Different way of gas supply for small volume MPGDs

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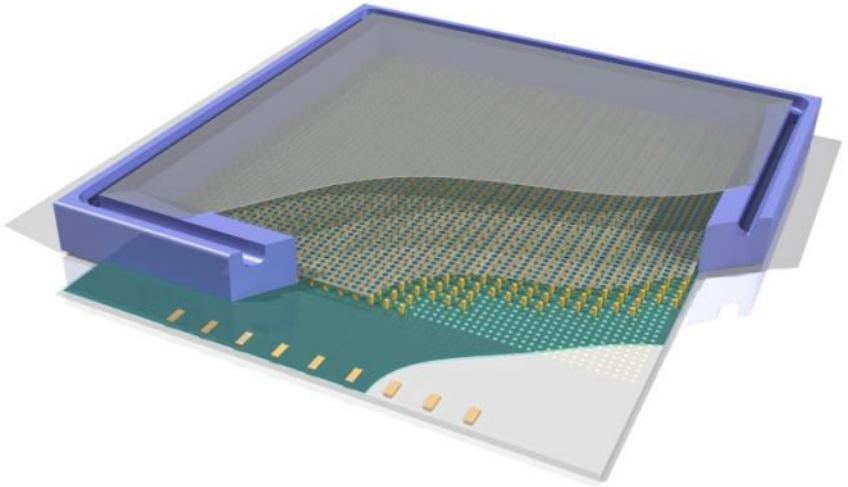
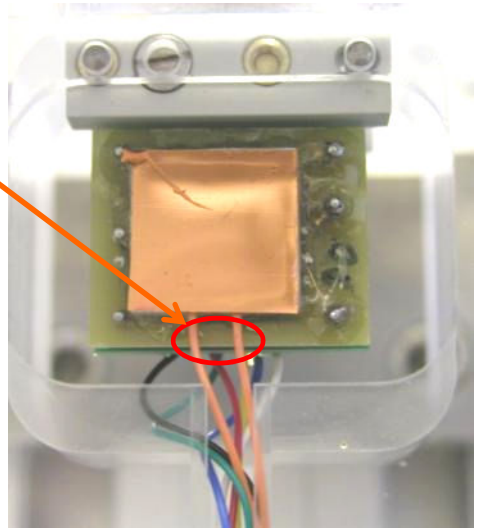
What is different for single chip MPGDs?



- Very small detector volumes
  - 1 Gossip detector ≈ **0.2 ml** (15 x 15 x 1 mm^3)
- => very small gas flows may be used
  - 10 volume changes/hour
  - => 33 µl/min (**2 ml/h**)
  - Commercial mass flow controllers go down to ~ 2 ml/min FS
    - => permit flows down to 100 µl/min
- For practical reasons we normally use bit larger flows
  - 2 - 5 ml/min (**0.12 – 0.3 l/h**)

Advantages of small flows (0.12 – 0.3 l/h)



- Permitting very thin gas lines
  - Gas lines 1/32" (≈ 0.8 mm OD) well feasible
    - 3 m tubing **0.5 mm ID** with CO_2 and 0.12 – 0.3 l/h
    - => Back pressure 10 – 24 mbar
  - Gas line of 1/64" (≈ 0.4 mm OD) not excluded
    - 3 m tubing **0.25 mm ID** with CO_2 and 0.12 – 0.3 l/h)
    - => Back pressure 0.15 – 0.4 bar
  - (Using normal size gas pipes (6 mm OD or larger) would lead to very long reaction times)
- On site mixing of small flows hard
  - Long flow measurement times
  - (almost) out of range of commercial mass flow controllers
- => use premixed gas bottles

How to get premixed gas bottles?

