Instrumentation Issues for Study II

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Instrumentation issues were not a major constraint on the Study II Design

- Although the bunches are large and intense, the magnitude of backgrounds are uncertain, and space is limited, there seem to be a number of options which can produce useful solutions.

- An active R & D program is underway to systematically look at useful options, there are no results from Lab G at this time. These are expected soon.

  These include:
  - better measurements of X rays from rf cavitys
  - measurements of
    - SC edge Bolometers
    - Ion chambers
    - Secondary emission monitors and faraday cups
    - Gas detectors
    - CdTe array monitors

  Assembly and checkout is proceeding . . .

- In the meantime there have been developments in target instrumentation.

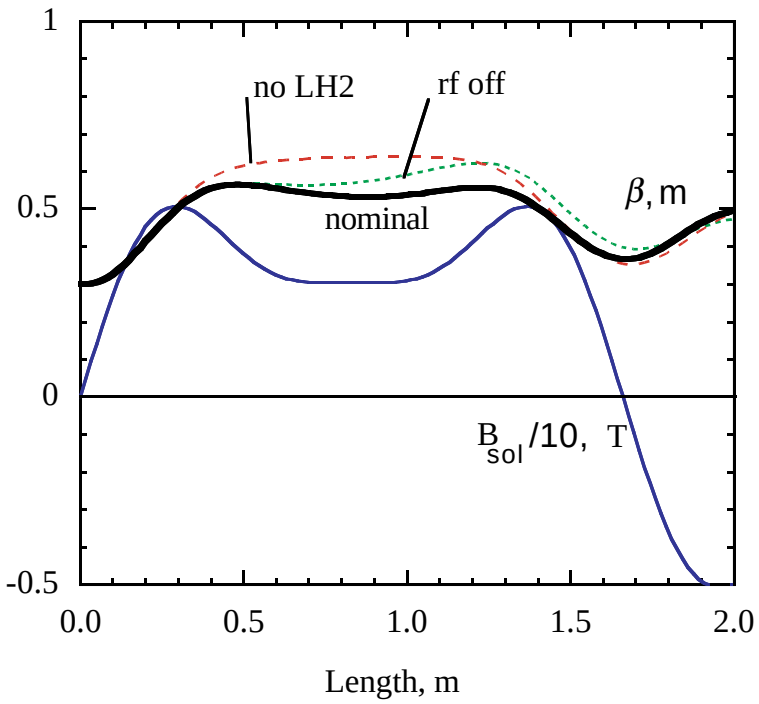
The primary instrumentation problems are involved with the cooling line.

- Since $\Delta\varepsilon$/cell is small, we assume emittance measurements will be made at widely separated points.

- The primary problem will be understanding alignment and matching of the beam through the bunching and cooling sections. In addition to monitoring the centroid position (with profile monitors) and energy variations (with bunch timing), the Twiss parameters, or more easily the variations of the Twiss parameters, can also be measured with profile monitors.

Failure modes such as loss of hydrogen or arcdown of an rf cavity have been studied in a preliminary way.

- The change in β functions from a rf or absorber problem can be estimated using algebraic analysis.



but the subsequent evolution of these mismatches is complex.

Synchrotron motion complicates downstream behavior.

Limited instrumentation locations can cause confusion.

Angular momentum in the cooling line is a complication.

- Canonical angular momentum is a conserved quantity when there are no absorbers, but we have many. Thus we can have a residual angular momentum which can cause problems matching into the transport and accelerator lines.

