Status of sensor R&D in Minsk

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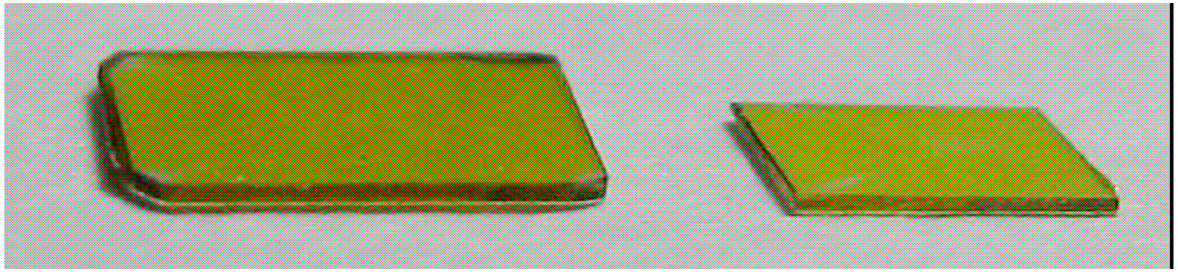
Availible technology

Synthetic monocrystalline diamonds produced by “ADAMAS” plant near Minsk (www.bsuproduct.by/index.php/.91....1.0.0.html)

The diamond plate size of 5x5 mm area and 200-1000 um thickness

Different catalytic environments and synthesis conditions are investigated in order to reduce the impurity content.

The detectors could be used in beam monitoring and similar applications.



Our institute have the following facilities

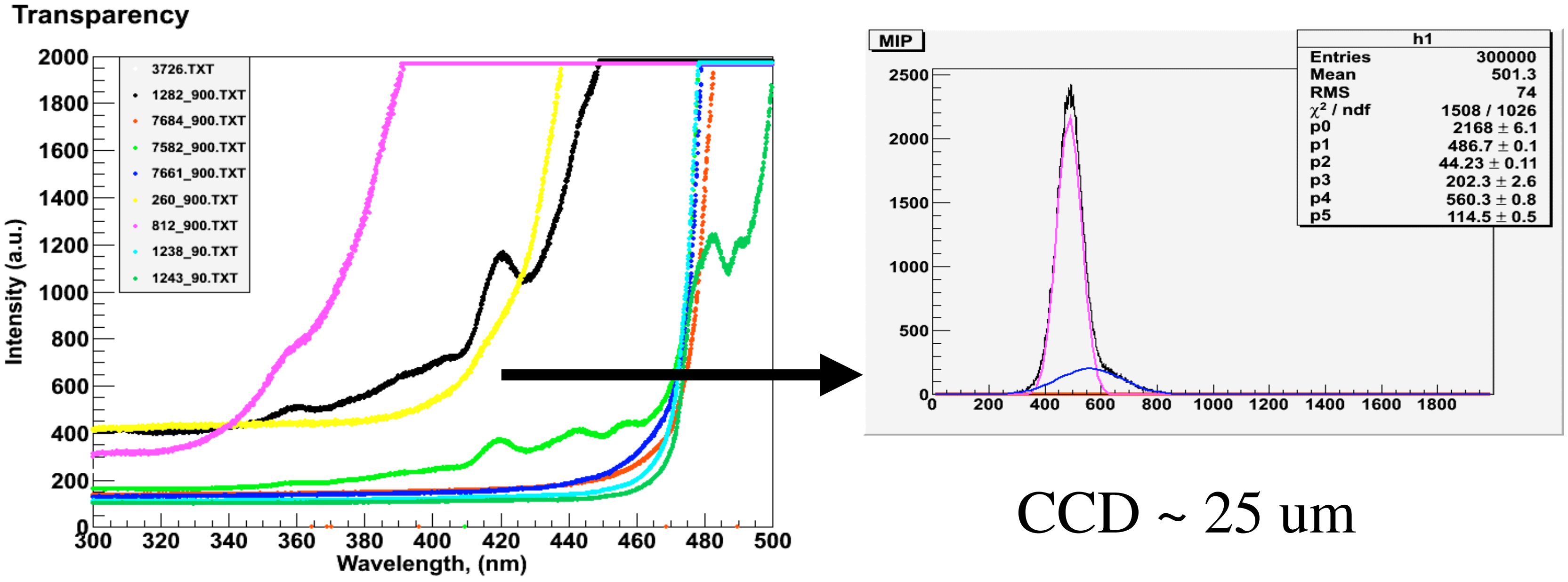
- CCD measurement setup
- Absorption spectroscopy setup (optical)

