Courtney Boykin

Recycler Electron Cooler Diagnostics and Instrumentation

Supervisor: Arden Warner

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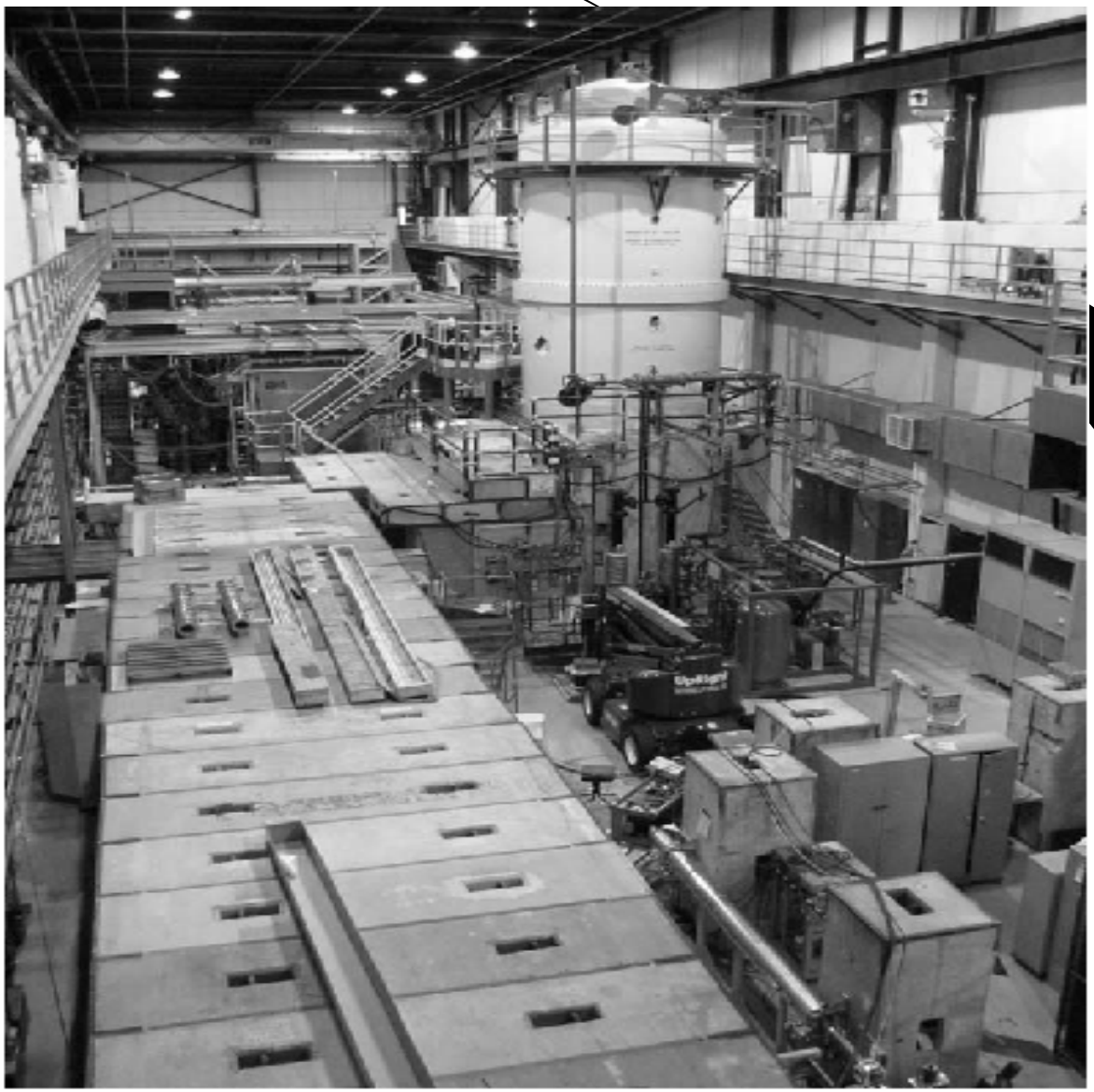
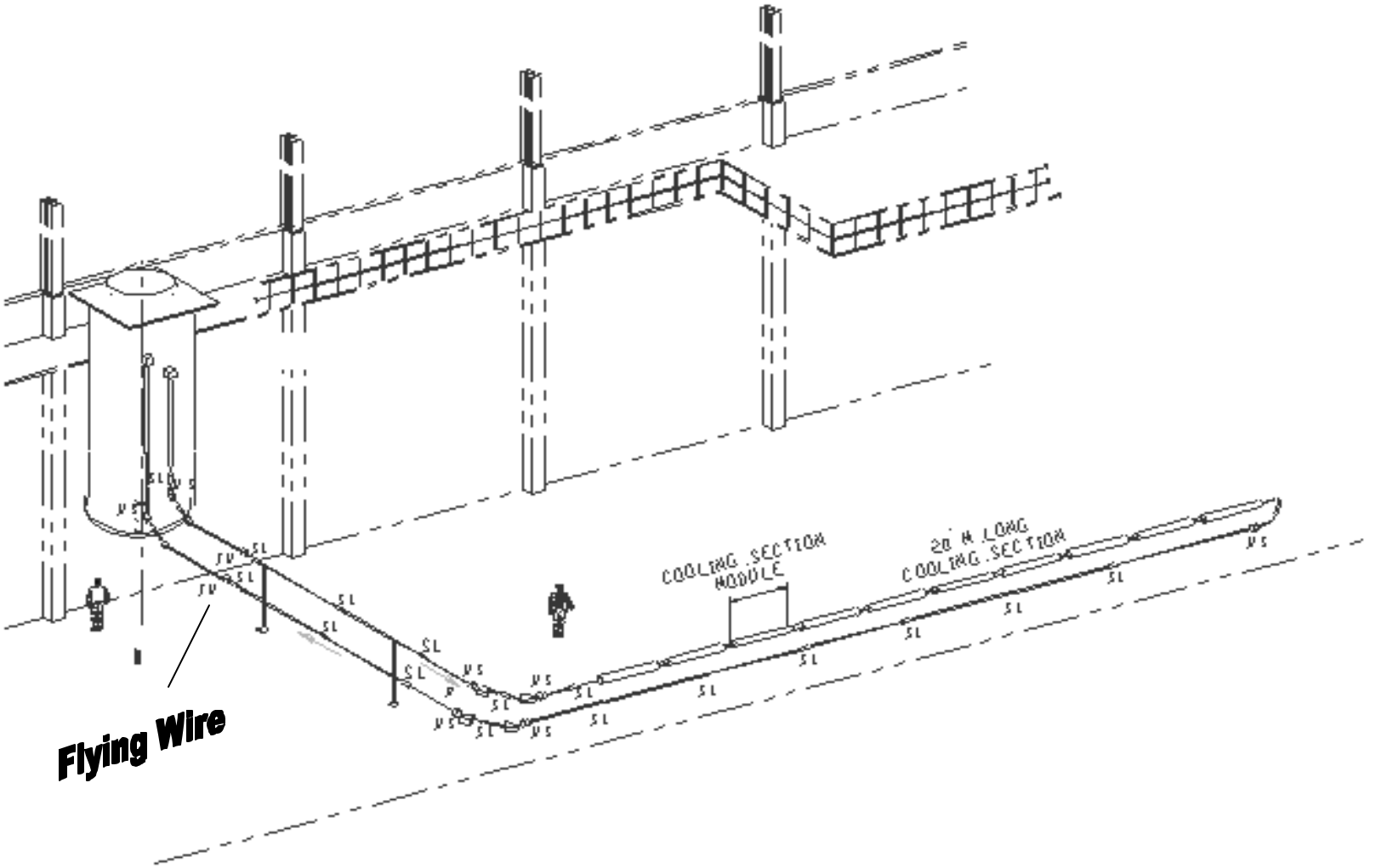
ELECTRON COOLING

