Tests at the Aachen “Flight Simulator”

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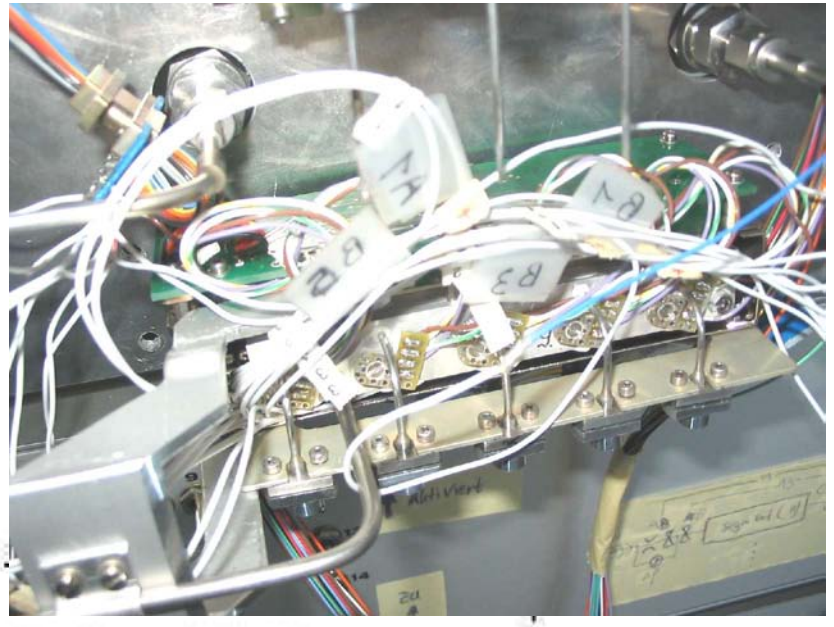
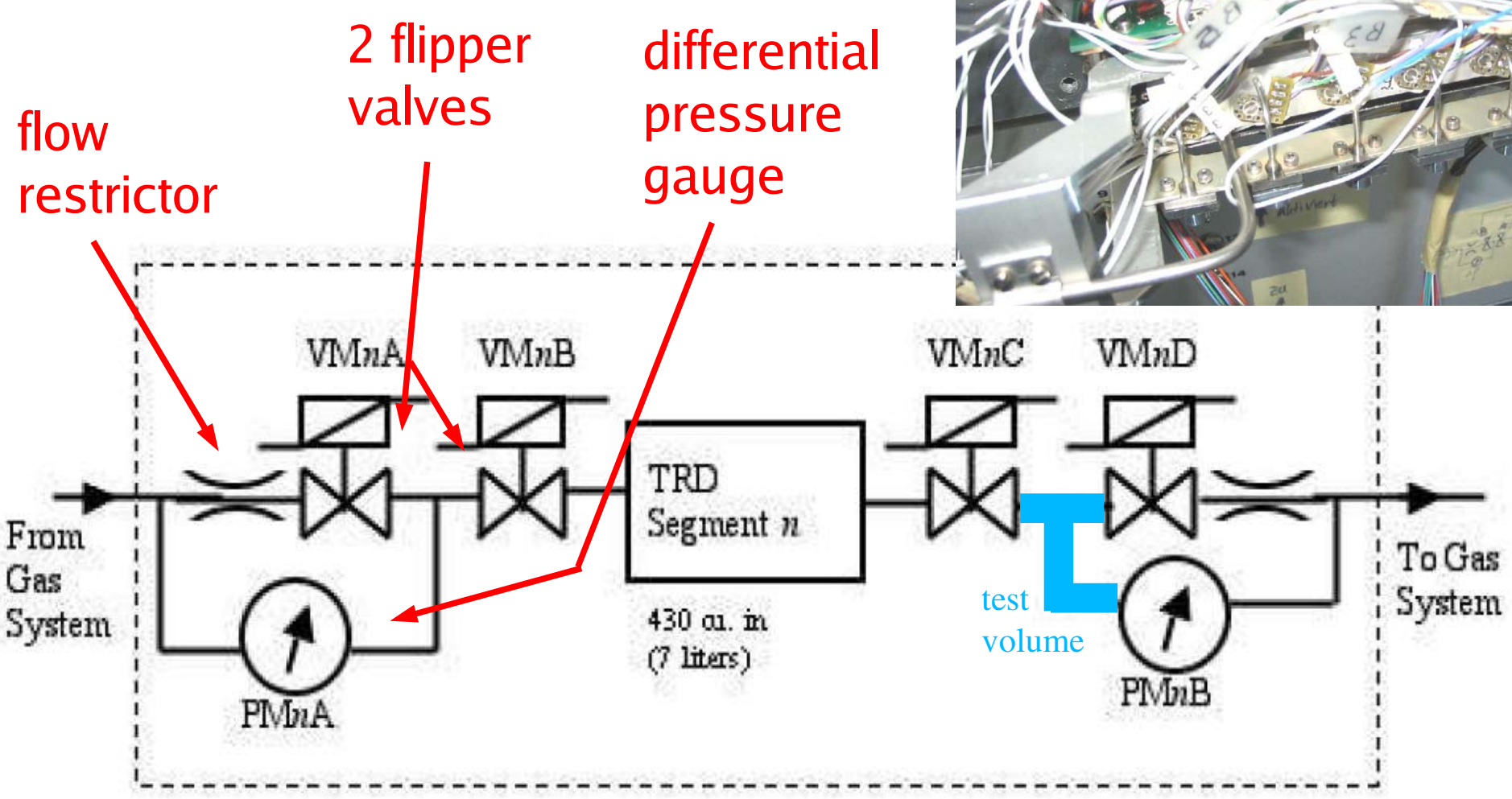
Overview

- Tests of manifold functionality
- Leak detection measurements and simulation
- Cosmic Test

