A purity monitoring system for the H1 Liquid Argon Calorimeter

Babaev A.
ITEP, Moscow and DESY, Hamburg

H1 Collaboration

Nine years performance

Outline:

- Purity System
  - LAr Calorimeter
  - probes
  - electronic chain, DAQ
  - spectra
- Purity monitoring
  - Signal response of the probes
  - HV curve
  - History plots 1991 - 2000
- Temperature effect
- Conclusion

Purity System: Location

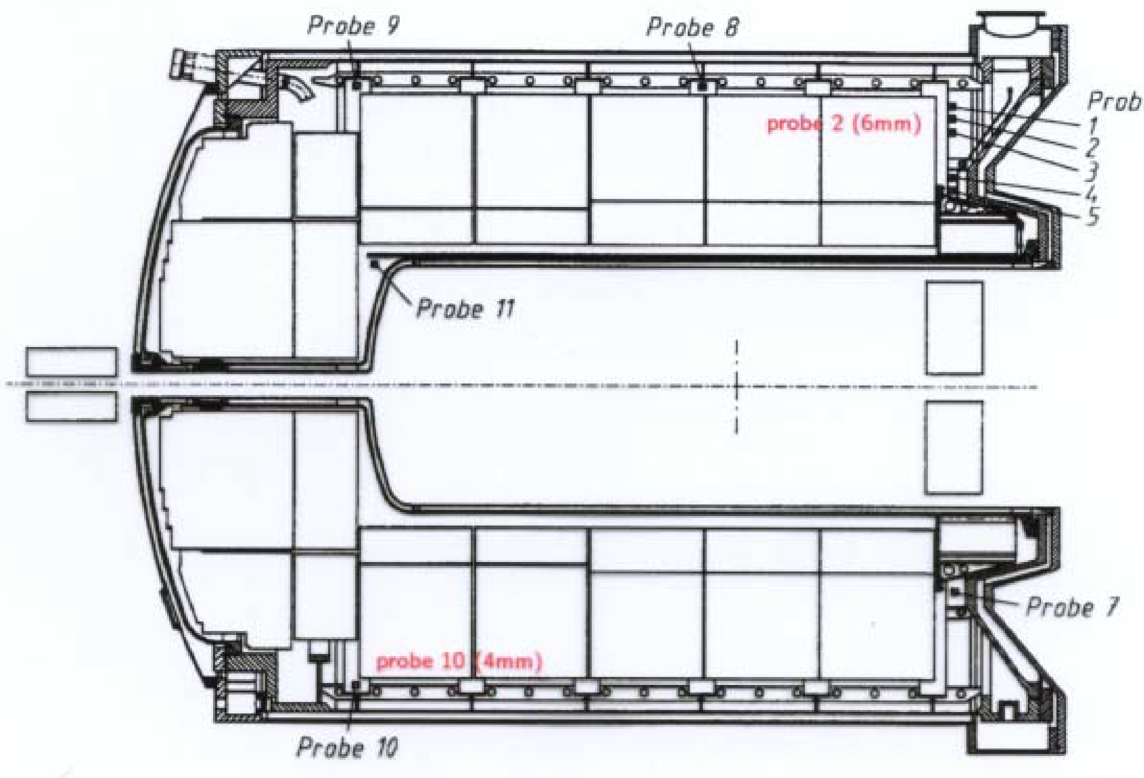
LAr Calorimeter (53 m^3), filled end of January 1991.
No purification is used.
Only LAr losses are compensated.

I.Abt et al., NIM A386(1997) 310

10 small ionisation chambers with radioactive source (Bi or Am) localised in cryostat.

