

(X)GMD Control Systems Design

SLAC National Accelerator Laboratory

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Outline

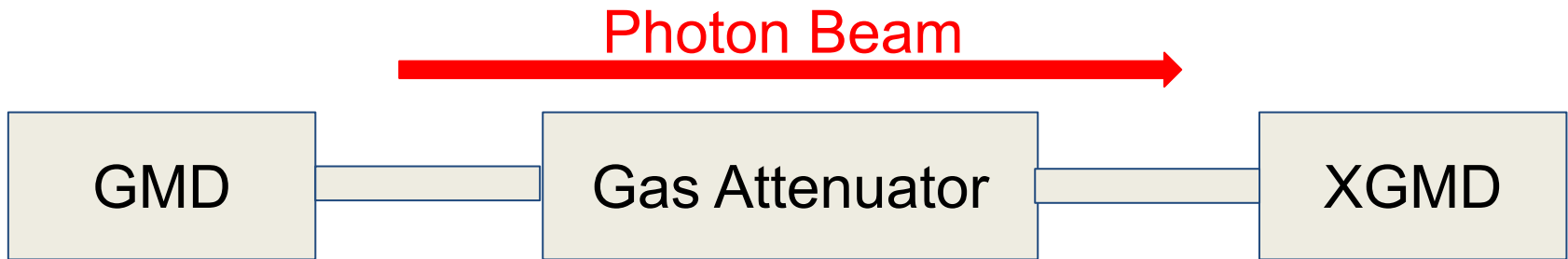
- Introduction
- Location
- Physics
- Control Systems - High-voltage controller
- Control Systems - Keithley
- Control Systems - Signal Digitizers

Introduction

- GMD = Gas Monitor Detector
- Monitor and detect what? Photon beam energy.
- Goal: to have a measurement of the photon beam energy, bunch by bunch at 1 MHz at most.

Introduction

- Context:



- The users can control how much energy they want by putting more or less gas inside the Gas Attenuator.
- The GMDs are responsible to measure the energy before and after the attenuator.
- Thinking on a car: the Attenuator is the gas pedal and the GMDs are the tacometer. (only that in here more gas means less energy)

Introduction

- What is XGMD?
 - Is the next generation GMD.
 - A newer version compared to the 10 years old GMD.
 - It was bought recently.
 - By convention, SLAC is calling the upper stream of the Gas Monitor Detectors as simply GMD and the downstream one, XGMD.

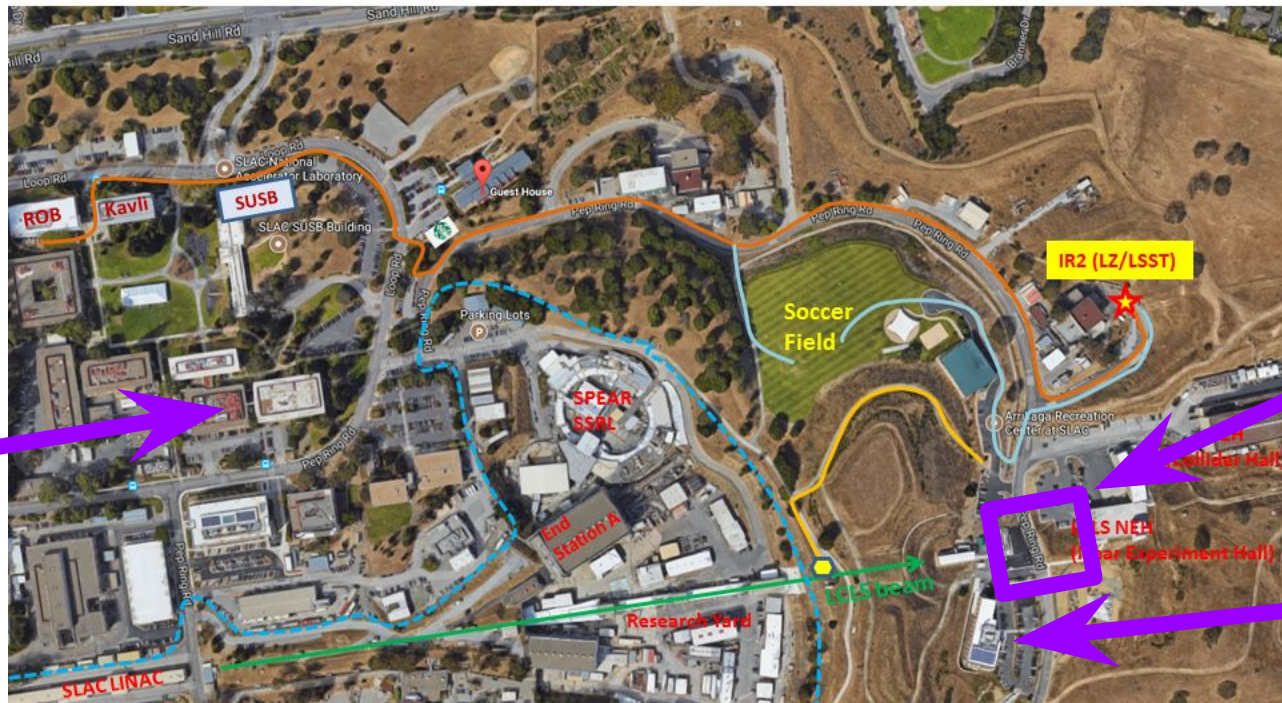
Introduction

- All documents with deeper explanation of this presentation can be found here:
 - <https://docs.slac.stanford.edu/sites/pub/Publications/High-Performance%20System%20for%20the%20XTES%20GMD%20upgrade%20and%20XGMD%20ESD.pdf>
 - https://docs.slac.stanford.edu/sites/pub/Publications/HPS_for_the_XTES_GMD_upgrade_and_XGMD_FR.pdf
 - <https://docs.slac.stanford.edu/sites/pub/Publications/High-Performance%20System%20for%20the%20XTES%20GMD%20upgrade%20and%20XGMD%20ICD.pdf>