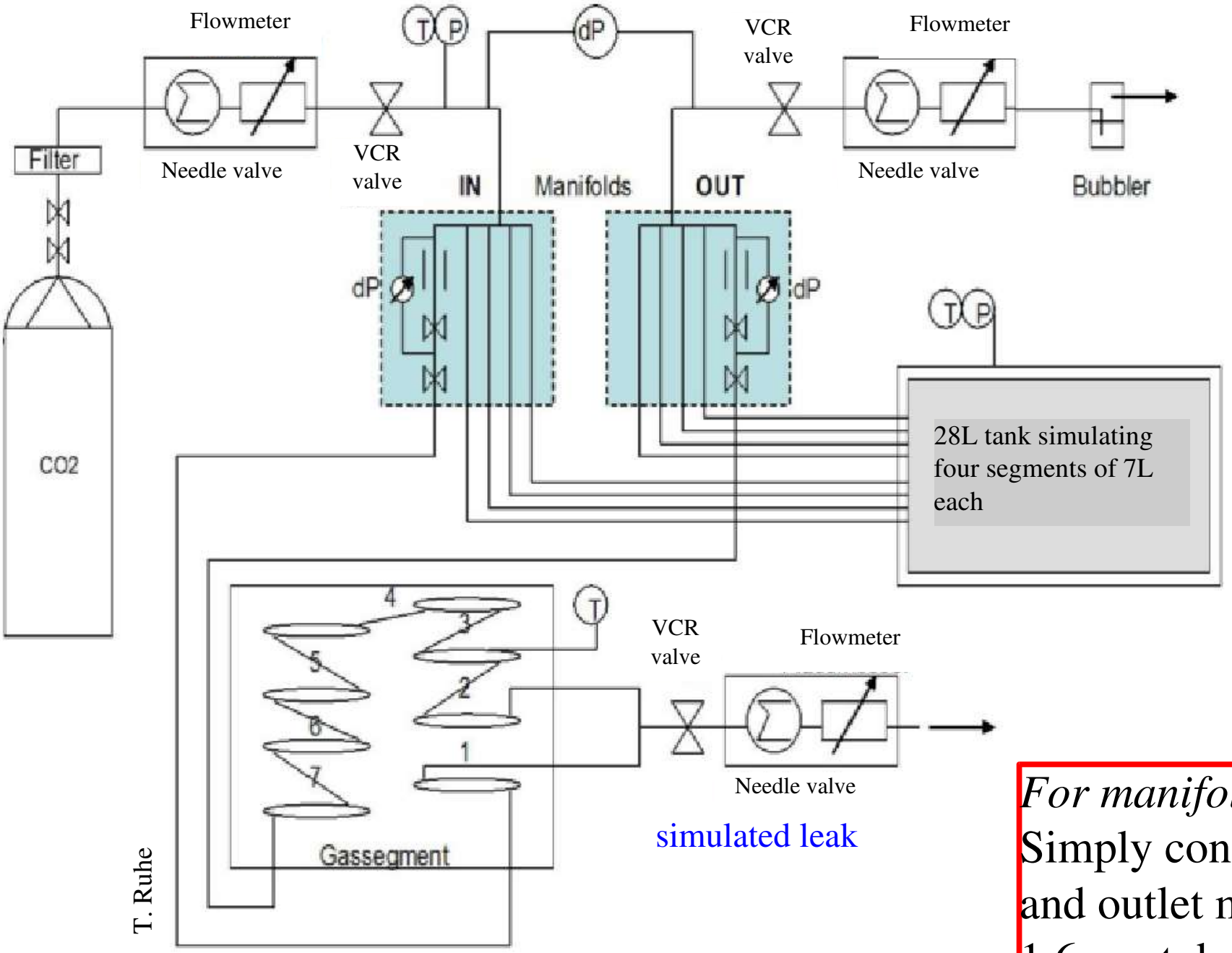
Manifold layout





entry manifold segment exit manifold

Schematic of test setup



For manifold test:
Simply connect inlet and outlet manifolds by 1.6mm tubes.