$\alpha -\ ^{241}Am: \quad E_\alpha = 5.442\ and\ 5.484\ MeV$
$\beta -\ ^{207}Bi: \quad E_{\gamma_1} = 0.569\ , E_{\gamma_2} = 1.063\ and\ E_{\gamma_3} = 1.77 Me$

- Location of purity probes

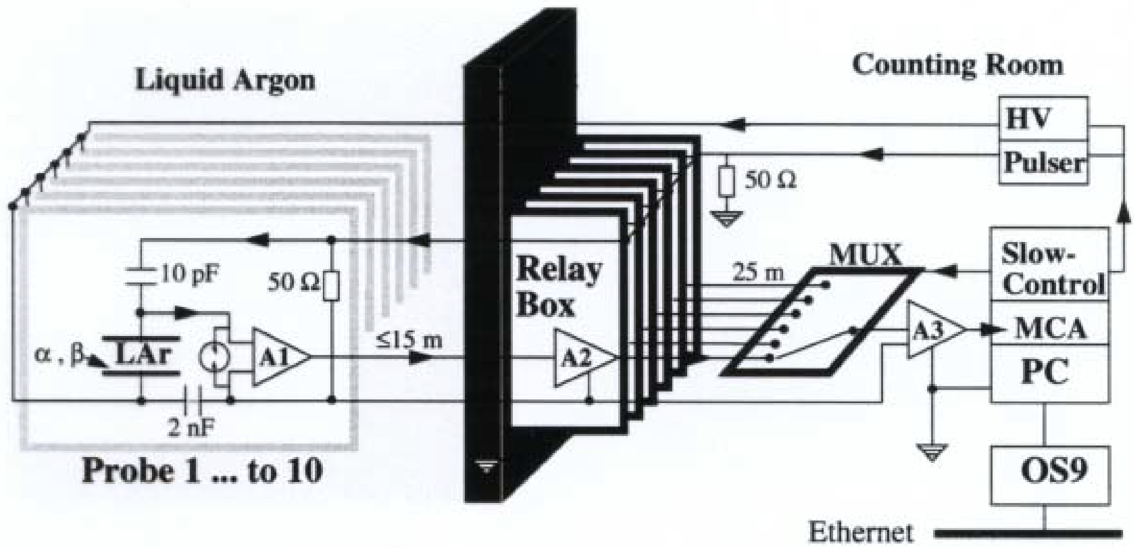


- Probes

probe(#)	1	2	3	4	5	7	8	9	10	11
source	α	β	β	α	β	β	β	β	β	β
gap(mm)	2	6	4	2	4	4	4	4	4	4

Purity System: Electronic

- Electronic chain



LPNHE Paris

- Cold charge sensitive preamplifier A1 (Radeka, BNL) with additional input protection by neon bulb

  $ENC =$ 300-400 electrons
- Analog units (A2), Multiplexer, amplifier (A3) ORTEC 57
- Pulser (DAC Keithley 570, generator ORTEC 419)
- PC with PCA card (MCA), processor OS-9

→ 32 parameters are monitored :
all HV and LV,
calibration voltages,
DC and AC offsets ,
noise, 150Hz noise etc.

Tools

→ Purity data is stored:

on PC:	the last 10 HV spectra
on processor OS-9:	amplitude monitoring and HV curves data
on H1 Data Base:	OS-9 and LAr temperature data

Oracle Query for the Liquid Argon Purity

Start (date & time)
01.09.2000 | 00:00

End (date & time)
01.10.2000 | 00:00

Line fit option
No line fit option

Start date	**End date**
01.09.2000	01.10.2000

Purity Probes:	**Histogram types:**
1_up_backw	raw signal (R)
2_up_backw	calibrated signal (C)
3_up_backw	temp. corr. sig. (TC)
4_mid_backw	(TC-C)/C
5_mid_backw	gain (G)
7_low_backw	
9_up_forw	<-- *Types of probes:*
10_down_forw	***alfa* : 1,4**
11_mid_center	**beta : 2,3,5,7,9,10,11**

Customize:

TYPE	Y*min(%)*	Y*max(%)*
(R)	96	102
(C)	96	102
(TC)	96	102
(G)	0.8	1.2

Instructions for use | **Show Summary**

Submit Query | Clear Form | Expert page

Last update by Antoni Cyz (cyza@mail.desy.de), and Janusz Martyniak (martynia@mail.desy.de), Dec 01, 1998 at 12:49.

