Update on Radioactive Sources in DUNE

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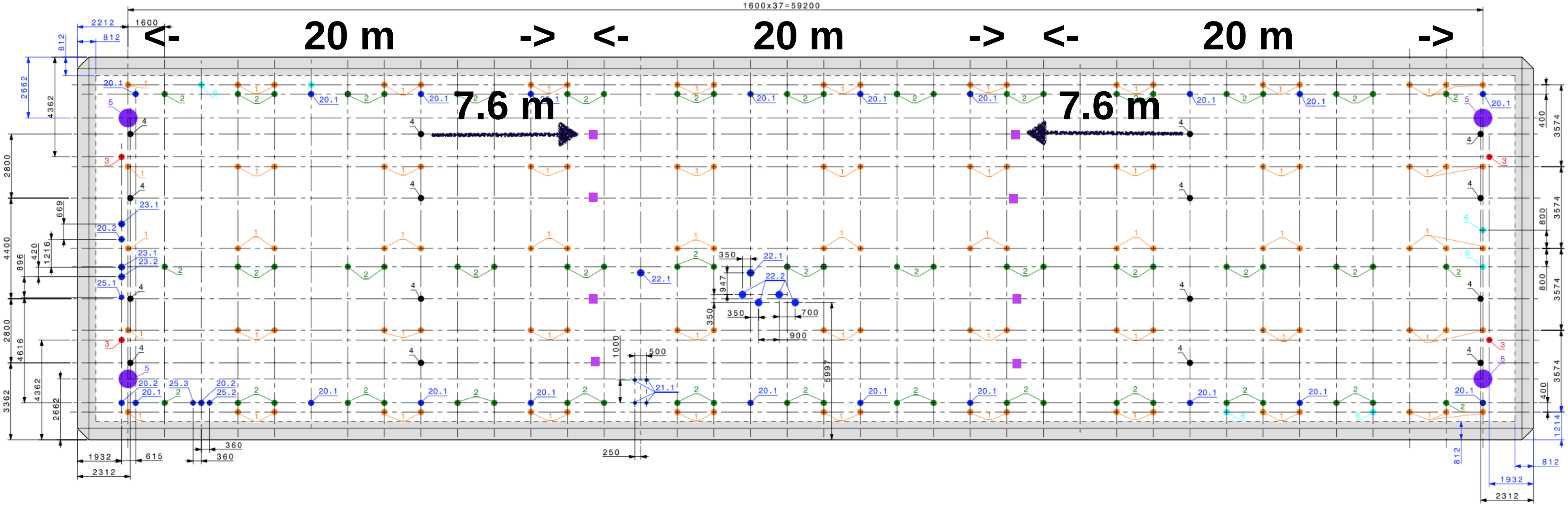
DEEP UNDERGROUND NEUTRINO EXPERIMENT

SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

DUNE Calibration Task Force

Phone Meeting, 19-Oct-2017

Re-iterate 16 Penetration Positions in Alternate Scheme



- A 58Ni-252Cf source will emit 8-9 MeV gammas which are in the right range for calibration the energy response in the SN region. As absolute energy calibrations would otherwise be difficult this capacity should be foreseen.
  - A Ni source will probably need ~100mm space including N moderator.
- Dynamic T-gradient monitors should also be foreseen at the detector ends and it is reasonable to combine these functions in single larger penetrations. Assume a 250 mm crossing tube.
- 16 penetrations total. 8 roughly centered in each TPC drift and 8 at the ends of the detector. The penetrations at the ends should not be more than 0.5m from the field cage but sufficiently far away not to risk the field.
  - Need to check rate when a natural position is determined.

External radioactive source deployments

$^{58}Ni(n,\gamma)^{59}Ni$

TRI-PP-96-7
Apr 1996

A 7–9 MeV isotopic gamma ray source for detector testing

Joel G. Rogers[a*], Mark S. Andreaco[b], and Christian Moisan[a]

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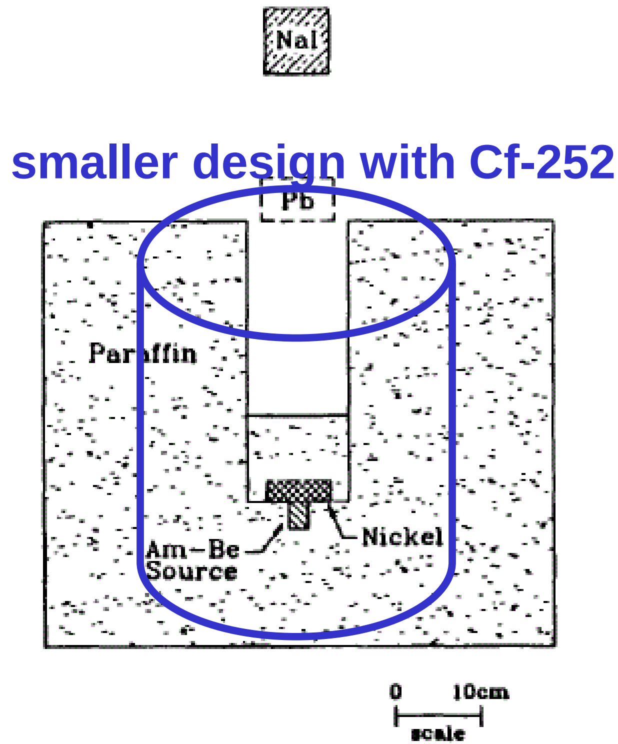


