K.Abe
Gas System
May 13, 1998

RPC Gas

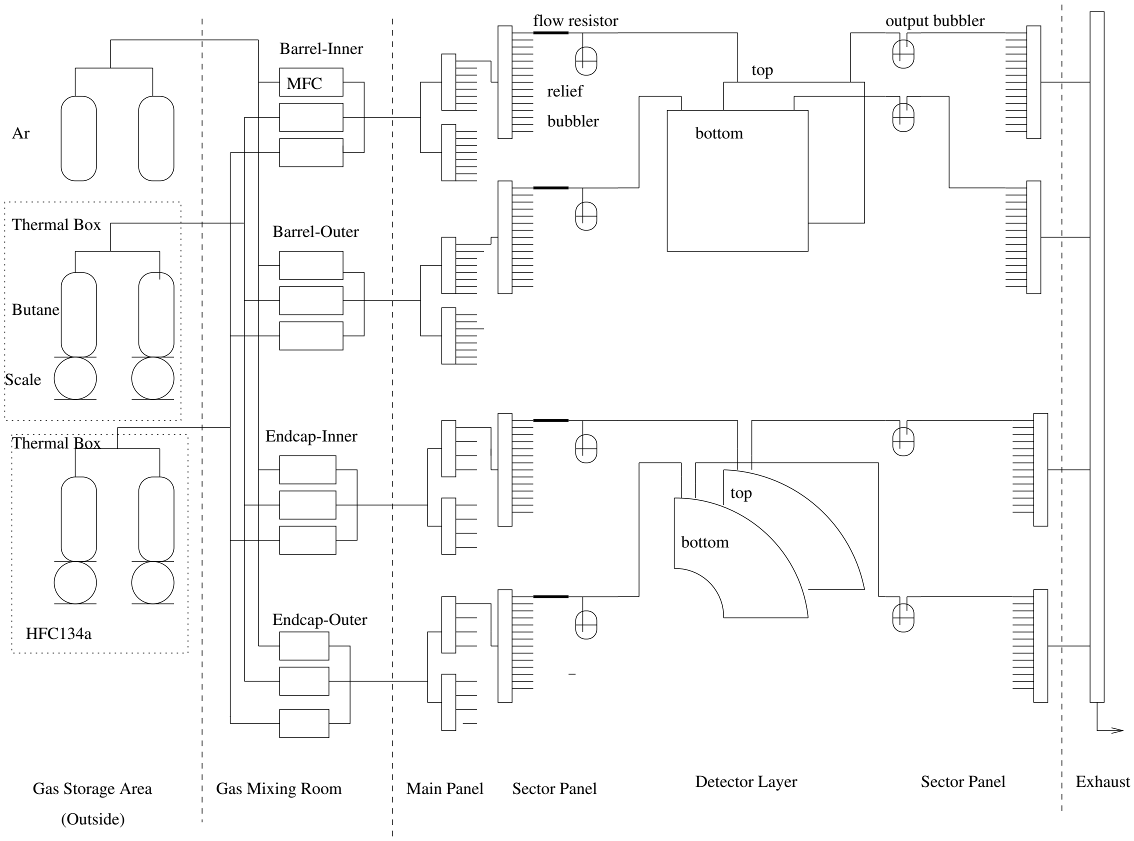
Gas	Frac.	Mol.Wt.	Density g/l	Specific Ht. $cal/g^\circ c$	Boil. Pt. $^\circ c$
Argon	30%	39.95	1.784	0.125	
Butane	8%	58.12	2.6	0.389	-0.5
HFC-134a	62%	102.0	4.5	0.20	-26.3

Table 1: *Density at $0^\circ c$, Boiling Point at 1atm.*

- Density 3.53 g/l (2.9 times heavier than air):
  2 mmH_2O back-pressure for every 1 m height.
- Gas is non-flammable.
- Butane and HFC-134a must be heated during winter

