Valencia Nov-2011

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- **OUTLINE**

  - Occupancies
  - High Sensitivity and Thin Devices in CLIC Background
  - NIEL
  - Test Beam

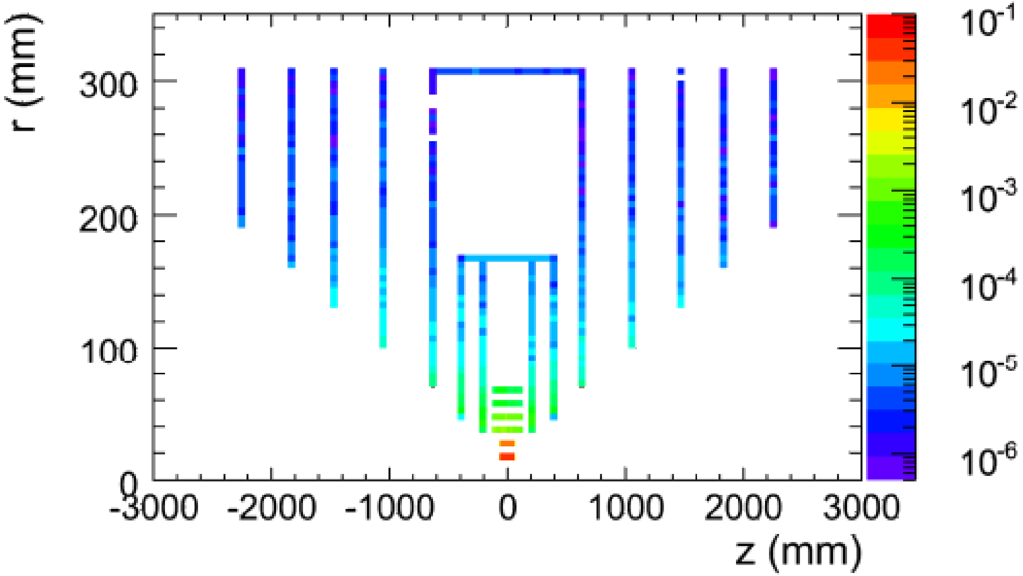
Occupancies in an 20x100um^2 APD

ILC - CLIC

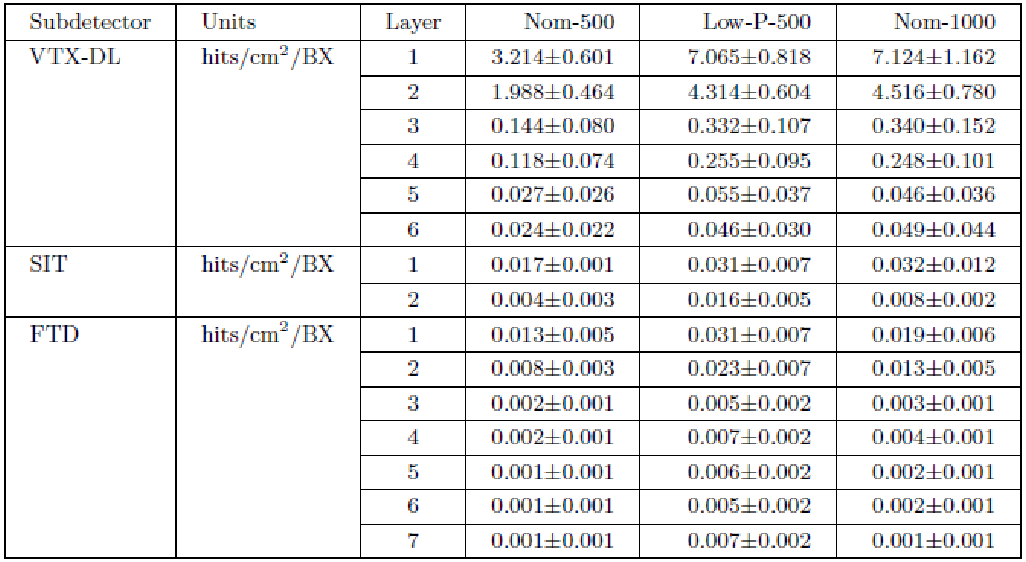
- Train structure in ILC-CLIC.

	ILC	CLIC
BX / Train	*2820*	*312*
Time between BX	*337ns*	*500ps*

- Density of Hits/BX in ILC.



