Location of BLMs in the LHC

- **The BLM system (short overview)**
- **Data from the BLM system**
- **Installation in the arcs**
- **Installation in the insertion regions**

Purpose of the BLM system

- **Machine protection against damage of equipment and magnet quenches**

- **Setup of the collimators**

- **Localization of beam losses and help in identification of loss mechanism**

- **Machine setup and studies**

The BLM families

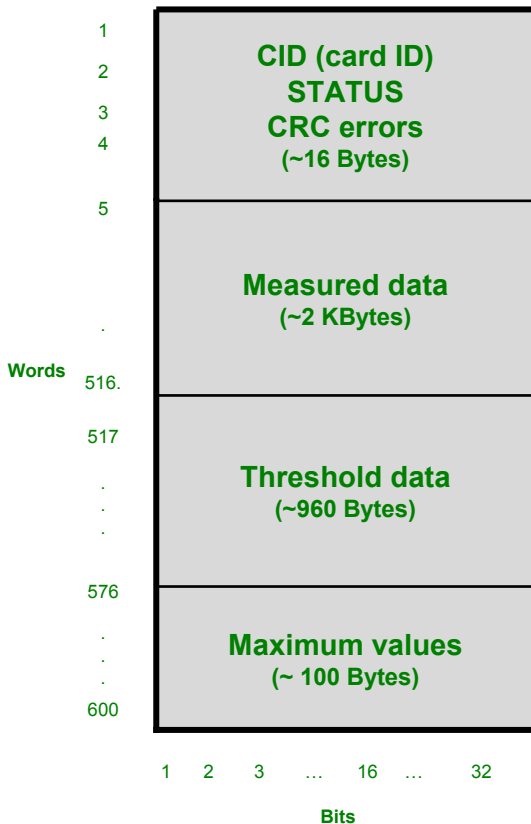| Position	Description	Number of detectors
BLMA	Quadrupoles along the ring (6 per quadrupole), ionization chambers attached outside of cryostat, time resolution 2.5ms.	**~3000**
BLMS	Critical aperture limits or positions, ionization chambers, time resolutions 1 turn: **BLMSI** (ion. ch.)	**~400**
BLMS*	Critical positions for injection losses, extended dynamic range: **BLMSI** (ion. ch.) + **BLMSS** (SEM), time resolution 1 turn.	**~100**
BLMC	Collimation sections, **BLMCI** (ion. ch.) + **BLMCS** (SEM), time resolution 1 turn, used to set up the collimators.	**~110**
BLMB	Primary collimators, not part of baseline scenario, for beam studies, bunch-by-bunch resolution.	**10**

Estimation of fluency through the BLMs

		min	max	
BLMA **BLMS**	**7 TeV**	$5 \cdot 10^3$	$8 \cdot 10^8$	**mips / cm^2 s**
	450 GeV	10^2	10^{10}	**mips / cm^2 s**
BLMC	**7 TeV**	$1.5 \cdot 10^4$	$6.4 \cdot 10^{13}$	**mips / cm^2 s**
	450 GeV	$2 \cdot 10^5$	10^{16}	**mips / cm^2 s**

Signals from the BLM system

- **Dump signal**
- **Logging**
- **Post mortem**

Logging Data Arrangement

These data have to be read with a rate of a second in order to be stored in a database as well as to give a graphical representation for the control room.

Words	
1 2 3 4	**CID (card ID)** **STATUS** **CRC errors** **(~16 Bytes)**
5 . 516.	**Measured data** **(~2 KBytes)**
517 . . . 576	**Threshold data** **(~960 Bytes)**
. . . 600	**Maximum values** **(~ 100 Bytes)**

1   2   3   …   16   …   32

Bits

- The card's *Threshold* table. (~ 22 KBytes)
- The measured & calculated data. (< 2 KBytes)
- The used *Threshold* values. (< 1 KBytes)
- The max of read values (100 Bytes)
- Additional info (card ID, status, errors) (~16 Bytes)

Total from each card ~ 28KB per minute

From C. Zamantzas, not jet implemented – under discussion.