The purpose of Fermilab electron cooling is to shrink the phase space of the antiproton beams. It involves interacting a 4.3 MeV, 0.5 A DC electron beam with 8.9 GeV antiproton beam over a 20 meter long section in the Recycler Ring.

FULL SCALE BEAMLINE AT WIDEBAND



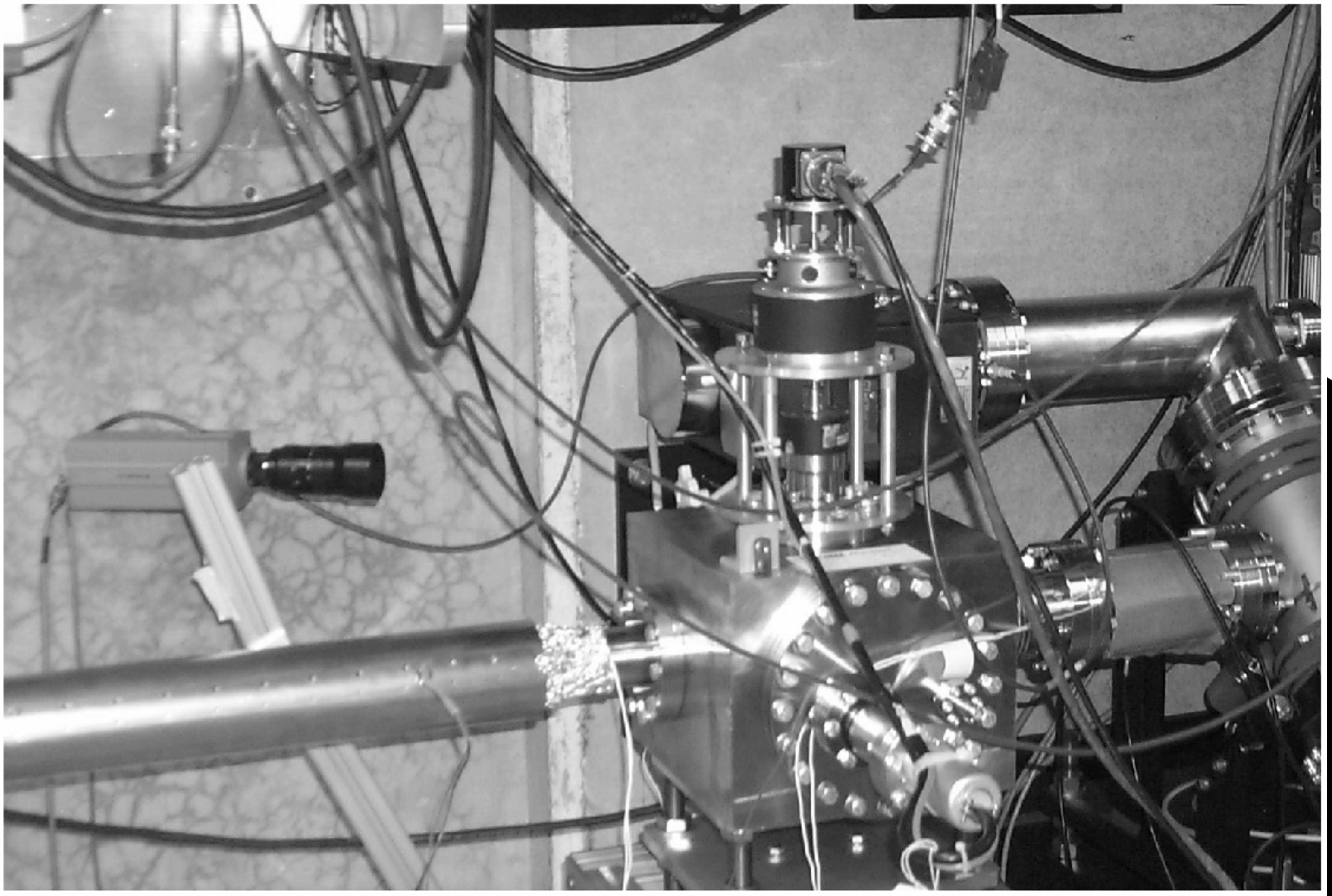
SCHEMATIC OF ELECTRON COOLER



FLYING WIRE

- The flying wire consists of a piece of carbon wire with a diameter of 25μm capable of moving with a speed of up to 8 m/s.
- The wire itself is surrounded by a Faraday cup made of copper. The cup is designed to capture the secondary electrons that are produced when the wire passes through the beam.
- The flying wire is used to obtain the beam profile, the beam position, and the hard edges of beam.