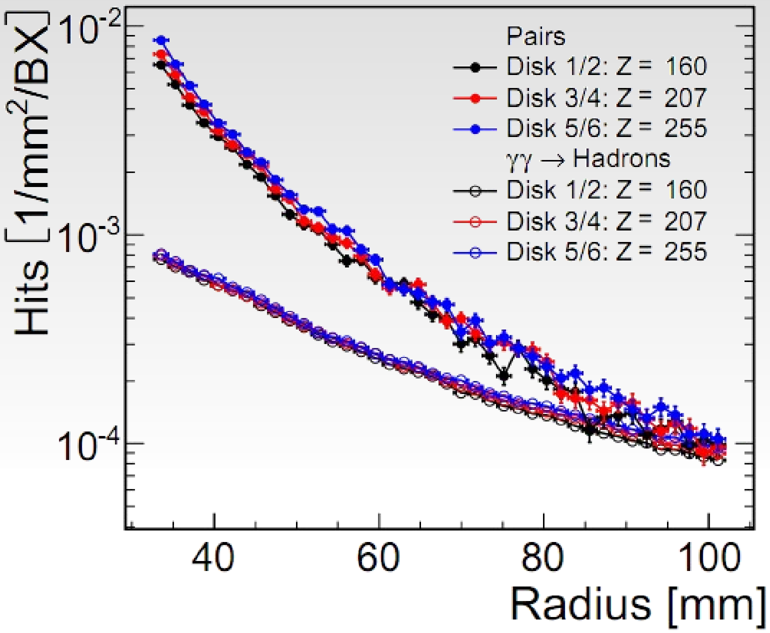
Hits/mm^2/BX



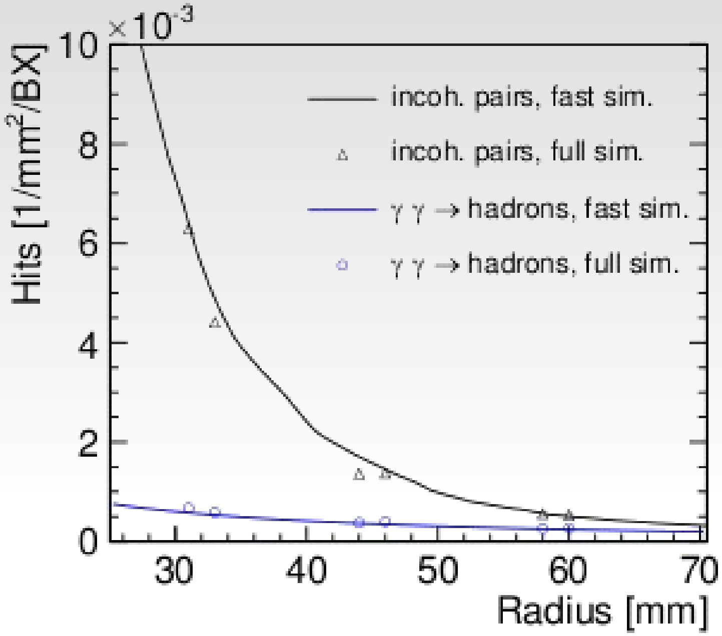
Subdetector	Units	Layer	Nom-500	Low-P-500	Nom-1000
VTX-DL	hits/cm^2/BX	1	3.214±0.601	7.065±0.818	7.124±1.162
		2	1.988±0.464	4.314±0.604	4.516±0.780
		3	0.144±0.080	0.332±0.107	0.340±0.152
		4	0.118±0.074	0.255±0.095	0.248±0.101
		5	0.027±0.026	0.055±0.037	0.046±0.036
		6	0.024±0.022	0.046±0.030	0.049±0.044
SIT	hits/cm^2/BX	1	0.017±0.001	0.031±0.007	0.032±0.012
		2	0.004±0.003	0.016±0.005	0.008±0.002
FTD	hits/cm^2/BX	1	0.013±0.005	0.031±0.007	0.019±0.006
		2	0.008±0.003	0.023±0.007	0.013±0.005
		3	0.002±0.001	0.005±0.002	0.003±0.001
		4	0.002±0.001	0.007±0.002	0.004±0.001
		5	0.001±0.001	0.006±0.002	0.002±0.001
		6	0.001±0.001	0.005±0.002	0.002±0.001
		7	0.001±0.001	0.007±0.002	0.001±0.001

Background vs DCR

- Density of Hits/BX in CLIC.



