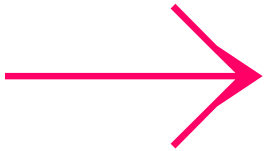
A Longterm Aging Study of the Honeycomb Drift Tubes of HERA-B Using a Circulated and Purified CF_4-Gas Mixture

M. Capeáns [a], K. Dehmelt [c], M. Hohlmann [b], B. Schmidt [b]

[a]CERN (Geneva)
[b]DESY (Hamburg)
[c]University of Mainz

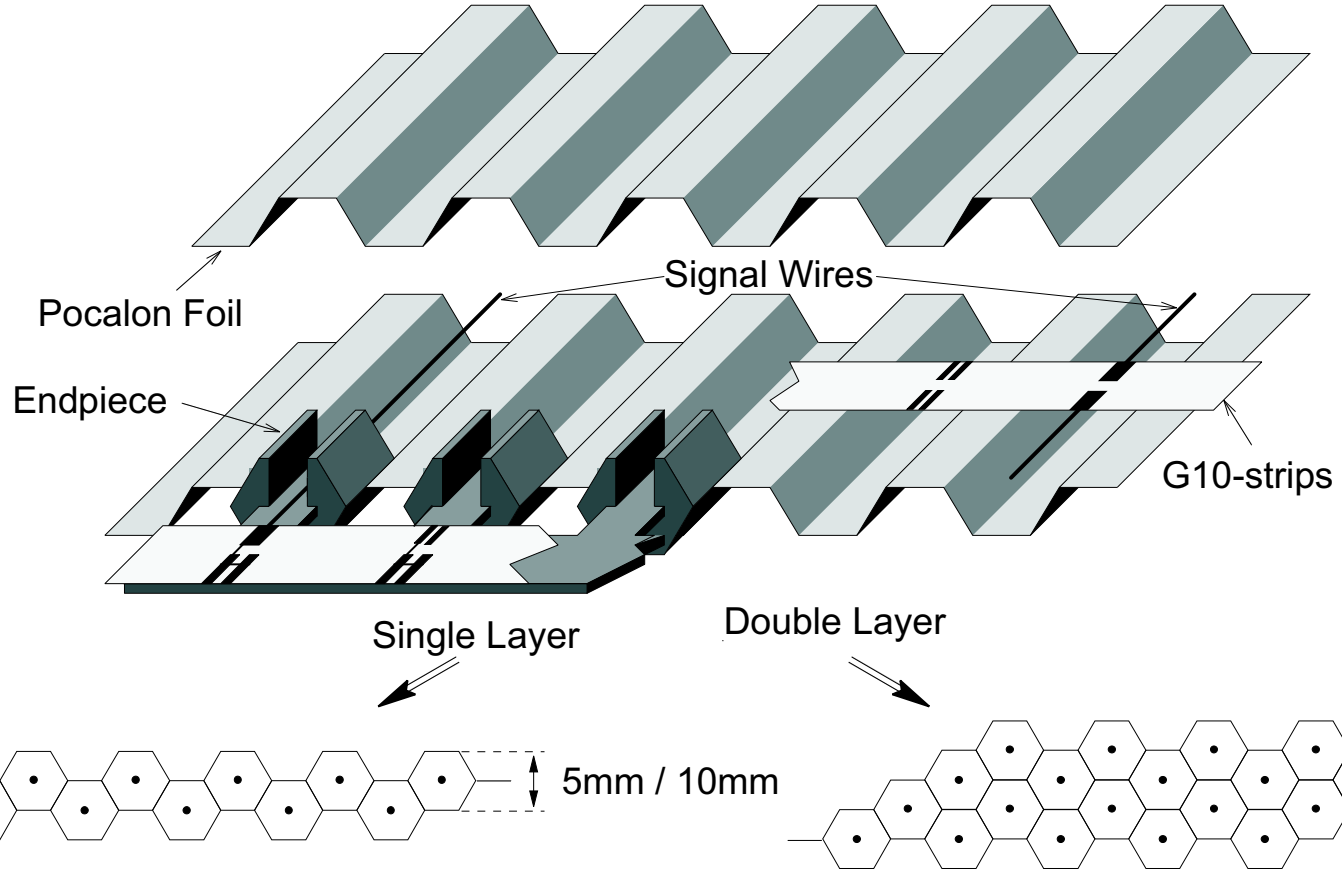
Motivation for aging study:

- ***Recirculating*** gas-system with CF_4 -gas mixture for the ***OTR***
- Need to test purifiers
- Monitoring of pollutants
- Longterm-behaviour of Honeycomb Drift Tubes for the ***OTR***



Simulation of the OTR and its gas-system

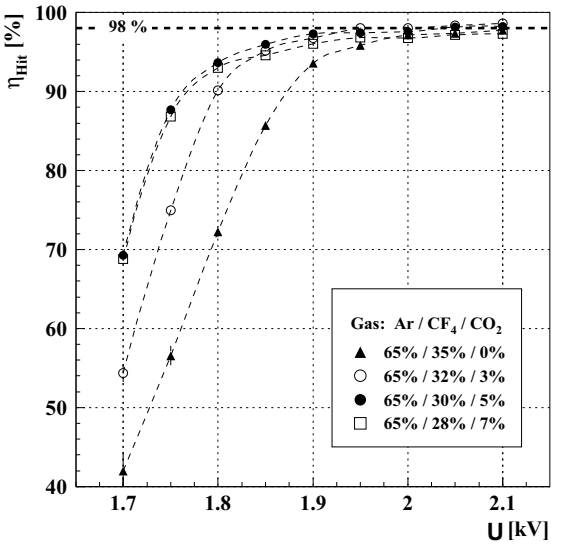
Honeycomb Drift Tube (HDC) of the OTR

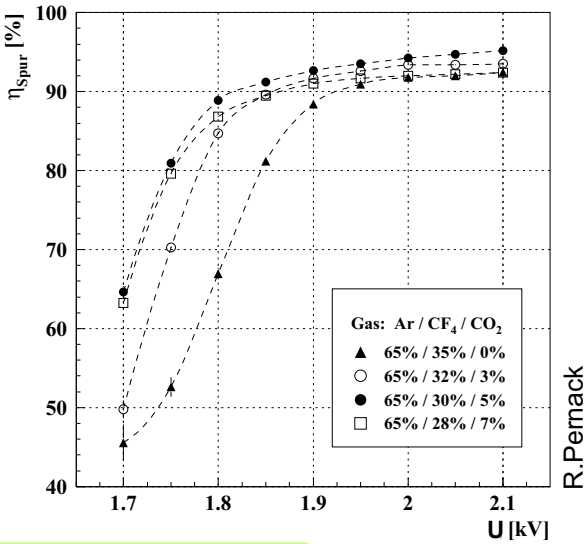


- Pocalon, 75 m Coated with Cu & Au
- Signal wires, Au/W, 25 m

Counting Gas for the OTR

- Interaction rate:
  40MHz
  needs
- Gas mixture:
  $Ar:CF_4:CO_2$ (***65:30:5***)
  due to
- Drift velocity:
  140 m / ns (4-6kV/cm)
- Price of CF_4:
  ~50 € / kg
- Gas volume of OTR:
  ~22 m^3





