

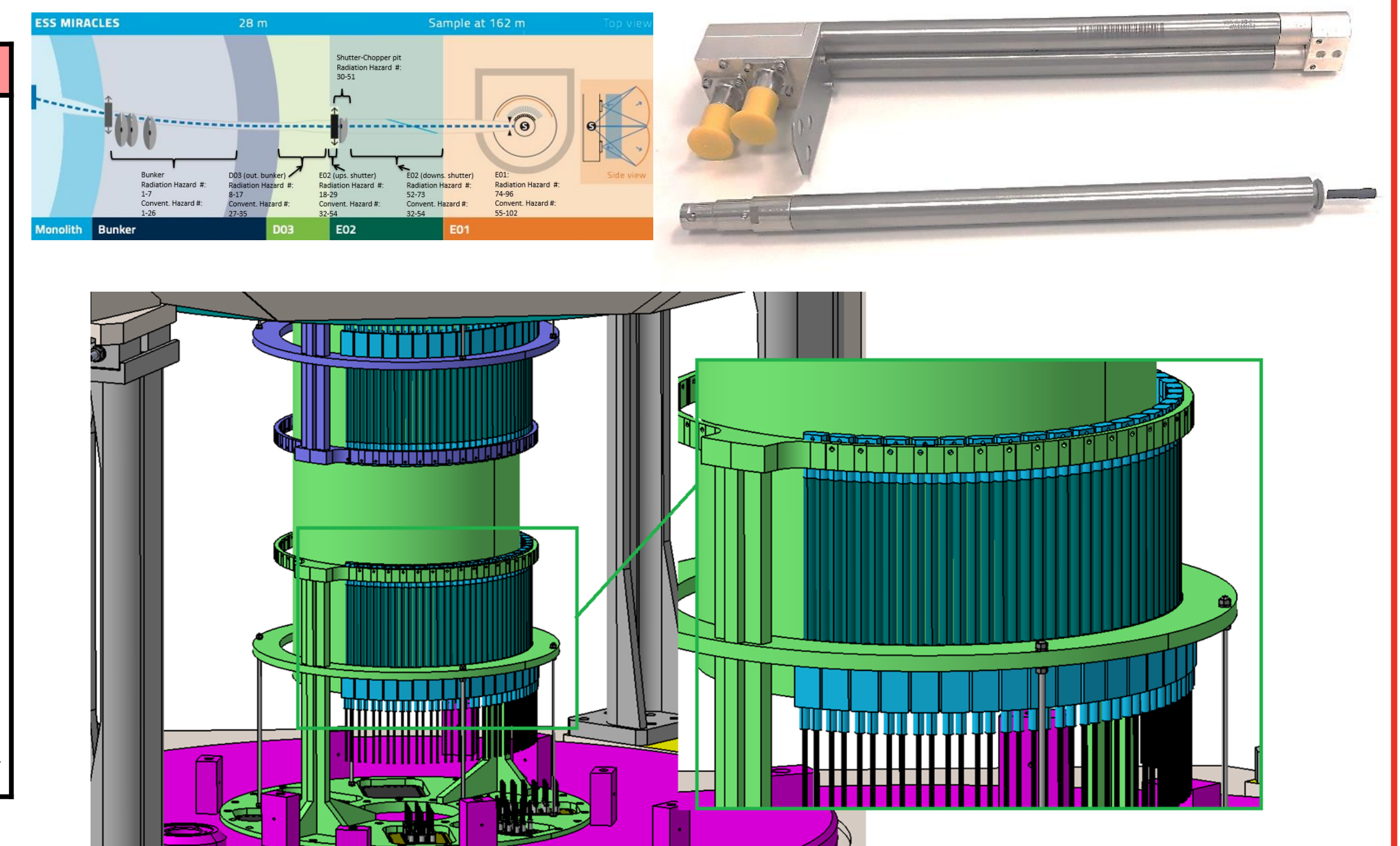
MIRACLES is a neutron time-of-flight backscattering spectrometer. The detection system consists of two arrays of 48 detectors configured in a semicylindrical layout with a cylinder radius (distance sample axis, detector axis) of  $\sim 230$  mm, surrounding the sample environment above and below the sample plane. Every tube, with diameter  $\varnothing = 12.7$  mm will thus cover a horizontal scattering angle of  $3.24^\circ$ , from  $9.5^\circ$  to  $165^\circ$ .