a) Inner Disks FTD

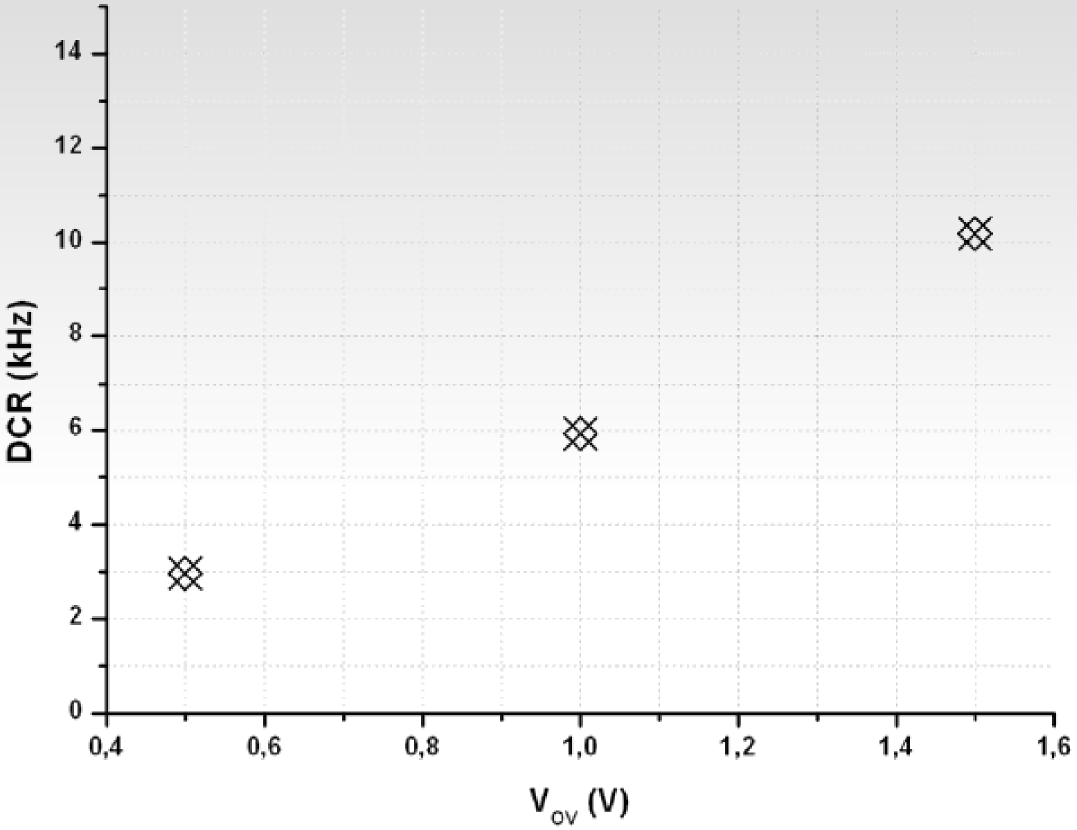


b) Barrel

- Hit densisty/pixel/BX. Pixel of 2000um^{2} APD
  - ILC VXD → 6e-5 – 5e-7
  - ILC FTD → 3e-7 - 2e-8
  - ILC SIT → 3e-7 – 8e-8
  - CLIC VXD → 2e-5 - 2e-6
  - CLIC Inner Disks FTD→ 2e-5 - 2e-7

Background vs DCR

- DCR vs Voltage



- For an APD 20x100um^2 biased 1V over breakdown. DCR=6kHz
  - DC Counts in ILC BX time: 2e-3
  - DC Counts with 10ns of gating: 6e-5
  - DC Counts in CLIC BX time: 3e-6

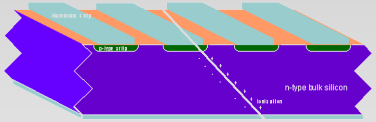
Background vs DCR

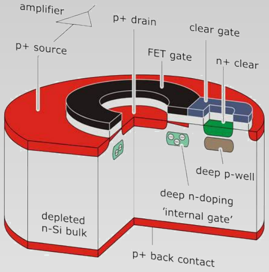
- Summary

	CLIC [Hits/Pixel/BX]	ILC [Hits/Pixel/BX]
VXD	2e-5 - 2e-6	6e-5 - 5e-7
FTD	2e-5 - 2e-7	3e-7 - 2e-8
SIT		3e-7 - 8e-8
DC Counts/BX		
	3e-6	2e-3
With 10ns gating		6e-5

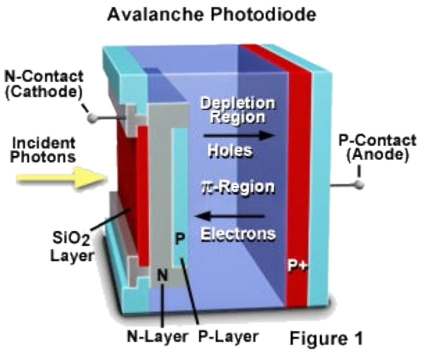
High Sensitivity and Thin Device into CLIC Background