Pictures of test setup

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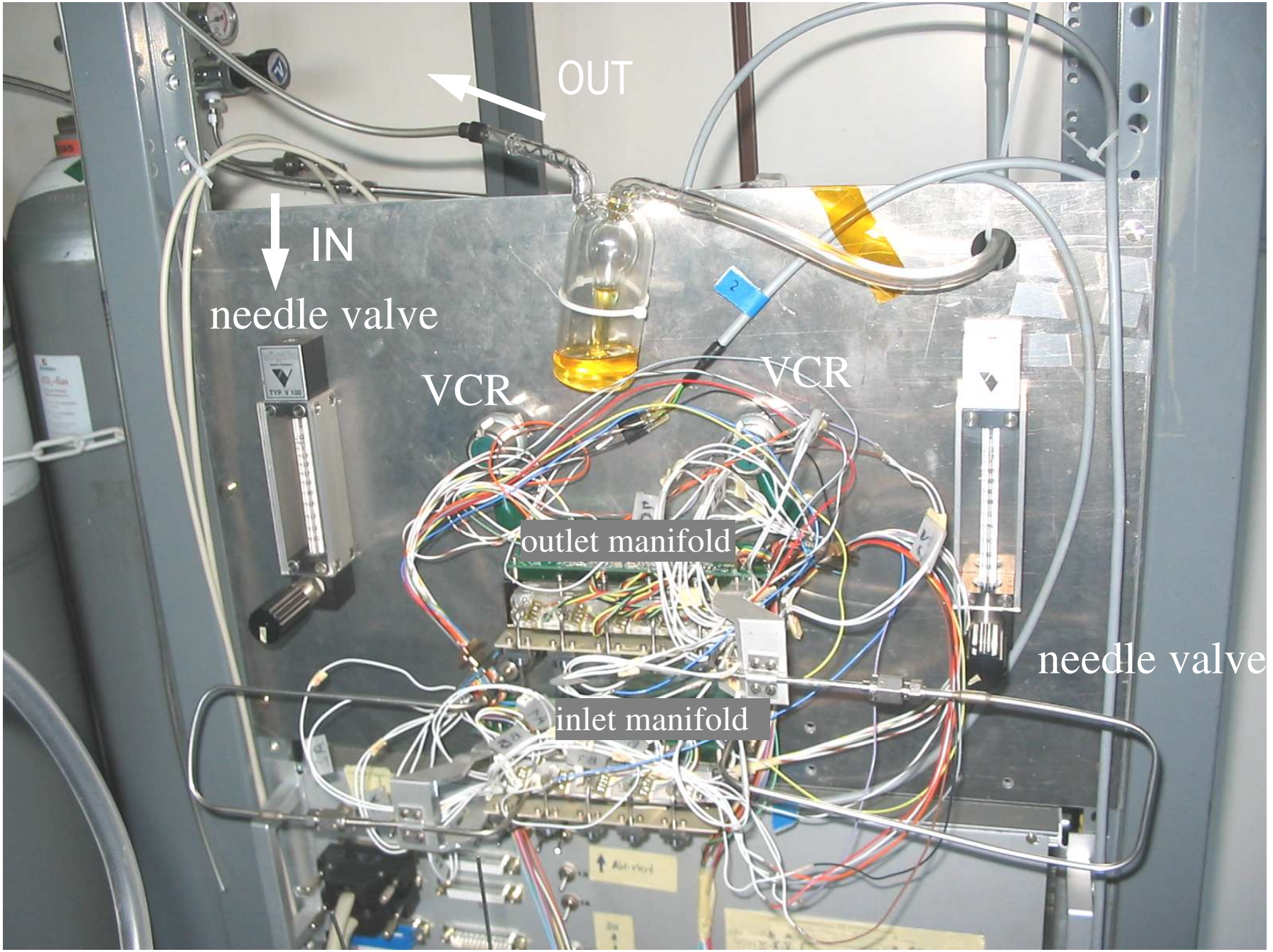
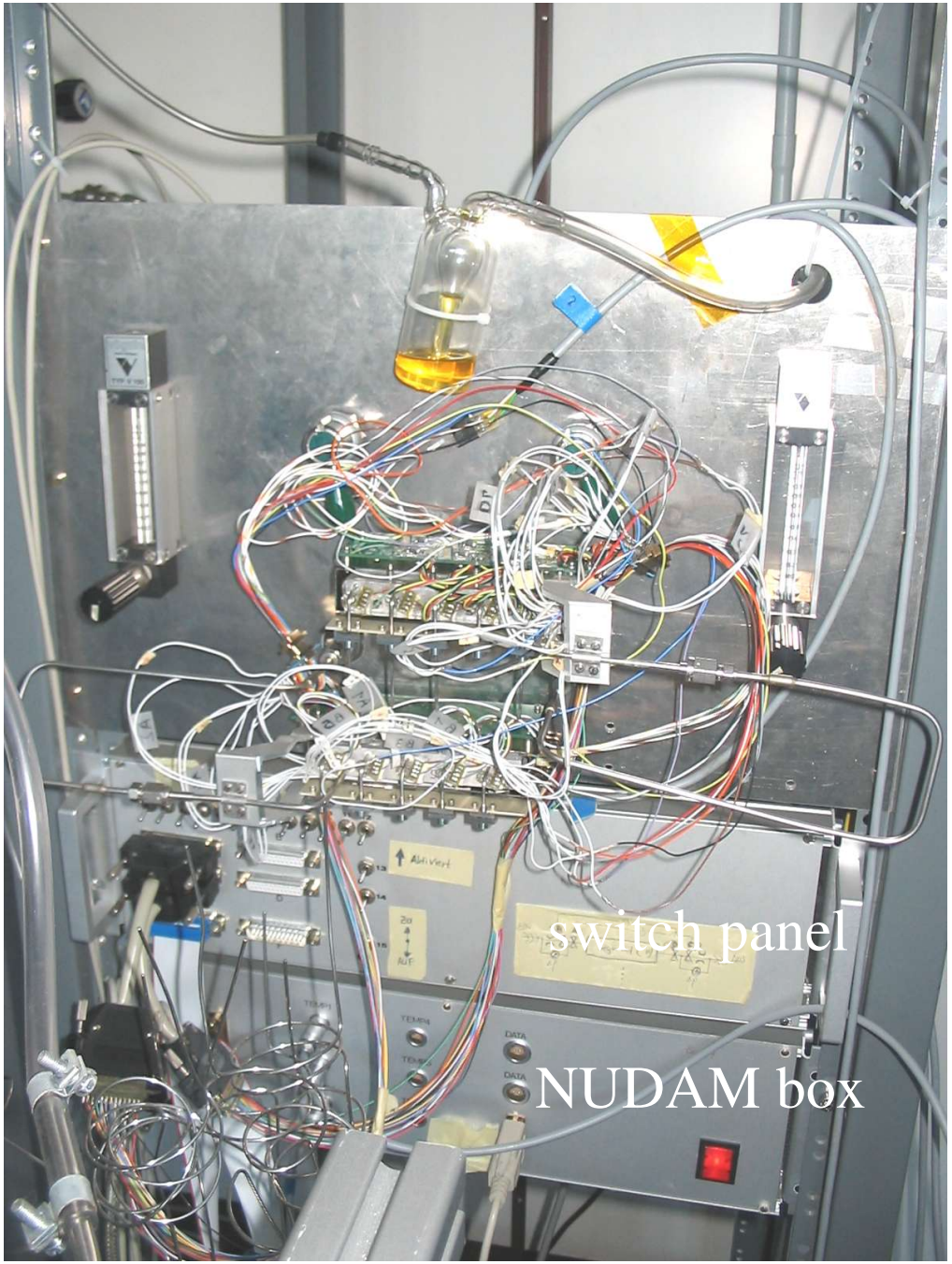
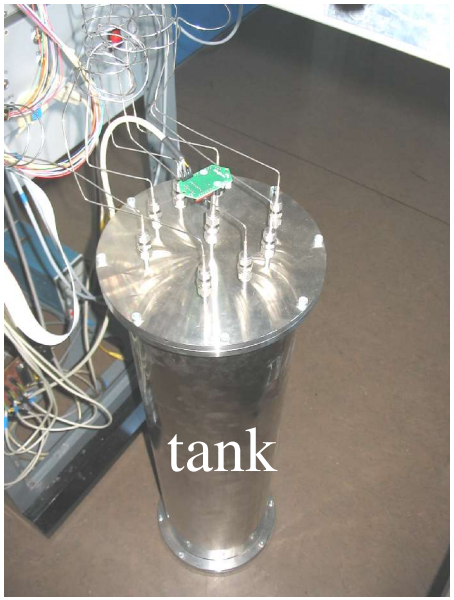