How a Control Room Representation could look

The Control Room will be able to issue the Warning level alerts from logging data and have a graphical representation:
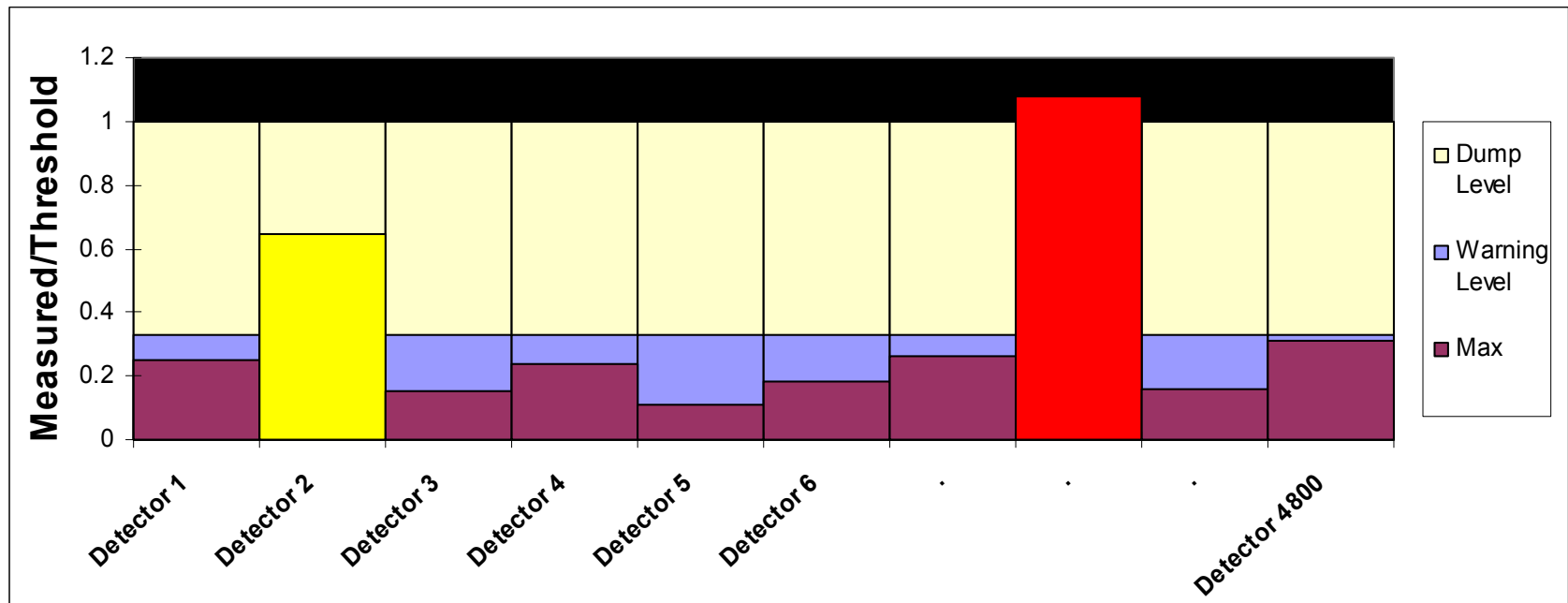
The 12 values measured for each detector have to be normalised by their corresponding threshold value; from those 12 the maximum value is displayed.

From C. Zamantzas, not implemented.

Post Mortem Data Recording

- **Two circular buffers**
    - 2000 turns of both signals received
    - Integrals of 10 ms (data needed for further analysis)
- **Double the above system and toggle between them using the stop PM recording trigger**
    - Never stop recording (i.e. avoid start input)
    - Test of PM will be possible anytime
    - Accidental/error-triggering proof
- **PM freeze from TTCrx through the backplane.**
- **Time-Stamp appended later by crate CPU.**
    - At PM freeze the CPU records the time and later when it reads the PM Data appends it to them.
- **Calculations:**
    - 1000 turns $\Rightarrow$ 2000 acquisitions * ~250 bits frameword
    - $\Rightarrow$ 60 KB/signal * 2 signals/card = 120 KB /card
    - $\Rightarrow$ 120KB/card * 18 cards/crate = 2.1 MB /crate

From C. Zamantzas, not jet implemented – under discussion.

