Options for the Polarized D Preinjector

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(Kevin Brown will follow with thoughts on Booster/AGS)

- Linac - Booster – AGS experimental floor
- Tandem – Booster – AGS experimental floor
- Tandem – target room at Tandem

- Vertical polarization & multiturn injection into Booster ?
- Horizontal polarization & single (few?) turn injection directly into the storage ring?

Use the 200 MeV H- Linac ?

- The Alvarez linac is designed with a fixed velocity profile (protons to 200 MeV)
- One can't increase the accelerating gradient enough to maintain the same velocity profile for D (sparking in cavities, not enough rf power)
- Alternative is to accelerate D in the 4π mode – try and make the D velocity profile such that it hits an accelerating gap every second rf cycle.
- Unfortunately, this only works for a few tanks, because the accelerating gaps get to be too large a fraction of a cell length, and the drift tube bore increases, allowing more field penetration, etc.
- This has been tested (60's and 70's), modeled, etc. The result for our linac is that D can only be accelerated through 3 of our 9 cavities (i.e. 30 MeV D-). The beam would then have to drift through the remaining cavities.

D- in the Proton Linac

- Simulation results (D. Raparia) – only accelerates through 3 tanks
  - Output energy ~ 30 MeV
  - Transmission ~ 7%
  - 0.7 MeV rms output energy spread
  - D injection energy must be 390 keV
  - Very sensitive to injection energy, gradients, phases, etc.

- A new RFQ will be required to inject D into the linac. This would replace the proton RFQ, with ~ 1 week needed for each swap in/out.
  - (one can consider modifying the injection region to leave both RFQ's in place)
- To first order, D running would not be compatible with proton running.

The BNL Optically Pumped Polarized H- Ion Source (OPPIS) can be modified to produce polarized D-. Expect similar intensity to present polarized H- (~ 1 mA).

Dual optical pumping – both Rb neutralizer and ionizer cells - demonstrated on the KEK OPPIS – got ~ 300 uA D- (vector polarized)

We would need a new Rb ionizer & second laser (have)

Producing vertical polarization before linac injection is an added complication – significant modifications to the LEBT line would be required.

Intensity Estimate (Linac)

- Source output 1 mA (400 uS, 6.7 Hz)
- Linac output (30 MeV) 50 μA (5% efficiency)
- Booster input 6.25×10^{10} ions/pulse
  (50 μA*400 μS*50% efficiency; rep rate up to 6.7 Hz)
- Bunch into h=6 and extract 1 bunch (1 turn of r~ 6m ring)
  1×10^{10} ions/pulse
- 10% from Booster to experimental floor ?
  1×10^{9} ions/pulse

Polarized D from the Tandem ?

- The Tandem is presently used for 17 MeV D+ injection into the Booster for RHIC, so transmission, Booster injection, etc. are well known

- A new polarized source would be needed at the Tandem
  - Build another OPPIS ? (or get IUCF source ?)
  - Source would have to be installed on a 150 kV platform

- One issue is the small acceptance of the Tandem, compared to the typical emittance of a high intensity polarized D- source.
  - Normalized D acceptance ~ 0.3 π mm mrad
  - BNL OPPIS for D- estimated to have ε_n ~ 1-2 π mm mrad
  - IUCF CIPIOS has ε_n ~ 1.2 π mm mrad

Intensity Estimate (Tandem)

- Source output 1 mA (300 μS, 5 Hz)
- Within acceptance 100 μA ?

- Booster input 6×10^{10} ions/pulse
  (scaled from present D efficiencies; rep rate up to 6.7 Hz)

- Bunch into h=6 and extract 1 bunch (1 turn of r~ 6m ring)
  1×10^{10} ions/pulse

- 10% from Booster to experimental floor ?
  1×10^{9} ions/pulse

Direct Tandem Injection into the Storage Ring

- The Tandem routinely operates at 14 MV terminal voltage
  (= 28 MeV D)
- Potential space for a ring in a target room (49’ diameter, wall-to-wall)
- One would have more flexibility in operating schedule, reduced operating costs (no Booster or AGS)

Intensity estimate:

Tandem output 75 μA (up to 500 μs; up to 5 Hz)

