Test-Facilities at SLAC and at other North American Labs

Colloque international sur les collisionneurs linéaires
LCWS04 April 22nd, 2004 — Paris, France

LLNA

TRIUMF

LBNL

SLAC

- **A-Line and End Station A**
- **FFTB**

(Many transparencies are from M. Woods and T.Fieguth

~~**Cornell, Jefferson Lab**~~

Carsten Hast (SLAC)

Radiation Tests at Livermore (LLNL)

Livermore has a photo injector and a thermionic gun
(currently not operable but they want to get it going again)

followed by a 4 section linac which gives

90 – 150 MeV electrons

- **They can make short pulses < 300 fsec**
- **Radiation levels are 10^6 – 10^8 rad/hour**
- **Charge in a pulse is 1.5 – 2 μC**
- **Quite large neutron flux**

Seems to be quite uncomplicated to get beam time
(helps to be American due to security issues at Livermore)

Contact is: Aaron Tremaine [tremaine1@llnl.gov]

LLNL Linac Specs

Thermionic injector and RF linac

Long Pulse Mode

Repetition rate	up to 300	Hz
Micropulses per macropulse	~8000	
Micropulse charge	~0.25	nC
Macropulse charge	1.96	uC
Macropulse Length	up to 2.8	usec
Micropulse Length	~30	ps
Beam Energy	13-130	MeV
Micropulse current	8.4	A
Macropulse current	0.7	A
Average current	0.6	mA
Normalized emittance	260	mm-mrad
Radiation dose	10^6 to 10^8	R/h at 1 m
Minimum spot radius (at 100 MeV)	260	microns
Peak current density	4	kA/cm^2

Short Pulse Mode

Repetition rate	up to 1440	Hz
Micropulses per macropulse	6 to 60	
Micropulse charge	~ 2	nC
Macropulse charge	up to 120	nC
Macropulse Length	2 to 20	nsec
Micropulse Length	~30	ps
Beam Energy	13 to 130	MeV
Micropulse current	120	A
Macropulse current	10	A
Average current	173	uA
Normalized emittance	260	mm-mrad
Radiation dose	10^5 to 10^7	R/h at 1 m
Minimum spot size	260	microns
Peak current density	34	kA/cm^2

Measured: 1-100 Rad per shot with Brem. X-rays

Measured: Megarad doses into targets using the beam directly

With 77.5 MW total RF power, 650 mA macropulse current, 92 MeV beam energy, 300 Hz PRR, and 2.8 μs pulse length maximum average beam power is 50.4 kW

Photoinjector at 5 MeV: Measured on test-stand

Repetition rate	10	Hz
Pulse length	1 to 10	psec
Beam energy	5	MeV
Peak current	up to 100	A
Normalized emittance	< 10	mm-mrad
Minimum spot radius	50	microns
Peak charge density	6.4	MA/cm^2

Photoinjector at 30-100 MeV:

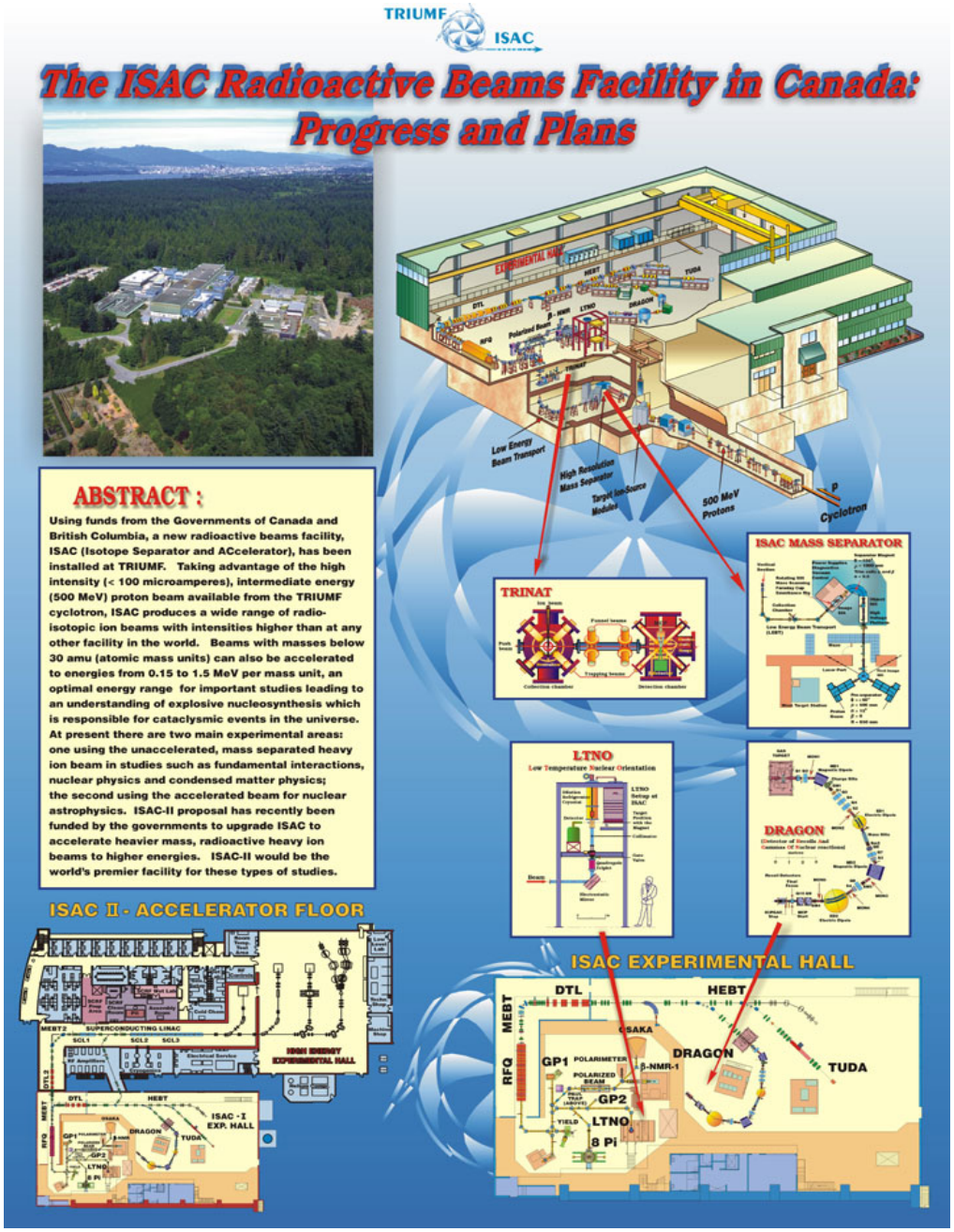
Repetition rate	10	Hz
Pulse length	1 to 10 (<350 fs compressed)	psec
Beam energy	5-100	MeV
Peak current	up to 100 (~800 compressed)	A
Normalized emittance	9.3	mm-mrad
Minimum spot size measured	70	microns
Peak charge density	32	MA/cm^2

TRIUMF's Radioactive Beams Facility

ISAC (Isotope Separator and Accelerator)

