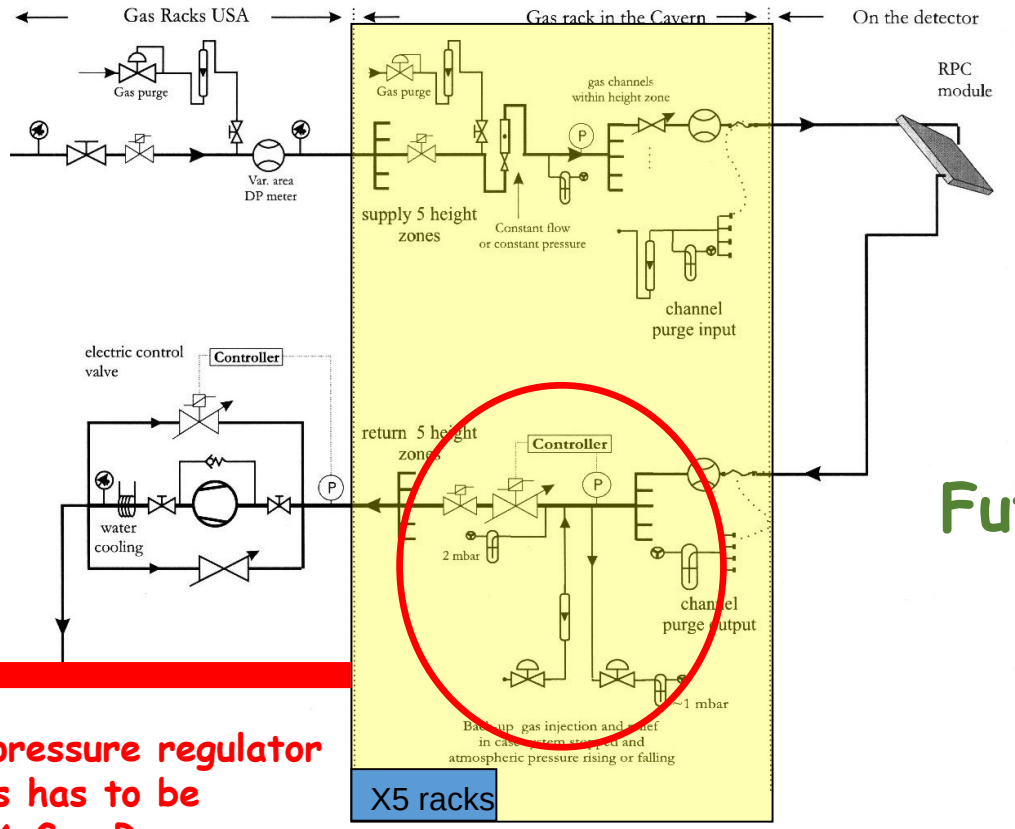
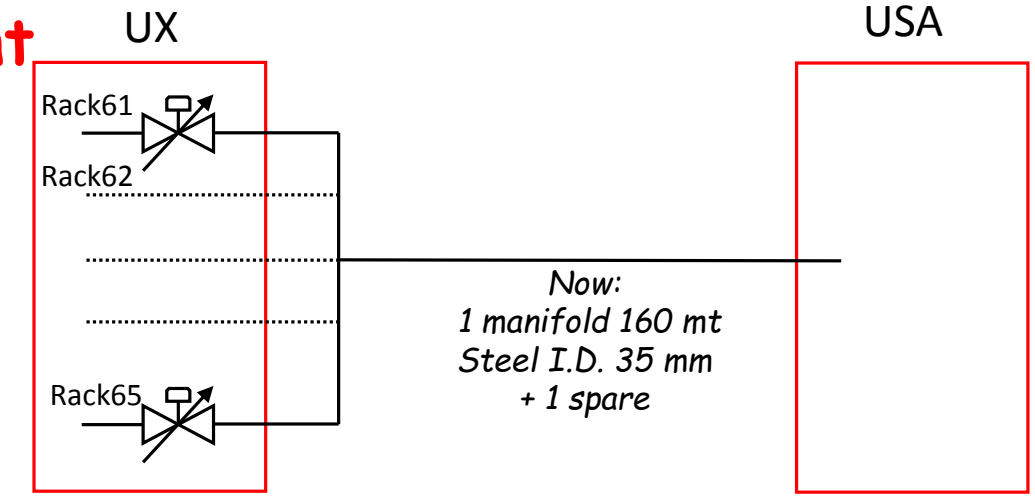
A better mitigation of the output noise was suggested by the Gas Group,