The 96 tube detectors will be arranged in 48 doublets: every pair is connected in series, forming a U-shape, by means of a resistance located at the tube end closer to the sample plane. Cable connection shall be insulated to rule out any RF isolation or ground issue, as well as to increase thermal stability.

## Purpose of the tests

The purpose of the tests are to validate electronics and detector tubes (doublet and pigtail) using real neutron signal. In electronics, 2 preamplifier models from CAEN are tested: A1422 and R1443.

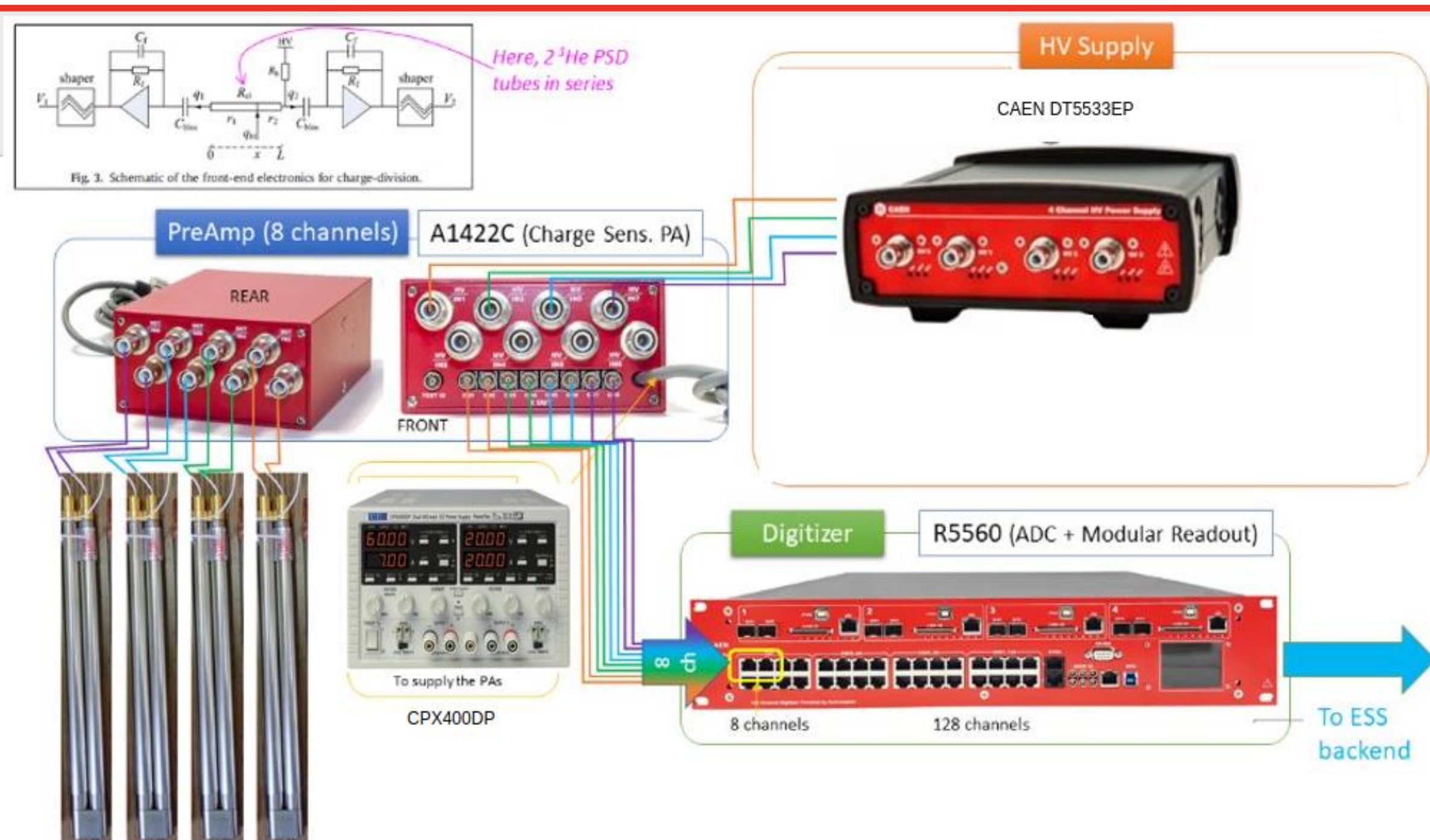
QUICK FACTS	
<b>Sector</b>	West
<b>Beam Port</b>	W5
<b>Class</b>	Spectroscopy
<b>Commissioning/Operation</b>	2027/2028
<b>Moderator</b>	Cold
<b>Length (source to sample)</b>	162.5 m
<b>Q-Range (at <math>\lambda = 6.27</math> Å)</b>	$0.2 - 2 \text{ Å}^{-1}$
<b>E-Transfer Range (at <math>E = 2.08</math> meV)</b>	$-1.9 - +20 \text{ meV}$
<b>Wavelength Band</b>	$\Delta\lambda = 1.7 \text{ Å}$ ( $\pm 500 \text{ µeV}$ )
<b>Wavelength Range</b>	$2 - 20 \text{ Å}$
<b>Momentum Resolution</b>	$\Delta Q/Q = 5 - 10 \%$
<b>Energy Resolution (QENS)</b>	$\delta(h\nu) = 2-45 \text{ µeV}$



