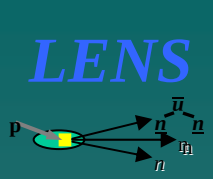

Upgrade of the LENS Proton Linac: Commissioning and Results

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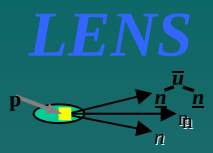
Outline

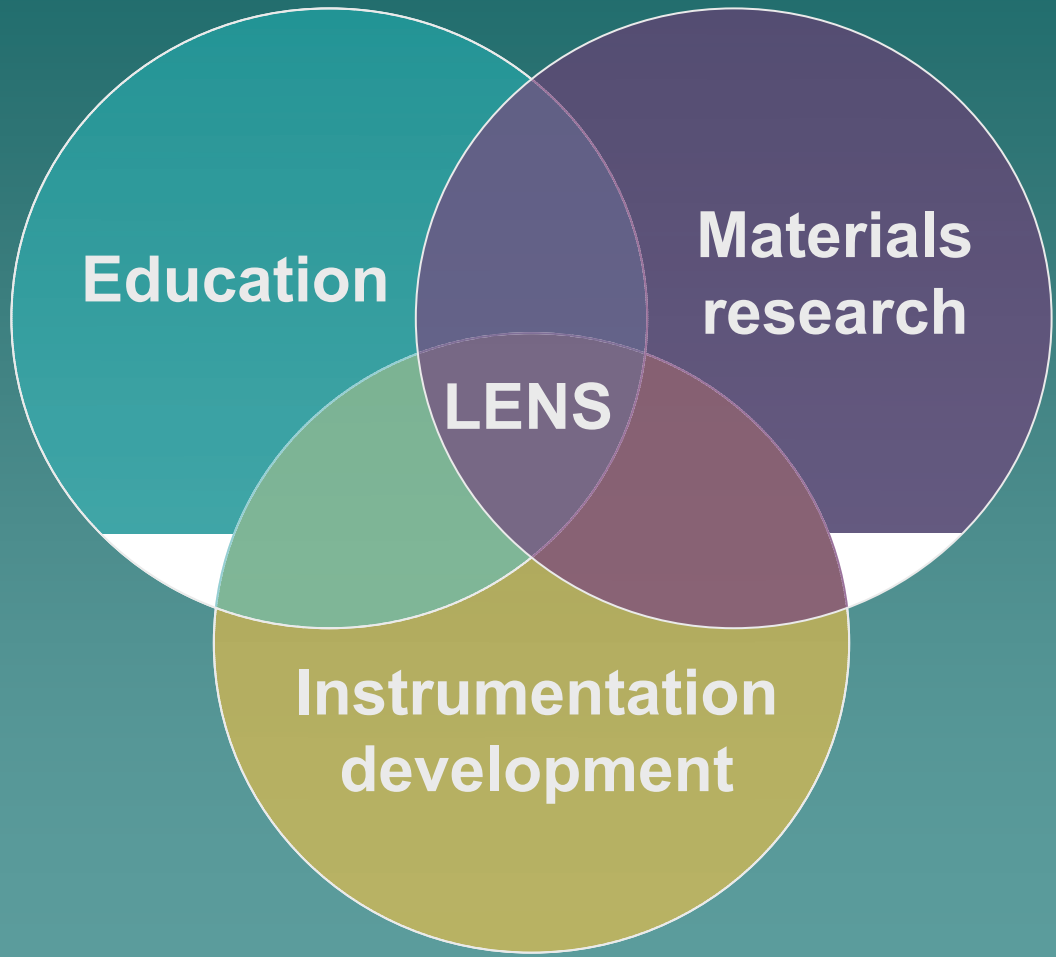
- What is Low Energy Neutron Source?
- Current status of the facility.
- Design goals.
- Upgrade path of the LENS.
- Neutron prospective of the facility.
- Conclusion.



