

**SCINTILLATOR BASED LOW ENERGY  
BEAM DIAGNOSTICS AT THE  
LBNL 88-INCH CYCLOTRON**

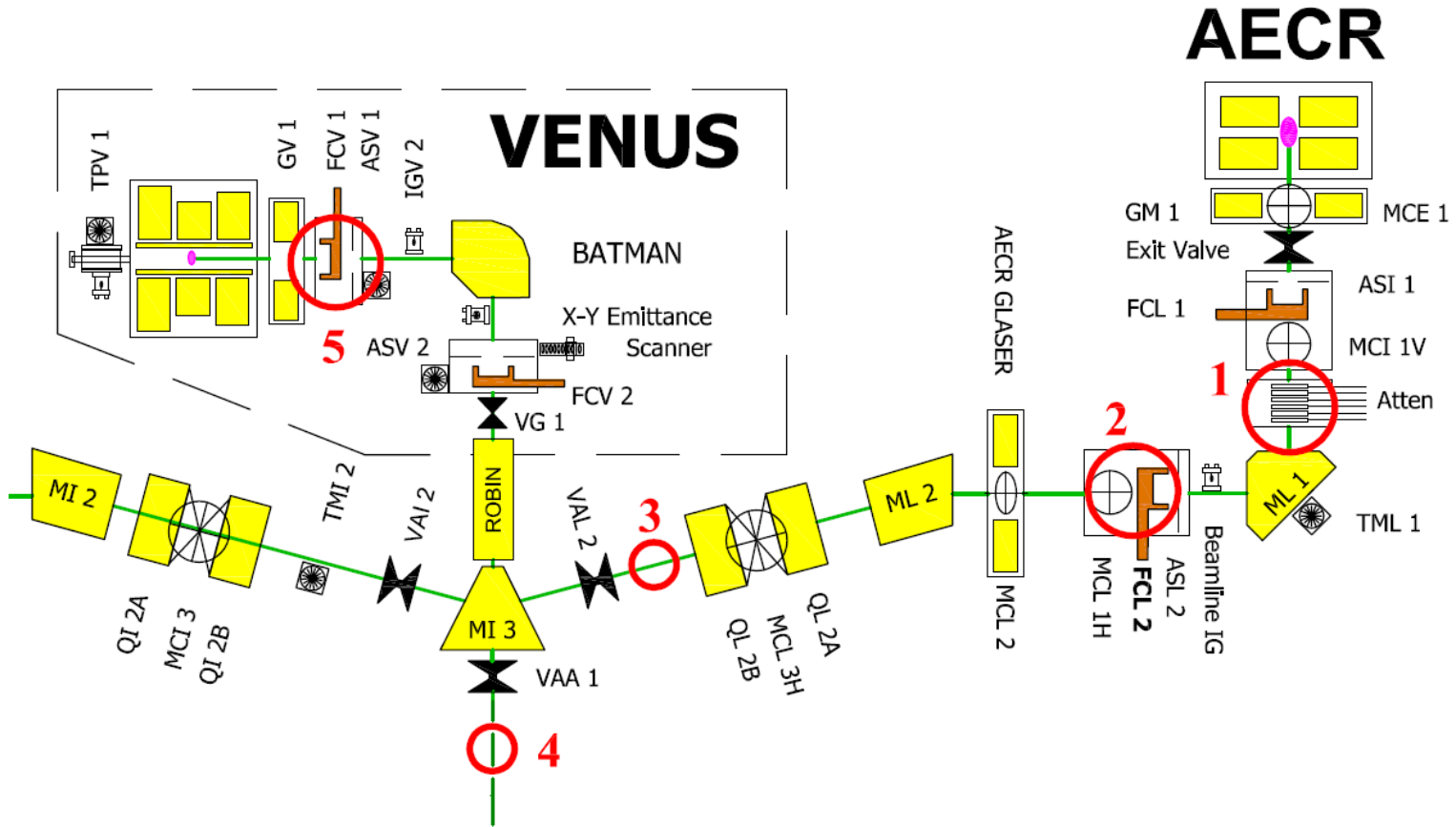
Scintillator Workshop, GSI Darmstadt,  
February 15<sup>th</sup> 2011

# Outline



- **Scintillator Applications at LBNL**
- **First Scintillator Characteristics**
- **Scintillators for Usage With Pepper-Pot Emittance Scanners**
- **Summary & Outlook**

# Beam Line Configuration



We have 4 transparent scintillators crystal discs and one painted aluminum discs.