FLYING WIRE AT WIDEBAND



CROSS SECTION OF FW

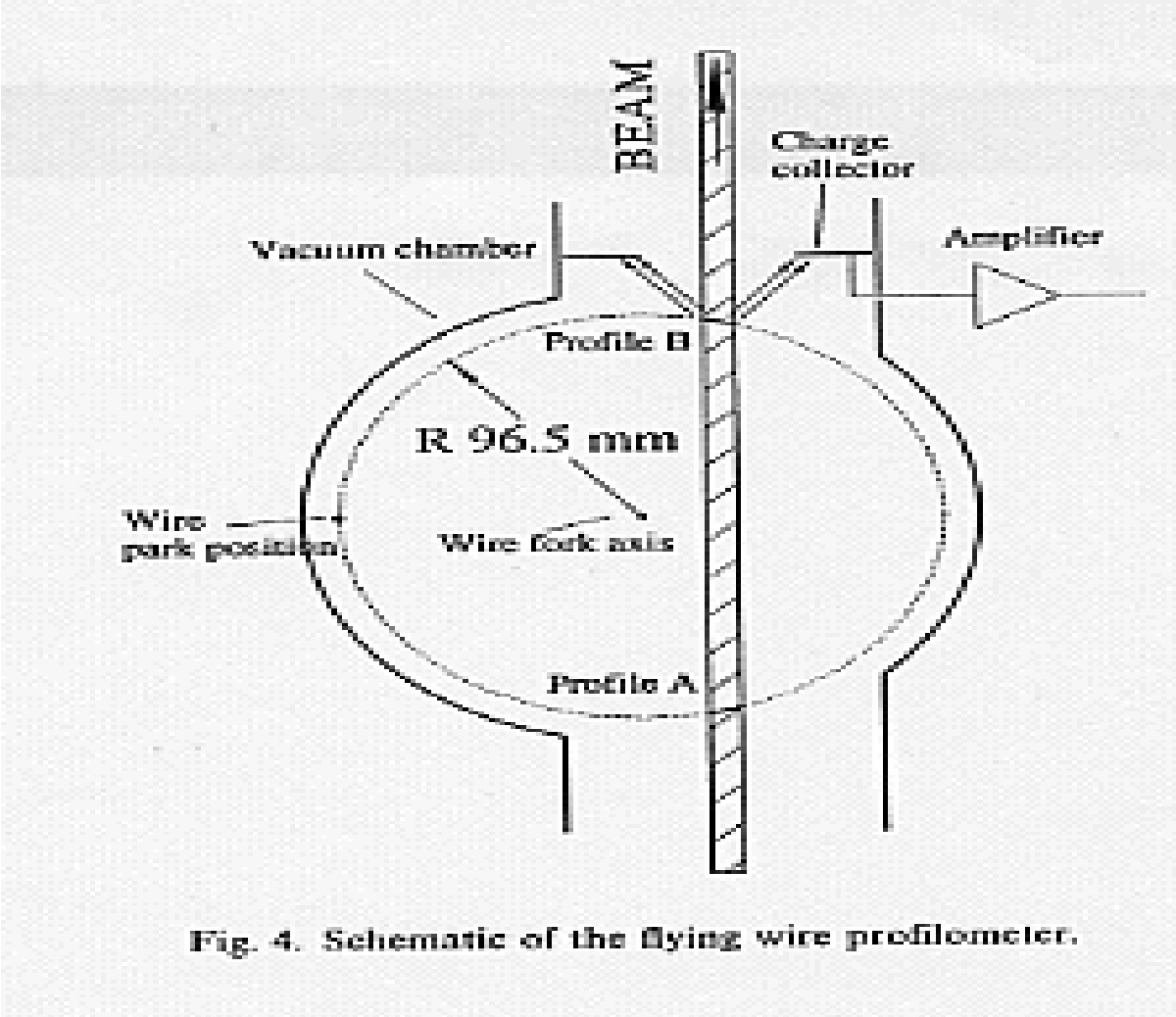
