POLITECNICO DI MILANO

NESCOFI@BTF
2011-2013





EXPERIMENTS PERFORMED IN 2012

Davide BORTOT
PhD student at Politecnico di Milano

NESCOFI@BTF_2013 Launch meeting 29-01-2013

CONTENTS

1) NESCOFI@BTF Project

2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

4) Multi-channel electronics and new Active Detectors D2

5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL of Uppsala University

1) **NESCOFI@BTF Project**

2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

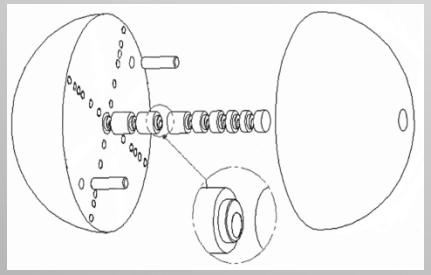
3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

4) Multi-channel electronics and new Active Detectors D2

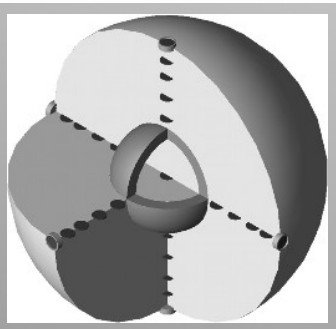
5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL of Uppsala University

REQUIREMENTS:

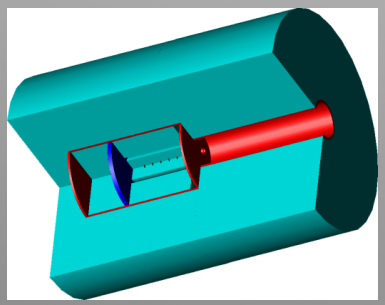
1) Wide energy range
2) Isotropic response
3) Develop of an array of ACTIVE thermal neutron detectors



Low-energy version[1]
30 cm diameter
37 measurement positions



High-energy version[2]
25 cm diameter
31 measurement positions
Lead shell



Cylindrical Spectrometer

[1] J..M. Gomez-Ros, R. Bedogni, I. Palermo, A. Esposito, A. Delgado, M. Angelone, M. Pillon, Design and validation of a photon insensitive multi detector neutron spectrometer based on Dysprosium activation foils, Radiation Measurements 46-12 (2011).
[2] J. M. Gomez-Ros, R. Bedogni, M. Moraleda, A. Esposito, A. Pola, M.V. Introini, G. Mazzitelli, L. Quintieri, B. Buonomo, Designing an extended energy range single-sphere multi-detector neutron spectrometer, Nuclear Instruments and Methods in Physics Research A 677 (2012) 4-9.

1) NESCOFI@BTF Project

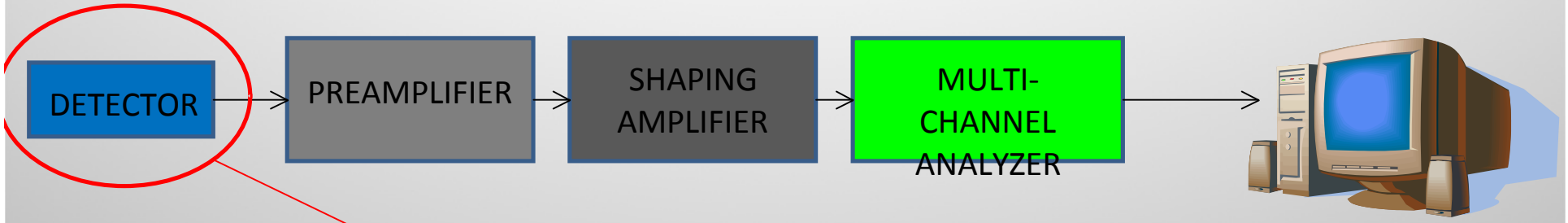
2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

