Phase II advancement report & Pixel Barrel Mockup integration in to the Cooling System

[Report covering the period from 15 October to 5 December 2001]

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Participating part-time
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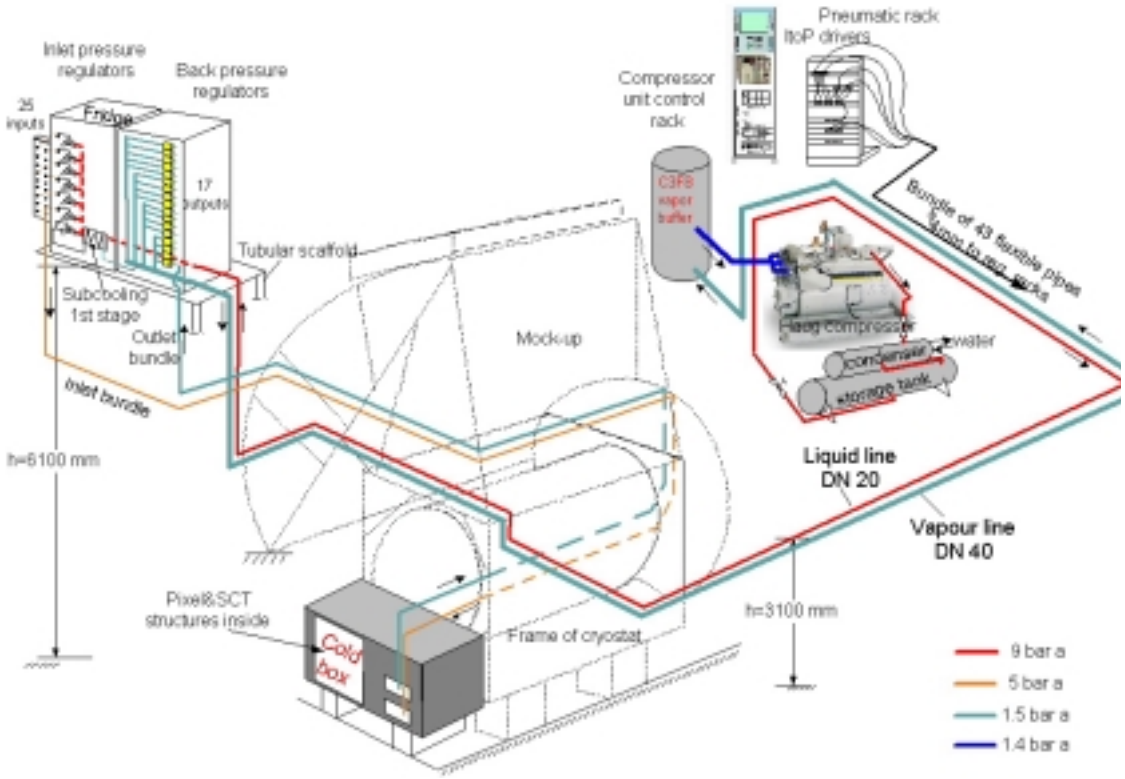
Agenda:

- Phase II progress
- Pixel structure installation in to the Cooling Circuit
- Performed tests and results
- Summary and conclusions

• Phase II Progress:



Second stage sub-cooling inlet has been moved close to the Cold box, more appropriate valve for the 1st stage sub-cooling was installed

***A Cooling system** is installed around Service Mockup structure in the Bldg. 175. Working fluid is C_3F_8. Target operational temperature of evaporation is around –25 ℃. Projected cooling power corresponds approximately to 6 kW.*

Progress overview:

Compressor-Condenser Unit – continuously operating since late September 2001.

Different sub-cooling loop [contra-flow] implemented and tested.

Pixel Barrel Mock-up connected and checked.

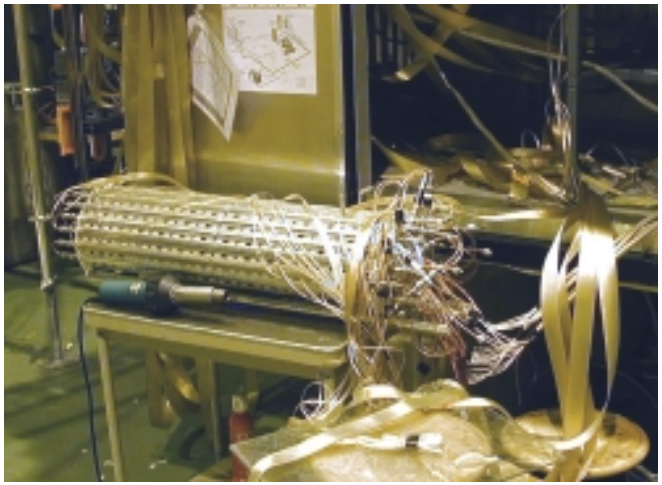
DAQ monitoring – improved and some bugs on SCT structures fixed; all necessary calibrations done, pixel part included in to the project.

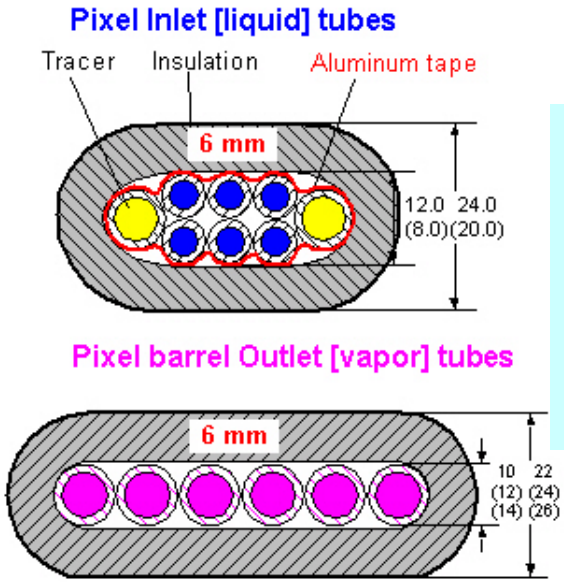
Power supply rack for pixel part completed and tested [variable power load, ILB connected] – it increases total available load for the CS circuit by 1.3 kW.

