Subject	Project
23rd Radiation Working Group	*Component Technology Board (CTB)*
Writer *R. MANGERET [RM]* **Company** *Airbus DS*	**Representing:** *Eurospace*

Participants *(Attendees)*

Name	Company	Representing
T. CARRIERE [TC]	*Ariane Group*	*Eurospace*
G. CHAUMONT [GC - 14/06]	*STM*	*Silicon manufacturer*
E. DALY [ED – 13/06]	*ESA*	*ESA*
R. ECOFFET [RE]	*CNES*	*CNES*
K. ERIKSSON [KE]	*RUAG*	*Eurospace*
H. EVANS [HE – 13/06]	*ESA*	*ESA*
V. FERLET CAVROIS [VFC – 13/06]	*ESA*	*ESA*
G. FERNANDEZ [GF]	*ALTER*	*Eurospace*
T. KAUPISCH [TK])	*DLR*	*DLR*
R. MAREC [RoM]	*TAS*	*Eurospace*
C. POIVEY [CP – 13/06]	*ESA*	*ESA*
M. POIZAT [MP – 13/06]	*ESA*	*ESA*
S. RASON [SR – 14/06]	*ESA*	*ESA*
G. SANTIN [GS – 13/06]	*ESA*	*ESA*
C. TRAN THI [CTT]	*OHB*	*Eurospace*
D. TRUYEN [DT]	*MICROCHIP*	*Silicon manufacturer*
P.X. WANG [PXW]	*3D+*	*Silicon manufacturer*

Distribution Attendees + :

F. BOURGEOIS (UMS); P. CALVEL (TAS); R. DE MARINO (ESA); F.X. GUERRE (ALTER/HIREX); M. MELOTTE (TAS-ETCA); T. NUNS (ONERA); M.G. PERICHAUD (ESA); J. PRATLONG (TELEDYNE E2V), M. ROSTEWITZ (TESAT/DLR), M. SARNO (TAS)

Key Words
(Mots Clés)

	Action / Status
AGENDA [RM]	
Wednesday 13th of June, starting 2:00 pm, ESTEC room Na213 1. CERN & FAIR collaboration agreements and activities [ED/VFC] 2. Radiation summer school [VFC] 3. Radiation belt models [ED] 4. Review of on-going actions [RM] 5. Displacement Damage specification [CP] 6. SHE on SDRAM / status vs ECSS [RM/CP] Thursday 14th of June, starting 9:00 am, ESTEC room Nb325 7. SEE on diodes, latest status [CP] 8. SET template for opto and analog ICs [CP/TC] 9. HCMOS tested as per MIL and schottky diodes [GC] 10. GaAs and SEE testing [RM/MGP] 11. LDR on III-V devices [RM] 12. AOB : maximum fluence to reach for SEE testing [TC]	
CERN & FAIR COLLABORATION AGREEMENTS AND ACTIVITIES [ED/VFC]	
ED and VFC present some slides about on-going collaborations with CERN and FAIR (see slides in Annex A) GSI name will disappear for FAIR (2 B€ investment…); it becomes an international collaboration. FAIR will be a scientific facility however they could be open to industrial usage. Possibility to tilt to achieve higher LET values. Available with broad beam of µbeam. Since this facility could be an answer to the need expressed by the RWG about high energy ion	

facility for SEE testing purpose (thick packages, modules, stacked dies, etc…) it is proposed to send a support letter from RWG to FAIR organization. **A23-1:** VFC to send a draft of support letter that the RWG could address to support the initiative. VFC also sent the google page link to the facilities: https://docs.google.com/document/d/1oI2h9RznJ1zaStJc4k7ZttIZYSsa8DjAcXdvY2kvuYc/edit *Note 1: US high energy ion facility $7000 per hour.* *Note 2: KVI 30 MeV beam will be tested by ESA in October, 2018; ESA, CERN + University. Can be used for industrial purpose. Facility is operational.*	**A23-1: VFC 09/2018**
RADIATION SUMMER SCHOOL [VFC]	
Radiation summer school ESA and GSI/FAIR, Darmstadt May 2019 Main risk for astronauts are radiation (long duration missions in deep space) however very little training available in this area => proposed to implement this summer school permanently in Europ through ESA and FAIR/GSI collaboration agreement. 2-3 weeks in May/June 2019, 15 students. ESA looking for sponsorship. CNES could be part of, RE to check. Independent to ESA academy (which would develop one week radiation training). A presentation of this event is provided in Annex B.	
RADIATION BELT MODELS [ED]	
There have been strong discussions in the course of the ECSS E-ST-10-04C update mainly concentrated on radiation belt models. Main identified issue was about the introduction of a model as a standard while not yet stabilized. Since ECSS WG is not the proper forum to discuss about such items, the idea would be to set an expert group studying in advance the state of the art in the area, and the associate need to introduce a model as a future standard. The problems are to find a functioning mode and to find a funding source. As a first step, ED proposes that the working group should tackle the radiation belt models topic (IRENE (AE9/AP9), GREEN) and help to establish a roadmap. ED proposes that the RWG nominates the task force/WG members and then, a TRP activity could eventually be triggered. The first step (apart setting a cost estimate for this action) would be to collect user needs (prime	

