Introduction

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SNS Accelerator Diagnostics

December 14, 2000

Outline

- Introductions
- Charge to the committee
- Overview of SNS
  - Neutron facilities
  - Layout
  - Accelerator parameters
- Overview of Beam Diagnostics
  - List of systems
  - Notes on controls and instrument design
- Commissioning Schedule

The Diagnostics Team

- BNL
  - **Peter Cameron**, Phil Cerniglia, Chris Degen, Roger Connolly, Marty Kesselman, John Cupolo, Bob Sikora, Joe Mead, Vjelko Radeka, David Gassner, Al Della Penna, Craig Dawson
- LANL
  - **John Power**, **Mike Plum**, Jim Stovall*, Bob Hardekopf, Bob Shafer, Matt Stettler, Walt Sommer, Sergey Kurennoy,…
- LBNL
  - **Larry Doolittle**, John Staples*, Alex Ratti, Darryl Oschatz, Jozsef Ludvig
- SNS/ORNL
  - **Tom Shea**, Richard Witkover, Sasha Aleksandrov*, …

Diagnostics Advisory Committee

- Bob Webber, FNAL (chairman)
- Jim Crisp, FNAL
- Glenn Decker, ANL
- Ron Johnson, SLAC
- Tom Powers, JLab
- Marc Ross, SLAC