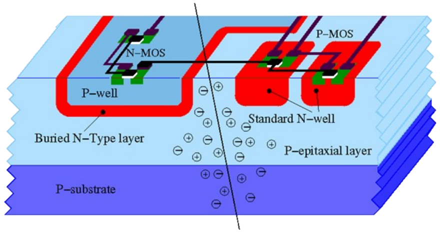
Technology dependence Studies





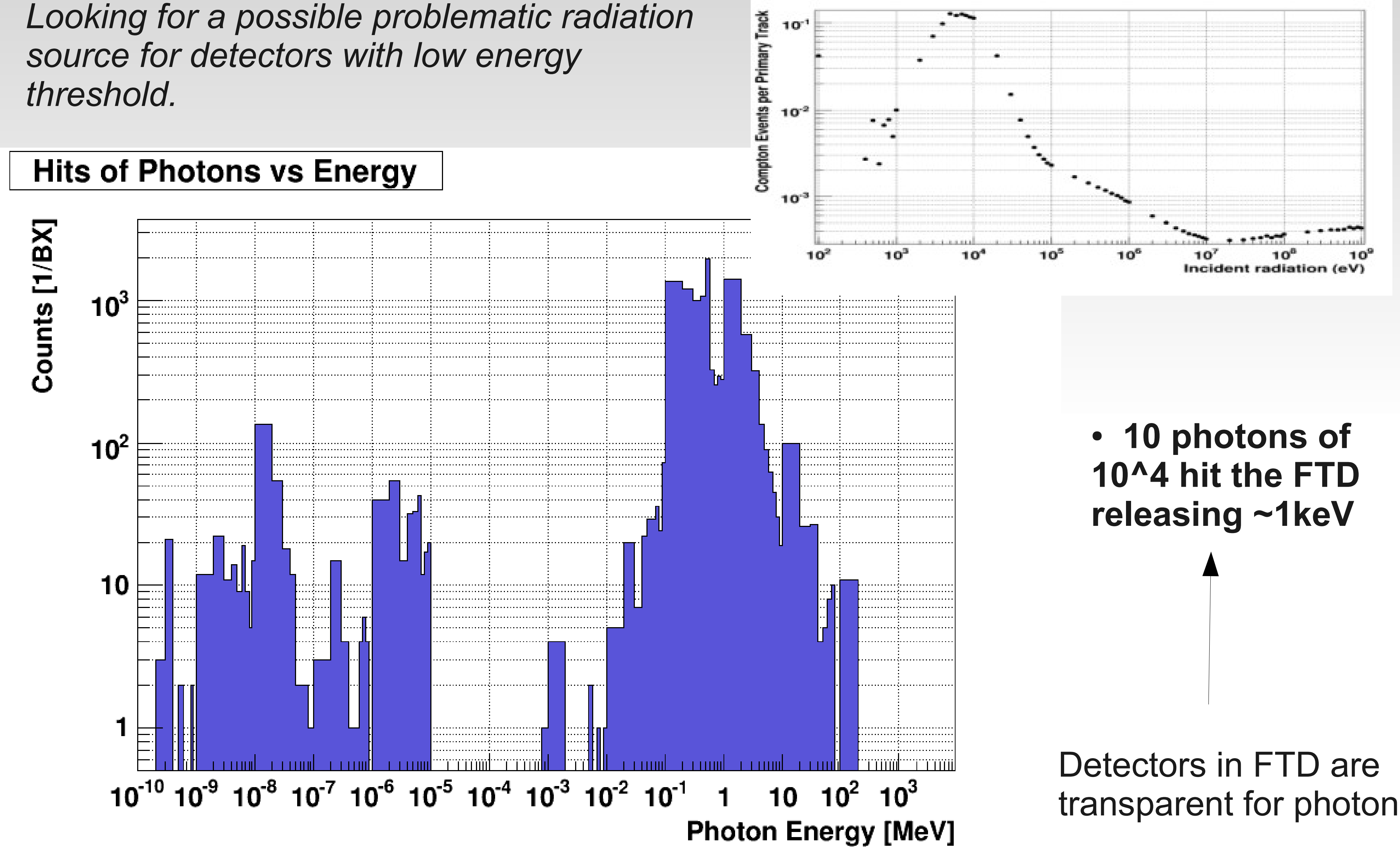
- Studies of background to know the occupancy of the detectors don't take into account any special technology.
- Different types of technology present different energy threshold. From single electron to 400e.
- Different technologies present different sensitive thickness. From 1um to 200um.
- Different detection threshold and sensitive thicknes could mean different occupancies in the detector.
  - ↑ Sensitive thickness → ↑ Hit Density by clustering.
  - ↑ Detection threshold → ↓ Hit Density by losting hits without enough energy deposition.





Photon distribution. Interaction with the FTD.

Looking for a possible problematic radiation source for detectors with low energy threshold.