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Location



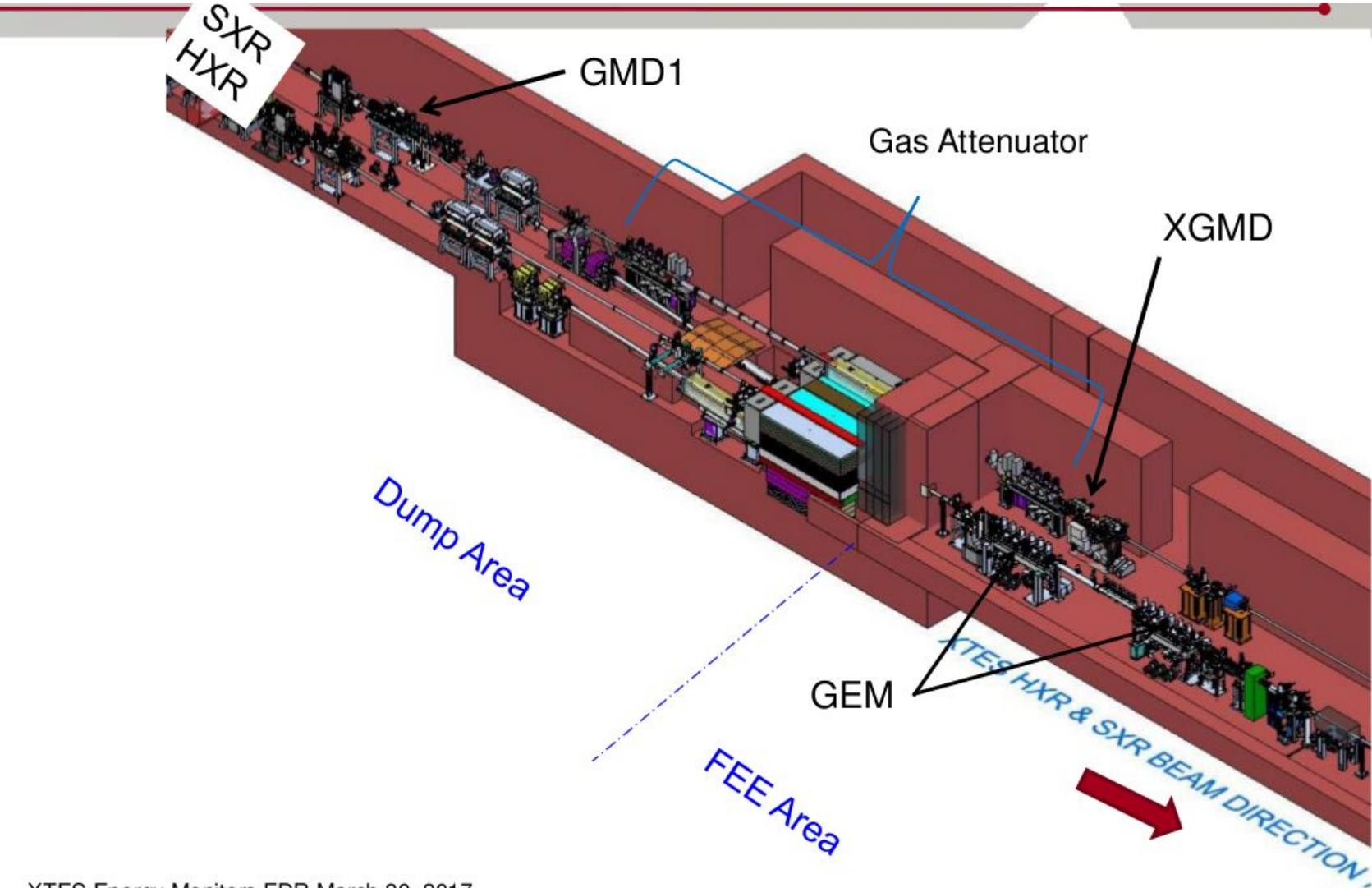
EBD/FEE

Building 901

Building 84



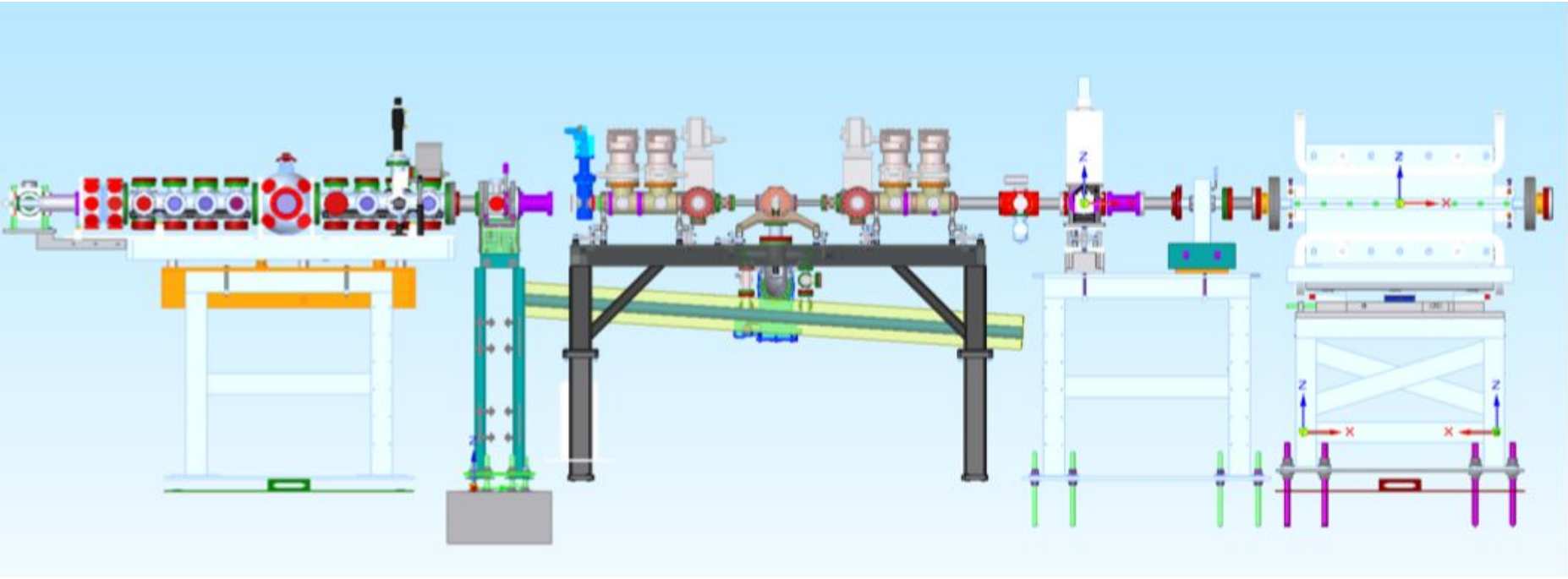
Location



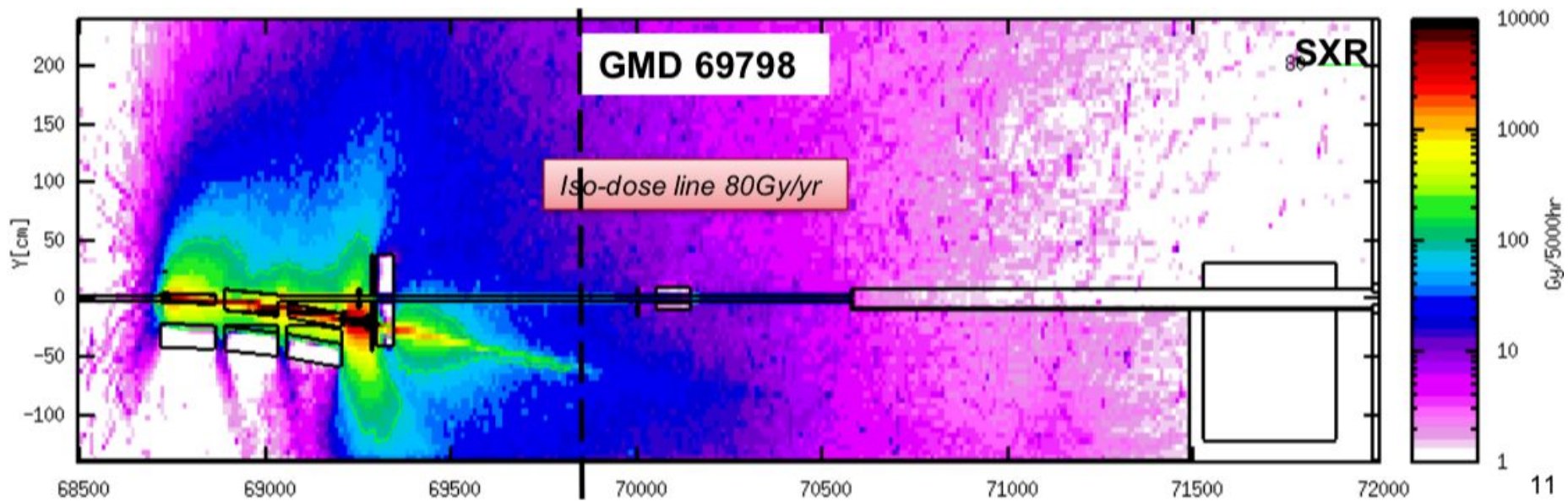
Location



Location



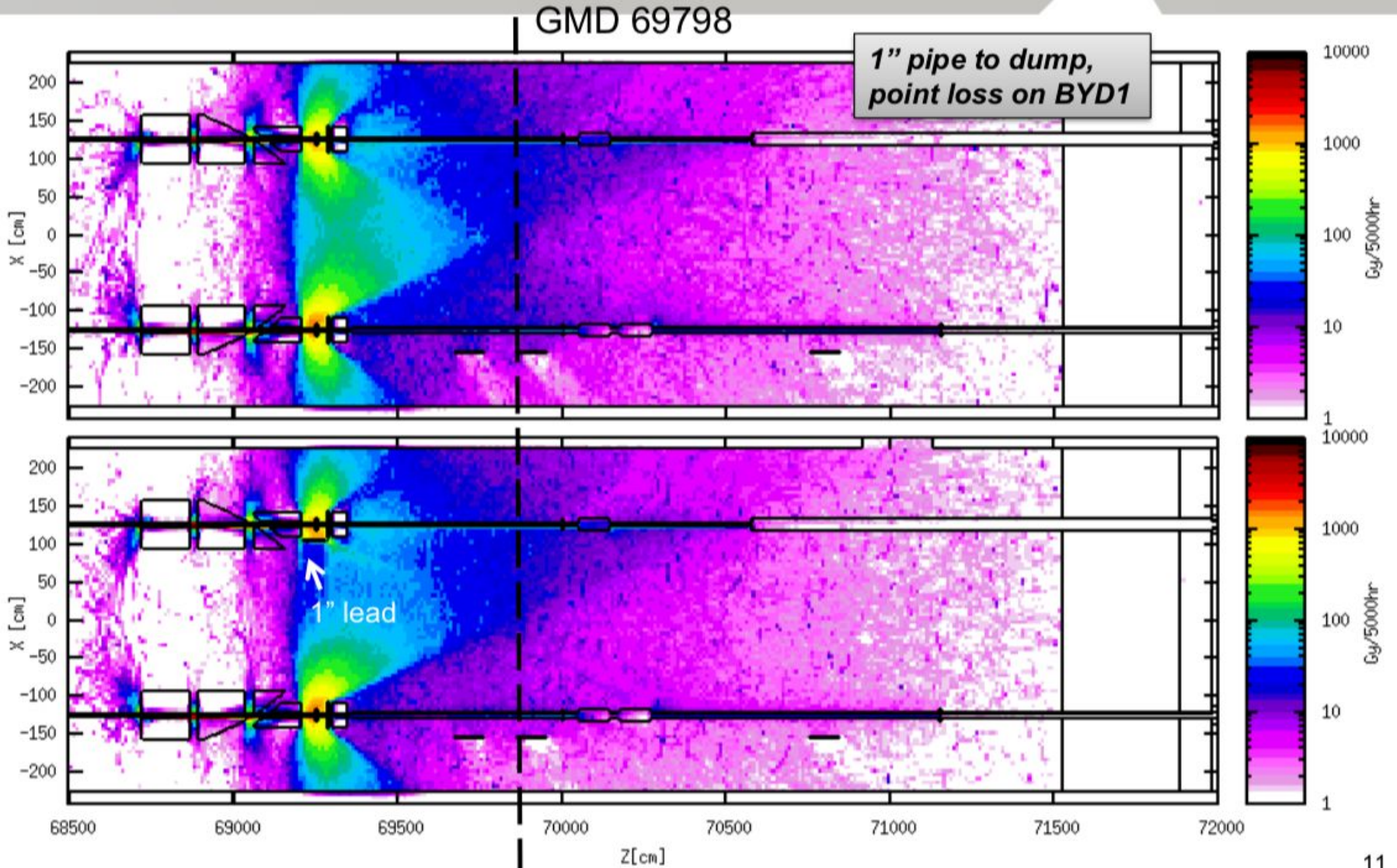
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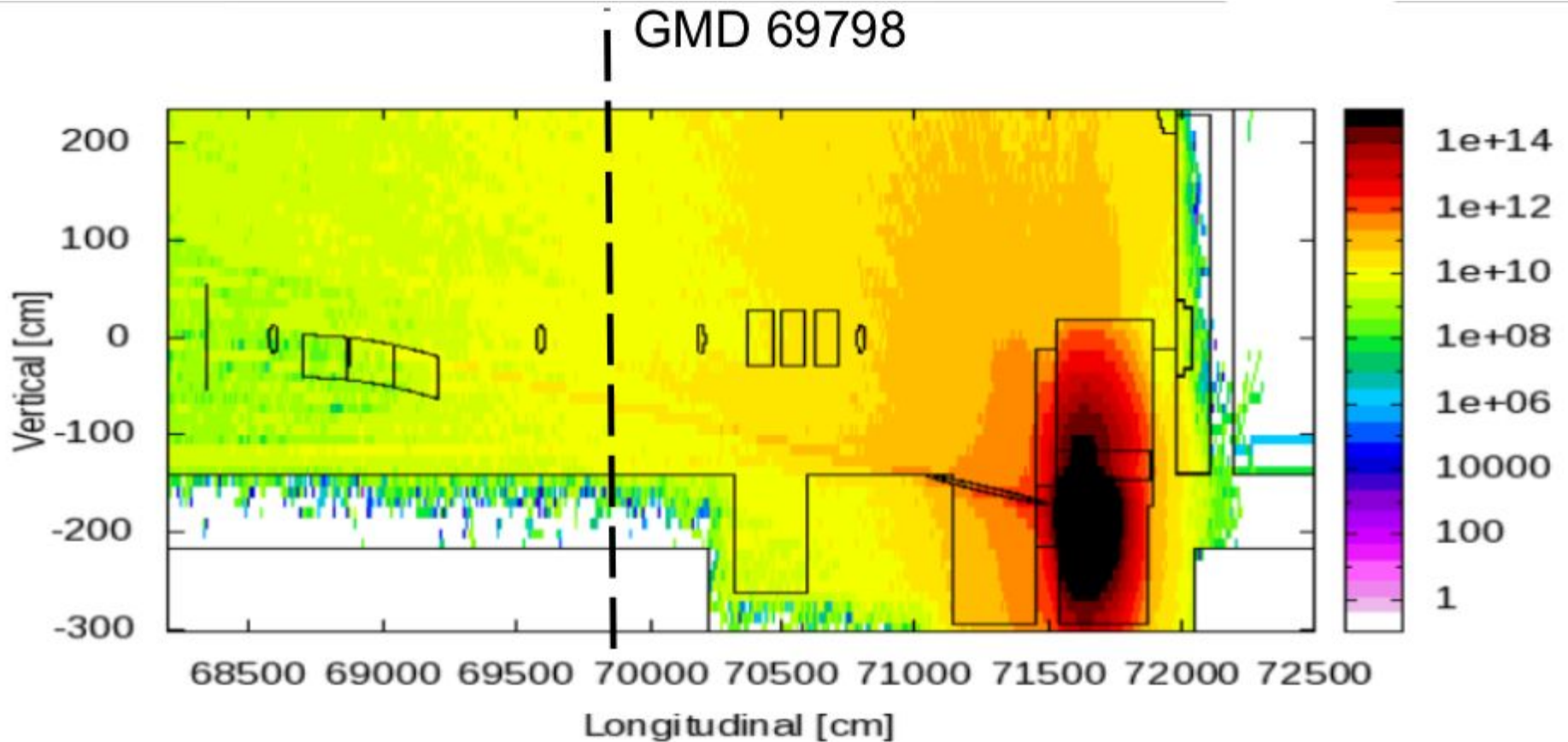
Beam Direction