Table 1 - Thermal (n,γ) Rates from natural Ni taken from ref. [3]

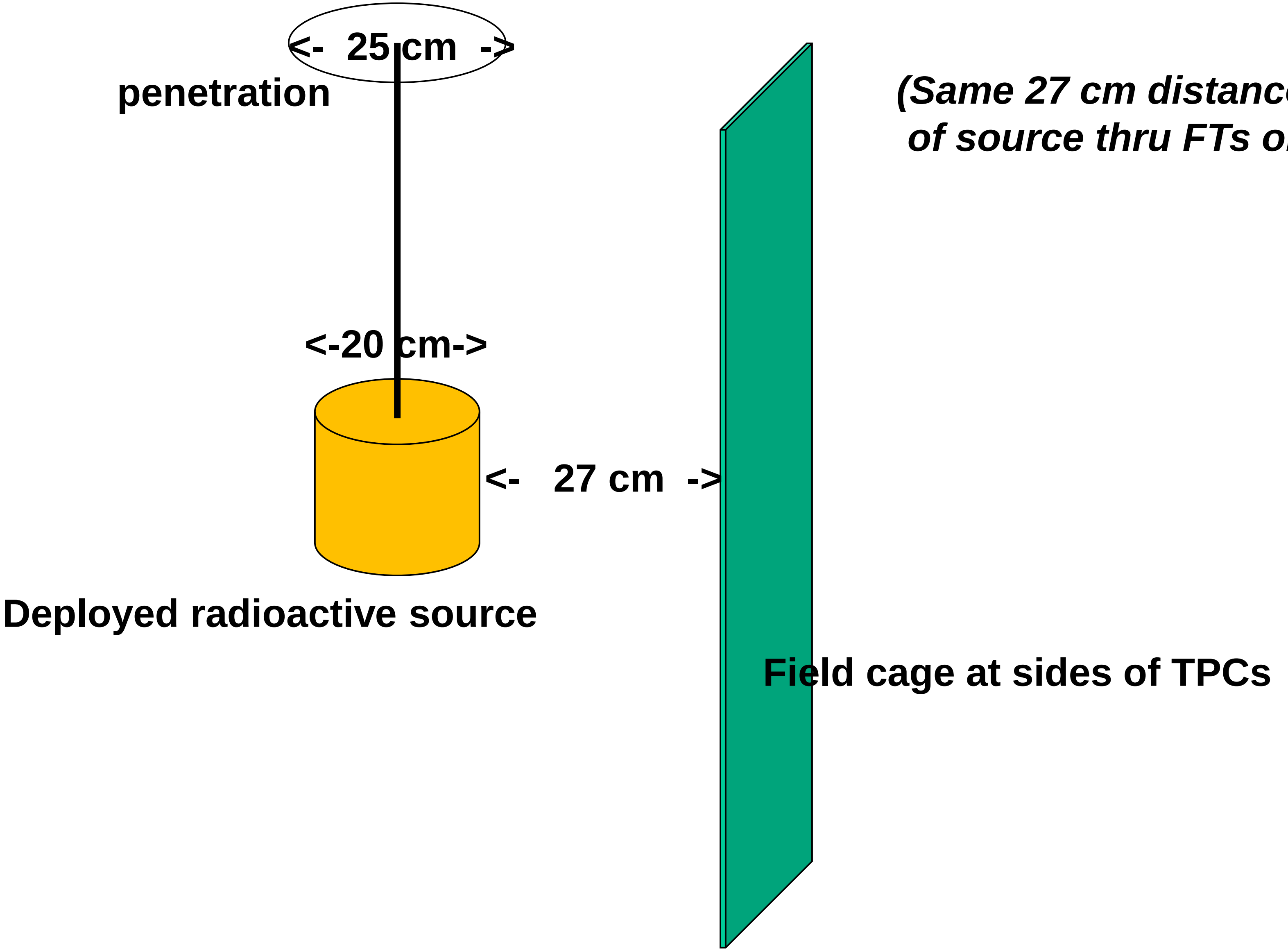
Gamma Energy (MeV)	Rate (photons/100 captures)
8.997	26
8.532	11
8.119	2.5
7.817	6
7.528	4
7.22	0.4
7.05	0.6
6.839	9
6.58	2
6.34	1
6.10	1.3
5.99	0.4
5.82	3
5.70	0.6
5.31	1.3

[3] E. Troubetzkoy and H. Goldstein, "A compilation of information on gamma ray spectra resulting from thermal neutron capture", USAEC Report, ORNL-2904 Oak Ridge National Laboratory, 1960.