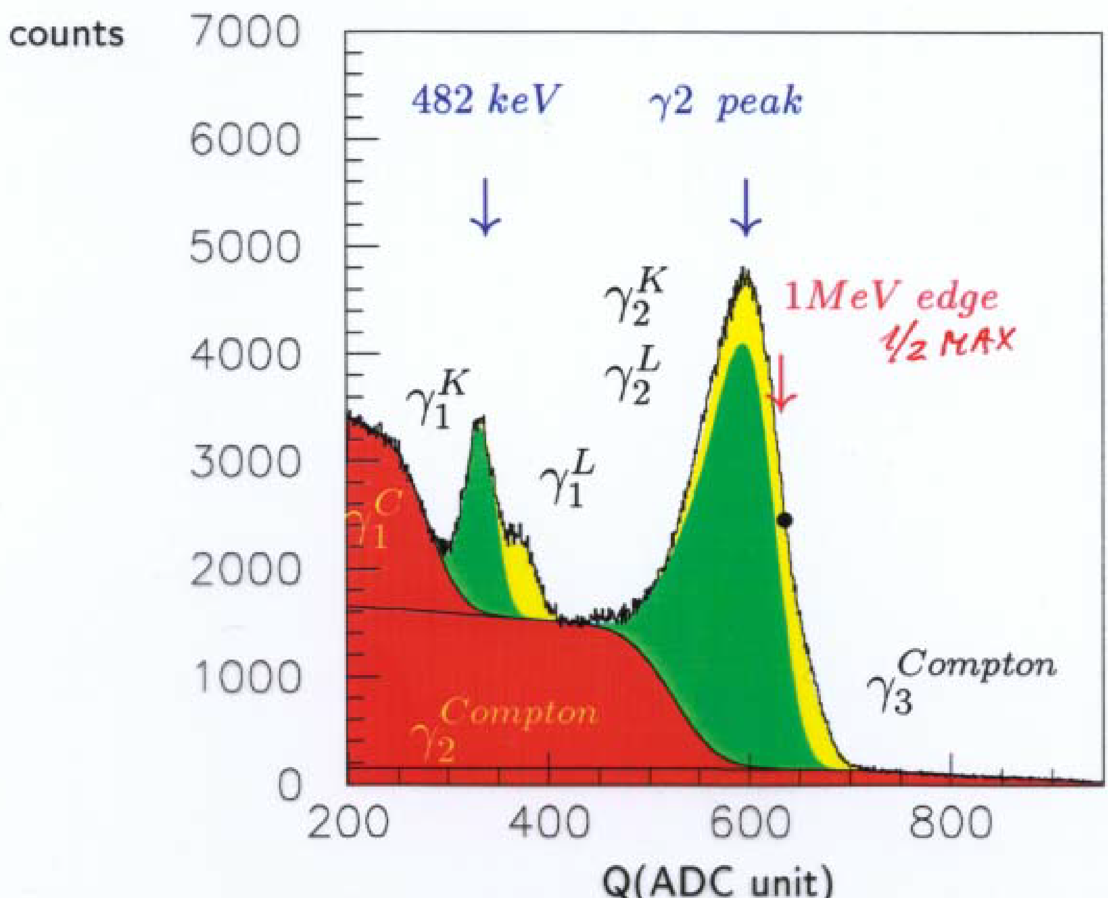
Purity System: Spectra

- Estimators of ^{207}Bi spectrum

$\rightarrow 482\ keV$ peak

$\rightarrow \gamma_2\ peak$

$\rightarrow 1\ MeV\ edge$ (half maximum)



Shape of the spectrum well described by the analytical function for all three estimators.

