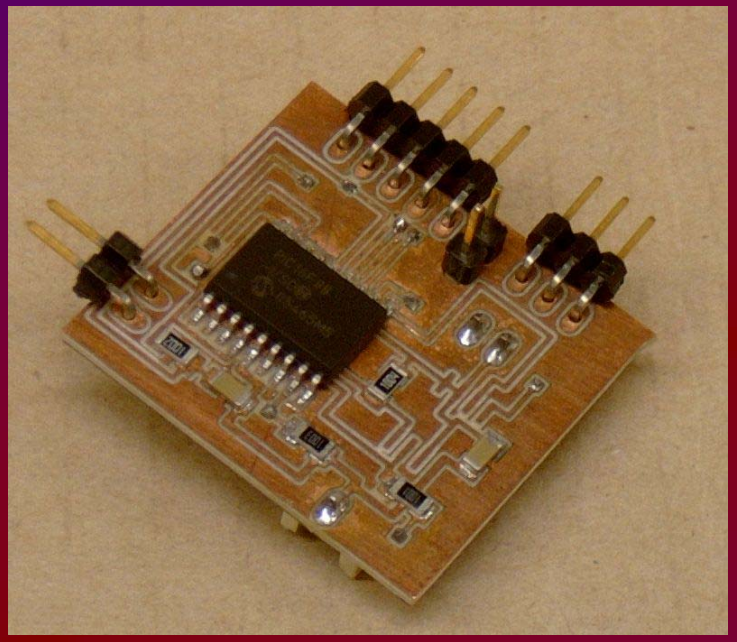
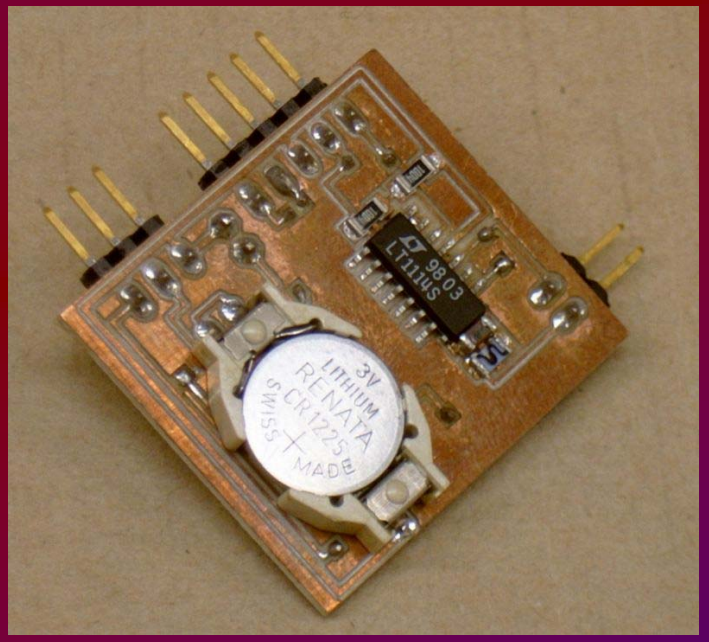
Pediatric Dynamometer

