SNS Diagnostics

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LANL SNS Physics Team

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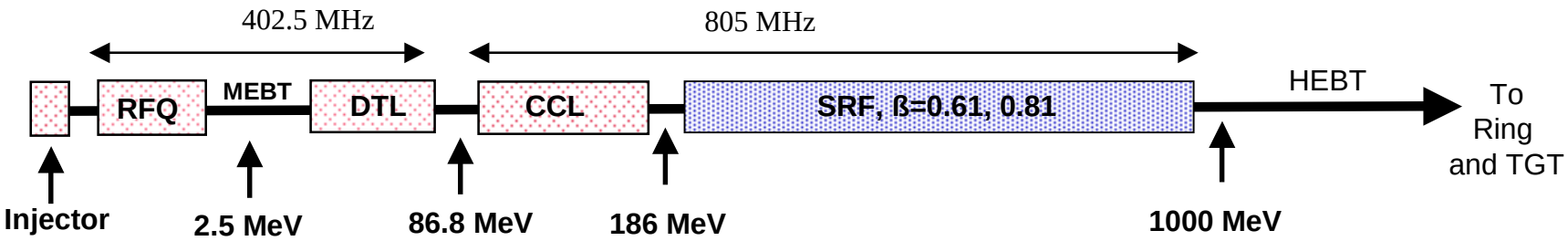
LANL diagnostics deliverables



MEBT	DTL	D-plate (7.5 MeV)	CCL	SCL	HEBT	RTBT
5 WS (elec. only)	5 WS	1 WS	8 WS	32 WS (16 elec.)	3 WS (dumps)	1 Harp
6 BPM (elec. only)	10 BPM	3 BPM	12 BPM	32 BPM	22 BPM (elec. only)	
2 Sl&Col (act. only)	6 CM (p/u only)	1 CM	2 CM (p/u only)	1 CM		
	5 ED/FC	1 ED/FC	1 ED/FC			
		2 Sl&Coll emit				
		1 Phosphor screen				
		1 8 seg. halo scraper				
		1 Beam stop / F-Cup				

Key
WS = wire scanner
BPM = beam position monitor
Sl&Col = slit and collector emittance station
CM = current monitor
ED/FC = energy degrader & Faraday Cup

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Requirements summary

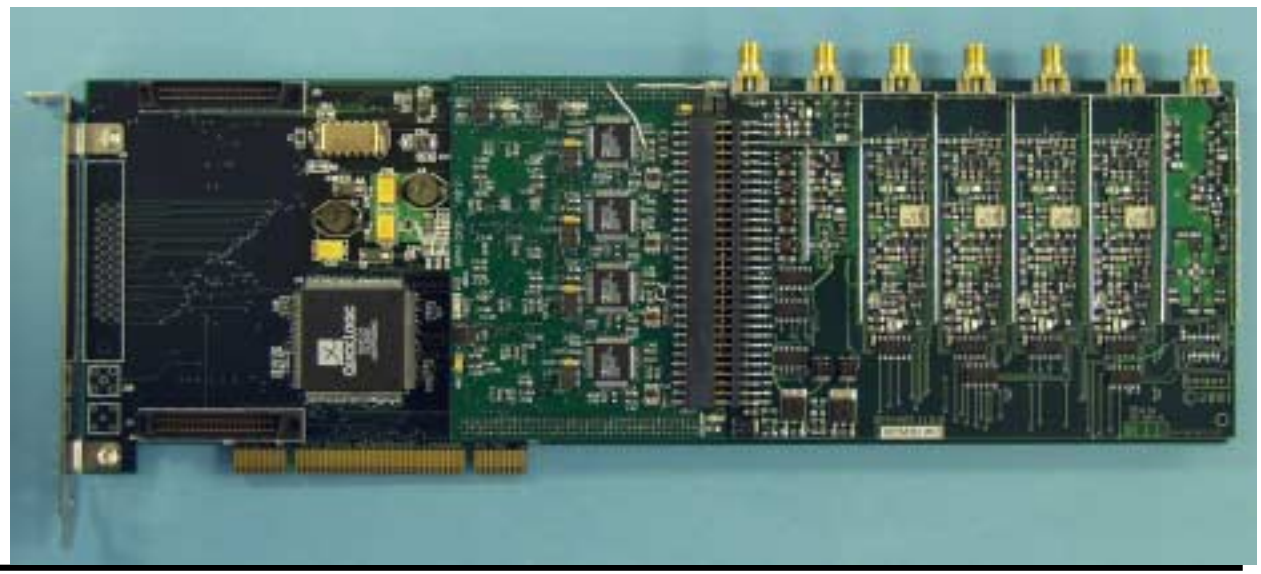
Device	*Requirement*	*Status*
BPM	**Quantity = 57 pickups, 85 elec.** **Accuracy = 1% aperture radius.** **Beam current = 10 – 56 mA**	**PDR, part of FDR, 2 DTL pickups delivered, CCL & SCL prototypes in fab., prototype electronics.**
WS	**Quantity = 49 pickups, 38 elec.** **Accuracy = 10% width meas.** **Beam current = 10 – 56 mA, 50 – 100 μs, 10 Hz.**	**PDR, prototype actuators, prototype electronics.**
CM	**Quantity = 10 pickups, no elec.** **Accuracy = 1% of full scale** **Beam current = 10 – 56 mA**	**DTL pickups on order.** **CCL / SCL pickups being specified.**
ED/FC	**Quantity = 7** **Beam current = 10 – 56 mA, 50 μs, 1 Hz.**	**Design in progress.**
Harp	**Quantity = 1 pickups, 1 elec.** **Accuracy = 10% width meas., 0.5 mm pos'n meas.**	**Design in progress.**
D-plate	**Quantity = 1**	**PDR, final design in progress.**