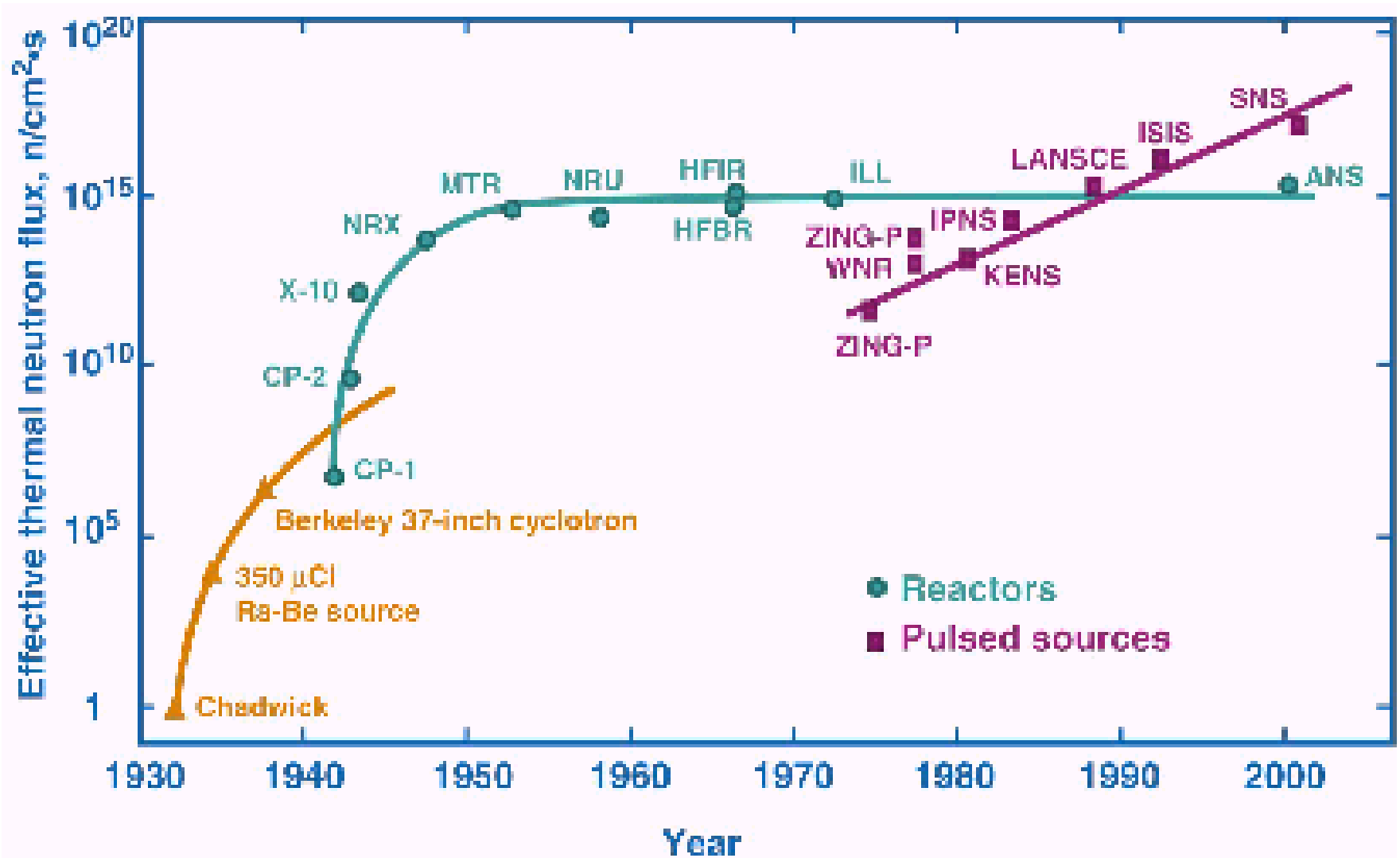
Charge to the Committee

- General comments
  - This is the initial meeting of the advisory committee, and the presentations are meant to be introductory in nature
  - Future reviews will concentrate on specific systems and require attendance by only a subset of the committee
  - Committee is encouraged to ask questions during the presentations
  - Chairman presents brief summary at closeout; full report in a few weeks
- Guiding questions for this review:
  - Is the proposed collection of diagnostics adequate for commissioning and operation of this facility?
  - Are the selected technologies appropriate?
  - For each presented system, is the conceptual design reasonable?

Why Neutrons?

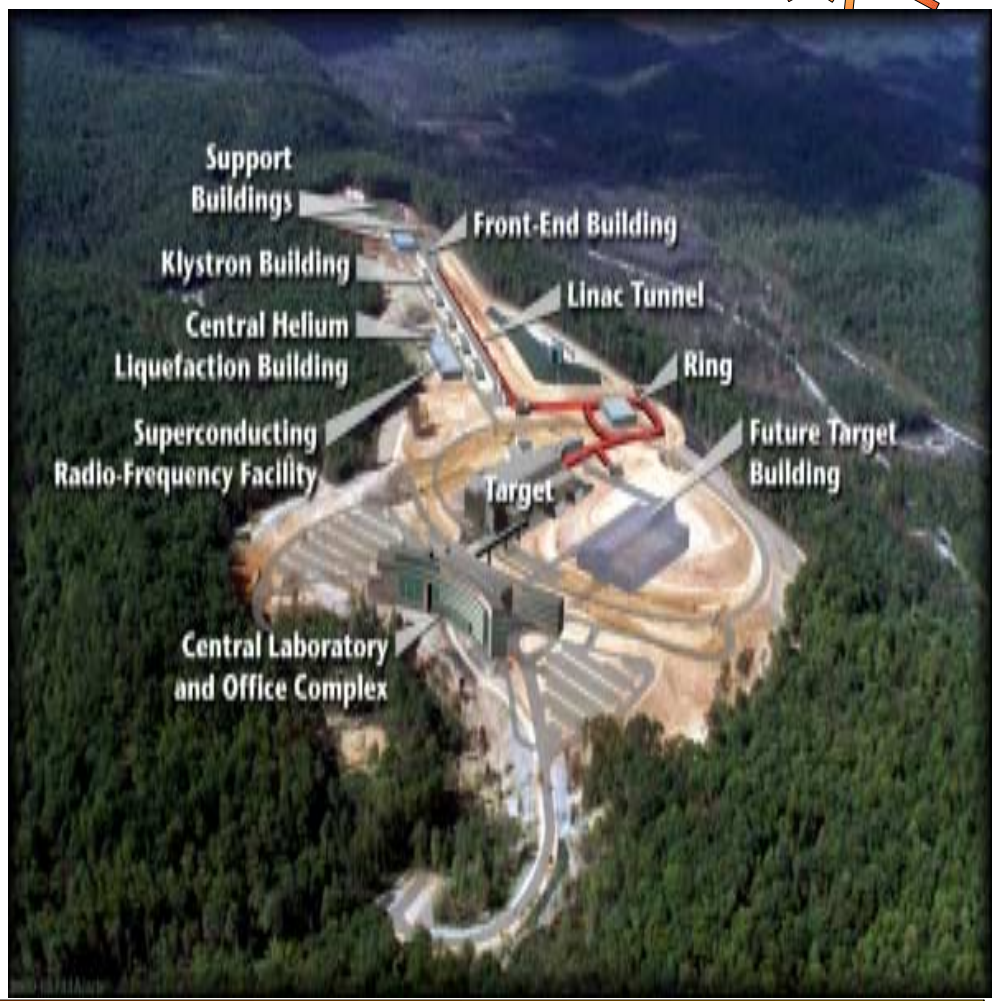
- Penetrate bulk materials
- Magnetic moment but no charge: probe magnetic structure
- Use polarized beams to study atomic orientation
- Thermal neutrons excite typical lattice modes, molecular vibrations
- Wavelength to acquire structural information from 10^-13 to 10^-4 cm
- Exploit isotopic substitution in scattering experiment, i.e replace a sample's hydrogen with deuterium