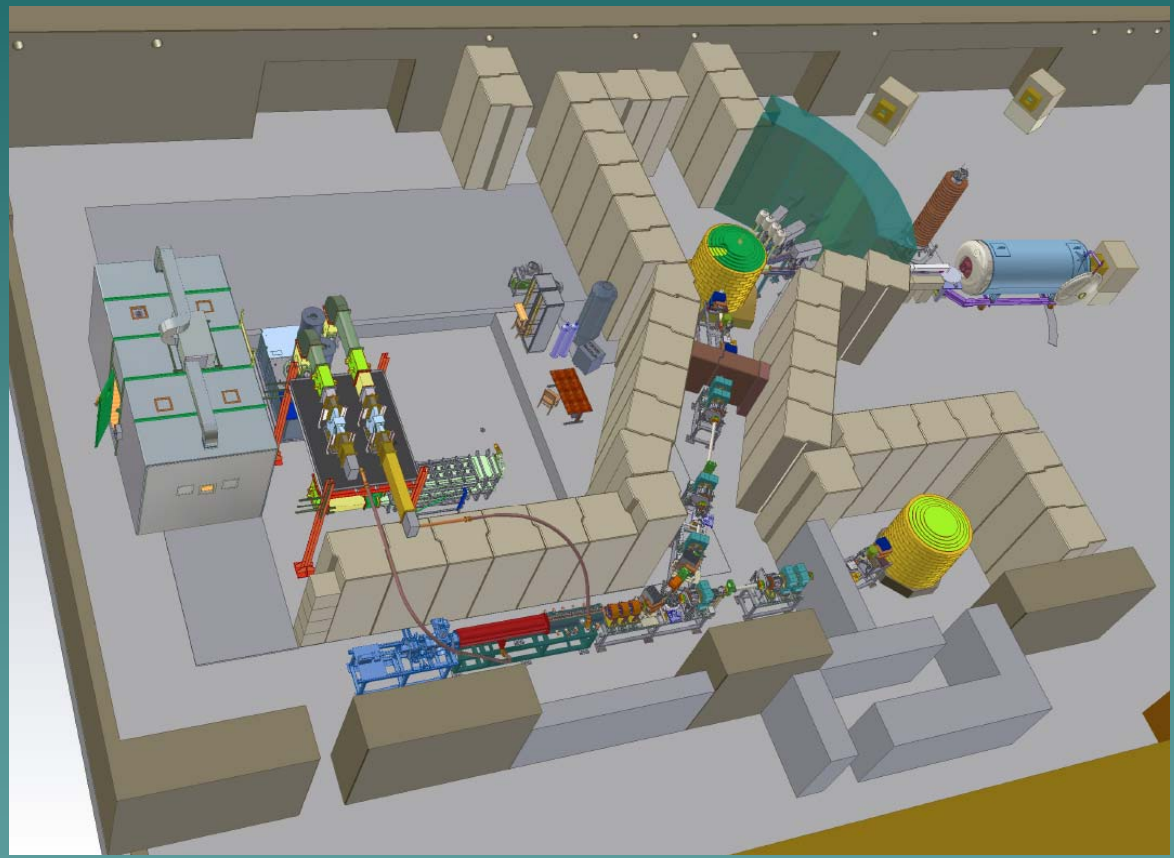
Low Energy Neutron Source

- LENS is an accelerator driven pulsed neutron source.
- Neutrons are generated in low-energy (p, nx) reactions (E_p<13MeV) in Beryllium. Protons are provided by a linear accelerator.
- LENS provides cold neutrons for material research, neutron physics and technology and neutrons in MeV energy range for neutron radiation effects research.
- LENS has a variable pulse width (from ~10 μs to ~1.4 ms).
- Beamlines devoted to materials research and neutron instrumentation development are under construction.

