The "**Ri**(velatori)**pe**(r)**N**(eutroni)" Set-up for Neutron Spectroscopy

M. Cinausero

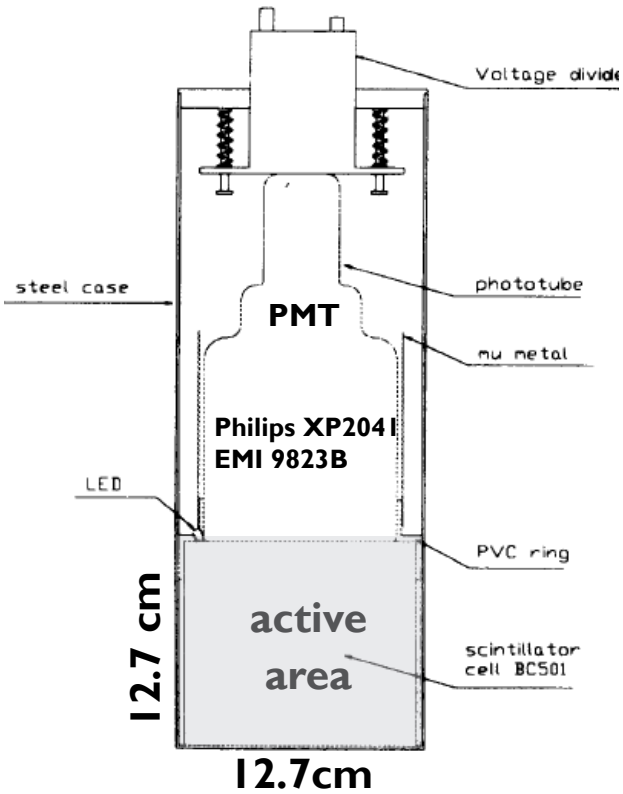
Laboratori Nazionali di Legnaro

Outline

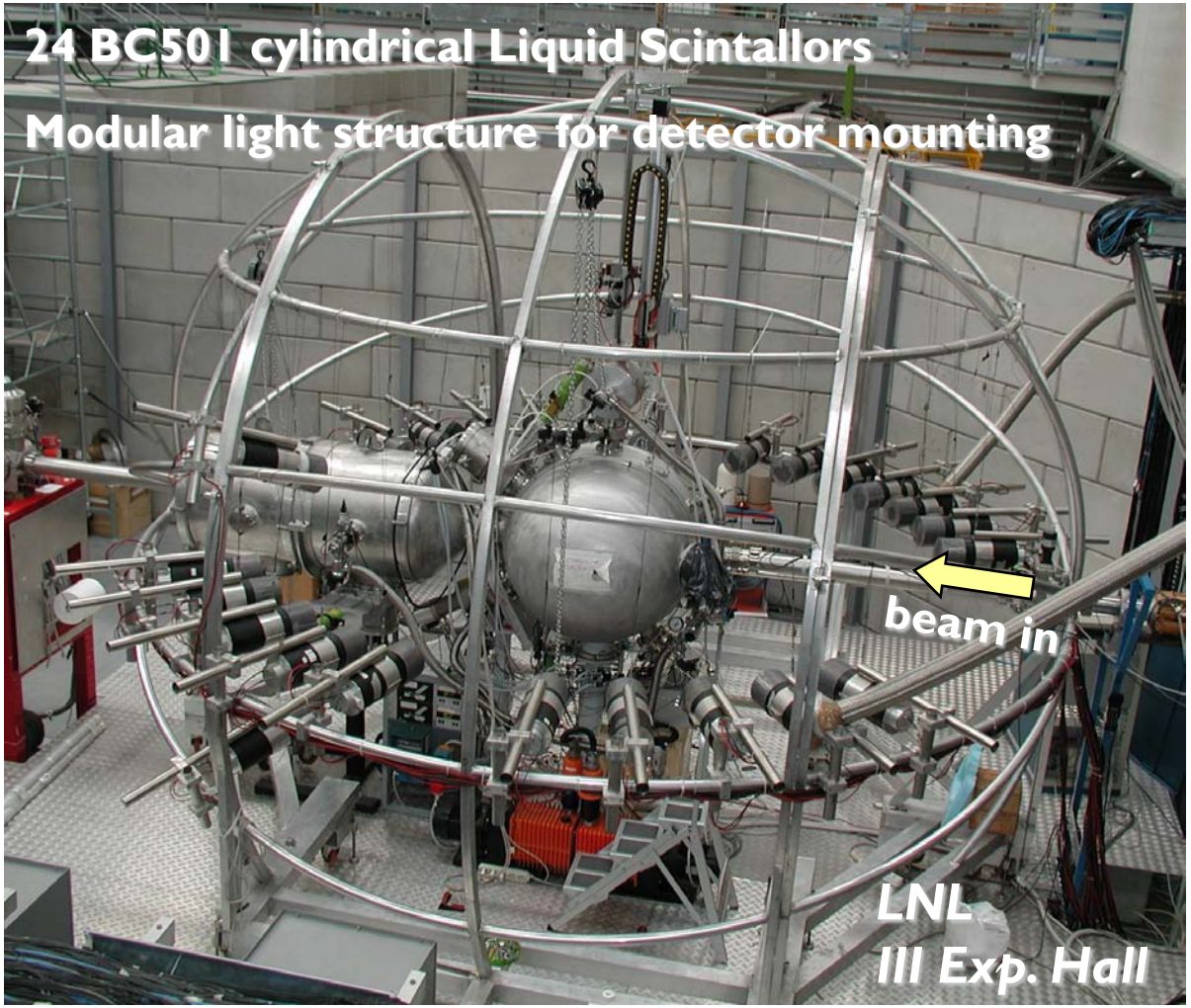
- Performances of the apparatus
- Trigger and ancillary detectors
- Digital electronics tests

