Progress in UCSD Chamber Simulation Experiments

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Electronic copy: http://aries.ucsd.edu/najmabadi/TALKS
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Thermo-mechanical Response of the Wall Is Mainly Dictated by Wall Temperature Evolution

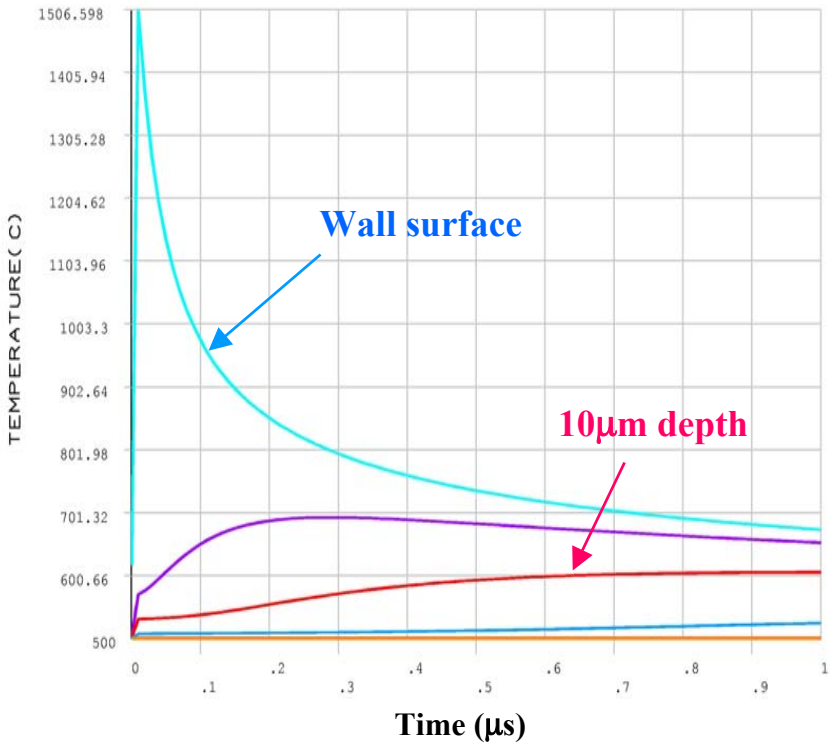
- Most phenomena encountered depend on wall temperature evolution (temporal and spatial) and chamber environment
  - ✓ Only sputtering and radiation (ion & neutron) damage effects depend on "how" the energy is delivered.

- In order to develop predictive capability:
  - ✓ There is no need to exactly duplicate wall temperature temporal and spatial profiles. (We do not know them anyway!)
  - ✓ Rather, we need to measure and understand the wall response in a relevant range of wall temperature profiles and in real time.

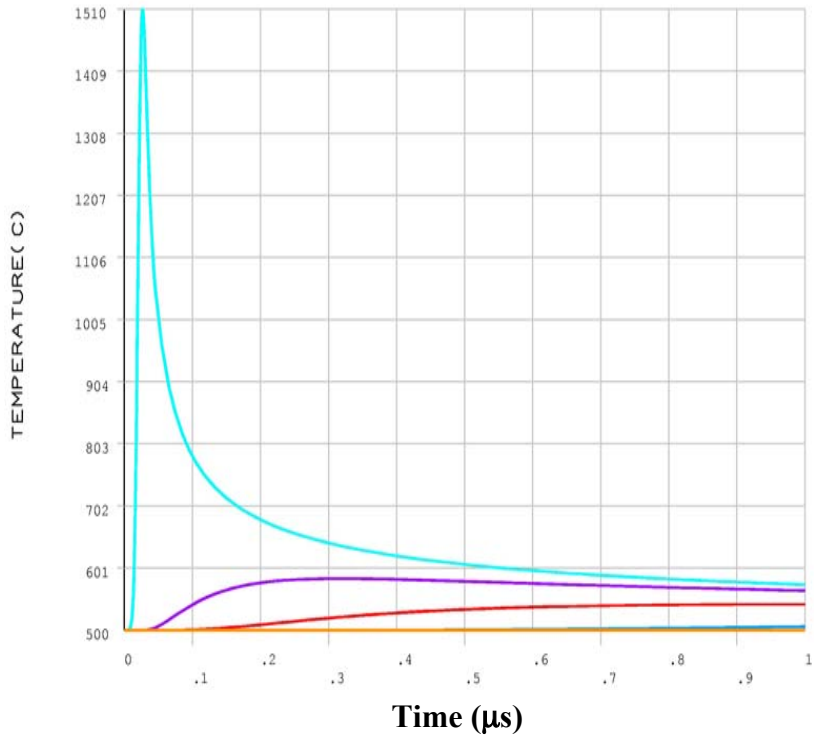
- Most energy sources (lasers, X-rays, ion beam) can generate similar temperature temporal and spatial profiles.