Location

Beam Direction



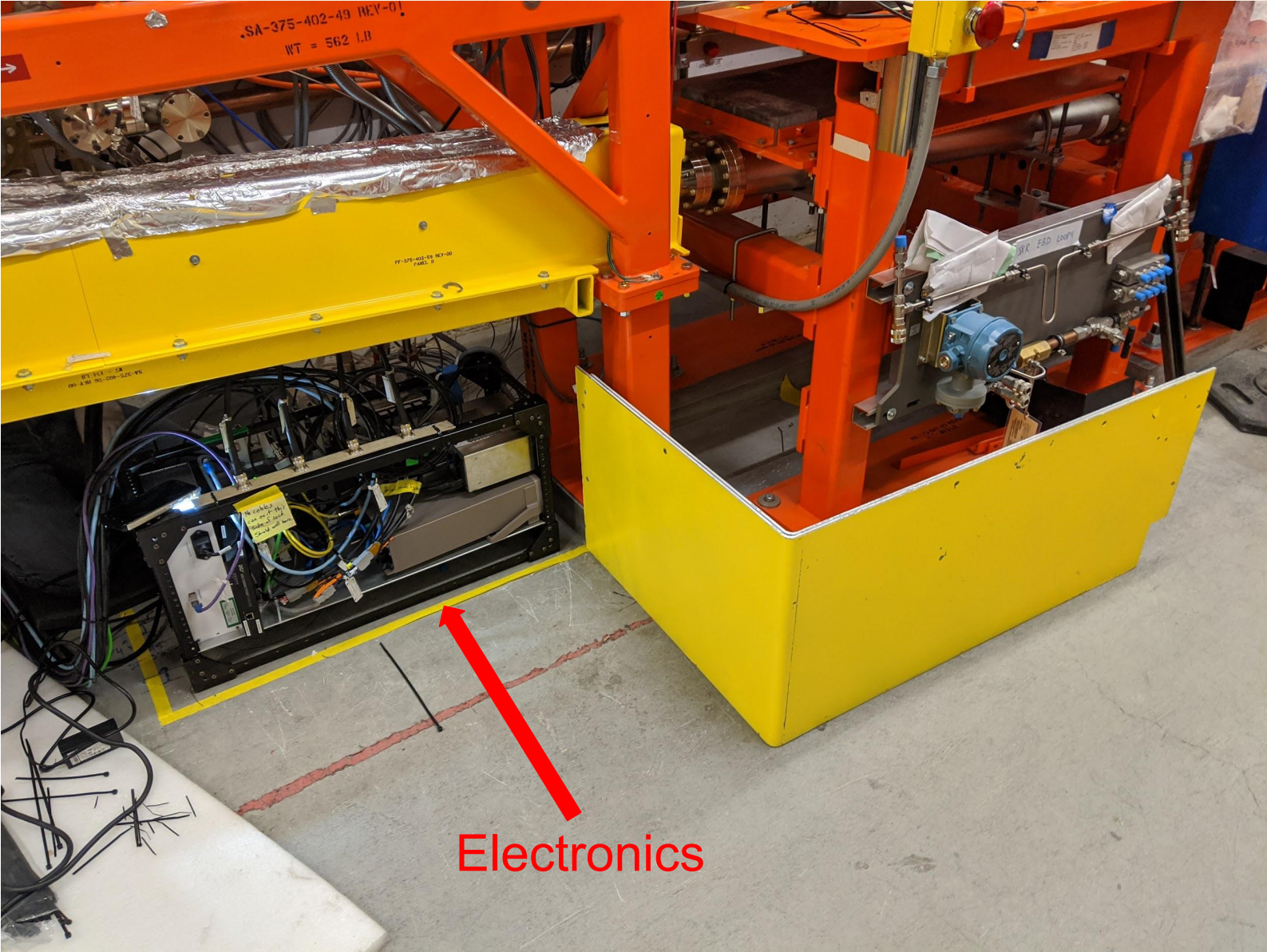
Location



(b) LCLS-II HXR plane: 4.0 GeV at 60 kW (SXR) + 60 kW (HXR) for 5000 h/y

Beam Direction

Location



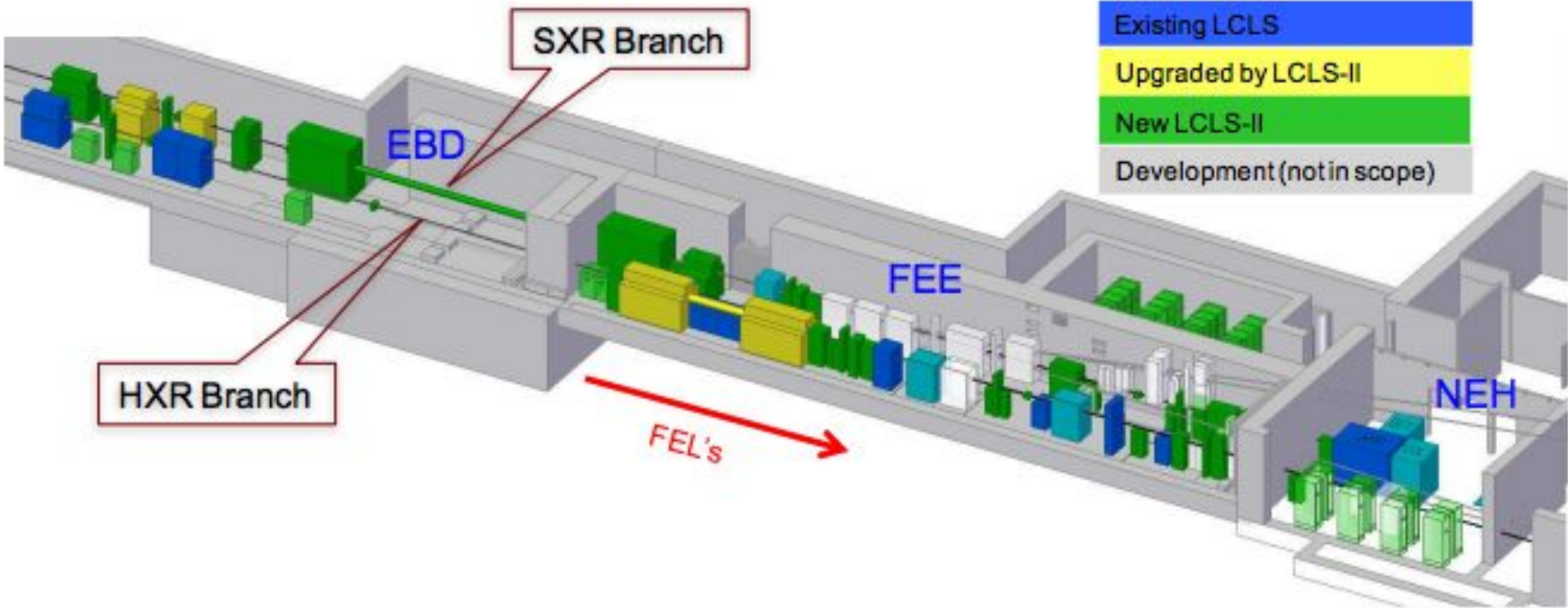
Electronics

Location

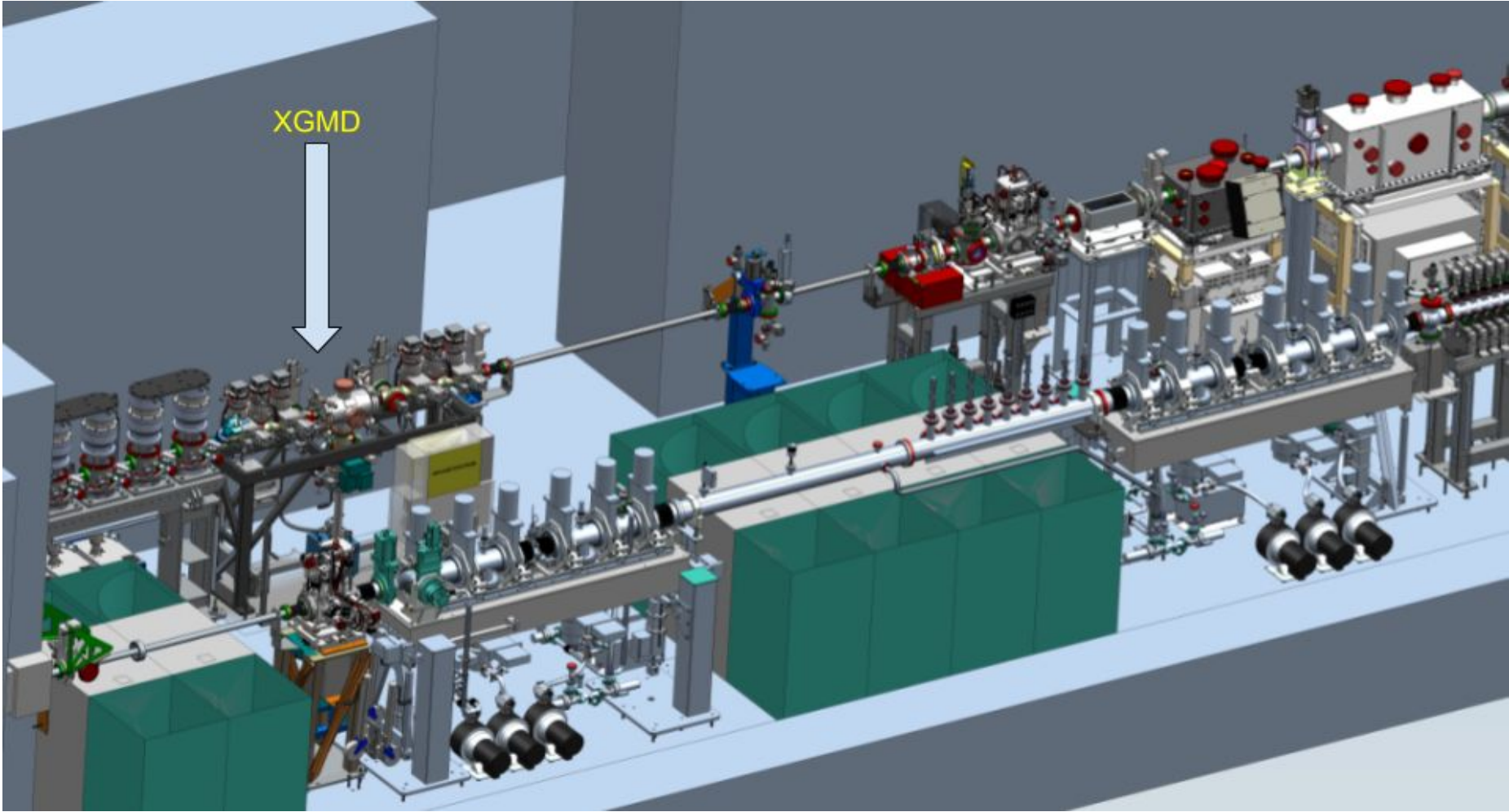


Lead Shield

Location



Location



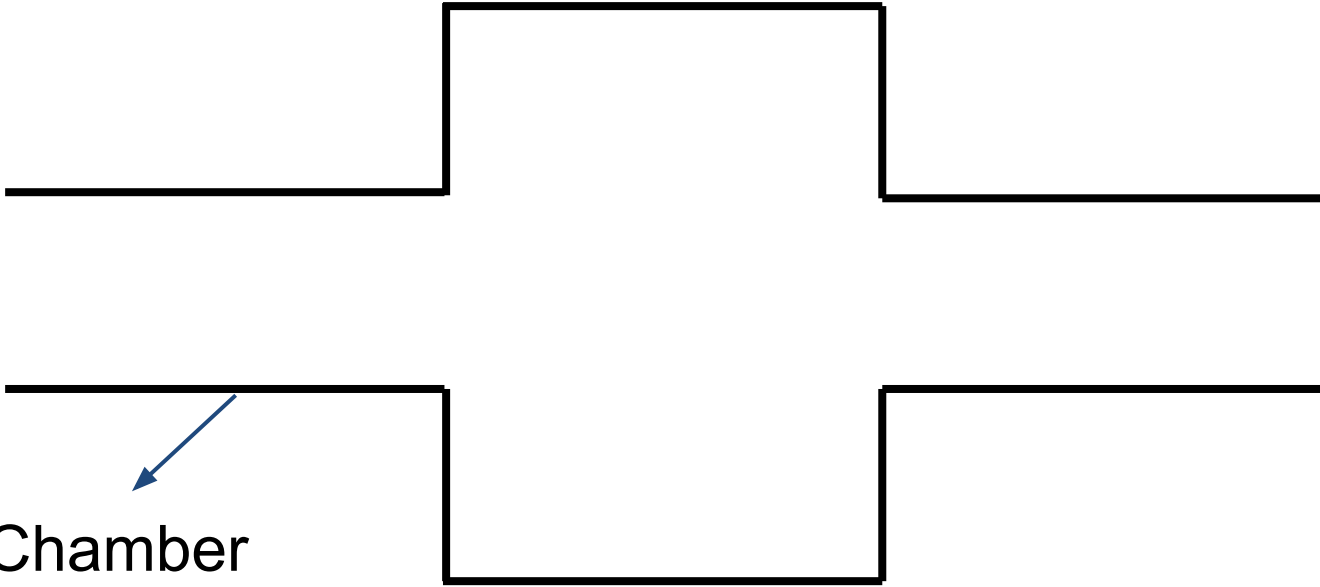
Location

LCLS Front End Enclosure

Outline

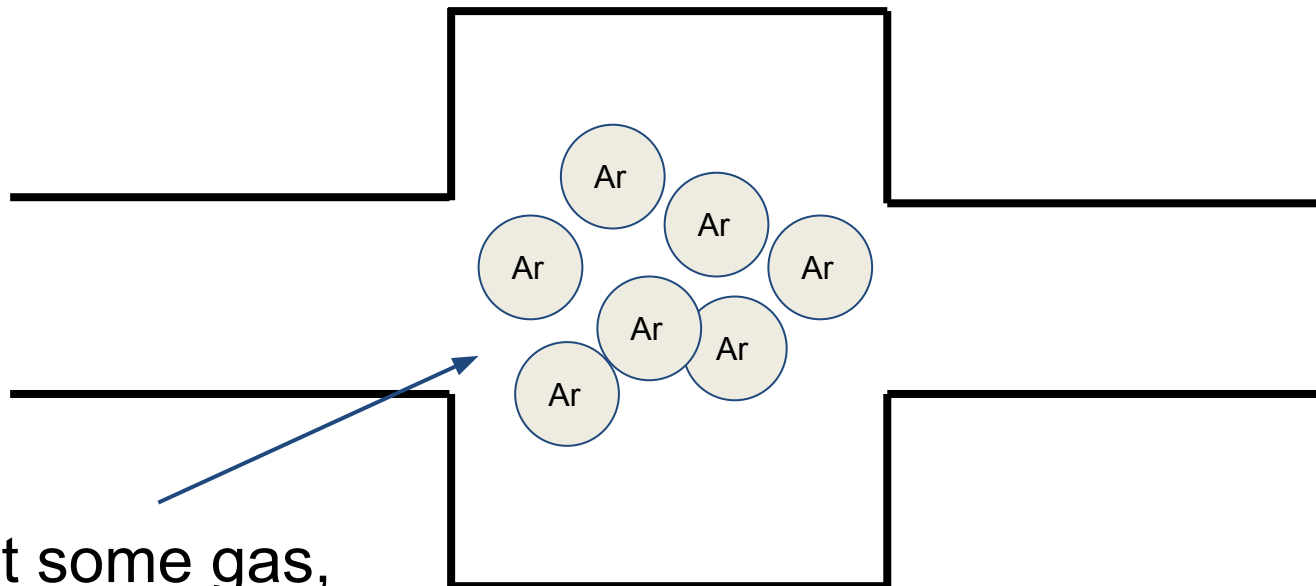
- Introduction
- Location
- **Physics**
- Control Systems - High-voltage controller
- Control Systems - Keithley
- Control Systems - Signal Digitizers

