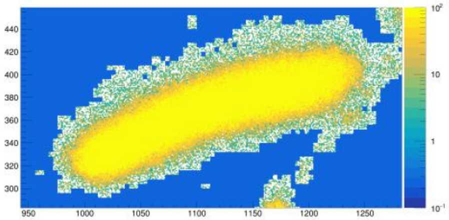
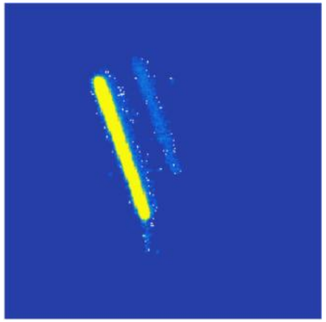
Oxided GEM Episode II

Giorgio Dho

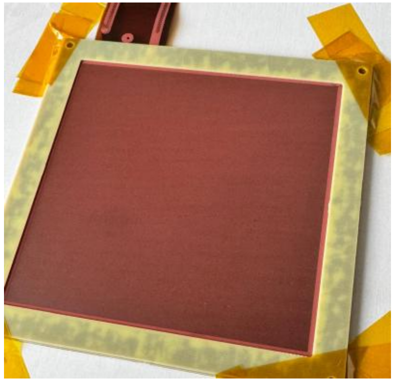
Recap

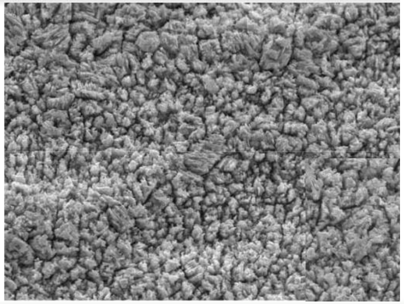
- Oxided GEMs employed to limit the reflection of tracks on images → **Success!**

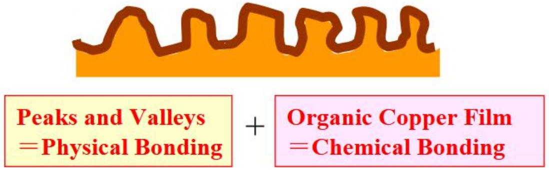


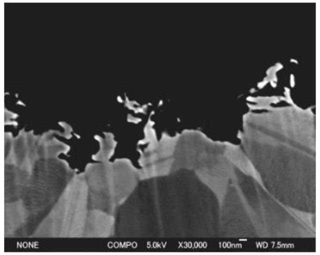


- They are not really oxided: V-Bonded
  - Bath of chemicals which etches non perfect Cu crystals generating small valleys
  - Depth about 500 nm, width similar with organic copper film of 10s nm
  - Likely to be mildly resistive
  - Going through a second etching, the border of the GEM holes is cleaned more leaving the GEM ring hole wider









Experimental Setup

- With Davide F we discovered these GEMs (including the non V-bonded) are single masked
- This means the orientation of the GEM matters (different size of the holes)
- Could this explain the reduced light yield measured with respect to old GIN setup?
- Since December 24, Quest2 and EHD lens arrived and replaced old optical readout
- We need to retest the GEMs in both orientations with new cameras and max aperture

Relevant things:

Old data -> Fusion and Xenon lens

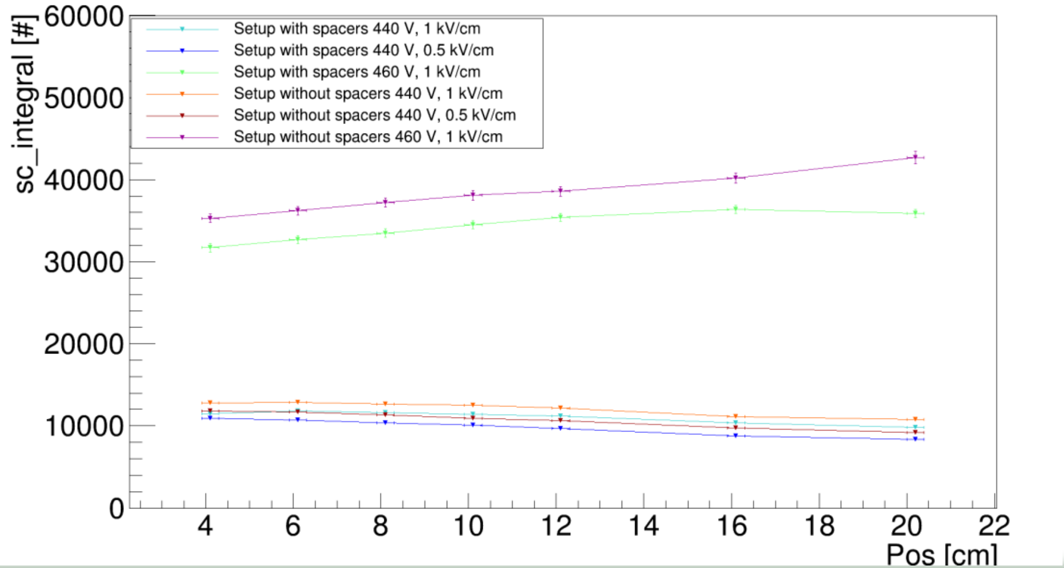
The rest -> GEM3 oxided, EHD lens, QUEST2

Spacers or not Spacers

- Since we had to tinker with the optical distance we tried 2 setups to focus on GEM plane

With spacers	
Distance to GEM:	33.4 cm
Spacers:	2 mm
Focus lens:	108 cm
Solid angle:	$8\ 10^{-4}$
Pixel image size:	46 um

Without spacers	
Distance to GEM:	33.9 cm
Spacers:	0 mm
Focus lens:	20.5 cm
Solid angle:	$8.3\ 10^{-4}$
Pixel image size:	45 um



- The solid angle formula predicts 3.7% more light for no spacers
- No spacers config also had less humidity (effect estimated of 4-5%)
- Measured difference in favour of no spacers: 9%

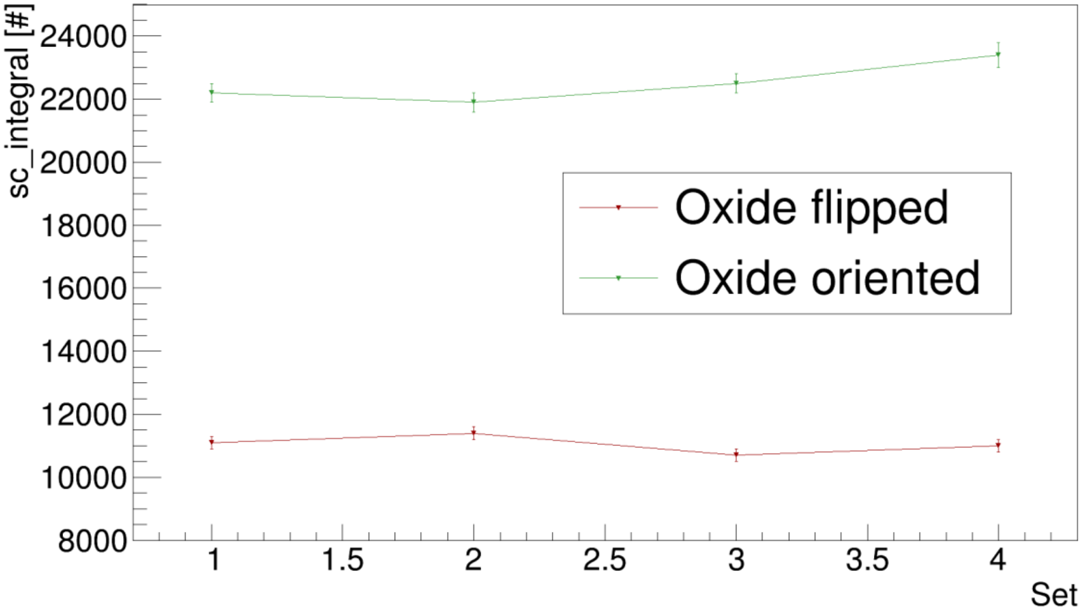
We are in the right ballpark

Spacers do not affect LY

GEM combo

- To see if the oxided GEM is the one responsible for the different light response we tried different GEM voltage setups

