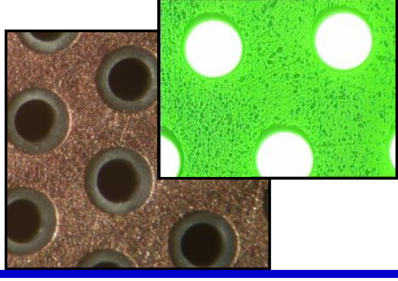


IBF in THGEM-based PHOTON DETECTORS,

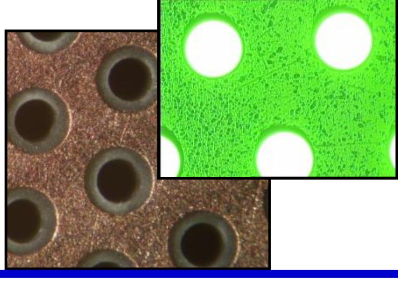
an update

S. Dalla Torre

PREVIOUS TALK:
F. TESSAROTTO, June 2012

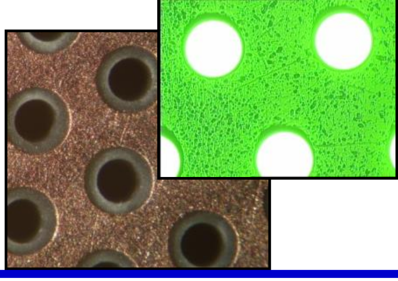
on behalf of an

Alessandria , Aveiro, CERN, Freiburg, Liberec, Prague, Torino, Trieste Collaboration

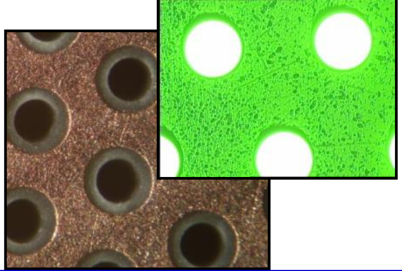


LAY-OUT

- INTRODUCTION
- STATUS 1 YEAR AGO (REMINDER)
- FINAL RESULTS
- CONCLUSIONS



INTRODUCTION



IBF in Photon Detectors

The relevant IBF in Photon Detectors (PD):

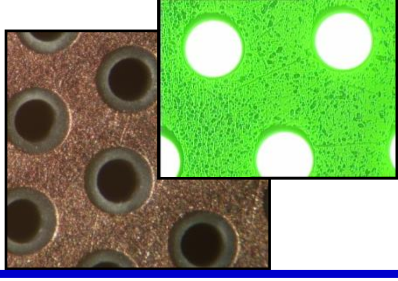
Photocathode bombardment

- A problem already in vacuum-based PDs, when the vacuum is degraded
- In gas PDs the tolerable bombardment depends on the photoconverter:
  - **CSI:** non negligible QE for λ < 210 nm (VUV)
    - The highest work function among usual photoconverter
    - QE degradation: integrated Q > a few mC/cm^2 → ageing, limited gain
    - High resistivity: difficulty to neutralized the charge (Malter effect) → limited gain
    - IBF rates a few times 10^{-2} required
  - **Visible light photoconverters:** K-Cs-Sb, Na-K-Sb
    - QE degradation: integrated Q > a few μC/mm^2
    - IBF rates a few times 10^{-4} required

OUR INTEREST

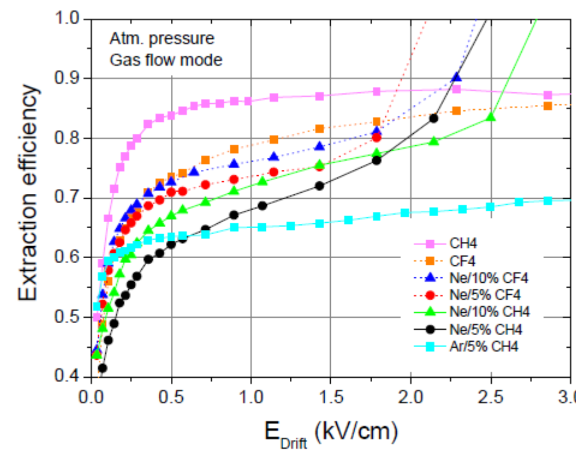
H. Hoedlmoser et al., NIMA 574 (2007) 28.

