MACHINE INDUCED BACKGROUNDS IN IR2 AND IR8

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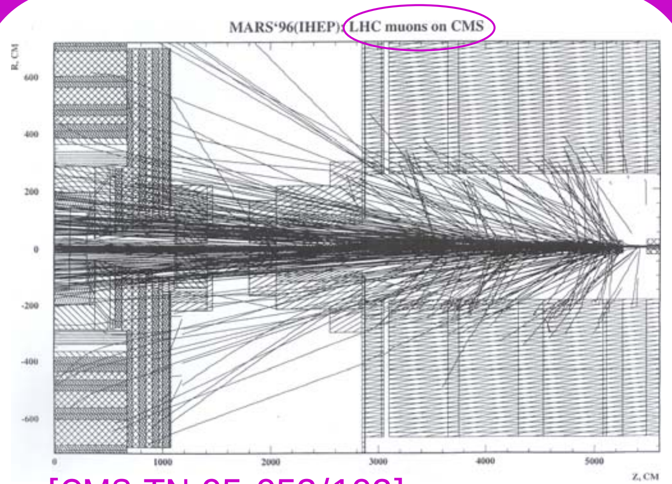
INTRODUCTION

MACHINE INDUCED BACKGROUND AT THE LHC

- Secondary flux in the IRs induced by the beam losses in the machine
- Several origins (=*sources of the background*):

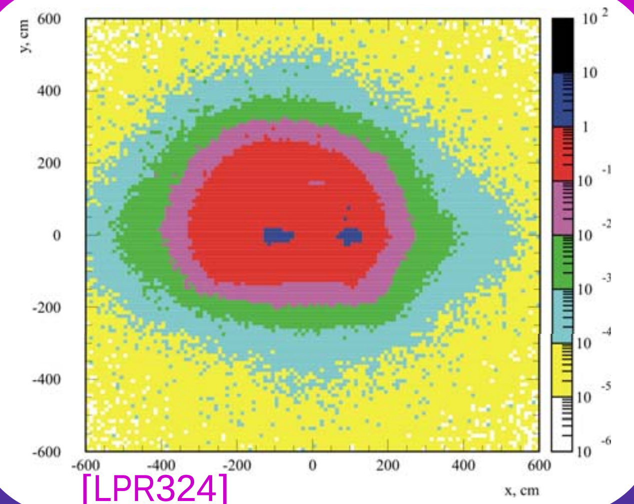
  collimation inefficiency, beam-gas losses, collisions in the IPs
- These sources produce particles "scattered out" from the beam

  If followed by the interaction in the IR → Background flux towards the IP
- Absolute value scales with BEAM INTENSITY (among other operating conditions)



[CMS TN 95-053/102]

1996:
Workshop on the LHC backgrounds
Example: losses at inner triplet → cascades → background flux