Pictures of test setup





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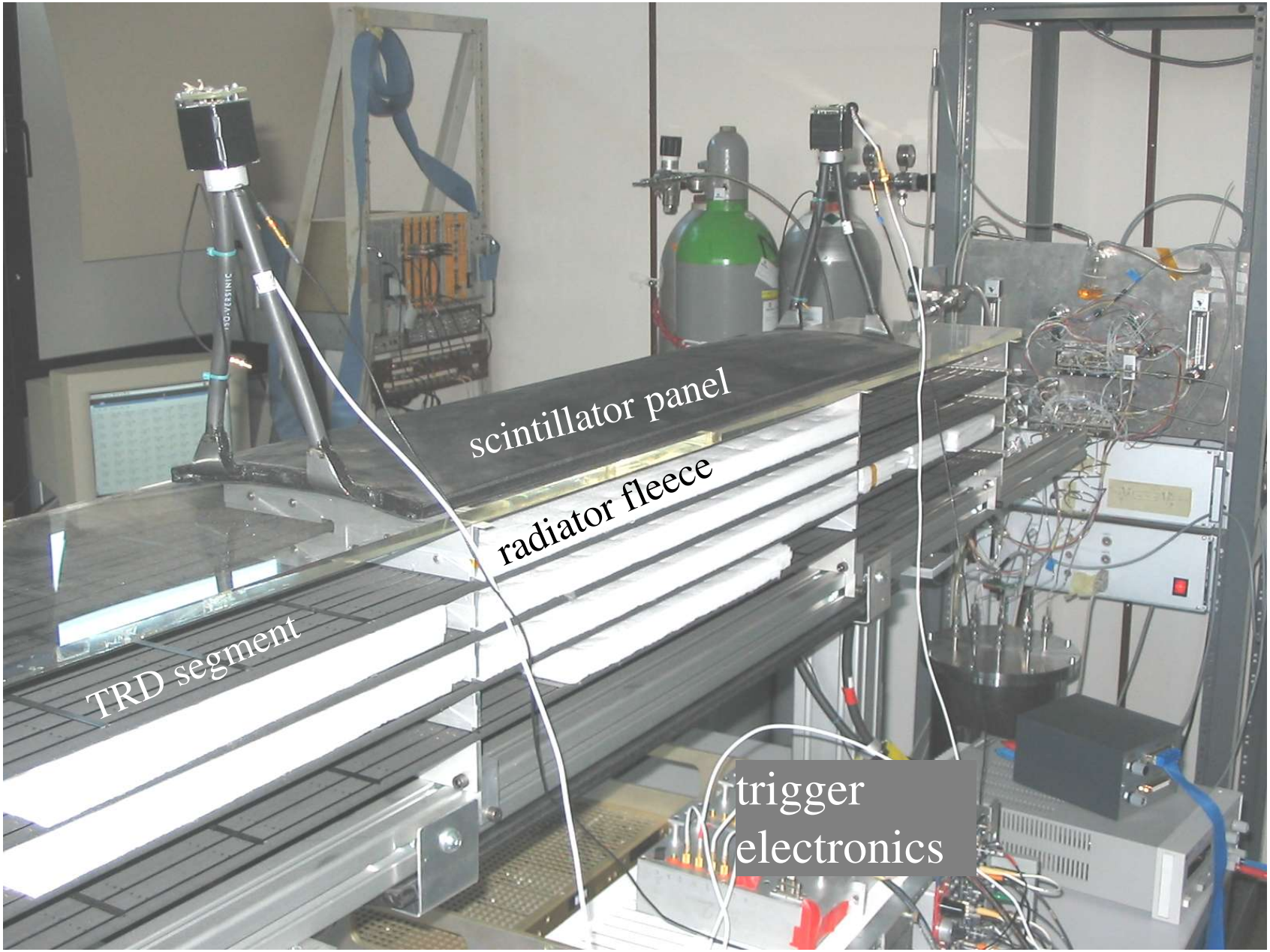


Manifold test procedure

1) Test valve opening. *EM manifolds: OK*

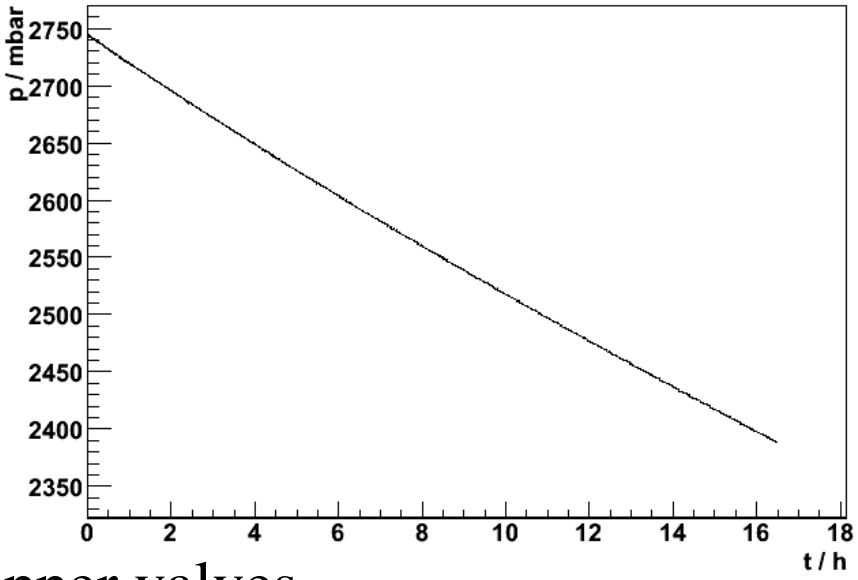
2) Measurement of calibration constants for differential pressure sensors. *EM manifolds: factors (0.92 ± 0.01) and (0.99 ± 0.01) respectively to design value of 0.1 mV/mbar*

3) Pressure drop at flow restrictors.

EM manifolds: large variations, Δp=5-25 mbar @ 2.2 l/h; design: 50mbar @ 1 l/h

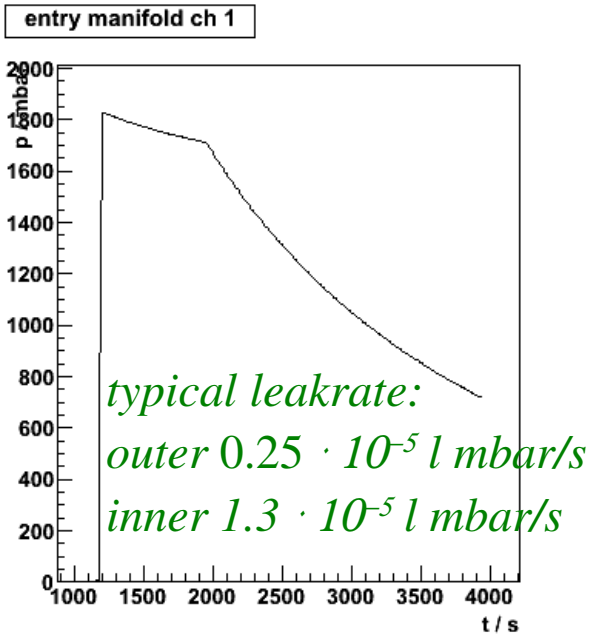
4) Overall gas tightness.

