HGTD Test Beam Status

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HGTD workshop at IHEP
10/06/2019

Overview

- Two test beam campaigns successfully finished in 2019
  - March and May
  - At DESY (electrons beam)
    - IHEP sensors have been tested in May
- Next test beam in August (at DESY)
  - Altiroc will be tested

List of tested sensors - March Test Beam

- Reference sensor: CNM 9088 W9LGA35 un-irradiated
- HPK sensors (3.1 & 3.2):
  - Un-irradiated 2*2 arrays
  - Irradiated single pads and 2*2 arrays (: 8e14n, 1.5e15n, 1e15p, 3e15n, 6e15n)
- CNM W4 (Standard) vs W5 (C-infused) vs W6 (Gallium):
  - Irradiated 2*2 arrays (6e14p)
- Voltage points

List of tested sensors - May Test Beam

FBK

Sensor	Channels	Board Type	Irrad	Annealing	Voltage steps	Plans	Date tests should be run:
FBK UFSD3 W5 (B+C) 2x2	1	UCSC	3e15n		700!!,650!,600,550,500	time, cold	17.05 - Done
FBK UFSD3 W5 (B+C) 2x2	1	UCSC	1.5e15n		550, 500,450,400,350	time, cold	17.05 - Done

IHEP

NDL BV60 unirrad	1	UCSC	no		90, 70, 50	time, room (-90V) and cold (-60V)	15.05 - Done
NDL BV170 unirrad	1	UCSC	no		130, 90, 50	time, room (-145V) and cold (-120V)	15.05 - Done

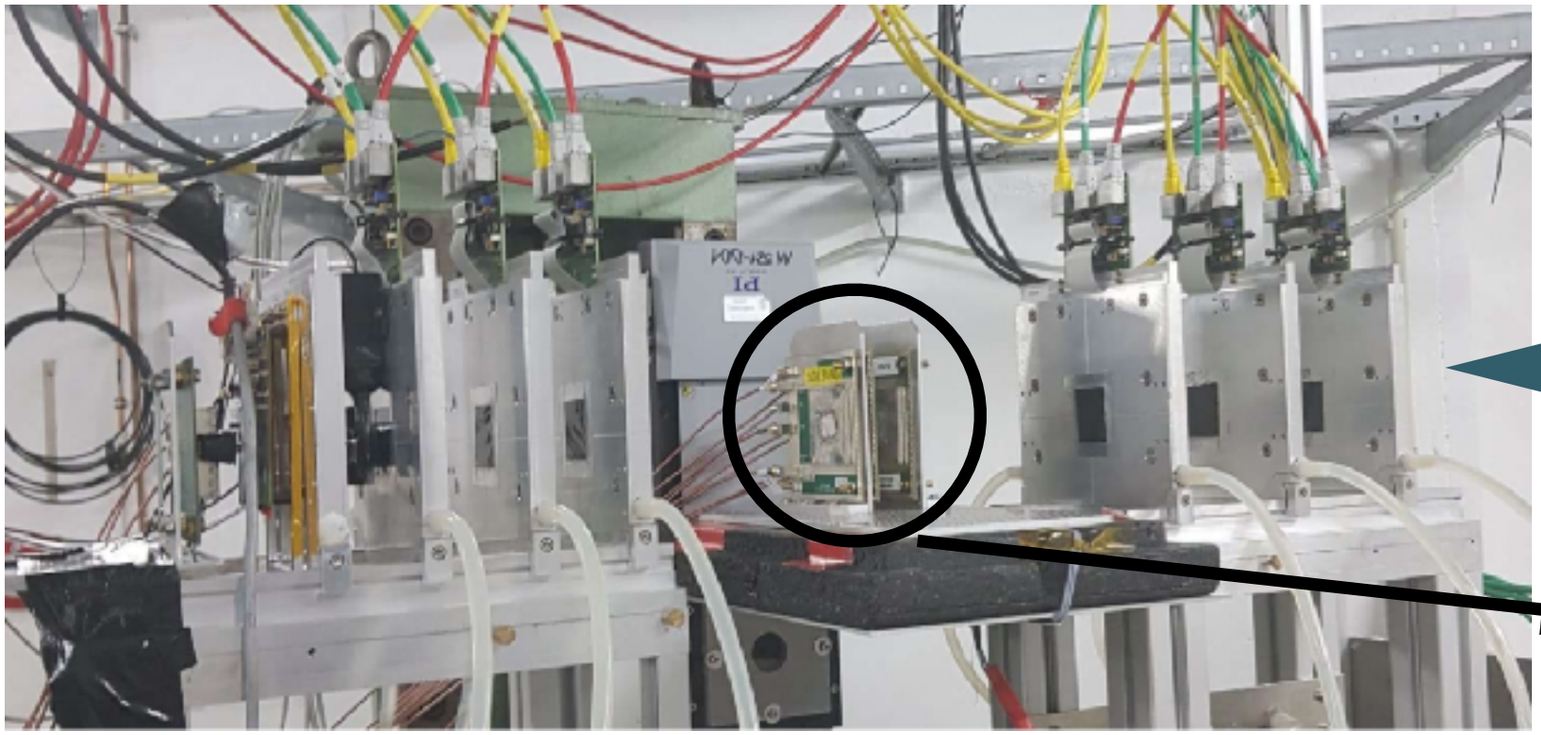
HPK

HPK 3.2 SE3 (high gain)	1	UCSC	1.5e15n		650!, 600, 550,500	time, cold	18.05 - Done
HPK 3.2 SE3 (high gain)	1	UCSC	3e15n		700!!,650!,600,570,550	time, cold	18.05 - Done
HPK 3.2 SE5	1	UCSC	1.5e15n			time, cold	If there is time