# Why scintillators?

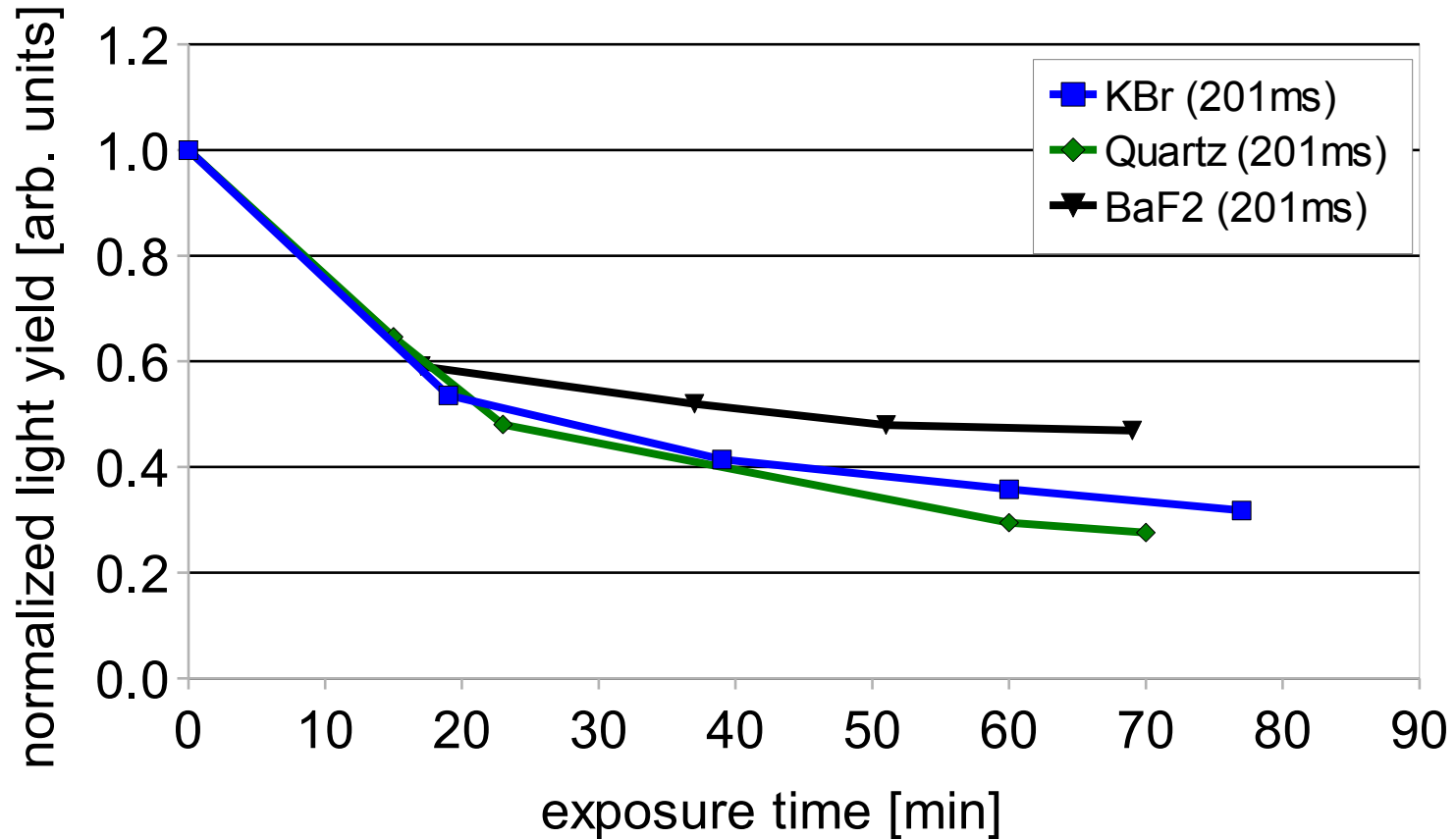


The advantage of using a scintillator screen in ion beam diagnostics is that they are easy to use and they give reasonably good qualitative information as to what the ion beam cross section looks like.