it consists in the movement of the pulses generators as far as possible from the chambers

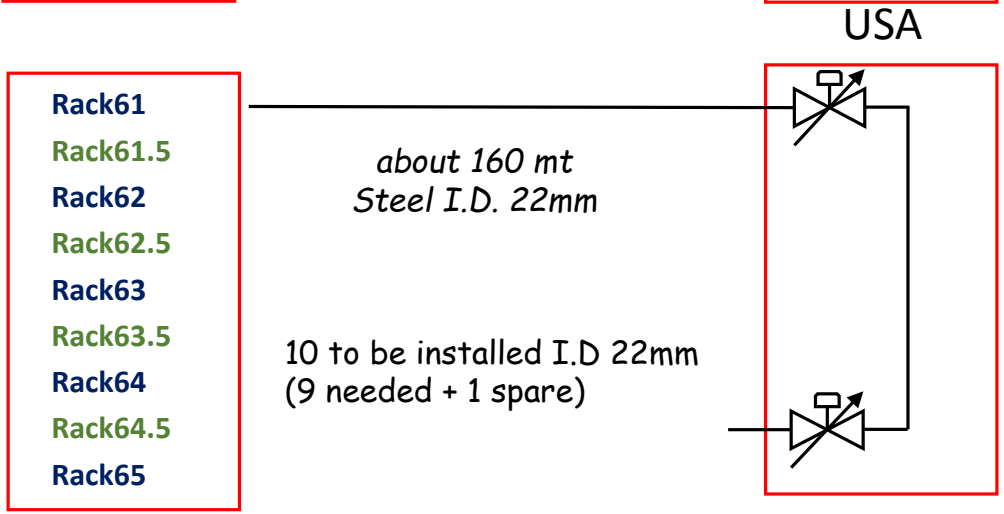


The Output pressure regulator in each Racks has to be moved in USA Gas Room

Present

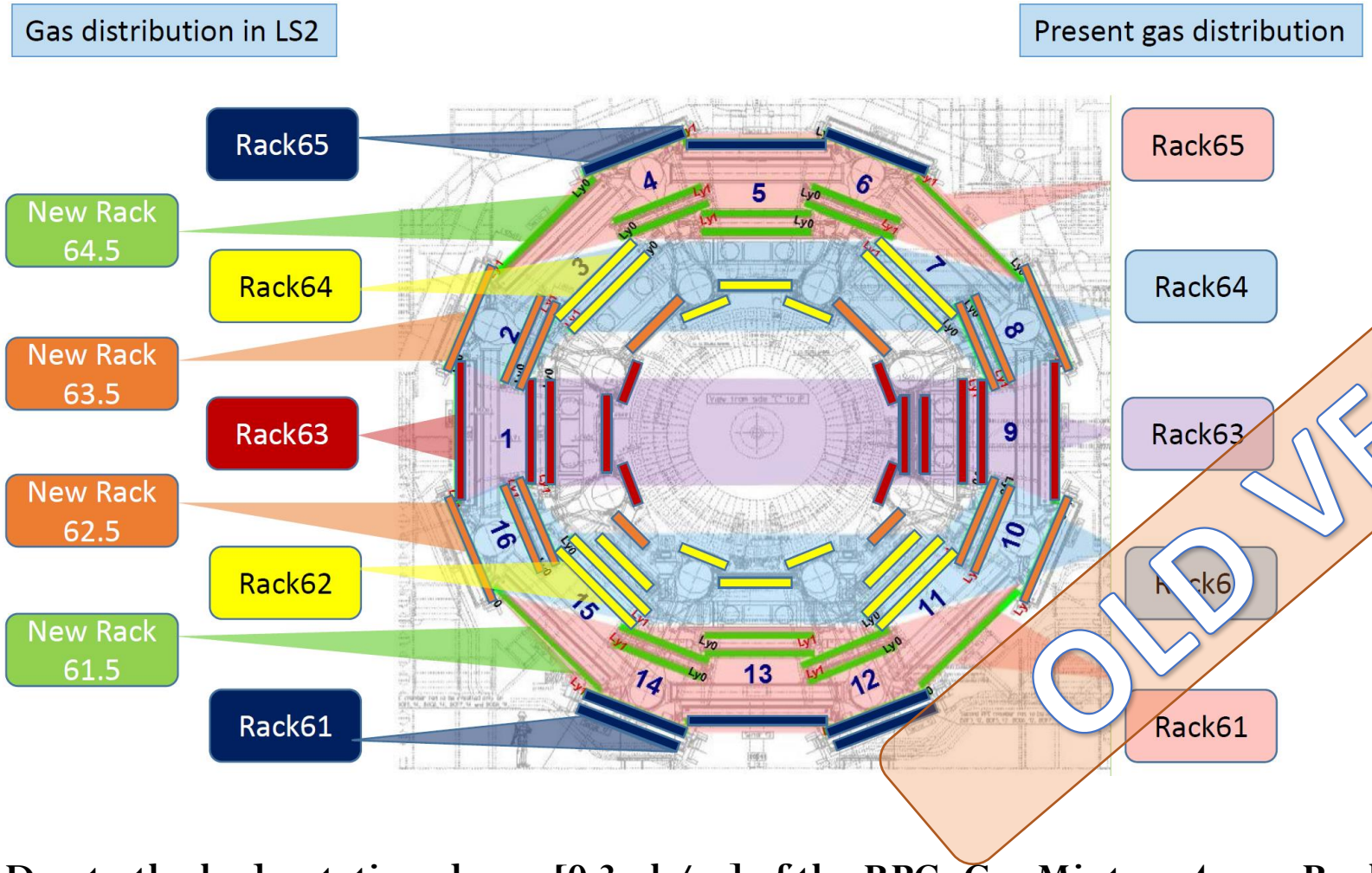


Future



The change will be tested in one Rack at beginning of LS2 with the present spare manifold for a precise evaluation of the noise improvement.

New 4 Racks to minimize the pressure inside the chambers



- ✓ The solution is to increase the vertical partition
- ✓ Less DeltaP = less leaks
- ✓ Additional 4 new Racks expected in LS2 also useful for the BI project in phase2
- ✓ 56 out 128 manifold to be moved to the new Racks

OLD VERSION

Due to the hydrostatic column [0.3mb/m] of the RPCs Gas Mixture 4 new Racks will be added at present system for a better pressure equalization.

Manifold to be moved to the new Racks

Rack 61	Ch 1	*BOL11A.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 2	*BOL11A.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 3	*BOL11C.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 4	*BOL11C.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 9	*BMS12.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 10	*BMS12.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 11	*BMS12.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 12	*BMS12.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 17	*BML13.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 18	*BML13.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 19	*BML13.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 20	*BML13.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 25	*BMS14.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 26	*BMS14.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 27	*BMS14.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 28	*BMS14.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 29	*BOL15A.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 30	*BOL15A.Ly1*	move to	**Rack 61.5**
Rack 61	Ch 31	*BOL15C.Ly0*	move to	**Rack 61.5**
Rack 61	Ch 32	*BOL15C.Ly1*	move to	**Rack 61.5**
Rack 62	Ch 1	*BOS16A.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 2	*BOS16A.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 3	*BOS16C.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 4	*BOS16C.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 5	*BMS16.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 6	*BMS16.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 7	*BMS16.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 8	*BMS16.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 17	*BMS10.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 18	*BMS10.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 19	*BMS10.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 20	*BMS10.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 21	*BOS10A.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 22	*BOS10A.Ly1*	move to	**Rack 62.5**
Rack 62	Ch 23	*BOS10C.Ly0*	move to	**Rack 62.5**
Rack 62	Ch 24	*BOS10C.Ly1*	move to	**Rack 62.5**

