ESA Laser SEE Studies

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Matra BAE Dynamics

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Summary

- Aims
- Devices
- Picosecond LASER Facility (SEREEL)
- Laser test results (532nm - Green)
- Laser test results (1064nm - Infra red)
- Ion beam test results
- Laser Calibration
- Sensitive Depth and Thickness Analysis
- FPGA Tests

AIMS

- Develop Green Laser Facility
- Compare tests with Infra red Laser tests
- Investigate effects of feature size on Laser capability
- Calibrate against Ion Beam test results
- Investigate sensitive thicknesses and depths
- Investigate Laser induced errors within FPGA

Devices

Part No.	Manufacturer	Revision	Feature Size
CY7C109	Cypress	-	0.65
		-	0.42
M5M51008	Mitsubishi	A	0.8
		B	0.6
		C	0.4
KM681000	Samsung	A	0.7
		B	0.6
		C	0.4
		E	0.3 (TFT)*

All devices are 128k x 8 (1MBit) SRAM

* Thin Film Transistor

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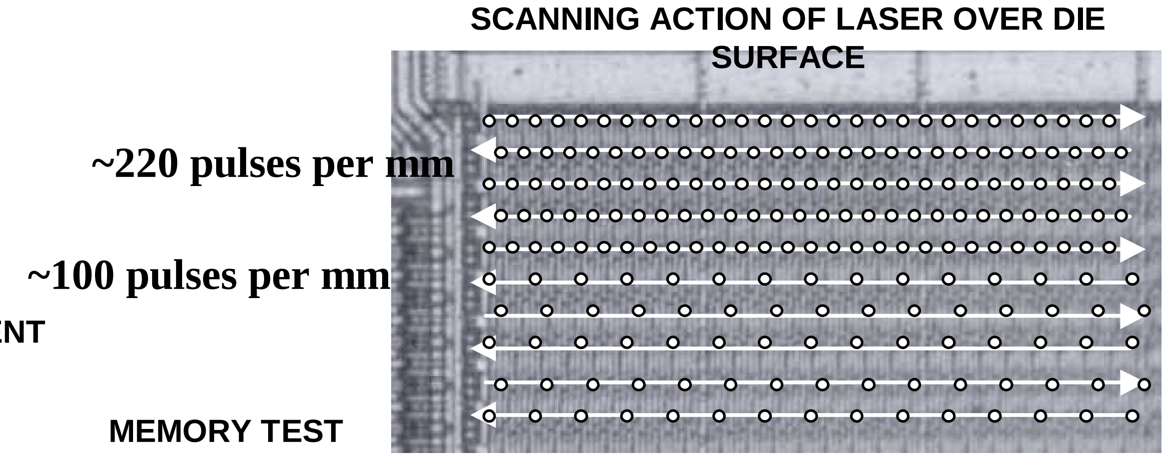
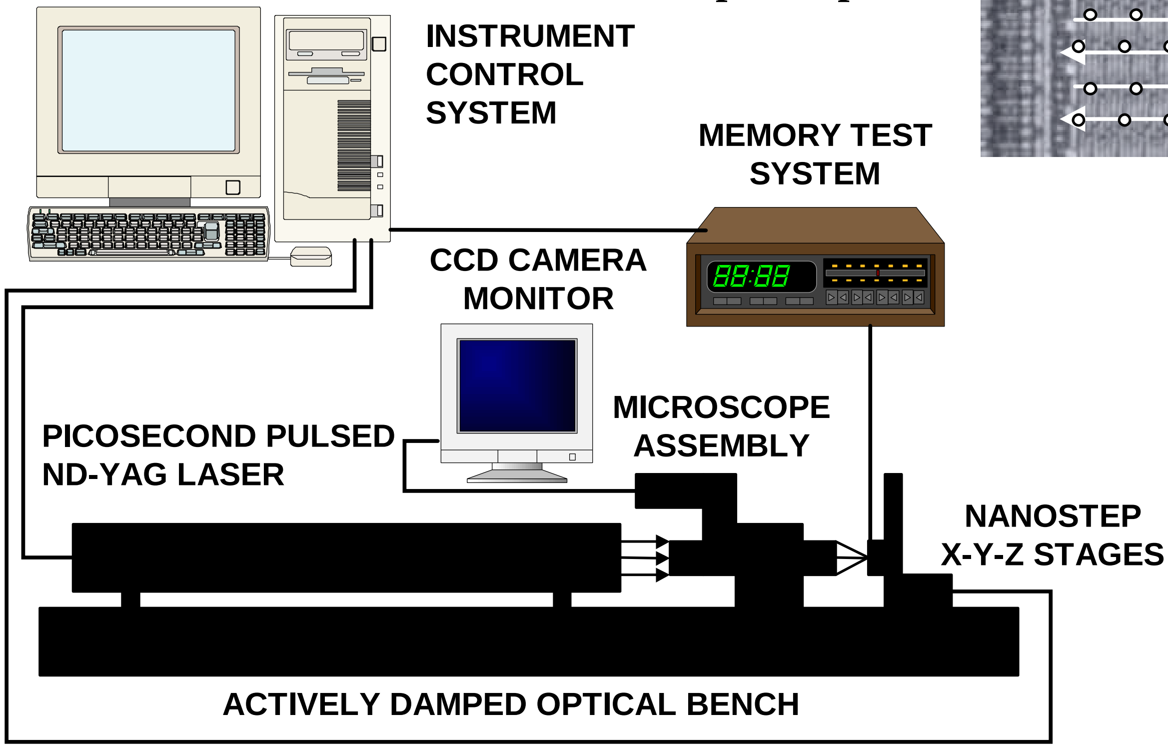
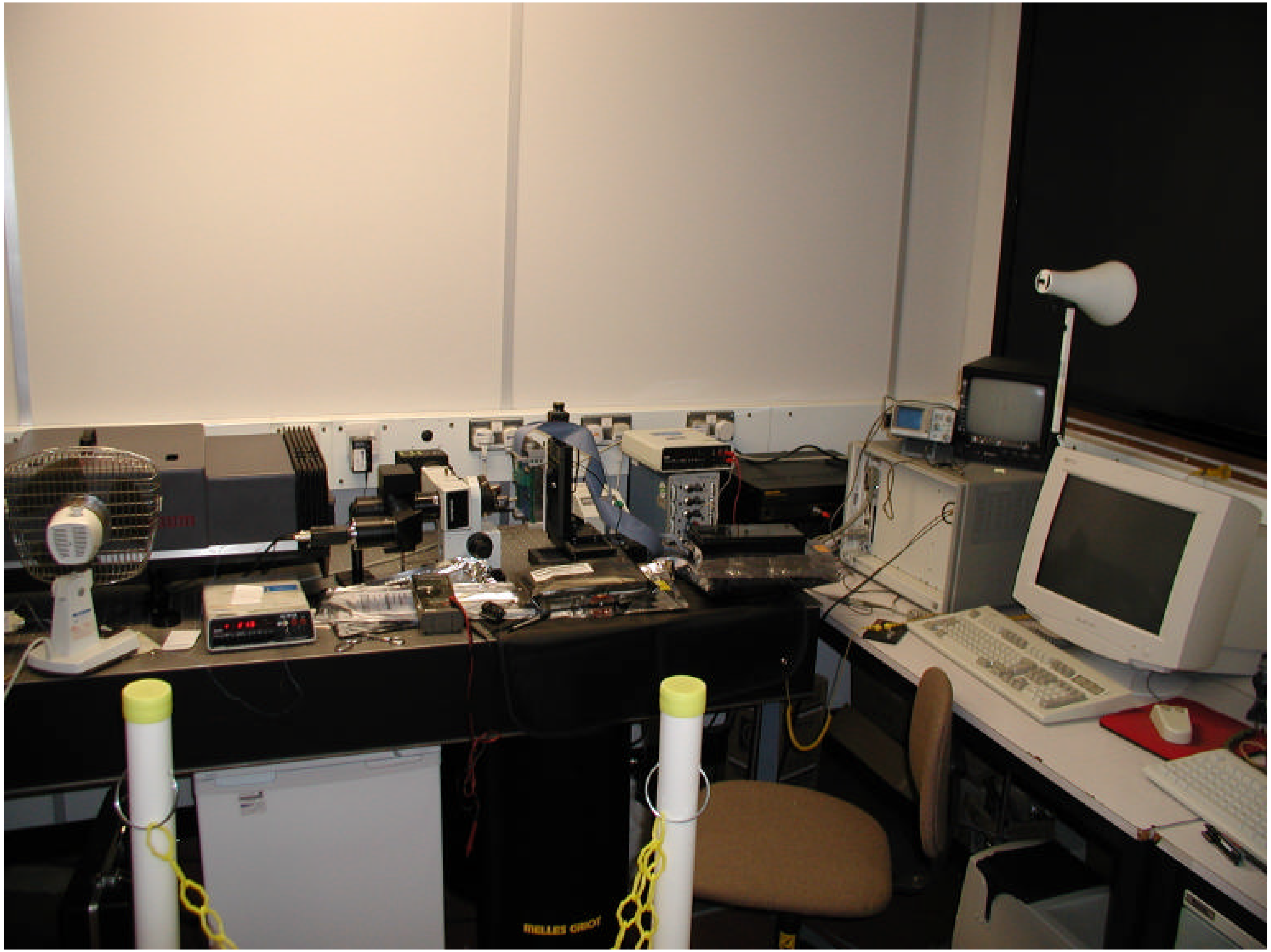
Picosecond Laser Test Facility (SEREEL)