4) Multi-channel electronics and new Active Detectors D2

5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL of Uppsala University

2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

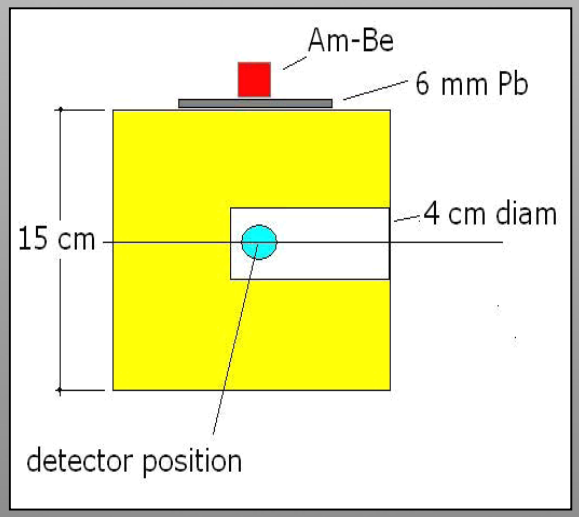


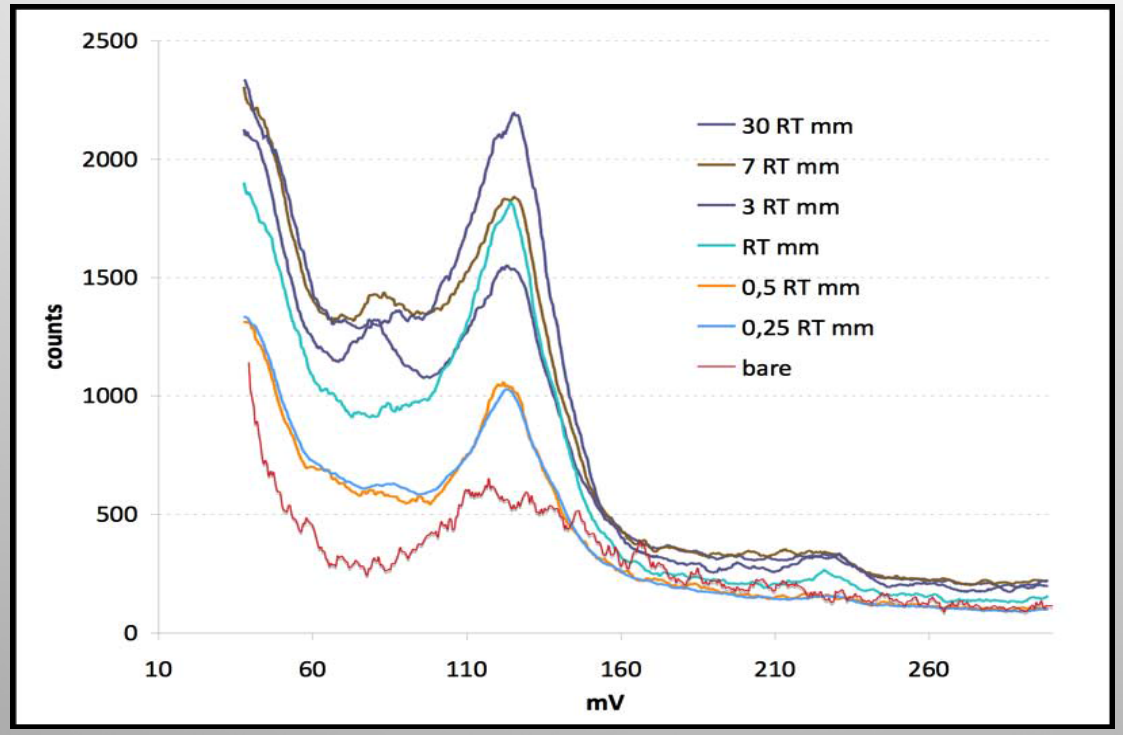
- ✓ Neutron response
- ✓ Dimension
- ✓ Cost

Active Thermal Neutron Detectors

D1

- D1#1
- D1#2
- D1#3
- D1#4
- D1#5
- D1#6
- D1#7



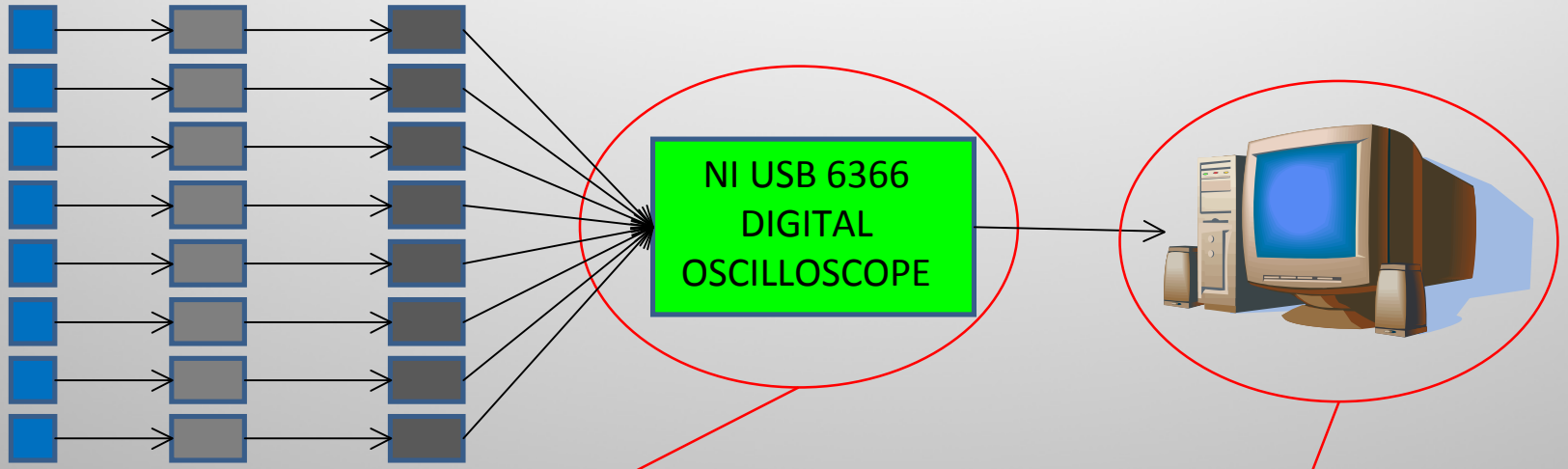


Thickness of D1detector [RT]	Total/RT [-]	Background/RT [-]	Net/RT [-]
30 RT	0.87	1.06	0.61
15 RT	0.97	1.17	0.70
7 RT	1.14	1.37	0.81
3 RT	1.29	1.33	1.23
RT	1.00	1.00	1.00
0.50 RT	0.59	0.65	0.51
0.25 RT	0.59	0.65	0.50