Physics input

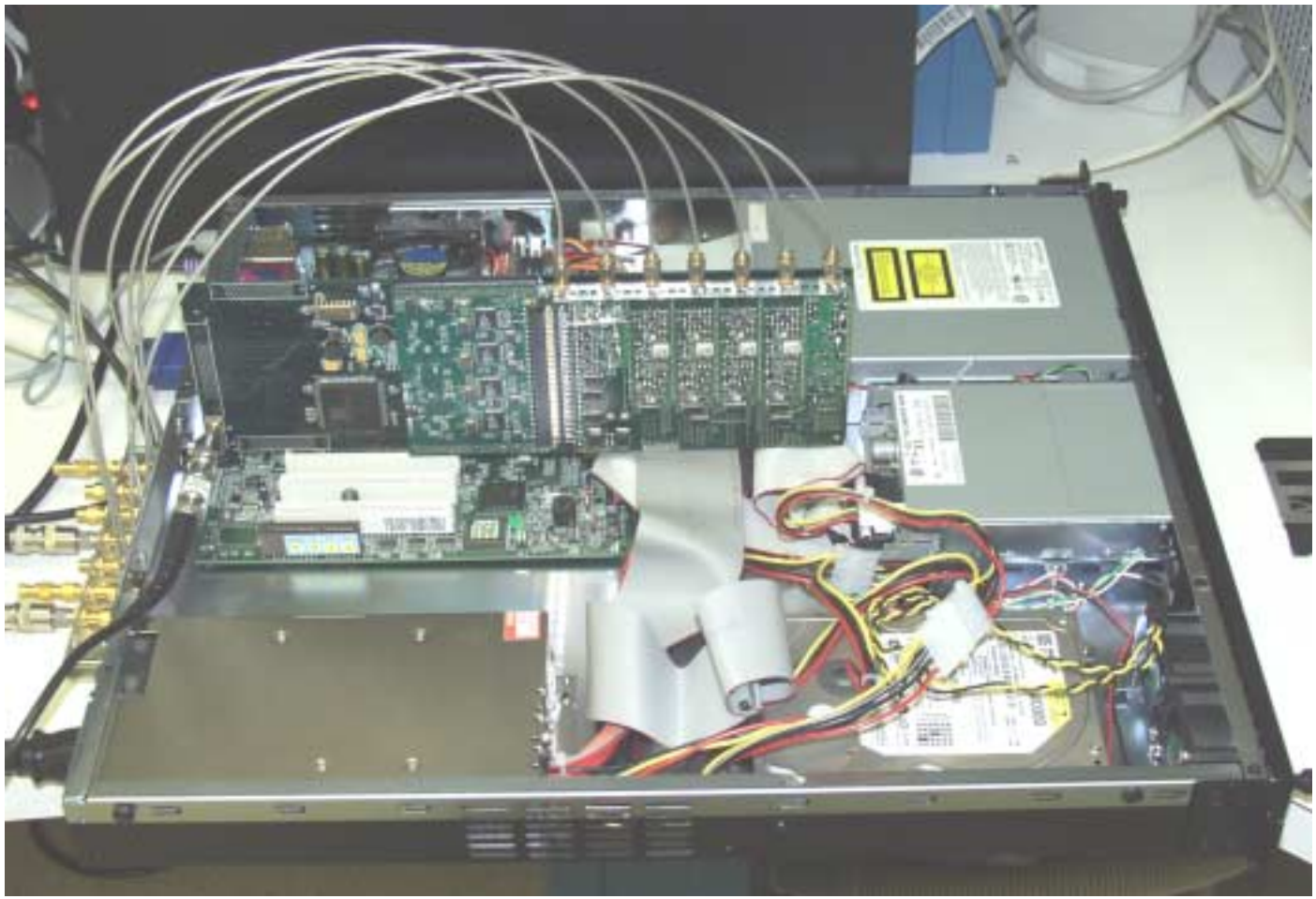
- **Past design reviews have pointed out the lack of input from physics and commissioning teams on the diagnostics requirements and placements.**
- **Physics and commissioning are now catching up:**
  - DTL commissioning plans, including the plan for the D-plate, are now detailed *(**http://www.sns.gov/projectinfo/operations/commissioning.htm**).*
  - CCL BPM placements refined based on CCL steering studies (Nath, Crandall).
  - WS accuracy expectations (Jeon, Plum tech note).
  - CCL WS accuracy requirements and placements refined by DTL to CCL matching studies (Jeon, Stovall, Assadi tech note).
  - Harp accuracy requirement (RTBT interface workshop, 20/Sep/01).

BPMs

- Two DTL pickups to be delivered Dec/01.
- Prototype CCL and SCL pickups now in fab.
- Electronics in prototype stage.
- Six electronics units to be delivered to LBL Jan/02.