A.Breskin et al., NIMA 553 (2005) 46



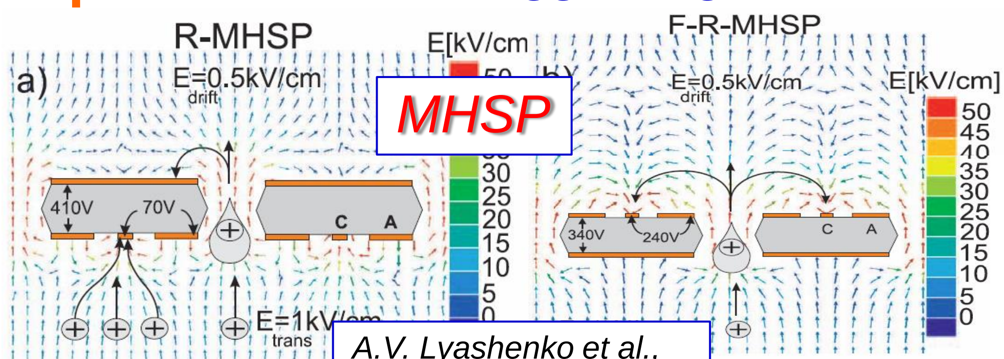
IBF in GAS PDs, THE DILEMMA

- ***High E at the photocathode surface required for effective photoelectron extraction***



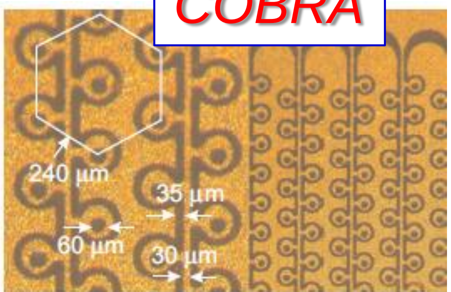
C. D. R. Azevedo et al., 2010 JINST 5 P01002

- ***High E at the photocathode surface increases the IBF rate***
  - ***More field lines end at the photocathode***
  - ***Extra intermediate electrodes ((F-R) MHSP, COBRA)***
  - ***THGEM: staggered geometries***



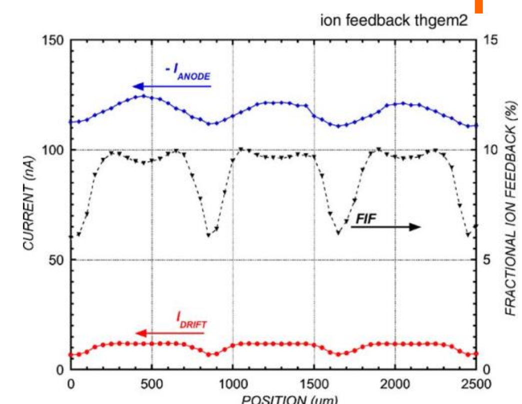
MHSP

A.V. Lyashenko et al., JINST 2 (2007) P08004

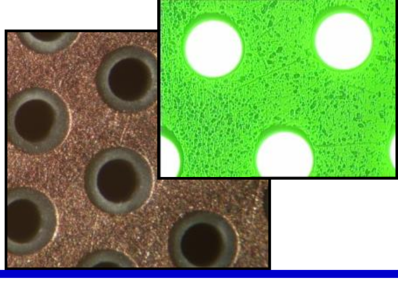


COBRA

A.V. Lyashenko et al., NIMA 598 (2009) 116



F. Sauli , L. Ropelewski, P. Everaerts, NIMA 560 (2006) 269.



IBF, our needs and goals

- PIDs (and other ionization sources) must be taken in account as well
- IN COMPASS RICH-1 environment:

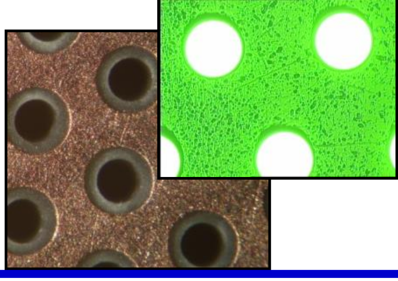
NOW *FUTURE*

	MWPC	THGEM
photoelectron rate	$\approx$10 Hz/cm^2	$\approx$10 Hz/cm^2
MIP rate	$\approx$10 Hz/cm^2	$\approx$10 Hz/cm^2
gain, i.e. number of ion-electron pairs generated per multiplied electron	4×10^4	4×10^5
collected electrons per MIP	20	$\approx$5
IBFR	$\approx$50%	$\approx$5%
N_i	2×10^4	2×10^4
ion bombardment rate at the photocathode (from MIP and photoelectrons)	4.2×10^6 Hz/cm^2	1.2×10^6 Hz/cm^2