E.Barrelet H1 − IN − 587(09/2000

Practically we used:

- Estimator $1\ MeV\ edge$
- Statistical accuracy of the point $1\ MeV\ edge$ is 0.03% for 5 min measurement

Purity Monitoring: Amplitude

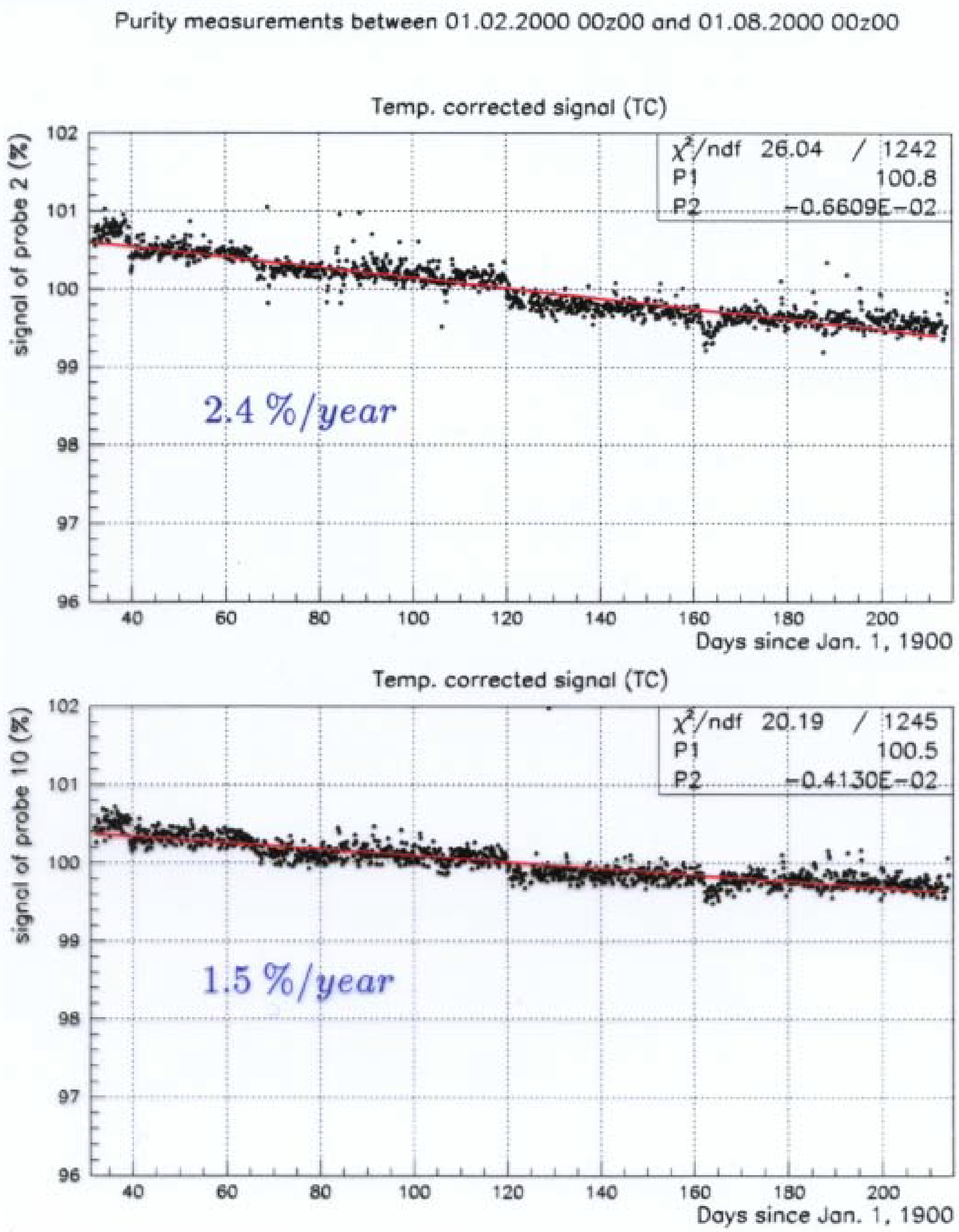
- Amplitude response of the probe

$$Q = f(t)|_{HV=constant}$$

monitored since 15.01.1991

→ every three hours all probes are measured and calibrated

- Result for probes #2 (D=6mm) and #10 (D=4mm)