BUT:

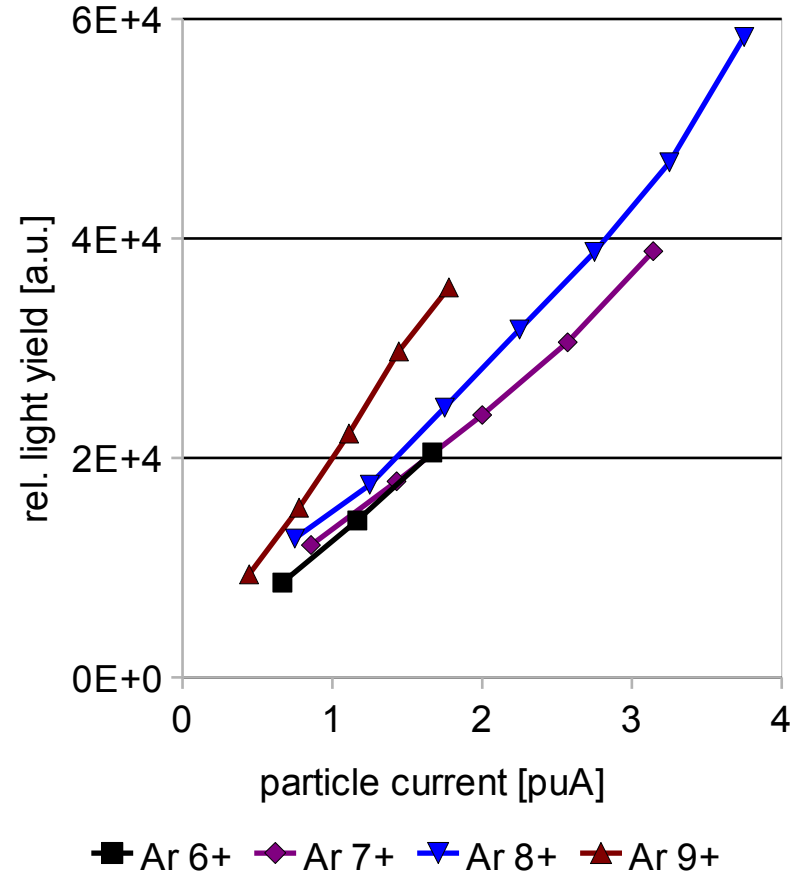
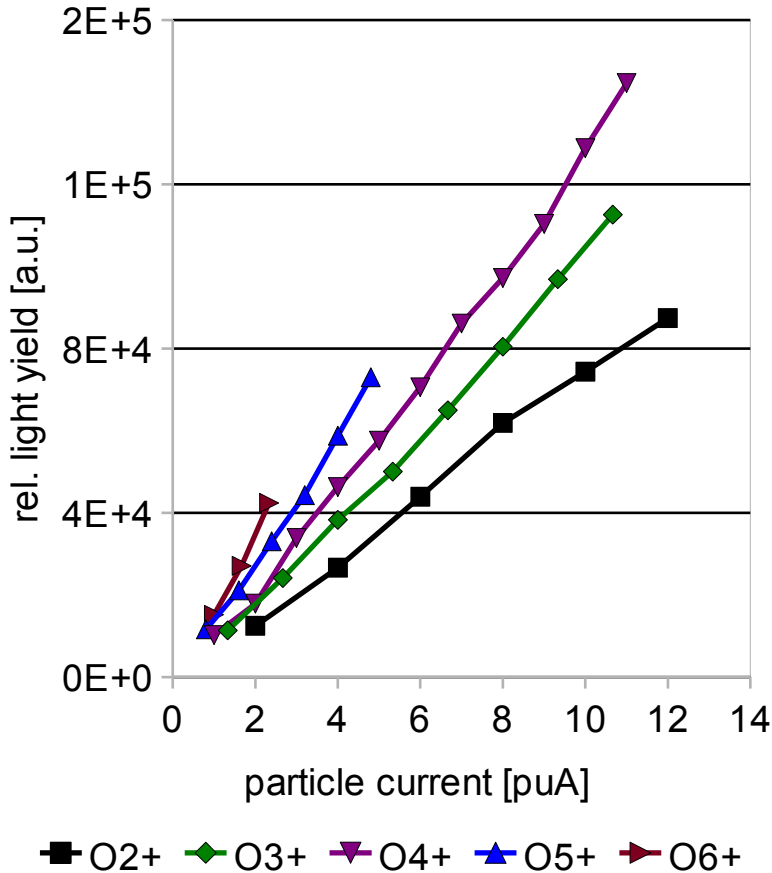
- Their light yield decreases with the particle exposure.
- They pose a limit when imaging low current (and low charge state) beams, hence the S/N ratio is bad → Difficult data analysis.

