Follow Up

Discharge/gain-shift problem of the Asian 100μm thick GEM, and an experience of the LHCb GEM muon chambers

RY and TM
The LC TPC Japan group

WP Meeting No.164
5 Dec. 2012

The Tests of the Asian GEM
In the fall 2011 and in September 2012

- **In the winter 2011-2012 we tested the Asian 100μm thick GEM (by laser drilling with a cure by a chemical etching process). We found, with the irradiation by Fe55, the significant and continuous gain decrease, and a high-rate discharge immediately after the HV switch-on. The discharge eventually calmed down to a stable rate (1 discharge/min). Without the irradiation, we did not see the gain shift and the discharge rate was rather stable at a level of 0.1 discharge/min. (See next slide).**

- **In Sep 2012, we tested two new GEMs by modified processes and also the old GEMs. Even with the irradiation we did not see the gain shift and the high-rate discharge immediately after the HV on (with a surprise). The discharge rate was at the level of 0.1 discharge/min (which may be still high compared to the standard CERN GEM).**

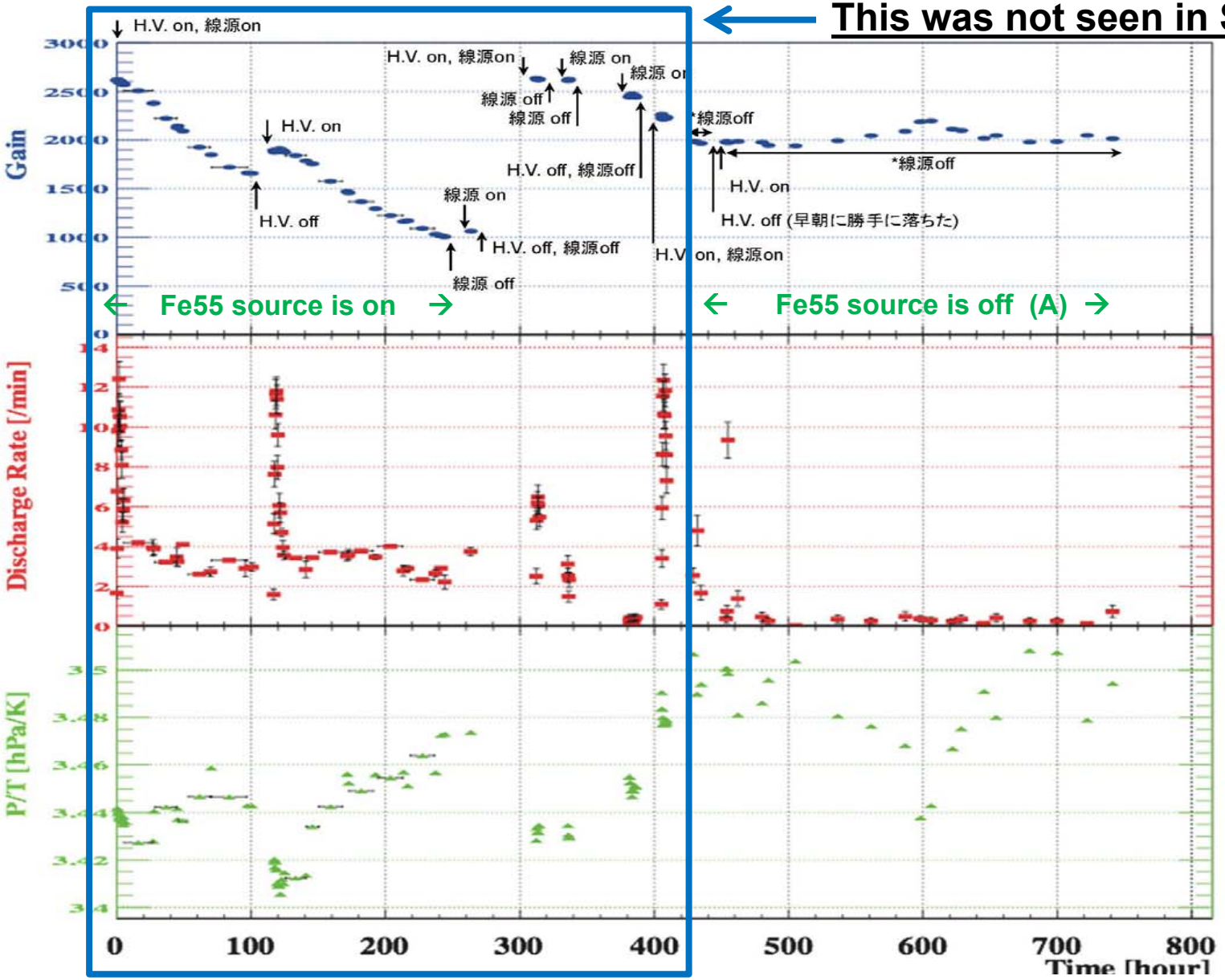
- **The test set up was not change at all between the two tests. Between the tests the T2K gas flow was kept. When the test was resumed in Sept. 2012 , the CF4 gas bottle was switched to a new CF4 bottle from a different company (and of a different quality).**