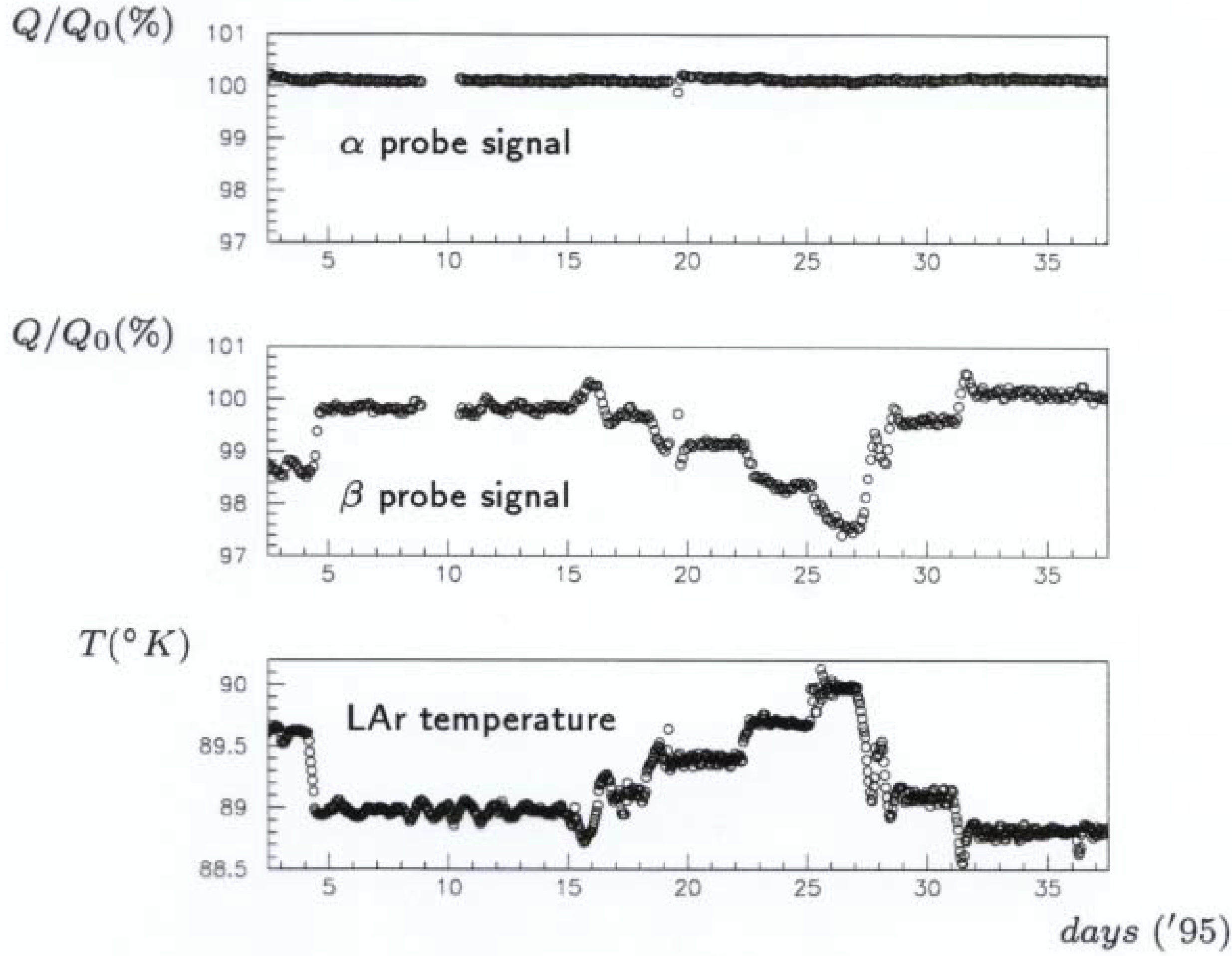


- for calorimeter D=2.4mm, $1/A * \Delta A/\Delta t = 0.93\,\%/year$

Temperature effect

- Temperature scan

→ discoverred in January 1995



→ Linear fit $\Delta Q/Q = -k\Delta T$ yields

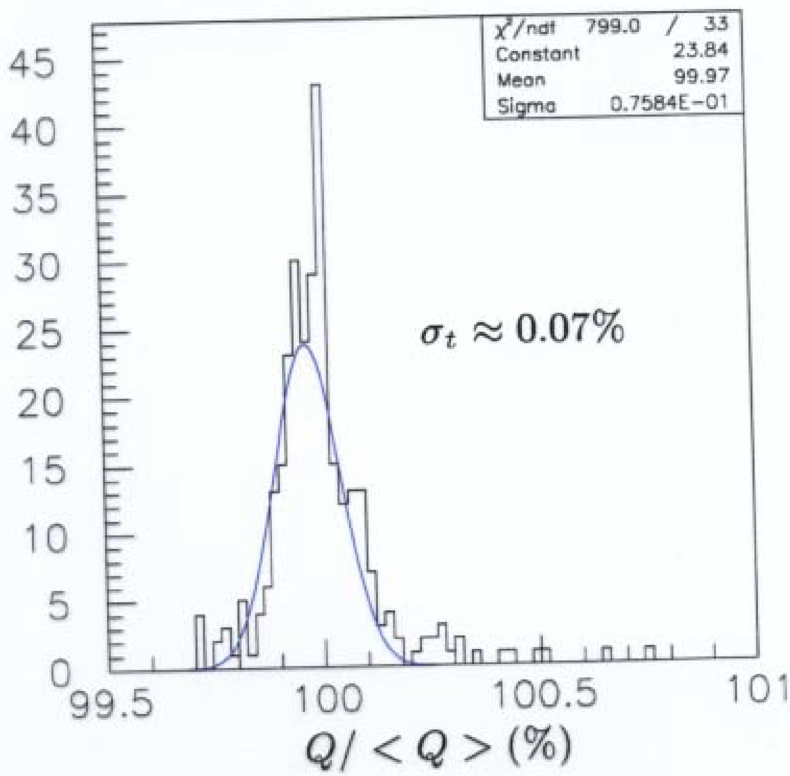
$k = 1.8\%/^\circ K$ for 6mm gap

$1.1 < k < 1.5\%/^\circ K$ for 4mm gap

- NO temperature effect for all α probes

Temperature effect: (cont.)

