POSSIBLE COMMISSIONING CONSTRAINTS FROM BACKGROUND IN LHC EXPERIMENTS

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CERN July 26 2006

CLASSIFICATION OF THE BACKGROUND SOURCES

BEAM-GAS LOSSES IN THE LSS's

- Beam intensity and energy (7 TeV assumed everywhere)
- Gas pressure ($n_{<H2>}$ [mol/m^3] varies between start-up and conditioned machine: 1.8x10^{12} (43, start-up), 5.7x10^{12} (156, start-up), 5.3x10^{12} (nominal))
- Mechanical layout of the IR (including the shielding in IR2/8)
- Machine optics (weak dependence…)

BEAM-GAS LOSSES IN THE COLD SECTORS

- Gas pressure (single value: ~10^{15} H_2 mol/m^3, for 100h "beam-gas" beam lifetime)
- Machine optics (β^* in the IP, strong dependence!)
- Configuration of the limiting apertures in the IR

TERTIARY HALO LOSSES IN THE IR

- Configuration of the limiting apertures in the IR
- Collimation inefficiency
- Rate of the primary losses in the CS

  → …depends on the beam-gas loss rate, luminosity in the IP's, imperfections…

EXAMPLE: BACKGROUND AT IP8

BEAM-GAS VS. TERTIARY BACKGROUND

Radial distribution of particle flux density for NOMINAL machine

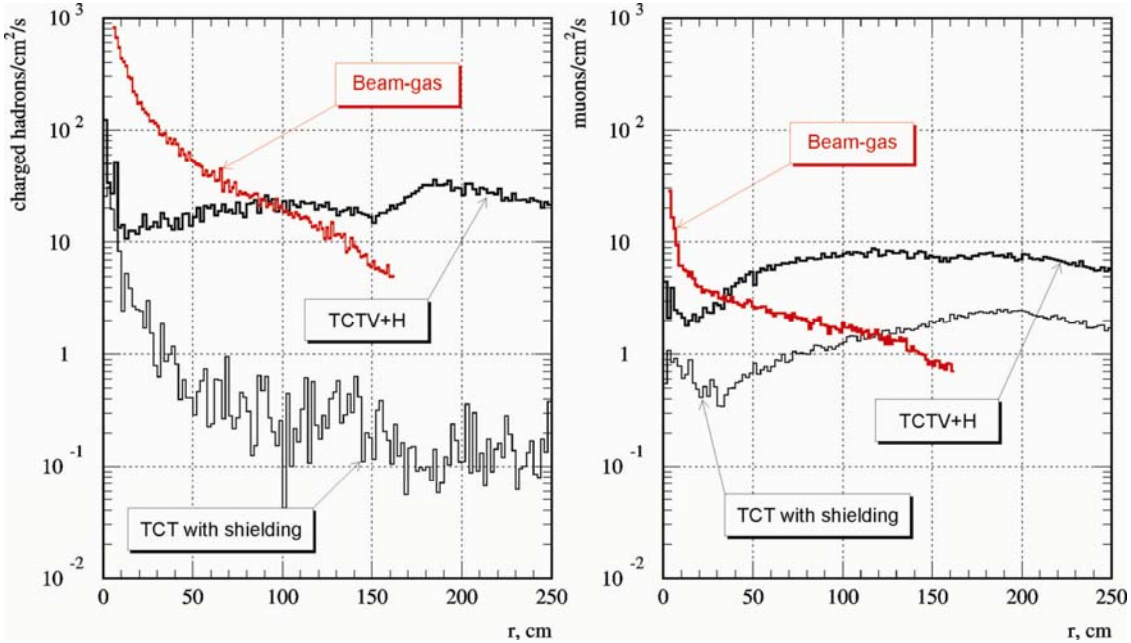
→ …at 1m from IP8 without and with shielding in IR8 (IR7 side)

BEAM-GAS

- Gas pressure estimates as in LPN 307
- Only losses in LSS8
- No shielding

TERTIARY BACKGROUND

- Primary loss rate in IR7 for 30h beam lifetime
- TCTV/H at 8.3σ
- Shielding in IR8



CONCLUSION

Sources are equal at ~1m from beam line, tertiary background dominates at large R

BACKGROUND IMPACT ON THE EXPERIMENTS

BEAM-GAS LOSSES IN THE LSS's

IR8

Gas pressure estimates 2001 for NOMINAL running conditions

→ 6% of Level 0 muon trigger bandwidth (fixed at 200 kHz)