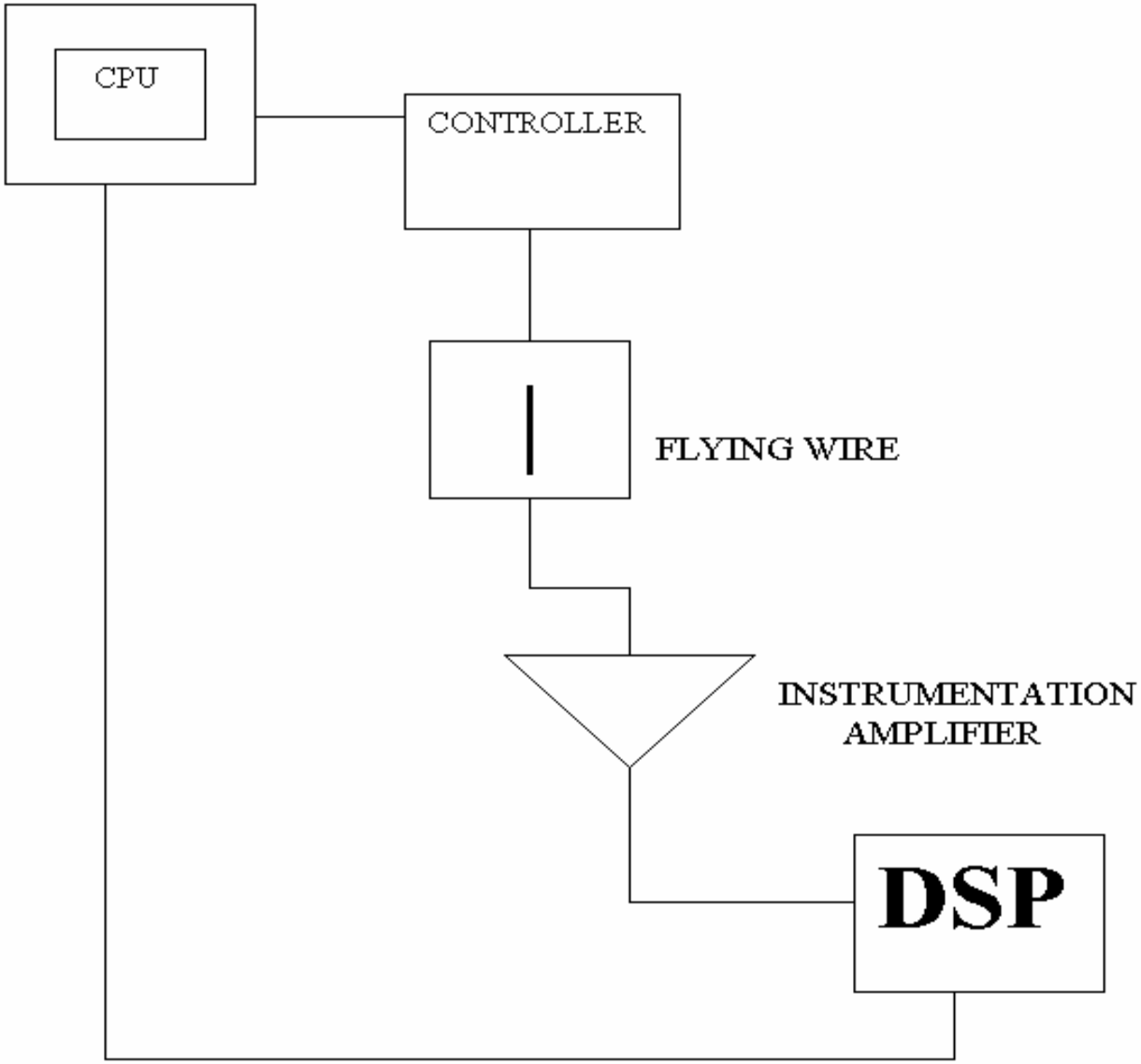


Fig. 4. Schematic of the flying wire profilometer.

