First performance study on luminosity monitor and active mask by JIM simulation

T.Tauchi, JLC weekly meeting, 12/10, 1999

For this study;

(1) Luminosity monitor
geometrical acceptance:
\[ 163 < z < 178 \text{ cm} \quad \text{and} \quad 0.05 < \theta < 0.15 \text{ rad.} \]
made of tungsten with no sensitive detector
segmentation:
\[
\begin{array}{ccc}
r & 32 \text{ divisions} & \Delta r \sim 5\text{ mm} \\
\phi & 16 \text{ divisions} & \Delta \phi \sim 3.2 - 9.7 \text{ cm} \\
z & 128 \text{ divisions} & \Delta z \sim 1.17\text{ mm} \\
\end{array}
\]

(2) Active mask (front part of conical mask)
geometrical acceptance:
\[ 30 < z < 37.5 \text{ cm} \quad \text{and} \quad 0.15 < \theta < 0.20 \text{ rad.} \]
made of tungsten(W) and silicon pad( Si,200\mu m^{\dagger} )
\[ 5\text{mm}^{\dagger}\text{W/Si}/(1\text{cm}^{\dagger}\text{W/Si})^{7} \quad 8 \text{ layers} \]
segmentation:
\[
\begin{array}{ccc}
r & 8-10 \text{ divisions} & \Delta r = 2\text{ mm} \\
\phi & 32 \text{ divisions} & \Delta \phi \sim 0.9 - 1.2 \text{ cm} \\
\end{array}
\]

\[ B = 2 \text{ Tesla and 3 Tesla} \]
Generated events
(1) $e^+e^-$ pairs by cain21d 
parameter A at $E_{cm}=500\,\text{GeV}$ 
100 bunch crossings 
correspond to 1 train crossing
(2) an electron/ muon into luminosity monitor 
and active mask 
50 GeV and 250 GeV electrons 
250 GeV muons

Simulation results
(1) Energy deposits in total volume

<table>
<thead>
<tr>
<th>$B=2,\text{T}$</th>
<th>$e^+e^-$ pairs</th>
<th>50 GeV $e$</th>
<th>250 GeV $e$</th>
<th>250 GeV $\mu$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$am$</td>
<td>264 MeV</td>
<td>120.4 MeV</td>
<td>541.0 MeV</td>
<td>0.48 MeV</td>
</tr>
<tr>
<td>$lm$</td>
<td>152 GeV</td>
<td>49.9 GeV</td>
<td>249.5 GeV</td>
<td>1.67 GeV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$B=3,\text{T}$</th>
<th>$e^+e^-$ pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>$am$</td>
<td>29.3 MeV</td>
</tr>
<tr>
<td>$lm$</td>
<td>46.7 GeV</td>
</tr>
</tbody>
</table>

$am=\text{active mask, } lm=\text{luminosity monitor}$

Map of energy deposit in $lm$ at $B=2\,\text{T}$

![Map of energy deposit in $lm$ at $B=2\,\text{T}$](image-url)
a 50 GeV electron with 100 bunch crossings: Luminosity monitor

PROX + LM: energy deposit (keV): Z vs R

PROY + LM: energy deposit (keV): Z vs R

ID=212, N=2248

ID=216, N=125

ID=213, N=125
a 50 GeV electron with 100 bunch crossings: Luminosity monitor

+ LM: energy deposit (keV): Z vs PHI

ID=218, N=2248

PROY + LM: energy deposit (keV): Z vs PHI

ID=219, N=125

PROX + LM: energy deposit (keV): Z vs PHI

ID=222, N=125

+ LM: energy deposit (keV): Z vs PHI
a 250 GeV electron with 100 bunch crossings: Luminosity monitor

PROX + LM: energy deposit (keV): Z vs R

ID=224, N=3553

PROY + LM: energy deposit (keV): Z vs R

ID=231, N=325

PROX + LM: energy deposit (keV): Z vs R

ID=232, N=325

+ LM: energy deposit (keV): Z vs R

ID=231, N=325
a 250 GeV electron with 100 bunch crossings: Luminosity monitor

+ LM: energy deposit (keV): Z vs PHI

ID=234, N=3553

PROY + LM: energy deposit (keV): Z vs PHI

ID=235, N=325

PROX + LM: energy deposit (keV): Z vs PHI

ID=236, N=325
a 250GeV muon into active mask

AM: energy deposit (keV) vs R

AM: energy deposit (keV) vs phi

AM: energy deposit (KeV) as a function of Z

AM: energy flow (GeV) as a function of Z
a 50 GeV electron into active mask

AM: energy deposit (keV): Layer vs phi

AM: energy deposit (keV): Layer vs phi

+ AM: energy deposit (keV): Layer vs phi
a 50 GeV electron into active mask

AM: energy deposit (KeV) as a function of Z

ID=490, N=1777

AM: energy flow (GeV) as a function of Z

ID=491, N=1777

AM: energy deposit (KeV) as a function of Z

ID=1490, N=115

AM: energy flow (GeV) as a function of Z

ID=1491, N=115
A 250 GeV electron into active mask

AM: energy deposit (keV): Layer vs phi

+ AM: energy deposit (keV): Layer vs phi
a 250 GeV electron into active mask

x 10^6

AM: energy deposit (KeV) as a function of Z

ID=490, N=1777

AM: energy flow (GeV) as a function of Z

ID=491, N=1777

AM: energy deposit (KeV) as a function of Z

ID=2490, N=212

AM: energy flow (GeV) as a function of Z

ID=2491, N=212
TOP: $B=3$ tesla and BOTTOM: $B=2$ tesla

LM: energy deposit (keV): $Z$ vs $R$

ID=202, N=190478

LM: energy deposit (keV): $Z$ vs $R$

ID=1202, N=75
TOP: $B=3$ tesla and BOTTOM: $B=2$ tesla

AM: energy deposit (keV): Layer vs phi
Conclusions

(1) Lumonisity monitor

Among the total energy deposit of 152 (46.7) GeV/train due to $e^+e^-$ pairs, only $54^*(14^*)$GeV comes from the front at $B=2(3)$T, while most comes from the inner-back.

(* sum of incoming energies)

$\phi$ segmentation (16 div.) is very important, r segmentation is desired to determine $\theta$ with $\delta\theta$~a few m radian.

So, a fine-segmented W/Silicon calorimeter seems to be ideal. Thickness of tungsten must be optimized in terms of energy-resolution.

(2) Active Mask

First layer (5mm$^t$ W) has ~ 50% energy deposit for $e^+e^-$ pairs.

$\phi$ segmentation (32 div.) is very important.

8 layers of W/Si-pad calorimeter works very well for vetoing high energy electrons.