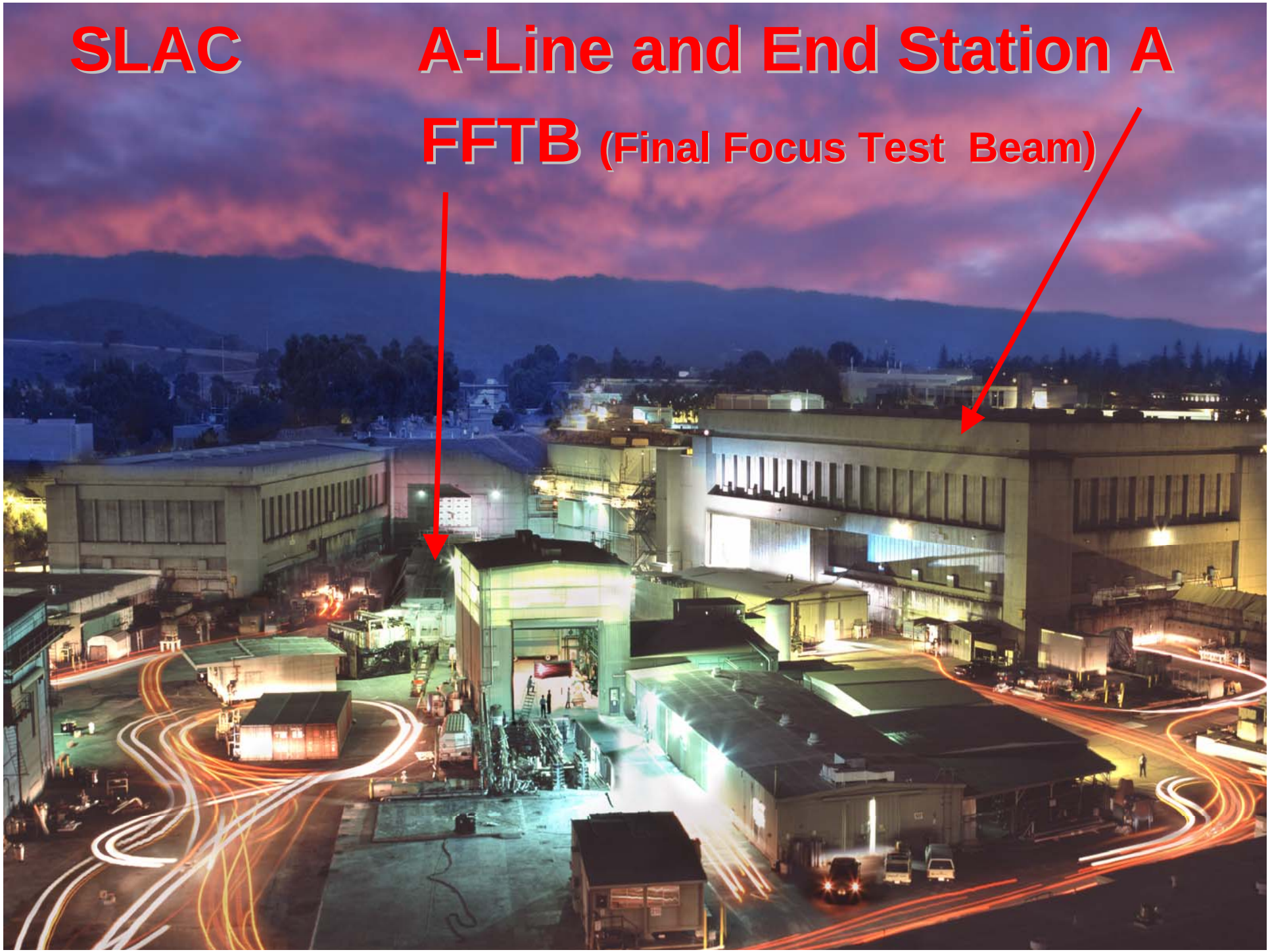
- Looks great for studying neutron damage
  (or other heavier isotopes)
- They are doing research, but I have not seen any direct advertisement of radiation damage tests
- I didn't get a reply to some questions I send to someone I found on the web, but I didn't try too hard either…

http://www.triumf.ca/isac/isac_home.html


TRIUMF
ISAC
The ISAC Radioactive Beams Facility in Canada: Progress and Plans
ABSTRACT :
Using funds from the Governments of Canada and British Columbia, a new radioactive beams facility, ISAC (Isotope Separator and ACcelerator), has been installed at TRIUMF. Taking advantage of the high intensity (< 100 microamperes), intermediate energy (500 MeV) proton beam available from the TRIUMF cyclotron, ISAC produces a wide range of radio-isotopic ion beams with intensities higher than at any other facility in the world. Beams with masses below 30 amu (atomic mass units) can also be accelerated to energies from 0.15 to 1.5 MeV per mass unit, an optimal energy range for important studies leading to an understanding of explosive nucleosynthesis which is responsible for cataclysmic events in the universe. At present there are two main experimental areas: one using the unaccelerated, mass separated heavy ion beam in studies such as fundamental interactions, nuclear physics and condensed matter physics; the second using the accelerated beam for nuclear astrophysics. ISAC-II proposal has recently been funded by the governments to upgrade ISAC to accelerate heavier mass, radioactive heavy ion beams to higher energies. ISAC-II would be the world's premier facility for these types of studies.
Low Energy Beam Transport
High Resolution Mass Separator
Target Ion Source Modules
500 MeV Protons
P
Cyclotron
TRINAT
ISAC MASS SEPARATOR
LTNO
Low Temperature Nuclear Orientation
DRAGON
ISAC II - ACCELERATOR FLOOR
ISAC EXPERIMENTAL HALL
DTL
HEBT
MEBT
RFQ
OSAKA
GP1
POLARIMETER
DRAGON
TUDA
β-NMR-1
GP2
LTNO
8 Pi