# Scintillator Characteristics (1)



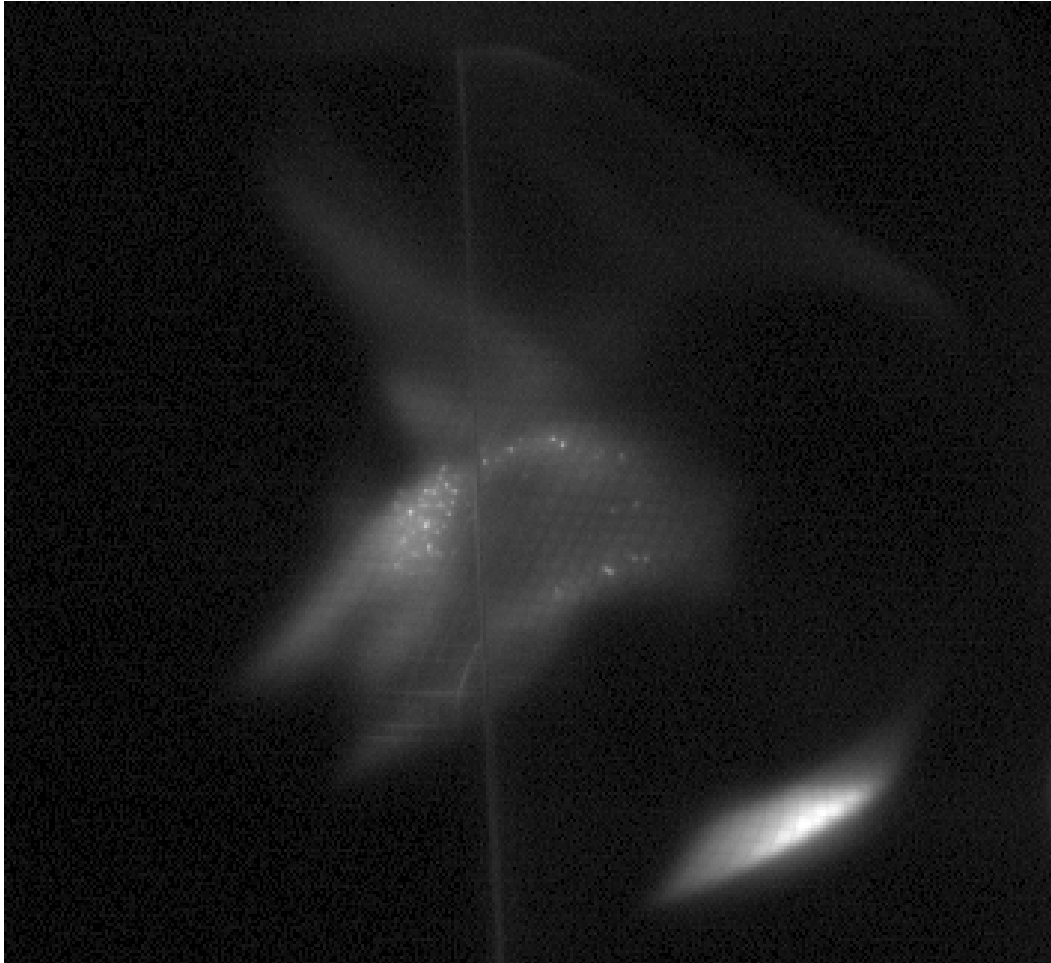
All tested materials show an approximately similar decay rate of the light yield.

# Scintillator Characteristics (2)



The generated light is linearly growing with the particle current. No saturation effects could be seen in the investigated intensity range.