- Studies on new material for neutron detection

The RipeN set-up: The Apparatus

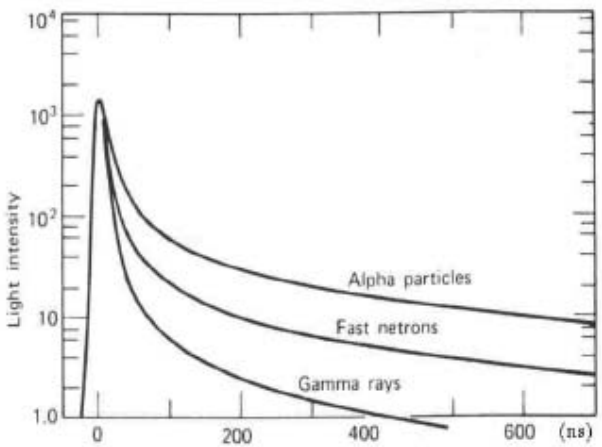


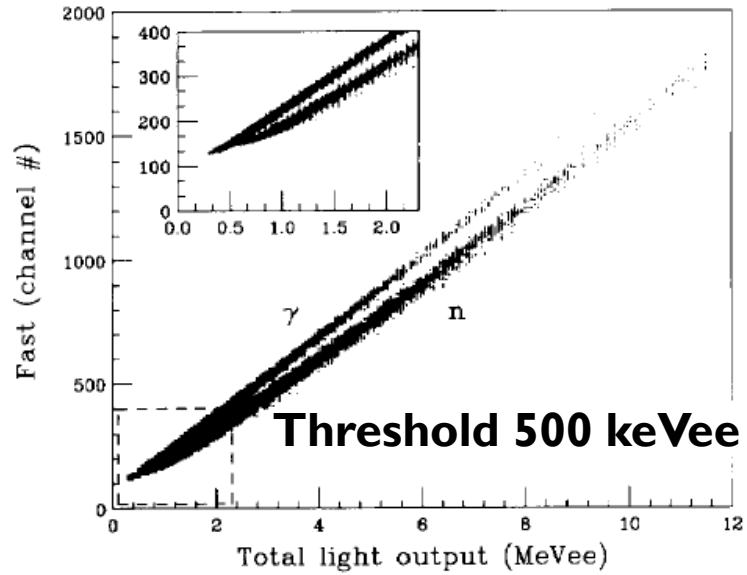
2 m Flight path
$\Delta\Omega \approx 3$ mSr
$\Delta\theta \approx \pm 2^o$

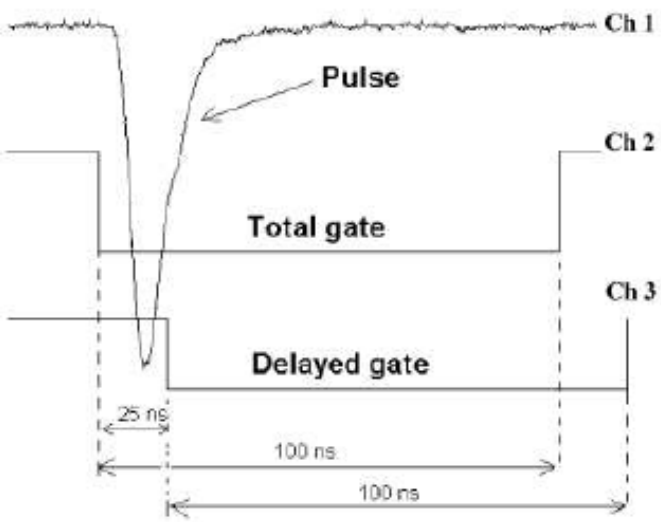


N. Colonna et al., NIM A 381 (1996) 472

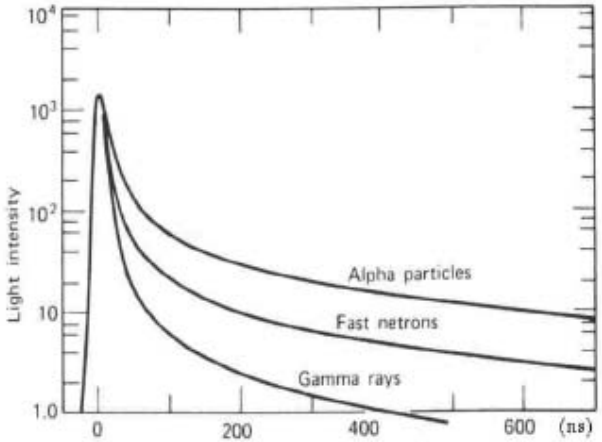
The RipeN set-up: Neutron-gamma discrimination