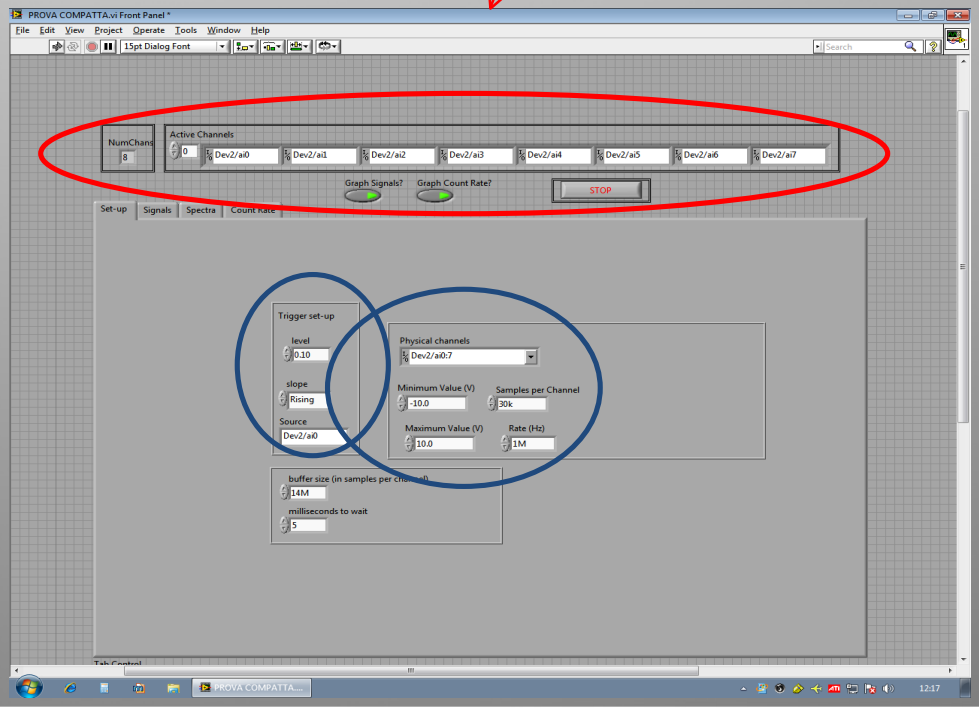
Response = 0.021 cm^2

Detector RT	Counts
n1	246072
n2	211657
n3	246313
n4	219147
Average	230797
Std dev	18038
Variability	7,8%

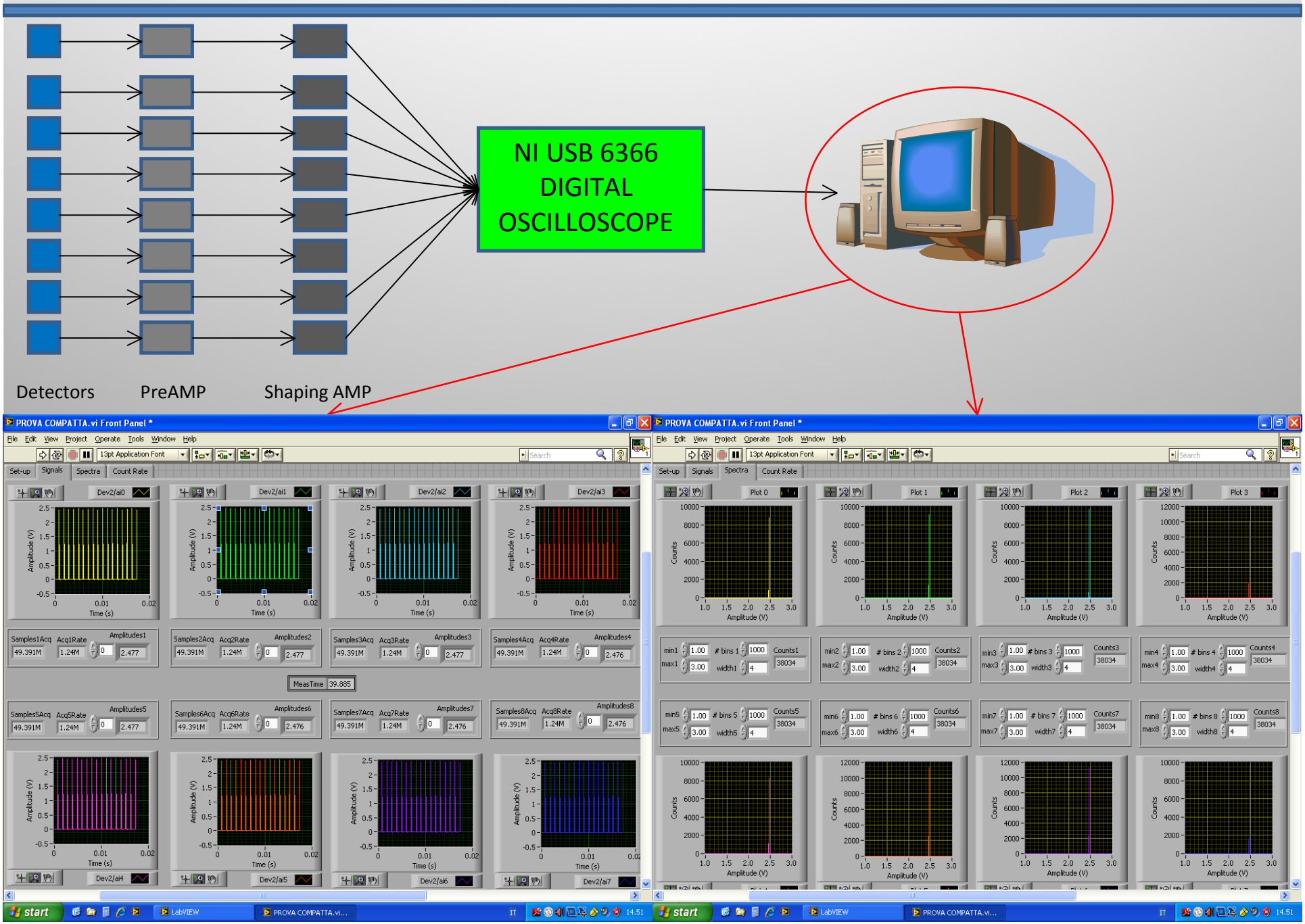
2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System



