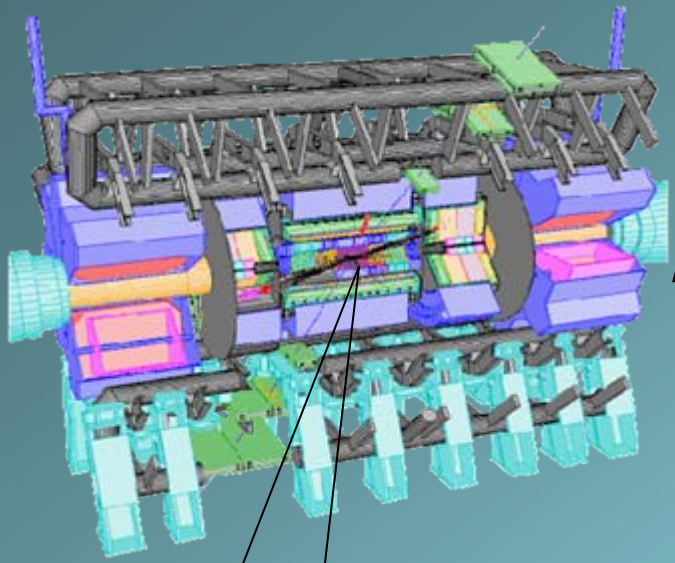
Tecniche Automatiche di Acquisizione Dati

Introduzione all’elettronica modulare

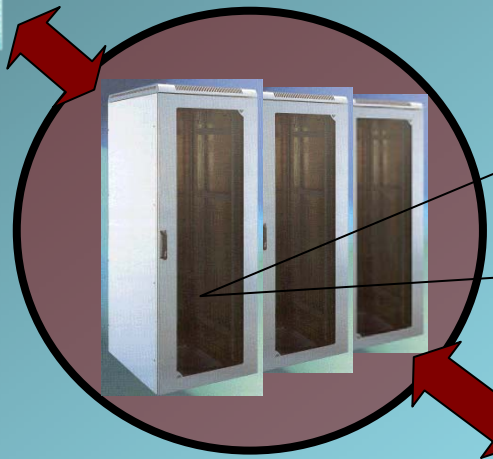
Definizioni (Dall'Oxford Dictionary)

- Modular:
  - Originally: designating or conforming to a system of building design or construction based on a standard module (see MODULE).
  - Hence more generally: involving or consisting of modules or discrete units as the basis of design, construction, or operation;
  - (also) intended to form part of such a system.
- Module:
  - A component of a larger or more complex system. Any of a series of independent units or parts of a more complex structure, produced to a standard design in order to facilitate assembly and allow mass production.

Definizioni



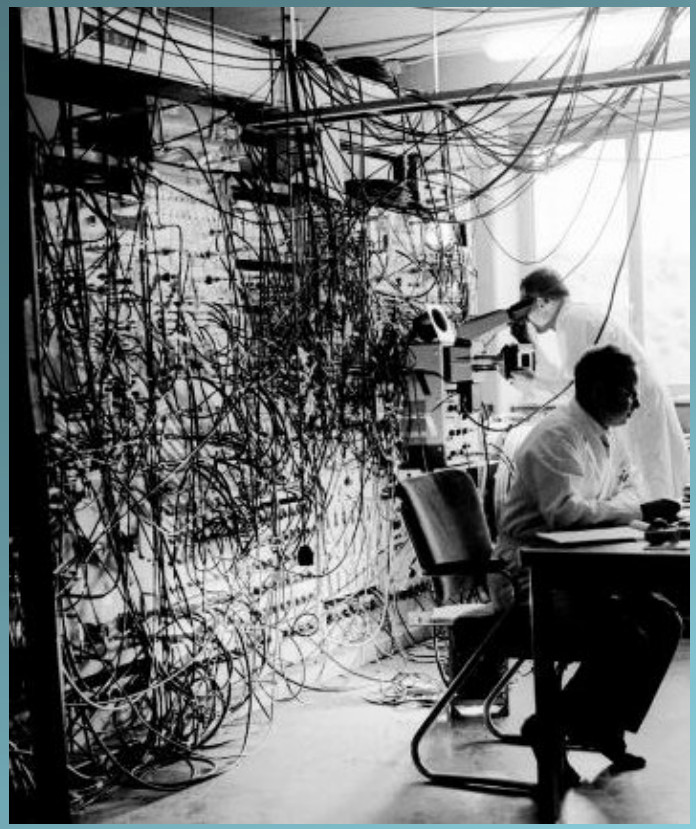
Detector & elettronica di front-end



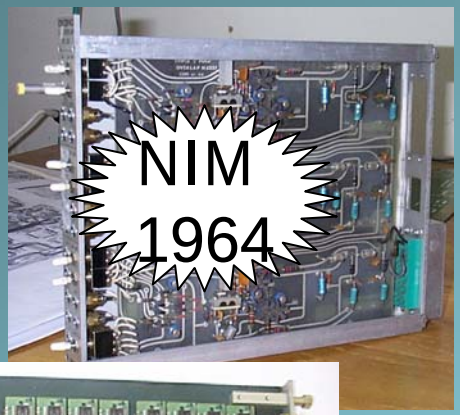
Elettronica modulare – trattamento del segnale, trigger, riduzione dati di primo livello

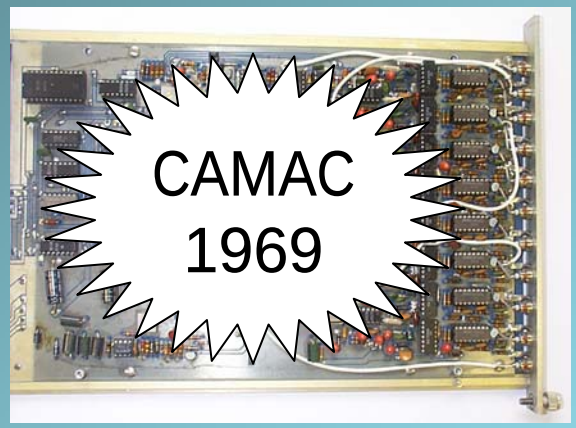
Computing farms, etc.

