Experimental result of HPRF September 2008 run and future plan

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Test in Sep 2008 run

• How does plateau voltage depend on material?
  ‣ Depend on melting point?
  ‣ Cu(1085 °C), Al(660 °C), Sn(232 °C)

• Does dopant gas eat electron swarm?
  ‣ Apply SF6

• Optical measurement
  ‣ Measure how does electron grow up arc
Cu run

9/18/08 N2 run

9/17/08 N2 run

Retake in pure H2 after SF6 runs

Pu signal [no correction] [V]

Pressure [psi]

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H2 +

N2 ×

SF6 (dp/p=0.01%) *

SF6 (dp/p=0.2%) ○
Breakdown voltage in various electrodes

Pure H2

Calibration is under investigating

PU signal [V]

Pressure [psi]

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RF power duration time dependence

Flat top time (Sep 2008 run)

Aluminum electrode in pure H₂

1250 psi (on plateau)
850 psi (knee)
500 psi (Paschen)

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First optical measurement

Optical feedthrough

Operated pressure $\leq 1,600$ psi

RCA8575

Optical fiber
15 feet long
Locate PMT away from cavity
Optical signal is delayed by cable + optical device

Timing calibration is required
Process Fast Signal Measurement

High pickup voltage (process 2)

Low pickup voltage (process 1) No breakdown

PU signal [V]

H2 Gas Pressure [psi]

Breakdown

Voltage read on Oscilloscope [V]

PMT out

Reflected power

Time [s]
PU Rise/Decay Time Analysis

Time constant [μs]

Run Number

Decay time
Rise time

Green marker: Injected RF power normalized by maximum power

expplot = Plot[expfunc /. \{a -> 0.25, b -> 0.37 \times 10^{-3}\},
\{x, -0.37 \times 10^{-3}, 1 \times 10^{-3}\}, PlotStyle -> \{Orange, Dashed, Thick\}]

expplot = Plot[expfunc /. \{a -> 0.27, b -> 0.42 \times 10^{-3}\},
\{x, 1.585 \times 10^{-3}, 4 \times 10^{-3}\}, PlotStyle -> \{Orange, Dashed, Thick\}]

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PU Rise/Decay Time Analysis

(Breakdown)

Time constant [ns]

Green marker: Injected RF power normalized by last point in H2 run

explot = Plot[expfunc /. {a -> 0.44, b -> 0.0017 \times 10^{-3}},
                  {x, -1.2011 \times 10^{-7}, -0.006 \times 10^{-5}}, PlotStyle -> {Orange, Dashed, Thick}]

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Optical Signal Analysis

Probability of spark during RF power on

No Correlation between single photon signal and RF power
Optical Signal Analysis (II)

Rise Time [ns]

Decay Time [ns]

Pure H2

SF6

Run Number

1.0  1.5  2.0  2.5  3.0  3.5  4.0

1.0  1.5  2.0  2.5  3.0  3.5  4.0

pure H2

SF6

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Conclusion

• Tested Cu, Al, Sn with N2, H2, H2+SF6, He, He+SF6

• Observed strong material dependence of metallic breakdown voltage

• Observed effect of dopant gas in PU signal voltage

• No clear evidence of dopant gas effect in PU decay constant

• No clear evidence of dopant gas effect in optical signal

• Possibly observed precursive light but not clear because of bad detector resolution
Future plan (I)

Beam test

• What is the measurement parameters?
Future plan (II)

Spectrometer for optical measurement

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