- **We analyzed the remaining gas in the old bottle, but we could not find any significant change (within our standard gas-quality check by a gas company) except that they found C2F6.**

Longer Measurement by the Beginning of Jan 2012

A summary plot of the discharge rate and the gain shift
Measured for the module with the termination plate

This was not seen in Sept. 2012



*) ゲイン測定時のみ線源を当てる。1回の測定で約10分程度。

The CF4 gas bottle for the test in the winter 2011-2012

Gas quality check in 2007

No.JG004026010 CF4_3(000)0004

高エネルギー加速器研究機構 御中

検査成績表

品名	四フッ化炭素(CF4)	2007年6月19日
グレード	5N	関東電化工業㈱渋川工場
充填日	2007年06月18日	〒377-8513
ロット番号	90618-23	群馬県渋川市渋川1497
数量	32kg*1	TEL0279 23 3211(代)
容器	47L	FAX0279 25 1106
出荷案内番号	JG00402601	品質管理部品質管理課
出荷日		

検査項目	単位	規格	検査結果
純度(空気を除く)	vol%	99.999 以上	99.999 以上
水分	volppm	2.0 以下	0.16
酸分(HFとして)	volppm	0.4 以下	0.24 以下
空気	volppm	15.0 以下	2.0 以下
ｸﾛﾛﾌﾙｵﾛｶｰﾎﾞﾝ	volppm	1.0 以下	0.1 以下

Gas quality check in 2012

関東電化工業株式会社
精密化学品第2部

CF4調査依頼品 分析結果について

ご依頼頂きました分析結果について下記の通り、記します。

記

ロットNo.:90618-23
容器No.:PLL 89059

		出荷時検査値 (2007年6月19日)	戻り容器分析値 (2012年10月16日)	
水分	vol.ppm	0.16	0.14	Water
酸分	vol.ppm	<0.24	<0.24	HF etc
空気	vol.ppm	<2	<2	Air
ｸﾛﾛﾌﾙｵﾛｶｰﾎﾞﾝ	vol.ppm	<0.1	0.4	(*)

(*) C2F6, C3F8, CHF3, CCLF3, C2ClF5

"ｸﾛﾛﾌﾙｵﾛｶｰﾎﾞﾝ"の項目は、C2F6,C3F8,CHF3,CClF3,C2ClF5の合計量を報告しております。返却容器では、C2F6が検出されました。

The new CF4 Gas bottle for the test in Sept.2012
(In general a better quality than the old one)