One Laser Pulse Can Simulate Wall Temperature Evolution due to X-rays

NRL Target, X-ray Only
1 J/cm^2, 10 ns Rectangular pulse



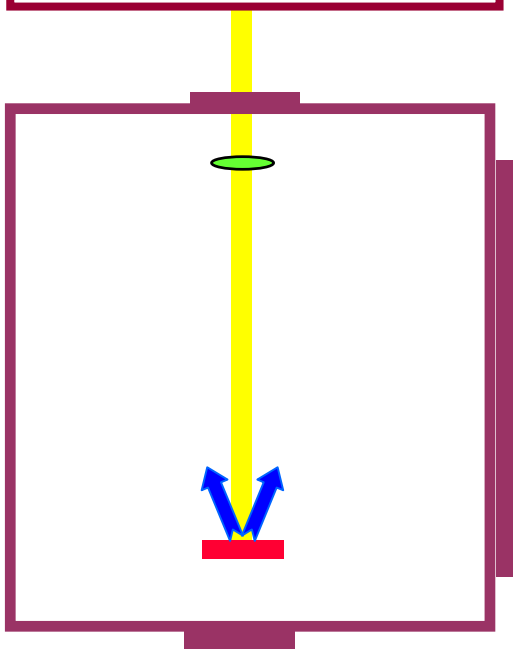
Laser
0.24 J/cm^2 ,10 ns Gaussian pulse



- Only laser intensity is adjusted to give similar peak temperatures.
- Spatial temperature profile can be adjusted by changing laser pulse shape.

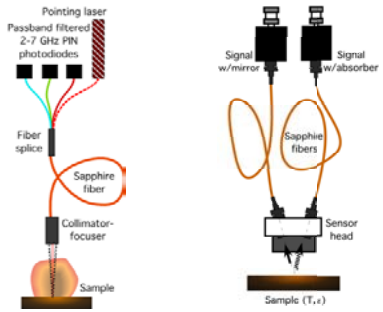
Careful Measurements of the Wall response is the Focus of our Simulation Experiments

Laser pulse simulates temperature evolution



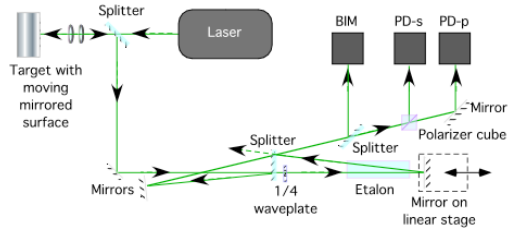
Vacuum Chamber provides a controlled environment