Low Energy Neutron Source



LENS Facility
Current Status



- Beam Energy 7 MeV
- Beam Current 25 mA
- Pulse Width 10 – 300 μSec
- Pulse Rep Rate Up 20 Hz
- Beam Duty Factor $\leq 0.6\%$
- Peak power ≤ 175kW
- Average Power ≤ 1 kW
- Neutron Rate 10^{12} n/s

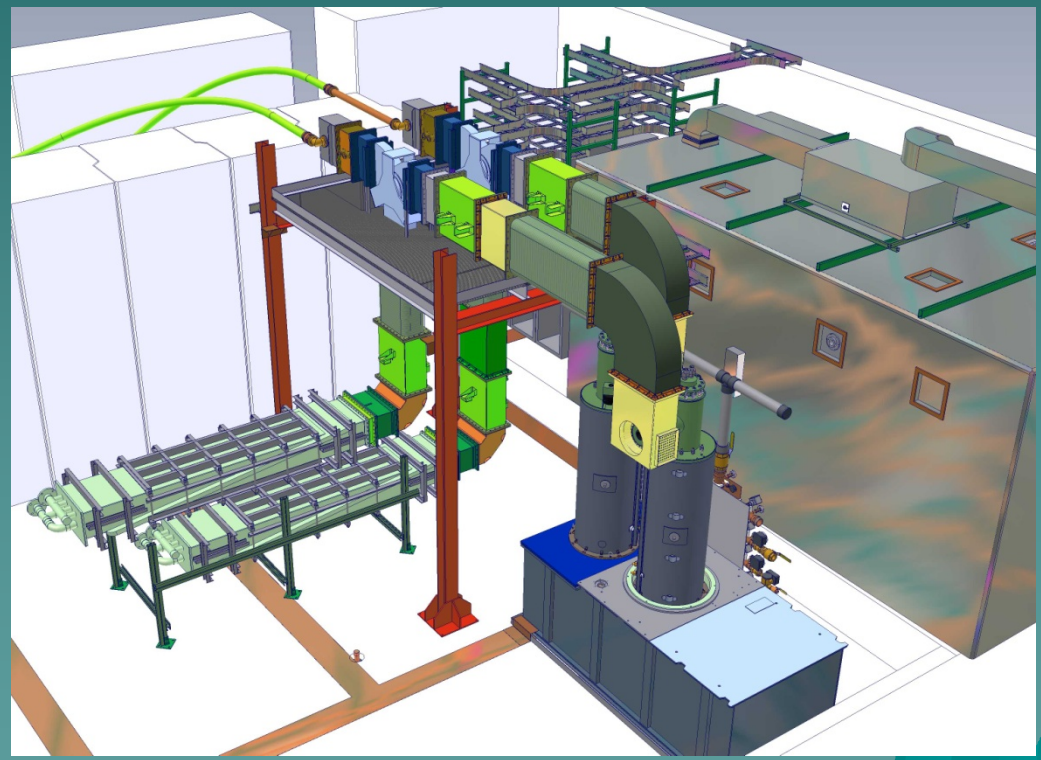
LENS

LENS Power Upgrade Path

Goal: higher average power of a proton beam, delivered to the target

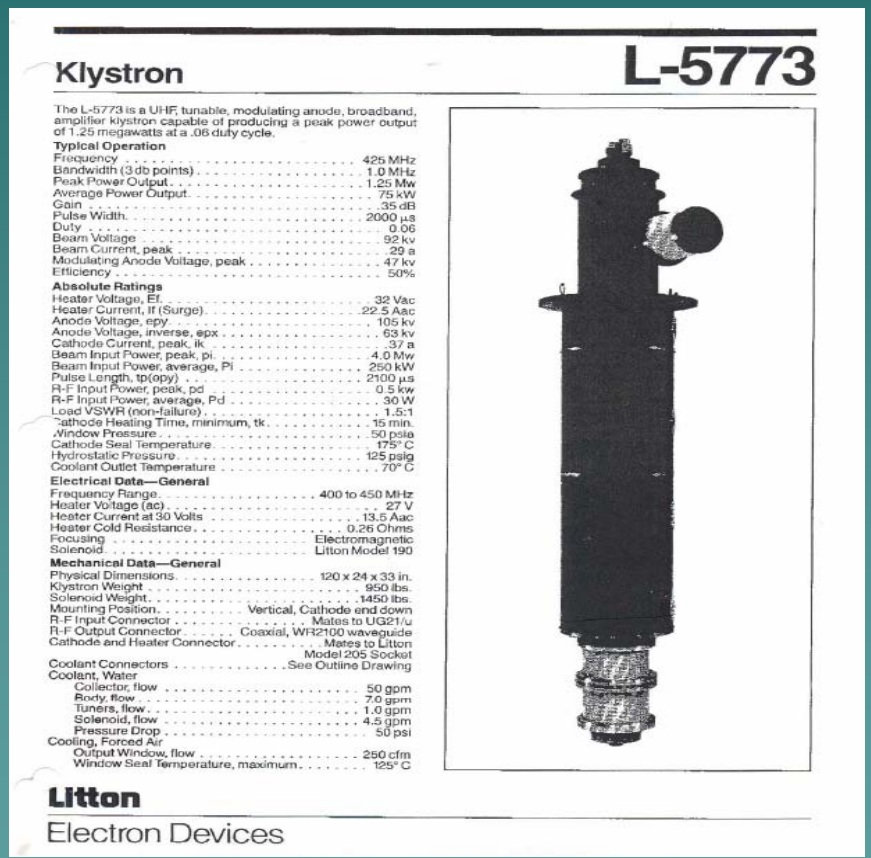
Upgrade	Beam Energy	Beam Current	Beam Duty	Power, Peak/Av	Neutron Rate
Klystron installation	7 MeV	25 mA	0.6%	175/1 kW	10^{12} n/s
New DTL section	13 MeV	25 mA	≤1%	325/3 kW	10^{13} n/s
New power supply for klystron tubes	13 MeV	25 mA	~2.5%	325/8 kW	10^{13} n/s
//					
New injector and RFQ	13 MeV	50 mA	~2.5%	650/16 kW	10^{14} n/s