検査成績書

昭和電工株式会社
化学品事業部門 品質保証部
TEL 044-322-6874
承認 清水　担当 大久保

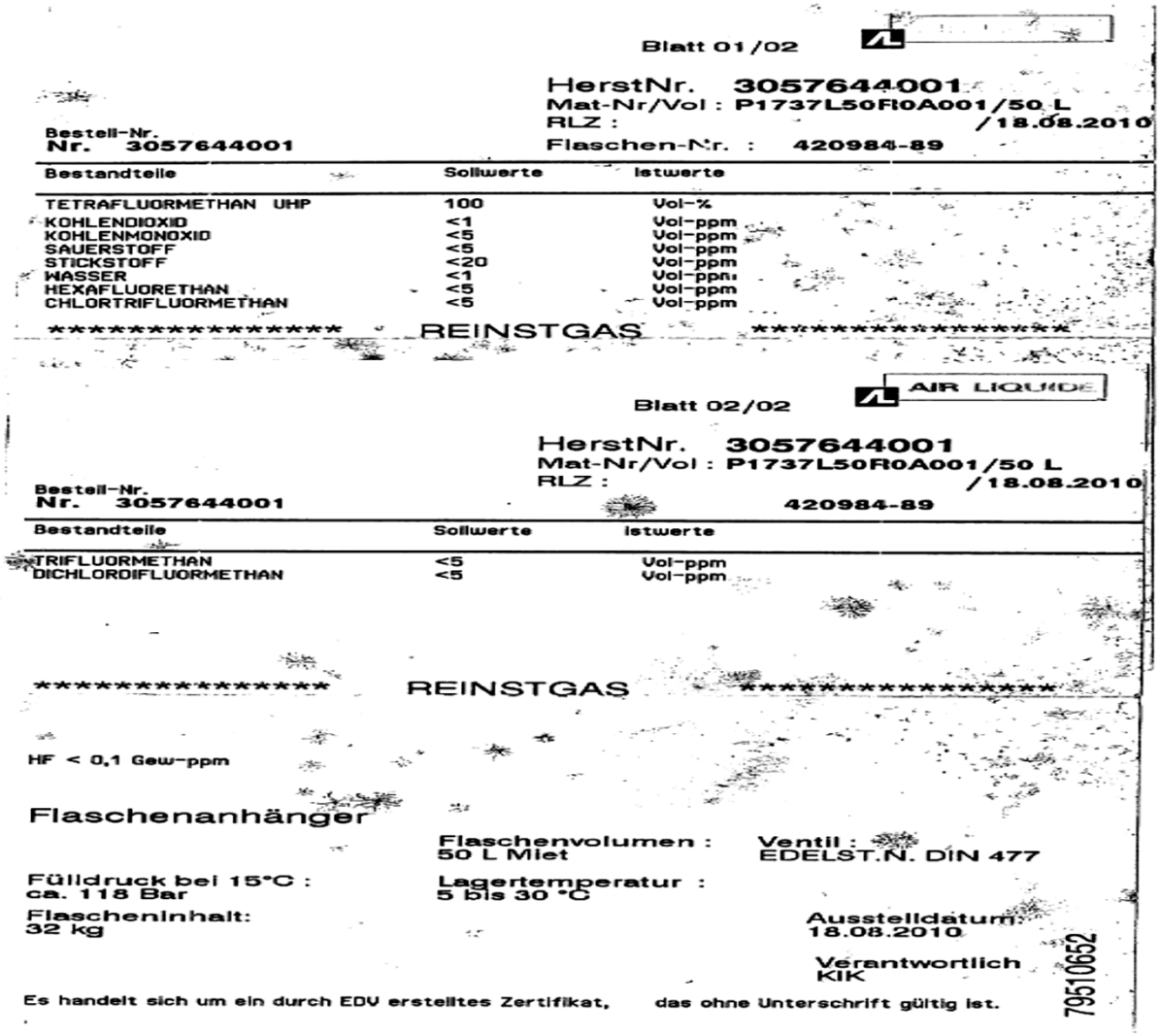
東北大学　御中

出荷伝票No. 0006134303
出荷日 2012年 3月 6日

製品名 ：高純度 ＦＣ－１４
荷 姿 ：４７Ｌボンベ３３ＫＧイリ
ﾛｯﾄNo. ：１４１２０３０
ﾎﾞﾝﾍﾞNo. ：ＰＬＮ 59357

検査項目	単位	品質保証値	検査結果
純分 (CF4)	vol%	≧ 99.9997	≧ 99.9997
H2O	volppm	≦ 0.5	< 0.1
酸分 (HF etc)	volppm	≦ 0.1	0.01
N2	volppm	≦ 10	< 1
O2＋Ａｒ	volppm	≦ 2.0	< 1.0
ＣＨ4	volppm	≦ 0.5	< 0.4
ＣＯ	volppm	≦ 0.5	< 0.4
ＣＯ2	volppm	≦ 0.7	< 0.6
ＣＨＦ3	volppm	≦ 0.6	< 0.5
ＳＦ６	volppm	≦ 0.2	< 0.1
その他弗化炭素 (Other CnFm)	volppm	≦ 2.0	< 0.5