→ Recirculating gas system

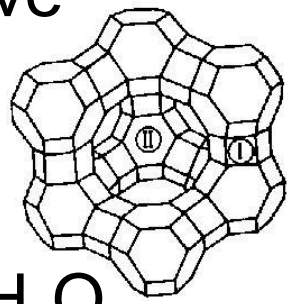
The Purifiers for the OTR

- Recirculating gas-system:
  - Air (leaks)
  - Plasma chemistry products ? (Processes in avalanche,material outgassing,crack products)

ACCUMULATION !
Needs purification.

- R3-11G Catalyst:

Removal of oxygen
46% Cu (highly dispersive)
$2Cu + O_2 \rightarrow 2CuO$
Regenerative



- Molsieve 3A:

Removal of H_2O
(and other pollutants?)
"Inverse sieve"

Experimental Setup for Aging Test

- Honeycomb test module:

  16 drift tubes, each of ***40cm*** length

- X-ray source:

  Cu-anode, running at ***20kV***
  Beam spot size ~ ***12cm*** diameter

- Customized gas system:

  Operation in '***open-loop***' & '***closed loop***'
  Regulated chamber pressure (no bubbler)
  Monitoring main & trace gas components
  Removal of oxygen & water

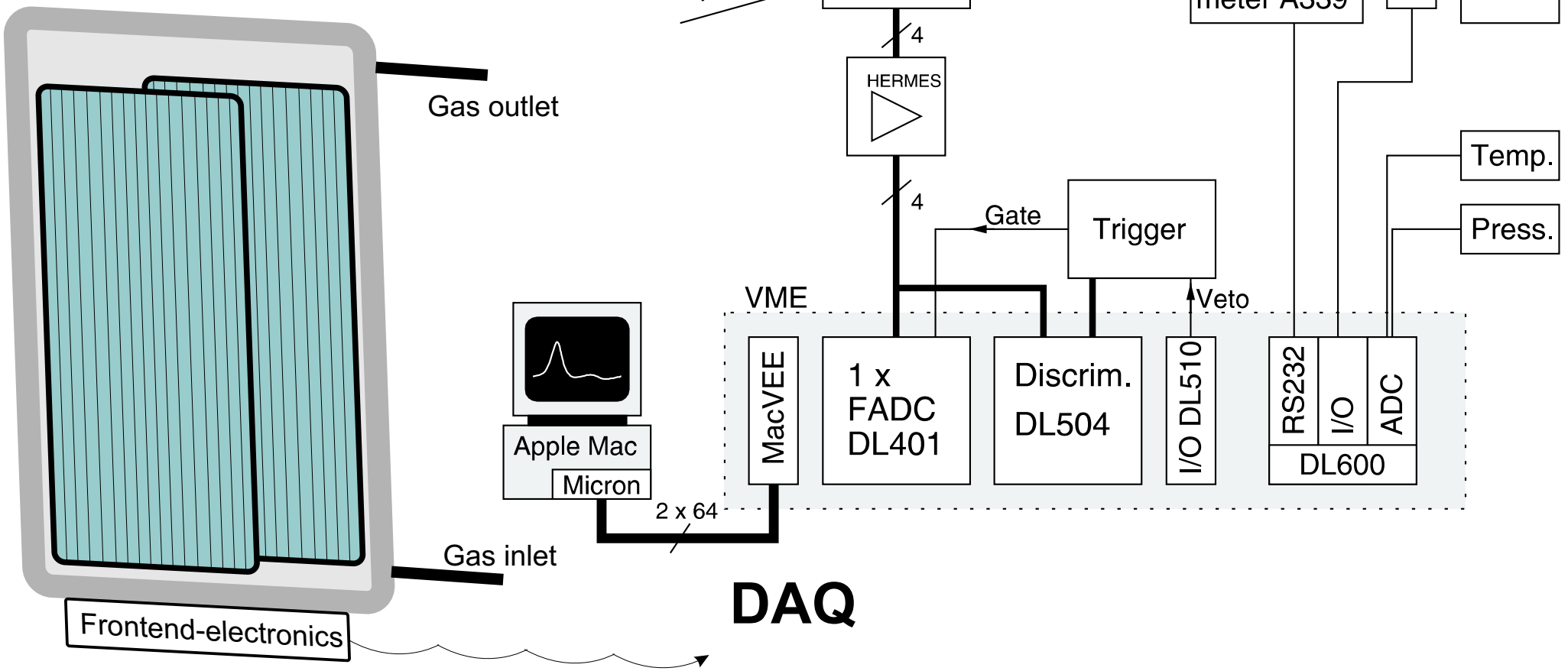
- Electronic readout system:

  FADC, ADC, Currentmeter

Equipment
Test Modules & DAQ

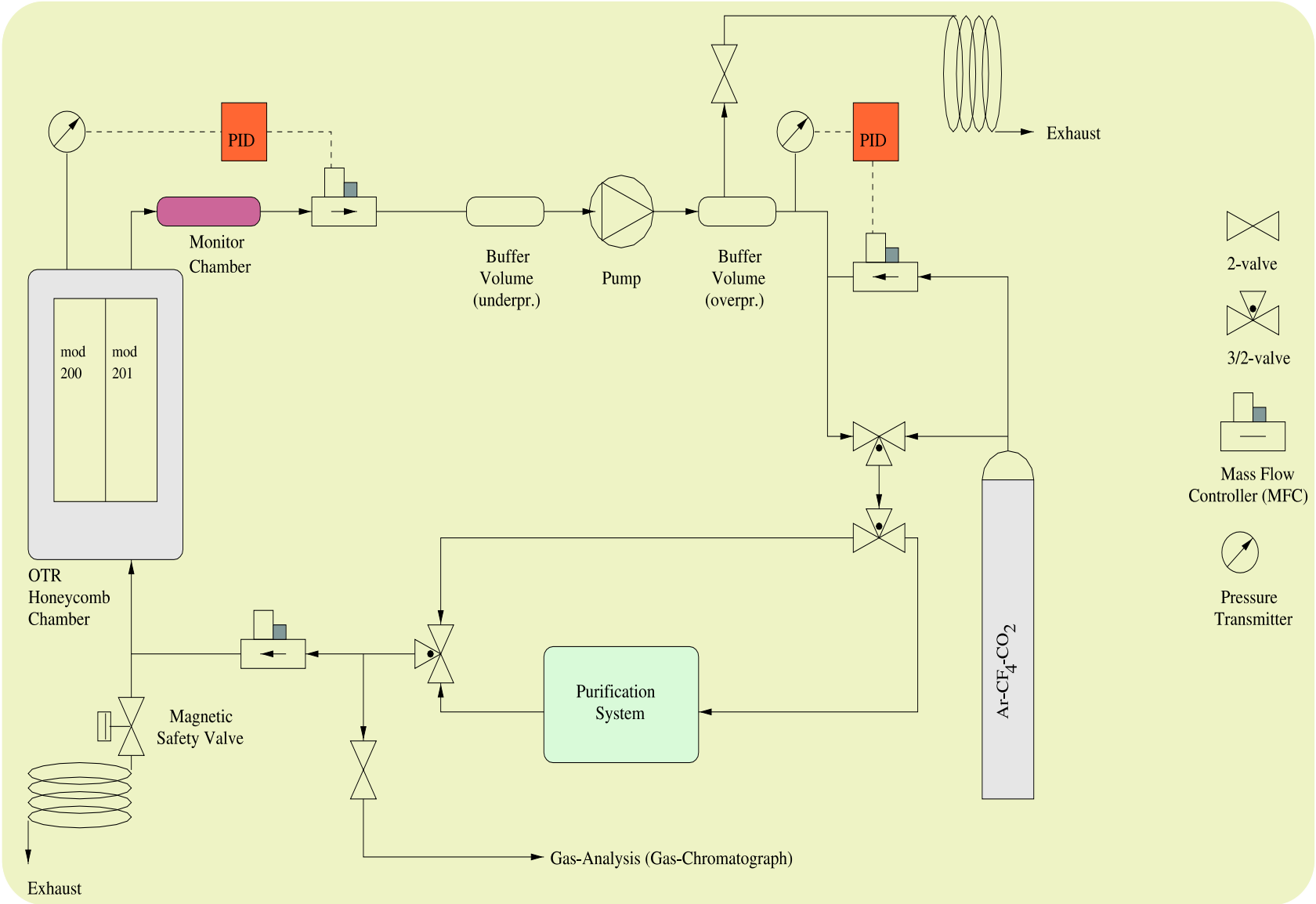
HDC-test-modules:

2 x 16 channels,
two coated pocalon foils



Equipment - Gas Supply

PID-flow regulated, very clean gas system, chamber covered with Mylar-foil



Equipment
Gas Monitoring

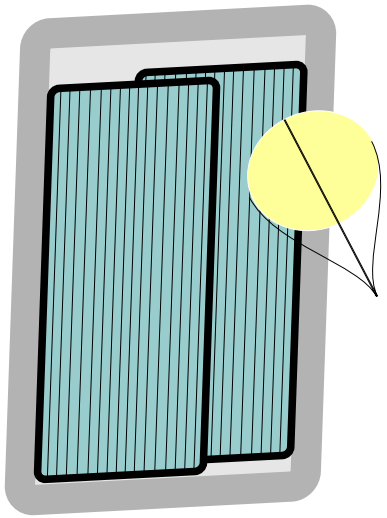
- ***Gas Chromatograph*** HP5890,
  Mass spectrometer +
  Electron Capture Detector
  with individual chromatography columns

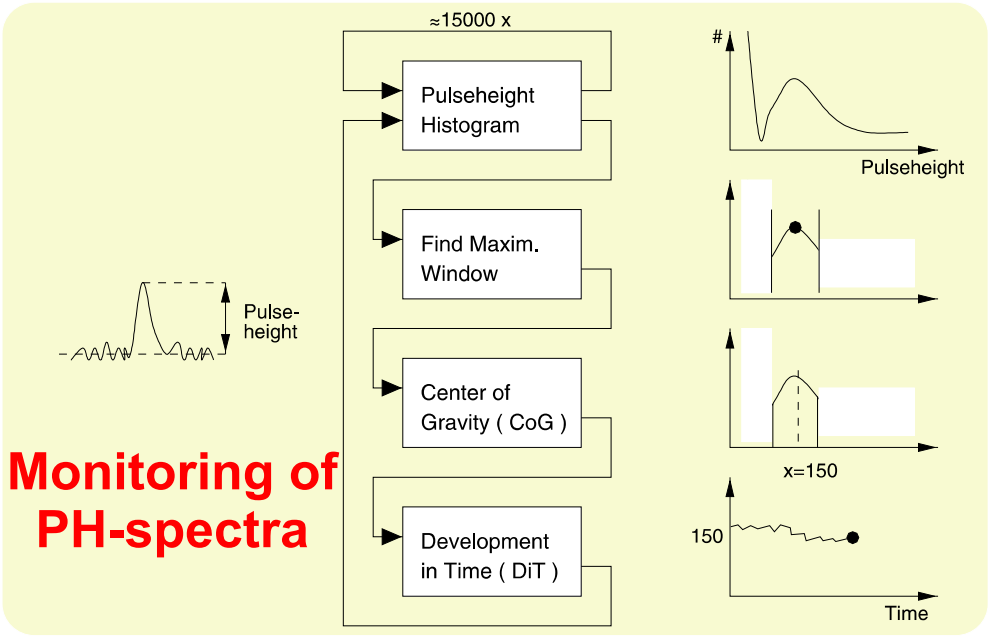
  ➡

  Quality of Counter gas
  Pollutants (if any)
- Commercial ***oxygen meter***
- Commercial ***dewpoint sensor***