CNM

CNM 10924 W6S1020	1	UCSC	1e15p		530!!, 480, 440	time, cold	16.05 - Done
CNM 10478 W5S1115	1	UCSC	1e15p		680!!, 660, 560	time, cold	16.05 - Done
CNM 10478 W4S1099	1	UCSC	1e15p		520	time, cold	19.05 - Running
CNM 10478 W4LG07	1	UCSC	3e15p		610, 550	time, cold	18.05 - Done
CNM 10924 W6S1006	1	UCSC	3e15n		740, 720, 700, 680, 660, 640, 460	time, cold	19.05 - Done

IHEP sensors at DESY

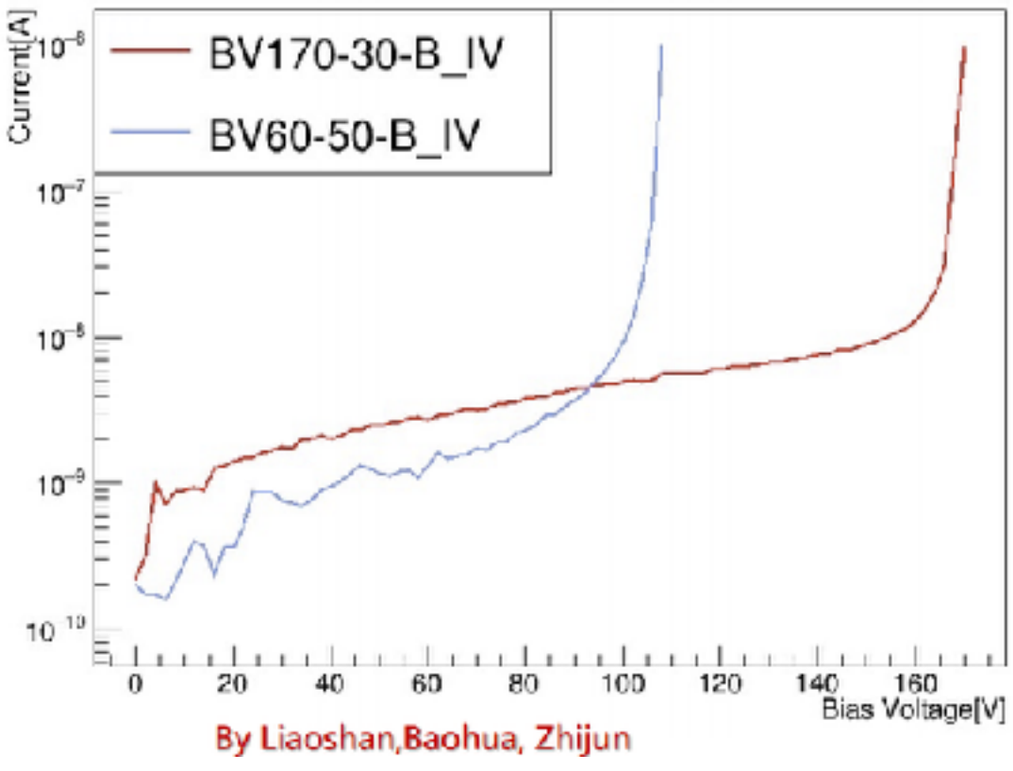


- Operation temperature: 20°C
- Operation Voltages:
  - NDLBV170: 50, 90 130V (started showing auto triggering at 150)
  - NDLBV60: 50, 70, 90V

IHEP sensors: I-V measurement before DESY

@ room temperature

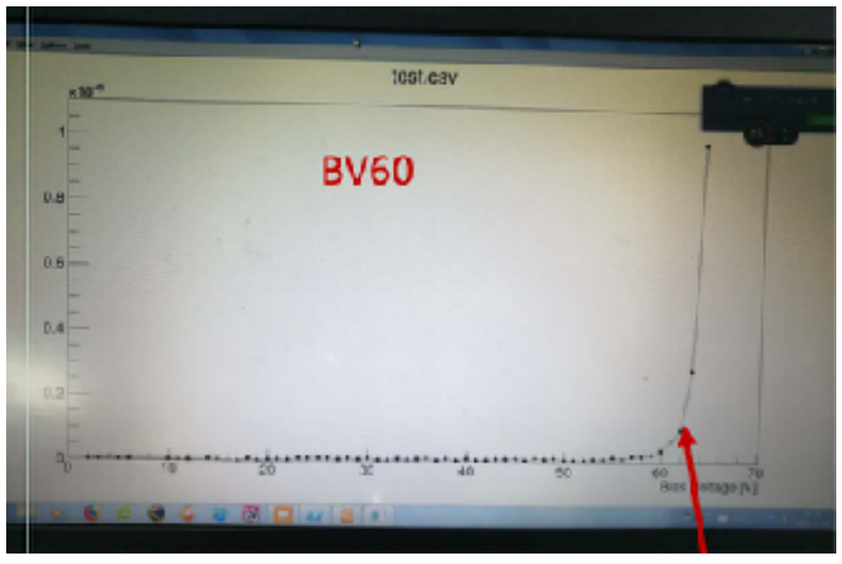
- BV60 break down above 90V,
- BV170 break down above 160V

