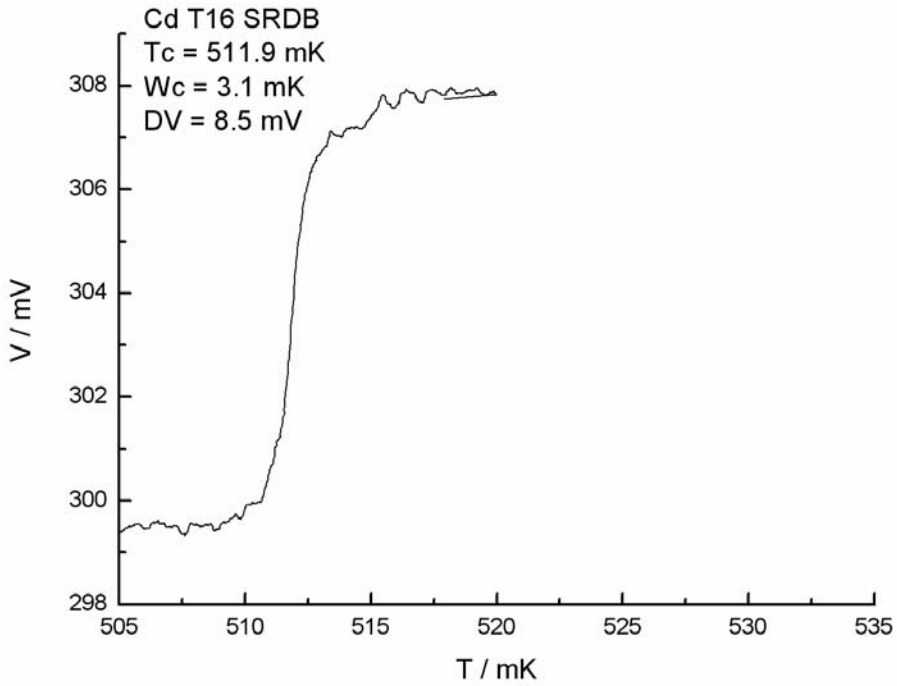




Improvements to samples after run 11

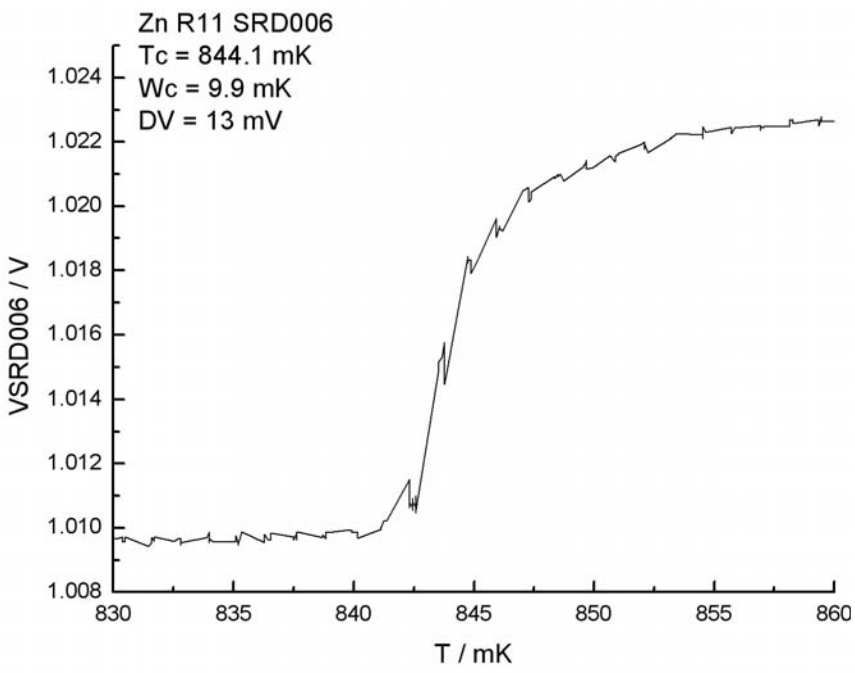
Cd

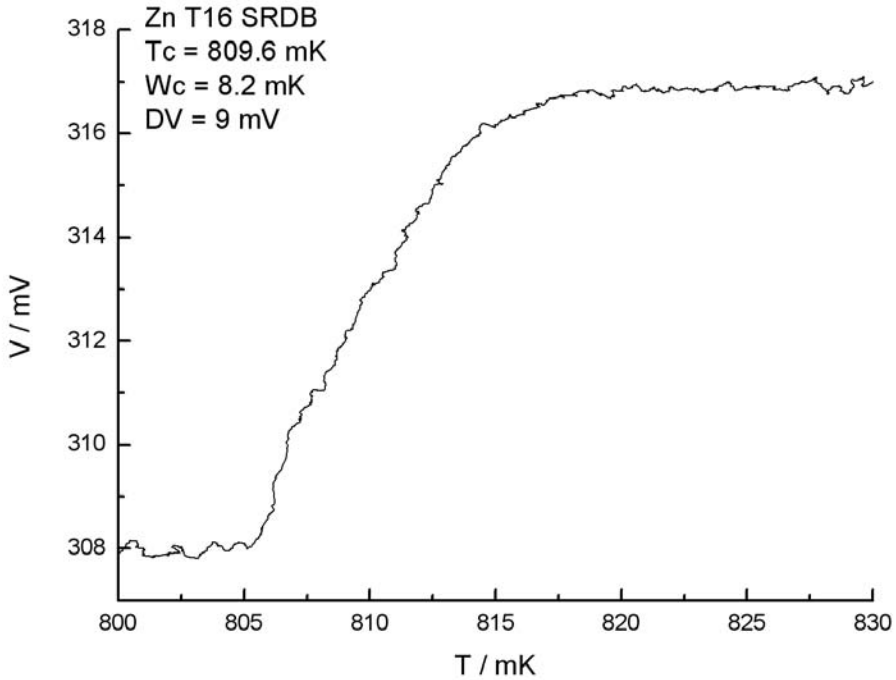




Improvements to samples after run 11

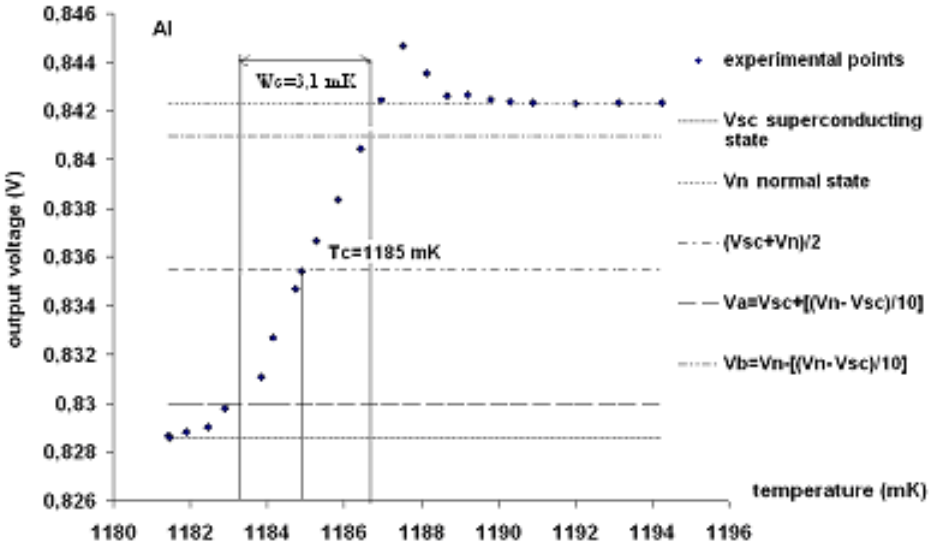
Zn



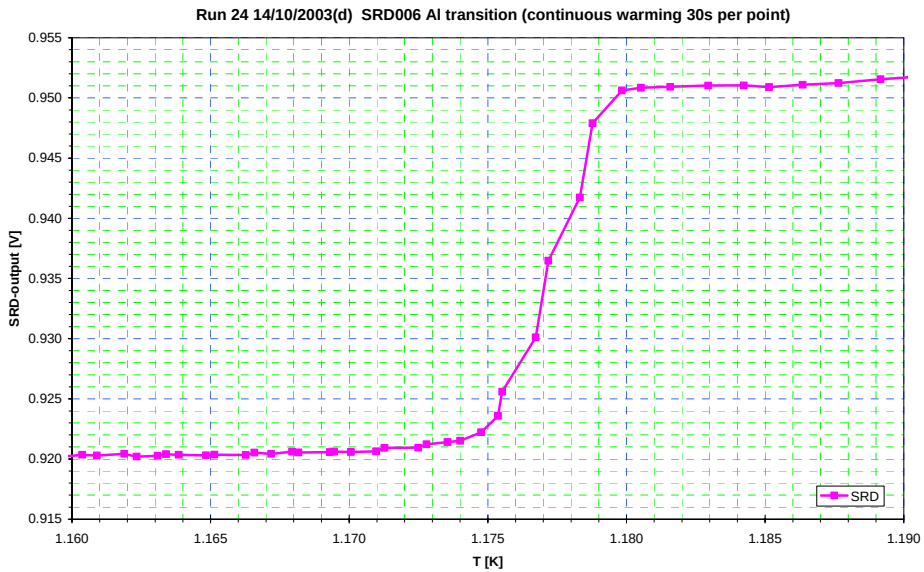


Improvements to samples after run 11

Al



SRD005 / BNM



SRD006 / NPL

Evaluation of prototypes

#	calibration	samples modified	evaluation	status
SRD003	run 11	$AuAl_2$, Al	CNRS / AL	in progress
SRD004	run 11	-	PTB	report ready
SRD005	run 10	-	BNM-INM	report ready
SRD006	run 11	$AuIn_2$, $AuAl_2$, Al	NPL	in progress

Recent reports, posters, manuals, presentations

2003