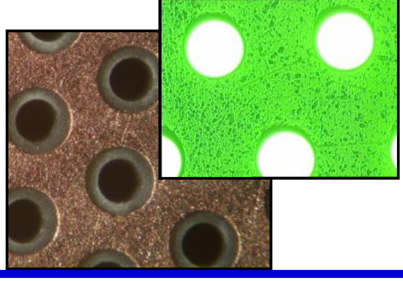
Reverse Bias !!!

GOAL !!!

NOTE: we normalize to the total ionization



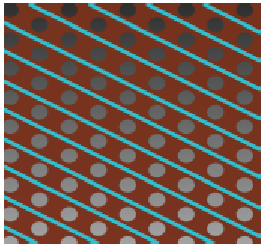
STATUS 1 YEAR AGO

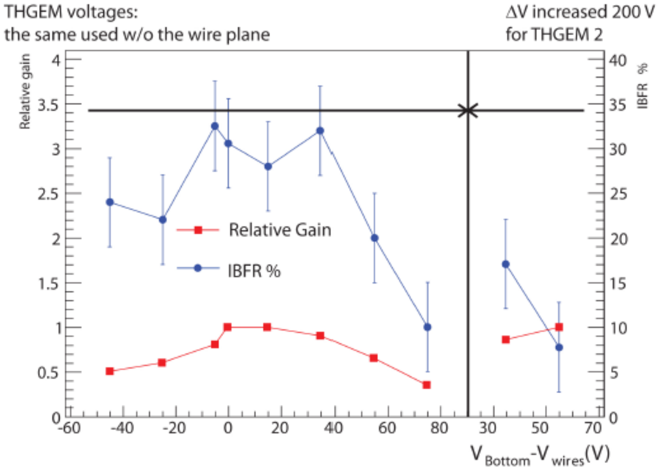


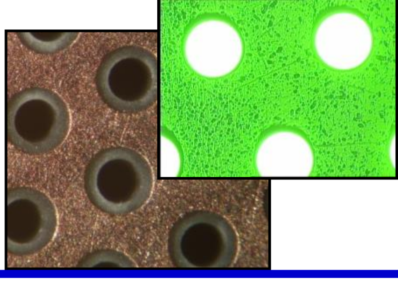
IBF suppression by extra electrodes

- **THICK COBRA**
  - IBF rate ~ 5% (F.D. Amaro et al., JINST 5 (2010) P10002; J.F.C.A. Veloso et al., NIMA 639 (2011) 134)
  - Our analysis, geometrical constrains
    - Assuming traces and clearance at least 0.2 mm → hole diameter d 0.3 mm, pitch p 1.2 mm namely d/p=0.25, while d/p=0.5 is needed (photoelectron extraction, total gain)

- **Extra wire plane** (technical difficulties)

