Gas mixtures for quality control of the sTGC chambers

Konstantin Filippov on behalf of Moscow cluster

Participants:

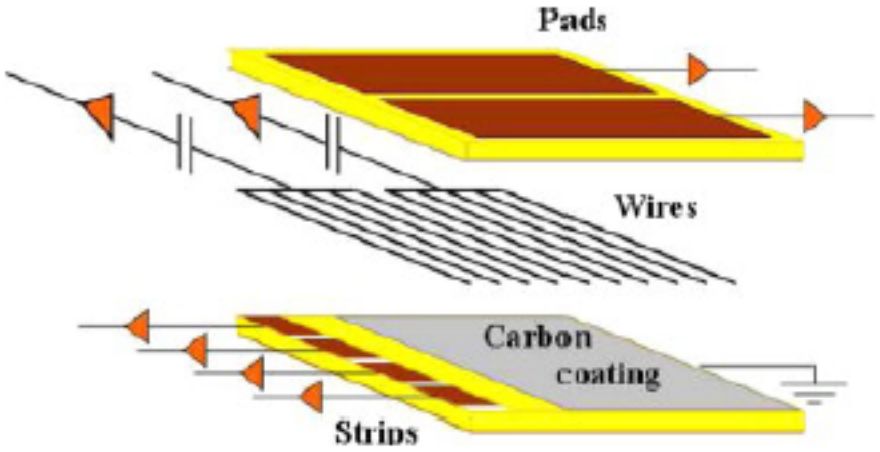
NRNU MEPhI:
A. Romaniouk
S. Smirnov
V. Sosnovtsev
P. Teterin
K. Vorobev
D. Shchukin

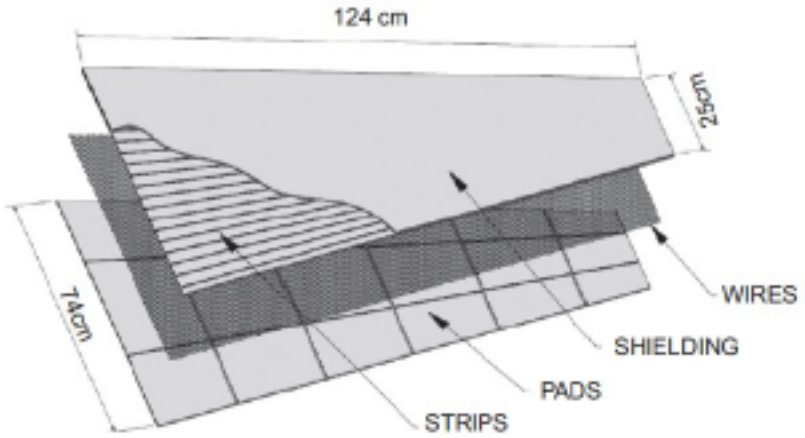
Lebedev Phys. Inst:
S. Konovalov
V. Tikhomirov
V. Tsekhosh

Weizmann Institute of Science:
G. Mikenberg
V. Smakhtin
M. Shoa

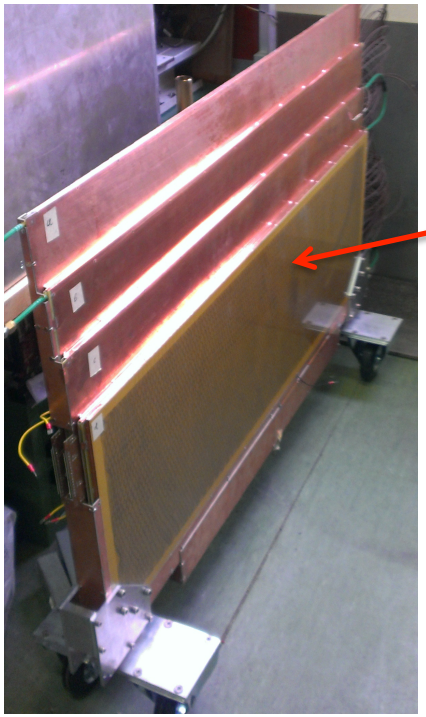
sTGC structure

- No deterioration up to a total irradiation dose of 6 Coulomb/cm^2;
- Can operate well up to background radiation levels of approximately 17 kH/cm^2 of detected photons and 75 kHz/cm^2 of detected neutrons;
- Position resolution of approximately 60-70 um per detector-plane at perpendicular incident angle and 150 µm at large angles.