8 analog inputs
2 MS s^{-1} max Sample Rate
16 bits Resolution



2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System



1) NESCOFI@BTF Project

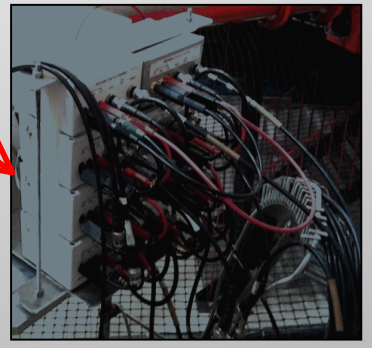
2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

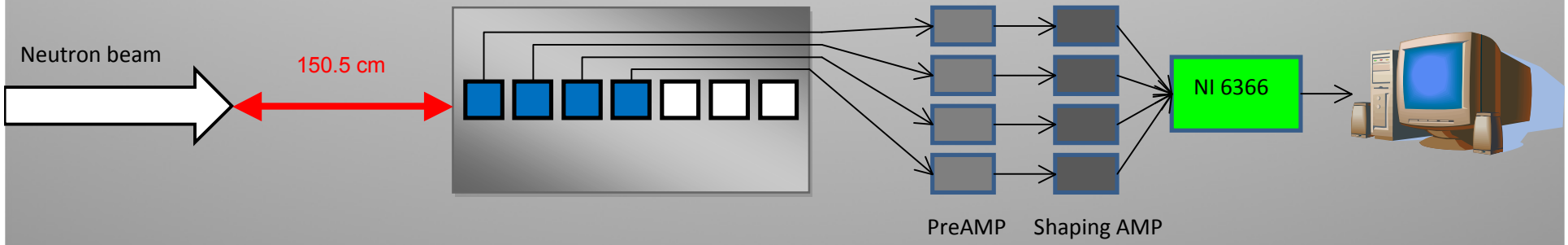
3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

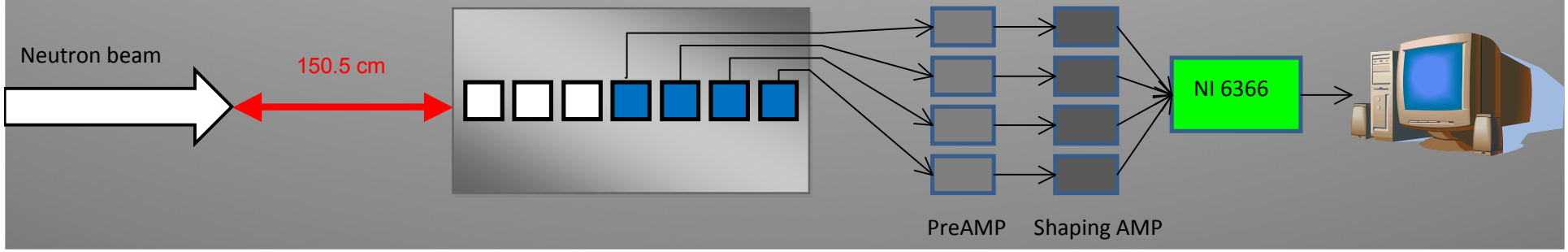
4) Multi-channel electronics and new Active Detectors D2