Using Cf-252 (or even better AmLi) would significantly reduce size of source, such that it would fit a 20 cm diameter feedthru

Safety distance of deployed radioactive source wrt. FC

318.66 mm - (250 mm diameter / 2) + ~80 mm shrinkage = 273.66 mm



(Same 27 cm distance of source thru FTs on top of FC)

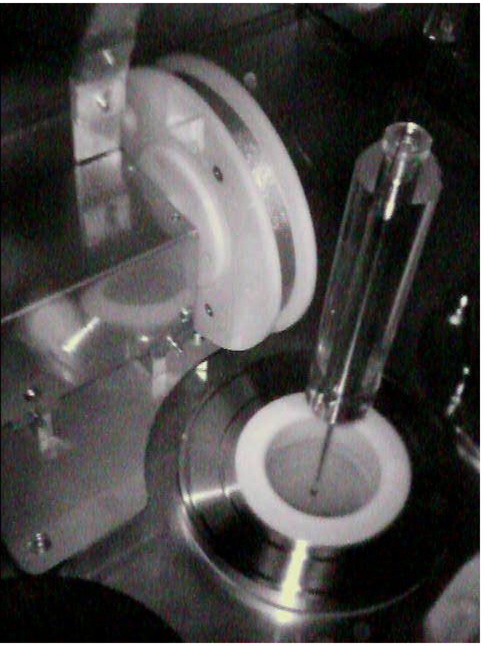
Double Chooz Calibration Deployment System inside Glove Box:

Automated fishline system for target deployments:

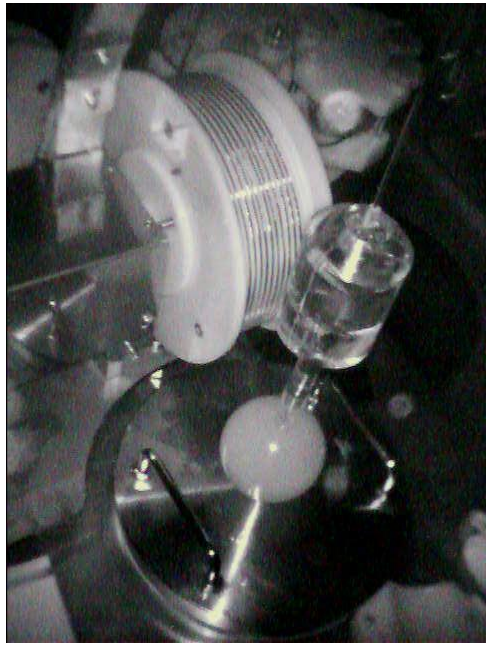
+/-2 mm precision over 7 m

-> 2 systems available in Jan 2018

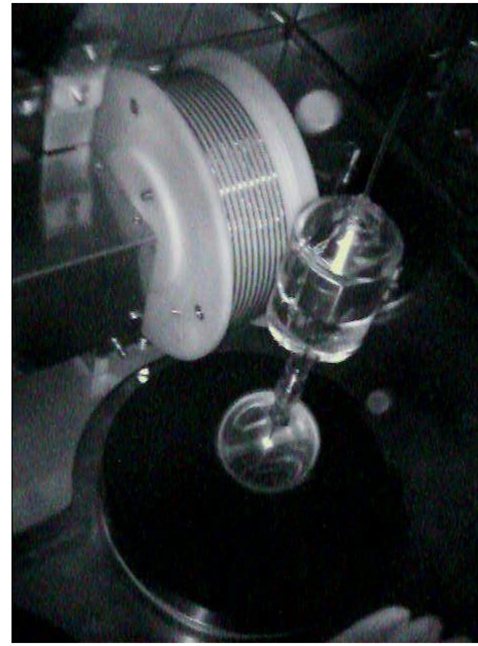
radioactive source



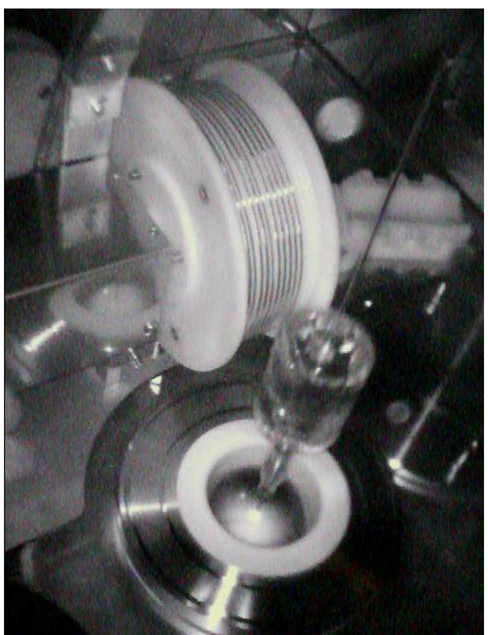
Blue Laser



UV Laser

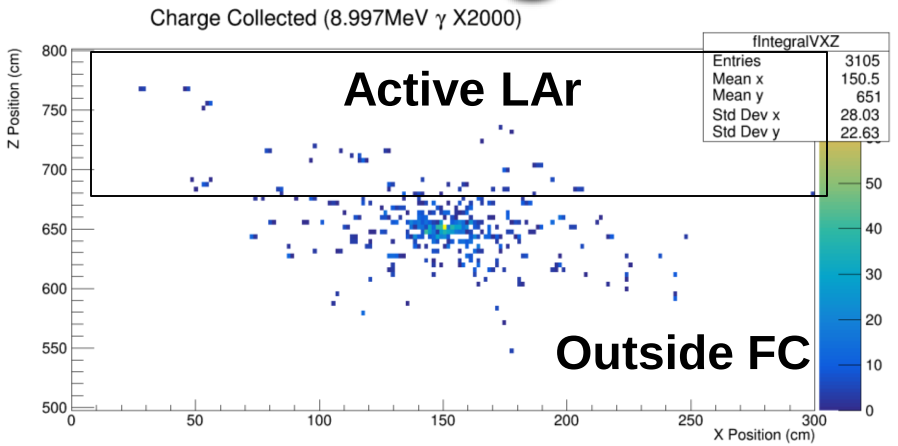


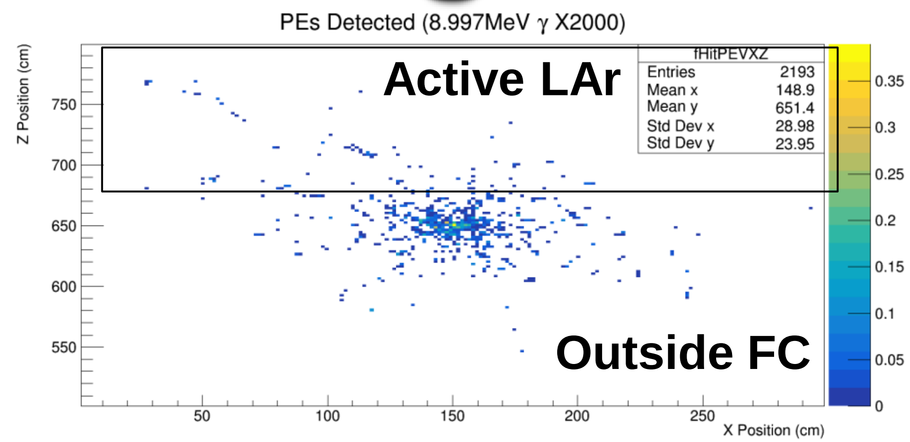
UV Laser w/ hat



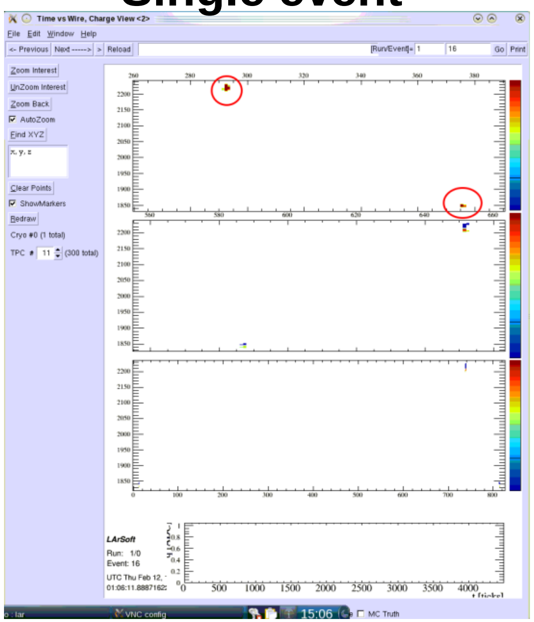
Simulation of 9 MeV gamma's in LAr

charge   Source at half-drift   light





Single event



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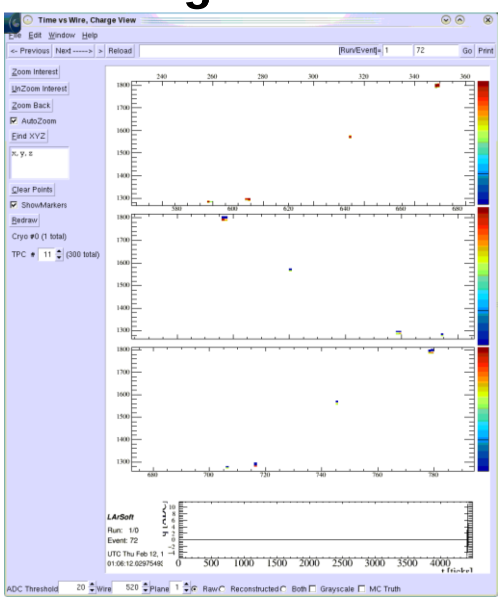

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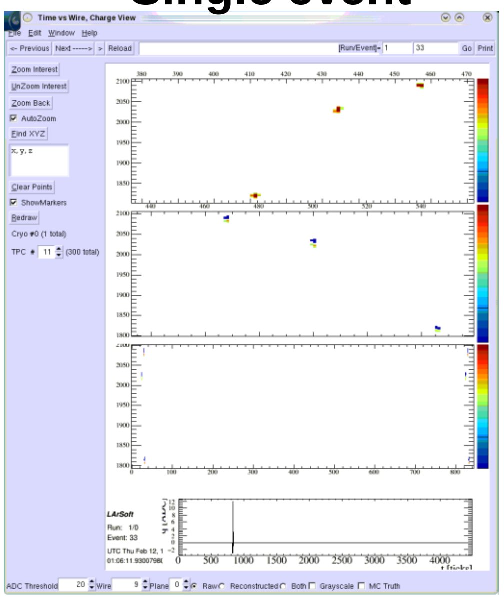