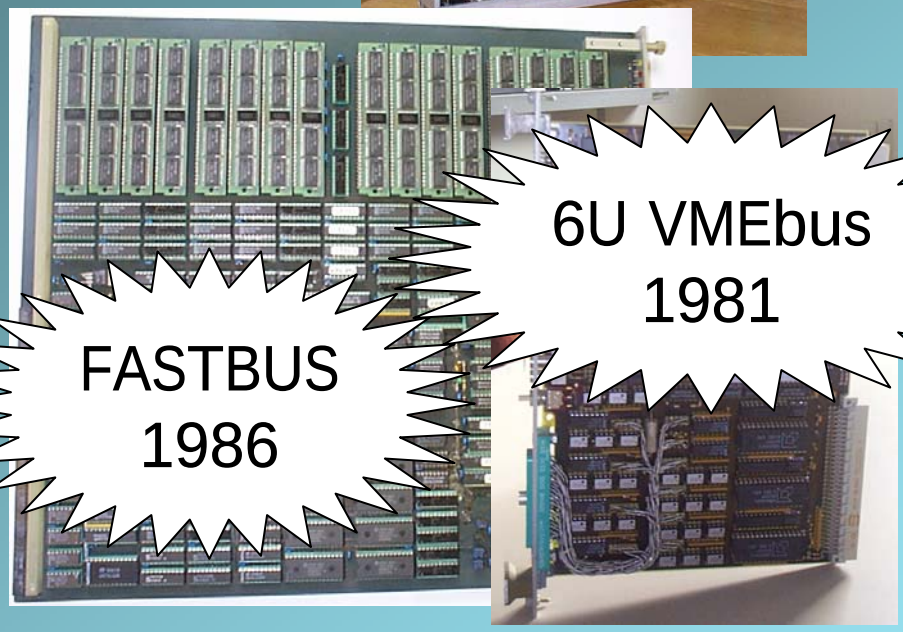
La preistoria…

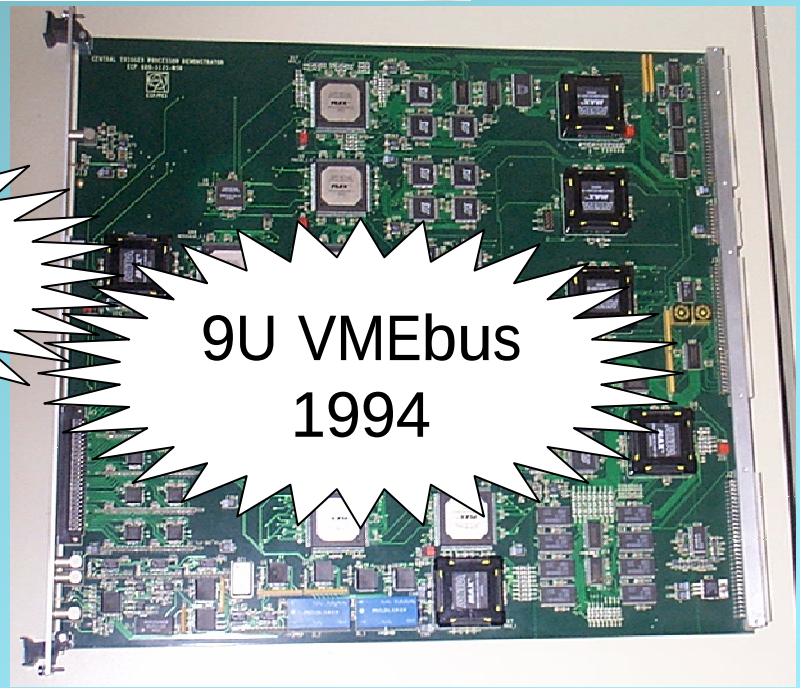


…e poi arrivarono



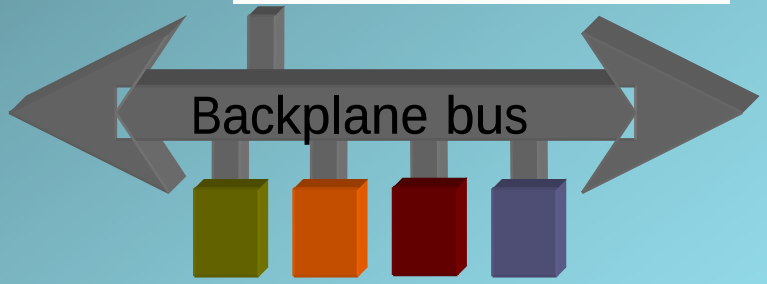




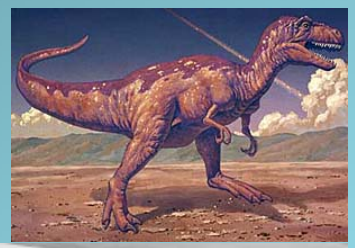


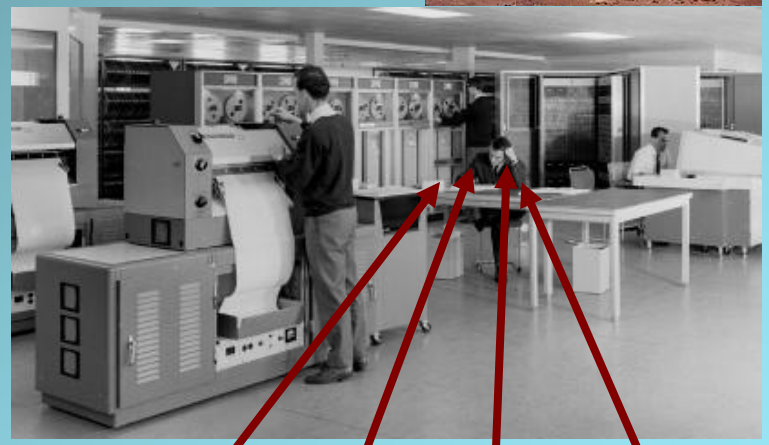
Storia..

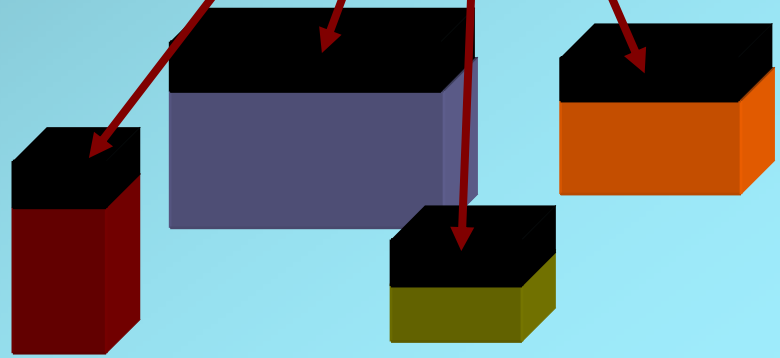
- Portarono:
  - Flessibilità, intercambiabilità
  - Facilità di ristrutturazione
  - Interfacciamento semplificato
  - Riduzione dell'impegno di progettazione
  - Riutilizzabilità degli elementi.