5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL of Uppsala University

3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

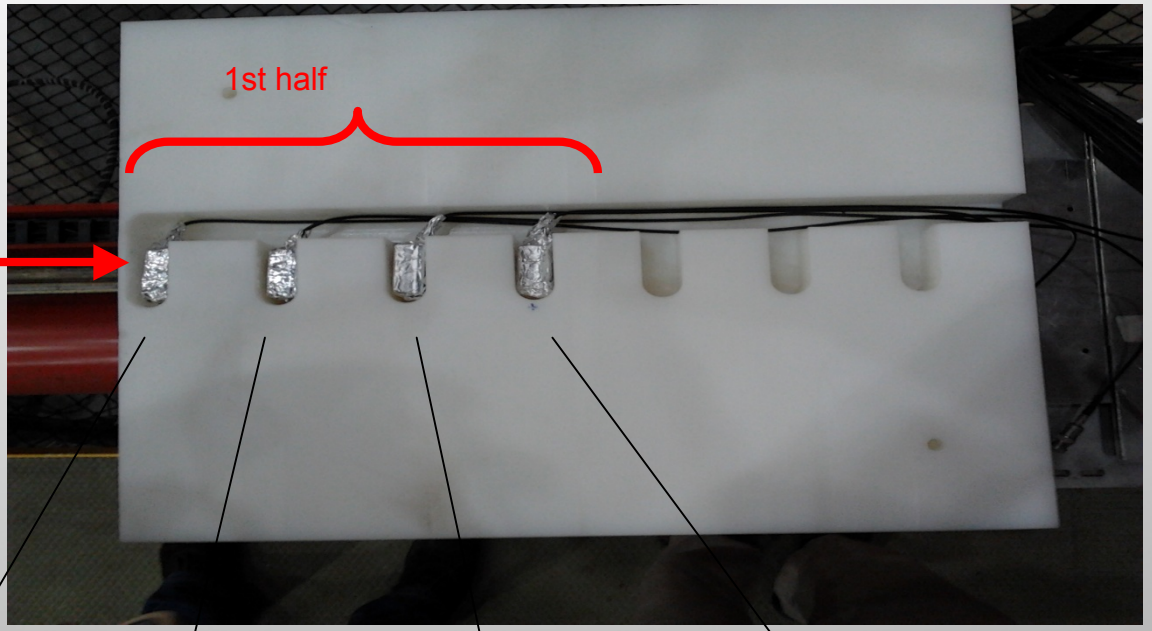




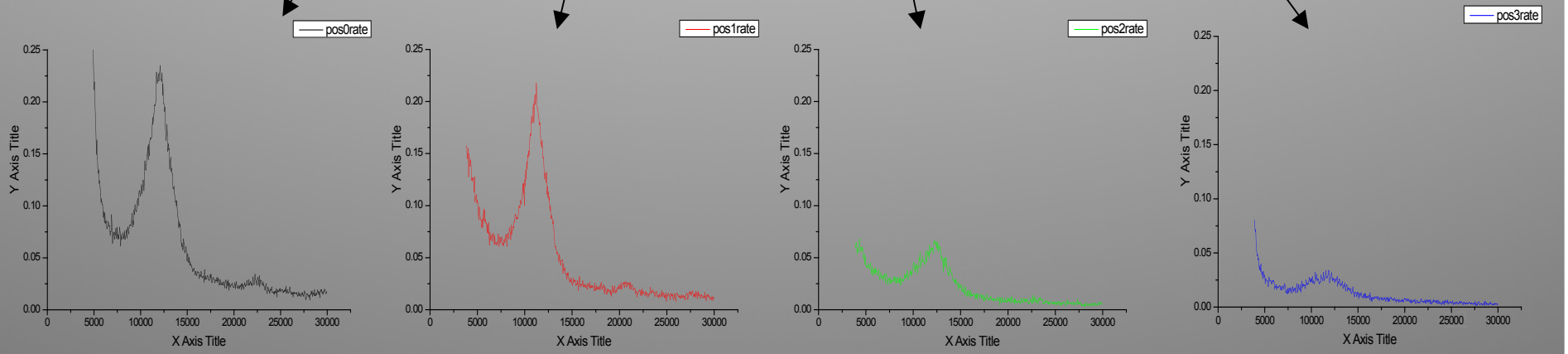


n BEAM 565 keV

150.5 cm

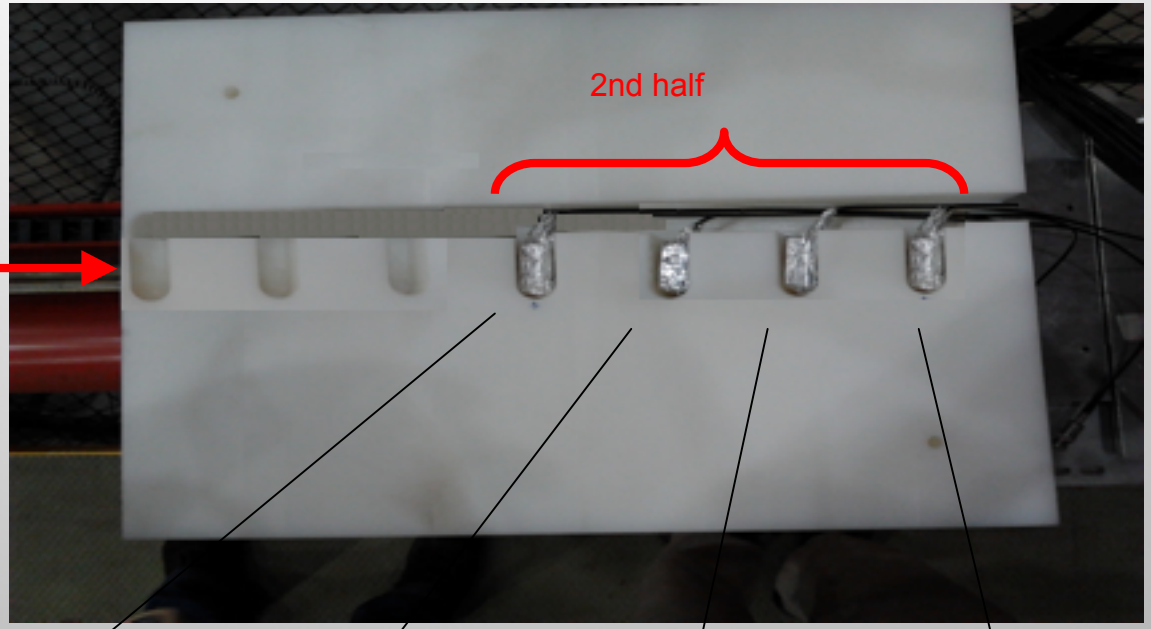


PULSE MODE

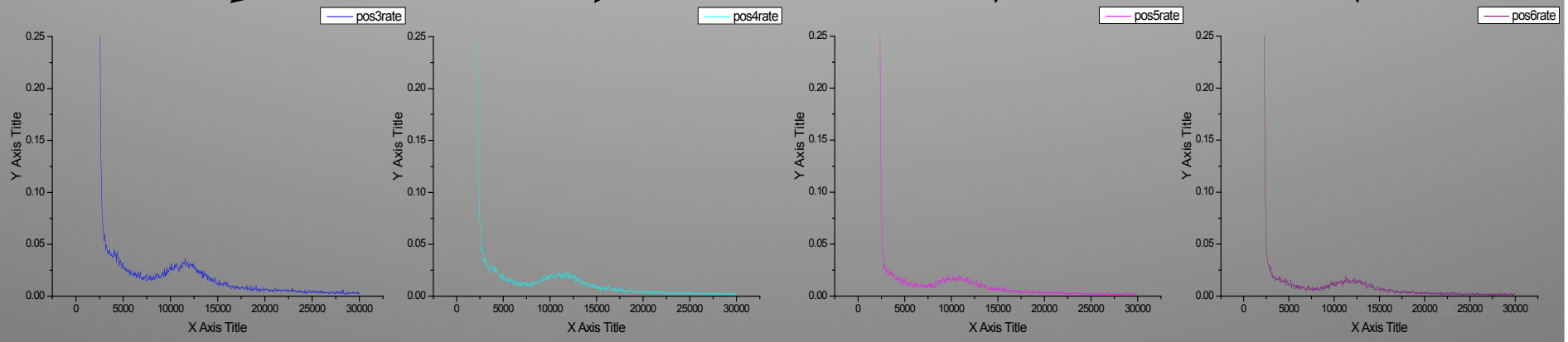


n BEAM 565 keV

150.5 cm

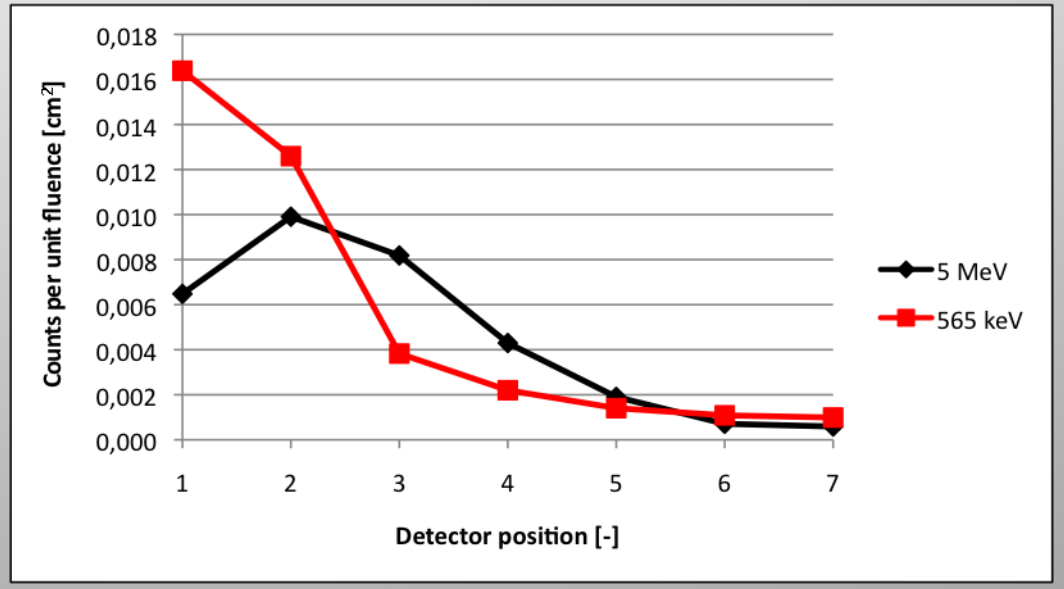


PULSE MODE



3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

