

***Detectori avansati pentru rate mari de numarare,
electronica front-end asociata
si evaluari de date nucleare
(DEFENUDA)***

Contract Number: 71-144/14.09.2007

Director Proiect: Prof. Dr. Mihai Petrovici

Durata: 18.09.2007 - 18.09.2010



Parteneri in Consortiu



***Conducator: Institutul National de Fizica si Inginerie
Nucleara "Horia Hulubei" (IFIN-HH)***

Partener 1: Universitatea Bucuresti, Facultatea de Fizica

Partener 2: Onlinesolutions Media Srl

Buget/Cofinantare: 2 000 000 lei/53 334 lei

<http://niham.nipne.ro/Parteneriate/parteneriate.html#A3>

Obiectivul general al proiectului: *mentinerea si cresterea vizibilitatii si competitivitatii grupului nostru prin parteneriate in domenii prioritare generate de cerintele si capacitatea stiintei nucleare de a rezolva probleme complexe de la experimentele viitoare de mare anvergura in fizica nucleara, la noua generatie de reactori nucleari.*

Elementele de noutate

Dezvoltarea unei noi generatii de:

- detectori de radiatie de tranzitie (TRD);
- detectori cu electrozi rezistivi (RPC);
- electronica "front-end" asociata;
- baze de date nucleare importante pentru noua generatie de reactori nucleari

Beneficiarii rezultatelor, potentialul de aplicare in economie:

- se impune dezvoltarea unei noi generatii de detectori pentru experimentele ce vor fi realizate la viitoarele acceleratoare. Aceste experimente isi propun evidentierea unor fenomene foarte rare in evenimente de ordinul a milioane pe secunda
- aceste activitati sunt parte integranta a unor proiecte de anvergura internationala:
 - Compressed Baryonic Matter (CBM) - FAIR din Darmstadt, Germania
 - Integrated Infrastructure Initiative in Hadron Physics: I3HP/FP6 si I3HP2/FP7
- modelele si calculele detaliate de fisiune nucleara abordate in cadrul proiectului contribuie la dezvoltarea bazelor de date nucleare pentru viitoarele generatii de reactori energetici.

CONCLUZII

Etapa 1: Date experimentale multi-parametrice privind neutronii prompti si fragmente de fisiune descrise de modelul POINT BY POINT

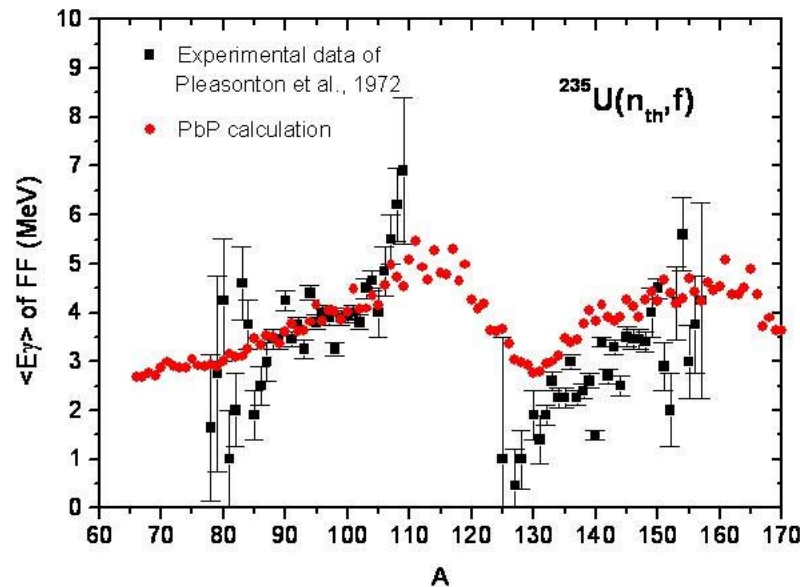
Finantare: Buget – 166 667 lei

Achizitii realizate: -

Precursori/rezultate intermediare:

1. Imbunatatirea codului de calcul SPECTRUM

2. Elaborarea codului de calcul PAIRPAR



➤ Rezultatele PbP in foarte bun acord cu datele experimentale pentru $\text{TXE}(A)$, $v_{\text{pair}}(\text{TXE})$, $\langle \epsilon \rangle(A)$

➤ Analizand rezultatele PbP multi-parametrice:

$v_{\text{pair}}(A)$ pt. TKE dat si $v_{\text{pair}}(\text{TKE})$ pt. $\{AH,AL\}$ dat:

- scaderea liniara evidenta a v_{pair} cu TKE
- acordul foarte bun cu datele exp. a lui v_{pair} pt. TKE din regiunea mediana
- o usoara subestimare pt. $^{235,233}\text{U}(n_{th}, f)$ si f.usoara supraestimare pt. $^{252}\text{Cf}(\text{SF})$ a multiplicitatii experim la perechile de FF aflate aproape de fisiunea simetrica
- la TKE mari tendinta de subestimare a datelor experim., mai vizibila la $^{235,233}\text{U}(n_{th}, f)$

➤ $\langle v \rangle_{\text{tot}}(\text{TKE})$ bun acord cu d.exp., mai putin la TKE joase (supraestimare a d.exp. la fel ca si alti autori, alte modele), la TKE mari acord mai bun cu d.exp. ca alti autori (S.Lemaire, P.Talou, T.Kawano, M.B.Chadwick, D.G.Madland - calcule Monte-Carlo si N.V.Kornilov, F.-J.Hambsch, F.J.Vorobiev - neutroni de sciziune, etc.)

➤ Rezultatele PbP pentru $\langle E_{\gamma} \rangle(A)$ in excelent acord cu datele experimentale existente

mult mai bune fata de rezultatele altor autori/modele :

(S.Lemaire, P.Talou, T.Kawano, M.B.Chadwick, D.G.Madland – prin calcule Monte-Carlo)

Stadiile de realizare

Finantare: Buget: 666 667 lei

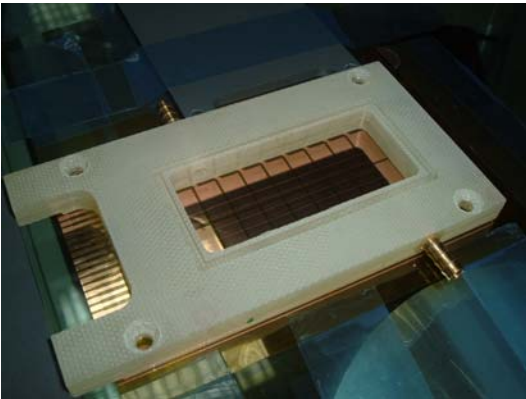
Etapa 2: Achizitii realizate: Echipament de laborator + Echipament de calcul- 44 810.31 lei



Etapa 2- prima parte: TRD de mare eficacitate si rate mari de numarare – analiza completa si caracterizare.

Precursori/rezultate intermediare:

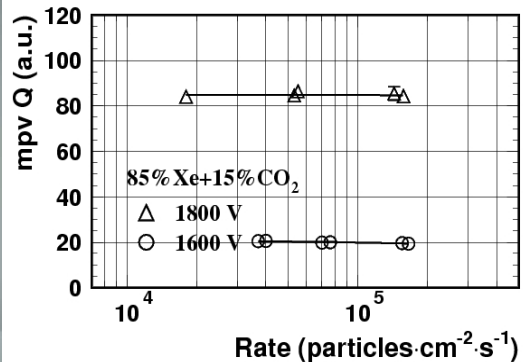
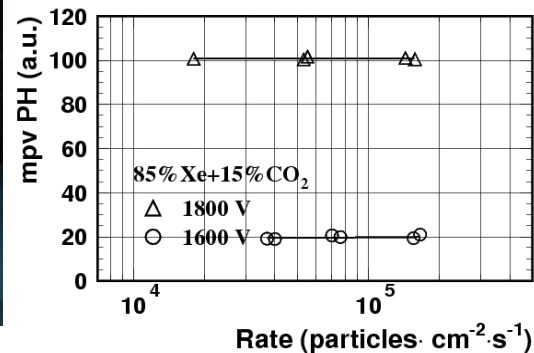
1. Model experimental + Model de laborator TRD



2. Prototip detector TRD



3. Programe de analiza a datelor experimentale; rezultate experimentale



4. Cerere inregistrare brevet nr: A/00570/22.07.2009

Summary and Outlook

- A High Counting Rate Transition Radiation Detector based on a simple Multiwire Proportional Chamber fulfills the requirements in terms of:
 - position resolution: smaller than 200 μm
 - pion efficiency: 12.5% for a 6 layer configuration @ p=1GeV/c, Rohacell radiator, 1900 V anode voltage
 - good performance up to 200 kHz/cm² counting rate
- Improved pion rejection factor is obtained for a double sided architecture
 - estimated pion efficiency: 0.7% for six layers configuration @ p=1.5 GeV/c, regular periodic foil stack radiator (20/500/120), 1800 V anode voltage
- A real size prototype was designed and is in construction
 - Within the present mechanical considerations, for a six layers configuration one could reach a 76% geometrical efficiency for a polar angle range between 1 - 6 deg
- Such an architecture could be of interest for high efficiency muon chamber in a high counting rate environment.