RF System Upgrade



Details: WEPMS027

RF System Upgrade



Klystron **L-5773**

The L-5773 is a UHF, tunable, modulating anode, broadband, amplifier klystron capable of producing a peak power output of 1.25 megawatts at a .06 duty cycle.

Typical Operation

Frequency	425 MHz
Bandwidth (3 db points)	1.0 MHz
Peak Power Output	1.25 Mw
Average Power Output	75 kW
Gain	35 dB
Pulse Width	2000 µs
Duty	0.06
Beam Voltage	92 kv
Beam Current, peak	29 a
Modulating Anode Voltage, peak	47 kv
Efficiency	50%

Absolute Ratings

Heater Voltage, Ef	32 Vac
Heater Current, If (Surge)	22.5 Aac
Anode Voltage, epy	105 kv
Anode Voltage, inverse, epx	63 kv
Cathode Current, peak, ik	37 a
Beam Input Power, peak, pi	4.0 Mw
Beam Input Power, average, Pi	250 kW
Pulse Length, tp(epy)	2100 µs
R-F Input Power, peak, pd	0.5 kw
R-F Input Power, average, Pd	30 W
Load VSWR (non-failure)	1.5:1
Cathode Heating Time, minimum, tk	15 min.
Window Pressure	50 psia
Cathode Seal Temperature	175° C
Hydrostatic Pressure	125 psig
Coolant Outlet Temperature	70° C

Electrical Data—General

Frequency Range	400 to 450 MHz
Heater Voltage (ac)	27 V
Heater Current at 30 Volts	13.5 Aac
Heater Cold Resistance	0.26 Ohms
Focusing	Electromagnetic
Solenoid	Litton Model 190

