Interfacing CAMAC Instrumentation to the USB

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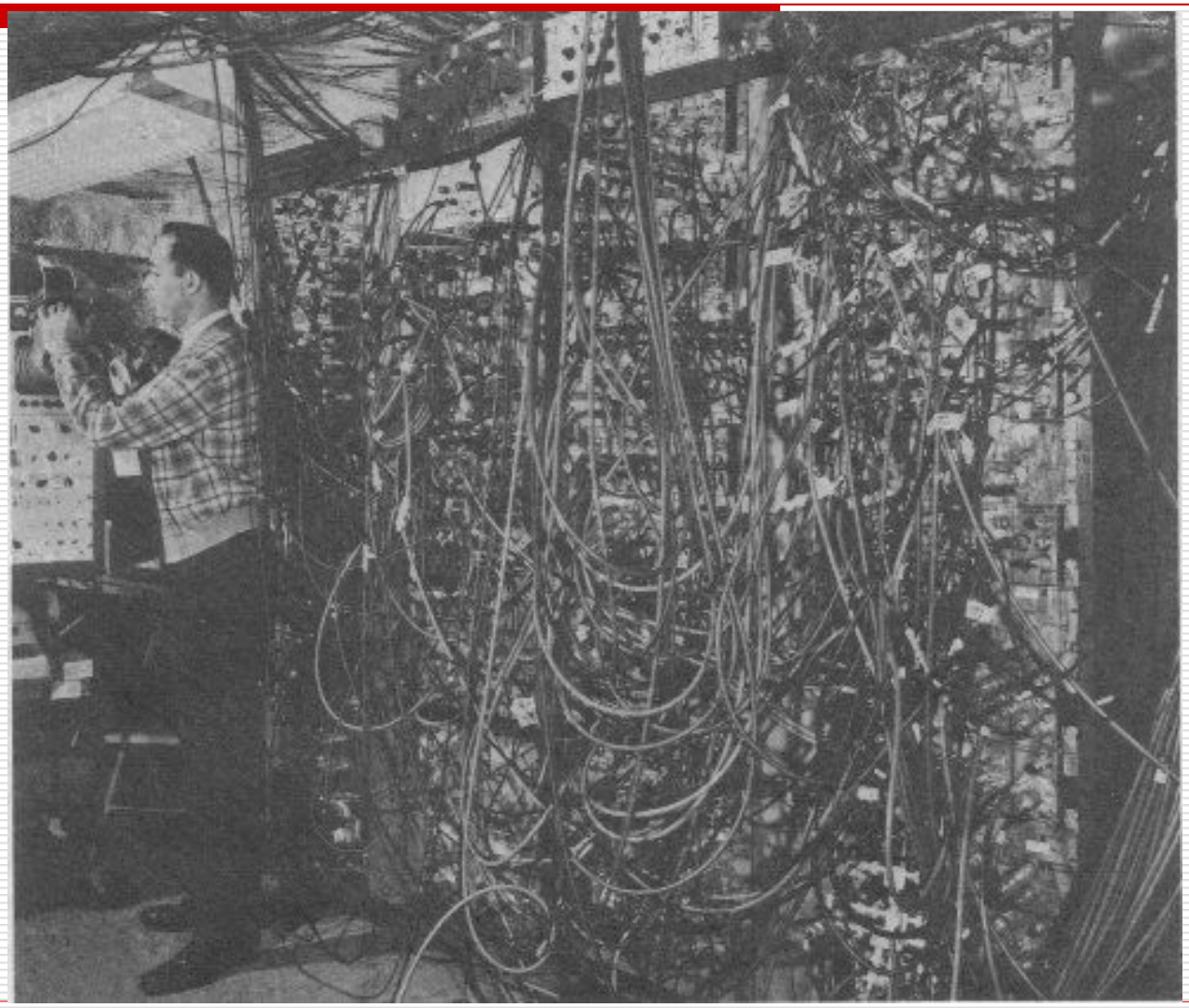
CAMAC & R.V. RIBAS

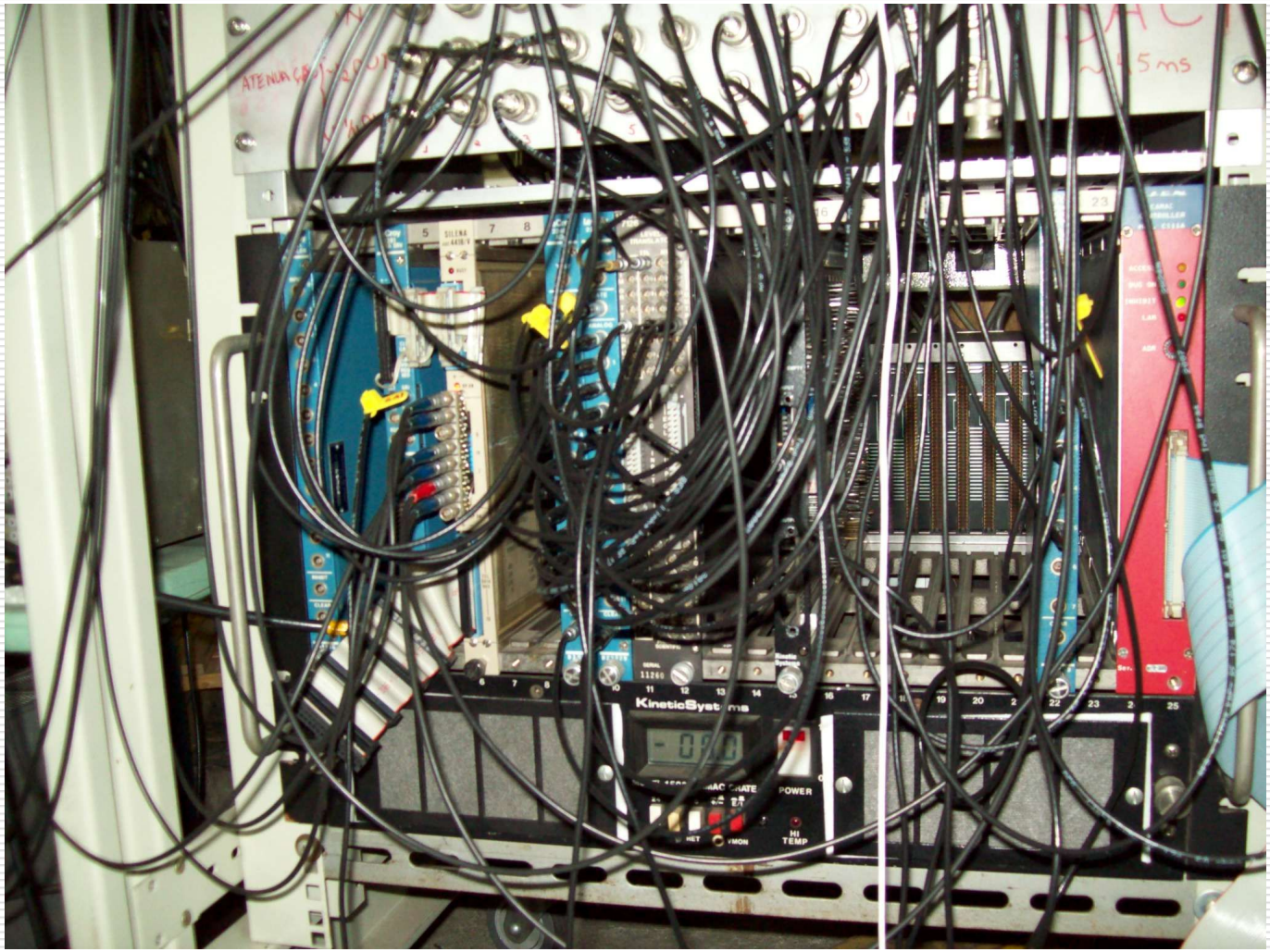
- *Camac appeared in the early 70´s.*
- *I graduated in the early 70´s.*
- *We are both getting old.*
- *But both of us are still useful!*

