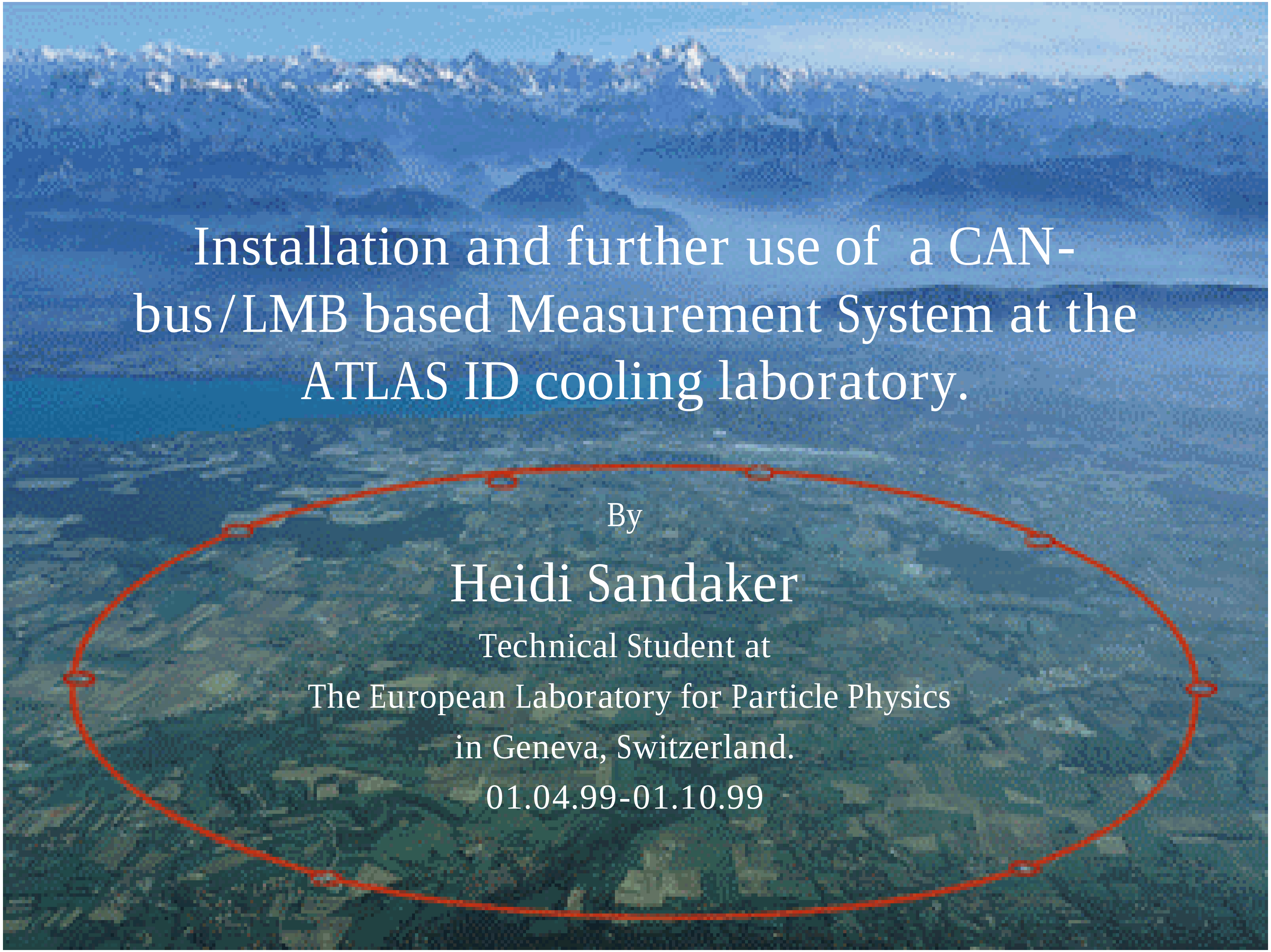

Installation and further use of a CAN-bus/LMB based Measurement System at the ATLAS ID cooling laboratory.

By

Heidi Sandaker

Technical Student at

The European Laboratory for Particle Physics

in Geneva, Switzerland.

01.04.99-01.10.99

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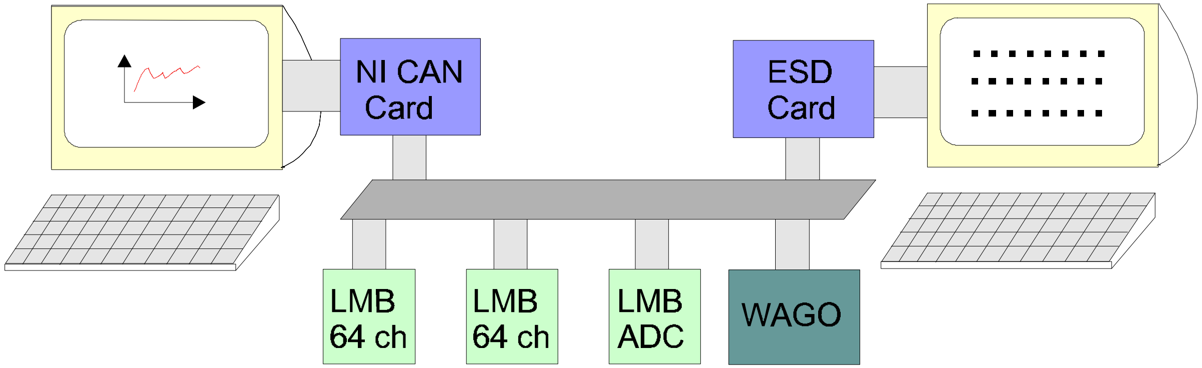
* Presentation of the test done at the ATLAS ID cooling laboratory.
    - Cooling rig
    - Example of tests
* Why we need the CAN bus-LMB system.
* Realization of the first data acquisition system based on CAN-LMB.
    - Presentation of the different sensors
    - CAN bus
    - Data acquisition program
* Tests of this first DA-system
    - Presentation of the structure to be tested
    - Results
* Future development of the DA-system
    - Structures to be tested (Phase 2)
    - Number and types of sensors
    - Other aspects