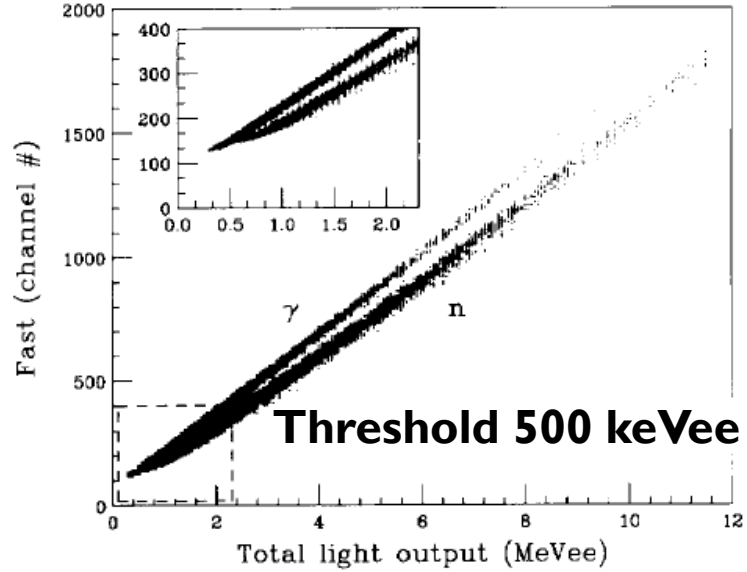


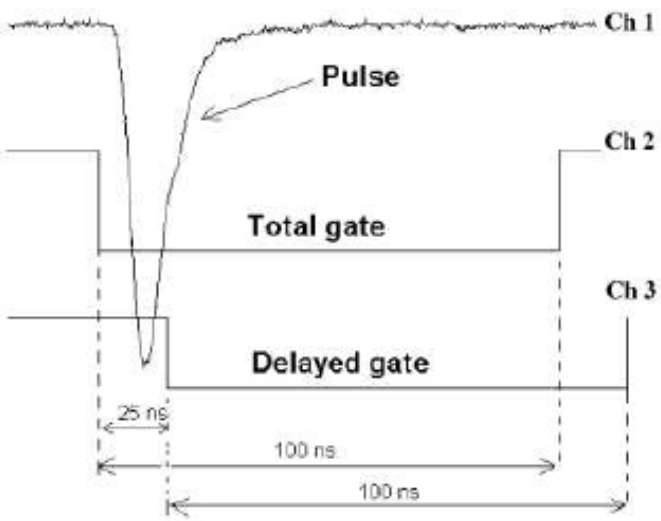


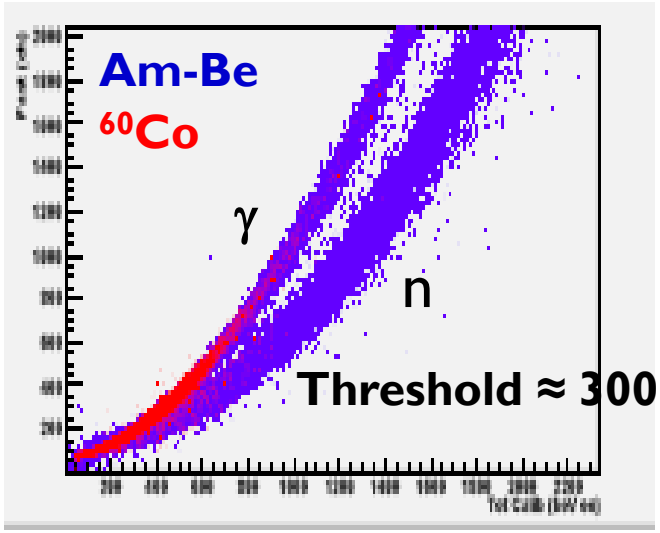


The RipeN set-up: Neutron-gamma discrimination









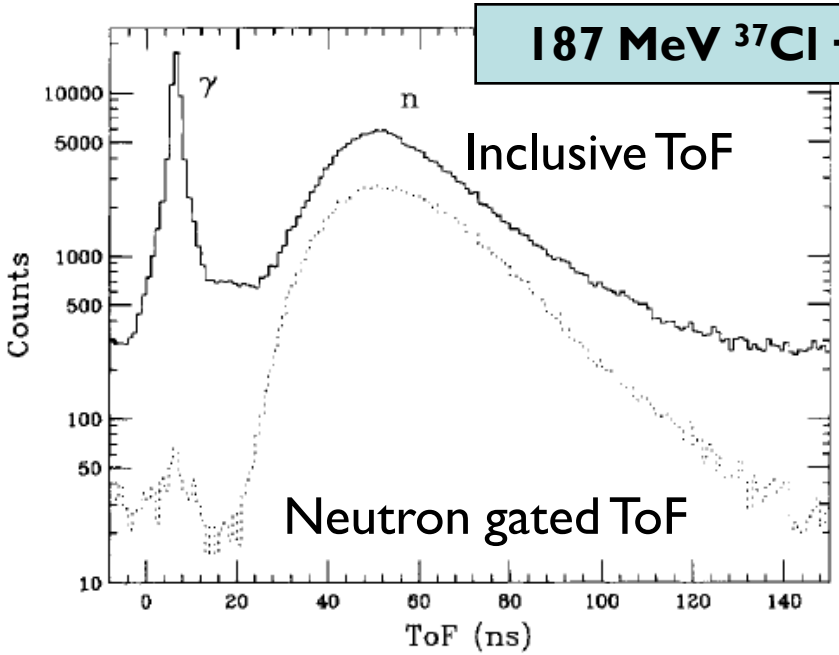
G. Guastalla, Master Thesis Univ. of Bologna 2010

The RipeN set-up: Neutron energy measurement

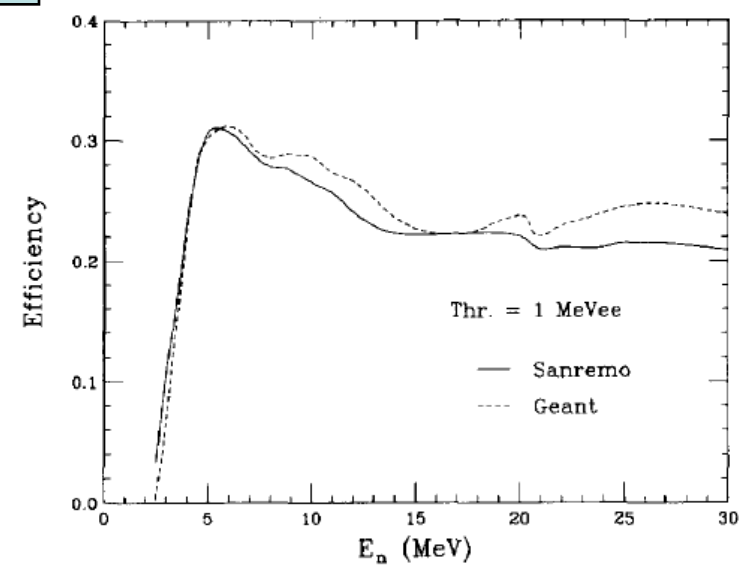
$$E_n = \frac{1}{2} m_n \frac{L^2}{t^2}$$

$$\frac{\Delta E}{E} = 2\sqrt{\left(\frac{\Delta L}{L}\right)^2 + \left(\frac{\Delta t}{t}\right)^2}$$

