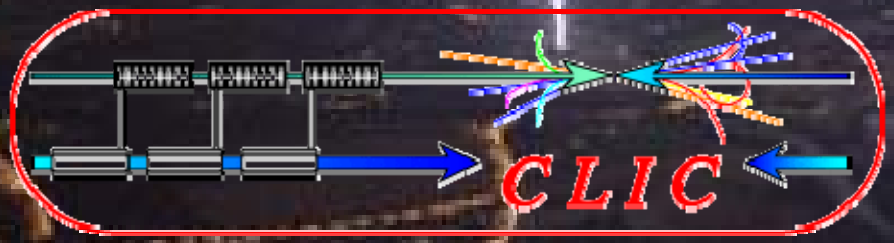
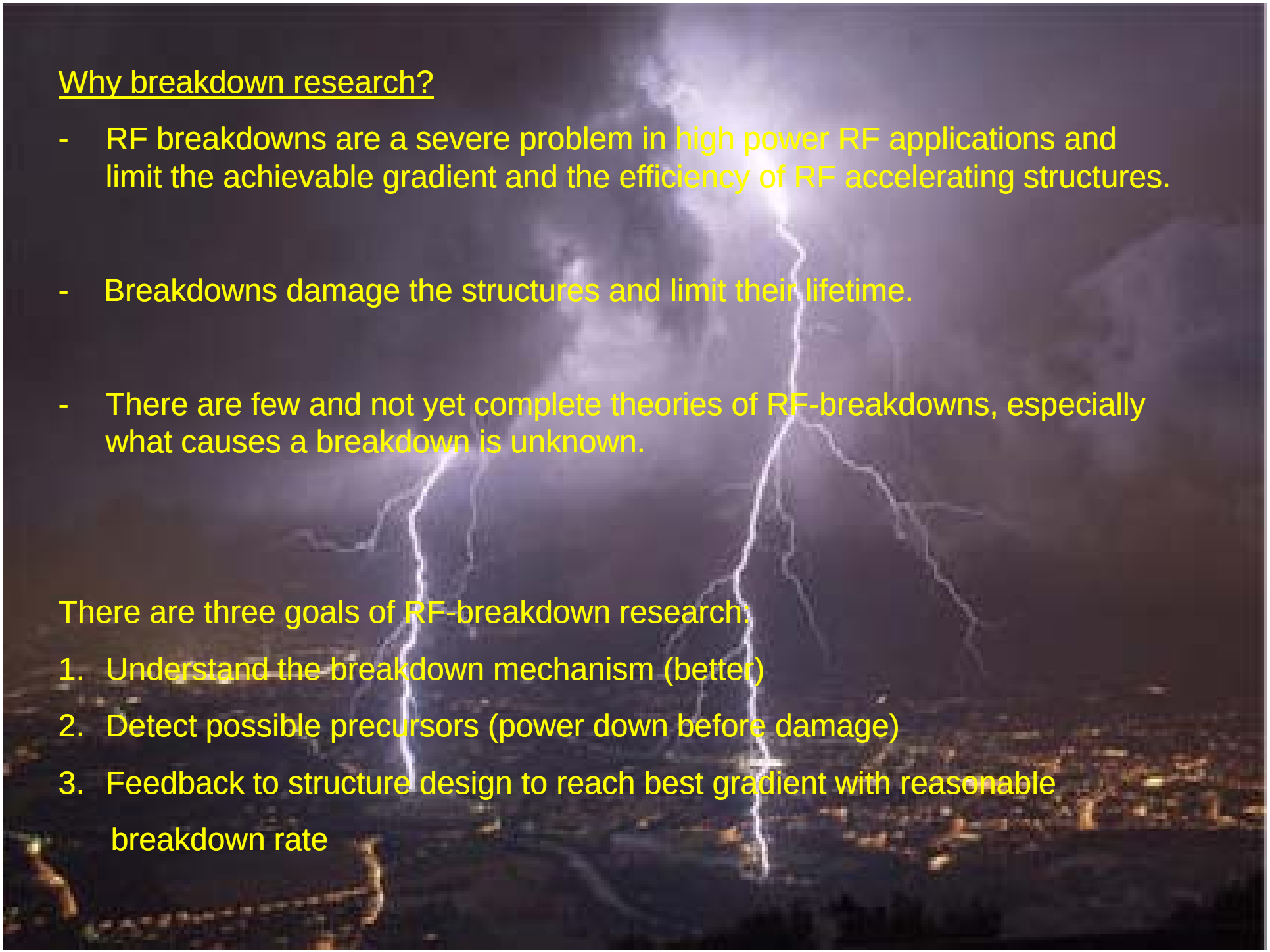
Experimental RF-breakdown studies



Jan W. Kovermann

CLIC workshop, 16-18. Oct. 2007



Why breakdown research?