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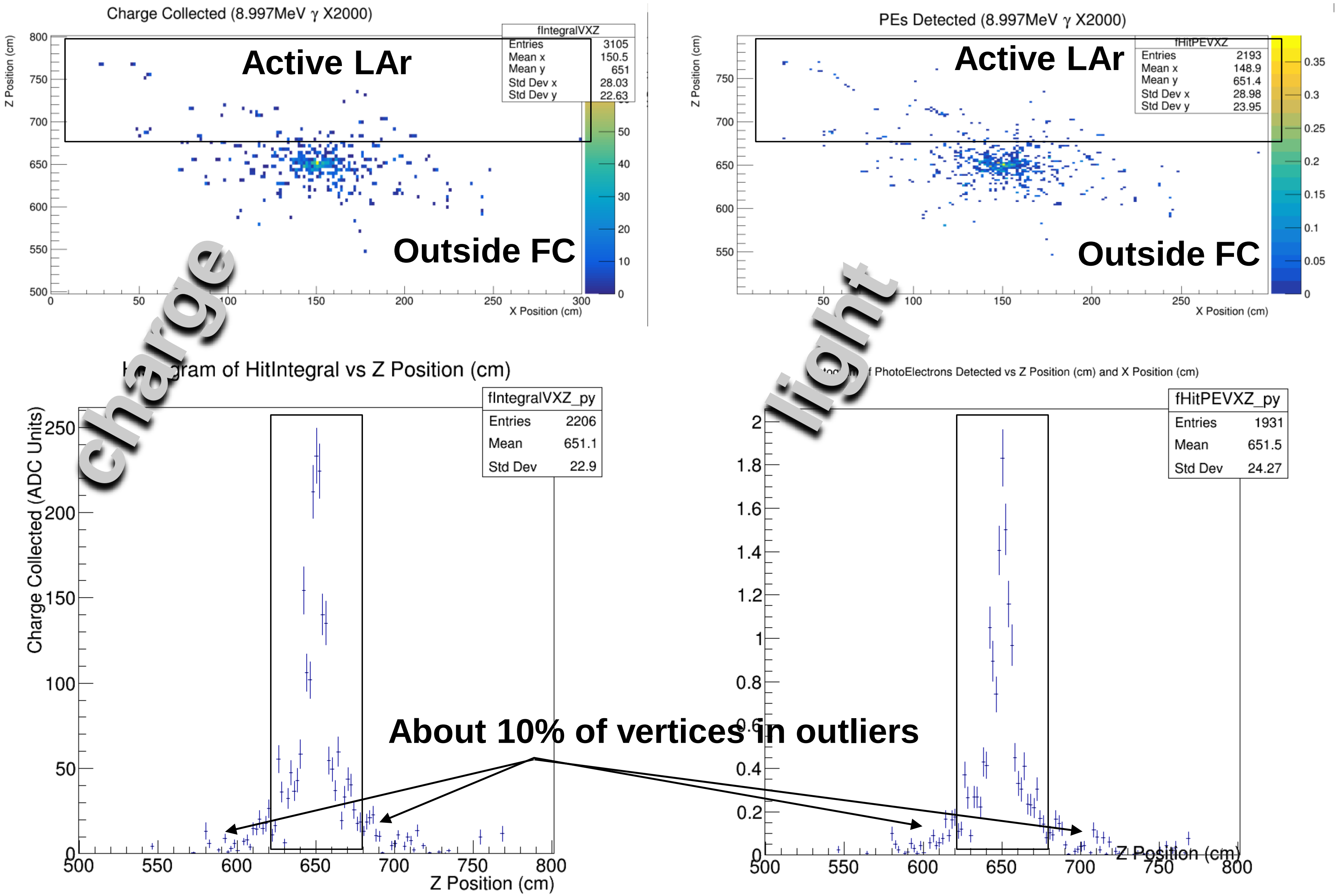
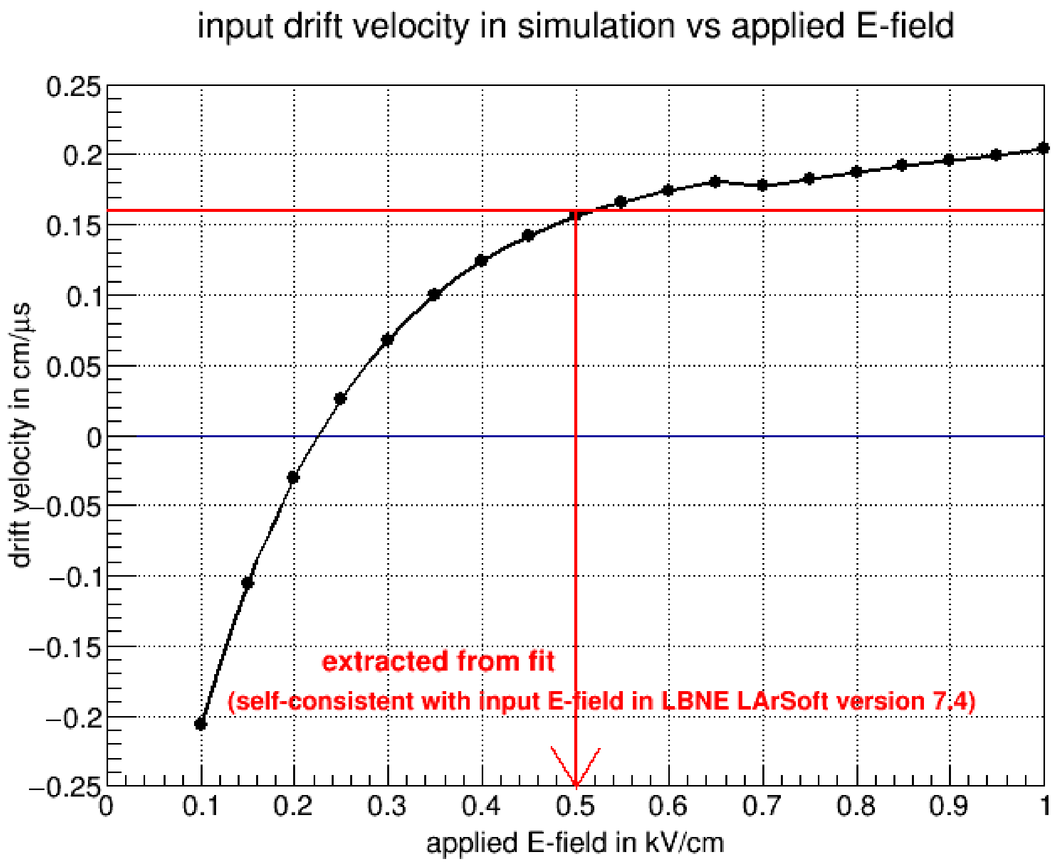