1960´s – Before CAMAC:

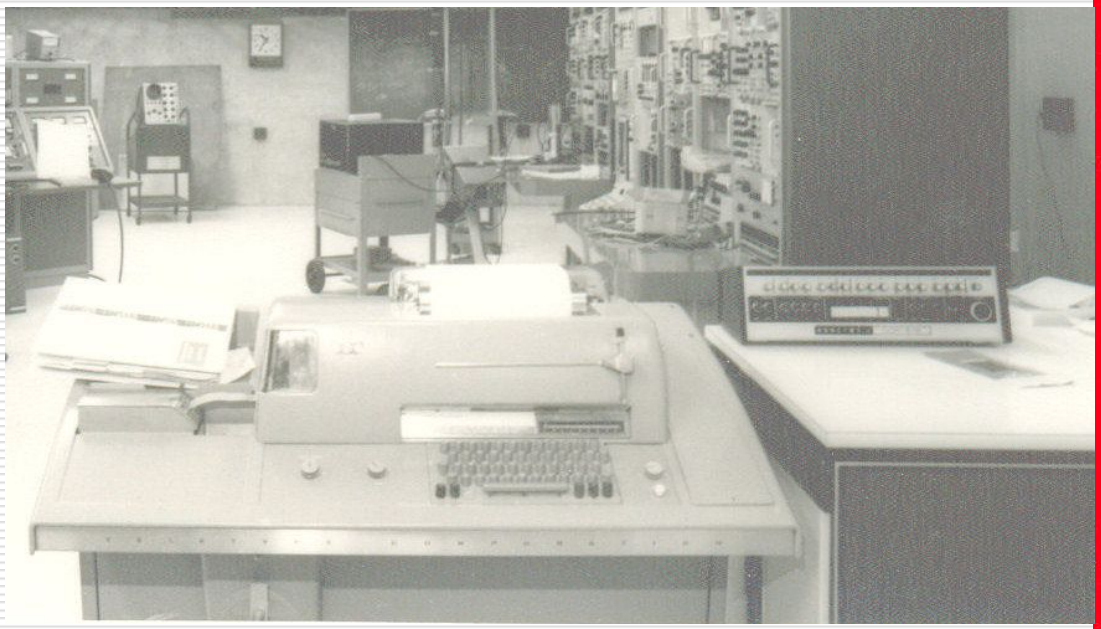
Complexity of traditional systems comes to its limits...

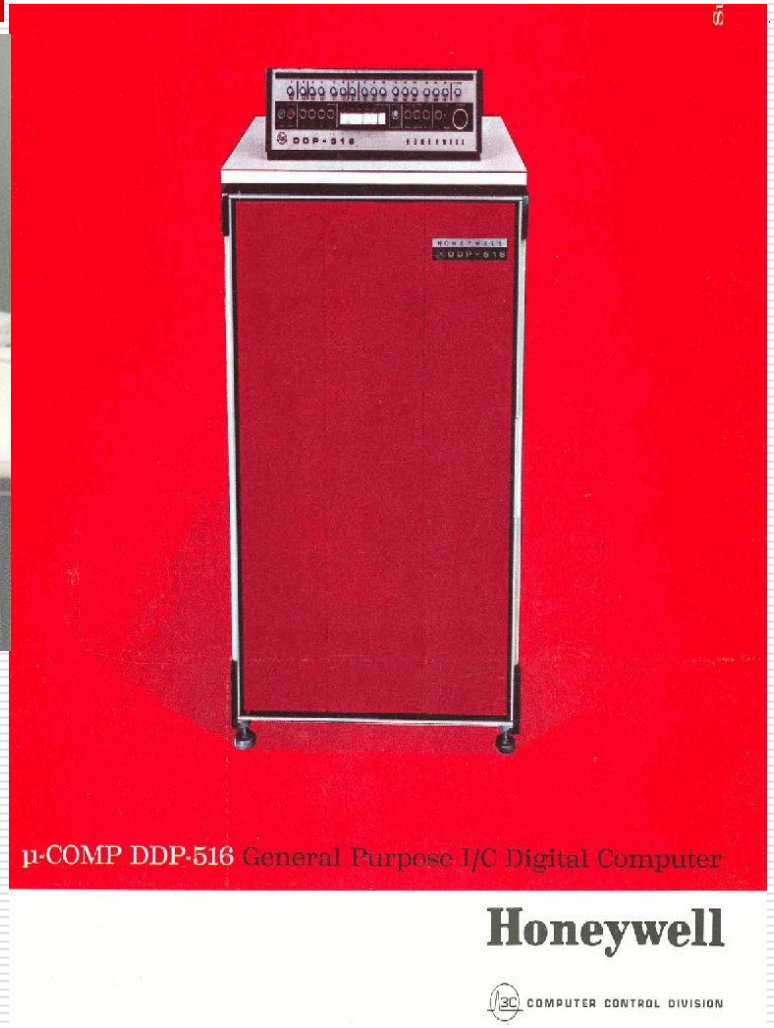


Computer **A**utomated **M**easurement **A**nd **C**ontrol ~ 1970



Honeywell DDP-516 (66-72)