Why do we need a CAN-bus/LMB based measurement system

- Cheap solution needed
  - Large number of sensors
  - Two wire read out possible for temperature sensors
- High reliability
- Robust concerning
  - Magnetic fields
  - Radiation
- Noisy environnement
- Real time

CAN-bus & LMB based measurement system



LMB 64 ch: Temperature
Pt-100, 4 wire read out

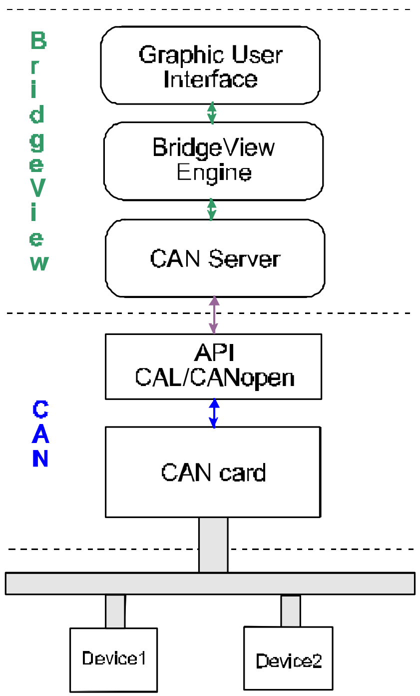
LMB ADC: Pressure (0-10V)
Mass flow (0-10V)
Valve Status
Heater status
(Sonar Gas analyzer) etc..

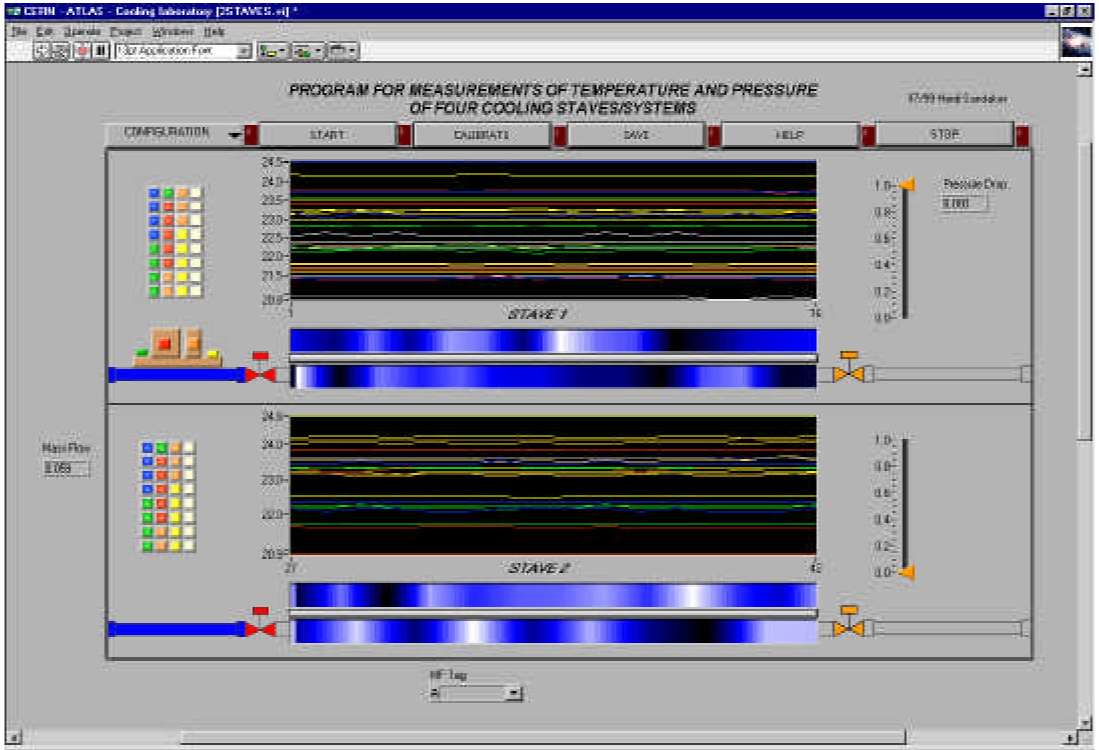
WAGO: Valve control
Heater control

Measurement System

Sensor type	No	Type	Name	LMB	V range (V)	I (A)	Comments
Temperature	64	AI	Pt-100	PT-100	+/-0.1	100p	4 wire read out
Pressure	0-8	AI	RS	ADC+ V div.	0-10	100ì	Max current
		AI	ST	ADC+ V div.	0-10	100ì	Max current
Mass flow	0-8	AI	BH	ADC+ V div.	0-10	ins.	For big rig
		AI	S	ADC	0-5	ins.	For little rig
Isolation valve control	4	DO	HW	WAGO	5 (TTL)	5m	Controlling pressurised air
Heater Control	4	DO	Custom (TTL)	WAGO	5 (TTL)	5m	Turns heaters On/off
Isolation valve status	8	DI	Custom (TTL)	ADC	0-5 (TTL)	5m	Using AI
Heater status	0	DI	Custom (TTL)	ADC	0-5 (TTL)	5m	Using AI