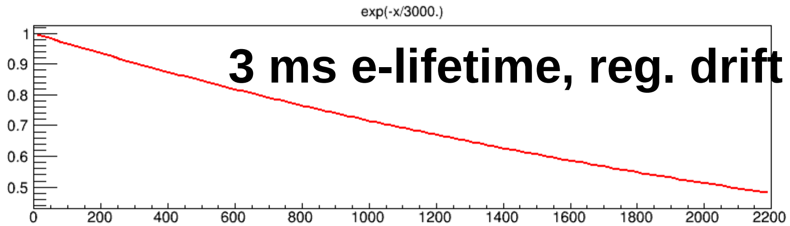
Drift velocity vs E-field

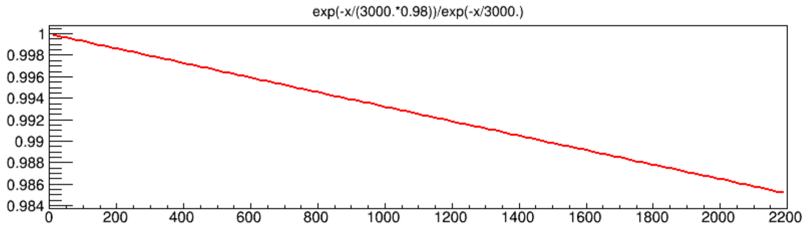


Do we really achieve our HV goal and e-lifetime?