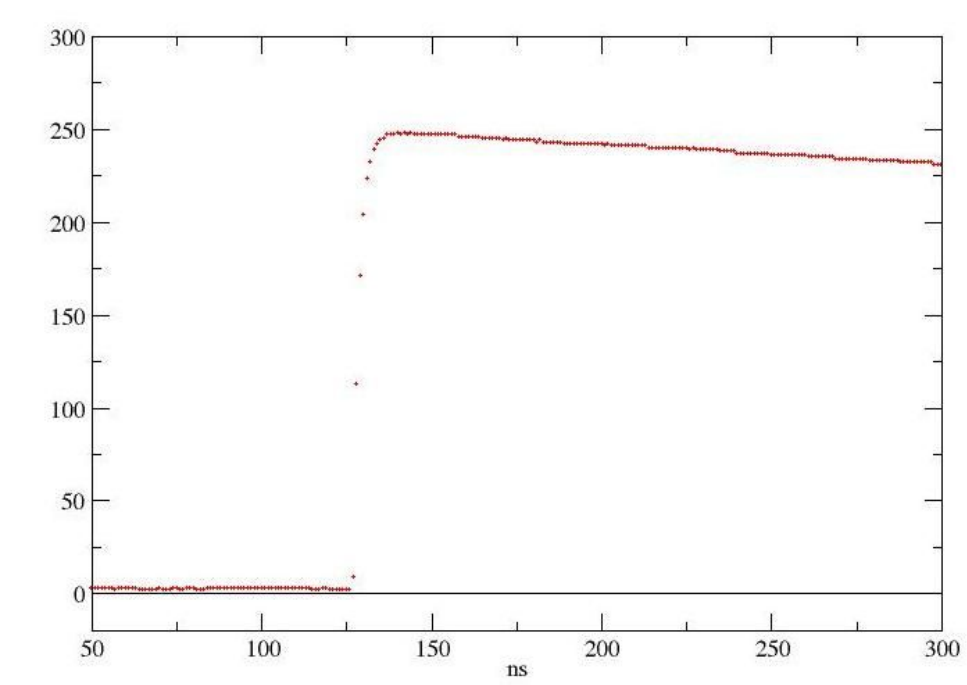


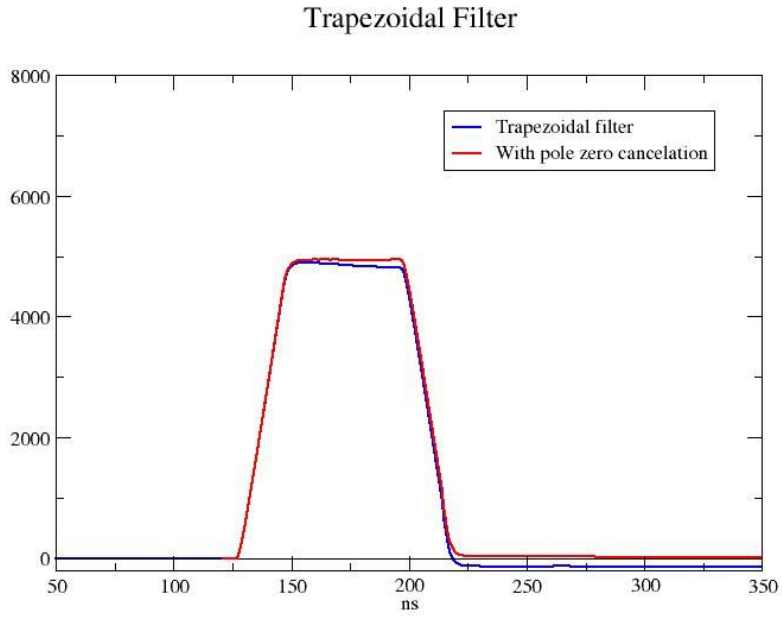
32 kB RAM (Max), 120 kg 1 m^3

Computers Changed a Lot…

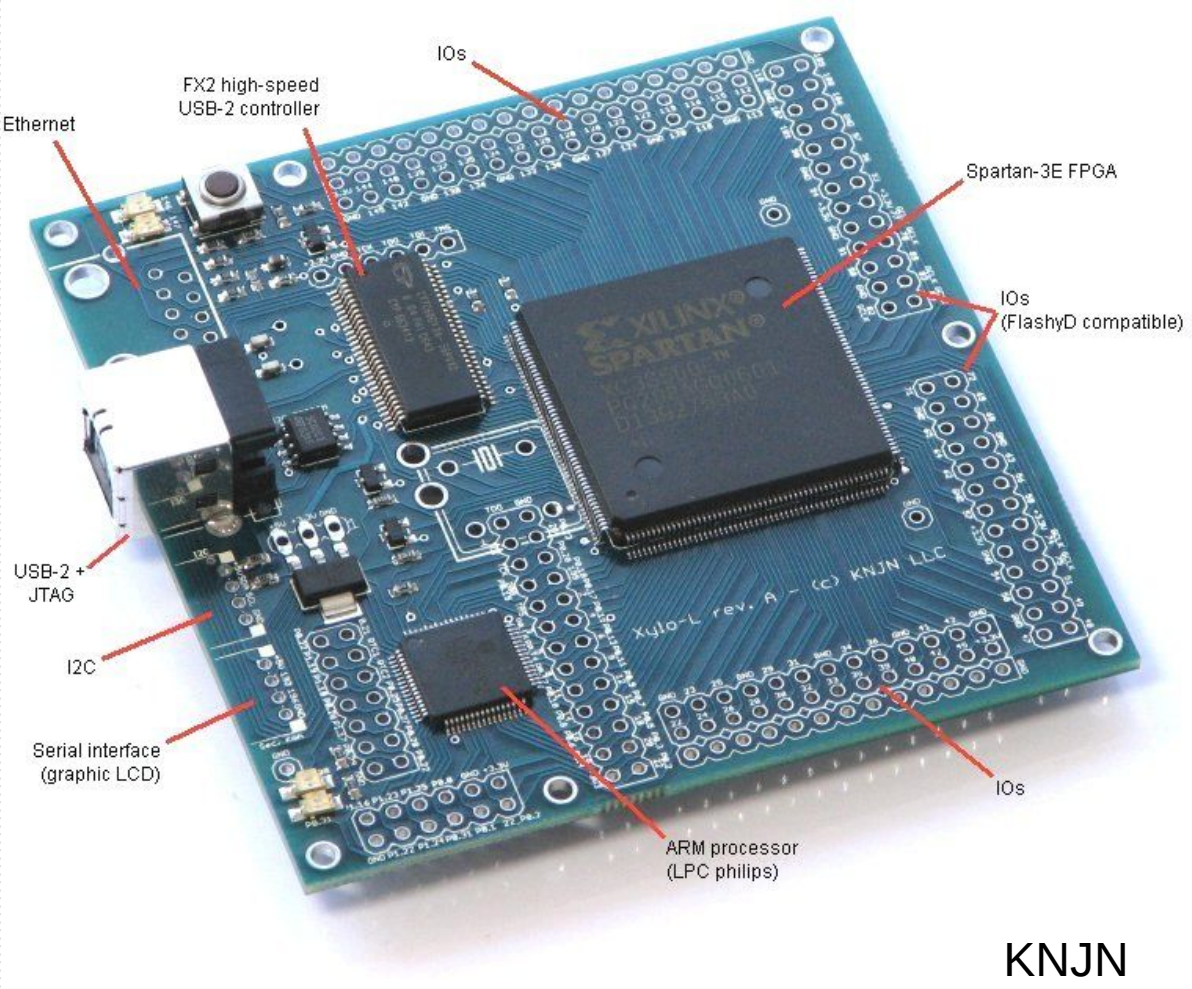
- *In 1970, computer technology did not permit to include processors in the Camac crate or modules.*
- *Interfacing a Camac crate to computers is no longer done with the definitions of the IEEE-Standards (Branch/Serial Drivers).*
- *Most newer available interfaces are also becoming outdated (ISA, PCI).*
- *Evolution of OS also brings difficulties with software drivers.*