for Pediatric Bone Health Studies





Armand O'Donnell
Advisor: Dr. Jay Zemel

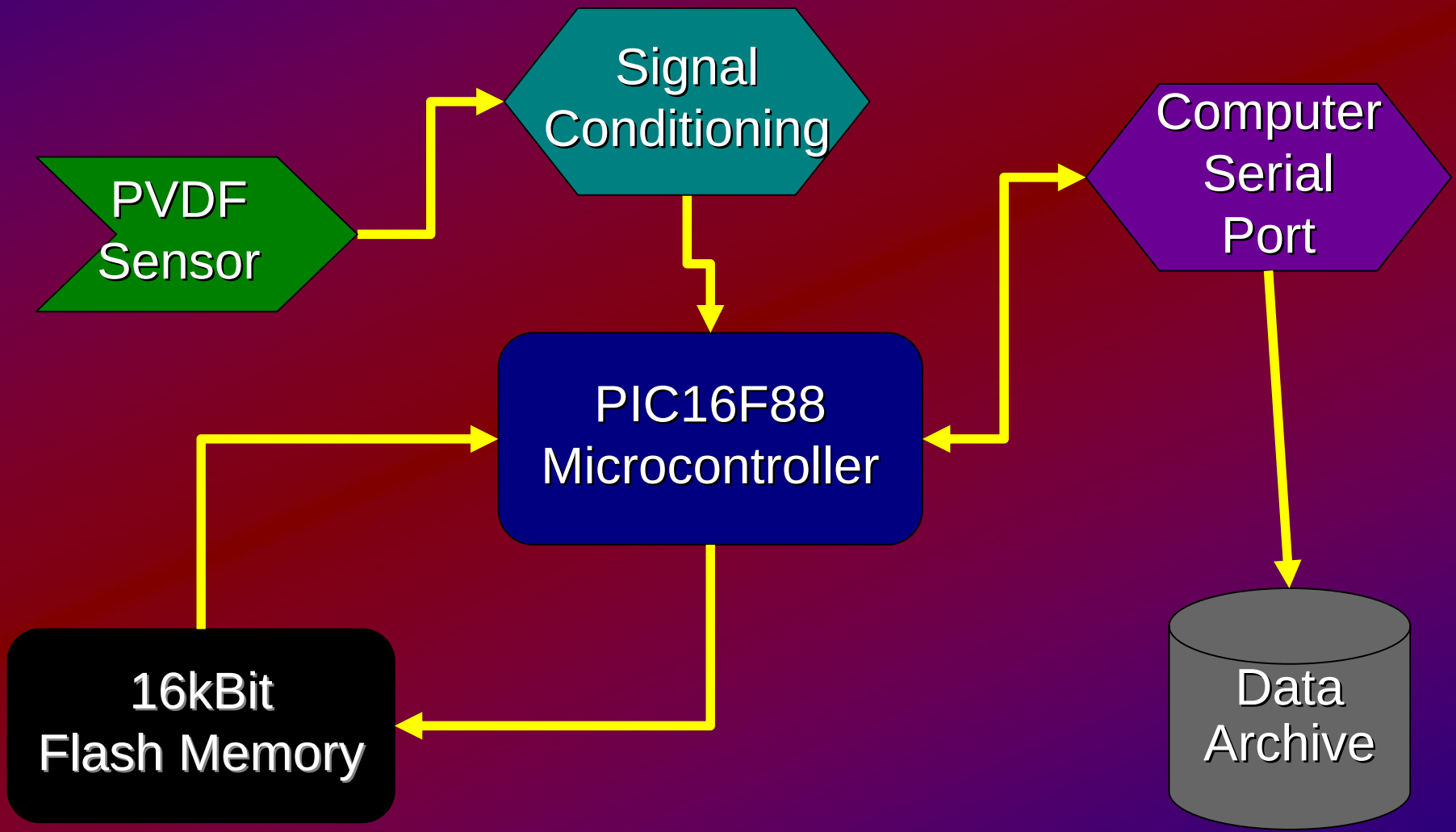
Motivation for Pediatric Dynamometer

- Children's Hospital of Philadelphia:
- Certainly a correlation between strenuous exercise and bone density-but difficult to measure accurately with current technology.
- Surveys unreliable, treadmills not practical for studying children.
- Peak force important: need to monitor each step
- Ideally, need a customizable device.
- Modular: algorithm and sensors can be changed