contractors) for radiation models. **A23-2:** RM to initiate this first step and report to CTB about the initiative.	**A23-2 : RM** **next RWG**
REVIEW OF ON-GOING ACTIONS [RM]	
Postponed to next RWG.	
DISPLACEMENT DAMAGE SPECIFICATION [CP]	
It is agreed by the RWG (pending opposite opinion from the CTB) that the specification will be written as a guideline (e.g. 25100). Existing draft has been reviewed in real time and comments directly inserted in the document. **A23-3:** RM to send the updated document to T. Nuns [TN] and CP **A23-4:** TN/CP: to update the specification and to send it for final review to RWG members.	**A23-3 : RM** **W27** **A23-4 : CP/TN** **November 2018**
SHE ON SDRAM / STATUS VS ECSS [RM/CP]	
ESA presented that some in orbit events due to stuck bits (also called Single Hard Error – SHE) have pointed out the need to characterize at ground level w.r.t. this kind of SEE. Also RUAG had some concern with in-orbit event due to stuck bit. This is applicable to DRAM/SDRAM/DDR memories. The question is: how to address this SEE issue, what to do in order not to reproduce this on future products.	
- The first comment is that if the phenomenon is quite well known by the radiation engineering, it could not be the case for the electronic design engineering. Therefore, the first level recommendation would be to widely advertise for this phenomenon. - Then, radiation engineering shall insure that the SEE test conditions allow the identification of stuck bits/weakened cells. - Phenomenon is more visible with protons; so a recommendation would be to perform proton SEE testing on these kinds of memories. In general, WG members highlight that the phenomenon is complex and will require further studies, in particular in the DDR area. 3D+ would be interested to support.	

A23-5: RM to escalate the need for R&D in the area to CTB PXW proposes to disseminate a design note about the various possibilities to mitigate SHE. **A23-6:** PXW to disseminate the note to RWG members. Lastly, the RWG does not recommend updating the ESCC 25100 specification.	**A23-5 : RM** **14th of June** **A23-6 : PXW** **next RWG**
SEE ON DIODES, LATEST STATUS [CP]	
Due to beam issue at GANIL, there is no further data to review. Either there is another beam slot at GANIL before the end of the year, either it will be tested at UCL. M. Poizat to provide status for the next RWG.	
SET TEMPLATE FOR OPTO AND ANALOG CIRCUITS	
<u>SET template for opto-couplers:</u> RoM spot that actual template contained in ECSS-Q-ST-60-15C would likely apply to analog (slow) optocouplers; it is not necessarily valid for digital optos where the optocoupler may include logic elements which can lock the output for a given (long) time duration. There is a feeling from RWG members that templates for optocouplers shall be split in two (at least) categories. This would need to be considered in the next update of ECSS-Q-ST-60-15C (RHA). More detailed discussions will be held in the next RWG. <u>SET template for analog ICs:</u> TC has examples of circuits whose SET look to be more stringent than the ones of SET templates provided in ECSS-Q-ST-60-15C. The main identified issue prior to decide whether these templates shall be refurbished is to spot how the SET is considered in the design analysis. If the SET templates characteristics are clearly defined, it may not be the case for the application guide lines which would certainly need some further practical clarifications. First notion is to consider the SET template value (duration/amplitude) at the output of the considered device, and to simulate the effect of such transient within the considered application. Nevertheless the different roles of application and device influence would benefit to be more explicit. Item to be put at the agenda of the next RWG meeting. In preparation to the next RWG meeting, an action (A23-7) is put on the RWG members to provide - examples (if any) of “exceptional” SET, and, - more insight on how the designers takes this into consideration in each respective organization.	**A23-7 : All** **next RWG**

KE: at RUAG, SET templates and SET tests are performed; in case template is used, it is electrically simulated in the design by injection at the device output; in all cases, no in-flight event recorded since this process is applied.

PXW: SET analyses are performed for analog devices included in modules; as of today the analysis if performed with use of test data. The possibility to use SET templates would be appreciated.

RoM: not to forget that the SET templates are derived from space business test heritage.

Next question is: would it be applicable to commercial devices?

HCMOS TESTED AS PER MIL AND SCHOTTKY DIODES [GC]

HCMOS:

GC mentions a non-conformance procedure regarding TID test vs ESCC system on the "old" HCMOS family. At that time, the non-compliance to ESCC 22900 was accepted.

The process which was applied at that time: sample parts, irradiate at 310 rad/h up to 50 krad then parts brought back to Rennes and measurements done in Rennes; meaning measurements not performed within the 2 hours (deviation to ESCC 22900); parametric and functional testing performed in Rennes, if satisfactory, part is accepted.

For a particular case, parts were recently irradiated up to 100 krad, and there was a huge increase of the supply current (out of specification starting at less than 25 krad); dose rate was similar. STM performed additional tests at very low dose rate (36 rad/h) on the same wafer (+ same area of the wafer) and all parts remained within the specification.

Test on different area of the wafer also provided different results.

On this old family, there is obviously a high non uniformity of parts, even within wafers. GC highlights that this is likely a general observation on old technologies.

In this case there was no influence of the time duration between irradiation and measurements.

Therefore on this family STM would ask to apply the annealing sequence as per MIL system. STM plan to do it for less than 24 hours however MIL system allows using annealing time longer than that (determined by the applicable dose rate).

DR will not change, functional testing will be performed in situ and if all parts are functional, parts will be brought to Rennes and measured parametrically.

RWG technically approves the proposal of STM to deviate from ESCC 22900 specifications for the HCMOS family since it does not represent a technical risk (it is still following the MIL standard).

STM plan to update the ESCC specification of this device with highlighting the deviation. How this shall be handled is not to be treated within the RWG.

