Analytical Instrumentation

A graduate course (Chem532b)

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Course content

1. Introductions. **1 hr**
2. Building a Virtual Instrument **2 hrs**
3. Analyzing and Saving a Signal **2 hrs**
4. Expanding the Features of a VI **2 hrs**
5. Acquiring Data and Communicating with Instruments **2 hrs**
6. Using Other LabVIEW Features **2 hrs**
7. Using External Code in LabVIEW **4 hrs**
8. Case studies **8 hrs**

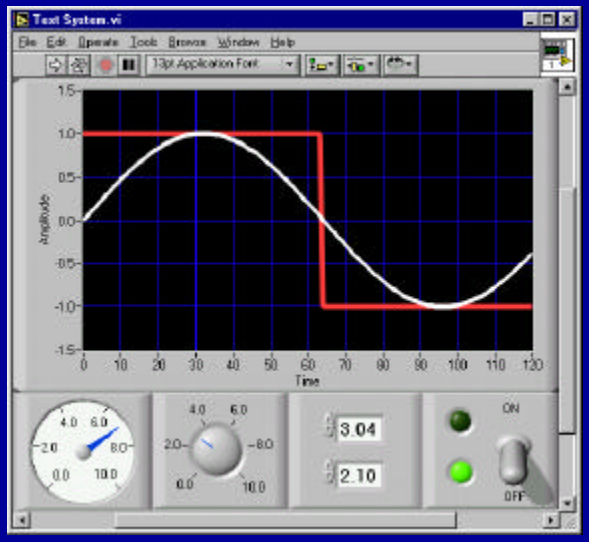
- **Case study 1. Monitoring synthetic procedure in situ**
- **Case study 2. Electrochemistry**
- **Case study 3. Spectroelectrochemistry**
- **Case study 4. Laser photochemistry and photoelectrochemistry**
- **Case study 5 Scanning Probe Microscopy**
- **Case study 6 PID control in chemical engineering**

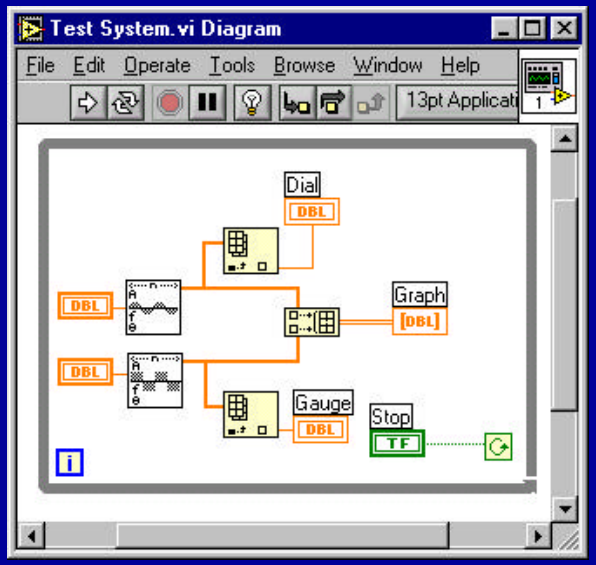
9. Evaluation. **4-5 hrs**

Students will make a VI for their own research, write a report (specification) on the VI and present it to the class.

Why LabView?

- Graphical Programming
  - Easy to use
  - Faster Development Time
  - Graphical User Interface
  - Graphical Source Code
  - Easily Modularized
  - Application Builder to create stand-alone executables
  - Localized in French, German, and Japanese





LabVIEW History

Express 7 2003 - LabVIEW 7 Express

6.1 2002 - LabVIEW 6.1 significant new features like remote panels and event structures