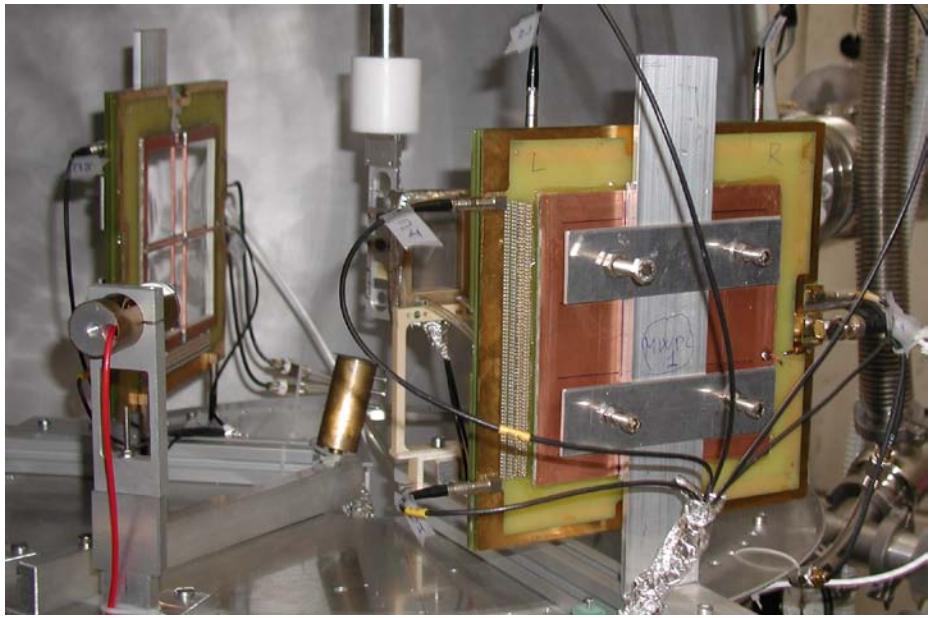
187 MeV ^{37}Cl +^{120}Sn



Detector response function

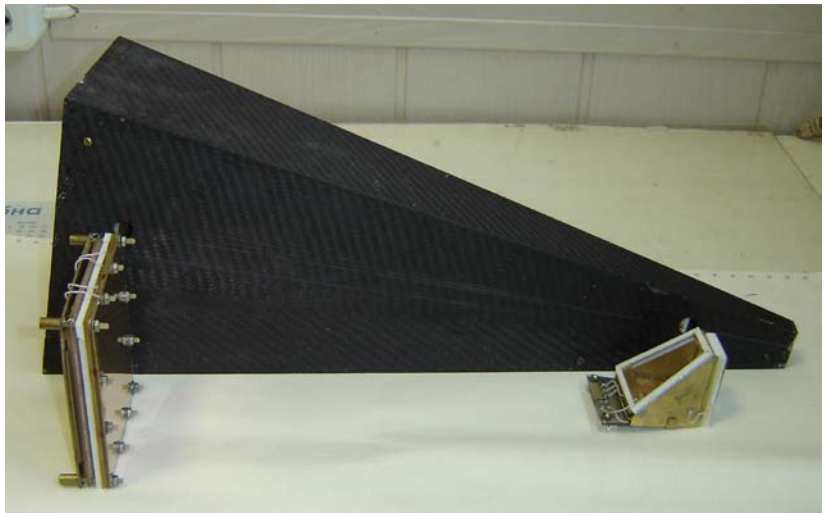


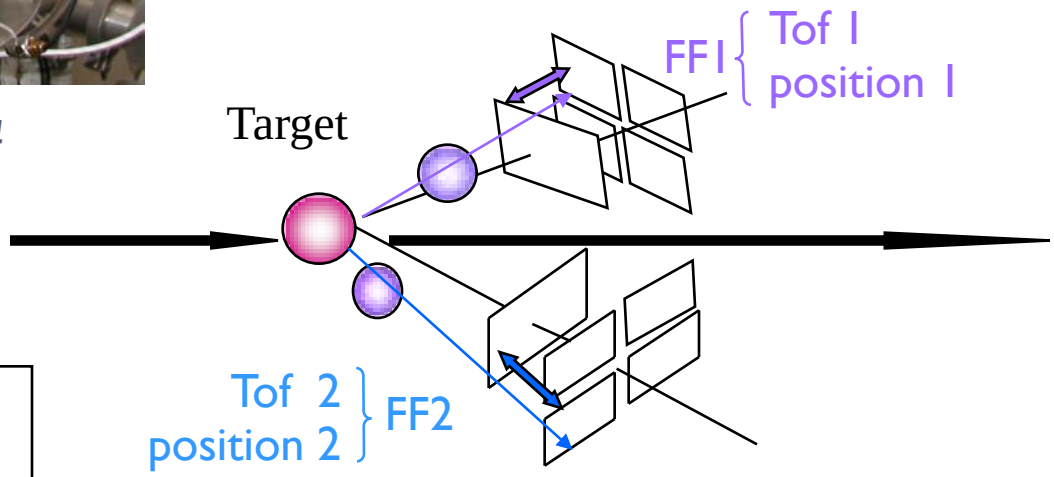
MultiWire Gas Detectors + PPAC



R.G.Thomas et al., PRC 75 (2007) 024604

CORSET MCP system for 8πLP

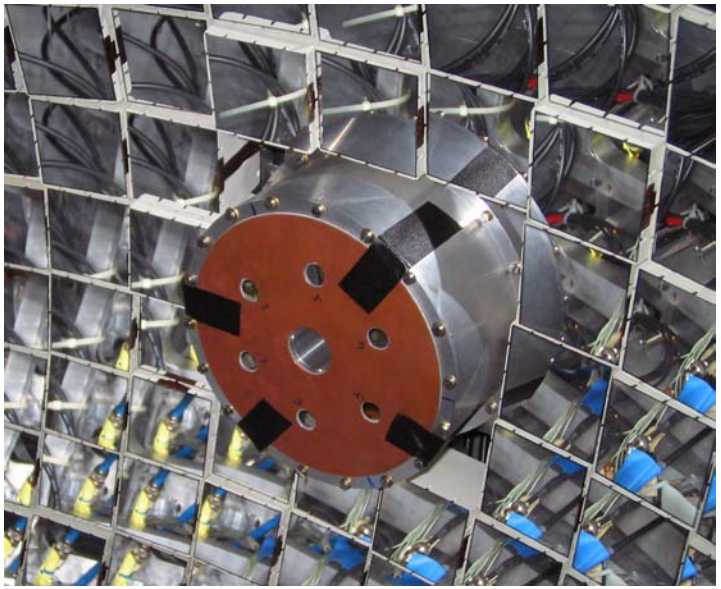




