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Hard radiation from long spark discharges

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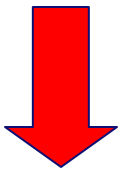
Outline

- Motivation
- Experimental setup
- Results measurements
  - Positive polarity discharges
  - Negative polarity discharges
- Conclusions

Motivation

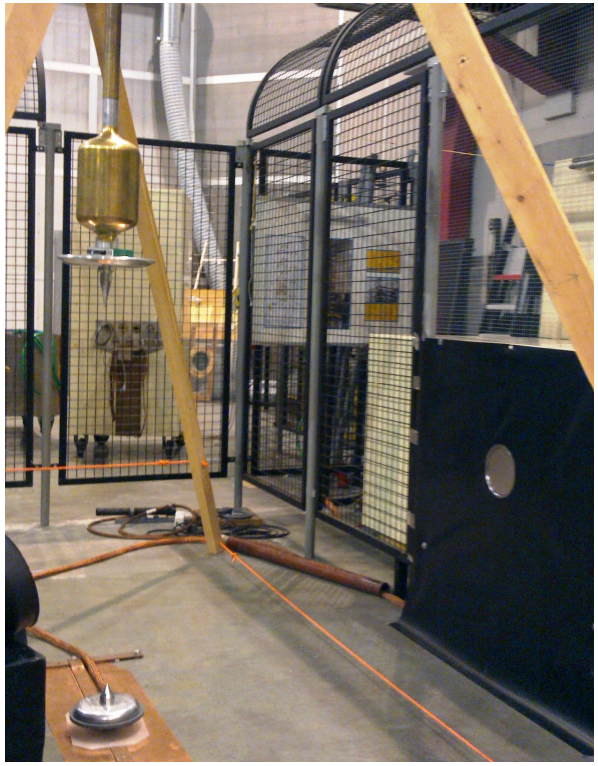
- Satellite detection of TGF's
- X-ray from lightning
- X-ray from long laboratory spark discharges
- X-ray from diffuse discharges