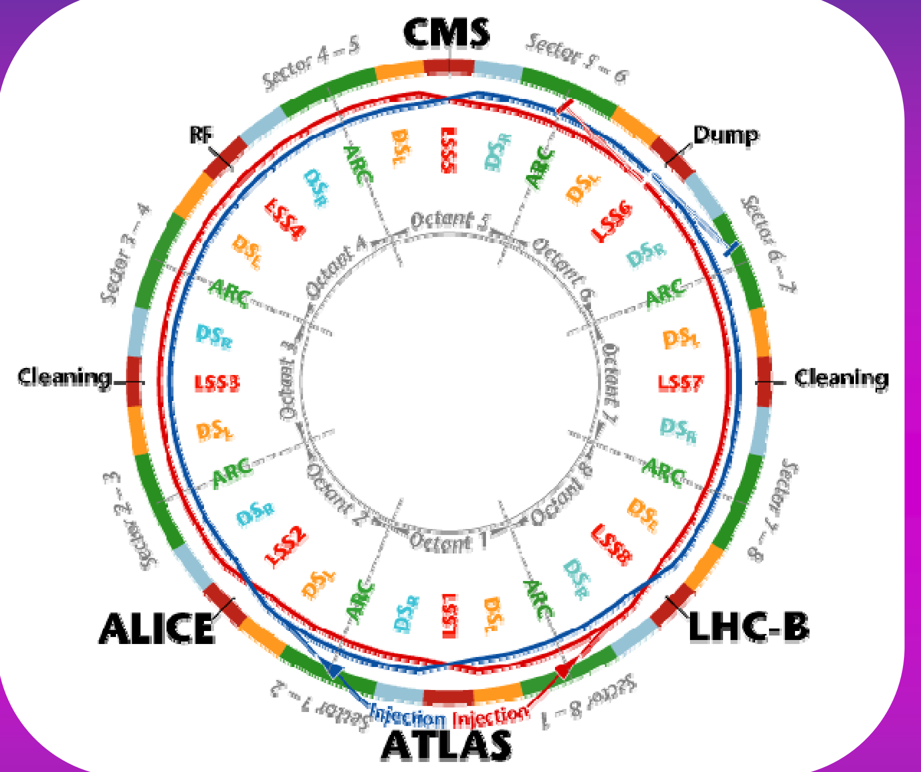
[LPR324]

WHY IR2 & IR8 ?

SPECIFIC FEATURES OF THE IR2/8

Considering the background is important:

- Experiments will operate at low luminosity
  - → same beam *(=background)* as P1/5
  - → no TAS at Q1 – no shielding
- P2/8 are next to IR3/7 at Beam 2/1
  - → the closest limitations to the cleaning
- P2/8 have P1 in between
  - → no cleaning for the losses from the IP1 *(high luminosity IP!)*



LHCb: *"...contribution to the L0 trigger... varies from several percents to the whole filled output bandwidth... with strong dependence on the running conditions..."*

PRELIMINARY STUDIES

2000: "perfect" machine

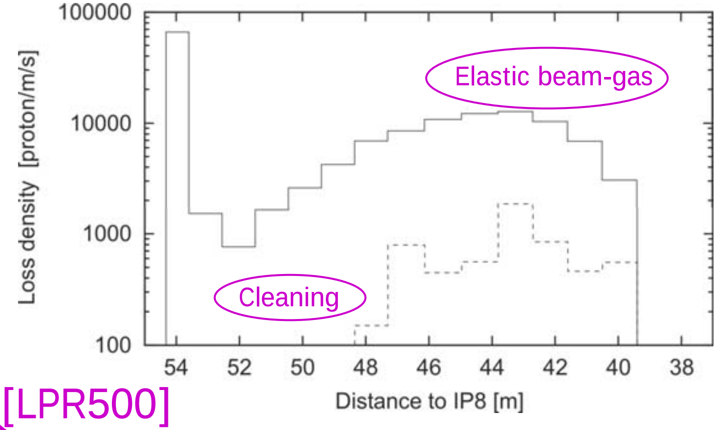
2004: "realistic" operating conditions

BACKGROUND SOURCES

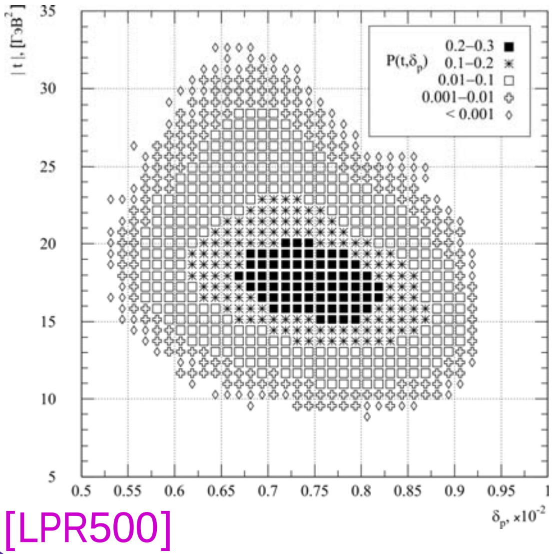
SOURCES CONSIDERED [LPN258]

The "DISTANT" sources

- Collimation "inefficiency"
  - → Out-scattered halo not intercepted by the collimators of the CS insertion
- Elastic scattering in the cold sectors between IR and CS insertion



[LPR500]



[LPR500]

→ *ONLY* "elastic" products will be transported downstream by the optics!