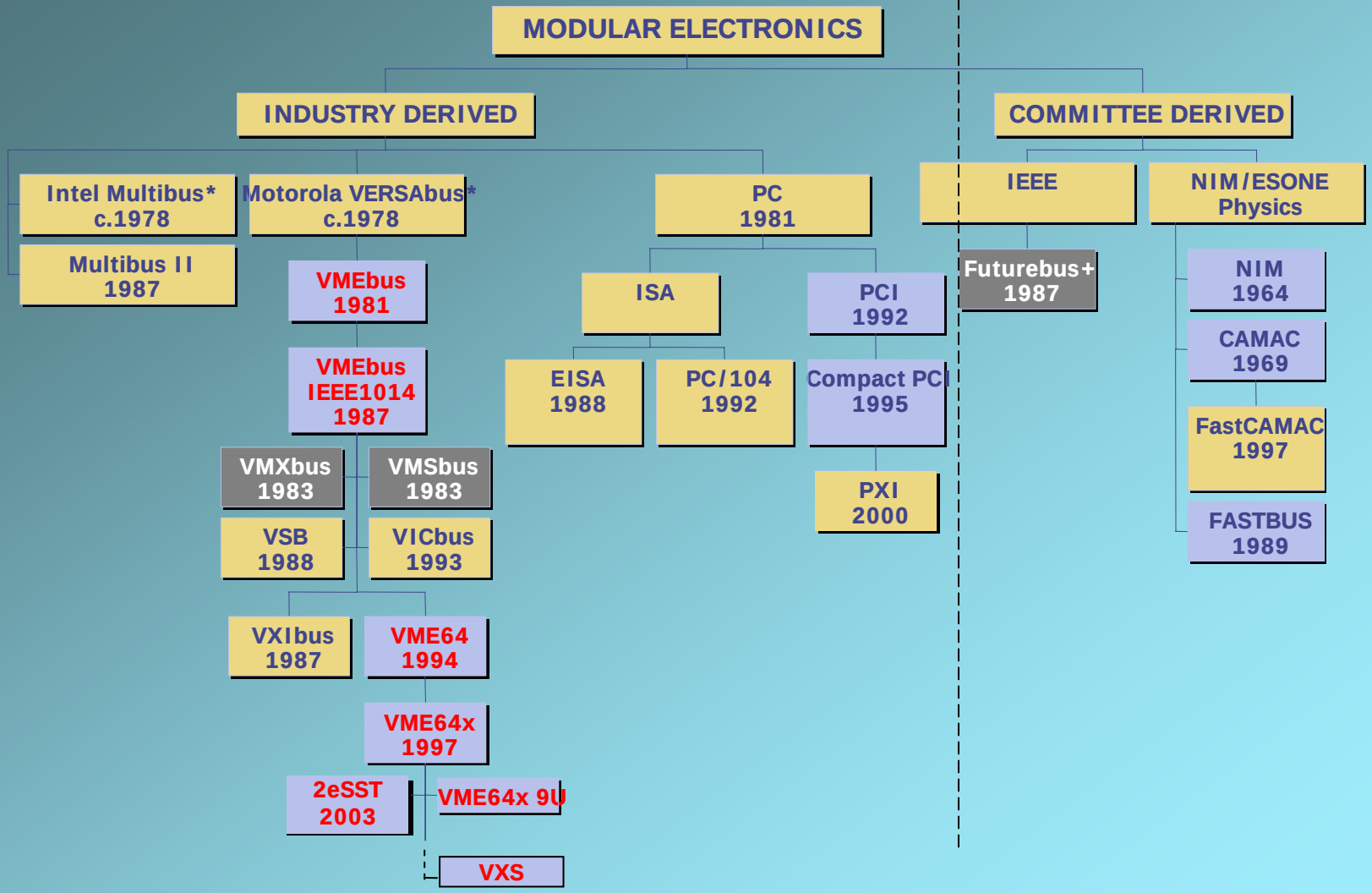
VS







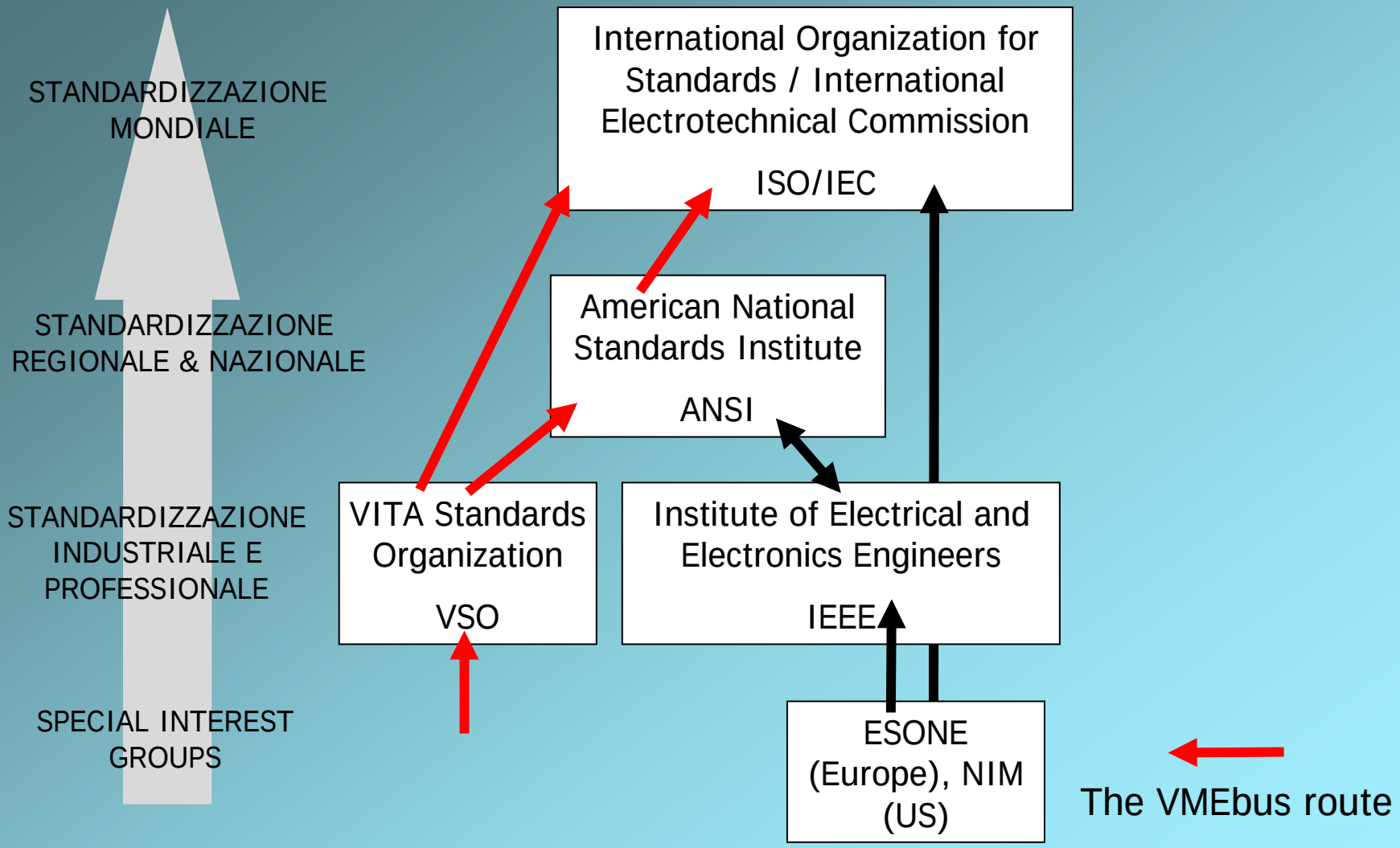
Lo sviluppo


MODULAR ELECTRONICS
INDUSTRY DERIVED
COMMITTEE DERIVED
Intel Multibus* c.1978
Motorola VERSAbus* c.1978
PC 1981
IEEE
NIM/ESONE Physics
Multibus II 1987
VMEbus 1981
ISA
PCI 1992
Futurebus+ 1987
NIM 1964
CAMAC 1969
VMEbus IEEE1014 1987
EISA 1988
PC/104 1992
Compact PCI 1995
FastCAMAC 1997
VMXbus 1983
VMSbus 1983
PXI 2000
VSB 1988
VICbus 1993
FASTBUS 1989
VXIbus 1987
VME64 1994
VME64x 1997
2eSST 2003
VME64x 9U
VXS

Gli standard

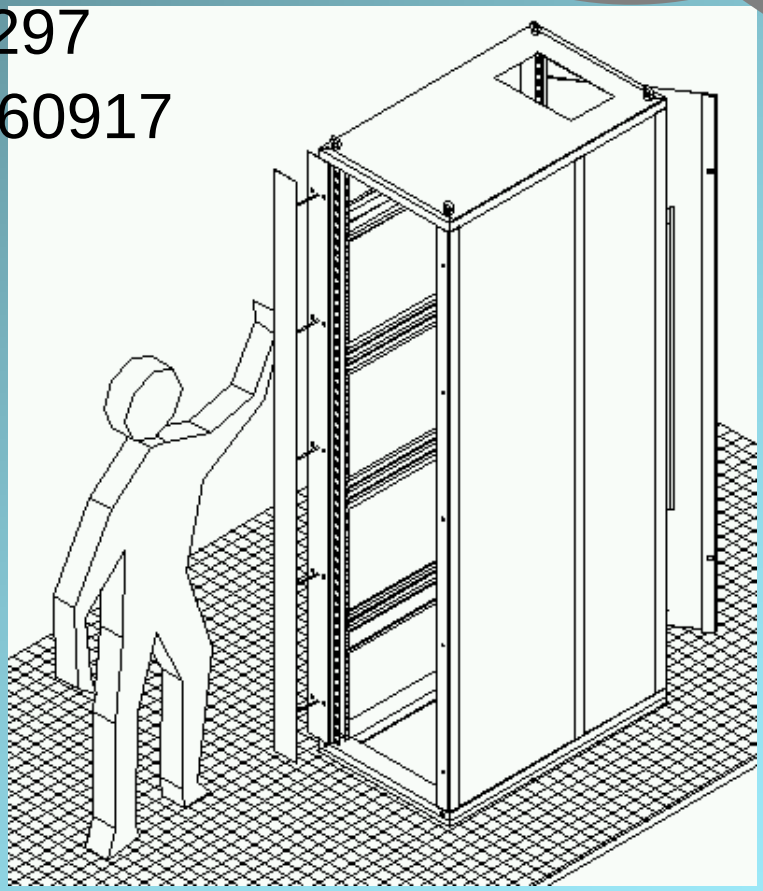
- **Open** standard: sono definiti da qualche ente di standardizzazione nazionale o internazionale (o consorzi industriali)
  - Non ci sono brevetti
  - Niente diritti di proprietà
  - Assicura l'intercambiabilità e l'interoperabilità.
- In contrasto con gli standard **proprietari**.

