E.H. #1 RPC Gas System Commissioning — Preliminary Report

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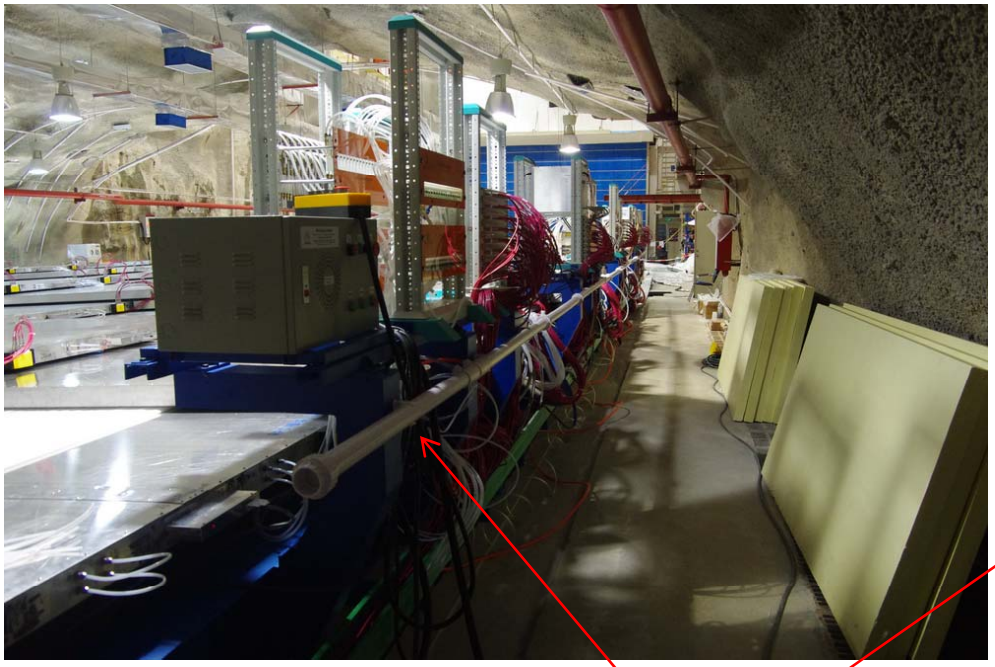
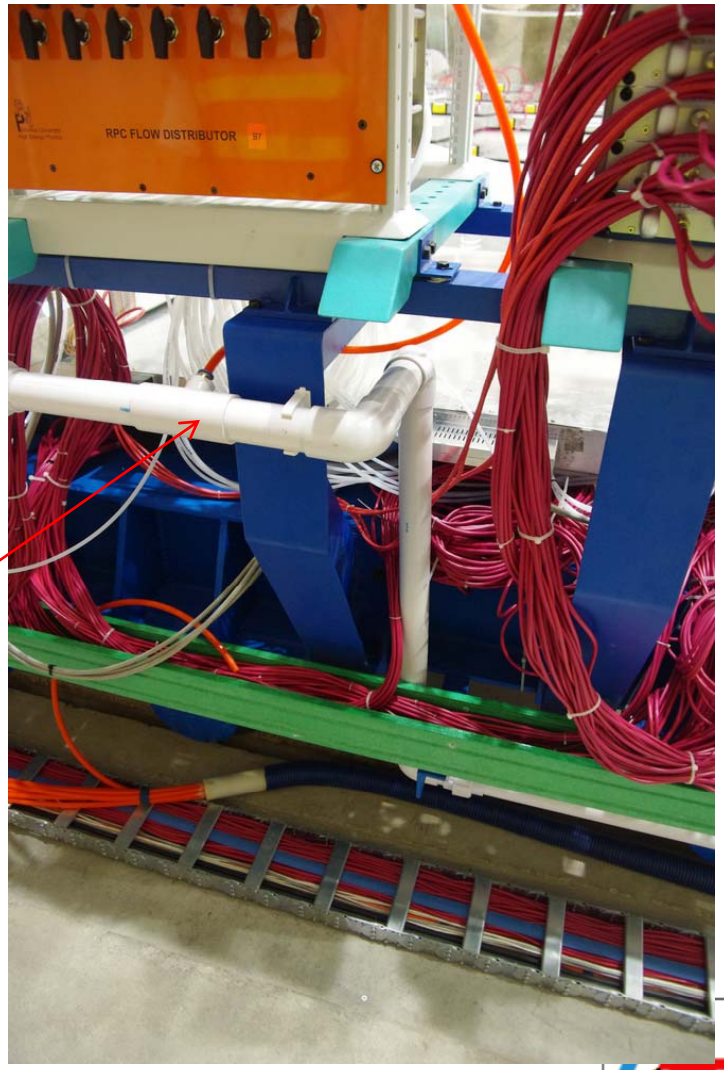
(April 29, 2011)

The work done since April Daya Bay workshop

- Installed 5cm diameter gas returning pipe that greatly reduces the gas flow resistance for all gas channels (see next slide);
- Brought Isobutane cylinder into gas room, leak checked, mixed Daya Bay RPC gas mixture and provided to all RPC modules;
- Repaired a bad Timer in the Gas Flowmeter Crate;
- Continuously flow the Daya Bay gas mixture for more than 2 weeks at two different flow rates;
- Recorded the bubbling rate and gas mixing ratio data into MySQL database;
- Worked in two shifts for commissioning the gas system (Lu is on the Daya Bay night shift in Princeton through remote monitoring to make sure if gas system is normal, Mengyun/Qingmin is on the Daya Bay day shift at Daya Bay locally to check and fix the problem), the remote desktop of LogMeIn software is proved to be labor/time efficient;
- Have done most of the integration work for the relevant DCS hardware and software into RPC Gas System.

