

AIDA 2020

Advanced European Infrastructures
for Detectors at Accelerators

Femto-box

A CERN summer student project 2016

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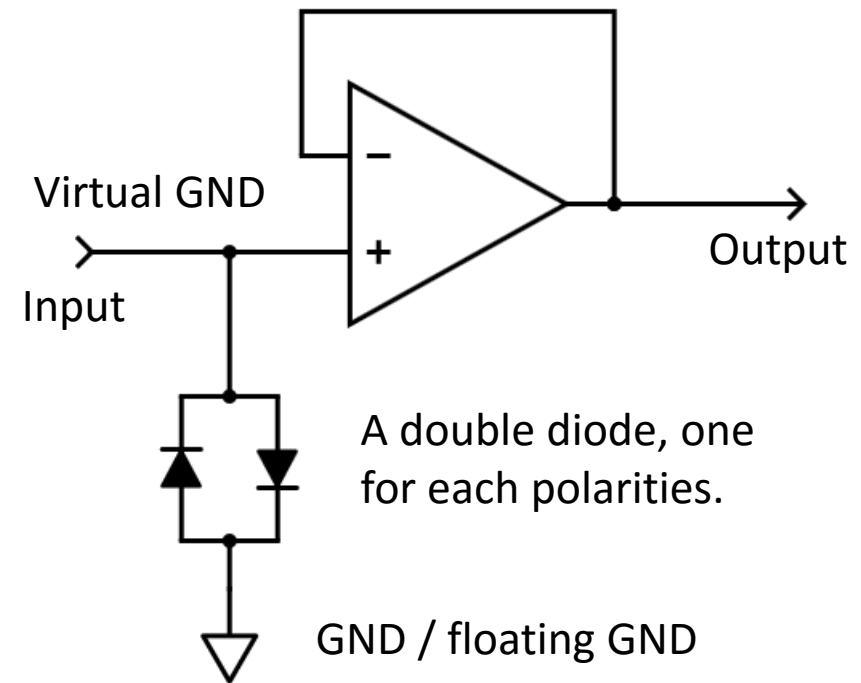
Features

- Measures current in a large dynamic range
 - 10fA - 1 μ A
- Temperature compensation
- Spark protected
- Portable box
- Power supply through battery or external voltage source
- Low cost
 - Common components