Schottky diodes: STM has qualified some new Schottky diodes up to 3 Mrad at HDR; devices were still in specification at the end of the irradiation even though some increase of the leakage current has been observed. STM would be interested to qualify parts at a given radiation level (e.g. 300 krad(Si)) however without testing each lot (single shot testing except if traceability change). RWG recommend setting the radiation level at more than 300 krad(Si) since such diodes are naturally considered as not sensitive up to 300 krad(Si). RWG status is that it could be an advantage for STM to exhibit some TID test results up to TBD Mrad(Si), nevertheless this does not mean it could allow to get an ESCC qualification stamp since this does not strictly follows the process. GC also mentions that STM will test the schottkys for SEB (actually some samples available at CNES).	
GAAS AND SEE TESTING [RM/MGP]	
Due to unavailability of MGP, the topic is postponed to the next RWG located at ESTEC.	
LDR ON III-V DEVICES [RM]	
Out of the Minutes of Meeting #100 - JC-13.4 Subcommittee on Radiation Hardness Assurance (Reno, NV, May 22, 2018) a specific issue with respect to III-V parts has been pointed out: it was noted that these parts in general are very low risk for high dose rate [HDR] TID and DD; however, there was a low dose rate [LDR] concern for III-V parts [switches]. RWG attendees are in general not aware of this potential issue, the general statement in this area is that such devices are generally quite tolerant to TID. Two actions are taken: **A23-8:** RM to find out which organization/people highlighted this issue. **A23-9:** all RWG members to make a survey within each individual network/bibliography about the topic and report back at the next RWG.	**A23-8 : RM next RWG** **A23-9 : All next RWG**
MAXIMUM FLUENCE TO REACH FOR SEE TESTING [TC]	
SEE proton test as specified in ESCC 25100: highest fluence to reach is 1E11 #/cm^2. Ariane asks for a reliability of 1E-4 at equipment level, which is down sized to 1E-5 at device level. For Ariane 6, the proton fluence reached during the mission is 1E7 protons above 20 MeV. This addresses mainly destructive and major SEE events.	

To be compliant with such reliability requirement, fluence to be achieved during test shall be at least 1E12, however TID level deposited during the test may be so high that the device will not fail because of SEE but because of TID. As a summary, the fluence to reach for SEE testing is a matter of reliability requirement and it also depends on the amount of same components used in flight (e.g. mass memory). The purpose of the ESCC specification is to provide minimum values which shall be used so we cannot leave it completely open. A way to overcome TID issue would be to increase the sample size taking into consideration that 1E12 can be achieved through testing 10 devices up to a fluence of 1E11 each. The RWG recommendation is then as follows: The proton SEE test shall be performed up to the minimum fluence of 1E11 #/cm^2 as required in ESCC 25100, however shall also meet the reliability requirement of the considered application/system. This may trigger the need to reach larger fluence values through increase of fluence on individual devices (pending TID issues) or increase of sample size. RoM: the possibility to stop a SEE test when 100 events are recorded shall be understood as valid only for the observed SEE, it does not cover others (e.g. recording 100 SEUs and stopping the test does not allow to demonstrate non-sensitivity to MBU (or SEFI…) if the reached fluence is not large enough.	
AOB	
Zener diode: Within the ECSS-Q-ST-15C document, there is a specific TID requirement for all "Voltage reference, Zener" to be considered for TID sensitivity. To the opinion of the RWG, there is a need to consider Zener diodes for TID tolerance only when the diode is used as a precision voltage reference. The point is to define what means "precision voltage reference". In order to address this point during the next RWG, all members from space industry are asked to provide such definition according to their respective organizations. **A23-10:** eurospace members of RWG to provide with their definition of "Zener diode used as a precision voltage reference" RoM: at TAS, precision voltage reference means less than 1% deviation and most of the time, for such application ICs are used instead of diodes (same at RUAG). Next RWG: **Monday/Tuesday 3r/4th December 2018 gently invited by STM in Montrouge, south of Paris.** **A23-11:** every RWG attendee to confirm quickly to RM that they are available.	**A23-10 : Eurospace next RWG** **A23-11 : all 07/2018**

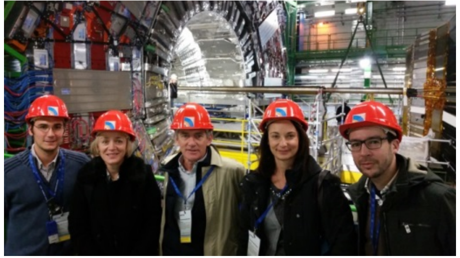
Annex A

ESA Collaborations with CERN, FAIR

Eamonn Daly, Véronique Ferlet-Cavrois

RWG 13 June 2018

ESA / TEC CERN Collaboration



EPS, QCA visit LHC, 2014

- Formal "Cooperation Agreement" signed by ESA, CERN DGs, 2014
- Regular collaboration meetings (KO Dec. 2014 at CERN w TEC-EPS/TEC-QEC)
- ESA support review of "R2E" radiation to electronics; problem in LHC; anticipate more in upgrade "HL-LHC"
- ESA-CERN NPI Ph.D. (Maris Tali)
  - e^- SEUs: applicable to JUICE, using VESPER
  - RADECS best student paper award
- Components collaborations
  - Testing/experiments in CERN & ESA facilities
  - Radiation monitoring techniques (ESA standard SEU monitor, CERN "RADMON" boards)
  - COTS evaluation/deployment (presentation of R2E COTS work to ESA WG)
  - RHA processes discussions
- Detector spin-in: exploitation of several CERN detector technologies in TRP, GSTP, etc. (contact TEC-EPS):
  - Miniaturised ASIC radiation detector with Greek consortium based on CERN MAPS* technology for high luminosity upgrade of LHC
  - CERN TIMEPIX detectors flying on Proba-V and used in ARTES activity
  - 3D Si detector technology investigated in 2 TRP studies
  - Miniature radiation monitor (RAL, UK) based on CERN MAPS* technology
- Radiation interaction simulation tools (P. Nieminen)
  - Geant4 initiated by CERN, ESA is a member
  - Fluka also strongly supported by CERN; used extensively for human spaceflight