6i 2000 - LabVIEW 6i brings the internet to measurement and automation

5 1998 - LabVIEW 5 connectivity, multithreading

4 1996 - LabVIEW 4 has customizable interface

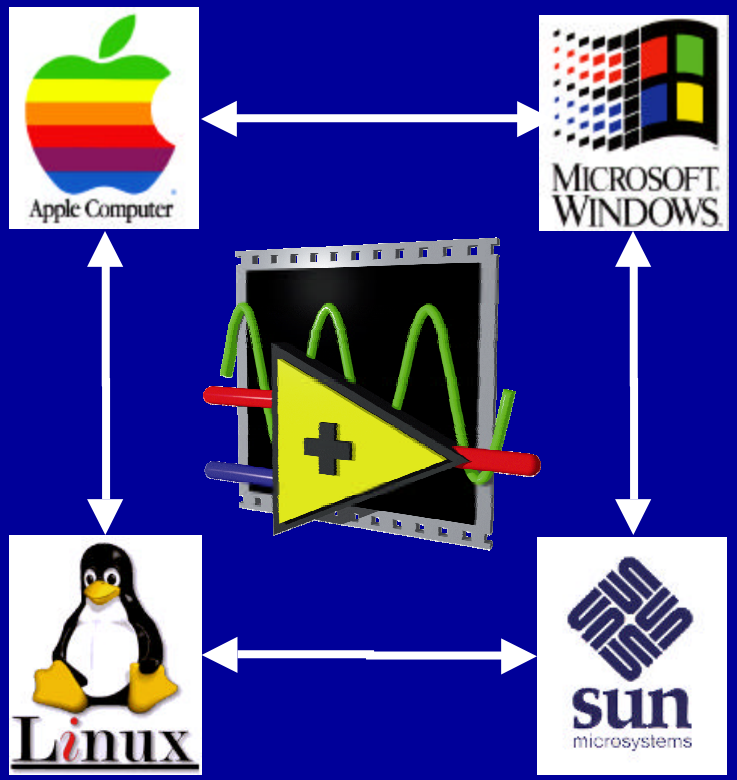
3 1994 - LabVIEW 3 has add-on toolkits

2 1990 - LabVIEW 2 is now a compiler

1 1986 - LabVIEW 1 introduced on the Mac

Multi-Platform Compatibility

- Platform neutral
- Migrate applications between platforms



Network-based Measurement & Automation

Your entire Measurement and Automation system can be controlled with LabVIEW locally, or over the Internet

Acquisition with LabVIEW

LabVIEW is completely compatible with National Instruments hardware, and also works with a variety of third party devices

- LabVIEW can acquire data by using one or more of the following devices:
  - GPIB
  - Serial
  - Data Acquisition (DAQ)
  - Remote Data Acquisition (RDA)
  - PCI eXtensions for Instrumentation (PXI)
  - Image Acquisition (IMAQ)
  - Motion Control
  - Real-Time (RT) Board
  - PLC (through OPC Server)

Analysis with LabVIEW

Analysis can either be done directly in LabVIEW, or with third party software such as Matlab, HiQ, or C

- LabVIEW includes the following tools to help you analyze your data:
  - Analysis VIs for Differential Equations, Optimization, Curve Fitting, Calculus, Linear Algebra, Statistics, etc.
  - Signal Processing VIs for Filtering, Windowing, Transforms, Peak Detection, Harmonic Analysis, Spectrum Analysis, etc.

Presentation with LabVIEW

Presentation with LabVIEW can be done on your PC or over a network, and you can use third party software like Excel, or DIAdem

- LabVIEW includes the following tools to help you present your data:
  - On your machine - Graphs, Charts, Tables, Gauges, Meters, Tanks, 3D Controls, Picture Control, 3D Graphs (Windows Only), Report Generation (Windows Only)
  - Over the Internet - Web Publishing Tools, Datasocket (Windows Only), TCP/IP, VI Server
  - Enterprise Connectivity Toolset - SQL Tools (Databases), Internet Tools (FTP, E-mail, Telnet, HTML)

Course Goals

This course prepares you to:

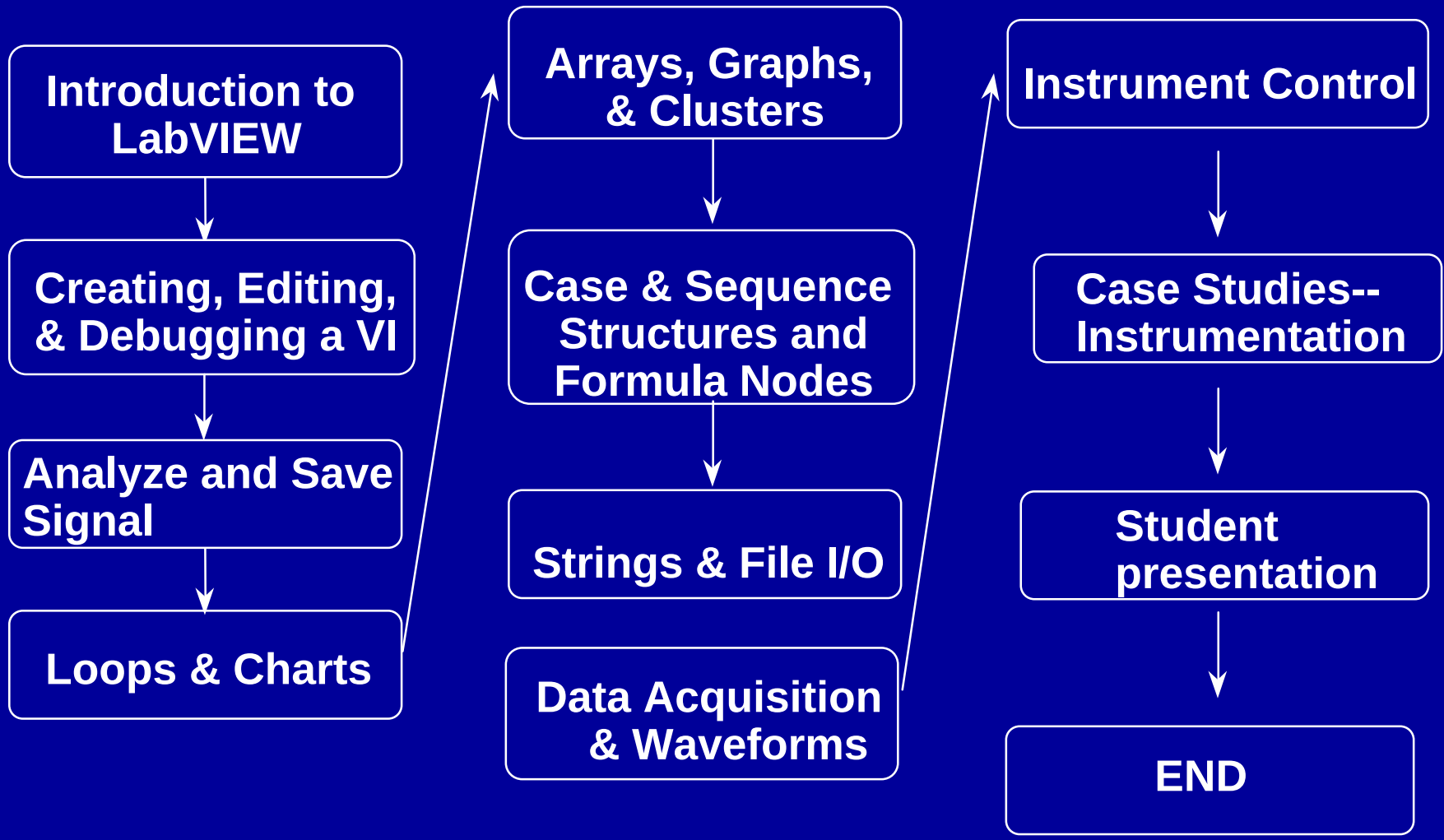
- Use LabVIEW to create your applications
- Use various debugging techniques
- Understand front panels, block diagrams, and connectors/ icons
- Use both built-in LabVIEW functions and library VIs
- Create and save your own VIs so you can use them as subVIs
- Create applications that use plug-in data acquisition (DAQ) boards
- Create applications that use GPIB and serial port instruments

Course Non-Goals

It is *not* the purpose of this course to discuss the following:

- **Instrument Circuit Design**
- **Programming theory**
- **Every built-in LabVIEW object, function, or library VI**
- **Analog-to-digital (A/D) theory**
- **The detailed operation of the serial port or GPIB bus**
- **How to develop an instrument driver**
- **The development of a complete application for any student in the class**

Course Map


Introduction to LabVIEW
Creating, Editing, & Debugging a VI
Analyze and Save Signal
Loops & Charts
Arrays, Graphs, & Clusters
Case & Sequence Structures and Formula Nodes
Strings & File I/O
Data Acquisition & Waveforms
Instrument Control
Case Studies-- Instrumentation
Student presentation
END

Lesson 1
Introduction to LabVIEW

You Will Learn:

A. What a virtual instrument (VI) is
B. The LabVIEW environment
C. LabVIEW Help Options

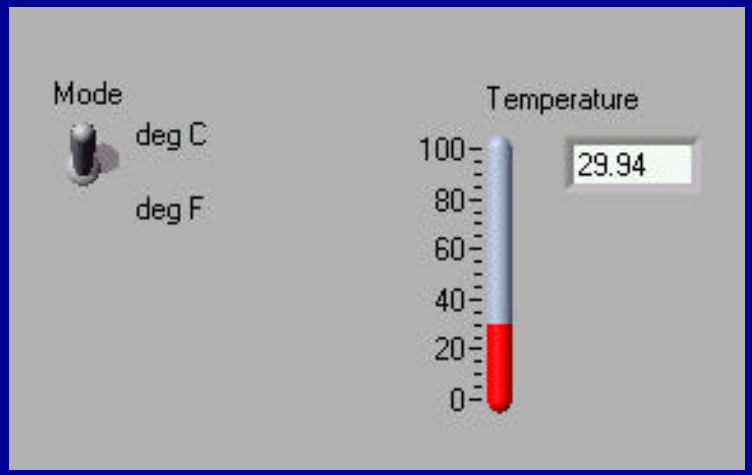
Virtual Instruments (VIs)