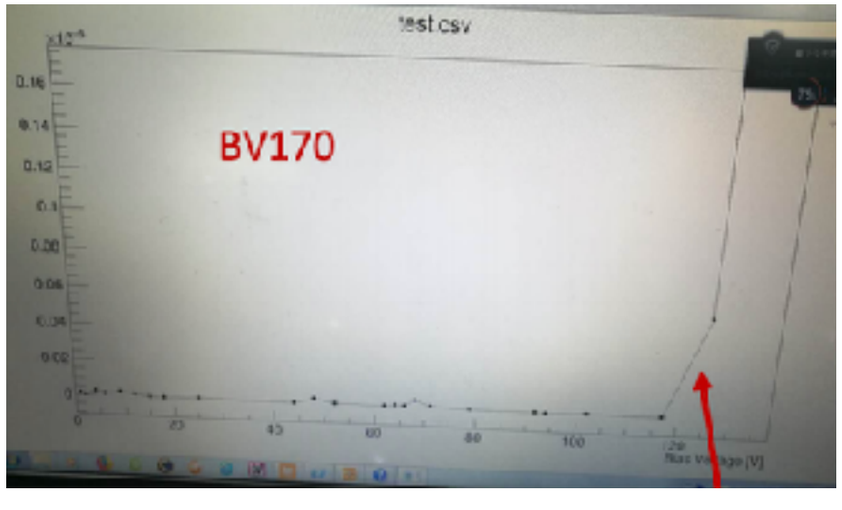


By Liaoshan,Baohua, Zhijun

@ -30°C

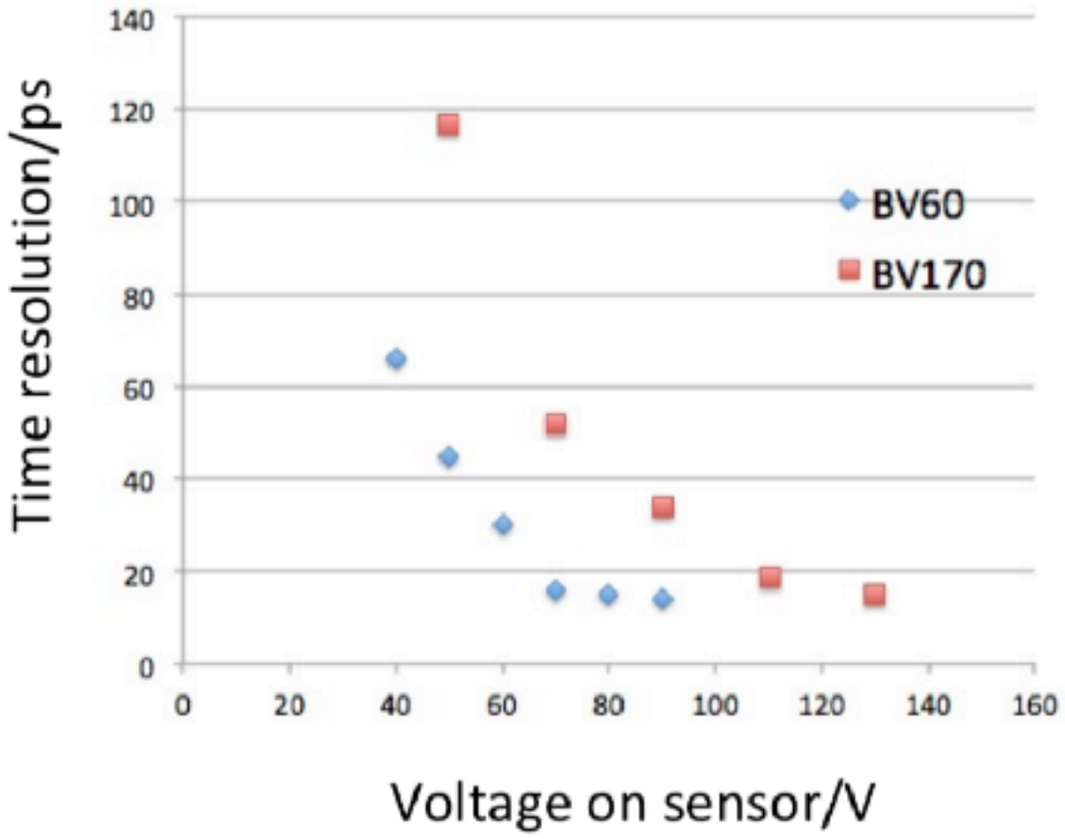
- BV60 break down above 60V
- BV170 break down above 120V