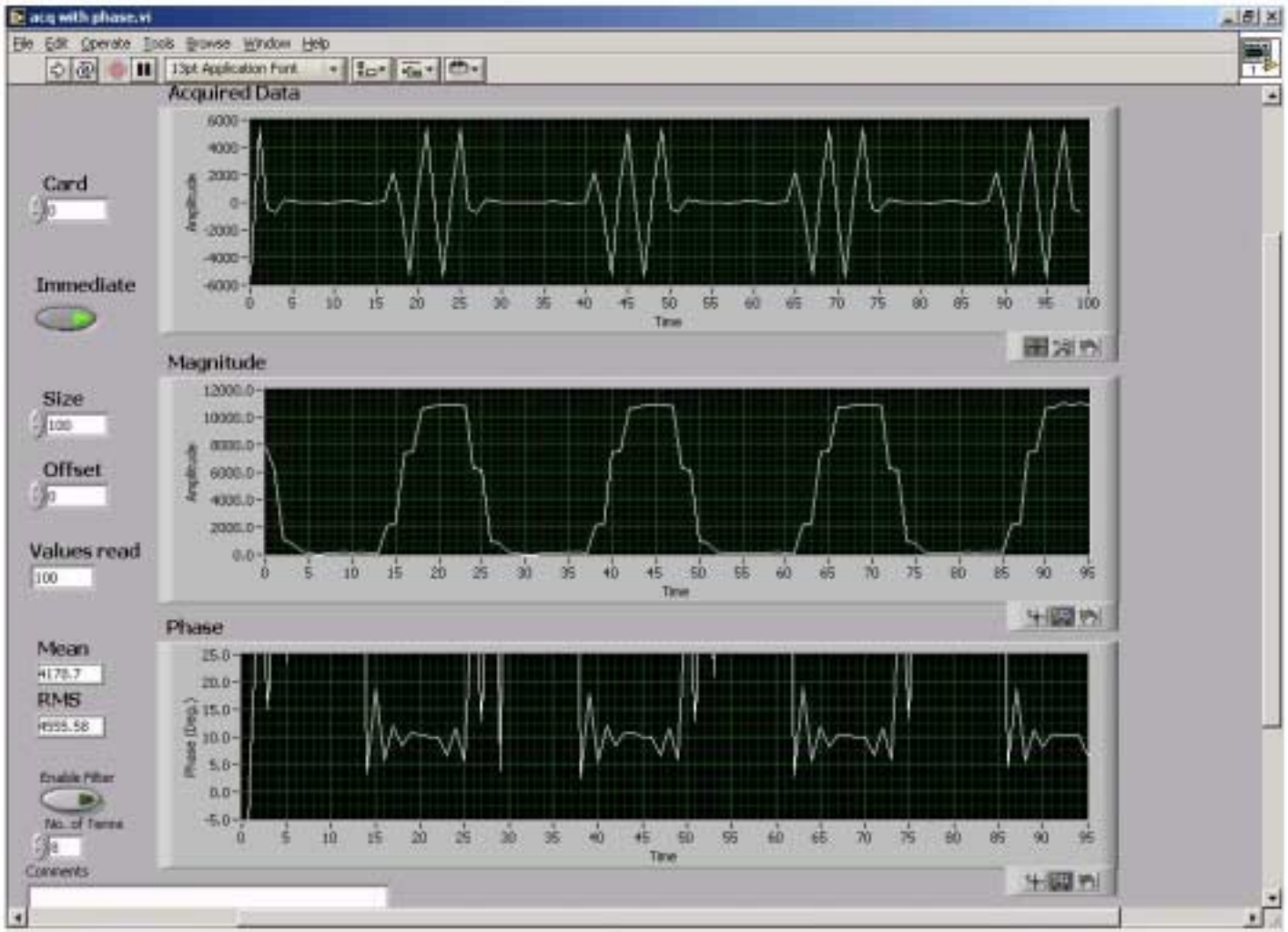


BPM chassis



Prototype signal processor PCI card mounted in 1U rack-mounted PC.

BPM waveforms



Simulation of 300 ns beam pulse.

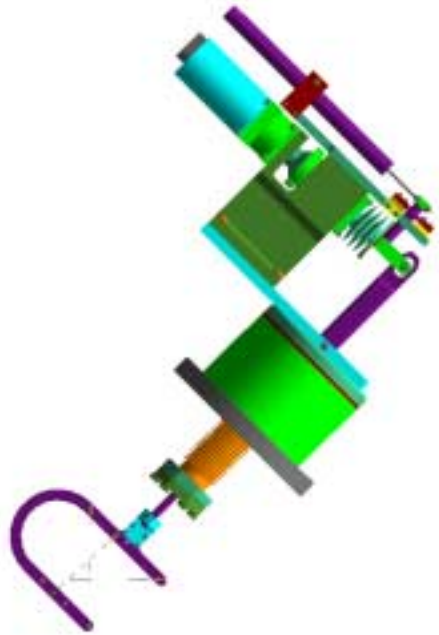
Top: digitization of the down-converted signal.

Middle: Amplitude measurement.

