

# *ex situ* $^3\text{He}$ polarizer system

University of New Hampshire

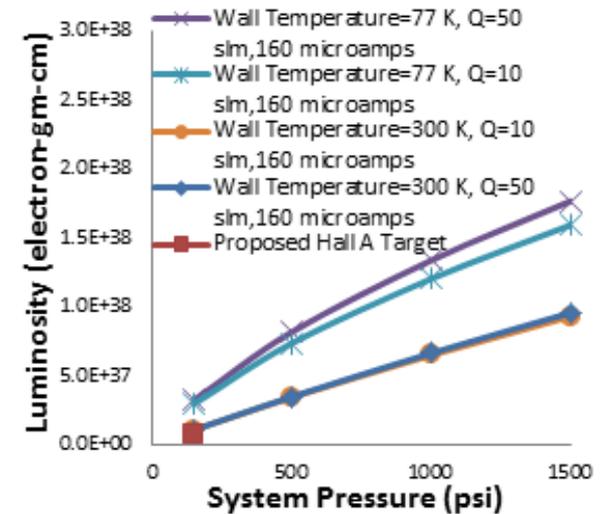
Xemed LLC

# Rationale

- By providing optical pumping repolarization rates that keep ahead of beam depolarization rates, we propose development of a scalable polarized  $^3\text{He}$  target system that:
  - provides a  $^3\text{He}$  target thickness as high as  $1.0 \text{ g/cm}^2$ ,
  - accepts the full  $160\mu\text{A}$  polarized beam current at Jefferson Laboratory, and
  - maintains 65% polarization at luminosity of  $10^{38} \text{ e-nucleons/cm}^2$ .

# Goals

- Spin-up rate of one mole per hour (25% per hour with four moles of  $^3\text{He}$  gas)
- Beam depolarization constant  $10^{-39}$  per e-nucleon/cm<sup>2</sup> per hour per mole
  - for rate, multiply times luminosity
  - divide by dilution

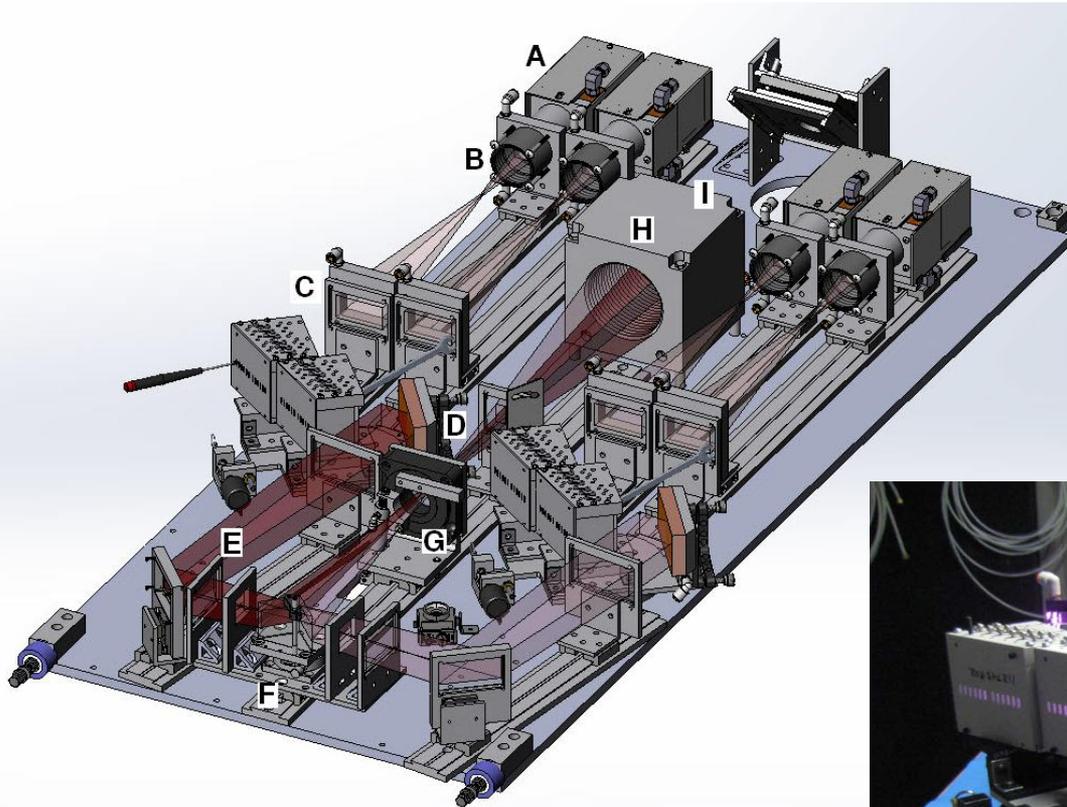


- Assuming beam depolarization dominates losses, peak figure-of-merit occurs at luminosity  $10^{39}$  with half polarization,  $\sim 35\%$
- Maintains  $\sim 65\%$  polarization at luminosity  $10^{38}$  e-nucleons/cm<sup>2</sup>