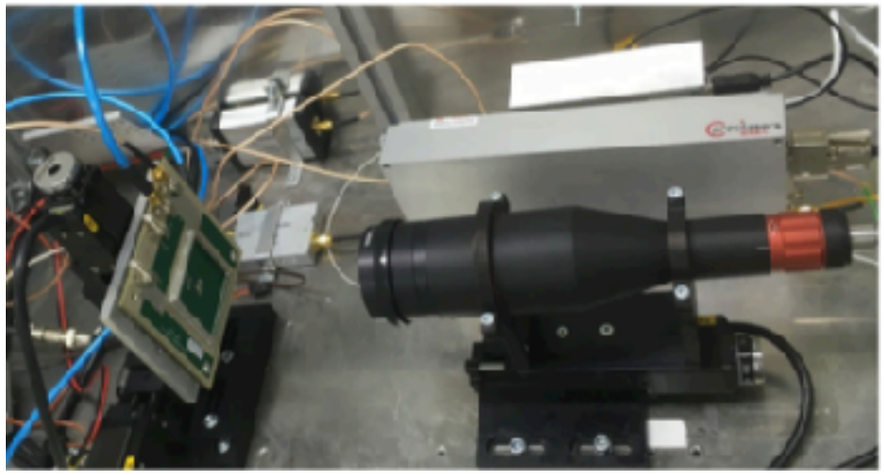


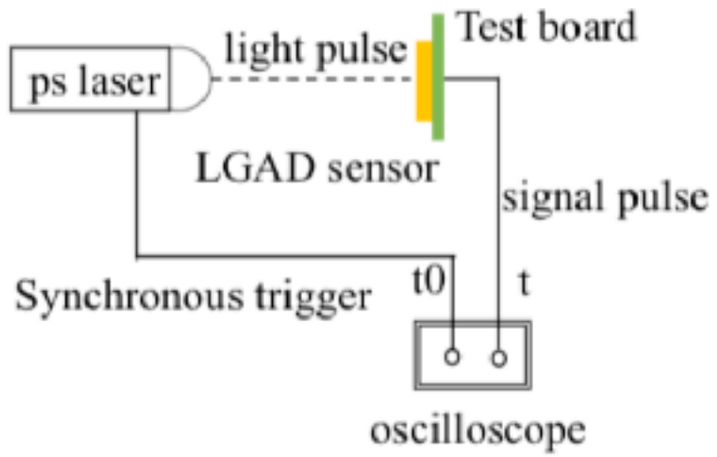


IHEP sensors: time resolution - Lab laser test

- Preliminary LGAD time resolution using a laser system at IHEP
  - By comparing t0 from laser trigger and t1 from LGAD We have preliminary result of time resolution of NDL sensor







IHEP sensors: May Test Beam - General informations

- Detailed informations about all the runs and the full list of sensors can be found here:

https://docs.google.com/spreadsheets/d/19wAAz2TZdayF_LWKn0-crHXcIbfLRYChQpdAgFXxU5Y/edit#gid=1556342074

- List of sensors with their irradiation info can be found here:

https://docs.google.com/spreadsheets/d/19wAAz2TZdayF_LWKn0-crHXcIbfLRYChQpdAgFXxU5Y/edit#gid=1309702600

- The I-V measurements of the sensors including IHEP are here:

https://docs.google.com/spreadsheets/d/19wAAz2TZdayF_LWKn0-crHXcIbfLRYChQpdAgFXxU5Y/edit#gid=986207540

- Data stored directly on eos (will be processed by Nikola Makovec for the analysis)

Test Beam Analysis status

- All the test beam data are stored on eos space
  - Including oscilloscope and tracking data
- Summary of IHEP tasks on 2018 data

1. Studied the time performance stability of a reference sensor used in all the test beam campaigns since 2017 (understand its behaviour vs time)

2. Alignment of the sensors during the test beam

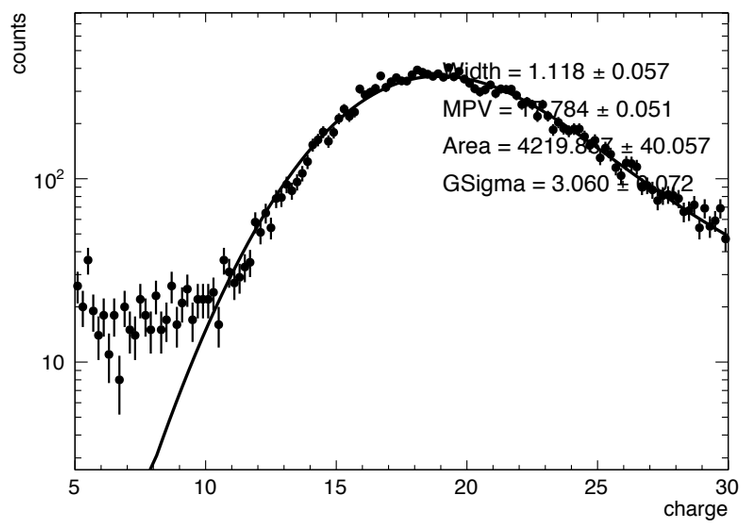
3. Charge and pulseheight uniformity performance

Stability performance - reference sensor

- Studied the stability of the collected charge for 2018 test beams
  - Using a Gaussian*Landau function to fit the charge distribution

T = -30° / HV = 200V	Charge (fb)
April	18 ± 0.08
June	15.3 ± 0.12

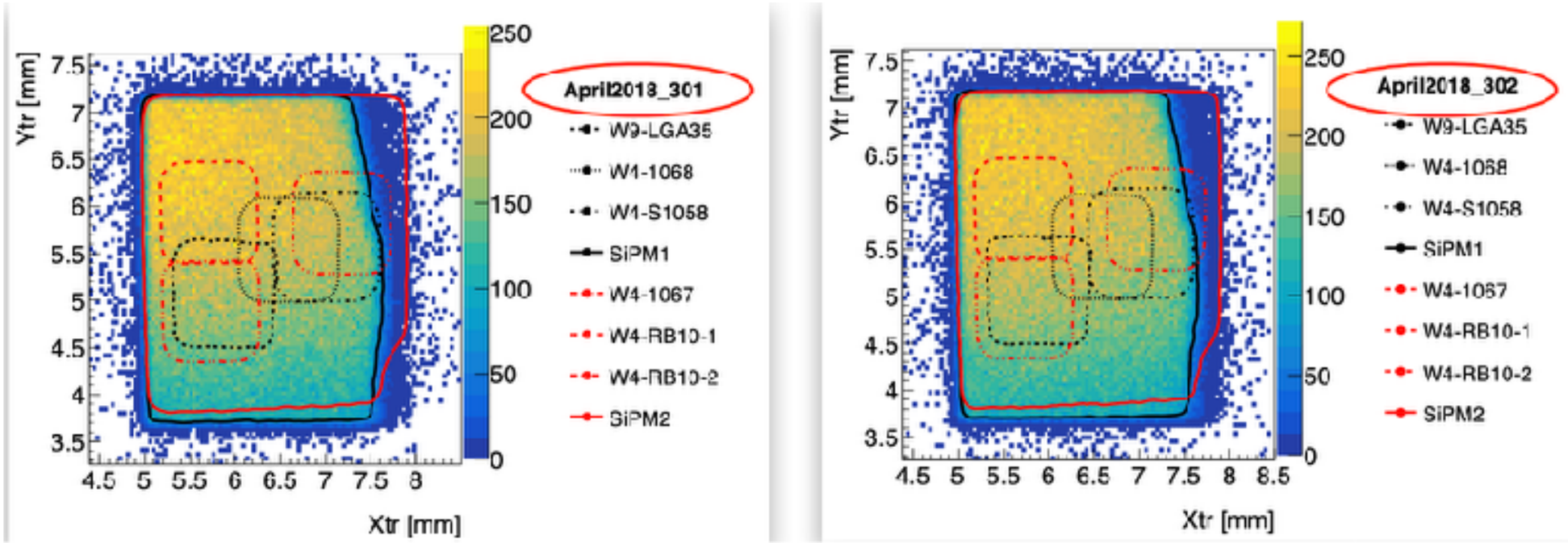
T = -30° / HV = 180V	Charge (fb)
September	12.8 ± 0.04
October	10.9 ± 0.05