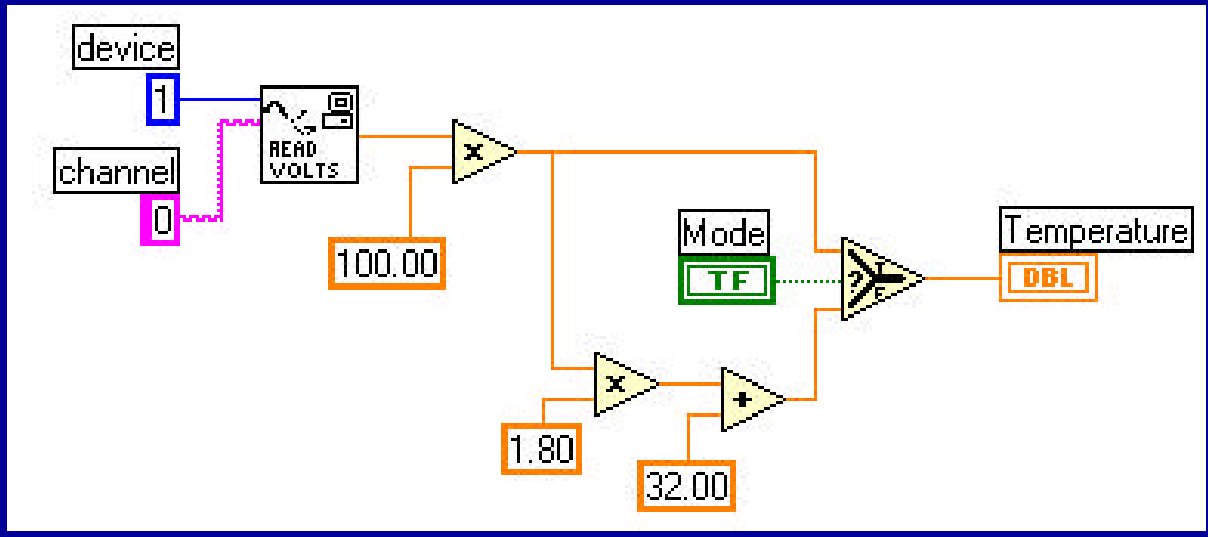
Front Panel

- **Controls = Inputs**
- **Indicators = Outputs**

Block Diagram

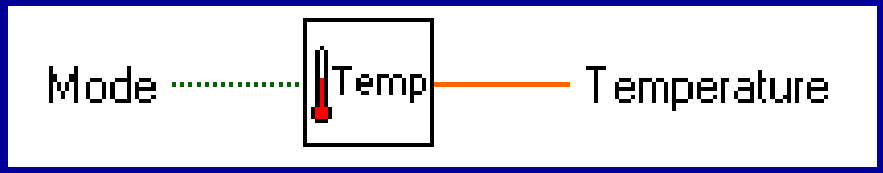
- **Accompanying "program" for front panel**
- **Components "wired" together**