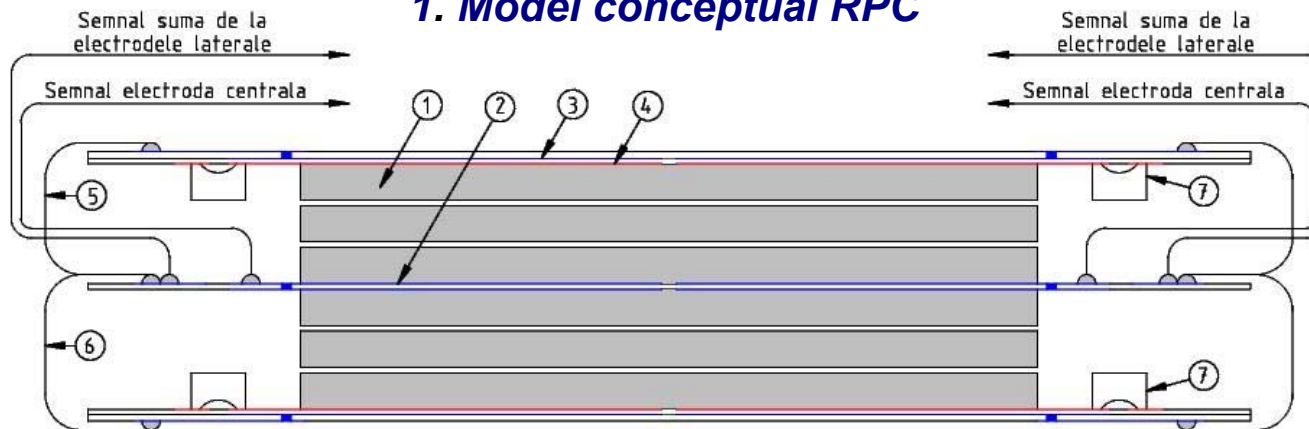
Stadiile de realizare



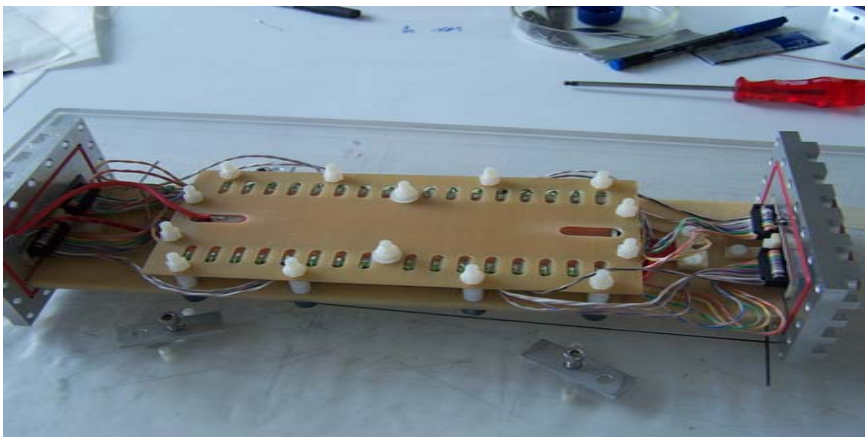
Etapa 2 – a doua parte: RPC cu electrod de citire cu structura de pad-uri si electrozi din sticla cu rezistivitate mica.

Precursori/rezultate intermediare:

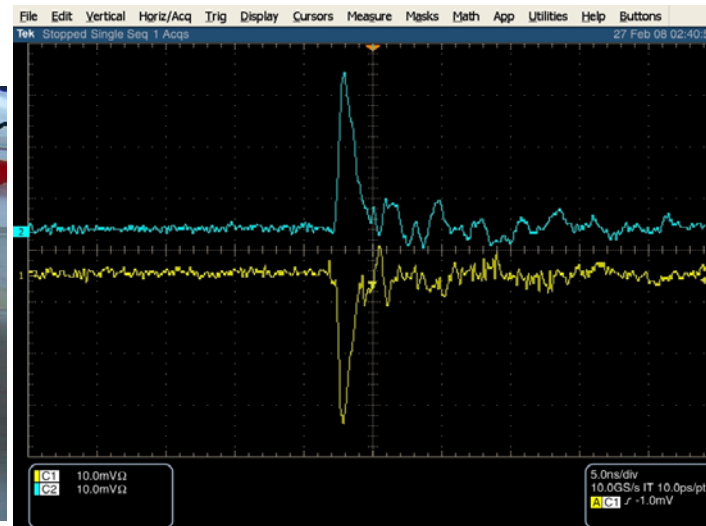
1. Model conceptual RPC



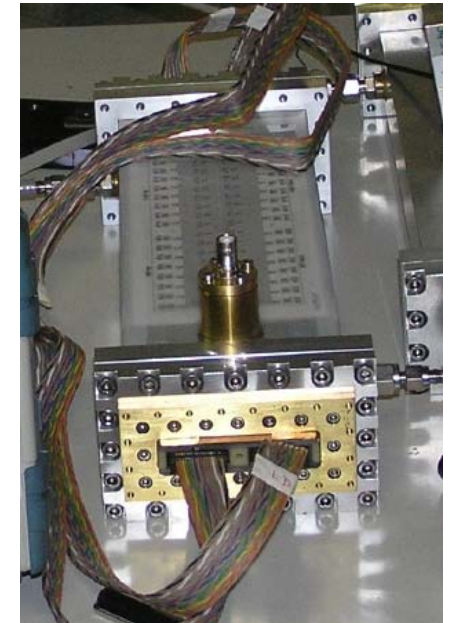
2. Model experimental + Model de laborator RPC



4. Teste de laborator



3. Prototip detector RPC



5. Cerere inregistrare brevet nr:
A/00635/12.08.2009

Stadiile de realizare



Etapa 3: Metodica si electronica suport pentru testare a unui microcircuit (parte I- motherboard+card CHIP).

Finantare: Buget – 96 209 lei

Achizitii realizate: -

Precursori/rezultate intermediare:

2. Model de laborator + Model experimental Placa de Baza

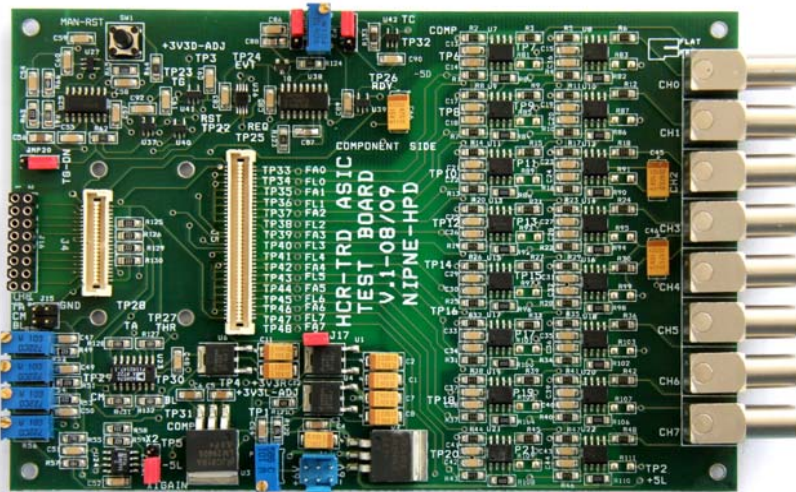
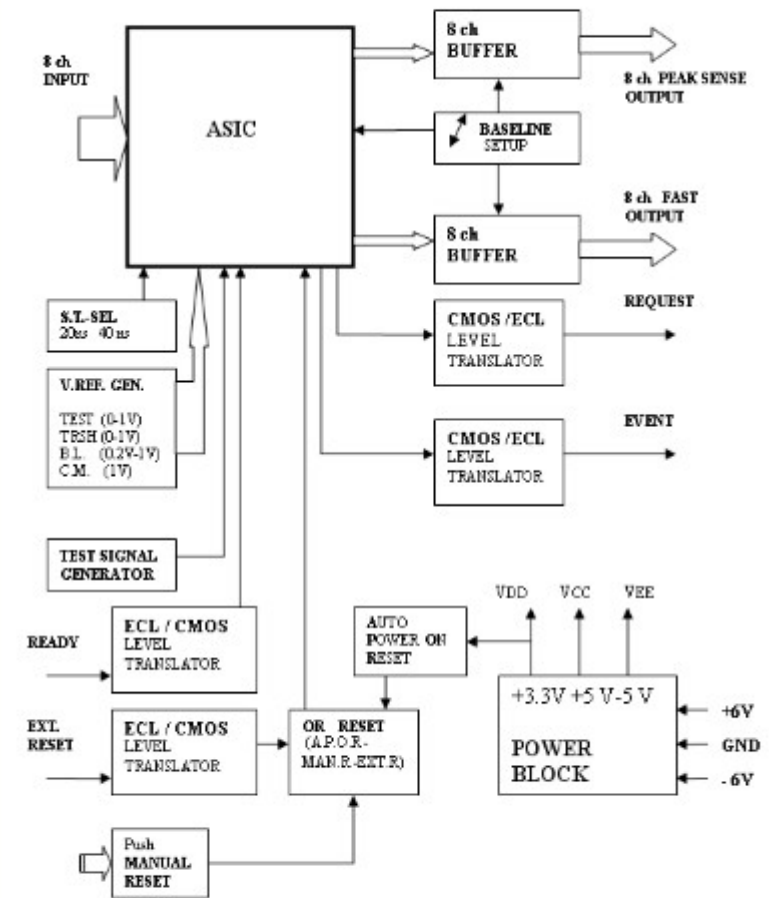