Physics



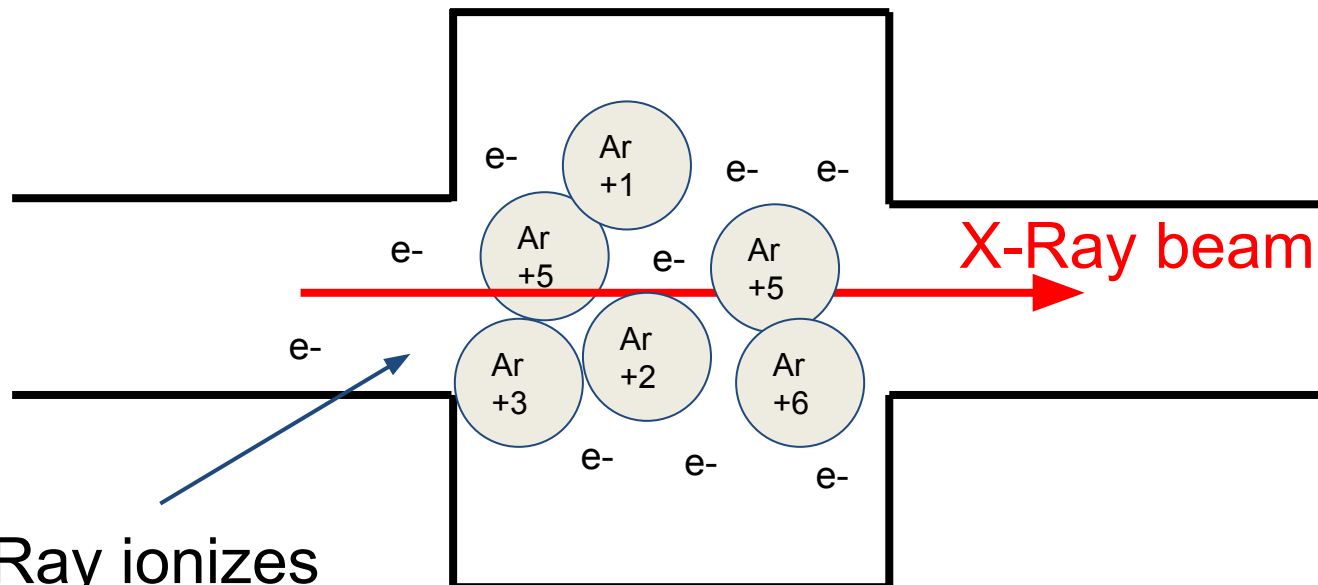
Chamber

Physics



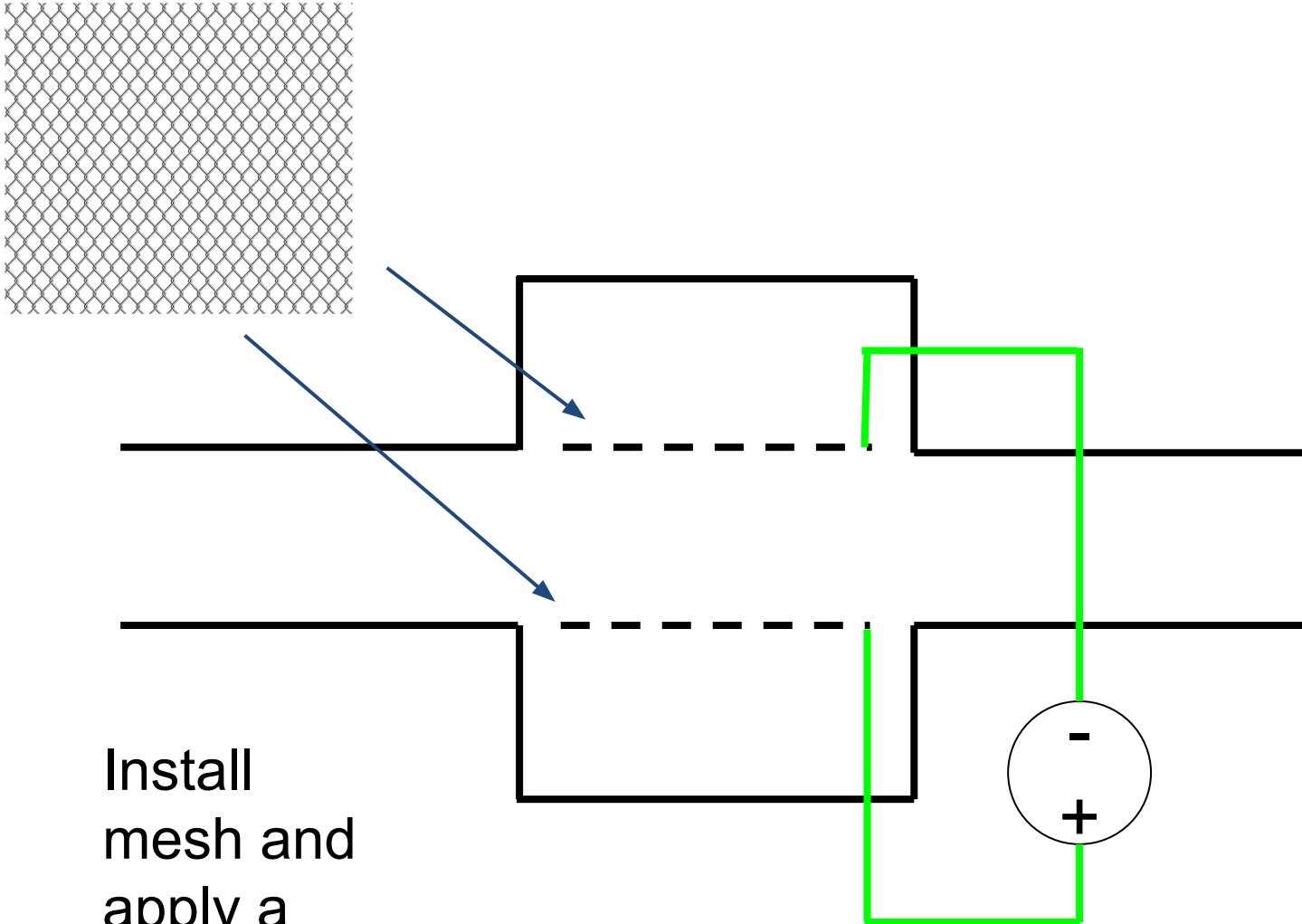
Put some gas,
for instance
Argon

Physics



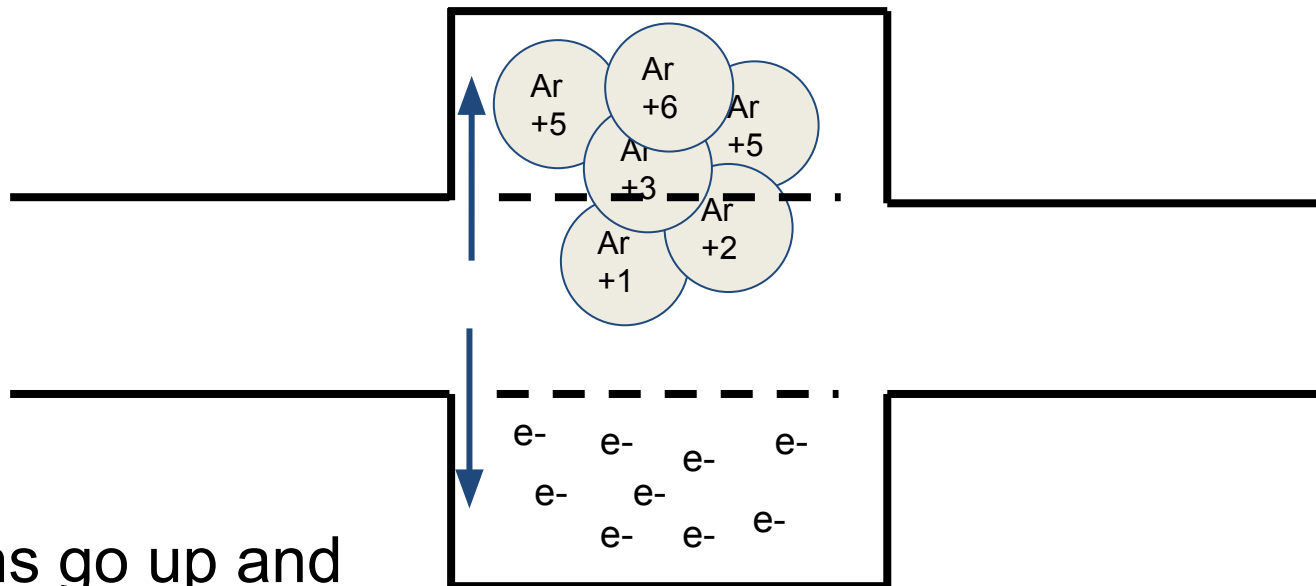
X-Ray ionizes
the gas and
frees electrons

Physics



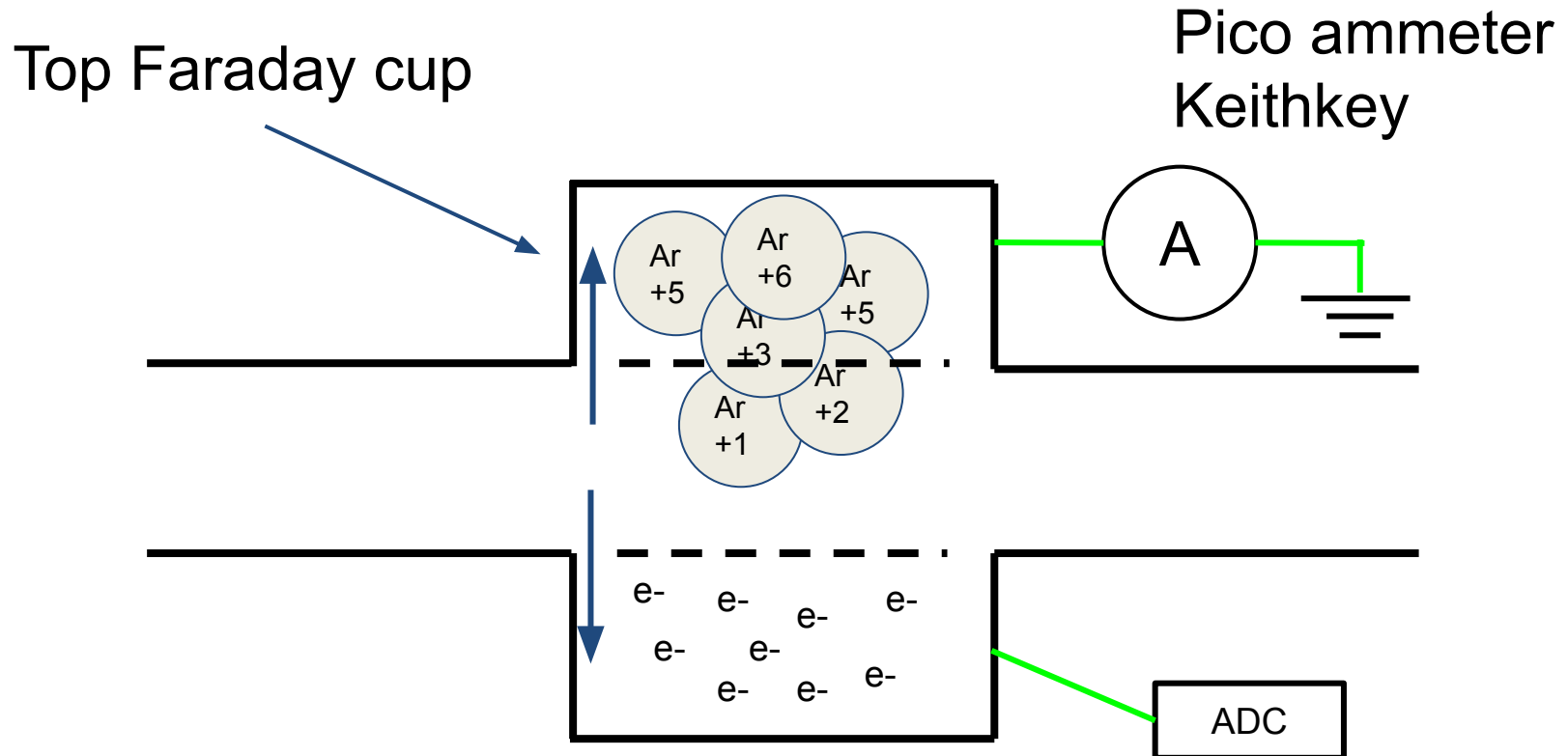
Install
mesh and
apply a
voltage

Physics



ions go up and
electrons go
down

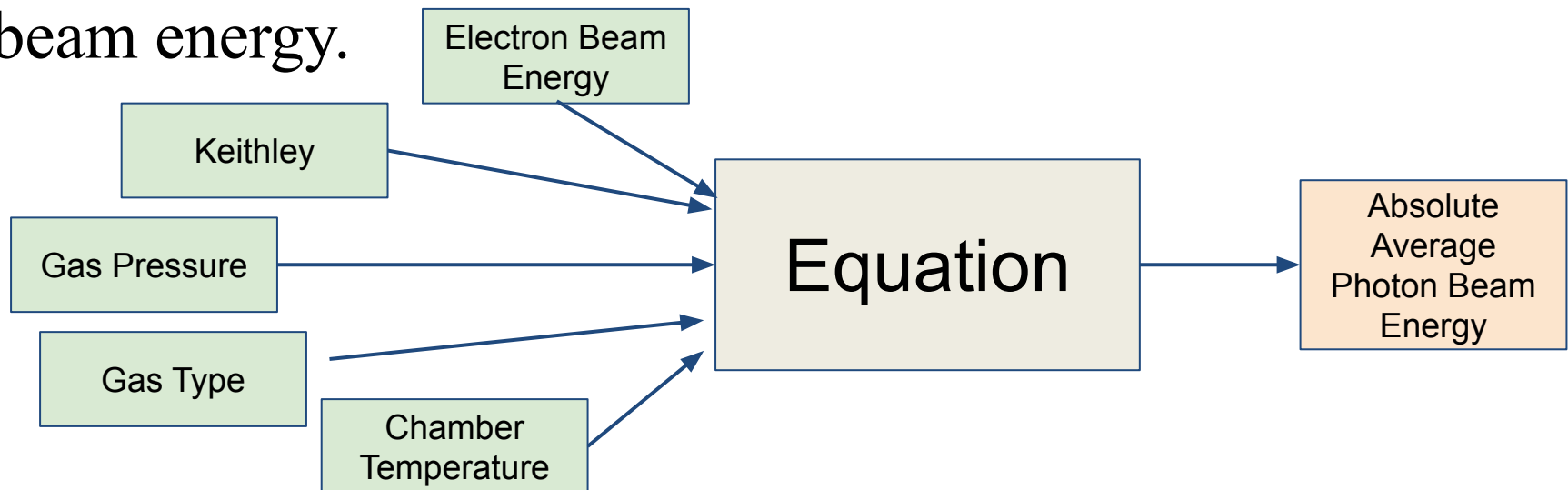
Physics



- Keithley measures the current generated by ions hitting the top Faraday cup.
- The signal from the electrons hitting the bottom Faraday cup are being digitized.

Physics

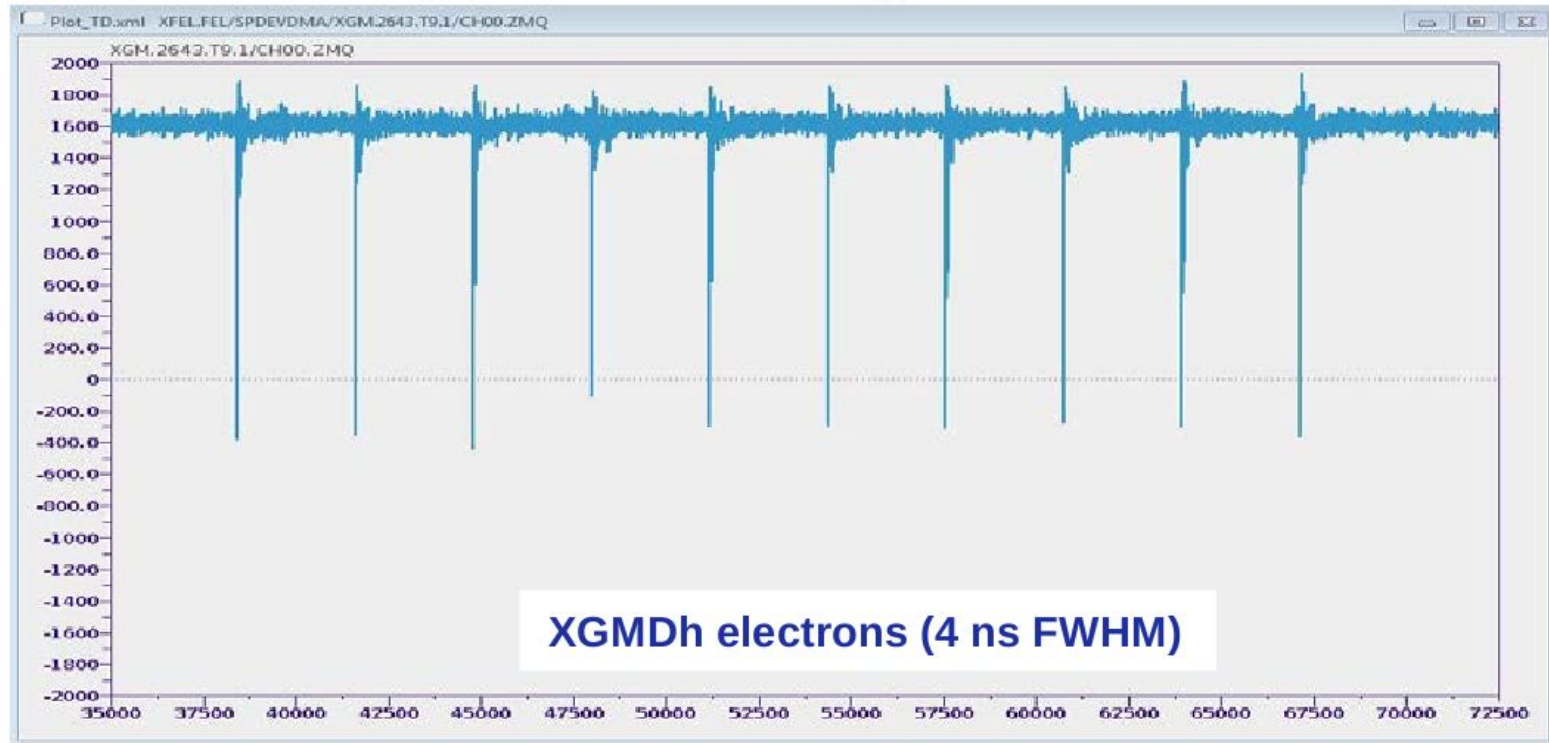
- The Keithley provides a slow measurement of the current as it "sees" the current like it was continuous.
- This measurement is combined with other inputs in an equation and the result is an absolute value for the photon beam energy.



- The problem here is that this method can't provide us the energy for each photon bunch individually.

Physics

- The digitizing of the electrons signal:



- The problem here is that we get a dimensionless number for each bunch that needs to be correlated with the Keithley measurement for calibration.