Current work

“Adamas” is working on the optimisation of synthesis process

We are working on establishing the selection criteria to distinguish “detector grade” crystals without cutting and metallisation

Optical absorption spectroscopy



CCD ~ 25 um

Lower N content -> edge closer to UV -> better detector properties

Current work

A number of samples were investigated - so far the samples with "good" optical spectrum show CCD above the average

~20 vs < 10 um

Thermobaric treatment seems to improve the detector properties
At the moment we are investigateing this.

A few new crystals were selected on the basis of optical spectra and measured. The best have about 25 um CCD. We are going to make measurements after the thermobaric treatment.

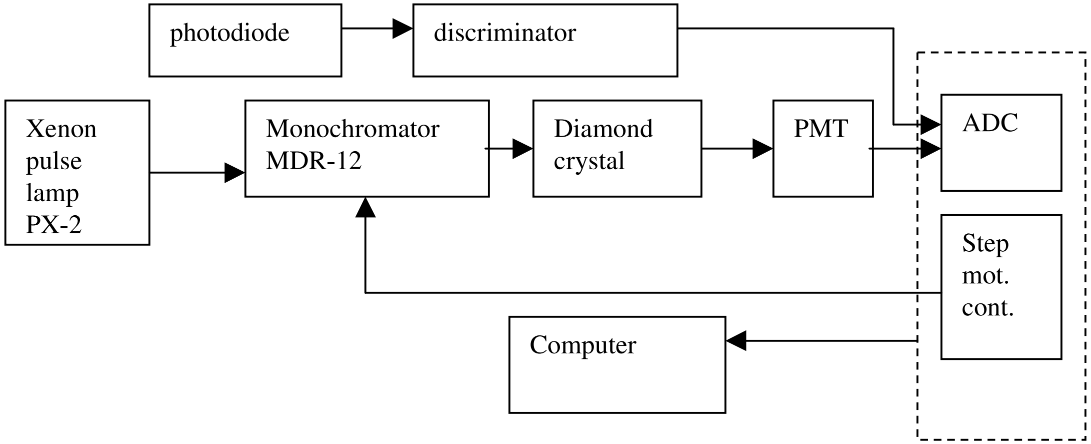
Investigation of different
catalytic environments
and their influence

Future work

Nitrogen pulse laser will be used for optical fluorescence spectrocopy
This will allow to get more information about impurities and improve the selection process

A number of new synthesis thechniques will be tried out by ADAMAS

Absorption setup



photodiode

discriminator

Xenon pulse lamp PX-2

Monochromator MDR-12

Diamond crystal

PMT

ADC

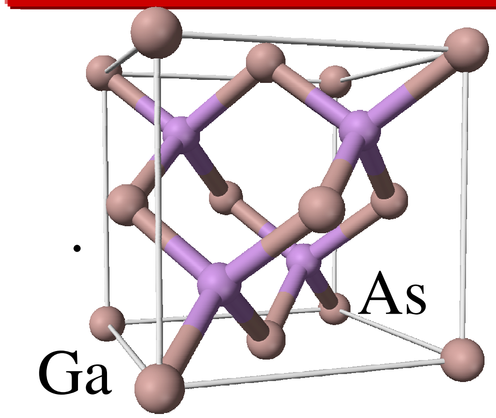
Step mot. cont.