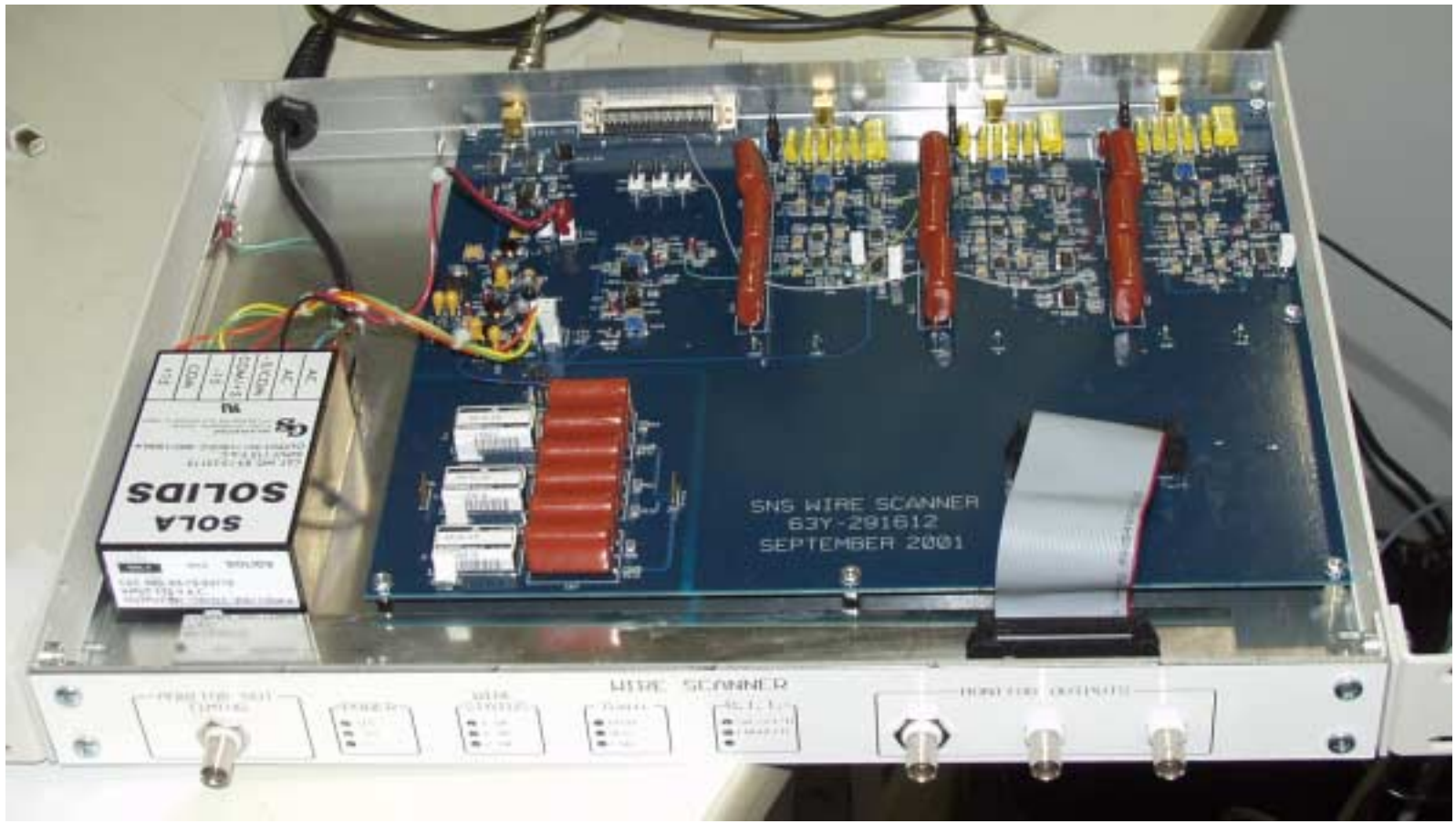
Bottom: Phase measurement.

Wire scanners

- Prototype DTL/CCL actuator recv'd and tested (bellows failed). (No impact on delivery schedule.)
- Prototype SCL actuator received 3/Dec.
- 3 signal wires (x, y, and diagonal).
- Electronics in prototype stage.
- Six electronics units to be delivered to LBL early January.
- Beam power limited to 50 – 100 μs, 10 Hz.