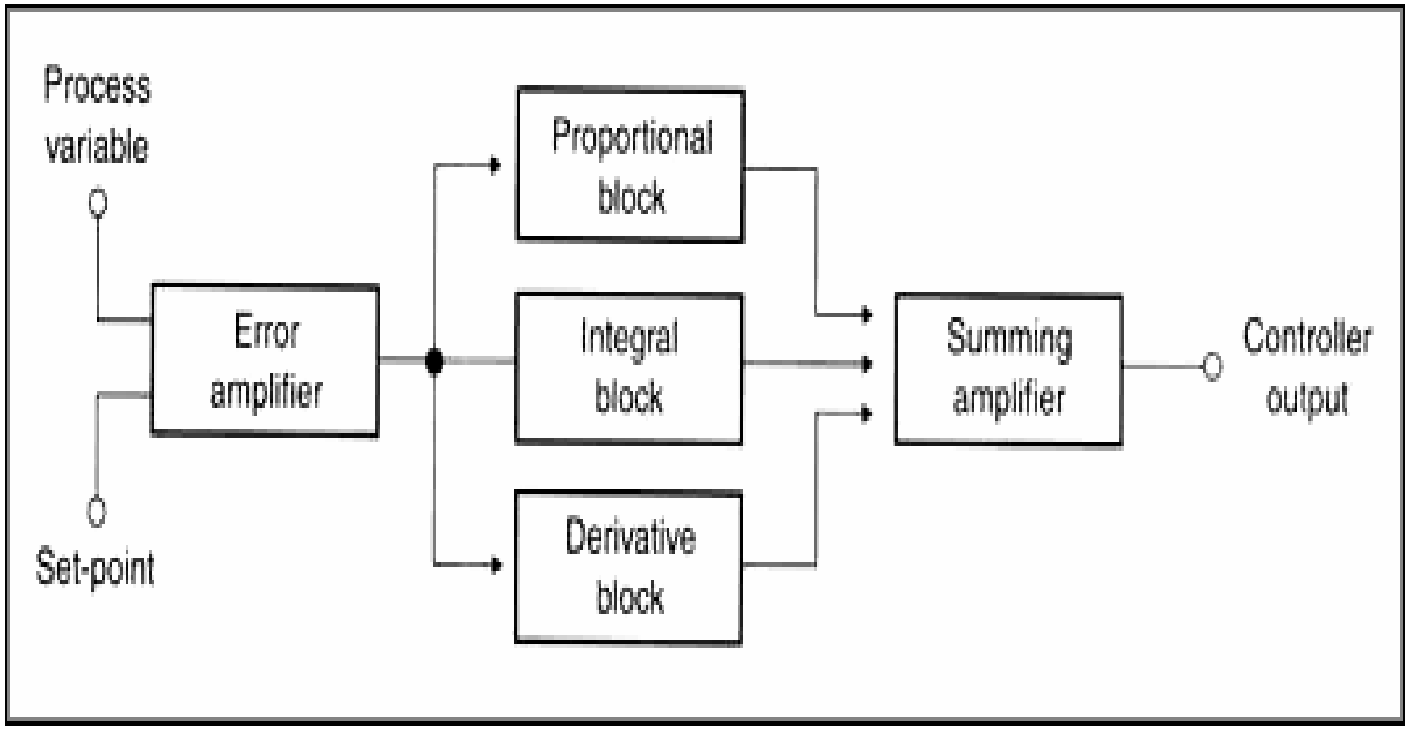
DIAGRAM OF PROCESS



MY CONTRIBUTIONS

- Assisted with acquiring the parameters for stable PID control of wire
- Helped design and build an instrumentation amplifier that can be used to amplify the secondary emf signal obtained from the flying wire. The signal will eventually be digitized and processed with a single Digital Signal Processor.
- Began writing a LabVIEW application that controls movement of the flying wire and data acquisition.

