PLANS FOR A **SHORT INTENSE NEUTRON SOURCE** (SHINES)

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WHY A NEUTRON SOURCE?
AND WHERE?

• To promote science in the developing countries.
• Focus world funding for a science lab in a developing country
• Where to built it?
  • Attractive for the scientists in developed countries
  • Ecologically and economically sustainable
  • Close to Green energy sources
  • Easy to travel to, specially for scientists from developing countries
REQUIREMENTS

• Power: 1.5 MW
• Energy: 1-8 GeV
• Repetition rate: 50-60 Hz
• Particle: p or H⁻
• Pulse length at target: 1 μs
Optimal Energy: Neutron production is best between 0.5-3GeV. Use lowest possible energy to decrease costs for LINAC, ring and target.

Currents: \( P = E \times I_{\text{ave}} \):
1.5MW = 1.5mA \times 1 \text{ GeV} (\text{after LINAC/on Target})
(1.5 mA = 50 mA \times 50 \text{ Hz} \times 0.6 \text{ ms})

\[ N = I_{\text{ave}}/q = 1.5\text{mA}/1.6 \times 10^{-19} \sim 10^{16} / \text{sec} \]
\[ N_t = N / f = 2 \times 10^{14} \text{ particles in the RCS stored, it is achievable!} \]

*Multi-turn injection (>100 turns) \(\Rightarrow \text{H}^+\)*

### Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam power on target</td>
<td>1.5 MW</td>
</tr>
<tr>
<td>Beam energy on target</td>
<td>1 GeV</td>
</tr>
<tr>
<td>Proton pulse length on target</td>
<td>900 ns</td>
</tr>
<tr>
<td>LINAC peak current</td>
<td>60 mA</td>
</tr>
<tr>
<td>Pulse rep. rate</td>
<td>600 (\mu)s</td>
</tr>
<tr>
<td>Beam availability</td>
<td>&gt;98%</td>
</tr>
<tr>
<td>LINAC length</td>
<td>236 m</td>
</tr>
<tr>
<td>RCS circumference</td>
<td>260 m</td>
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</table>
## ACCELERATOR

<table>
<thead>
<tr>
<th>Component</th>
<th>E (MeV)</th>
<th>F(MHz)</th>
<th>Temp (K)</th>
<th># Modules</th>
<th>Cavities</th>
<th>L (m)</th>
<th>I (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>0.045</td>
<td>--</td>
<td>300</td>
<td>1</td>
<td>-</td>
<td>2.5</td>
<td>60</td>
</tr>
<tr>
<td>LEBT</td>
<td>0.045</td>
<td>--</td>
<td>300</td>
<td>1</td>
<td>-</td>
<td>1.5</td>
<td>60</td>
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<tr>
<td>RFQ</td>
<td>3</td>
<td>352.21</td>
<td>300</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>56.65</td>
</tr>
<tr>
<td>MEBT</td>
<td>3</td>
<td>352.21</td>
<td>300</td>
<td>1</td>
<td>3</td>
<td>2.5</td>
<td>56.65</td>
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<tr>
<td>DTL</td>
<td>100</td>
<td>352.21</td>
<td>300</td>
<td>6</td>
<td>6</td>
<td>40</td>
<td>51.5</td>
</tr>
<tr>
<td>Low Beta</td>
<td>288</td>
<td>704.42</td>
<td>2</td>
<td>19</td>
<td>38 (0.51)</td>
<td>77</td>
<td>51.5</td>
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<tr>
<td>High Beta</td>
<td>1000</td>
<td>704.42</td>
<td>2</td>
<td>12</td>
<td>72 (0.78)</td>
<td>114</td>
<td>51.5</td>
</tr>
<tr>
<td>RCS</td>
<td>1000</td>
<td>1 &amp; 2 &amp; 4</td>
<td>300</td>
<td>1</td>
<td>2</td>
<td>260</td>
<td>eq. 50</td>
</tr>
</tbody>
</table>
MEBT & CHOPPER

• To match the beam out of RFQ to DTL a Medium Energy Beam Transport is designed.

• MEBT is equipped with a Chopper to remove 36 bunches out of 352 bunches (10%)
TARGET STATION

Collector (+window)
Target body
Distributor (rotating)
Pre-distributor (static)
He
Ls
Ls/2 = L
beam
TARGET STATION

• Lead @ $E=1.0 \text{ GeV}$ $L_{\text{min}}= 550 \text{ mm}$

• $E=1.5 \text{ GeV}$ $L_{\text{min}}= 950 \text{ mm}$

Safety factor $L_s=L \times 2$ therefore target radius $R_t=Ls/2=L$

At 50 Hz revolution frequency of target, $\omega \geq 300 \text{ min}^{-1}$

Energy density peak (at equal material and beam radius)

\[ e^* \sim E/L \implies e^*_{1.5\text{GeV}} \approx 0.75 \, e^*_{1.0\text{GeV}} \]

\[ \Delta T^* = f(\alpha,e^*,\tau) \quad (\text{in } 1^{\text{st}} \text{ approx } \Delta T^* \sim c_p^{-1},\rho^m,\sigma^4,k^{-1},\tau^{-1}) \]

Stresses/thermal/radiation fatigue

Target material

Liquid to Supercritical He cooling

• A Target designed for short pulse can be used for long pulses
LOCATION?
A POSSIBLE SOLUTION?

MALDIVES

... and enjoy the life!
SUMMARY

• A 1.5 MW neutron source using available science/expertise is proposed

• The LINAC is designed to use the energy in the most efficient way

• Proposed lab is based on green energies only
THANK YOU FOR YOUR ATTENTION