- Interactions with residual gas in the IR
  - → both elastic and inelastic
- Collisions in the neighbouring IP

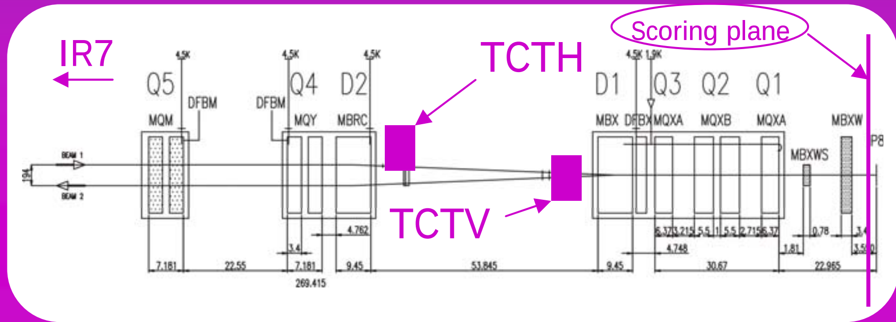
P1→IR8 probability distribution

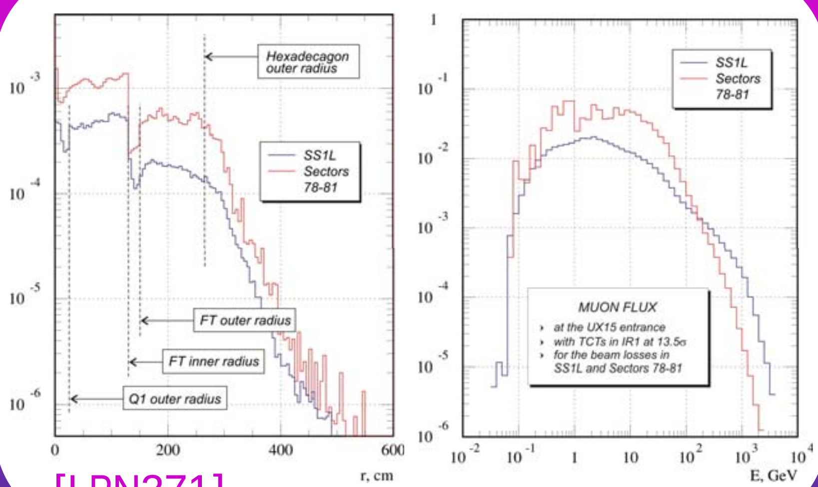
NO QUENCH - NO BACKGROUND ?

TERTIARY BACKGROUND

The source is the halo out scattered from the IR7 and cleaned in the IR8 by the TCTs

- Two tertiary collimators in each part of LSS8
- Vertical TCT at D1, horizontal at D2
  - → D2-D1 is the longest drift in SS
- Heavy (tungsten) collimators





[LPN371]

FORMULATION OF THE PROBLEM

- TCTs are here to protect D1-Q1 from quench
  - → an aperture limitation in the IR
- The “cleaned” protons will be converted to a “tertiary” background towards the IP

LPN371: *for elastic beam-gas losses TCTs in IR1 are the dominant background source*

TERTIARY BACKGROUND (1)