X-ray studies of the sTGS prototype



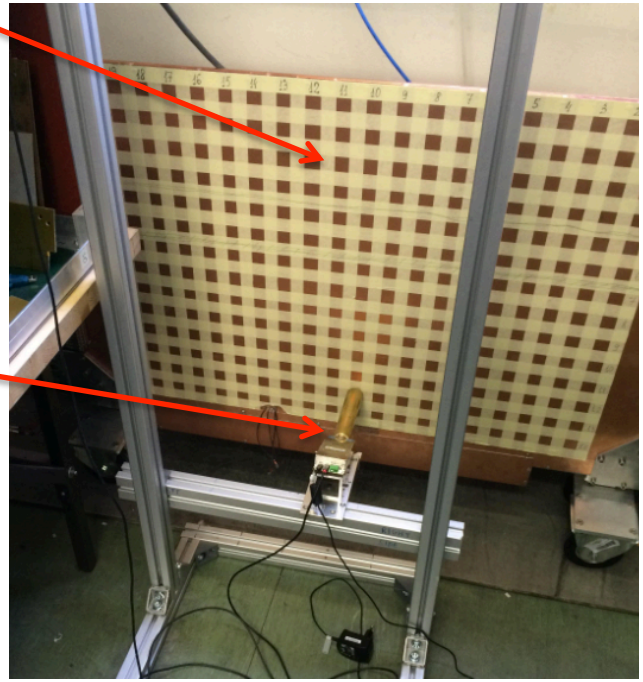
The main goal:

Obtain some experience with the detector operation, understand detector behavior with different gases and define possible modes of scanning.

Tests were carried out with one of the first sTGC test beam prototypes in "manual mode". Scans were done with **2.5 cm step** with collimator of **3 cm** diameter.

Studied:

- Gas gain uniformity
- Reproducibility
- Hot spots
- Some other issues



Collimator

Tasks

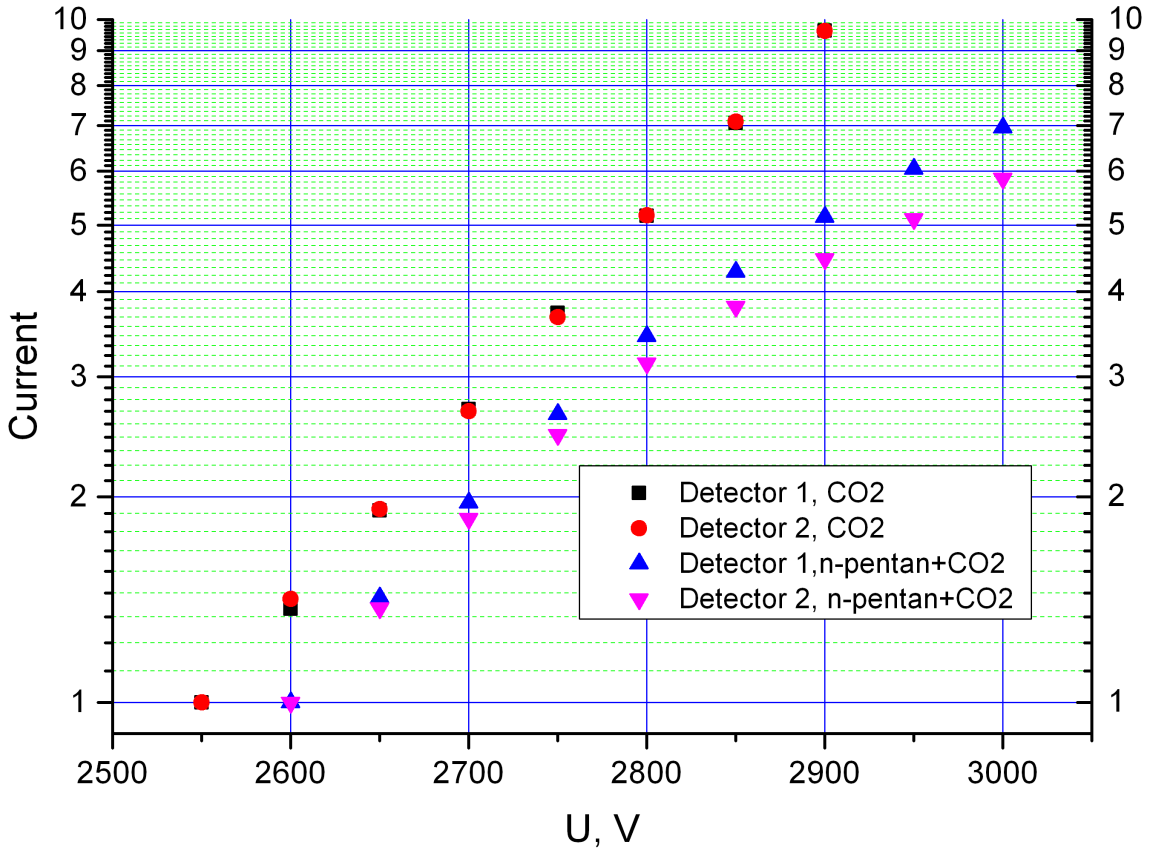
I. Study of the gas mixtures properties
   - Current as a function of applied voltage
   - Gas gain (current map)