New Way: Digital Pulse Processing





FPGA + Flash ADCs



KNJN

Digital Equivalent – NIM Modules

- *Leading Edge Discrimination:*
- •y[n]=x[n]-x[n-k](*differentiation*)
- •y[n]= (x[n]+x[n-2]) +x[n-1]<<1(*Gaussian filtering*)
- •Threshold comparison →LED time
- *Constant Fraction Discrimination*:
- •y[n]=x[n]-x[n-k](*differentiation*)
- •y[n]= (x[n]+x[n-2]) +x[n-1]<<1(*Gaussian filtering*)
- •y[n]=x[n-k]<<a-x[n](*constant fraction*)
- •*Zero crossing comparison →CFD time*
- *Trapezoidal filter and energy determination*:
- •y[n]=y[n-1]+ ((x[n]+x[n-2m-k]))–(x[n-m]+x[n-m-k]))

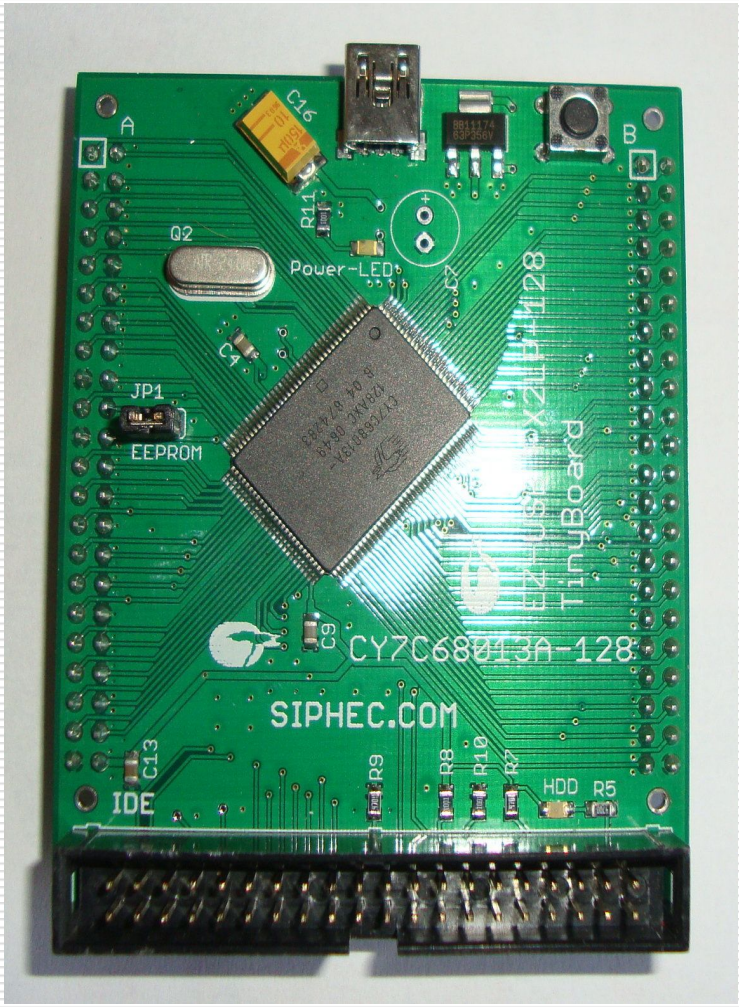
(programming FPGA: Verilog/VHDL)

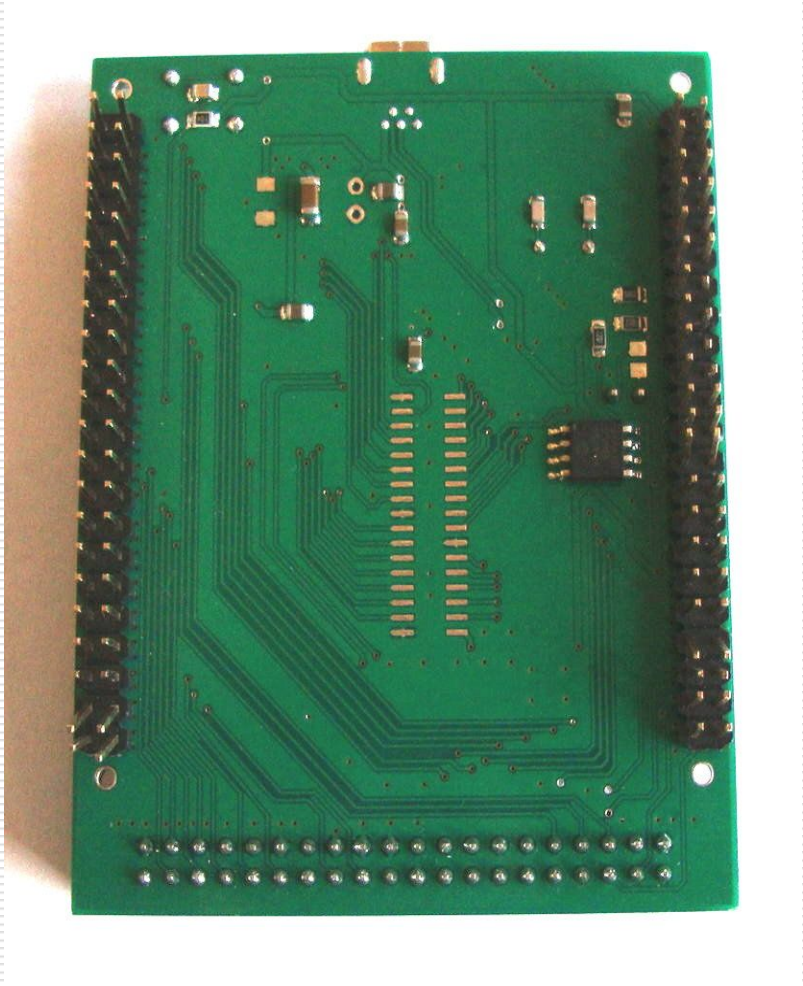
J.T. Anderson et al. IEEE N25, 6 p1751 (2007)

Reviving old Camac Modules

- *Interface to the USB (fast, hot-plug).*
- *Introduce local processing capabilities to handle events and event buffering.*
- *Dedicate interface to 2-4 Camac modules, without need of heavy, 25 units Camac Crates.*
- *Acquisition software similar to that we are still using.*