Data Acquisition program



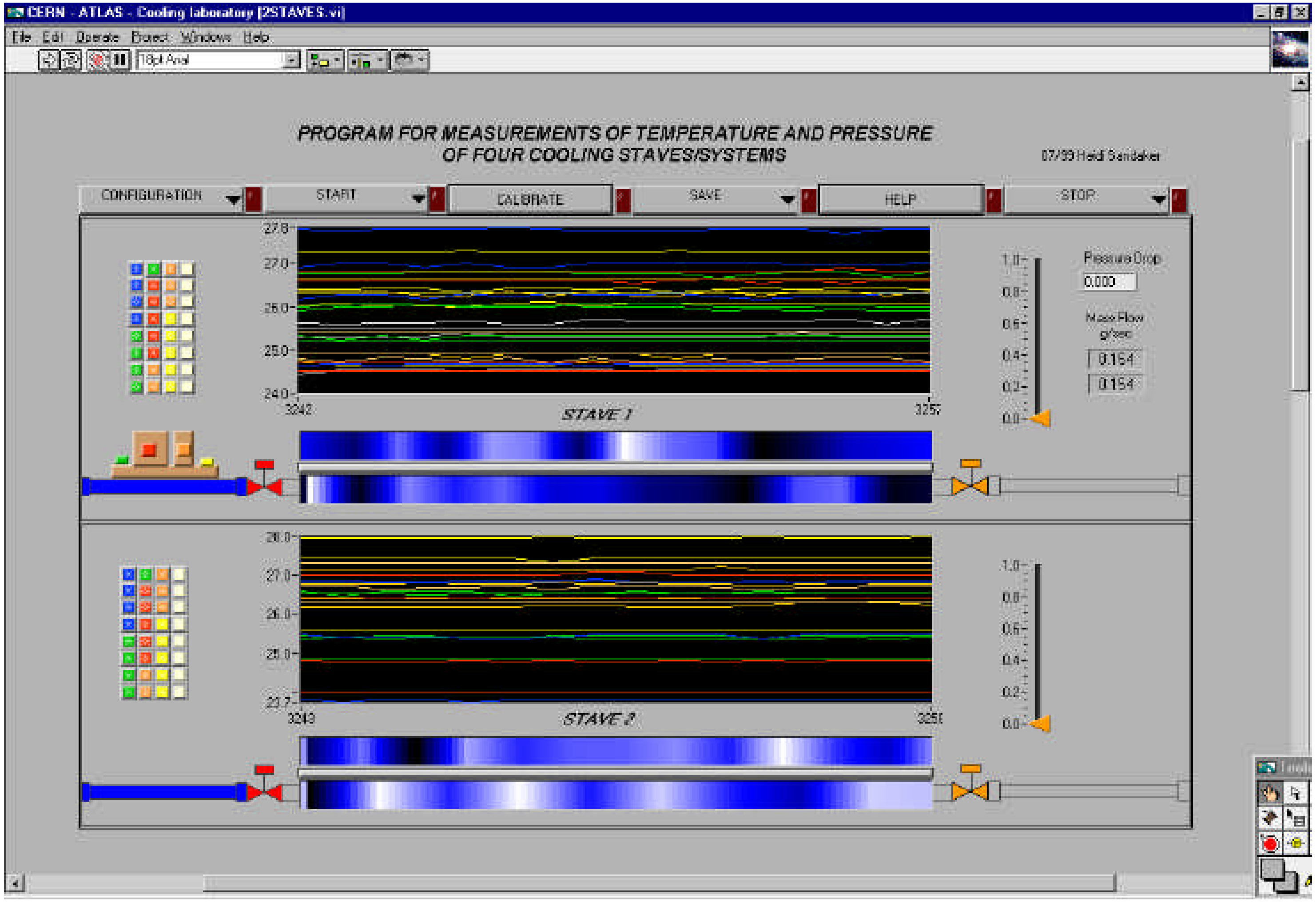


Other aspects

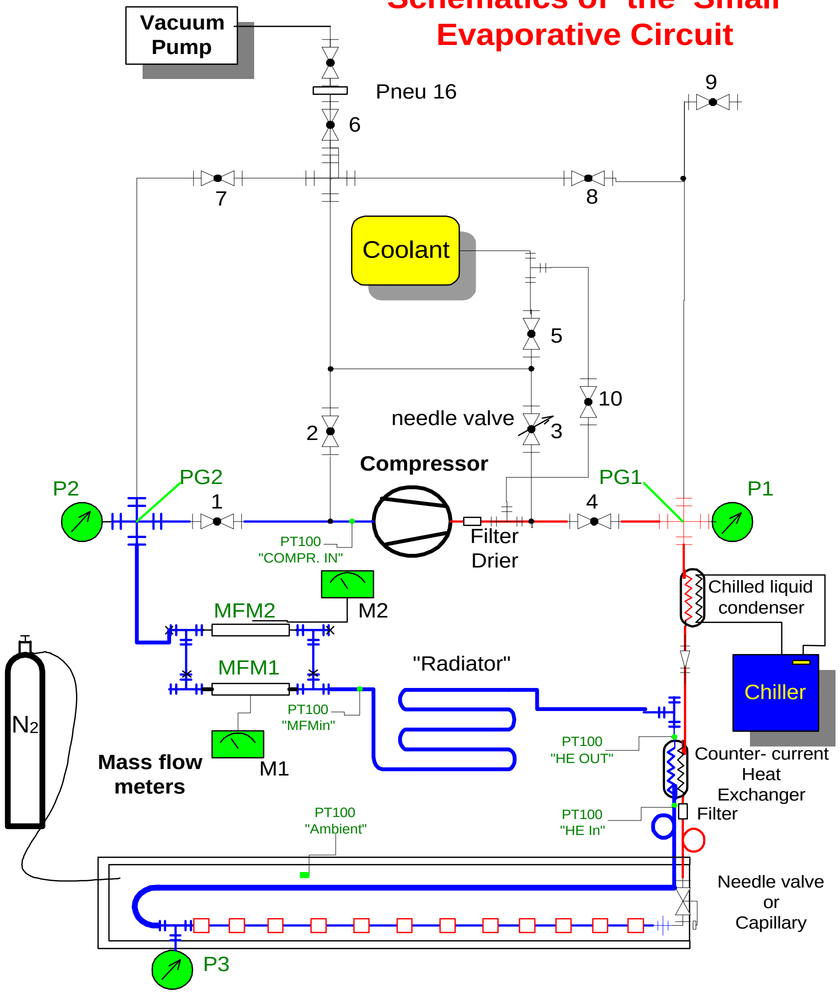
- Tests

Table of sensors:

Sensor type	No	Type	Name	LMB	V range (V)	I (A)	Comments
Temperature	384	AI	Pt-1000	ADC + termin.	+/-0.1	100p	2 wire read out
Pressure	32+	AI	?	ADC	0-10		
Pressure control	16	AO	H	WAGO	0-10	100ì	Via analog compressed air
Mass flow metering	1	AI	?	ADC	?	?	
Mass flow control	16	AO	H	WAGO	0-10	100ì -	Via analog compressed air
Isolation valve control	32	DO	HW	WAGO	5 (TTL)	5m	Controlling pressurised air
Heater Control	44	DO	Custom (TTL)	WAGO	5 (TTL)	5m	Turns heaters On/off