Berkley (LBNL)

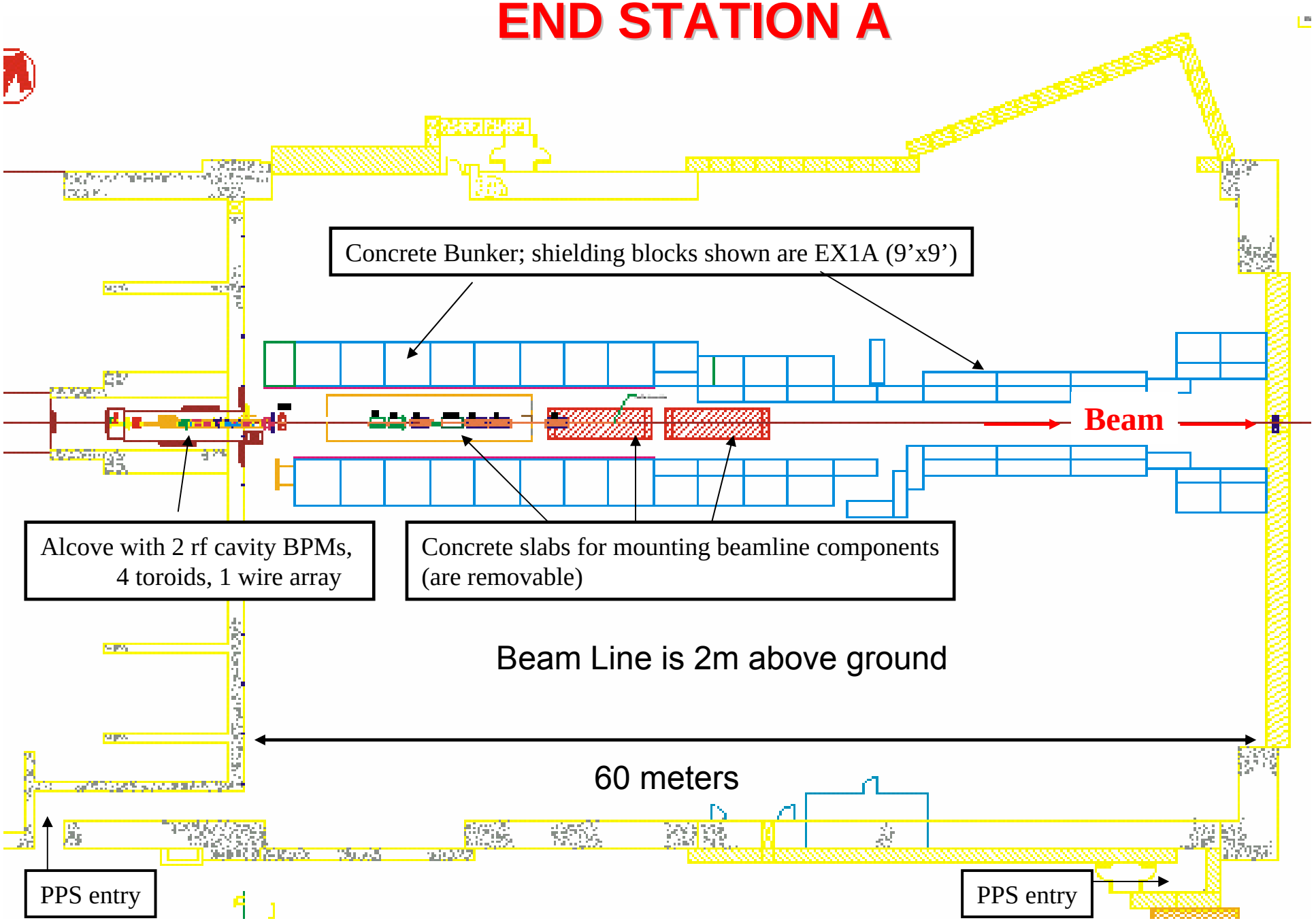
- Didn’t find out any specifics only that they do have beams for doing radiation tests (I know they did some readout electronics irradiation for BaBar)