FIG. 3

1. Model conceptual Placa de Baza

Main Board of the NIHAM FEE ASIC for a High Counting Rate TRD



ASIC - M.B. BLOCK DIAGRAM

Stadiile de realizare



Etapa 4: **Finantare: Buget/Cofinantare – 135 191 lei / 8 900 lei**
Achizitii realizate: -

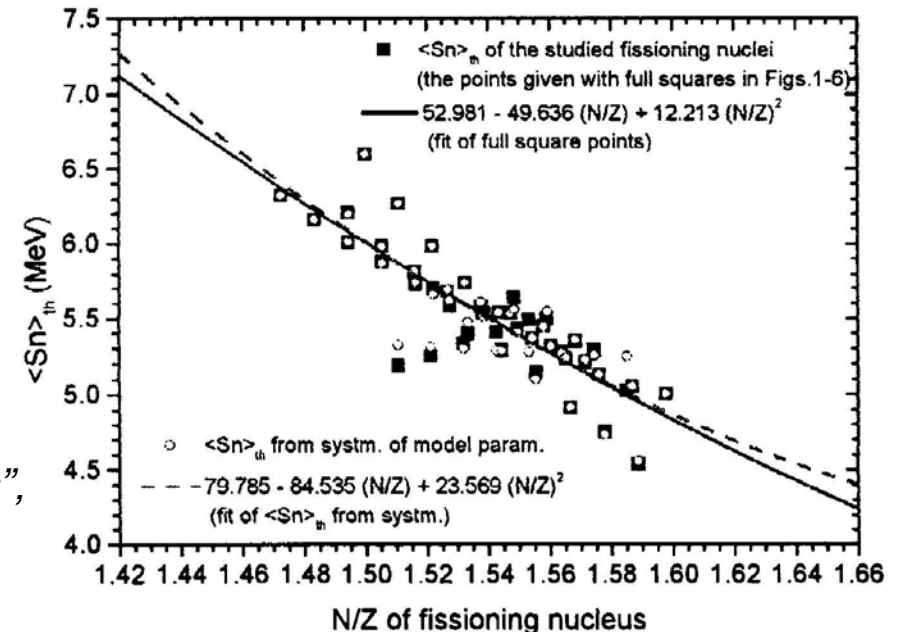
Etapa 4 – partea I : *Sistematica observabilelor care caracterizeaza partea prompta a procesului de fisiune (partea I – fisiunea indusa cu neutroni termici pe izotopii U si Pu).*

Precursori/rezultate intermediare:

Calcul de date nucleare:

A. Tudora, *Prompt fission neutron and fission fragment data described by the Point by Point model verifying systematics of Los Alamos model parameters*,
AIP Proceedings, Int. Conf. Nuclear Fission FISSION-2009, Mai 13-16 (2009), CEA-Cadarache, France

E. Rich, A. Tudora, G. Noguere, J. Tommasi, J-F. Lebrat,
Modeling of the $^{242}\text{Pu}+n$ reaction for fast reactor applications,
Nuclear Science and Engineering 162 (2009) 171-191.



