



Argentine Atomic Energy Commission Bariloche Atomic Center Balseiro Institute



Wireless Sensor Network for Measuring Radiation on a Nuclear Research Reactor

Eng. Rodrigo José Carbajales



Introduction

Reactor RA-6 is an open-pool research reactor, used for training and research inaugurated in 1982.

For instance, in 2002 one of its bunkers was turned into a BNCT (Boron Neutron Capture Therapy) facility, for the treatment of cancer.

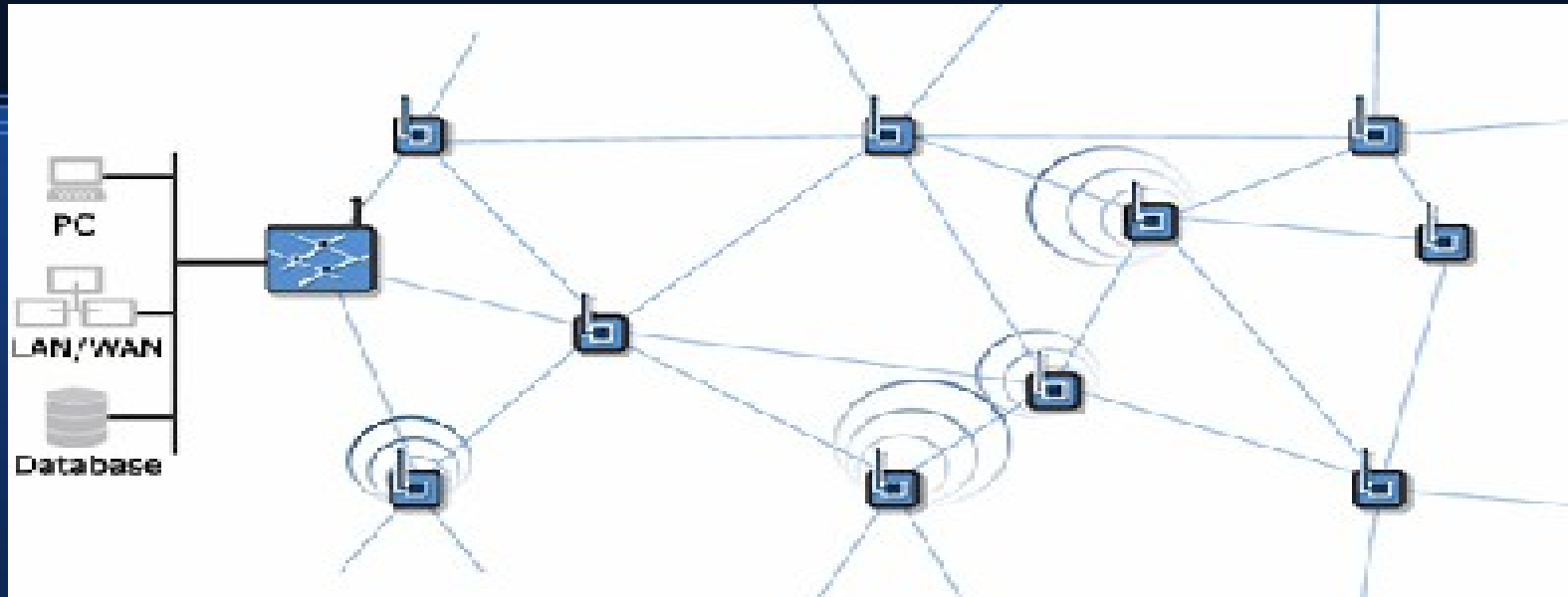
We want to develop a WSN to measure environment above all radiation for two reasons:

- 1.- To be introduced as a Conventional Instrumentation System
- 2.- to measure environment around the reactor to inform population.

An old equipment and motes were the starting point.