DataSets	VGEM1	VGEM2	VGEM3
1:	440	440	440
2:	450	450	420
3:	450	420	450
4:	420	450	450



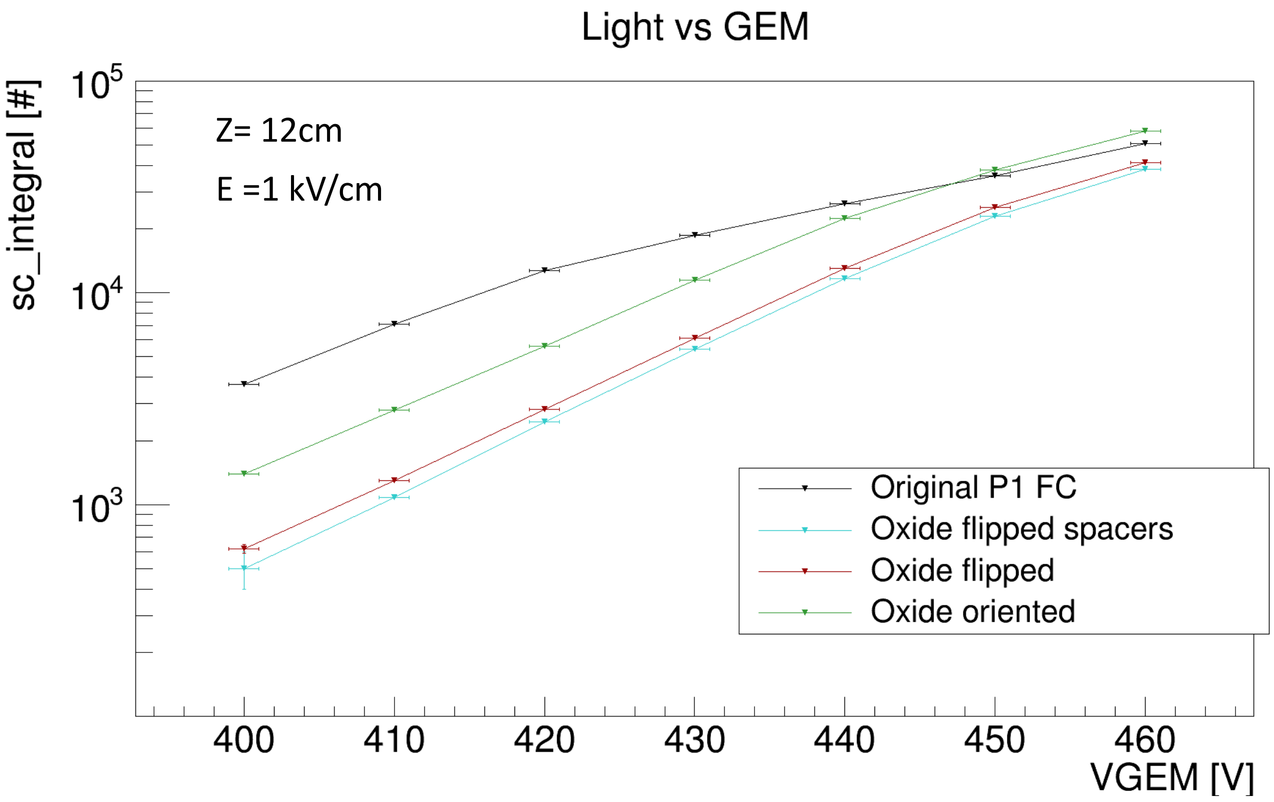
Max difference between VGEM distribution 6.5%