Returning gas pipe





5cm diameter returning gas pipe.

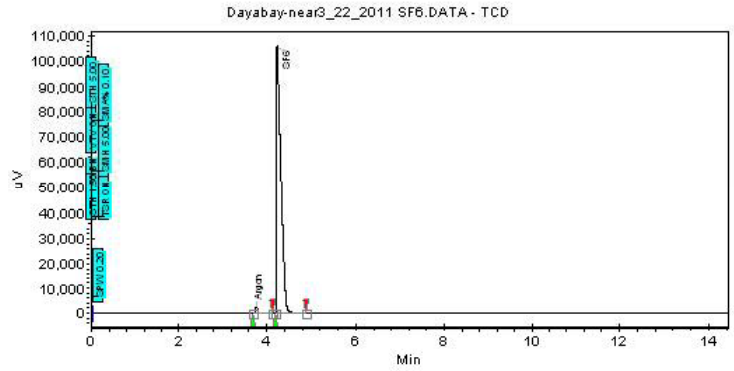
Gas mixing ratio

Chromatogram : Dayabay-near3_22_2011 1_47_44 PM11_channel1

System : Dayabay-near
Method : Dayabay-near
User : admin

Acquired : 3/22/2011 1:48:32 PM
Processed : 3/22/2011 2:03:09 PM
Printed : 3/26/2011 10:49:20 AM

SF_6



Peak results :

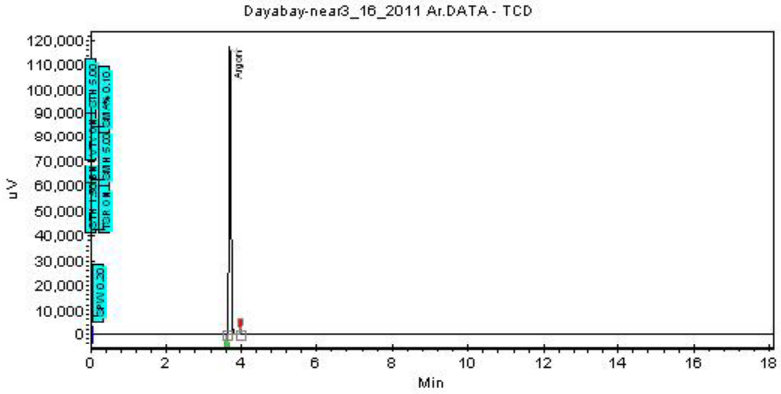
Index	Name	Time [Min]	Quantity [%]	Height [uV]	Area [uV.Min]	Area(Raw) [%]
1	Argon	3.76	1.02	3111.2	182.5	1.526
2	SF6	4.22	98.98	106348.9	11777.4	98.474
Total			100.00	109460.0	11959.9	100.000

Chromatogram : Dayabay-near3_16_2011 4_18_38 PM3_channel1

System : Dayabay-near
Method : Dayabay-near
User : admin

Acquired : 3/16/2011 4:19:21 PM
Processed : 3/16/2011 4:37:41 PM
Printed : 3/26/2011 11:00:54 AM

Ar



Peak results :

Index	Name	Time [Min]	Quantity [%]	Height [uV]	Area [uV.Min]	Area(Raw) [%]
1	Argon	3.70	100.00	117442.4	7281.8	100.000
Total			100.00	117442.4	7281.8	100.000

GC calibration chromatograms

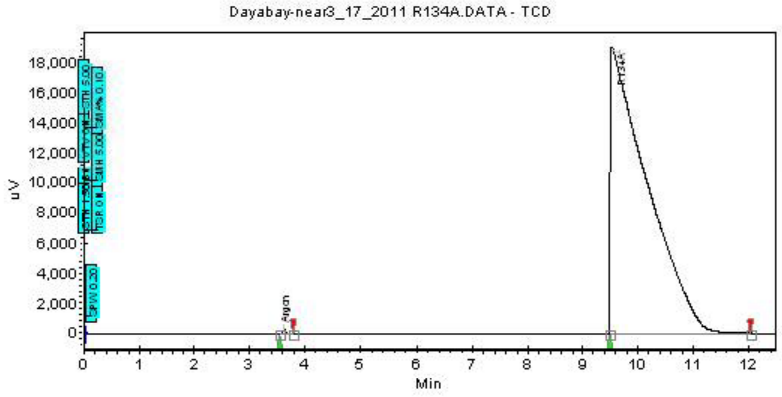
Gas mixing ratio (cont'd)

Chromatogram : Dayabay-near3_17_2011 8_26_08 AM1_channel1

R134A

System : Dayabay-near
Method : Dayabay-near
User : admin

Acquired : 3/17/2011 8:26:52 AM
Processed : 3/17/2011 8:40:16 AM
Printed : 3/26/2011 10:52:12 AM