- RF breakdowns are a severe problem in high power RF applications and limit the achievable gradient and the efficiency of RF accelerating structures.

- Breakdowns damage the structures and limit their lifetime.

- There are few and not yet complete theories of RF-breakdowns, especially what causes a breakdown is unknown.

There are three goals of RF-breakdown research:

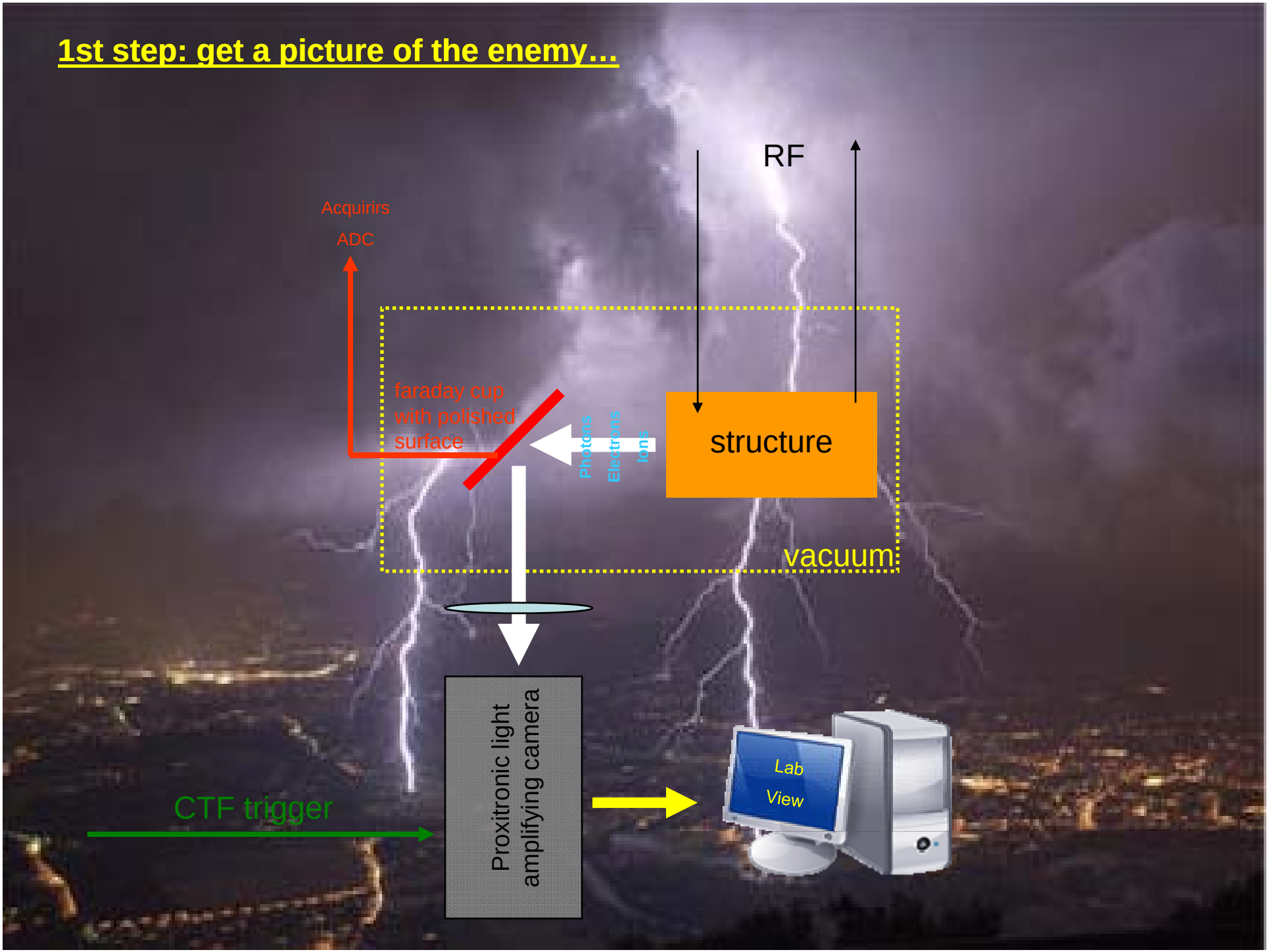
1. Understand the breakdown mechanism (better)
2. Detect possible precursors (power down before damage)
3. Feedback to structure design to reach best gradient with reasonable breakdown rate