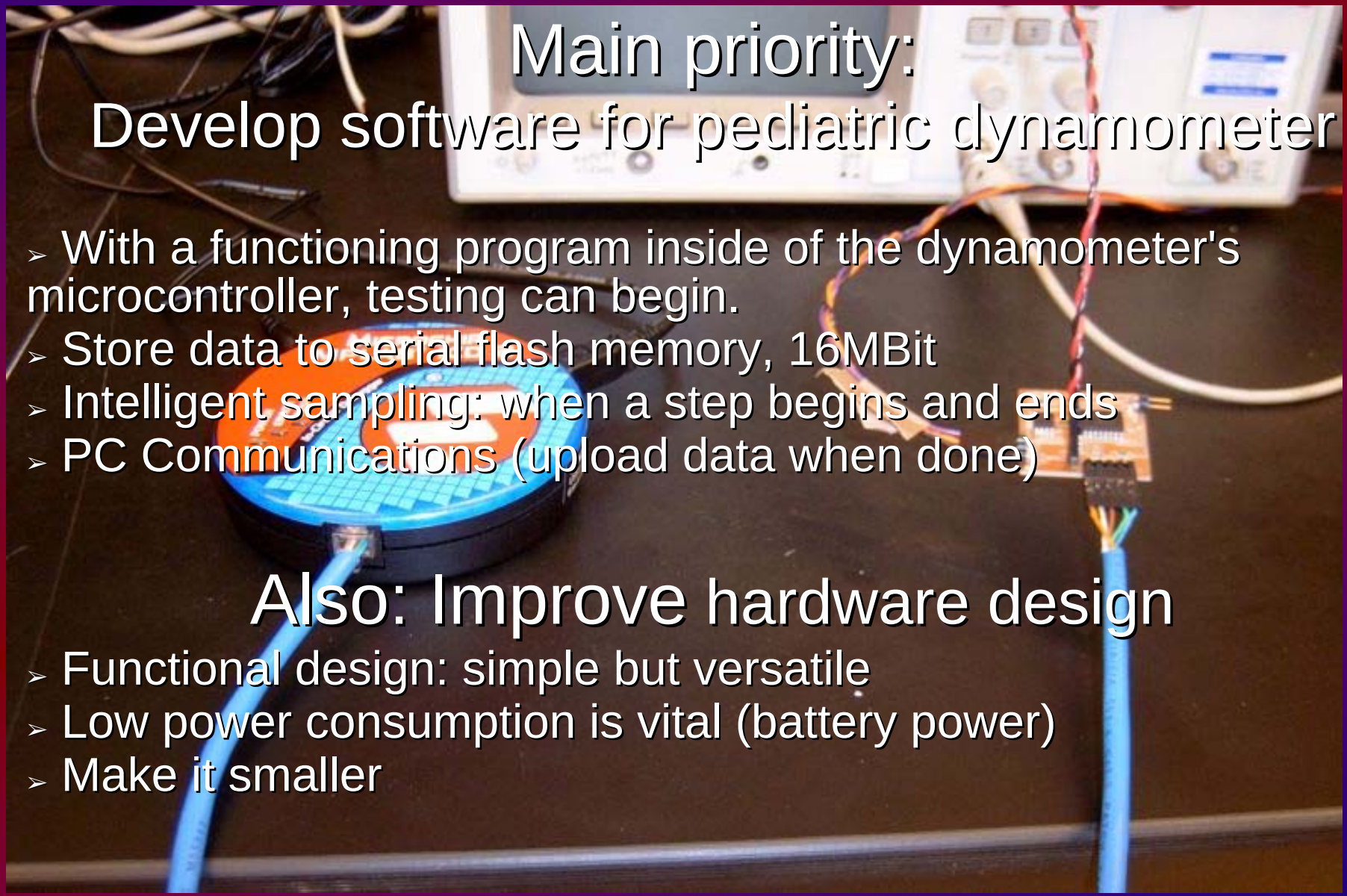
Background

- Sunfest 2004-Olivia Tsai began project
  - Laid the groundwork for beginning the project:
    - Piezoelectric polyVinyliDene Fluoride (PVDF)
    - Mechanical testing of sensors
- Senior Design 2004-2005
  - Progress in software, using C for programming PIC
  - Analog properties of PVDF and amplifiers
  - Wear device around ankle, wireless link w/PC
- Senior Design 2005-2006
  - Reduced size of dynamometer
  - Small enough to fit inside of a child's shoe!

Block Diagram



Goals for Sunfest 2006



Main priority:
Develop software for pediatric dynamometer

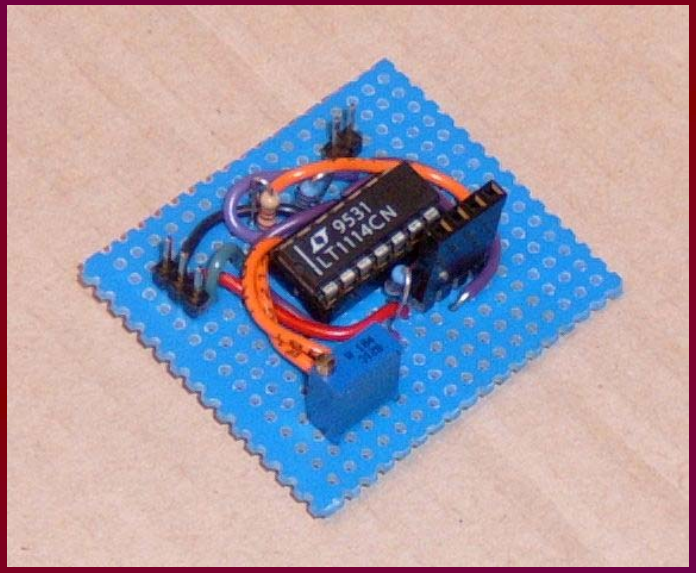
- With a functioning program inside of the dynamometer's microcontroller, testing can begin.
- Store data to serial flash memory, 16MBit
- Intelligent sampling: when a step begins and ends
- PC Communications (upload data when done)