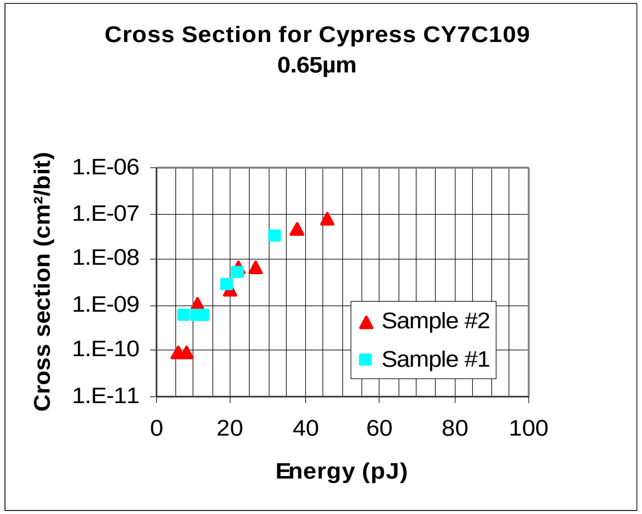


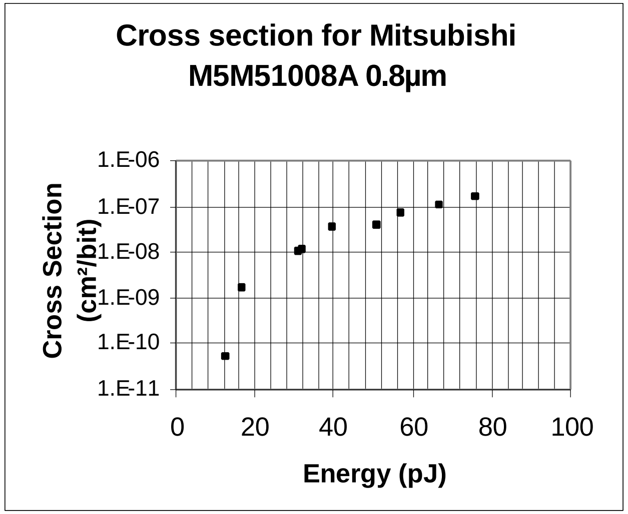
Green Laser Pulses

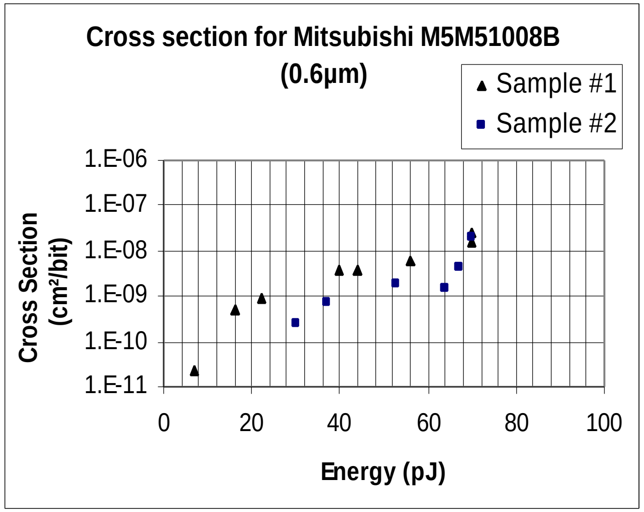
A harmonic oscillator crystal has been installed. Green laser pulses at 532nm are now successfully being produced.

