Highlights of the 2004 Beam Instrumentation Workshop

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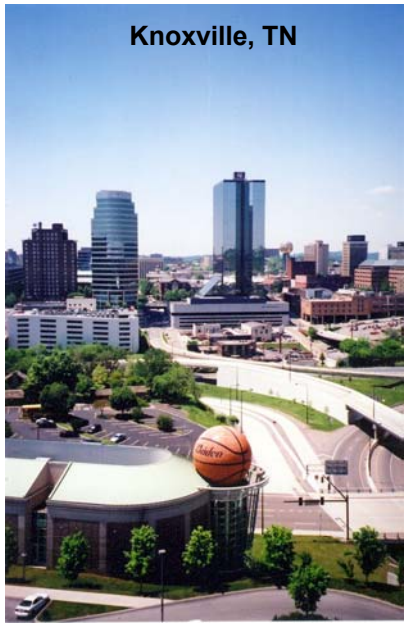
Beam Physics Seminar
Jefferson Laboratory
May 21st, 2004

2004 Beam Instrumentation Workshop

BIW04 WWW.SNS.GOV/BIW04 11TH BEAM INSTRUMENTATION WORKSHOP

KNOXVILLE, TENNESSEE
MAY 3-6, 2004

Where: Knoxville, TN
When: May 3 – 6, 2004
Who: Physicists and Engineers (107 attendees)
Why: *"To exchange ideas and review instrumentation designs and to serve as an introduction to relevant topics for engineers and scientists with the aid of tutorial sessions."*



Program Included:

1 Faraday Cup Talk
3 Tutorials
4 Invited Talks (1)
15 Contributed Talks (2)
44 Posters
Discussion Groups
Tour of the SNS Facility

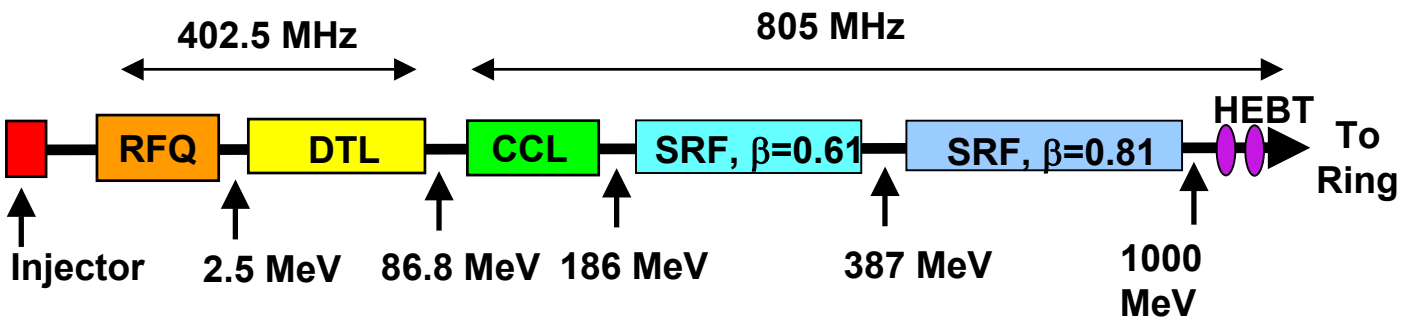
2004 Beam Instrumentation Workshop (cont'd…)

- Faraday Cup Award "recognizes and encourages innovative achievements in accelerator and beam instrumentation"
- And the 2004 Faraday Cup Award goes to… T. Mitsuhashi (KEK)
- Discussion Groups: They had the best of intentions but…
  - ✓ they can easily become dominated by a few individuals
  - ✓ they can lack an expert or someone to lead the discussion

SNS Conceptual Design

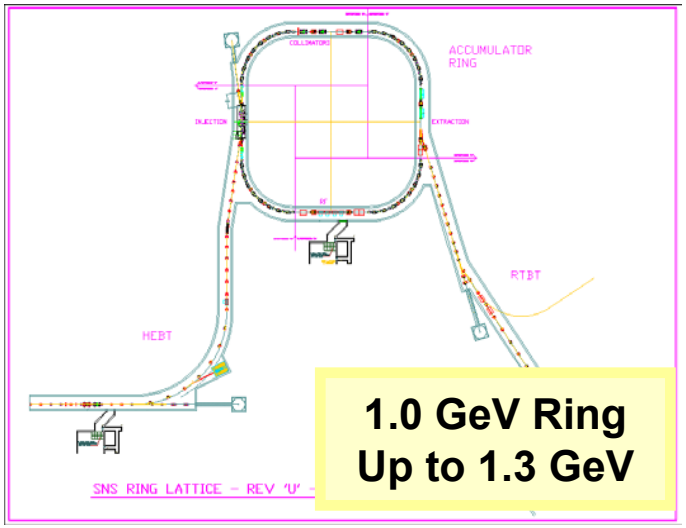
(Courtesy of Tom Shea, ORNL)