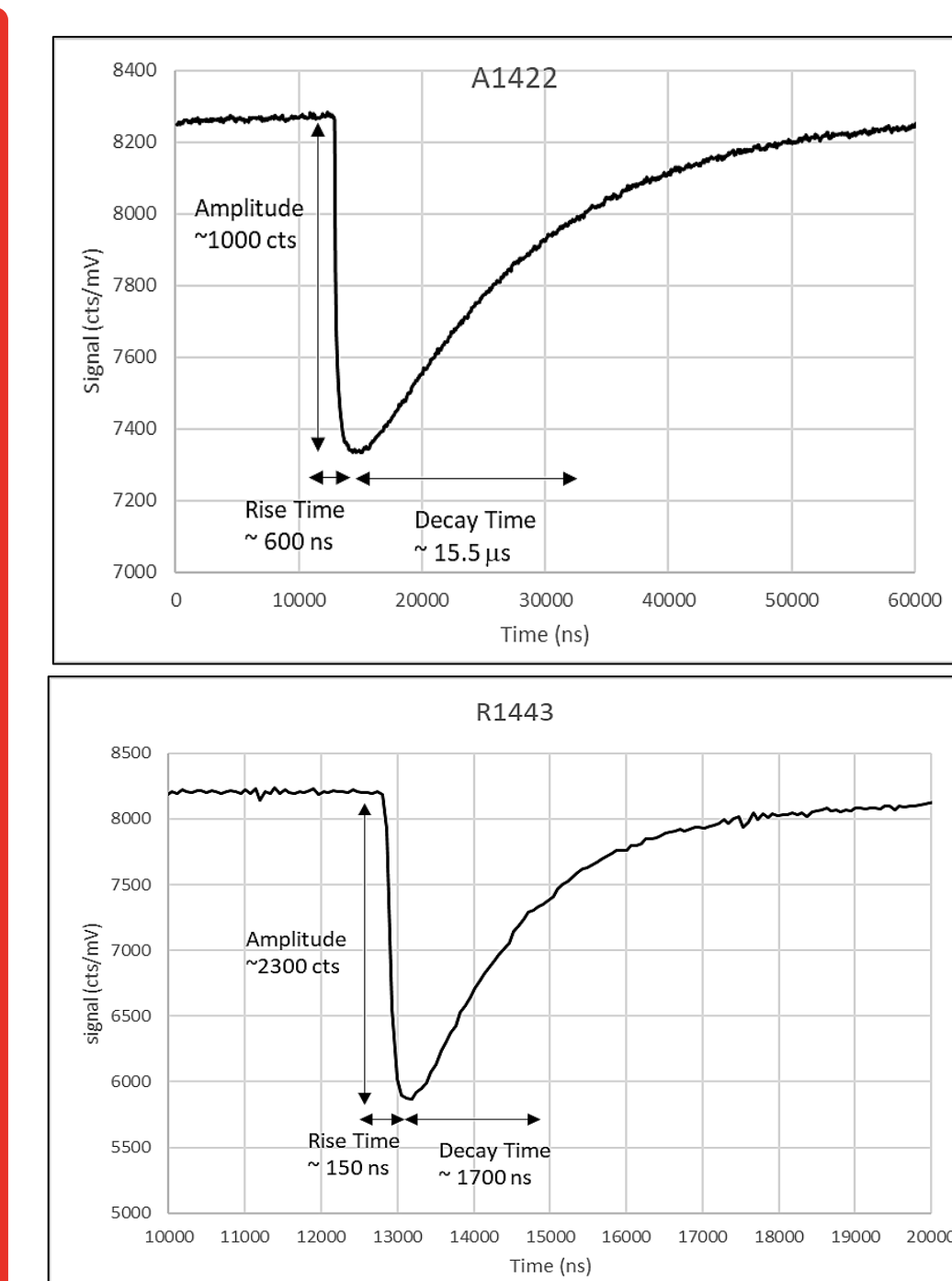
## DETECTOR TEST BENCHES LAYOUT

### A1422 Preamplifier

The gain of the preamplifier is 90 mV/MeV (Si), 2,04 V/pC. A1422 device is powered by a 12V CPX400DP supply. Bias Voltage inserted in each channel of Preamplifier.