Peak results :

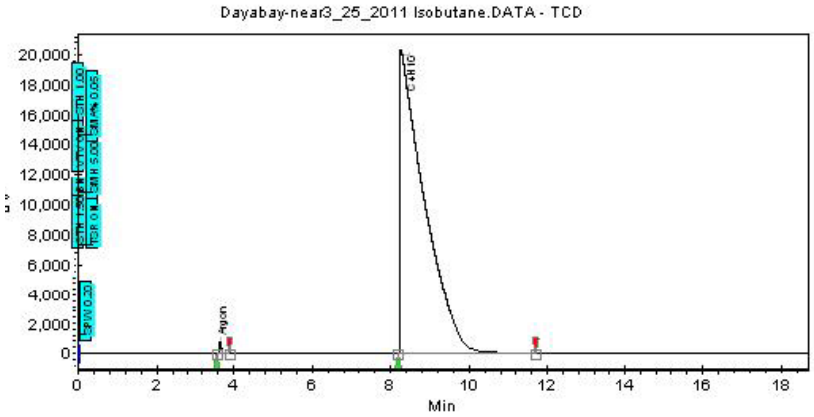
Index	Name	Time [Min]	Quantity [%]	Height [uV]	Area [uV.Min]	Area(Raw) [%]
1	Argon	3.62	0.07	316.2	18.0	0.123
2	R134A	9.53	99.93	19088.2	14586.6	99.877
Total			100.00	19404.4	14604.5	100.000

hromatogram : Dayabay-near3_25_2011 _01_05 PM24_channel1

Isobutane

em : Dayabay-near
od : Dayabay-near
r : admin

Acquired : 3/25/2011 4:01:53 PM
Processed : 3/25/2011 4:20:48 PM
Printed : 3/26/2011 10:45:48 AM



eak results :

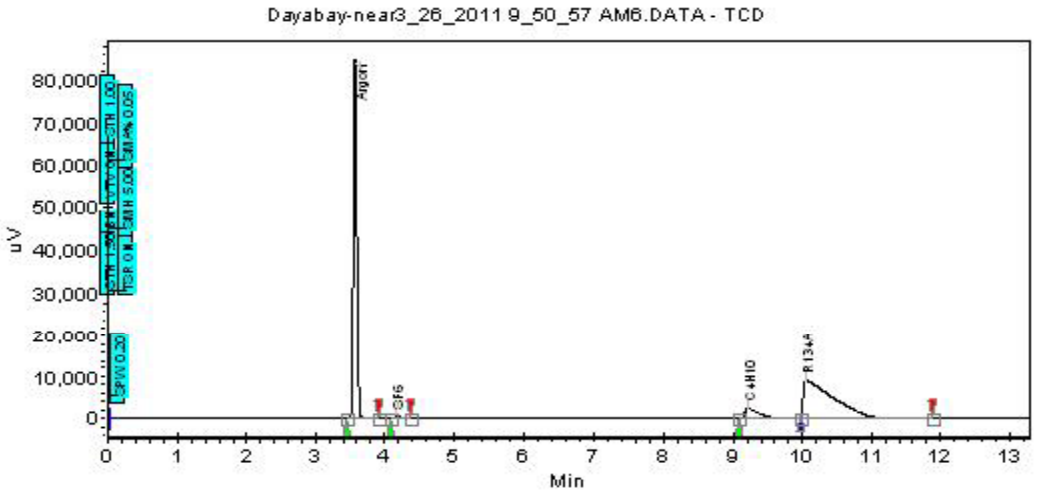
ex	Name	Time [Min]	Quantity [%]	Height [uV]	Area [uV.Min]	Area(Raw) [%]
	Argon	3.66	0.18	87.1.3	49.0	0.333
	C4H10	8.27	99.82	20384.8	14653.5	99.667
Total			100.00	21256.1	14702.5	100.000

Daya Bay RPC gas mixture

Chromatogram : Dayabay-near3_26_2011 9_50_57 AM6_channel1

System : Dayabay-near
Method : Dayabay-near
User : admin

Acquired : 3/26/2011 9:51:44 AM
Processed : 3/26/2011 10:05:13 AM
Printed : 3/26/2011 10:16:05 AM