SLAC
A-Line and End Station A
FFTB (Final Focus Test Beam)

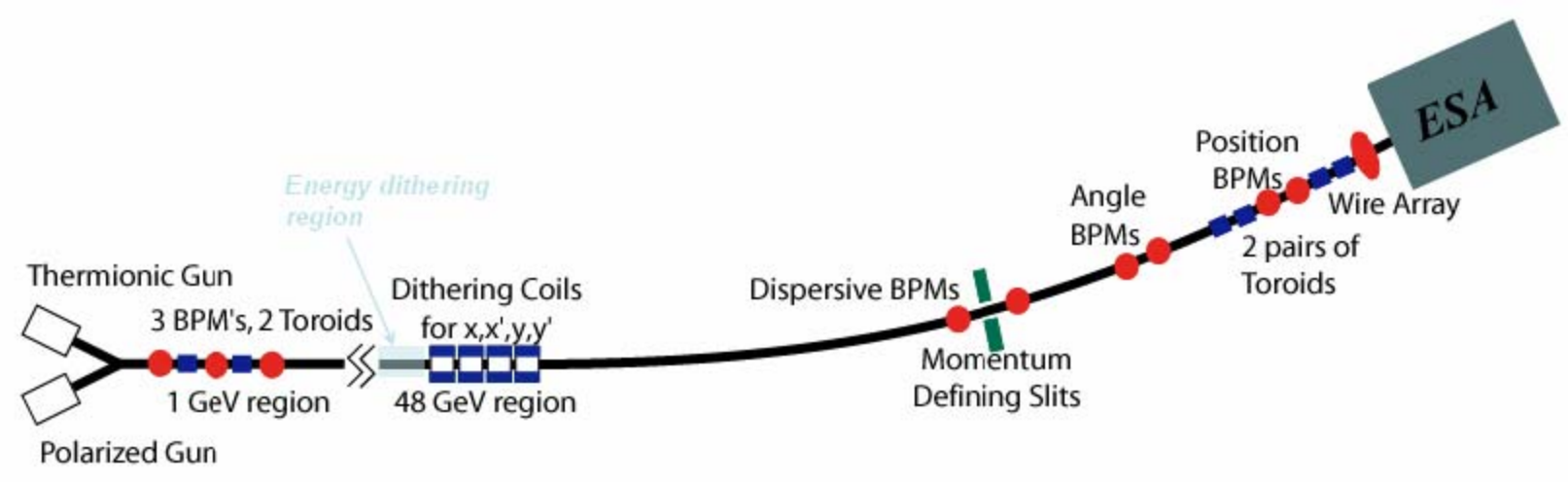
Beam Parameters at SLAC ESA, NLC-500, and TESLA-500