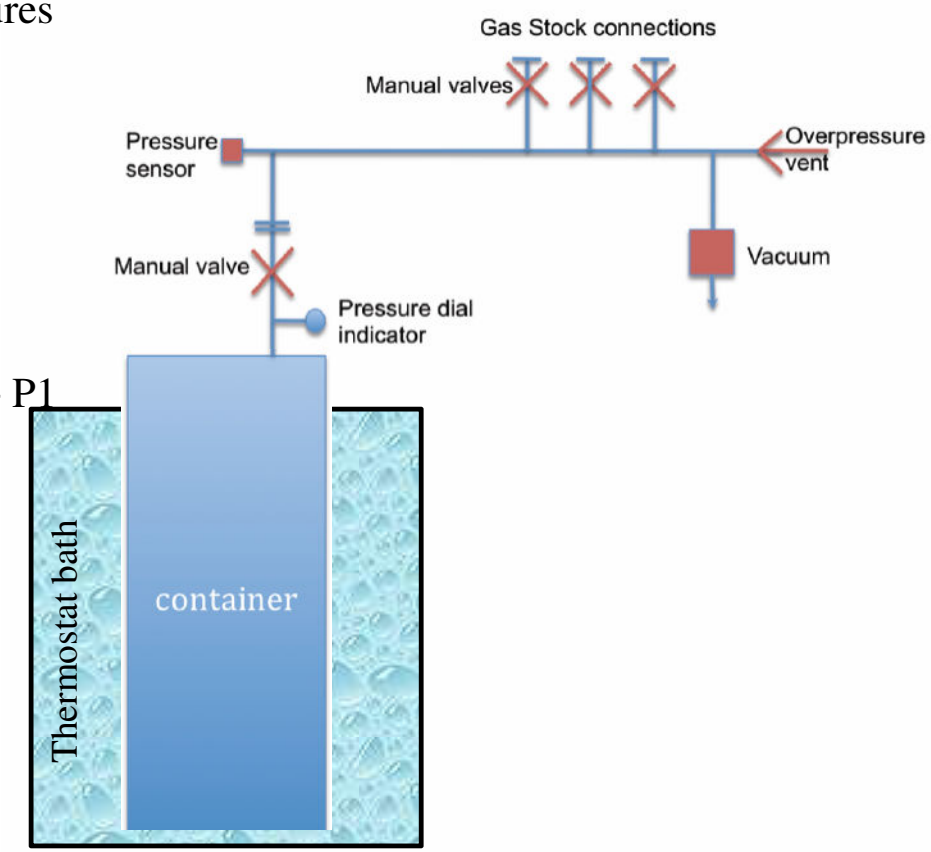
- Custom specified mixtures from commercial gas suppliers not attractive
  - Expensive
  - Long delivery time (~5 - 6 weeks)

- **=> We are considering gas mixing in house (Nikhef)**

Planned mixing station at Nikhef

- Equipment
  - Gas bottle
  - Vacuum pump
  - Accurate absolute pressure sensor(s)
  - Thermostat bath
  - PC for controlling valves and pressures

- Procedure
  - Evacuate bottle
  - Insert gas 1 until pressure P1
  - Insert gas 2 until pressure P2 + P1
  - Insert gas 3 until pressure P3 + P2 + P1
  - Etc .....