Challenge

W
S
N



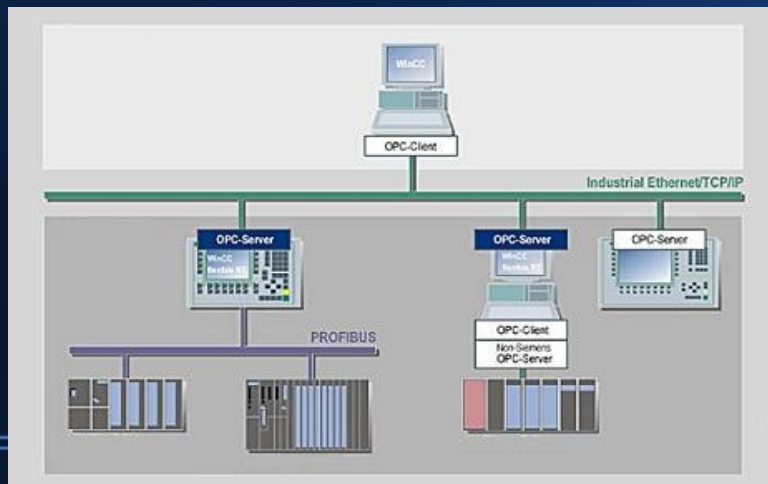
Inside Reactor

Outside Reactor



Ionizing
Radiation

O
P
C



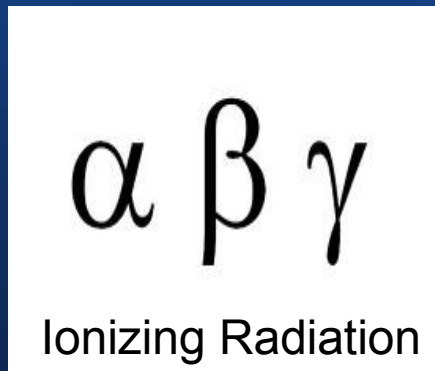
Instrument System

W
E
B



Information

Challenge I



Build a Wireless Radiation Sensor to be part as a
Wireless Sensor Network

Starting point an old dose rate meter and motes. 4

Challenge II



With the device ready make the WSN as a part of an instrumentation system or an environmental measurement system

Why Motes?

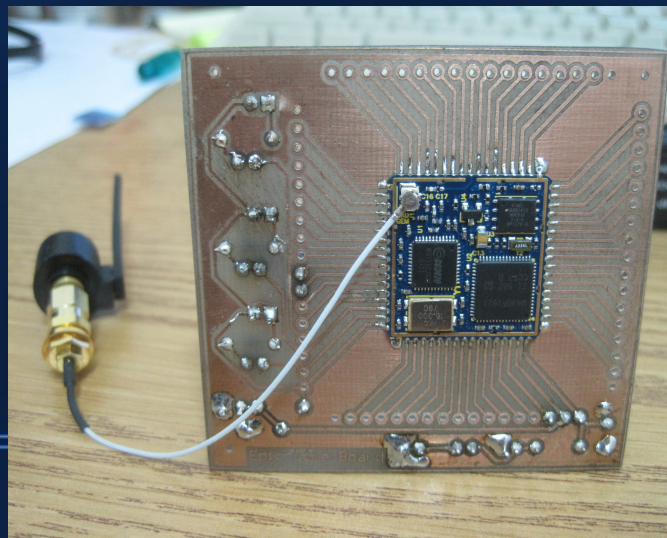
Low power and small!



Tmote Sky is an **ultra low power** Wireless module for use in WSN

250kbps 2.4GHz IEEE 802.15.4
8MHz MSP430 microcontroller
(10k RAM, 48k Flash)
Integrated ADC, DAC, 16 pin

TinyOS support:
mesh networking and communication



Epic: An Open Mote Platform



www.tinyos.net

TinyOS is an open source, event-based operating system designed for low-power wireless devices, such as those used in sensor networks, personal area networks, smart buildings, and smart meters.

Written in the nesC programming language as a set of cooperating tasks and processes optimized for the memory limits of sensor networks.