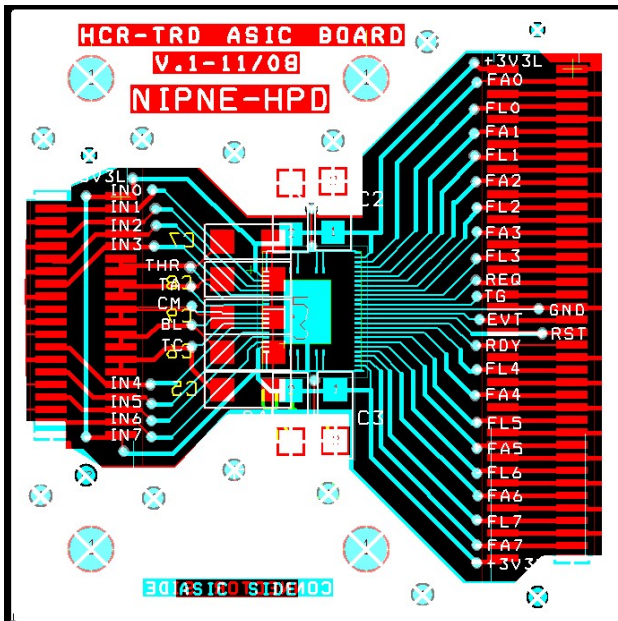
Stadiile de realizare



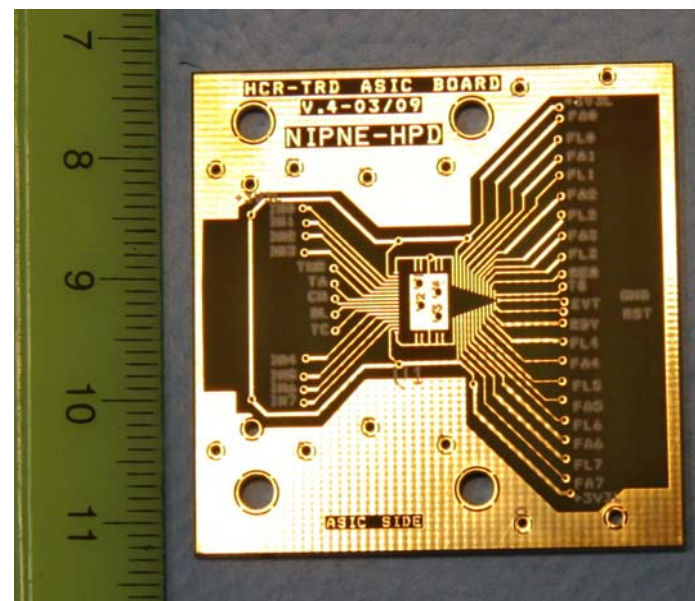
Etapa 4 – partea a II-a: Metodica si electronica suport pentru testare a unui microcircuit partea II- Realizarea structurii hardware de testare a circuitului ASIC pentru detectori TRD cu rata mare de incidenta.

Precursori/rezultate intermediare:

1. Model conceptual circuit ASIC



2. Model de laborator + Model experimental circuit ASIC



→ Pulse Shaping

3. Teste de laborator

Fast out and peak sense out – details (avg.)



Stadiile de realizare



Etapa 5: Metodica si electronica suport pentru testare a unui microcircuit, partea III – Caracteristicile principale ale microcircuitului ASIC.

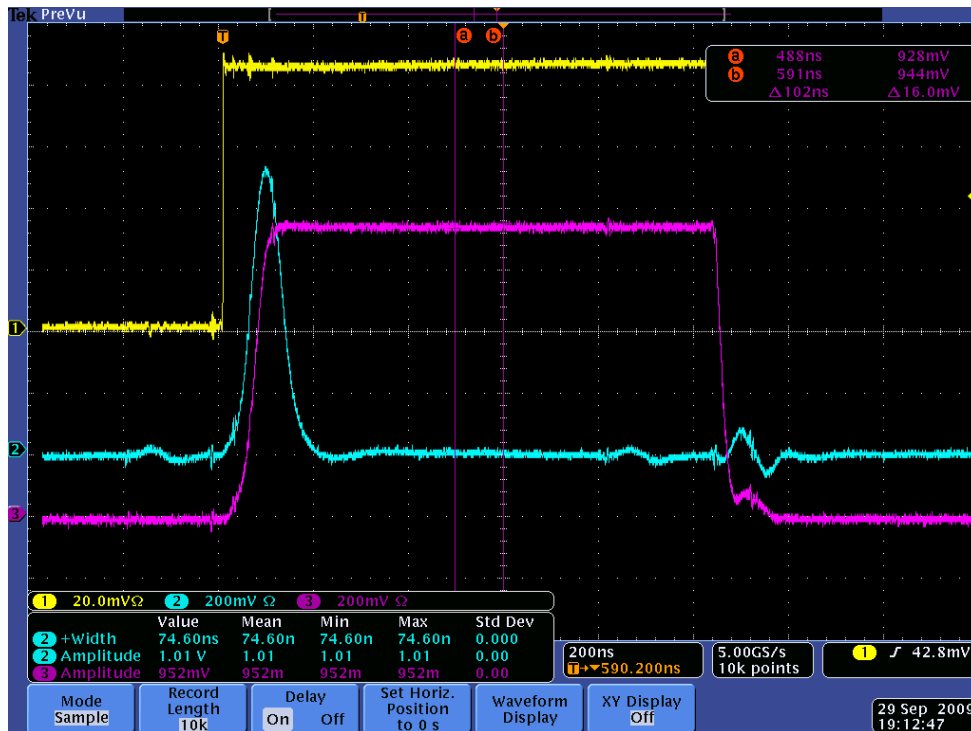
Finantare: Buget – 85 585 lei (credit angajament)