- Peruzzi, A., de Groot, M.J. , "Evaluation of Uncertainty in the Realization of the Provisional Low Temperature Scale from 10 mK to 1 K at Nmi" in *Proceedings of the International Conference on the Uncertainty of Measurement UNCERT 2003);*

- SRD partners, 'Report on the development of SRD technology', May 2003, project deliverable 2.1;

- HDL, 'Information on the installation of an SRD1000 device in a dilution refrigerator', June 2003;

- HDL, 'Procedure to degauss the SRD1000 Cryoperm shielding using the DCS-10', June 2003;

- HDL, 'Checking the residual magnetic field inside the SRD1000 shielding at low temperatures using the ACS10', June 2003;

- Peruzzi, A., Bosch, W.A., 'Procedure for the Evaluation of SRD1000 prototypes', July 2003;

- Presentation by Andrea Peruzzi at the Wroclaw Low Temperature Thermometry seminar, October 2003;

- Presentation by Andrea Peruzzi at Estec / ESA Noordwijk, December 2003.

2002

- Bosch, W.A., et al. , “First Prototypes of the Superconductive Reference Device SRD1000”, in *Proceedings of the 8th Symposium on Temperature: Its Measurement and Control in Science and Industry*, Chicago, 2002;

- Bosch, W.A., et al., “SRD1000: a Superconductive Reference Device for thermometry below 1K”, poster presented at the LT23 conference Japan, 2002, and Physica B, 329-333 (2003), pp. 1562-1563.

2004 actions

- Reports: evaluation, TIP, final
- Market developmet
- Resources for calibrations
- Pilot series (5 - 10 devices)
- SRD technology
    - Improve sample quality, additional batches (Ir / Ir_xRh_y)
    - Mo single crystal (T_C = 900 mK) to replace Zn / Al
    - Ti layer with T_C = 300 mK
    - Include thermometer for interpolation (CMN / PdFe / AuEr)