OLD VERSION

Rack 64	Ch 1	*BOS2A.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 2	*BOS2A.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 3	*BOS2C.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 4	*BOS2C.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 5	*BMS2.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 6	*BMS2.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 7	*BMS2.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 8	*BMS2.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 17	*BMS8.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 18	*BMS8.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 19	*BMS8.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 20	*BMS8.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 21	*BOS8A.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 22	*BOS8A.Ly1*	move to	**Rack 63.5**
Rack 64	Ch 23	*BOS8C.Ly0*	move to	**Rack 63.5**
Rack 64	Ch 24	*BOS8C.Ly1*	move to	**Rack 63.5**
Rack 65	Ch 1	*BOL3A.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 2	*BOL3A.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 3	*BOL3C.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 4	*BOL3C.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 9	*BMS4.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 10	*BMS4.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 11	*BMS4.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 12	*BMS4.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 17	*BML5.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 18	*BML5.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 19	*BML5.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 20	*BML5.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 29	*BOL7A.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 30	*BOL7A.Ly1*	move to	**Rack 64.5**
Rack 65	Ch 31	*BOL7C.Ly0*	move to	**Rack 64.5**
Rack 65	Ch 32	*BOL7C.Ly1*	move to	**Rack 64.5**

The Rack 63 is unchanged because is connected only to vertical chamber. In the Racks 62, 62.5, 63, 63.5, 64 will be connected in phase 2 to the new 48 manifold for the BI project