Isolation valve status	32	DI	Custom (TTL)	ADC	0-5 (TTL)	5m	Using AI LMB
Heater status	44	DI	Custom (TTL)	ADC	0-5 (TTL)	5m	Using AI LMB

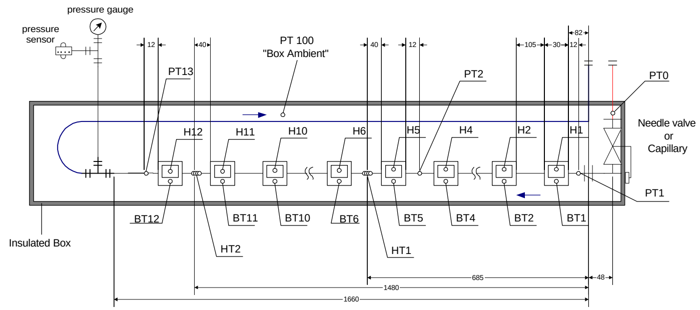

CERN - ATLAS - Cooling laboratory [2STAVES.vi]
File Edit Operate Project Windows Help
PROGRAM FOR MEASUREMENTS OF TEMPERATURE AND PRESSURE
OF FOUR COOLING STAVES/SYSTEMS
CONFIGURATION
START
CALIBRATE
SAVE
HELP
STOP
Pressure Drop
0.000
Mass Flow
g/sec
0.154
0.154
STAVE 1
STAVE 2

Schematics of the Small Evaporative Circuit



Small rig

Position of the sensors attached to the single-tube for heat transfer coefficient measurements



