BWA/lmg

PS/DR/Note 2001-049 (Min.)
11.10.2001

Minutes of PS Technical Meeting No. 123
held on 10th October 2001

DSP, Digital Signal Processing

Present: *B.W. Allardyce, M-E Angoletta, S. Baird, F. Blas, J. Boillot, V. Chohan, J.P. Delahaye, B. Frammery, R. Garoby, J.L. Gonzales, J. Gruber, C. Hill, K.D. Metzmacher, F. Pedersen, F. Perriollat, J.P. Potier, J.P. Riunaud, P. Royer, K.H. Schindl, J. Serrano, F. Voelker*

c.c. : *H. Haseroth, K. Hübner (DSU), S. Maury, T. Linnecar (SL), C. Wyss (DG)*

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1. F. Pedersen explained the history of DSP for Schottky signals at AAC from 1987-96, Q-measurements at the PS from 1989-94, Q-measurements on the Booster from 1991-99, and for Schottky signals at AD from 1998 to the present day. During the 1990s the use of DSPs was dogged by the chips going out of production due to the fast evolution of technology, with the consequent need to constantly change the system.

   Nevertheless, some considerable successes were registered. He pointed out that commercial instruments can sometimes do the job, but they usually suffer from speed limitations compared to a DSP solution. He stressed that the software effort is dominated by system overheads in the DSP and the DSC, not by the real signal processing.

2. M.E. Angoletta presented the details of the AD work. The longitudinal Schottky worked well, but the transverse signals turned out to have severe signal/noise problems so that they could not be used as originally foreseen. This is a pity because they would have yielded a permanent visualisation of beam properties in a non-destructive manner. Instead, the transverse pick-ups are being used to provide Q-values via BTF.

   The system is very complicated with three software layers (DSP, real-time tasks, applications), and is based on a digital receiver board DRX which is much more than just a DSP board.

   The AD system has been successful and is working, although it does not do what was originally intended due to the S/N problems with the transverse pick-ups. There is a good development environment. The coding effort centres on board management rather than on actually processing the signals; the effort for AD was about $1^1/_2$ – 2 years. The system can be seen as a multi-channel programmable spectrum analyser.

3. M.E. Angoletta then presented some slides in order to "demystify" DSPs. She contrasted DSPs with microprocessors and microcontrollers, explained that new CPUs often have some DSP capabilities, and that FPGAs (fast programmable gate arrays) are a promising

development. F. Pedersen pointed out that FPGAs provide a possible way of passing from one generation of board to the next without having to change everything. This constant changing of the technology is redolent of what happened 20 years ago with microprocessors.

It was emphasised that code development has become much easier with the arrival of a number of tool packages on the market.

4. F. Pedersen then presented his view of areas in PS where DSP technology would probably be needed in future. He raised questions concerning the harmonisation of Q-measurements on the various machines in order to profit from the work already done, for example by using the same boards for all the machines and LEIR.

   He also raised the question of the use of DSP in low-level RF controls by showing what was happening at other laboratories. CERN seems to be lagging behind in the use of this new technology; mostly these other labs have invested in systems employing home-designed VXI boards, but CERN has little expertise in this field.

5. In the discussion it was pointed out that modern power converters already contain DSP processing (although not to the level of sophistication needed to process signals from beam pick-ups) and PO Group needs people who understand the technology. It was clear that PS has only a handful of people who are knowledgeable on DSPs, and we must avoid wasting effort by going in different directions with the technology available (e.g. choosing several different processors in the Division).

   Since these techniques will become more and more used, **we need to ensure that our personnel receive suitable training**, but we must avoid that the effort on this subject becomes too large (in other labs the manpower effort quoted is way beyond PS resources).

   It was decided to **set-up a small working group** (M.E. Angoletta, J.L. Gonzales, H. Peschardt, J. Serrano) to advise the DL on how best to proceed (e.g. what technical training is needed and for whom, whether to use just a single type of DSP in the Division, whether help could usefully be obtained in SL where there seem to be more people who are knowledgeable etc.). In parallel, **group leaders should communicate to R. Garoby** the domains where they see the use of DSPs in the next few years, in order to obtain an overall picture of the magnitude of what faces us and to be able to allocate priorities; he will present a résumé to the PSMB.

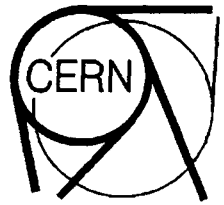
   The slides of F. Pedersen can be found on the G disk, p/Pedersen/Public/Talks and for M.E. Angoletta under a/angolett/Public/DSP-talk.

   Attached to these minutes are their conclusions

B.W. Allardyce

F. PEDERSEN

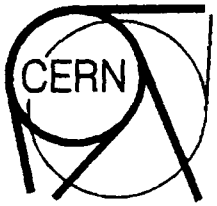
Summary



- FFT Analysis in real time is the method of choice to measure tunes and to analyze Schottky signals
- Today we have 3 different (but all successfully completed) DSP systems in 3 different rings (PS, PSB, AD)
- One project (Schottky analysis in AAC by DSP) was never completed due to inadequate resources and/or not high enough priority
- There is a fast evolution in technology. Some companies disappear (VASP-16 problem), some DSP's disappear from the market DBV96, Motorola 96001 DSP's disappeared.
- Even with big and solid companies like Pentek, we had several hardware problems: ADC module noise (+18 dB!!) and dual port memory management of Global DSP memory.
- Software effort is dominated by system overhead software in DSC and DSP. Not by signal processing software.
- Difficult projects to manage, many hardware and software layers.

F. PEDERSEN

DSP's in low level RF (CERN?)

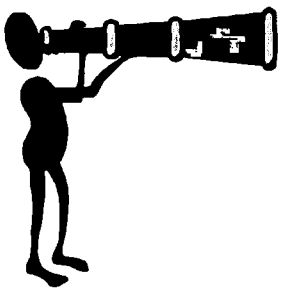


- Many other labs are going the way of using I/Q baseband processing and a mixture of analog, hard wired digital (CPLD's), and DSP for RF field and tune control:
- Examples SNS (LANL), JLAB, FNAL, BNL, TESLA (Desy). CERN are a bit behind...
- For next generation of low level RF in the PS division (Linac II upgrade, SPL, all rings LLRF), *we will have to seriously consider* going to a more recent technology
- Most labs go for VXI modules with Texas DSP and have all had to develop their own VXI modules. *We are at present looking around!* This as well as the DSC and DSP software and CPLD circuit development requires significant and specialized human resources.
- We have presently few staff resources experienced in VXI board design, CPLD design, I&Q RF receiver front ends, DSP software
- Difficult technical and management choices!

ME. ANGOLETTA

Conclusions

- **A SUCCESS !** Intensity-measurement system running continuously + reliably since May 2000.
- Very complex system: many s/w & h/w pieces needed before using the DSP part.
- DSP code writing effort centred on board managing rather than on digital signal processing.
- Very good DSP development environment (much easier code writing / debugging!).



Future challenges:

- Board + low-level s/w considered in LEIR, PS(?), PSB(?) for BTF tune measurement.
- The system implements a multi-channels, programmable spectrum analyser: other applications possible!

M. E ANGOCETTA

Conclusions

- DSP, micro-controllers, -processors slowly converging to broader capabilities/market-base.
- FPGAs very promising front ends for DSP systems.
- Code development simplified by new development environment.
- High performance DSP code development easily achieved.