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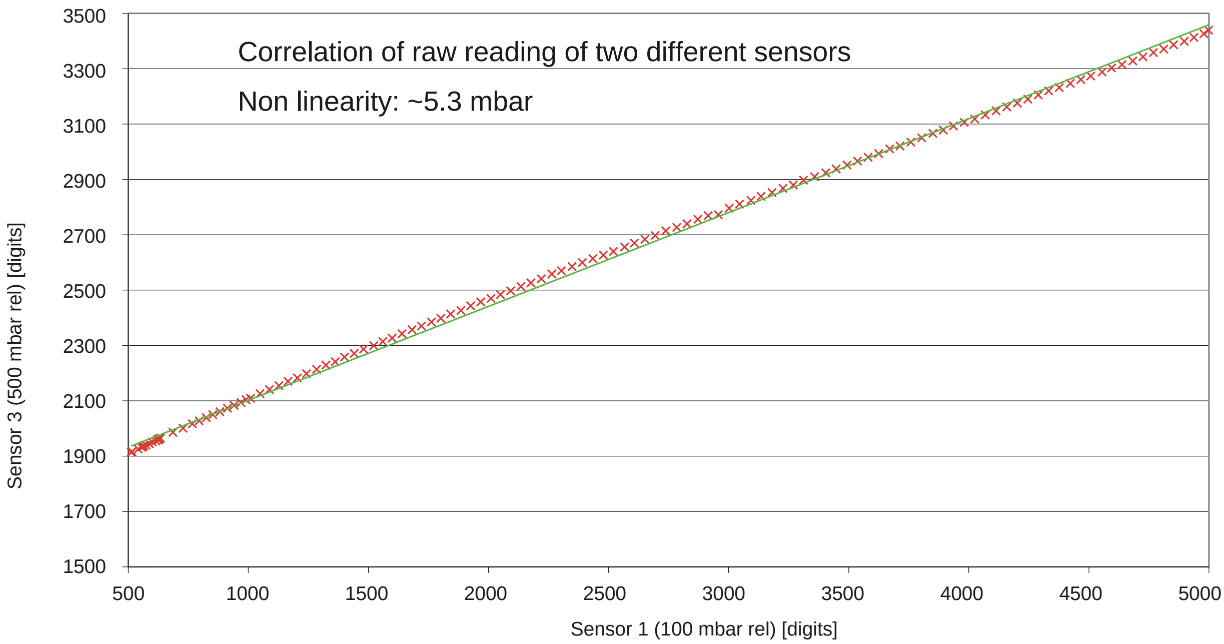
Preparation of Equipment to Monitor Gas Pressure in CMS Muon Drift Tube Chambers

1. Sensor Calibration.
2. Gas Tightness.
3. Measurement of Impedance.
4. O_2 Test.

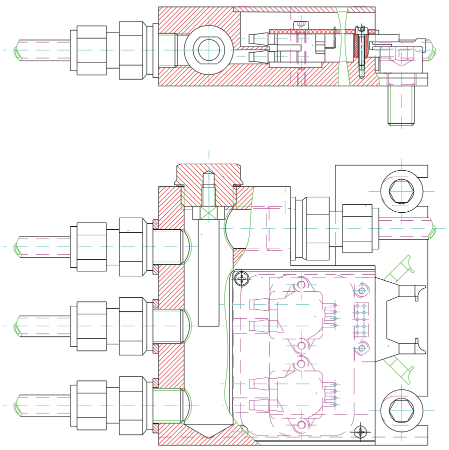
Sensor Calibration



- Calibration:
  - determine offset
  - improve precision
  - is QC of each sensor and ADC
- Method: calibrate several sensors simultaneously
  - faster
  - increase precision in relative calibration of sensors (precision less dependent on manometer)
- Aim: precision 1 mbar
- 10 bit ADC
- Sensors seem to have very similar calibration

Use of Sensors

- SL tightness tests at production center



- DT Pressure monitoring at CMS

- At each point measure with 2 Sensors:
  +/- 500 and +/- 100 mbar range (relative pressure)