Mechanical Data—General

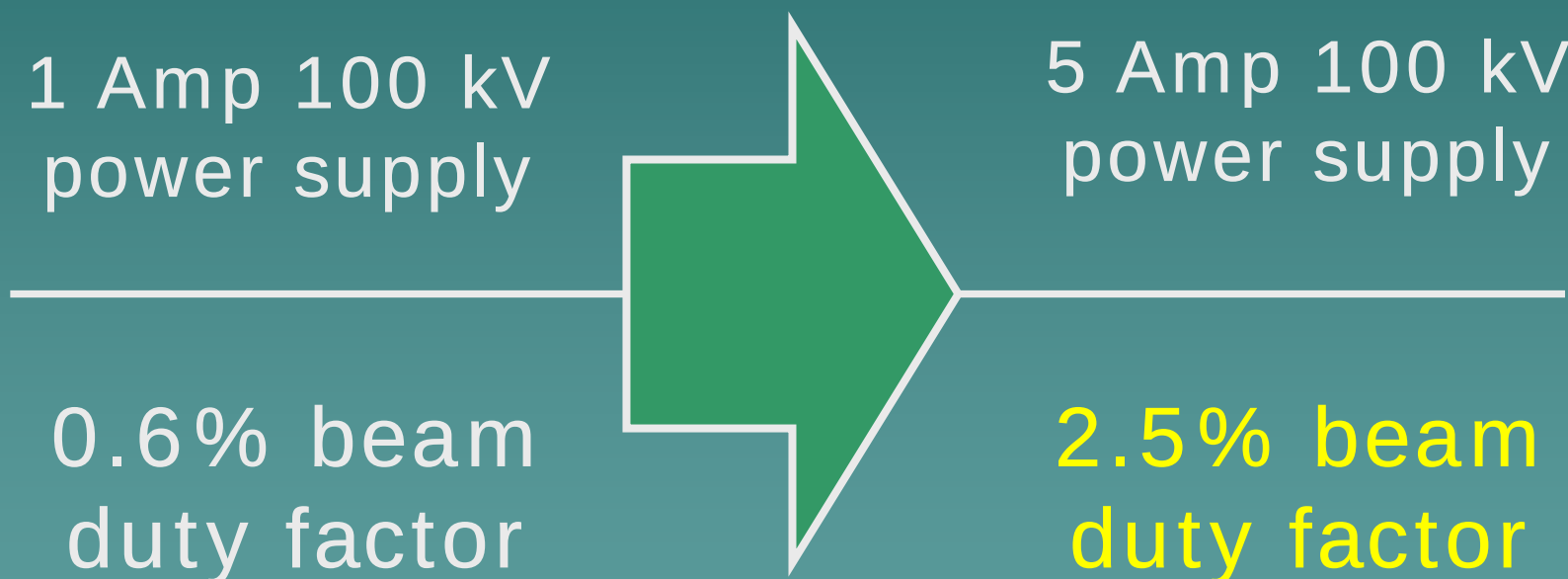
Physical Dimensions	120 x 24 x 33 in.
Klystron Weight	950 lbs.
Solenoid Weight	1450 lbs.
Mounting Position	Vertical, Cathode end down
R-F Input Connector	Mates to UG21/u
R-F Output Connector	Coaxial, WR2100 waveguide
Cathode and Heater Connector	Mates to Litton Model 205 Socket
Coolant Connectors	See Outline Drawing
Coolant, Water	
Collector, flow	50 gpm
Body, flow	7.0 gpm
Tuners, flow	1.0 gpm
Solenoid, flow	4.5 gpm
Pressure Drop	50 psi
Cooling, Forced Air	
Output Window, flow	250 cfm
Window Seal Temperature, maximum	125° C

Litton
Electron Devices

Beam Improvements

	Old RF System	With Klystrons
Peak current	10 mA	25 mA
Duty Factor	0.4%	0.6%
Min Pulse Length	50 µsec	10 µsec
Max Pulse Length	150 µsec	300 µsec

RF System Upgrade

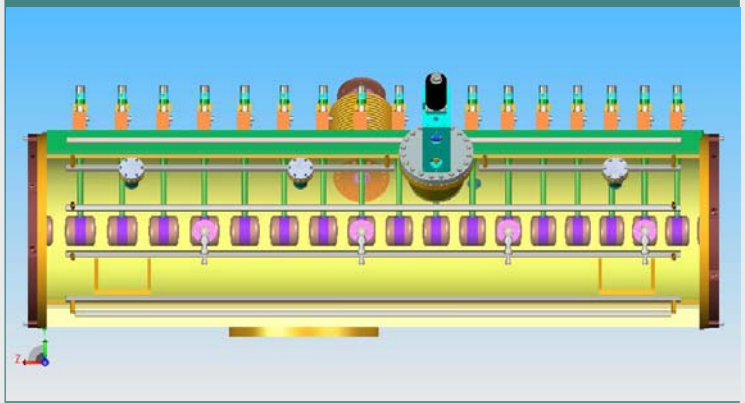


Accelerator Upgrade

A new DTL section designed by **AccSys Technology Inc.**

DTL Parameters

Input energy	7 MeV
Output energy	13 MeV
Output current	50 mA
Beam transmission at 50 mA	100%
Duty Factor	6%
Peak RF power at 50 mA	750 kW

