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Detectors, Amps ADC's

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This is an attempt to bring together all that we know about the developments in amplifiers etc over the last few years as they effect the performance of the sheet resistance detectors through our electronics and readout system. It is hoped this will enable us to focus on how best to proceed.

In the beginning.....

Way back at the start of the MEGHA project, we carried out some tests on the performance of the sheet resistance detectors we planned to use. At that time the only supplier was Hamamatsu and their detectors had a thickness of 300 microns. These tests were carried out using Cooknell preamps, Ortec amps and Daresbury ADCs. The tests showed that while our usual shaping times of 1-2 microseconds were adequate to give good position resolution, the energy signal suffered from a position dependent ballistic deficit which required longer shaping times. To eradicate the effect required 10 microseconds.

As the project has developed we have built our own preamps and amplifiers and also evolved a DA system using Silena ADCs. This arrangement works well for the position signals (and indeed for strip detector use where similar shaping times are used) but has run into problems when we use the longer shaping times needed for the energy signals on the sheet resistance detectors. There are two aspects to this, both of which are related.

Firstly, the new MEGHA amps produce a different pulse shape compared to an Ortec amp (not surprising as they are a "cheap and cheerful" version). While the rising part of the pulse has a semi-Gaussian shape similar to an Ortec, the falling part is skewed to longer times. The effect is that when running at a shaping time which gives a similar rising part to an Ortec on 6 microseconds, the MEGHA amps give a falling part of the pulse which lasts about twice as long as that on an Ortec amp. Apart from possible problems of pileup at high rates, this would not have been a problem, where it not for the fact that the Silena ADCs cannot cope with pulses having long shaping times (the manual quotes an acceptable range of 1-8 microseconds time to peak. For Ortec amp the time to peak is approx 2x shaping time). The problem is that the peak detect and hold circuit operates by comparing the level of the input pulse with a delayed version of the input pulse, registering the peak when the former drops below the later. Because the delay is very short, for slowly varying pulses (long shaping), this difference never gets large enough to trigger the discriminator.

More recently we have started getting detectors from another manufacturer (Eurisys) which are thicker (500 microns) and have a different sheet resistance. The larger thickness means a smaller capacitance and coupled with the different resistance means that the performance is very different. Firstly, it appears that lower resistance feed out resistors on the position signals are required for best resolution and secondly, we seem to be able to get away with shorter shaping times (6 microseconds rather than 10 microseconds).

Another recent development is that we are now starting experimental programmes at GANIL and Strasbourg, where the readout system and detectors used will be different from that at ANU. Furthermore, the initial experience at GANIL suggests that the performance achieved is different in different locations, possibly because of the different frequency profile of the noise environment at each location.

A number of solutions to the problem have been suggested:

1. Do nothing. Use shorter time constants on the energy signals and live with (correct out) the ballistic deficit.

2. Use a charge integrator section in the MEGHA amps instead of the Silena peak detect circuits. A prototype circuit has been designed but not yet tested. However, while this is a viable solution of the MEGHA amps, it doesn't solve the problem for experiments at GANIL or Strasbourg where we plan to use the Silena ADCs on the old DA system

3. Develop a better peak detect circuit for the ADCs. David Smith did in fact design one and we have working examples of this. It works fine, but has only been tested so far with short shaping times and in any case it was intended for the MEGHA amps and would need further work to operate inside the Silena ADCs.

4. Redesign the MEGHA amps to have a more Gaussian shape

5. Switch to completely different amplifiers with better shaping. Ortec amps are prohibitively expensive. CAEN offer a possible unit, but the performance is as yet untested and the cost may be a bit too high. However, a few of these for the energy signals and using the MEGHA units for the position signals may be possible (see later section for comparison of costs).

We are now in a rather complex situation where we have to decide on "fixes" for our problem, which may differ between ANU, GANIL and Strasbourg. In all cases the "problem" only arises when sheet resistance detectors are used. There is no difficulty with the strip detectors, or indeed with any detectors which require shaping times of only a few microseconds. However, it does seem that for the Eurisys detectors we have purchased recently, shorter shaping times are required. So if we plan to order thicker detectors in the future, the present problems may not be relevant.

ANU (MEGHA)

Here we have an investment of nearly 100 Hamamatsu detectors which we want to use (although there is no reason why we shouldn't switch to Eurisys for any future orders).

The simplest solution here would seem to be to develop the sample and hold circuit for use in the energy amplifiers.

Questions. How much work involved?
What timescale?
How many?
What cost?

What time constants to install in amps as defaults?

GANIL

Here we can't use the same solution as we have to make use of the Silena ADCs. Possible solutions are:

1. Buy different amps
2. Buy some new amps for the energy signals only
3. Use the existing Charissa amps (80 available) for the energy signals
4. Switch to thicker detectors (lower shaping)
5. Improve the fall-time of the amplifier signals
6. Design a new peak detect circuit for the Silenas
7. Switch to different ADCs

Each of the above has cost implications and would also need tests performed to check the performance is adequate. These need to be detailed.