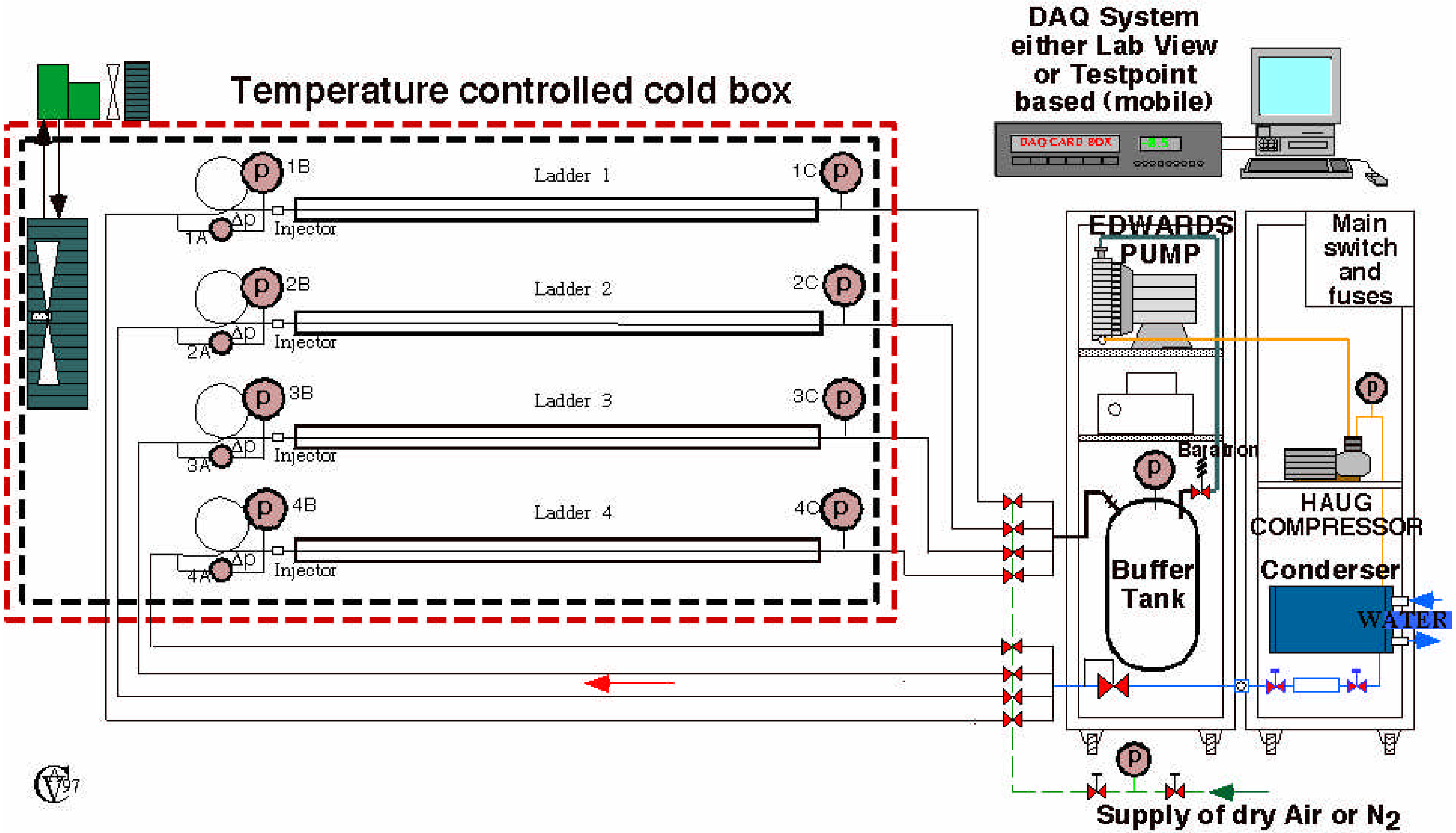
HT (1,2) - coil heater-thermometers

PT (0..3) - PT100 sensors on the pipe [total number of sensors on the pipe = 13]

H (1..12) - heaters -on blocks

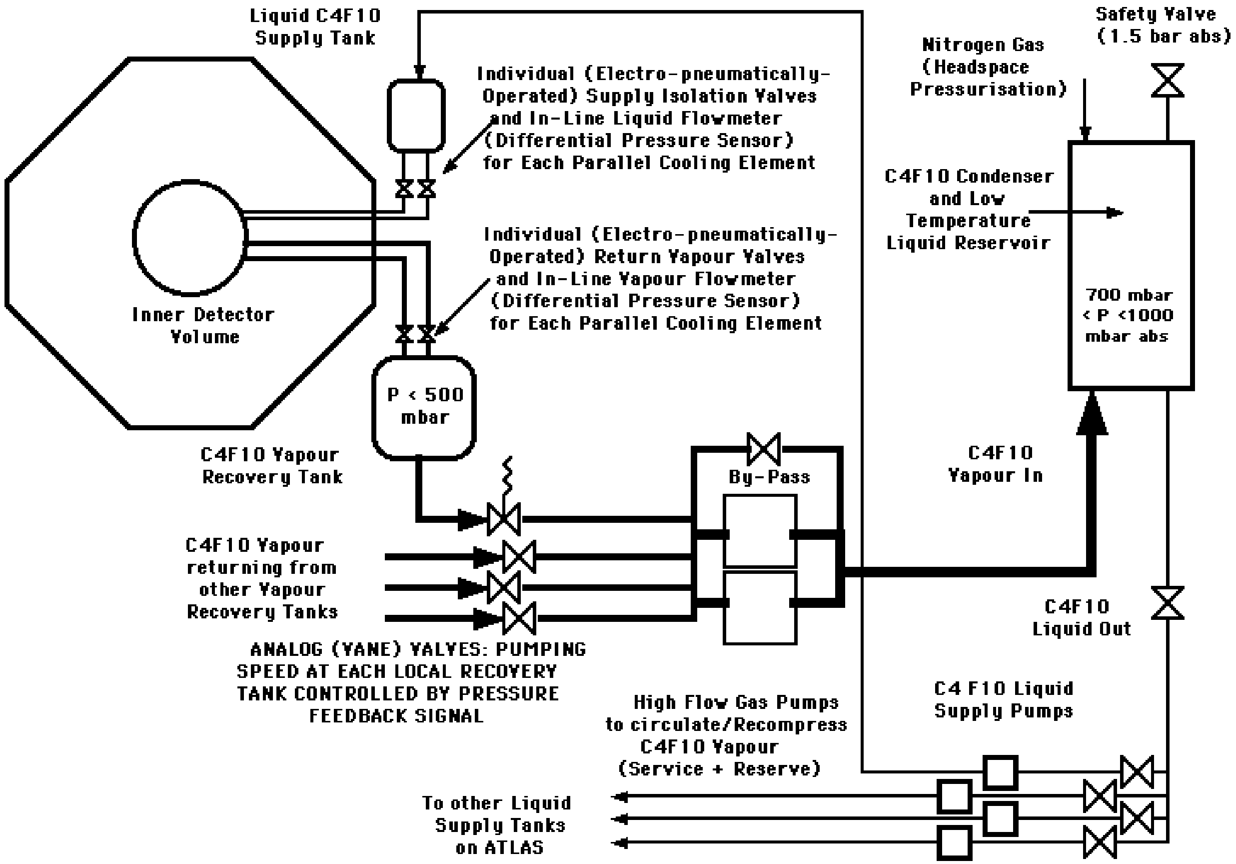
BT (1..12) - PT100 sensor on the blocks [total number of sensors on the blocks = 12]