# Image Artifacts ... or not?

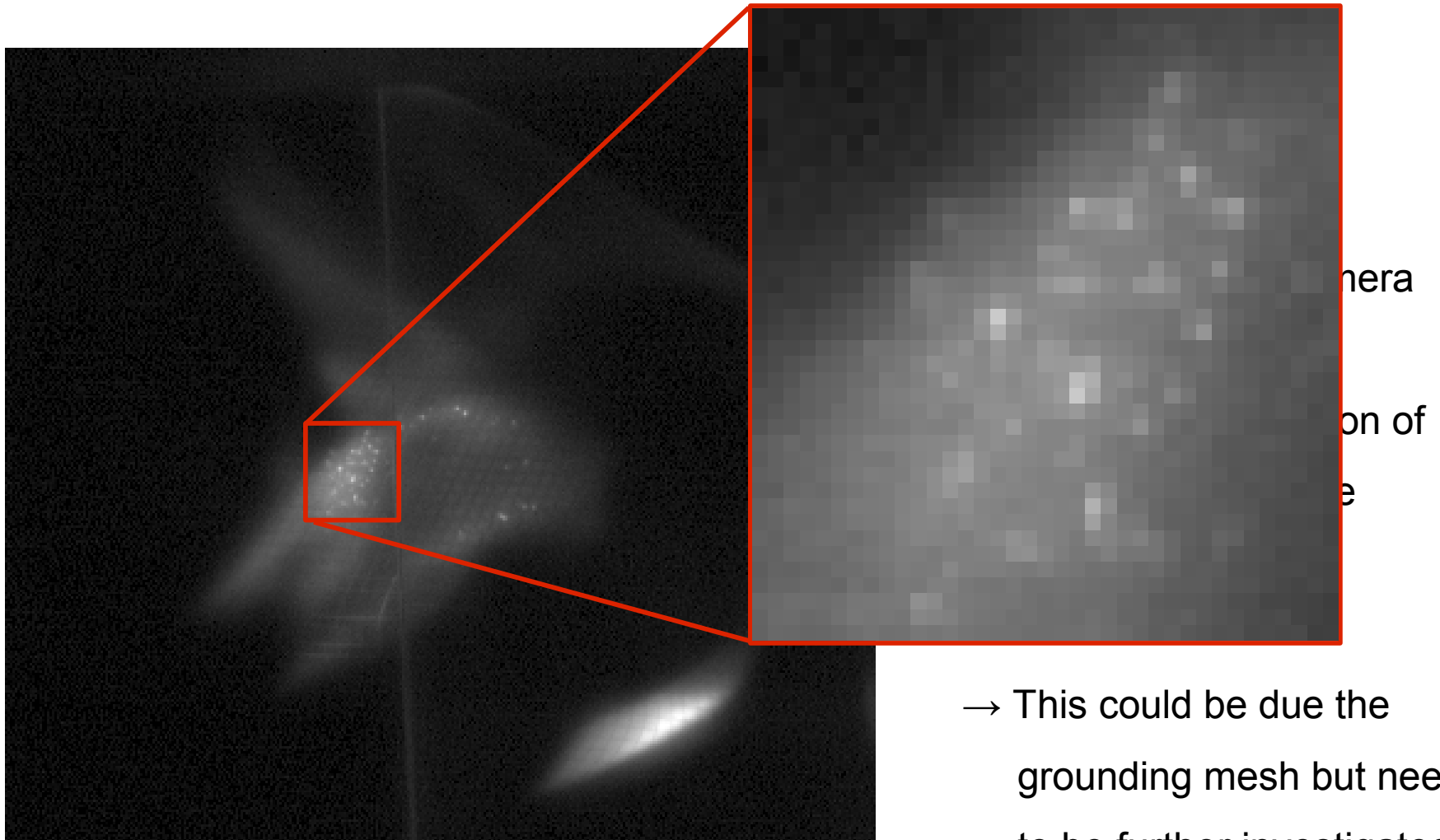


- Oxygen 4+ beam (10kV)
- 4mm thick KBr disc
- image captured with a MARLIN F145 B2 camera looking perp. to the beam

Notice:

- The bright center region of the beam shows some “glowing”.