Also: Improve hardware design

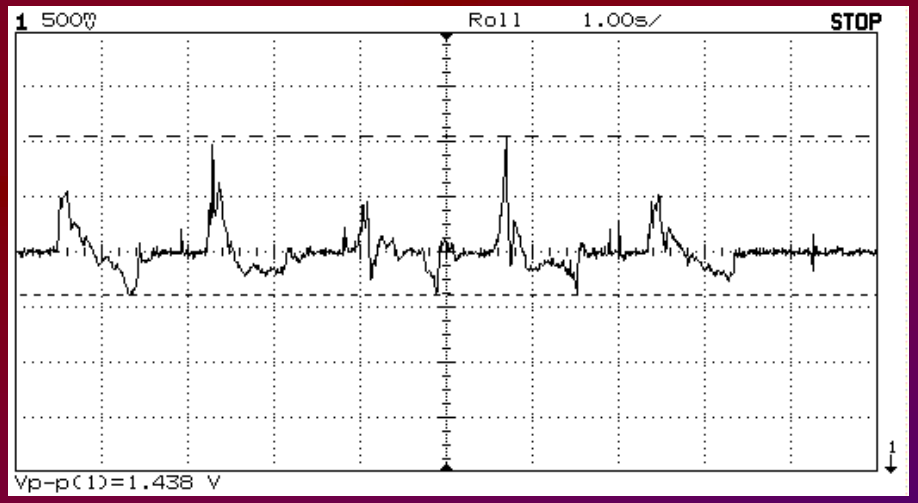
- Functional design: simple but versatile
- Low power consumption is vital (battery power)
- Make it smaller

Charge Amplifier/Analog Integrator

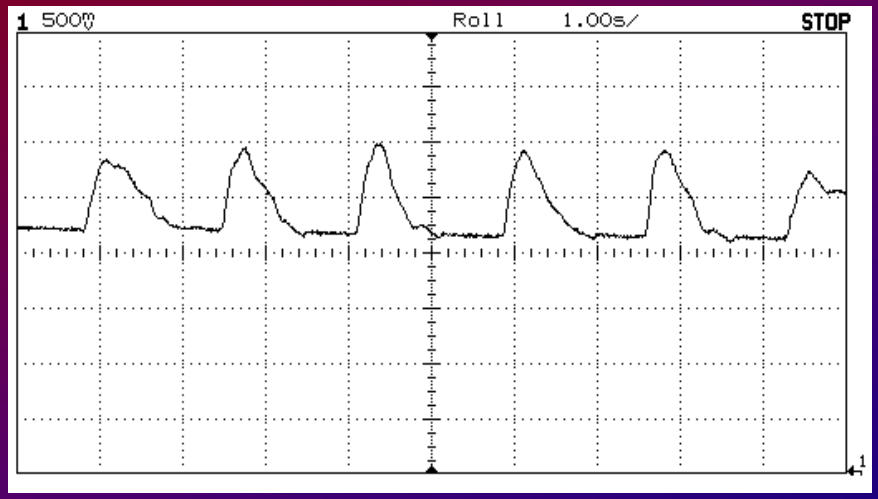
- Integration in hardware, smooth measurements of force on PVDF
- Continuous integration means no missed samples
- Output proportional to force:
- Simpler calculations