# Funding

- Three DOE SBIR funded projects (no funds allocated from DOE Nuclear Physics program)
  - Helium-3 polarizer development
  - Non-ferrous  $^3\text{He}$  pressurization (for e-beams at JLab)
  - Non-ferrous  $^3\text{He}$  evacuation (for n-analysis, such as SNS)

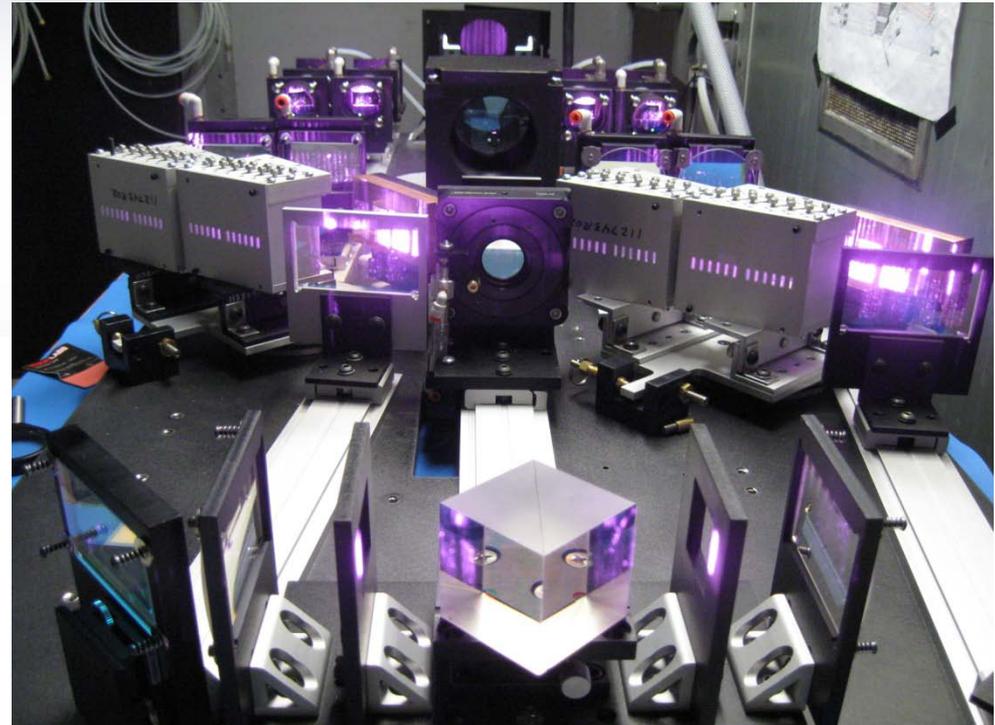
# Status: 2700 Watt narrowed laser



## Specifications:

Power	2.7kW	(2.12kW circular aperture)
Wavelength		794.8nm
Locking efficiency		75%
Spectral width		0.6nm (2.4nm narrowed)
Spectral intensity		4.5kW/nm (1.5 narrowed)
Beam divergence		3x6mrad

- A: Lasers, total of 4
- B: External cavity
- C: Step mirrors
- D: Grating
- E: Beam shaping optics
- F: Combining prism
- G: Diffuser/ waveplate
- H: Main collimator
- I: Exit optic

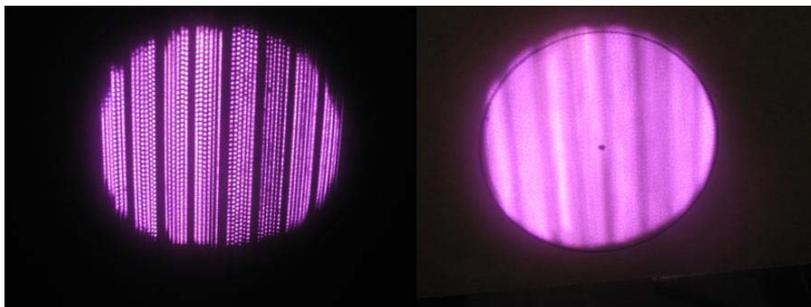
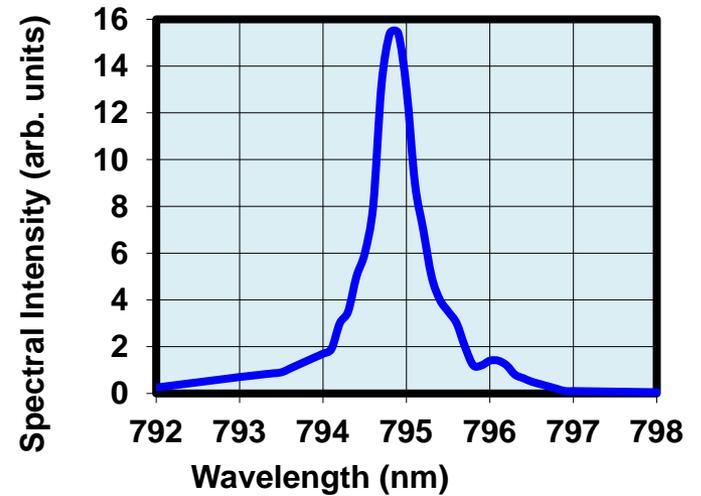