II. Study hot spots for two gas mixtures and their comparison

Current in the chamber as a function of applied voltage

Gases:

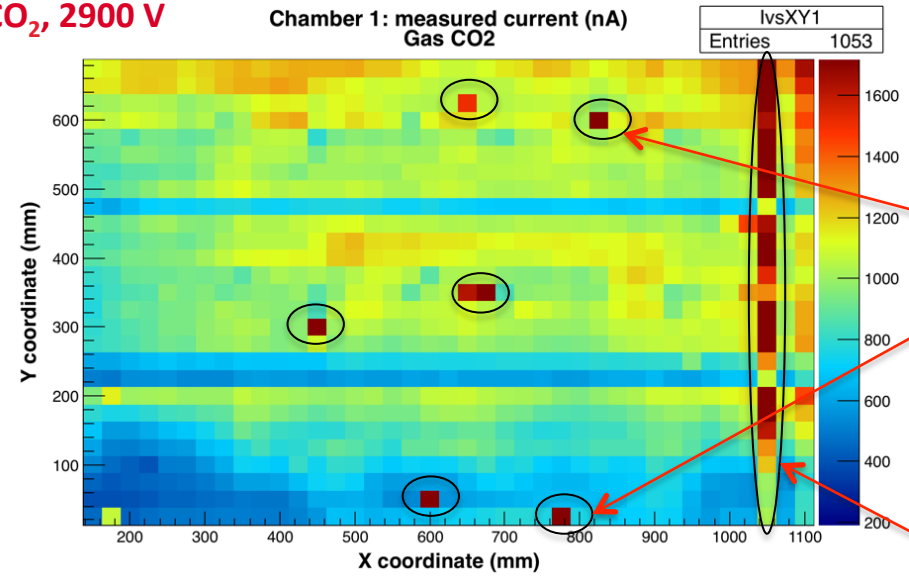
- CO_2 100% at 2900 V
- n-pentane/CO_2 (45/55) at 2800 V (working point)