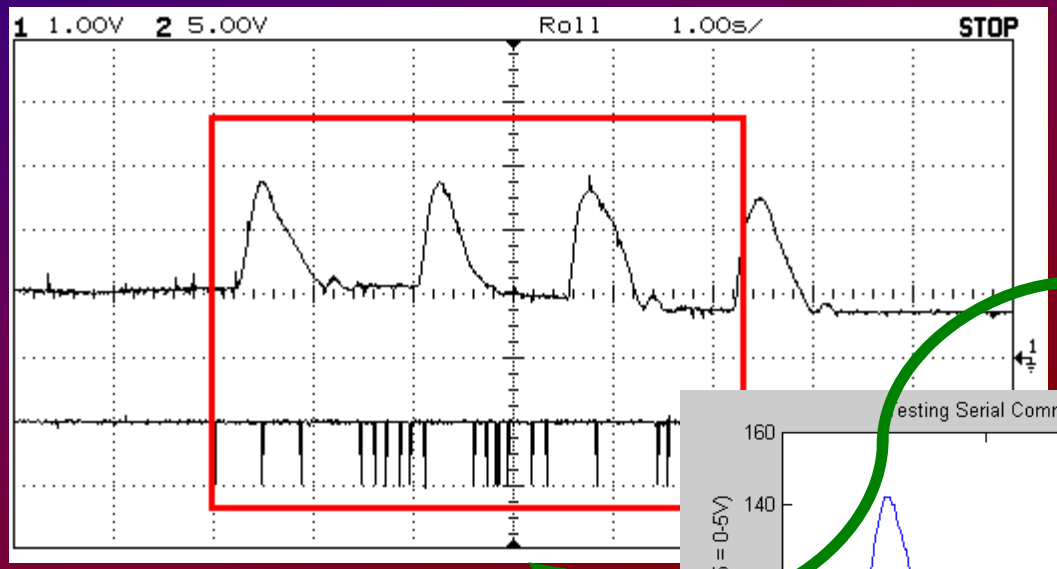
PVDF Sensor



Integral of PVDF

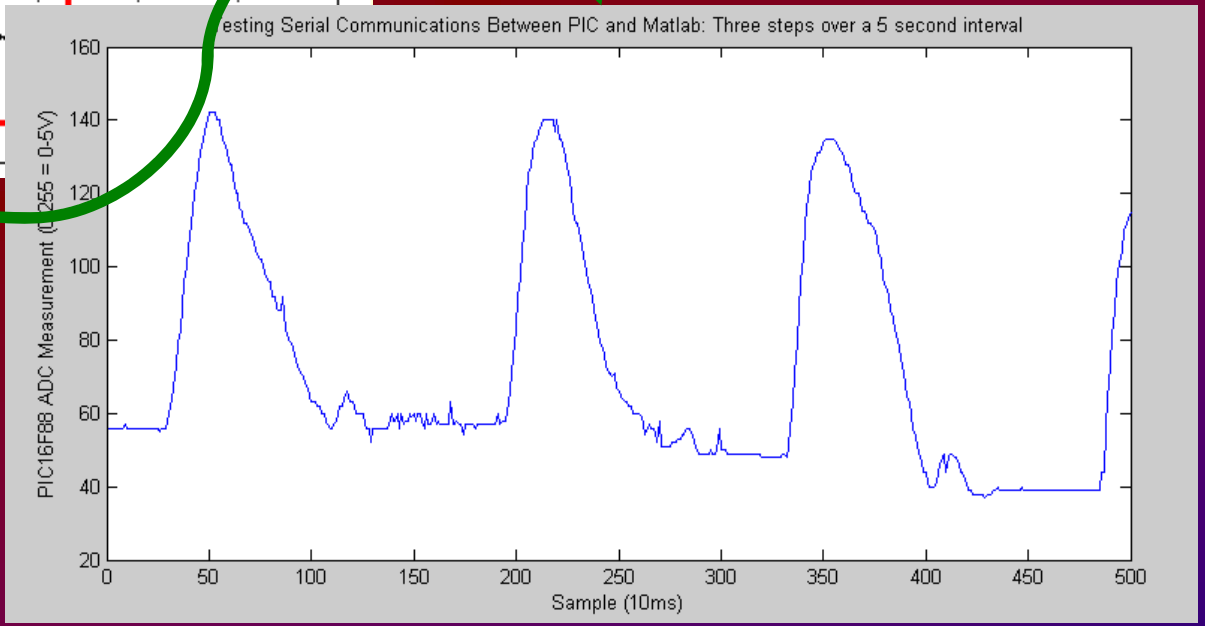


Analog-to-Digital Conversion



- Five usable ADC's
- 10-bit conversion
- 200 samples/sec

Self-calibrates with respect to reference voltage every 256 samples

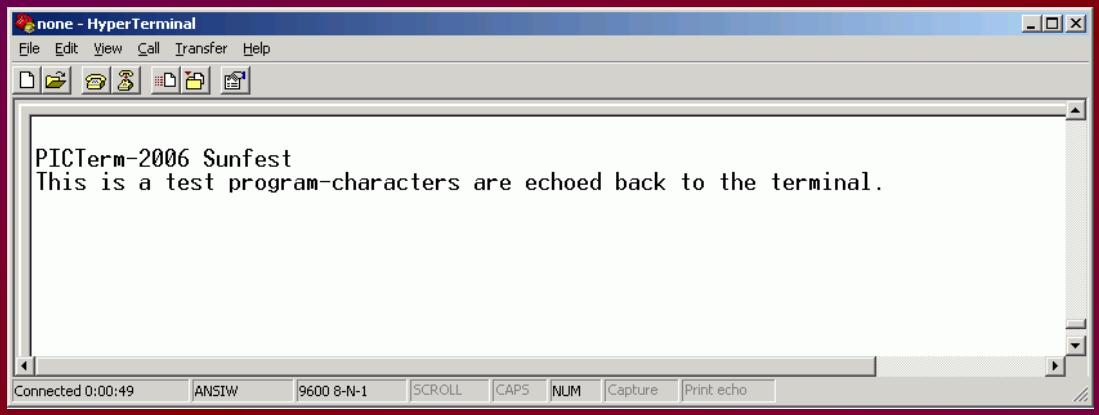