Some decrease of the collected charge with time

Sensors alignment

- Study the alignment of sensors during the test beam
  - By doing maps showing the sensors/SiPM positions in the perpendicular plane to the incoming particles
  - Using the tracking information from the telescope
- Plot the X-Y 2D distributions and apply cleaning cuts to select the sensors signal and determine the position of a given sensor



Summary and outlook

- 4 test beams planned for 2019
  - Two of them are done (DESY)
  - Altiroc will be tested at the next test beam in August at DESY
  - IHEP sensors have been tested in May at room temperature only
- Plan for test beam analysis
  - IHEP participated to the test beam analysis of 2018 data
  - The plan is to contribute to the analysis of 2019 when it re-starts
    - Will coordinate with the test beam conveners to distribute the tasks

Back up

Stability performance - reference sensor (3)

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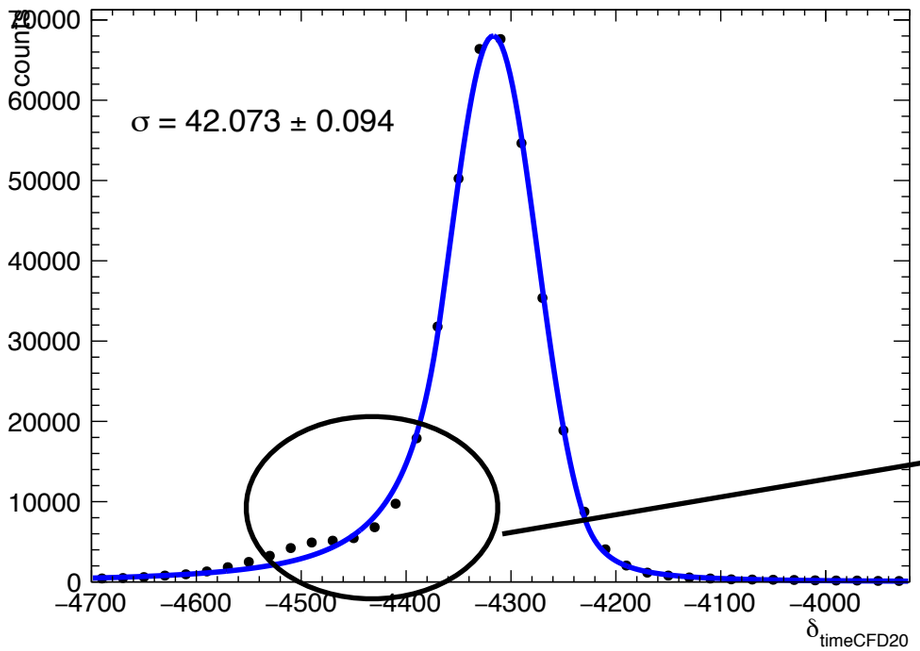
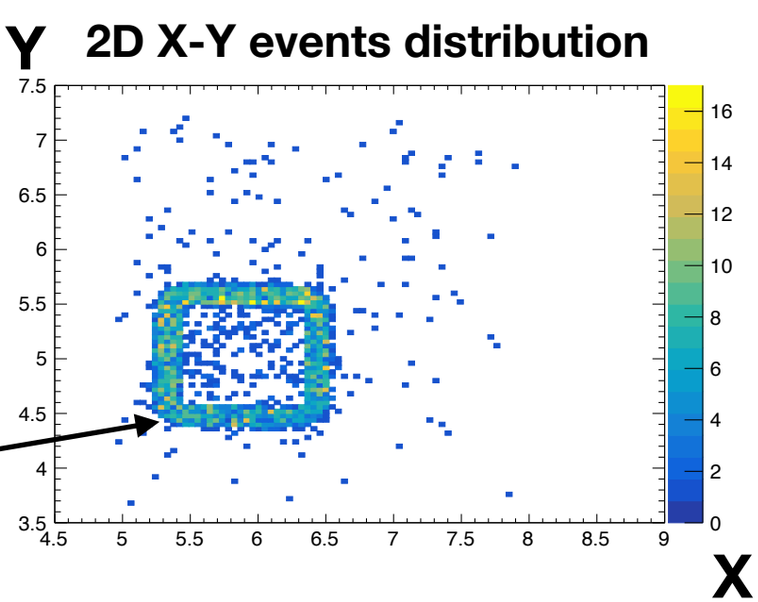
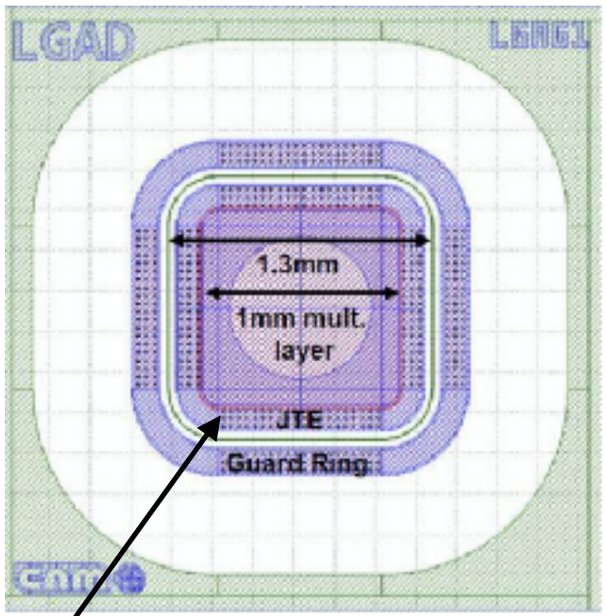
- A small bump of events has been seen at the left tail of the DeltaTime(LGA35,SiPM)