Difference between flipped and oriented GEMs 100%

The two regular GEMs were flipped and this caused the light loss

VGEM scan

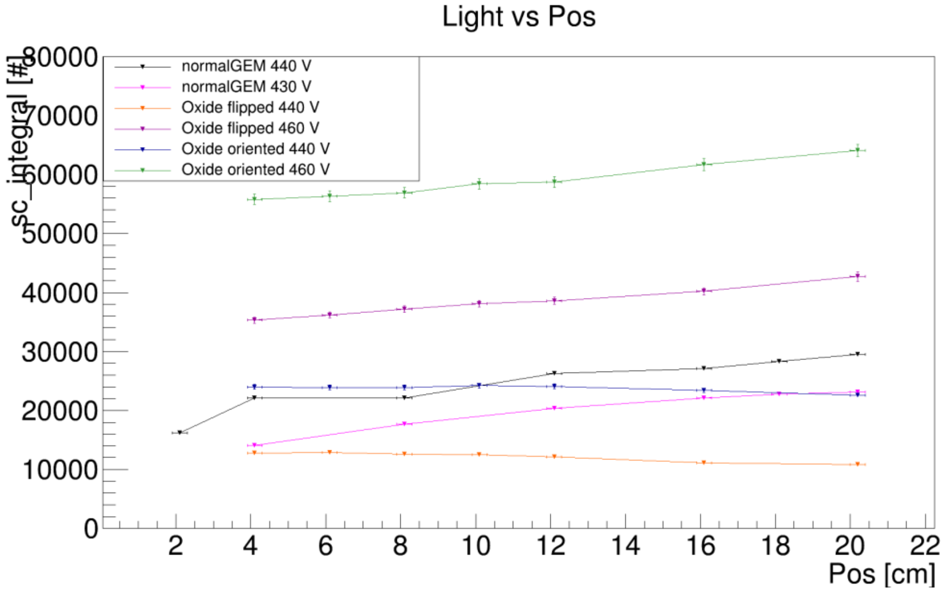
- Now that we have a set of data with high light yield we can compare with old GEMs behaviour



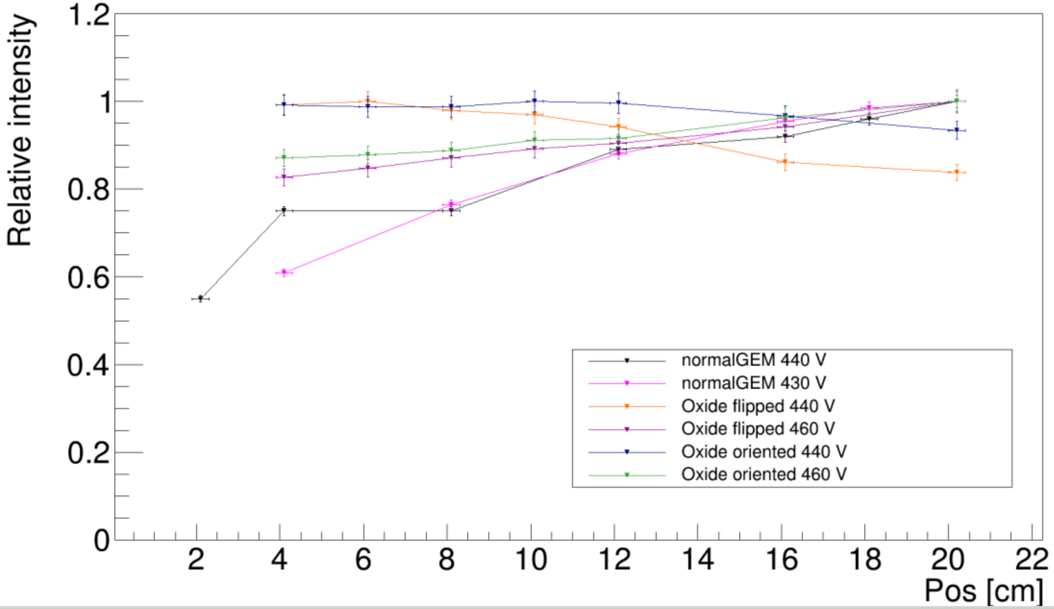
- Similar behaviour between flipped and non flipped until 450 V
- Old GEMs are saturating faster
- Also oxided GEM is saturating