Cypress-FX2 Microcontroller with USB interface

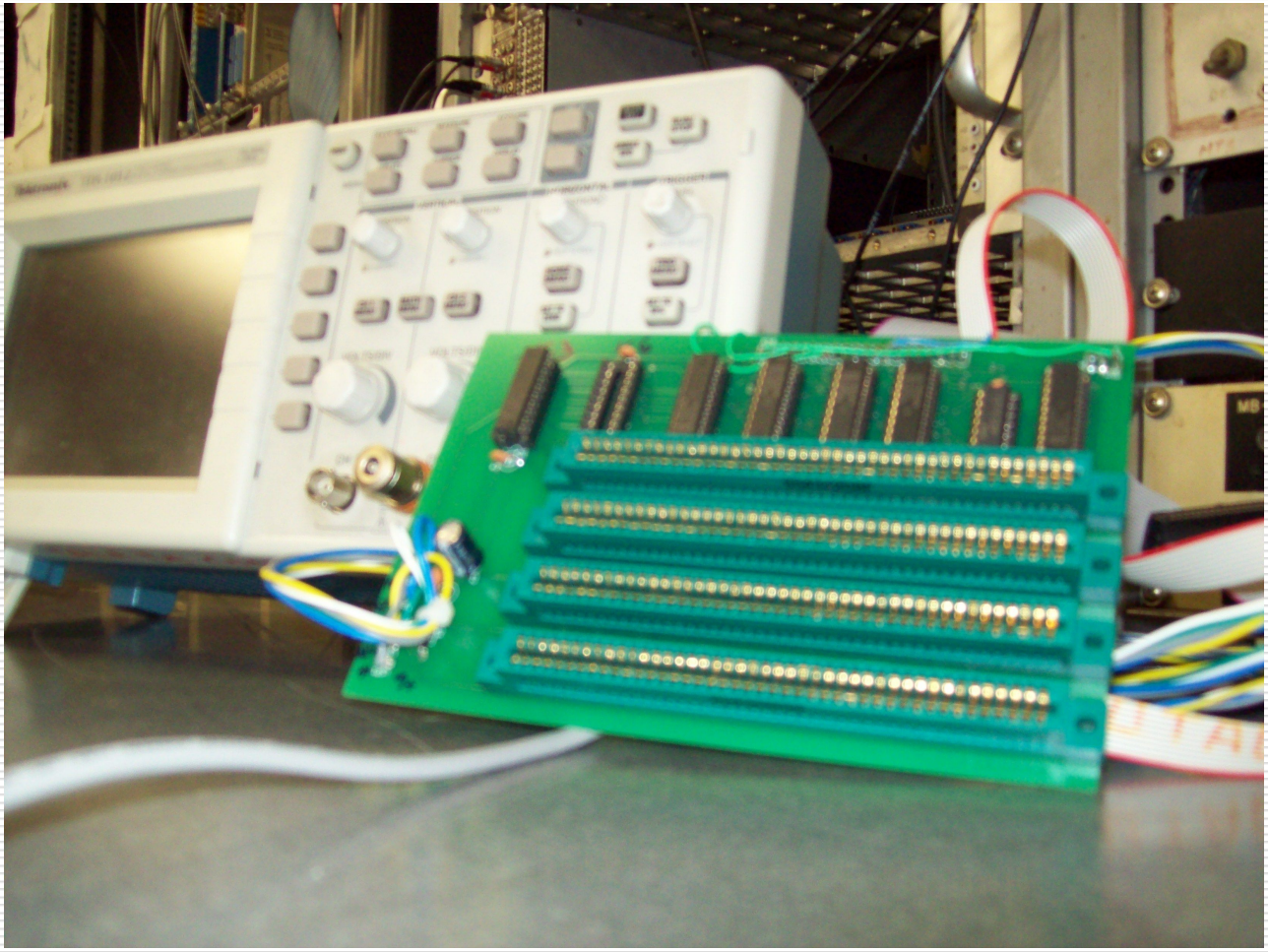




EZ-FX2

- *USB 2.0 interface:*
  - *Freeware drivers and basic software available for Linux (cycfx2prog by Wolfgang Wieser).*
  - *All USB endpoint fifo buffers.*
- *Includes a 8051 microcontroller:*
  - *C programable (sdcc), 16kB RAM.*
  - *5x8 bits IO registers.*

Dedicate interface for 2/4 Camac Modules




CAMAC-USB

User´s Event Handler

```
// event definition
    dd[nn++]=0x01;
    dd[nn++]=0x80; //event header – 0x8001
    rout1(0x00); //read E1 - A=0, F=0
    rout1(0x01); //read E2 - A=1, F=0
    rout1(0x02); //read E3 - A=2, F=0
    delay(10);
    rout1(0x00); //read T1
    rout1(0x01); //read T2
    rout1(0x02); //read T3
    dd[nn++]=0xFF;
    dd[nn++]=0xFF; //end event  - 0xFFFF
    af=0xbc; //A=12, F=11 - clear module 1
    naf(af,1);
    af=0x9c; //A=12 F=9 - clear module 2
    naf(af,2);
//end event definition.
```