Physics

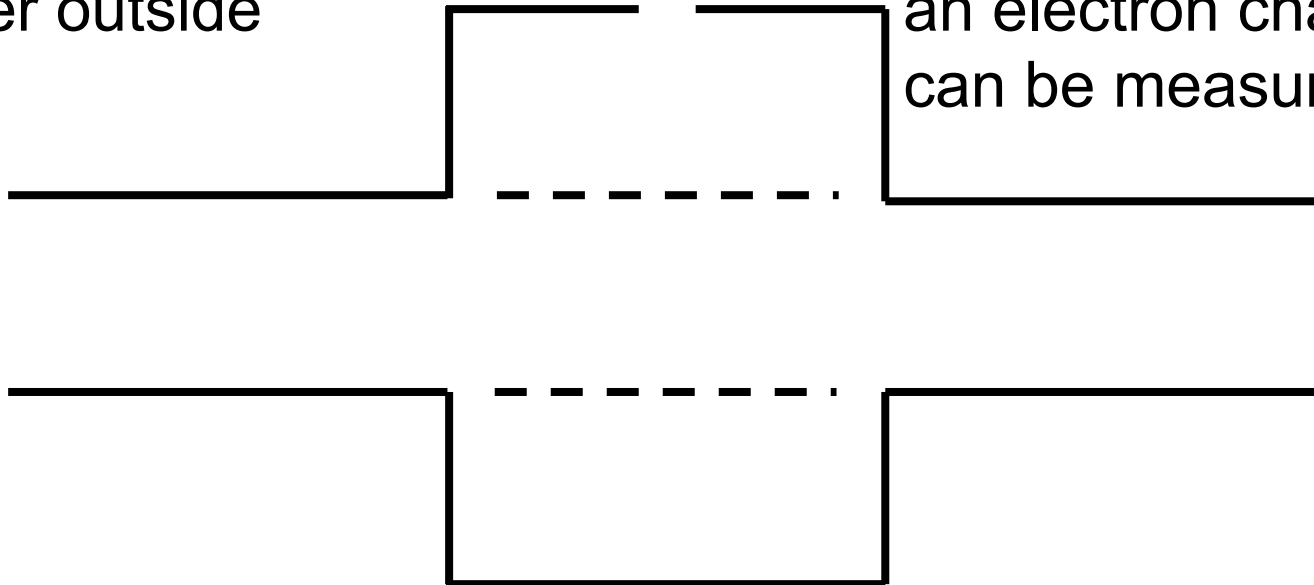
- That's not all that can be done with the GMD

Physics

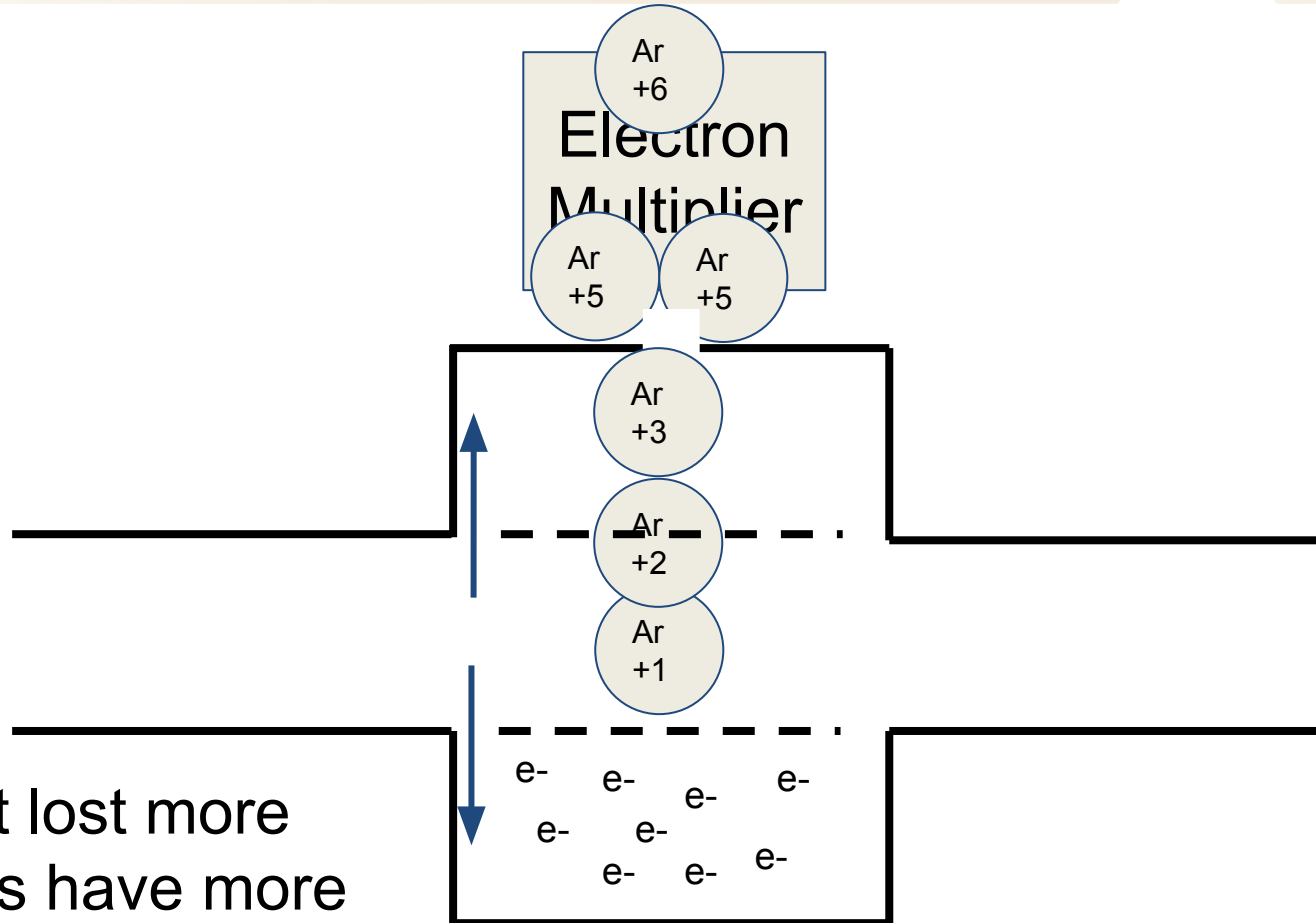
Build a small hole on the top Faraday cup and place an Electron Multiplier outside

Electron Multiplier

The few ions that escape through the hole hit the EP and generate an electron chain that can be measured

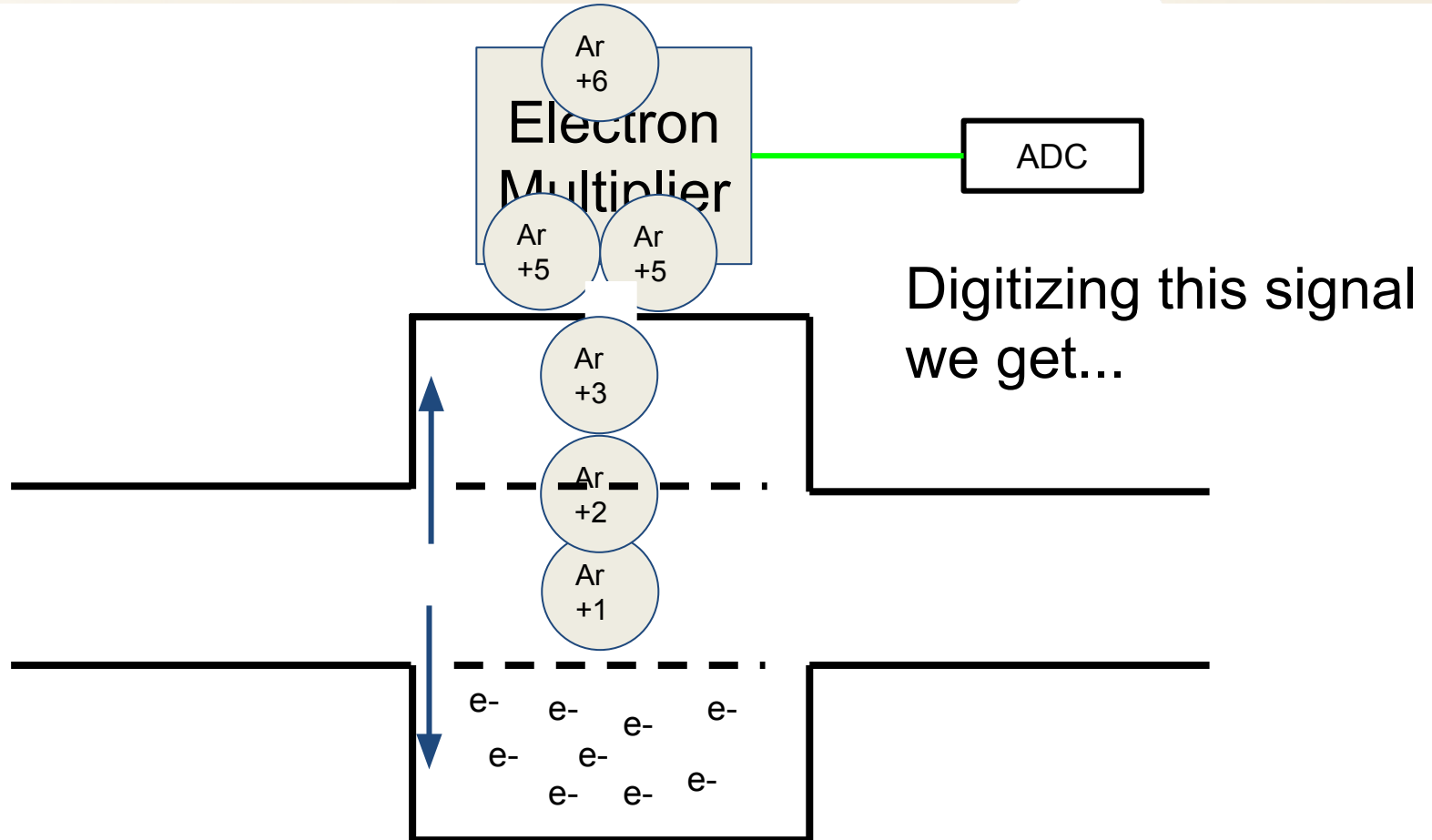


Physics

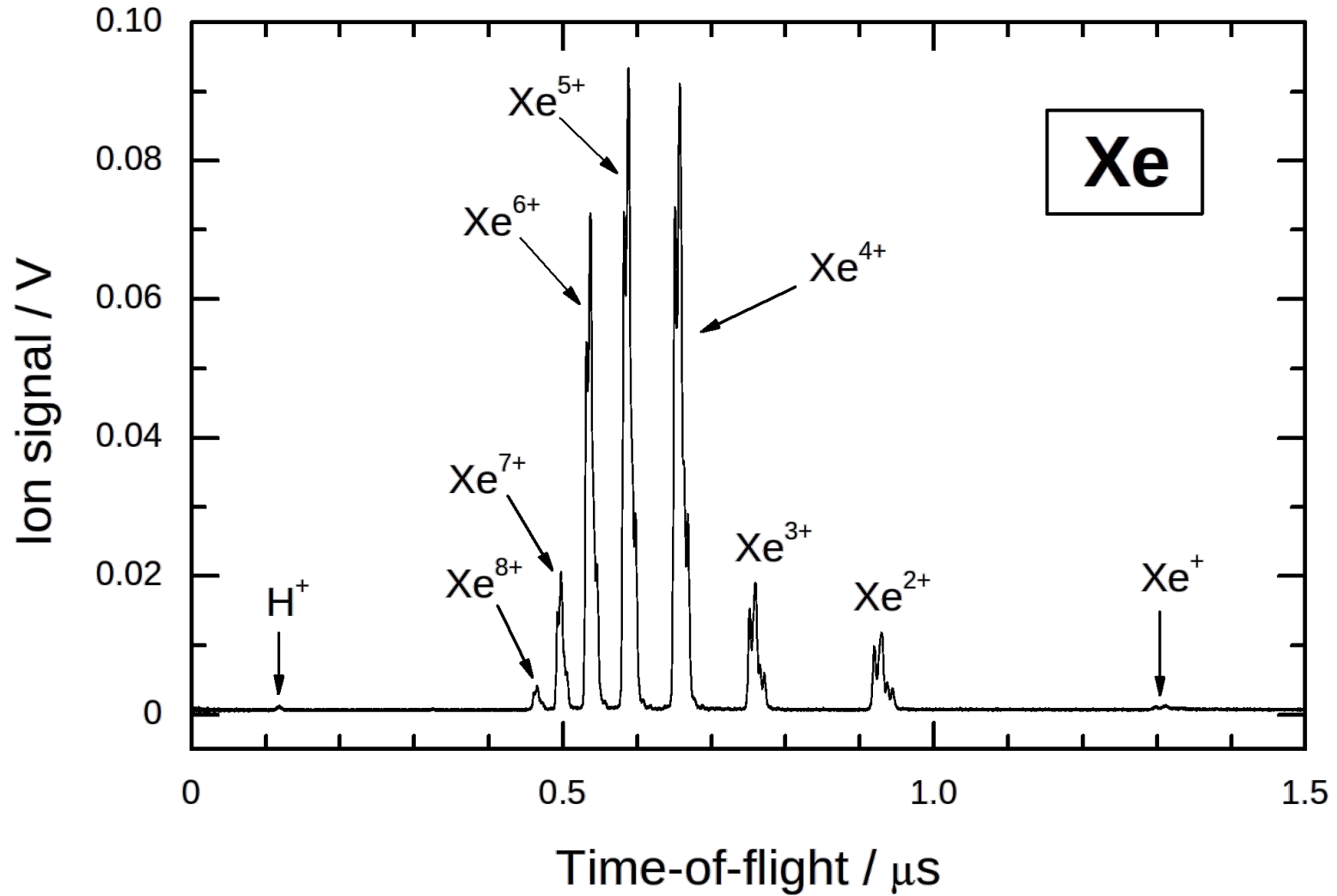


ions that lost more electrons have more positive charge and arrive first at the EP