Major SNS Facility Parameters

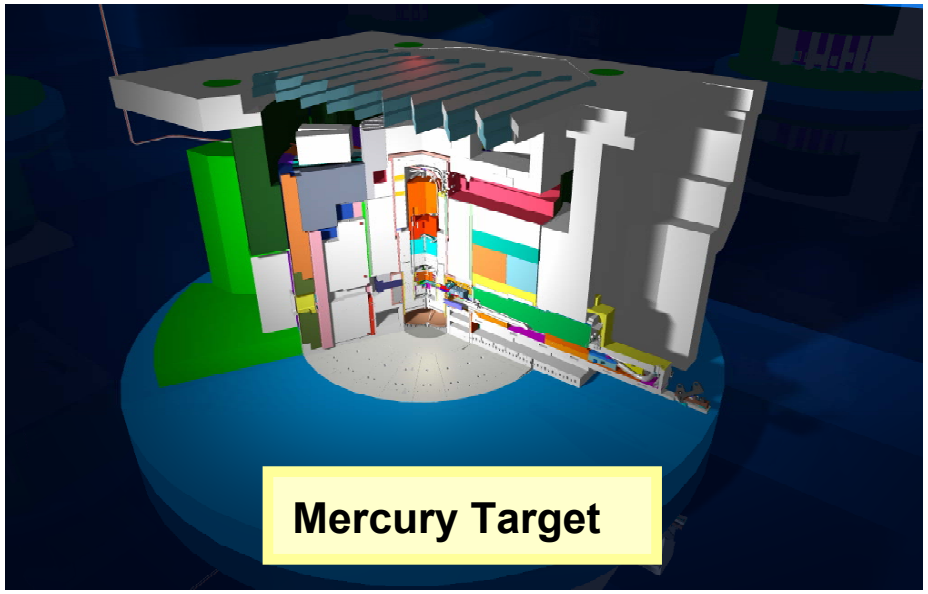


1 RFQ
6 DTL Tanks
4 CCL Modules

11 Medium-β Cryomodules - 3 Nb cavities each
12 High-β Cryomodules - 4 Nb cavities each



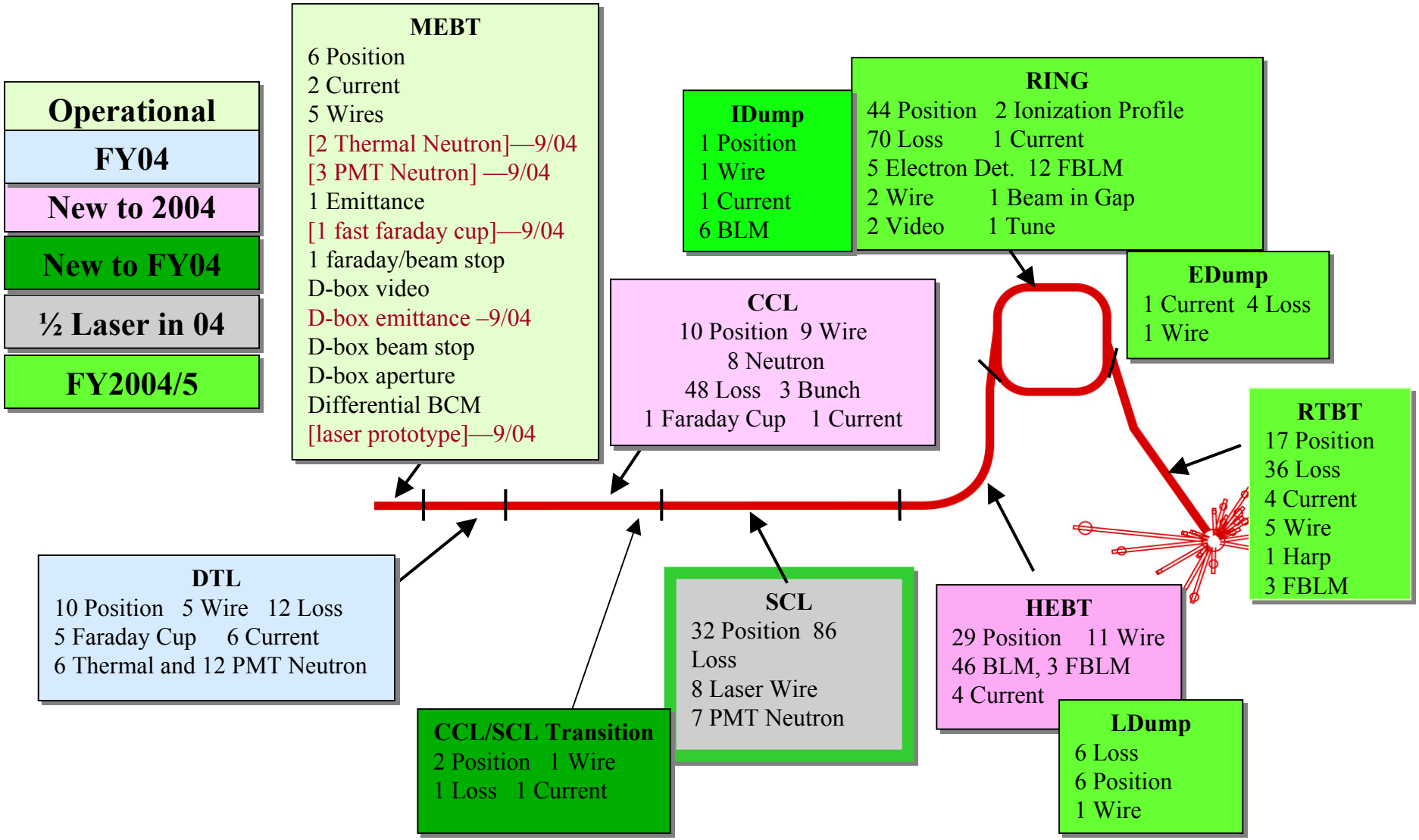
1.0 GeV Ring
Up to 1.3 GeV



Mercury Target

(Courtesy of Tom Shea, ORNL)

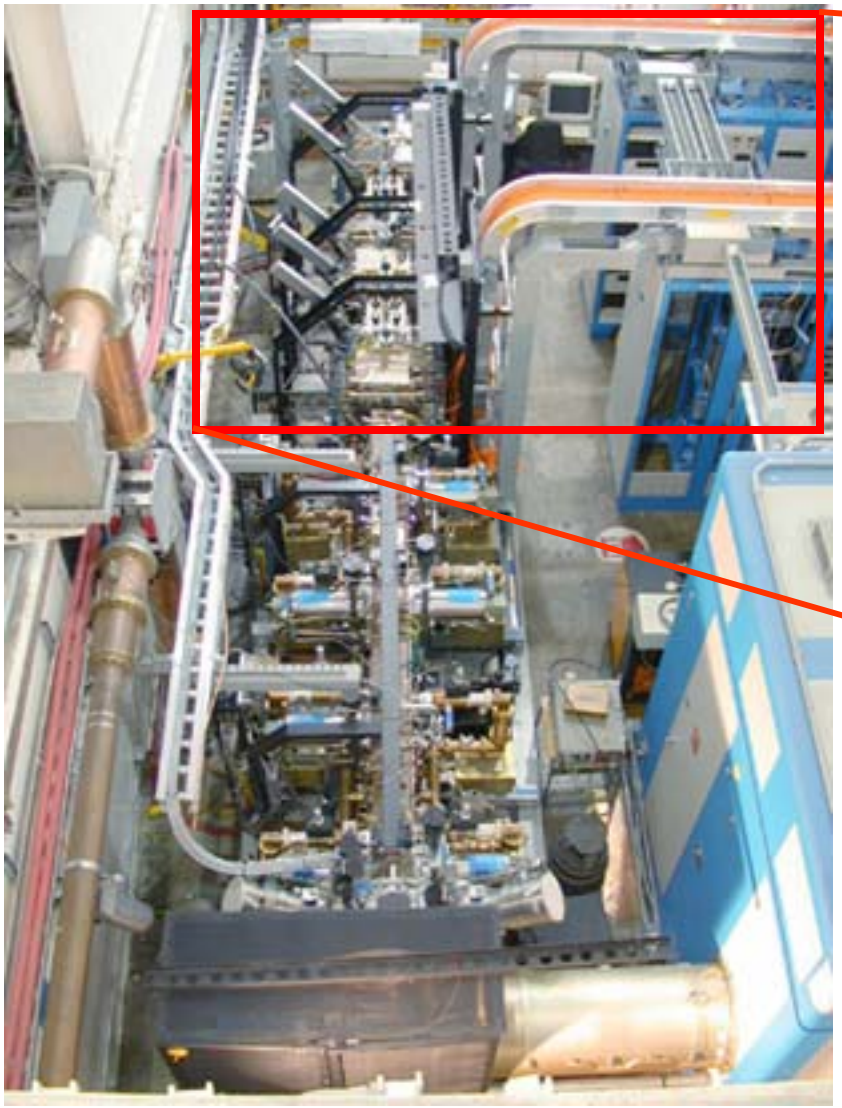
SNS Diagnostics Deployment



(Courtesy of Tom Shea, ORNL)