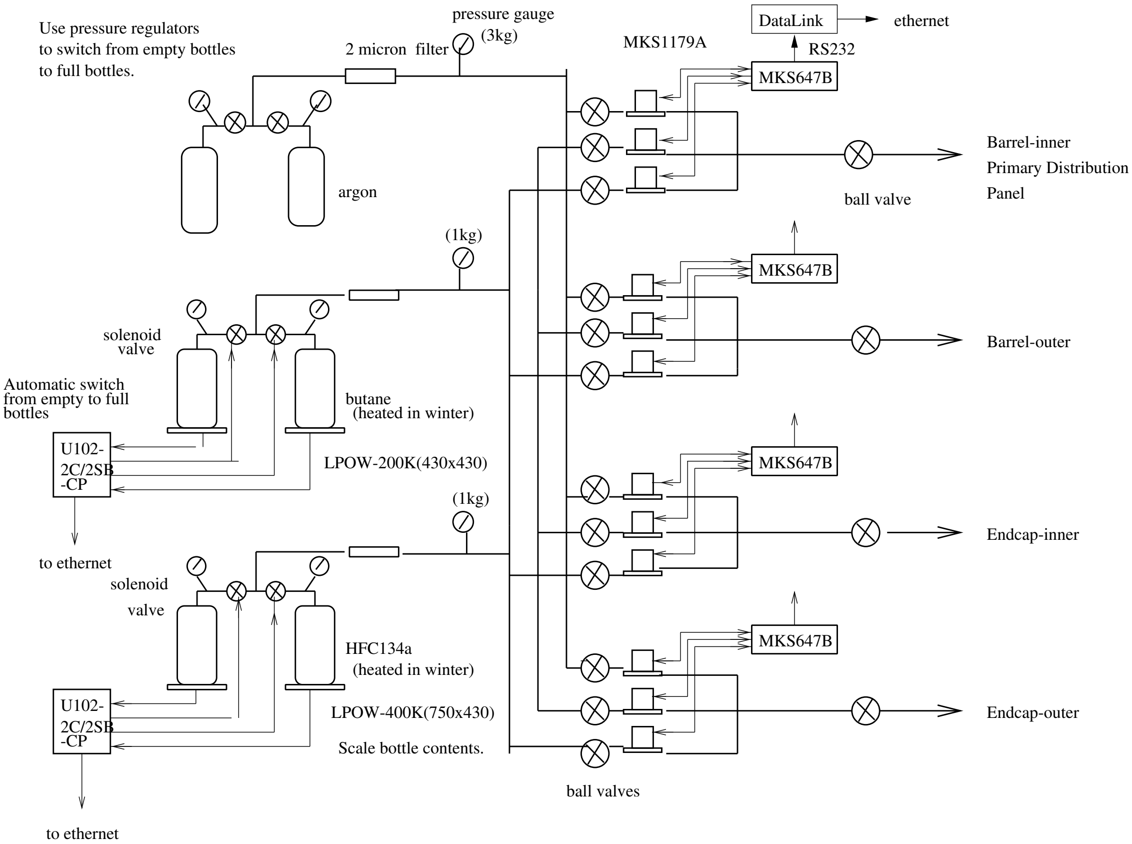
RPC Operation

- Gas lines
  - 704 Independent gas lines:
    240×2 in Barrel
    112×2 in Endcap
  - Gas volume per layer:
    Endcap - 8.8 l, all same
    Barrel - Ranges from 7.3 l(#2) to 11.5 l (#15)
  - Total gas volume 6.8 m^3
- Flow Rate
  - 8 to 10 cc/min during normal operation
  - Can go up to 20 cc/min for purging
  - 6 to 7 l/min total flow in normal operation
- Pressure
  - 3 to 5 mmH_2O above atmospheric pressure in average
  - Up to ± 2 mmH_2O difference inside vertical layers due to gas weight
  - Relief bubblers at the input-side of RPCs are set at 20 mmH_2O
  - Pressure drop across one layer less than 5 mmH_2O at 10 cc/min flow rate.


flow resistor
output bubbler
Barrel-Inner
MFC
top
relief
bubbler
Ar
bottom
Thermal Box
Barrel-Outer
Butane
Scale
Endcap-Inner
Thermal Box
top
bottom
Endcap-Outer
HFC134a
Gas Storage Area
(Outside)
Gas Mixing Room
Main Panel
Sector Panel
Detector Layer
Sector Panel
Exhaust

Gas Supply

Gas	Content in one bottle	Duration of one bottle	Bottles in Bank	Bottle Change
HFC-134a	100kg (22 m^3 gas)	3.5 days	2	7 days
Butane	50kg (19 m^3 gas)	23.6 days	1	23.6 days
Argon	7 m^3	2.3 days	5	11.5 days



Gas Mixing Station

- Four independent gas-mixing stations:
  Barrel-Inner, Barrel-Outer,
  Endcap-Inner, Endcap-Outer
- Each station consists of one MKS 647 controller and three MKS 1179 Mass Flow Controllers.
- Settings of MFCs:

Mixing Station	Type of Gas	GCF	MFC Range ($SCCM$)	Max.Rate ($SCCM$)	Normal Rate ($SCCM$)
Barrel Inner	HFC-134a	0.32	10,000	3,200	1,240
	Ar	1.37	5,000	6,850	600
	Butane	0.26	2,000	520	160
Barrel Outer	HFC-134a	0.32	10,000	3,200	1,240
	Ar	1.37	2,000	2,740	600
	Butane	0.26	2,000	520	160
Endcap Inner	HFC-134a	0.32	10,000	3,200	620
	Ar	1.37	5,000	6,850	300
	Butane	0.26	2,000	520	80
Endcap Outer	HFC-134a	0.32	10,000	3,200	620
	Ar	1.37	2,000	2,740	300
	Butane	0.26	2,000	520	80