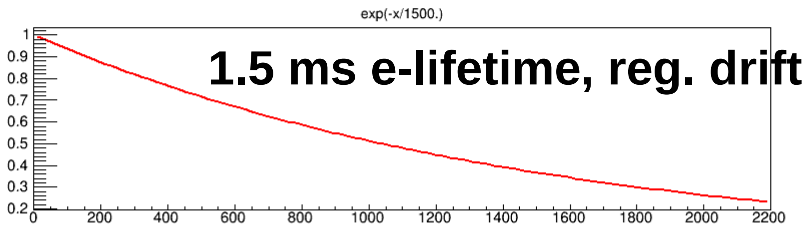
Scenarios

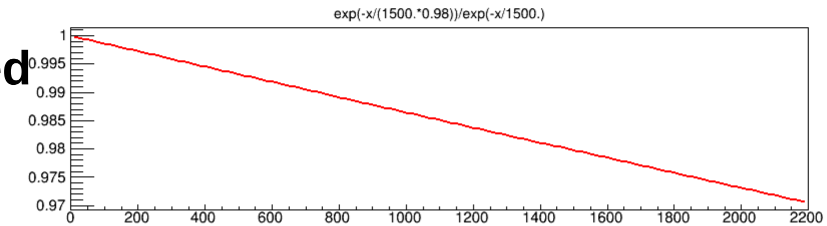
3 ms e-lifetime, reg. drift speed



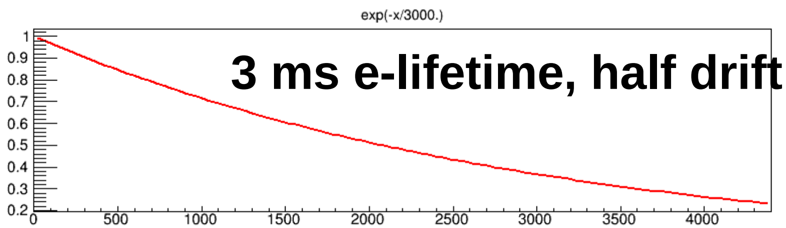


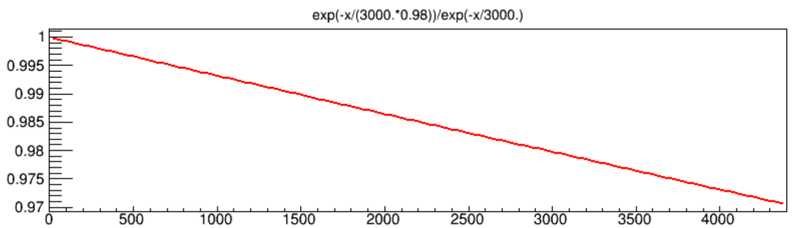
1.5 ms e-lifetime, reg. drift speed





3 ms e-lifetime, half drift speed





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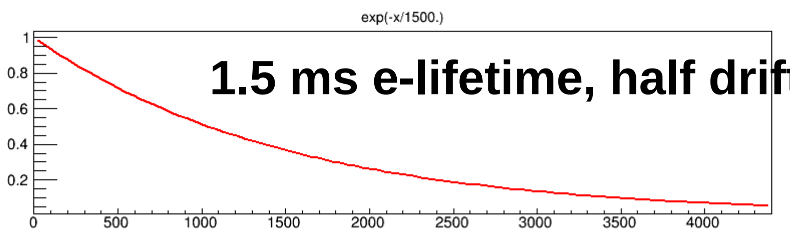
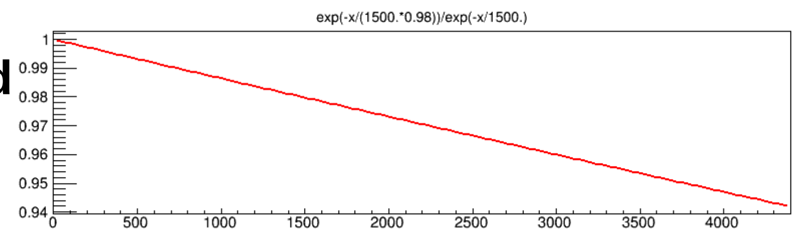
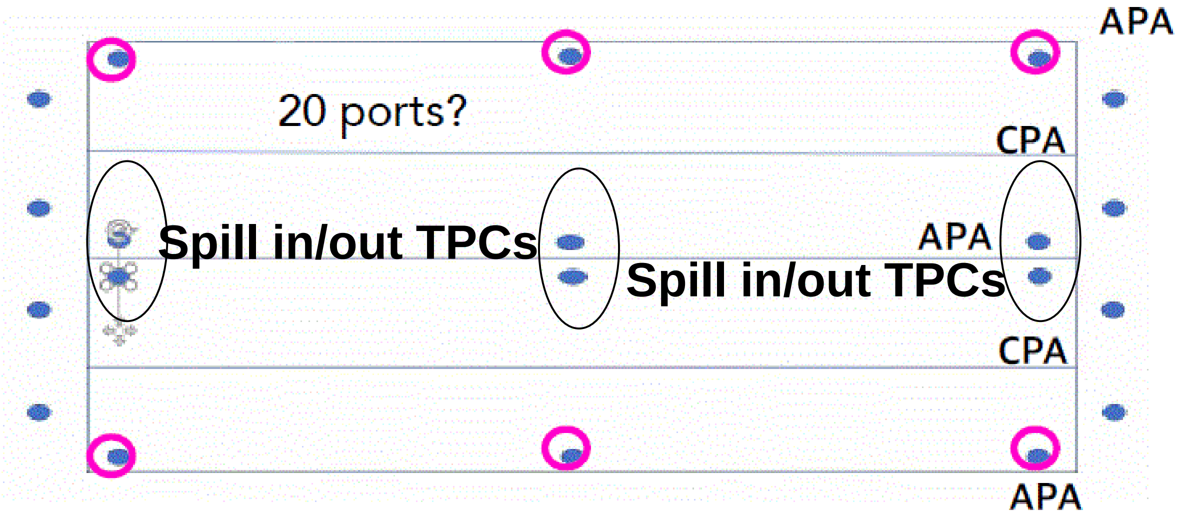
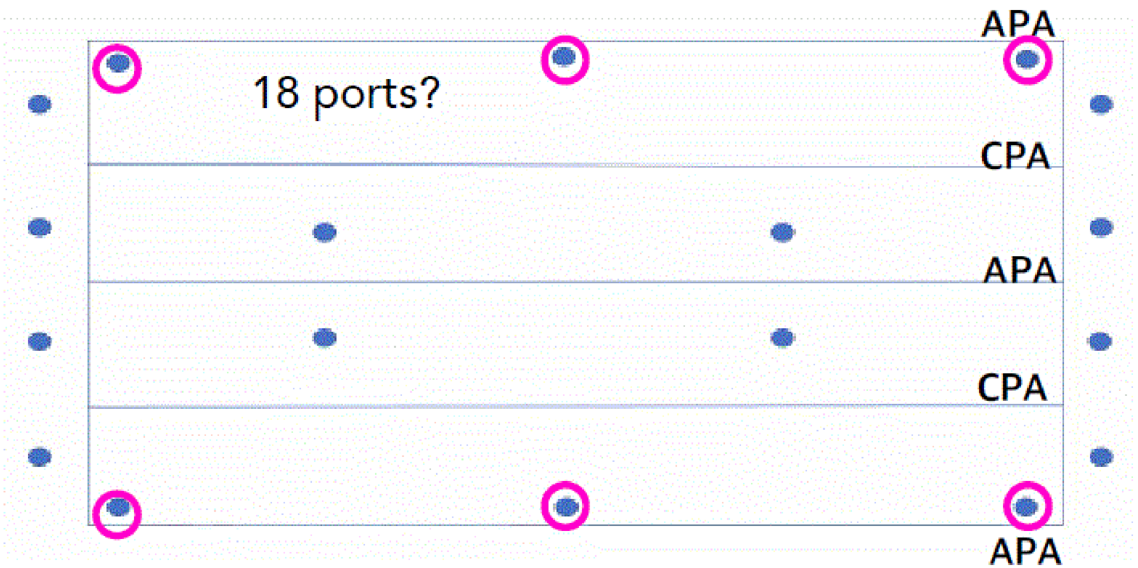




Feedthru Options

Main question: How to arrange the 4 or 6 ports in the central region?