Present system

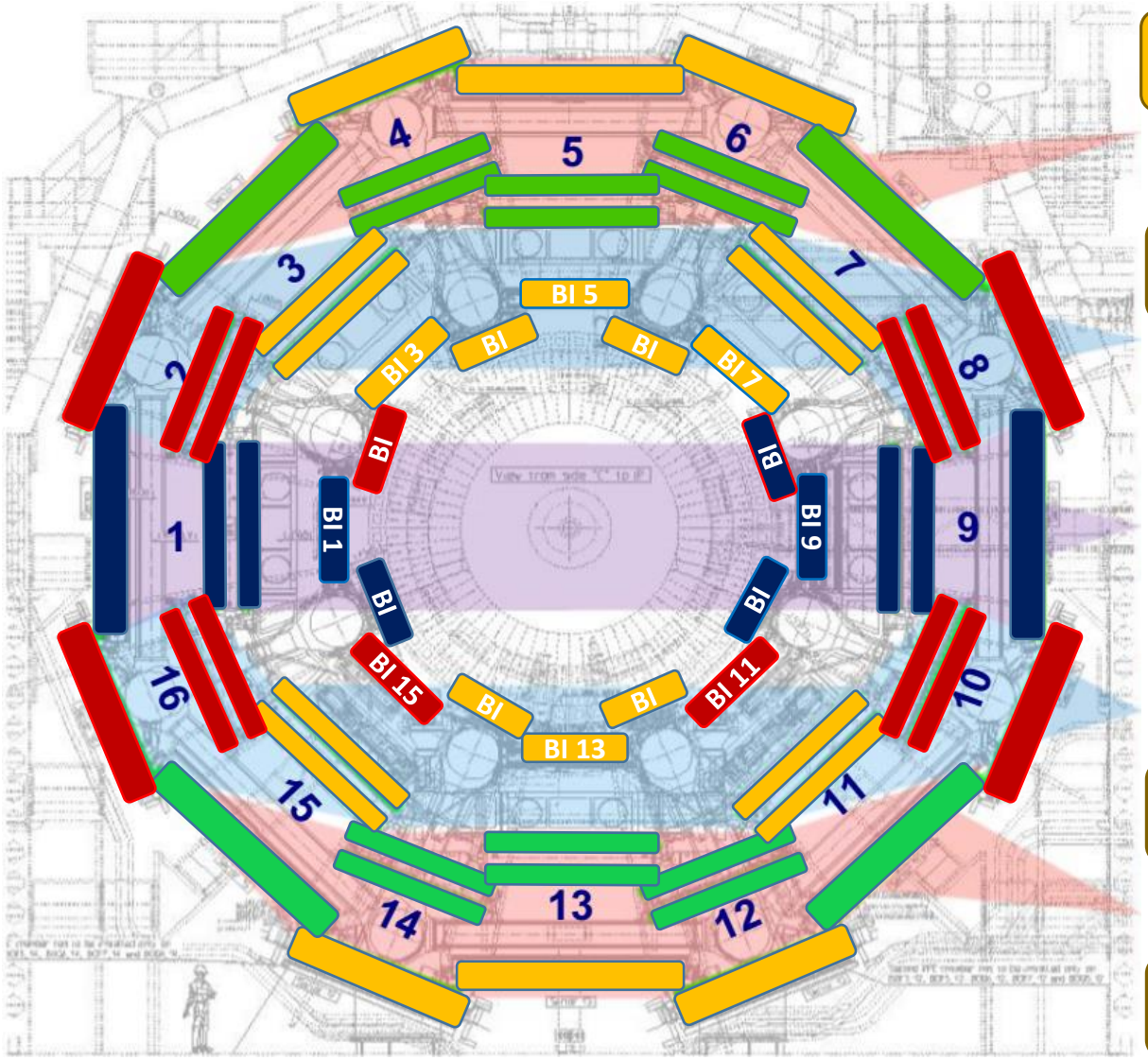
Rack65

Rack64

Rack63

Rack62

Rack61



Future upgrade

New Rack 65.5

Rack65

New Rack 64.5

Rack64

Rack63

Rack62

New Rack 61.5

Rack61

New Rack 60.5

Manifold to be moved to the new Racks

RACK 60.5

Ch	From	Label
1	Rack 61_ch5	BOSA12.Ly0.DP1
2	Rack 61_ch6	BOSA12.Ly1.DP2
3	Rack 61_ch7	BOSC12.Ly0.DP1
4	Rack 61_ch8	BOSC12.Ly1.DP2
5	Rack 61_ch13	BOLA13.Ly0.DP2
6	Rack 61_ch14	BOLA13.Ly1.DP1
7	Rack 61_ch15	BOLC13.Ly0.DP2
8	Rack 61_ch16	BOLC13.Ly1.DP1
9	Rack 61_ch21	BOSA14.Ly0.DP1
10	Rack 61_ch22	BOSA14.Ly1.DP2
11	Rack 61_ch23	BOSC14.Ly0.DP1
12	Rack 61_ch24	BOSC14.Ly1.DP2
13	empty	
14	empty	
15	empty	
16	empty	
17	empty	
18	empty	

RACK 61.5

Ch	From	Label
1	BML15.Ly0.DP2	Rack 62_ch9
2	BML15.Ly1.DP1	Rack 62_ch10
3	BML15.Ly0.DP2	Rack 62_ch11
4	BML15.Ly1.DP1	Rack 62_ch12
5	BML11.Ly0.DP2	Rack 62_ch13
6	BML11.Ly1.DP1	Rack 62_ch14
7	BML11.Ly0.DP2	Rack 62_ch15
8	BML11.Ly1.DP1	Rack 62_ch16
9	BI sect. 12	
10		
11	BI sect. 13	
12		
13	BI sect. 14	
14		
15		
16		
17		
18		

RACK 64.5

Ch	From	Label
1	BML3.Ly0.DP2	Rack 64_ch9
2	BML3.Ly1.DP1	Rack 64_ch10
3	BML3.Ly0.DP2	Rack 64_ch11
4	BML3.Ly1.DP1	Rack 64_ch12
5	BML7.Ly0.DP2	Rack 64_ch13
6	BML7.Ly1.DP1	Rack 64_ch14
7	BML7.Ly0.DP2	Rack 64_ch15
8	BML7.Ly1.DP1	Rack 64_ch16
9	BI sect. 3	
10		
11	BI sect. 4	
12		
13	BI sect. 5	
14		
15	BI sect. 6	
16		
17	BI sect. 7	
18		