BLM locations in the arcs – transverse plane

Phi (angle in transverse plane) distribution of particles exiting the vacuum vessel (GEANT simulation)

$phi_{mean} = 10.59°$
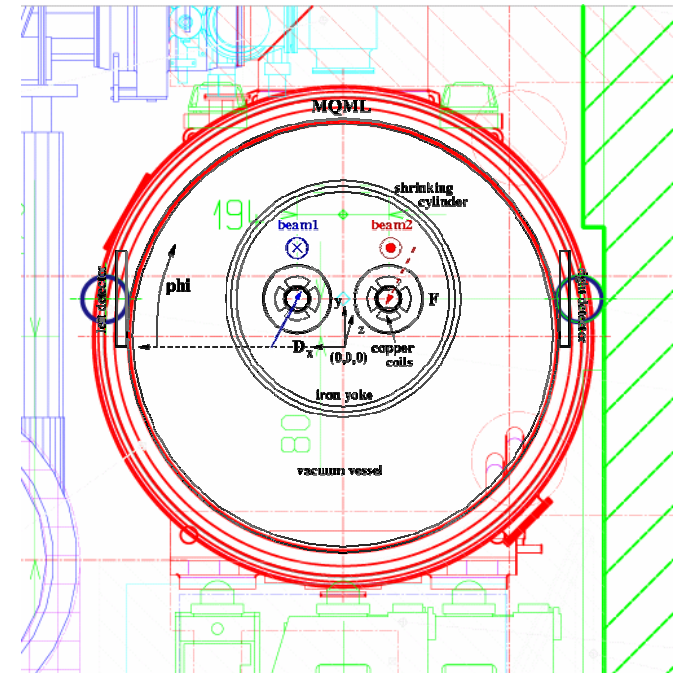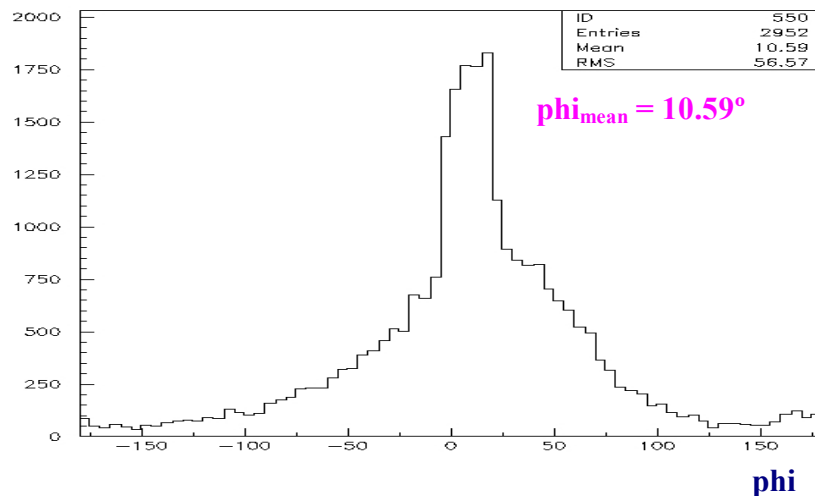
- **BLMs installed outside of the cryostat, maximal signal in horizontal plane (least amount of material).**

- **Number of shower particles underneath the cryostat: ~10 times less than in horizontal plane.**

BLM locations in the arcs – longitudinal

- 3 loss locations simulated: shower development through the cryostat, GEANT 3.
- The positions of the BLMs are chosen to:
  - reduce difference between inside and outside loss
  - minimize crosstalk
  - distributed loss to resemble point loss
  - reduce difference with and without MDCO.
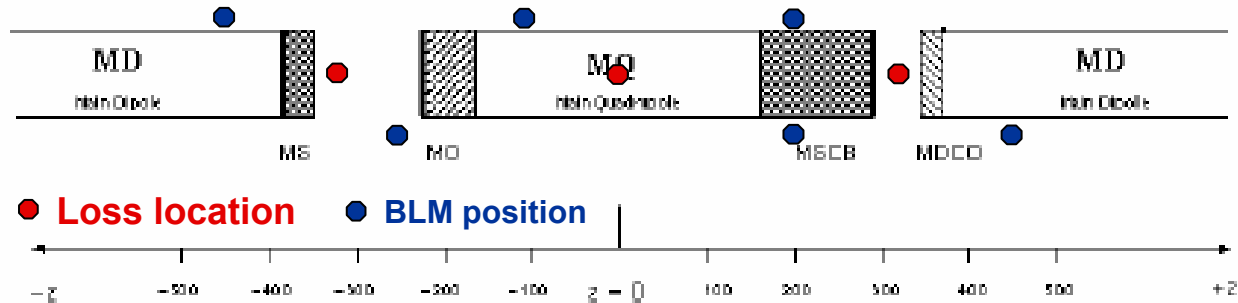
First simulation results on longitudinal proton loss distribution

Tracking of tertiary halo particles, E.B. Holzer and V. Kain (end of 2003), complete aperture model (DS and arc right of IR7), (halo particles simulated by R. Assmann), ideal alignment.