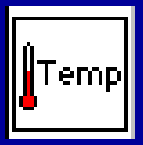




Hands-on: C to F conversion

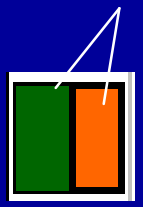
Icon/Connector





icon

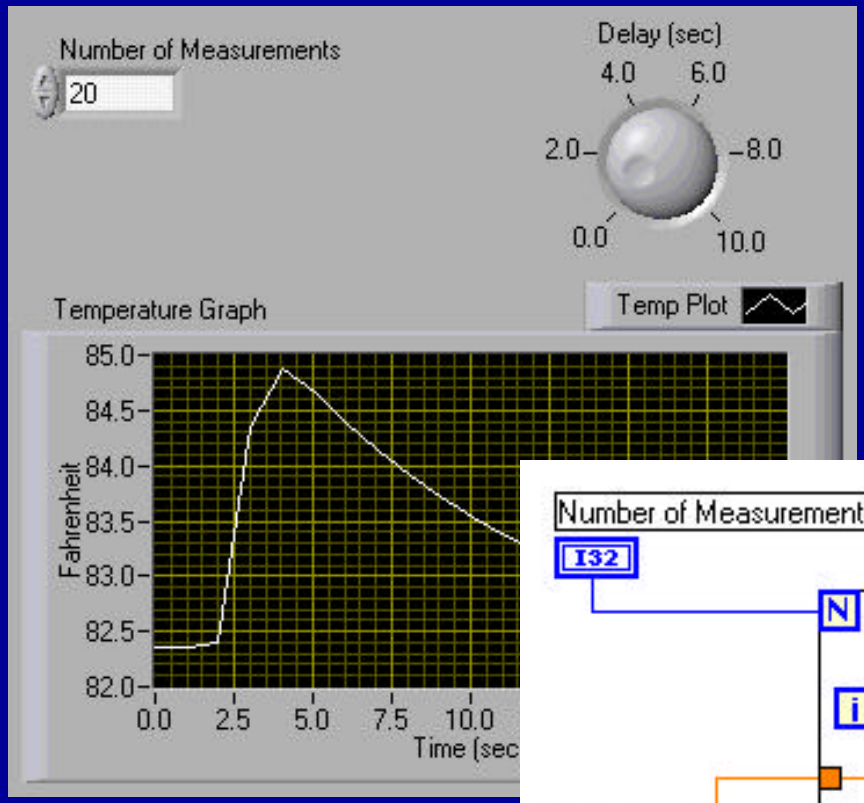
terminals



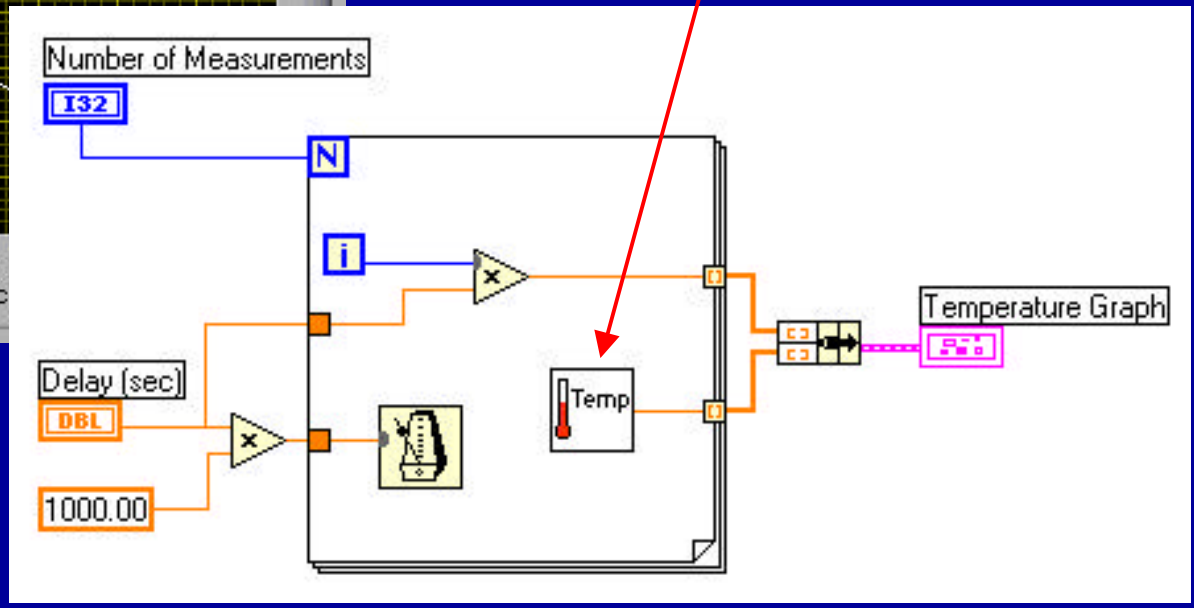
connector

- An icon represents a VI in other block diagrams
- A connector passes data to and receives data from a “subVI” through terminals