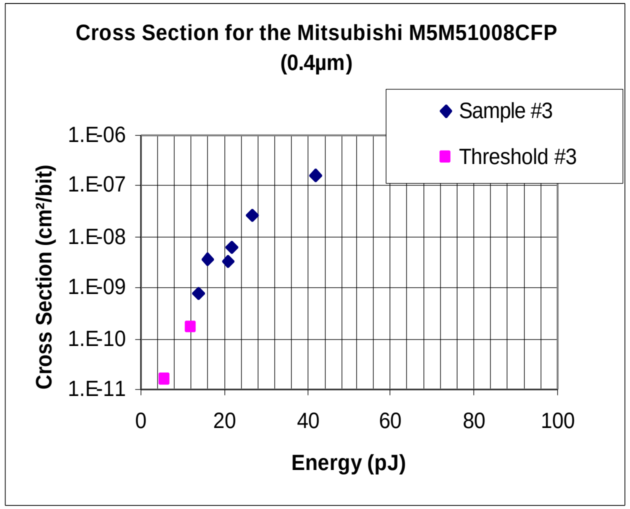

MELLES GRIOT

Green Laser Pulse Results









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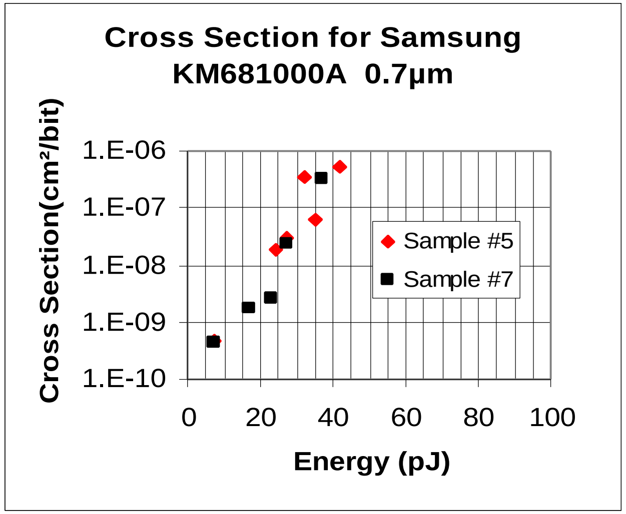
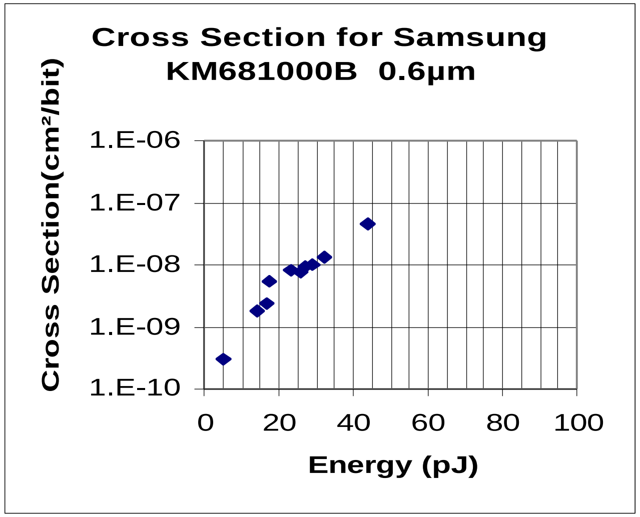
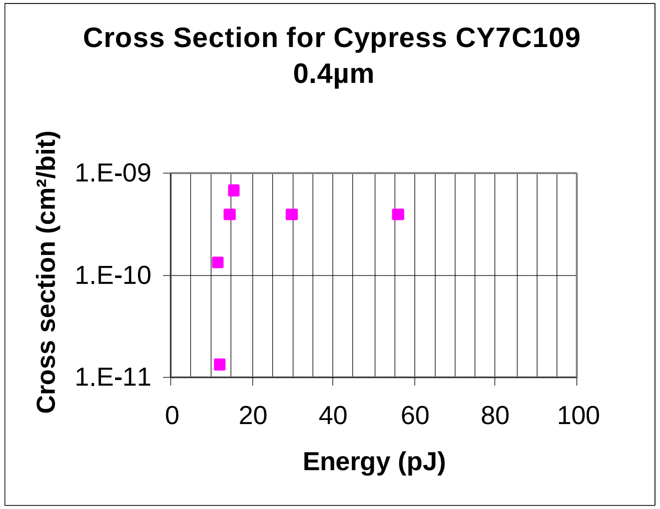
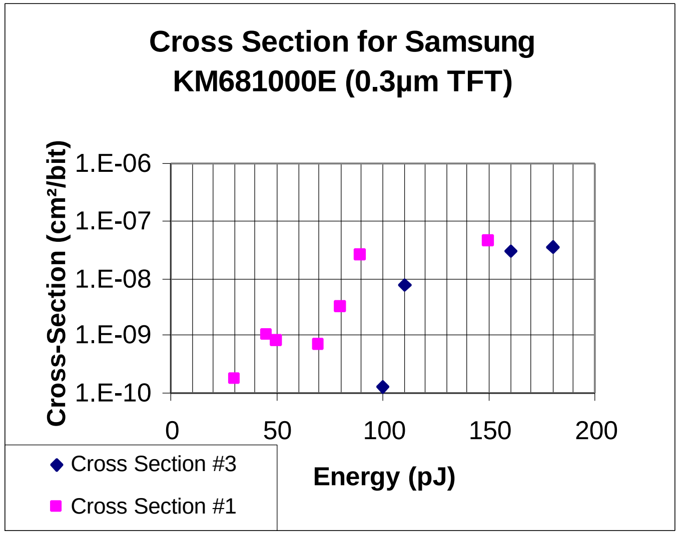
Green Laser Pulse Results (Cond)