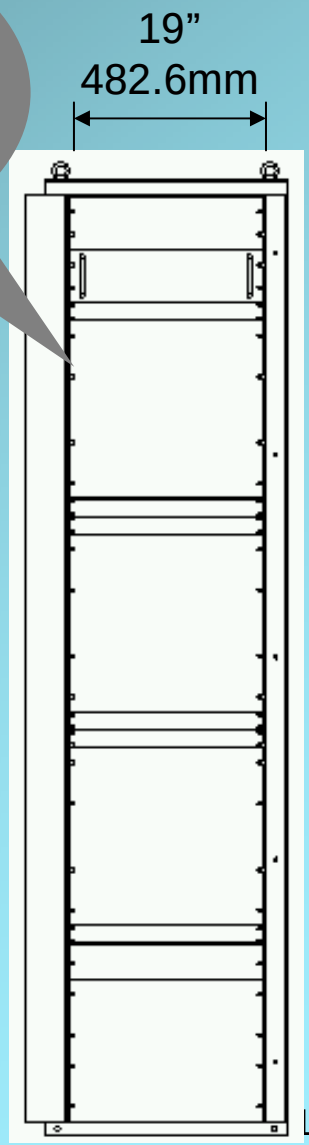
Le origini: esempio NIM/VME



Un po’di terminologia

- **Rack**
  - Una struttura dove sono montati gli elementi.
  - 19” - IEC 60297
  - Metric - IEC 60917

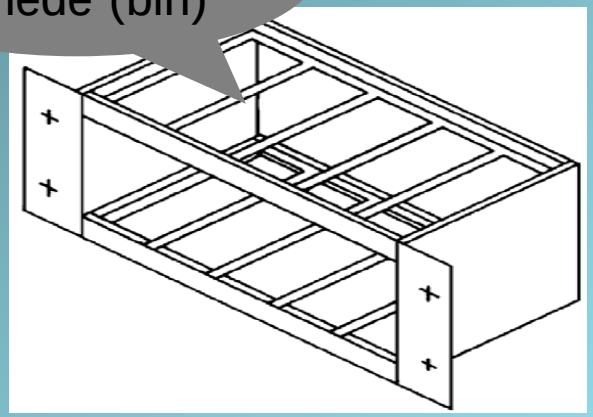




Un po’di terminologia

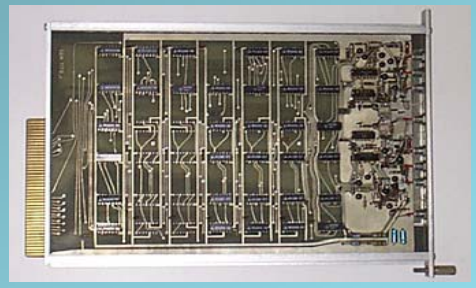
- **Crate** (cestello): la struttura che alloggia I moduli da installare nel rack.
- **Backplane**: il pannllo posteriore del crate dove sono alloggiati I contatti elettrici e di comunicazione.

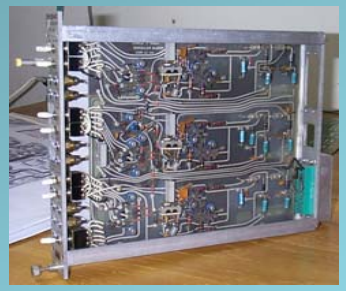
Alloggiamento schede (bin)

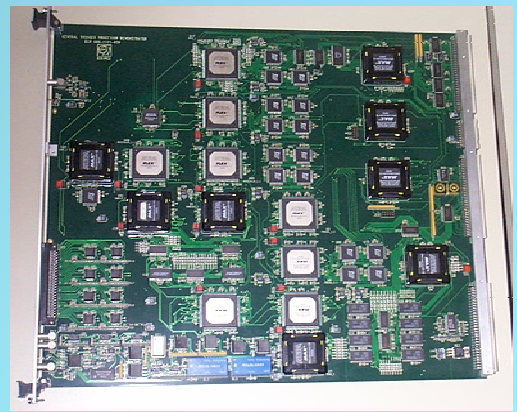


Un po’di terminologia

- Moduli
  - Schede (boards)
  - Plug-in units
  - Transition modules o piggy-back

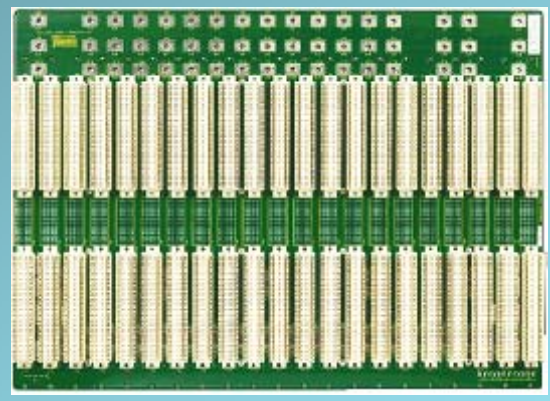


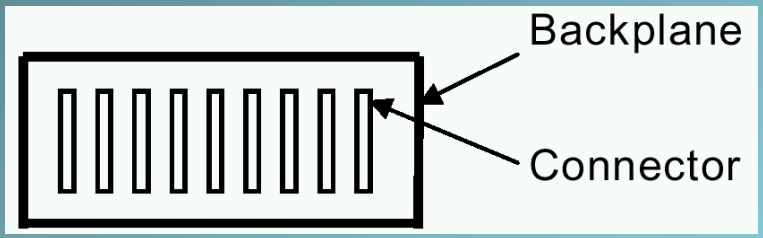


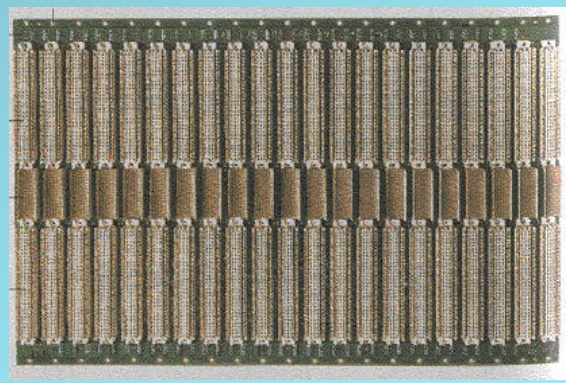


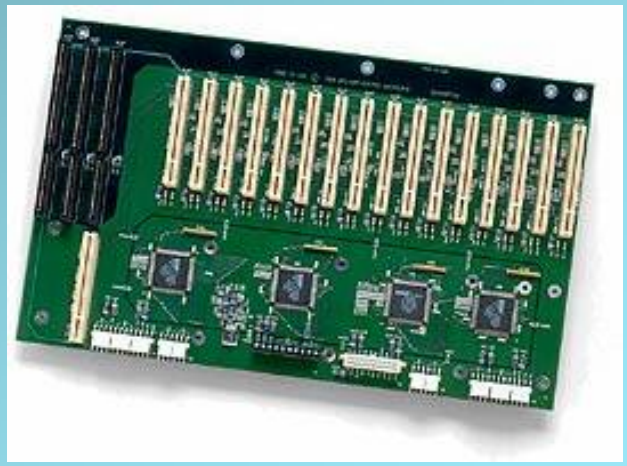
Backplane

- Interconnette i moduli
  - Trasmette segnali
  - Da priorità ad azioni
- Distribuisce alimentazione e massa
- Può essere attivo o passivo