RACK 65.5

Ch	From	Label
1	BOSA4.Ly0.DP1	Rack 65_ch5
2	BOSA4.Ly1.DP2	Rack 65_ch6
3	BOSC4.Ly0.DP1	Rack 65_ch7
4	BOSC4.Ly1.DP2	Rack 65_ch8
5	BOLA5.Ly0.DP2	Rack 65_ch13
6	BOLA5.Ly1.DP1	Rack 65_ch14
7	BOLC5.Ly0.DP2	Rack 65_ch15
8	BOLC5.Ly1.DP1	Rack 65_ch16
9	BOSA6.Ly0.DP1	Rack 65_ch25
10	BOSA6.Ly1.DP2	Rack 65_ch26
11	BOSC6.Ly0.DP1	Rack 65_ch27
12	BOSC6.Ly1.DP2	Rack 65_ch28
13	empty	
14	empty	
15	empty	
16	empty	
17	empty	
18	empty	

With the new Rack will be available the connections points for the phase 2 RPCs BI project installed at least 2 for sector.

In the space left by the removed manifold in the Racks 62, 63, 64 will be connected the remaining 18 BI channel.

Summary of Gas System upgrades costs

ISSUE	UPGRADE		Responsibility		TOT. kCHF
Shockwave	Regulation valves move from UX to USA	New Rack in USA	Gas Group		75
		Pipe from UX to USA	Atlas TC	To be evaluated	?
Chamber pressure lowering	4 new Racks	Racks	Gas Group	75 KCHF x4	300
		Pipe movement between Racks x56	TC + Muon RPC	To be evaluated	?
O_2 sensor	New Analysis “module” in USA/SGX1 for RPC				25
				Total	**400**

About LS2 inert humidified gas circulation

❑ From TFE to inert at fixed pressure

The chambers Flow will be set by the Input pressure controlled by Hagen-Poiseuille law

$$\Delta P = \frac{8\mu L}{\pi r^4}\phi$$

$\Delta P_{Ar} = 2.54$
$\Delta P_{TFE} = 1.57$
$\Delta P_{Air} = 2.05$
$\Delta P_{CO_2} = 1.67$

(@ L=1mt; r=1mm $\phi = 1\frac{l}{h}$)

@ fixed P $2.54\ \phi_{Ar} = 1.57\phi_{TFE}$ $\phi_{Ar} = 0.61\phi_{TFE}$ $\phi_{Air} = 0.76\ \phi_{TFE}$

❑ **At fixed pressure higher flow with Air or Nitrogen than Ar**

About LS2 inert humidified gas circulation

- Thermal Gas Mass Flow Meters sensitivity from TFE to inert

	K relative to N_2	Cp (Cal/g)	Density (g/l)
TFE $C_2H_2F_4$	.51	.127	4.22
Air or Nitrogen	1	.24	1.29
Ar	1.45	1.24	1.78
CO_2	.74	0.20	1.96

$$K_{gas} = \frac{1}{d \times C_p}$$

where d = gas density (gram/liter)
C_p = coefficient of specific heat (cal/gram)

$$K = \frac{Q_a}{Q_r} = \frac{K_a}{K_r}$$

where Q_a = mass flow rate of an actual gas (sccm)
Q_r = mass flow rate of a reference gas (sccm)
K_a = K factor of an actual gas
K_r = K factor of a reference gas

$$Q_{Ar} = \frac{K_{Ar}}{K_{TFE}} Q_{TFE}$$

$$Q_{Ar} = 2.58 Q_{TFE}$$
$$Q_{Air} = 1.96 Q_{TFE}$$

- **At fixed pressure higher flow with Air or Nitrogen than Ar**