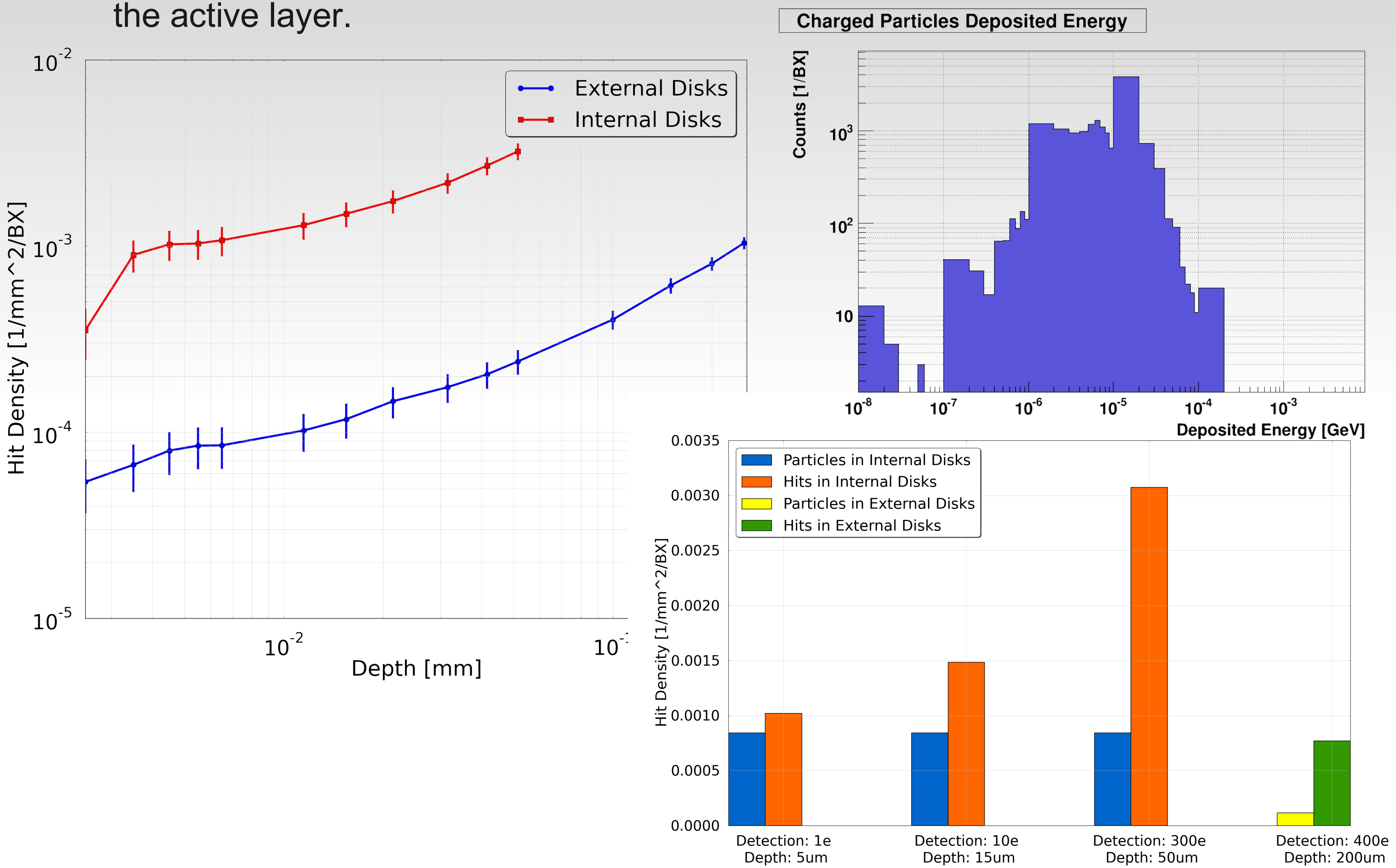


- **10 photons of 10^4 hit the FTD releasing ~1keV**

Detectors in FTD are transparent for photons.

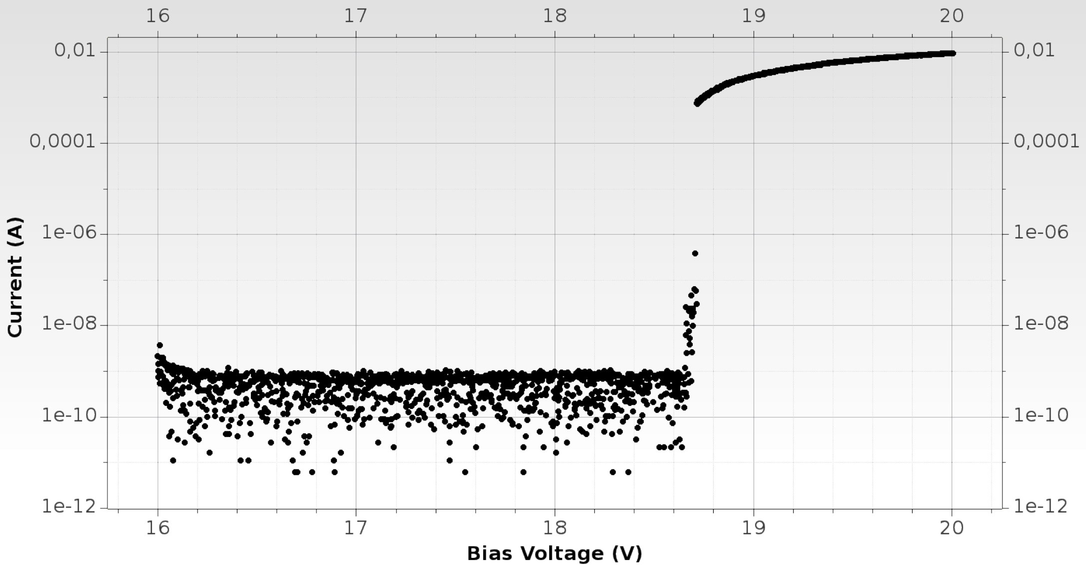
Varying the sensitive depth.

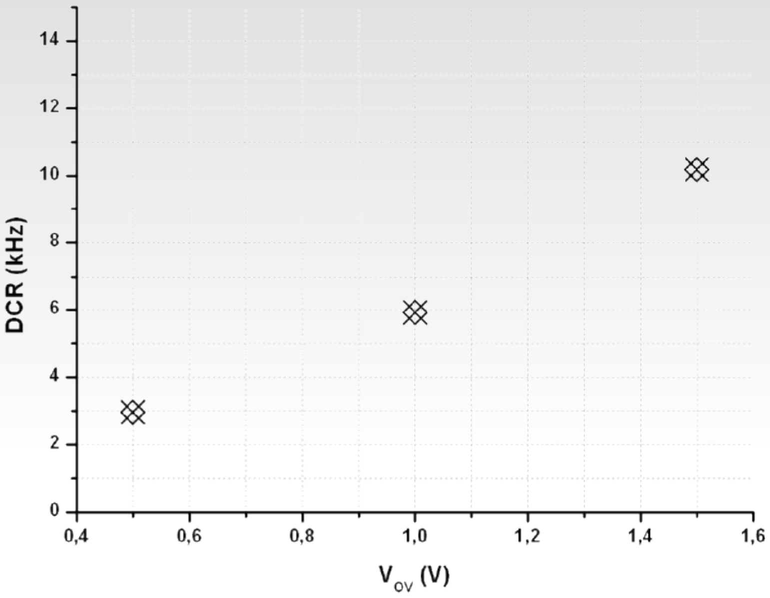
Number of hit 25x25 um² pixels increases strongly with increasing thickness of the active layer.