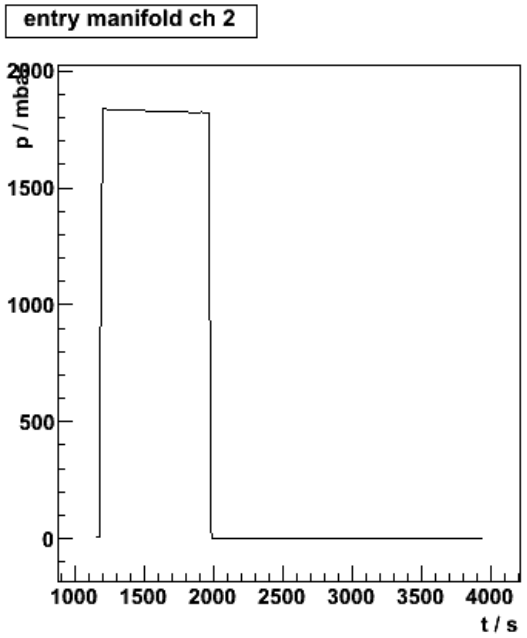
EM manifolds: overall leak of $6 \cdot 10^{-5}$ l mbar/s @ 1atm He; entry manifold only: $0.9 \cdot 10^{-5}$ l mbar/s @ 1atm He

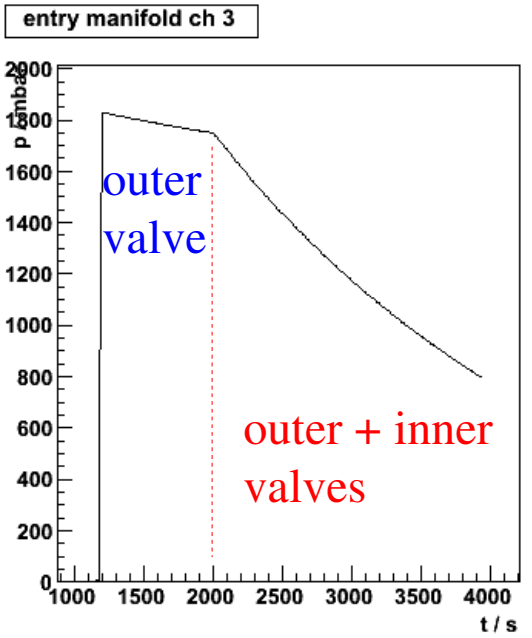


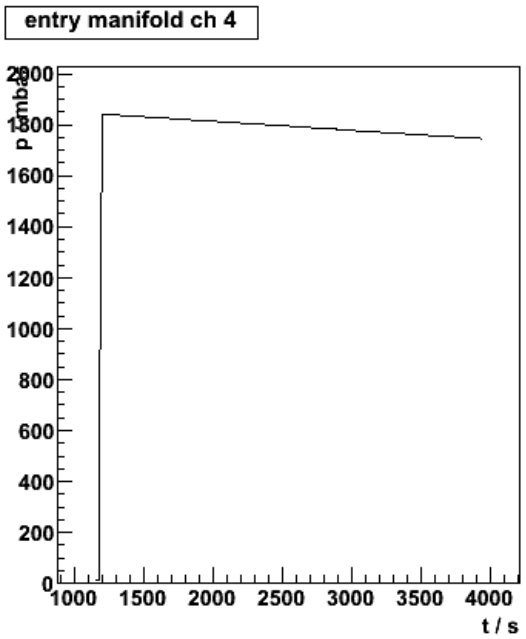
5) Tightness of individual flipper valves.