Achizitii realizate: -

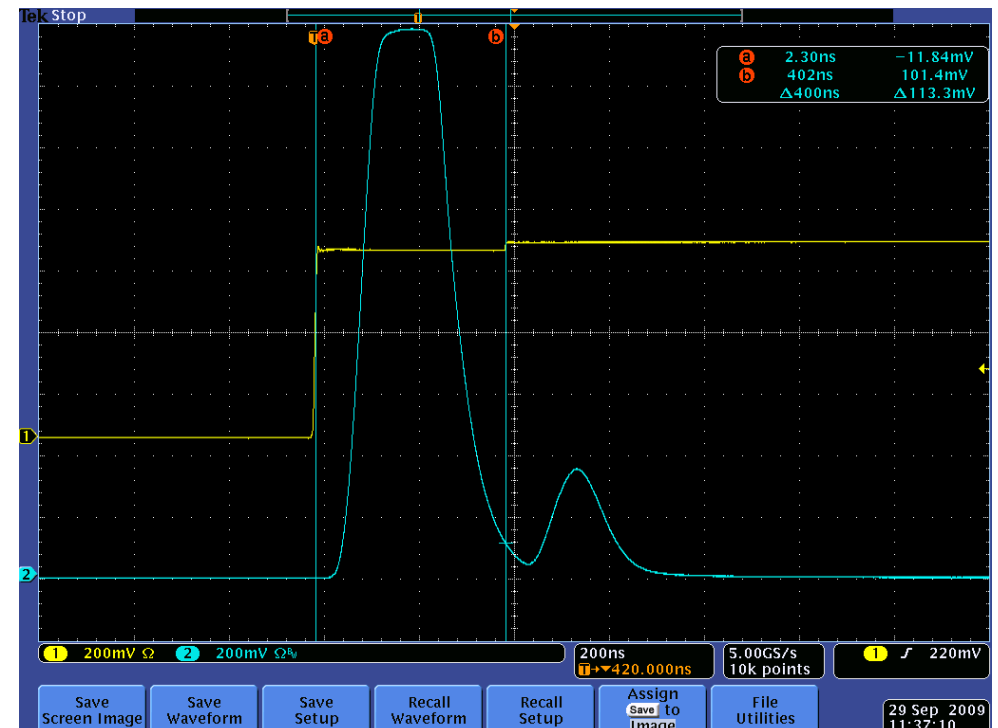
Precursori/rezultate intermediare:

1. Elaborare scheme si proceduri de testare a microcircuitului ASIC
2. Teste de laborator

Fast out and peak sense out – 20 ns shaping time



Excellent action of fast recovery circuitry!



Participare tineri cercetatori



- *1 doctorand (IFIN-HH): masuratori si calibrare date experimentale*
- *1 student Universitatea Muenster – stagiul de cercetare Mai 2009:
masuratori si calibrare date experimentale*



1. E. Rich, A. Tudora, G. Noguere, J. Tommasi, and J.-F. Lebrat, *Modeling of the $^{242}\text{Pu}+n$ reaction for fast reactor applications*, *Nucl. Sci. Eng.* 162 (2009) 171-191.
2. M. Petris, M. Petrovici, D. Bartos, I. Berceanu, V. Simion, A. Radu, A. Andronic, C. Garabatos, M. Klein-Boesing, R. Simon, F. Uhlig, J.P. Wessels, A. Wilk, *Rate Capability of a High Efficiency Transition Radiation Detector* *Romanian Journal of Physics*, (in press).
3. M. Klein-Boesing, A. Andronic, D. Bartos, I. Berceanu, V. Catanescu, C. Garabatos, N. Heine, A. Herghelegiu, C. Magureanu, D. Moisa, M. Petris, M. Petrovici, A. Radu, V. Simion, F. Uhlig, J.P. Wessels, and A. Wilk, *Position resolution of a high efficiency Transition Radiation Detector for high counting rate environment*, *Nucl. Instr. Meth. in Phys. Res. A* 585(2008) 83-87.
4. A. Tudora, *Multi-parametric prompt neutron and fission fragment experimental data described by the "Point by Point" model*, *Ann. Nucl. En.* 35 (2008) 1-10
5. M. Petris, M. Petrovici, V. Simion, I. Berceanu, D. Moisa, *High counting rate transition radiation detector*, *Nuclear Instruments and Methods in Physics Research A* 581(October 2007), 406 – 409

Diseminare – rapoarte stiintifice



1. *D. Bartos, G. Caragheorgheopol, F. Dohrmann, K.D. Hildenbrand, B. Kampfer, R. Kotte, L. Naumann, M. Petris, M. Petrovici, V. Simion, D. Stach, C. Williams, J. Wuestenfeld*
In-beam test results of the Pestov Glass Resistive Plate Counter prototypes
CBM Progress Report 2008, ISBN 978-3-9811298-6-1, 2009
2. *M. Klein-Boesing, J.P. Wessels, M. Petris, M. Petrovici, V. Simion, F. Uhlig*
High efficiency TRD for CBM in test beam and simulation
CBM Progress Report 2007 (2008), p. 41, ISBN 978-3-9811298-5-4