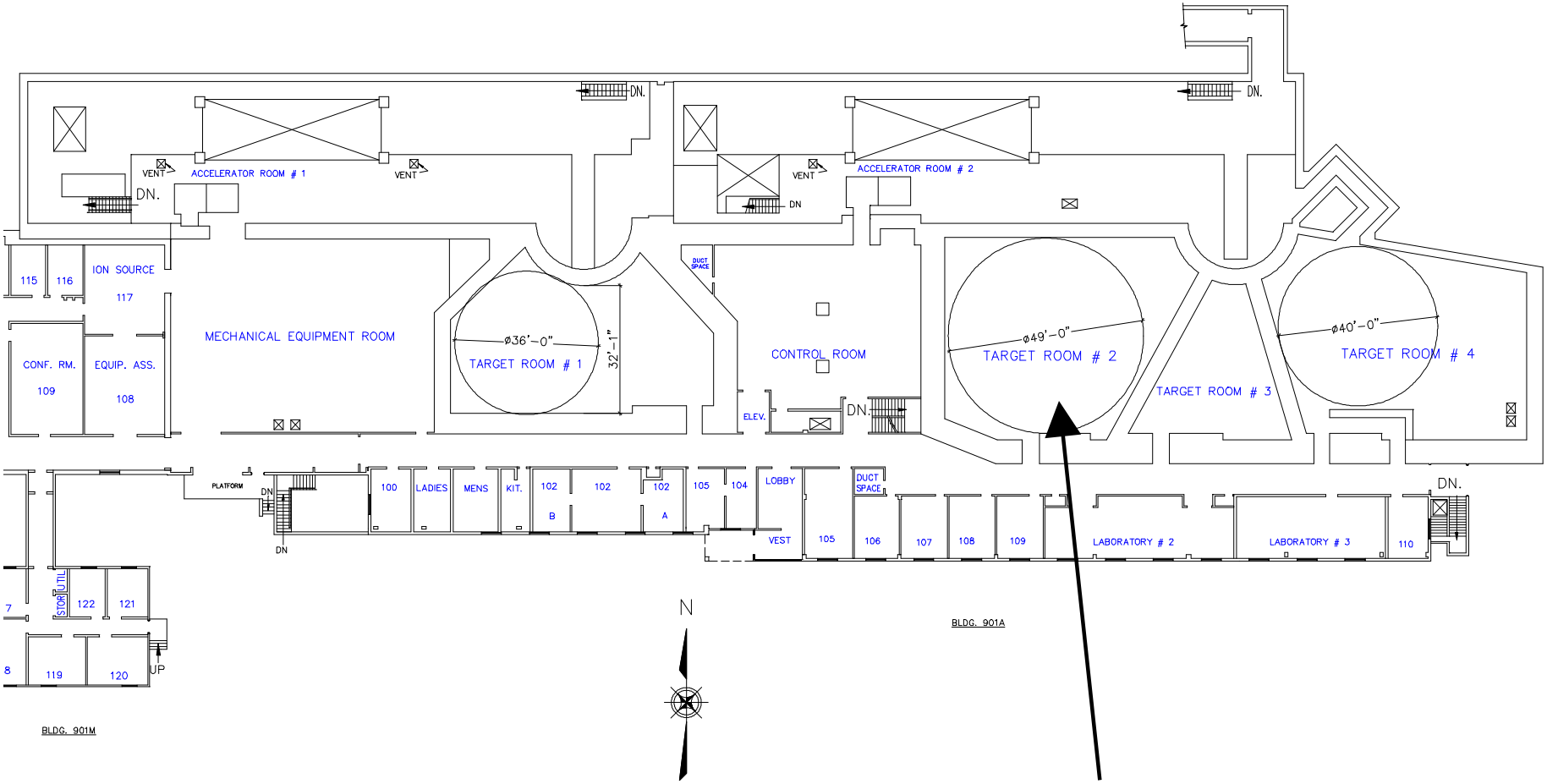
if only 1 turn into r=5m ring at 28 MeV (~ 600 ns)

~ 2×10^8 ions/pulse

(One can consider multiturn injection or adding a compressor ring)

dE/E ~ 10^{-4} typical. A few x 10^{-5} has been achieved for nuclear physics experiments in the past (with some loss of intensity).

Tandems and Target Rooms



Target Room 2 – 49' diameter possible

Conclusion

Either the Linac or Tandem could deliver polarized D to Booster, with the same intensity to first order.

Using the Linac requires a new RFQ; using the Tandem requires a new polarized source.

The Linac is the cheaper solution, but using the Tandem is more straightforward.

Direct injection into a ring from the Tandem may also be an option. (There may be an issue with activation of tank insulating gas with 28 MeV D, which has to be explored).