Energy [keV]	Fluence [cm^{-2}]
5000	1.03E+6
565	3.27E+6



☑ Simultaneous acquisition and elaboration of signals from different detectors in a realistic neutron field

✘ Adopted commercial electronics

✘ Response of D1 sensor
- Neutron-gamma discrimination
- Acquisition threshold value

1) NESCOFI@BTF Project

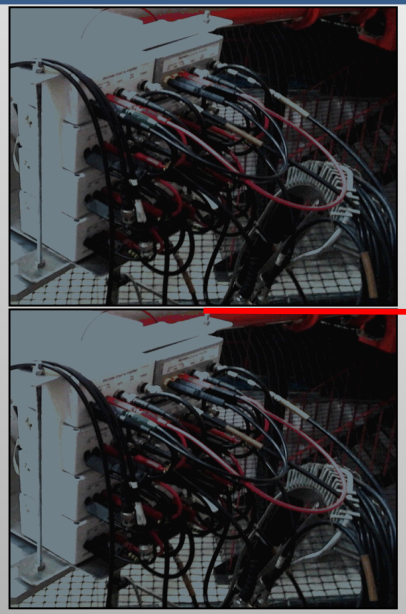
2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

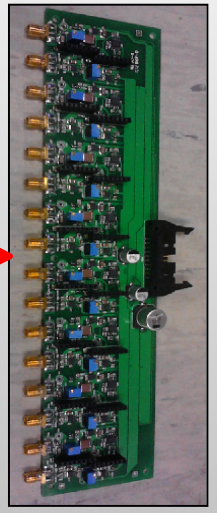
3) Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL

4) Multi-channel electronics and new Active Detectors D2

5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL of Uppsala University

4) Multi-channel electronics and new Active Detectors D2



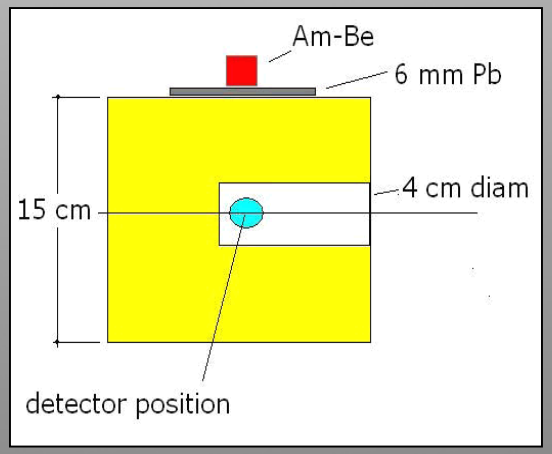


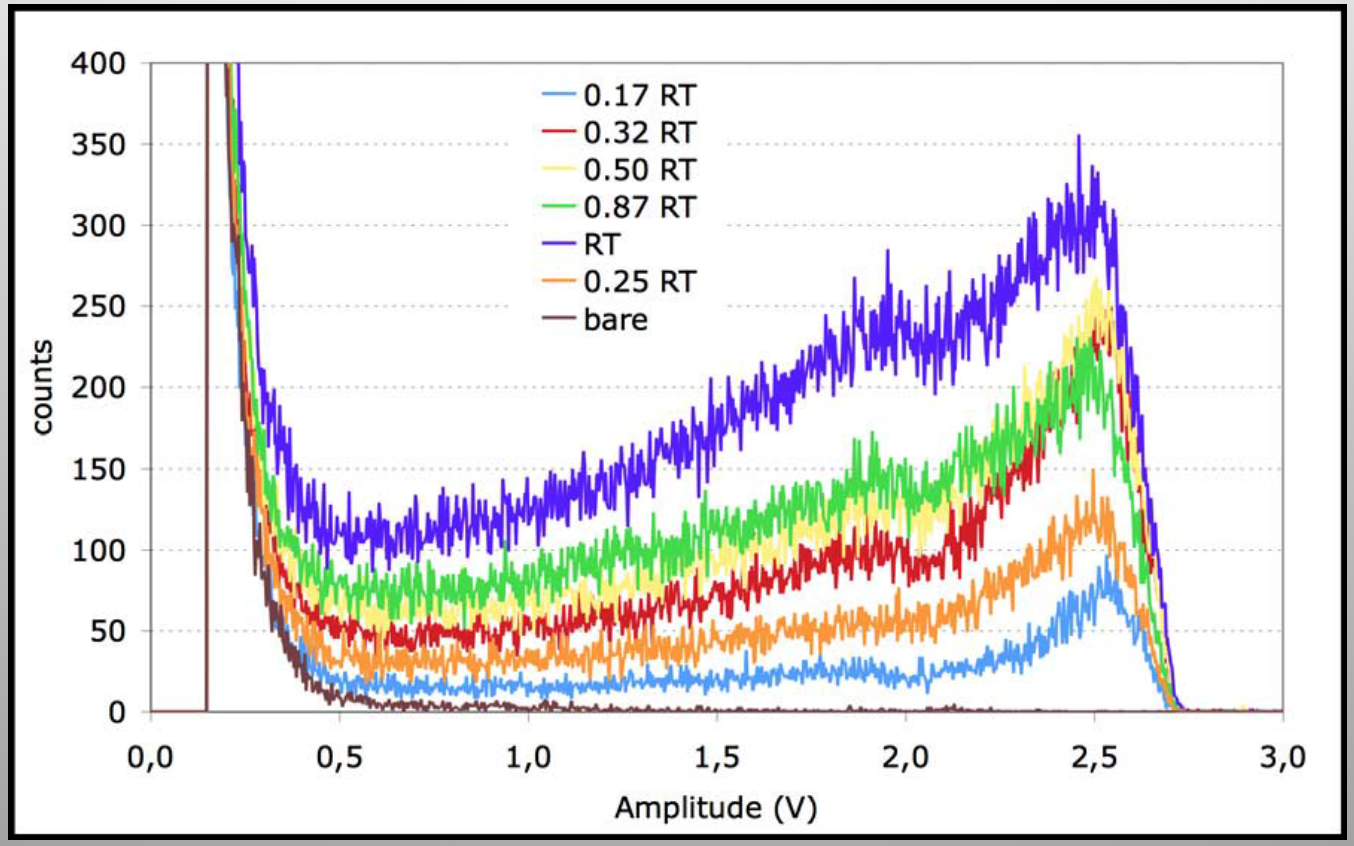
Indipendent channels

-a detector input
-a test input
-a commercial charge-sensitive preamplifier module
-a commercial linear shaping amplifier module
-independent power supplies

Active Thermal Neutron Detectors
D2

D2#1
D2#2
D2#3
D2#4
D2#5
D2#6





thickness of D2 detector [RT]	Net counts [-]	Net counts / RT counts [-]	Response [cm^2]
0.17	18921	0.14	0.004
0.25	38171	0.28	0.007
0.32	67487	0.50	0.013
0.50	81391	0.60	0.015
0.87	85800	0.63	0.016
1.00	135104	1.00	0.026

1) NESCOFI@BTF Project

2) Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System

3) Application of D1 ATND in the Mini-Cylindrical Spectrometer

4) Multi-channel electronics and new Active Detectors D2

5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL of Uppsala University

5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL

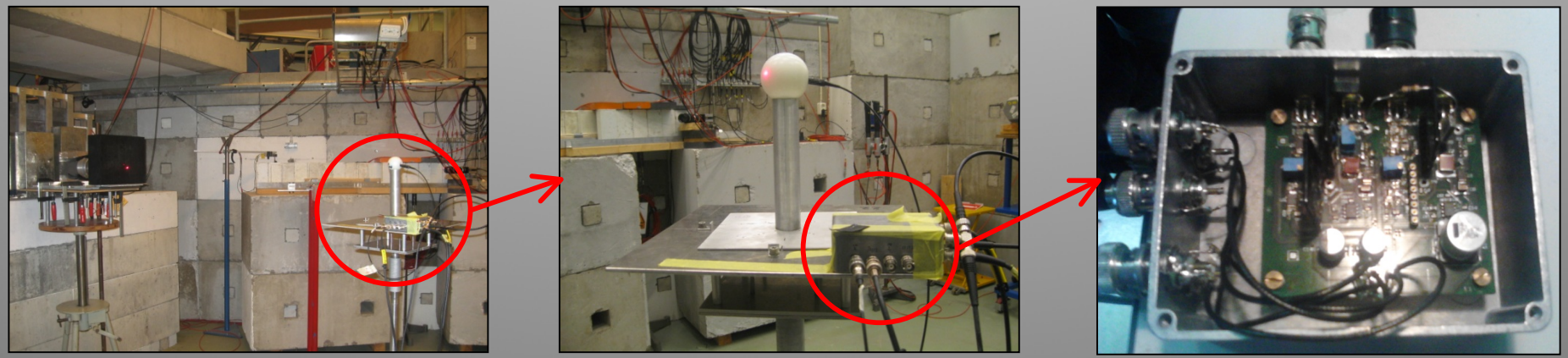
UPPSALA UNIVERSITET
The Svedberg Laboratory