CF4 gas used for LP TPC at DESY



Blatt 01/02

HerstNr. 3057644001
Mat-Nr/Vol : P1737L50FI0A001/50 L
RLZ : /18.08.2010

Bestell-Nr.
Nr. 3057644001

Flaschen-Nr. : 420984-89

Bestandteile	Sollwerte	Istwerte
TETRAFLUORMETHAN UHP	100	Vol-%
KOHLENDIOXID	<1	Vol-ppm
KOHLENMONOXID	<5	Vol-ppm
SAUERSTOFF	<5	Vol-ppm
STICKSTOFF	<20	Vol-ppm
WASSER	<1	Vol-ppm
HEXAFLUORETHAN	<5	Vol-ppm
CHLORTRIFLUORMETHAN	<5	Vol-ppm

********** REINSTGAS **********

AIR LIQUIDE

Blatt 02/02

HerstNr. 3057644001
Mat-Nr/Vol : P1737L50R0A001/50 L
RLZ : /18.08.2010

Bestell-Nr.
Nr. 3057644001

420984-89

Bestandteile	Sollwerte	Istwerte
TRIFLUORMETHAN	<5	Vol-ppm
DICHLORDIFLUORMETHAN	<5	Vol-ppm

********** REINSTGAS **********

HF < 0,1 Gew-ppm

Flaschenanhänger

Flaschenvolumen : 50 L Miet

Ventil : EDELST.N. DIN 477

Fülldruck bei 15°C : ca. 118 Bar

Lagertemperatur : 5 bis 30 °C

Flascheninhalt: 32 kg

Ausstelldatum: 18.08.2010

Verantwortlich KIK

Es handelt sich um ein durch EDV erstelltes Zertifikat, das ohne Unterschrift gültig ist.

79510652

Operational Experience of the Triple-GEM Detectors of the LHCb Muon System: Summary of 2 years of data taking

Alessandro Cardini / INFN Cagliari, Italy
Giovanni Bencivenni / LNF INFN, Italy
Patrizia de Simone / LNF INFN, Italy

We the hear this story of LHCb at the IEEE/NSS 2012.

Operations in LHCb

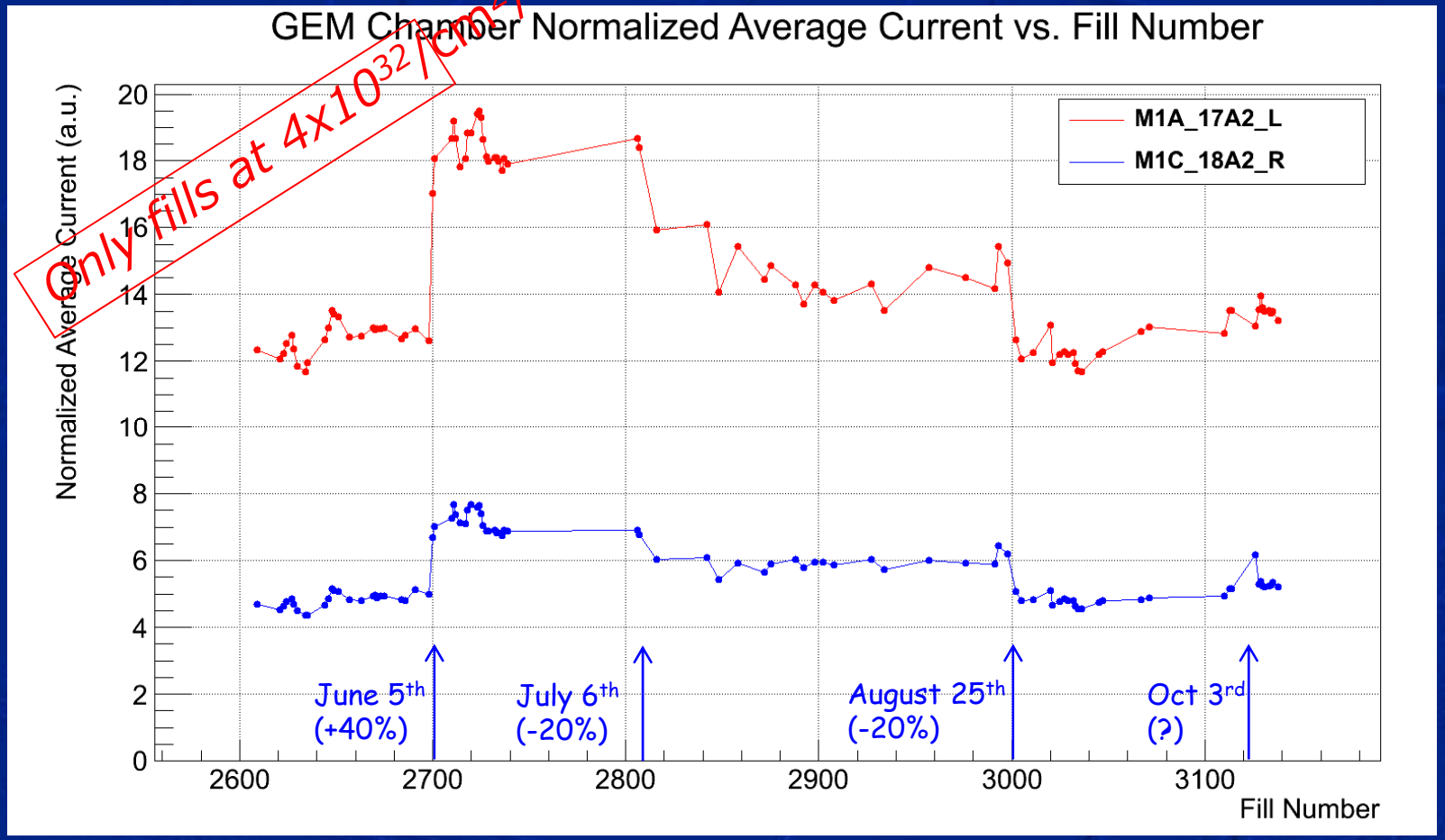
Gas-related issues:

Monitoring the Gas Mixture

The LHCb GEM Gas System

- Made by CERN Gas Group – Open-loop system
- $Ar/CO_2/CF_4$ in percentages 45/15/40
- Flows: ~80 cc/min per detector – monitored by ECS
- Fresh mix analysis permanent tools:
  - Gas Chromatographer (GC)
  - $H_2O + O_2$ measurement
- Possibility of sampling return gas with portable GC

2012 GEM Current Jumps

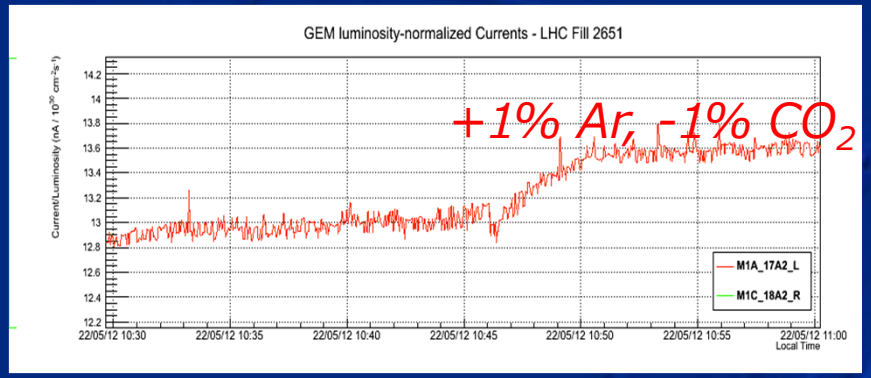


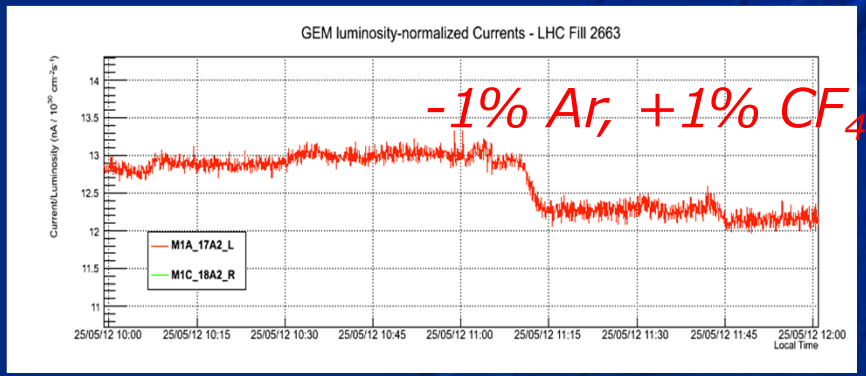
- Observed some "jumps" in ALL triple-GEM detector luminosity-normalized currents all along this year
- True Gain variations! ➔ detector signals move correspondently in time