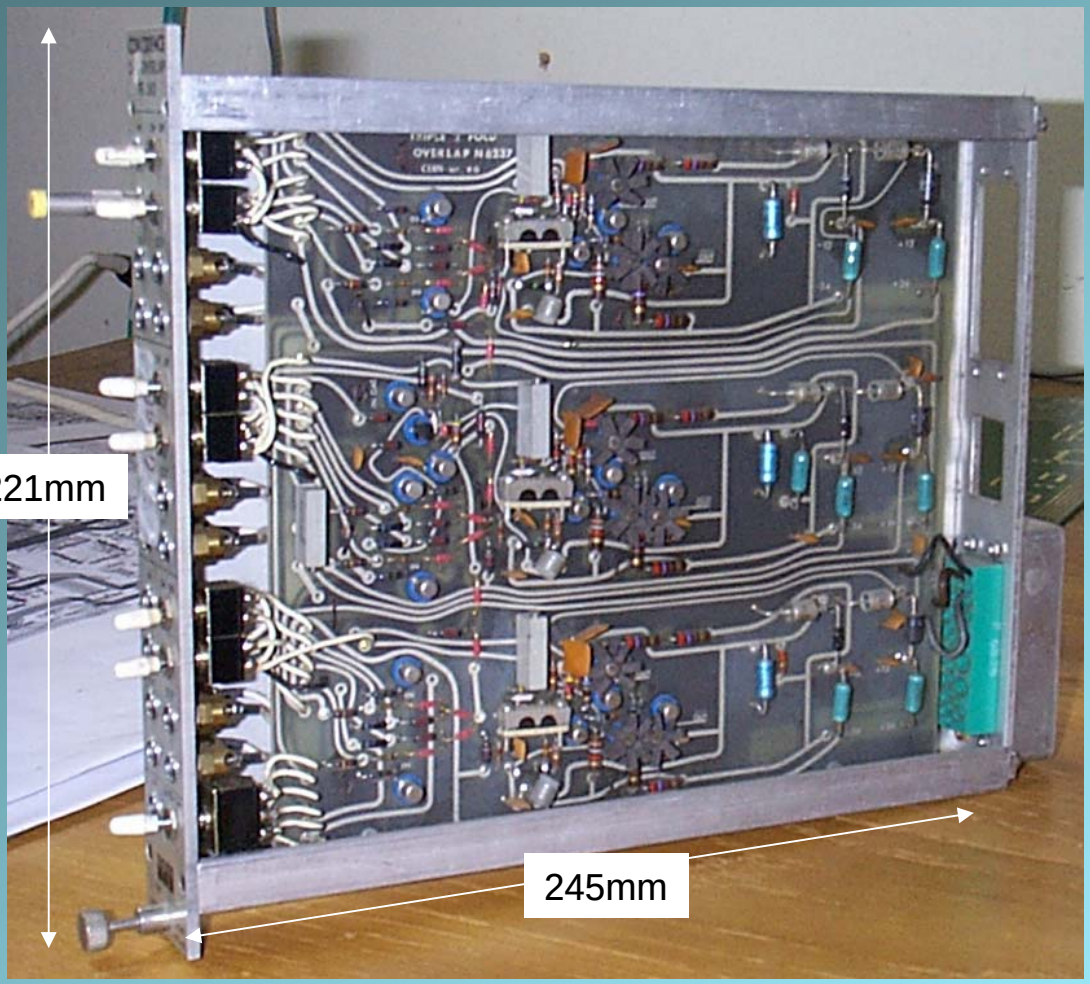




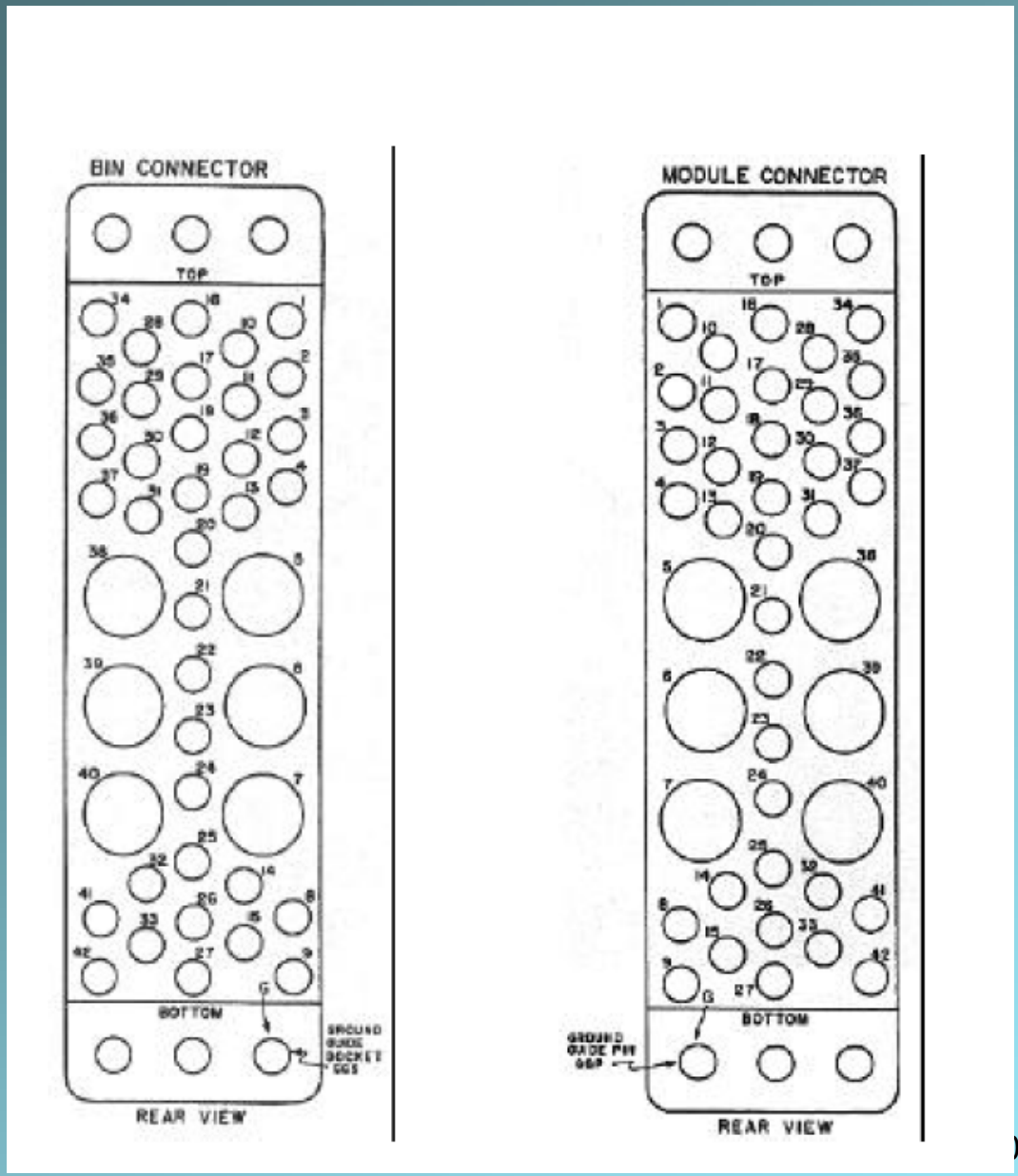
Standard NIM (1964)

- Nuclear Instrument Module/Nuclear Instrumentation Methods
- Origine: US Dept. of Energy
- Strumentazione modulare, high-speed logic
  - No control backplane – Solo per distribuzione alimentazioni
  - 12 moduli per crate (box schermate)
  - Alimentazioni ±6V, ±12V, ±24V
  - GPIB (IEEE488) come interfaccia comune (1983)
- Funzioni tipiche
  - Software-less “plug and play”
  - Logica, amplificatori, shapers, porte, discriminatori,…
- Molto vecchio ma ancora utile e molto usato in laboratorio