→ Thermal fluctuations of the LAr are $0.5 - 1\,^\circ K$.
They yield the fluctuation of $Q/<Q> \approx 2\sigma$.



→ What produces the temperature effect?

- range
- ionisation density

→ we can not explain the absence of the temperature effect with α's, as well as its presence with β's.

Purity Monitoring: HV curve

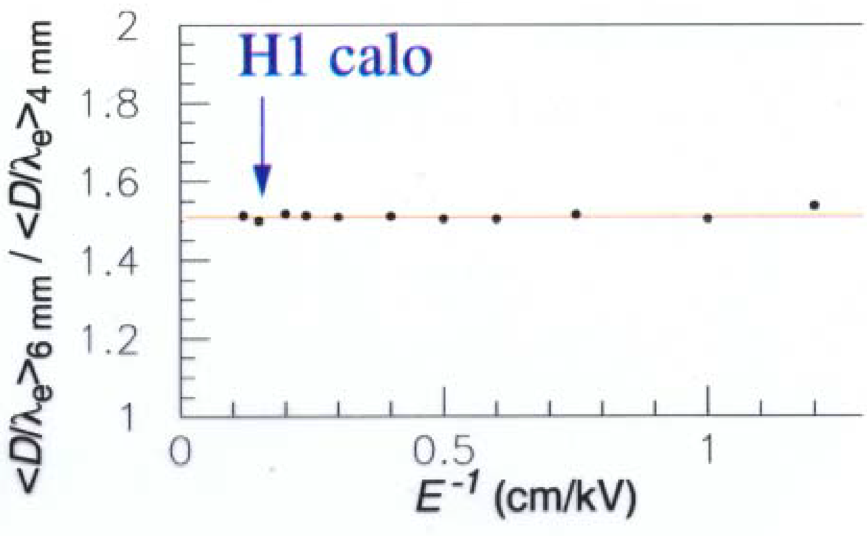
- HV curves with a small point to point error