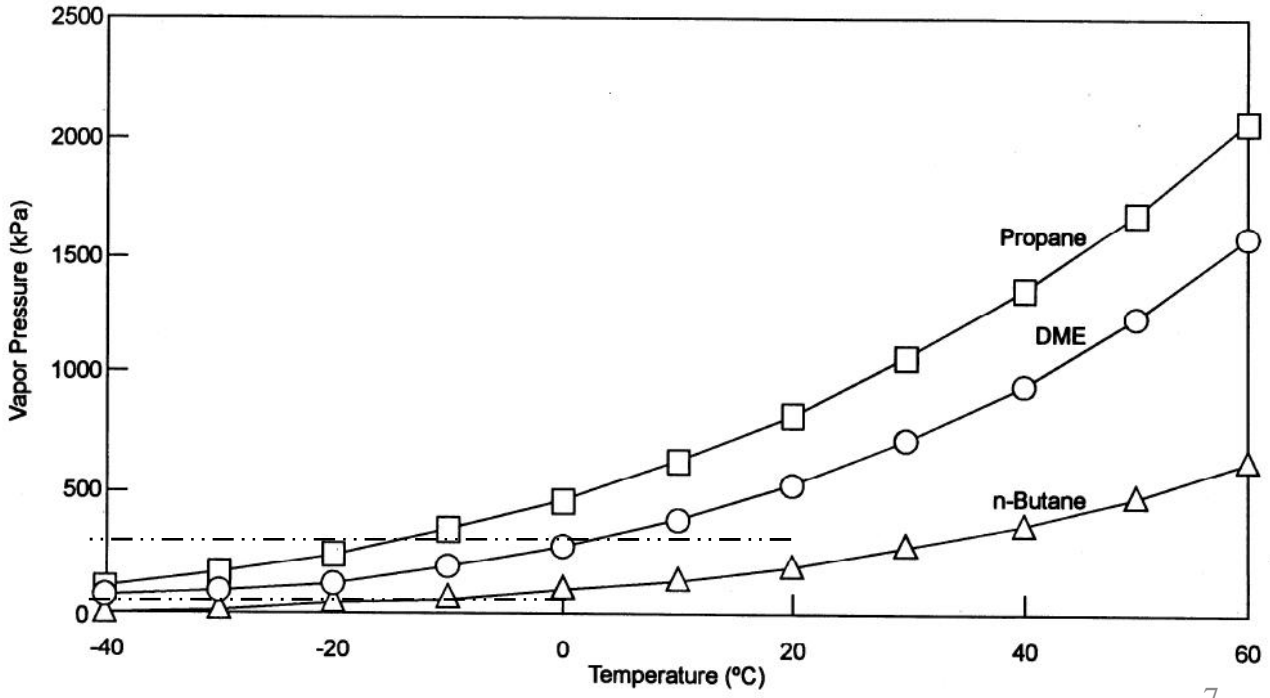
Gas bottle

- Apply light weight bottle
  - Originally intended for butane, propane
  - Volume: 12.3 l
    - (also bigger available (26.5 l))
  - Material: AISI 304 (stainless steel)
  - Test pressure: 30 bar
  - Burst pressure: 120 bar
  - Identification label on bottle

Empty weight 4.1 kg

Vapour pressures vs temperature

- Maximum bottle pressure often determined by condensation point
  - Isobutane 2.6 bar @ 15 ºC
    - => Ar/iC_4H_{10} 50/50 can be no more than 5.2 bar abs or **4.2 bar gauge**
  - DME 5.1 bar @ 20 ºC
    - Boiling point – 24.8 ºC



Security measures for the gas mixing station at Nikhef

- Creating mixtures with flammable gases at Nikhef allowed if
  - Done in well vented space
  - Explosion detection available
  - Proper grounding of equipment
  - Only accessible for limited number of persons
  - These persons are well trained
  - Additional fire extinguisher is present
  - Risk analysis has been made
  - Flammable gas indication is outside
  - Security staff has been informed and instructed

Using flammable gas mixtures at a CERN test beam

- We can load up to 234 l into the 12.3 l bottle
  - Sufficient for beam test using 0.3 l/h (1 month)
- But pressure of DME and isobutane mixtures limited by vapour pressure