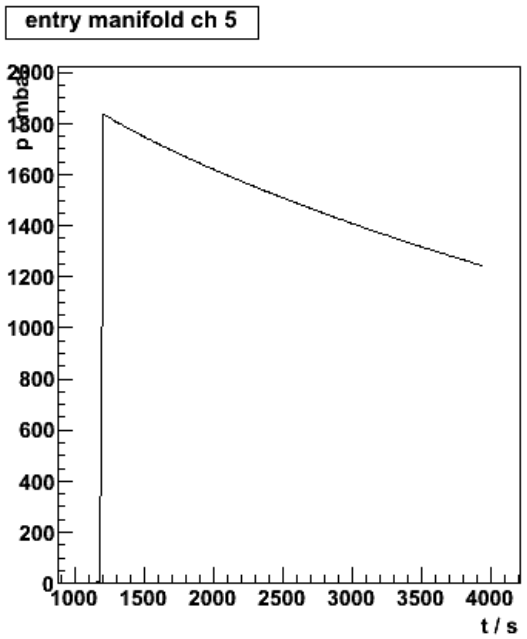
Testing valve tightness







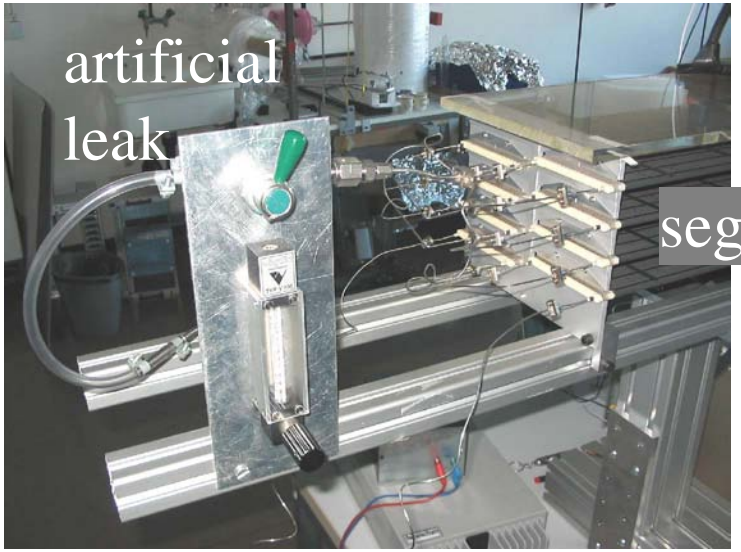




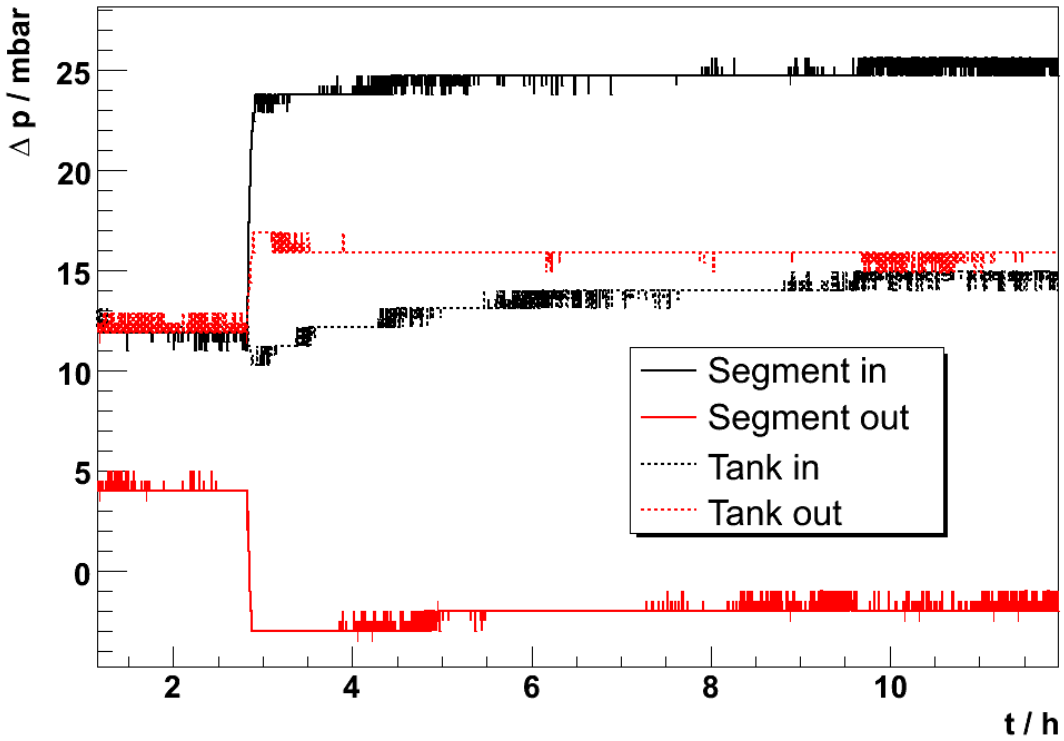
- Fill volume between the two flipper valves (≈0.04 ml) with gas, measure pressure drop.
- At some point (*here: t ≈2000s*) remove 1.6mm tubes linking the manifolds.
- Fit two exponentials.

Leak detection measurements

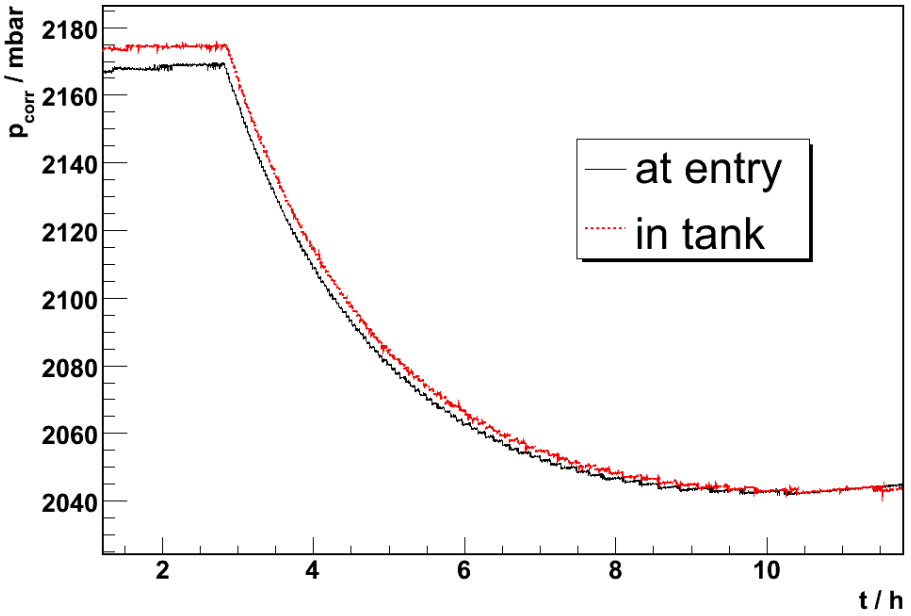
- Adjust flow through system using the needle valves.
- Wait for equilibrium.
- Open leak, measure manifold differential pressures over time.