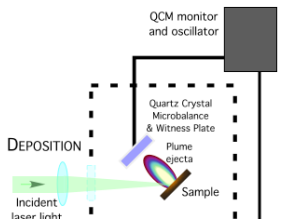
A suite of diagnostics is identified

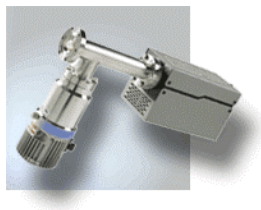


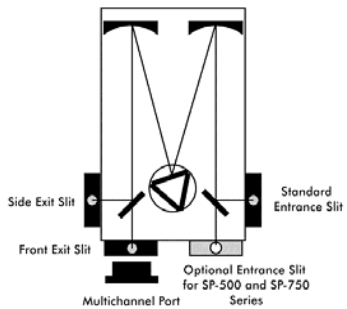
Real Time Temperature

Real Time Thermal shock and stress









Per shot Ejecta Mass and Constituents

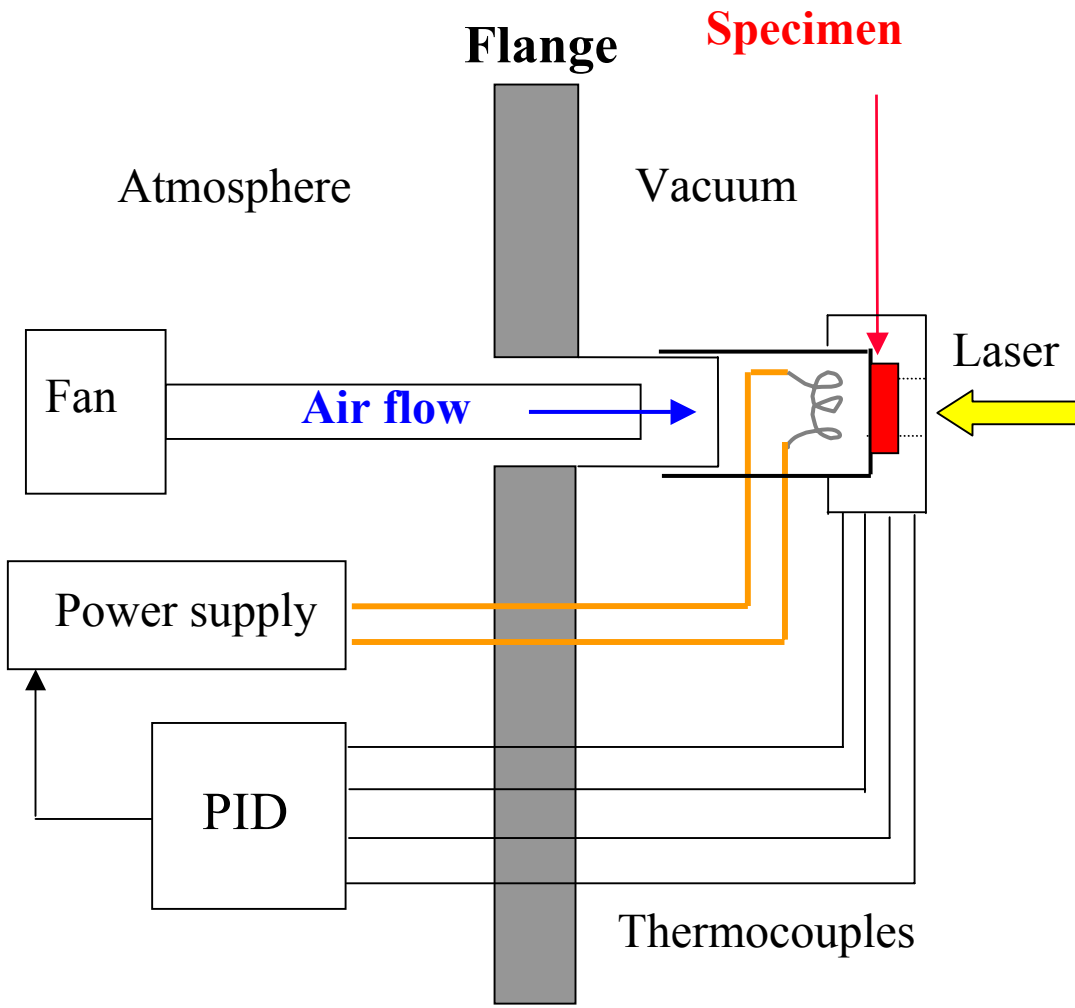
Sample can be examined for material behavior after high rep-rate experiments