Computer

Gallium Arsenide radiation hardness review

K. Afanaciev

The material



Gallium arsenide (GaAs)

Compound semiconductor, direct bandgap
Two sublattices of face centered cubic lattice
(zinc-blende type)

Semiinsulating - no p-n junction

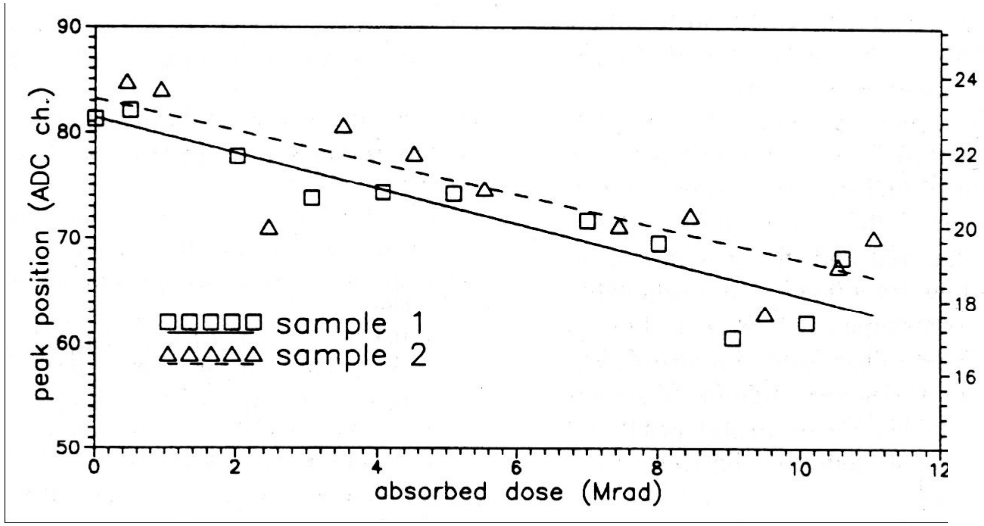
Doped with shallow donor (Sn) and then compensated with deep acceptor (Cr) resulting in a I-type conductivity.

Signal charge transport mainly by electrons

		GaAs
	Density	5.32 g/cm^3
●	Pair creation E	4.3 eV/pair
●	Band gap	1.42 eV
●	Electron mobility	8500 cm^2/Vs
	Hole mobility	400 cm^2/Vs
●	Dielectric const.	12.85
●	Radiation length	2.3 cm
	Ave. E_{dep}/100 µm (by 10 MeV e^-)	69.7 keV
	Ave. pairs/100 µm	13000
	Structure	p-n or insul.

Radiation Tests of Semiconductor Detectors. Valery Chmill
PhD Thesis, 2006

Material: Cr and Fe compensated semiinsulating GaAs



23 MeV Neutrons

Fluence up to 1.2x10^{15}

Also V.B. Chmill et al. /Nud. *Ins&. and Meth. in Phys Res. A* 395 (1997) 65-70

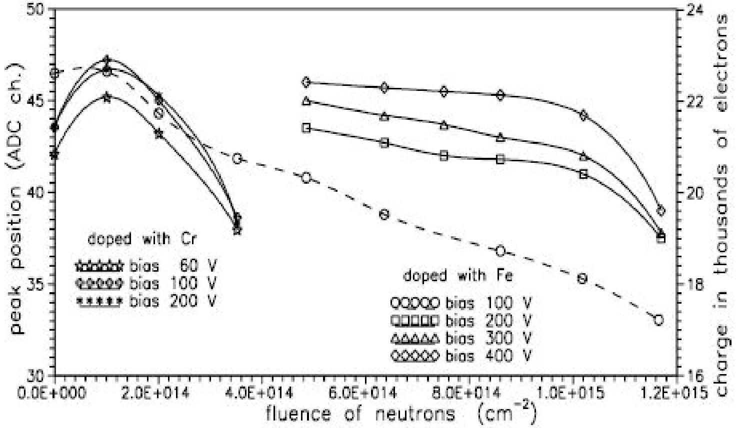


Figure 4.7: Charge collection (spectrum peak position for most probable energy loss) vs. neutron irradiation. The lines are drawn to guide the eye.