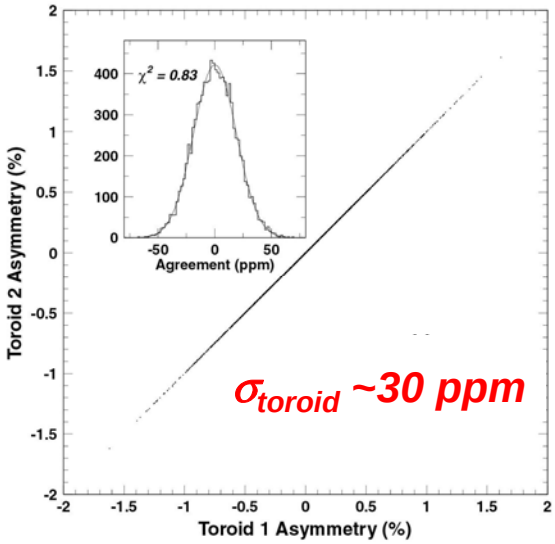
Parameter	SLAC ESA	NLC-500	TESLA-500
Charge/Train	5×10^{11}	14.4×10^{11}	
Repetition Rate	10-30 Hz	120 Hz	5 Hz
Energy	25-50 GeV	250 GeV	250 GeV
e^- Polarization	85%	80%	80%
Train Length	270ns / 340ns	267ns	1 ms
Microbunch spacing	0.3ns / 340ns	1.4ns	337 ns
Bunches per train	2		2820
Bunch Charge	2.0×10^{10}		2.0×10^{10}
Energy Spread	0.15%	0.3%	0.1%