• Pixel structure installation in to the Cooling Circuit

ACTIONS:

- "CS" HARDWARE WORK [TUBE CONNECTIONS, SWG CROSSES, CAPILLARIES]
- SENSORS ATTACHEMENT & CABLING & e-LMB CALIBRATION and PVSS PROJECT MODIFICATION
- POWER SUPPLIES AND ILB CABLING
- OVERALL TESTS OF THE INSTALLED STRUCTURE
- We do appreciate 4 days help of the **GENOVA technicians** (F. Vernocchi and A. Rovani) during final cabling work

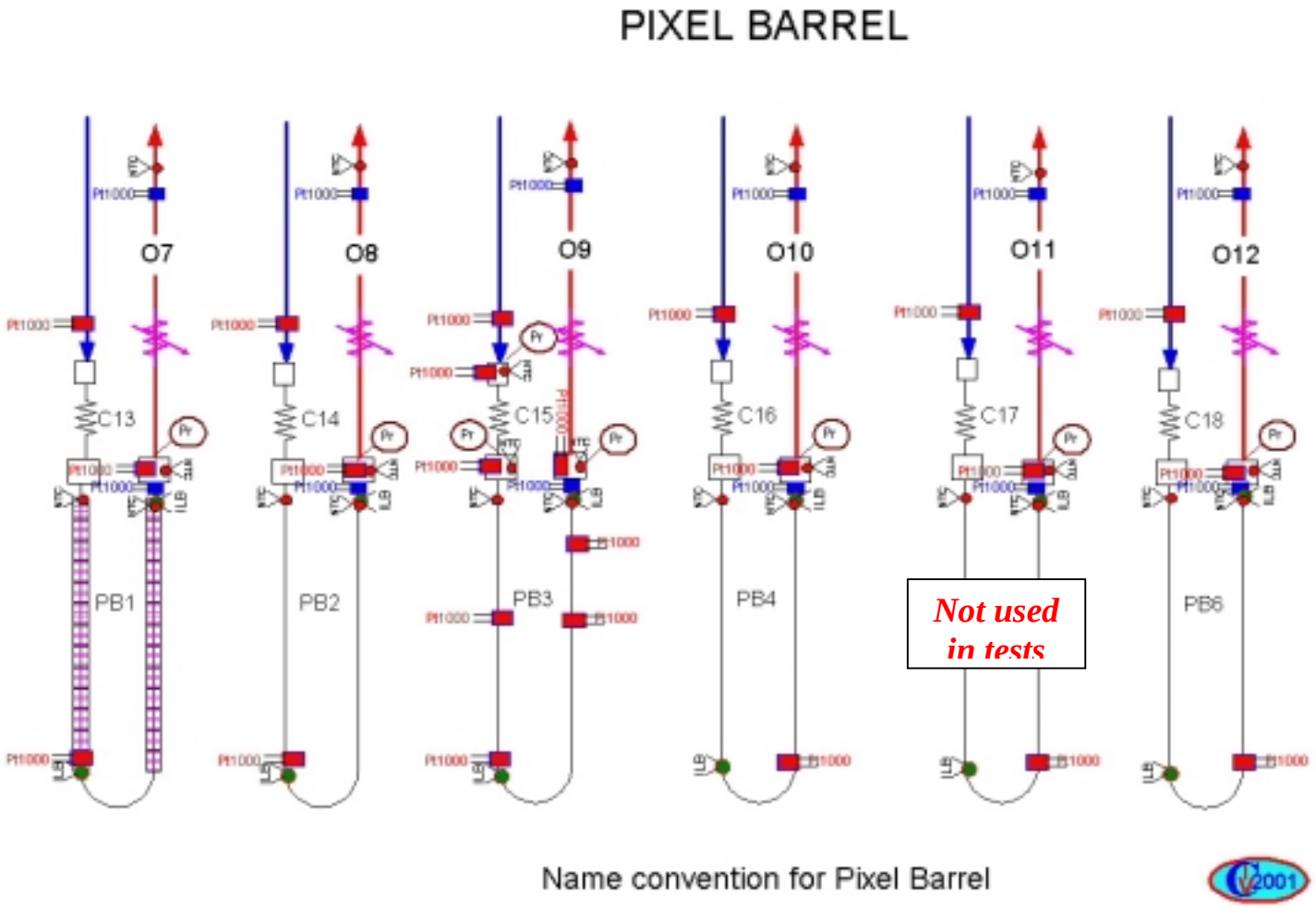




Outlet [vapor] tubes heated after the Cold box with 0.7 m long heater [500W] with safety thermo-switch set to 50 °C

Stucture	Tubes	Place	OD/ID	Length approx
	[fluid type]		[mm]	[m]
	Liquid	from reg. Rack	6mm/4mm	19.7
Pixel Barrel		to Cold box	4mm/2mm	2.6
Mockup		in Cold box	4mm/2mm	1
		Capillary	ID=0.8mm	60/70/8090
	Vapour	in Cold box	8mm/6mm	~2.4
		from Cold box	10mm/8mm	7
			12mm/10mm	7.6
		to the Rack	14mm/12mm	5.9
	liq/vap	PBarMcp tracers	2 lines 8mm/6mm	22.3

INSTALLED SENSORS AND THEIR PLACEMENT



SENSORS:

e-LMB monitoring:

- **8 pressure sensors**

[7 of **Press_Tr_BT7005A7C** [up to 5 bara]
[1 of **Press_Tr _ BT7007A7C** [up to 7 bara]

- **26 NTC's**
- **16 Pt1000's**

ILB uses:

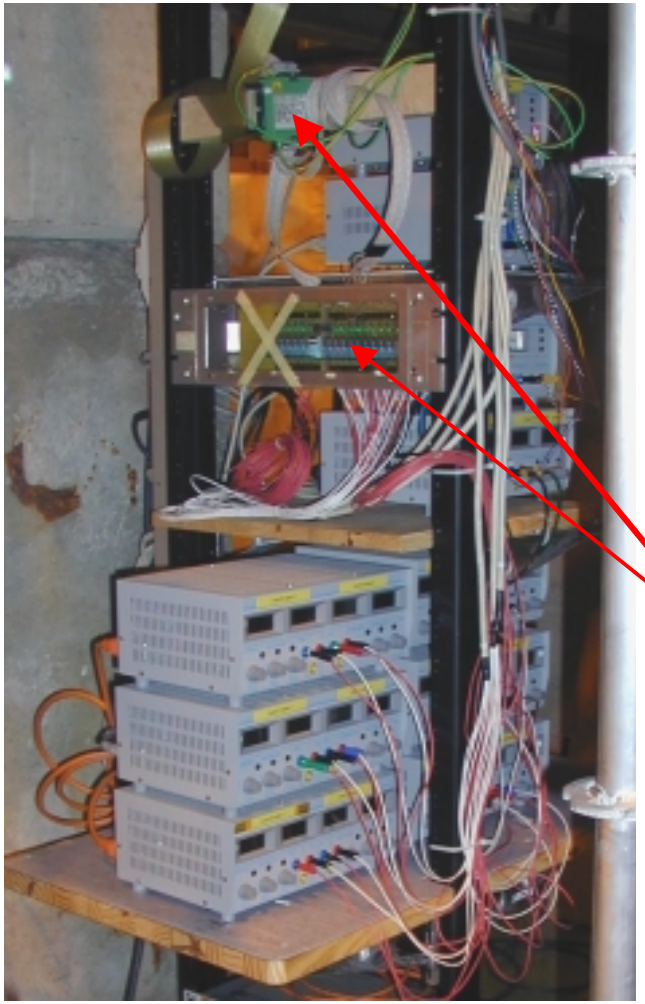
- **12 NTC**'s, each of them placed on the surface at the end of the stave

PCL control sensors [PID]

- **12 Pt1000's**

Note:
Swagelok crosses replaced original massive blocks and sensors monitor temperature of the fluid directly [probes mounted in Swagelok crosses

Power supplies and the ILB:



- Power supply rack was assembled with:
  - 7 dual Power supplies PS-2403D [40V / 3A]
  - 3 single Power supplies PS-303A [30V / 3A]

There are 12 individually powered staves arranged in 6 loops attached to the barrel mockup. Power can be set individually on each stave in the range from 0 W to 100 W via 6 dual power supplies. Small heaters are attached to the outlet tube of the each pixel loop. Expected dissipating power load is around 20 W per heater. Two single power supplies and one half of the dual power supply are used for them. The second half of the dual power supply is used to power Relais switch board.