**MAPS = monolithic active pixel sensor*

Outlook / Issues / Potential

- Wide-scale use of COTS in future developments at CERN, via its "common solutions" programme
  - ✓ ESA interest as part of it's COTS investigations (industry interest?)*
  - ✓ CERN use of ESA technology (e.g. BRAVE, ...)
- ESA-CERN exchanges on RHA particularly with regard to COTS (TEC-QEC, TEC-ED)
- Collaboration on test facilities (technology, methods, access) (TEC-QE, TEC-EPS, TEC-ED)
- CERN's VESPER, CHARM and other "injector" facilities are potentially useful
  - ✓ CERN will face problems when CHARM/Injectors shut down during LHC upgrade
- CERN RADMON upgrades (TEC-QEC, TEC-EPS)
  - ✓ fly in space (IOD, Cubesat w Montpellier)
  - ✓ include floating gate technology
- Simulation tools (TEC-EPS, P. Nieminen)
  - ✓ Update physics models
  - ✓ Continue validation campaigns

*potential to extend, e.g. to ITER, civil nuclear,...

Radiation Experiments at Accelerators

- Several radiation experiments in common using particle accelerators at:
  - UCL (Louvain-la-Neuve, Be) for heavy ions
  - KVI (Groningen, NL) for 180MeV protons and 40-90MeV/c heavy ions
  - Micro-beam + SIS + UNILAC at GSI (Darmstadt)

- Very high energy experiments in preparation at CERN
  - 40 GeV/c Xe in 2017, several ESA/TEC experiments on digital ICs, power, optocouplers, and SREM radiation monitor
  - **In 2018:** North Area, **159 GeV/n Pb** beam (12-18 Nov)
    CHARM, **6 GeV/n Pb beam** (12 Nov-2 Dec)

- Radiation Hardness Assurance publications in common
  - Energy dependence of single event effects
  - GeV hadron and mixed-field effects
  - NSREC and RADECS conferences 2014, 2015, 2016

https://www.esa.int/Our_Activities/Space_Engineering_Technology/CERN_hosts_ESA_for_high-energy_radiation_experiments

gineering & technology

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ESA > Our Activities > Space Engineering & Technology

CERN HOSTS ESA FOR HIGH-ENERGY RADIATION EXPERIMENTS

Super Proton Synchrotron

19 December 2017 An ESA-led group subjected components and space equipment to the most intense beam of ultra-high energy heavy ions available – short of travelling into space – during a week-long visit to CERN, the European Organization for Nuclear Research.

Test items were placed in a path of an experimental beamline fed by the Super Proton Synchrotron (SPS) particle accelerator. Located in a circular tunnel nearly 7 km in circumference, the SPS is CERN's second largest accelerator after the Large Hadron Collider (LHC), which the SPS feeds into in turn.

ESA was invited to make use of the Geneva-based centre's beamline as part of an ESA–CERN cooperation agreement signed by their respective Director Generals.

The team donned hard hats and ventured into a ground floor 'cave' surrounded by protective concrete blocks to place items in the beam path, retreating upstairs before the beam was fired.

ESA team at beamline

"It was a very exciting experience – we were exploring," said Véronique Ferlet-Cavrois, heading ESA's Power Systems, EMC and Space Environments division. "This ion beam is equivalent to the ultra-high energy part of the galactic cosmic ray spectrum – above 10 GeV/nucleon – whose effects have never been experimentally measured on the ground before."

Space is a vacuum, but it is far from empty. It is awash in charged particles, including protons from the Sun as well as cosmic rays from the wider Universe, highly charged nuclei originating from violent cosmic regions such as exploding stars or black holes, then accelerated by magnetic fields during their galactic journeys.

FAIR

- Facility for antiproton and ion research
- Development at GSI* of SIS-18 ➜ SIS-100
- 2022 ➜ full operation 2025

CRC	B	p, various heavy ions	65 MeV p ~10 MeV/n heavy ions
GANIL	F	various heavy ions	0-95 MeV/n heavy ions
JYFL	FI	p, various heavy ions	60 MeV p, ~15 MeV/n heavy ions
LNS	I	various heavy ions	10-100 MeV/n heavy ions
GSI	D	H-U	4.5 GeV p, 2 GeV/n heavy ions
FAIR	D	H - U	30 GeV p, 2- 10 GeV/n heavy ions

*GSI will become FAIR

ESA-FAIR

- 2008- studies of high energy effects on electronics, shielding, biological effects etc.
- Feb 2013: meeting between ESA and GSI to explore potential of FAIR for space
- ESA initiated study by Fraunhofer 2014-2016 →
- Visit by DG to GSI in 2016
- April 2017 ESOC to better define cooperation
- Feb14 2018 DGs sign cooperation agreement
- Covers radiation biology, electronic components, materials research, shielding materials and instrument calibration


Fraunhofer INT

GSI

Application of the FAIR Facility to Space Radiation Research

Final Report

GSI (FAIR) plans 2018

At SIS-18 and UNILAC microprobe:

- 1-7 Sept: 1-2 GeV/n **Pb** beam

(can be degraded down to 100 MeV/n, LET coverage is about 15-35 MeVcm2/mg)

- 23-26 Nov: 1-2 GeV/n **Fe** beam

(can be degraded down to 100 MeV/n, LET coverage is about 1-4 MeVcm2/mg)

Participants include ESA, CERN, CNES, Universities (Oslo, Jyväskylä, Padova)

KVI plans 2018

Mid Oct – end Oct

30 MeV/n cocktail (Xe, Kr, Ar, Ne, O, C) and 90 MeV/n cocktail (Ne, O, C)

Participants include ESA, CERN, Universities (Oslo, Padova)

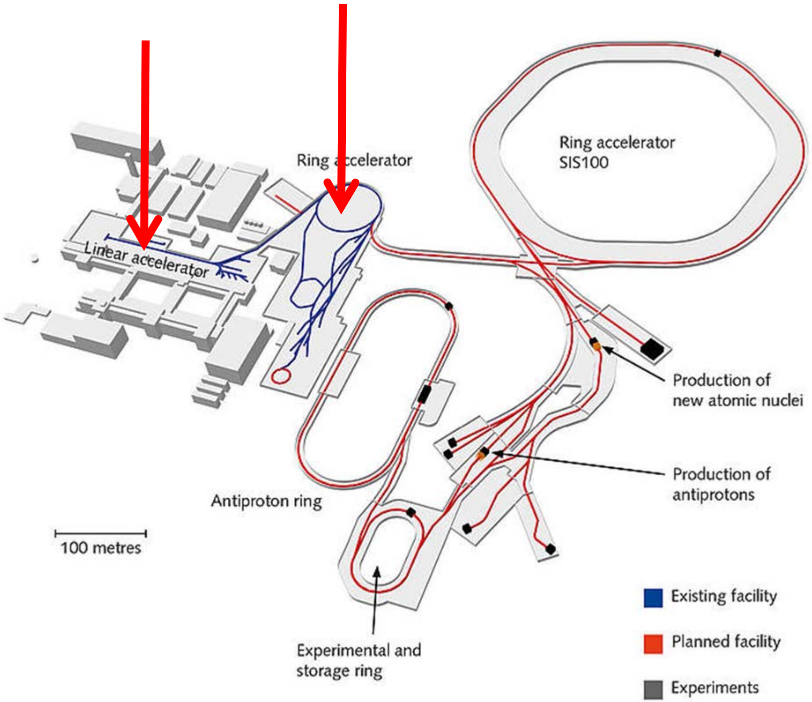
Relevance of FAIR

Our “Established” test facilities:

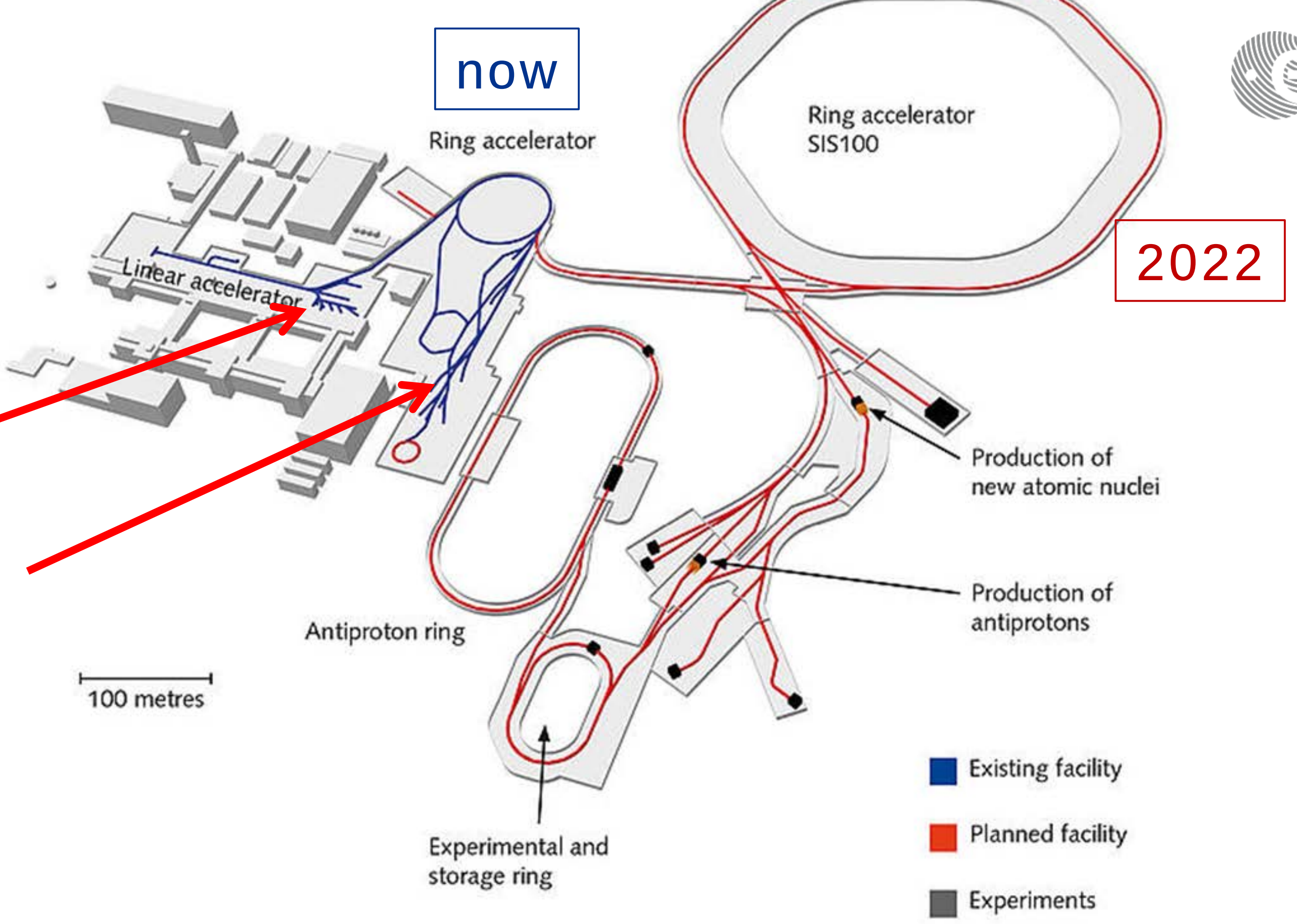
- have low ion energy (10-100 MeV/n)
- so low range (mm)
- incomplete representation of nuclear interactions