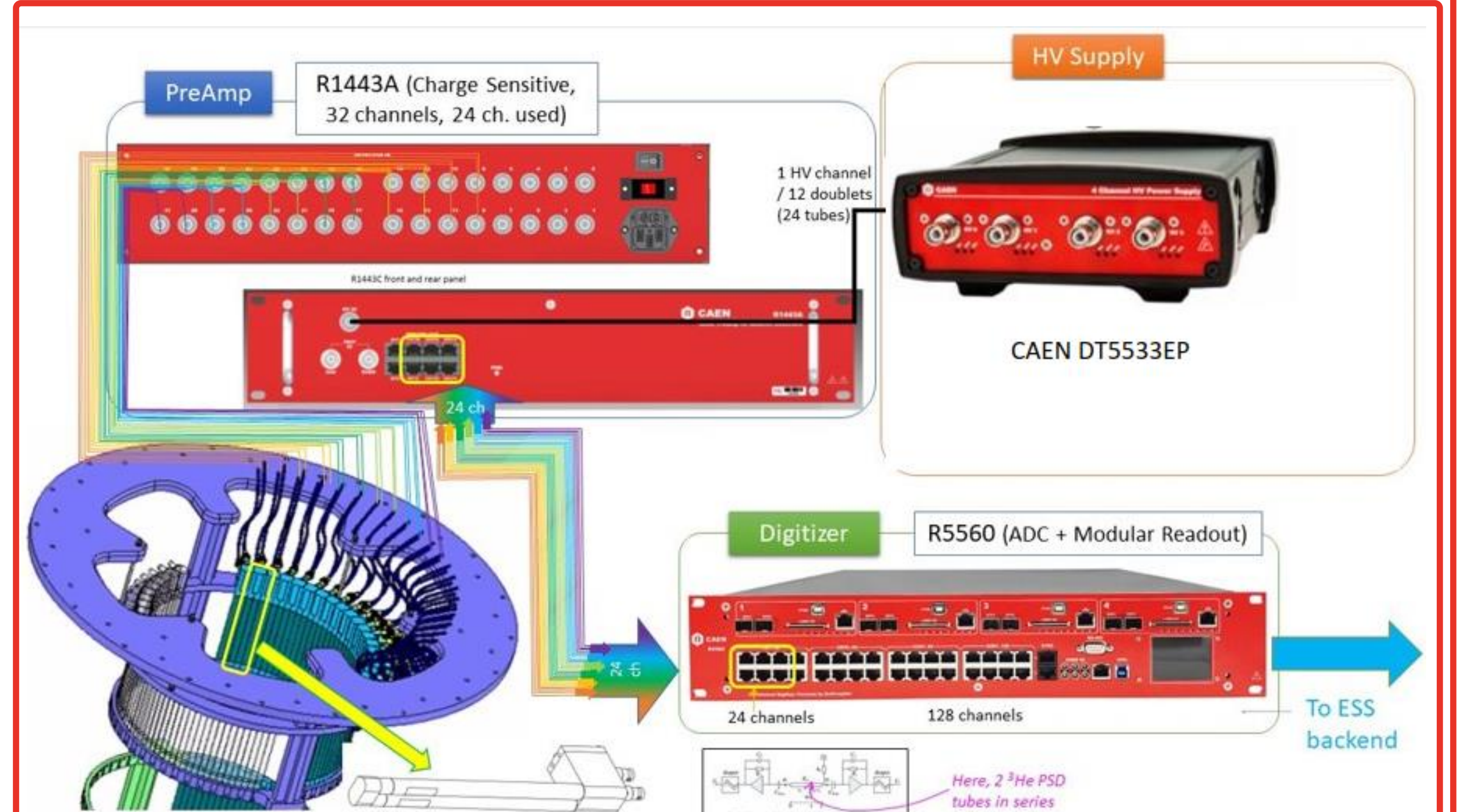


Although A1422 is suitable, R1443 presents better features, in terms of decay time and gain.