- Pixel Interlock Box and Relay Switch board:
  - Each of the 12 staves has an individual NTC sensor for **ILB**, and the "limit" temperature for the stave is set to 20 °C.

We do appreciate initiative and help of our colleagues from **Wuppertal University**; Suzan Kersten who helped us with ILB & power supplies and Peter Kind who prepared Relay Switch board and detailed instruction for wiring up the setup

DAQ monitoring status [e-LMBs, PVSS, PLC …]

Sensors are connected into the **e-LMB #7** using **four flat cables**

Pixel / Cable #3 /
16 Pt1000 / Ch 0-15

Pixel / Cable #4 /
8 Press / Ch 32-39
7 Pt1000 / Ch 40-46

Pixel / Cable #2 /
14 NTC / Ch 16-29

Pixel / Cable #1 /
12 NTC / Ch 48-59

Major improvement were introduced in the PVSS project monitoring:

- Some “bugs” on the SCT structures were cleared
- All necessary calibrations done to all 7 eLMB boxes [eLMBs, adapters and sensors].
- Mobile Prague DAQ with reference calibrated sensors was used for the verification. Former differences between NTC and Pt1000 reading were eliminated.
- Monitoring project can run in two modes [Scan mode and with OPC server presence].
- Major problems with monitoring stability were eliminated, but minor problems still appear. More work needed.
- Data retrieval procedure from the database has to be improved.
- **Pixel part is included in to the project.**

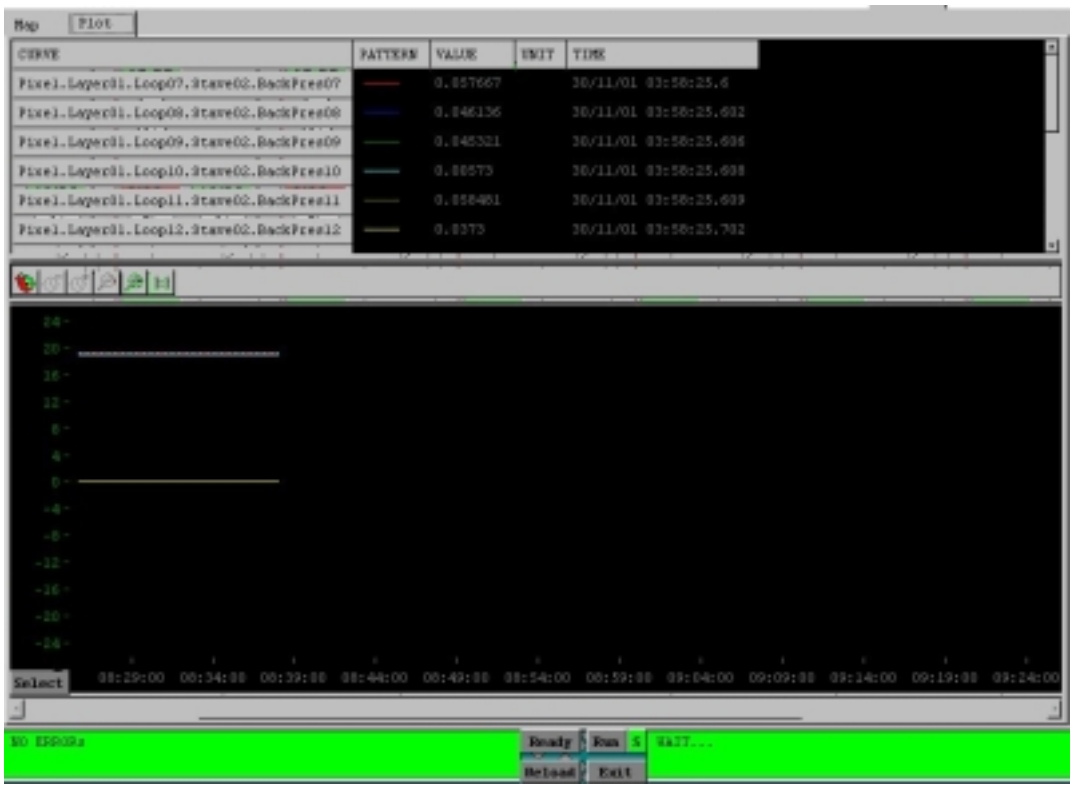
Listing of the Pixel Barrel Sensors from the PVSS project database