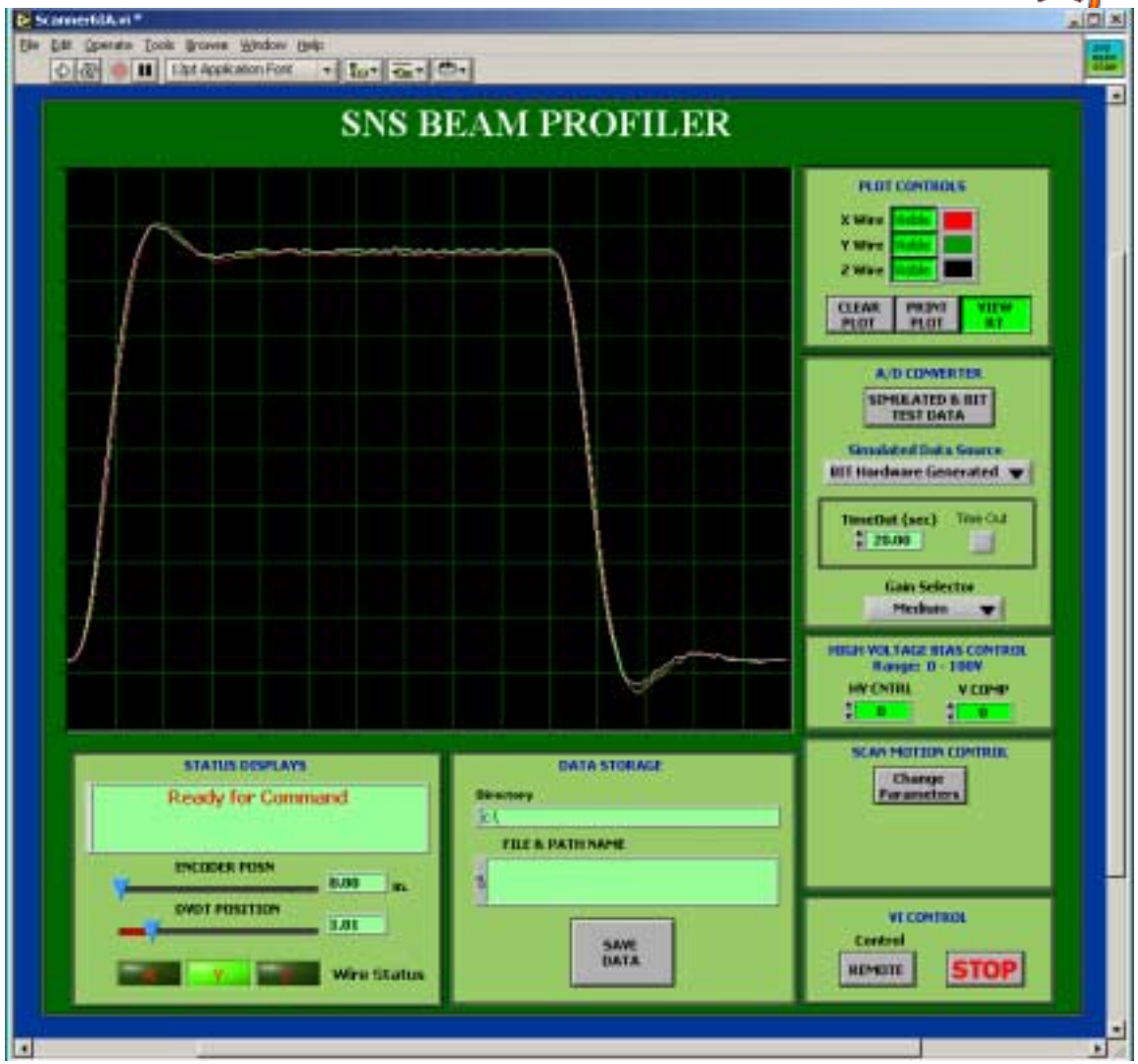
SNS WS signal processor electronics



Prototype signal processor in 1U rack-mounted chassis.

Example of WS self-test

- 100 μs pulse capacitively coupled into front end.
- Three separate channels are displayed.



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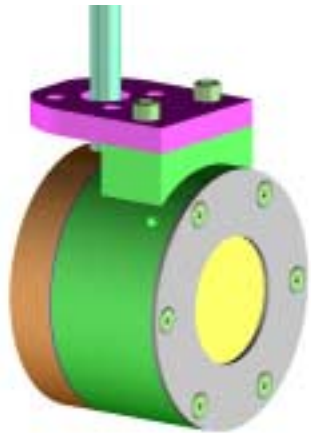
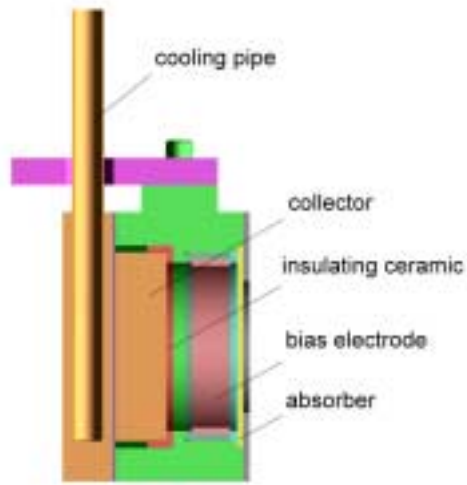
Energy degrader / Faraday Cups

- **Both energy degrader and Faraday Cup are mounted on single actuator.**
- **First 3 units use graphite energy degrader. Rest use copper.**
- **Thermal properties modeled with finite element code.**
- **Beam power limited to about 50 μs, 1 Hz.**
- **Graphite insert in Faraday Cups for high peak temperatures in transient response.**
- **Final design is now in progress.**