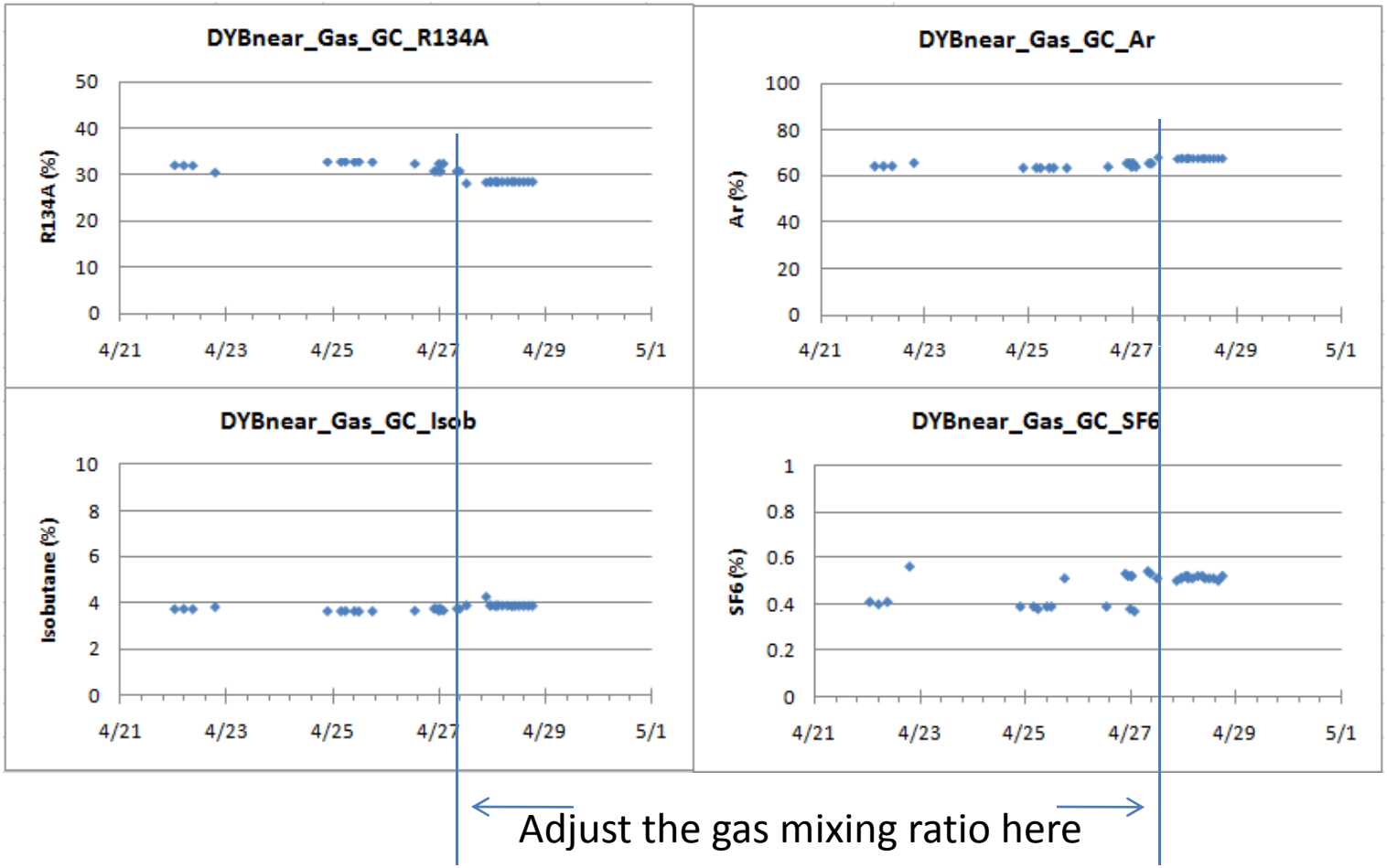


Peak results :

Index	Name	Time [Min]	Quantity [%]	Height [uV]	Area [uV.Min]	Area(Raw) [%]
1	Argon	3.57	35.38	84923.2	4868.8	48.991
2	SF6	4.17	0.67	1134.8	61.5	0.619
3	C 4H 10	9.20	7.69	2332.5	584.9	5.885
4	R 134A	10.05	56.25	9003.3	4423.0	44.505
Total			100.00	97393.8	9938.1	100.000

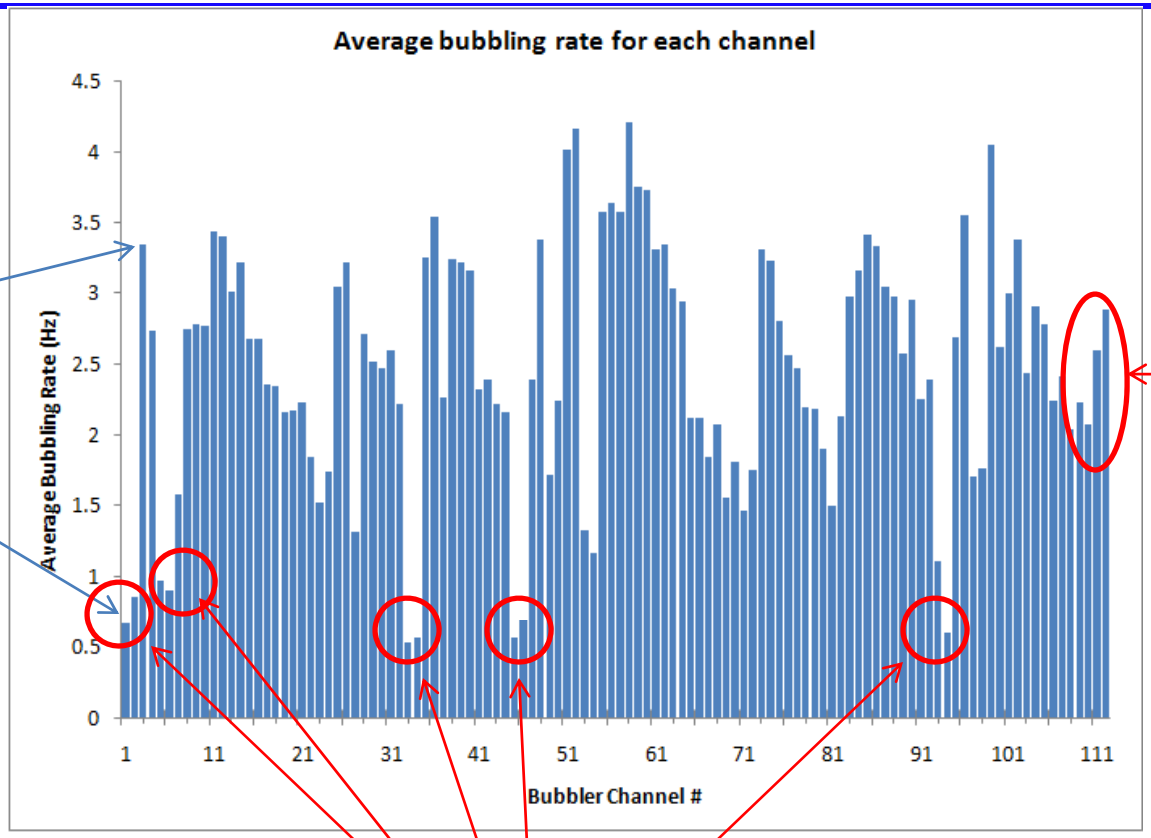
Raw data. Corrected by calibration curves, the mixing ratio is:
65.73: 3.95: 29.81: 0.51
Very close to our nominal ratio: 65.5:4:30:0.5.