Strasbourg

The needs here are probably much the same as at GANIL as the same readout system is to be used. Whatever changes are made for GANIL will enable similar running to be carried out at Strasbourg.

Comparison of costs of MEGHA amps to CAEN option

Nobby and Wilton can provide details. When we costed it recently the CAEN was twice the price. However, since then a number of problems with the CAEN approach have surfaced. Firstly, they have a large power consumption, meaning we can't put as many in a crate as we thought and the cost hence goes up (more crates). Secondly, the fast signal is the same polarity as the input, so we have to have discriminators which can handle either polarity inputs. The type we had costed up was a 16 channel version, but it only works on positive polarity. So we have to use different ones and the ones we have found so far are only 8 channel. Hence there will be a further increase in the cost we estimated. We need to get the details sorted out.

Status of Charissa amplifiers at GANIL
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1. There are two types of amps at GANIL - OLD type and NEW type
OLD type are individual, manually controlled, 8 per Eurocrate.
NEW types are computer controlled, 32 per large Eurocrate.

Both types have TWO time constant settings which can be accessed by either setting internal links (OLD type) or by computer command (NEW type).

Original specification for BOTH types of amplifiers was for BIPOLAR output pulses.

ORIGINAL specification for time constants settings were:

0.75uS, 1.7uS for OLD type (BIPOLAR output)

(in addition to front panel BNC output, some crates also have the output sent to a LEMO socket at RHS of crate; a UNIPOLAR pulse is also available at the front panel test point connector which is inverted with respect to the normal bipolar output)

1.7uS and 6uS (nominally) for NEW type (BIPOLAR output available on front panel LEMO skt; a UNIPOLAR, which is inverted w.r.t front panel bipolar, is also available from 2mm jack socket on front panel)

During June 1997, the following modifications were made to adapt a number of amps to the conditions/detectors at GANIL

Section A - OLD style amps.

Number off.   Label on front panel   Specifications

(changes marked with *)

41 (+3 faulty returning to Bham		
	MOD (near top screw)	UNIPOLAR o/p for TC=0.75uS * BIPOLAR 0/p for TC=1.7uS
15	CsI MOD (near top screw)	UNIPOLAR for TC=3.7uS * BIPOLAR o/p for TC=1.7uS
12	NONE	UNMODIFIED ie TC=0.75us bipolar + TC =1.7us bipolar

SECTION B - NEW style amps

32	none	UNIPOLAR for TC=4.7uS * BIPOLAR for TC=1.7uS

SUMMARY of amps available from Ganil

total of 53 old style amps to move onto Strasbourg with TCs=0.75,1.7us (41 unipolar@0.75us, 12 bipolar) PLUS 15 old style amps with TCs=1.7,3.7us (3.7us unipolar,1.7bipolar) PLUS 32 new style amps with TCs=1.7(bip), 4.6us(unipolar) ; thus if one can use 1.7us bipolar we have 53+15+32=100 amps - enough for just 3 strip PSDs + a few spares...]

Note that approximate time constants for the modified amps were obtained by comparing the measured time to peak with time constants on an ORTEC 572. However, the Charissa amps have longer overall times because the falling edge of the pulses has a simple RC time constant, rather than a semi-Gaussian.

Notes on TCs, detectors etc

AT Ganil, we found the best position resolution for sheet PSDs was for short TC (0.75us unipolar) and 270ohm in series with preamp at corners (hence the mods above). For the energy signals, teh Eurisys detectors were happy with the OLD style amps (CsI MOD) with ~ 3.7uS unipolar, but the Hamamatsu detector needed 6uS unipolar from an ORTEC which could not be read by a SILENA ADC, but was handles OK by a LeCroy 2259A ADC.

The CsI scintillators used the 4.7uS unipolar setting on the new amps which appears to be handled OK by the Silenas.

Odd Thoughts

1. Should we be using/thinking about unipolar or bipolar? In general unipolar runs into problems with baseline shifts for high rates (No worries at GANIL). Larger peak to noise ratio than bipolar so improves resolution?

2. The performance depends on environment+detector+lead resistors+shaping time combination. Will we ever find a single solution?

3. To what extent are the preamps a factor in all this? Problems last run with huge signals from thick CsI preamps.

4. We need a long list of test which need carried out. Which can be done on a bench in the UK (remember need DA system to check things)? Which need to be done with beam, or in the environment of each laboratory? When could we do these? Can we risk any running before we undertake these tests?

5. Can we use positions to reconstruct energy from the PSD's !

6. How do we cope with long pulses in the Silena peak detect circuit? David Smith's circuit will work inside the amps at ANU (So far only tested up to 2uS pulses at ANU!) but not inside the Silena ADC without modification. What about the Gated Integrator?

7. Can we model the preamp-PSD response using SPICE+Richard's code and come up with more answers than questions!

Finally

Comments welcome before or at the meeting!