Physics



Physics



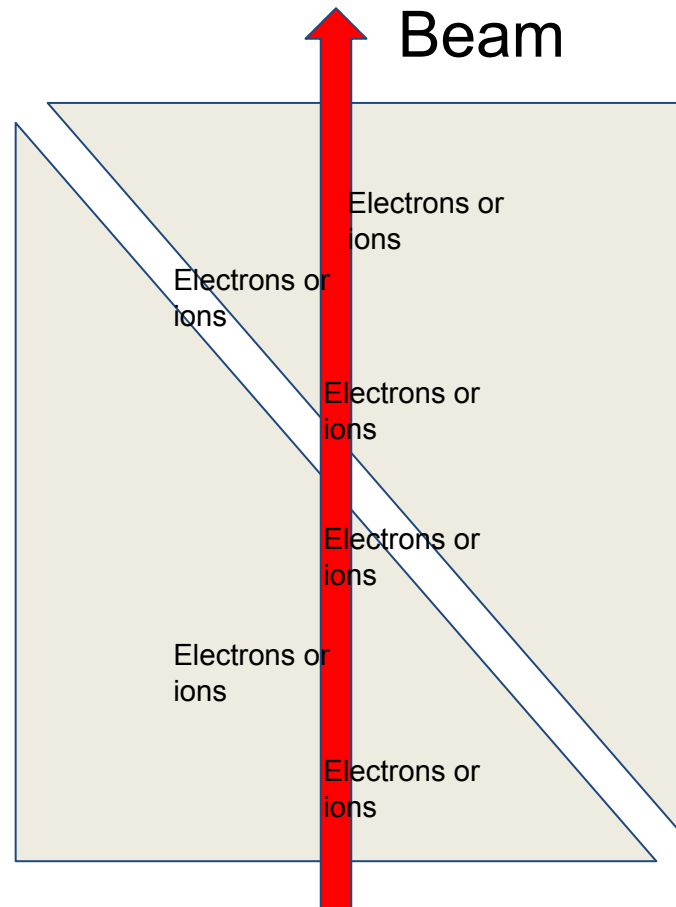
Physics

- With this spectrography we can check:
 - If the GMD has the correct gas
 - If it is pure enough
 - If the pressure is adequate

Physics

- But there is more! (Only for XGMD, though)

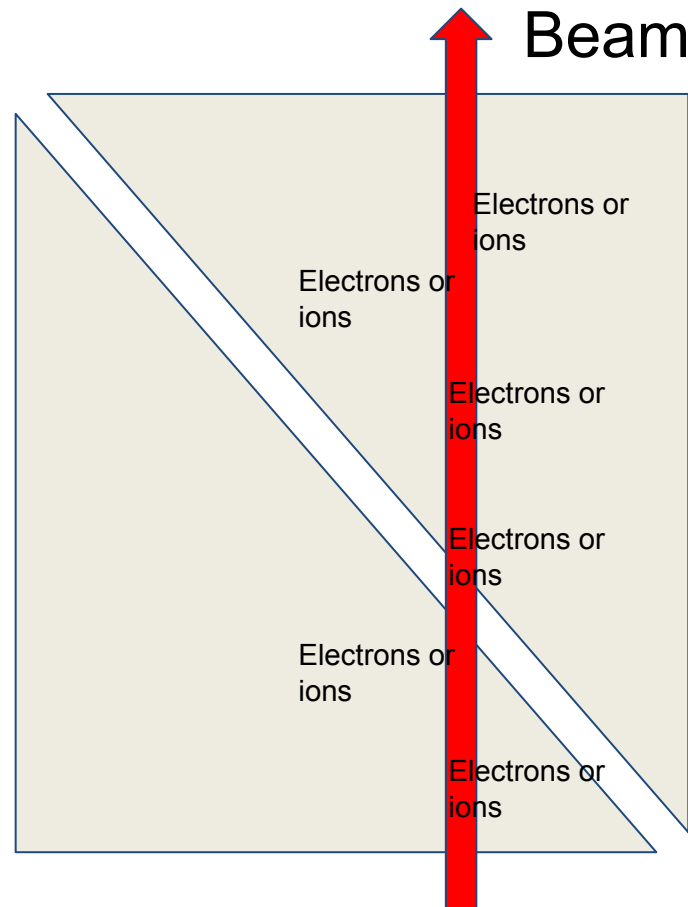
Both Faraday cups (electrons and ions) are divided in 2 parts



Physics

- But there is more! (Only for XGMD, though)

Both Faraday cups (electrons and ions) are divided in 2 parts



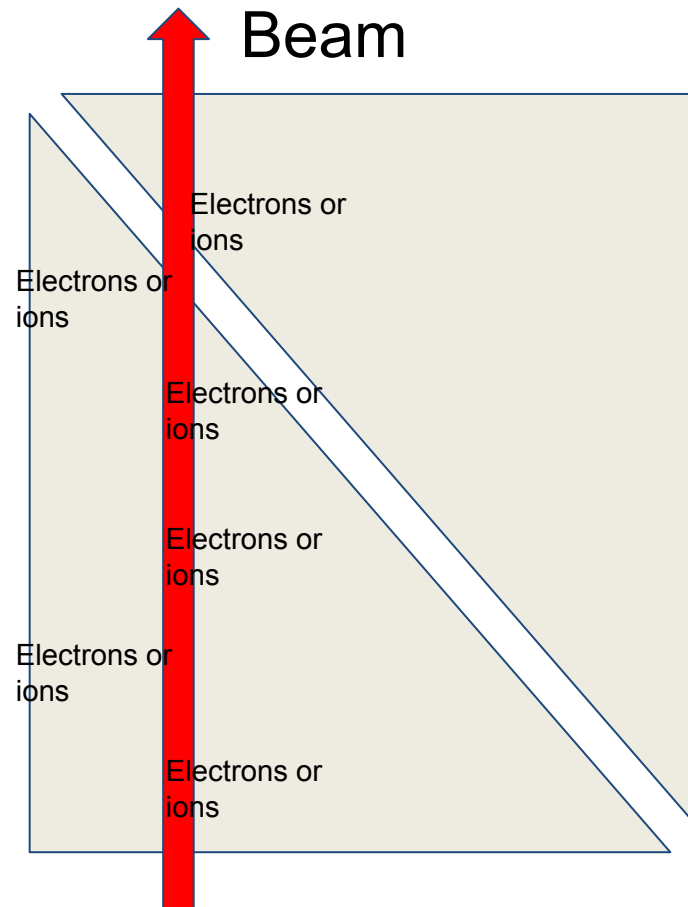
Beam to the right brings more electrons or ions to this side

Physics

- But there is more! (Only for XGMD, though)

Both Faraday cups (electrons and ions) are divided in 2 parts

Beam to the left brings more electrons or ions to this side



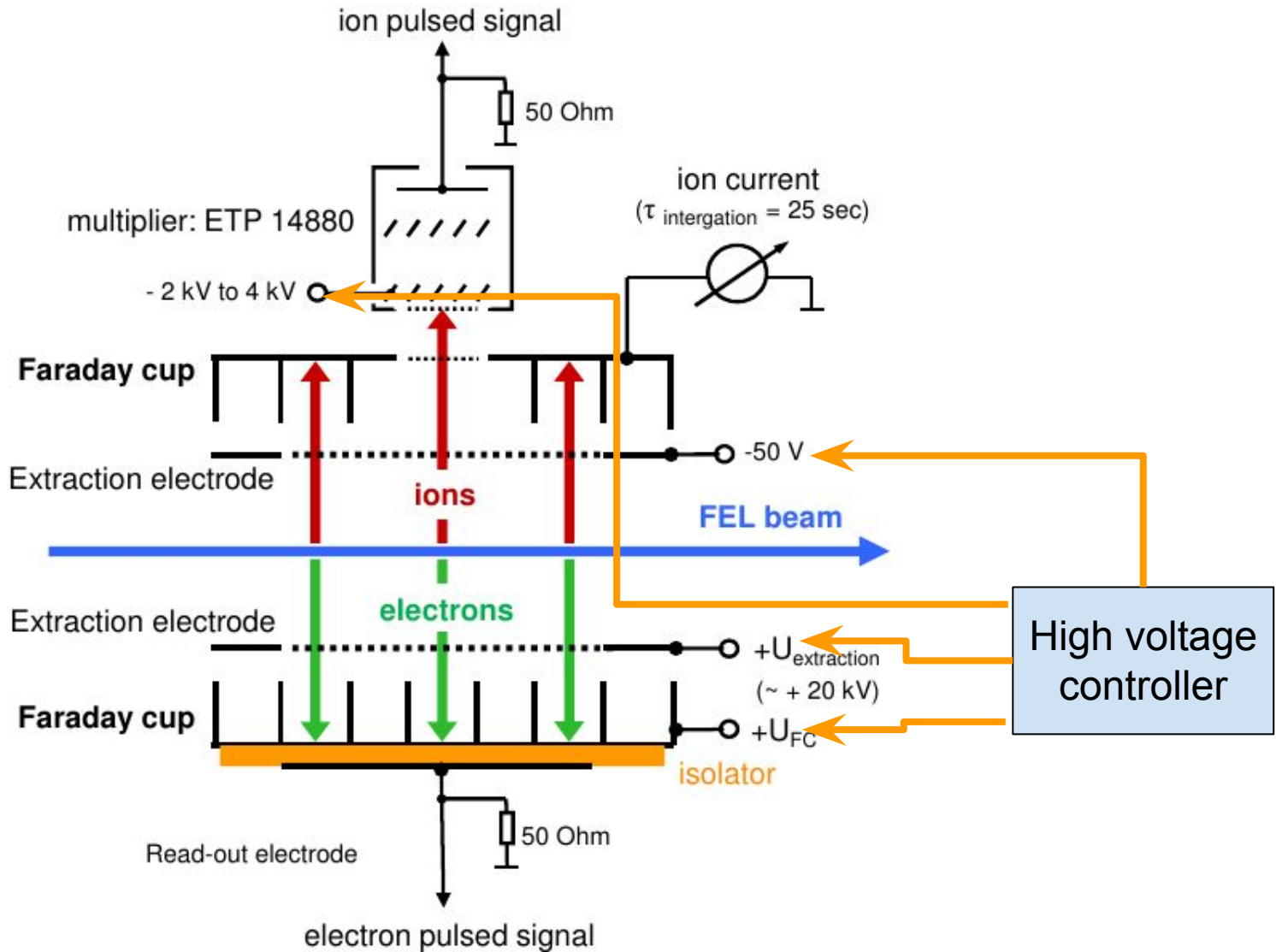
Physics

- That means that we can measure the x-ray beam position in one dimension!
- Naturally, we see that we can use the same logic as BPM to measure energy and position.
 - The BPM firmware is the basis for the GMD firmware.
 - The GMD IOC application will use some concepts of the BPM IOC application.

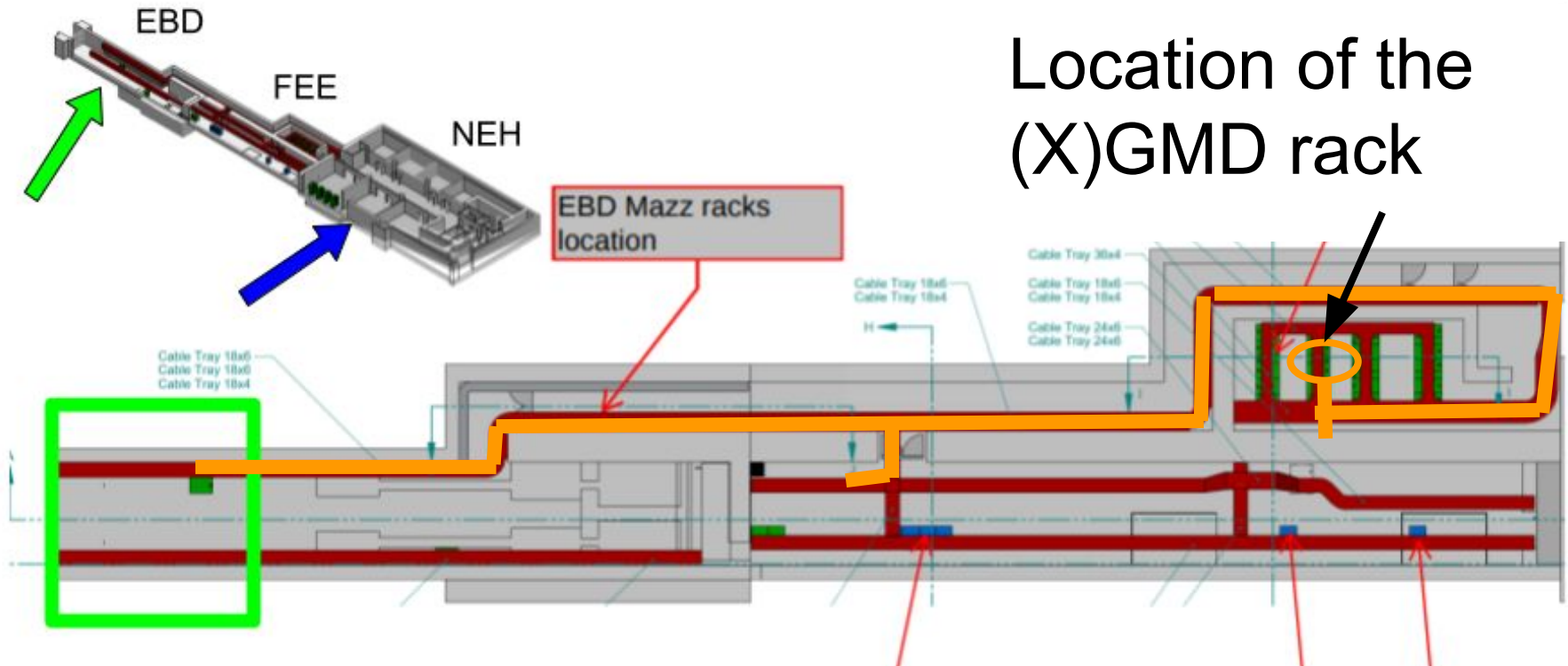
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- **Control Systems - High-voltage controller**
- Control Systems - Keithley
- Control Systems - Signal Digitizers

Control Systems - High-voltage controller



Control Systems - High-voltage controller



Location of the
(X)GMD rack

In orange:

- 4 SHV cables for the GMD
- 4 SHV cables for the XGMD

Control Systems - High-voltage controller

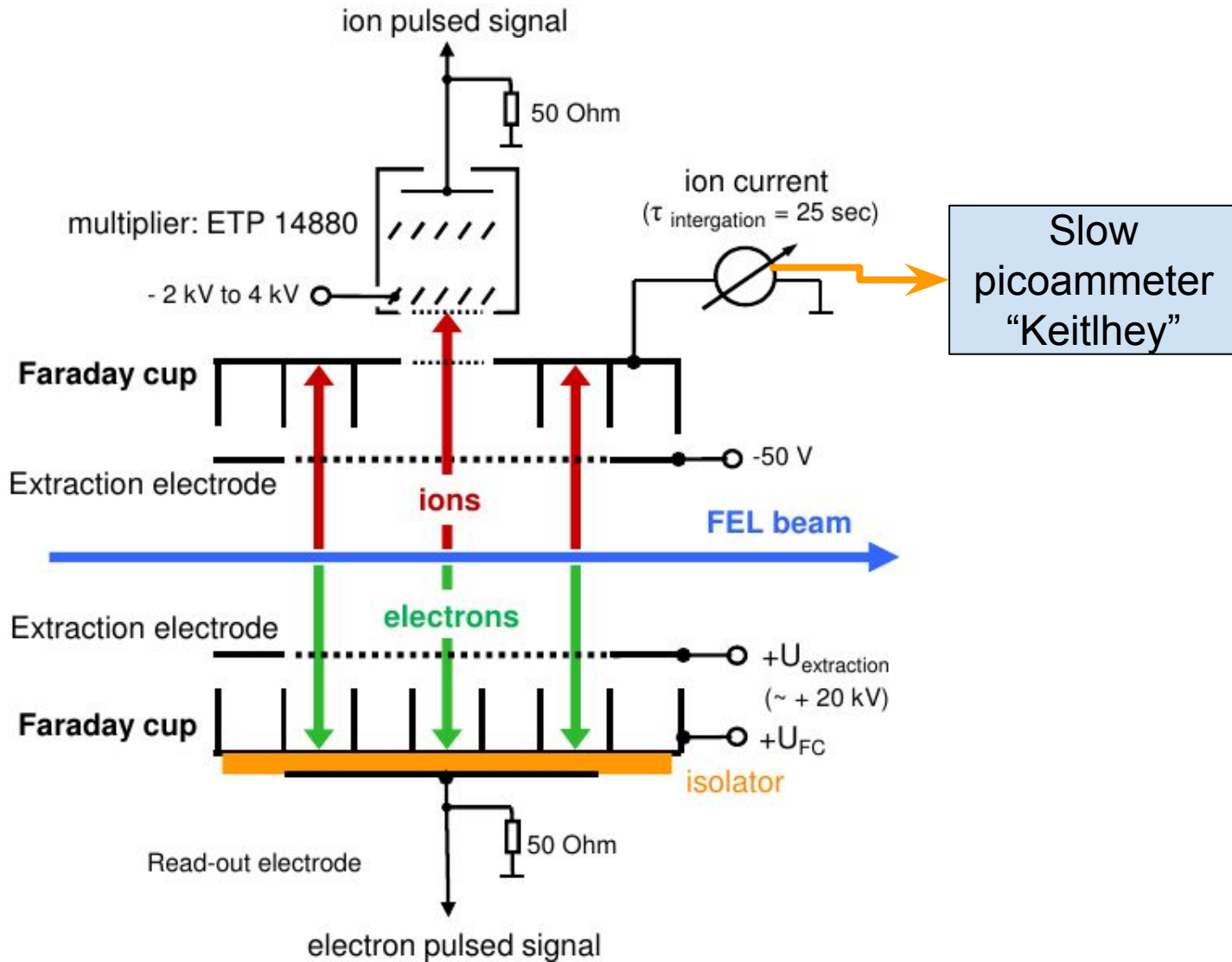


- iSeg CC24 controller:
 - Embedded Linux with EPICS IOC ready
 - Ethernet connection
- iSeg EHS F530x high-voltage module

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Control Systems - Keithley

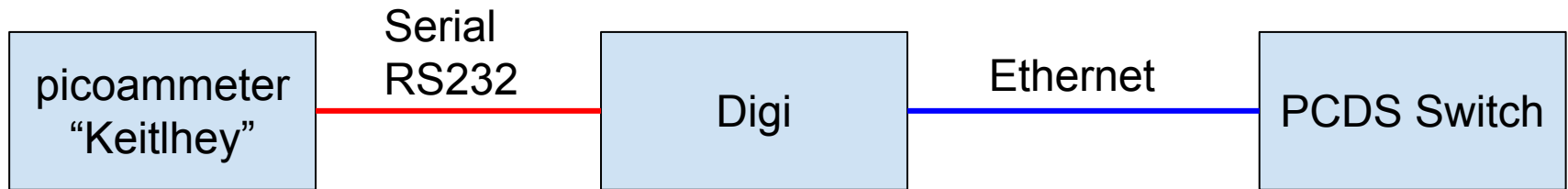


Control Systems - Keithley

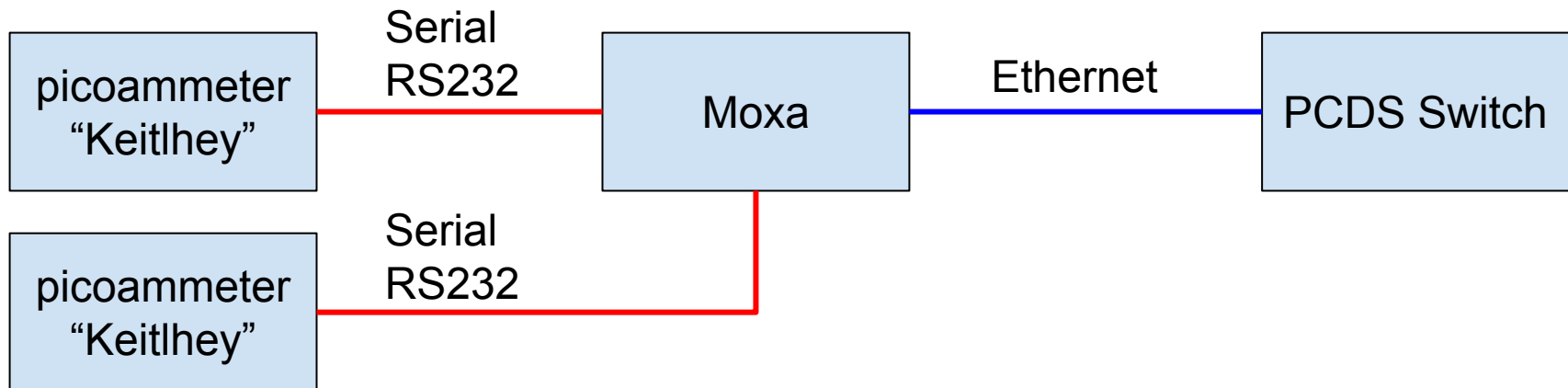


Control Systems - Keithley

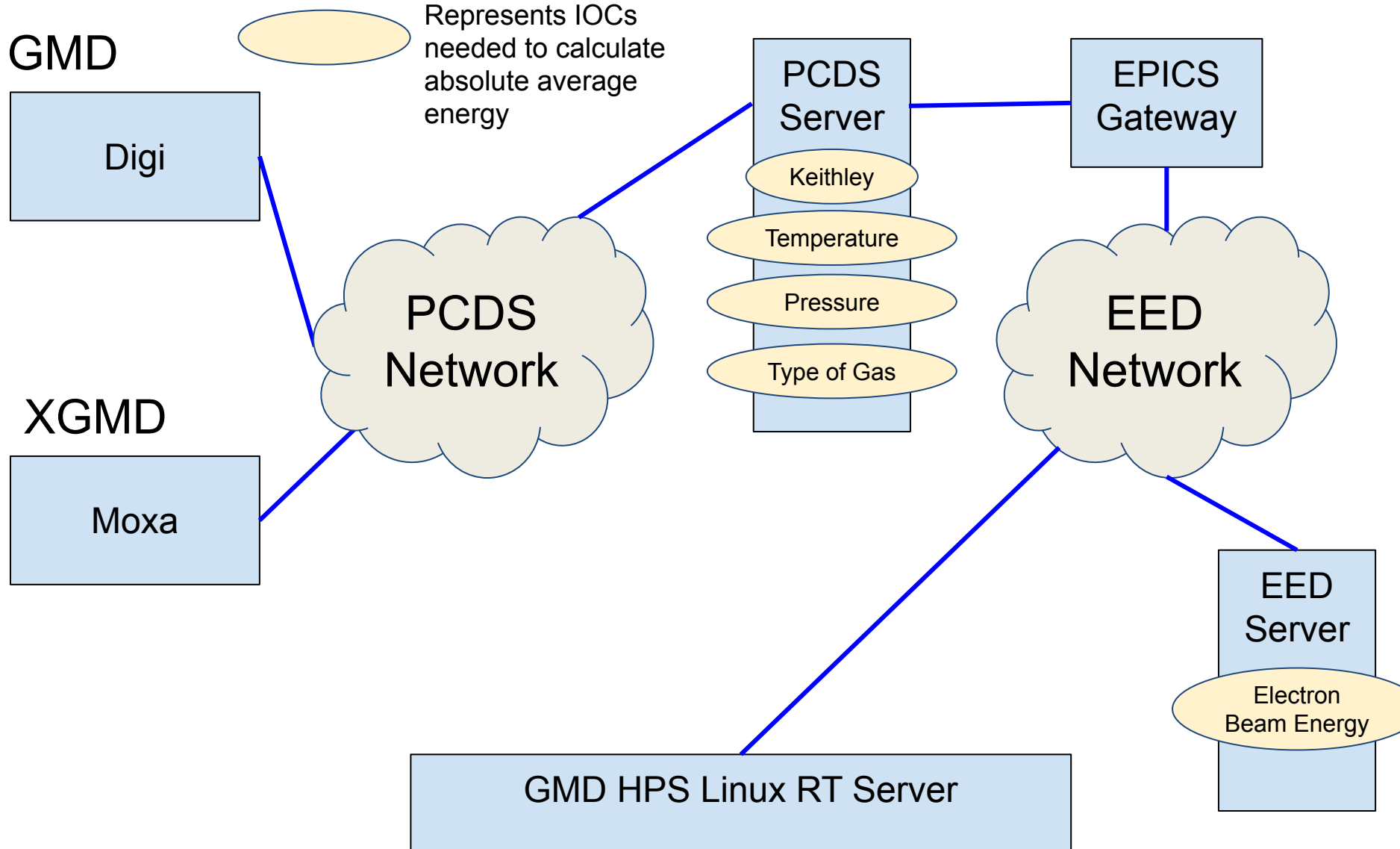
For GMD:



For XGMD:



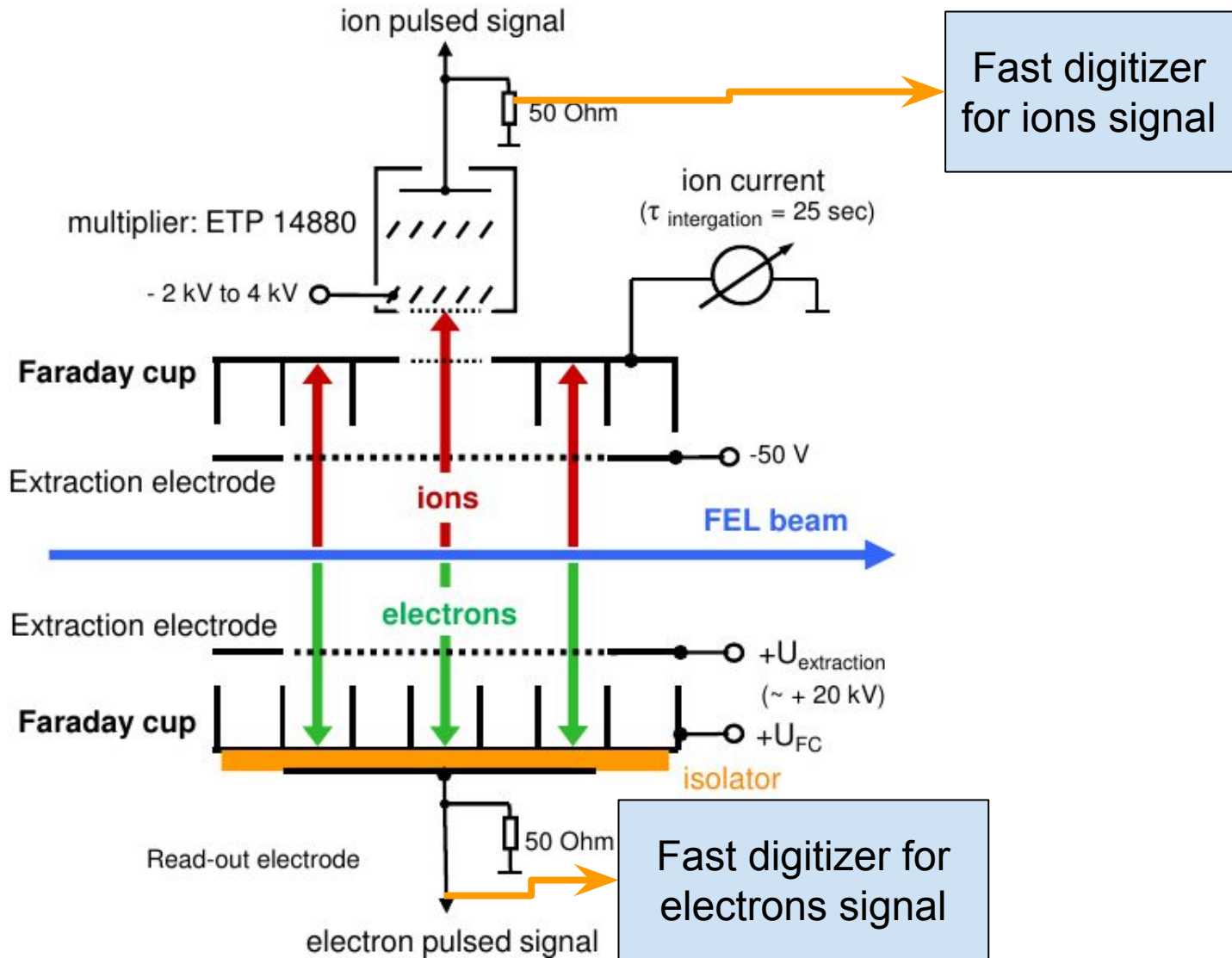
Control Systems - Keithley



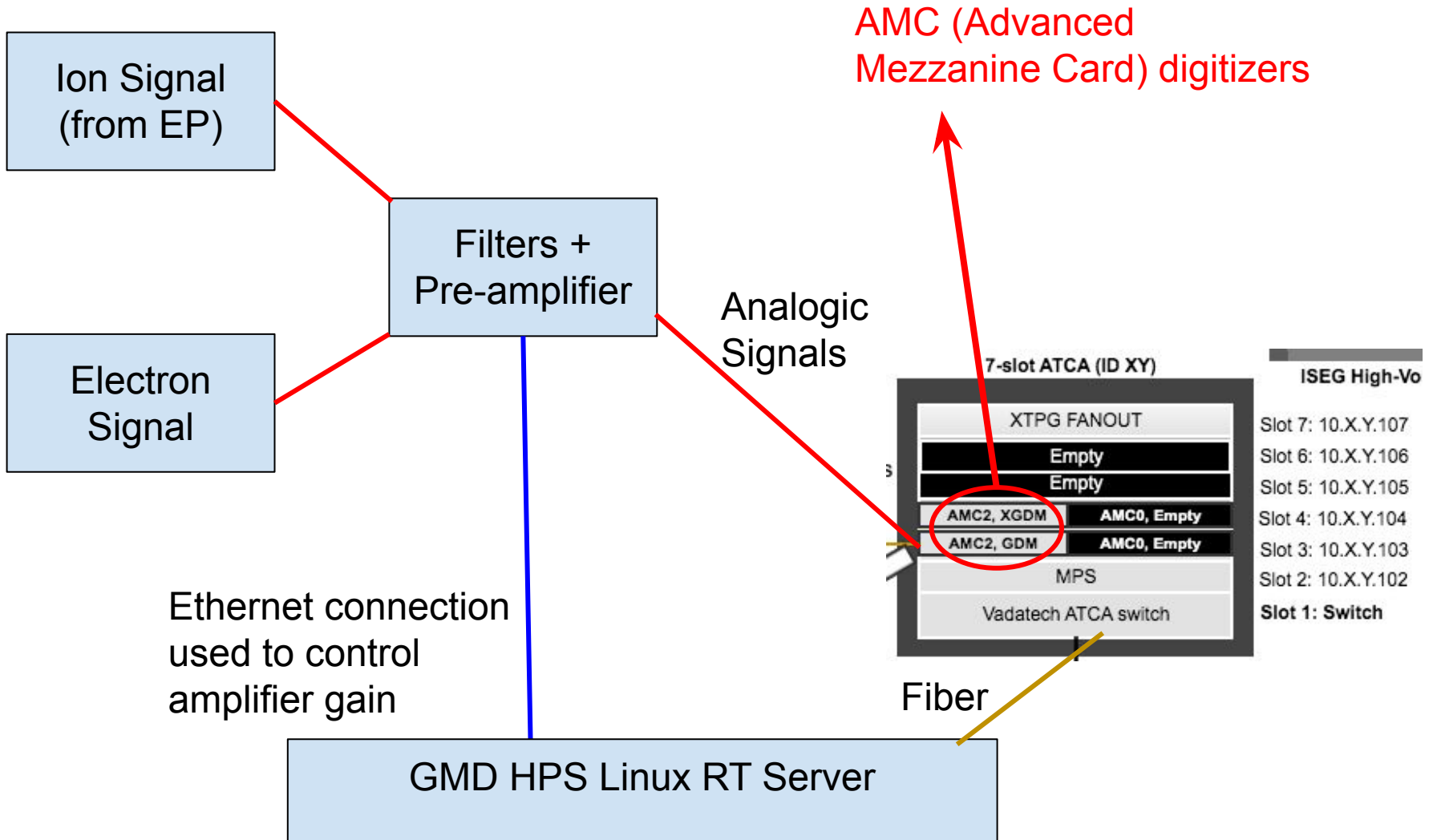
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Control Systems - Signal Digitizers



Control Systems - Signal Digitizers



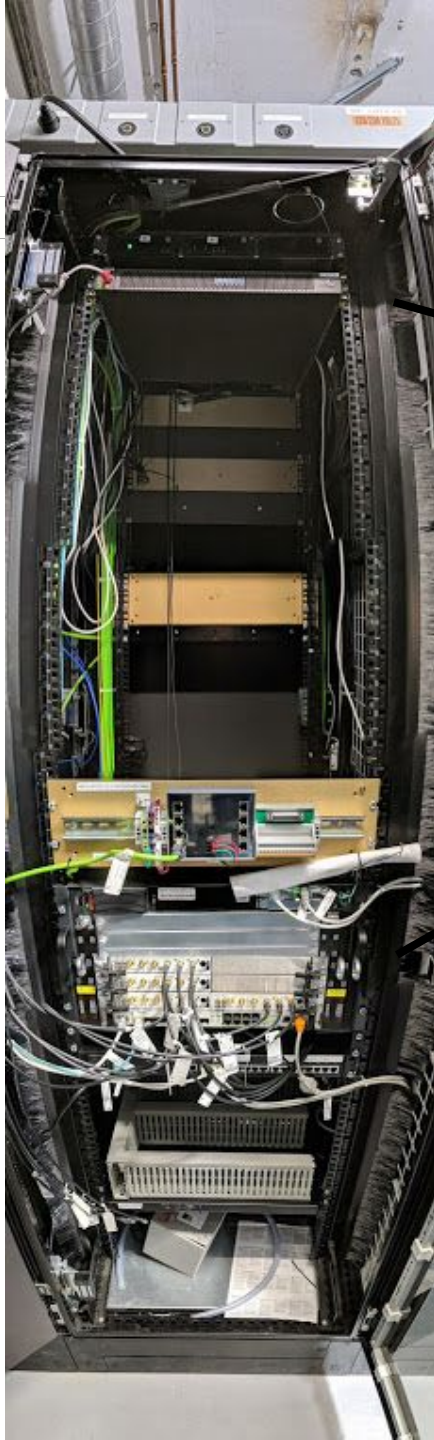
Control Systems - Signal Digitizers

Pre-amplifier developed by TID



Filters

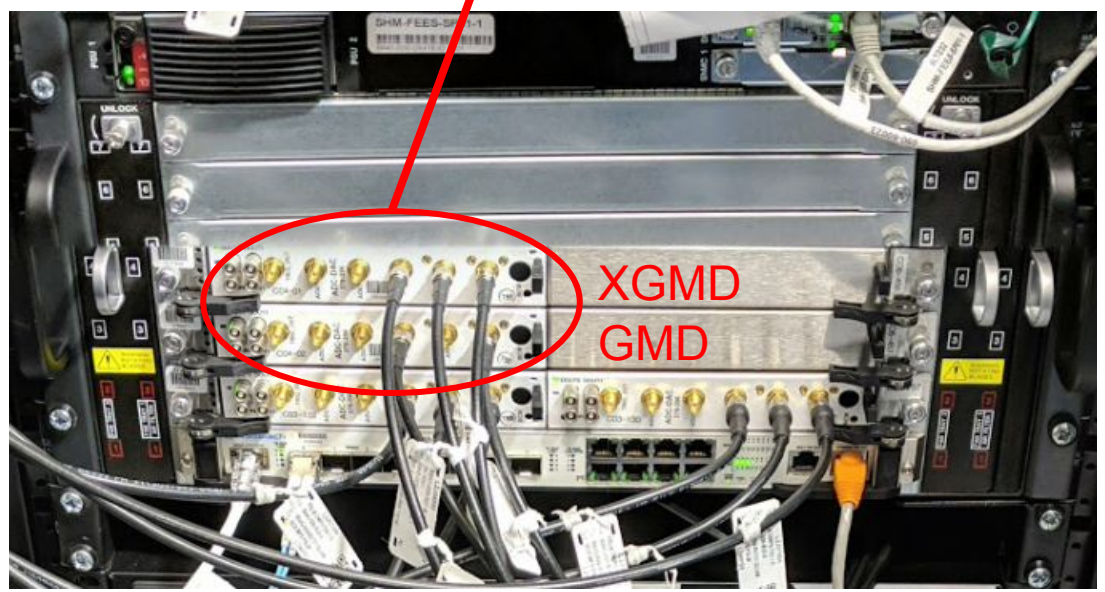
Control Systems - Signal Digitizers



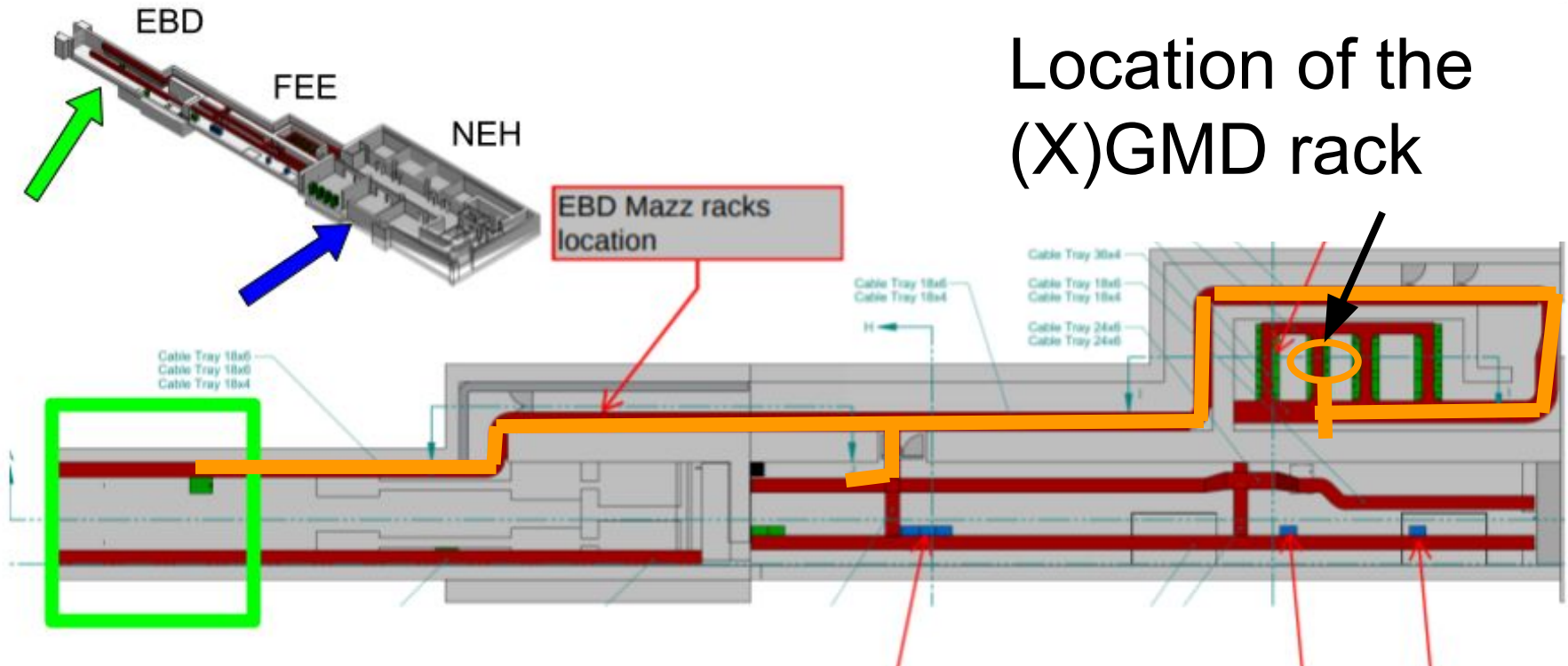
Linux RT Server

AMC (Advanced Mezzanine Card) digitizers

ATCA crate



Control Systems - Signal Digitizers

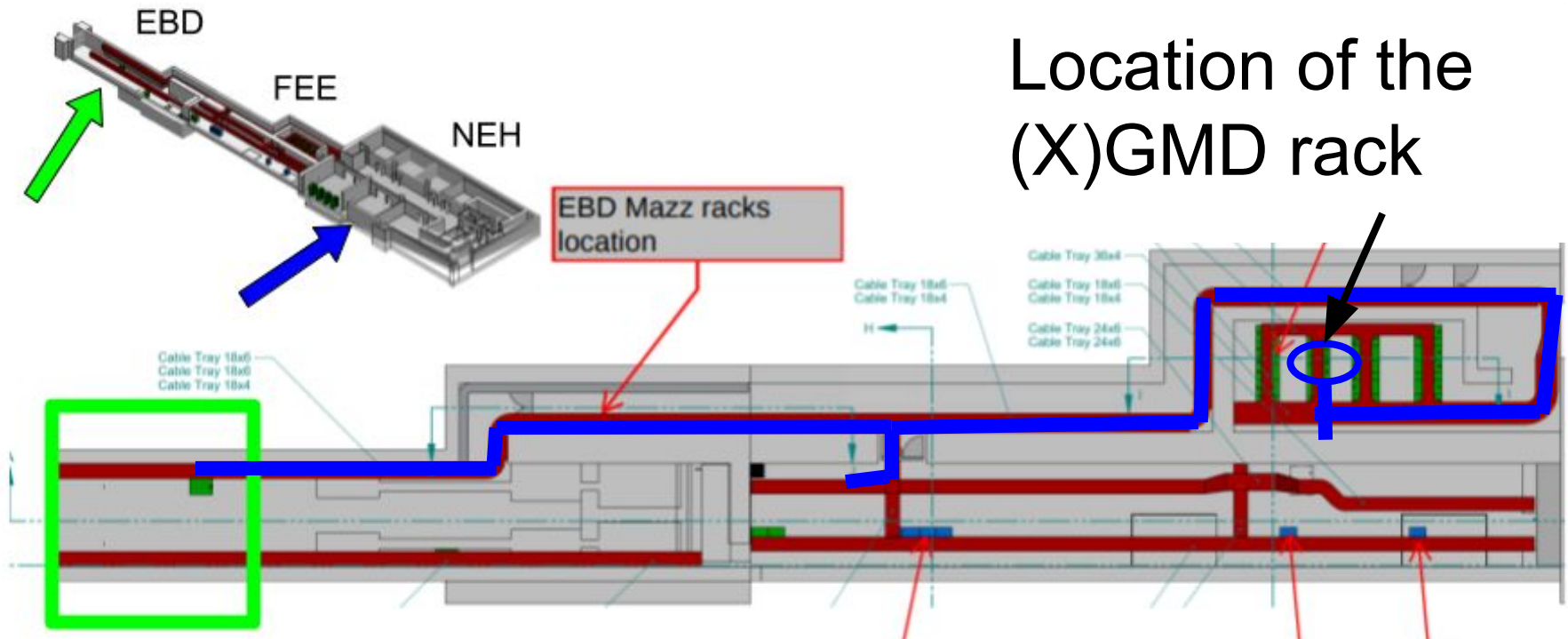


Location of the
(X)GMD rack

In orange:

- 4 LMR400 cables for the GMD (signal)
- 4 LMR400 cables for the XGMD (signal)

Control Systems - Signal Digitizers



In **blue**: Ethernet cables for the pre-amplifier

- The cables connect the pre-amplifiers directly to the Linux Server Network Interface.
- No switch is used.

Control Systems - Signal Digitizers

Pre-amplifiers have static IP that have to be loaded by the firmware engineer at B 84.