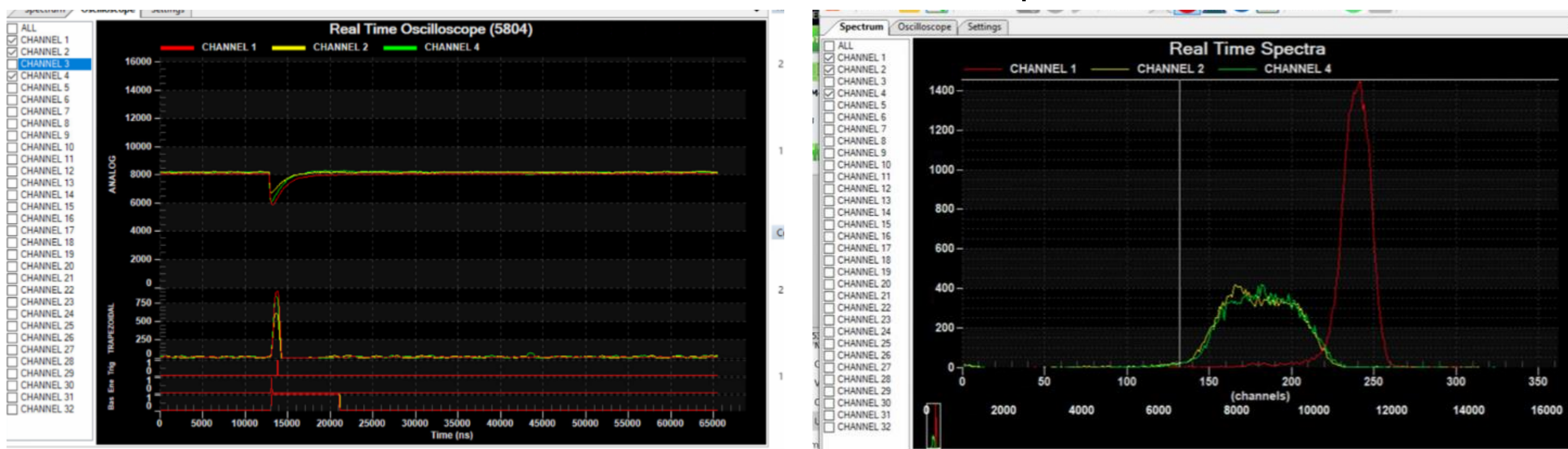
### R1443 Preamplifier

The gain of the preamplifier is 2.25 V/pC. Bias Voltage from DT5533EP, added in one input which is spreaded over the 32 channels of the Preamplifier.



## MEASURES

The output channels of the PAs will be connected (RJ45) to the 128-channel digitizer (CAEN R5560B). The output from the digitizer is linked to CAEN