Irradiation

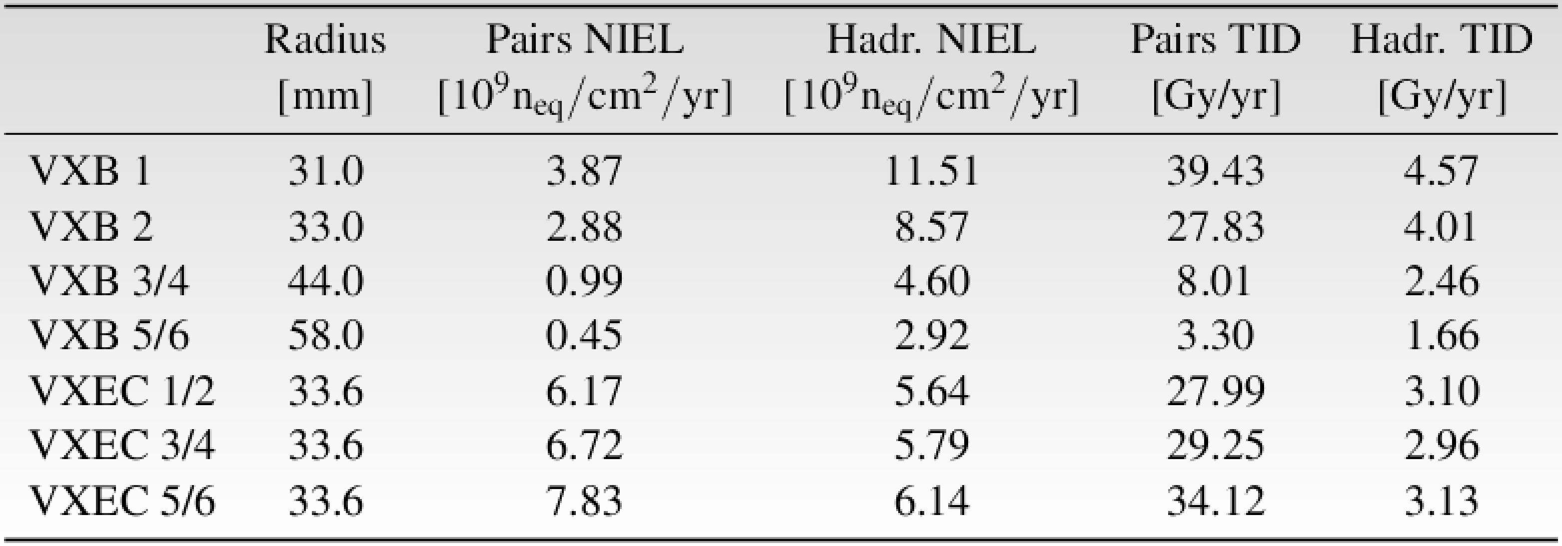
NIEL Study





- Leakage current of 10^{-9} provoke 6kHz of DCR with 1V of overvoltage.

NIEL Study



	Radius [mm]	Pairs NIEL [$10^9 n_{eq}/cm^2/yr$]	Hadr. NIEL [$10^9 n_{eq}/cm^2/yr$]	Pairs TID [Gy/yr]	Hadr. TID [Gy/yr]
VXB 1	31.0	3.87	11.51	39.43	4.57
VXB 2	33.0	2.88	8.57	27.83	4.01
VXB 3/4	44.0	0.99	4.60	8.01	2.46
VXB 5/6	58.0	0.45	2.92	3.30	1.66
VXEC 1/2	33.6	6.17	5.64	27.99	3.10
VXEC 3/4	33.6	6.72	5.79	29.25	2.96
VXEC 5/6	33.6	7.83	6.14	34.12	3.13

- Leakage current due to neutron flux

$$I = \alpha \phi V = 1.59 \cdot 10^{-13} A$$

with $\alpha = 3.99 \cdot 10^{-17}$A/cm, $\Phi = 10^{12}$ n/cm^2 and V=4000μm^3.

With this increment of leakage current due to irradiation is not expected an important increment of DCR.

Test Beam

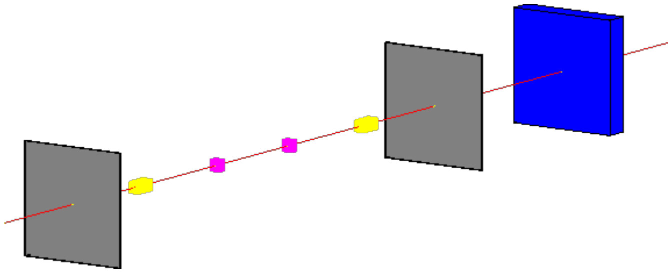
Geant Set-ups

Set-Up

- Trigger: 2 or 4SiPM, 2 scintillators
- 2 DUT, 250μm of thickness for each one.