DeltaT(LGA35 - SiPM)





Sensor layout



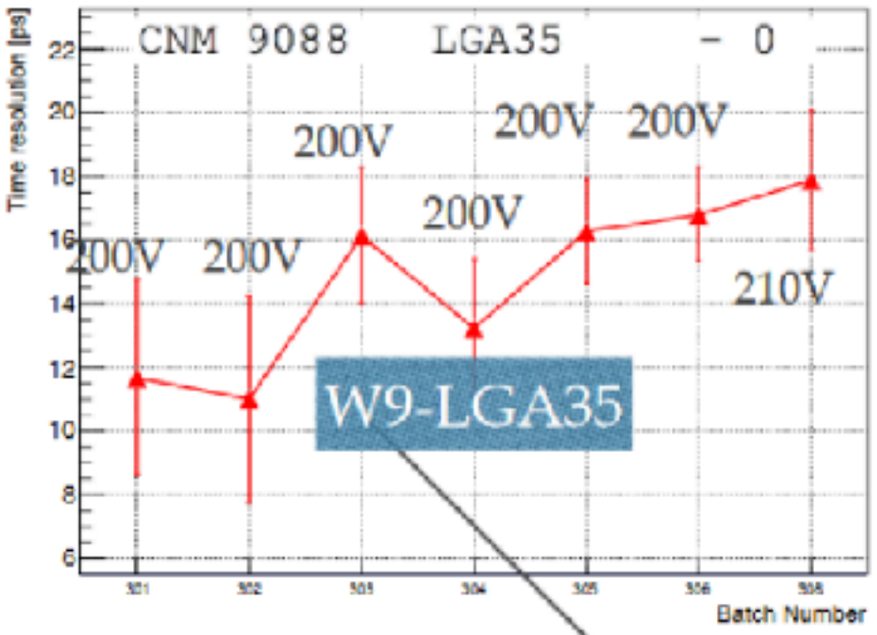
DeltaTime between the sensor and the SiPM used in the time resolution method

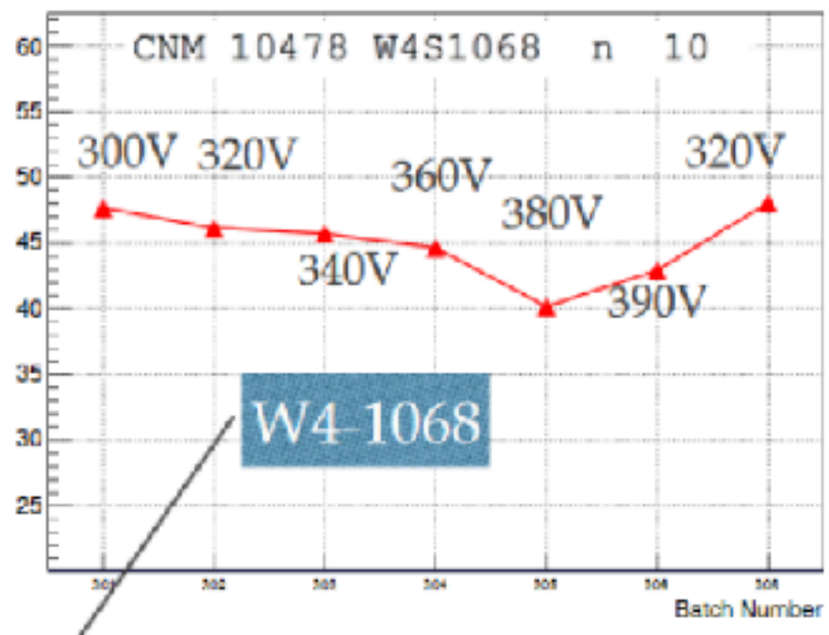
- The bump is coming from the JTE (implant that protect the pad) => expected
- The effect was not seen for irradiated sensors