Gas mixing ratio stability



The nominal mixing ratio is Ar/R134A/Isobutane/SF6 65.5/30/4/0.5).
The mixing ratio looks quite stable.

Bubbling rate



3-d channel

See next slide for explaination

1-st channel

No RPC modules connected to these four channels

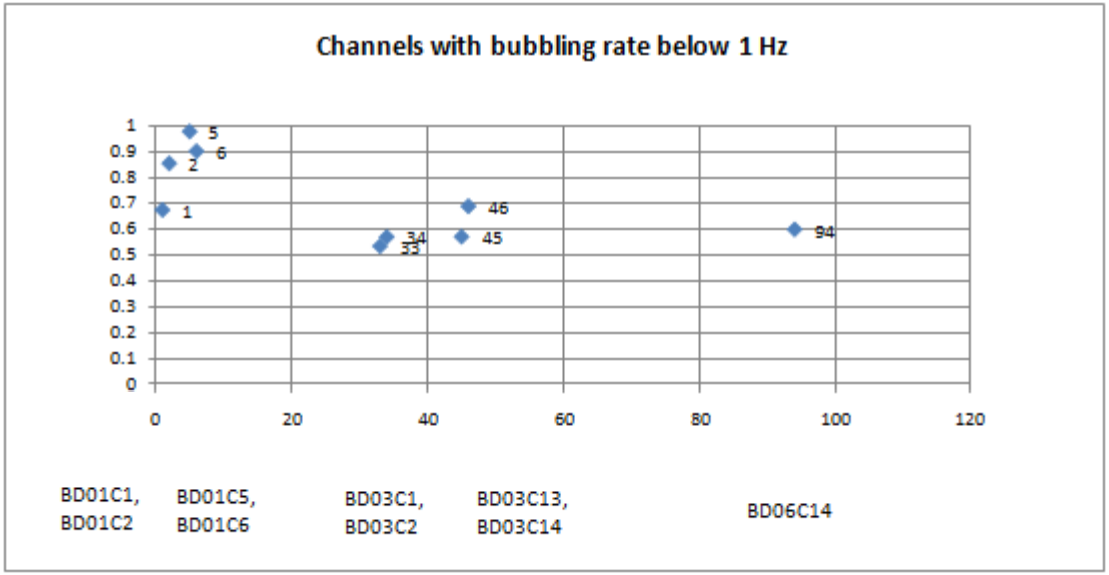
Averaged bubbling rate in ~ 1 month run (3/28 to 4/28) for all 108 gas channels (last four channels are not connected to RPC modules). It is noticed that some channels the rates are much lower than others, this is a indication of gas leakage for those channels.

