ATF background study

SNW- Dec 1 '09

We made a measurement of background rates with a scintillation counter and an APD placed 2 feet below beamline 2, roughly in the middle of the floor. In this note we concentrate on the APD result since it is the most relevant for our Hybrid PhotoDetector.

Here is an approximate summary of the measured APD collected charge for each beam intensity- ie electrons per bunch:

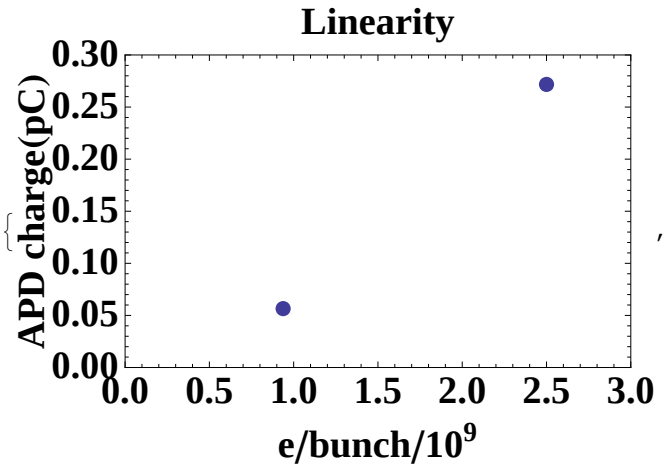
In[964]:=
```
qe = 1.6 * 10^-19;
Ibunch1 = 150 * 10^-12 / qe;
Ibunch4 = 400 * 10^-12 / qe;
Gain = 230; R = 50; nanosecond = 10^-9; mV = 10^-3; picoCoulomb = 10^-12;
t1 = 20 nanosecond;
q1 = 65 mV / R * t1 / 2;
N[q01 = q1 / Gain / picoCoulomb];
t2 = 15 nanosecond;
N[q02 = 80 mV / R * t2 / 2 / Gain / picoCoulomb];
N[q03 = 75 mV / R * t1 / 2 / Gain / picoCoulomb];
t4 = 25 nanosecond;
N[q04 = 250 mV / R * t4 / 2 / Gain / picoCoulomb];
Print[Style["                  APD charge deposition(pC) ", 18, Red]]
Style[TableForm[{{N[q01], N[q02], N[q03]}, {, N[q04],}},
  TableHeadings -> {{"10^9 e/pulse", "2.5*10^9 e/pulse"},
    {"no shield", "10 cm Pb-front", "10 cm front & side"}}, TableSpacing → {3, 3}], 14]
```

Out[977]=

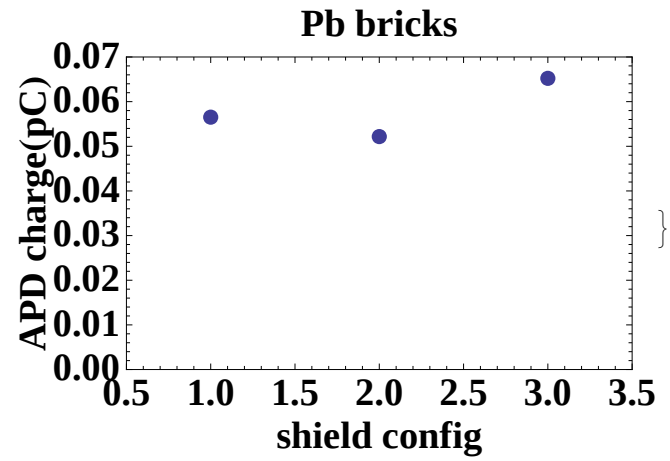
APD charge deposition(pC)

	no shield	10 cm Pb-front	10 cm front & side
10^9 e/pulse	0.0565217	0.0521739	0.0652174
$2.5*10^9$ e/pulse	Null	0.271739	Null

Out[978]=


Linearity
APD charge(pC)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
e/bunch/10^9

,


Pb bricks
APD charge(pC)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.5
1.0
1.5
2.0
2.5
3.0
3.5
shield config

}

The charge deposition seems not to be linear with beam intensity, which is surprising. We''ll assume it is for the moment which might be a worst case. Also the shielding in Grigor's test wasn't enough to reduce the charge deposit. Configurations 2->3 should be better than 1 since he added 10 cm of Pb shielding in each case.

Let's consider the unshielded configuration with 10^9 e/pulse. It is 0.057 pC in a volume of $64\,\text{mm}^2$ by 60μm depletion depth.

The HPD target is ~1mm radius *8μm.

It would be surprising if the charge deposit from backgrounds were not proportional to active volume, particularly since it is so hard to shield.

In this case we can calculate the signal in the HPD due to backgrounds at 10^9. It is (volumes are in mm^3):

```
In[979]:= VAPD = 64 * 0.06;
          VHPD = Pi * 1^2 * 0.008;
          ratio = .025 / 3.84
          N[qHPD = q01 * ratio]
          ScientificForm[Neh = qHPD / qe * picoCoulomb]

Out[981]= 0.00651042

Out[982]= 0.00036798

Out[983]//ScientificForm=
          2.29988 × 10^3
```

This is only slightly more than the charge deposit of 1 single photoelectron (since they are accelerated to 8 kV). It's not clear whether we could work with this level of background. But if it is 10 times less at 10^8electrons per bunch then we shouldn't have any trouble even without any shielding.