Aging Test Procedures

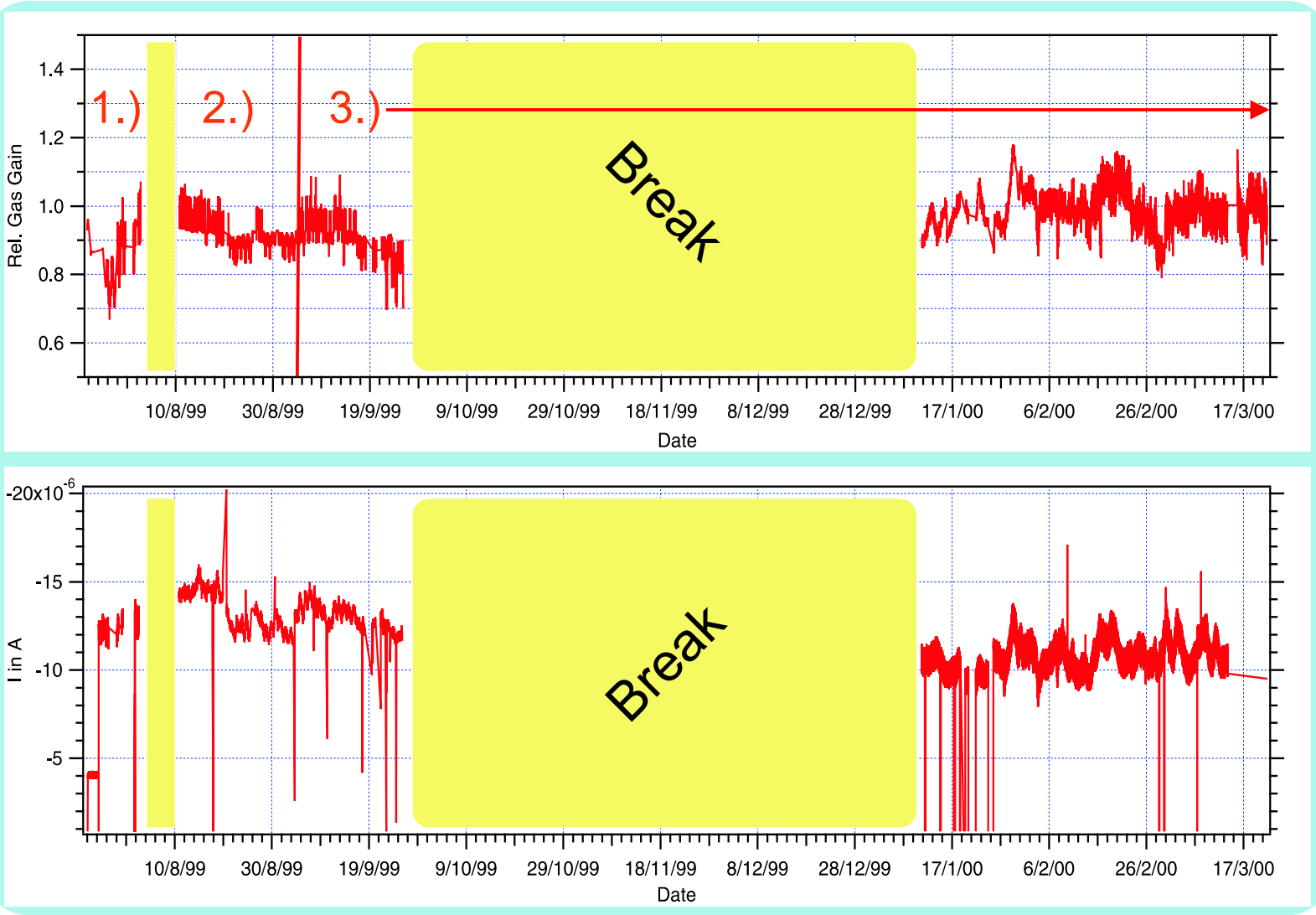
- Examination of module functionality
- Irradiation of half circle area (ø≈12cm)
- Readout of 3 wires (PH-spectra)
- Current monitoring
- Monitoring of T, p
- Monitoring of gas quality
- HERA-B OTR gas-conditions:
  - Recirculation
  - Gas purification
  - Fresh gas ~ 2% / h