Big rig



DAQ System
either Lab View
or Testpoint
based (mobile)
DAQ CARD BOX
Temperature controlled cold box
1B
1C
Ladder 1
Injector
1A
Δp
2B
2C
Ladder 2
2A
3B
3C
Ladder 3
3A
4B
4C
Ladder 4
4A
EDWARDS
PUMP
Main
switch
and
fuses
Baratron
HAUG
COMPRESSOR
Buffer
Tank
Condenser
WATER
Supply of dry Air or N_2

Placement of the sensors in ATLAS

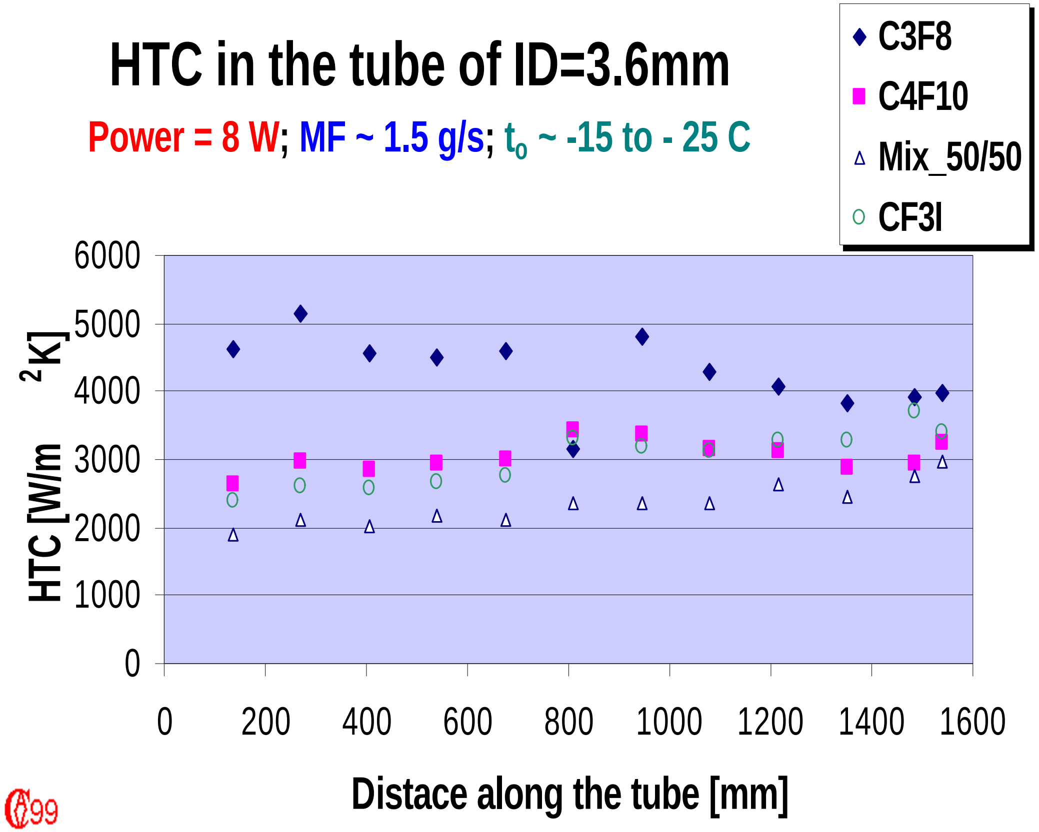


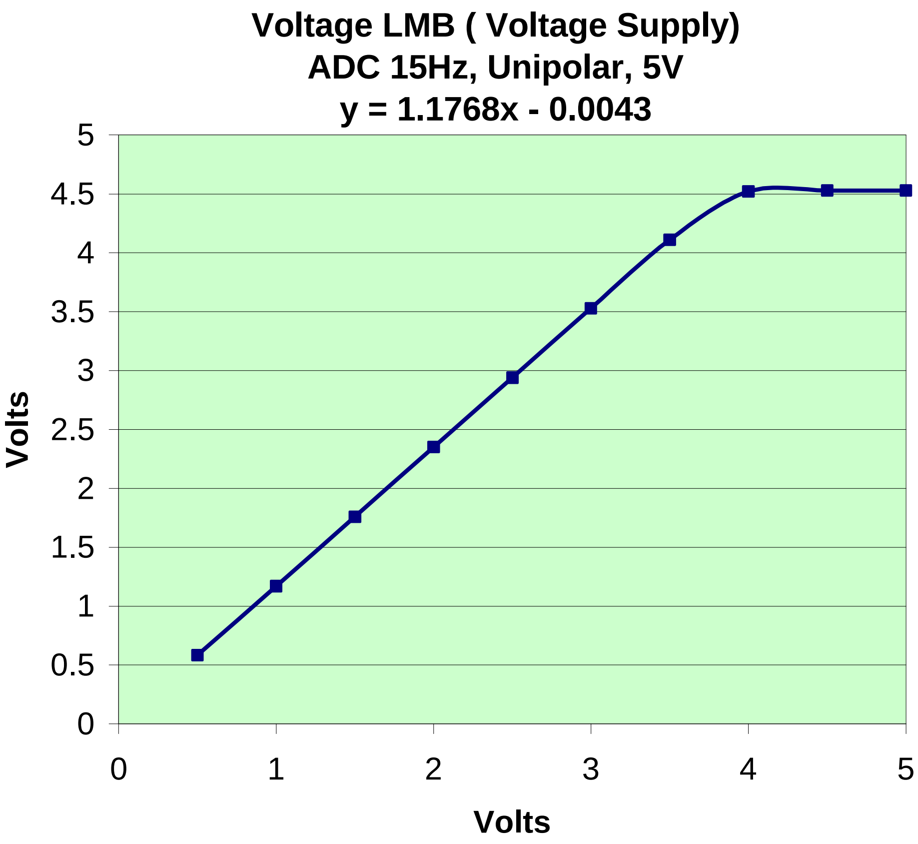
Layer	R (cm)	No Elements	Power /element	Manifold Factor	Elements /group	Power /group
SCT No.4	54	56 (staves)	120 W	2 series/ 2 parallel (4 staves)	8 (2 mflds)	480 W x 2
SCT No.3	46	48 (staves)	120 W	2S+2P (4 staves)	8 (2 mflds)	480 W x 2