RPC gas channel assignment

		Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #	Channel #
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Crate #	7	H1C9R1B1In	H1C9R1B2In	H1C9R2B1In	H1C9R2B2In	H1C9R3B1In	H1C9R3B2In	H1C9R4B1In	H1C9R4B2In	H1C9R5B1In	H1C9R5B2In	H1C9R6B1In	H1C9R6B2In	short	short	short	short
		BD07C1	BD07C2	BD07C3	BD07C4	BD07C5	BD07C6	BD07C7	BD07C8	BD07C9	BD07C10	BD07C11	BD07C12	BD07C13	BD07C14	BD07C15	BD07C16
Bub ch #		97	98	99	100	101	102	103	104	105	106	107	108				
Crate #	6	H1C8R1B1In	H1C8R1B2In	H1C8R2B1In	H1C8R2B2In	H1C8R3B1In	H1C8R3B2In	H1C8R4B1In	H1C8R4B2In	H1C8R5B1In	H1C8R5B2In	H1C8R6B1In	H1C8R6B2In	H1C7R1B1In	H1C7R1B2In	H1C7R2B1In	H1C7R2B2In
		BD06C1	BD06C2	BD06C3	BD06C4	BD06C5	BD06C6	BD06C7	BD06C8	BD06C9	BD06C10	BD06C11	BD06C12	BD06C13	BD06C14	BD06C15	BD06C16
Bub ch #		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Crate #	5	H1C7R3B1In	H1C7R3B2In	H1C7R4B1In	H1C7R4B2In	H1C7R5B1In	H1C7R5B2In	H1C7R6B1In	H1C7R6B2In	H1C6R3B1In	H1C6R3B2In	H1C6R4B1In	H1C6R4B2In	H1C6R5B1In	H1C6R5B2In	H1C6R6B1In	H1C6R6B2In
		BD05C1	BD05C2	BD05C3	BD05C4	BD05C5	BD05C6	BD05C7	BD05C8	BD05C9	BD05C10	BD05C11	BD05C12	BD05C13	BD05C14	BD05C15	BD05C16
Bub ch #		65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Crate #	4	H1C6R1B1In	H1C6R1B2In	H1C6R2B1In	H1C6R2B2In	H1C5R1B1In	H1C5R1B2In	H1C5R2B1In	H1C5R2B2In	H1C5R3B1In	H1C5R3B2In	H1C5R4B1In	H1C5R4B2In	H1C5R5B1In	H1C5R5B2In	H1C5R6B1In	H1C5R6B2In
		BD04C1	BD04C2	BD04C3	BD04C4	BD04C5	BD04C6	BD04C7	BD04C8	BD04C9	BD04C10	BD04C11	BD04C12	BD04C13	BD04C14	BD04C15	BD04C16
Bub ch #		49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Crate #	3	H1C4R1B1In	H1C4R1B2In	H1C4R2B1In	H1C4R2B2In	H1C4R3B1In	H1C4R3B2In	H1C4R4B1In	H1C4R4B2In	H1C4R5B1In	H1C4R5B2In	H1C4R6B1In	H1C4R6B2In	H1C3R1B1In	H1C3R1B2In	H1C3R2B1In	H1C3R2B2In
		BD03C1	BD03C2	BD03C3	BD03C4	BD03C5	BD03C6	BD03C7	BD03C8	BD03C9	BD03C10	BD03C11	BD03C12	BD03C13	BD03C14	BD03C15	BD03C16
Bub ch #		33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Crate #	2	H1C3R3B1In	H1C3R3B2In	H1C3R4B1In	H1C3R4B2In	H1C3R5B1In	H1C3R5B2In	H1C3R6B1In	H1C3R6B2In	H1C2R3B1In	H1C2R3B2In	H1C2R4B1In	H1C2R4B2In	H1C2R5B1In	H1C2R5B2In	H1C2R6B1In	H1C2R6B2In
		BD02C1	BD02C2	BD02C3	BD02C4	BD02C5	BD02C6	BD02C7	BD02C8	BD02C9	BD02C10	BD02C11	BD02C12	BD02C13	BD02C14	BD02C15	BD02C16
Bub ch #		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Crate #	1	H1C2R1B1In	H1C2R1B2In	H1C2R2B1In	H1C2R2B2In	H1C1R1B1In	H1C1R1B2In	H1C1R2B1In	H1C1R2B2In	H1C1R3B1In	H1C1R3B2In	H1C1R4B1In	H1C1R4B2In	H1C1R5B1In	H1C1R5B2In	H1C1R6B1In	H1C1R6B2In
		BD01C1	BD01C2	BD01C3	BD01C4	BD01C5	BD01C6	BD01C7	BD01C8	BD01C9	BD01C10	BD01C11	BD01C12	BD01C13	BD01C14	BD01C15	BD01C16
Bub ch #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			Crates assignment:		crate#1		crate#5										
					crate#2	crate#3	crate#4	crate#6	crate#7								

Gas channel label convention:
H1: E.H. #1; C: Column #, from 1 to 9; R: Row #, from 1 to 6; B: Branch # of module, 1 or 2;
Crate #7 is on the Hall's gate side;
Short: no RPC module is connected, only a short tube instead;
Purple colored cells indicate possible "leaky" modules: C1R1, C2R1, C3R1, C4R1 and C7R1, all are on Row #1 (see next slide) ?!

The Possible "leaky" channels



Set the criterion at 1Hz, all "leaky" channels are listed on the left.
4 pairs and one single channels. Each pair corresponds to one RPC module, thus we total have 4 and one half suspect "leaky" modules.