Monitoring of PH-spectra

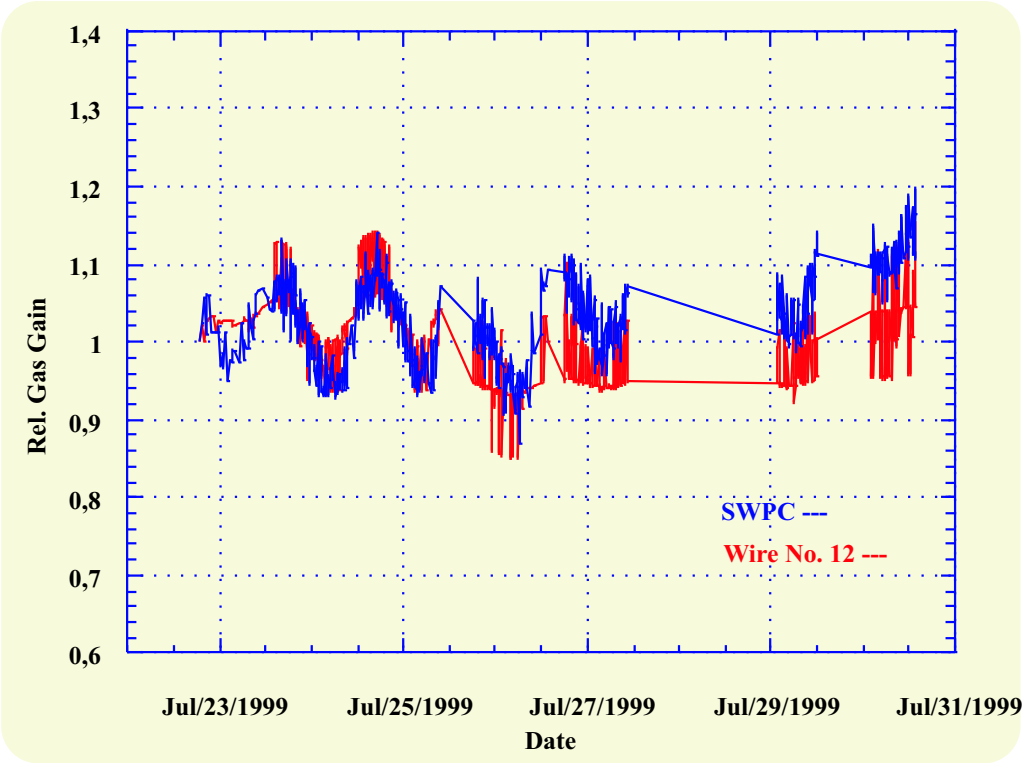
Aging test: Gas Gain Development I

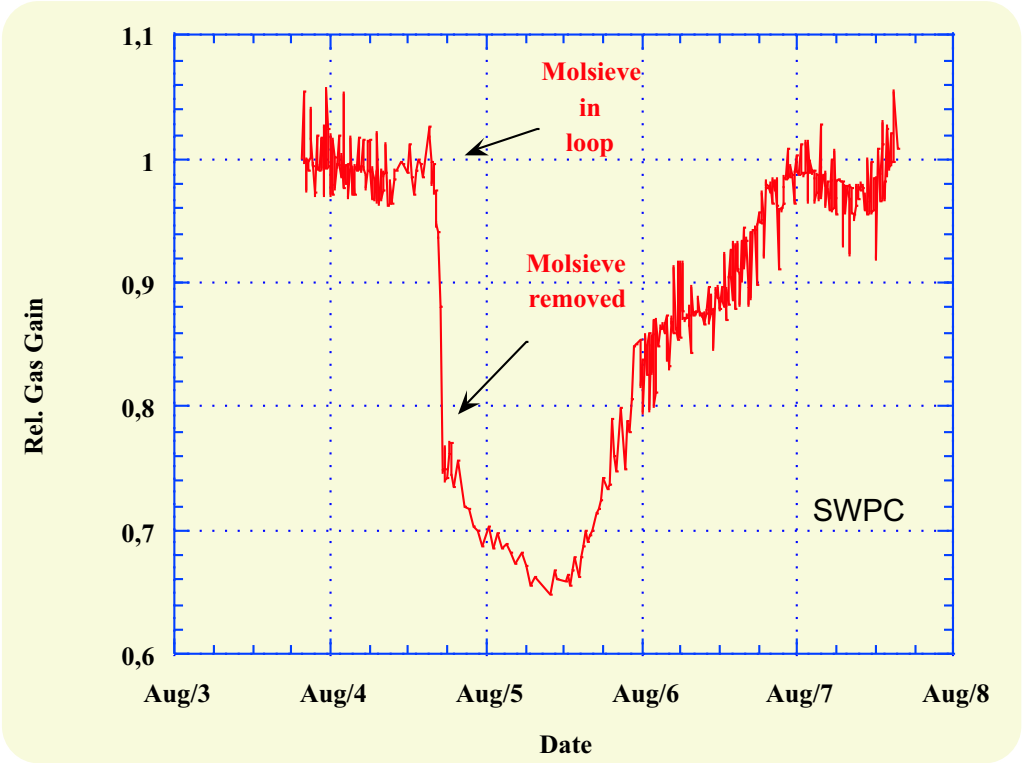


Relative raw gas gain development and current for all periods

- 1.) No Purification, open loop
- 2.) Molsieve, closed loop
- 3.) Molsieve + R3, closed loop

Aging test: Gas Gain Development II



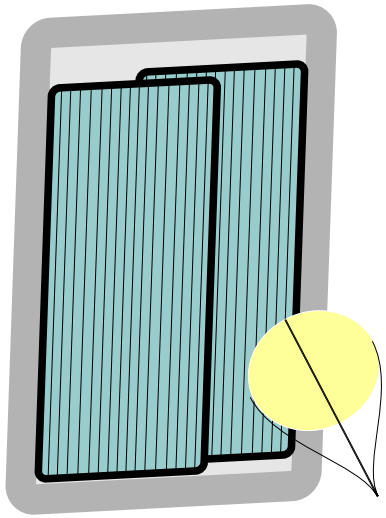


Run without purification:

Correlation of HDC and SWPC

Not saturated molsieve changes gas-composition

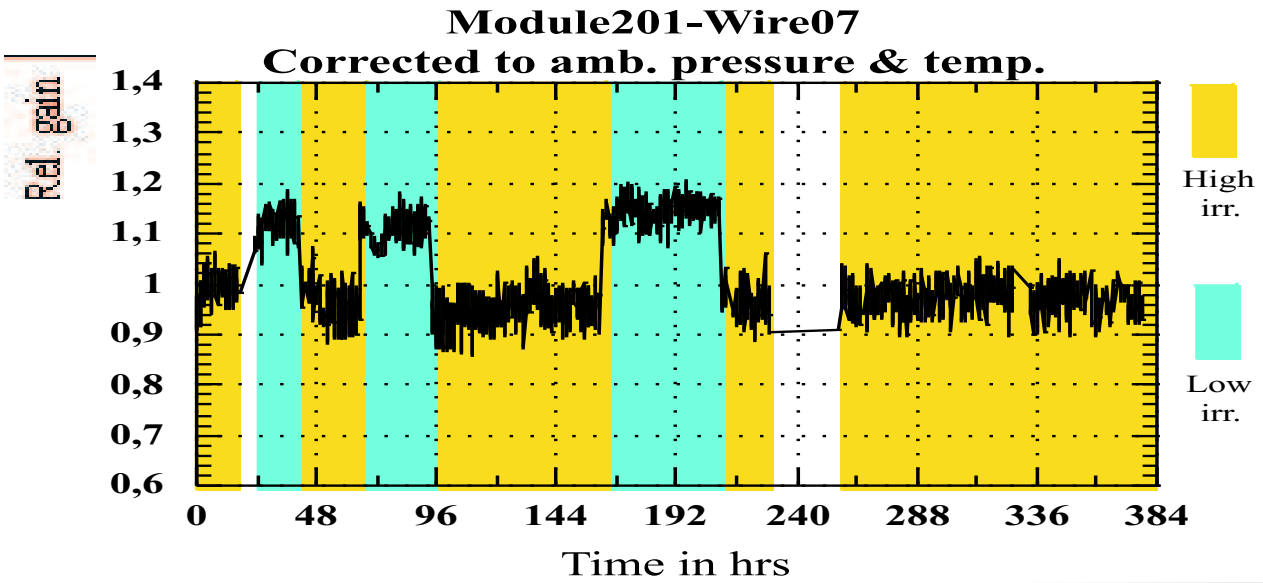
Aging test: very high irradiation



Irradiation performed with

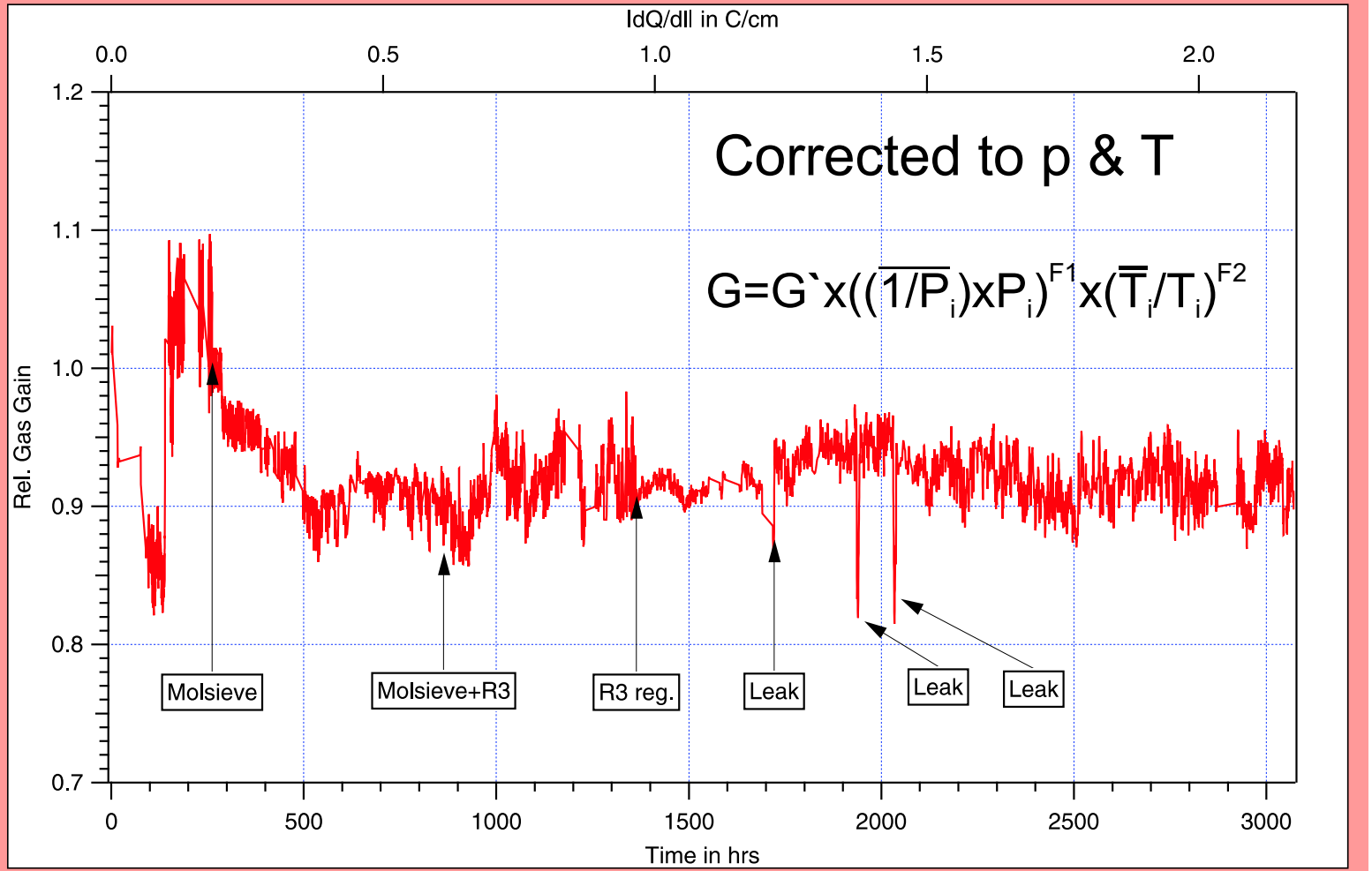
~1 A / cm

- closed loop without purification



- Observation of dark pulses (kHz)
- Observation of pollutants: CH_2Cl_2 $C_2H_6F_2Si$
- Disappeared when switching to open loop
- Disappeared with purification (closed loop)