Front End Diagnostic Systems

Commissioned spring 2002



(Photo Daryl Oshatz, LBNL)

Five diagnostic systems, all prototypes of linac/ring systems provided by LBNL, LANL, BNL, ORNL:

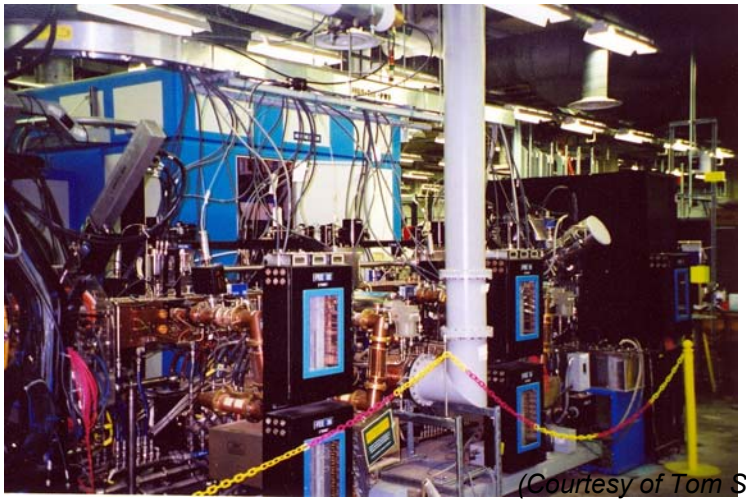
1 Emittance System

2 Beam Current Monitors

6 Beam Position Monitors

5 Carbon Wire Scanners

1 Laser Profile (Test)

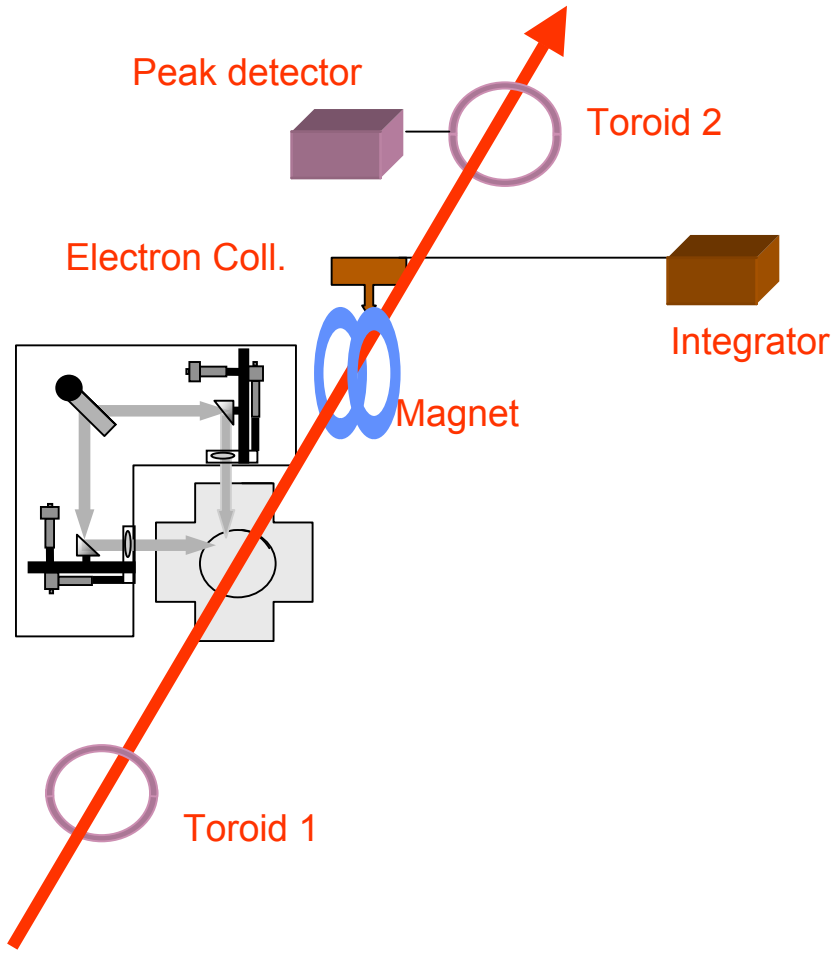


(Courtesy of Tom Shea, ORNL)

Electron Stripping

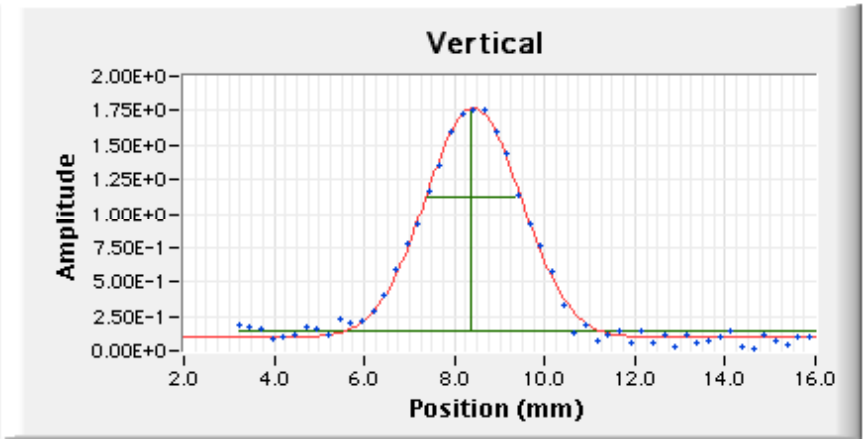
Examples…

- For 1000 MeV H^- beam, it takes a carbon foil of just 400 $\mu g/cm^2$ (2.2 microns thick) to strip 98% of the H^- ions to H^+.
- At 2.5 MeV it takes just 15 nm of carbon to strip the electrons.
- Stripping just one electron from an H^- ion takes even less material.
- Just about any material used for an interceptive beam diagnostic device will strip electrons from an ion beam.
- Sometimes stripping can be a good thing – e.g. laser profile monitor.