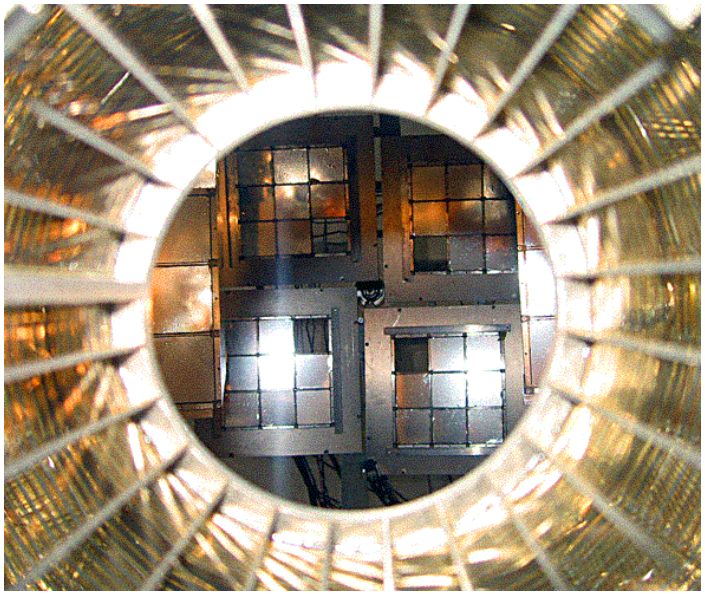
See: E.Vardaci et al, LOI

The RipeN set-up: Fusion-evaporation and pre-equilibrium studies

PPAC gas detectors



Phoswich detectors

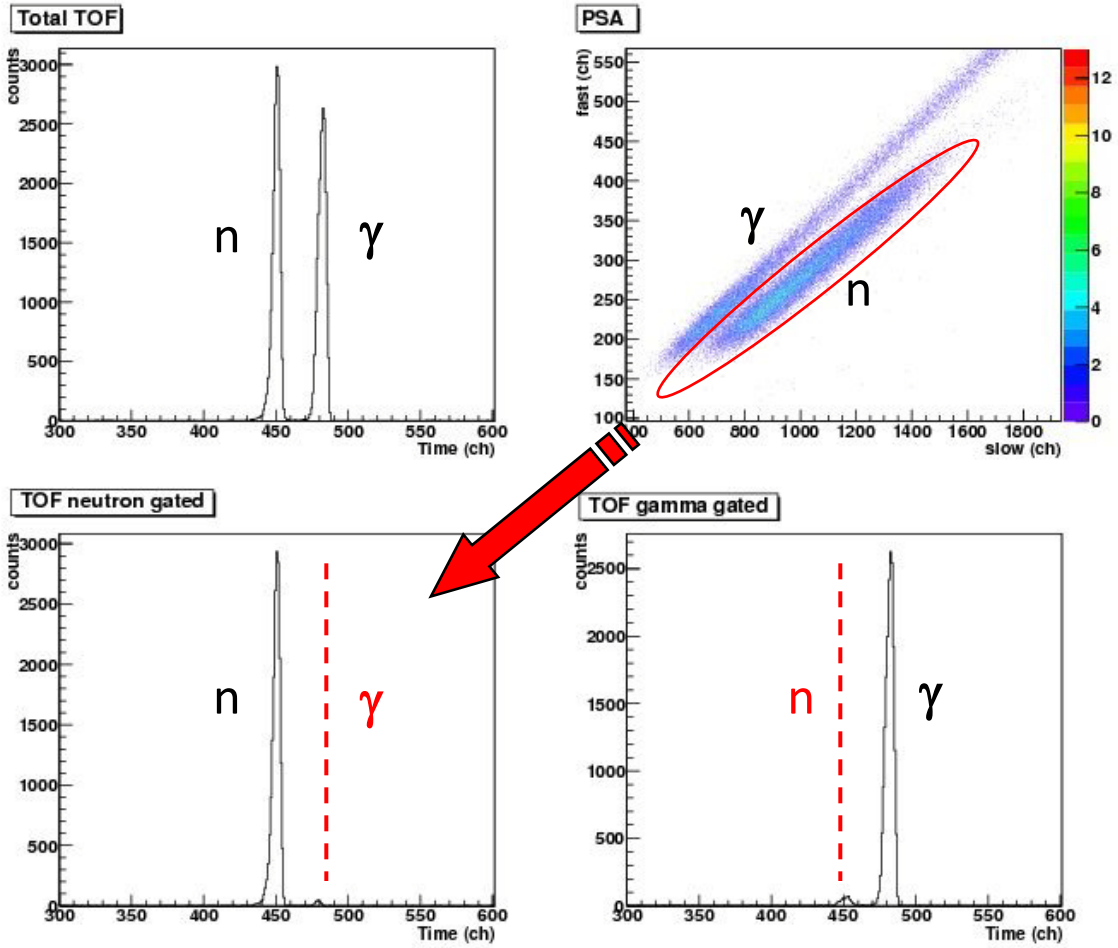


Experiments in connections with charged particle spectrometers: GARFIELD and 8πLP