# Image Artifacts ... or not?

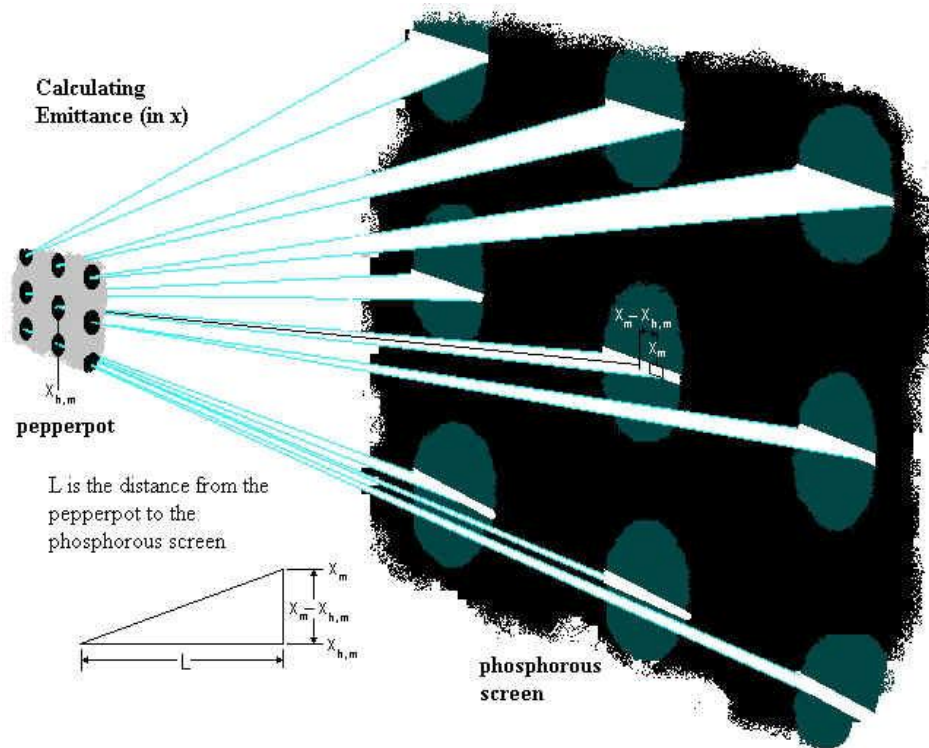


→ This could be due the  
grounding mesh but needs  
to be further investigated.



# Emittance, Pepper-Pot & Scintillators

A pepper-pot is a beam diagnostics device that allows the measurement of all four transversal emittances of a particle beam



- A hole mask (pepper-pot plate) is mounted into beam line → particles can only pass through the holes
- Those particles create a light pattern on a scintillating surface behind the pepper-pot plate which is captured with a camera.
- The structure of the light pattern is directly influenced by the beam emittance
- The allocation of spots to their originating hole is important for the proper function