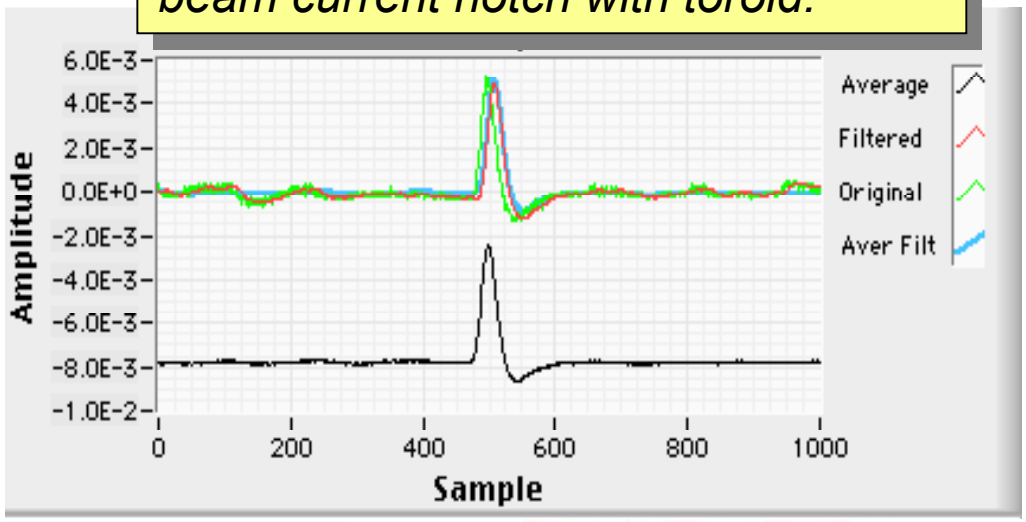


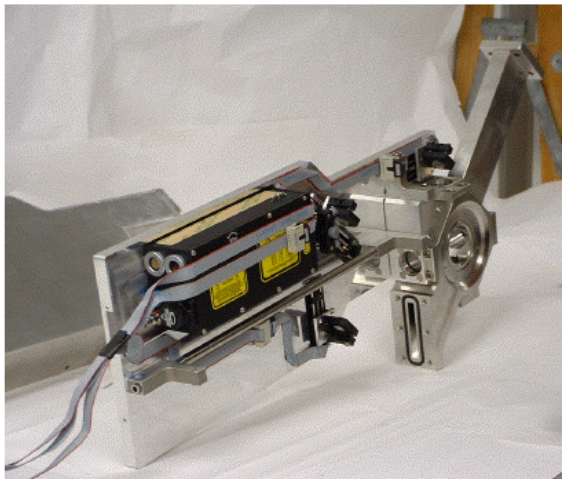
(Courtesy of Mike Plum, ORNL)

Laser Profile Monitor Testing at Berkeley



Neutralize 10ns of H- beam with Q switched Nd:YAG laser. Measure beam current notch with toroid.





Laser system – BNL
Beam box - LBNL

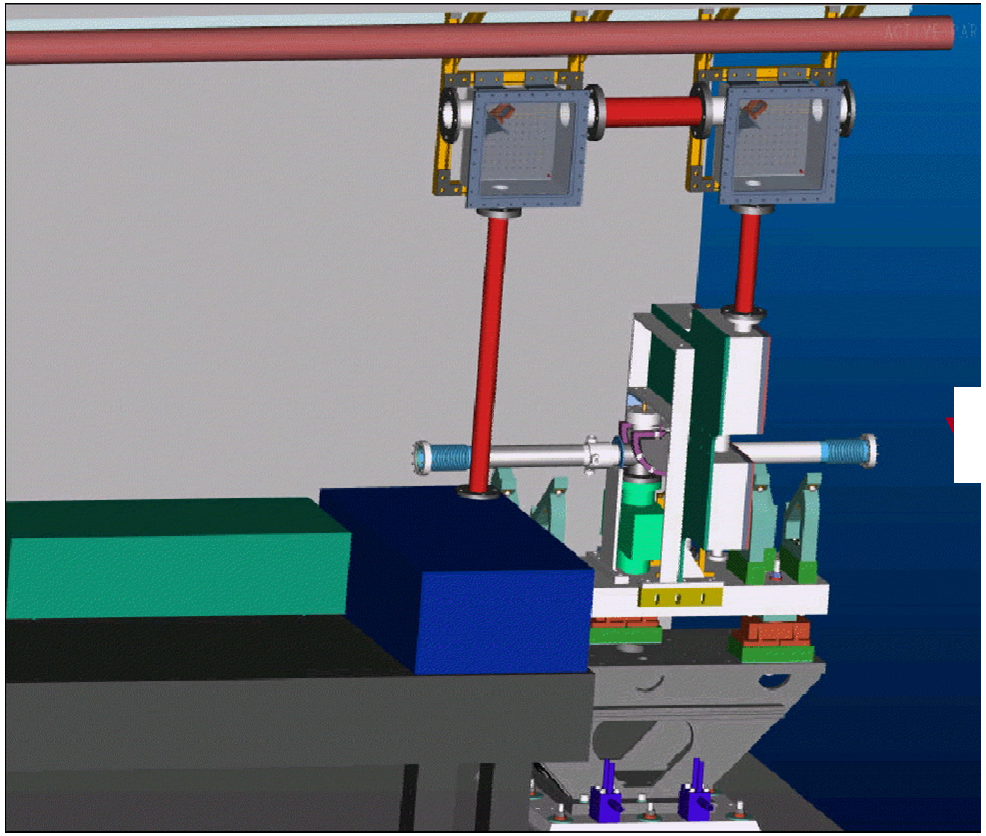
Cable and installation - BNL

Electronics, software – BNL,ORNL

(Courtesy of Tom Shea, ORNL)