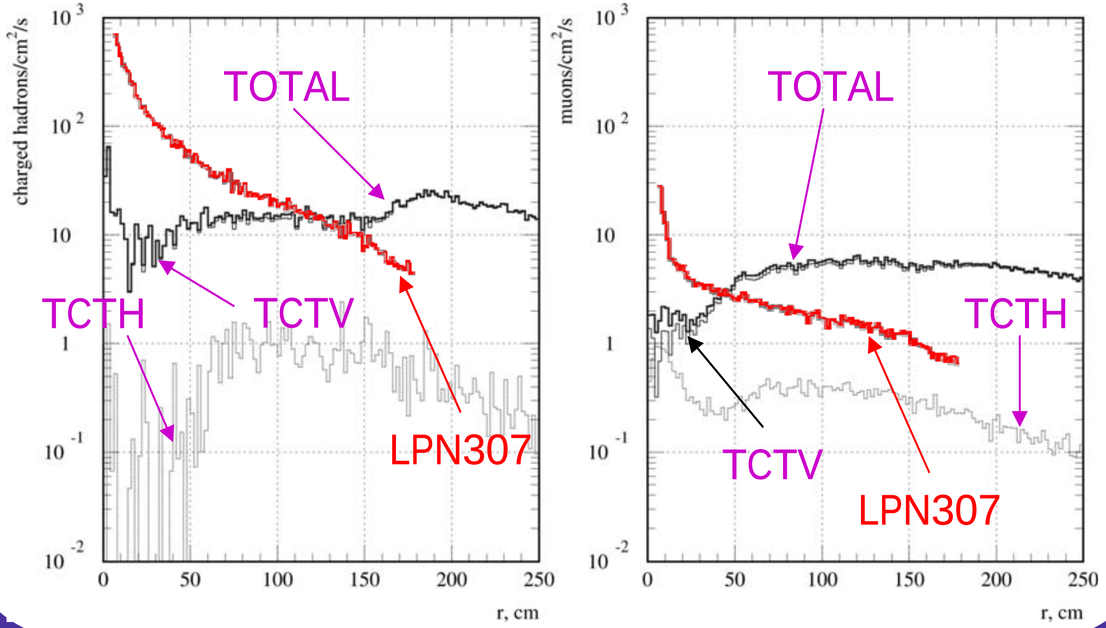
SECONDARY PARTICLE FLUX AT THE IP8

Source: loss maps generated within Collimation Project

- Vertical halo in TCTV and horizontal in TCTH
- Re-normalised for the *30 hours* beam lifetime

→ LPN273: *"1,03x10^6 muons/s … under the "3rd year +90days" LHC running conditions…"*

TOTAL PARTICLE FLUX		
	Charged hadrons	Muons
VH@TCTV	3,66x10^6	1,05x10^6
HH@TCTH	1,26x10^5	5,15x10^4



RADIAL DISTRIBUTION

- Particle flux density *f(r)* [particles/cm2/s]
- For charged hadrons/muons
- Compared with LPN307

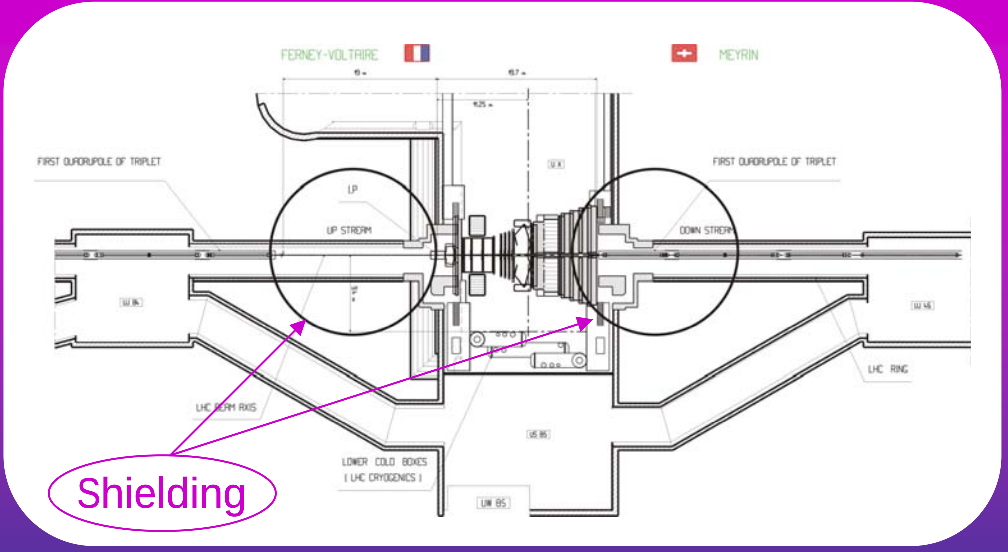
→ *beam-gas estimates for NO SHIELDING case*