SCI-Readout SW. During these tests CH2 and CH4 of the digitizer are connected to a doublet, thus Position Sensitive Detectors, and CH1 is connected to open doublet, in counter mode.



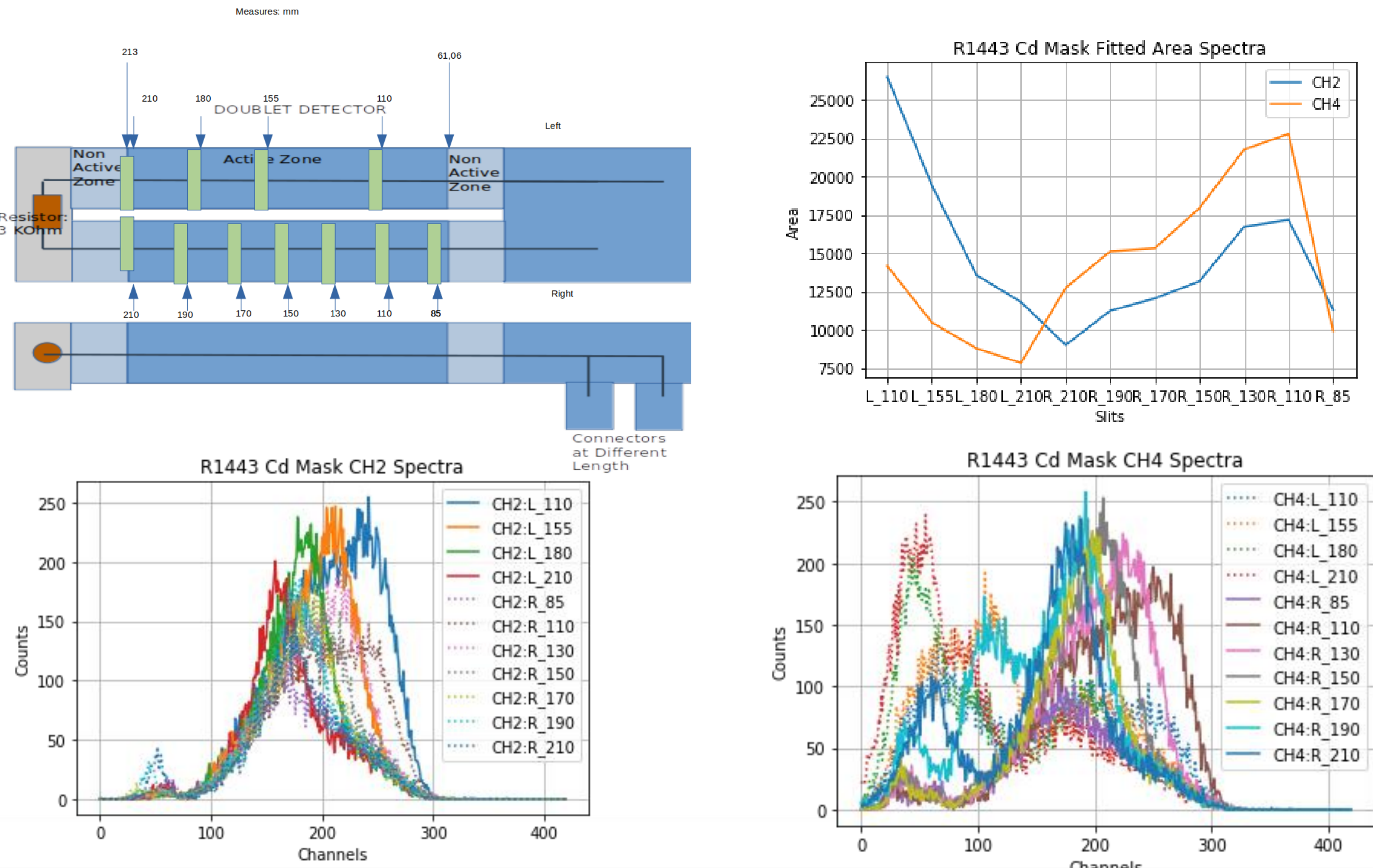
Settings from CAEN SCI-Readout SW menu are configured to achieve among others, suitable peaking time, flat top, energy sample, gain and signal decay constant.