Example: Temperature VI

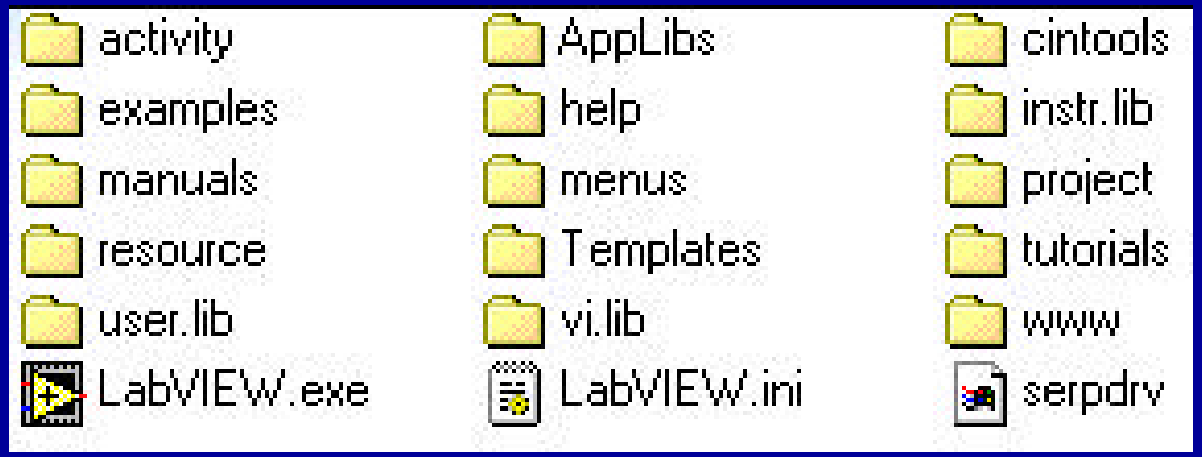


SubVI from previous slides



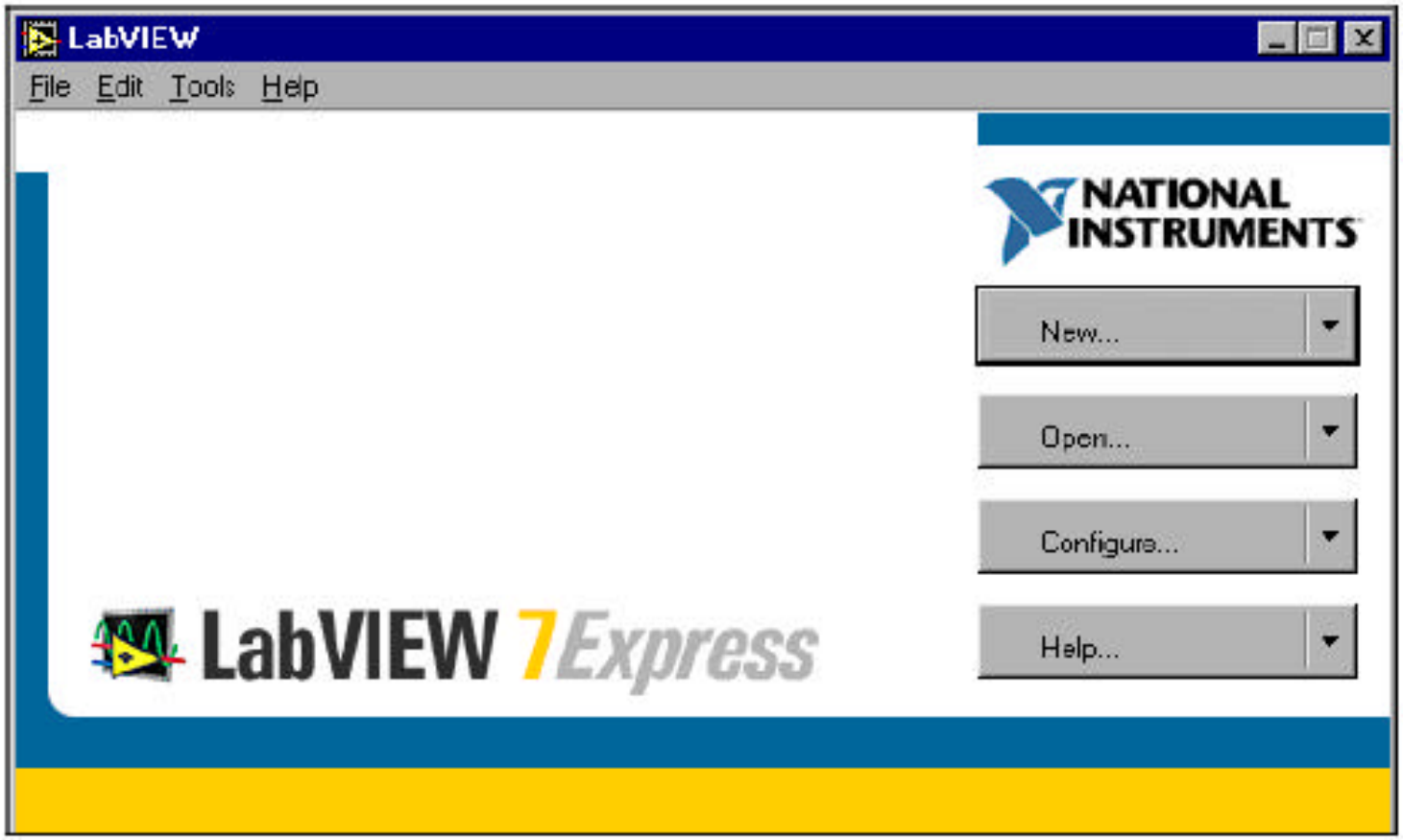
LabVIEW Files

Start menu (task bar)»Programs»
National Instruments LabVIEW