Sources for CERN and DESY

- Pions. 120GeV
- Electrons. 6GeV



Set-Up used in Geant4 to performed the simulations

Summary. Pixel width: 20µm. Guard Ring: 1.5µm

Silicon: 250um

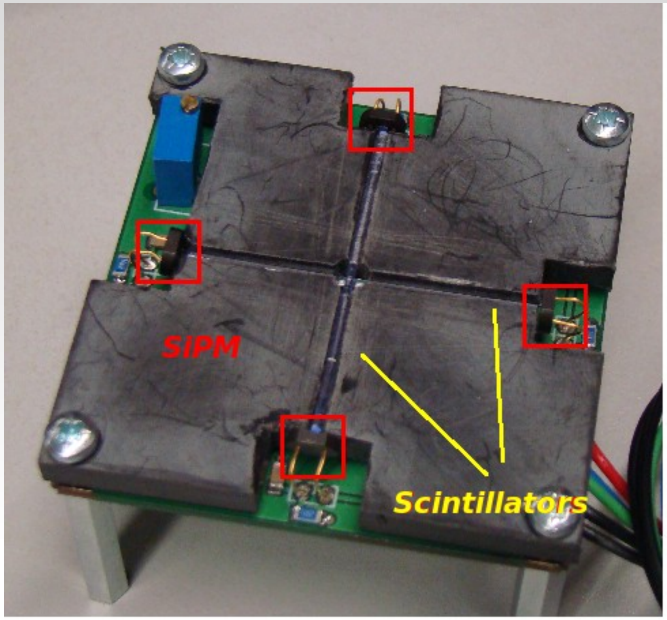
Detector at 2cm	Source: Pions					
Set-UP	X-Mean (um)	X-Sigma (um)	Y-Mean (um)	Y-Sigma (um)	Peak (um)	R-Sigma (um)
Test Beam 2Sc	-0,0005862	0,6163	-0,004412	0,618	0,7101	0,4987
Test Beam 4Sc	0,002556	0,7225	0,001112	0,726	0,8336	0,5772

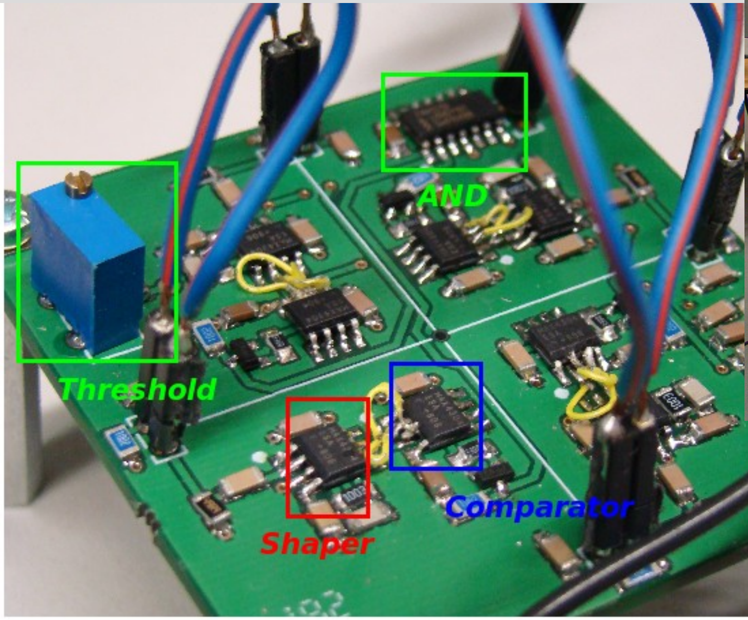
Detector at 10cm	Source: Pions					
Set-UP	X-Mean (um)	X-Sigma (um)	Y-Mean (um)	Y-Sigma (um)	Peak (um)	R-Sigma (um)
Test Beam 2Sc	-0,0002046	1,522	-0,007752	1,522	1,851	1,369
Test Beam 4Sc	0,00902	1,771	0,002611	1,777	2,168	1,577

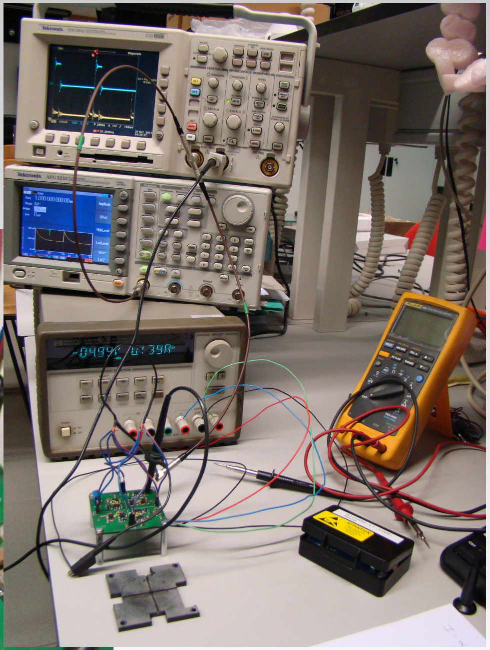
Detector at 2cm	Source: Electrons					
Set-UP	X-Mean (um)	X-Sigma (um)	Y-Mean (um)	Y-Sigma (um)	Peak (um)	R-Sigma (um)
Test Beam 2Sc	0,00799	13,09	-0,01855	13,01	14,64	10,38
Test Beam 4Sc	0,03827	14,71	0,007252	14,72	16,75	11,43