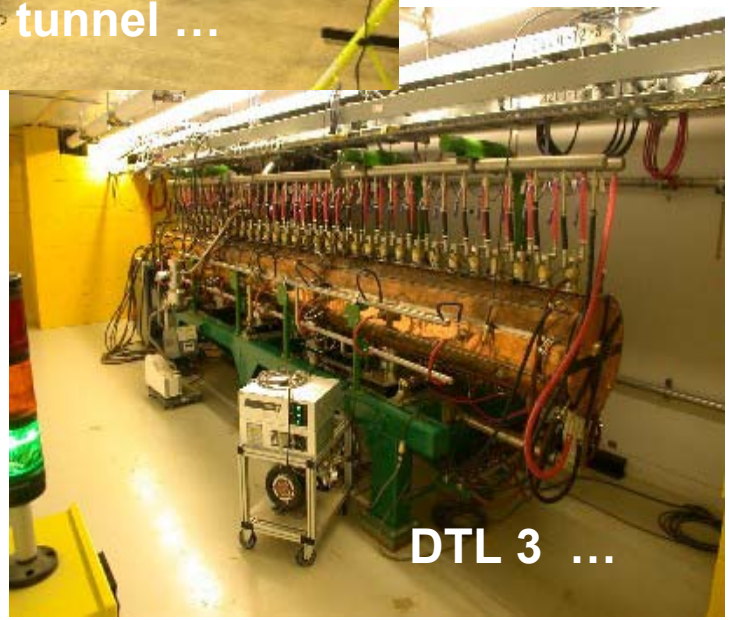
Test SCL Laser Profile Monitor

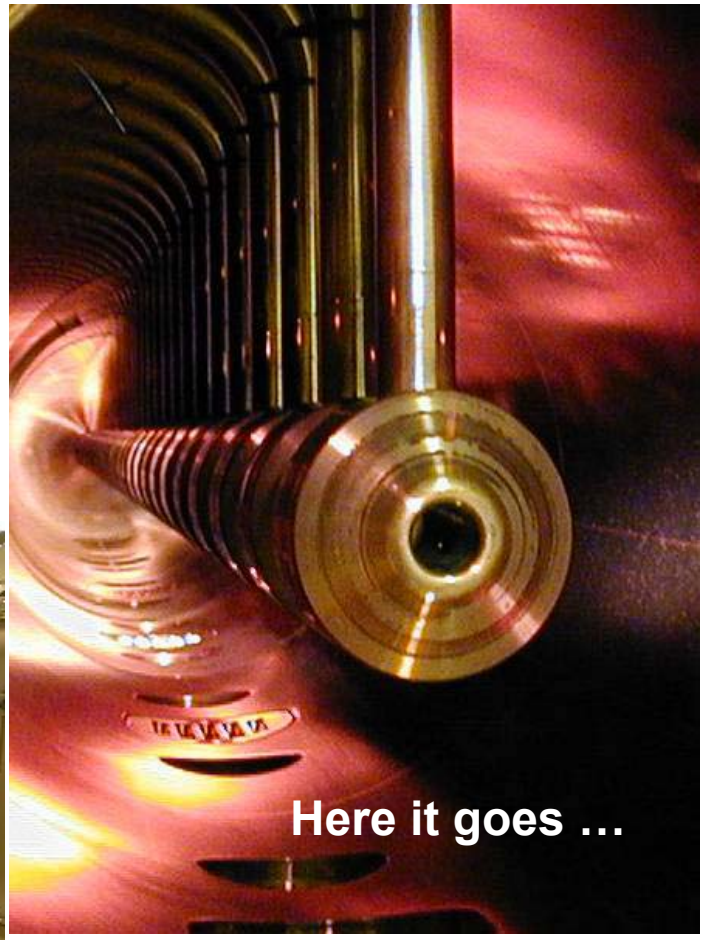
- Multiple Labs, multiple ORNL Groups
- Agile development – 6 months, concept approval to deployment



(Courtesy of Tom Shea, ORNL)

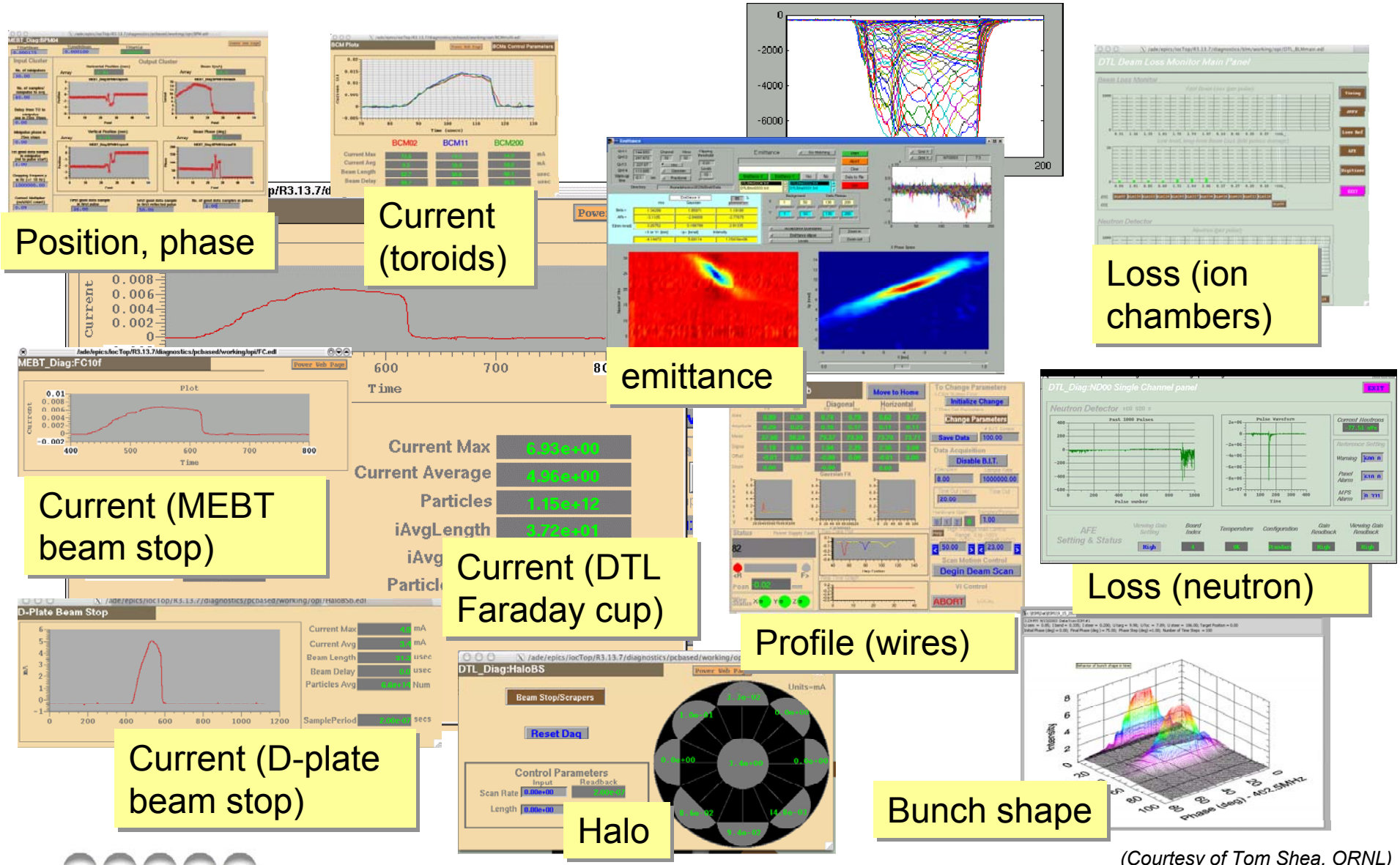
Drift Tube Linac (DTL) – 6 Tanks Total





(Courtesy of Tom Shea, ORNL)