Components of Simulation Experiment

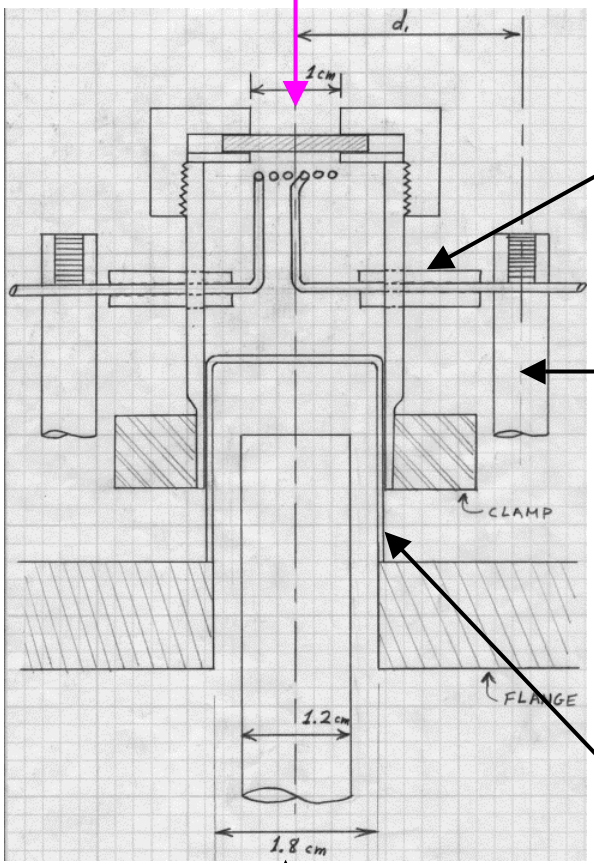
➢ High-Temperature Sample Holder	Designed, In Fabrication.
➢ Preparation of Vacuum Chamber	Ready
➢ Optical Train	
✓ Main laser:	Ready
✓ SBS Cell	In assembly
➢ Master Timing Control System	Tested on protoboard Awaits Integrated Test
➢ Data Acquisition System	Equipment Purchased Software is under development
➢ Diagnostics:	
✓ PIMAX and Spectrograph	Ready
✓ Thermometer	Designed, Parts purchased
✓ IR Camera	Purchase is deferred to June.
✓ Quartz Microbalancing	Purchase is deferred to June.
✓ RGA	Purchase is deferred to June.

High Temperature Sample Holder

- **Function:** Maintains an equilibrium temperature of 500-1000°C to simulate laser-IFE wall conditions.
- Both active cooling (over cooling) and heating (for feedback control).
- Radiative heating from a tungsten element is the best option:
  - ✓ Uniform temperature
  - ✓ No insulator
  - ✓ Can easily exceed 500°C
  - ✓ Halogen lamps are not small enough to fit behind a ~1 cm diameter sample.