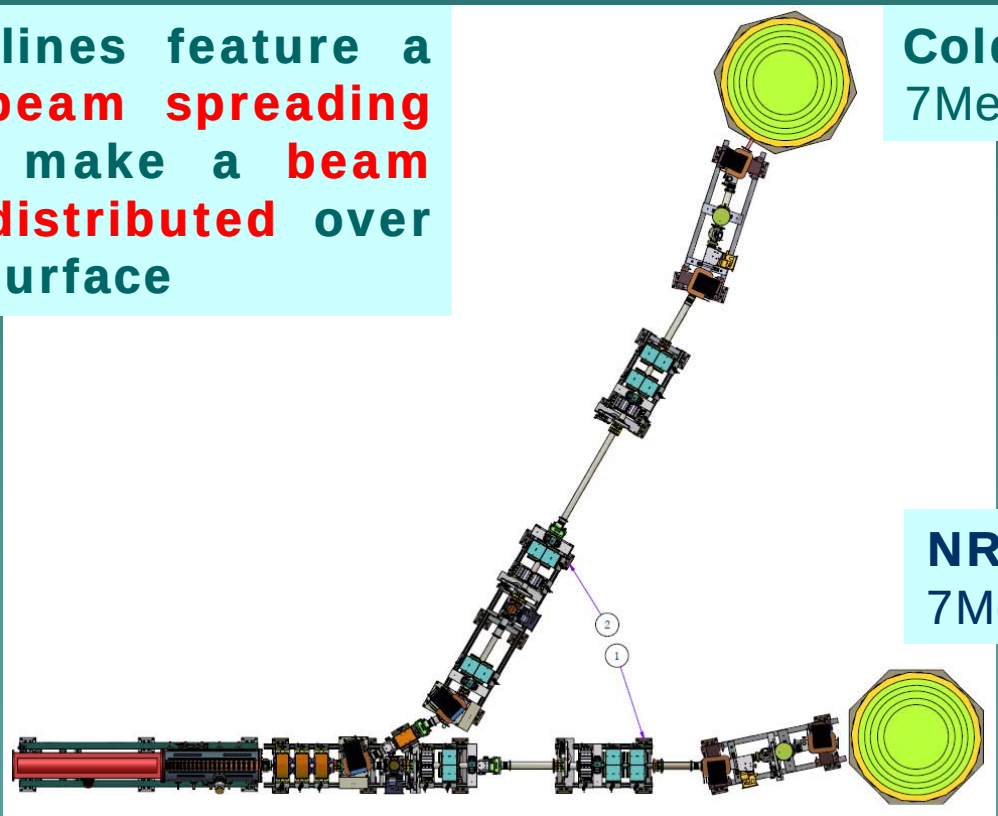


Beam Parameters

Input energy	7 MeV
Output energy	13 MeV
Output current	25 mA
Beam transmission at 50 mA	100%
Beam Duty Factor	2.5%
Peak RF power at 50 mA	750 kW

Beamline Upgrades

Both beamlines feature a nonlinear beam spreading system to make a beam uniformly distributed over the target surface