IR5

Estimates of year 1996 for NOMINAL running

→ 1% of p-p related; **only occupancy, no trigger rate**

NOMINAL

Here: 7 TeV, 530 mA, β^* 10m at IP8 and 0.5m at IP5

BACKGROUND IMPACT ON THE EXPERIMENTS (2)

BEAM-GAS LOSSES IN THE COLD SECTORS

IR1

- Most recent gas pressure estimates from 2004
- 43 bunches, 7 TeV and 0.5m@IP1
- TCTV/H in IR1 at 13.5σ

→ 90% of losses in the cold sectors cleaned; 55% and 374% **addition** to hadron/muon background from the losses in the LSS

TOTAL BEAM-GAS BACKGROUND

Only muon flux, cold sectors plus beam-gas in LSS

→ 18% of Level 0 bandwidth (IR8) and 5% of p-p related background (IR1/5)

NOTE

With **no** shielding in IR8 and **full** shielding in IR1/5 assumed

BACKGROUND IMPACT ON THE EXPERIMENTS (3)

TERTIARY BACKGROUND

IR8

- Estimated for nominal machine, full collimation system and **30h** beam lifetime
- Dominates at large R from the beam
- Same level as beam-gas from the losses in LSS8

  → Total muon background at IP8 ~24% of p-p related
- Full shielding suppresses 2/3 of the total background

  → At commissioning shielding will be staged…

FINAL NOTE

- **No** safety factor is included
- All these estimates are **theoretical**

IP1/5 AT STAGE I PHYSICS RUN

STAGE I: 43 BUNCHES

- NOMINAL: 3.2×10^{14} p/beam, 1.15×10^{11} p/bunch; 5.3×10^{12} H_2 mol/m^3

  → 1.7×10^{12} p/beam (43 on 43, 4×10^{10} p/bunch); 1.8×10^{12} H_2 mol/m^3 (start-up)
  4.2×10^{11} H_2 mol/m^3 (conditioned)

  IN TOTAL = ~(1710, 7410) ↘

- Luminosity [$cm^{-2}s^{-1}$]: with β^* = 18m: 10^{34} → 6.8×10^{29} = ~14700 ↘

  with β^* = 2m: 10^{34} → 6.1×10^{30} = ~1640 ↘

…AND 156 BUNCHES

- 9×10^{10} p/bunch, 5.7×10^{12} - 6.3×10^{11} H_2 mol/m^3

  IN TOTAL = ~(27, 250) ↘

- Luminosity [$cm^{-2}s^{-1}$]: with β^* = 2m: 10^{34} → 1.1×10^{32} = ~91 ↘

  with β^* = 18m: 10^{34} → 1.2×10^{31} = ~820 ↘

IP8 AT STAGE I PHYSICS RUN

BEAM-GAS BACKGROUND IN IR8

Contrary to IP1/5, LHCb at Stage I appears in a advantageous situation

→ …if significant number of bunch-crossings will be provided in IP8

SCALING TO THE STAGE I CONDITIONS

- o 3.2×10^{14} p/beam, 1.15×10^{11} p/bunch, 5.3×10^{12} H_2 mol/m^3

  → 156 on 156, 9×10^{10} p/bunch, 5.7×10^{12} - 6.3×10^{11} H_2 mol/m^3

  IN TOTAL = ~(27, 250) ↘

- o *WHILE* with β^* = 2m Luminosity [$cm^{-2}s^{-1}$]: 2×10^{32} → 1.1×10^{32} = ~1.8 ↘

COMPARING TO p-p RELATED

18% of Level 0 muon trigger bandwidth at NOMINAL running conditions

→ (~1%, < 1%) at Stage I Physics Run conditions

NOTE

ONLY beam-gas background in IR8 → **no tertiary** background included…

CONCLUSION

"NOMINAL" BEAM-GAS BACKGROUND

IR1/5: ~5% of p-p related with FULL shielding

IR8: ~18% of Level 0 rate with NO shielding (6% with FULL – T.B.C.)

SCALING TO STAGE I CONDITIONS

IR1/5: background increase varies from factor ~3 to the full dominance of the machine background over p-p related

IR8: advantageous machine/p-p related background ratio

→ …only if there will be significant number of collisions in IP8

NO TERTIARY background included

→ But it is known how to scale it with the rate of the losses…

CONCLUSION (2)

FINAL REMARKS

Squeeze as soon as possible AND as low as possible

Estimate the collimation inefficiency AND loss rate at commissioning

Monitor the gas pressure in the LSS's and cold sectors

THESE ESTIMATES ARE THEORETICAL

With NO safety factor included – and the background is already at THE LIMIT

→ …need to start really measuring it with the first beam in the machine…