BLOCK DIAGRAM OF TYPICAL PID CONTROLLER



INSTRUMENTATION AMPLIFIER

Instrumentation amplifier can be used to amplify the secondary electron signal obtained from the flying wire

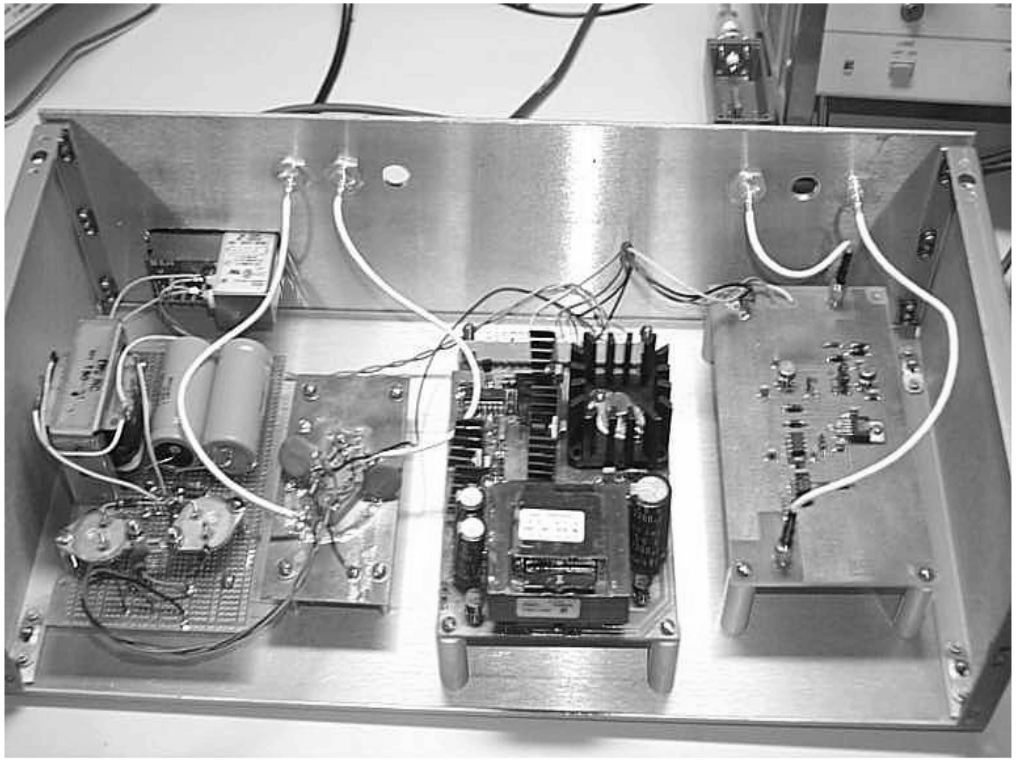
PARAMETRS:

- bias to approximately $\pm$ 100 volts
- remotely programmable
- variable gain
- bandwidth of 1-5MHz

PICTURE OF AMPLIFIER

It is comprised of :

- ± 130V power supply
- an op amp circuit
- ± 15V + 5V power supply
- a transimpedance amplifier



LABVIEW APPLICATION

Will be used to control the movement of the flying wire

- Move wire at variable speed
- Update wire position using an optical encoder
- Set index
- Show response curve
- Generate statistics

CONCLUSIONS

- Stable PID control of the wire has been obtained
- The instrumentation amplifier has been characterized
- The LabVIEW application still requires some additional coding

FUTURE PLANS

- Develop DSP processing for front end analysis of the flying wire and other instrumentations
- Optically control the amplifier at high voltage.

ACKNOWLEDGMENTS

- I wish to thank Dianne Engram, Elliott McCrory, Dr. Davenport, and other members of the SIST committee for this invaluable summer experience.
- Thanks to my supervisor, the talented Dr. [illegible] Warner, who has been a wonderful role mod[illegible]
- Thanks to the entire Electron Cooling group for your help during this summer.
- Also much thanks to the RF group, particularly Rene Padilla and Jeneen Irvin, for their assistance with the instrumentation amplifier.

QUESTIONS?

If there are any questions, feel free to ask them now.