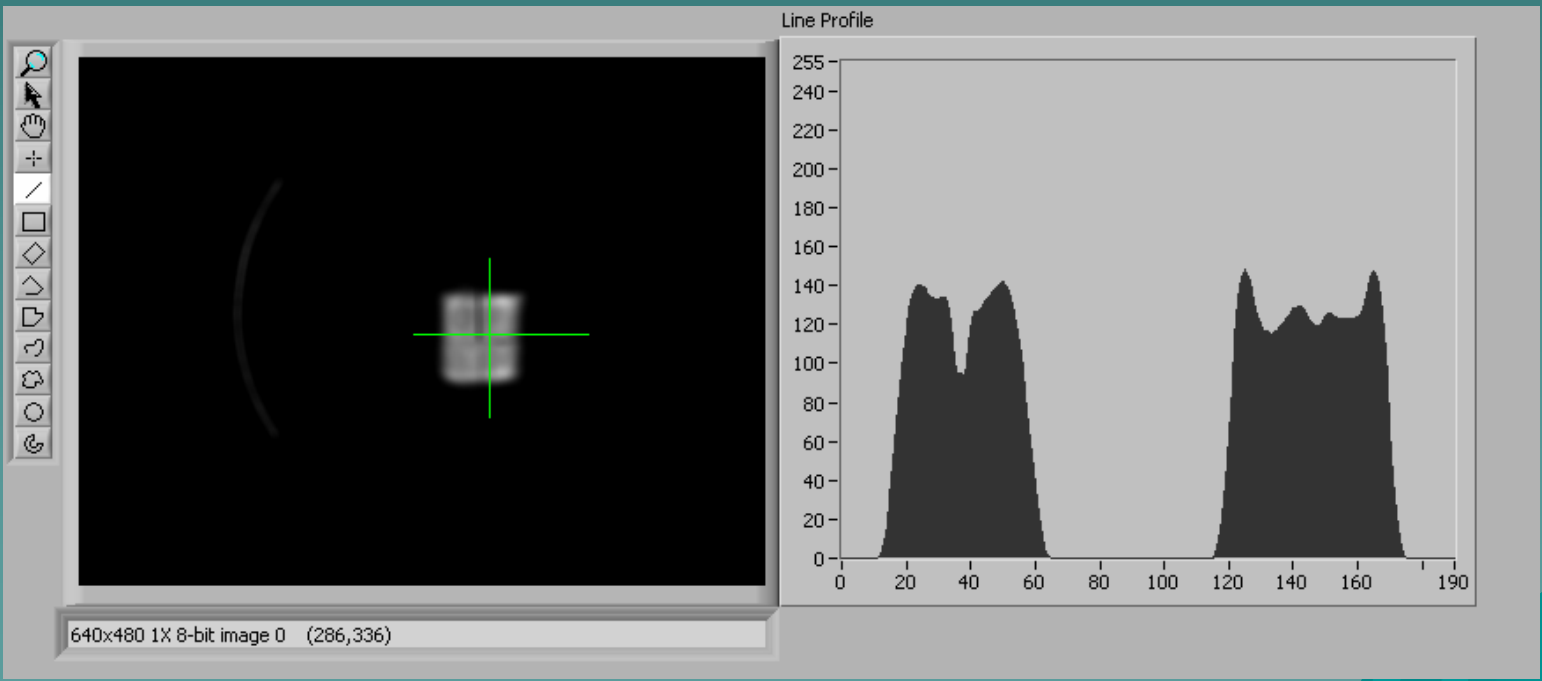
Cold Neutron Target
7MeV 25mA df≤0.02%

NRERP target
7MeV 25mA df≤0.6%

Octupole Beam Spreading System

First tests of the uniform beam tuning

Details: TUPAS046



What's about neutrons?

Main features of the LENS neutron beams:

- Long neutron beam pulse (~ msec).
- Cold and very cold neutrons (T_{spec}<10 K).

Research Areas:

- Study of large-scale (1nm -10mm) structures in materials.
- Instrumentation development (SANS, SESAME).
- Moderator development.

Future Plans

- New RFQ designed by TechSource, Inc. Close coupled to the PL-7 accelerator.
  - 100 mA 3 MeV 6% duty factor.
  - 50 mA 3 MeV 6% duty factor.
  - Under construction in ACCEL Instruments.
- New Proton Injector designed by IUCF.
  - 115 mA 75 kV LEDA based ion source.
  - Beam is matched to the new RFQ by LEBT.
- New 100 mA 13 MeV DTL.

Conclusions

- Installation and commissioning of the klystron based RF system is completed.
- Upgrade of the high voltage supply for the klystron tubes is scheduled for October 2007.
- Installation of the 13 MeV 50 mA DTL is scheduled for September 2007.
- Come to full operation with 25 mA 13 MeV 2.5% beam delivered to either target in December 2007.
- Target irradiation will be uniform.

Thanks