Quadrupoles
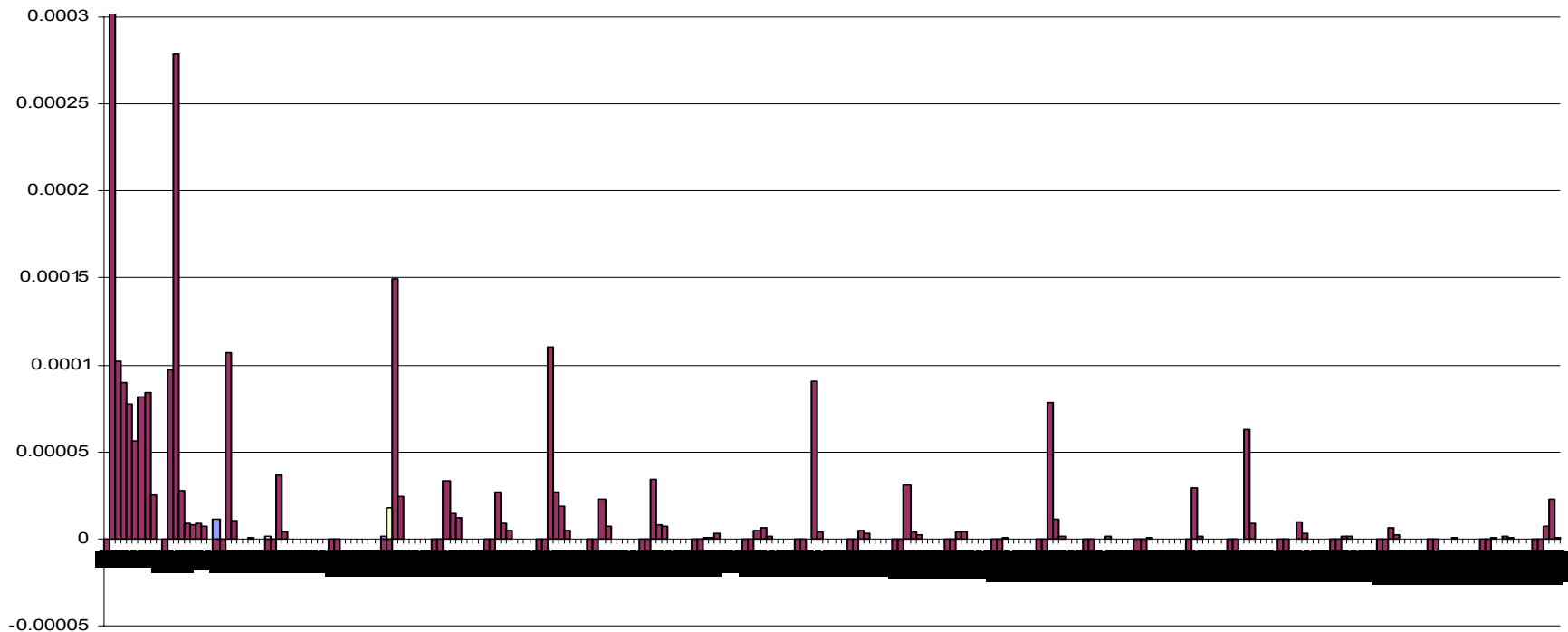
Longitudinal losses strongly peaked at the beginning of the quadrupoles (dipoles not shown).