manifold Δp



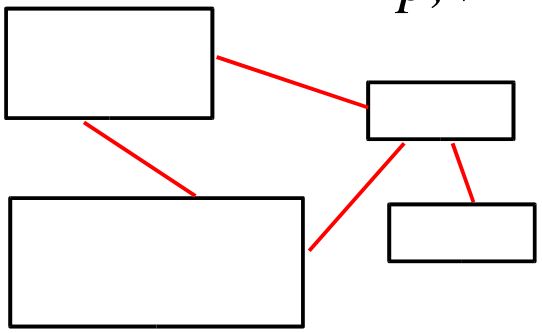
system pressure



Leak detection simulation

consists of volumes and links

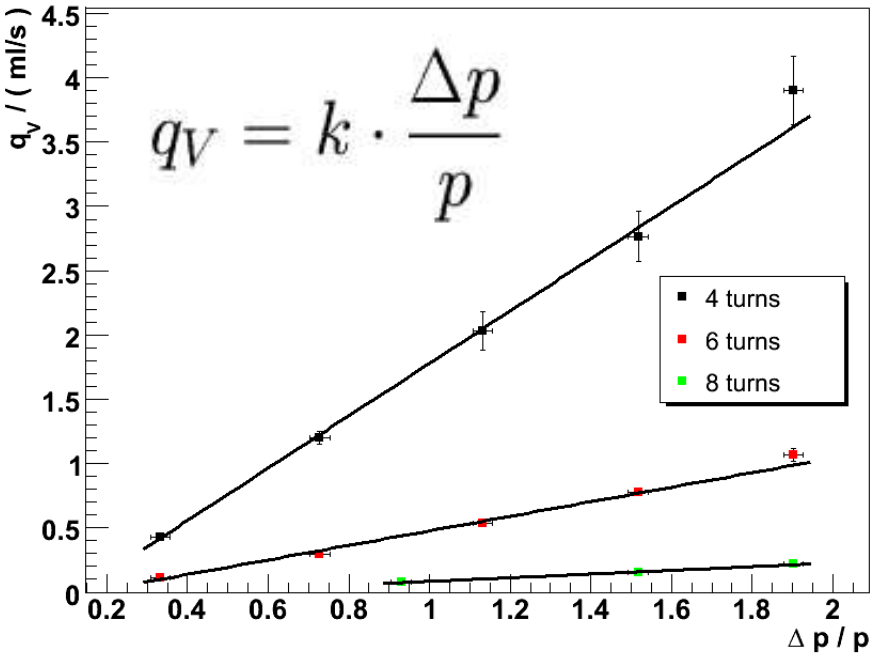
p, V k



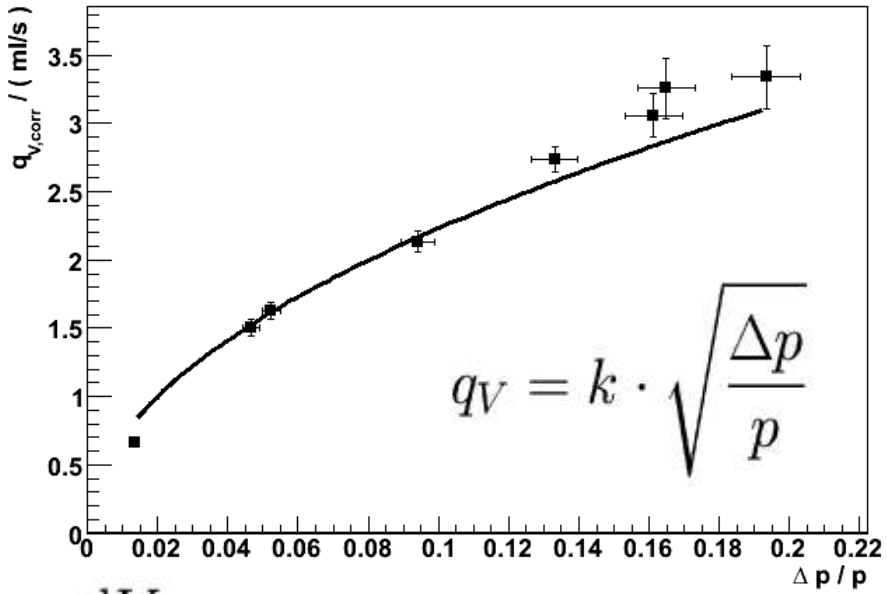
- *needle valve*
- *flow restrictor*
- *pump (q_V=const.)*

- Use discrete timestep Δt
- Initial conditions $p_{i,0}$
- Loop over links, calculating ΔpV

Needle valve



Flow restrictor, EM inlet manifold, channel 1



$$q_V \equiv \frac{\mathrm{d}V}{\mathrm{d}t}$$

Simulation results

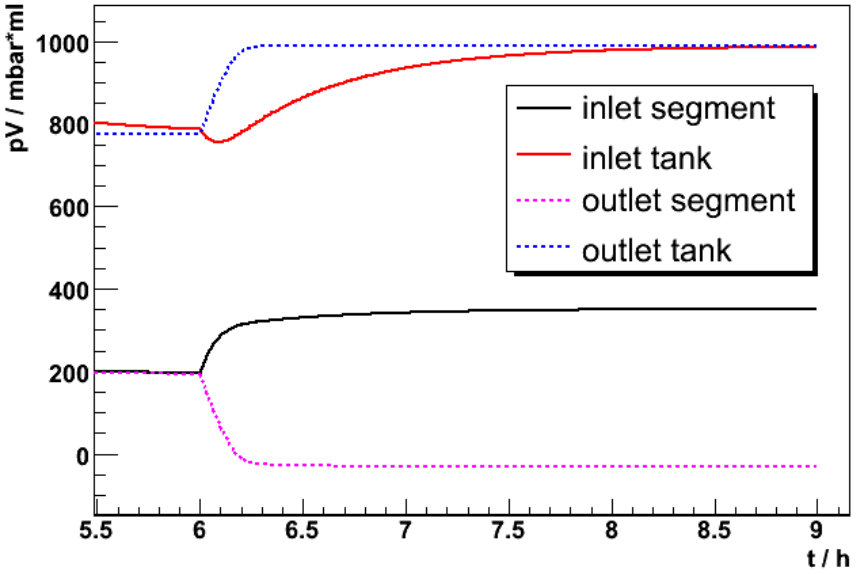
open system

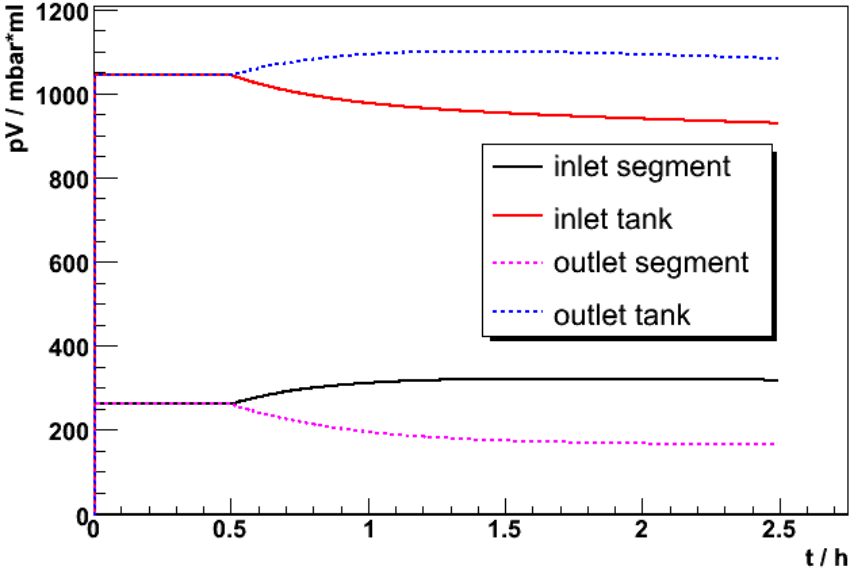
example

Box C

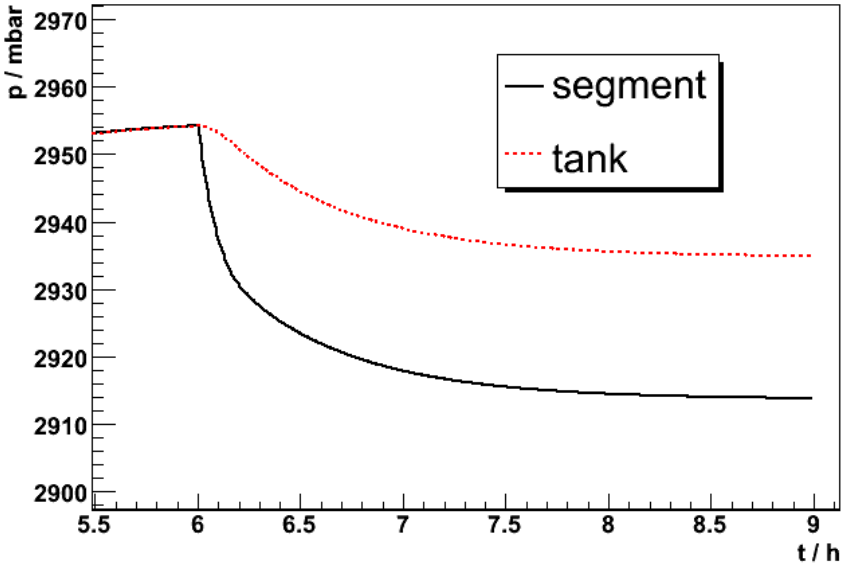
(same manifold valves, same leak)