ID	Level05	Level04	Level03	Level02	Level01	Unit	Chan
385	Pixel	Layer01	Loop07	Stave02	BackPres07	6	32
386	Pixel	Layer01	Loop07	Stave01	CapiTemp01	6	0
387	Pixel	Layer01	Loop07	Stave01	ModlTemp01	6	16
388	Pixel	Layer01	Loop07	Stave01	ModlTemp13	6	1
389	Pixel	Layer01	Loop07	Stave02	ModlTemp26	6	17
390	Pixel	Layer01	Loop07	Stave02	PipeTemp06	6	2
391	Pixel	Layer01	Loop07	Stave02	PipeTemp07	6	18
392	Pixel	Layer01	Loop07	Stave02	OutlTemp01	6	19
393	Pixel	Layer01	Loop08	Stave02	BackPres08	6	33
394	Pixel	Layer01	Loop08	Stave01	CapiTemp01	6	3
395	Pixel	Layer01	Loop08	Stave01	ModlTemp01	6	20
396	Pixel	Layer01	Loop08	Stave01	ModlTemp13	6	4
397	Pixel	Layer01	Loop08	Stave02	ModlTemp26	6	21
398	Pixel	Layer01	Loop08	Stave02	PipeTemp06	6	5
399	Pixel	Layer01	Loop08	Stave02	PipeTemp07	6	22
400	Pixel	Layer01	Loop08	Stave02	OutlTemp01	6	24
401	Pixel	Layer01	Loop09	Stave01	InjePres15	6	34
402	Pixel	Layer01	Loop09	Stave01	BackPres15	6	35
403	Pixel	Layer01	Loop09	Stave02	BackPres09	6	36
404	Pixel	Layer01	Loop09	Stave01	CapiTemp01	6	6
405	Pixel	Layer01	Loop09	Stave01	CapiTemp02	6	7
406	Pixel	Layer01	Loop09	Stave01	CapiTemp03	6	25
407	Pixel	Layer01	Loop09	Stave01	CapiTemp04	6	8
408	Pixel	Layer01	Loop09	Stave01	CapiTemp05	6	26
409	Pixel	Layer01	Loop09	Stave01	ModlTemp01	6	27
410	Pixel	Layer01	Loop09	Stave01	ModlTemp08	6	9
411	Pixel	Layer01	Loop09	Stave01	ModlTemp13	6	10
412	Pixel	Layer01	Loop09	Stave02	ModlTemp19	6	11
413	Pixel	Layer01	Loop09	Stave02	ModlTemp24	6	12
414	Pixel	Layer01	Loop09	Stave02	ModlTemp26	6	28
415	Pixel	Layer01	Loop09	Stave02	PipeTemp06	6	13
416	Pixel	Layer01	Loop09	Stave02	PipeTemp07	6	29
417	Pixel	Layer01	Loop09	Stave02	OutlTemp01	6	30
418	Pixel	Layer01	Loop10	Stave02	BackPres10	6	37
419	Pixel	Layer01	Loop10	Stave01	CapiTemp01	6	14
420	Pixel	Layer01	Loop10	Stave01	ModlTemp01	6	48
421	Pixel	Layer01	Loop10	Stave02	ModlTemp14	6	15
422	Pixel	Layer01	Loop10	Stave02	ModlTemp26	6	49
423	Pixel	Layer01	Loop10	Stave02	PipeTemp06	6	40
424	Pixel	Layer01	Loop10	Stave02	PipeTemp07	6	50
425	Pixel	Layer01	Loop10	Stave02	OutlTemp01	6	51
426	Pixel	Layer01	Loop11	Stave02	BackPres11	6	38
427	Pixel	Layer01	Loop11	Stave01	CapiTemp01	6	41
428	Pixel	Layer01	Loop11	Stave01	ModlTemp01	6	52
429	Pixel	Layer01	Loop11	Stave02	ModlTemp14	6	42
430	Pixel	Layer01	Loop11	Stave02	ModlTemp26	6	53
431	Pixel	Layer01	Loop11	Stave02	PipeTemp06	6	43
432	Pixel	Layer01	Loop11	Stave02	PipeTemp07	6	54
433	Pixel	Layer01	Loop11	Stave02	OutlTemp01	6	55
434	Pixel	Layer01	Loop12	Stave02	BackPres12	6	39
435	Pixel	Layer01	Loop12	Stave01	CapiTemp01	6	44
436	Pixel	Layer01	Loop12	Stave01	ModlTemp01	6	56
437	Pixel	Layer01	Loop12	Stave02	ModlTemp14	6	45
438	Pixel	Layer01	Loop12	Stave02	ModlTemp26	6	57
439	Pixel	Layer01	Loop12	Stave02	PipeTemp06	6	46
440	Pixel	Layer01	Loop12	Stave02	PipeTemp07	6	58
441	Pixel	Layer01	Loop12	Stave02	OutlTemp01	6	59

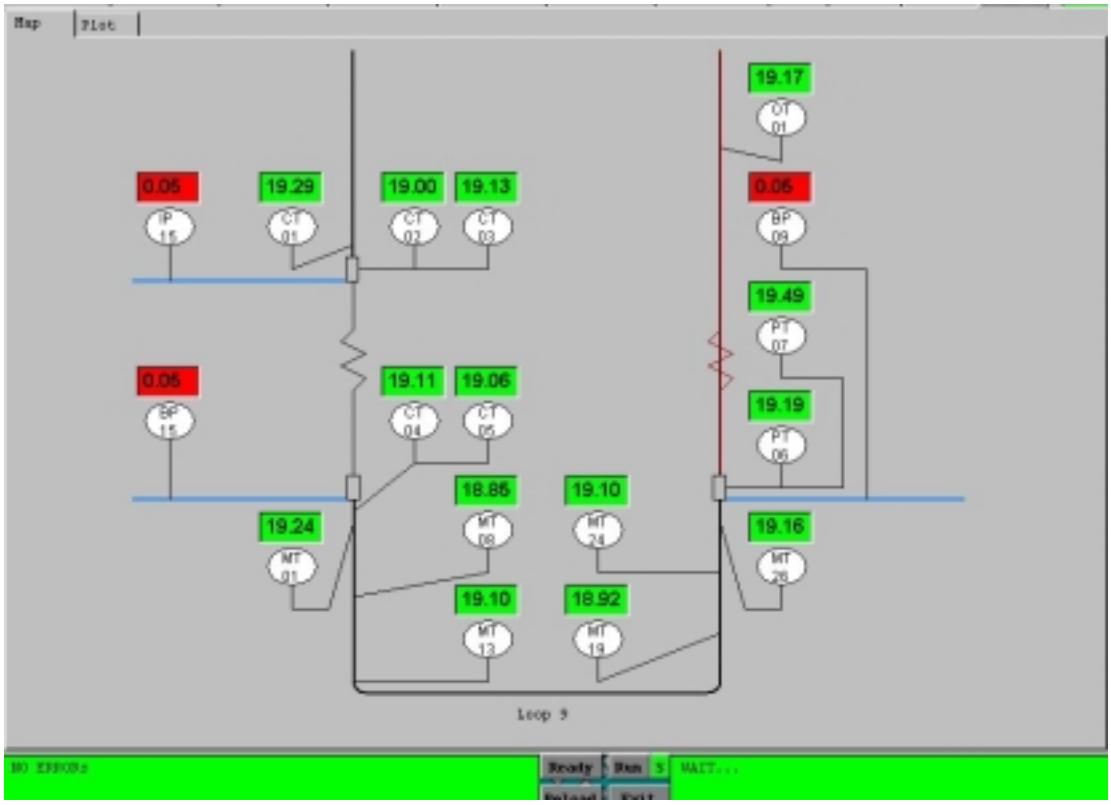
Monitoring during test runs [Screens and features]:

Basic Screen

Adequate plot mode for the basic screen



Extended Pixel Barrel Loop # 09



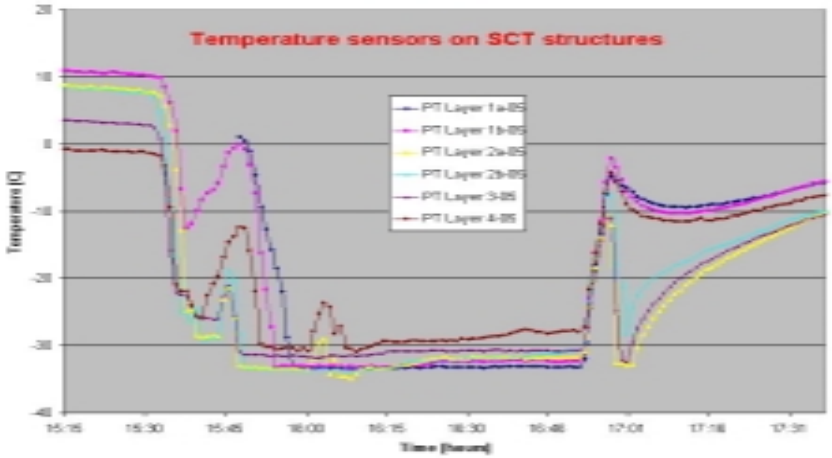
Flow control & comments on PLC:

Control system based on the PLC is used for the Cooling Circuit due to the fact that present status of development work does not allow to use eLMB+PVSS for the purpose.