BLM installation in the insertion regions

- **Collimation regions**
- **ATLAS and CMS**
- **Injection (ALICE and LHC B)**
- **IR4 and IR6**

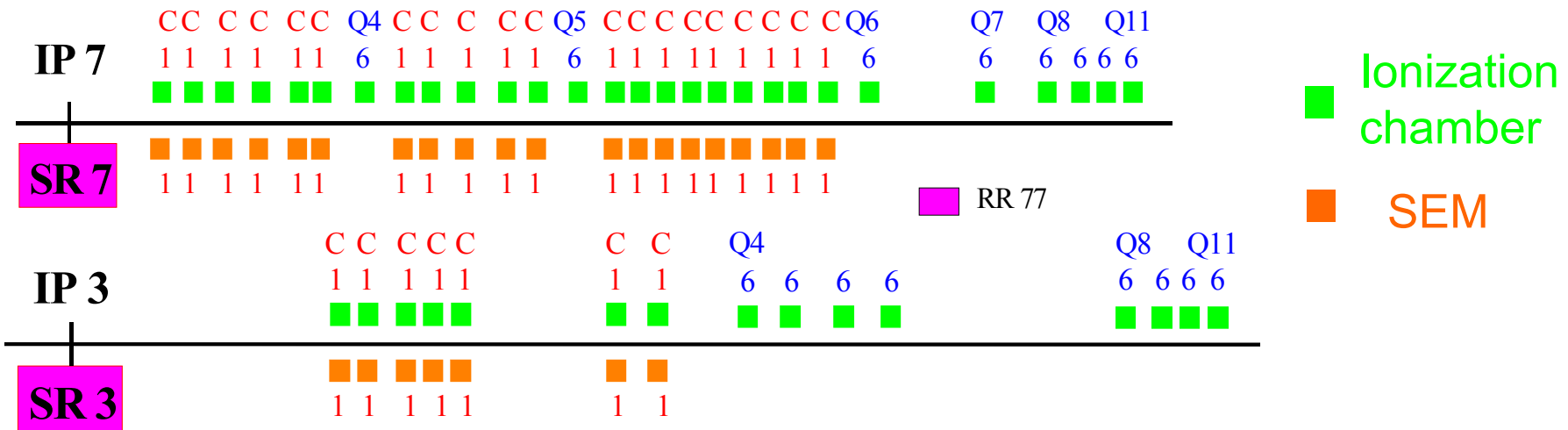Sketch with detector locations and number of monitors (G. Ferioli):

BLMA (blue), BLMC (red), BLMS (black) … number of monitors per location

Table with the BLMS ("SI" – ionization chamber, and "SS" – SEM) and BLMC ("CI" and "CS") locations per insertion region.

One side of IP only, has to be multiplied by two to get the number per IP, if not indicated differently.

Only one beam, if not indicated differently.

Collimation regions

CC C C CC Q4 C C C C C Q5 C C C CC C C C CQ6   Q7   Q8   Q11

IP 7

1 1 1 1 1 1 6 1 1 1 1 1 6 1 1 1 11 1 1 1 1 6   6   6 6 6 6

■ Ionization chamber

SR 7

1 1 1 1 1 1   1 1 1 1 1   1 1 1 11 1 1 1 1

RR 77

■ SEM

C C C C C   C C   Q4   Q8   Q11

IP 3

1 1 1 1 1   1 1   6 6   6   6   6 6 6 6

SR 3

1 1 1 1 1   1 1

BLMA (blue), BLMC (red), BLMS (black) … number of monitors per location

IR	Collimator	DIS Q8 prot	DIS Q11 prot	DIS xx ion
3	xxx CI + CS	SI	SI	SI
7	xxx CI + CS	SI	SI	SI