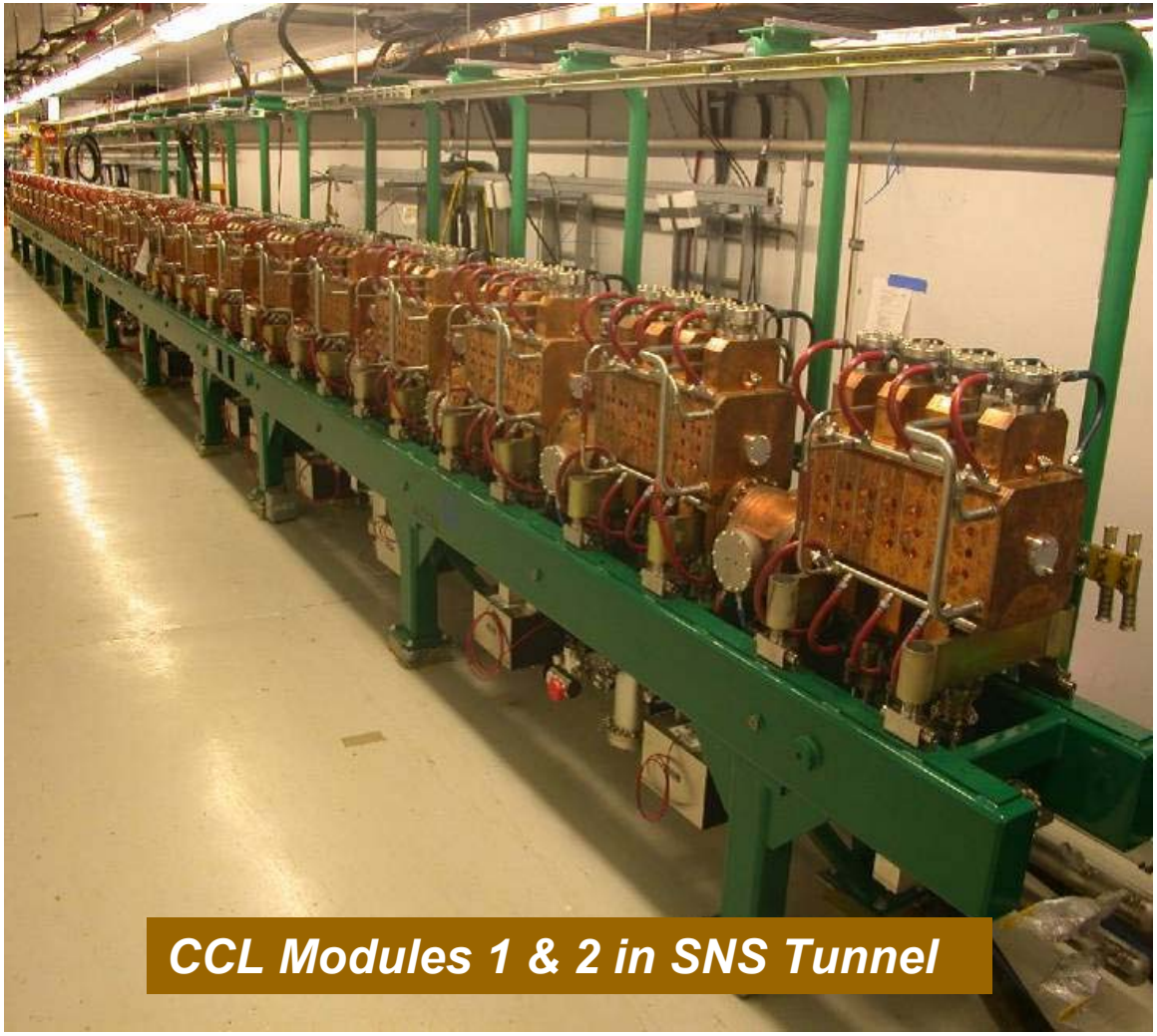
DTL1 Results: Example Measurements



(Courtesy of Tom Shea, ORNL)

Remainder of DTL and Coupled-Cavity Linac (CCL)

Plan September 2004 commissioning start

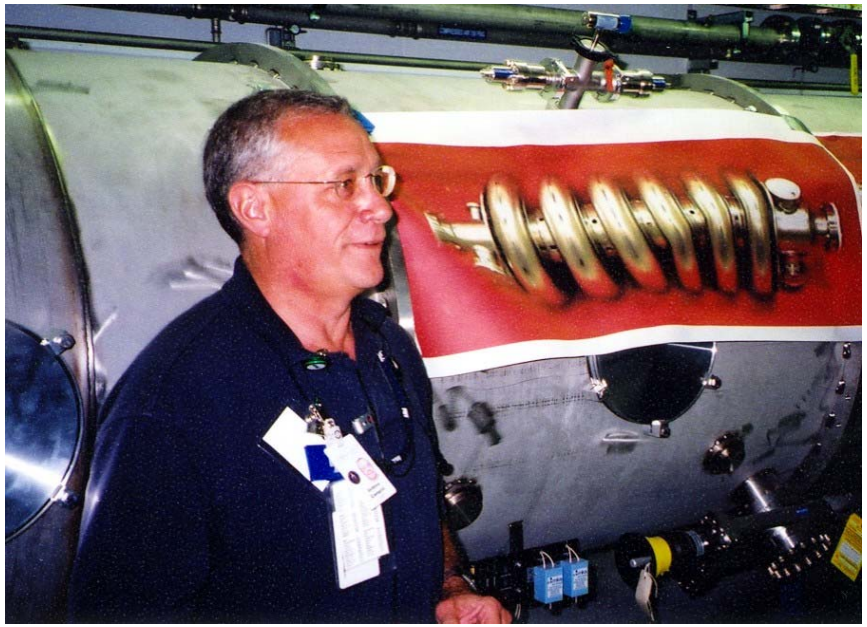


(Courtesy of Tom Shea, ORNL)

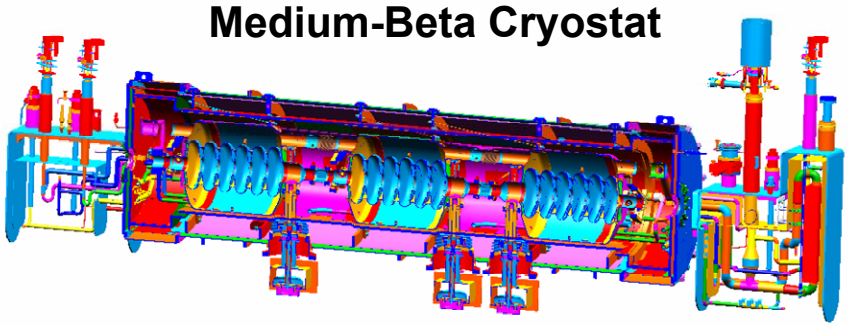
Superconducting Linac (SCL)

