Dragon Project

DRAGoN – Drone for RAdiation detection of Gammas and Neutrons

04/07/2018

Presentation overview

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   b. Radiation Detection System
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Introduction

Nuclear materials may compose a threat to public health and homeland security in the form of:

- terrorism threats,
- orphan sources,
- nuclear accidents,
- radioactive contamination.

Dragon Project's Focus

The goal of the Dragon project is to design, develop and characterize a mobile system composed of an **Unmanned Aerial Vehicle (UAV)**, with a **Radiation Detection System (RDS)** capable of identifying radioactive contamination spread over an area of a few to tens of square meters.

Value Proposition

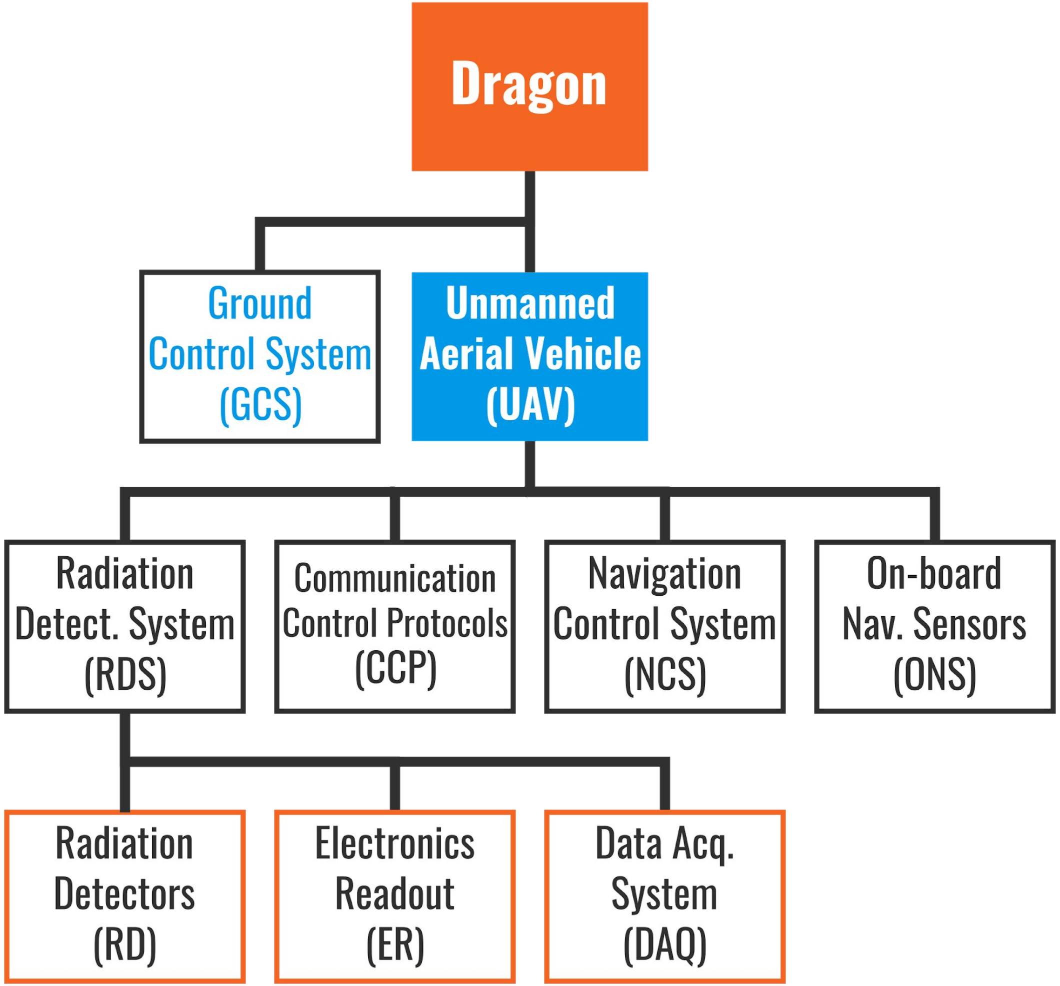
The Dragon prototype will detect and discriminate **simultaneously gamma and neutron** radiations.