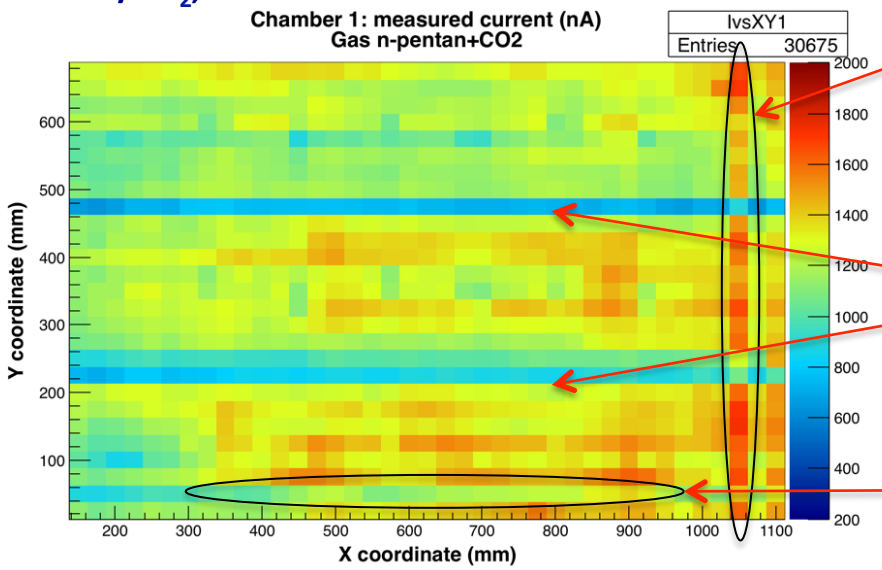
In the sTGC base line mixture gas gain saturation effects are observed at 2750 V.
This also means that gas gain is less dependent on the chamber effects -> good for operation, but may not be good to find effects.

Current map of chamber 1

CO_2, 2900 V



nPentane/CO_2, 2800 V



Many hot spots in CO_2, but only **one** is observed in the sTGC base line mixture.

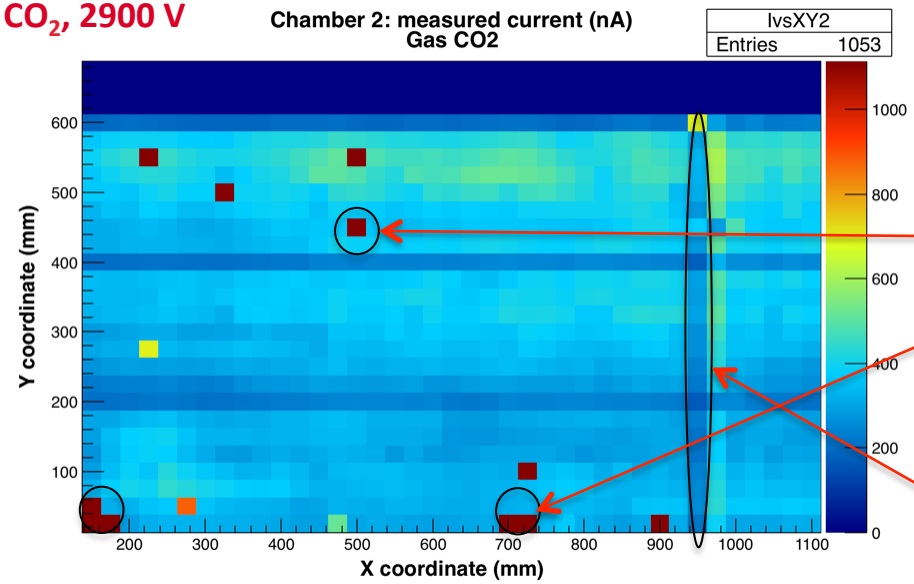
Wire defect:
gas gain higher
(reason is not clear)