# Measured performance



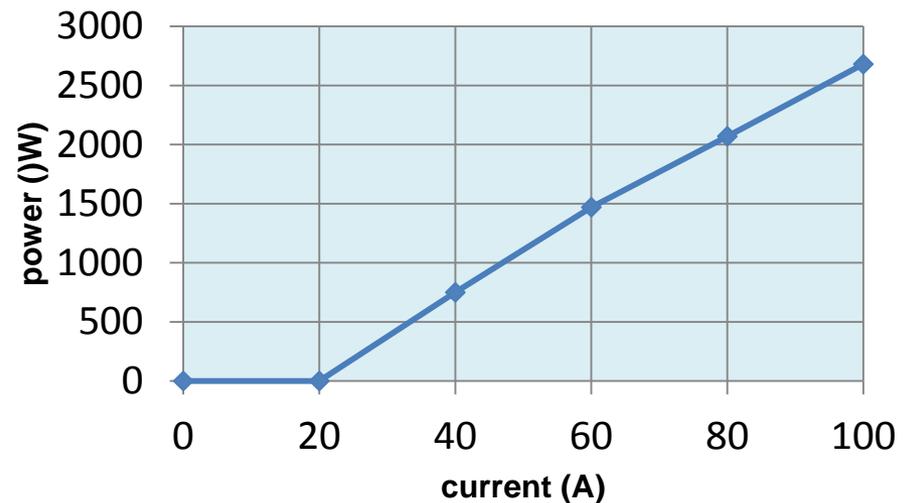
Four 12 bar lasers (foreground) combining their outputs into a single 10 cm diameter beam (center).

Wavelength locked beam @2.7kW



48 Bar exit beam, and 1m downstream with diffuser. Divergence  $\sim 3 \times 6$  mrad (hor x vert.)

Power 0.6 nm narrowed laser (max = 110A)



# Status : Non-ferrous Diaphragm Pump



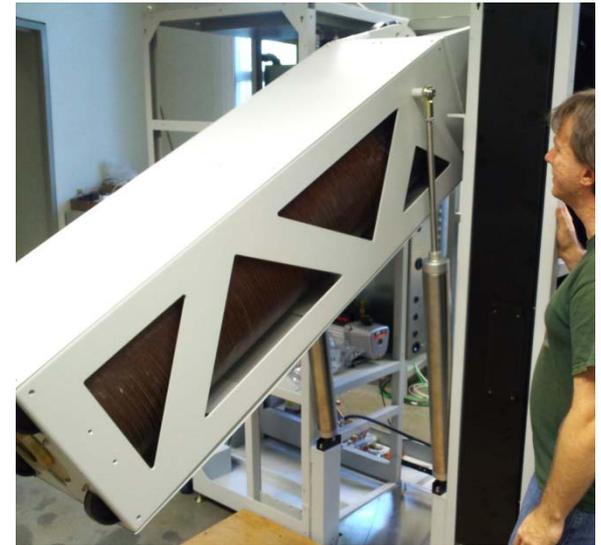
Generic diaphragm pump image, Fluitron, Inc.



- Piston-driven hydraulic compression
- Nominal 30 cps
- Compression ratio ~6.5
- Two pumps ordered
- Low pressure: 50 torr to 150 psi
- 150psi to 1000 psi @ 15 SLM
- PEEK valves
- Titanium head 6AL4V
- Three-layer diaphragm
- Phosphor-bronze wetted
- Components machined
- Delivery end of January

- Holding field consists of 180cm dia coils
- 30cm dia “sweet spot” for NMR

# $^3\text{He}$ Polarizer



- 8.5 liter cell operates at nominal 10 amagat
- Fully integrated system with on-board automation and diagnostics

# Outlook

- System assembly and testing planned during the first 3 months of 2012, to complete Phase 1 goals
- SBIR Phase 2 proposal will be due April 4, 2012
- **A strongly worded endorsement from JLab Hall C could prove pivotal to favorable reviews and continued development (with no impact on DOE Nuclear Physics funding)**