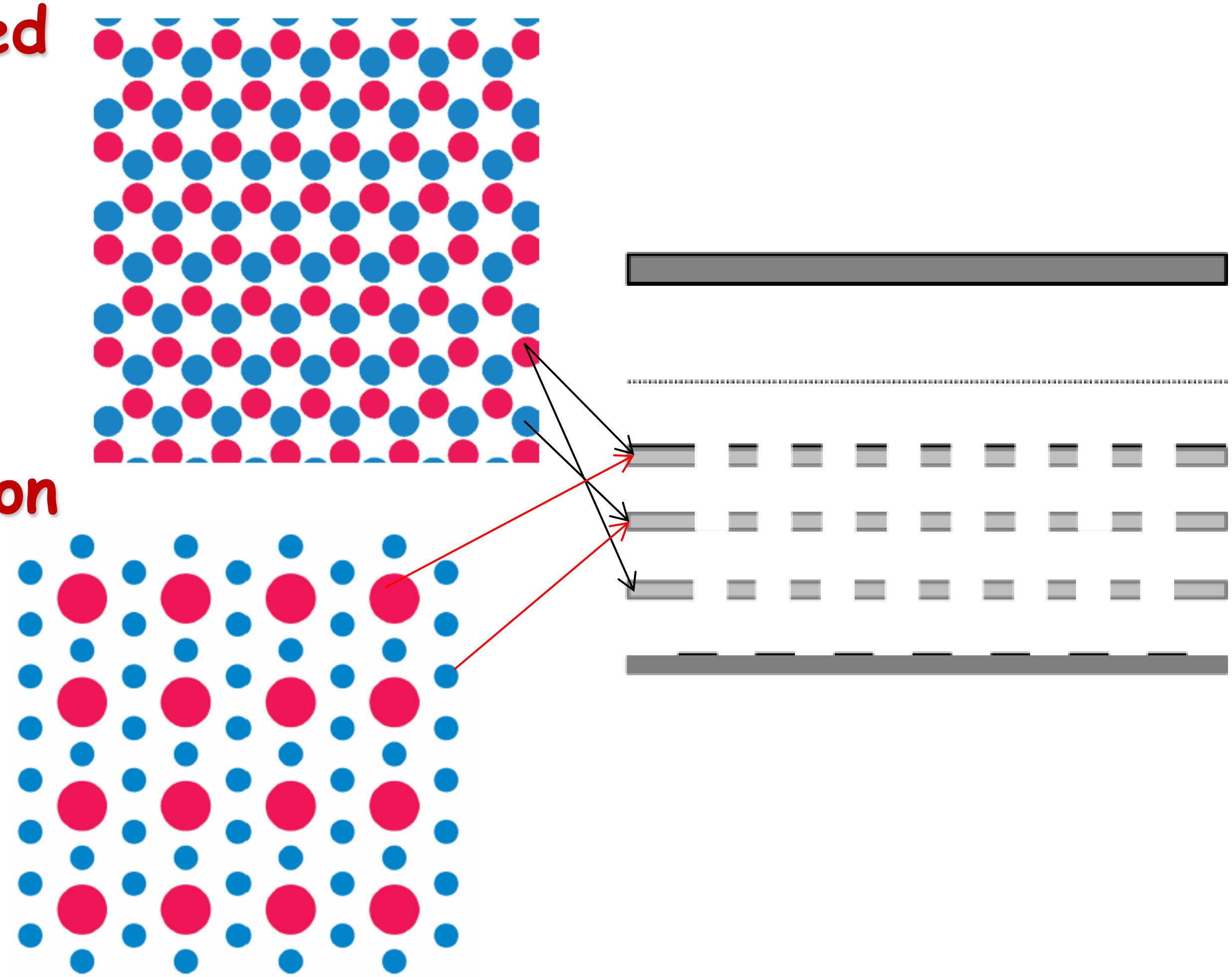


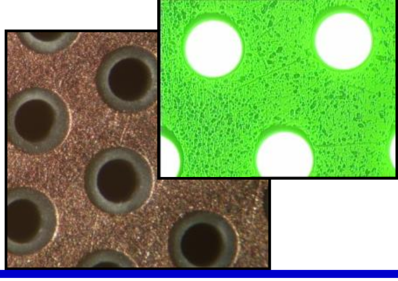




IBF suppression by staggered holes

- **Standard staggered configuration**
- **Flower configuration**
  - But low gain and efficiency: abandoned

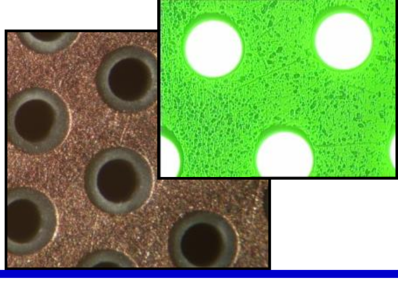




FINAL RESULTS

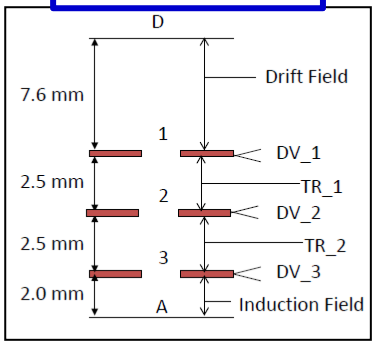
(published:

M. Alexeev et al., 2013 *JINST* 8 P0102)

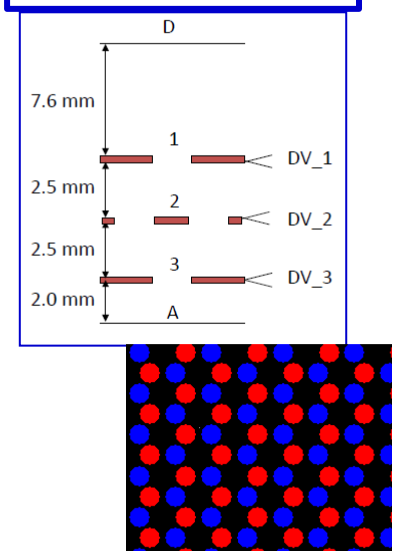


IBF: staggered vs aligned

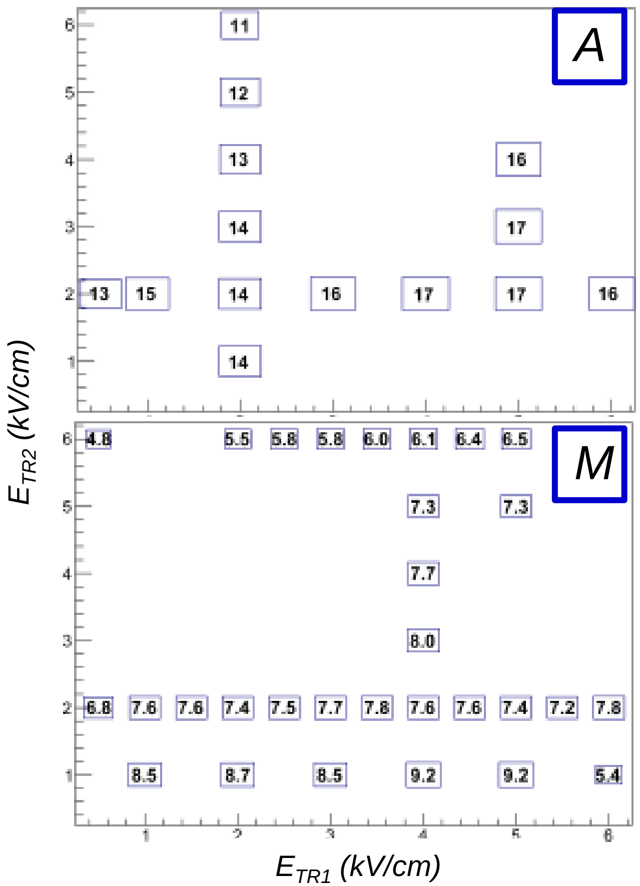
A -aligned



M -misaligned

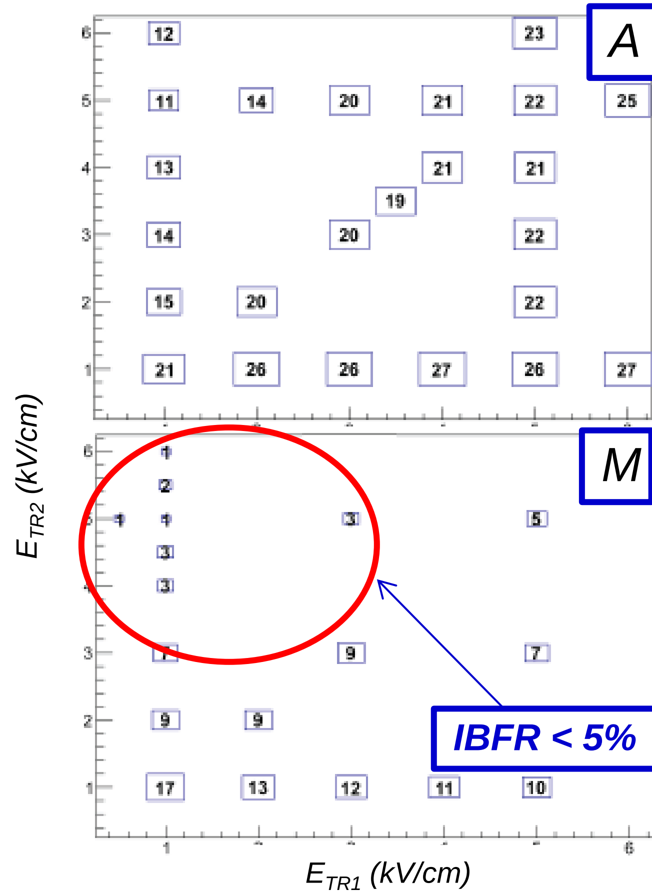


Effective GAIN (x 10^4)



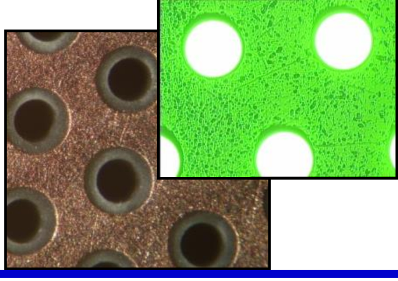
Identical V

IBFR (%)



IBFR < 5% !