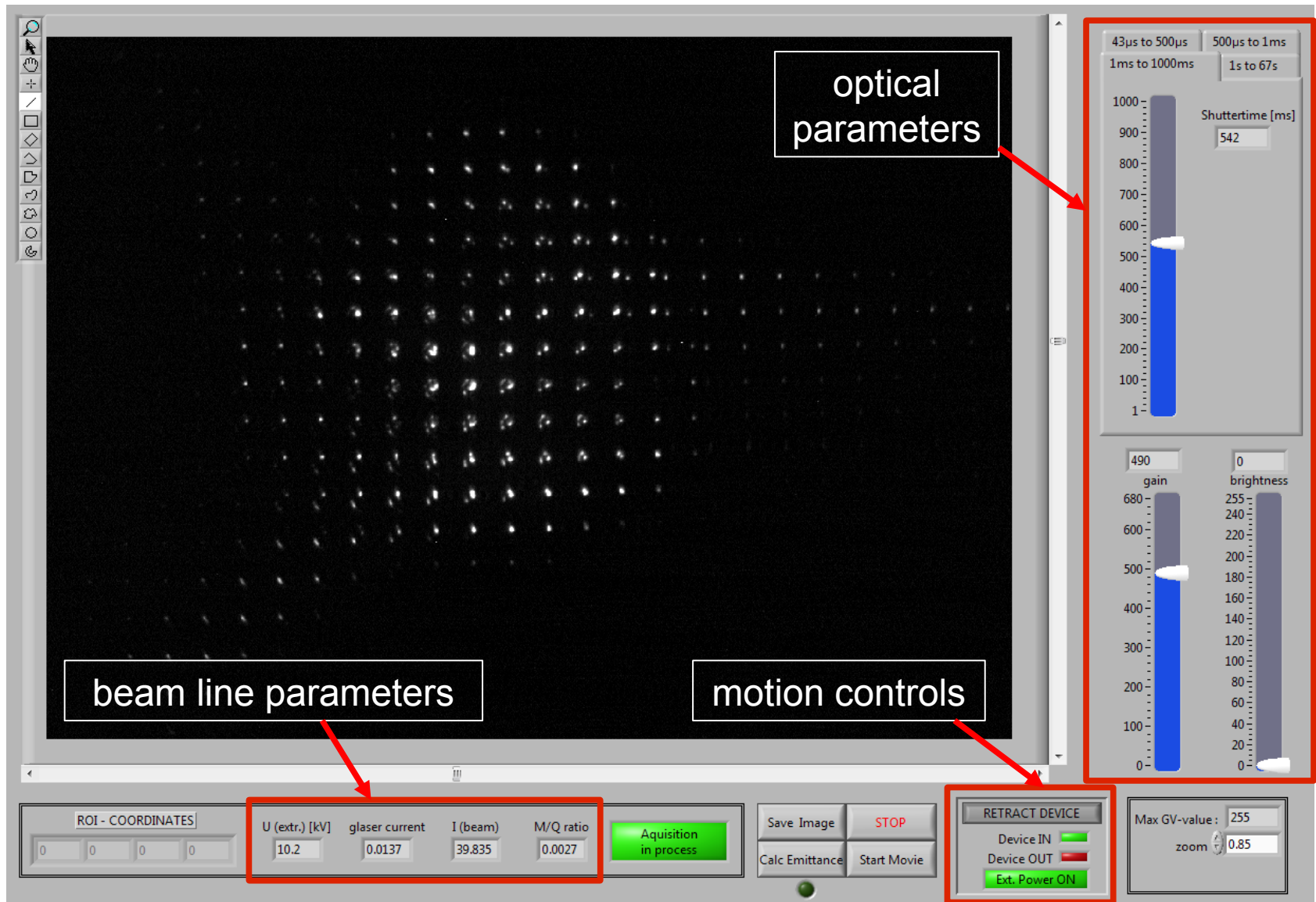
# Data Acquisition



The software interface displays a central grid of bright spots on a black background. To the right, there are three vertical sliders: "Shuttertime [ms]" with a value of 542, "gain" with a value of 490, and "brightness" with a value of 0. The bottom panel contains various control elements:

- ROI - COORDINATES:** Four input fields with values 0, 0, 0, 0.
- U (extr.) [kV]:** 10.2
- glaser current:** 0.0137
- I (beam):** 39.835
- M/Q ratio:** 0.0027
- Buttons:** "Save Image", "STOP", "Calc Emittance", "Start Movie", "RETRACT DEVICE", "Device IN", "Device OUT", "Ext. Power ON", and a green "Aquisition in process" button.
- Other controls:** "Max GV-value: 255" and "zoom: 0.85".

