# RADSAGA Work Package 3-4 Review

*November 12-13th 2019*

## Report from the Review Committee

## Scope of the review:

The review focused on the evaluation of the system level test methodology developed in the European Union-funded RADSAGA project, carried out under the Marie Skłodowska-Curie Actions. In particular, the following points were addressed and evaluated:

- overall progress and deliverables of the innovative training network (ITN) project;
- industrial needs and applicability of system tests in complex radiation environments; and,
- readiness and steps required towards a handbook for system qualification in complex radiation environments.

Closely linked to project studies performed on component testing, radiation environments and monitoring, the system qualification part of the ITN addresses the decisive question of how such tests will be able to provide effective reliability information as opposed to being bound by standard bottom-up individual component characterization. The latter is hardly practical for modern complex assemblies (such as systems-on-a-chip) hosting a vast amount of devices and functions. The feasibility and preparation of a full-system test largely depends on current and future radiation facility parameters as well as the interaction of the radiation environment with the system components, all of which need to be carefully considered by simulations, then to be quantified and translated into an applicable guideline process. Within RADSAGA, the combined findings are to be condensed in a corresponding handbook of guidelines and tools for radiation tolerant design and radiation testing of components and systems in complex environments. This shall serve initially as a discussion basis for engineers across working on the design and characterization of electronic systems in a broad range of application fields. It shall combine fundamental radiation aspects (i.e. particle interactions with matter, synergetic and coupled effects, etc.) and practical aspects (i.e. predictive tools, test facility information, etc.) providing insight to radiation reliability otherwise inaccessible even for the most experienced radiation expert. Finally, the handbook shall serve as a decisive input for a new European radiation testing standard. There are currently plenty of radiation methodologies standards and guidelines distributed by several authorities for space, avionics and ground applications. None of them deals explicitly with system-level radiation testing. The main challenge of writing such a guideline lies in the wide range of functional integration (from few components on a PCB or integrated in the same chip to entire satellite, airplane or car control systems) and the multi-scale variability of different systems (analog/digital, COTS systems and related custom systems, various radiative environments, data portability from one system to another, etc.).

## Programme: https://indico.cern.ch/event/843292

## Reviewers:

The international review panel was chaired by Jonathan Pellish (NASA) and Markus Brugger (CERN). Additional panel members included: Jyotika Athavale (Intel), Francoise Bezerra (CNES), César Boatella (ESA), Enrico Chesta (CERN IPT-KT), Federico Faccio (CERN EP-ESE), Renaud Mangeret (Airbus), and Anthony Sanders (NASA).

# Contents

## Executive summary:

The Committee thanks the RADSAGA team for the clear and comprehensive presentations and for the open and valuable discussions that fully addressed the scientific, organizational and resource situation of the applicable project work packages.

*Main recommendations and expected follow-ups until the end of RADSAGA and beyond [max ½ - ¾ page].*

***[Jonny, Markus]***

## Session Summary:

*Brief summary of each contribution (<findings>), related discussion points or questions (<comments>) and possible feedback to be taken into account (<recommendations>).*

### 1. Introduction and general remarks

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**RADSAGA review introduction and objectives *[Markus]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

**System level testing status in radiation effects community *[Jonny]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

### 2. Facilities and radiation environment considerations

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**Radiation field representativeness, homogeneity and penetration requirements *[Francoise]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

Recommendations (later only combined with others in final chapter)

…

**System level testing in CHARM *[Tony]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

Recommendations (later only combined with others in final chapter)

…

**System level testing in ChipIr *[Jyotika]***

… *One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

Recommendations (later only combined with others in final chapter)

…

**Board and system level testing in other RADSAGA facilities and beyond *[Renaud]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

Recommendations (later only combined with others in final chapter)

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## *3. Study cases and related methodology*

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**ESR7: Wide-bandgap DCDC converter *[Federico]***

*One sentence introduction*

ITN achievements, overall progress and findings

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Comments

…

Recommendations (later only combined with others in final chapter)

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**ESR12: 3D Point-of-load DCDC *[Federico]***

*One sentence introduction*

ITN achievements, overall progress and findings

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Comments

…

Recommendations (later only combined with others in final chapter)

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**ESR14: Software Defined Radio for space applications *[Cesar]***

*One sentence introduction*

ITN achievements, overall progress and findings

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Comments

…

Recommendations (later only combined with others in final chapter)