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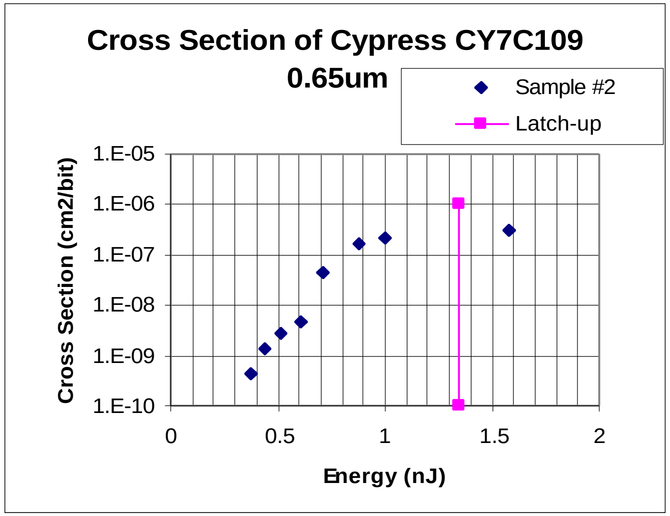
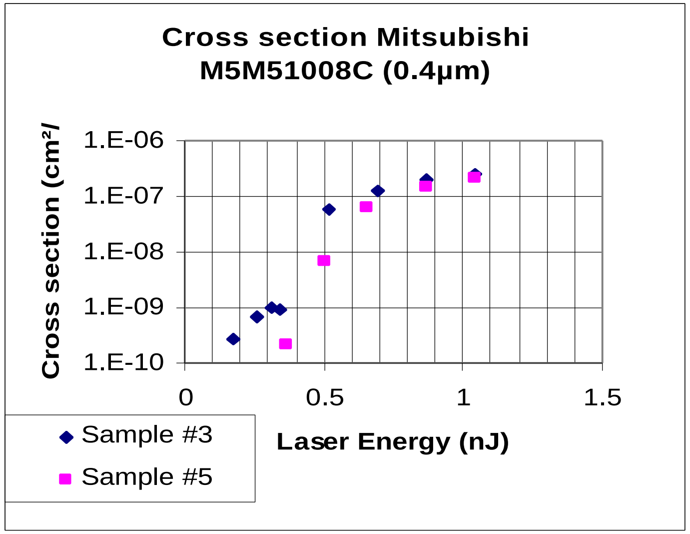
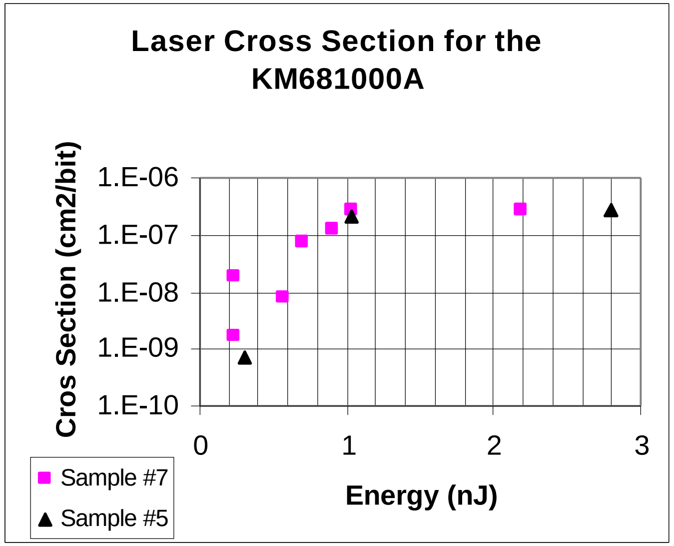
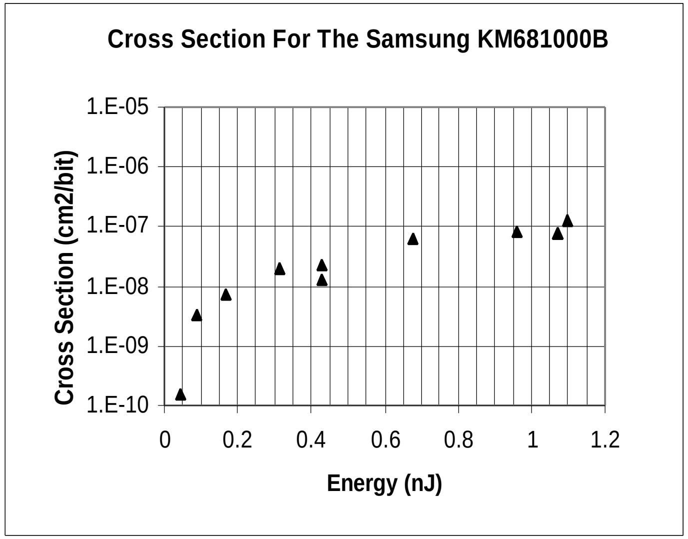
Infra Red Laser Pulse Results









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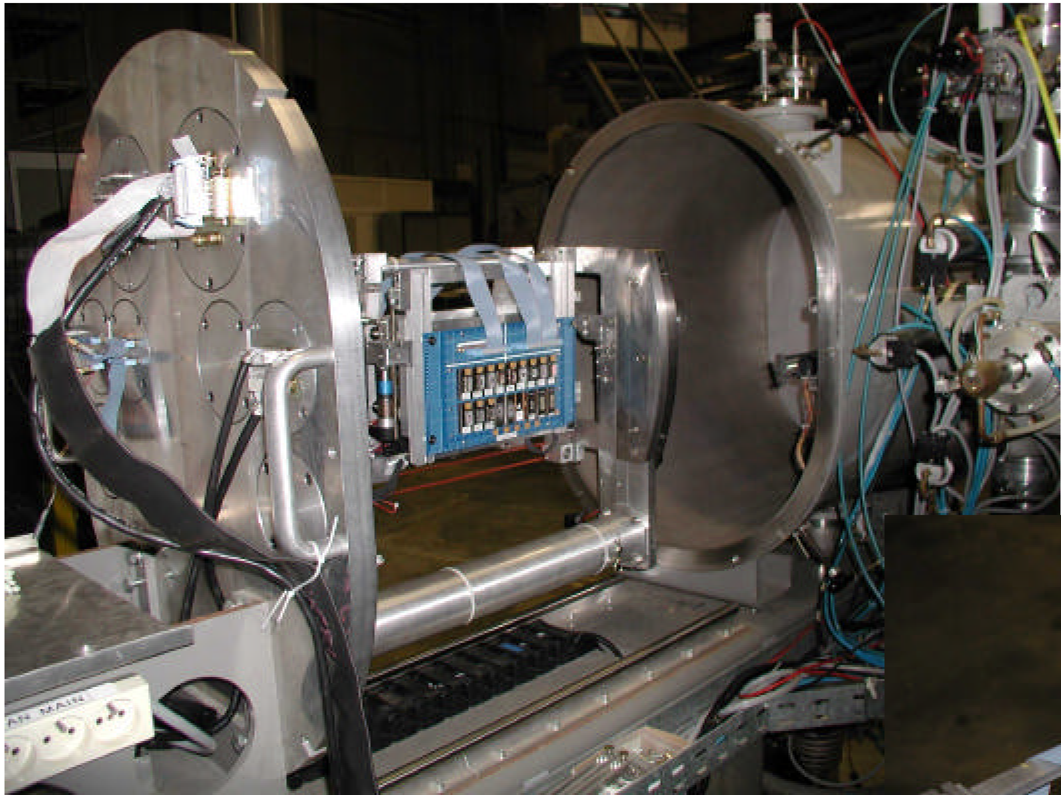
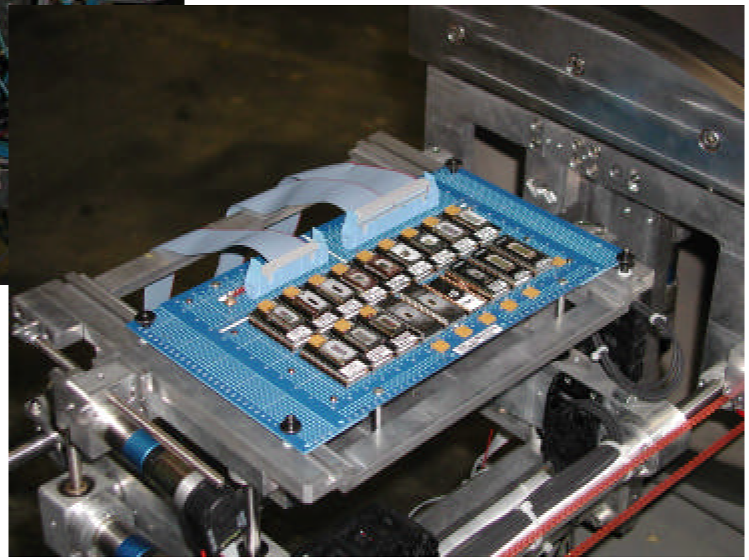
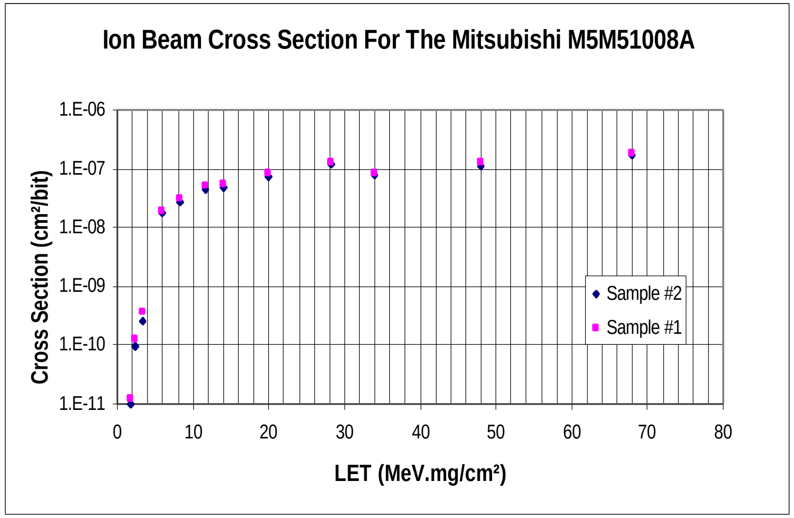