Modulo NIM



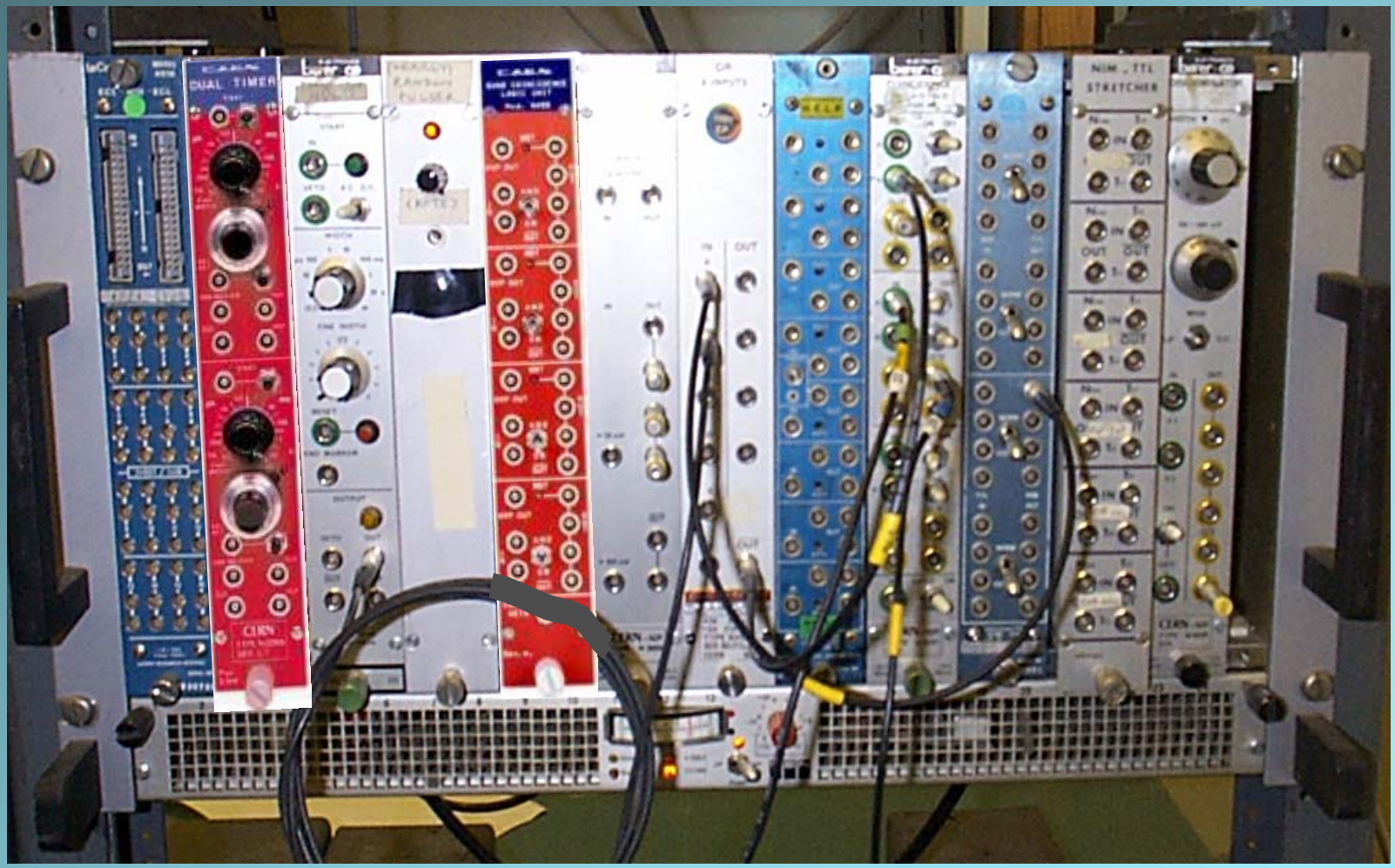
NIM - schema del connettore



PIN	FUNCTION
1	RESERVED
2	RESERVED
3	SPARE
4	RESERVED
5	
6	
7	
8	+200 V D.C.
9	SPARE
* 10	+6 V
* 11	-6 V
12	RESERVED
13	SPARE
14	SPARE
15	RESERVED
* 16	+12 V
* 17	-12 V
18	SPARE
19	RESERVED
20	SPARE
21	SPARE
22	RESERVED
23	RESERVED
24	RESERVED
25	RESERVED
26	SPARE
27	SPARE
* 28	+24 V
* 29	-24 V
30	SPARE
31	SPARE
32	SPARE
33	117 V A.C. (HOT)
* 34	POWER RETURN GND
* 35	RESET
36	GATE
37	SPARE
38	
39	
40	
* 41	117 V A.C. (NEUTRAL)
* 42	HIGH QUALITY GND
G	GROUND GUIDE PIN

** Must be bussed to all bin connectors GPIB through PG12B.*

Crate NIM



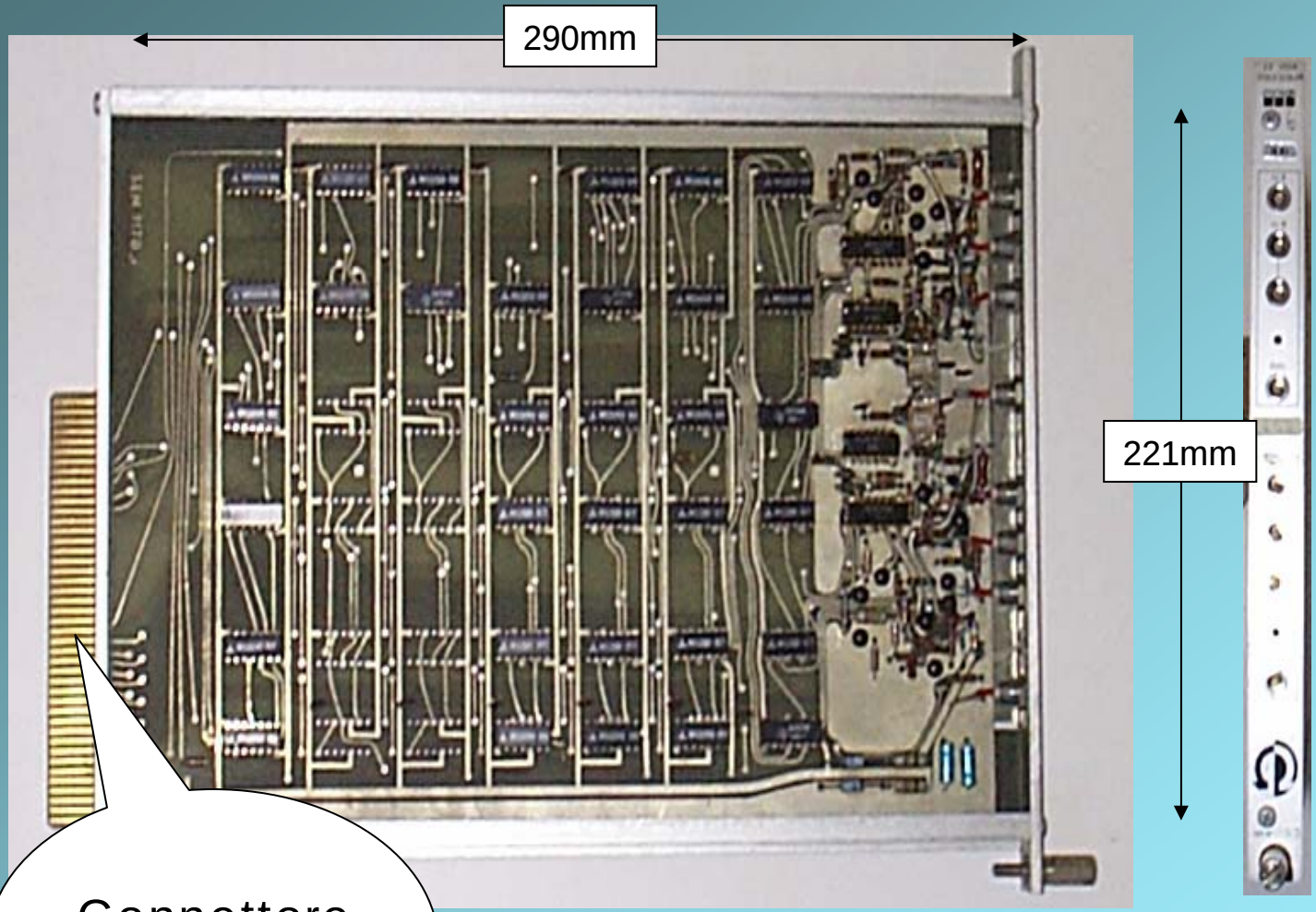
NIM - logica elettrica

		output	input
NIM			
standard positive logic	logic 1	+4 → +12 V	+3 → +12 V
	logic 0	+1 → -2 V	+1.5 → -2 V
standard fast negative logic	logic 1	-14 → -18 mA	-12 → -36 mA
(50 Ω impedance)	logic 0	-1 → +1 mA	-4 → +20 mA
	logic 1	-0.7 → -0.9 V	-0.6 → -1.8 V
	logic 0	-0.05 → +0.05 V	-0.2 → +1 V
TTL	logic 1	+2.4 → +5 V	+2 → +5 V
transistor transistor logic	logic 0	0 → +0.4 V	-0.2 → +0.8 V
BNC or lemo connections with coaxial cable			
ECL	high state	-0.81 → -0.98 V	-0.81 → -1.13 V
emitter-coupled logic	low state	-1.63 → -1.95 V	-1.48 → -1.95 V
34-pin (two 17-pin rows) connector from 100 Ω twisted pair cable			
complementary outputs – one high, one low			