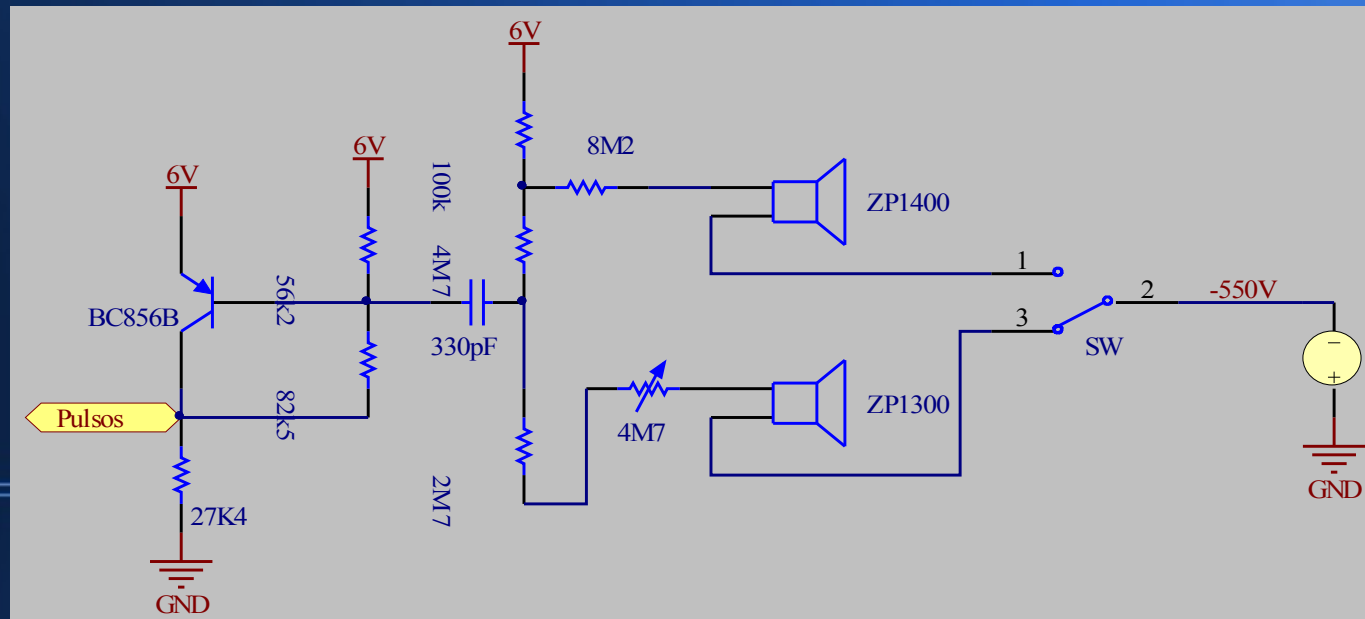
What is OPC?

OPC is an industrial protocol standard that specifies the communication of real-time plant data between control devices from different manufacturers.

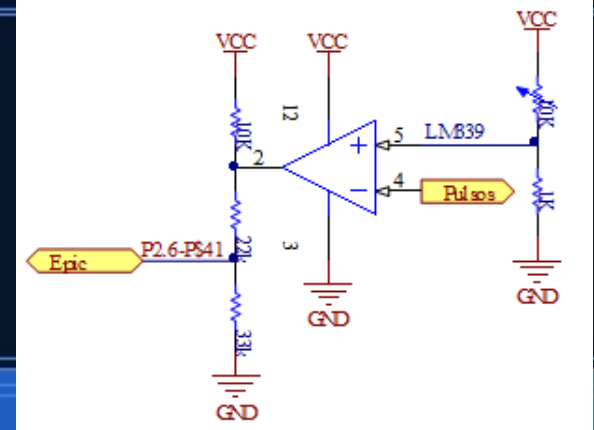
It uses open connectivity via open standards that could be combined with Wireless Sensor Networks (WSN) for a conventional instrumentation system.

Working with Geiger-Müller Counters

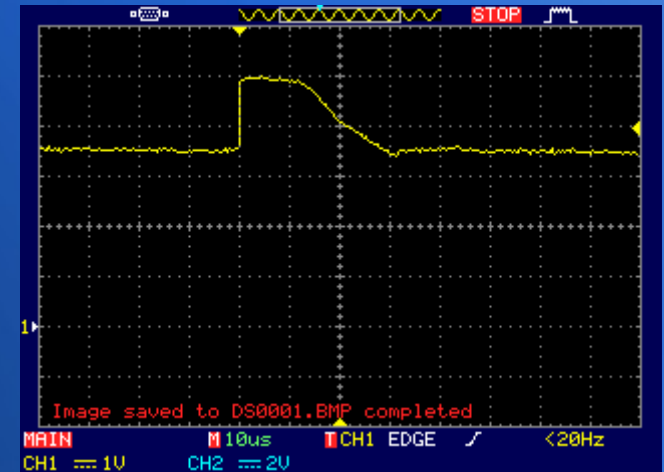
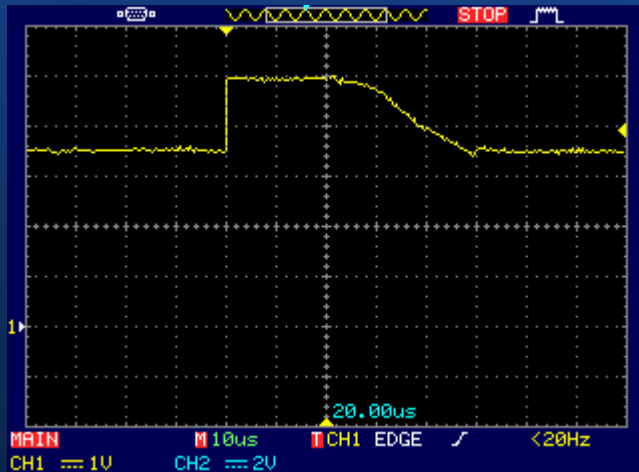
Teletector Automess telescope dose rate meter that measures Gamma and Beta radiation
Analog range: 0 - 10 Sv/h
Energy range: 80 keV - 2 MeV