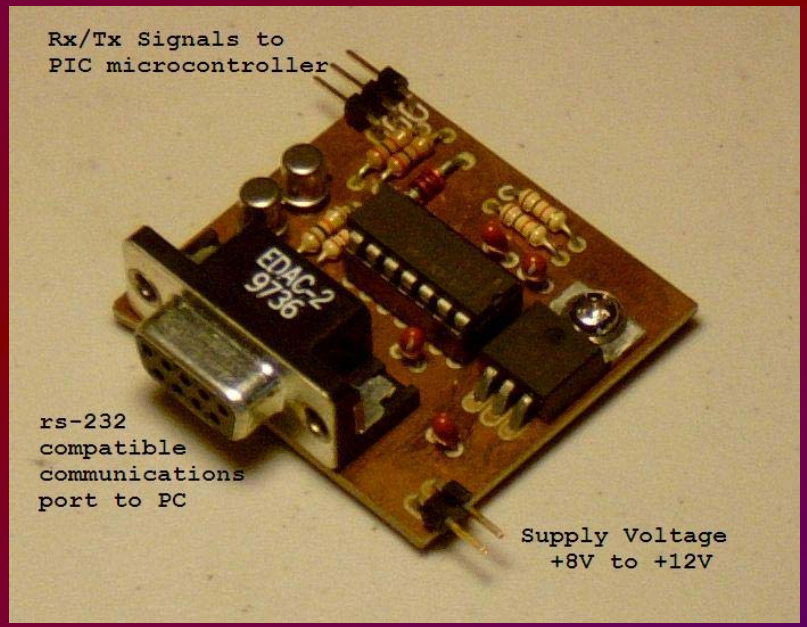
ADC measurements to serial interface
8-bit, 100 samples/sec

Serial Communications

Serial Communications Port of PC:

- Not used much anymore because of slow data rate
- Advantage: no drivers needed, relatively simple protocol-good enough here