GSI+FAIR gives a realistic GCR environment:

- GSI* facility now has up to 1GeV/n
- FAIR will go up to 10 GeV/n (protons 30 GeV)
- Access at various points for intermediate energies
- FAIR management are aware of high relevance to especially human biology



“GSI” name will disappear – all on site will be FAIR


now
Ring accelerator
Ring accelerator
SIS100
2022
Linear accelerator
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Production of
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Experimental and
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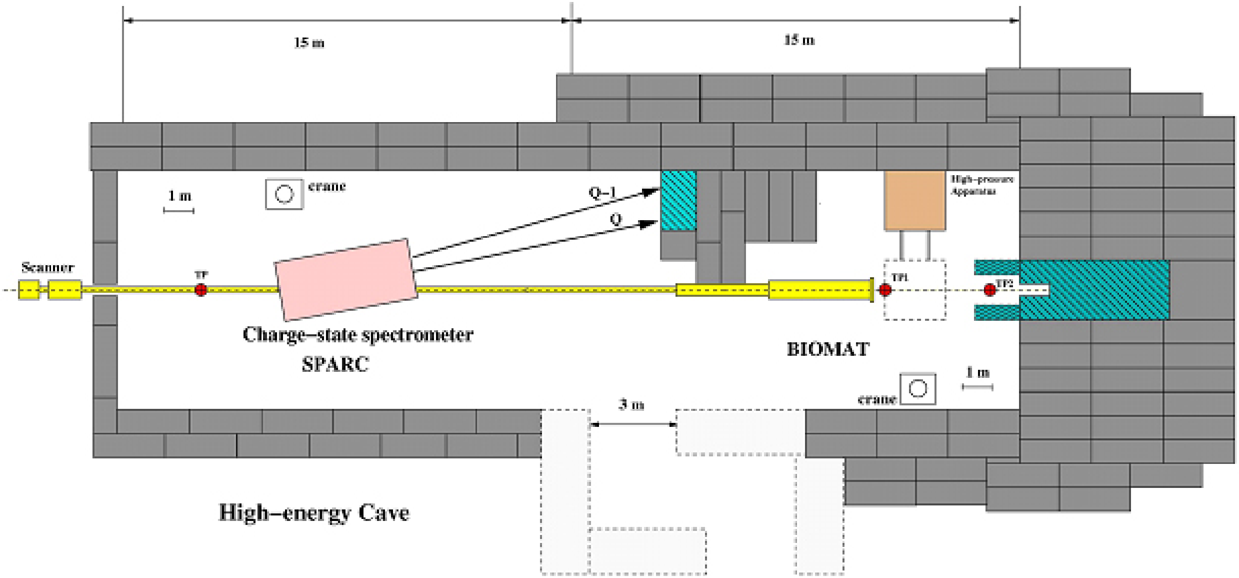
Existing facility
Planned facility
Experiments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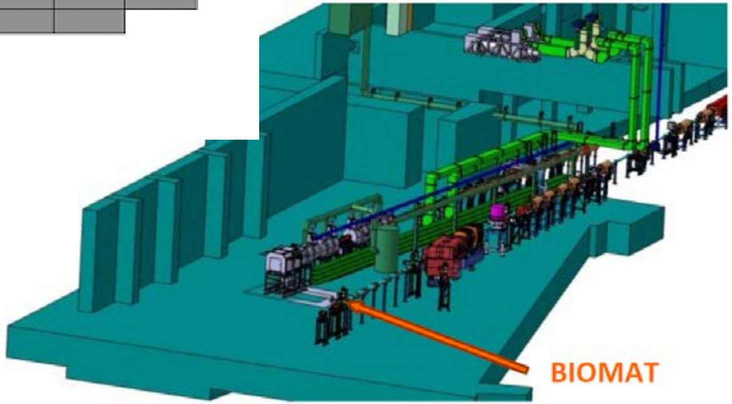
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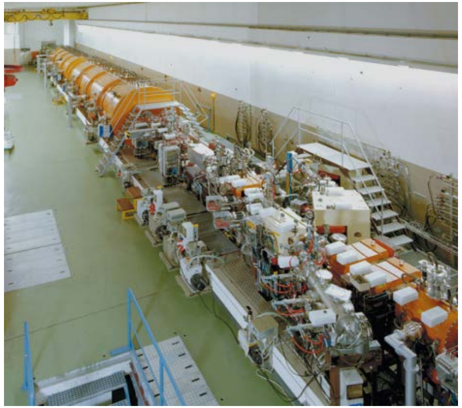
Past Activities