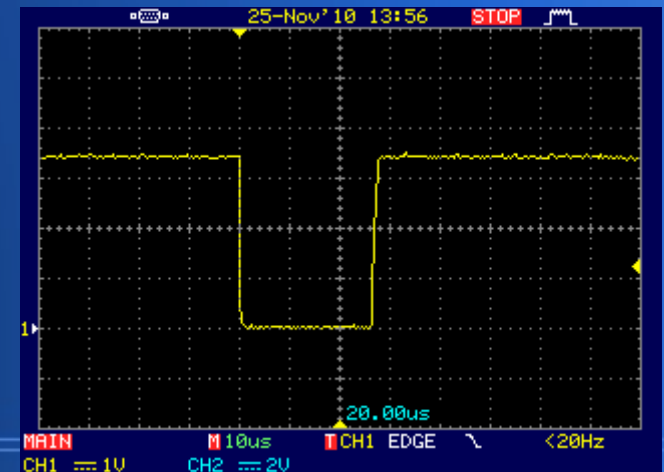
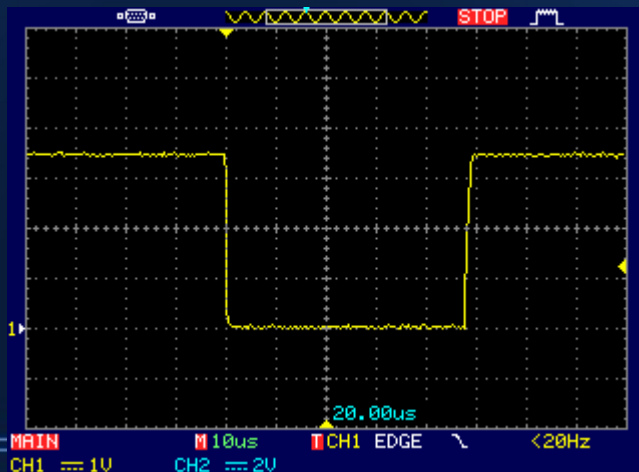
GM pulses adaptation



GM Pulses

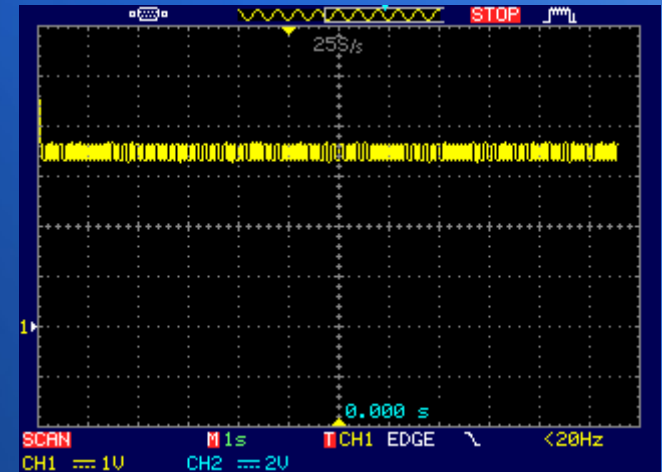
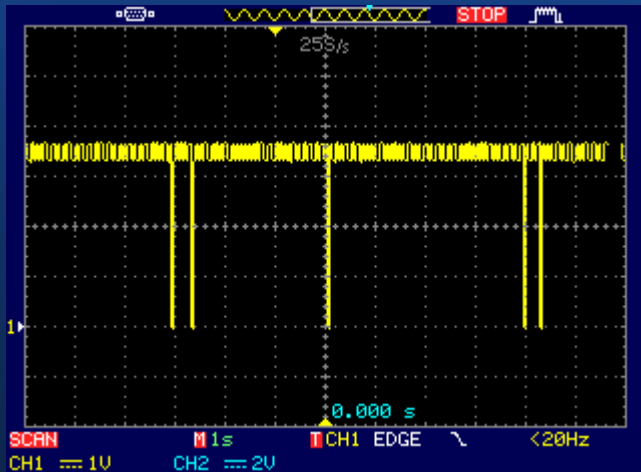