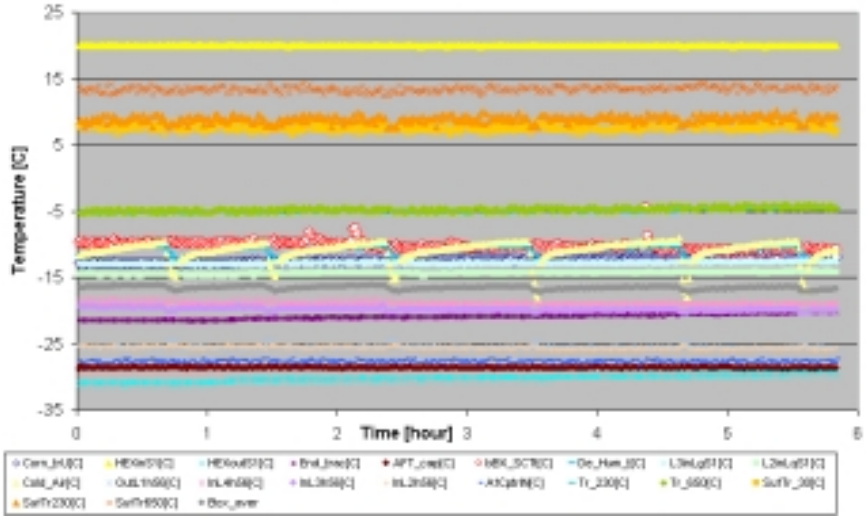
- PLC control and monitoring features were fully implemented and verified on the Compressor Condenser Unit [unattended continuous run since September 2001]
- More development work and time needed for PLC flow control features
- PLC flow control system may work at the end of the year

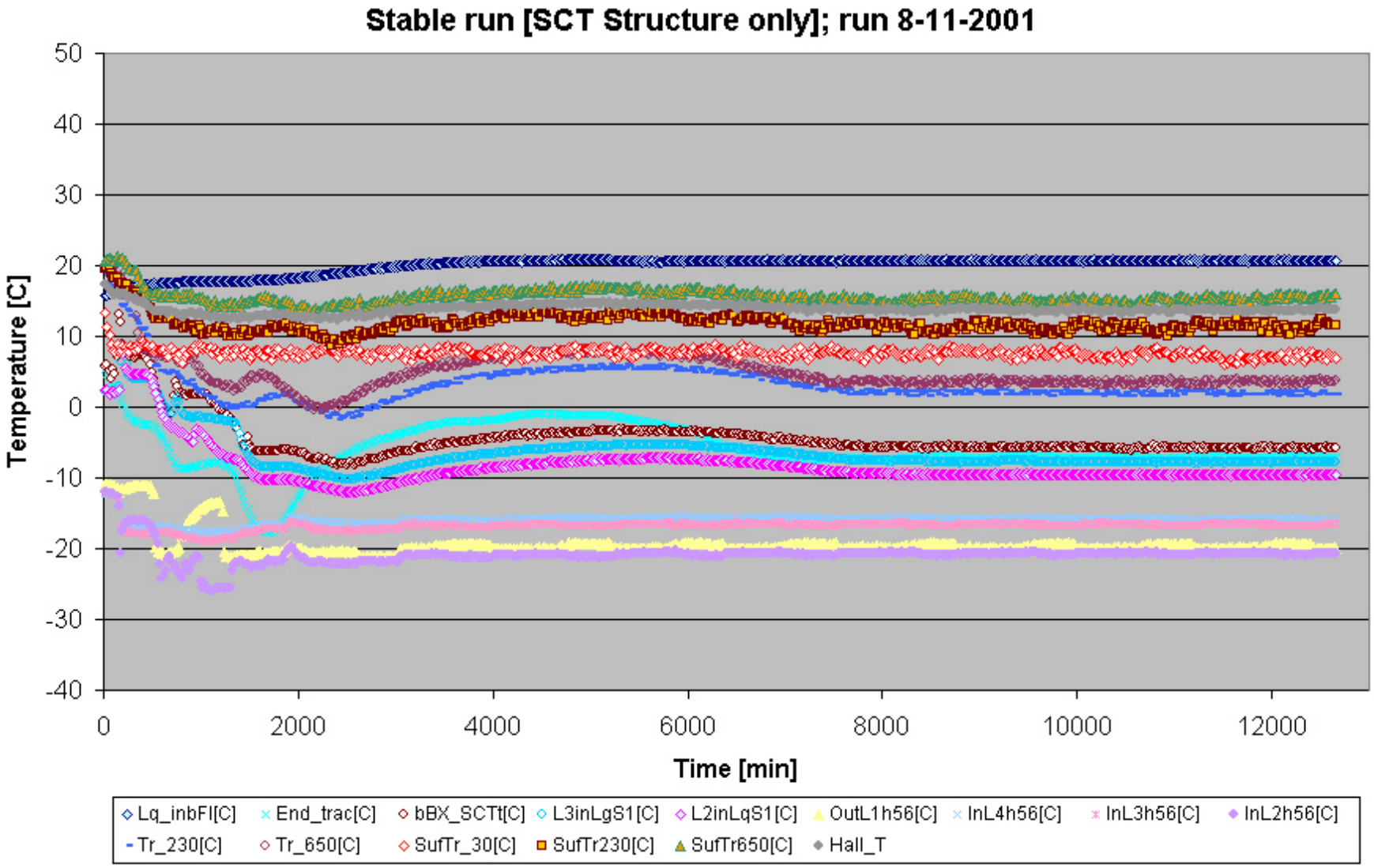
- **Measurements and Tests performed**

- **Tests with SCT structure have been repeated and comparable results were achieved while running at stable conditions [limitation for these test was 50% of the nominal power of the SCT load] – the first two weeks in October**
- **Basic verification of newly adopted sub-cooling lines was performed [stable condition observed even with 1st stage sub-cooling for the tests]**
- **Intensive tests and verification of the DAQ monitoring from middle of October until 12 November 2001**
- **Work on Pixel Barrel integration into the system from November 13 until November 30, 2001**