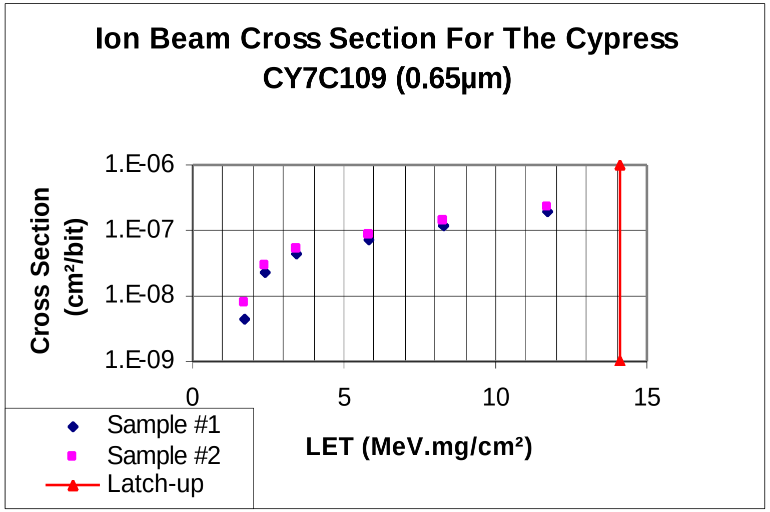
Memory Testing at UCL

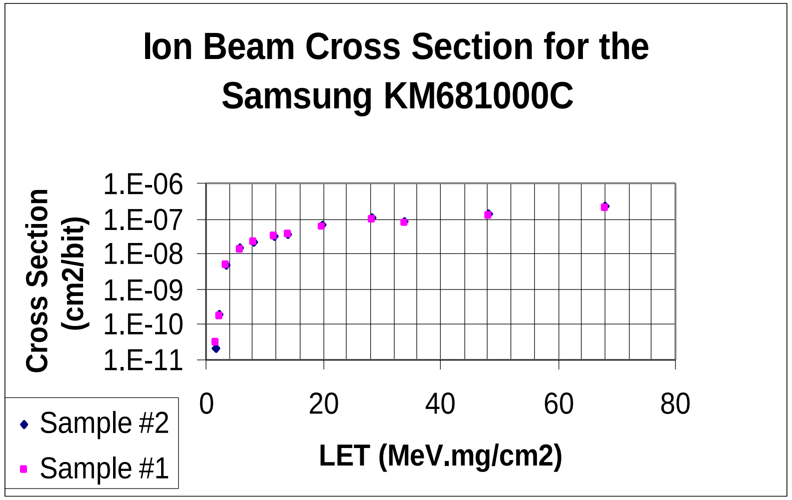
November 2000

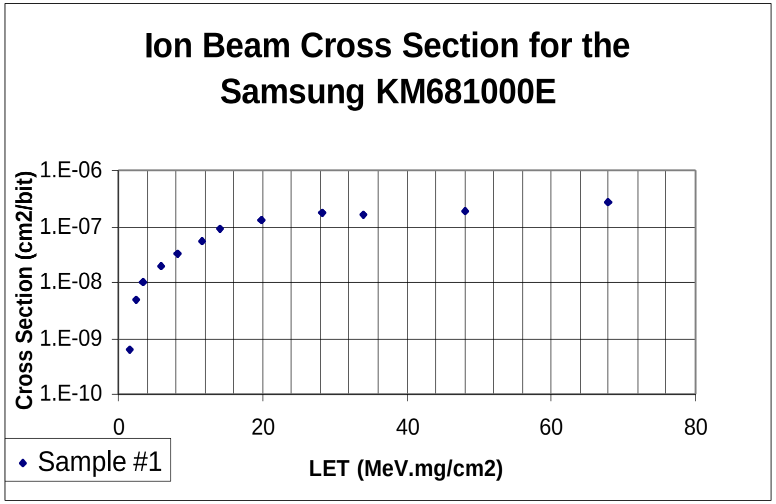


Ion Beam Results









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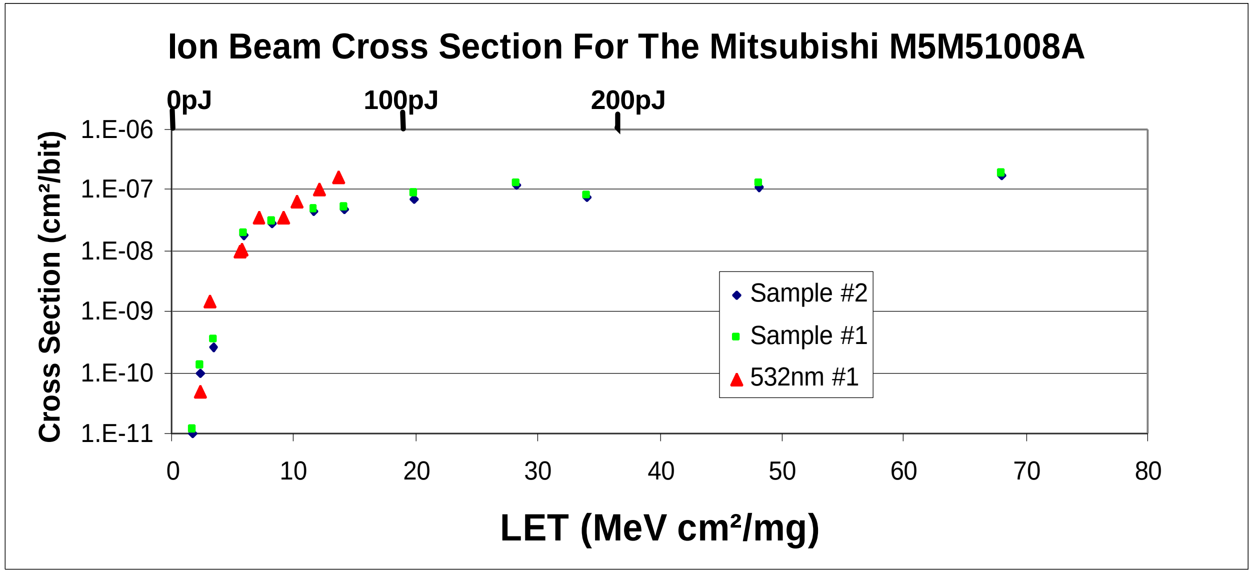
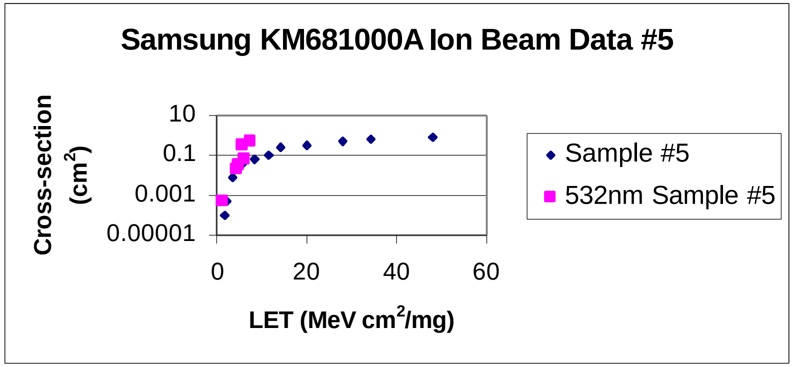
Laser Calibration