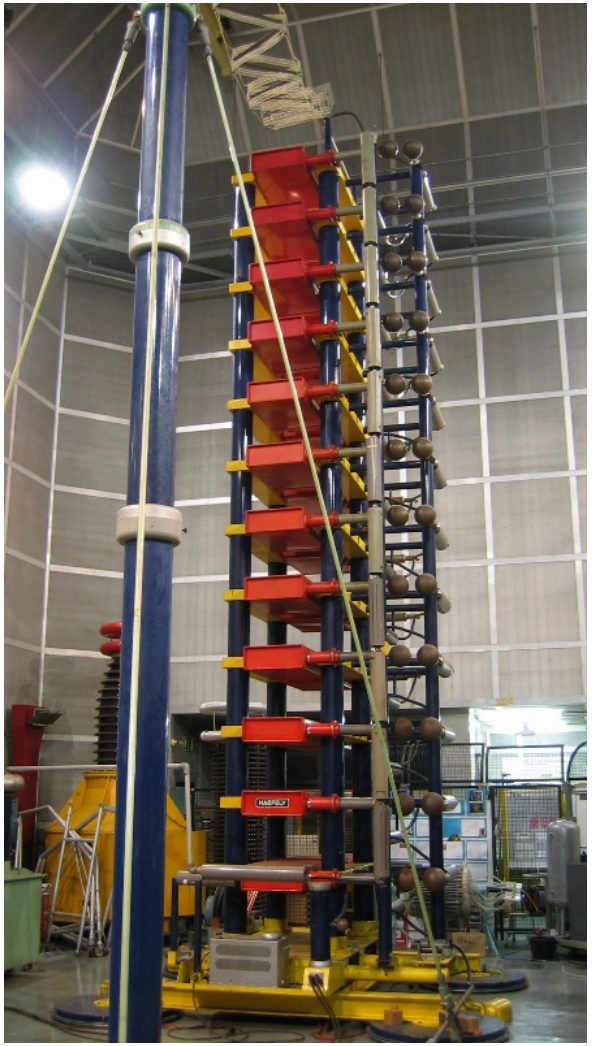


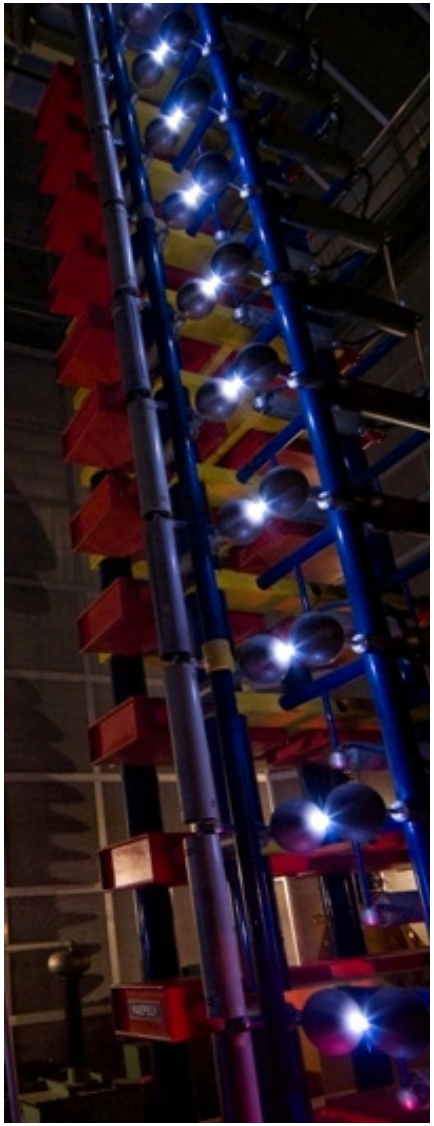
What is the mechanism behind this high energy process?

Experimental setup

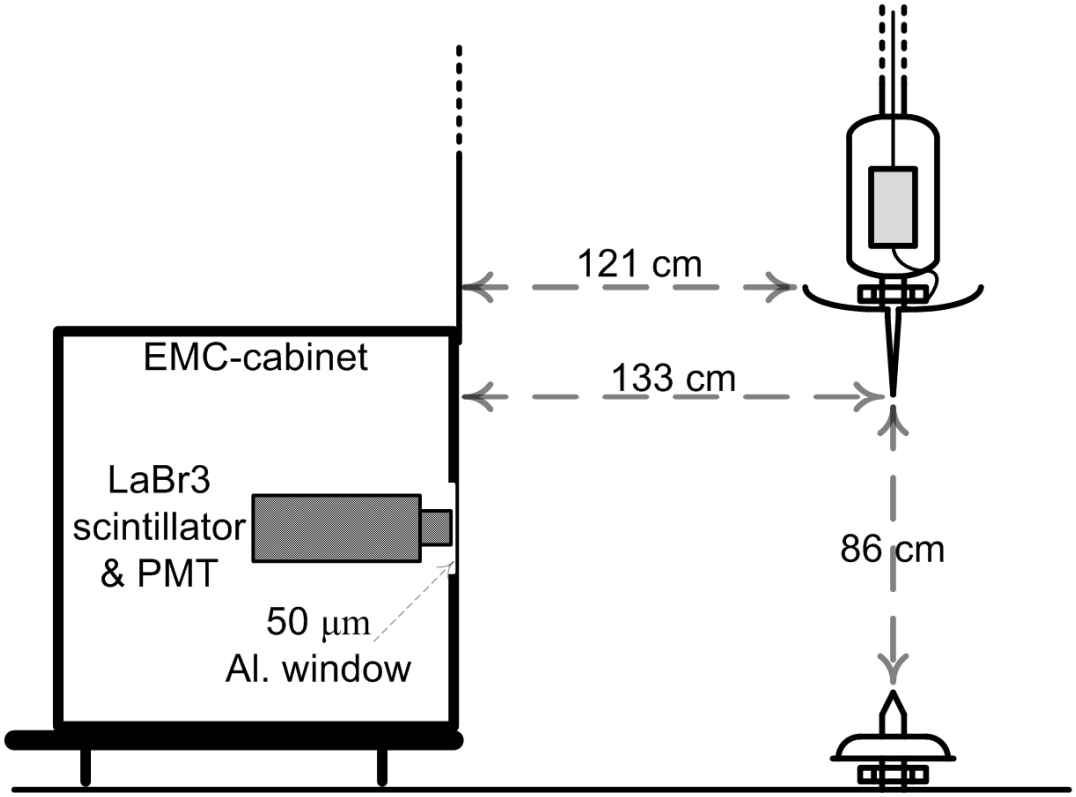
- 12 stage 2.4MV Marx generator
- properly shielded instruments
- 8m distance from Marx generator
- measurement of electrical properties in combination with energetic photons