High Temperature Sample Holder is Designed and is in Fabrication



Specimen

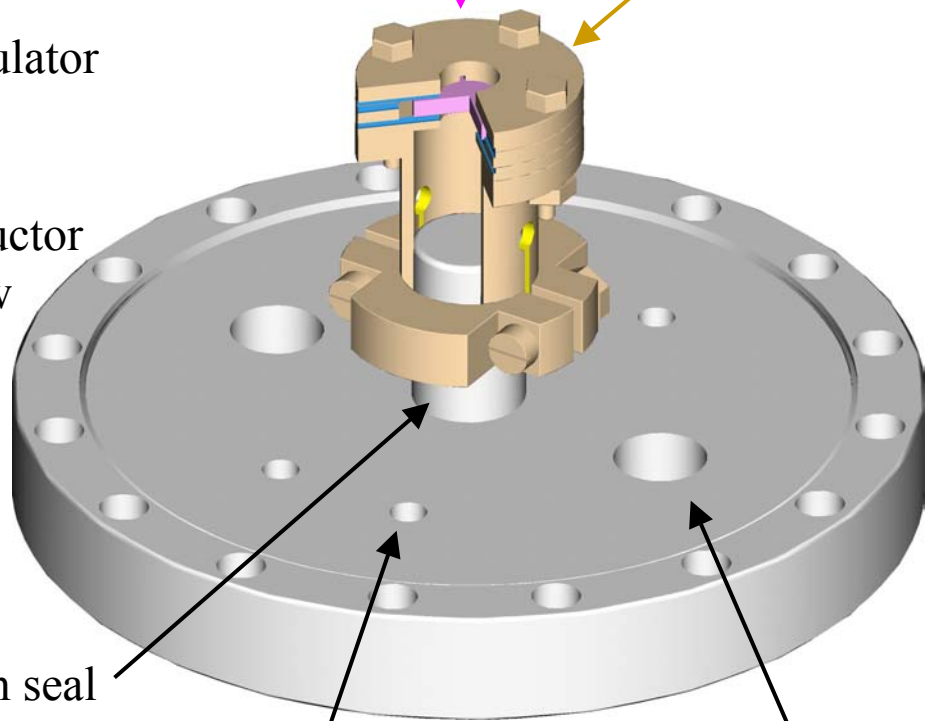
Sample holder is made of Mo

Ceramic Insulator

Copper conductor with set screw

S.S. vacuum seal

Air cooling inlet

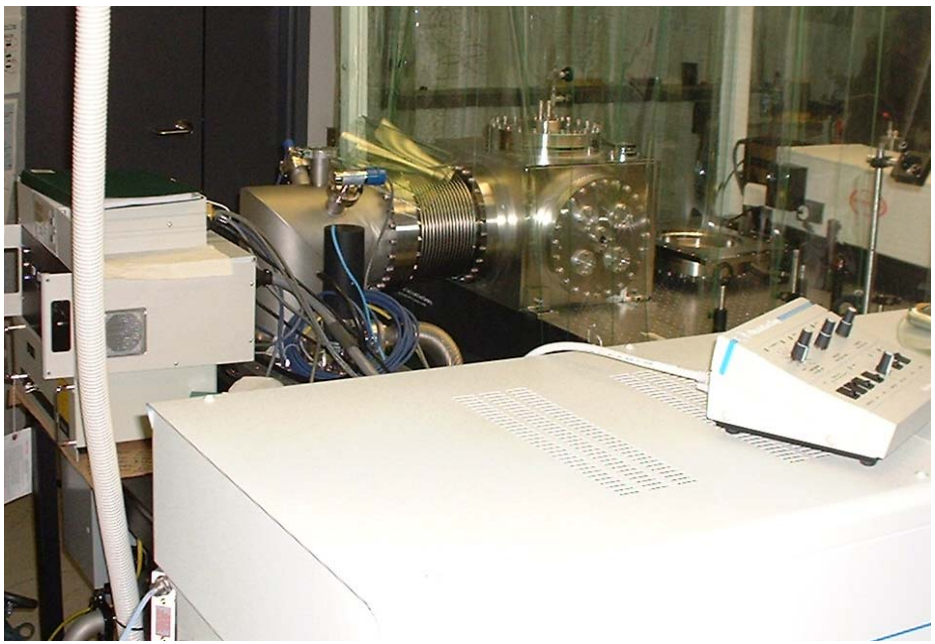


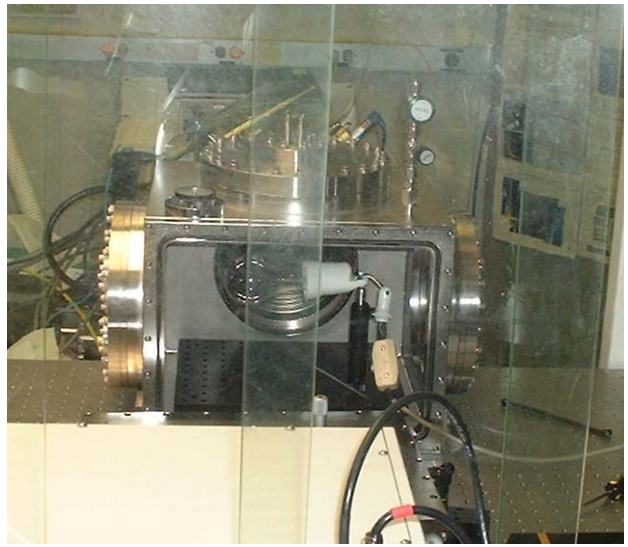
Thermocouple feed through

Power feed through

Vacuum System is Ready

- Vacuum System:
  - ✓ Capable to 10^{-8} Torr

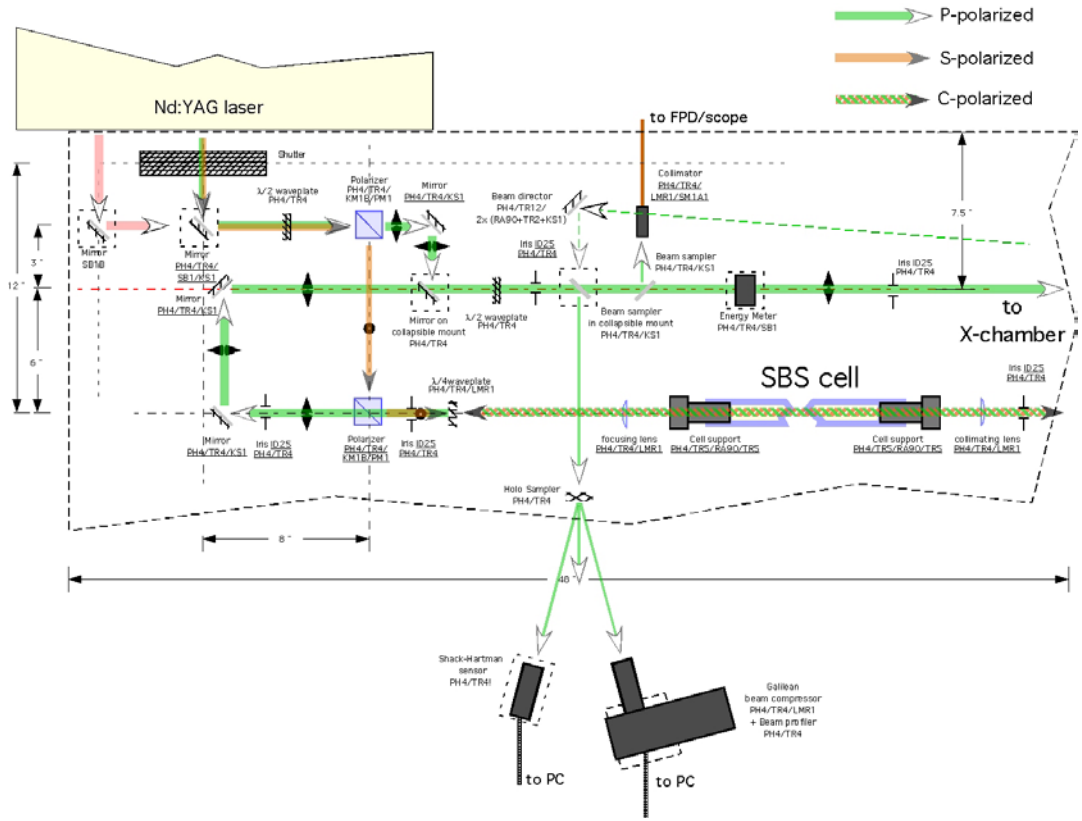




- High-temperature Sample Holder can radiate up to 100W into the chamber:

  Mockup Experiment

Laser Optical Train is Ready
New SBS cell is in Fabrication



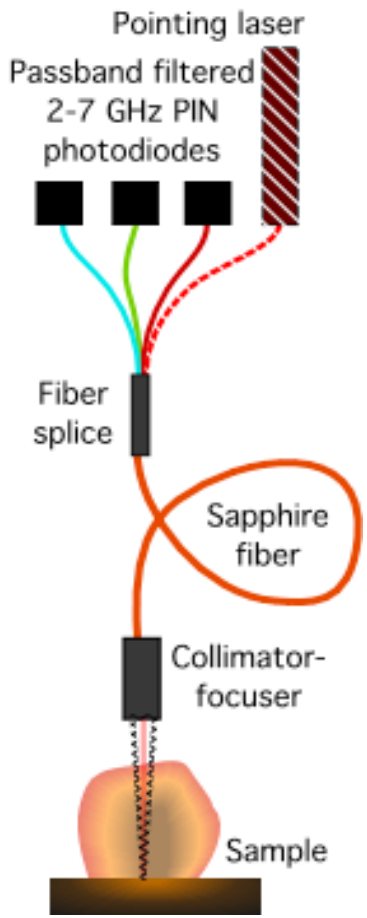
- Data Acquisition system is capable of 5 G sample/s.
  - ✓ Equipment installed. Software being developed.
- Timing/control system is tested at protoboard level.

Real-time Temperature Measurements Can Be Made With Fast Optical Thermometry

MCFOT–Multi-Color Fiber Optic Thermometry

- Compares the thermal emission intensity at several narrow spectral bands.

- **Time resolution ~100 ps to 1 ns.**
- **Measurement range is from ambient to ionization—self-calibrating.**
- **Simple design, construction, operation and analysis.**
- **Easy selection of spectral ranges, via filter changes.**
- ~~**Emissivity must be known.**~~
  - ✓ Emissivitiy Correlation can be used!



- Detailed Design completed. Parts Purchased.

Experiment Should Be Ready By June 2002