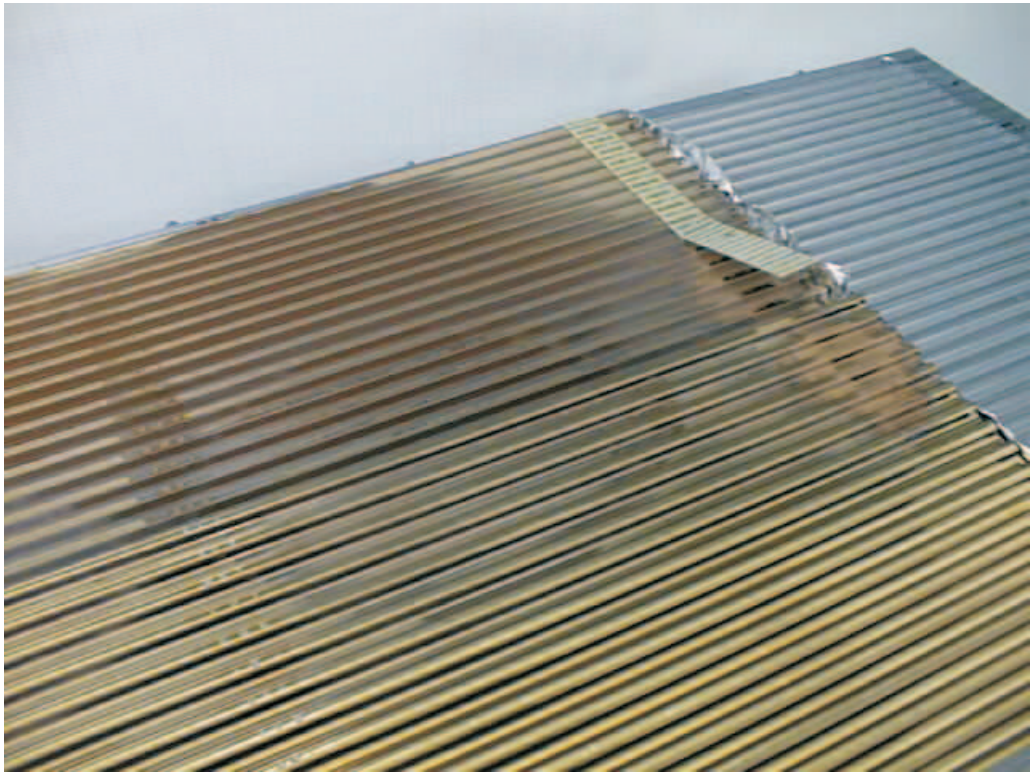
Aging test: Gas Gain Development III



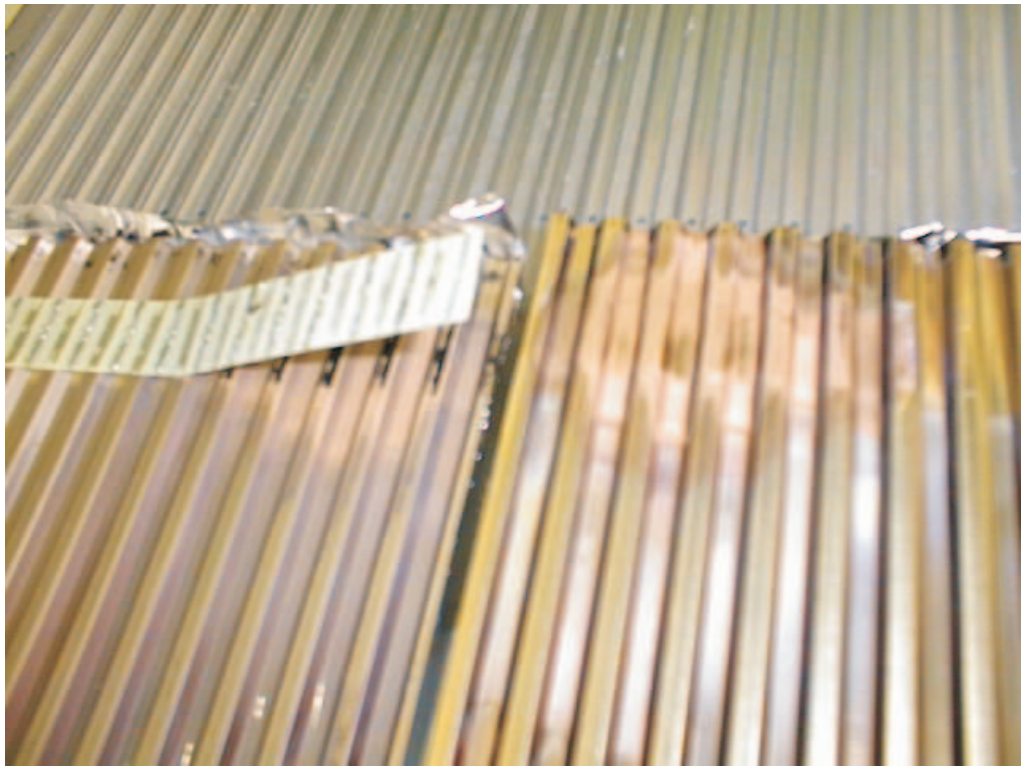
- ~2.3C / cm Accumulated
- ~0.2 A / cm

- Different periods of operation:
  - w/o purification
  - Molsieve
  - R3-11

The open module



- Gas outlet colored
- G10-strip shows spark traces



- Irradiation area visible
- No wire was ruptured

Summary and conclusion

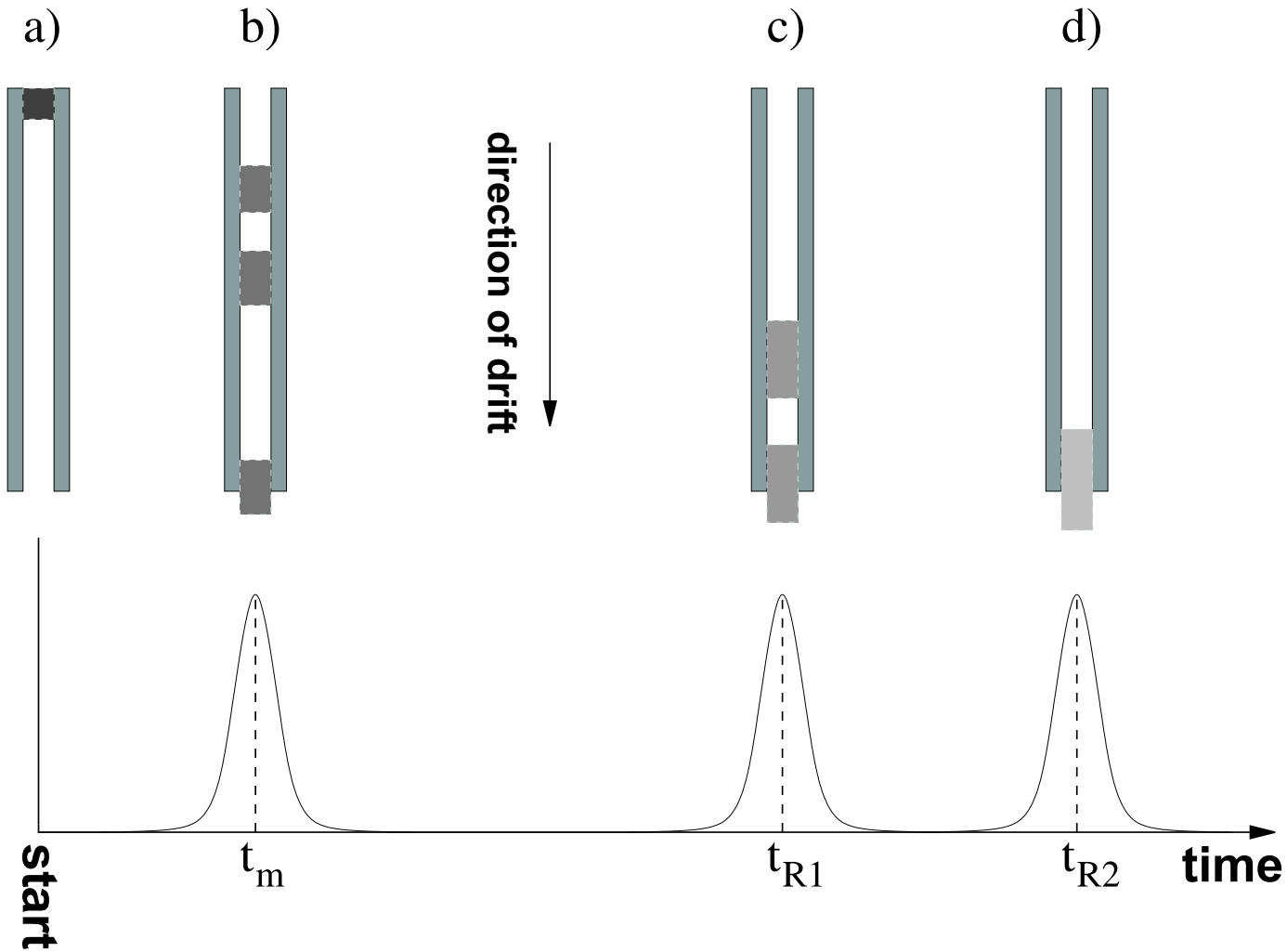
- Total accumulated charge ~2.3 C / cm within ~ 3000 hours within closed loop and purification
- Equivalent to more than three years of nominal HERA-B conditions in the hottest region
- No significant losses in gain observed
- Deviations in gain explainable due to ambient conditions