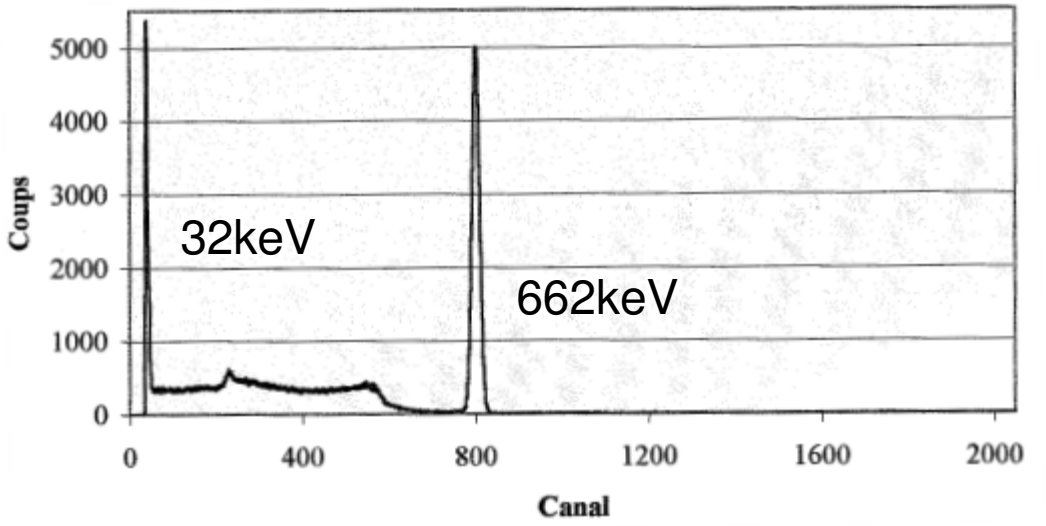
Schematic of experimental setup



X-ray detector properties (662keV)

	NaI(Tl)	$LaBr_3(Ce)$	BaF_2
a) # Photons/keV	38	63	1.8
b) Rise/fall [ns]	40/230	11/23	–
c) FWHM [ns]	270	38	4

$LaBr_3(Ce)$ response to ^{137}Cs



- 2.5% energy spectrum for 662keV photon (FWHM)
- 165% photoelectron yield with respect to NaI(Tl)
- good energy resolution