Planned instrumentation for breakdown research:

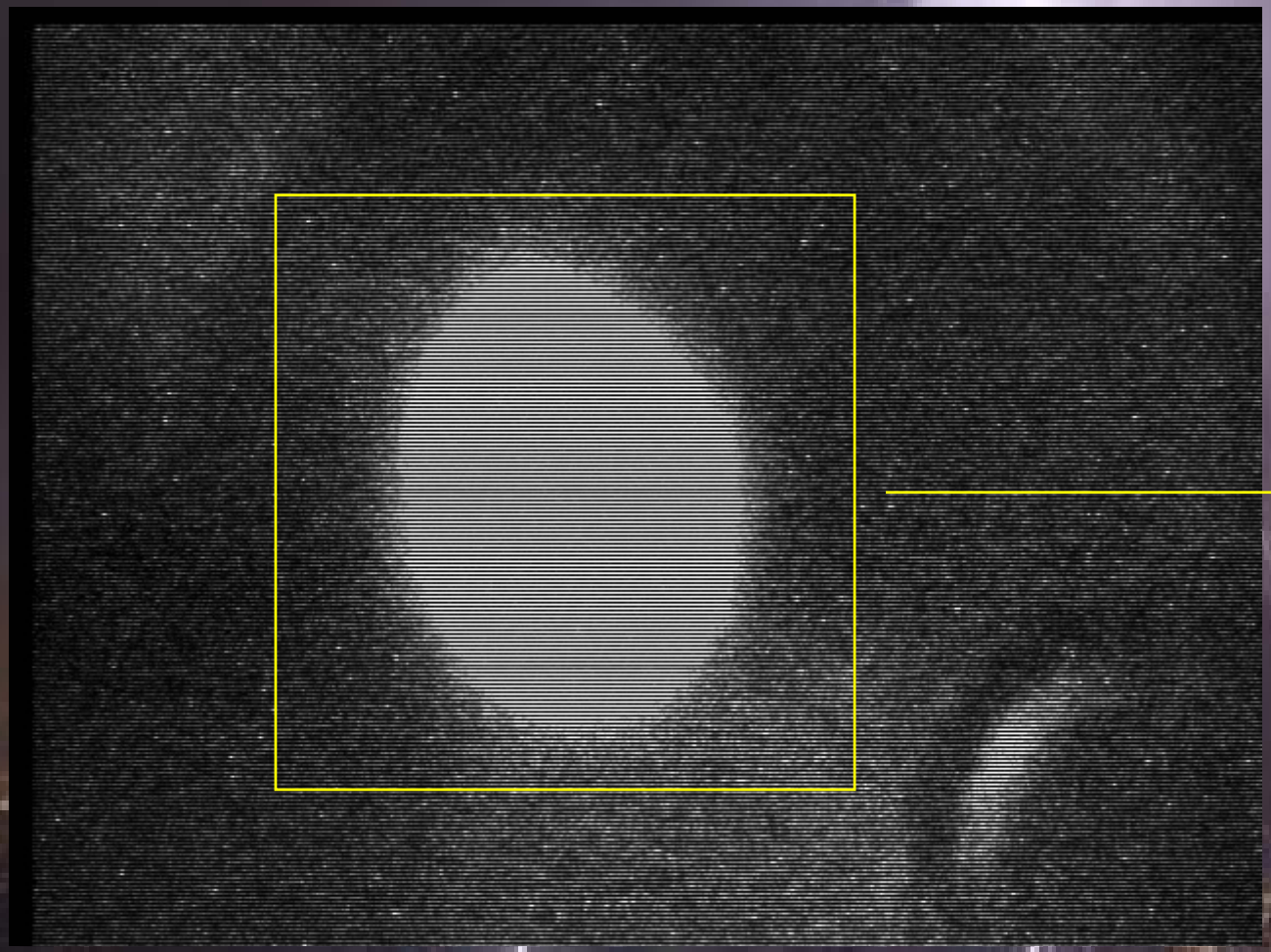
- Imaging of breakdowns (already done for 30GHz structures, difficult…)
- General timing between RF and light, reflected RF, electrons and ions
- Time resolved spectroscopy (field emission, residual gas, plasma?)
- X-Ray imaging
- Electron and ion spectroscopy
- Infrared imaging in X-Band cavities (surface heating?)
- Target for copper ions/clusters for SEM