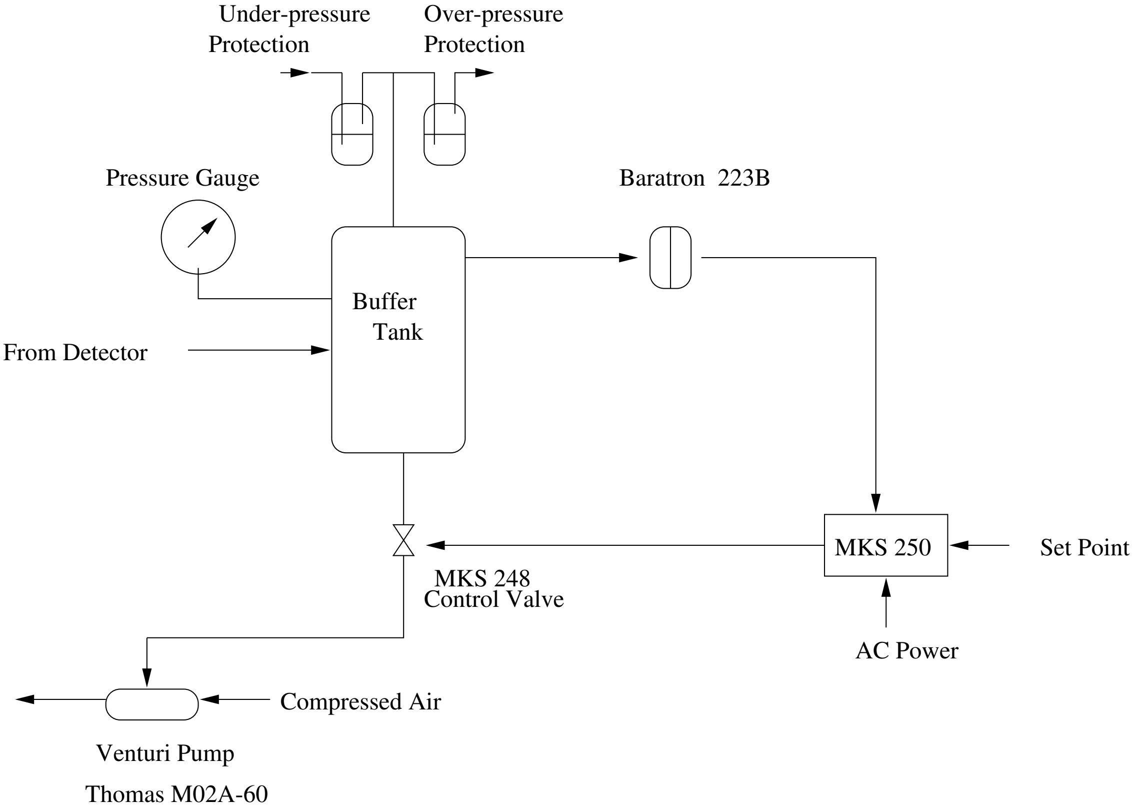
Table 2: *GCF stands for the gas correction factor. Max. rate is the maximum flow rate we can obtain from each MFC. Normal rate is the flow rate during our normal operation with 4,000 cc/min total to 480 barrel layers, 2,000 cc/min total to 224 endcap layers.*

Gas Exhaust

- One system of Venturi pump outside of Tsukuba Hall. Connected to air-compressor of gas-mixing room:
  25 - 50l/min air flow to Venturi pump.
- Four gas exhaust panels:

Exhaust Panel	Sectors connected
Hut-Upper	Barrel Sector 2 &3, Endcap Sector 1 & 2
Hut-Lower	Barrel Sector 4 & 5
Wall-Upper	Barrel Sector 0 & 1, Endcap Sector 0 & 3
Wall-Lower	Barrel Sector 6 & 7

- One exhaust panel consists of:
  - Control valve (MKS 248)
  - Pressure transducer (MKS Baratron 223B)
  - Pressure controller (MKS 250)
- Range of the pressure differential setting is between 0 and 10.
  - 0.0$\cdots$-5.0 Torr (-6.5 cmH_2O)
  - 5.0$\cdots$ 0 Torr
  - 10.$\cdots$ +5.0 Torr
- Pressure differential is monitored,besides the 250's digital display, by a panel gauge(-2 to +2 inch H_2O full scale) and by an overflow and a underflow bubbler.
- The control is open when AC power of 250 is off. If we leave the system in this status for a long time, the oil from the underflow bubbler might get into the system. To protect this, close the manual valve at the back of the exhaust panel.


Under-pressure Protection
Over-pressure Protection
Pressure Gauge
Baratron 223B
Buffer Tank
From Detector
MKS 250
Set Point
MKS 248 Control Valve
AC Power
Compressed Air
Venturi Pump
Thomas M02A-60

Maintaining the System

- Y. Yamaoka checks consumption rates of each gas periodically.
  Place orders of new bottles.
- Vendor delivers new bottles and connects to the pupply system.
- Status of Mass Flow Controllers can be monitored either locally at the MKS 647B screens inside the mixing room or by running Narita's program (http://www.awa.tohoku.ac.jp/ narita/gasctrl.html).
- KLM group members should periodically check:
  - Main distribution panels (2 for the barrel, 2 for the endcap).
    1. Flow meter readings
    2. Pressure gauge readings
    3. Valve positions
  - Sector distribution panels
    1. Bubblings of output bubblers
    2. Over-pressure of relief bubblers, but not bubblings
  - Exhaust control panels (4)
    1. Digital display of pressure-differential reading (about 5.0)
    2. Level of safety bubblers