Calibrating Green Example

1 pJ = 0.18 MeV cm^2 mg^{-1}

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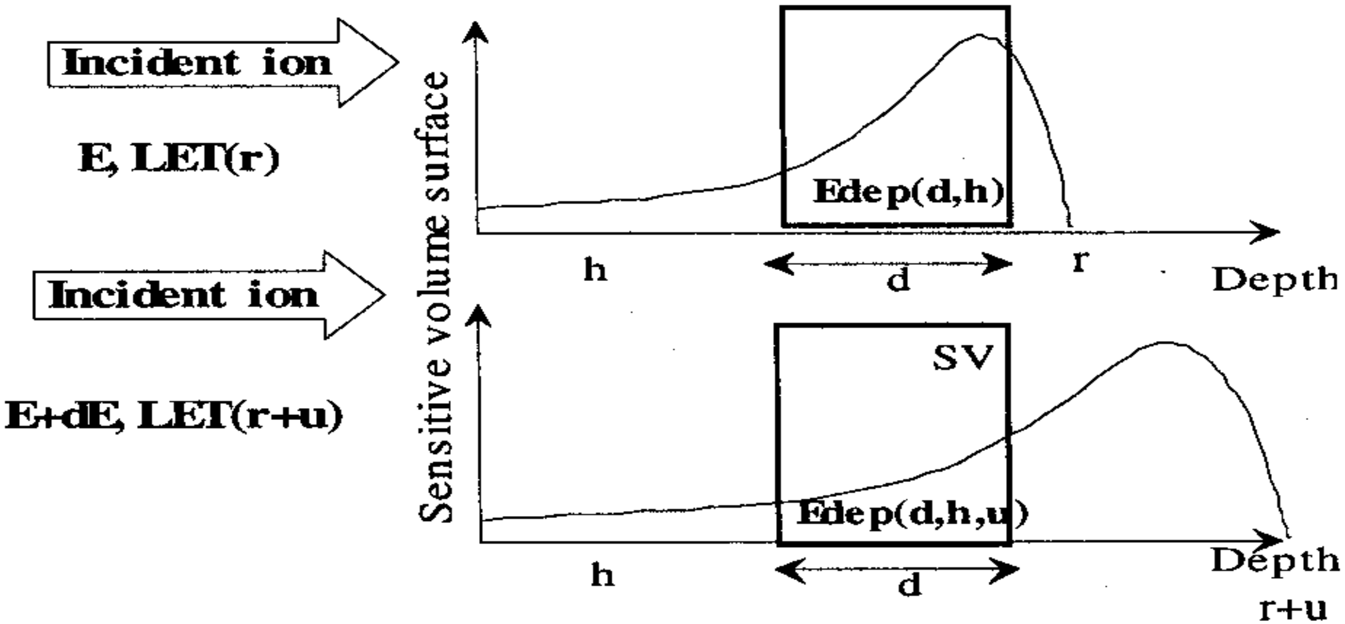
Sensitive Depths and Thickness Analysis

A method of using a beam of carbon ions at a range of energies in order to probe the depth and thickness of the sensitive region has recently been developed and tested by Inguimbert et al (RADECS 99)



The Bragg peak in the ion's energy deposition profile is moved through the sensitive volume by increasing the ion's initial energy

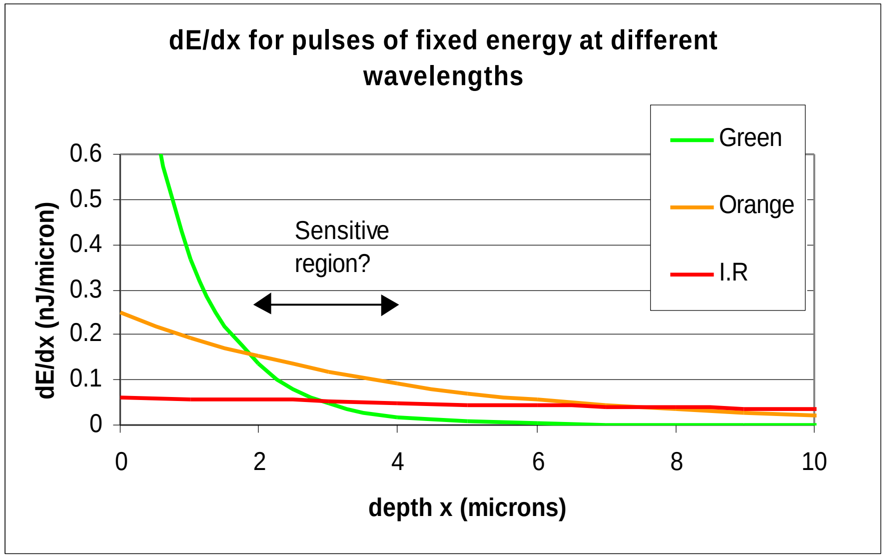
If an ion of a suitable species is chosen, then the device shows a distinct peak of upsets when the Bragg peak occurs within the sensitive volume

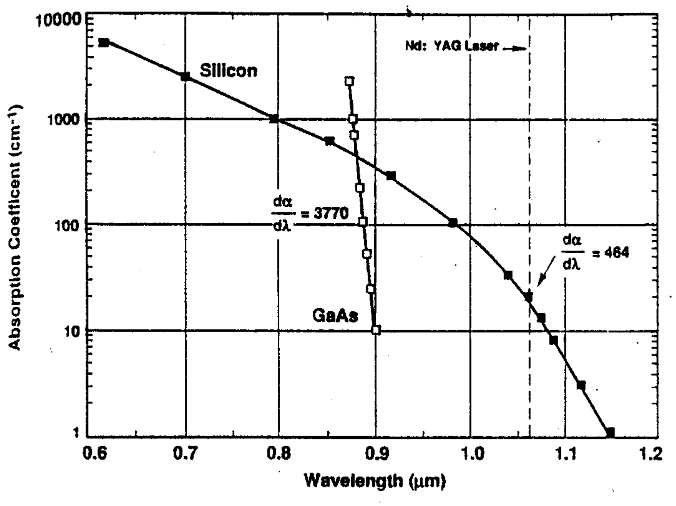
The energy deposition profile for laser pulses in silicon is a decaying exponential