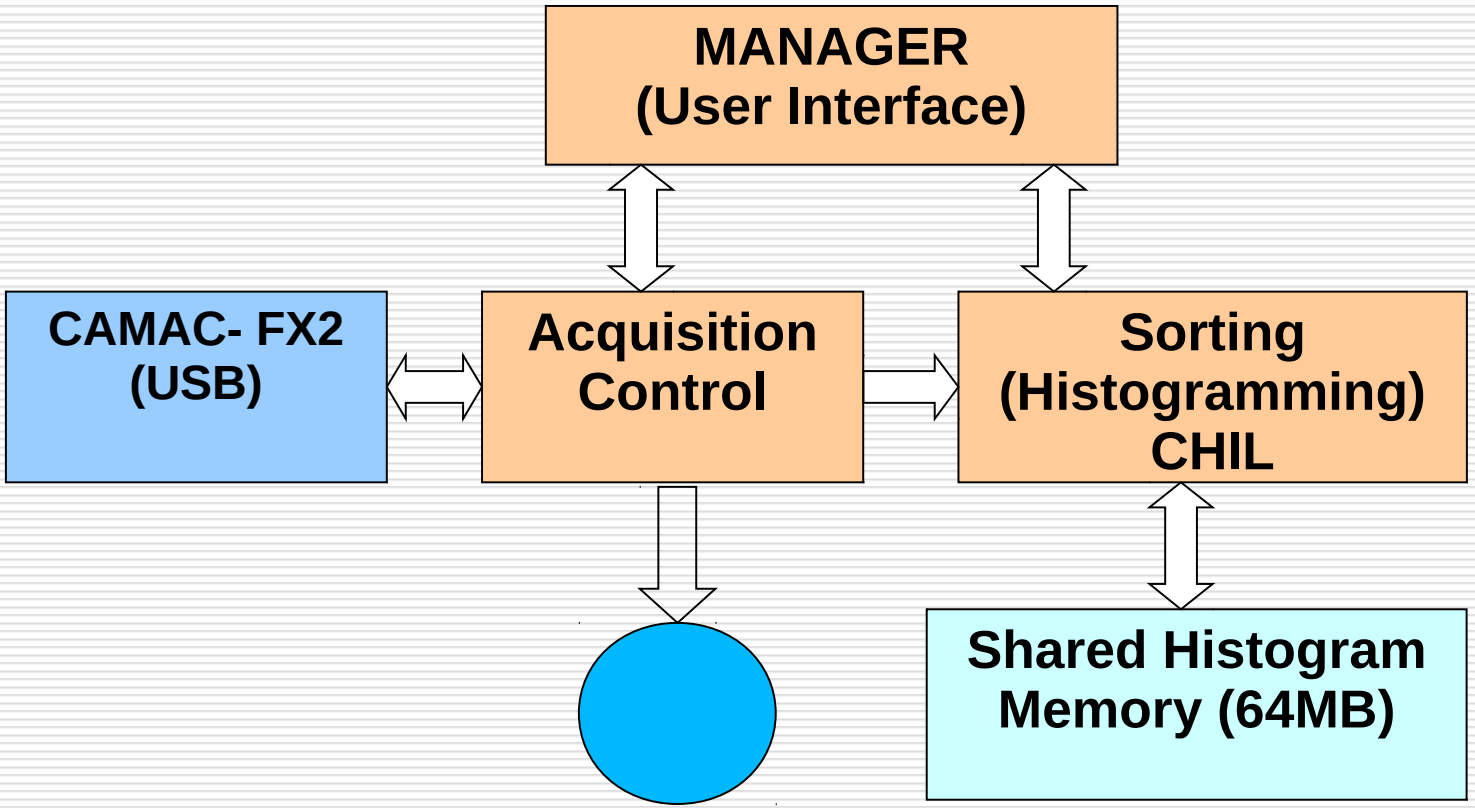
Performance

- *FX2 loops waiting for LAM.*
- *NAFs starts about 10 μs after LAM.*
- *Each NAF + coping data, etc. 4.5 μs.*
- *Total time for N ADCs (Nx4.5+10) μs.*
- *Conversion time:*
  - *Phillips 7164 (16x4k ADC/TDC/QDC): 7.2 μs*
  - *Silena 4418 (8x4k ADC/TDC) : 35 μs*
  - *Ortec 811 (8x2k ADC): 80 μs*
  - *LeCroy 2228 (8x2k TDC): 100 μs*
- *System is good for up to:*
  - *A few k-events/s.*
  - *Events about 100 bytes long.*

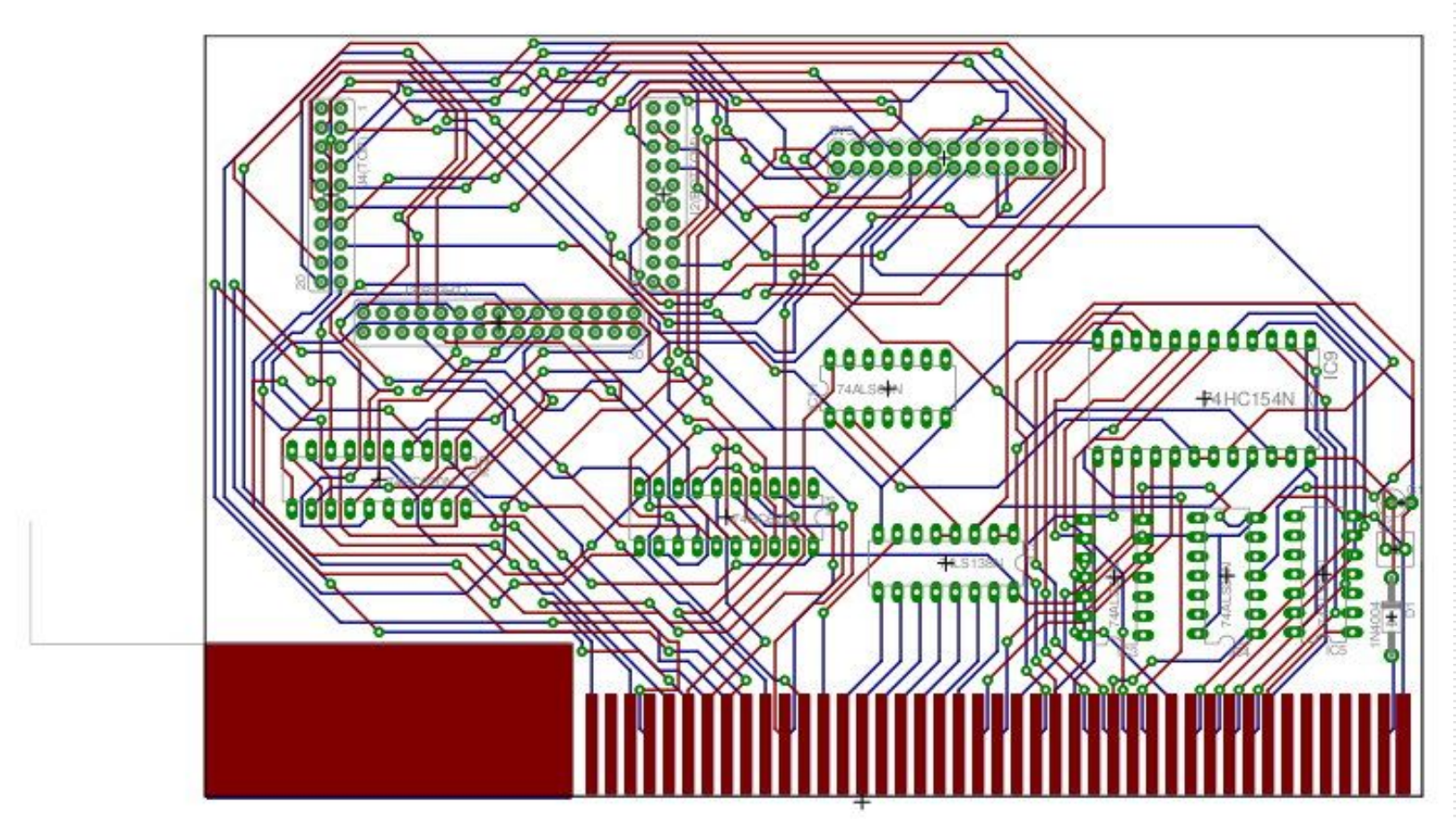
Acquisition Software

- *SPM-FX2*
  - *SPM = SADE Post-Modernum*
    - *SADE = DDP-516 time DAC-System*
    - *SPM = VAX-780 DAC-System*
- *Concurrent processes*
  - ***Manager**: distribute command to the acquisition and sorting modules (semaphores, shared memory, etc.)*
  - ***Acquisition**: get event buffers from Camac front-end, write to disk and send to sorting.*
  - ***Sorting**: histograms in a shared memory space that can be opened by external display and analysis program.*