Time resolution study for April2018 TestBeam

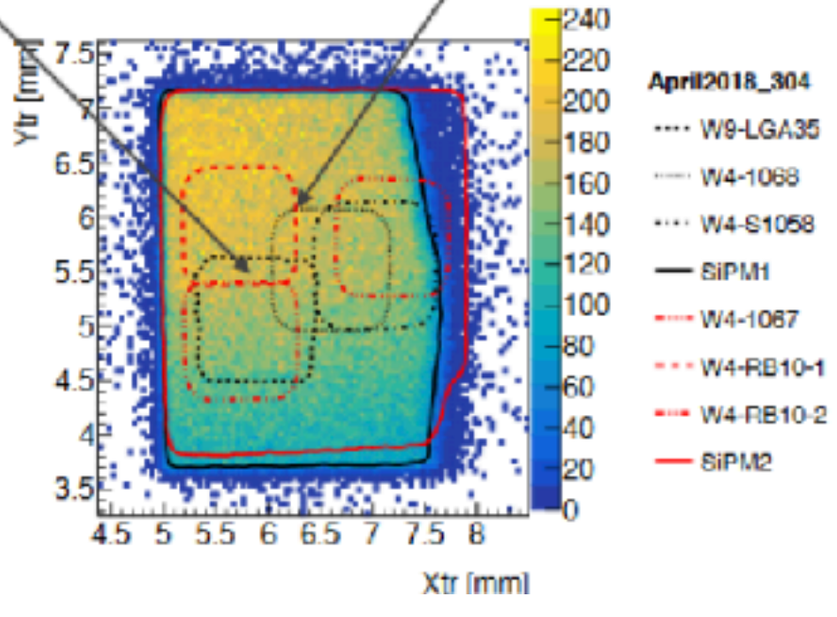
Bo

- Study the time resolution for different High Voltage and batches using April test beam





deltaT (peak +/- 2ns)
PulseHeight > 10 mV

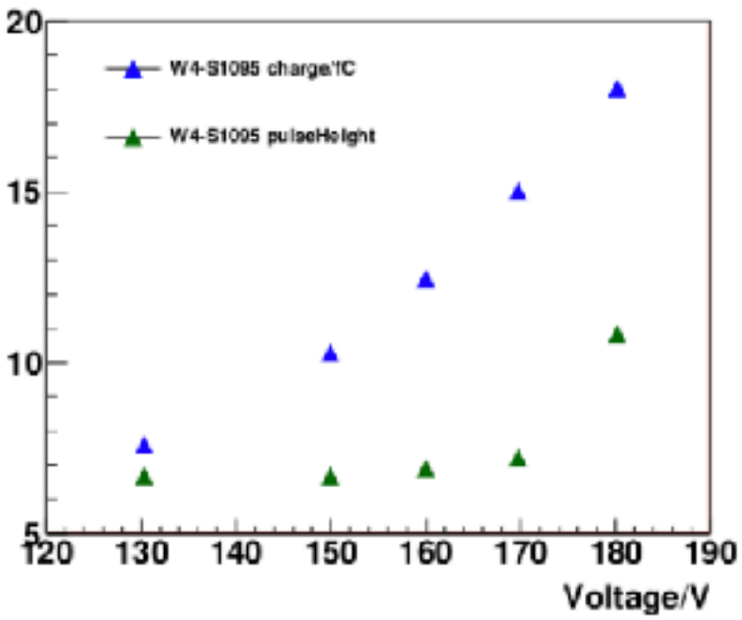


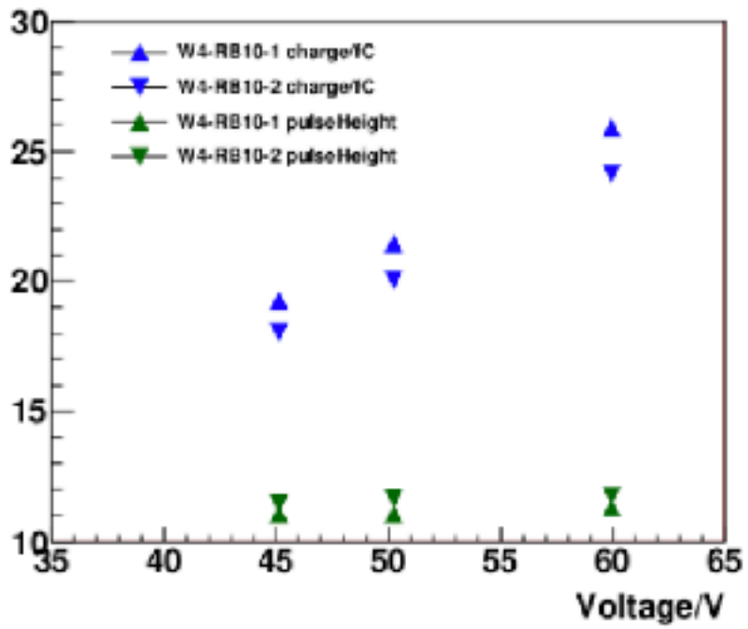
Charge and pulseheight performance

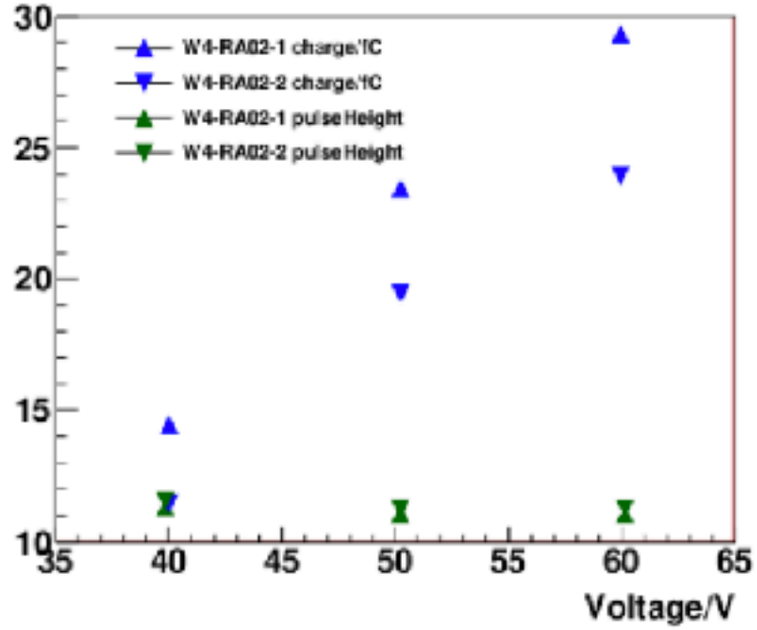
Suyu

- Study the charge and pulseheight for April test beam
  - Fit the distributions to get the MPV