Before we do any replacement we can do several checks to make sure the low bubbling rate is caused by module itself, not some trivial reason, such as loose Polyflow fitting at module side or bubbler side. Steps are as follows:

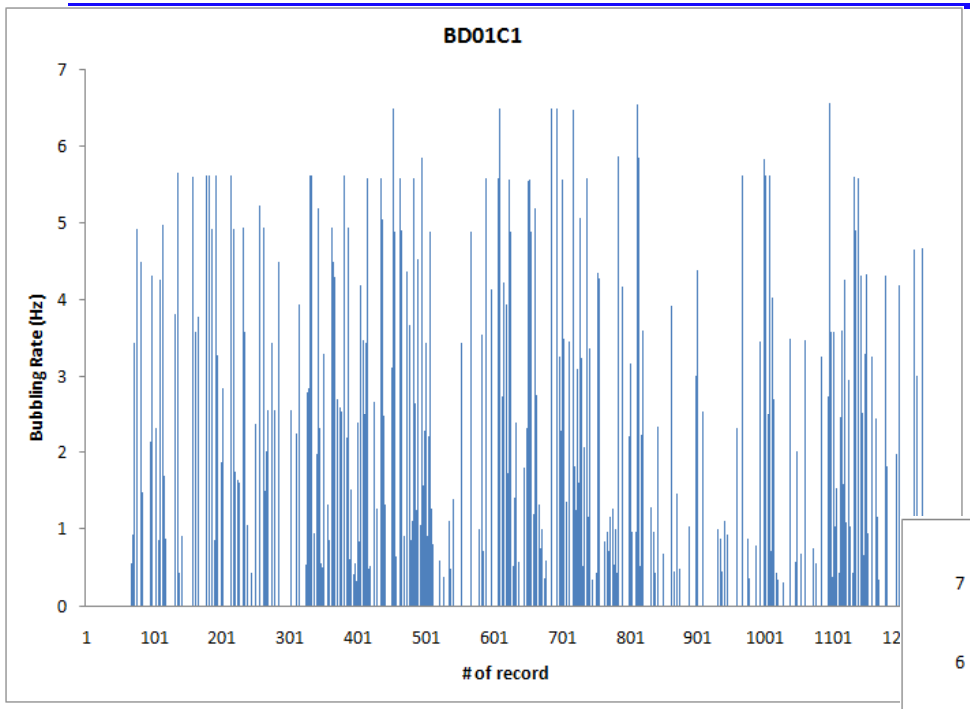
(1) Tighten the fittings at overpressure protection bubbler and digital bubbler side for the leaky channels, if no help go to next;

(2) Swap the leaky channels with neighboring normal channels at digital bubbler side, if low rate channel's number changes accordingly, the problem must be due to the leak on module side, otherwise it is due to the digital bubbler;

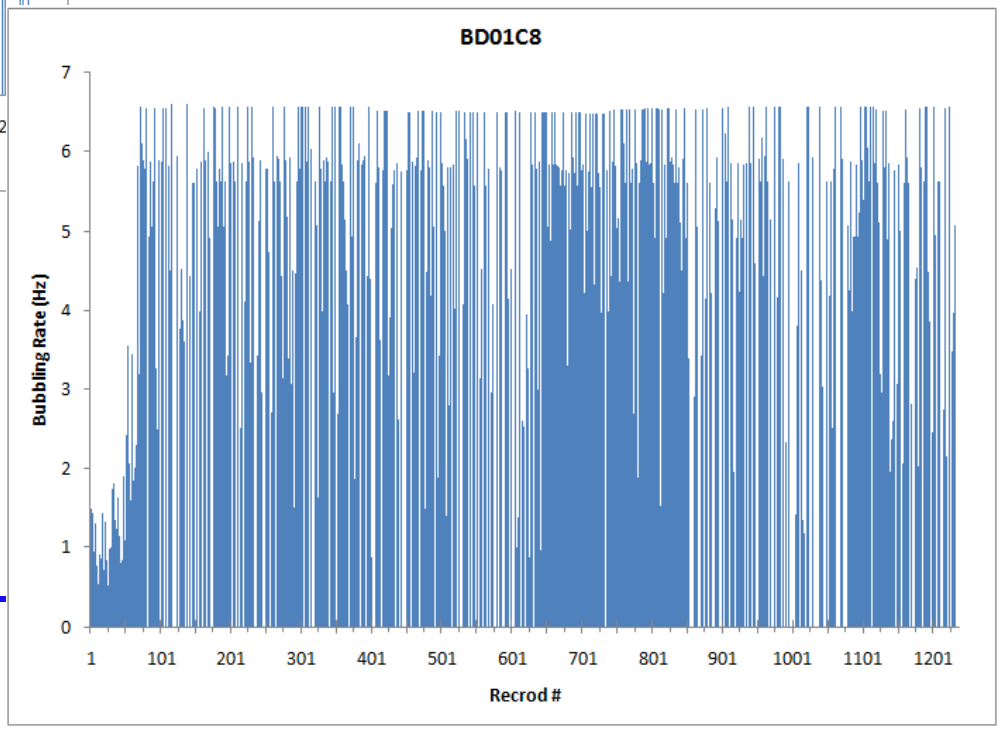
The Possible "leaky" channels (cont'd)

(3) Tighten the fittings on module side, if no help go to next step;
(4) Short the inlet and outlet tubes with a Polyflo union, if the rate becomes higher, the leak is due to module, otherwise the gas tubing is leaking;
(5) Replace the leaky modules with new ones.

Bubbling rate (cont'd)



1-st channel, the bubbling rate is very low. The plotted rate history in one month shows high fluctuation from record to record.