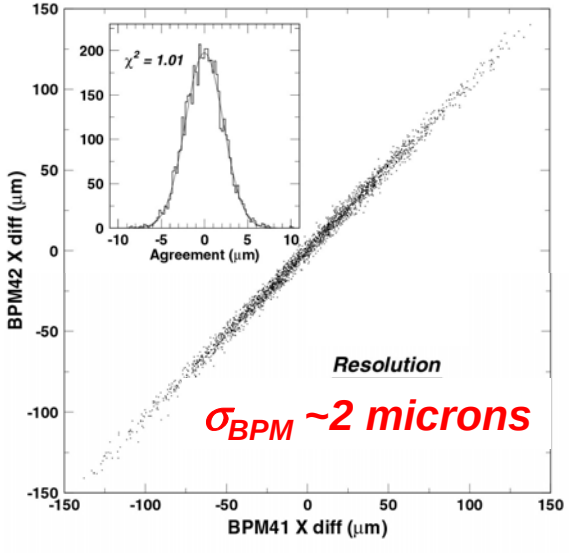
END STATION A

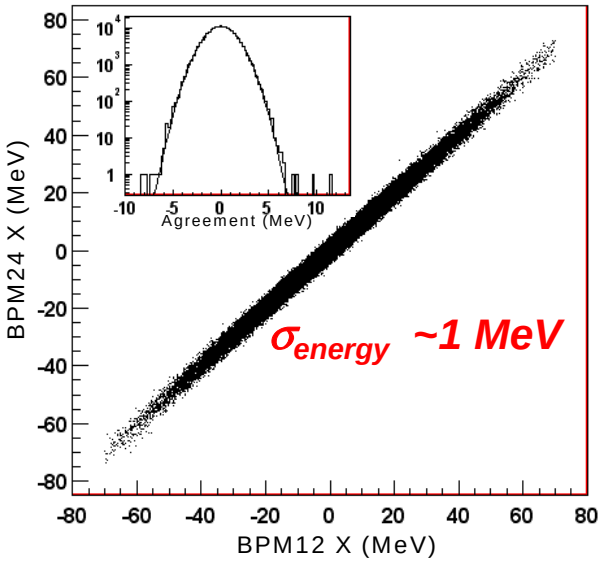


Beam Diagnostics for E-158









Secondary Beams to ESA

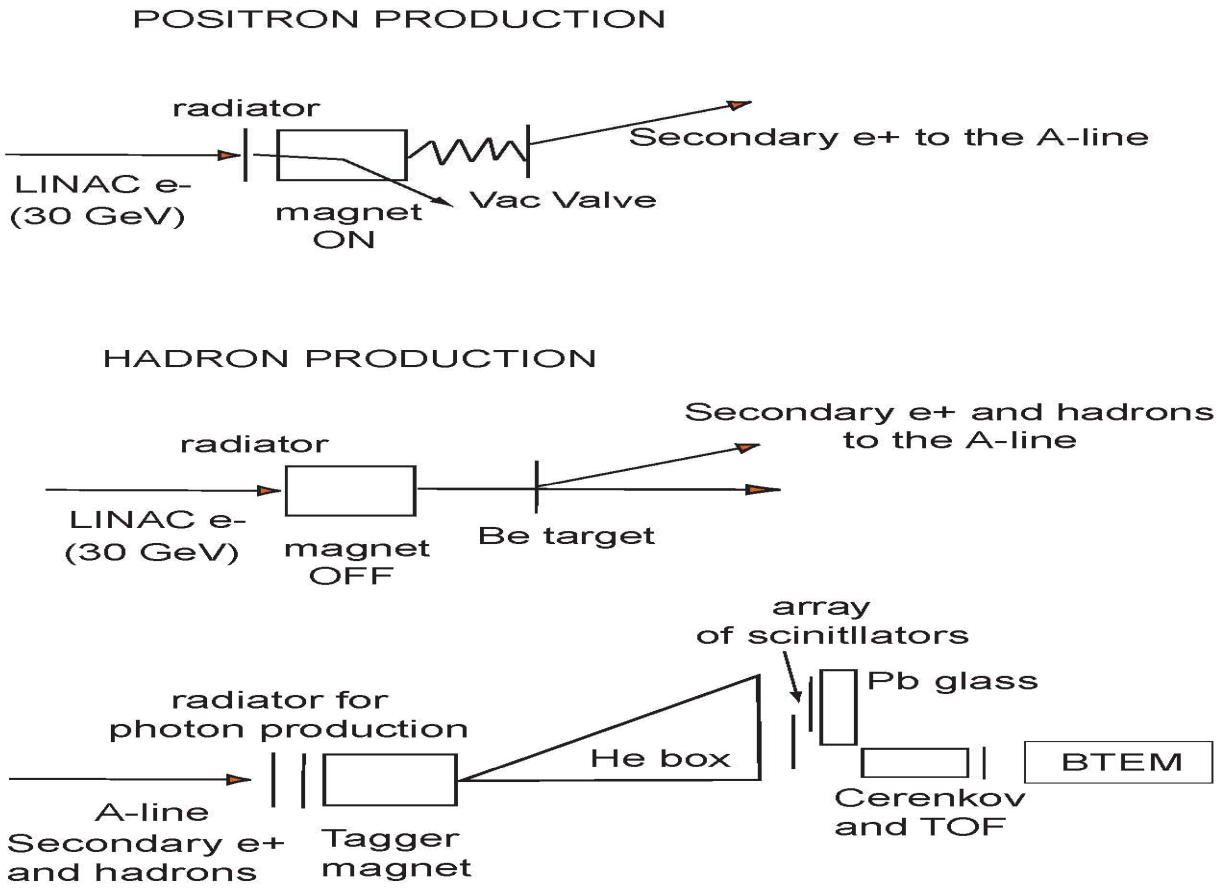


Figure 2: A schematic drawing (not to scale) of the experimental set–up.

Secondary Beams to ESA cont.

These low intensity beams have been useful for many calorimeter and other tests

1) Secondary electrons

- **500 MeV to 20 GeV**
- **usually one particle/pulse, but 3-4 mm rms half-width spot**
- **High momentum resolution**

2) Tagged photon beam using secondary e- (see above) on a bremsstrahlung target with tagging magnet and detector in the end station

3) Hadrons and positrons are produced with a 0.5 r.l. Be target in Beam switchyard (BSY)

- **Accepted into A-line at a 0.5 degree production angle. Small Acceptance 2.3x4 cm over 80 m drift.**
- **Averaging one particle/pulse allows use of TOF and Cherenkov techniques for particle identification for 5-20 GeV.**

- **At 14.5 GeV for 0.4 particles/spill total the yield was**

0.25 e+/spill
0.17 hadrons(K+,π+)/spill
0.01 protons/spill

see GLAST 1999 test results, SLAC-PUB-8682

End Station A

Is big, …

empty, …

…and ready for business

FFTB

Primary Beams

- 28.5 GeV electrons
- 1-2 x 10^{10} per pulse.
- typically 3ps pulse,
- small emittance, σ_x=4μm, σ_y=2.5μm, or SPPS short pulse with larger energy spread, have achieved σ_x=20μm, σ_y=20μm and σ_s=90μm for T465 test beam,
- 1-30 Hz.
- Loss limited to 1 kW by shielding