Commissioning Planned for March 2005

SCL Klystrons



Medium-Beta Cryostat

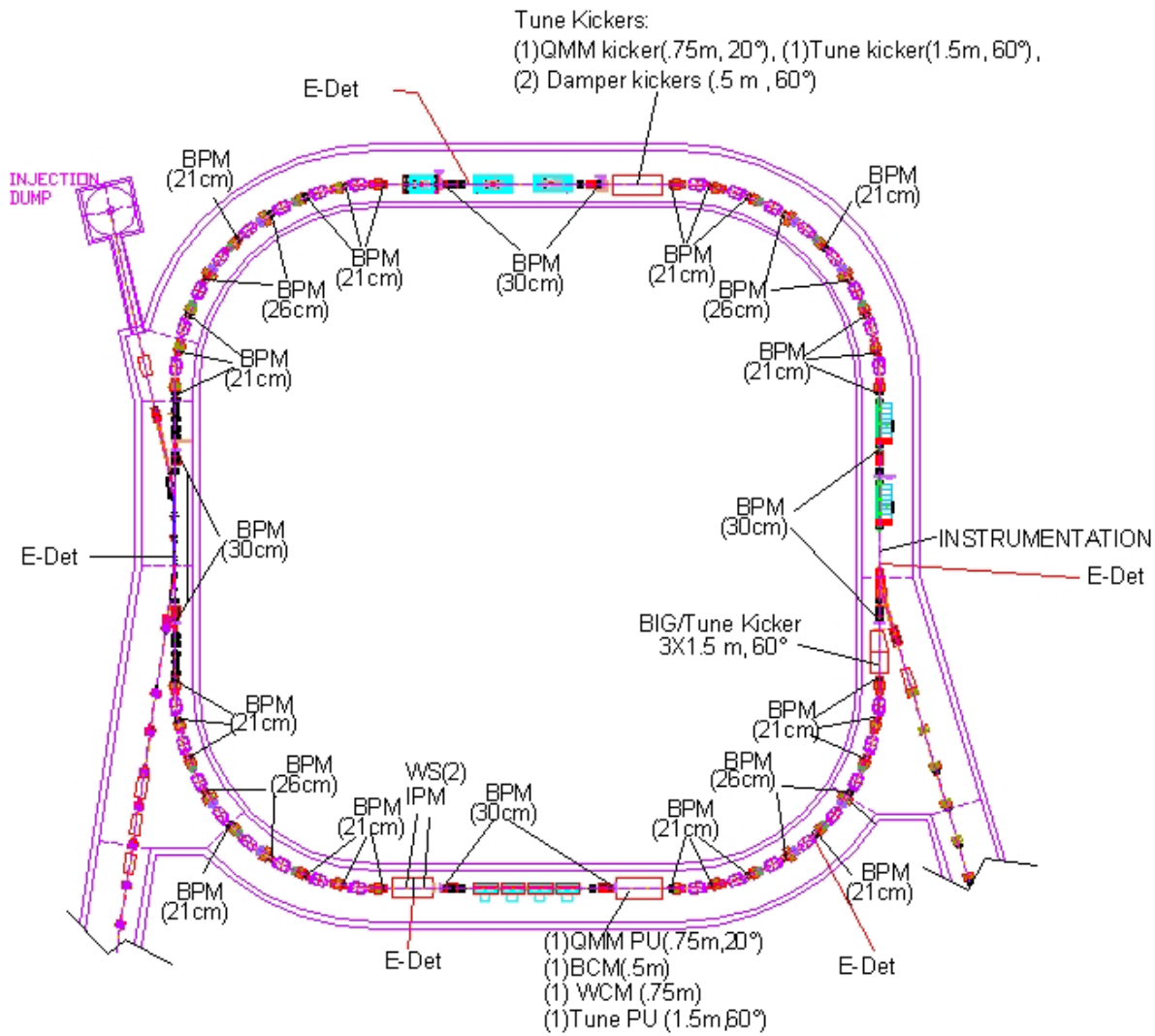


(Courtesy of Tom Shea, ORNL)

Accumulator Ring Diagnostics Layout

ACCUMULATOR RING

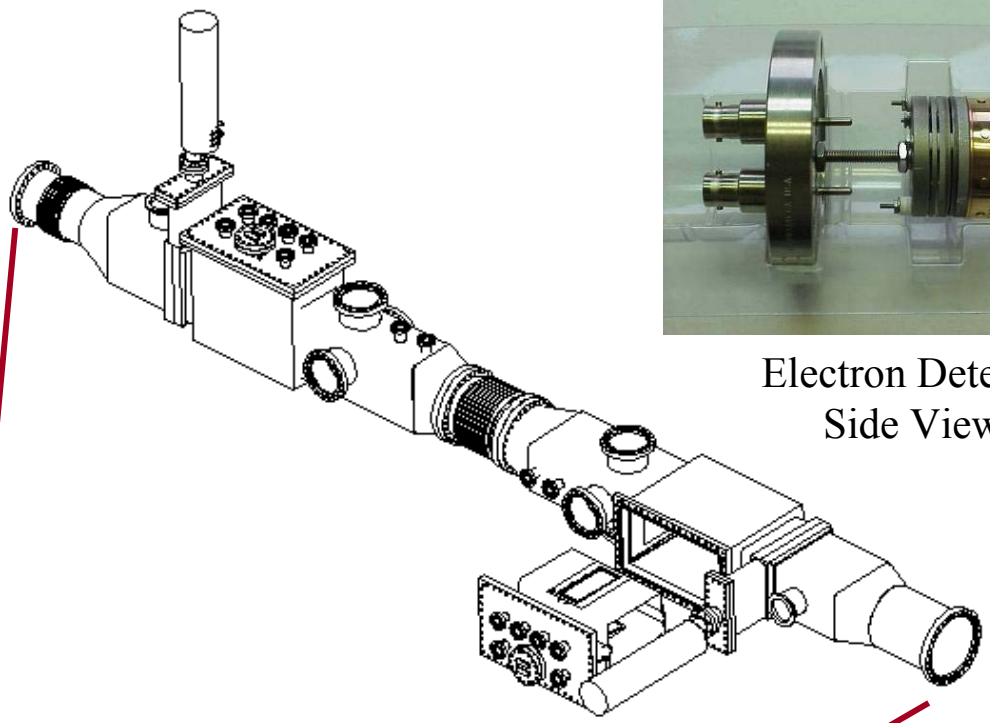
- WS: 2
- QMM : 2
- BCM: 1
- WCM: 1
- Tune :2
- E-Det: 5
- Damper kicker:2
- BIG: 1
- IPM :2
- BPM:
  - 21cm: 28
  - 26cm: 8
  - 30cm: 8
- BLM: 75
- FBLM: 12