Integrated energy degrader and Faraday Cup



Graphite insert for Faraday Cups

Current monitors

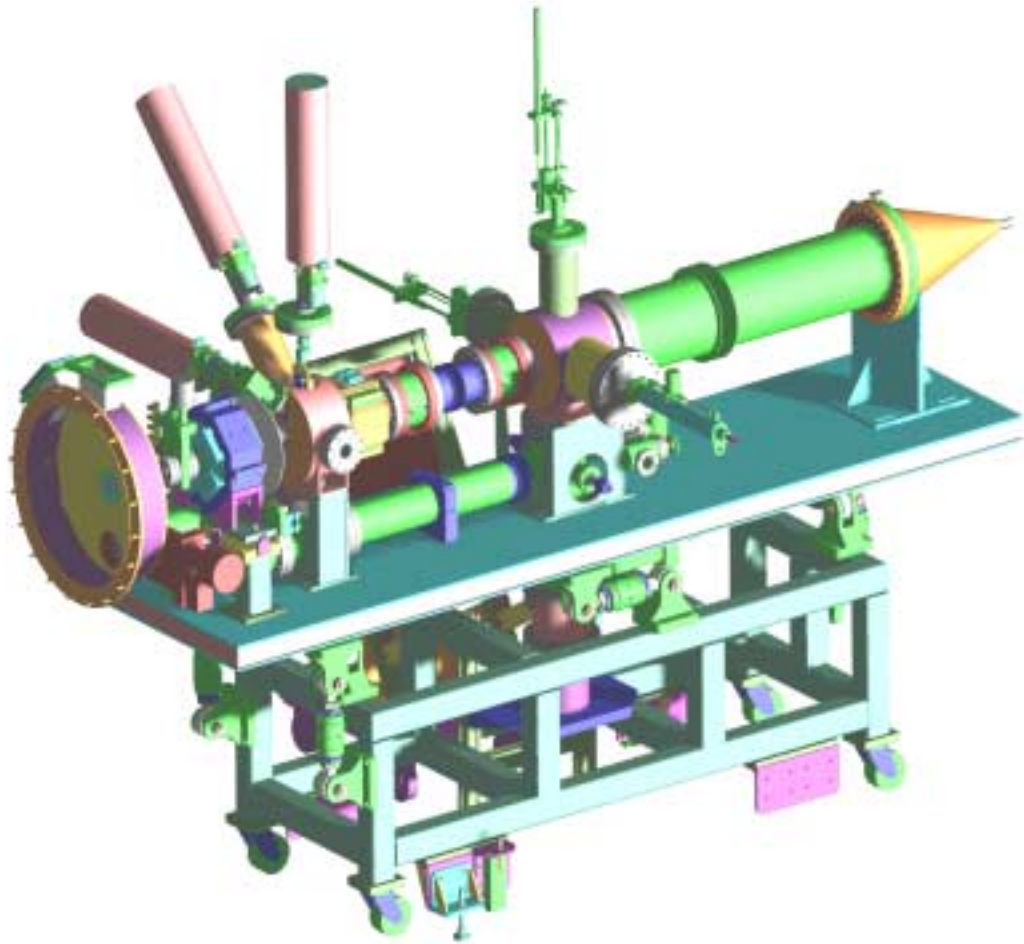
- **LANL is responsible for toroids only.**
- **In-vacuum DTL toroids have been ordered. Beam boxes and DTL tank endwalls are now in fab or out for bids.**
- **CCL and SCL outside vacuum toroid specification is in progress.**
- **Transition region vacuum break and housing have been designed.**

DTL CM

CCL / SCL CM

D-plate

- Used to commission linac up to 7.5 MeV (after DTL tank 1).
- Last chance to operate linac at full beam power.
- Final design is now in progress.



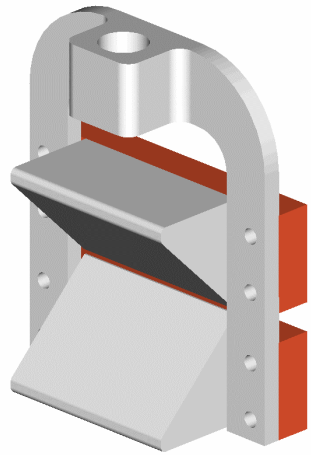
D-plate (7.5 MeV)
1 WS
3 BPM
1 CM
1 ED/FC
2 Sl&Coll emit
1 Phosphor screen
1 8 seg. halo scraper
1 Beam stop / F-Cup

D-plate measurements

- **Full power (16 kW)**
  - Test and develop the front end systems (ion source, low energy beam transport, RFQ, medium energy beam transport (MEBT)).
  - Measure DTL tank 1 transmission.
  - Measure beam energy by time of flight (TOF).
- **Reduced power (10 Hz, 50 μs pulse)**
  - Measure emittance with slit and collector method.
  - Determine phase and amplitude set points of DTL tank 1.
  - Measure wire scanner beam profiles.
- **Low power**
  - Test permanently mounted diagnostics in the DTL beam box.
  - Accommodate DTL beam aperture scans.
  - Test DTL tank 1 beam steering magnets.
  - Measure phosphor screen beam profile.