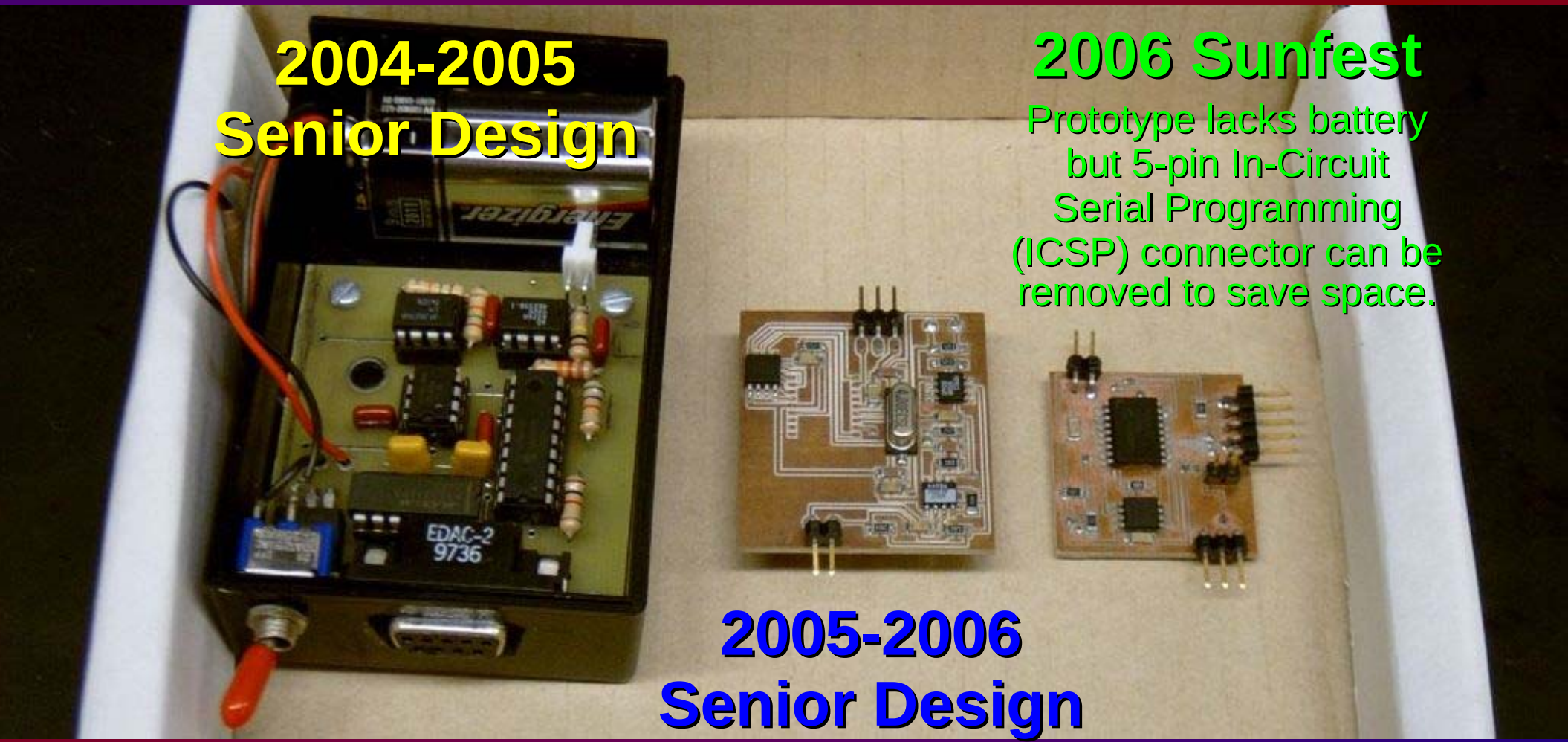




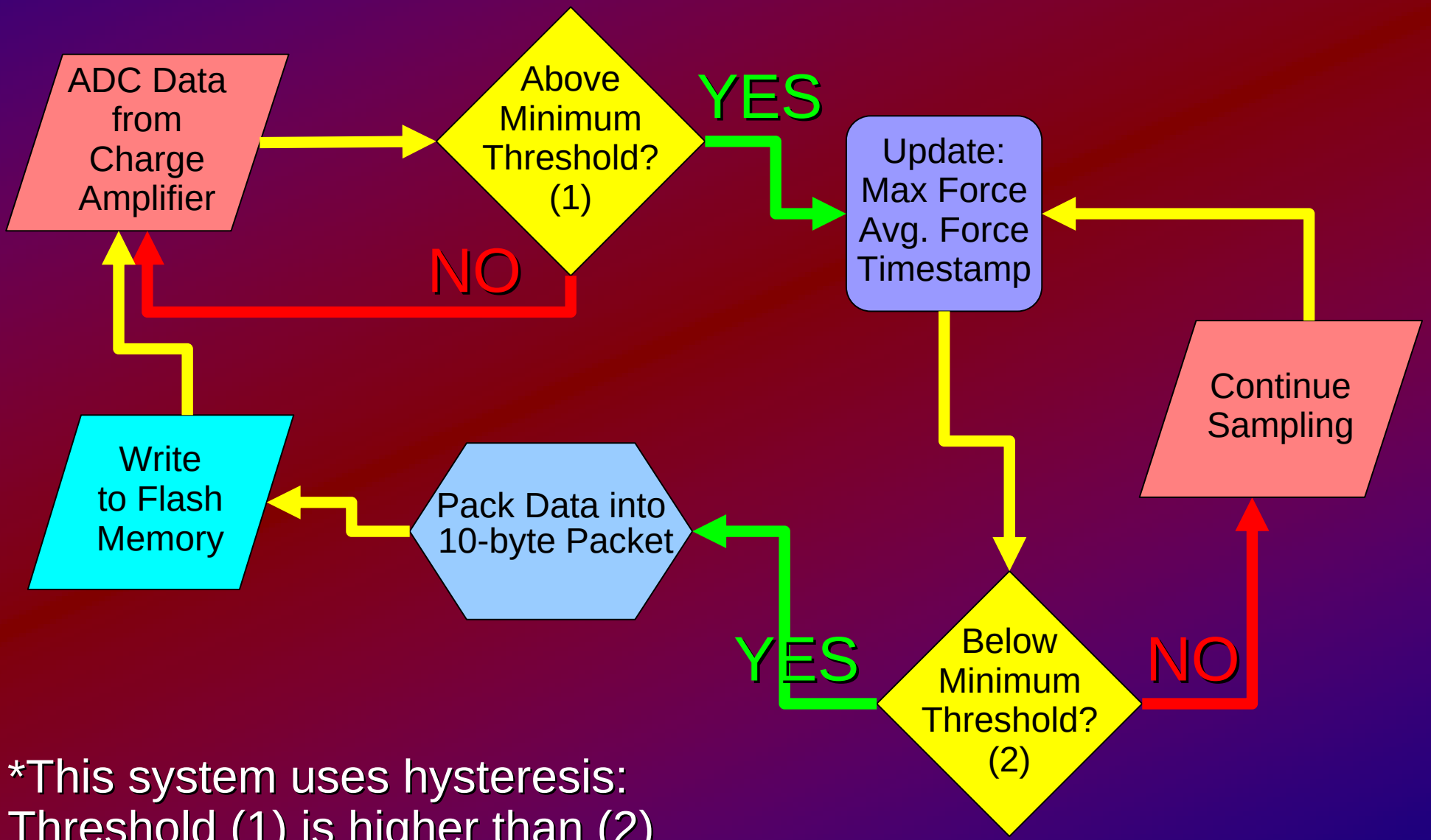
Serial Module:

- Used to interface microcontroller and personal computer
- Amplifies low-level signals from PIC to higher voltages required for Serial Communications Port.
- Cheap and quick to make.