The 1st stage sub-cool; the first 6 hours

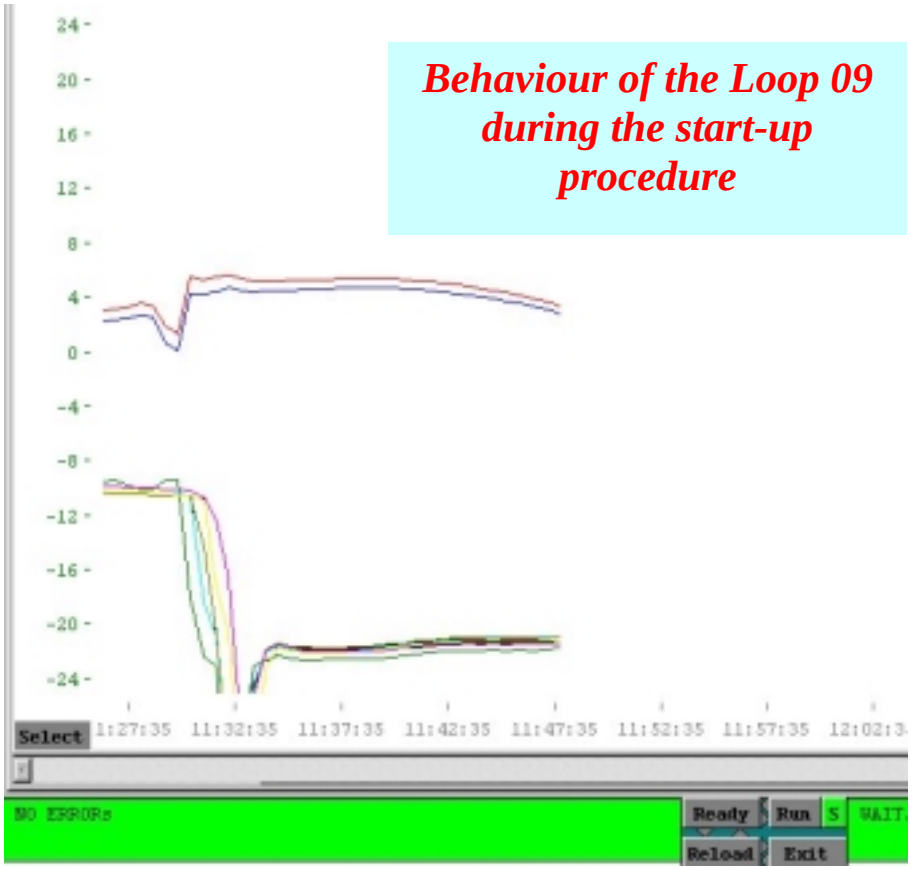



Stable run [SCT Structure only]; run 8-11-2001
Temperature [C]
50
40
30
20
10
0
-10
-20
-30
-40
0
2000
4000
6000
8000
10000
12000
Time [min]
Lq_inbFl[C]
End_trac[C]
bBX_SCTt[C]
L3inLgS1[C]
L2inLqS1[C]
OutL1h56[C]
InL4h56[C]
InL3h56[C]
InL2h56[C]
Tr_230[C]
Tr_650[C]
SufTr_30[C]
SufTr230[C]
SufTr650[C]
Hall_T

- **Measurements and Tests Performed with Pixel Barrel Mockup:**
  - **Pixel Barrel Mockup measurements using the Phase II circulator started on Sunday, December 2, 2001**

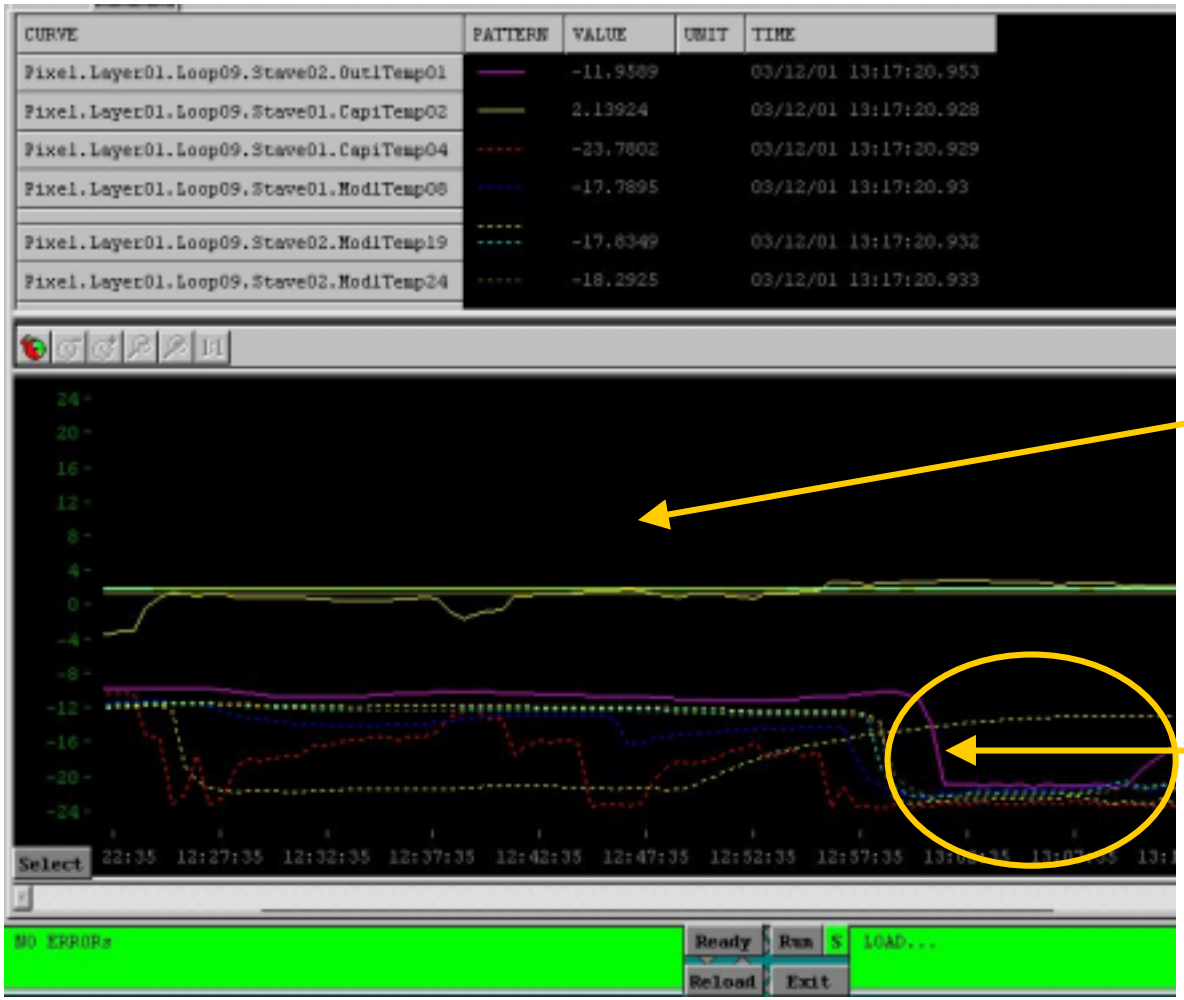
Standard tests were conducted so far:

- Start up procedure
- Runs without power and "search" for a minimum acceptable flow regime
- Runs with full power and observation of the surface temperature on the structure
- Runs with full power and establishing the minimal flow required to cool down the structure
- Sudden power cut-off [i.e. failure] and reaction of the system