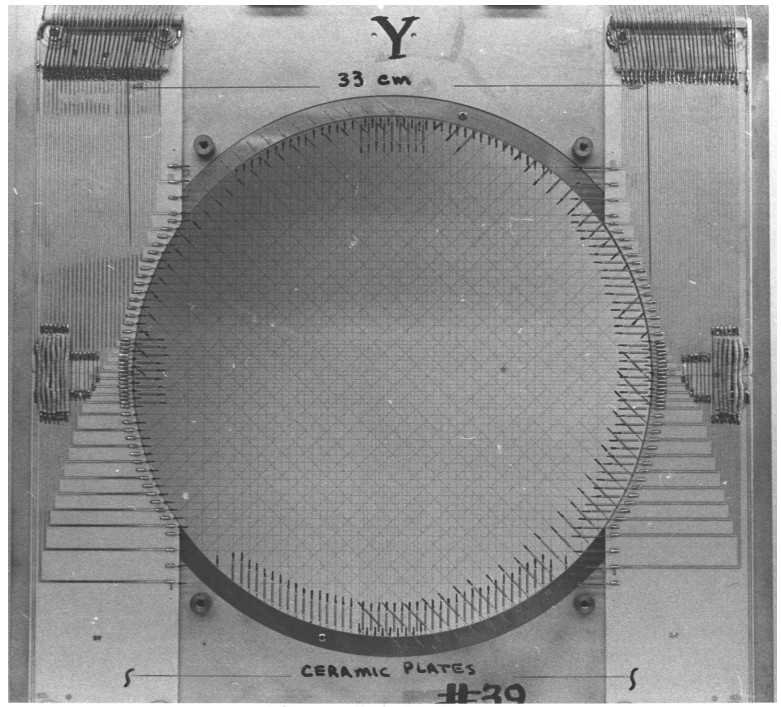
MEBT slit and collector

- LANL is responsible for delivery of actuators and the heads (slits and collectors).
- It is a challenge for these devices to withstand even 50 μs, 1 Hz beam pulses.
- Slits will be made of graphite.
- The collector will likely be a clone of the LANSCE design.
- Design is on hold while beam box issues are being resolved.



RTBT harp

- Design is based on the LANSCE 13” harps.
- Ceramic printed circuit board, 4-mil SiC wires mounted with hooks and springs.
- Three signal planes to resolve x-y correlations.
- About 99 signal wires with various spacings and spans.
- Electronics will be off the shelf VME/CAMAC.
- ORNL will probably choose to add a couple more insertable harps a few meters upstream of the main (fixed) harp.

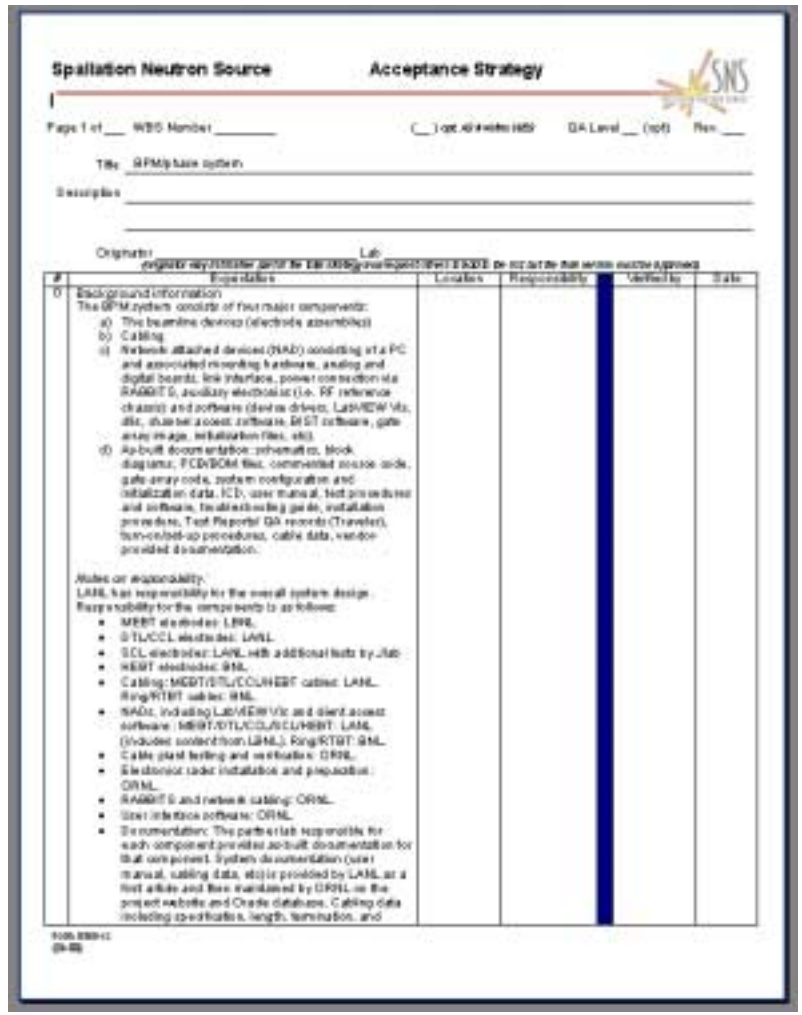


Design review status

System	PDR	FDR
BPM	27/Feb/01	DTL p/u 19/Sep/01 rest ~ Feb/02
Wire scanner	17/Jul/01	~ Feb/02
ED/FC	~ Jan/02	~ Mar/02
CM	BNL will arrange	
D-plate	18/Jul/01	~ Feb/02
Harp	~Fall/02	~Spring/03
MEBT slit & coll	on hold	