Regenerated Pulses

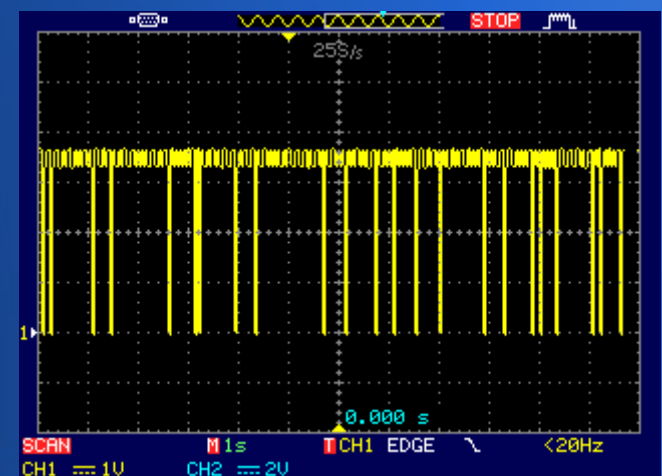
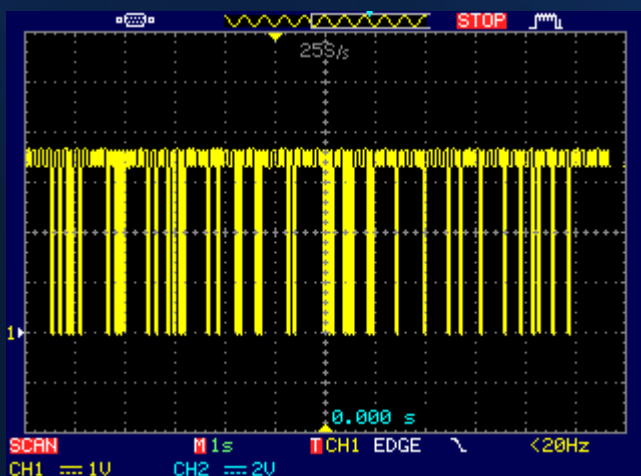


Background radiation and a radioactive calibration source of ^{137}CS with GM circuit