Several values of High voltage to accelerate ions is applied to the detectors to observe charge amplification.

### Position Sensitive Measures

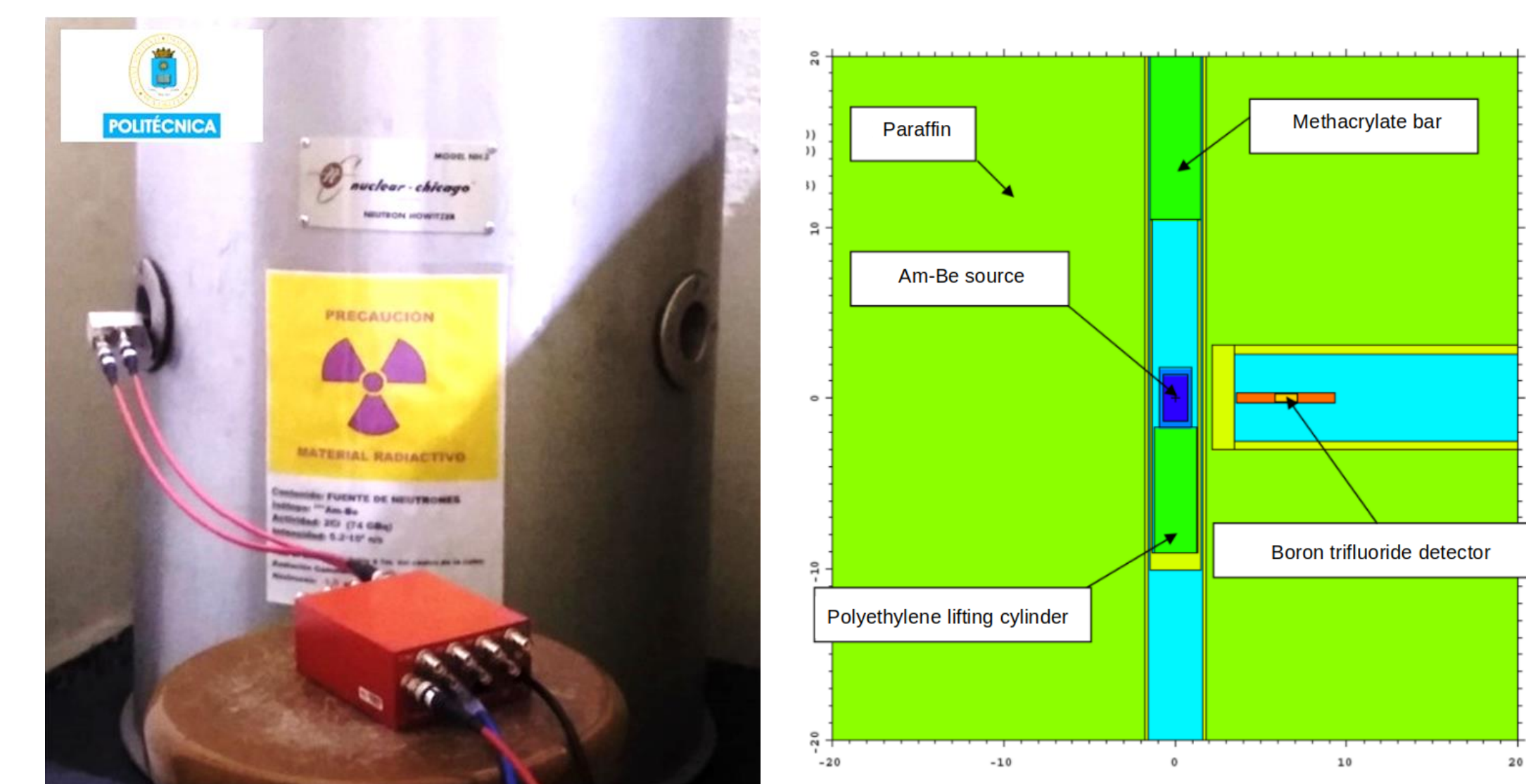
Neutron source has been covered partially with a slide of Cd. This Cd slide has an aperture of 10x13mm. The location of the tubes changes to different positions to set the slit along their surface.