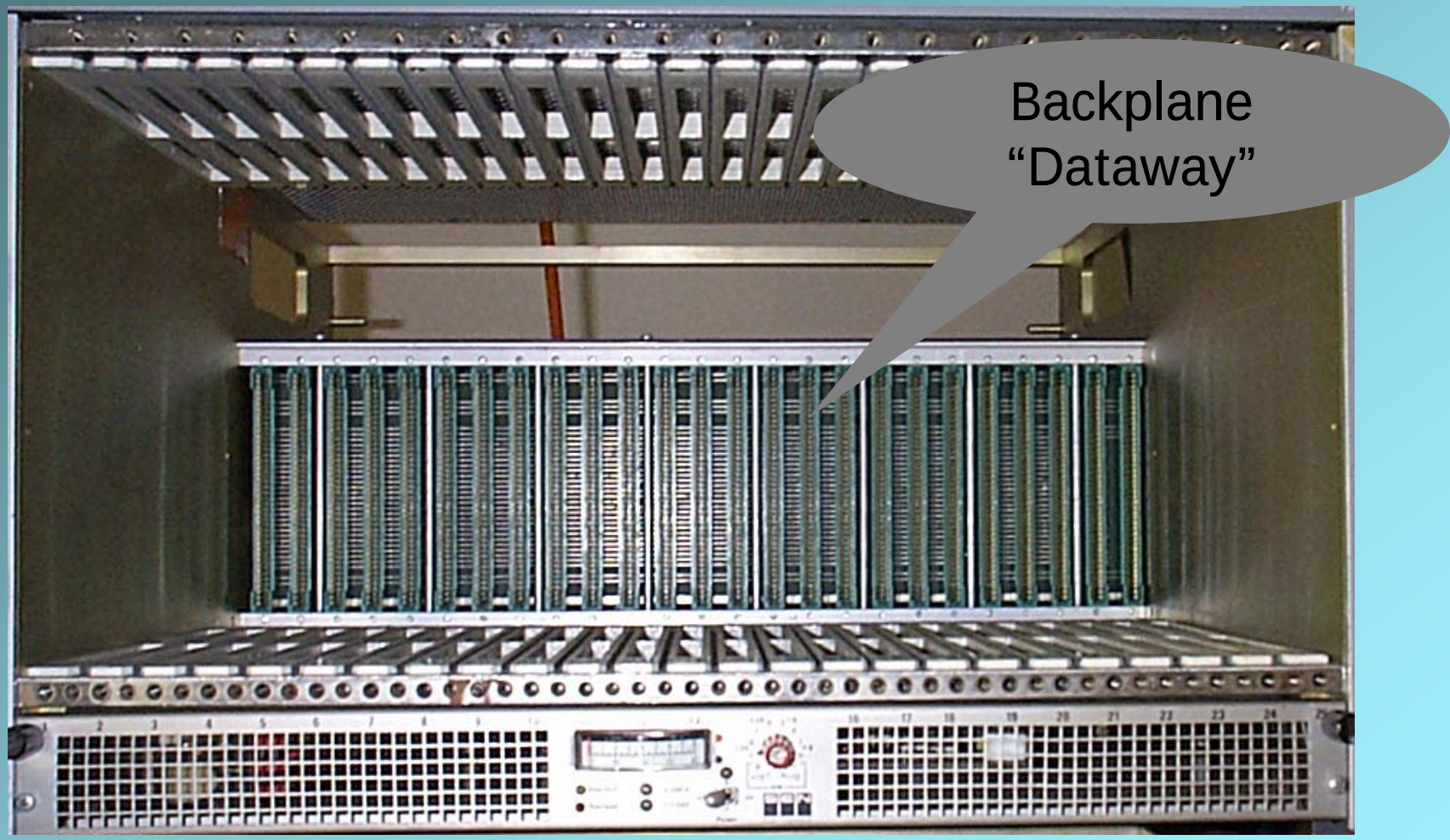
CAMAC - 1969

- Computer Automated Measurement and Control
- Origine: ESONE/NIM
  - EUR4100, IEEE 596, IEC 60516
- Strumentazione modulare controllata da computer
  - backplane da 25 slot (“dataway”)
    - slot 24 & 25 speciali per il “Crate Controller”
    - Singolo master
  - Alimentazioni: +24V, +6V, -6V, -24V
  - 1µs/operazione
- Funzioni tipiche
  - ADCs, TDCs, discriminatori, scalers, etc
- Applicazioni
  - read-out, test e misurazioni, controllo industriale,…

Modulo CAMAC



Crate CAMAC



Standard CAMAC

- Eccetto per il controller, ciascuna slot è connessa con 24 linee in lettura/scrittura che possono trasmettere dati a 24 bit.
- I moduli non sono connessi fra di loro ma solo tramite il controller
- La stazione di controllo è connessa ad ogni modulo con linee private:
  - 24 linee di indirizzamento (linee N) che devono essere attivate per comunicare con la stazione
  - 24 linee “look at me” LAM (linee L) che segnalano al controller che una stazione necessita attenzione.
- Per comunicare, il computer manda un messaggio al controller che:
  - Attiva la linea N
  - Attiva le linee di sotto-indirizzamento A
  - Attiva le linee di funzione (5 linee F)
- Le coordinate di ciascun modulo sono B (branch), C (crate), N (slot), A (stazione).

CAMAC Pinout

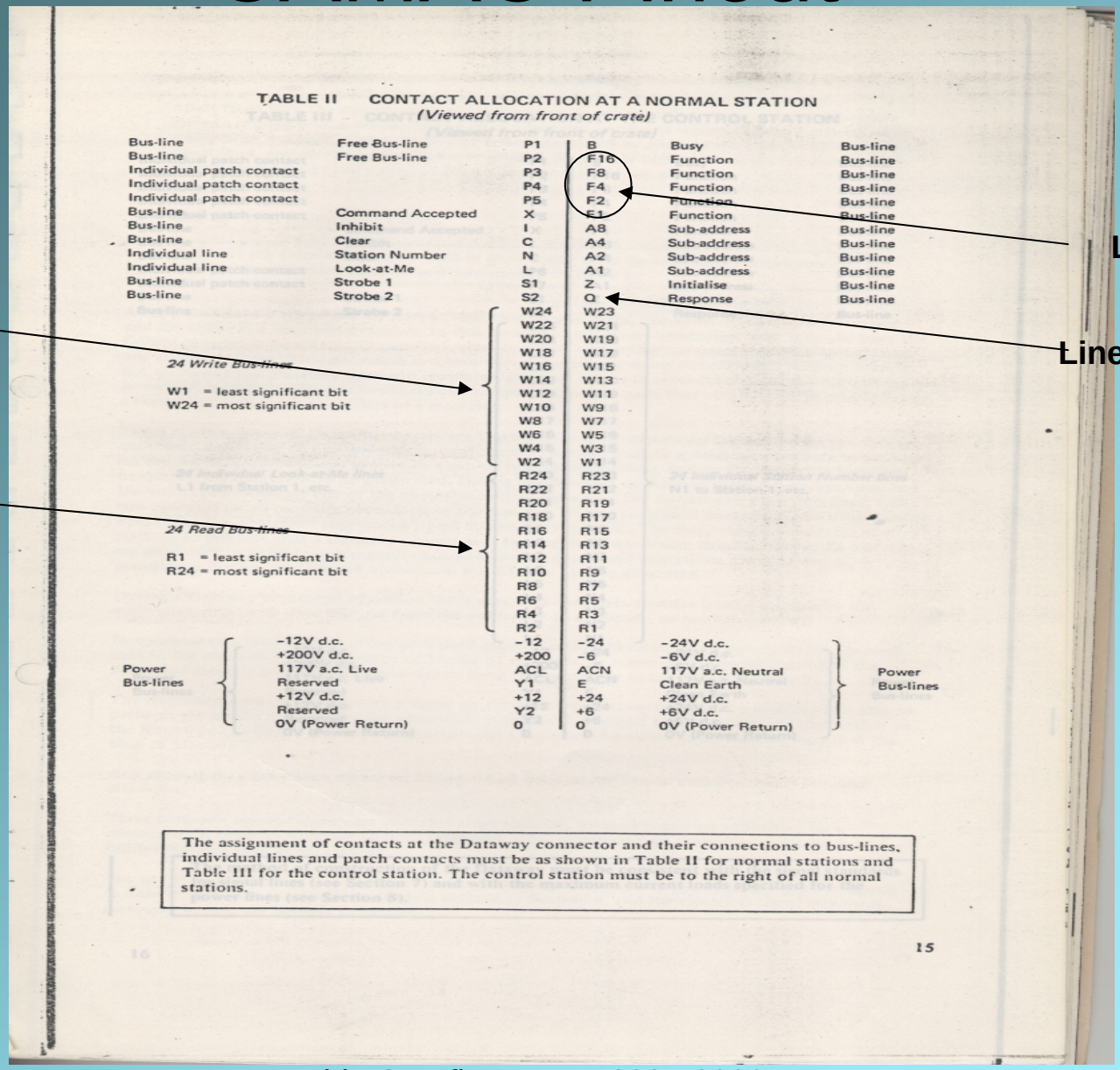


TABLE II CONTACT ALLOCATION AT A NORMAL STATION
(Viewed from front of crate)