Wire supports

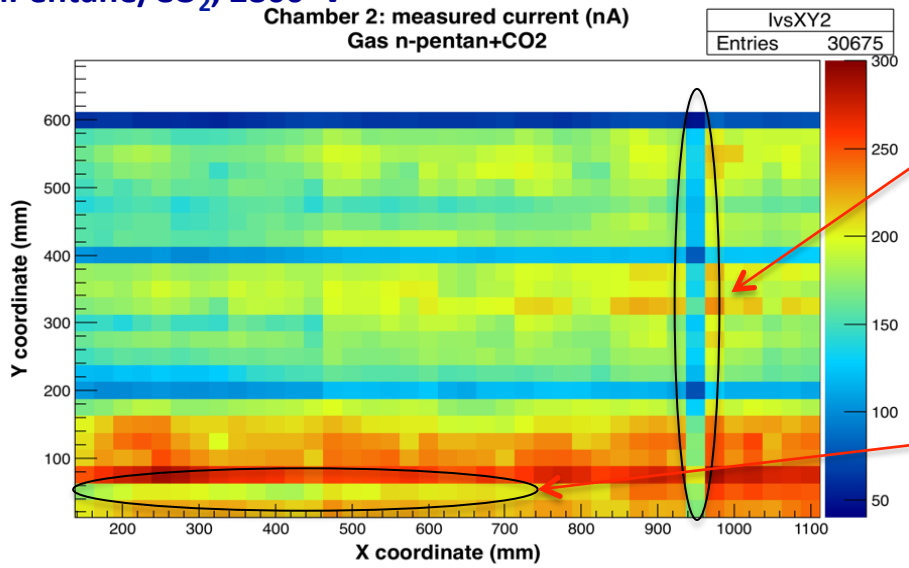
Strip defect

Current map of chamber 2

CO_2, 2900 V



nPentane/CO_2, 2800 V



Hot spots

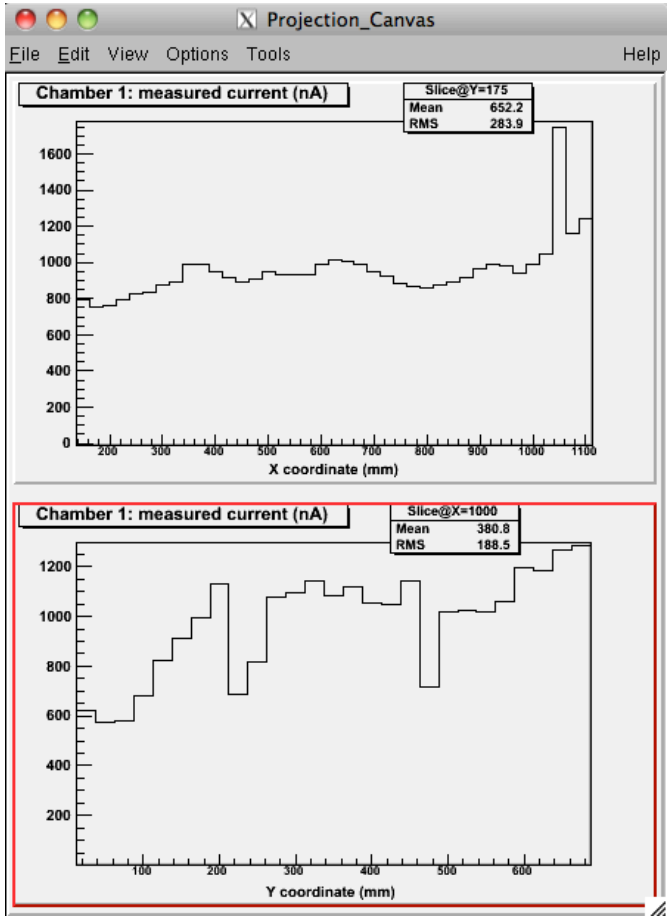
Wire defect:
gas gain lower
(reason is not clear)