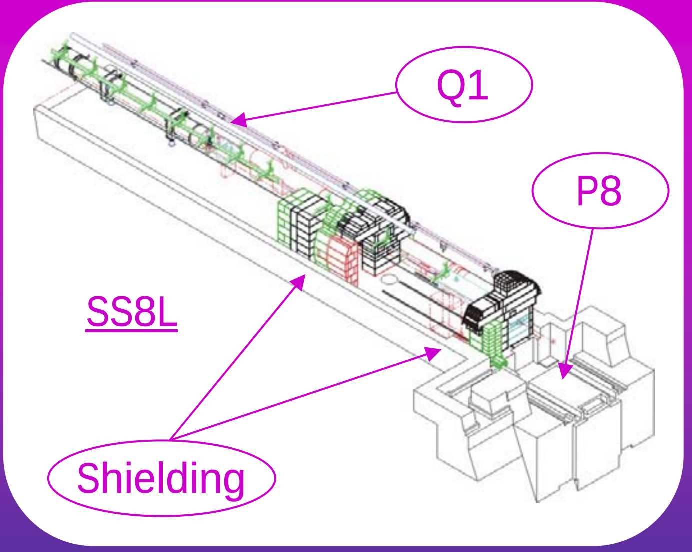
BACKGROUND SHIELDING

SHIELDING PLUGS IN THE IR2/8

Detector protection from the background as inner/forward shielding at the P1/5

- Proposed in 2002 [LPN307]
- The closer to IP/beam line – the better → Several installation constraints!
- Specific design for left/right parts of SS
- The possibility of a “staging” approach





TERTIARY BACKGROUND (2)

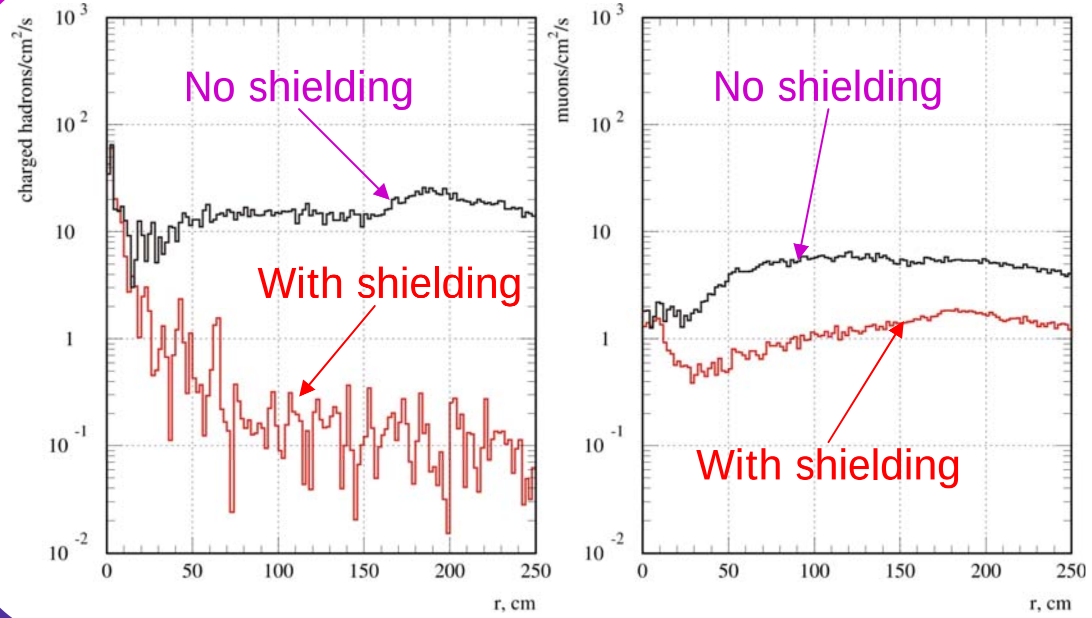
BACKGROUND IN THE PRESENCE OF THE SHIELDING