Secondary Beams

- These low intensity beams have been useful for many EMC tests and other tests.
- 1 to 30 GeV,
- usually one electron/pulse,
- several mm spot,
- 10-30 Hz

SLAC Test Beams in the Future

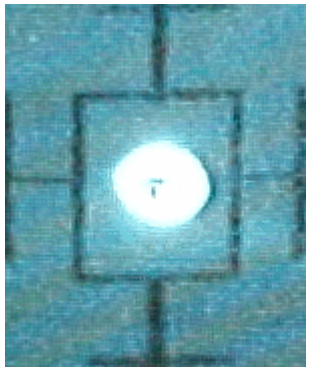
- Running of ESA or FFTB are mutually exclusive
- FFTB will go away in 2006 to make place for LCLS
- Until then there are many opportunities to schedule beam tests in FFTB
- ESA is in principal available for high power or single particle tests starting this summer

For all tests which take a significant amount of beam

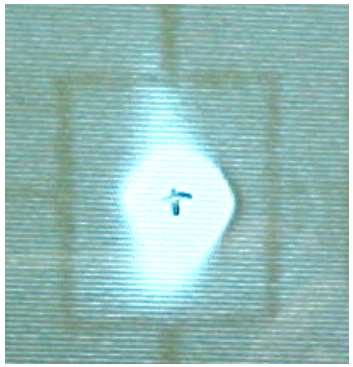
(= electrical power and time) there is some formality to be dealt with: at least a Test Beam Request for something short (a week or so) or an EPAC presentation

Backup Slides

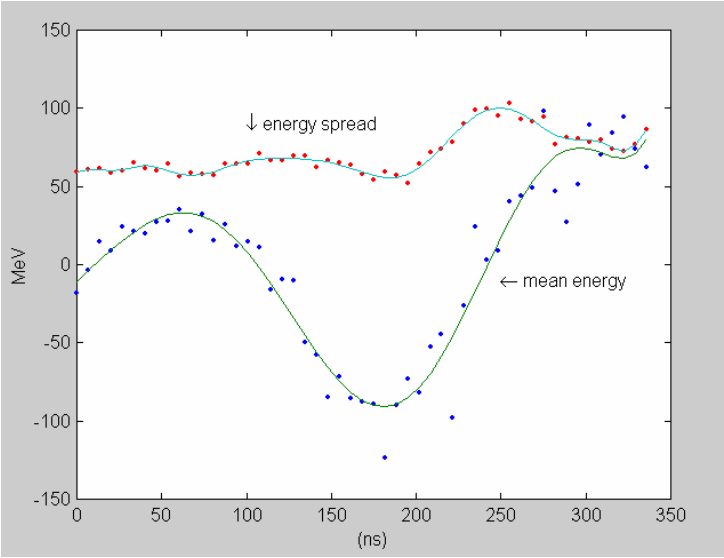
ESA can provide clean beams (little halo or beam tails)

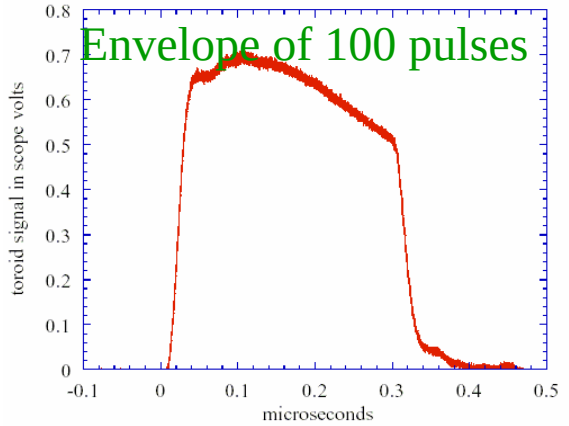


Or can provide beams with tails!



Can provide “banana” beams in energy by pulse shaping source laser intensity





Can translate banana energy distribution to banana spatial distribution by introducing dispersion