Peak position vs dose up to 110 kGy

^{137}Cs– gamma rays, *E* = 661 keV

About 20% drop

Radiation Tests of Semiconductor Detectors. Valery Chmill
PhD Thesis

Material: Cr and Fe compensated semiinsulating GaAs

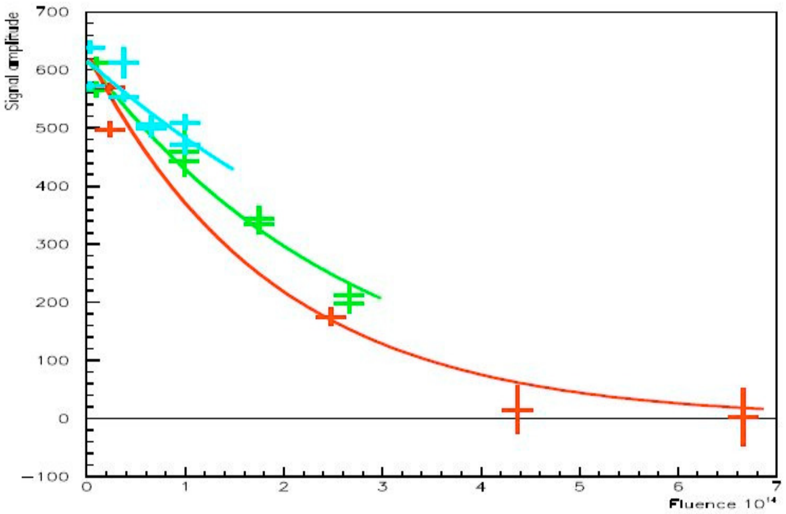
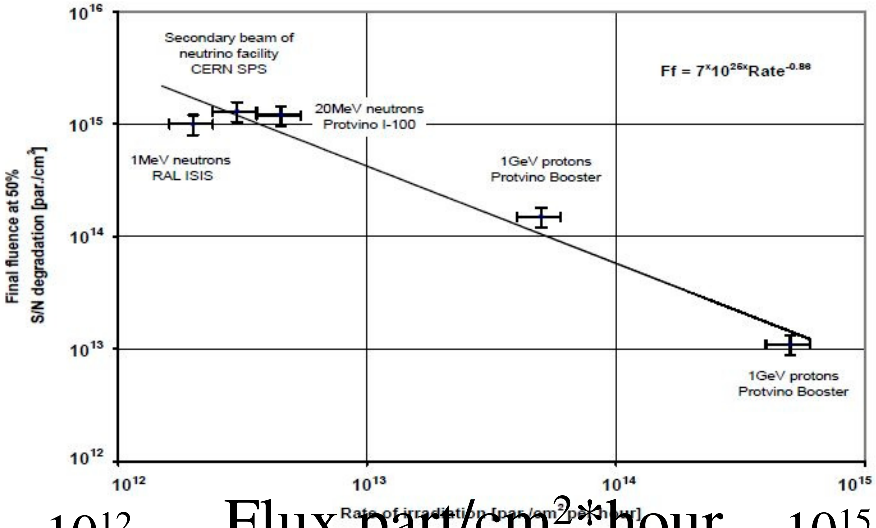


Figure 5.8: The degradation of signal response for bias value 76 V. The three lines correspond to the different positions for the GaAs detectors.



10^{12} Flux part/cm^2*hour 10^{15}

Figure 9.2: Half SNR degradation dependance for different rates of irradiation. Line is drawn as power fit result.