- Angular momentum also couples to the beam emittance

- We want the final angular momentum to be zero or,

$$\int_0^{\lambda} \eta(s)\beta(s)B(s) = 0,$$

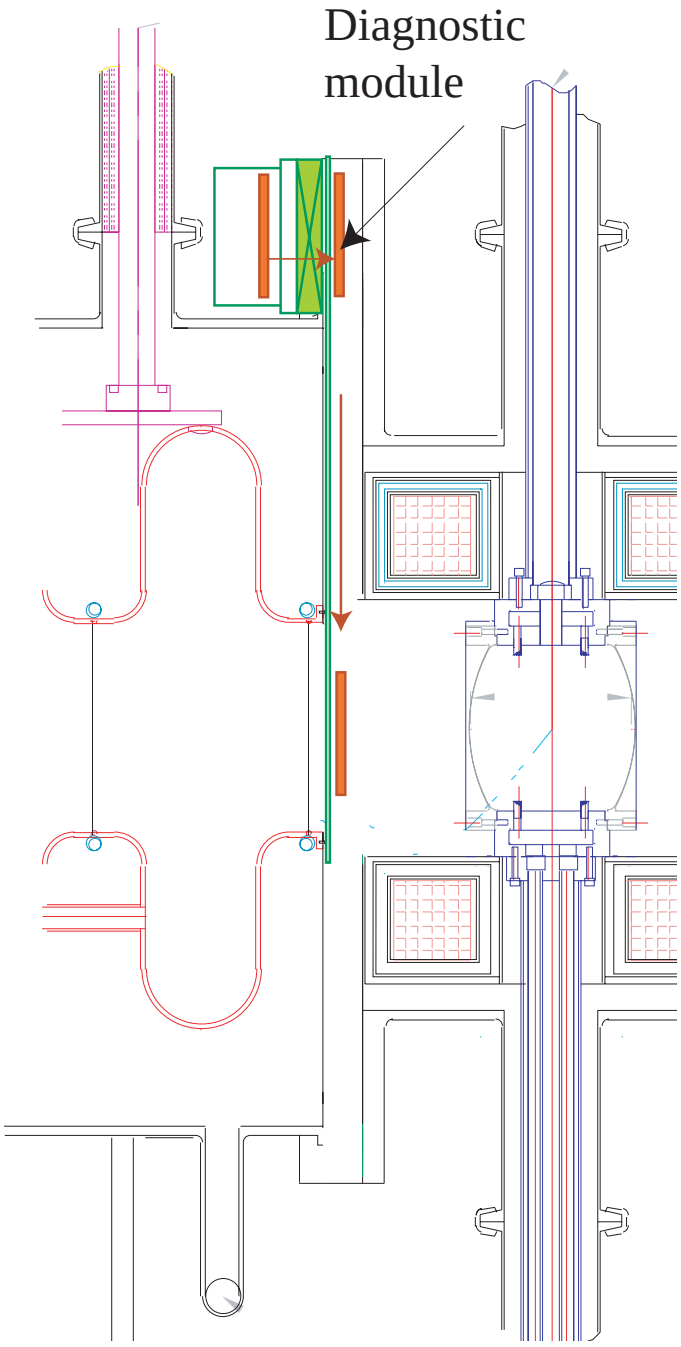
  where η, β and B are ionization rate, beta function and B field, all variables which can, in principle, be adjusted.

- The angular momentum can be measured at the end of the cooling line with “pepper pot” Cherenkov counters.

Backgrounds should not be a problem in the cooling line.

- Some from the target, some from rf cavities, some from decays.
- They can be measured if counters are fast.
- Bunches with 10^{12} muons should dominate backgrounds

Access is a problem, the expansion sections can be used for most of the measurements.



- Special instrumentation SFOFO sections are very expensive and should be minimized

Pencil beams will be useful for setting up all accelerator systems.

- These can be generated early in the cooling or bunching line. Collimation can define transverse range, low rf voltage can define small longitudinal area.

- Instrumentation should have sufficient dynamic range to usefully work with pencil beams.

Accelerator instrumentation is somewhat conventional.

The issues associated with the accelerator systems tend to be associated with optimization of conventional linacs and beamlines.

Standard techniques (profile monitors, timing, pencil beams), should be useful. Loss monitors become somewhat more useful at high energies.

Storage Ring concerns

There are primarily three issues:

- The muon beam parameters have to be measured with high accuracy to understand the ν beam.

  Conventional techniques seem useful.

- Polarization of the muons must be known.

  We considered a system using a small calorimeter close to the beam which can be used to measure the decay electron energy and determine the polarization. (Raja)

- The profile of the n beam must be known with sufficient accuracy to subtract contributions from outside the decay section of the storage ring.

  A large counter will be located downstream of the straight section which can separate the contributions of the matching sections, arcs and decay section, to give a useful estimate of the ν beam profile.

The actual diagnostic devices were not a focus of Study II.

- There are many options under study.
- An experimental program is getting underway, just as Study II is concluding, which will give us a lot of useful guidance on how these devices behave under dark currrent and x-ray backgrounds.

Summary

- There are a number of unique and complex problems associated with the design of a high power neutrino source.
  - Alignment
  - Matching
  - Angular Momentum
  - Polarization measurement
  - Precision measurement of ν beam direction and beam profiles

- While these issues require R&D, a number of options can be used to attack them.

- Standard techniques, profile monitors, pencil beams and good timing, can be used for most measurements.