LY vs Z scan

- Now that we have a set of data with high light yield we can compare with old GEMs behaviour



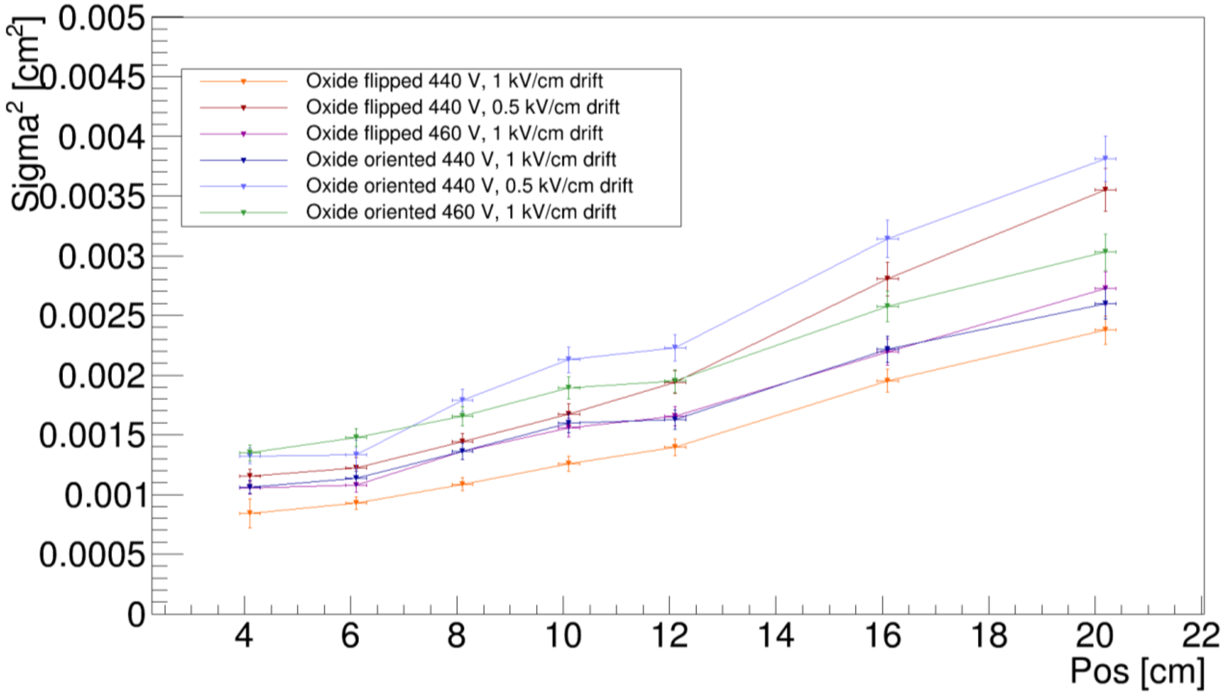
Saturation almost absent in oxided at 440 V



@ 4 cm instead of 40% reduction we have less than 20% with double the light!

Sigma vs Z scan

- Tgausssigma used for round ^{55}Fe spots to estimate the diffusion in the gas



Closer than 10 cm diffusion flattens… ??

- Above 10 cm data sets with same fields are parallel: same diff coefficient
- As done in the past the expected diffusions from simulation are compared to the measured:

Diff coeff

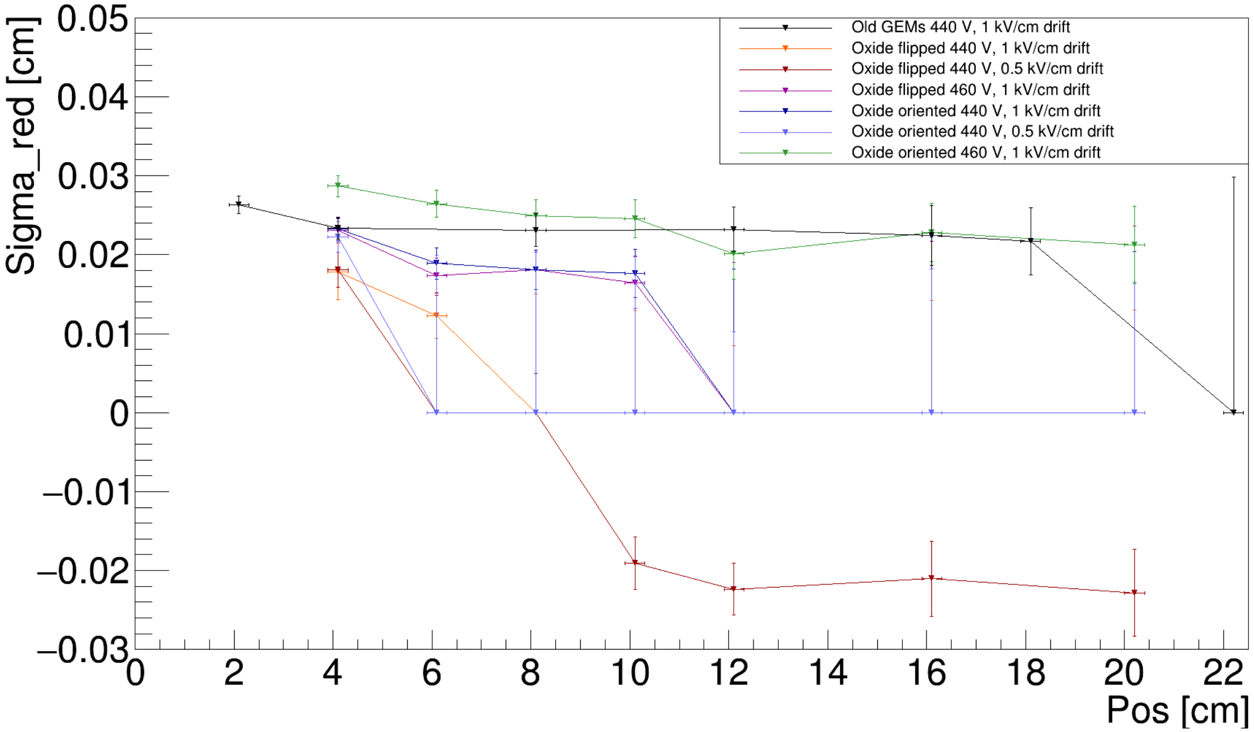
0.5 kV/cm	(138 ± 2) um/$\sqrt{\text{cm}}$
1 kV/cm	(115 ± 2) um/$\sqrt{\text{cm}}$

Expected from simulation

0.5 kV/cm	(142 ± 3) um/$\sqrt{\text{cm}}$
1 kV/cm	(113 ± 3) um/$\sqrt{\text{cm}}$

Diffusion affected by saturation

- Small analysis to check if the sigma0 term is affected by distance:
  1. Check if the expected diffusion (simulated diffusion coefficient x √z) and the measured one are compatible (error of about 5%)
  2. **If they are not compatible:** sigma0 computed as difference in quadrature of measured – expected
  3. **If they are compatible:** sigma0 is 0 and a 2 sigma error is used to estimate a rough 90% CL of sigma0



Higher saturation and light yield have somewhat constant sigma0 (black green)

Lower saturation condition have it increasing with small L

Conclusion

- Gin setup upgraded with QUEST2 and EHD lens
- Confirmation that the use of spacers does not affect light yield
- GEMs are now single mask with a preferential direction. This caused the reduction of light yield (2 were flipped)
- Less saturated behaviour confirmed for the oxided GEM
- It is possible to go with less saturation at even higher light yield
- Diffusion estimation confirms regularity of the drift field
- Question: Is lower saturation exposing its influence on diffusion?

GIN Activities

- New setup: 2 scintillators one above and one below GIN Faraday cage
- Lab II students:
  - Setup the acquisition (take data when something passes through the 2 scintillators
  - Goal: Characterisation of scntillators – measurement of drift velocity vs Edrift
- Federico (Master student):
  - Tag muon with defined z to apply machine learning techniques for:
    - absolute z determination
    - Removal of diffusion effect on tracks