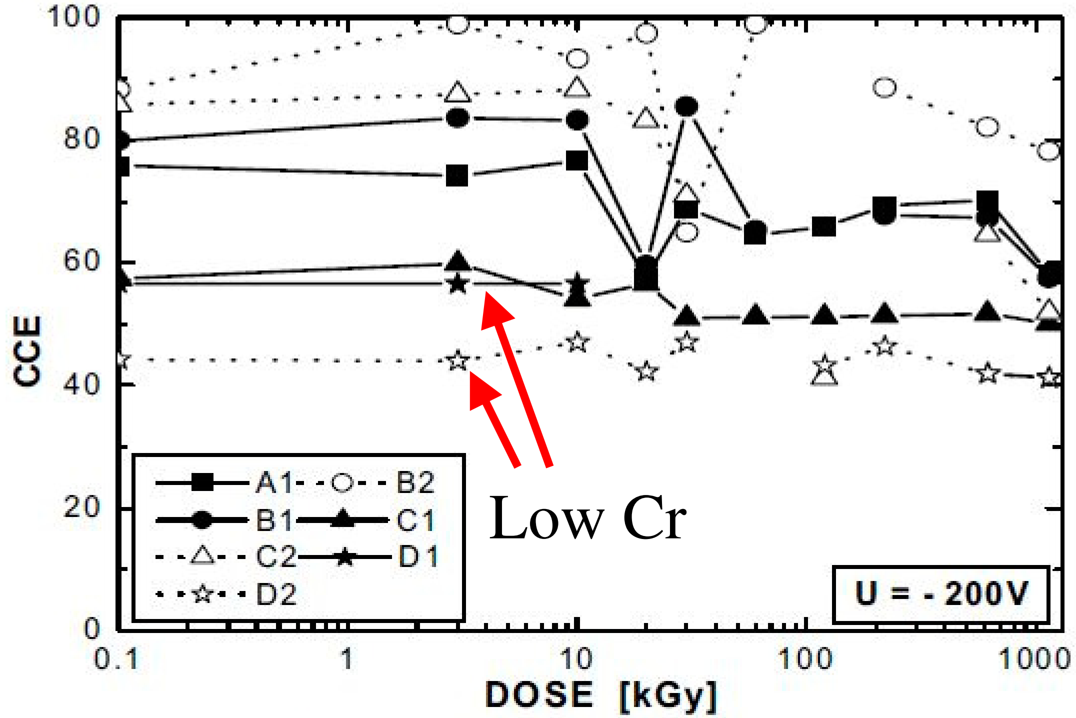
SPS Mixed Beam: 540 GeV protons on beryllium target. Max fluence 7x10^{14}

dose rate ratio 1(red) : 0.32 (green) : 0.16

The dose rate have influence on radiation hardness for hadron irradiation

Radiation resistance study of SI GaAs based radiation detectors to extremely high gamma doses

(Nuclear Physics B (Proc. Suppl.) 150 (2006) 402–406)



Low Cr

Figure 5: The CCE vs. irradiation dose for all types of samples

LEC semiinsulating GaAs undoped

Irradiation by ^{60}Co gamma source (1.17 and 1.33 MeV photons)

R.L. Bates et al. Recent results on GaAs detectors
(*Nuc1. Instr. and Meth. in Phys. Res. A 392 (1997) 269-273)*

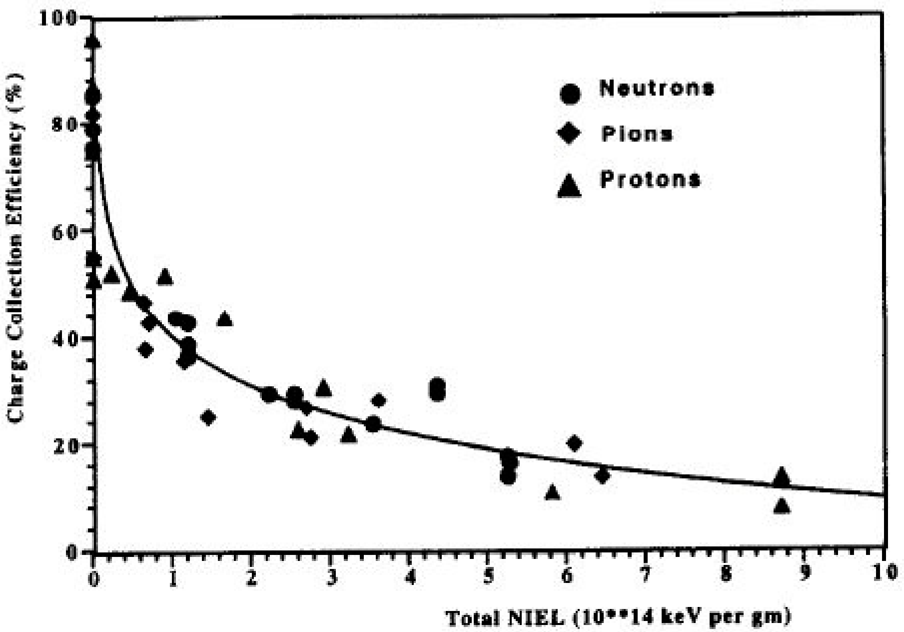


Fig. 4. The charge collection efficiency as a function of total NIEL for ISIS neutrons, 300 MeV/*c* pions and 24 GeV/*c* protons for 200 µm thick SI-U LEC GaAs detectors.