- Use of future sensors at production center
  is a long term sensor test

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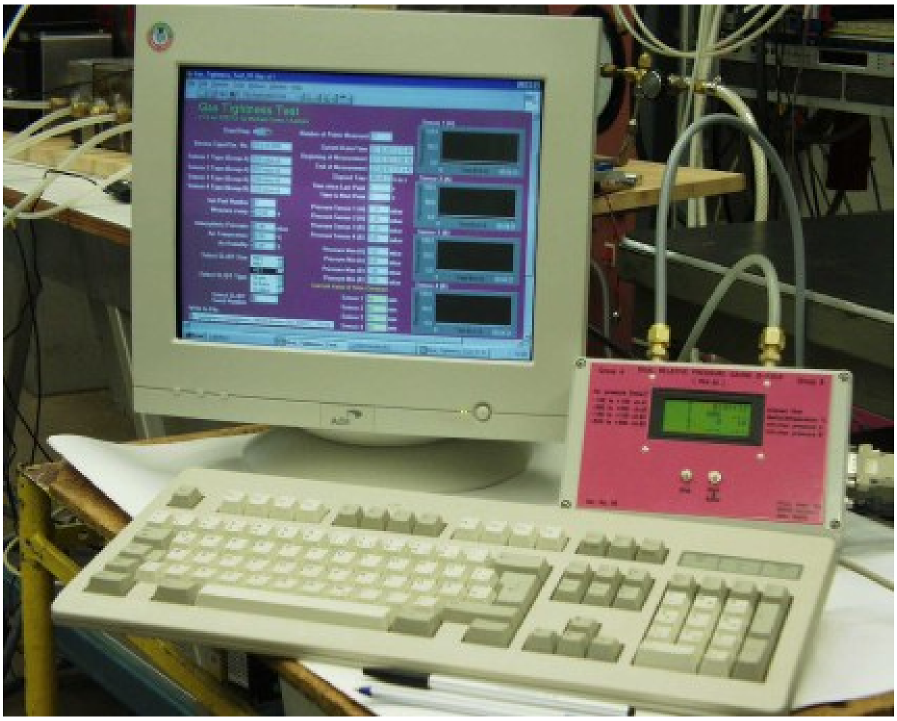
Software `Gas Tightness Test`

- Automatic readout of pressure at regular intervals; permits unattended running.

- Continous calculation and display of current Time Constant.

- Writes ASCII file with standarized Keywords for archiving and offline analysis. Standarized file name is generated automatically.

- Easy use permits to measure more often, e. g. to recheck gas tightness when a SL has been opened. Sensor box shown measures two SLs simultaneously.



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Example of a file:

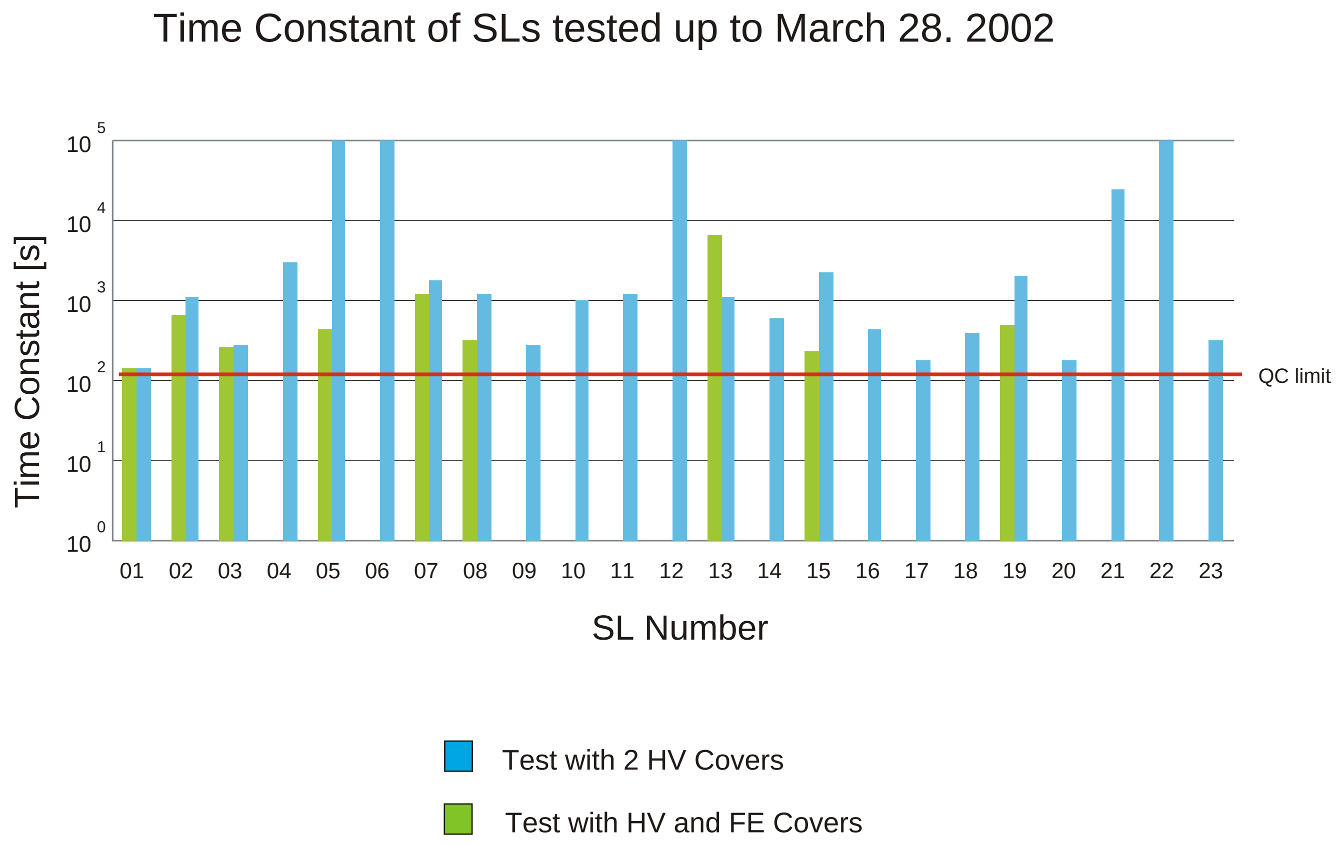
Keyword — Object — Date — Time

```
$FILENAME c:\gastightness_MB1SLphi019_020228_1932.txt
$SOFTWARE GASTIGHTNESS_TEST_V1.0AC
// Connected Devices --------------------------------
$SL/DT MB1SLphi019
$PRESSURE_BOX PG4-01/005
$SENS_1_TYPE 500 mbar rel (Group A)
$SENS_2_TYPE 500 mbar rel (Group A)
$SENS_3_TYPE 100 mbar rel (Group B)
$SENS_4_TYPE 100 mbar rel (Group B)
$PORT_NUMB 1
// Start Parameters ---------------------------------
$MEAS_INTERVAL 120 // [s] (Measurment every 120 s)
$P0_SENS_1 50 // [mbar] (pressure at Start Time)
$P0_SENS_2 50 // [mbar] (pressure at Start Time)
$P0_SENS_3 54 // [mbar] (pressure at Start Time)
$P0_SENS_4 54 // [mbar] (pressure at Start Time)
$ATM_PRESS 975 // [mbar]
$AIR_TEMP 23 //  [°C]
$AIR_HUMID 20 // [%]
 // Beginning of Measurement ------------------------
$BEGIN_MEAS 28.02.02 19:32:37

// Measured Data //
// A = Time [h:m:s]
// B = Time [s]
// C = Time Constant Sensor 1 [min]
// D = Time Constant Sensor 2 [min]
// E = Time Constant Sensor 3 [min]
// F = Time Constant Sensor 4 [min]
// G = Pressure Sensor 1 [mbar]
// H = Pressure Sensor 2 [mbar]
// I = Pressure Sensor 3 [mbar]
// J = Pressure Sensor 4 [mbar]
// K = Pressure Sensor 1 [digit]
// L = Pressure Sensor 2 [digit]
// M = Pressure Sensor 3 [digit]
// N = Pressure Sensor 4 [digit]
//
//  --------------------------------------------------------------------------------
//  A      B      C      D      E      F       G       H       I       J     K    L    M    N
//  --------------------------------------------------------------------------------
$BEGIN_TAB
00:00:15    15     0     0     0     0   50.0    50.0    54.0    54.0  157  156  199  198
00:02:15   135   Inf   Inf   Inf   Inf   50.0    50.0    54.0    54.0  157  156  199  198
00:04:15   255   Inf   Inf   Inf   Inf   50.0    50.0    54.0    54.0  157  156  199  198
00:06:15   375  -159   Inf  -341   Inf   52.0    50.0    55.0    54.0  158  156  198  198
00:08:15   495  -210   Inf  -450   Inf   52.0    50.0    55.0    54.0  157  157  199  198
00:10:15   615  -261   Inf  -559   Inf   52.0    50.0    55.0    54.0  157  157  199  198
00:12:15   735  -312   Inf   Inf   Inf   52.0    50.0    54.0    54.0  157  156  199  197
00:14:15   855   Inf   Inf   Inf   Inf   50.0    50.0    54.0    54.0  157  156  198  197
:
:
:
15:42:15 56535  2268  2268  2324  2492   33.0    33.0    36.0    37.0  151  150  179  179
15:44:15 56655  2272  2272  2498  2498   33.0    33.0    37.0    37.0  151  150  179  178
15:46:15 56775  2277  2277  2334  2503   33.0    33.0    36.0    37.0  151  150  179  179
$END_TAB
//
// End of Measurement -------------------------------------------------------------
$END_MEAS 01.03.02 11:20:01
$POINTS_MEAS 474
$ELAPSED_TIME 15:47:24
$PRESS_MAX_A 55 // [mbar]
$PRESS_MIN_A 33 // [mbar]
```

Gas Tightness Test of SLs

Measurement of Pressure Drop vs. Time



All 23 SLs tested passed the QC on gas tightness

Impedance

- DT Chamber will have different position at barrel yoke
  - different length of gas pipes
  - different pressure drop in the pipes
  - different pressure at different chambers

- Try to estimate the pressure drop $p_1 - p_2$ in different objects at the same flow rate i

- For a SL impedance measured:

$$\boldsymbol{R = \frac{p_1 - p_2}{i} = 0.0082 \ \frac{mbar \cdot hour}{litre}}$$

- SL equivalent: pipe length l with diameter ϕ which gives the same impedance:

pipe measured:

ϕ = 6 mm: l = 5.4 m
ϕ = 4 mm: l = 1.2 m

theoretical (Hagen-Poiseulle):

ϕ = 12 mm: l = 91 m
ϕ = 10 mm: l = 44 m
ϕ = 6 mm: l = 6.6 m
ϕ = 4 mm: l = 1.1 m

O_2 Content Test

- Test procedure:

  a) connect gas bottle directly to gauge and measure settled value
     (is ~10 ppm; no special calibration done yet)
  b) connect then the gauge to rinsed SLs and measure settled value

- Test execution:

  SL 013, 015 connected, measured after ~12 h
  Find O_2 value comparable to a)

  - Test passed