Neutron Sources



SNS Project – Big Picture

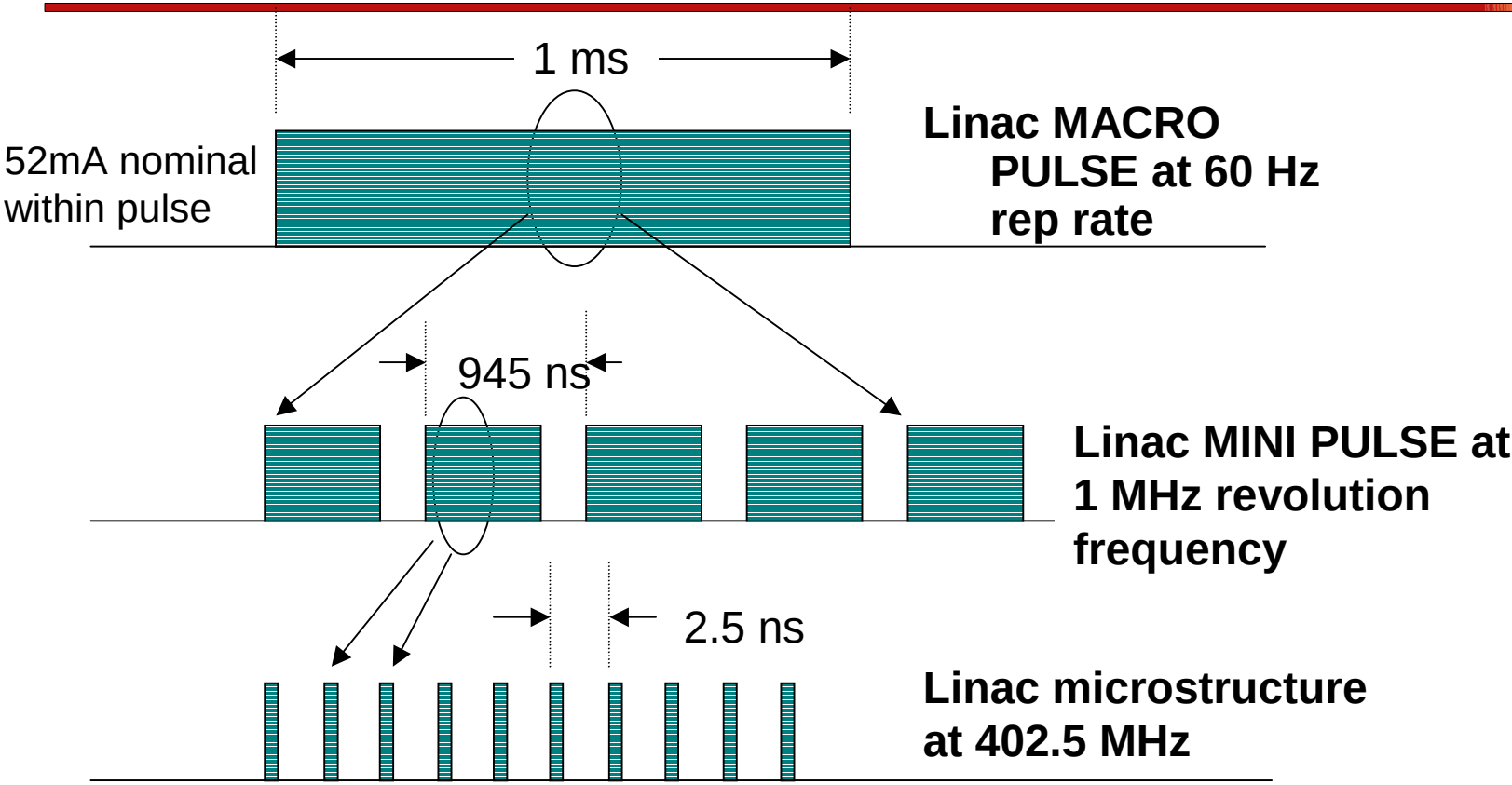
- $1.4B project
- $278.6M in FY01
- Completion in 2006
- Design 60% complete
- Construction in progress
- Site excavation complete (1.3 Mcy moved)
- Foundation work