Behaviour of the Loop 09 during the start-up procedure

- Runs without power and “search” for a minimum acceptable flow regime



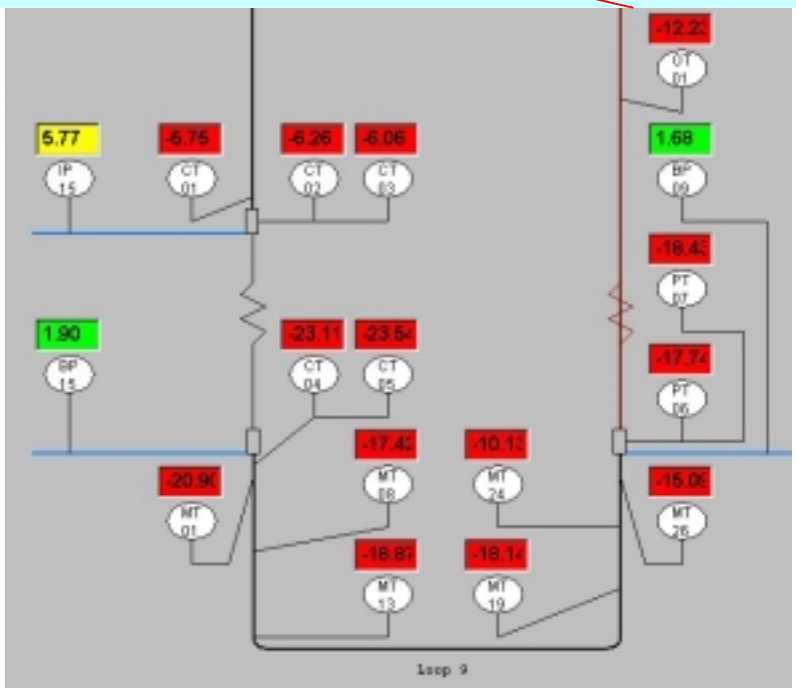
Behaviour of the Loop 09 during the “No Power”run and setting up the minimal flow through the structure

Outlet temperature of the exhaust tube exiting the Cold Box [i.e. Thermal enclosure]

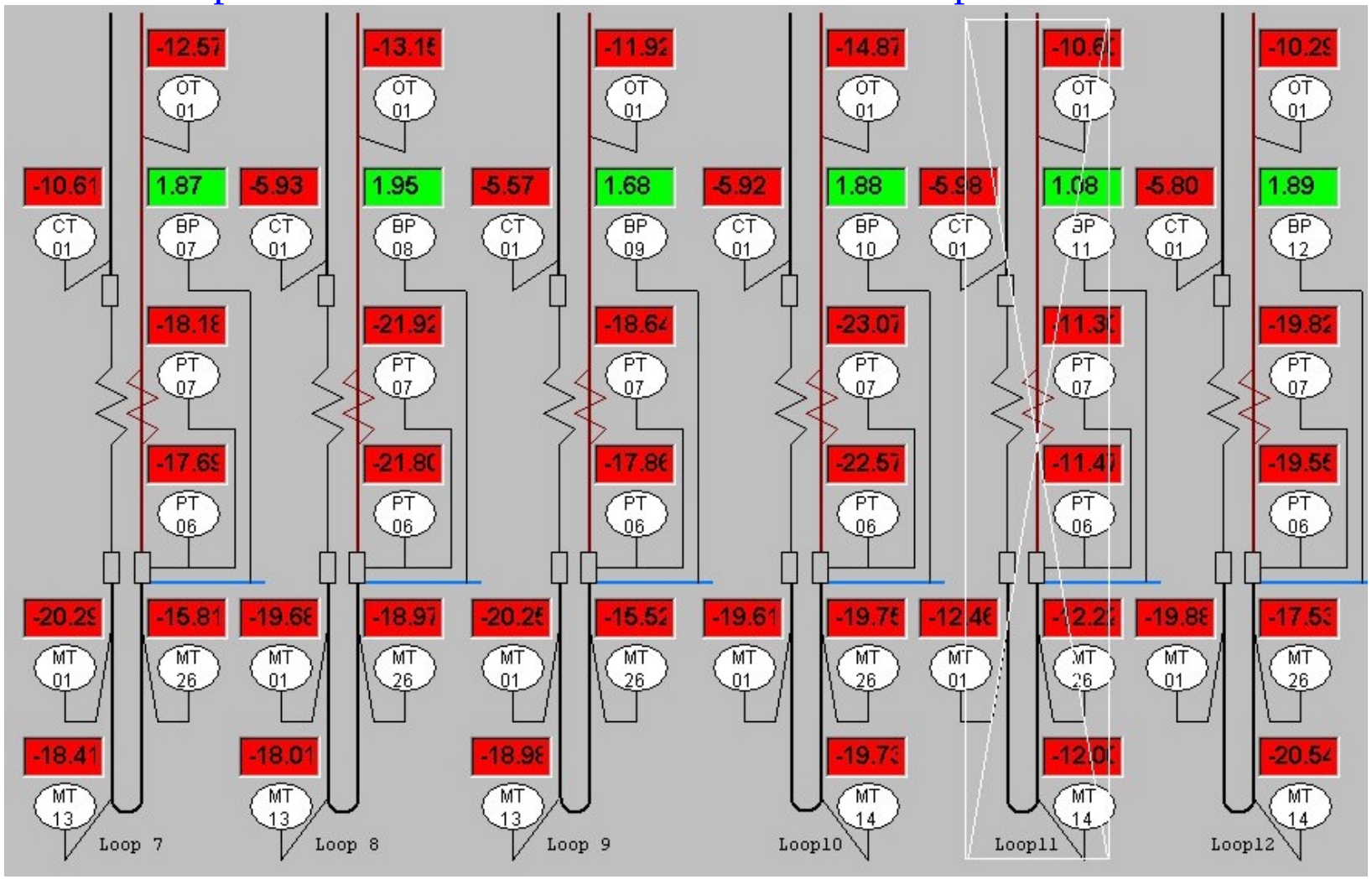
- Runs with full power and observation of the surface temperature on the structure

Establishing minimal flow @ Full power "ON"

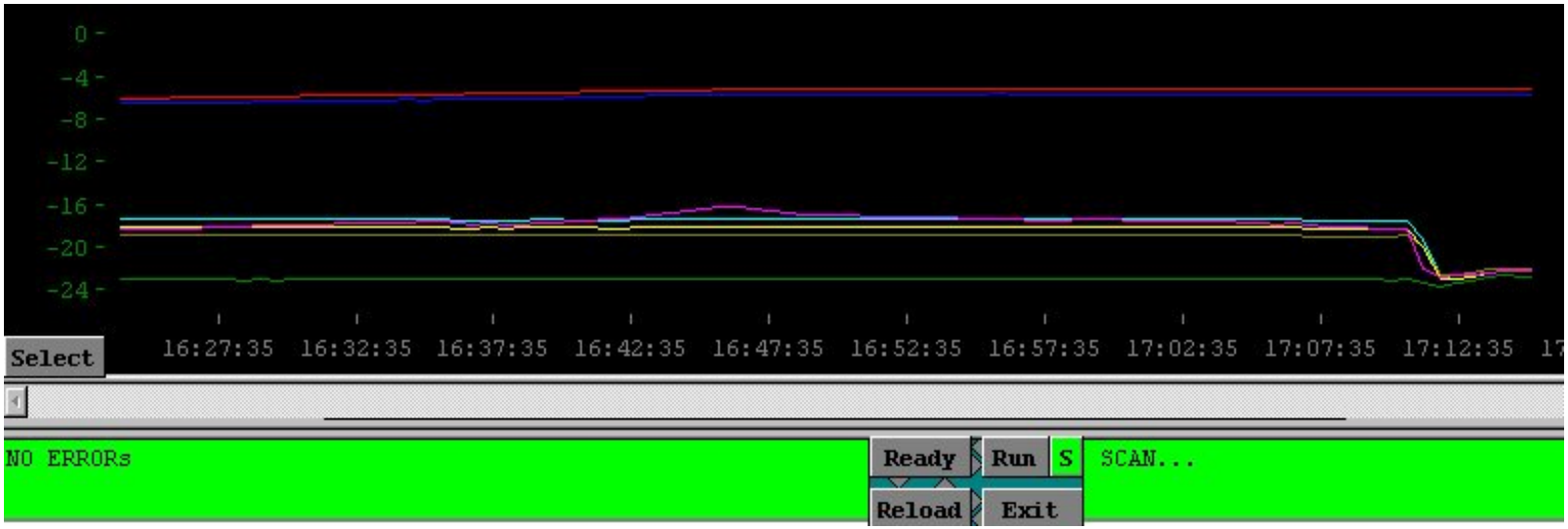
Perhaps "good news here" – outlet tube temperature, close to the Thermal enclosure ambient temperature