REMARK: after continuing of irradiation chamber became unusable. Reason ??
Under investigation.

Equipment
Gas Chromatograph

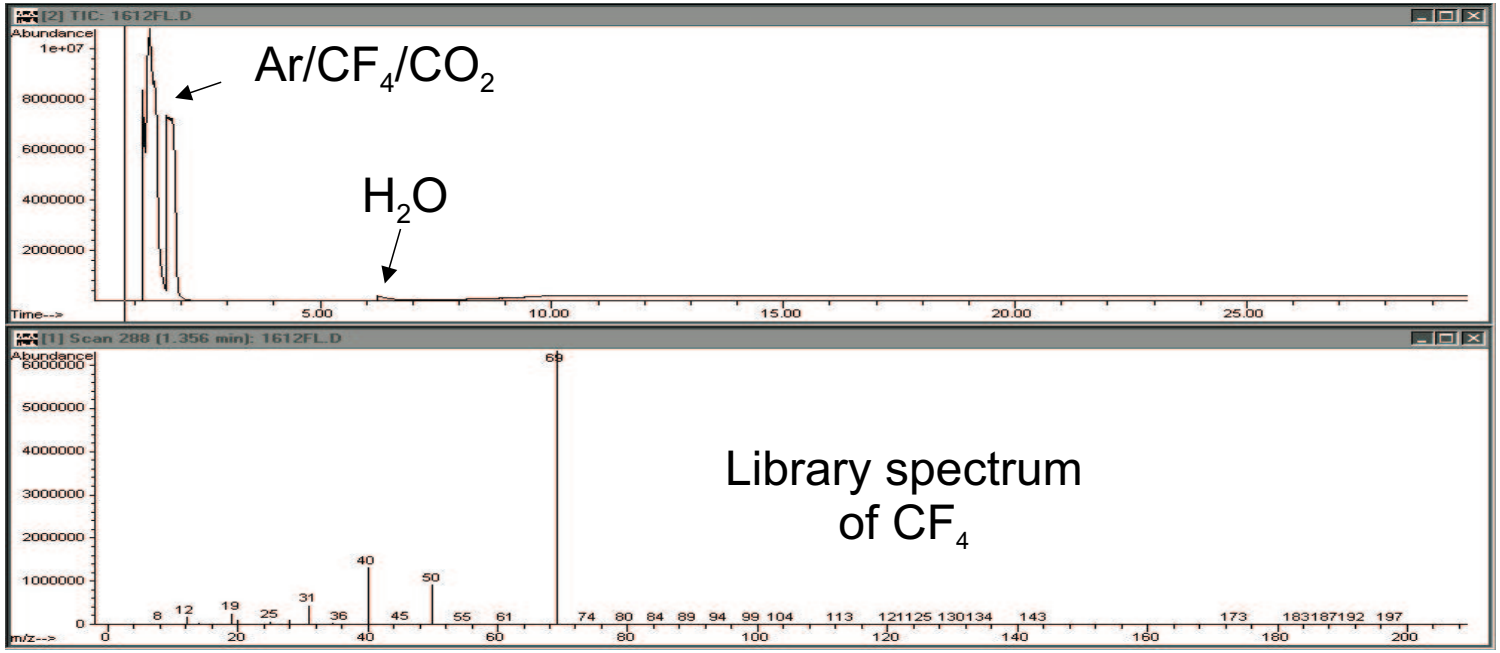
Basic idea:
separation of
gas components

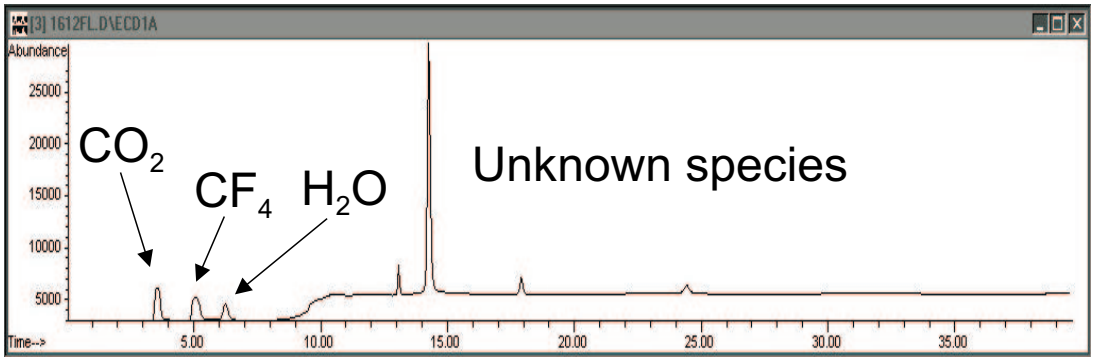
Agilent



Equipment
Gas Chromatograph
Detectors

Mass spectrometer:
Quadrupole
mass filter
Identification of components





Electron Capture Detector (ECD):
in detector volume $\rightarrow I_{const}$
electronegative species $\rightarrow I \neq const$