NIEL - non ionising energy loss

LEC undoped GaAs

R.L. Bates at al The effects of radiation on gallium arsenide radiation detectors
Nuc1. Instr. and Meth. in Phys. Res. A 395 (1997)54-59

neutrons

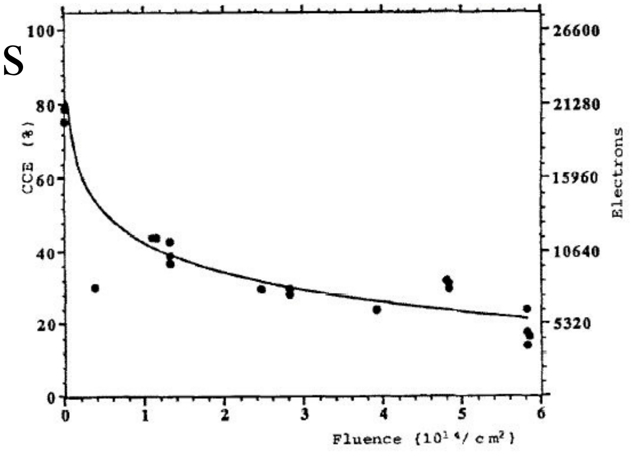


Fig. 5. The cce of 200 μm thick GaAs detectors as a function of neutron fluence, measured at 200 V and 20°C.

pions

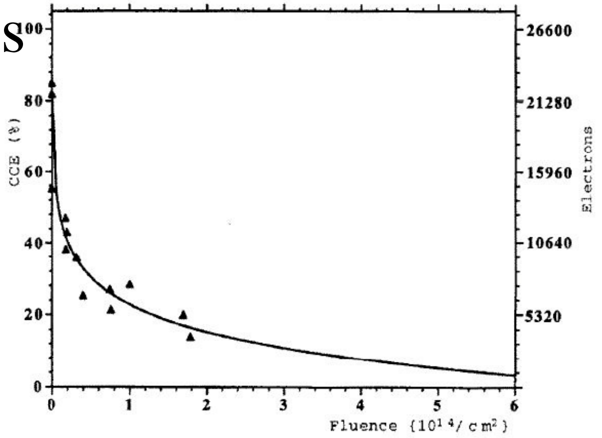


Fig. 7. The cce of 200 μm thick GaAs detectors as a function of pion fluence, measured at 200 V and 20°C.

LEC undoped GaAs

protons

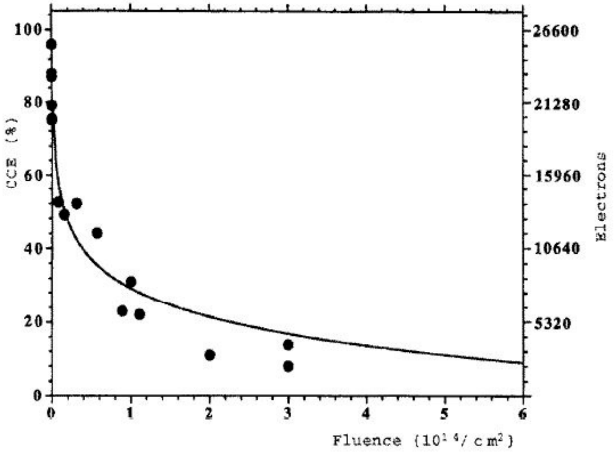


Fig. 6. The cce of 200 μm thick GaAs detectors as a function of proton fluence, measured at 200 V and 20°C.