Charge (blue) and pulse height (green)







- Flat pulseheight is under investigation (Suyu)

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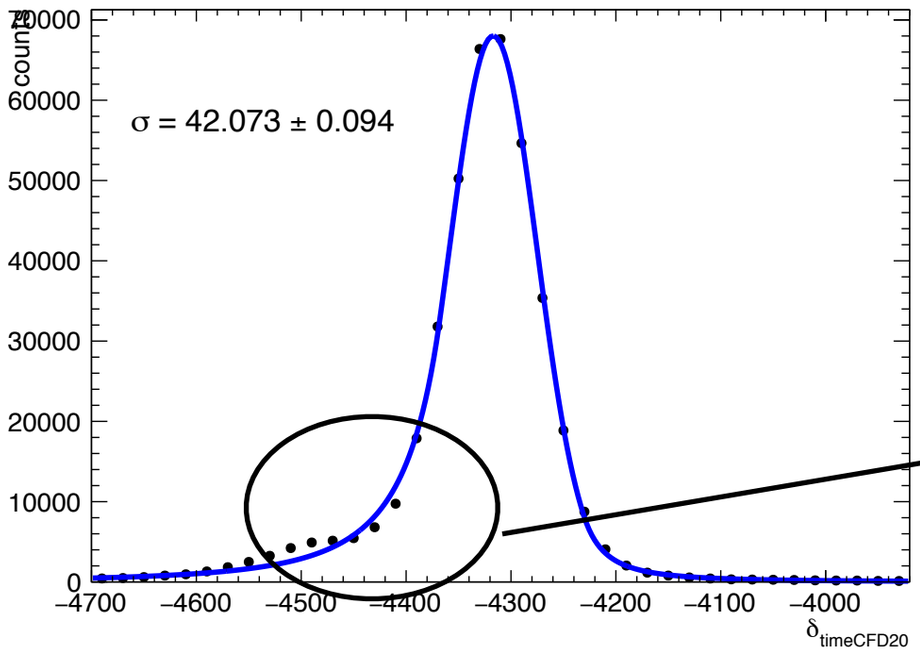

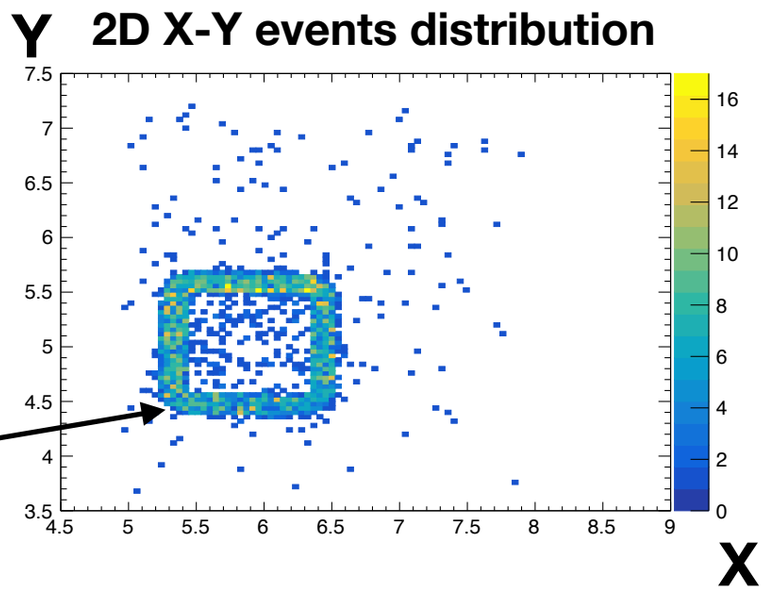

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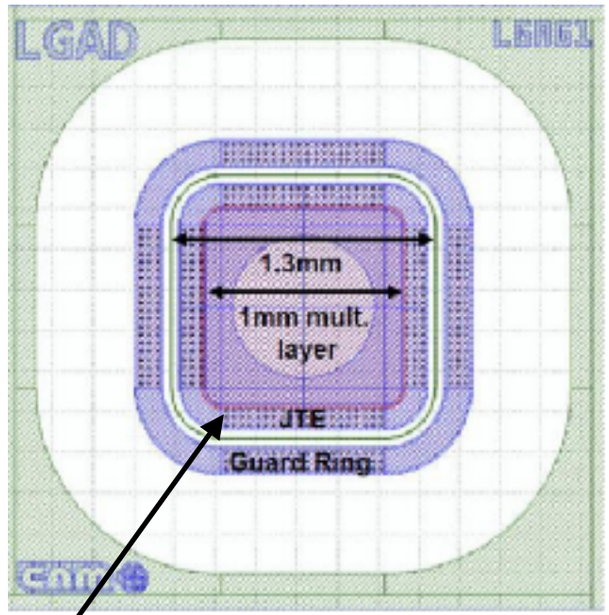

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