Acquisition Control and Histogramming



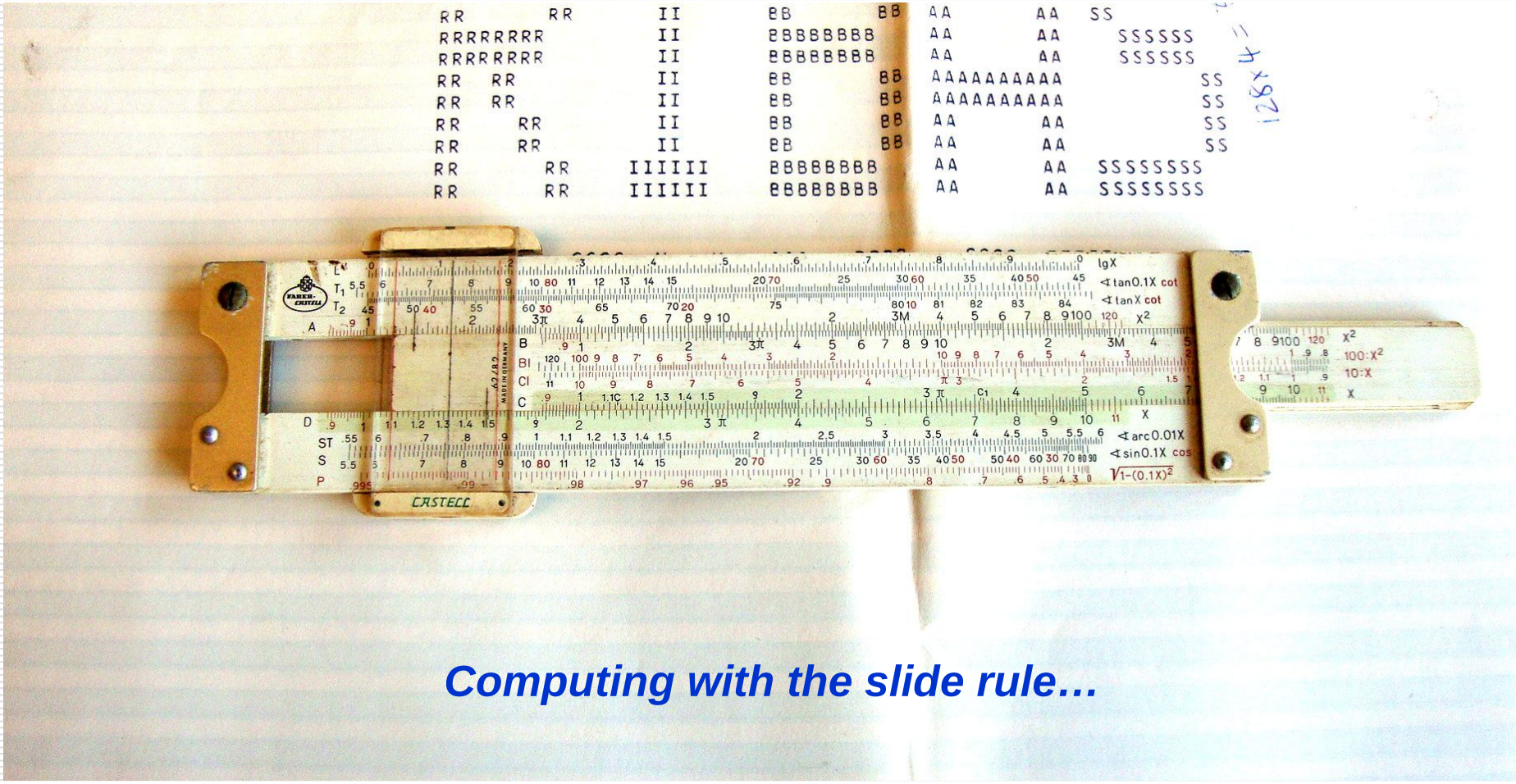
Standard Crate Controler



Conclusions

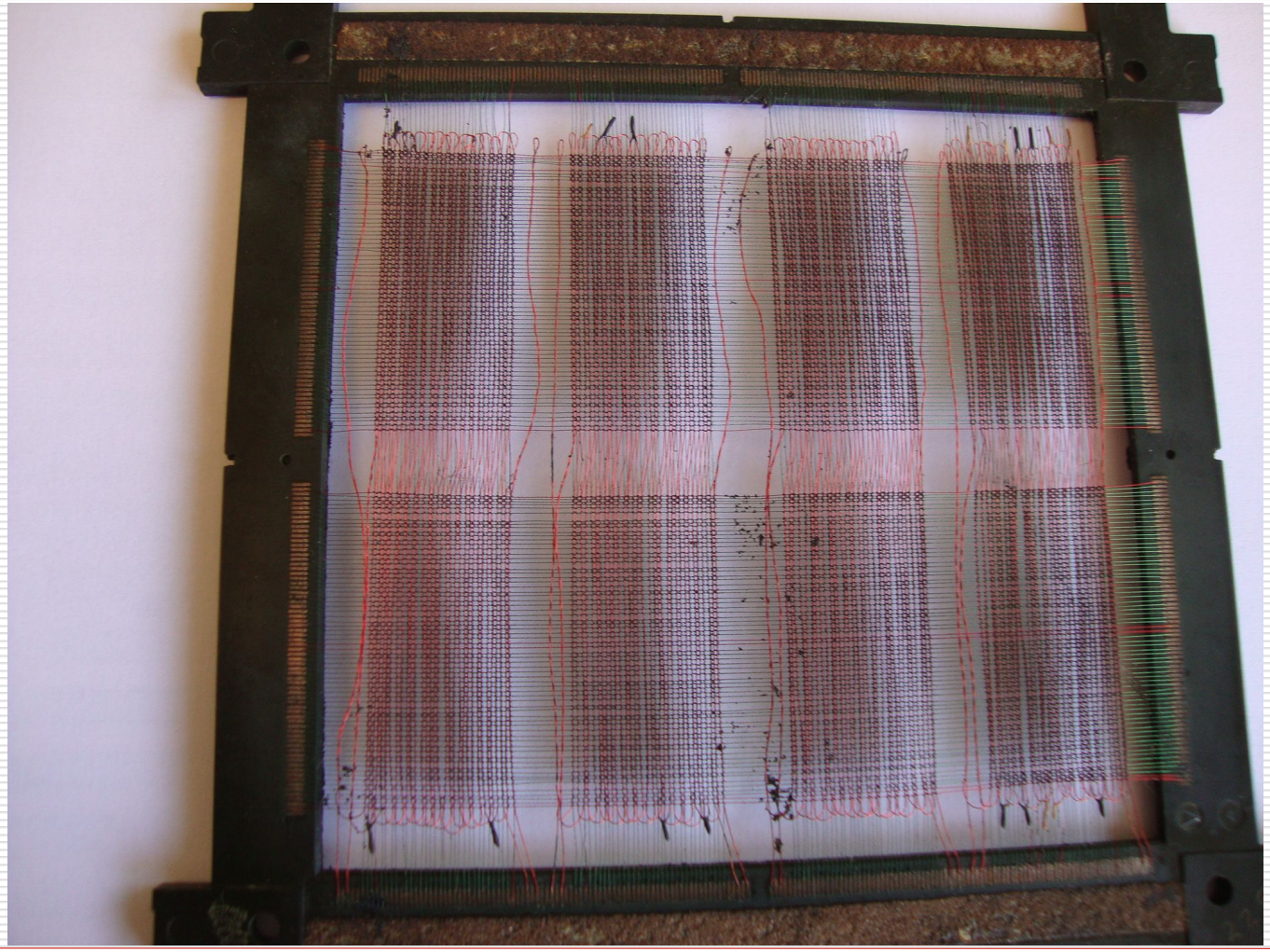
- *Camac instrumentation have a much longer lifetime then computers and the original interfaces.*
- *A versatile Data Acquisition system was developed to revive these modules.*
- *For the 2/4 modules system, power supply is not available commercially. Also is not easy:*
  - *To find the Camac edge connectors.*
  - *PCB costs the same for one as for a doze.*
- *If you need one system like that, please contact me.*

THANK YOU!
GRACIAS!