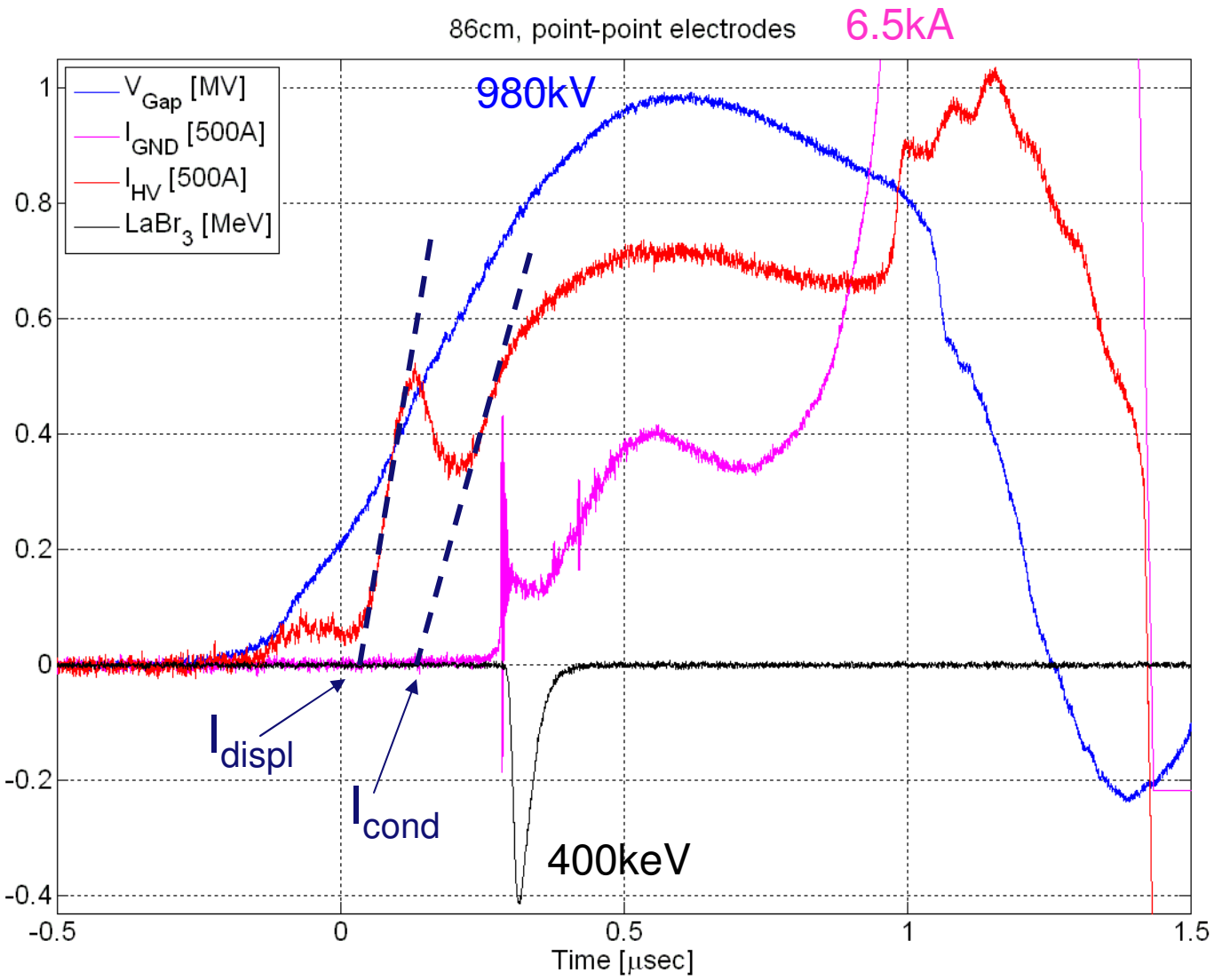
Difference between CZT- and scintillation detectors

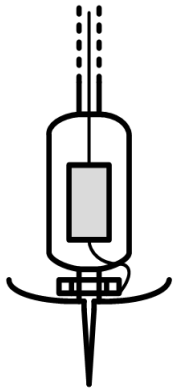
- CZT-detectors converts photon or electron energies to number of electron-hole pairs. → possible to discreet photon or electron energies

- Scintillation detectors converts photon or electron energies to visible light. → no difference in electron or photon detection!