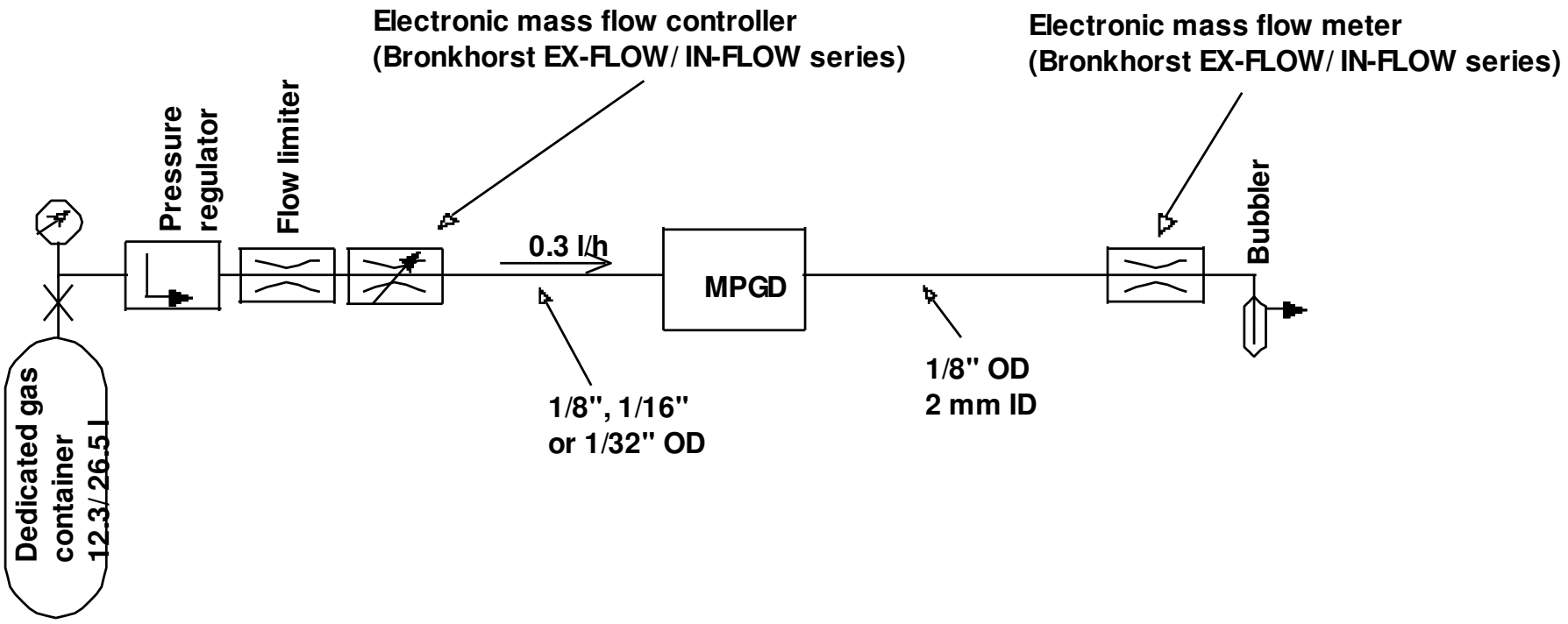
Mixture	P1 (bar abs)	P2 (bar abs)	P_{tot} (bar gauge)	Net content (l)	H_2 eq. mass(g)	Running time (days) at 0.3 l/h
Ar/CH_4 90/10	27	3	19	234	**6.7**	32.5
CO_2/DME 50/50	4	4	7	86	**25.4**	12
Ar/iC_4H_{10} 80/20	8.8	2.2	10	123	**26.0**	17

- Limited hydrogen weight (<< 0.4 kg)
  - **=> risk class 1 of CERN flammable gas safety manual**
  - **=> premix bottle possibly allowed in experimental area**
  - => short pipe lenghts =>low dead pipe volumes
  - Easy test beam set-up

One regular (50 l) bottle with iC_4H_{10} contains **6.75 kg** of H_2 equivalent mass
=> Risk class 2

Test beam gas system with premixed bottles

- Assume small flow (≤ 0.3 l/h)
- Flow regulated by electronic mass flow controller (explosion proof)
- Flow check (electronic mass flow sensor) at exhaust
  - => verifying leaks
- Upstream: thin pipes may be used (1/8”, 1/16”, 1/32”)
- Downstream: thicker pipes (1/8”)



Conclusions

- Using low gas flows ($\leq$ 0.3 l/h) has many advantages for lab and test beam experiments
  - Thin gas pipes (1/8")
  - Premix gas bottles in lab/ test beam area
  - Simple, non critical (1 channel) gas regulation
  - Easy and cheap experimental set-up
- Producing premixed bottles at Nikhef looks feasible