Backgrounds and Radiation Loads in VLHC Detectors

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Snowmass

Part 1. From IP
Part 2. From beam loss
100 TeV pp

1) Event properties
2) Fluxes in central tracker

as calculated with

DPMJET/MARS
50x50 TeV pp

\[ \text{dN/dPt (1/GeV/c)} \]

\[ \text{Pt (GeV/c)} \]

- Charged hadrons
- All hadrons
50x50 TeV pp

![Graph showing the distribution of charged hadrons and all hadrons. The x-axis represents Et (GeV), ranging from 0 to 5, and the y-axis represents dN/dEt (1/GeV), ranging from 10^{-3} to 10^2. The graph compares the distributions of charged hadrons (dashed line) and all hadrons (solid line).]
<table>
<thead>
<tr>
<th>Particle</th>
<th>$\langle E \rangle$, GeV</th>
<th>$\langle n \rangle$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p$</td>
<td>$0.23597 \times 10^5$</td>
<td>$0.46222 \times 10^{-1}$</td>
</tr>
<tr>
<td>$\bar{p}$</td>
<td>$0.16563 \times 10^4$</td>
<td>$0.33840 \times 10^{-1}$</td>
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<tr>
<td>$e^+$</td>
<td>$0.12733 \times 10^2$</td>
<td>$0.50200 \times 10^{-1}$</td>
</tr>
<tr>
<td>$e^-$</td>
<td>$0.82923 \times 10^1$</td>
<td>$0.55200 \times 10^{-1}$</td>
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<tr>
<td>$\nu_e$</td>
<td>$0.44893 \times 10^1$</td>
<td>$0.20800 \times 10^{-1}$</td>
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<tr>
<td>$\bar{\nu}_e$</td>
<td>$0.62834 \times 10^1$</td>
<td>$0.15800 \times 10^{-1}$</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>$0.20317 \times 10^4$</td>
<td>$0.77172 \times 10^1$</td>
</tr>
<tr>
<td>$n$</td>
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<td>$0.40044 \times 10^1$</td>
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<tr>
<td>$\bar{n}$</td>
<td>$0.16135 \times 10^4$</td>
<td>$0.33946 \times 10^1$</td>
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<tr>
<td>$\mu^+$</td>
<td>$0.46361 \times 10^1$</td>
<td>$0.16400 \times 10^{-1}$</td>
</tr>
<tr>
<td>$\mu^-$</td>
<td>$0.93866 \times 10^1$</td>
<td>$0.19400 \times 10^{-1}$</td>
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<tr>
<td>$K_L^0$</td>
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<td>$0.49982 \times 10^1$</td>
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<tr>
<td>$\pi^+$</td>
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<td>$0.45827 \times 10^2$</td>
</tr>
<tr>
<td>$\pi^-$</td>
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<td>$0.45155 \times 10^2$</td>
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<tr>
<td>$K^+$</td>
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<td>$0.52018 \times 10^1$</td>
</tr>
<tr>
<td>$K^-$</td>
<td>$0.19290 \times 10^4$</td>
<td>$0.51542 \times 10^1$</td>
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<tr>
<td>$\Lambda$</td>
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<td>$0.11880 \times 10^1$</td>
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<td>$\bar{\Lambda}$</td>
<td>$0.55848 \times 10^3$</td>
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<td>$K_S^0$</td>
<td>$0.20078 \times 10^4$</td>
<td>$0.49888 \times 10^1$</td>
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<td>$\Sigma^-$</td>
<td>$0.22324 \times 10^3$</td>
<td>$0.23380 \times 10^0$</td>
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<tr>
<td>$\Sigma^+$</td>
<td>$0.56489 \times 10^3$</td>
<td>$0.26360 \times 10^0$</td>
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<td>$\pi^0$</td>
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<td>$K^0$</td>
<td>$0.73638 \times 10^0$</td>
<td>$0.20000 \times 10^{-3}$</td>
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</table>
50x50 TeV VLHC (r=7 cm, z=lt.200), dN/dE (cm$^{-2}$ GeV$^{-1}$ per year)
$50 \times 50 \text{ TeV VLHC (} r=200 \text{ cm), } dN/dE \text{ (cm}^{-2} \text{ GeV}^{-1} \text{ per year)}$
$50 \times 50$ TeV VLHC neutrons, $E \cdot dN/dE$ (cm$^{-2}$ per yr) vs log10($E$/GeV)
I. Interaction Point

Stage 1: 40 TeV, $L = 1.10^{34} \text{ cm}^{-2}\text{s}^{-1}$
Stage 2: 175 TeV, $L = 2.10^{34} \text{ cm}^{-2}\text{s}^{-1}$

Central Tracker:

$\Phi_z \sim \frac{1}{r^2}$

$\Phi_n$

("gas", material dependent)

Stage 1  Stage 2

$3 \times 10^7$  $(4 \times 10^8)$

$\text{cm}^{-2}\text{s}^{-1}$ at $r=10\text{ cm}$

$D = 10 \ (30) \ \text{Mrad} \ \text{yr}$

Endcap calorimeter:

2 to 3 orders of magnitude higher at small radii

Forward $\mu$-system:

Hit rate (HR)

$2 \ 12 \ \text{kHz/cm}^2$

$15 \ 100 \ \text{Hz/cm}^2$

$\text{at } r=1\text{m}$

$\text{at } r>5\text{m}$

All $\uparrow$ with appropriate shielding!
CMS Hall

Dose (Gy/accident) - no

IP6 Unsynchronized Abort (shadows in)
CMS Hall

Dose (Gy/accident) - μ only

IPG Unsynchronized Abort (shadows in)
II. Beam Loss in IR

BL = 500 m⁻¹s⁻¹ warm/cold straights
2·10⁻⁴ m⁻¹s⁻¹ cold arcs

MARS: ± 150 - 180 m @ 500 m⁻¹s⁻¹

**Appropriate shielding**

1) in detector (endcap and forward)
2) around front collimator
3) plug at hall/tunnel
4) around D1 - D2 pipe

\[
\frac{\text{machine}}{\text{IP}} \sim \text{a few } \% \quad (\mu s)
\]