At first sight it is not obvious how this type of profile can reproduce the Bragg peak effect to probe the sensitive region depth and thickness

However, on plotting the energy deposition profiles for a range of wavelengths at constant pulse energy, it can be seen that the energy deposition in an arbitrary range of depth(say 2 to 4 microns for the present example) is a maximum at a wavelength in the middle of the range

It transpires that the peak energy deposition wavelength is very sensitive to the depth and thickness of the sensitive region





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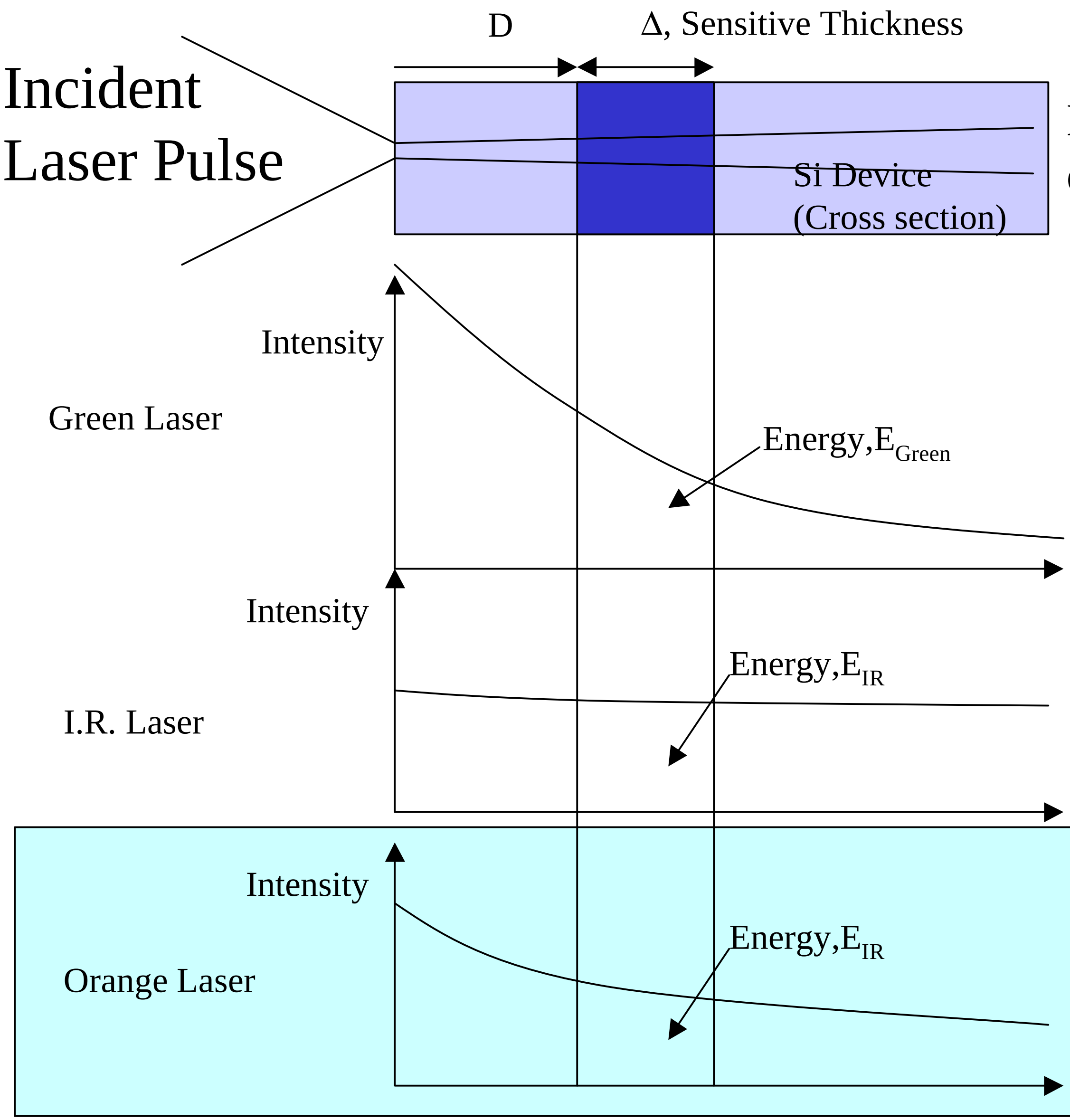


Energy deposited= $\frac{(Ep-Er)}{\alpha} \cdot e^{-\alpha D} \cdot (1-e^{-\alpha\Delta})$

Ep=Incident Laser Energy
Er=Reflected Laser Energy
α =Absorption Coefficient of Silicon

Produces 2 equations, three unknowns: $E_{Green}= E_{IR}$, D and Δ.

Therefore we intend to use a 3rd wavelength to produce 3 equations to solve for D and Δ

ACTEL 54SX16 FPGA

We have designed and blown a circuit in three samples

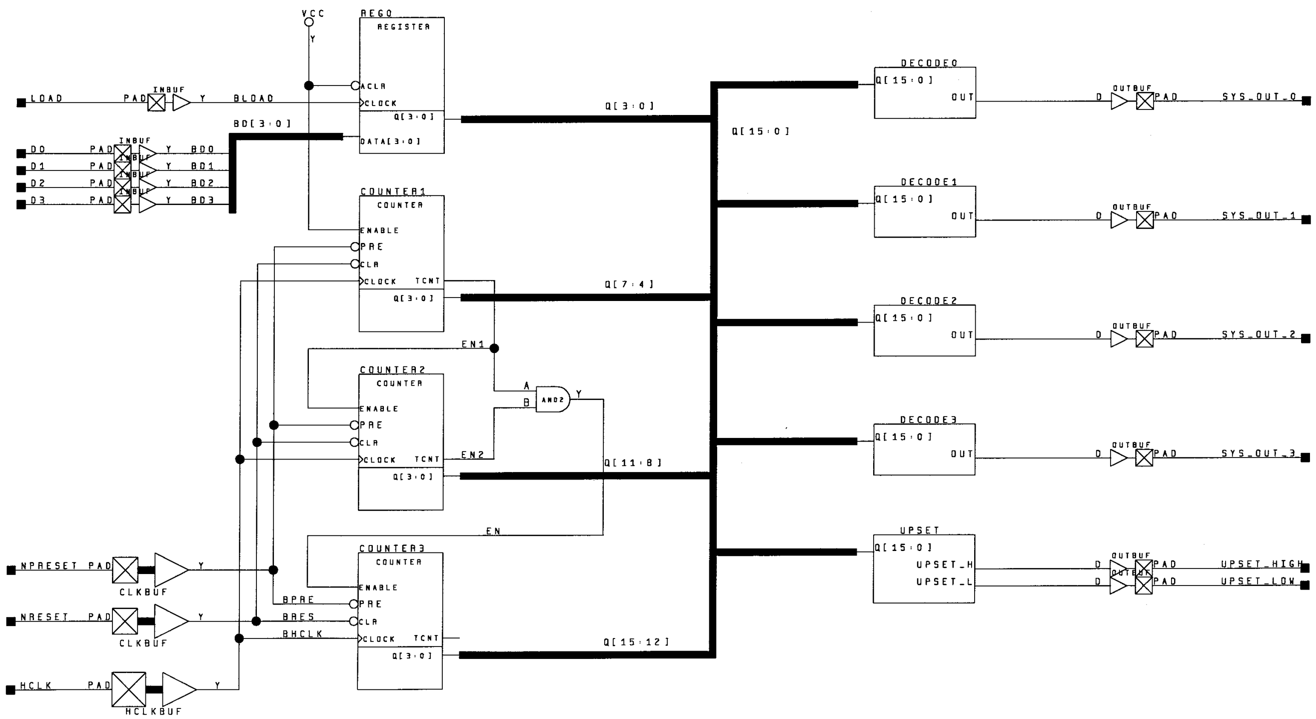
The circuit is designed as a compromise between the need to reproduce representative behaviours (such as some error events not being manifested at the outputs) and the need to avoid excessive complexity