Investigations performed

Possible causes of a gain change:

- Gas
  - GC-analysis show correct gas mixture within O(1%)
  - Small gas fraction changes (1%) create too-small gain changes (~5%)
- HV
  - 24 independent HV modules
- Temperature & Pressure
  - No temperature variations seen
  - Pressure variations not correlated

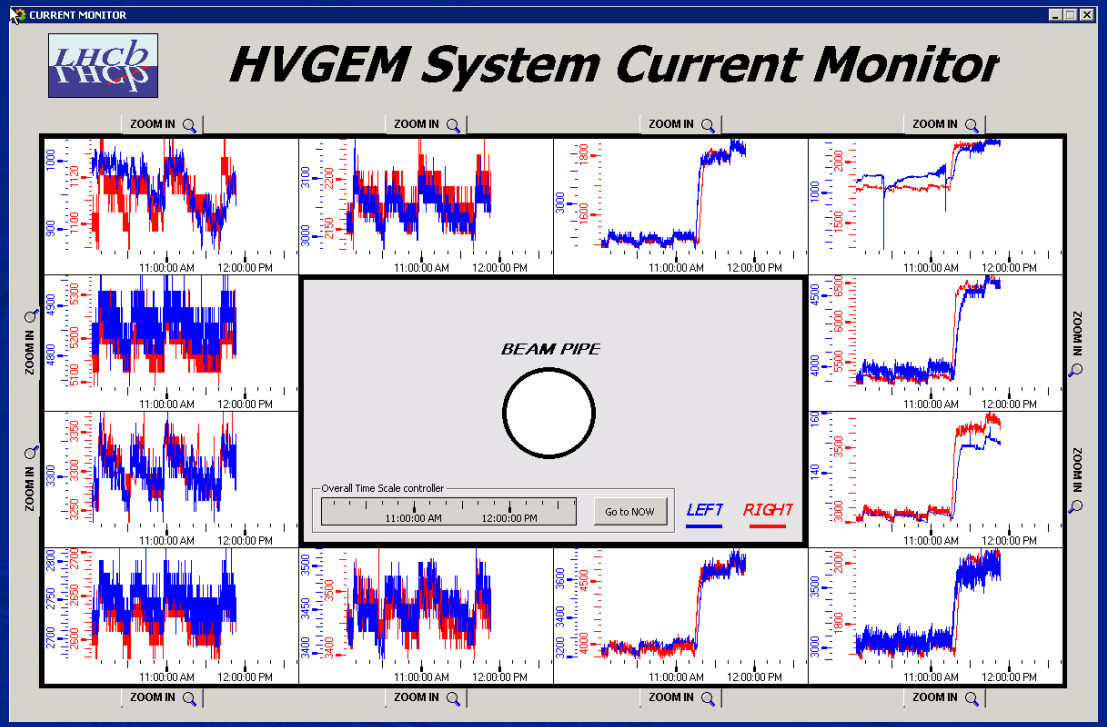




➔ *Origin of this problem???*

Premixed Gas Test

- Inject gas from pre-mixed bottle only on half of the detectors



- Should be the same gas… *but 20% current increase observed!*

➔ It's definitely something related to gas…

At last···

- Some correlations were found by Gas Group (R. Guida, B. Mandelli et al., see poster N14-132)
- It appears that some of the gain jumps are in coincidence with the change over of the CF_4 bottles
- Looking carefully at GC analysis some variations of O_2/N_2 seen··· is this correlated?
- Situation not yet clear – will carefully monitor future CF_4 bottle changes

What we learned? What to improve?

- Gas mixture is a very critical point
- Gas monitoring units (GC, …) are excellent devices, but sometimes you do not know what to look for
- Imperative to implement redundant gas checking tools
  1. Automatic current/luminosity checks – done
  2. Independent gain monitoring tool with a small source-irradiated triple-GEM detector – in progress

GEM Gas Monitoring Too