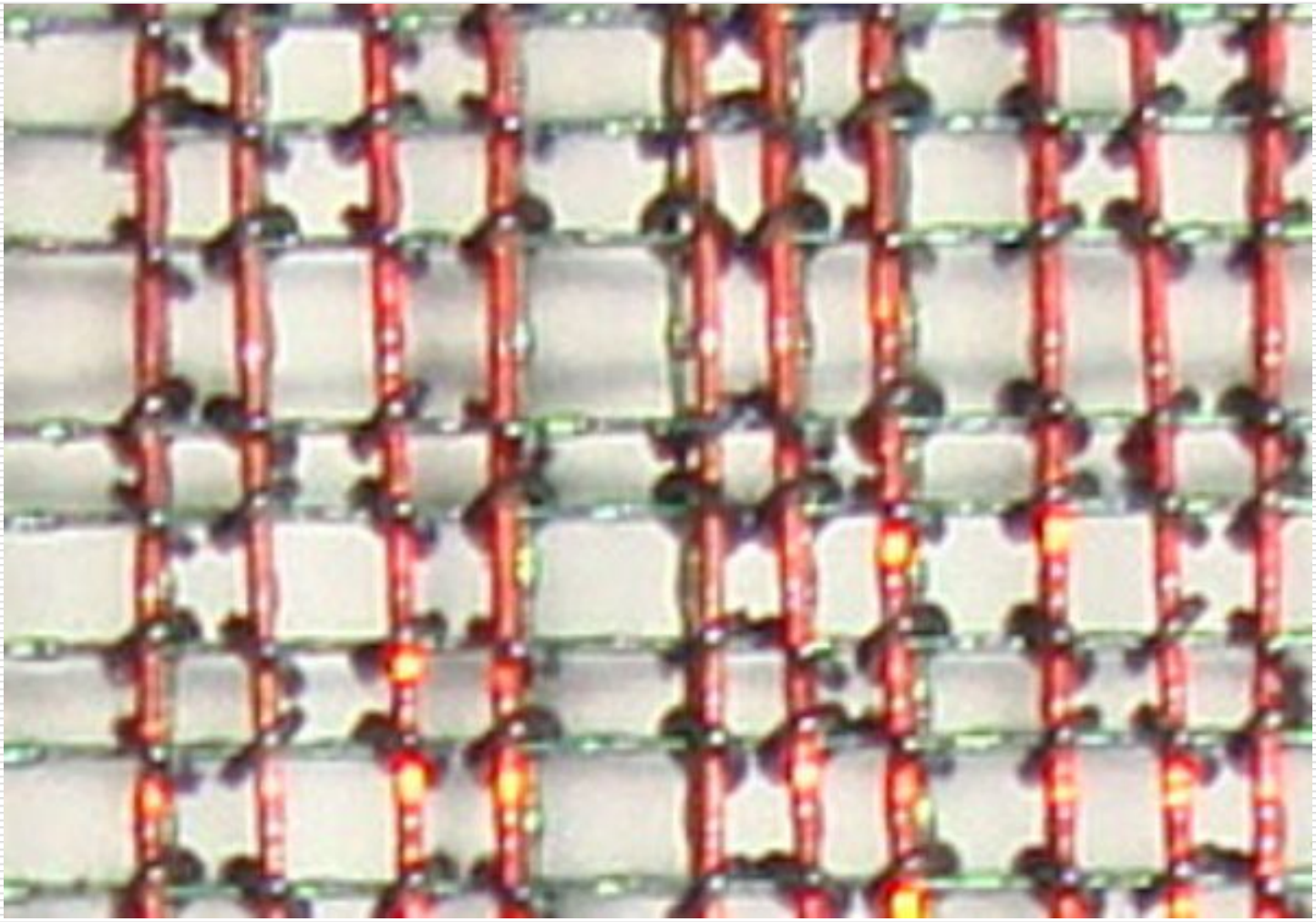


IBM 360/44

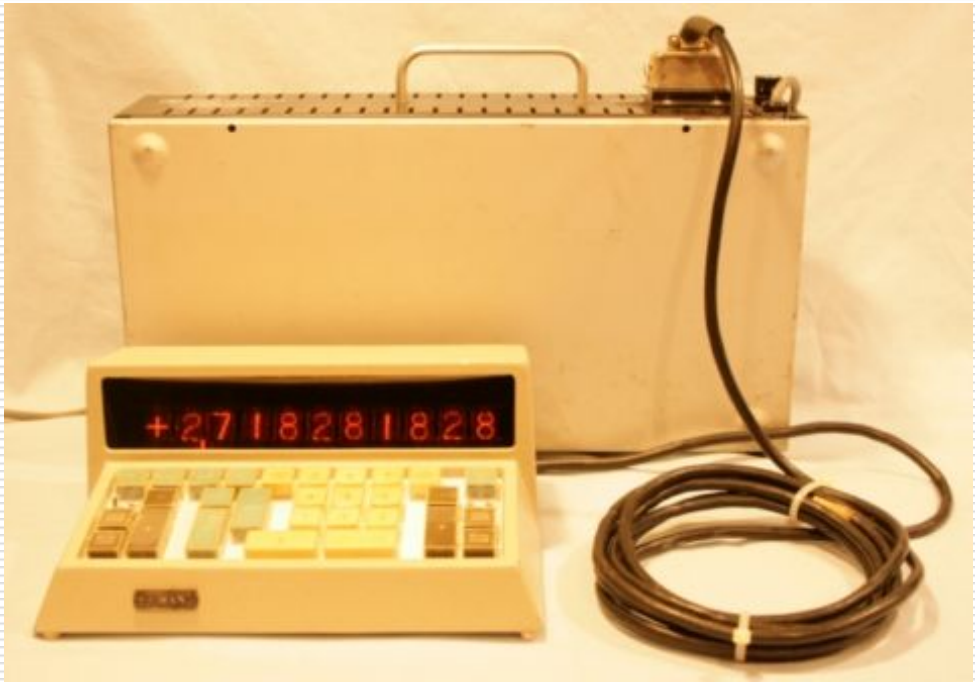
IBM 360/44 2kB RAM Module

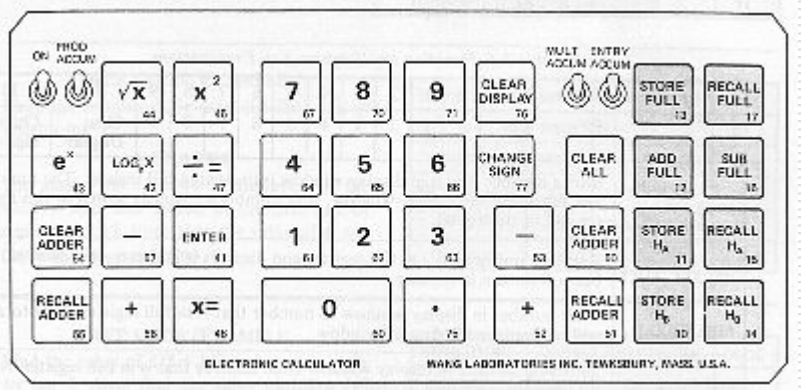


The small ferrite rings



WANG Programmable Calc.





Data Acquisition System
SADE – Lab. Pelletron, 1972