SCT No.2	38	40 (staves)	120 W	2S+2P (4 staves)	4 (1 mfld)	480 W x 1
SCT No.1	30	32 (staves)	120 W	2S+2P (4 staves)	4 (1 mfld)	480 W x 1
SCT Disk	-	4 (Quad-rants)	330 W	Quadrant	1	330 W x 1
Pixel No. 2	14	56 (staves)	101 W	2	7 (4pairs)	202 W x 4
Pixel No. 1	11	44 (staves)	101 W	2	6 (3pairs)	202 W x 3
Pixel B Layer	4.5	18 (staves)	143 W	1	2 (indiv.)	143 W x 2
Pixel Disk	-	12 (sectors)	55 W	2	2 (1 pair)	110 W x 1
TOTAL POWER (EXC. SCREENS, LOW MASS POWER RIBBONS)						5 kW

Phase 2:

1/8 of SCT and Pixel layers

Example of small rig measurements





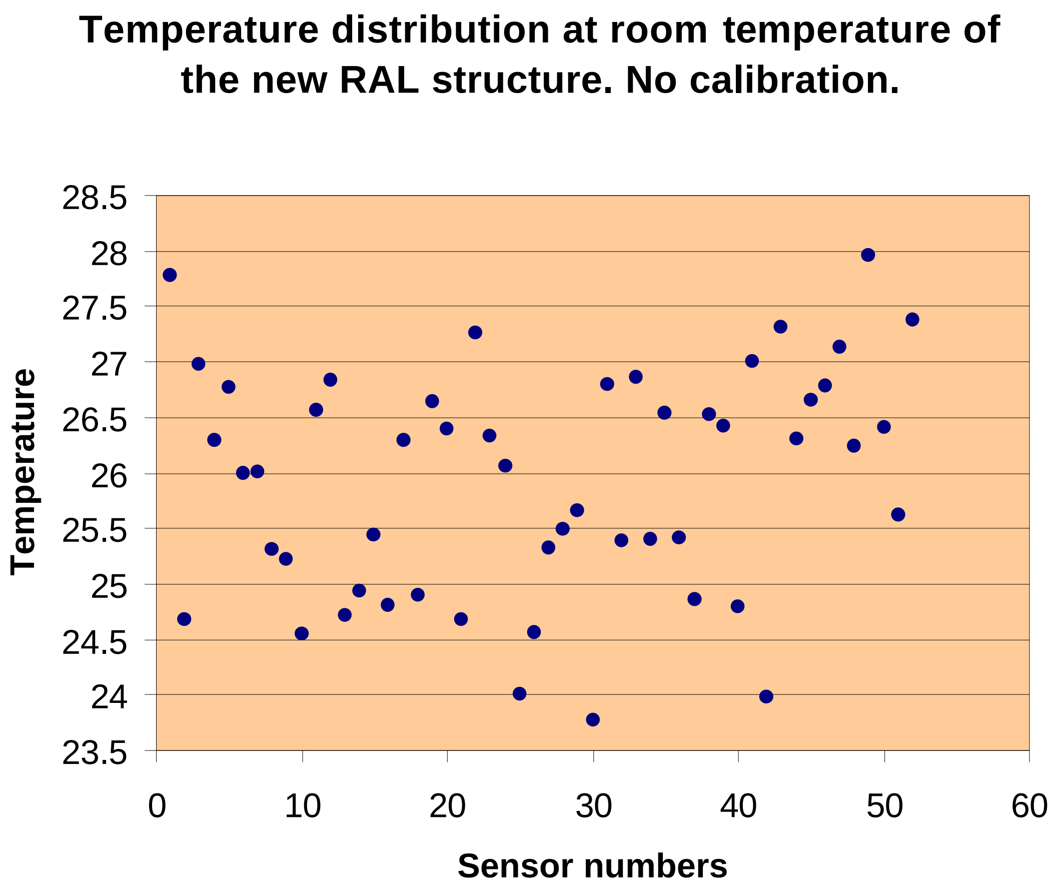
Test of ADC module:

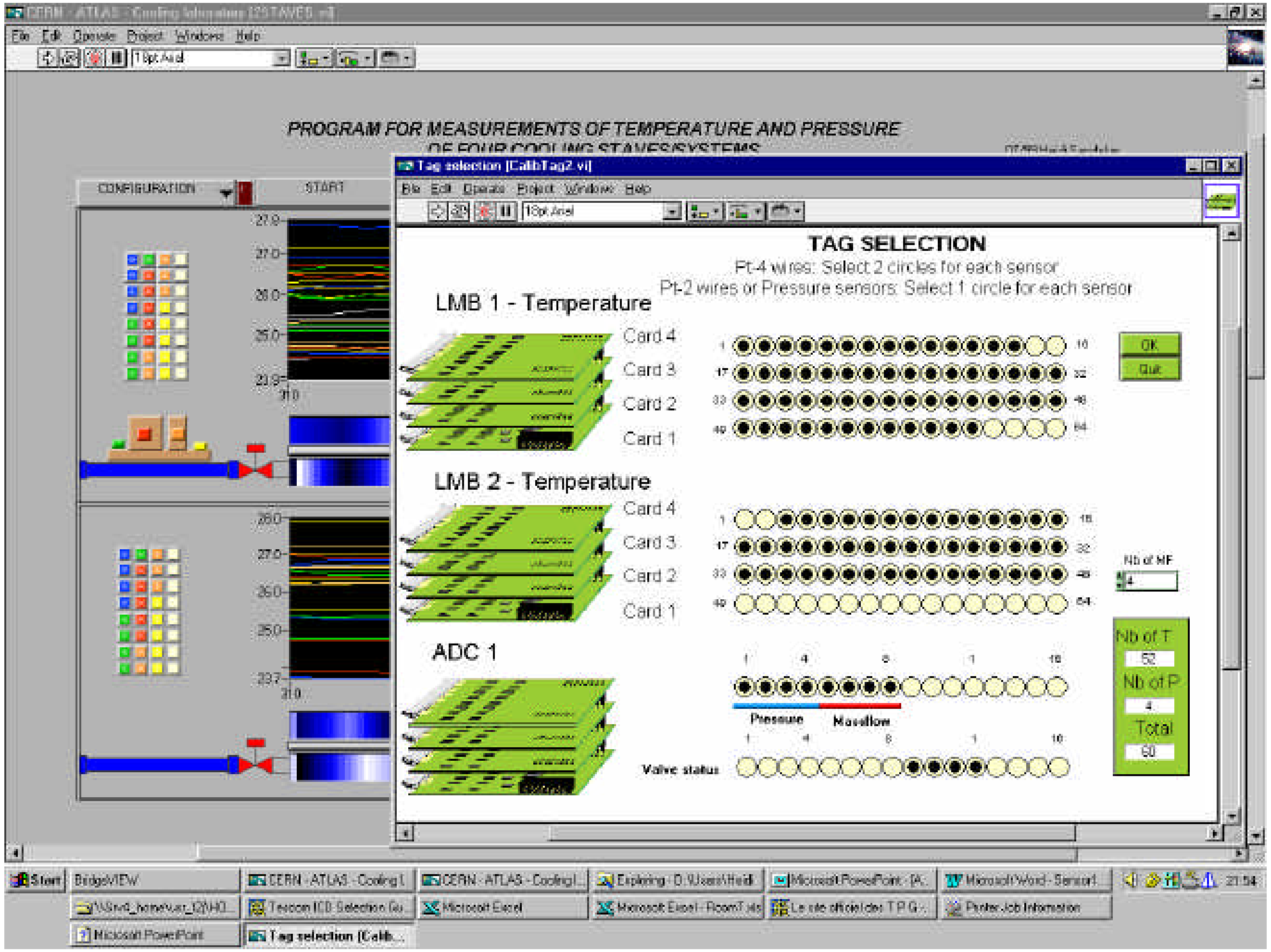
- Observed error of 18% of the values read by an LMB ADC. This number is independent of ADC range chosen.

- All the channels on one board have the same error, but it varies from board to board. (Each 16 channels).

→ Calibration

First test


Temperature distribution at room temperature of the new RAL structure. No calibration.
Temperature
Sensor numbers
28.5
28
27.5
27
26.5
26
25.5
25
24.5
24
23.5
0
10
20
30
40
50
60


PROGRAM FOR MEASUREMENTS OF TEMPERATURE AND PRESSURE
CONFIGURATION
START
Tag selection [CalibTag2.vi]
TAG SELECTION
Pt-4 wires: Select 2 circles for each sensor
Pt-2 wires or Pressure sensors: Select 1 circle for each sensor
LMB 1 - Temperature
Card 4
Card 3
Card 2
Card 1
LMB 2 - Temperature
Card 4
Card 3
Card 2
Card 1
ADC 1
Pressure
Massflow
Valve status
OK
Quit
Nb of MF
Nb of T
52
Nb of P
4
Total
60