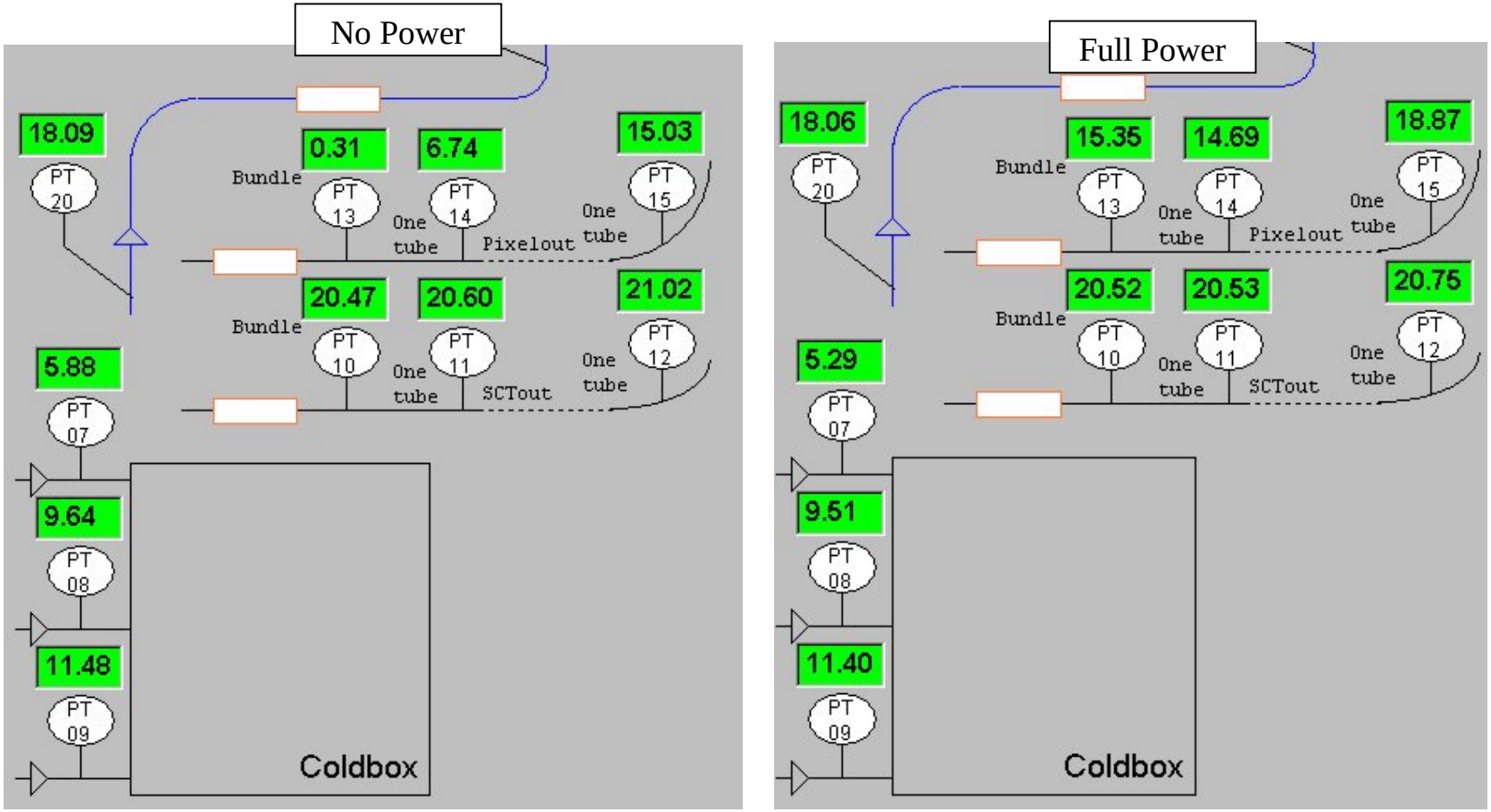
- Runs with full power and observation of the surface temperature on the structure



- Sudden power cut-off [i.e. failure] and reaction of the system



Temperature along the tubes → minimal flow "No Power" & minimal flow "Full Power"



• Summary and conclusions:

1.For the Cooling System:

- Phase II Cooling System for the ID has been put in operation at the end of September 2001 with SCT Mockup structures as the heat load [up to 50% nominal power]
- Major progress in monitoring using PVSS II was achieved during October 2001
- Pixel Mockup has been completed [tubing, sensors, power supplies, ILB] in November 2001 and integrated in the Cooling System [additional power load for the system up to 1.4 kW, tunable from 0-100% of nominal power]
- Number of test runs was performed to verify functioning of the system and two different arrangements of sub-cooling were tested.
- MORE TESTS TO BE PERFORMED WITH BOTH MOCKUP's IN THE SYSTEM FOR VARIOUS COMBINATIONS OF RUNNING PARAMETERS
- PID FLOW CONTROL FEATURE [VIA PLC] HAS TO BE IMPROVED AND IMPLEMENTED
- DAQ SYSTEM USING PVSS II HAS TO BE IMPROVED [Calibrations, ..], NAMELY STABILITY AND LATER SPEED HAS TO BE INVESTIGATED AS WELL AS POSSIBLE USE OF THE SYSTEM FOR PID CONTROL SHOULD BE STUDIED

2. Funding of the project:

- Well defined budget [even operational one], clearly divided between SCT and Pixel community is highly desirable – it is problematic to proceed with work when waiting for missing parts and material **several weeks** due to the lack of funding

3. Manpower:

- Manpower is permanent problematic matter in this project.
- System itself is far away from "push button" operation and it is not possible to develop it further with part-time visitors [sometimes newcomers not familiar with the system development] or with the help of students
- Project needs two or three people working full time, need for one full-time technician [familiar both with mechanical and electrical tasks] is evident.