Laser has a lot on the flange, so this could mean

- So, we maybe looking at using cameras/radioactive source during commissioning as needed
- Then Laser takes over these shared ports after that? (except for the ones outside the FC)

Is this reasonable?

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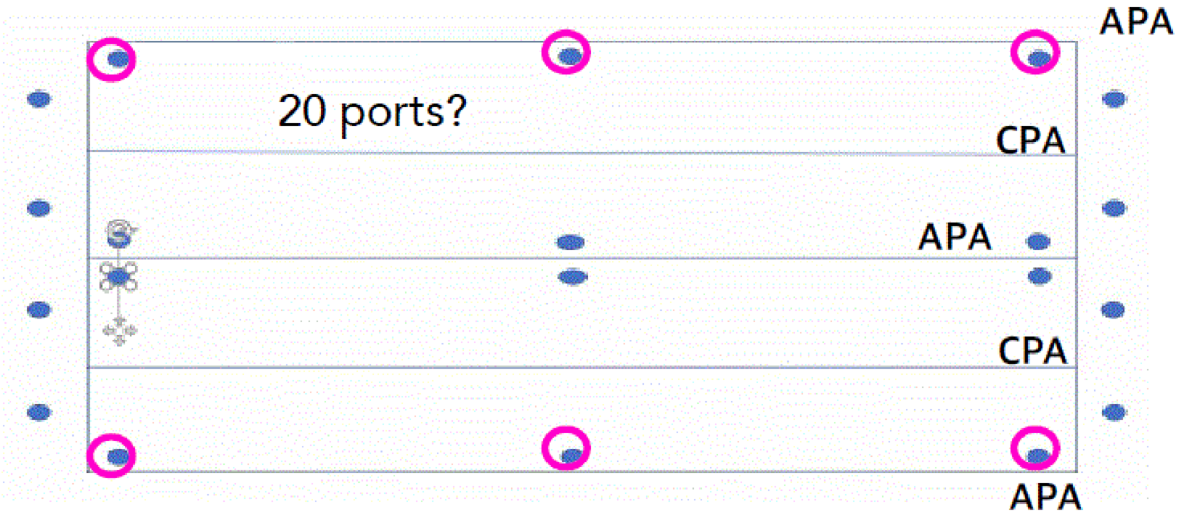

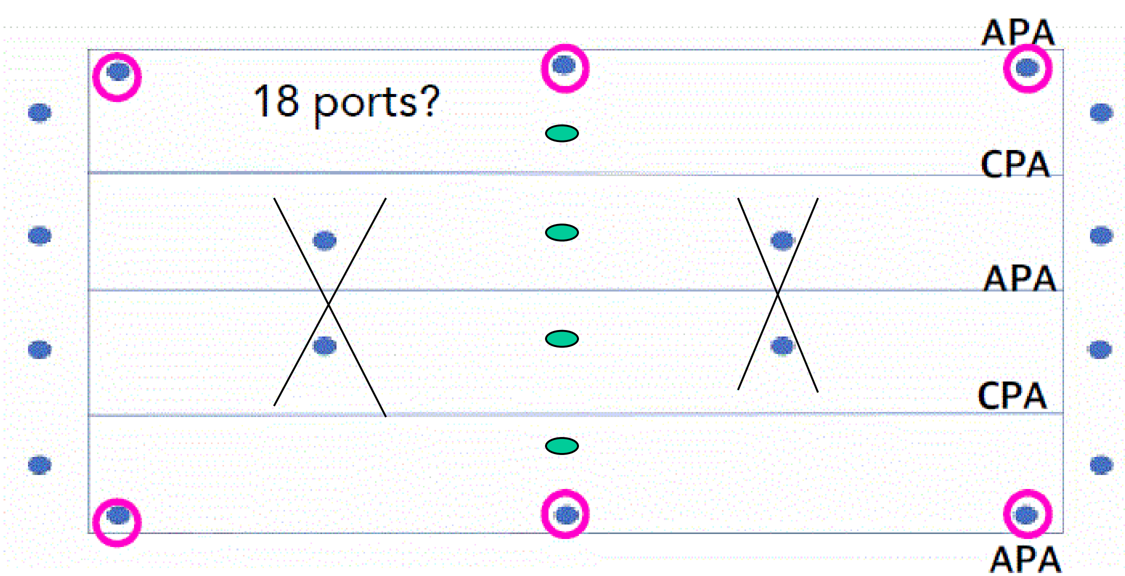

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Is this reasonable?

More reasonable with only 4 FTs in central columns but all at half-drift?

Deployment Plan

1. Dummy source deployment (within 2 months of the commissioning)
2. Present to TB on the dummy source deployment and
   get sign off/green light for the real source deployment (1 to 2 weeks)
3. First real source deployment (within 3-4 months of the commissioning)
4. Second real source deployment (within 6 months of the commissioning)
5. Assuming things will be reasonably stable, radioactive source will be deployed every half a year. Ideally, a deployment before a run period and after the run period are desired so you have at least two data points for calibration.
   This is important since you need to know if the state of the system has changed before and after the physics data run.
6. If stability fluctuates due to electronics changes at a particular location, one would want to deploy the source at that location once a month or more often depending on how bad the stability is.

In terms of how long it takes to deploy:
1. few hours (e.g. 8 hours -> one work day u/g) for one FT position
2. parallel deployment (one port to another) takes 2 days or so.
3. Full calibration campaign (with only one shared system) — at least a week.