Channels of digitizer are presenting signal in CH2 (Left tube) and CH4 (Right tube).



## Am-Be NEUTRON SOURCE

The Am-Be source has 2 Ci radioactivity which neutron emission is  $5.2 \times 10^6$  n/s. The source is inserted into a Howitzer cylindrical container. The container is filled with paraffin, which acts as neutron moderator. There is a radial channel in the container. Inserting the detectors into the radial channel, direct measurements can be done.



The source has 2 positions: "low" and "irradiation" position when lifting the source with the polyethylene cylinder. The tests have been done with the source in "low" position.

## CONCLUSIONS AND LESSONS LEARNED

Tests have been carried out to validate the selection of the final components for the front-end DAQ chain of the MIRACLES (ESS) detection system. Additionally, some lessons can be extracted from the experimental activities:

- Establish tests protocol beforehand, therefore all the required parameters are fulfilled reducing facility using time, because of tests repetition.
- Configure remote communication between electronics and controllers, when possible, to avoid unnecessary radiation on team members in charge of the experiment.
- Check cables and use always the same item in each dedicated connection.
- Avoid signal flicking, using common ground for the devices involved in the experiments.
- One channel of HV power supply in detector Preamplifiers is enough for biasing many detector channels.
- Active length of detector tubes is smaller than specified by manufacturer.
- To calculate position in PSD setups, slit must be set in accurate locations.
- More adjusted evaluation of timeline to integrate into the schedule of an ongoing project.

## REFERENCES

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- P. Luna, H.N. Bordallo, N. Tsapatsaris, K. H. Andersen, I. Herranz, F. Sordo, F. J. Villacorta, **Physica B** 564 64–68 (2019).
- F. J. Villacorta, D. Martín-Rodríguez, M. Bertelsen and H. N. Bordallo, **Quantum Beam Sci.** 6, 3 (2022).
- M.J. Christensen et al., **JINST** 13 T11002 (2018).
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