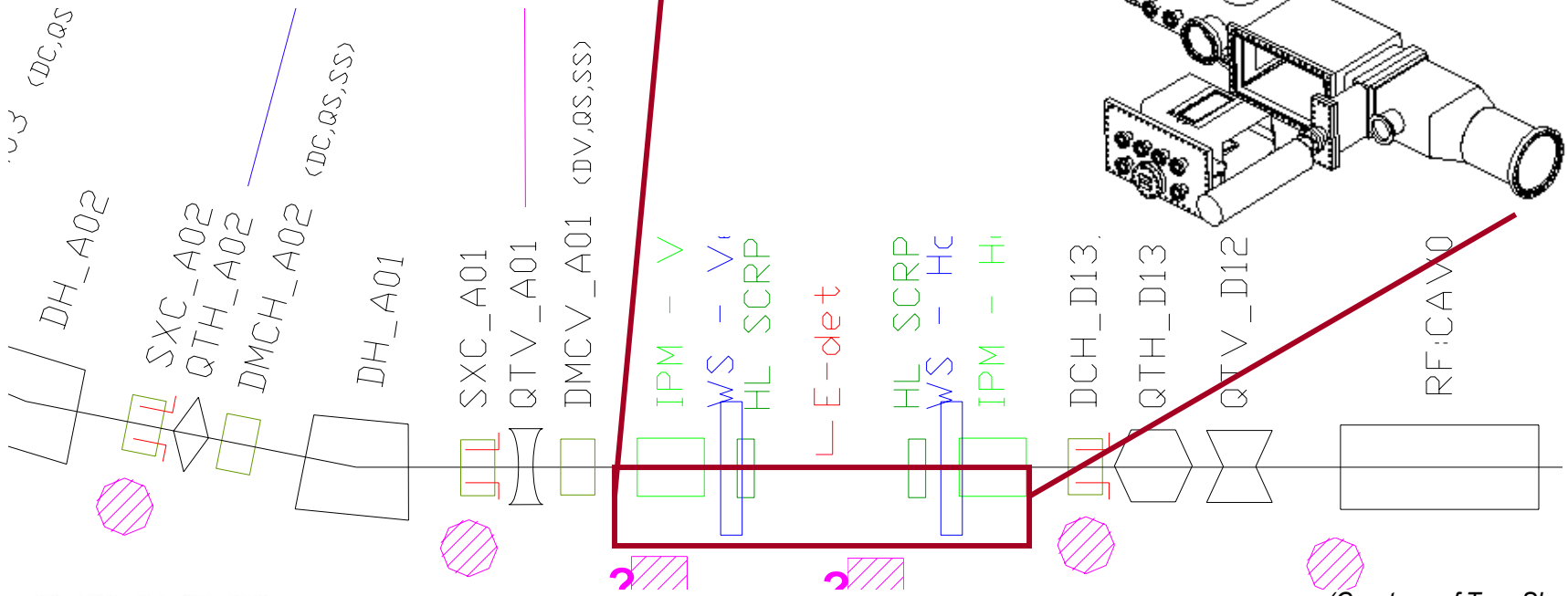
(Courtesy of Tom Shea, ORNL)

Diagnostics in One Section Downstream RF Section

Device	delivery
Ionization Profile	Sep/Oct 2004
Wire Scanner	Sep 2004
Halo Scraper	Sep 2004
Electron Detector	Sep 2004

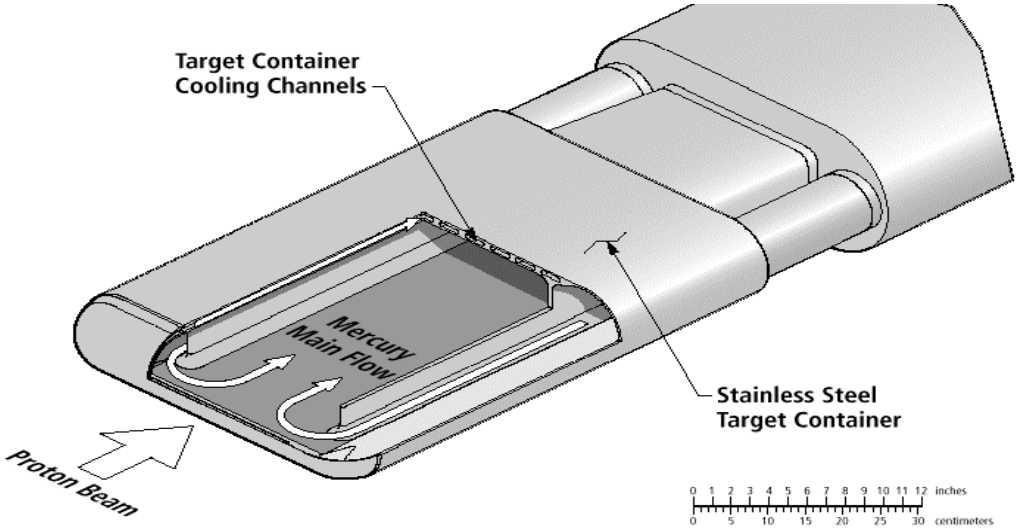


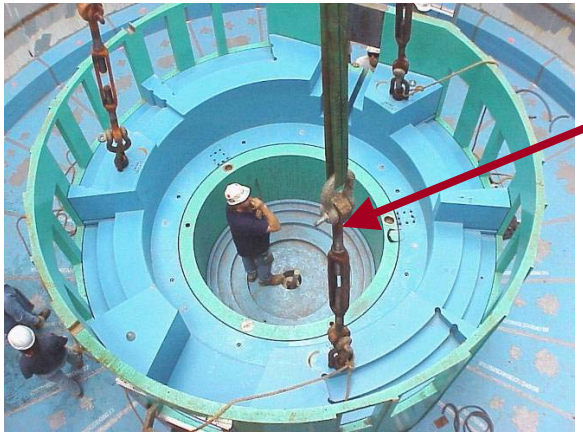
Electron Detector
Side View



(Courtesy of Tom Shea, ORNL)

The SNS Liquid Mercury Target





Core Vessel and Shielding

(Courtesy of Tom Shea, ORNL)

The SNS Front-End

- LBNL is responsible for the H- ion source and low energy beam transport and acceleration systems
- Diagnostics…
- The ions are accelerated to 2.5 MeV before they are delivered to the linac section

The SNS Linear Accelerator(s)

- The linac region consists of three different types of accelerating structures and is the responsibility of LANL and JLab:
  1. Drift Tube Linac (DTL) copper
  2. Coupled-Cavity Linac (CCL) copper
  3. Superconducting Cavities niobium

- The linac accelerates the beam from 2.5 MeV to 1 GeV
- Diagnostics… (laser wire near SRF cavities)

The SNS Accumulator Ring

- BNL is responsible for the accumulator ring which prepares the ion beam for delivery to the mercury target to produce neutrons
- A stripper foil is used to strip the ion beam to produce the neutrons that circulate the ring
- H- transported through High Energy Beam Transport Line (HEBT), stripped to protons with carbon foil at injection point
- After about 1000 accumulated turns, beam is extracted in one turn and travels downt the Ring To Beam Target (RTBT) line.

The SNS Target

- ORNL is responsible for the design and construction of the liquid mercury target.
- "The SNS will be the first scientific facility to use pure mercury as a target for a proton beam"[1] (1.4 MW of beam power)

[1] http://www.sns.gov/aboutsns/source.htm