The Spallation Neutron Source Partnership

U. S. Department of Energy

Time Structure of H- Beam



RING: H- stripped to p: 695 ns bunch length, 2*10^11 p first turn, accumulating to 2*10^14 p in about 1 ms, then kicked out to target

Parameters for the SNS

• Proton beam power on target	2.0 MW
• Average proton beam current on target	2.0 mA
• Proton energy on target	~1.0 GeV
• Pulse repetition rate	60 Hz
• Peak linac H- current	52 mA
• Chopper beam-on duty factor	68 %
• Front-end and linac length	332 m
• DTL output energy	87 MeV
• CCL output energy	185 MeV
• SRF linac output beam energy	~1.0 GeV
• Linac beam duty factor	6.0 %

Parameters for the SNS (cont.)

• HEBT length	170 m
• Accumulator ring circumference	248.0 m
• Ring orbit rotation time	945 ns
• Number of injected turns	1060
• Ring fill time	1.0 ms
• Ring beam extraction gap	250 ns
• RTBT length	151 m
• Protons per pulse on target	2.08E+14
• Proton pulse width on target	695 ns
• Target material	Hg
• Number of neutron beam shutters	18
• Initial number of instruments	10
• Availability	95% (goal)

Systems that will be presented

- Emittance scanners
- RF BPM/Phase monitors
- Current Transformers
- Wire Scanners (including laser option)
- D-plate (includes other systems)
- Baseband BPM
- Ion chamber loss monitors
- Fast loss monitors
- Ionization Profile monitor
- Harps

Systems that will not be presented

- Faraday cups
- Halo scraper
- Temporary beam stop
- Gas fluorescence monitor
- Phase width monitor
- Laser beam-in-gap monitor
- Beam-in-gap kicker
- Tune monitor
- Foil video
- Electron detector

Global responsibilities

- BNL
  - Loss monitors
  - Current monitor electronics
  - Video
- LANL
  - BPM/phase electronics
  - Harps
  - PC data acquisition platform
- LBNL
  - Linux data acquisition platform
  - Provide requirements and first beam for BPM/phase, current monitors, wire scanners, laser wire, gas fluorescence monitor, emittance scanner.

Control System Environment

- Based upon EPICS
  - IOCs: VME/VxWorks
  - Network protocol: Channel Access
- Global infrastructure
  - Event link (based on RHIC beam sync clock, FNAL Tclock)
  - Real Time Data Link (based on RHIC RTDL, FNAL mdat)
  - Switched ethernet network
  - Machine protection system

Data Acquisition

- Event driven data acquisition
  - Triggered by events on Event Link
  - Timestamp (and other data) for each pulse received from RTDL
- Digitizers close to source
  - simple analog front end, no hand tuning, better calibration
  - Most diagnostics should resolve single minipulse (700 ns), but also provide filtered, decimated data at < 60 Hz pulse rate.
  - data stream: raw (40MSa/s), filtered/corrected (1 MHz, 60 Hz), further averaging/calculations (60 Hz, 1 Hz), aggregation
- Aggregate: 5 Gbytes/s, 30 Gops/s
- Classic solution: embedded DSP/fpga on each VME or VXI card
  - VME bus and IOC processor only handle filtered, decimated data
  - Deeply embedded; specialized development tools; Potential orphan
- General purpose computing platforms for DSP
  - PC, EmbeddedNT: widespread but complex
  - Embedded, Linux: efficient but more custom

Networked Instruments

- ALL data, settings, and debug info must be accessible via a network interface (baseline: Channel Access)
- Complete built in self test
  - Acceptance testing during production
  - Online calibration
- Standardized data acquisition
  - Common timestamp
  - Common data structures
  - Consistent data acquisition model
- Availability, fault isolation
- Remote reset and administration
- Version and configuration control

Commissioning

- Front End at LBL: begin in late 2001
- Front End at Oak Ridge: early 2003
- DTL: begin in late 2003
- CCL: late 2004
- SRF: early 2005
- Ring: mid 2005
- First beam to target: late 2005