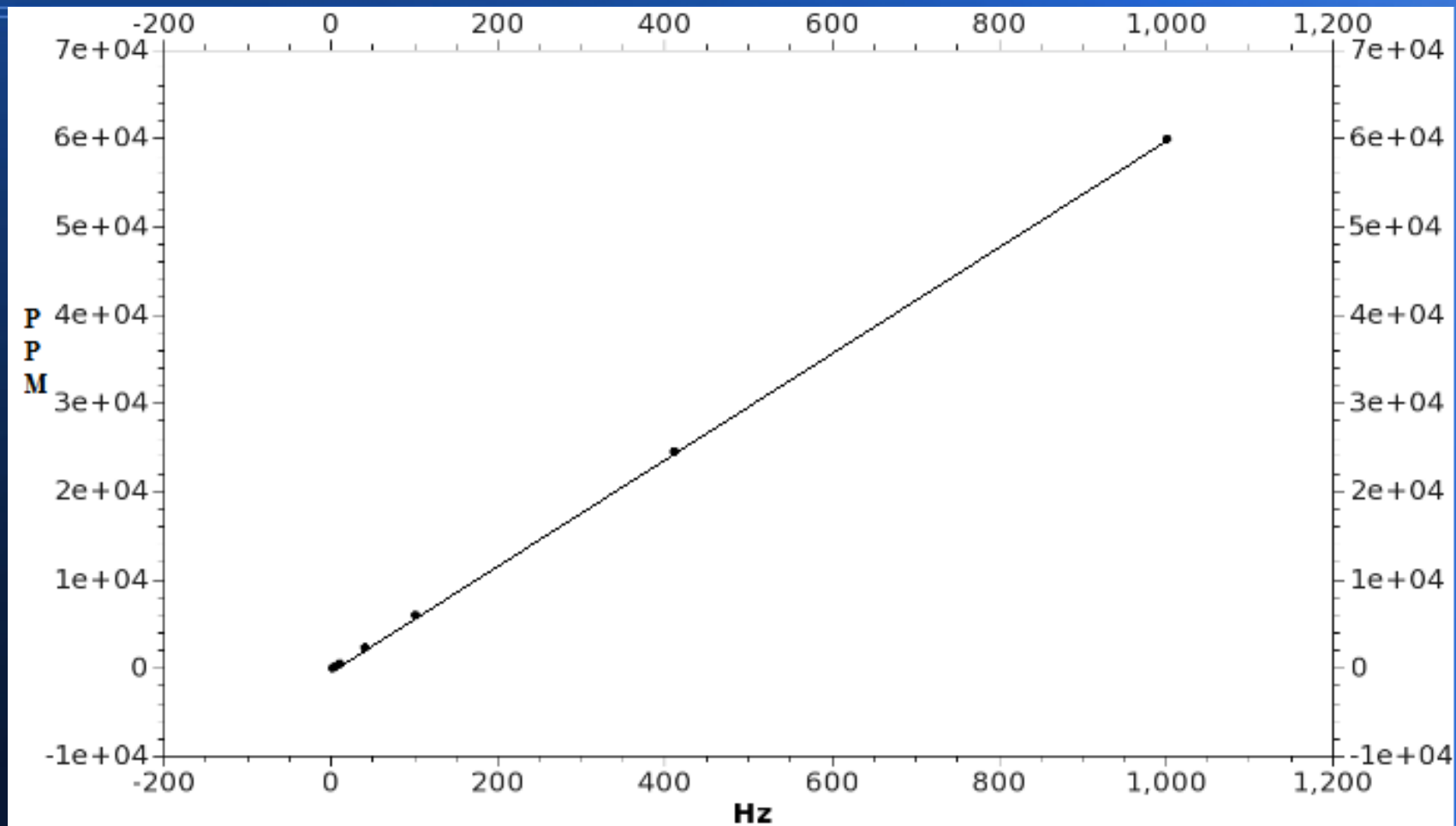
Background



^{137}CS
0,5226 μCi



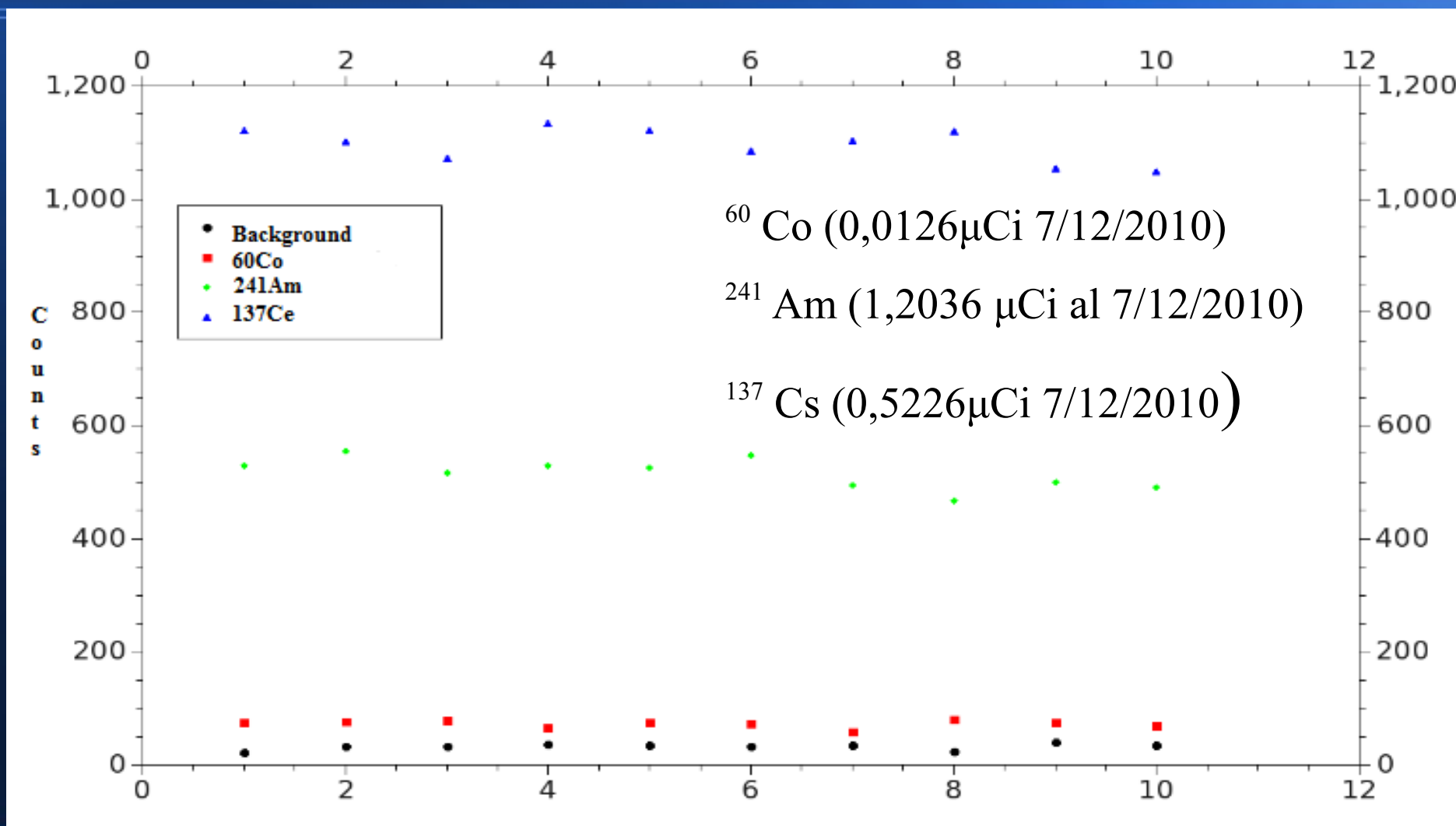
Tests with pulse generator in motes



For instance, ~1kHz, 65535 pulses (16 bits)