Diseminare – Conferinte si Workshopuri



- 1. Layout and radioactive source test results of the first double sided, split pad TRD prototype
M. Petris et al.
14th CBM Collaboration Meeting, October 6 - 9 , 2009, Split, Croatia*
- 2. Analog Chip for High Counting Rate Transition Radiation Detector
V.Catanescu
14th CBM Collaboration Meeting, Oct.6-9, Split, Croatia, 2009*
- 3. Preliminary results of tests on TRD Front-End Prototype Chip
G.Caragheorgheopol, D.Bartos,V.Catanescu
14th CBM Collaboration Meeting, Oct.6-9, Split, Croatia, 2009*
- 4. Status of Multigap, Symmetric, Strip readout, Differential architecture RPC prototypes
M. Petris et al.
CBM-Hadron Meeting, July 13 2009, GSI-Darmstadt*
- 5. Development of a transition radiation detector for a high counting rate environment
M. Petris (for CBM Collaboration)
DPG Spring Meeting + European Nuclear Physics Conference (EuNPC), March 16 - 20, 2009,
Bochum, Germany*
- 6. Analog FEE for High Counting Rate Transition Radiation Detector
V.Catanescu, D.Bartos, G.Caragheorgheopol
DPG Spring Meeting + European Nuclear Physics Conference (EuNPC),
March 16 - 20, 2009, Bochum, Germany*

Diseminare – Conferinte si Workshopuri



7. *Status differential strip RPC's*
M. Petris et al.
13th CBM Collaboration Meeting, March 09 - 13, 2009, GSI Darmstadt, Germany

8. *Layout and first test results of new TRD prototype*
M. Petris et al.
13th CBM Collaboration Meeting, March 09 - 13, 2009, GSI Darmstadt, Germany

9. *HCR-TRD requirements & their associated FEE*
M.Petrovici, et al.
CBM-FEE Workshop, Dec.5, GSI-Darmstadt, 2008

10. *Present Status of the first version of NIHAM TRD-FEE analogic CHIP*
V.Catanescu, M.Petrovici
12th CBM Collaboration Meeting, Oct.14-18, Dubna, 2008

11. *In-Beam Tests Results of the Pestov Glass Resistive Plate Counter Prototypes*
Mariana Petris et al.
12th CBM Collaboration Meeting, October 13 - 18, 2008, Dubna, Russia

12. *R&D Activities for Detector Development for High Counting Rate Environment*
Mariana Petris et al.
15th National Conference on Physics, Bucharest, 10-13 September 2008

Diseminare – Conferinte si Workshopuri



13. *Front-end electronics (FEE) for nuclear detectors based on the first ASIC developed by DFH-NIPNE*
V.Catanescu, D. Bartos, G. Caragheorgheopol
15th National Conference on Physics, Bucharest, 10-13 September 2008
14. *Present Status of the first version of NIHAM TRD-FEE analogic CHIP*
V.Catanescu
CBM_XYTER Meeting, April 17, GSI,Darmstadt, 2008
15. *Systematic studies of the in-beam test data of the Bucharest - Muenster prototype*
M. Petris et al.
10th CBM Collaboration Meeting, September 25-28, 2007, Dresden, Germany;
16. *Specific requirements for analog electronics of a high counting rate TRD*
V.Catanescu
10th CBM Collaboration Meeting, September 25-28, 2007, Dresden, Germany;



- 1. Cerere inregistrare brevet nr. A/00570/22.07.2009 “Detector de radiatie de tranzitie, de inalta eficienta, rata mare de numarare si rezolutie in pozitie in doua axe de coordonate”.***
- 2. Cerere inregistrare brevet nr. A/00635/12.08.2009 “Detector cu placi rezistive, pentru masuratori de timp de zbor cu rezolutie temporala de ~ 60 ps, cu arhitectura simetrica multistrat, cu informatie de pozitie in doua dimensiuni si citire diferentiala a semnalului, pentru rate mari de incidenta (aprox. 16000 particule/(cm² · s)”.***

Gestionarea resurselor financiare



- Gestionarea resurselor financiare s-a facut in acord cu obiectivele fazelor de executie asigurand cu preponderenta, in limita resurselor financiare, finantarea personalului inalt calificat implicat in realizarea proiectului, .***
- Datorita limitarii finantarii, numai un procent mic din bugetul proiectului a putut fi alocat procurarii de echipament de laborator si echipament de calcul.***
- Parteneriatul oferit de firma Onlinesolutions Media Srl a reprezentat o participare activa a acesteia la desfasurarea activitatilor proiectului prin implicarea atat financiara (cofinantarea acestui proiect) cat si prin activitati specifice.***

Posibile Aplicatii



Detectori de arie mare care pot furniza informatii de pozitie in doua dimensiuni, cu rezolutie de pozitie foarte buna, pentru sisteme de scanare industriale.