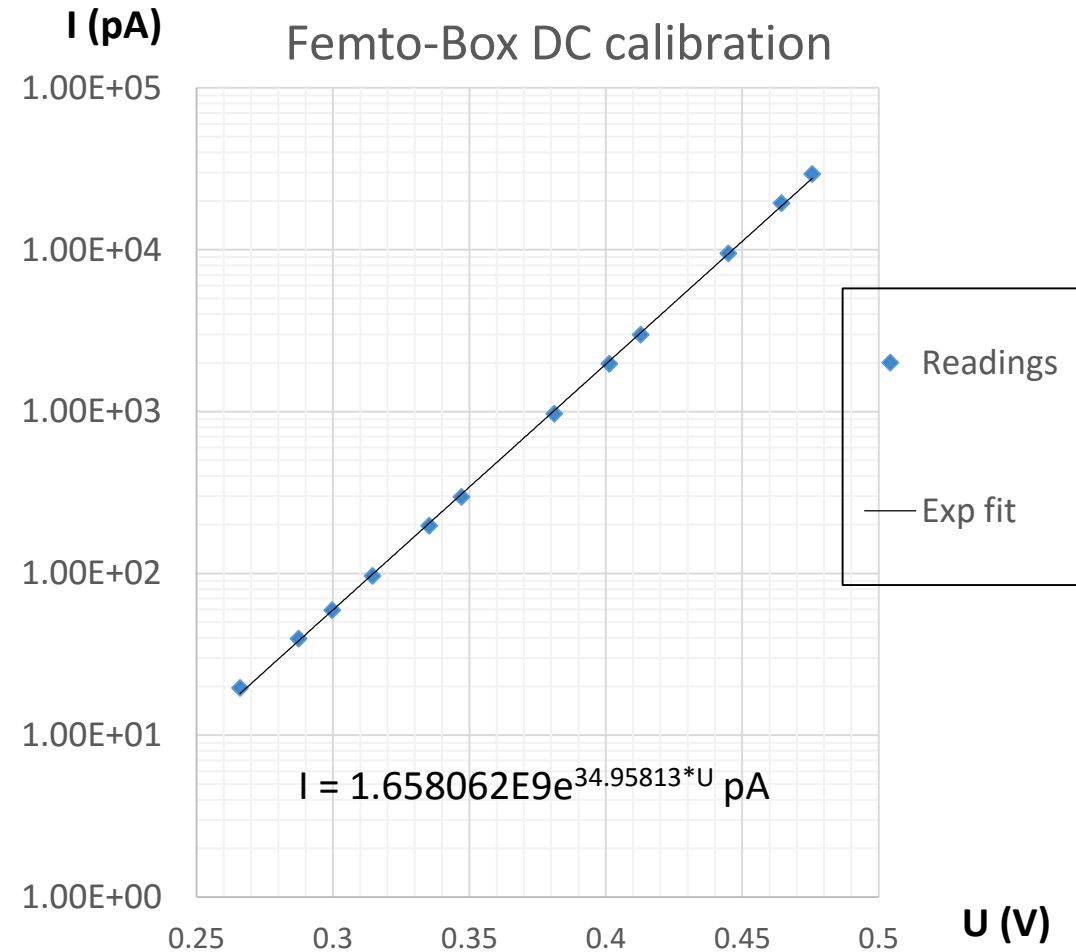
Newest features

- Can read positive and negative current from one input
- Can float in HV
 - i.e. current can be read from GEM electrodes
 - At the same time, can be powered by a power supply in GND



Principle of function

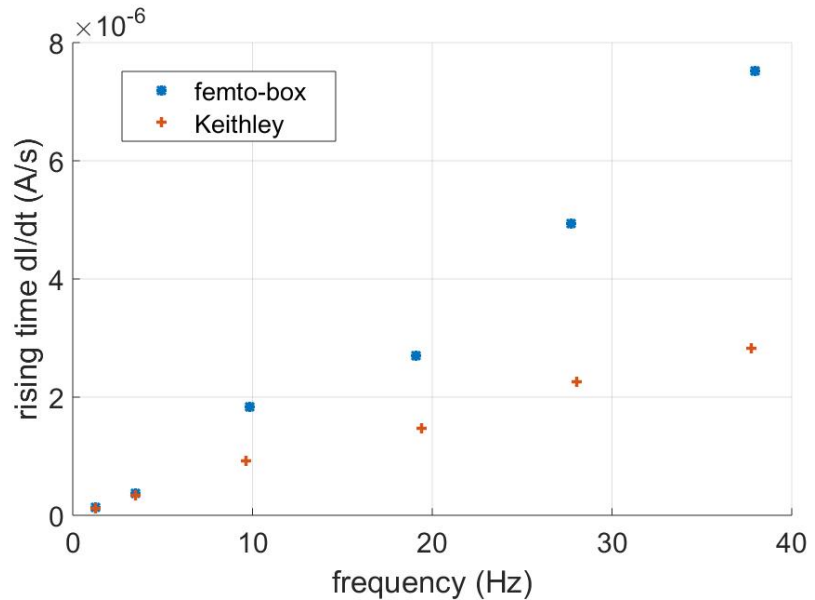
- Reading the voltage drop over a diode by an integrated moving coil display or alternatively multimeter, oscilloscope etc.
 - $U_{diode} \sim \ln(I_{diode})$.
 - Through calibration, corresponding current can be read.



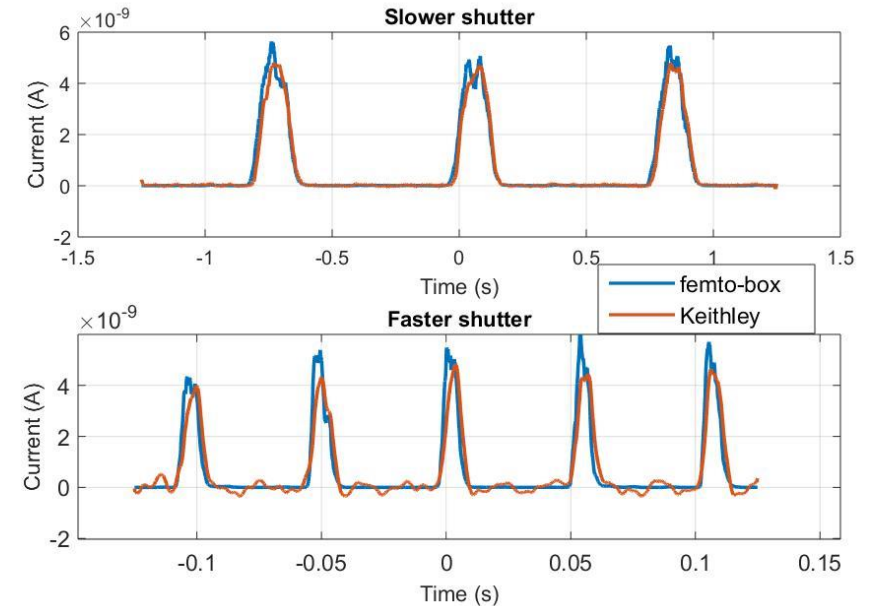
Time response to non-constant current



- Shutter opens and closes the x-ray source periodically.
- Signal is acquired simultaneously with the Femto-box and a Keithley picoammeter