Feedback of all results into a (GEANT4 and/or Microwave studio) simulation to eliminate effects of shielding, reflection, damping etc.

1st step: get a picture of the enemy…



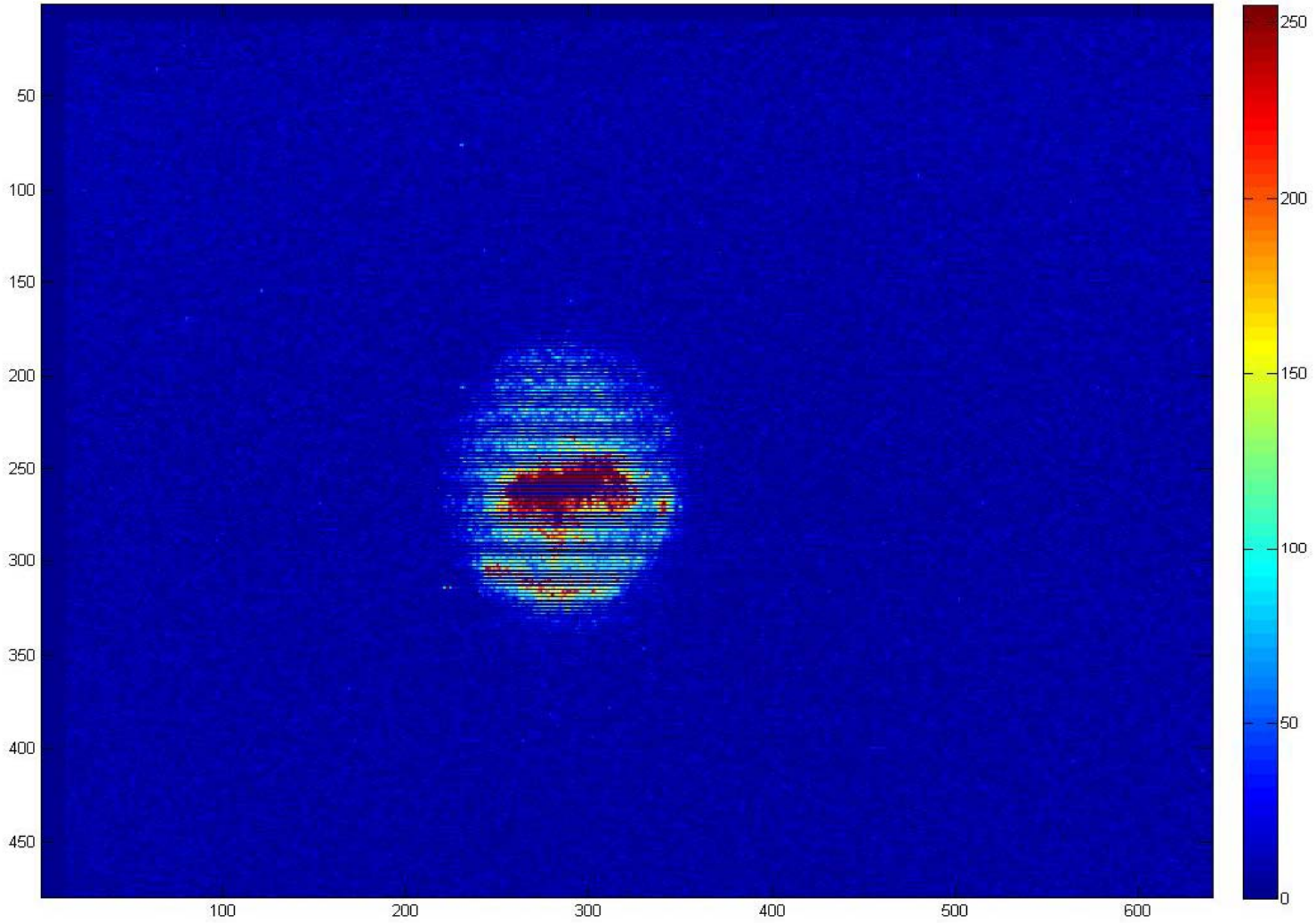
The image trigger



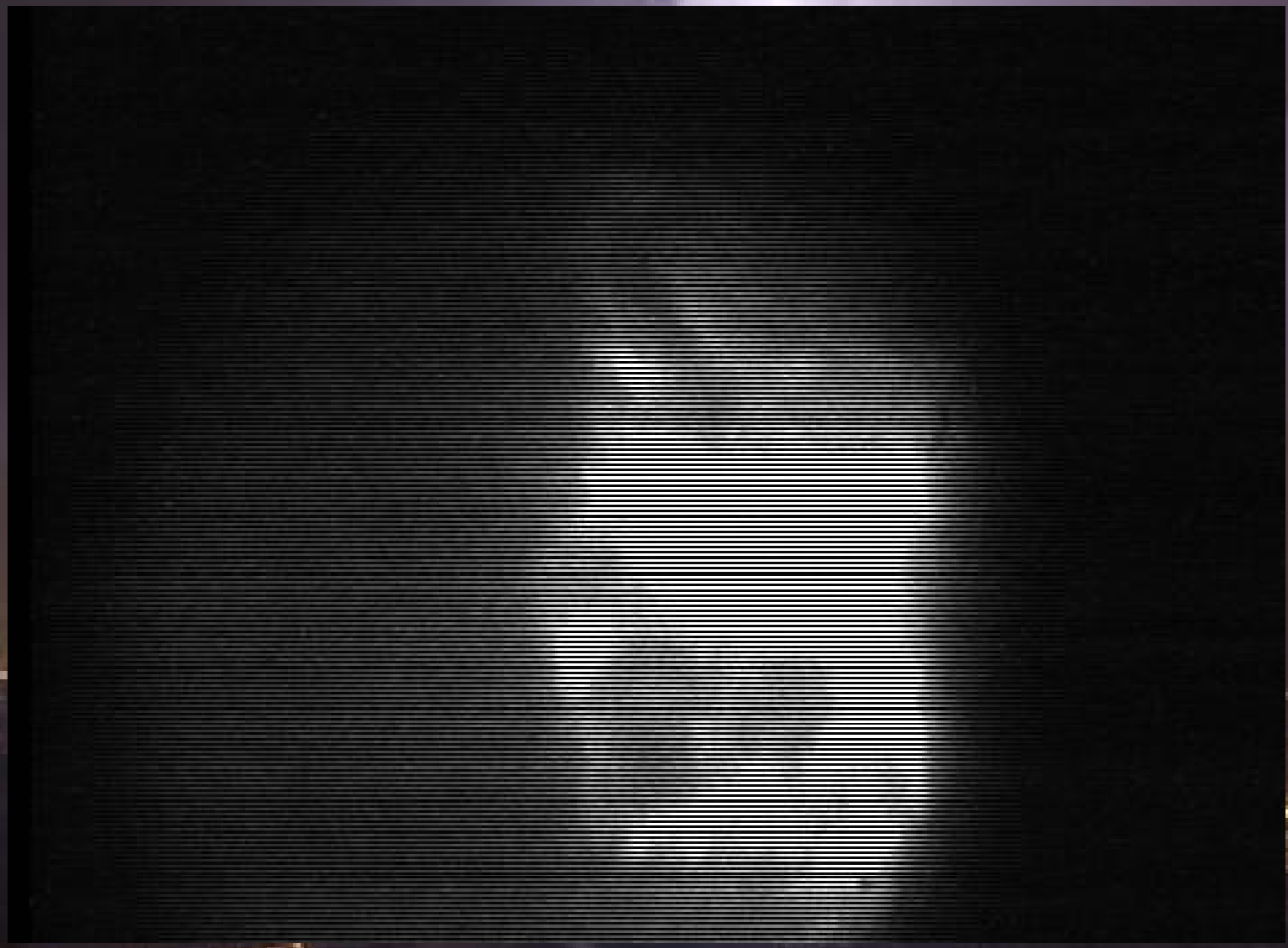
A LabView program calculates the average pixel intensity for each frame and triggers above a variable threshold…