Number of BLMS and BLMC locations

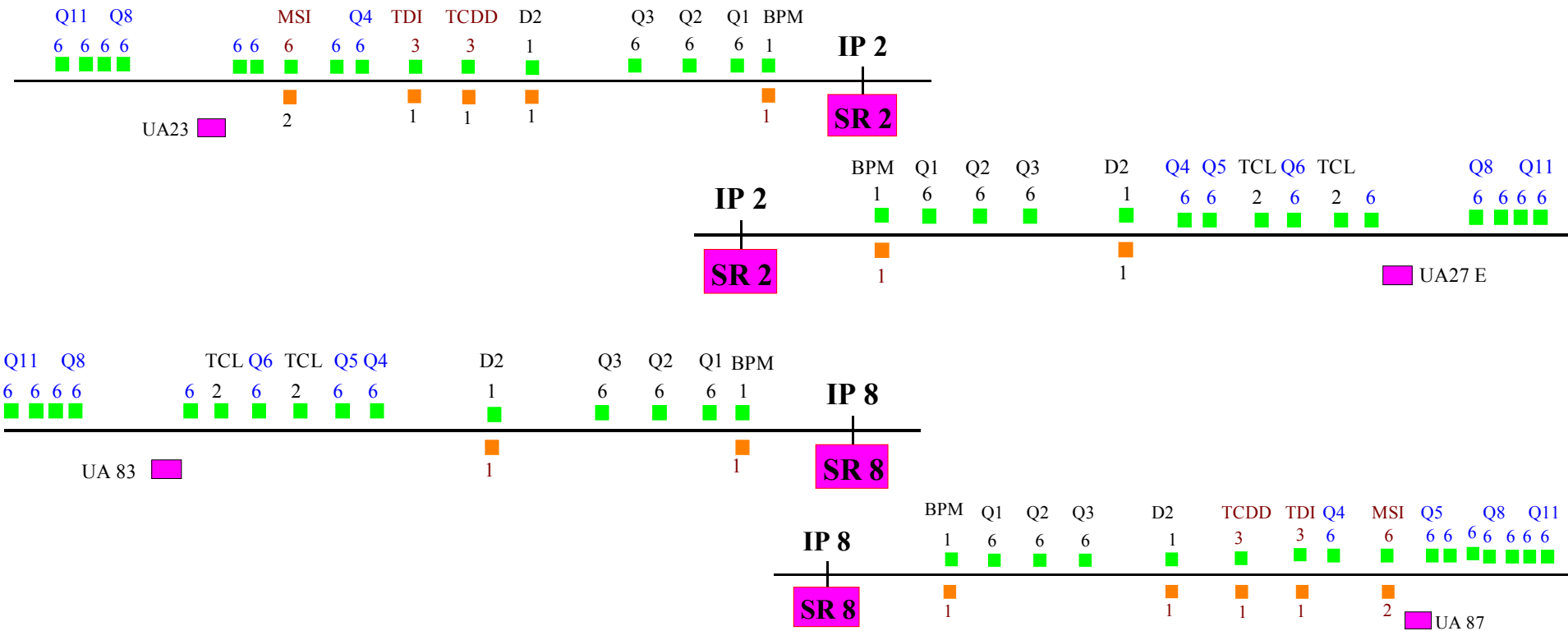One side of IP only, has to be multiplied by two to get the number per IP, if not indicated differently.

Only one beam, if not indicated differently

IR1 (ATLAS) and IR5 (CMS)
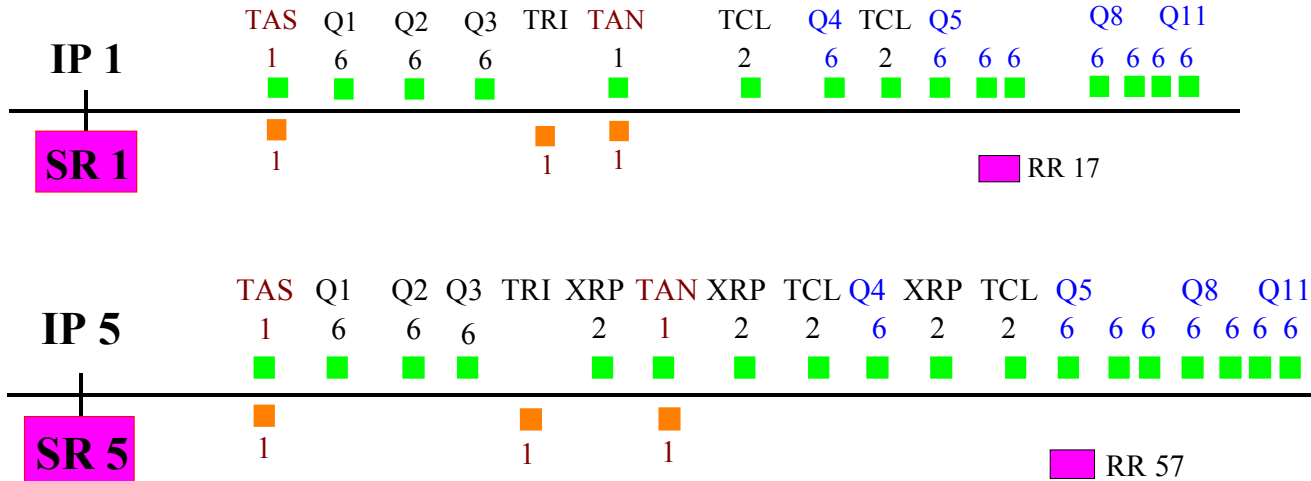
IR	TAS	TRIPLET two beam	TRIPLET abs	TAN	TCL1	TCL2	XRP 4 locations	DIS Q8 prot	DIS Q11 prot	DIS xx cap ion
1	SI+SS	2*SI	SS	SI+SS	SI	SI		SI	SI	SI
5	SI+SS	2*SI	SS	SI+SS	SI	SI	4*SI	SI	SI	SI