We have been given a map of the location of the circuit elements on the microchip die by Actel

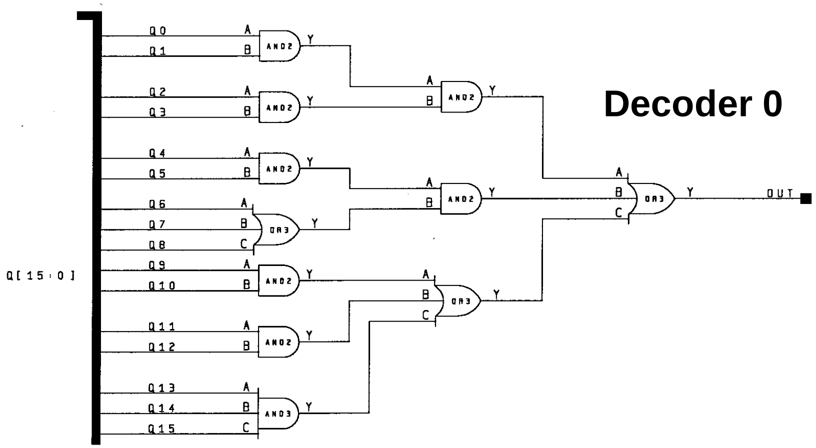
Testing at ion beam failed to produce any events

However, it is likely that the laser will produce events, since it can generate very high equivalent LET's

Circuit outline



Decoder 0



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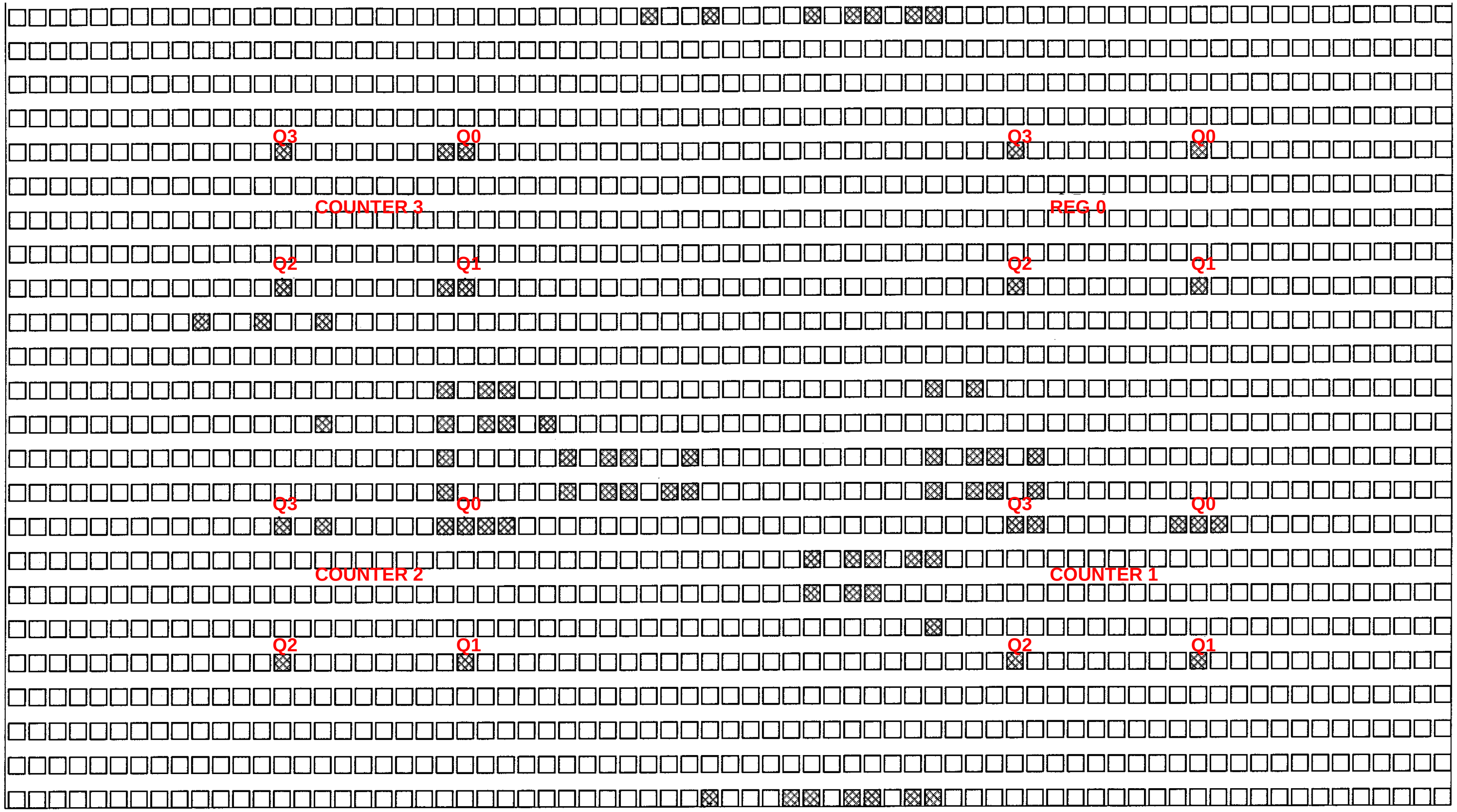
FPGA Die Map



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Conclusions

The empirical data has largely been generated for the SRAMs

- Laser tests using Green and I.R. Light
- Ion Beam tests

Preliminary analyses have been performed and the results look promising

- A calibration factor for Green Laser light has been derived
- feature sizes of 0.4 um can be tested on the Green Laser
- Detailed analyses are continuing.

We have begun to explore a novel application of lasers for the measurement of the sensitive volumes of memory cells

- it is hoped to extend this work using more laser wavelengths in the next year

Laser induced errors in FPGAs will be investigated very soon