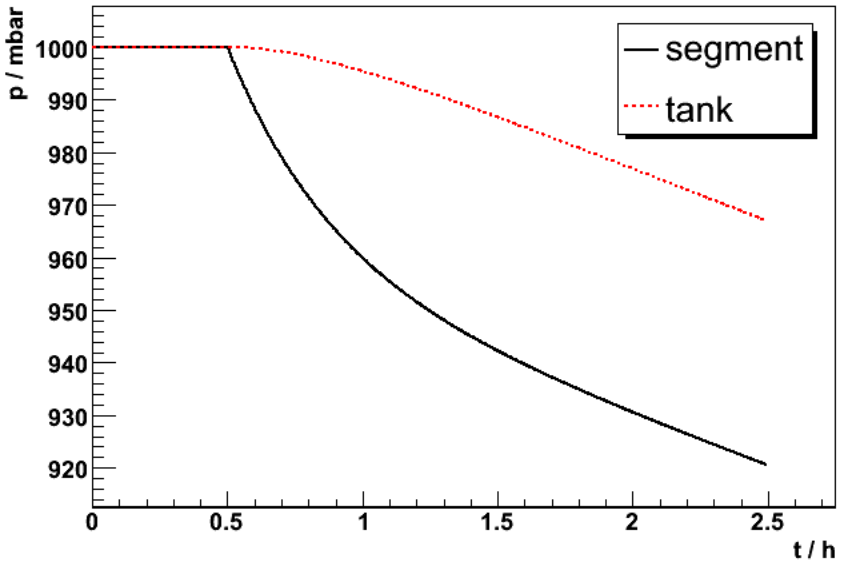
particle flux





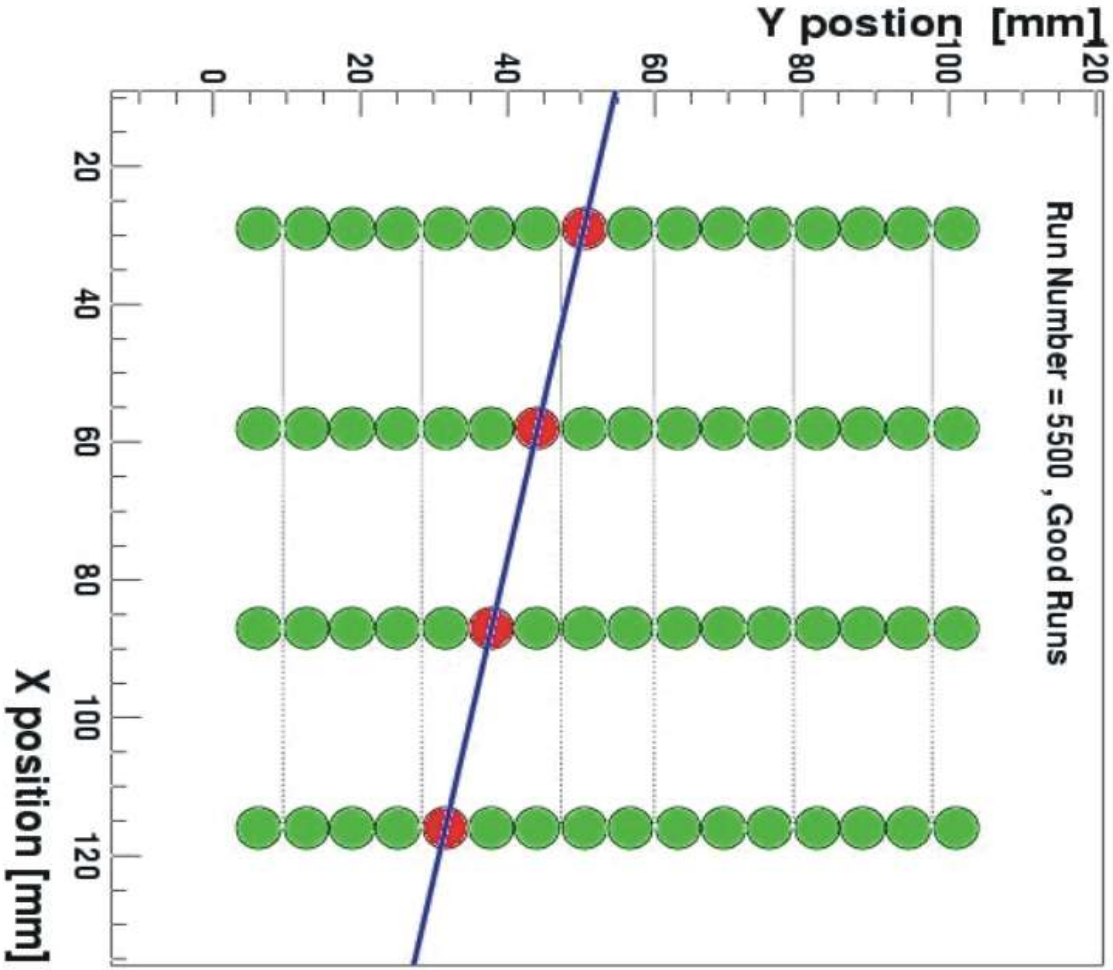
absolute pressures





Cosmic test

- Ar/CO_2 82:18 gas.
- Cosmic trigger provided by two scintillator panels from AMS01 veto counter.
- TRD segment read out using UFE, high voltage from UHVG.



C.H. Chung

Conclusion

- Flight simulator ready for thorough tests of manifolds.

- Leak detection studies with open gas system.
  Simulation employing simple discrete model available.
  Box C needed for tests under realistic circumstances.

- Cosmic test using full readout chain functional.

Appendix

Calculation of acceptable leak rate per manifold:

$25 \cdot 10^{-5}$ *l mbar/s* CO_2 diffusion loss per module (1m) with SF 1

$\cdot 4$ He diffusion factor 4 higher

$\cdot 500$ ≈500m total module length

/100 SF 100 (order of magnitude better than normal module)

/16 number of manifolds

$3 \cdot 10^{-4}$ *l mbar/s He* leak rate acceptable maximum