Injection – IR2 (ALICE) and IR8 (LHC B)

IR	BPM Q1	TRIP LET two beam	D2	MSI one side	TDI one side	TCDD one side	TCLI one side	DIS Q8 prot	DIS Q11 prot	DIS xx cap ion
2	SI+SS	2*SI	SI+SS	SI+SS	SI+SS	SI+SS	2* SI+SS	SI+SS	SI+SS	SI
8	SI+SS	2*SI	SI+SS	SI+SS	SI+SS	SI+SS	2* SI+SS	SI+SS	SI+SS	

IR4 (RF, instrumentation) and IR6 (extraction)

IP 4

Q5
6   6   6

Q8   Q11
6   6   6   6

SX 4

▯ UA 47

IP 6

MSD   TCDS   TCDQ
6   4   4

Q4   Q5
6   6

Q8   Q11
6   6   6   6

SR 6

2   2   2

2

▯ UA 67
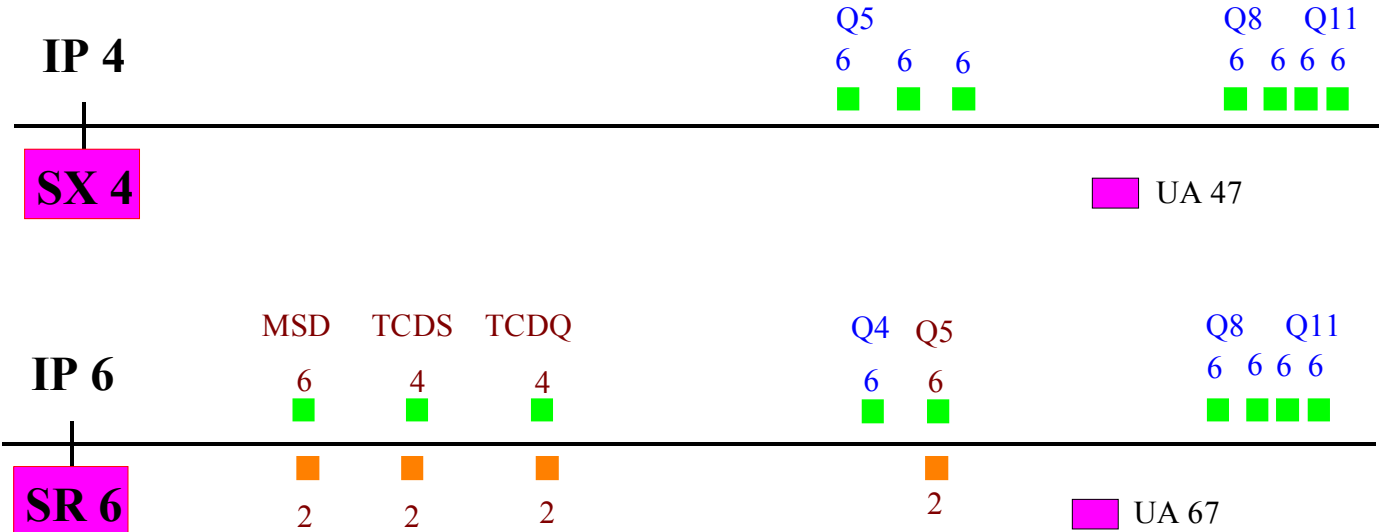
IR	MSD	TCDQ	TCDS	Q5	
4					to be defined
6	SI+SS	SI+SS	SI+SS	SI+SS	

Your input needed

- – **BLM locations in IR3, IR7 and IR4**
- – **Comments on the locations in IR1, IR2, IR5 and IR6**