In general, UAV are mainly focused on detecting and identifying gamma sources and **not neutron** radiation.

Safety and Security Standards

As the system intended use is in **potentially contaminated areas**, the project will consider the IAEA requirements for safety and security for mobile systems, including in particular the **ANSI N42.43**.

The Project's Structure



Unmanned Aerial Vehicle (UAV)

- Custom design and construction of the UAV mechanics: Design and assembly @ UniTN;
- On-board Navigation Sensors (ONS) (GPS/INS);
- Navigation Control System (NCS):

  BeagleBone Blue embedded computer.

Radiation Detection System (RDS)

- Radiation Detectors (RD) of **interchangeable** types:
  - **Radioactivity counter**

    based on a liquid scintillator (*e.g.* EJ-309B);
  - **Radionuclide identification system**

    based on an inorganic scintillator (*e.g.* CLYC-6).
- Electronics Readout (ER);
- Data Acquisition System (DAQ).

Communications & Control Protocols (CCP)

- Definition of standards;
- On-board communication between the NCS and ER;
- Evaluation of the required wireless bandwidth

  (in case of on-board or remote processing);
- Development of the communication protocols;
- Field tests.

Ground Control System (GCS)

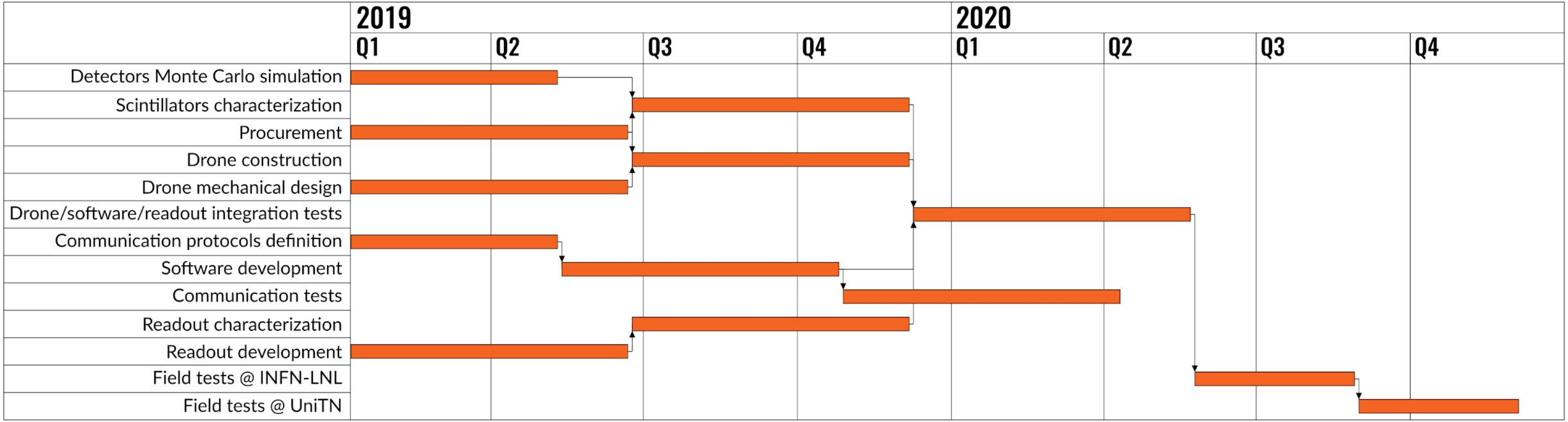
- Integration of the ONS information and RDS.
- Collection of the georeferenced data from the RDS.
- Progressively construction of the radiation counts map of the area of interest.
- A human operator can select specific areas in order to carry out a more detailed analysis.
- It can provide the gamma spectra if the spectroscopic detector is used.

Personnel

Padova		Trento	
S. Moretto	50%	*D. Brunelli*	60%
C.L. Fontana	40%	P. Tosato	40%
L. Stevanato	20%	A. Quaranta	20%
D. Fabris	10%		
G. Nebbia	20%		
F.E. Pino	20%		

Budget

Capitolo	Richiesta	Motivazioni
Missioni	5.000	Meeting and Experimental Tests
Inventario	60.000	UAV, Detectors, PMTs and SiPMs, Acquisition and elaboration electronics
Consumo	2.000	Embedded computers (BeagleBone), Electronics components, batteries, preamplifiers...



