

Development of Hyperfast Sensors for the HL-LHC Era

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US-DOE ADR&D/USCMS Phase II R&D:

"Hyperfast Si sensors: Mesh readout High Gain Avalanche Diodes"
CERN, FNAL, U. Penn., Princeton, Saclay+RMD-McDonald/White(coPI's)

RD51 common Project:

"Fast Timing for High-Rate Environments: A Micromegas Solution"
CERN, Demokritos, Princeton, Saclay, Zaragoza-Giomataris/White(coPI's)

Introduction

- Physics backgrounds due to jet mis-association in processes such as "Vector Boson Fusion" and also vertex merging could be significantly reduced by tagging physics objects with "time of occurrence".
- This is fully complementary to the z-vertex tag currently used to mitigate in-time pileup.

Recent papers:
"Calorimetry for the High Energy Frontier" Proceedings - Paris 2013
"The Role of Calorimeter Timing in Hi-Lum LHC Upgrades", S.White
<http://inspirehep.net/record/1280143?ln=en>
The Picosecond Timing Workshops series (2014)
<http://arxiv.org/abs/1409.1165>



=>
 $Z_v + \text{time}$

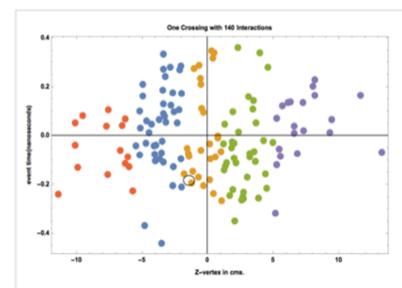
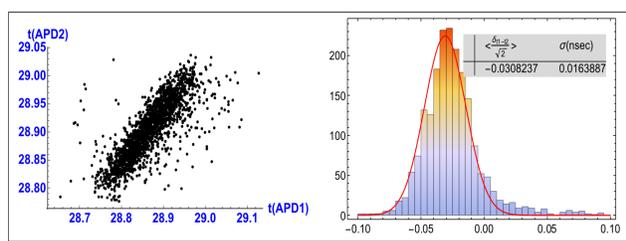
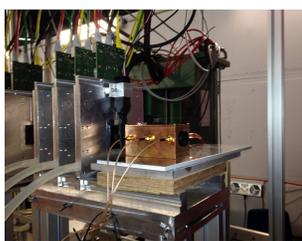
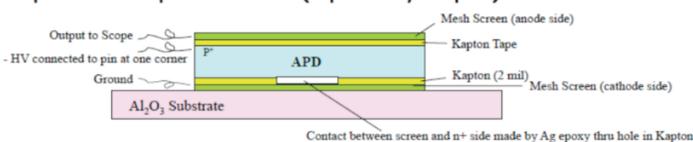


Fig. 1. Simulation of the space(z-vertex) and time distribution of interactions within a single bunch crossing in CMS at a pileup of 140 events- using LHC design book for crossing angle, emittance, etc. Typically events are distributed with an rms-in time- of 170 picoseconds, independent of vertex position.

Z-vertex tool for pileup mitigation

Hyperfast Silicon:

Top Screen Output Connection (capacitively coupled)



Typical beam setup
(DESY electron beam)

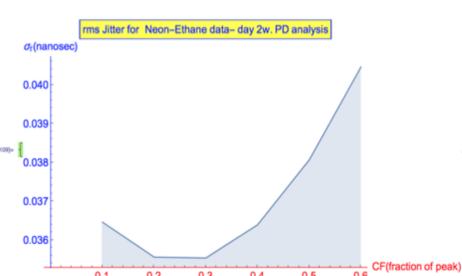
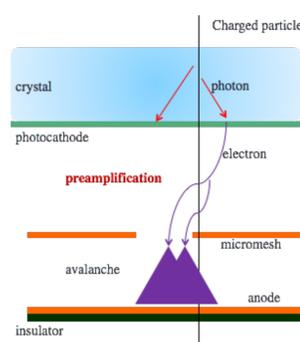
Laser@1MIP
->16 picosecond rms!!

See also:
SAMPIC talk by D. Breton

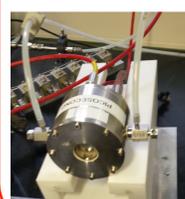
MicroMegas based:

(initial tests March/April 2015)

Ne-Ethane(10%)-200 micron drift+50micron Micro Bulk



36 picosecond rms on first try!!



Saclay Chamber
<-



Significant Progress on Metallization

- in collaboration w. RMD/Dynasil
- a fast Si detector must be a good capacitor@~1GHz
- now collaborating on packaging

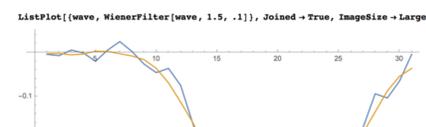
Summary of RMD 8x8 mm² APDs Dec. 13, 2013

	Dec. 13, 2013 432-6 Mesh	Nov. 14, 2013 4 (previously proposed)	Nov. 14, 2013 432-6-1n	Oct. 22, 2012 193A-6-1n	Oct. 22, 2012 420-3-4	Nov. 20, 2012 432-5	Sept. 26, 2012 unknown
	Al-mesh Au sintered	In-edged No Au	In-edged Au sintered	In-edged Au sintered	Al-coated No Au	Al-mesh No Au	standard n+ diffusion No Au
spatial uniformity	good	fair	fair	good	poor	poor-fair	poor
time walk	good	poor	fair	good	good	good	poor
time jitter	good	poor	good	good	good	good	poor data not available

2) weighting field uniformity (and internal series resistance elimination)

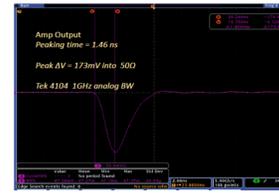
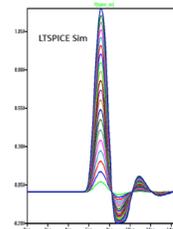
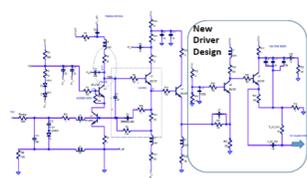
Common Issues of :

signal processing, FEE, Clock Distrib.



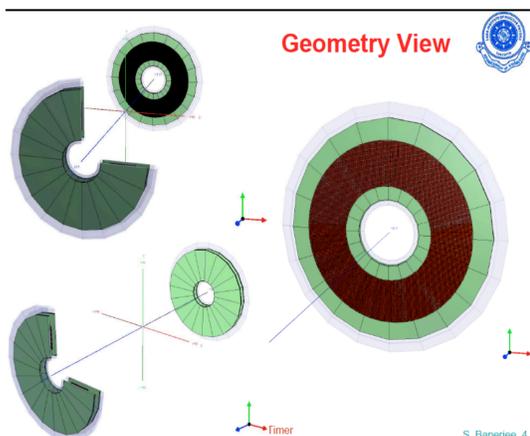
Progress on new Transimpedance Amp

Fast-amp with new driver



real response
to test pulse

solution with Si or MPGD options for end cap



Much Characterization done with ~ picosecond Lasers

"Greg's desk" (CERN)



"Lu's bench" (Princeton)