$Q = Q_0 * f_1(HV)$ or $D_{gap} / \lambda_e = f_2(HV)$

(taken at regular intervals for both 4 and 6 mm probes since 1991)

$0.03\%(\sigma_{stat}) < \sigma(Q/Q_0) < 0.07\%(\sigma_t)$

→ good precision on small absorption effects (e.g 1% on 5%) checked by comparing 4 and 6 mm probes:



→ precise determination of $1/\lambda_e$

$1/\lambda_e \propto 12.0/E + e^{-15.7/E} - 1.004$ (fit of empirical formula)

Purity Monitoring: HV curve

<u>non linearity of λ_e *vs E* for E>5kV/cm</u> (*cf. Hofmann et al. NIM* 135 (197
15

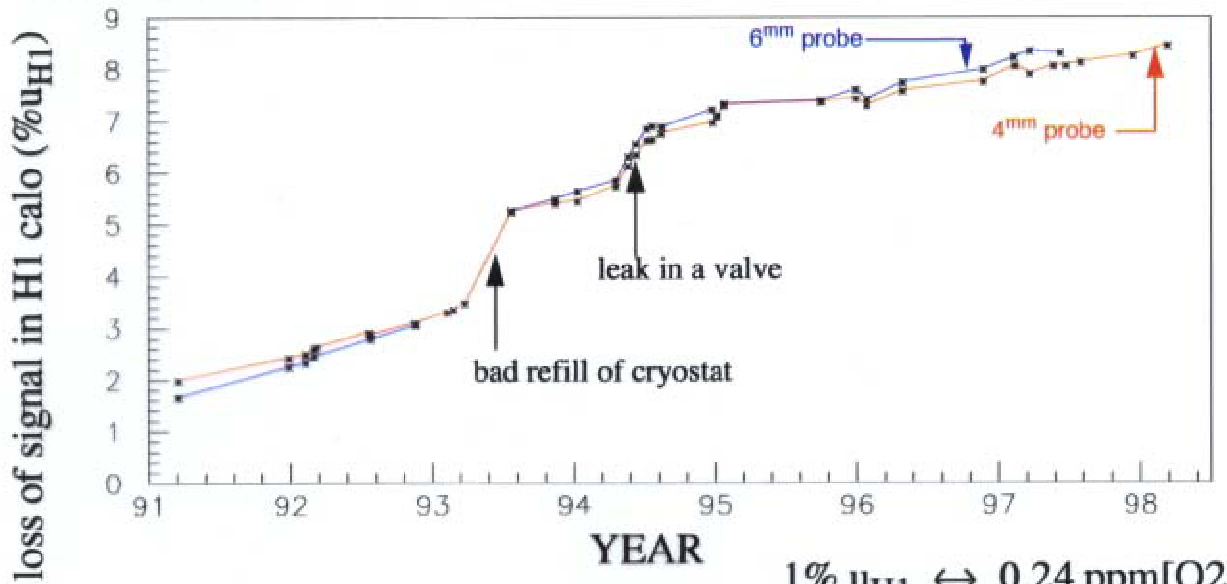
→ essential for the calibration of Bi probes and H1 calorimeter

- long term drift of calibration constant

$$\Delta Q_0/Q_0 \approx -1.5\%\,\Delta T < -1.5\%$$

checked against LAr temp. measurement (ΔT).

Each HV curve is corrected for ΔT. This yields:



1% u_{H1} ↔ 0.24 ppm[O2] [1]

→ dispersion of points within one HV curve: 0.1% (u_{H1} RMS)[1]

→ dispersion between 4 and 6 mm probes: 0.2% (u_{H1} RMS)[1]

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1. cf. forthcoming NIM article by H1 calorimeter group

Conclusion

- Purity System is working reliable since 15.01.1991, constantly monitoring the purity of the LAr Calorimete
- Two methods of the purity monitoring are used.
- The long term variation of the calorimeter response due to pollutions is well under control.
- Result of monitoring is used to detemine the charge collection efficiency for energy calibration of the calorimeter.
- A temperature effect for the signals from β probes was observed.
- We do not see the temperature effect for the α probes