

## The Method

In the continuous expansion method, the pressure is reduced by a restriction. The gas flows continuously from a volume at relativ high pressure into the calibration chamber and thereafter to the vacuum pump.

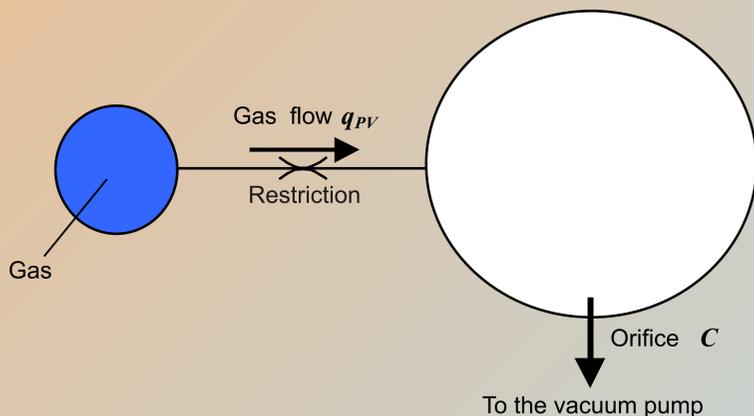


Figure 1: Scheme of the continuous expansion

The pressure in the calibration chamber is given by:

$$p = \frac{q_{pV}}{C}$$

$q_{pV}$  Gas flow  
 $C$  Conductance

## The Primary Standard CE-3

At the PTB, pressures in the range  $10^{-10}$  Pa to  $10^{-2}$  Pa are generated by the primary standard CE-3, based on the continuous expansion method.

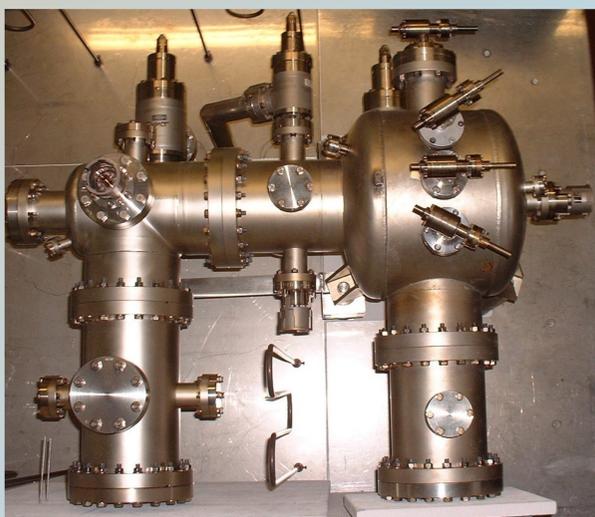


Figure 2: Primary standard CE-3

This method was improved to enlarge the calibration range.

For these purposes two calibration chambers (UHV-chamber  $V_1$  and XHV-camber  $V_2$  (Figure 3)) and two cryo pumps were used. Between these chambers a flow divider channels about 99% of the gas flow into  $V_1$  and 1% into  $V_2$ .

Thus the gas flow in  $V_2$  will be about a factor 100 lower than in  $V_1$ . The gas flow  $q_{pV}$  is produced and measured by the flowmeter FM-3.

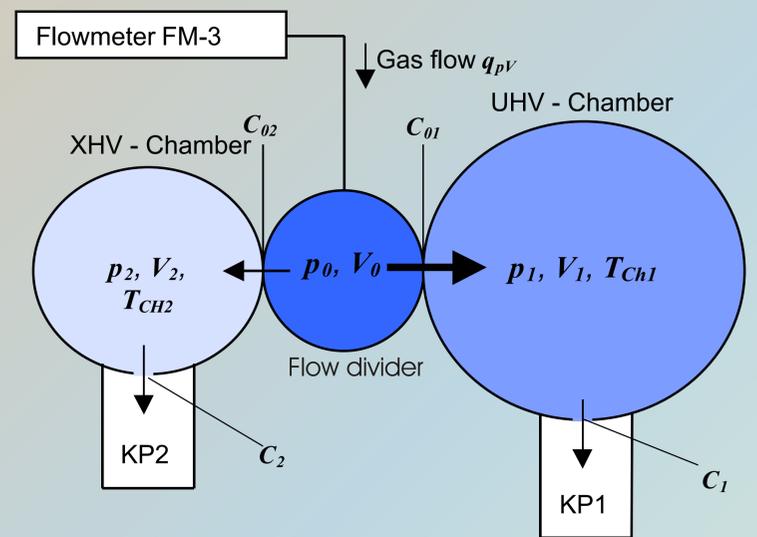


Figure 3: Scheme of the Primary standard CE-3

Cold surfaces at 2.6 K pump the gas molecules exiting from the two calibration chambers through the pump orifices. The high condensation probability of the gas molecules on these surfaces avoids backstreaming for most gas species into the calibration chamber. As a result the orifices act as a “black hole” for the gas molecules. If both cryo pumps operate, the gas flow  $q_{pV}$  is subdivided into two gas flows into the respective chambers :

$$q_{pV} = q_{01} + q_{02}$$

If only cryo pump KP1 operates, the calibration pressure in volume  $V_1$  is given by:

$$p_1 = \frac{q_{pV}}{\gamma_1 C_1} \frac{\sqrt{T_{CH1} T_0}}{T_{FM}}$$

- $T_{CH1}$  Temperature of chamber  $V_1$
- $T_{FM}$  Temperature of flowmeter
- $\gamma_1$  factor accounting backstreaming ( $\approx 1$ )
- $q_{pV}$  Gas flow rate
- $T_0$  Reference temperature 23°C
- $C_1$  Conductance of orifice

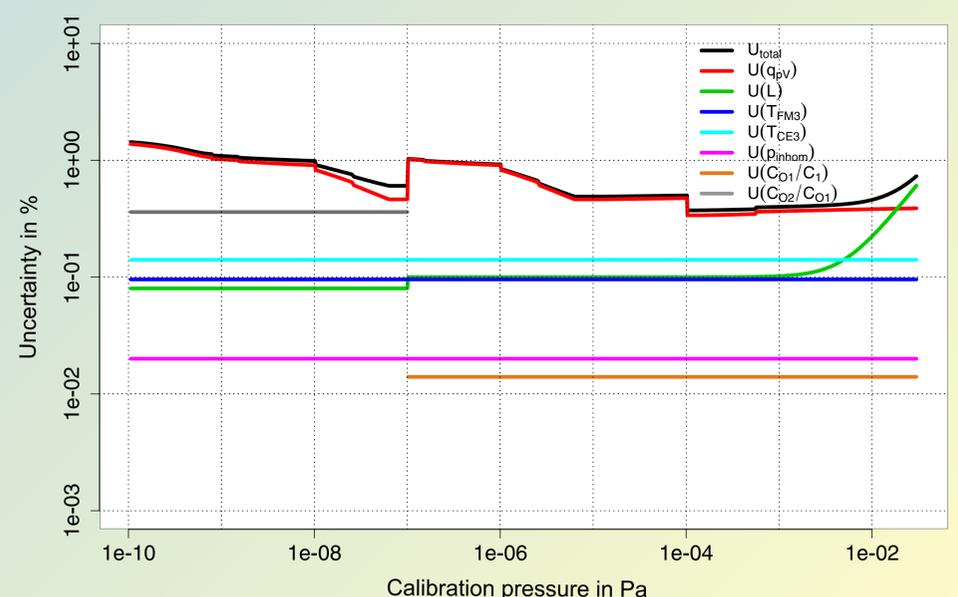


Figure 4: Uncertainty of generated pressure in CE-3