Results - Hardware



Results – Software (Sampling)

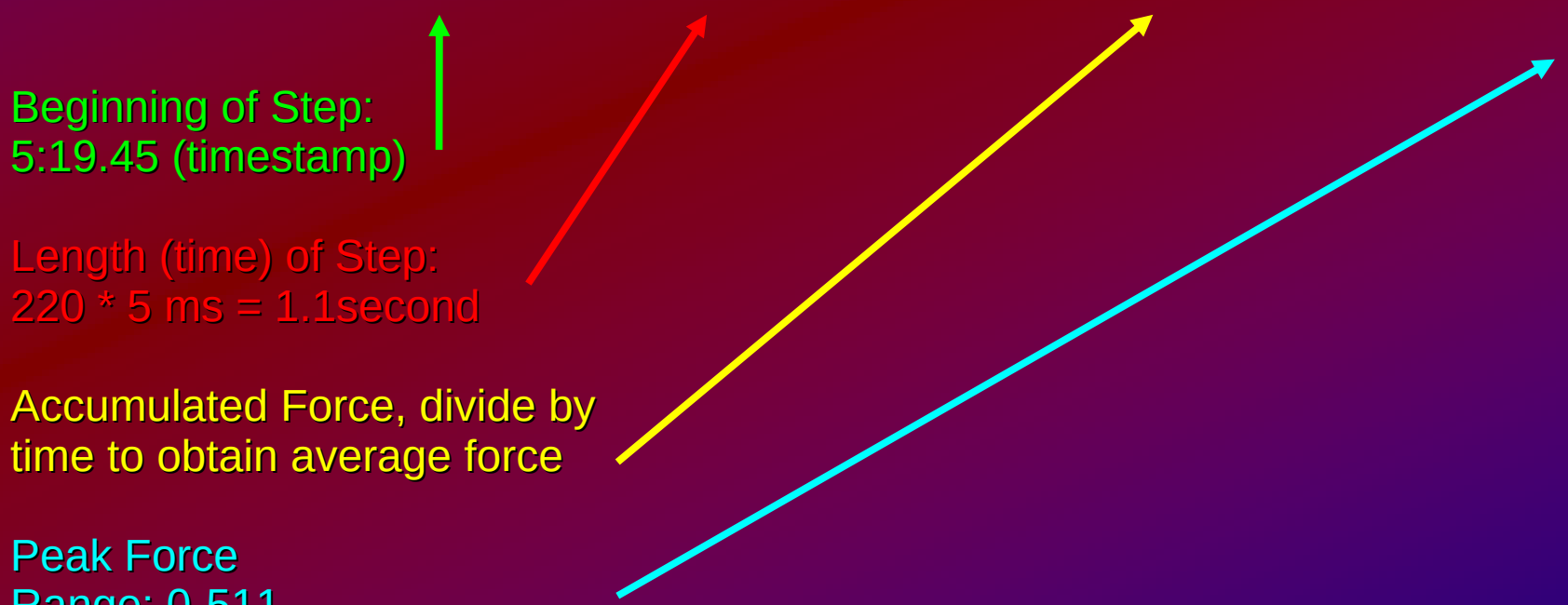


*This system uses hysteresis:
Threshold (1) is higher than (2)

Results – Software (Interface)

Data Organized in 10-byte Packets:
(In hexadecimal)

3A 8C 48 00 DC 00 15 7C 00 EB



Acknowledgements

- **Dr. Jay Zemel**
  - My advisor for this project
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  - For his support in providing the necessary parts and advice
- **Dr. Haim Bau** and **Dr. Howard Hu**
  - For tolerating our obnoxiously loud milling machine in their laboratory-Thanks!
- **Dr. Stephen Judd**
  - For reviewing and debugging my code

Lessons Learned

Build accurate prototypes.
Update design frequently.

Some signal processing problems can be solved with a combination of analog and digital circuits.

Low-level devices like the serial flash memory are becoming increasingly standard and “user friendly”. Who would have thought?