Combined model of simulations

- Same maps of the losses in the TCTs
- Shielding introduced in the left part of the LSS8
- Results compared to the previous TOTAL numbers

BACKGROUND SHIELDING

	Charged hadrons	Muons
VH@TCTV	$3,66 \times 10^6$	$1,05 \times 10^6$
	4.51×10^4	2.71×10^5
HH@TCTH	$1,26 \times 10^5$	$5,15 \times 10^4$
	3.21×10^3	2.72×10^4



EFFECT OF THE SHIELDING

- Charged hadrons flux removed at large radii
- Reduction factors

  charged hadrons: ~ 100

  muons: 2÷4

  (depending on halo type)
- *...minor effect around vacuum chamber...*

LHC MIB WORKING GROUP

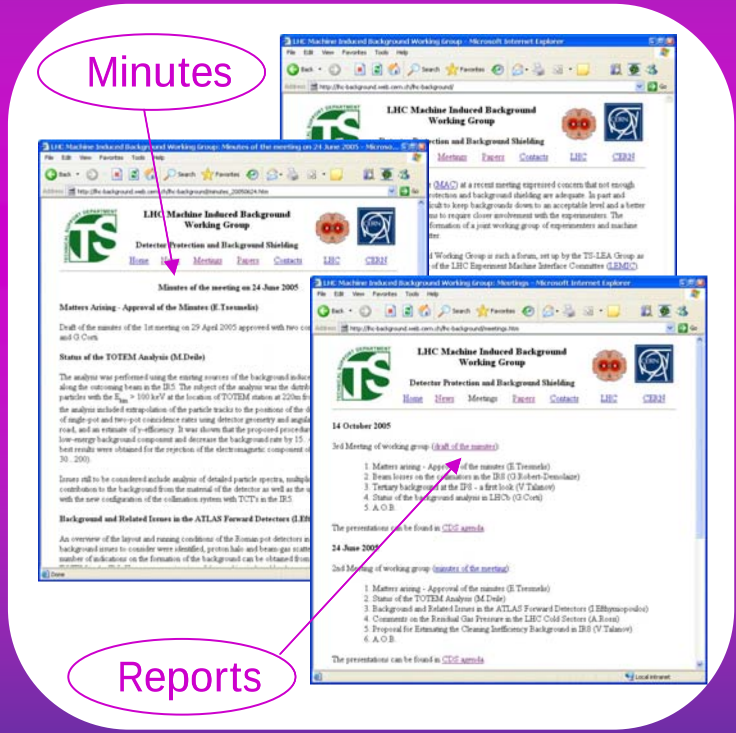
MACHINE INDUCED BACKGROUND WG

Forum on Detector Protection and Background Shielding

- Established in 2005 by TS/LEA
- Complex study of MIB problem
  - → Analysis of the background formation

    Prediction of the dynamics
    at different stages of machine operation

    Reduction and rejection from the signal



COLLABORATION WITH OTHER GROUPS

The study of the machine background is cooperative

- Collimation project
- Vacuum group
- Experimental collaborations

More information on WG pages at: cern.ch/lhc-background