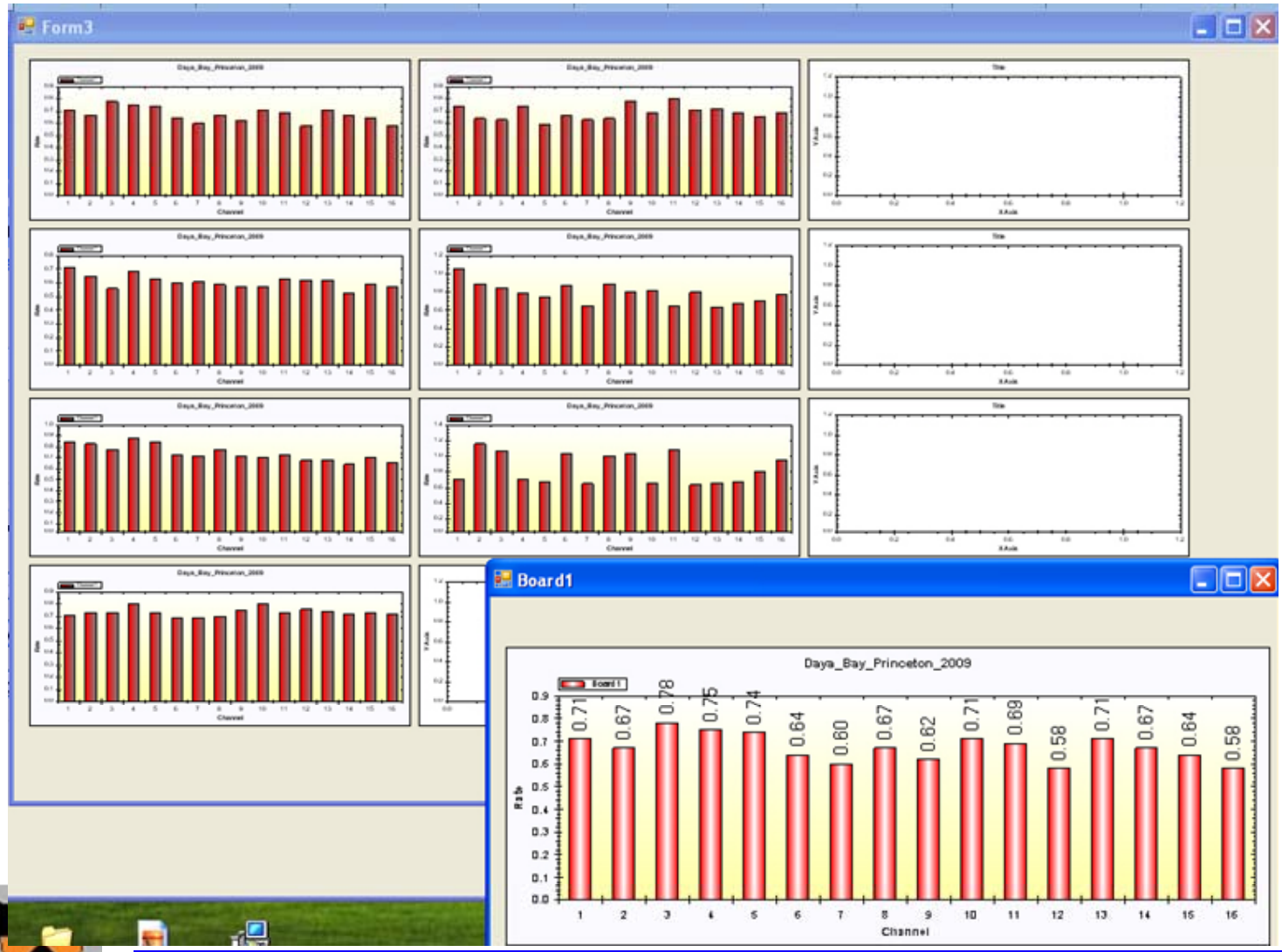
3-d channel, the bubbling rate is high. The plotted rate history in one month shows much less fluctuation from record to record.

Digital bubbler readout

The screen capture of the digital bubbler readout histograms for all 7 crates (16 channels/crate):

Three screen captures show the RPC "breathing" in the gas flow. If we connect the bubblers w/o RPC chambers we'll see the bubbling rate histograms w/o "breathing" as shown in next slide.

Bubbler histograms w/o "breathing"



Connect the outlet of the gas distribution channels to the digital bubblers directly (w/o RPC chambers), the bubbling rate histograms are quite uniform, no "breathing".

Status of the EH#1 RPC gas system

According to the results from the commissioning run the EH#1 RPC gas system is functioning normally, it is ready for providing the nominal Daya Bay RPC gas mixture to the RPC system.

During the commissioning run we did find two defective parts: one Simpson controller and one Timer, they were replaced without any trouble, but it reminds us we have to have local inventory for the parts used in the gas system.

Remaining problems:
(1) The Laptop used for controlling GC system needs to be replaced by a desktop PC. A new PC has been ordered and waiting for delivery.
(2) The communication link via USB-Ethernet cable-RS232 between the PC (in the gas room) and the bubbler readout crate (on the RPC supporting frame) is very sensitive to the interference from wall receptacle. Every time if there is a electrical device plugging in and out the receptacle will disrupt the RS232, as the result the bubbler program needs to be restarted. We are looking for more robust USB extender and Ethernet cable.