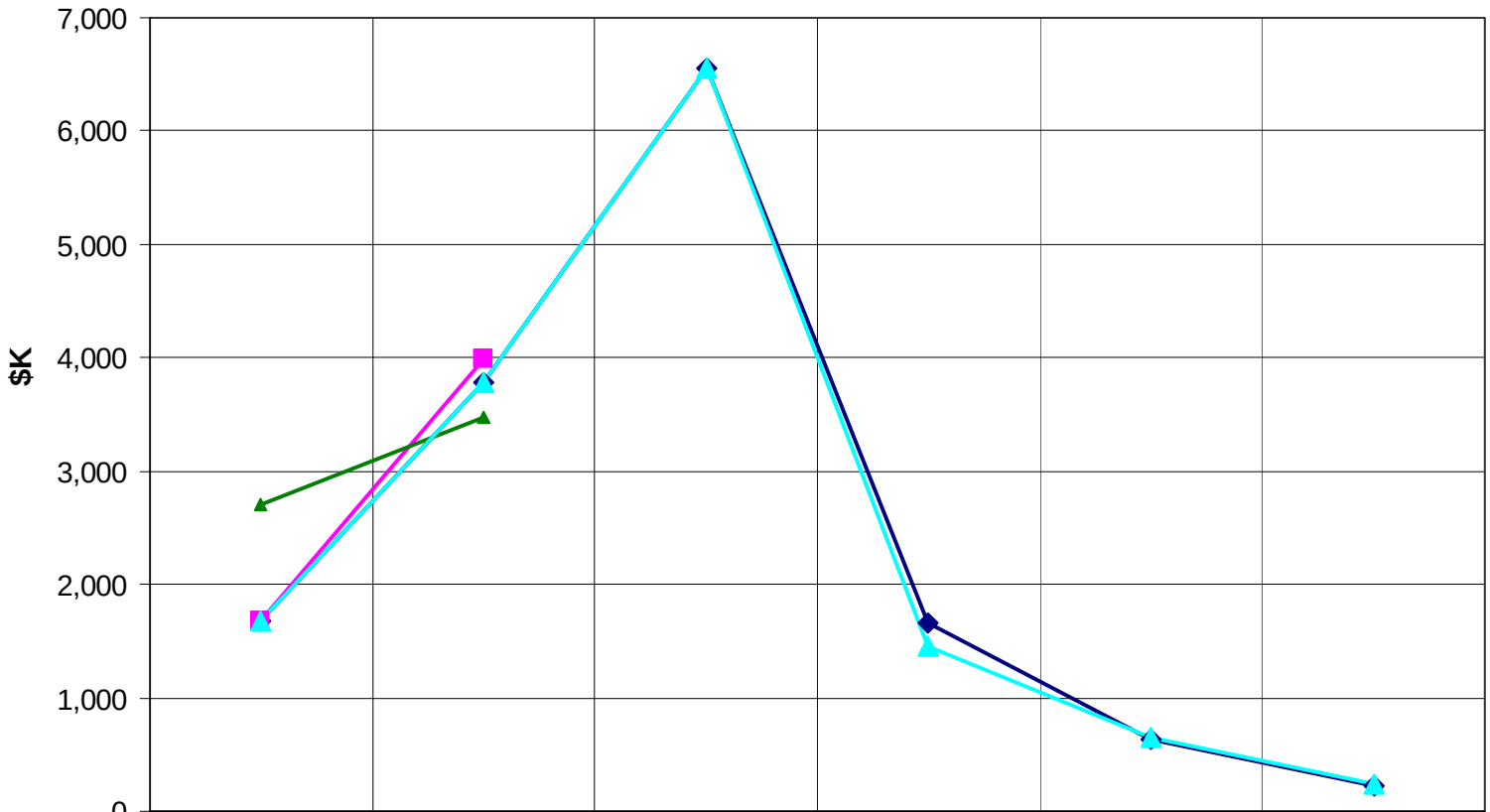
Handoff strategy

- Handoff strategy has been developed and documented.
- First units are developed and tested here at LANL.
- Rest of units are accepted at ORNL.
- M. Plum to move to ORNL for one year to complete handoff and to assist in linac commissioning.



Spallation Neutron Source Acceptance Strategy

Diagnostics budget profile



	FY 99-00	FY 01	FY 02	Fy 03	FY04	FY 05
BCWS	1,671	3,781	6,549	1,658	642	227
BCWP	1,672	3,987				
ACWP	2,696	3,479				
ETC	1,671	3,781	6,549	1,457	645	243

What's next?

- **During FY'02 we will move from the design and prototype phase to the fabrication phase.**
- **FY'02 deliveries**
  - BPM and wire scanner electronics to LBL January 2002.
  - D-plate to ORNL summer 2002.
  - DTL BPM pickups Dec. 2001, summer 2002.
  - DTL-1 beam box WS and ED/FC summer 2002.
- **During FY'03 we will be be working on delivering, installation, and testing.**
- **M. Plum to move to ORNL for diagnostics handoff and linac commissioning summer 2003 – summer 2004.**

Conclusions

- We have a good working relationship with ORNL and the other partner labs.
- We have a well defined handoff strategy.
- The beam diagnostic instrumentation is either in the prototype or the final design stage.
- We are on schedule to deliver instrumentation that meets all requirements.