HSE
Occupational Health & Safety
and Environmental Protection Unit

What are the consequences of delaying the shutdown from 2012 to 2013 for Radiation Protection?

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(on behalf of DGS-RP)

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Outline

1) Run parameters for 2011 and 2012 (M.Lamont)

2) Evolution of activation from today until 2013

3) Closer look at activation of arcs and DS

4) Summary and conclusions

(More details and results will be presented in Session 5)

Operational scenarios for proton runs

Source: M.Lamont 12/3/2010

	2011	2012
Energy	**4 TeV**	**4 TeV**
Probable bunch spacing	75 ns	50 ns
Maximum number of bunches	**936**	**1400**
Bunch intensity	**1.1e11**	**1.2e11**
Maximum stored beam energy	66 MJ	108 MJ
Beta*	2 m.	2 m.
Emittance	3 microns	2.5 microns
Peak luminosity	**6e32 cm-2s-1**	**2e33 cm-2s-1**
Number of days physics	200	200
Intensity ramp up time	6- 8 weeks	~3 months
Estimated integrated luminosity	**1 - 3 fb-1**	**~5 fb-1**

Evolution of activation

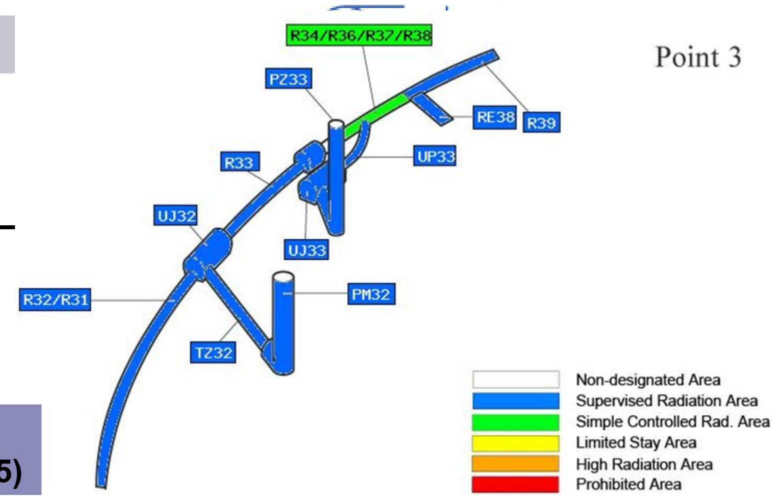
→ parameters important for RP estimates:

Year of operation	2010	2011	2012	
Energy	3.5 TeV	4.0 TeV	4.0 TeV	
Fraction of nominal beam intensity	13%	32%	53%	
Average luminosity, L_{avg} = ¾ L_{peak}	7.5e31	4.5e32	1.5e33	
Integrated luminosity, L_{int}	0.05 fb-1	1 fb-1	5 fb-1	
Number of days physics	39	129	193	$= 0.2 \times L_{int} / L_{avg}$

Evolution of residual dose equivalent rates until 2013
for areas where losses (activation) are related to the beam intensity, *e.g.*, IR3/7, arcs
(assuming linear scaling of losses with beam intensity, not considering heavy ion run, scrubbing run, *etc.)*

Dose rate ratios for shutdowns	2012/now	2013/now	2013/2012
One week cooling	3.9	7.4	1.9
One month cooling	4.9	10.0	2.0
Four months cooling	6.6	15.0	2.3

Dose equivalent rates – *IR3*



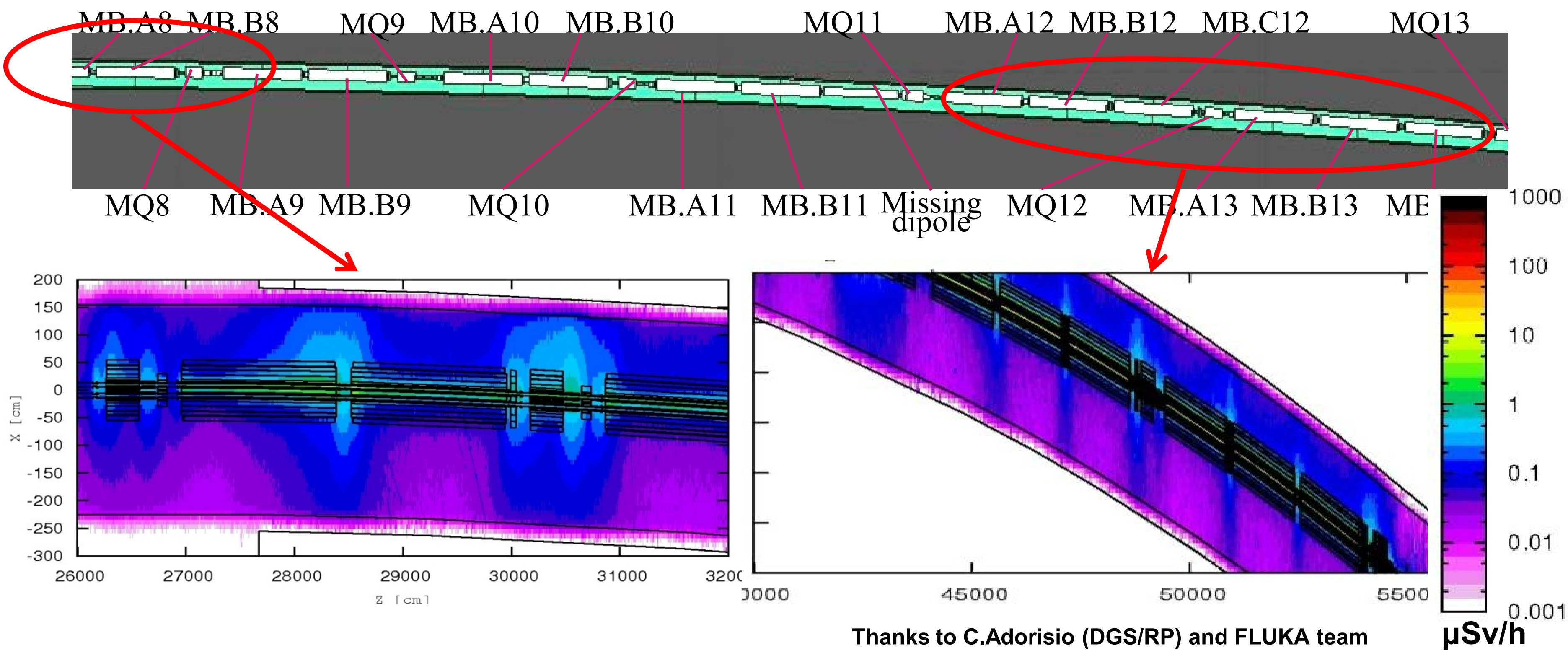
Dose equivalent rates (µSv/h) (about two months cooling)