Bus-line	Free Bus-line	P1	B	Busy	Bus-line
Bus-line	Free Bus-line	P2	F16	Function	Bus-line
Individual patch contact		P3	F8	Function	Bus-line
Individual patch contact		P4	F4	Function	Bus-line
Individual patch contact		P5	F2	Function	Bus-line
Bus-line	Command Accepted	X	F1	Function	Bus-line
Bus-line	Inhibit	I	A8	Sub-address	Bus-line
Bus-line	Clear	C	A4	Sub-address	Bus-line
Individual line	Station Number	N	A2	Sub-address	Bus-line
Individual line	Look-at-Me	L	A1	Sub-address	Bus-line
Bus-line	Strobe 1	S1	Z	Initialise	Bus-line
Bus-line	Strobe 2	S2	Q	Response	Bus-line
		W24	W23		
		W22	W21		
		W20	W19		
		W18	W17		
		W16	W15		
		W14	W13		
		W12	W11		
		W10	W9		
		W8	W7		
		W6	W5		
		W4	W3		
		W2	W1		
		R24	R23		
		R22	R21		
		R20	R19		
		R18	R17		
		R16	R15		
		R14	R13		
		R12	R11		
		R10	R9		
		R8	R7		
		R6	R5		
		R4	R3		
		R2	R1		
Power Bus-lines	−12V d.c.	−12	−24	−24V d.c.	Power Bus-lines
	+200V d.c.	+200	−6	−6V d.c.	
	117V a.c. Live	ACL	ACN	117V a.c. Neutral	
	Reserved	Y1	E	Clean Earth	
	+12V d.c.	+12	+24	+24V d.c.	
	Reserved	Y2	+6	+6V d.c.	
	0V (Power Return)	0	0	0V (Power Return)	

24 Write Bus-lines

W1 = least significant bit
W24 = most significant bit

24 Read Bus-lines

R1 = least significant bit
R24 = most significant bit

The assignment of contacts at the Dataway connector and their connections to bus-lines, individual lines and patch contacts must be as shown in Table II for normal stations and Table III for the control station. The control station must be to the right of all normal stations.

15

Linee funzione

Linea di risposta

Linee scrittura

Linee lettura

CAMAC Programming

- Le funzioni di programmazione del CAMAC sono nate al tempo del FORTRAN (’77), e le successive implementazioni, per lo più, si riferiscono alle funzioni FORTRAN.

•cdreg() Define a register

•cfsa() Execute a single function (32bit data)

•cssa() Execute a single function (16bit data)

•cccz() Crate initialize

•cccc() Crate clear

•ccci() Control crate inhibit

•ctci() Test crate inhibit

•cccd() Control crate demand

•ctcd() Test crate demand

•ctgl() Test graded lam

•cdlam() Define lam

•cclm() Control lam

•cclc() Clear lam

•ctlm() Test lam

Esempio di programmazione CAMAC

```
#include "ca.h"
void cdreg(int *ext,int b,int c,int n,int a); /* ext = adddress repr. B,C,N,A */
void cfsa(int f,int ext,int *data,int *q);
void cssa(int f,int ext,short *data,int *q);
void cccz(int ext);

/* CAMAC readout example */
   int ext, q;
   int data;
   cdreg(&ext,0,1,3,0); /* address module at slot 3 */

  /*Read(Function 0) on ext and put data in data */
   cfsa(0,ext,&data,&q);
   if (q != 0)
        {
                printf("bad response %d from 0,1,3,0\n",q);
        }
   cfsa(16,ext,1234,&q);/* write (function 16) 1234 to register */
   cfsa(0,ext,&data,&q);/*  read register into data */
   if (data !=1234)
        {
           printf( "bad compare: wrote 1234, read %d\n",data);
        }
```

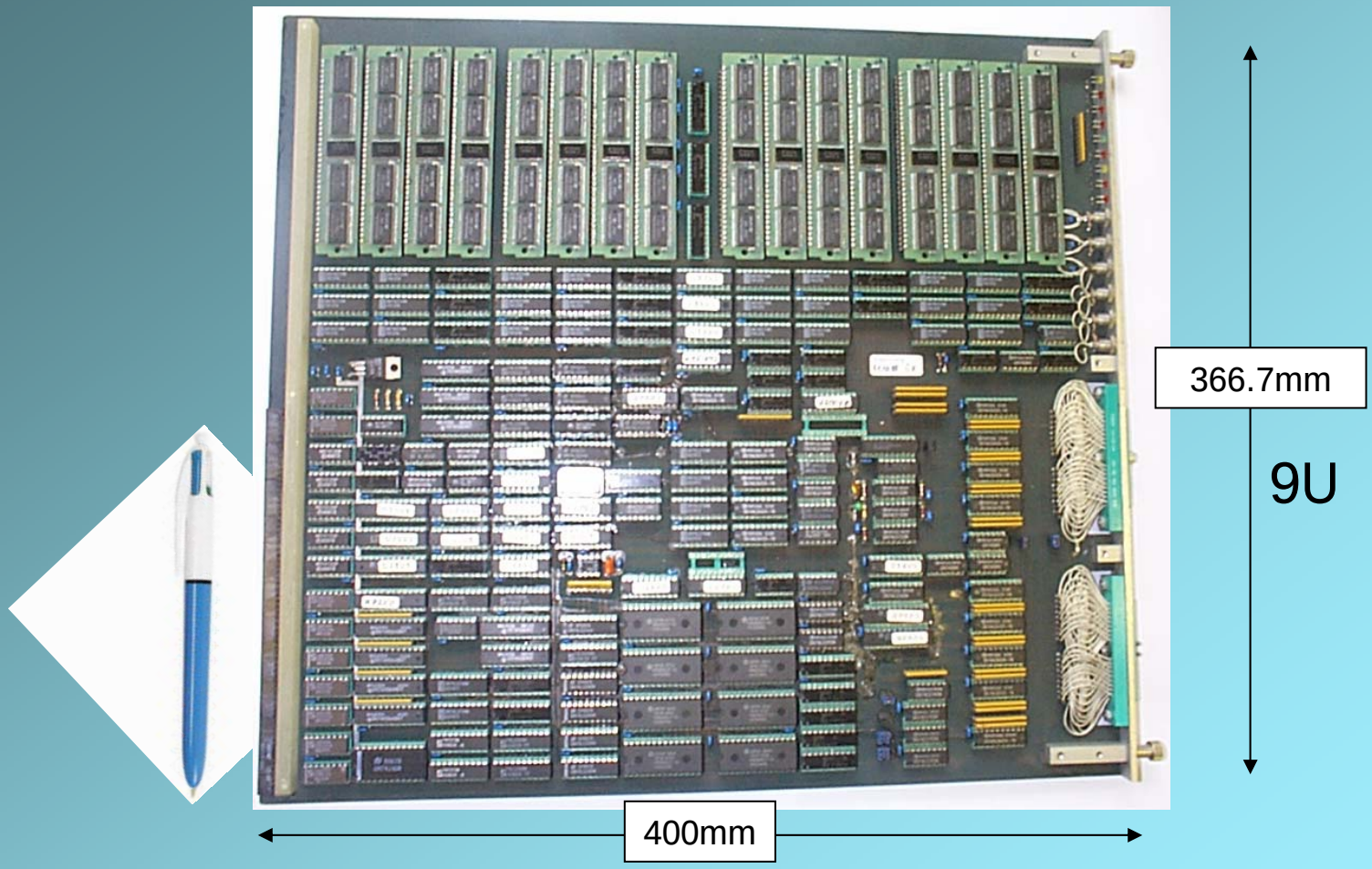
Come comunica CAMAC con il PC?

- Il Camac controller comunica tramite una scheda PCI sul PC o VME con una SBC (Single Board Computer) sul bus VME.
- In entrambi i casi c’è bisogno di un driver e/o di un mapping dello spazio di indirizzamento del camac controller sul bus di comunicazione (PCI o VME).

Fastbus

- Origine: NIM/ESONE - IEEE 960
- High-speed data acquisition
  - 26 station ECL backplane
  - Multi-master, arbitraggio distribuito
  - Power: +5V, -5.2V, -2V, ±15V
  - 160 Mbyte/s
- Funzioni tipiche
  - ADCs, TDCs, etc
- Aplicazioni
  - read-out in fisica, imaging in medicina
- Veloce, 9U boards, ma
- Abbandonata dal CERN per mancanza di interesse dall'industria (solo una dimensione per le schede,…)

Modulo FASTBUS



Crate FASTBUS