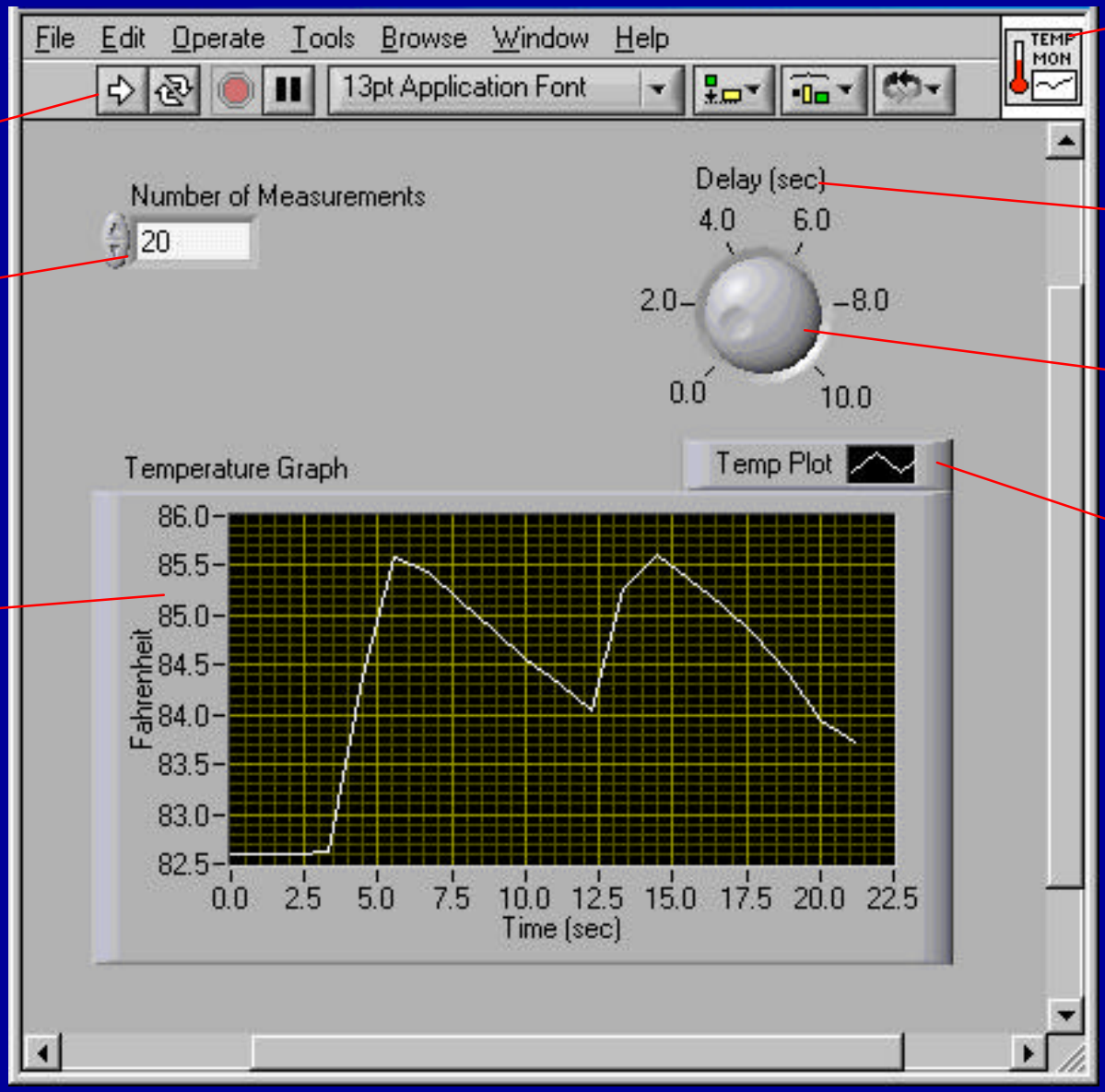


- **Keep vi.lib in the LabVIEW directory**
- **Place items in User.lib or Instr.lib to have them appear in the LabVIEW Control and Function Palettes**