Strip defect

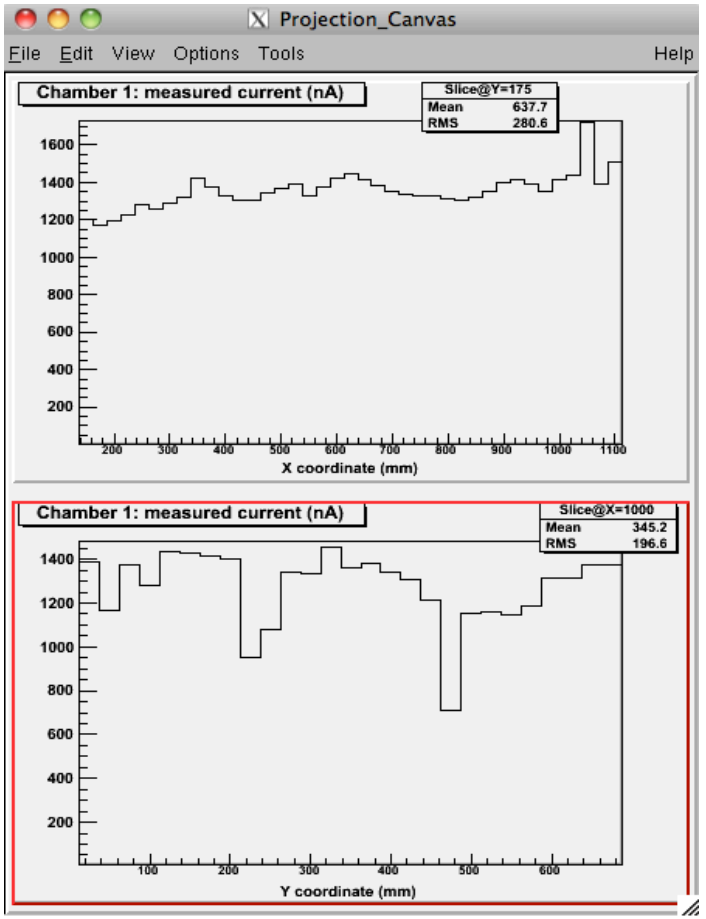
X,Y projection. Chamber 1

Point Y=175, X = 1000 mm

CO_2, 2900 V

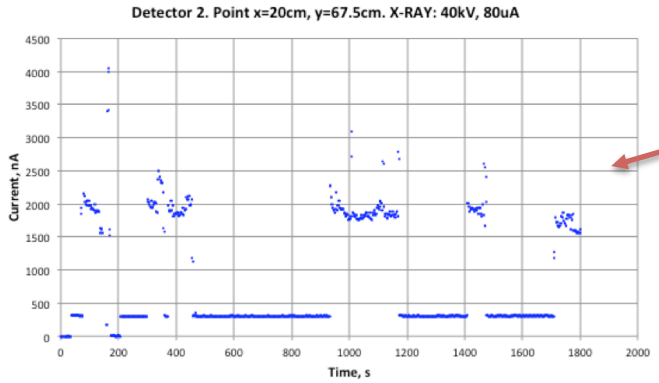


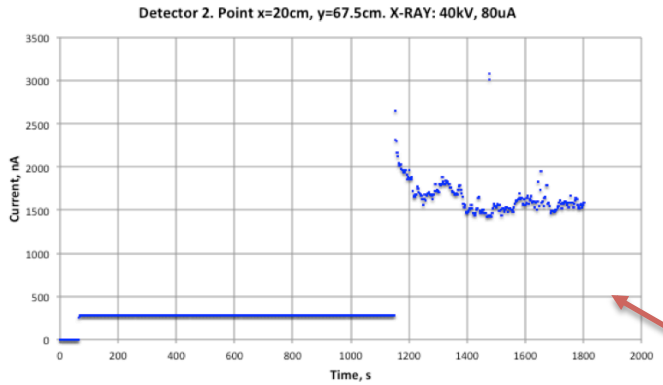
n-pentane/CO_2, 2800 V

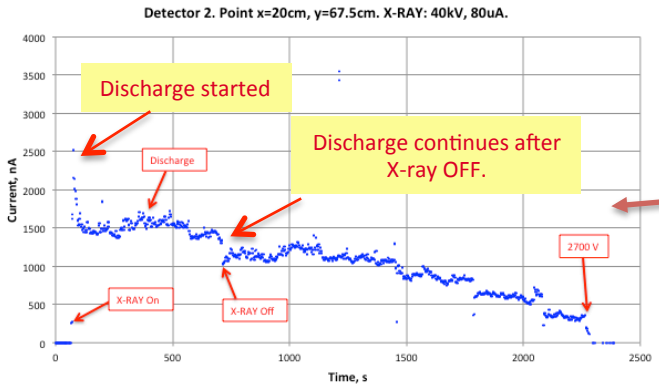


Gas gain uniformity is better in n-pentane/CO_2 mixture! Gas gain variation is 10.5% for CO_2 and 5.4% for n-pentane/CO_2 mixture.