Dragon Project’s Gantt Diagram

Backup slides

Radiation counting expected count rates

Geometry	Dimension	Natural radioactivity (^{238}U, ^{232}Th and ^{40}K)
Parallelepiped	200 mm x 100 mm x 25 mm	50 - 100 counts/s

Geometry	Dimensions	Source at 25 cm Neutron cps (Thr: 100 keVee)	Source at 100cm Neutron cps (Thr: 100 keVee)
Cylinder	50 mm dia. 200 mm thick.	63	4
Parallelepiped	200 mm x 100 mm x 25 mm	81	5

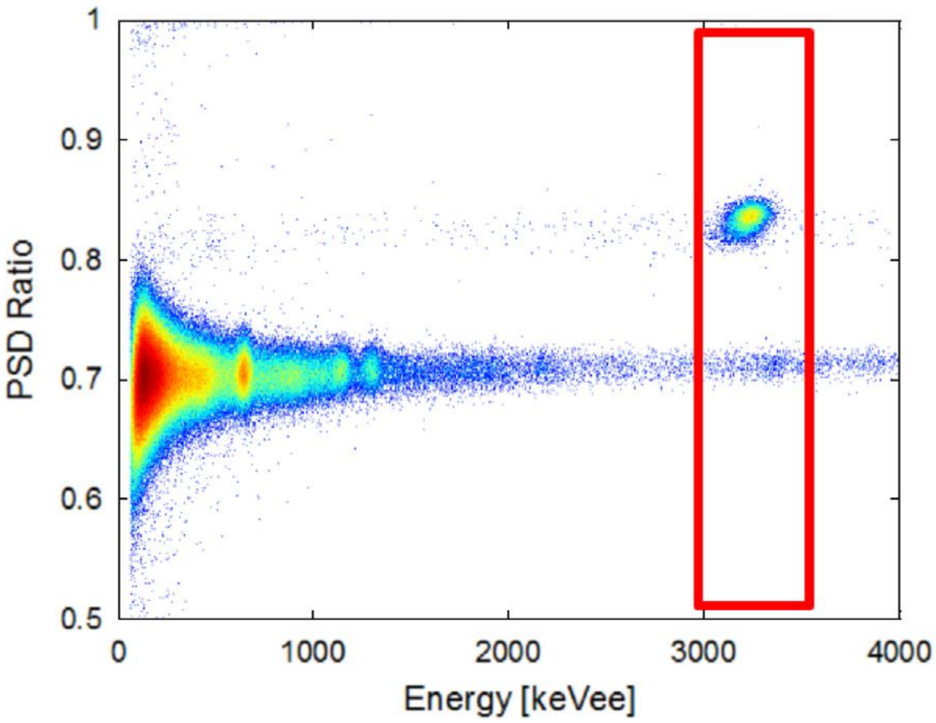
Radionuclide id. syst. expected count rates

Geometry	Detector Type	Dimensions	Total Intrinsic Efficiency	Full Peak Efficiency
Cylinder	CLYC-6-Li	50 mm dia. x 50 mm thick.	67%	25%
Cylinder	CLYC-6-Li	50 mm dia. x 25 mm thick.	43%	13%
Cylinder	CLLB	50 mm dia. x 50 mm thick.	75%	33%
Cylinder	CLLB	50 mm dia. x 25 mm thick.	50%	18%

^{6}Li-enriched CLYC-6 inorganic scintillator

2D histogram of PSD vs energy measured with a CLYC-6 obtained irradiated with a Am-Be source (Hamamatsu R6231-100mod PMT).

[Giaz *et al*. NIM A 810 (2016) 132–139]



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Boron-loaded liquid scintillator EJ-309B

2D histogram of pulse time length vs energy measured with Boron-loaded liquid scintillator irradiated with a Pu-Be source shielded with lead and paraffin.

[Swiderski, *et al.* IEEE Trans. Nucl. Sci. 57 (2010) 1]