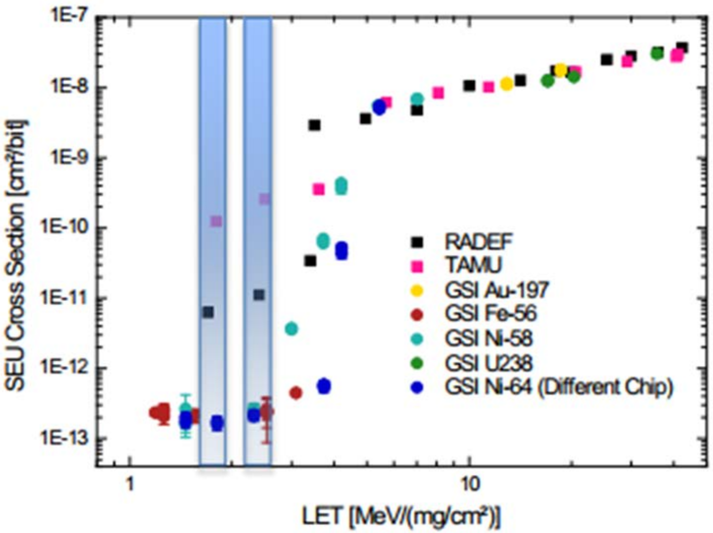
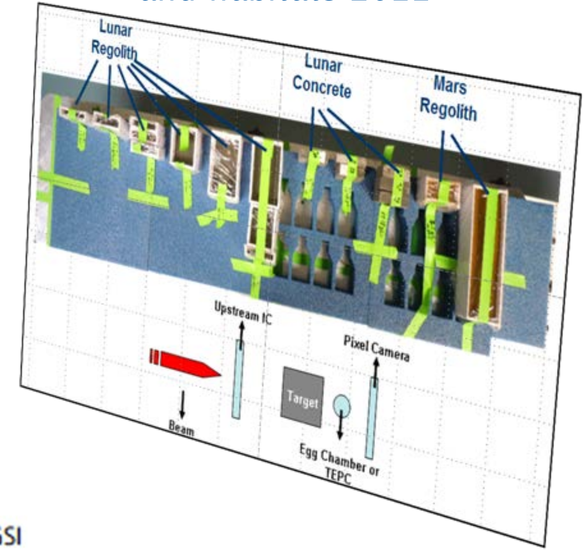


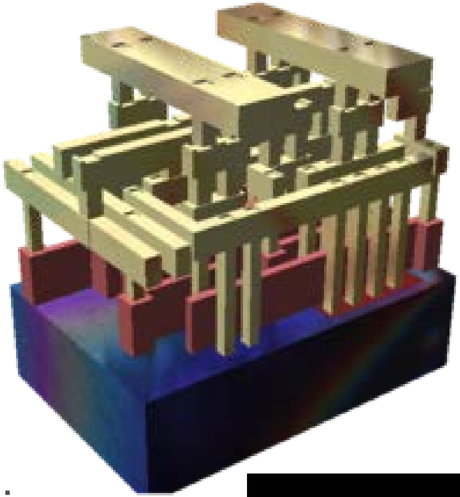
Figure 2: SEU cross section vs LET, taken with ions from RADEF, TAMU and GSI

Investigation and analysis of very high energy accelerators for radiation simulation 2008 - 2011

ROSSINI: Radiation Shielding by ISRU and/or innovative materials foe EVA, vehicles and habitats 2011-

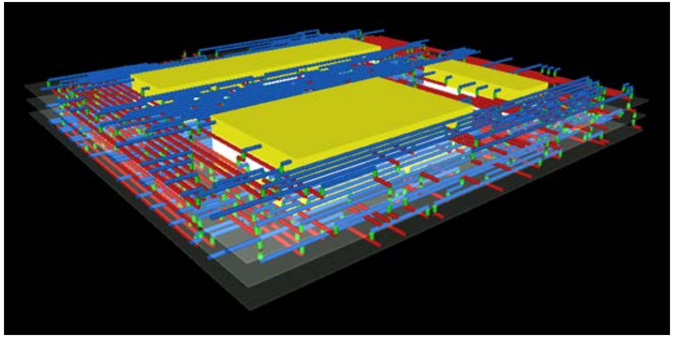


Future Challenges (1/3)

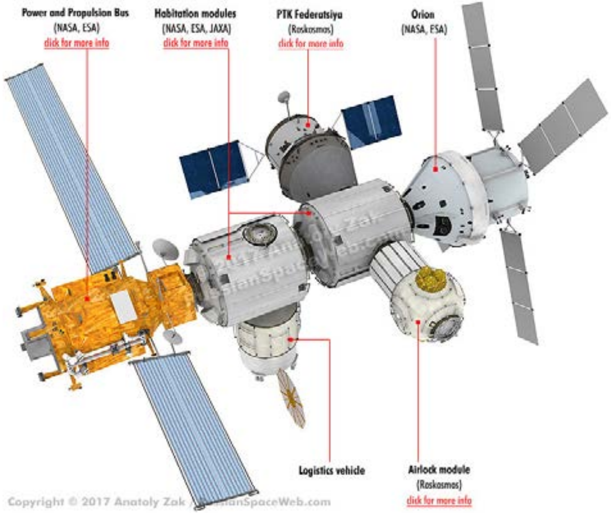


Microelectronics

- Complexity;
- COTS;
- moving into RHA “invalid” domains
- Some “super high rel.” applications (human mission critical support)