Tests with CO_2 gas

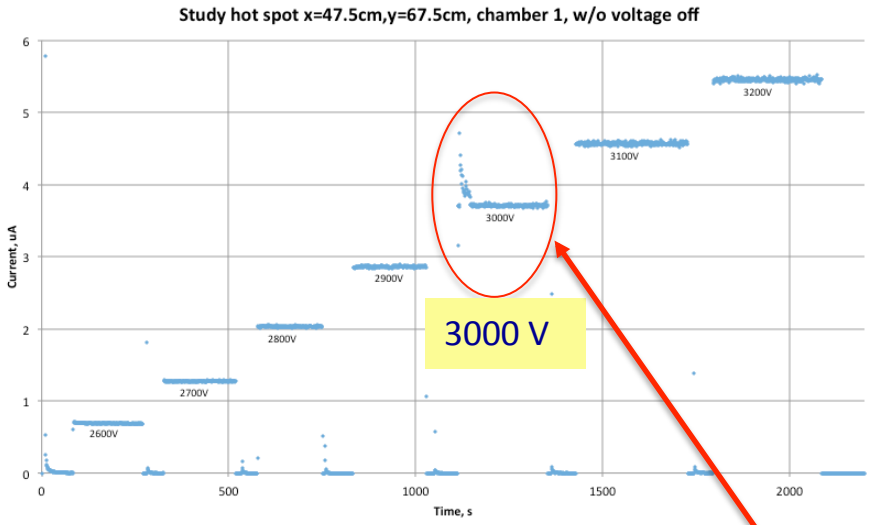


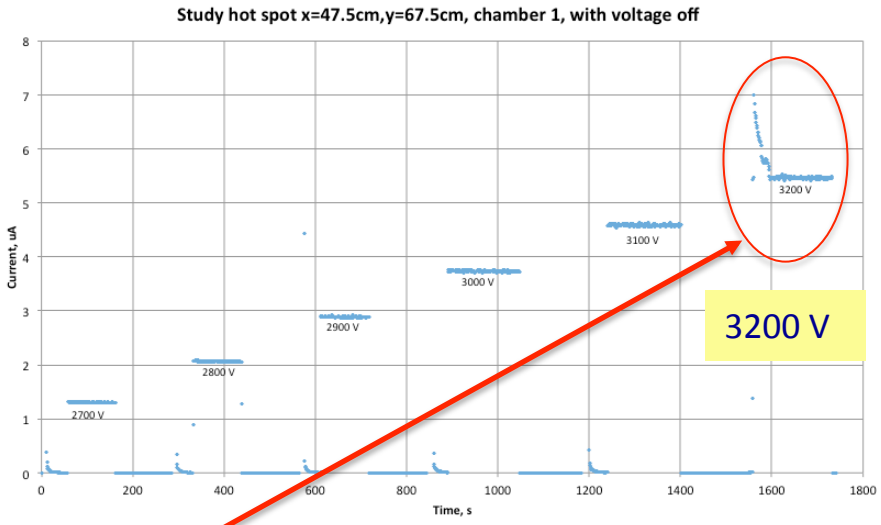




- Multiple repeating discharges with different duration.
- There are no discharges at the nearby points ⇒ the hot spot is located.
- After long irradiation of the nearby points discharges were disappeared ⇒ discharges depends on time of irradiation
- Discharge had stopped, when X-RAY was off ⇒ Discharge is continuous
- Discharge lasted even when X-RAY was off (Malter effect). Need to decrease HV. Discharge is self-sustaining.

Tests with n-pentane/CO_2 mixture





Only one hot spot was found, when chamber had been filled with n-pentane/CO_2 mixture. This spot corresponds to that which had discharges in CO_2 gas. Training allows to fix this problem.

Summary

- Tests with CO_2 gas are more sensitive to the chamber effects.
- If the goal of the tests is to find all defects, one should work with CO_2 mixture.
- Gas gain saturation is observed at 2750 V in n-pentane/CO_2 gas mixture.
- This mixture is much less sensitive to the chamber defects.
- To study chamber behavior at real operating conditions, one should work with sTGC base line mixture (n-pentane/CO_2).
- Gas gain uniformity depends on the gas mixture. Gas gain variation of 10.5% for CO_2 and corresponds to that of 5.4% for n-pentane/CO_2 mixture.
- Scans using X-ray irradiation allow to find chamber defects, which are critical for operation in radiation environment of LHC experiments .

Thank you for your attention!