Results measurements

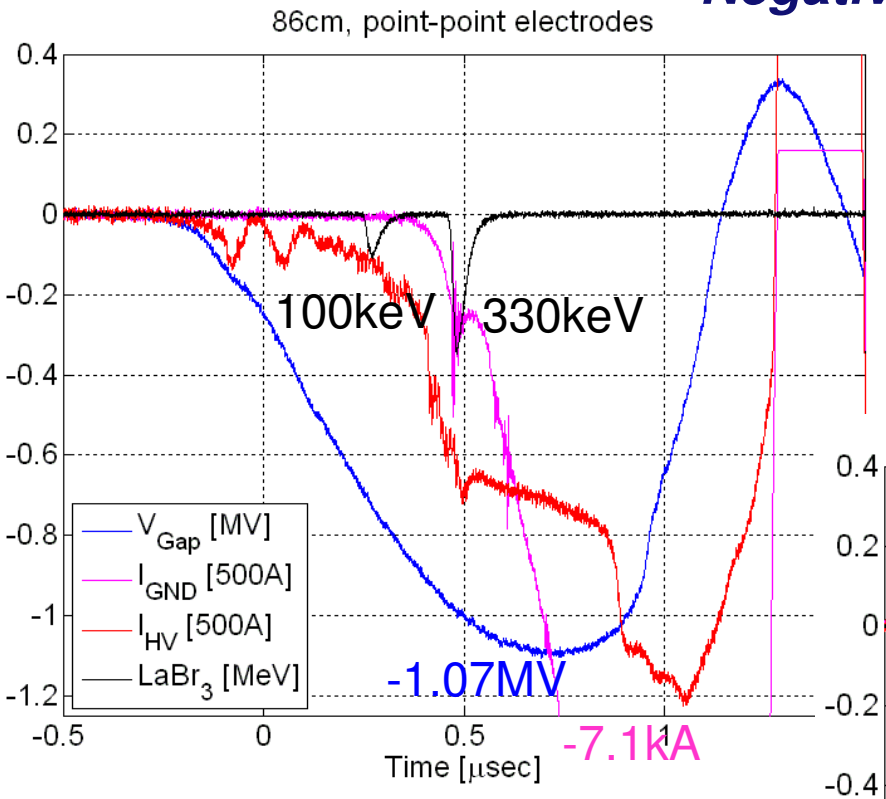
Positive discharges



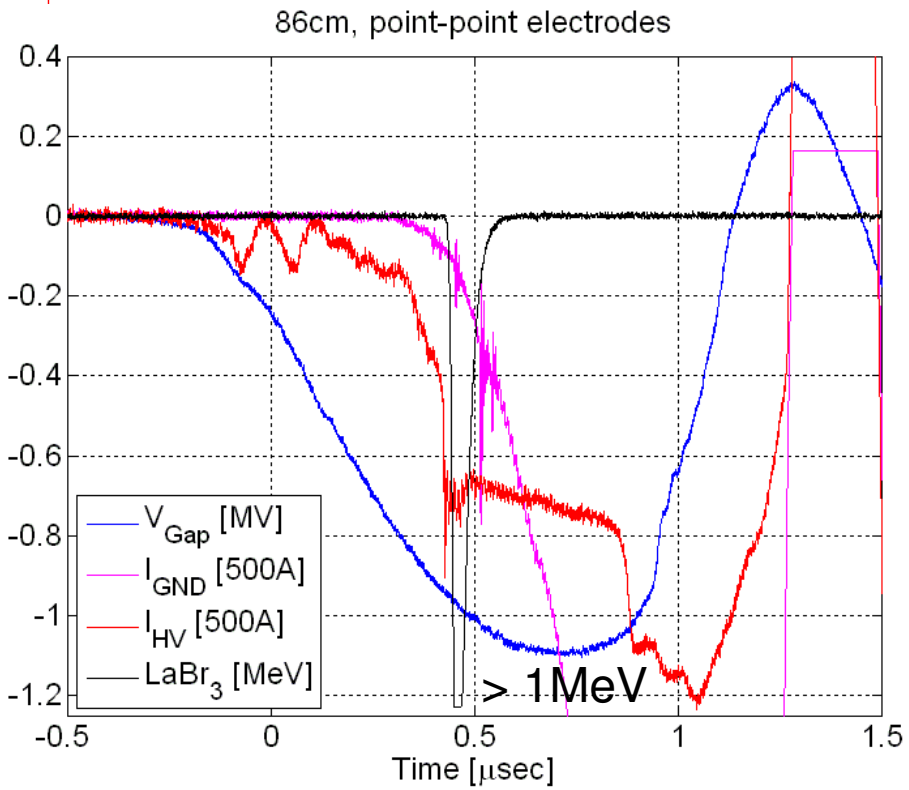


X-ray burst correlated with initialization of negative leader, near cathode

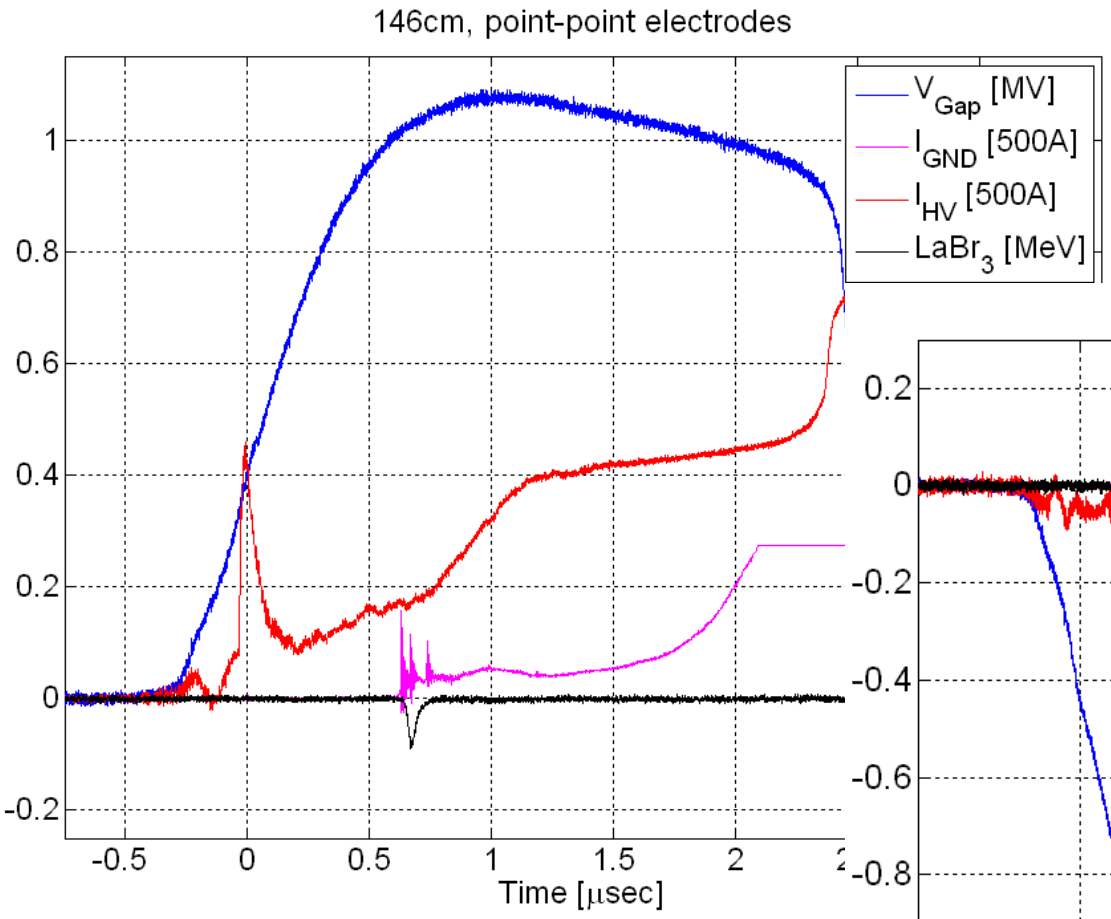
Negative discharges

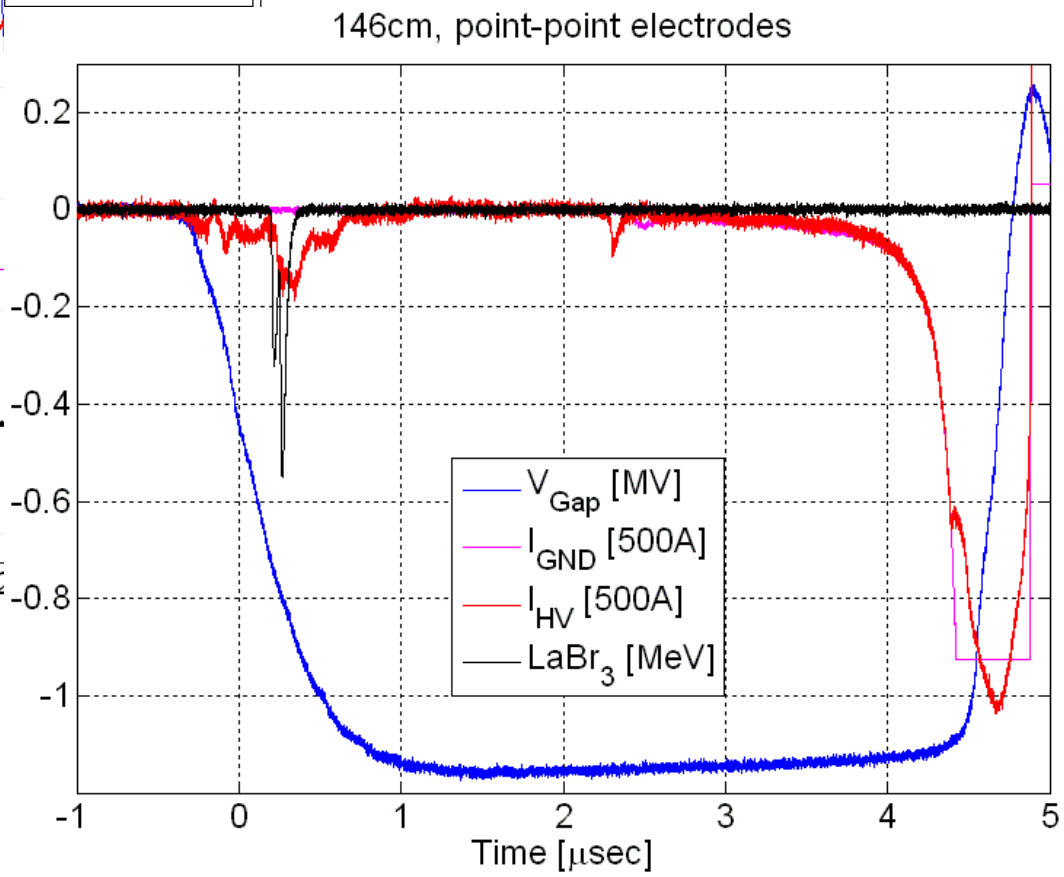


- More complicated process
- X-ray burst at initialization negative streamer/leader and stepping?



Larger electrode distance





Conclusions

- Only X-ray bursts during streamer/leader development
- Strong correlation with negative streamers/leader
- Positive HV polarity
  - near cathode
  - X-rays in 45% of discharges
- Negative HV polarity
  - near cathode and possibly during stepping
  - X-rays in 75% of discharges
  - More intense X-ray bursts (pile-up)
  - High-energetic electrons cannot be ruled out!
- Photon energies up to several 100keV
- Bremsstrahlung process

Thank You!