To be studied
Coupling with FAZIA Phase II:
Wall-like in forward direction,
Reactions in reverse kinematics

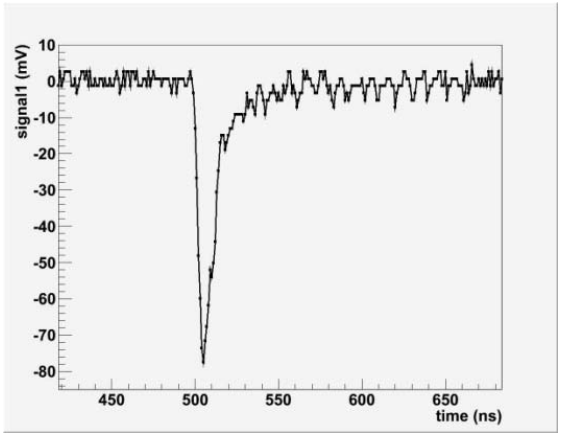
See: A. Di Nitto et al, LOI
V. Kravchuk et al, LOI
S. Pirrone et al, LOI
G. Casini et al, LOI

4 MeV p + Li pulsed beam @ CN Van de Graaf accelerator



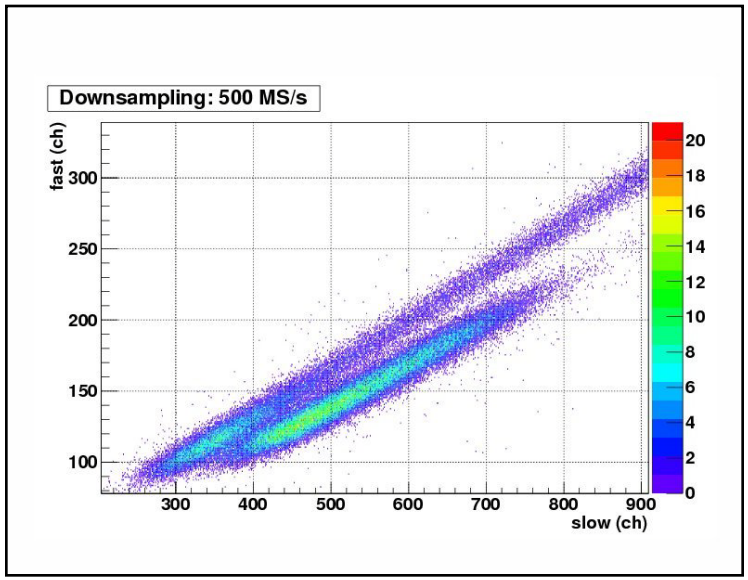
Acqiris DC271A Card
1GS/s, 8 Bit

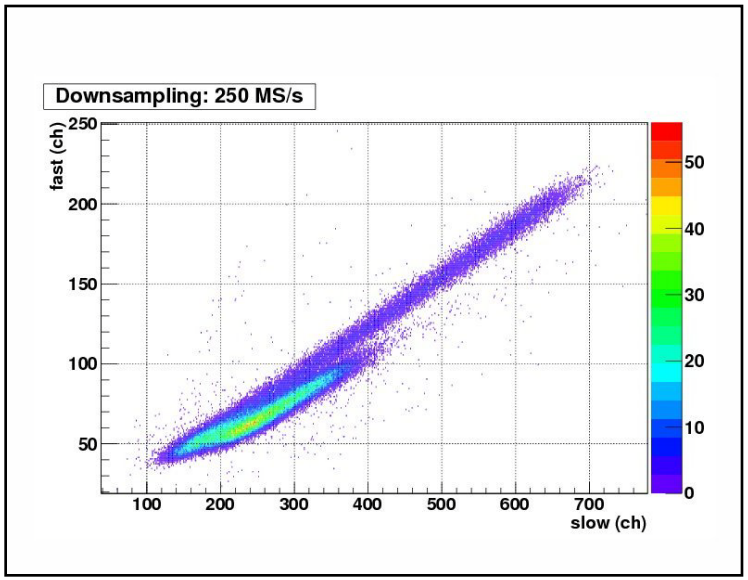
Example of
Sampled signal

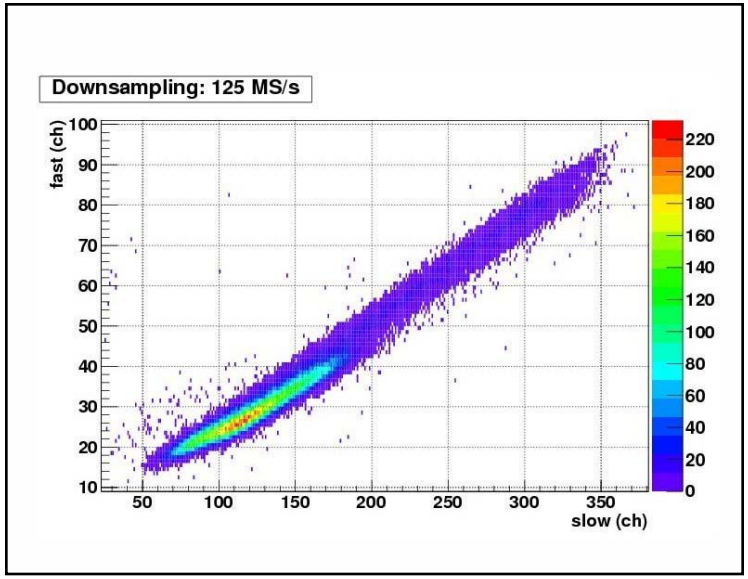


T. Marchi, LNL and Univ. of Padova
L. Bardelli et al., NIM A 521, (2004) 480 and private communication

Digital Electronics Tests: Downsampling of the original signal







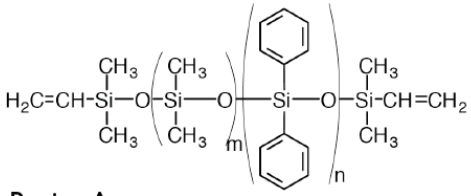
NEXT STEPS:

CAEN VT1720 Card (250MS/s, 12 Bit) already installed

Test with sources are starting

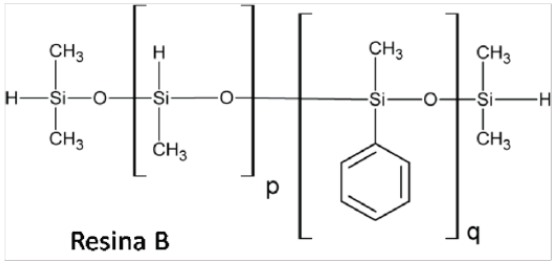
Synthesis procedure and samples production: Polysiloxane rubbers

Series	Cat.	1° dye	2° dye	Neutr. Abs.
K	3,0% Pt	PPO (0,5% - 2,0%)		
GD	3,0% Pt	PPO (0,5% - 1,5%)		Gd
MT	1,9% Pt	PPO (0,0% - 1,5%)		
SB	1,9% Pt	PPO (1,0% -2,0%)		
BBOT1	1,9% Pt	PPO (0,5% - 2,0%)	BBOT	
BBOT2	1,9% Pt	PPO (0,5% - 2,0%)	BBOT	Gd or B
LV1	1,9% Pt	PPO (1,0% - 1,5%)	LV (0.01% - 0,05%)	
LV	1,9% Pt	PPO (1,0% - 1,5%)	LV (0.01% - 0,05%)	Gd or B
LV *	1,9% Pt	PPO (1,0% - 1,5%)	LV (0.01% - 0,05%)	B (O- CARBORANE)
dPOPOP*	1,9% Pt	PPO (1,0%)	dPOPOP (0,01% - 0,02)	B (O- CARBORANE)



Resina A

dimetil-difenilsilossano
n/m = fenile % comp
4% – 22 %

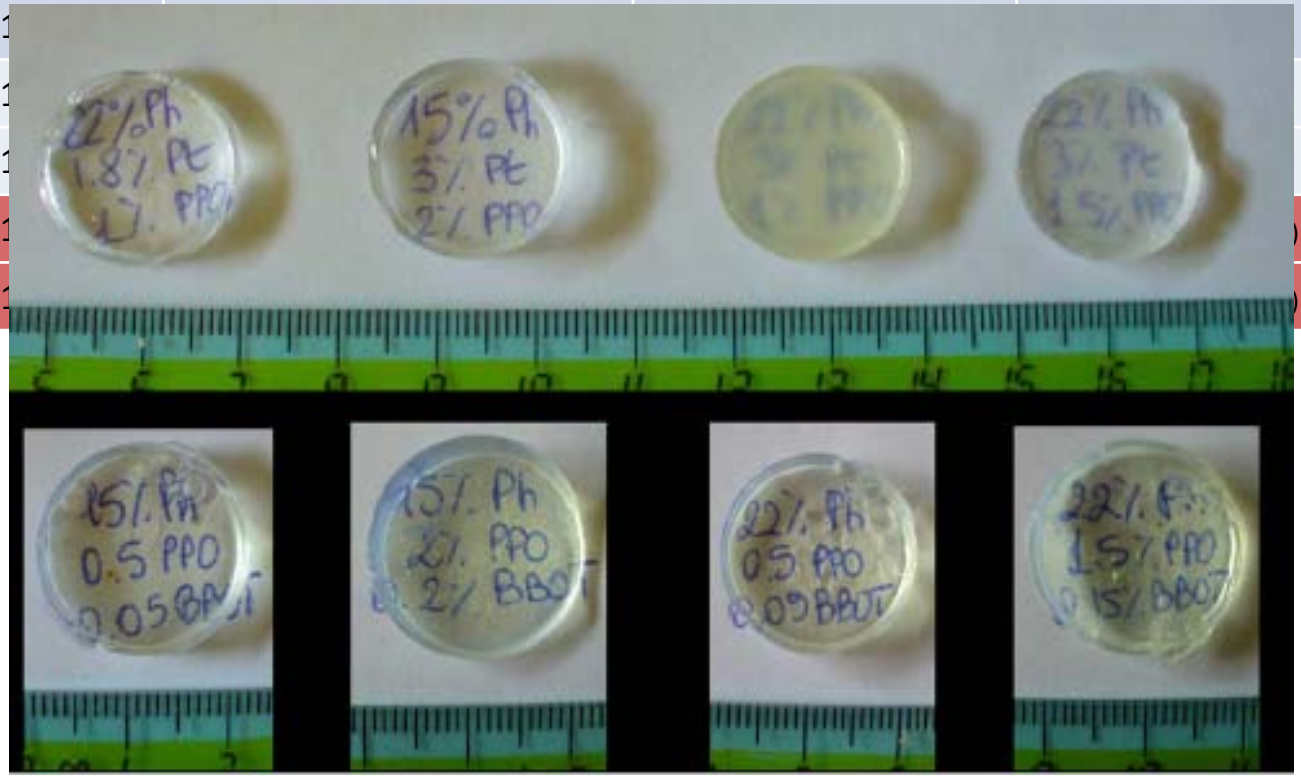


Resina B

fenilmetilsilossano
p/q ≈ 0.5

Synthesis procedure and samples production: Polysiloxane rubbers

Series	Cat.	1° dye	2° dye	Neutr. Abs.
K	3,0% Pt	PPO (0,5% - 2,0%)		
GD	3,0% Pt	PPO (0,5% - 1,5%)		Gd
MT	1,9% Pt	PPO (0,0% - 1,5%)		
SB	1,9% Pt	PPO (1,0% -2,0%)		
BBOT1	1,9% Pt	PPO (0,5% - 2,0%)	BBOT	
BBOT2	1			
LV1	1			
LV	1			
LV *	1			)
dPOPOP*	1			)