Radioactive calibration isotopes sources

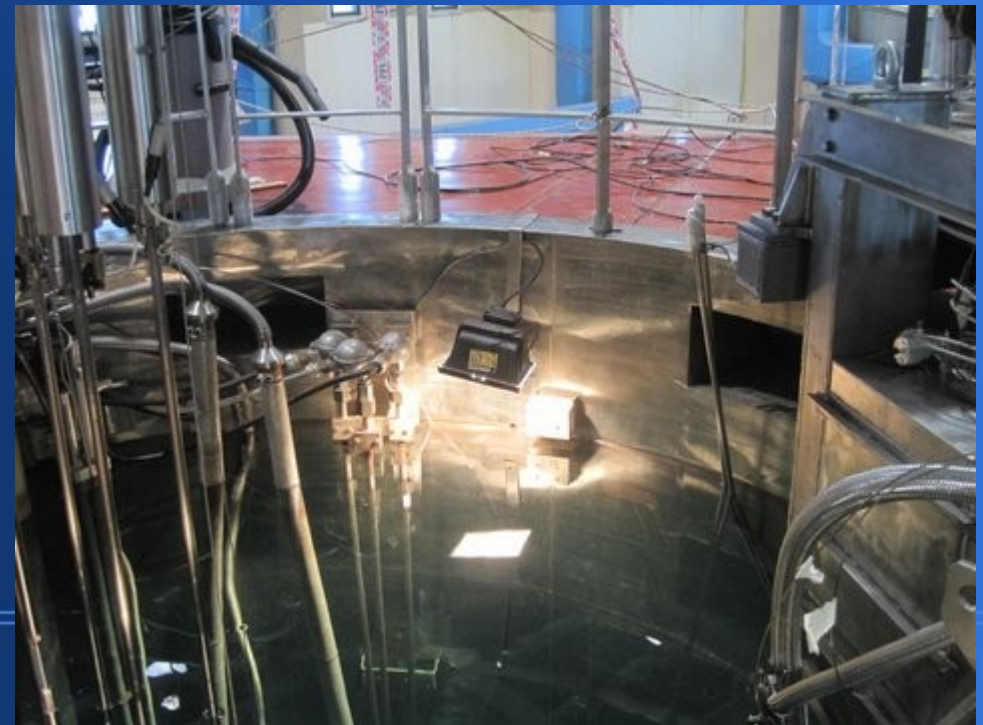
GM circuit + mote



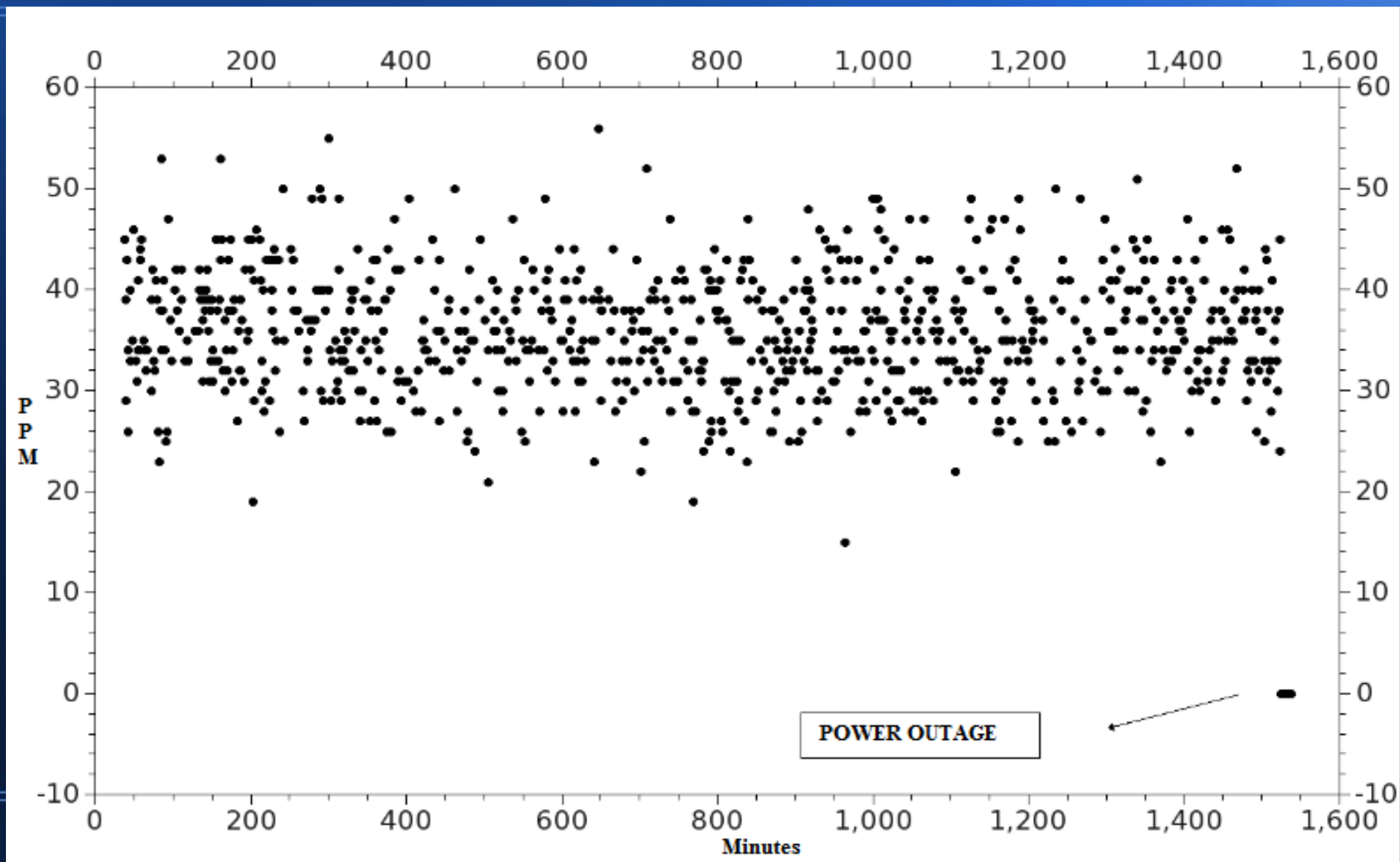
My desktop!!



Argentina RA-6



Background radiation inside RA-6



Tests with OPC

A mote was plugged to a computer where a OPC server was running. This computer acts as a Host in a OpenOPC gateway service.

Then, another computer running a Client service data made satisfactory reading through TCP/IP net.

Future work - getting data in Control Stations
(National and international regulations)

Wireless radiation Sensor

GM tube + HV polarization circuit + pulse
adaptation circuit + Mote

Power supply 2 AA batteries 3 volts and 120mW
consumption

Future Work

Optimize consumption to save batteries life and calibrate it.

Work on gateways and find the best solution to connect them
to conventional instrumentation system and to internet

Conclutions

It is possible to build a WSN inside a research reactor sensing radiation but it might be as a back-up system if they are reliable enough.

They could be part of conventional instrumentation system on future research reactors and power reactors too.

A WSN measuring environmental parameters around a reactor could be a useful tool, for instance, to give information to population on environmental conditions around the reactor.



Eng. Rodrigo José Carbajales
rodrigo.carbajales@cab.cnea.gov.ar

Balseiro Institute
Bariloche Atomic Center
Argentine Atomic Energy Commission

ICTP Trieste february, 2012^o

Grazie! Thanks! ¡Gracias!