A logfile includes intensity, name and Acquiris timestamp of each picture

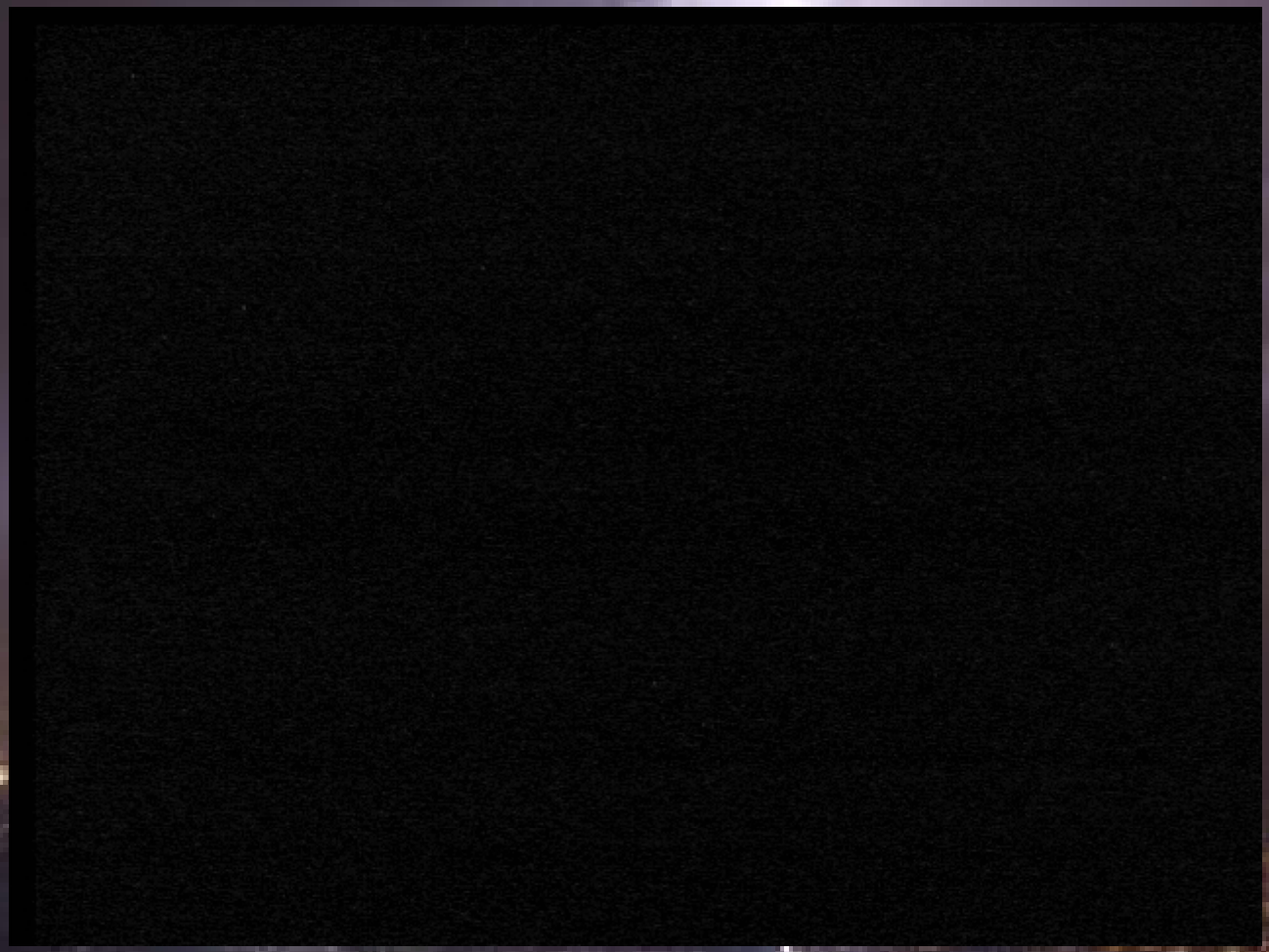
Some typical breakdowns…



Some typical breakdowns…



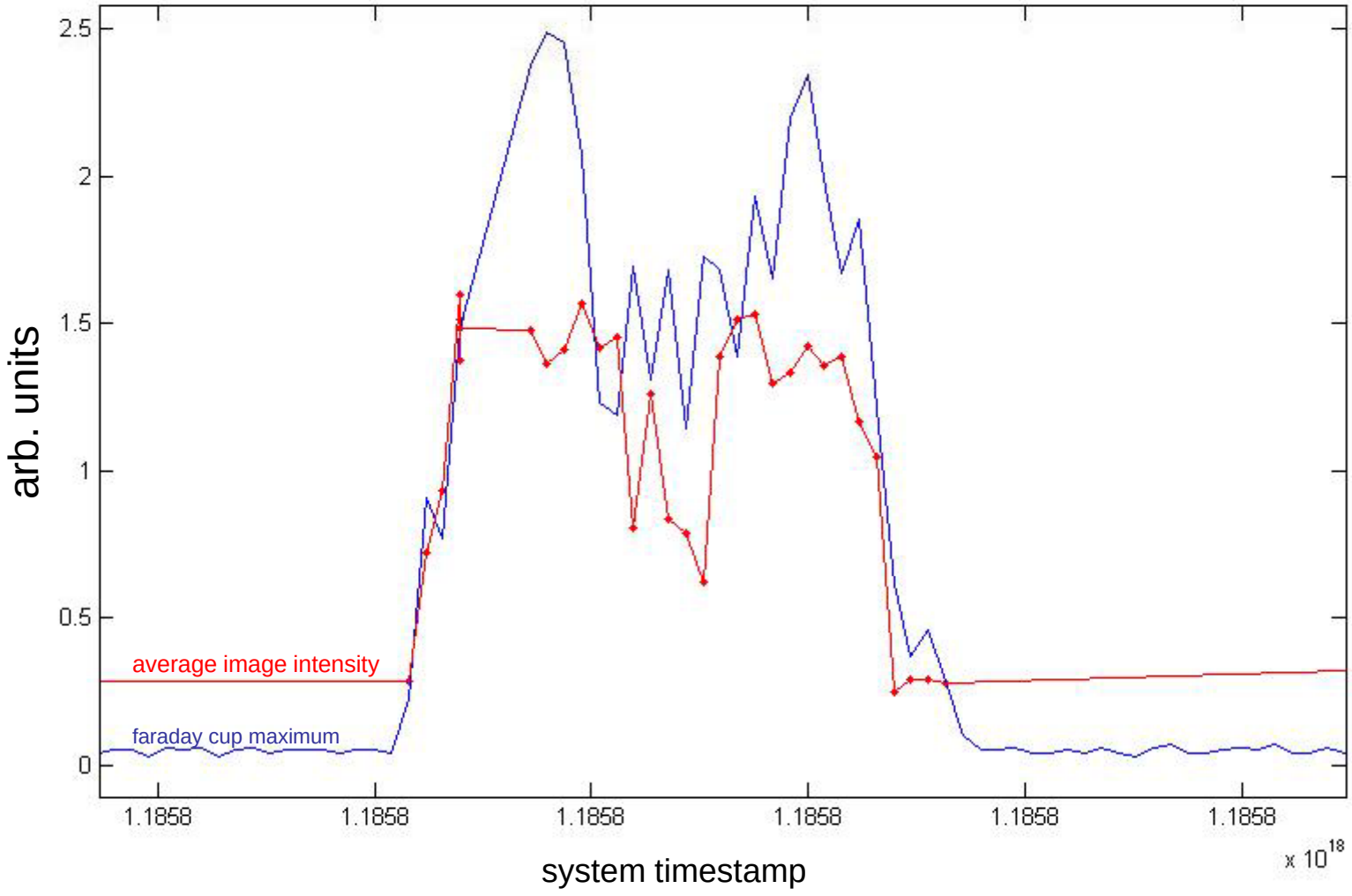
Breakdown… - THE MOVIE -

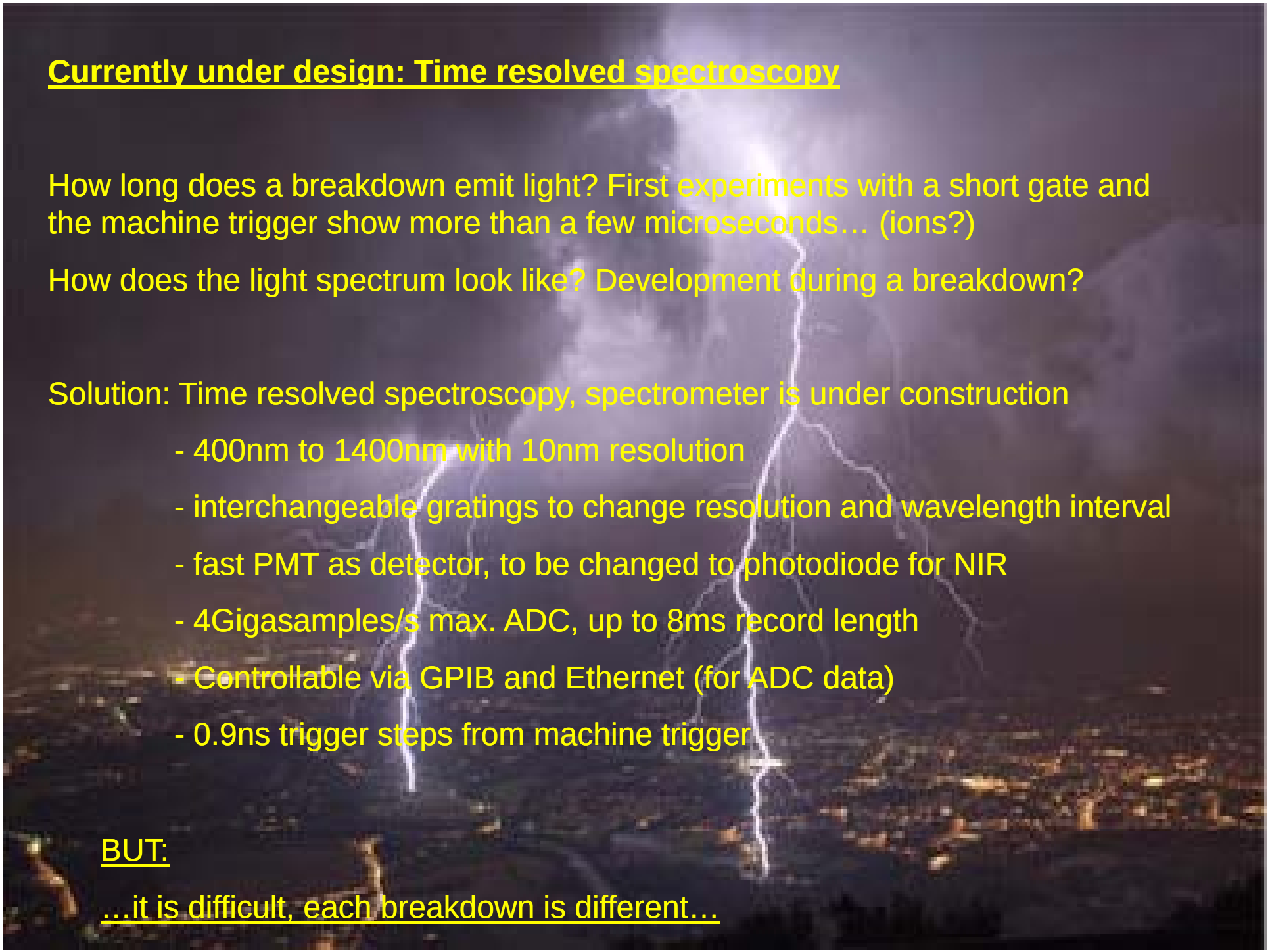


…and some strange effects…

Maybe a correlation with ion-currents?
Not (yet) found…

… data analysis going on …





Currently under design: Time resolved spectroscopy

How long does a breakdown emit light? First experiments with a short gate and the machine trigger show more than a few microseconds… (ions?)

How does the light spectrum look like? Development during a breakdown?

Solution: Time resolved spectroscopy, spectrometer is under construction

- 400nm to 1400nm with 10nm resolution
- interchangeable gratings to change resolution and wavelength interval
- fast PMT as detector, to be changed to photodiode for NIR
- 4Gigasamples/s max. ADC, up to 8ms record length
- Controllable via GPIB and Ethernet (for ADC data)
- 0.9ns trigger steps from machine trigger

BUT:

…it is difficult, each breakdown is different…

Outlook:

- Imaging attempt almost finished, some data analysis ongoing

-Spectrometer under construction, hopefully first tests this year

-Further experiments will be set up in parallel with upgrades on high power test-stand

-Suggestions and inspirations for possible measurements would be appreciated