Future Challenges (2/3)



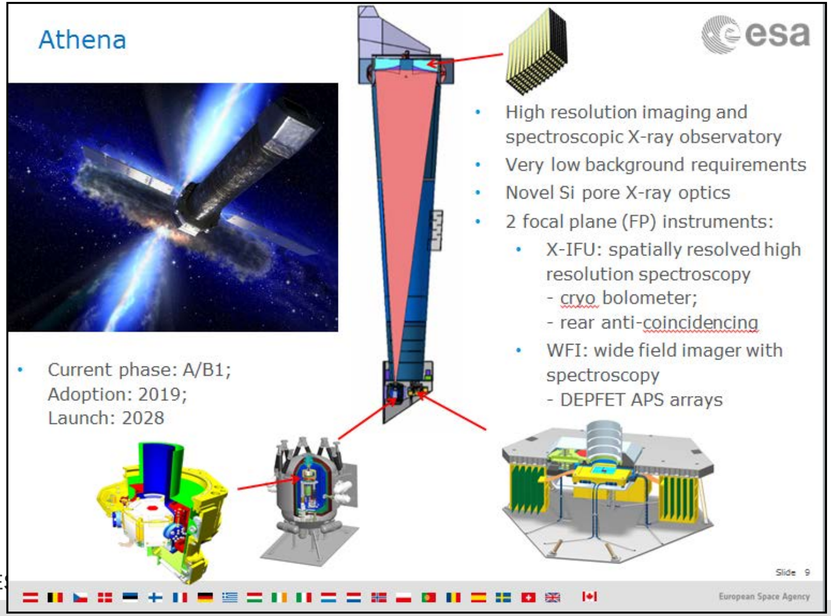
Human Spaceflight

- Cis-lunar, lunar, Mars;
- Biological effects;
- Radiation shielding
  ➜ basic data and material qualification
- A "super high rel." application

Future Challenges (3/3)

Effects on detectors on science missions

- Athena, eLISA are outside the magnetosphere to get low rad bkgr.
- Remaining threat = **GCR** ← needs intense evaluation



Daly, RADECS 2016

Next Steps with FAIR

- Coordination meeting @ FAIR 22 June
- Create annex to cooperation agreement detailing topics to work on
- Seeking funding to start implementing

Annex B

RWG -presentation of the Radiation summer school project

Jennifer Ngo-Ahn, Eamonn Daly, Veronique Ferlet-Cavrois

13/06/2018

Radiation summer school, ESA and GSI FAIR, Darmstadt, May 2019

Started from Human Spaceflight and Robotic Exploration:

- Thomas Reiter
- Jennifer Ngo-Ahn

TEC joined: space environments and effects, radiation hardness assurance

Whoever is interested to join:

Speakers

Sponsorship

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Review

Space Radiation: The Number One Risk to Astronaut Health beyond Low Earth Orbit

Jeffery C. Chancellor [1,2], Graham B. I. Scott [1,3] and Jeffrey P. Sutton [1,4,*]

1 National Space Biomedical Research Institute (NSBRI), and Center for Space Medicine, Baylor College of Medicine, 6500 Main Street, Suite 910, Houston, TX 77030-1402, USA; E-Mails: jeff.chancellor@bcm.edu (J.C.C.); graham.scott@bcm.edu (G.B.I.S.)

2 Department of Materials Science and Engineering, Dwight Look College of Engineering, Texas A&M University, 3003 TAMU, College Station, TX 77843-3003, USA

3 Department of Molecular and Cellular Biology, Baylor College of Medicine, 6500 Main Street, Suite 910, Houston, TX 77030-1402, USA

4 Department of Medicine, Baylor College of Medicine, 6500 Main Street, Suite 910, Houston, TX 77030-1402, USA

Background

- Cosmic radiation is considered the main health hazard for human exploration and colonization of the solar system.
- Unfortunately, very limited training is available for (European) students in this field: NASA's Summer School at the Brookhaven National Laboratory (NY), which had enabled students to be trained in radiobiological research and had led to many graduates pursueing high research positions in the space radiation field, was discontinued.
- It is now proposed to establish (in Europe) a permanent theoretical and practical Summer School programme under the recently signed Cooperation Agreement between ESA and FAIR/GSI to train students in basic heavy ion biophysics for both medical (therapy) and space (protection) applications.
- The location of ESOC as well as FAIR/GSI make them ideally suited for such a project, both in terms of expertise as well as in terms of available infrastructure (experimental areas, beams, dormitories for the students).

Proposal

- The Advanced European School on Heavy Ion applications in physics, biology, and medicine is to be held 2-3 weeks in May-June 2019 and shall be open for up to 15 students (graduated or post-doctoral fellows in physics, medicine, biology, and related disciplines).
- Week 1 will be dedicated to education and lectures on space exploration and technology, radiation biophysics, medical physics from various international experts in the field and is proposed to be held at ESOC.
- Week 2 and 3 would consist of simple physics and biology experiments with high-energy heavy ions, planned and designed by the students under the supervision of the instructors and are proposed to be held at FAIR/GSI.
- At the end of the programme, the students shall be asked to formulate and submit an ground-based space radiation experiment proposal in the context of ESA's Continuously Open Research Announcement for Investigations into the Biological Effects of Space Radiation (ref.: EUB(2017)/W31-05).

ALSO …

SERESSA 12-16 Nov 2018, ESTEC

https://indico.esa.int/indico/event/233/overview