8 standard spheres + 1 extended range sphere

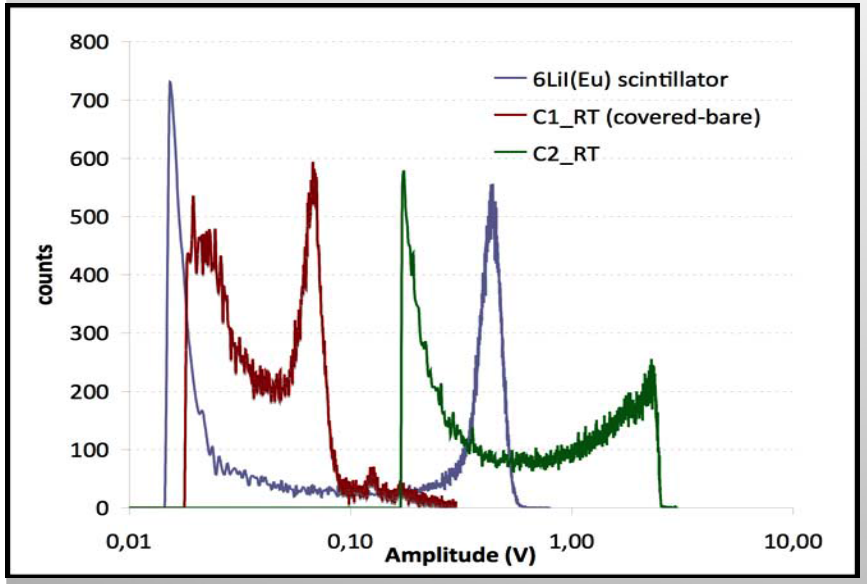
- ^{6}LiI (Eu) scintillator (REFERENCE)
- D1_RT active thermal neutron detector
- D2_RT active thermal neutron detector

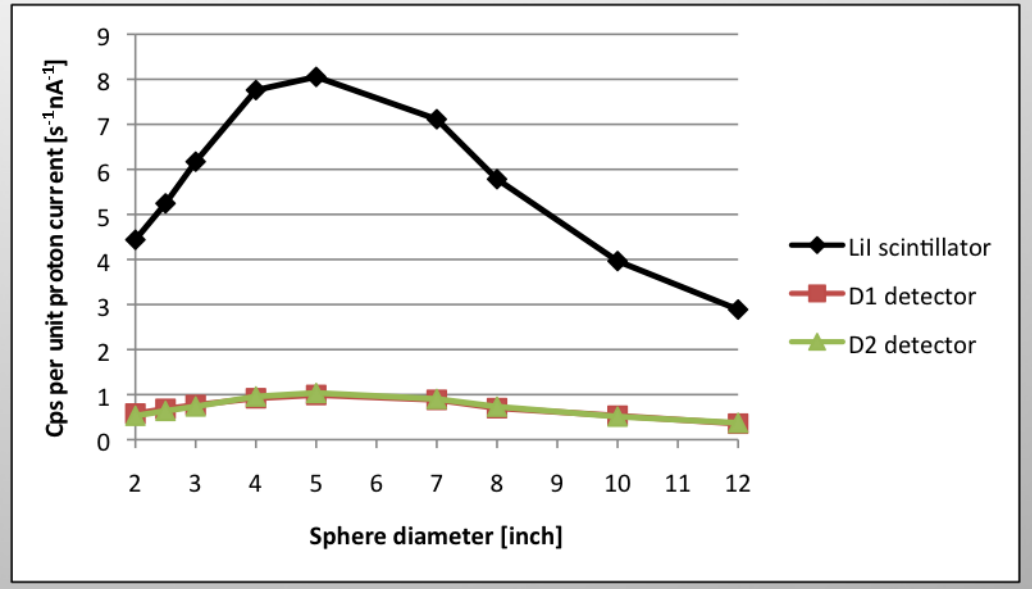
Neutron field generated by 30 MeV protons on a beryllium target

Ip = 50 nA for ^{6}LiI (Eu) scintillator
Ip = 200 nA for D1_RT and D2_RT detectors



5) Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL





$\varepsilon_{D1} \approx \varepsilon_{D2} \approx 1/8\ \varepsilon_{LiI}$

Diameter sphere (inch)	LiI cps/I_p [s^{-1} nA^{-1}]	D1 cps/I_p [s^{-1} nA^{-1}]	D2 cps/I_p [s^{-1} nA^{-1}]	LiI / D1 [-]	LiI / D2 [-]
2	4.44	0.58	0.53	7.66 ± 0.55	8.36 ± 0.59
2.5	5.24	0.68	0.64	7.67 ± 0.55	8.21 ± 0.58
3	6.17	0.77	0.74	8.02 ± 0.57	8.37 ± 0.59
4	7.76	0.92	0.96	8.44 ± 0.60	8.10 ± 0.57
5	8.05	0.99	1.04	8.12 ± 0.58	7.77 ± 0.55
7	7.11	0.88	0.90	8.05 ± 0.57	7.87 ± 0.56
8	5.78	0.70	0.73	8.26 ± 0.59	7.90 ± 0.56
10	3.96	0.53	0.51	7.46 ± 0.53	7.74 ± 0.55
12+Pb	2.89	0.35	0.37	8.14 ± 0.58	7.75 ± 0.55

- Development of the Active Thermal Neutron Detector D1 and the Data Acquisition System
- Application of D1 ATND in the Mini-Cylindrical Spectrometer at NPL
- Multi-channel electronics and new Active Detectors D2
- Application of D1 and D2 ATND in the Bonner Sphere Spectrometer at TSL and comparison with a reference detector (^{6}LiI (Eu) scintillator)

	D1 sensor	D2 sensor
Thermal neutron sensibility	Medium	Medium
Dimensions	☑ Adequate	☑ Adequate
n-γ discrimination	✘ Complex	☑ Simple
Response	0.021 cm^2	0.026 cm^2

Thanks for your Attention!