LabVIEW Startup Screen



Panel Window



Panel Toolbar

Digital Control

XY Graph

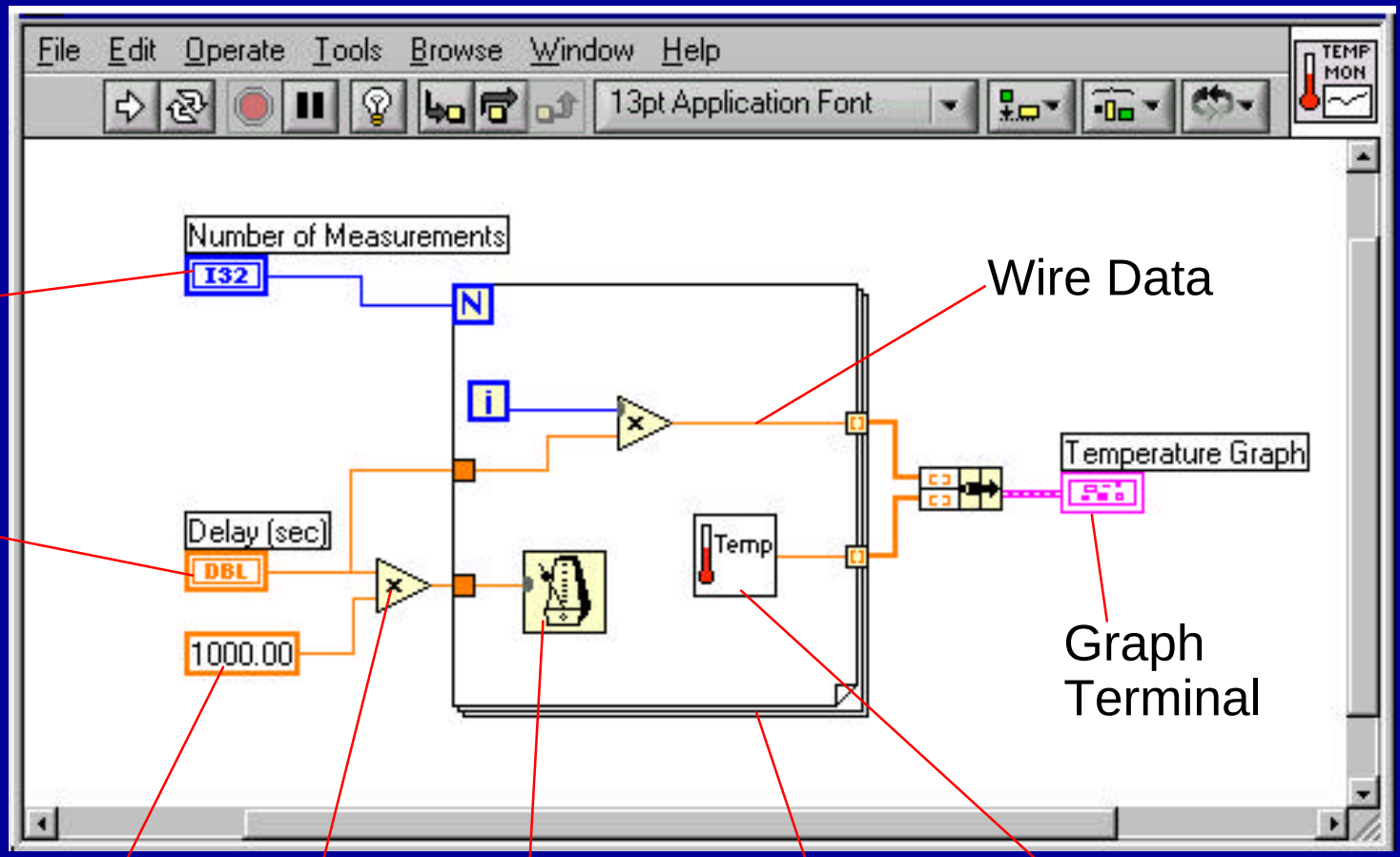
Icon Pane

Knob Owned Label

Knob Control

Graph Legend

Diagram Window



Status Toolbar

Run button

Continuous Run button

Abort button

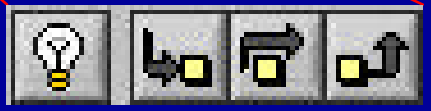
Pause/Continue button

Font ring

Alignment ring

Distribution ring

Reorder ring



Additional Buttons on the Diagram Toolbar

Execution Highlighting button

Step Into button

Step Over button

Step Out button

Warning indicator

Enter button

Menus

- **Pull Down Menus**

- **LabVIEW Shortcut Menus**

***Windows and UNIX* - Right-Click on object with mouse**

***MacOS* - Hold down open-apple and click with mouse button**

Tools Palette

- Editing and Debugging Tools
- Floating Palette

- Automatic Tool Selection
- Operating Tool
- Positioning/Resizing Tool
- Labeling Tool
- Wiring Tool
- Pop-Up Menu Tool
- Scrolling Tool
- Breakpoint Tool
- Probe Tool
- Color Copying Tool
- Coloring Tool

Control and Function Palettes

Controls Palette
(Panel Window)

Functions Palette
(Diagram Window)

- **Graphical, floating palettes**
- **Subpalettes can be converted to floating palettes**

Moving VIs Across Platforms

- **LabVIEW automatically translates and recompiles VIs**
- **File transfer utility mounts a disk from another platform**
  - ***Windows*** **: MacDisk and TransferPro**
  - ***MacOS*** **: DOS Mounter and Apple File Exchange**
  - ***Sun*** **: PC File System (PCFS)**

Note: Certain operating system-specific VIs are not portable – for example, DDE, ActiveX, and AppleEvents

Help Options

Show Context Help (Help menu)

- **Simple/Detailed Diagram Help**
- **Lock Help**
- **Online Help**

Contents and Index (Help menu)

- **All menus online**
- **Right-click on functions in diagram to access online info directly**

Summary

- Virtual instruments (VIs) have three main parts: the front panel, the block diagram, and the icon/connector
- The front panel is the user interface of a LabVIEW program and the block diagram is the executable code
- Menu options allow you to access different features in LabVIEW
- Use shortcut menus to customize any object in LabVIEW. Right mouse click on Windows and UNIX or Command-click for MacOS
- Floating Palettes
  - Tools Palette
  - Controls Palette (only when Panel Window is active)
  - Functions Palette (only when Diagram Window is active)
- There are help utilities including the Context Help Window and Contents and Index…
- Homework: F to C conversion VI