SHIELD OPTIMIZATION
for 2018 Drell-Yan RUN

• Goals:
  • Decrease the radiation dose in the environment around Bat. 888
  • Based on radiation shield used during run 2015
  • Design a absorber that allow to run at maximum intensity, ie. $10^9 \pi^{-}$/spill – SPS cycle 33.6s
  • The real dose must be scaled from this intensity
Old starting point: FLUKA and Chris Theis input file (Sept. 2010)

- Dose with C. Theis input files.
  - Beam: $\pi^-$
    - $p = 191 \text{ GeV}/c$; $\Delta p = 4.22 \text{ GeV}/c$ FWHM; gaussian
    - $x = y = 0 \text{ cm}$;
    - $\sigma_x = \sigma_y = 1\text{ cm}$; $\Delta x = \Delta y = 0$; pencil like beam
  - Absorber:
    - Large external concrete

- Conversion from pSv/prim to uSv/h
  - Spill in one hour:
    - SPS cy 33.6s: 107
    - SPS cy 45.6s: 79
  - Beam rate
    - $6\times10^8$
    - $1\times10^9$
    - $6e8@33.6s: c = 6.42\times10^4$
    - $1e9@33.6s: c = 1.07\times10^5$
    - $1e9@45.6s: c = 7.90\times10^4$

10$^9$ pion/spill @ 33.6s
old cryostat and target screen: C. Theis configuration

Same results Of C. Theis
Study of outgoing particles from concrete shield

Pseudo-detector 400x300x1 cm$^3$

Particles x primary, to be scaled by $10^9$ spill$^{-1}$
# Summary of the simulations

<table>
<thead>
<tr>
<th>configuration</th>
<th>note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final-04</td>
<td>configuration of 2015 run</td>
</tr>
<tr>
<td>Final-05</td>
<td>Final-04 + 80cm of concrete blocks on the Saleve side only</td>
</tr>
<tr>
<td>Final-06</td>
<td>Final-06 + 80cm of concrete blocks on top</td>
</tr>
<tr>
<td>Final-07</td>
<td>Final-06 but with 20cm of borated polyethylene (5%) instead of concrete</td>
</tr>
<tr>
<td>Final-08</td>
<td>Final-06 + 10cm of polyethylene on the concrete side blocks</td>
</tr>
</tbody>
</table>
Configuration Final-04

DAQ Mean: 4.08 uSv/h
DAQ Mean: 3.57 uSv/h
Configuration Final-06

DAQ Mean: 3.44 uSv/h

Dose-equivalent (uSv/h) for 10^8 pion/spill - 33.6 s (n=107x10^3) (Final05)

- Mean = N1 = 3.44 uSv/h
- Slope = M1 = -1.07e-03 uSv/h

Dose [uSv/h]

Z (cm) (y = 920 to 1317.5) (x = -16 to +16)

Dose [uSv/h]

Z (cm) (y = 920 to 1317.5) (z = -416 to 401.6)
DAQ Mean: 3.64 uSv/h

Dose-eq (uSv/h) ($10^8$ pion/spill - 33.6s) (n=107x10³) (Final05)

- $f(x) = M_1 \cdot x + N_1$
- Mean = $N_1 = 3.64$ uSv/h
- Slope = $M_1 = -5.85\times10^{-4}$ uSv/h

Dose-eq (uSv/h) ($10^8$ pion/spill - 33.6s) (n=107x10³) (Final05)

- $f(x) = M_1 \cdot x + N_1$
- Mean = $N_1 = 3.64$ uSv/h
- Slope = $M_1 = -5.85\times10^{-4}$ uSv/h
Configuration Final-08

DAQ Mean: 3.32 uSv/h
**Conclusions**

<table>
<thead>
<tr>
<th>configuration</th>
<th>Mean dose in control room (μSv/h)</th>
<th>Dose Reduction</th>
<th>note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final-04</td>
<td>4.08</td>
<td>0%</td>
<td>configuration of 2015 run</td>
</tr>
<tr>
<td>Final-05</td>
<td>3.57</td>
<td>-12.5%</td>
<td>Final-04 + 80cm of concrete blocks on the Saleve side only</td>
</tr>
<tr>
<td>Final-06</td>
<td>3.44</td>
<td>-15.7%</td>
<td>Final-06 + 80cm of concrete blocks on top</td>
</tr>
<tr>
<td>Final-07</td>
<td>3.64</td>
<td>-10.8%</td>
<td>Final-06 but with 20cm of borated polyethylene (5%) instead of concrete</td>
</tr>
<tr>
<td>Final-08</td>
<td>3.32</td>
<td>-18.6%</td>
<td>Final-06 + 10cm of polyethylene on the concrete side blocks</td>
</tr>
</tbody>
</table>

- 50% of particles outside concrete shield are low energetic neutrons
- The dose can be considerably reduced in the DAQ floor (beam level) adding 80 cm of concrete on Saleve side
- The concrete top help to lower the dose under the ceiling, small effects on DAQ floor
- 20-25 cm of borated polyethylene are more or less equivalent to 80cm of concrete
- Absorbtion by the building walls is unknown
- Other radical solutions are possible, but with costs and work enourmous
Configuration CT30

Sandwich of stainless steel & borated polyethylene (boron 5%)

- Absorber geometry (CT30)
- Concrete
- n. 3 SCIFI stations
- Hole for cryo detectors
Mean: 2.16 uSv/h

Configuration CT30