Polysiloxane scintillators properties: Light Output

% B	α – yield (% Ej-212)	γ – yield (% Ej-212)	α – yield (% Ej-254)	γ – yield (% Ej-254)
no	65 ± 16	74 ± 15	-	-
4	44 ± 13	49 ± 12	66 ± 22	69 ± 16
6	40 ± 14	48 ± 11	64 ± 24	62 ± 15
8	37 ± 13	41 ± 17	54 ± 17	57 ± 11

Test as neutron detectors: relative efficiency

Tabella 5.1: efficienze per la rivelazione di neutroni termalizzati relative all'EJ254.

run	campione	%B	I (/EJ254)	±
3	1	4	0.7	0.2
3	3	8	1.4	0.2
4	1	4	0.6	0.1
4	2	6	1.3	0.5

Tabella 5.3: efficienze per la rivelazione di neutroni veloci relative all'EJ254

run	campione	% Boro	I(/EJ254)	±
3	1	4	0.9	0.1
3	3	8	1.0	0.1
4	1	4	0.9	0.1
4	2	6	1.0	0.1

G. Guastalla, Master Thesis Univ. of Bologna 2010

NUCLEX-ORIONE Collaboration

- ✓ INFN Laboratori Nazionali di Legnaro:
  S.M. Carturan, M. C., M. Degerlier F. Gramegna, V. Kravchuk, T. Marchi, G. Prete, A. Quaranta, S. Sambi
- ✓ Bologna INFN and University:
  G. Baiocco, M. Bruno, M. D'Agostino, G. Guastalla, L. Morelli, G. Vannini
- ✓ Firenze INFN and University:
  L. Bardelli, S. Barlini, M. Bini, S. Carboni, G. Casini, N. Gelli, A. Olmi, G. Pasquali, G. Poggi
- ✓ Napoli INFN and University:
  A. Brondi, L. Campajola, A. Di Nitto, G. La Rana, R. Moro, A. Ordine, G. Spadaccini, E. Rosato, E. Vardaci, M. Vigilante

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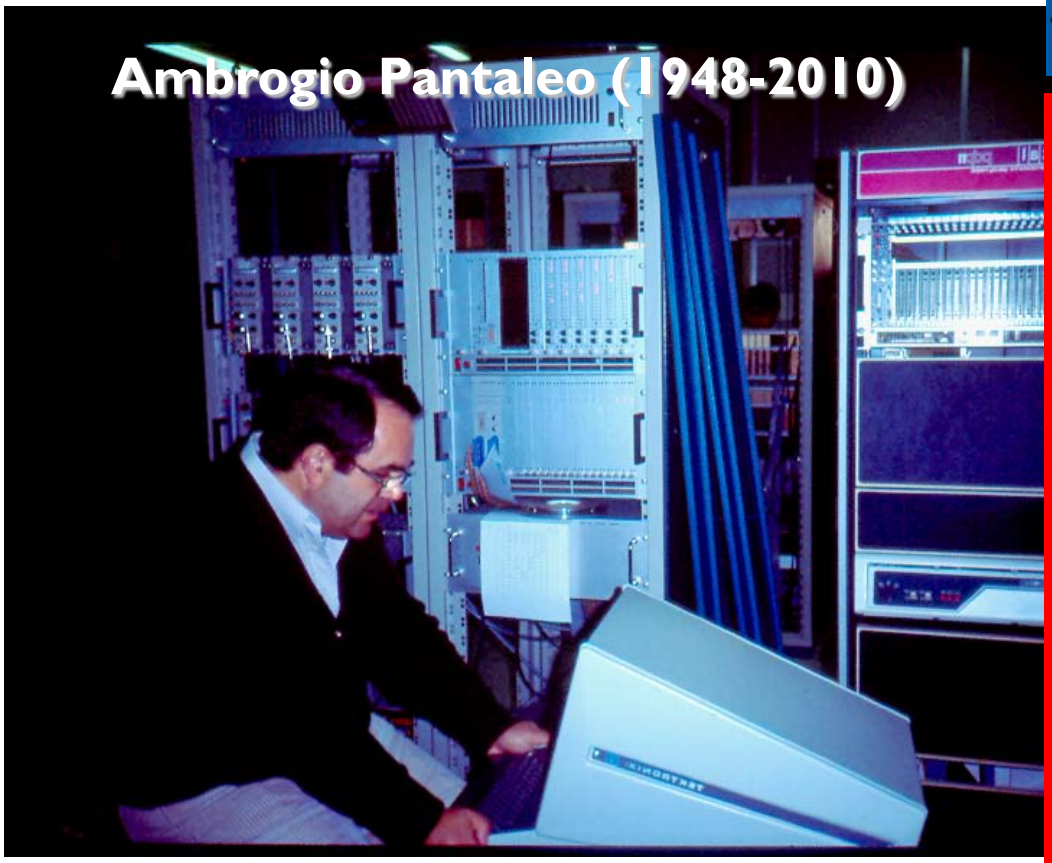
INFN Bari: ***V. Paticchio***



Italian Physical Society
Società Italiana di Fisica

From: Il Nuovo Saggiatore

…[Dal 1983 è stato responsabile nazionale del Gruppo "Rivelatori di Neutroni ", dedicato alla progettazione e realizzazione di un punto di misura neutronico presso i LNS, nell'ambito dell'iniziativa "Grandi attrezzature per il Laboratorio del Ciclotrone Superconduttore". Il prototipo scaturito dai suoi studi permette di fare spettrometria neutronica fino a 300 MeV. Le calibrazioni in efficienza e la determinazione della funzione di risposta le effettua sia presso il laboratorio del Dipartimento di Fisica dell'Università di Bari sia presso il laboratorio del TRIUMF di Vancouver. **Come risultato di queste attività sono stati realizzati, sotto la sua diretta responsabilità, presso i Laboratori Nazionali dell'INFN di Catania (LNS) e di Legnaro (LNL) due punti misura per spettrometria neutronica a grande angolo solido, utilizzati per studi su reazioni fra ioni pesanti.]….** V. Paticchio, INFN Bari