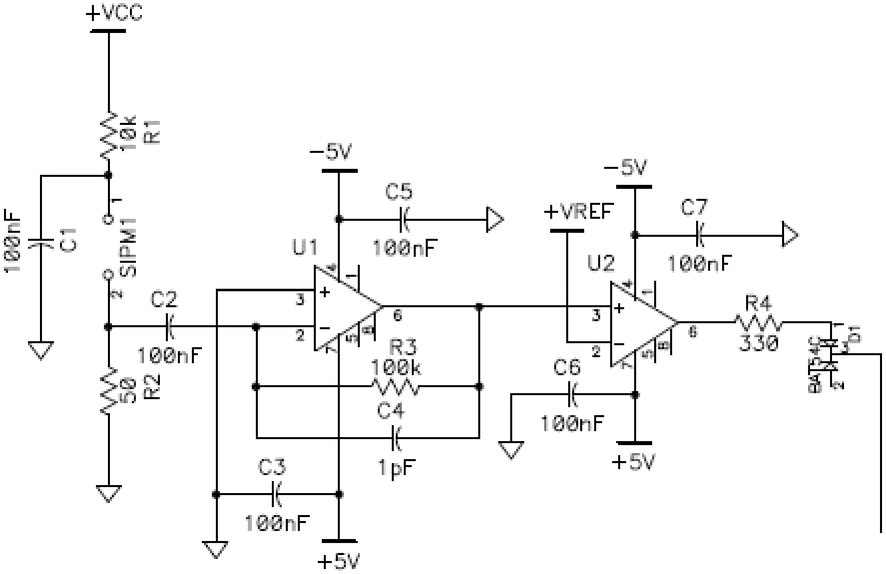
Detector at 10cm	Source: Electrons					
Set-UP	X-Mean (um)	X-Sigma (um)	Y-Mean	Y-Sigma (um)	Peak (um)	R-Sigma (um)
Test Beam 2Sc	-0,03474	37,41	-0,08219	37,25	38,88	32,32
Test Beam 4Sc	0,1675	41,42	0,001765	41,81	44,17	35,26

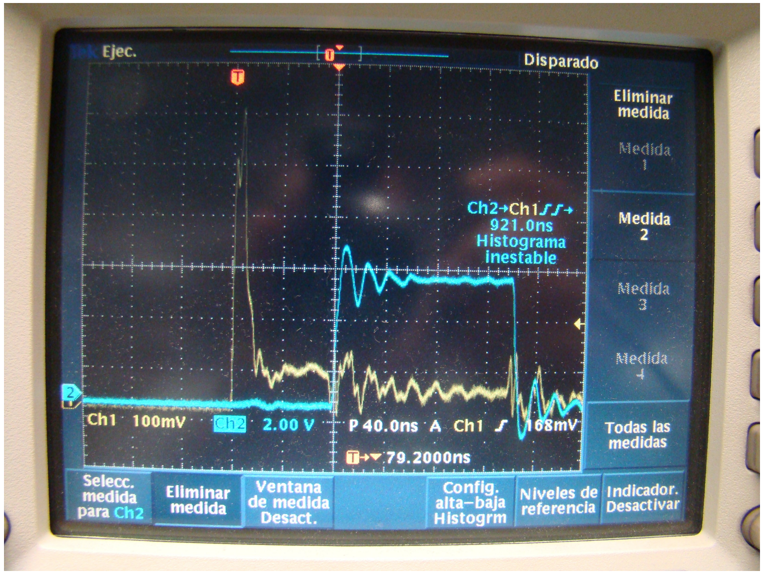
Trigger


SIPM
Scintillators


Threshold
AND
Shaper
Comparator




+VCC
R1
10k
1
C1
100nF
SIPM1
2
C2
100nF
R2
50
−5V
C5
100nF
U1
3
2
6
R3
100k
C4
1pF
C3
100nF
+5V
−5V
+VREF
C7
100nF
U2
3
2
6
C6
100nF
+5V
R4
330
BAT54C
D1


Ejec.
Disparado
Eliminar medida
Medida 1
Medida 2
Medida 3
Medida 4
Todas las medidas
Ch2→Ch1
921.0ns
Histograma
inestable
Ch1 100mV
Ch2 2.00 V
P 40.0ns A Ch1 ʃ 168mV
79.2000ns
Selecc. medida para Ch2
Eliminar medida
Ventana de medida Desact.
Config. alta-baja Histogrm
Niveles de referencia
Indicador. Desactivar

Conclusions

- DCR is in the same order of signal for CLIC but two orders more in ILC
- APD represents a better technology due to its thickness in density detection because of custtering.
- Present APD leakage seams to be enough big to blind the increment of leakage current due to non ionization radiation.
- Test Beam in DESY has to be the test for a good Test Beam in CERN.
  - Energy source in DESY could permit distinguish between pixels.
  - Energy source in CERN culd permit distinguish detection in guard ring.