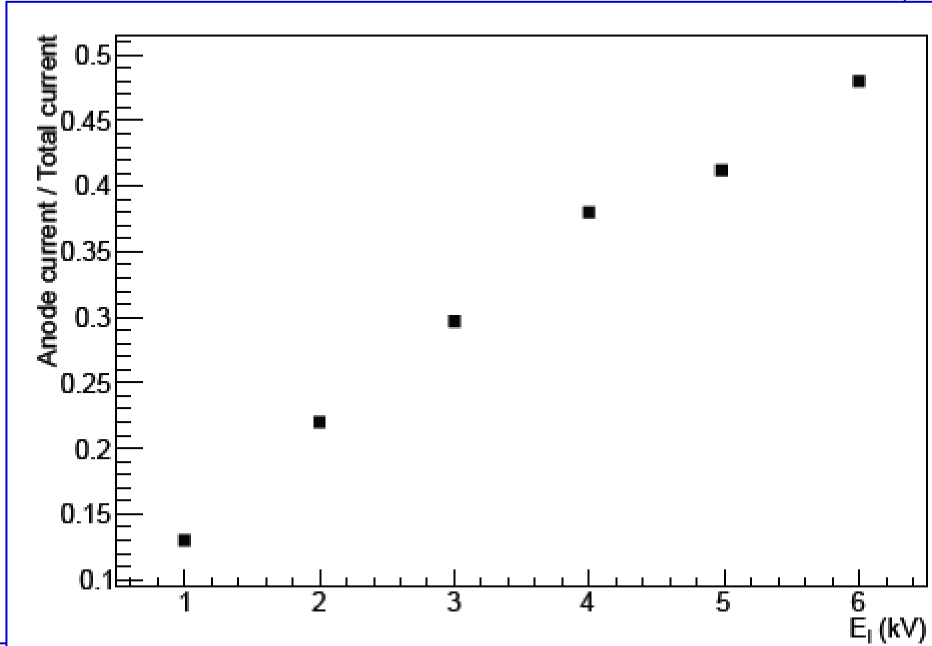
GAIN: down a factor 2 → recover by increasing the voltage

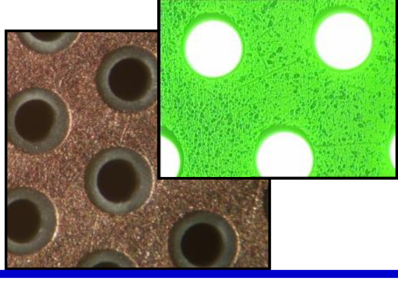


IBF: staggered vs aligned, more

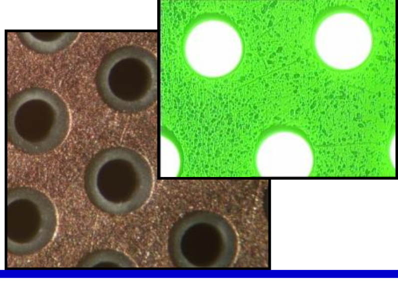
- **Gain "recovered"**
  - @ E_{TR1}= 1000 V , E_{TR2}= 4000 V
  - ΔV_1 : 1450 V → 1480
  - ΔV_2 : 1500 V → 1530
  - ΔV_3 : 1550 V → 1580
  - Gain: 8 x 10^4 → 20 x 10^4

- **Large E_{TR2}-values impose large E_I-values**
  - @ E_{TR1}= 1000 V, E_{TR2}= 4000 V →





CONCLUSIONS



CONCLUSIONS

- IBF rates < 5% are reachable with triple THGEMs preserving good gain
  - *Staggered configuration*
  - *@ E_{TR1} low (~1000 V) , E_{TR2} high (~4000 V)*
  - *E_I : high*
- → the resulting total voltage is high
  - *In the example provided: V_{tot} ~ 7.7 kV*