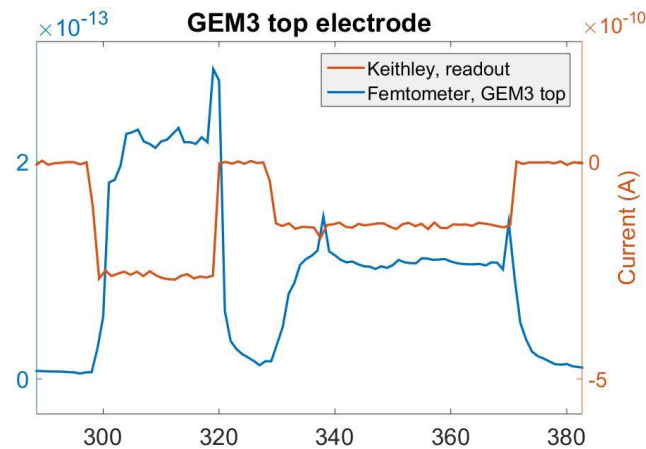
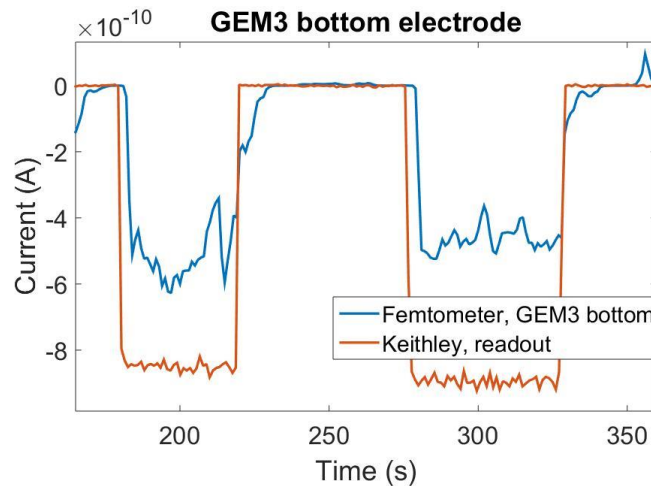


- As the frequency of shutter increases, the opening of the source becomes faster. Rising time means the averaged maximum slope of pulses.
- **According to the measurements, femto-box can read faster changes of current than Keithley picoammeter.**

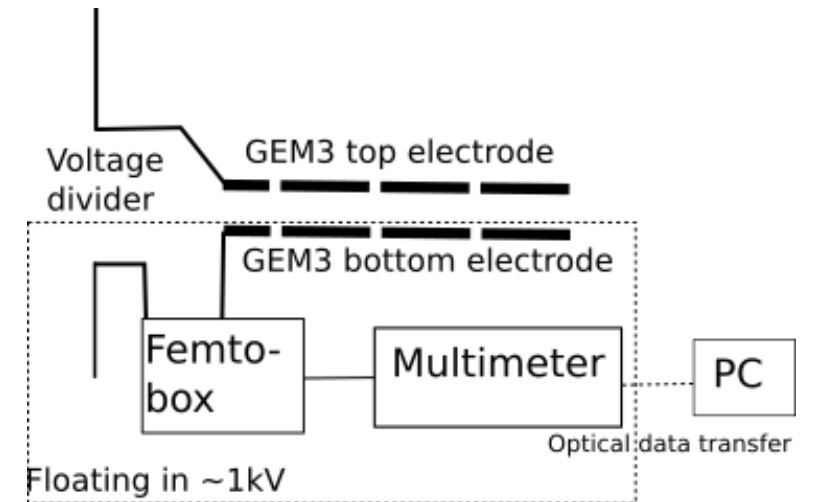


Reading current from GEM electrodes

- Femtobox was insulated well to float on HV.
 - Bottom of GEM3 electrode was at $\sim 1\text{kV}$.
- Current was simultaneously read from the triple GEM readout at the bottom.
- A source was put on and off the detector.



A small $\sim 200\text{fA}$ current was read from the GEM3 top electrode while floating in HV.



Future development

- The femtobox version with good time response had a bad noise performance compared to another version, which in turn had a slower response for alternating current. Could the good features of both versions be combined or optimized?
- An analog-to-digital converter (ADC) to operate in high voltage to replace the multimeter. Insulation up to 4kV would be required.

Questions?

Thank you!