# Data Acquisition



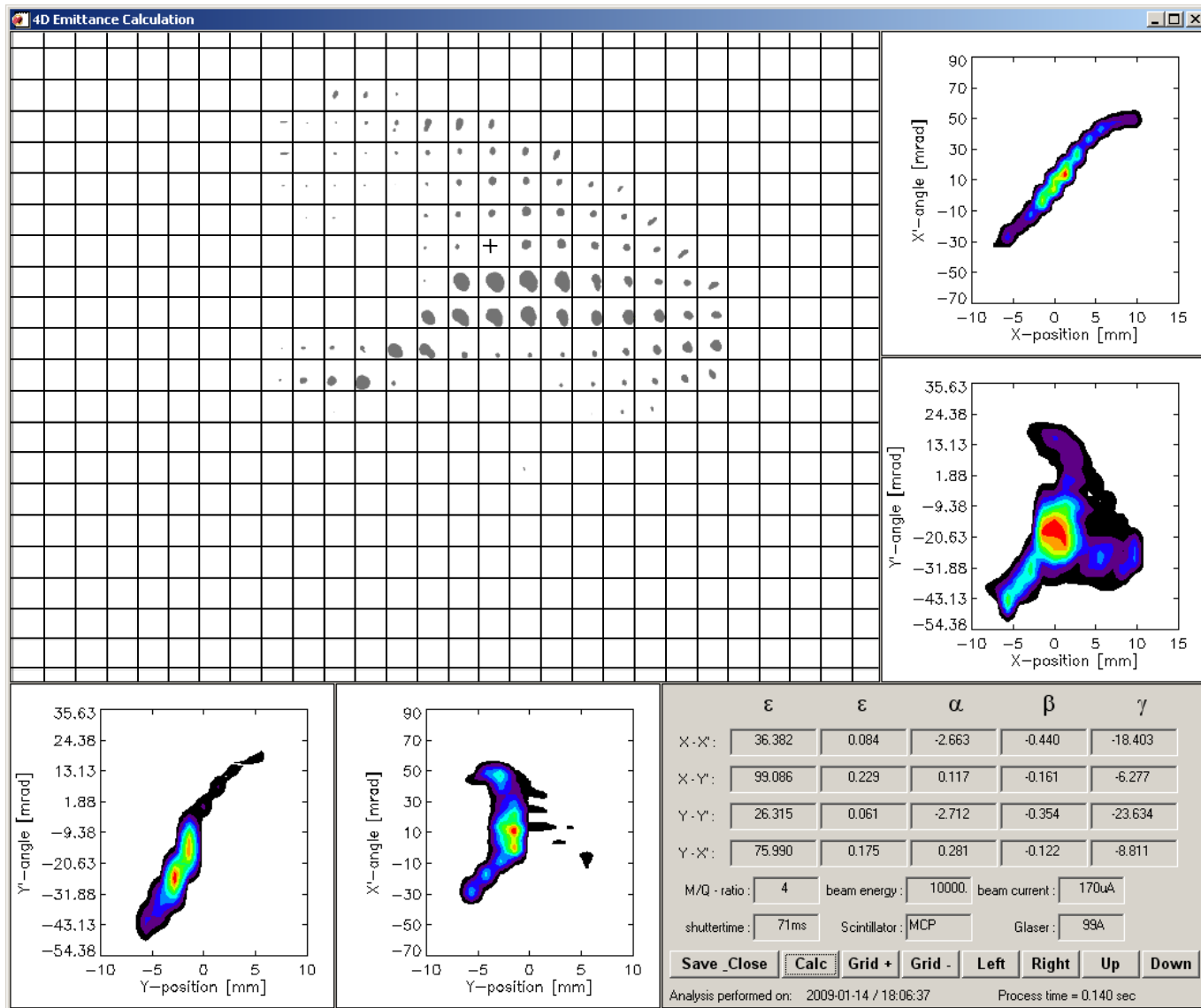
The interface displays a central image of a beam spot, labeled "optical parameters". To the right is a control panel with a "Shuttertime [ms]" slider set to 542, and "gain" and "brightness" sliders. At the bottom, a "beam line parameters" section shows a table of values, and a "motion controls" section includes a "RETRACT DEVICE" button and status indicators.

U (extr.) [kV]	glaser current	I (beam)	M/Q ratio
10.2	0.0137	39.835	0.0027

ROI - COORDINATES: 0 0 0 0

Max GV-value: 255  
zoom: 0.85

# Evaluating the Data



# Summary & Outlook



## Where are we now?

- We have 5 beam viewers successfully commissioned and in frequent use for tuning and beam development purposes at the 88-Inch Cyclotron.
- A pepper-pot scanner is developed and commissioned, however with focus on development of hardware and software for data acquisition and evaluation.

## What do we want to do next?

- Further develop the optical system of the pepper-pot and BV
  - Expand the measurements show for more materials and more beam species
  - evaluate the use of a more sensitive camera with a better resolution
  - put a number on the generated amount of photons per incident ion (rough estimation of the beam current while imaging it).
- Eventually find a way to overcome the challenges that the scintillators currently pose for the usage with pepper-pot.