IR3-Right	January 2011 (measurement)		January 2012 (Jan.2011 x fac.6.6)		January 2013 (Jan.2011 x fac.15)	
Element	**Contact**	**Aisle**	**Contact**	**Aisle**	**Contact**	**Aisle**
TCP	13.0	0.3	86.0	2.0	195.0	4.5
TCAPA	24.0	0.7	158.0	5.0	360.0	11.0
D3	7.0		46.0		105.0	
TCSG.5	7.5	0.2	50.0	1.3	113.0	3.0
MQWA.C	9.0		60.0		135.0	

	Area classification	Dose limit	Ambient dose equivalent rate: At permant workplaces	Ambient dose equivalent rate: In low-occupancy areas
	Non-designated Area	1 mSv / y	< 0.5 µSv h^{-1}	< 2.5 µSv h^{-1}
	Supervised Radiation Area	6 mSv / y	< 3 µSv h^{-1}	< 15 µSv h^{-1}
Controlled Radiation Area	Simple Controlled Radiation Area	20 mSv / y	< 10 µSv h^{-1}	< 50 µSv h^{-1}
	Limited Stay Area			< 2 mSv h^{-1}
	High Radiation Area			<100 mSv h^{-1}
	Prohibited Area			> 100 mSv h^{-1}

- Scaling assumes the IR7/3 loss ratio of the 2010 run
- Contribution from beam-gas interactions not included

Future situation – *DS and Arcs* *(here: IR7-right / Sector 78)*



Thanks to C.Adorisio (DGS/RP) and FLUKA team

- above plots are for ***January 2013*** (~one month cooling) and ***beam gas interactions*** (beam 1) only ($1x10^{15}$ H_2eq/m^3)
- dose rates close to background in the aisle, few µSv/h on contact to beam pipe
- known from other calculations that dose rates from losses due to leakage on collimators lead to localized spots with dose rates on contact of the order of 10 µSv/h
- thus, risks due to external irradiation should be in general very low

Interconnects - *induced radioactivity*

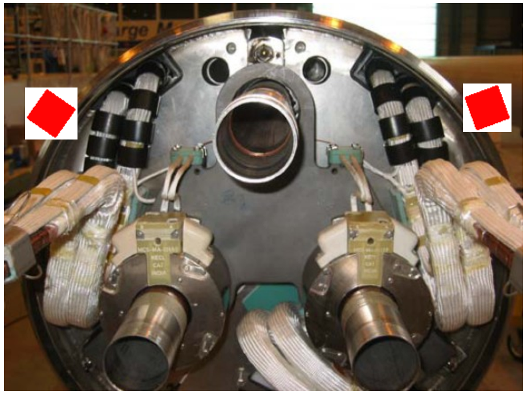
FLUKA studies show (details see presentation Session 5):

- very low activation of majority of bus-bars (those, where beam-gas interactions dominate activation)
- good margin for areas where point losses dominate
- consequently low risk of contamination and internal exposure
- nevertheless, precautions necessary (ALARA): use methods which do not produce small particles/dust, contain any small particles/dust (vacuum cleaner, plastic foils), *etc.*

Numerous sources of ***uncertainties***:

- actual beam-gas pressure
- activation by scrubbing runs
- loss assumptions (IR3 vs. IR7, losses in heavy ion runs)
- differences between actual and simulated geometry (collimator settings, imperfections, *etc*.)
- FLUKA models (e.g., for prediction of activation) and simulations (statistical uncertainties)
- ...

Verification by measurements essential !



Summary and conclusions

- Based on the operational scenarios for runs in 2011/12, beam intensity-dependent activation and residual dose rates will increase by about a factor of 4-7 during the 2011 run and by another factor of 2 during 2012 (assuming that losses scale approx. linearly with intensity, scrubbing *etc.* not considered). Thus, *RP constraints and recommendations for shutdowns in 2012 and 2013 are quite similar.*

- Residual dose rates in the arcs after the 2012 run are estimated to be very low (no limitation in duration of work). A few localised areas in the DS regions (loss points of protons or HI "leaking" from straight section) might show measurable residual dose rates (<10 μSv/h).

- Despite low residual dose rates in these areas, components might become "radioactive" and dissipation or incorporation of this radioactivity must be prevented (ALARA principle). Thus, use methods which avoid creation of small particles or dust, *e.g.*, (if possible) avoid grinding and similar methods, contain any radioactivity, *e.g.*, by using special vacuum cleaners, by protecting work site with plastic foils, *etc*.

- Due to significant uncertainties it is important to continuously monitor the evolution of activation (*e.g.*, survey measurements, material samples).