…

**ESR13: FPGA modules for avionics and new space applications *[Tony]***

*One sentence introduction*

ITN achievements, overall progress and findings

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Comments

…

Recommendations (later only combined with others in final chapter)

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**ESR15: On-Board Computer and camera for space applications *[Cesar]***

*One sentence introduction*

ITN achievements, overall progress and findings

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Comments

…

Recommendations (later only combined with others in final chapter)

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**Summary of methodology aspects derived from system-level testing *[Renaud]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

Recommendations (later only combined with others in final chapter)

…

**Roadmap for future activities, including guideline structure and outline *[Enrico]***

*One sentence introduction*

ITN achievements, overall progress and findings

…

Comments

…

Recommendations (later only combined with others in final chapter)

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## 4. *Discussions, Conclusions and Recommendations – Round Table Discussion [All]*

*Initial kick-off list of discussion points – others to be complemented based on things coming up during the individual discussions:*

- ***Agreement on naming conventions*** *(system level based on what (type) of components, software, radiation environments, etc.) -> essential for all conclusions*
- *Already well established for some applications (e.g. high reliability ground level, avionic), but knowledge and procedure is typically kept in-house*
  *-> focus on the issue that so far there is not enough* ***cross-community coordination***
- *In space community: so far only performed in a more systematic way for non-critical ISS applications (Proton Board Level Test Method [PBTM]) –* ***recently updated efforts and documentation available at various places (CNES, NASA, ESA, Airbus)***
  *-> individual tests done for ions at component level, but within system level functionality (ESA, etc.);*
  *-> for low-cost missions CNES standard procedure available for neutron based (mixed-field recommended)*
- *Increasing interest for new space applications (reduced launch cost, increased use of COTS, risk evaluation and acceptance, etc.)*
- *Typically, not to be seen as an alternative to component level qualification, but rather as an alternative to not testing at all*
- *Importance of evaluating investment and return of investment*
- ***Lack of existing best practice/guideline/handbook for system level testing***
- *Inefficient for system engineers without radiation effects background*
- ***Risk of not being able to compare different results, use work from other groups, etc.***
  ➔ *Re-usability of data often limited due to test conditions (device, software, test/biasing conditions, radiation fields, etc.)*
- ***Selection of parts for testing and applicability for system design (and eventual qualification)***
  - *Required link to procurement and tracing needs*
  - *Related detailed and careful definition of scope (both for handbook and later guidelines) is essential*
- ***What is the appropriate (and accepted) level of risk (for various applications)***
- ***Applicability to a future qualification methodology***
  - *Which test methodologies were developed together with the corresponding existing guidelines and testing methodologies?*
  - *Findings shall be split in two groups:*
    - *applicable today (to be published/distributed through which channels?)*
    - *requiring further development/documentation/testing to answer existing/future qualification requirements from industry*
  - *What is needed to further develop the above points and make them available to industry?*
  - ***How could a system level qualification guideline or approved methodology be structured in order to be used in industrial applications?***
  - *What upgrades/modifications to existing/future test facilities are required in order to apply qualification methodologies on an industrial scale?*
- What **future discussion platforms** are required?

## Cross-Cutting Requirements and Focus-Points

The following aspects have been identified throughout the review as important for the completion of the RADSAGA project, as well as future related activities. The following paragraphs summarize the main conclusions and recommendations if applicable.

***TID/TNID/SEE evaluations performed on common parts across the projects, result applicability, and specific requirements [Tony]***

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***Component versus system-level qualification (highlight gaps / short-comings) [Federico]***

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***System-level versus component test evaluation (highlight advantages / project coverage) [Jonny, Renaud]***

…

***Compatibility within various radiation environments (applications and test), as well as corresponding needs for a future guideline/handbook [Francoise]***

…

***Existing guidelines and corresponding future steps required to get to an official guideline/handbook for mixed radiation fields and system testing (e.g., content, recommendations, approval, etc.) [Cesar]***

…

***Existing test facilities and related tools/infrastructure and future needs, also to be considered for future proposals [Markus]***

…

***Industry integrator perspective and provide feedback on the knowledge necessary to interpret and apply future guidelines – i.e., what will take to make project output practically executable? [Renaud]***

…

***Needs from industry for a guideline/handbook [Jyotika, Renaud]***

…

***Application areas, industrial partners/contacts (within and outside project), as well as their present/future needs to ensure competitiveness [Enrico]***

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## References

[1] RADSAGA project