



FRAUNHOFER Test-Campaigns & Facilities

(R2E) Mitigation Project: www.cern.ch/r2e

RadWG March 25th 2013

M. Brugger for the R2E Project

- ④ **Fraunhofer test facilities**
- ④ **Blanket contract**
- ④ **Typical test 'life-cycle'**
- ④ **On-going tests & Cost Example**
- ④ **Tests in pipeline**

■ Co-60 gamma sources

- MDS Nordion GammaMat TK1000 A/B
- MDS Nordion GammaMat TK100

■ X-ray sources

- Febetron 705 (pulsed)
- Comet MXR-451 (continuous)

■ Neutron generators

- Thermo Electron D-711
- EADS Sodern Genie 16C

■ Pulsed laser SEE test system

- Lumera STACCATO
- CryLas DSS1064-Q1

■ Sun simulator

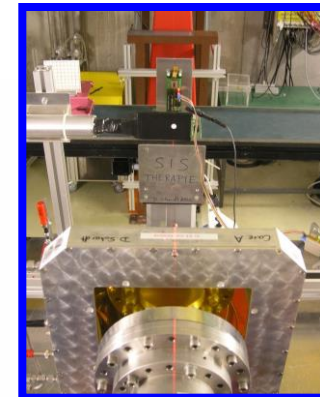
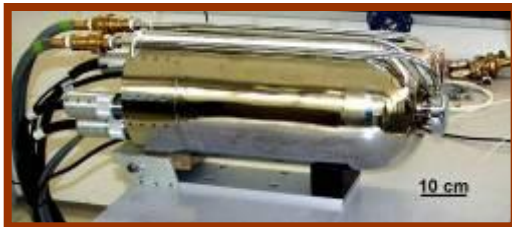
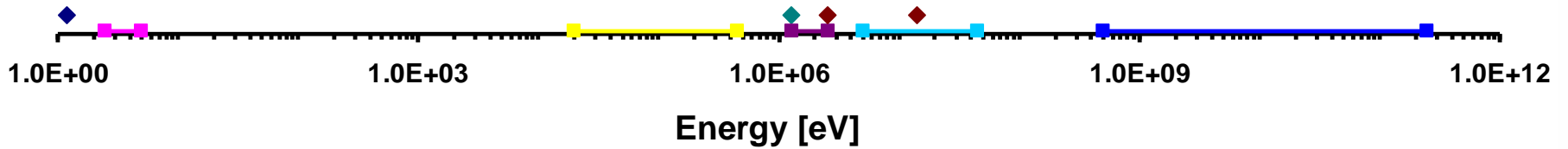
- Oriel LS0911

■ External facilities

- Proton-irradiation at FZ Jülich
- Relativistic heavy ions at GSI Darmstadt (currently limited availability)

■ External Co-60 sources

Test Facilities



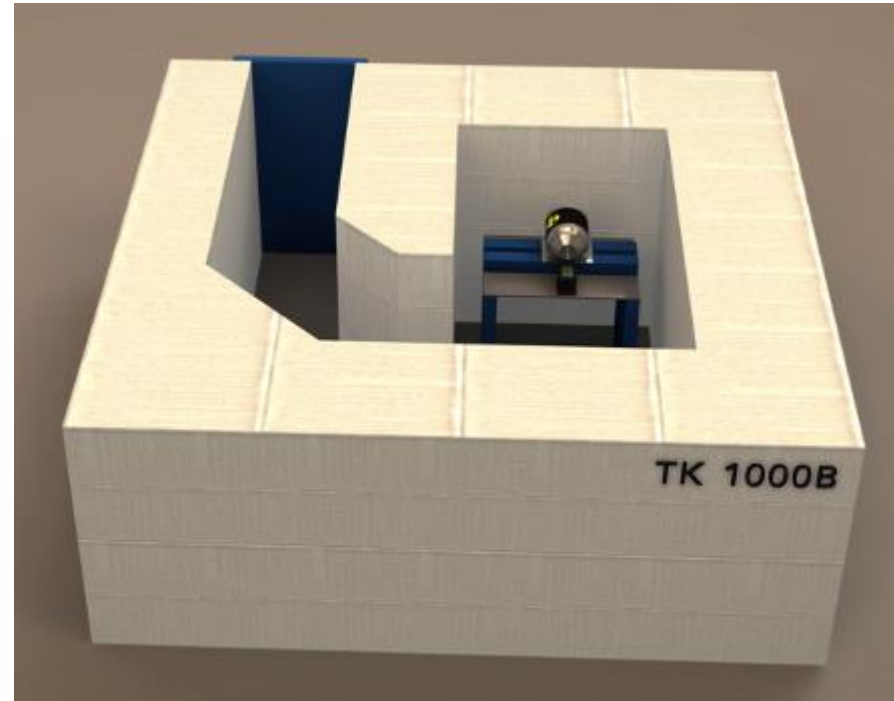
Co-60 Source (TID Tests)

- Typical activity:
 - 2×10^{13} Bq (500 Ci)
- Maximum dose rate:
 - ~ 3 Gy/s (300 rad/s)
- Maximum dose (very small samples):
 - 1 MGy (100 Mrad) in 4-6 days
- Temperature range:
 - -55°C to $+150^{\circ}\text{C}$
- Dosimetry:
 - Calibrated ionisation chambers and TLDs (LiF)
- Large test volume ($\sim 1 \text{ m}^3$)



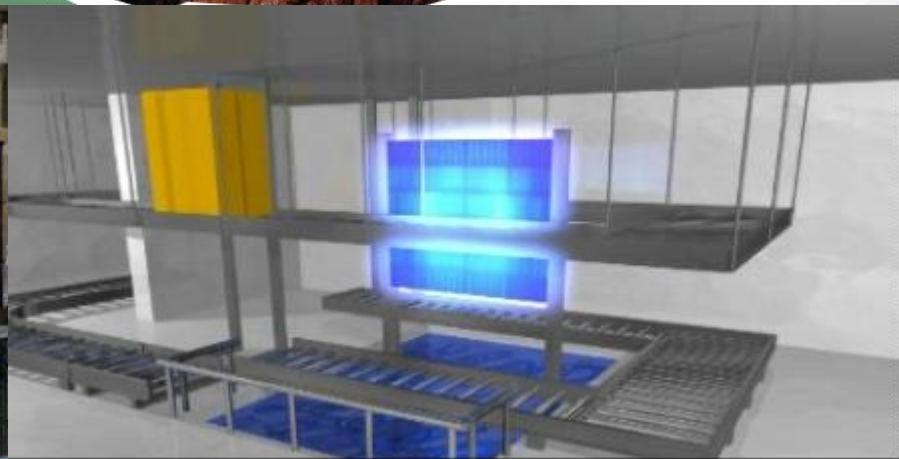
Co-60 Source (TID Tests)

- Bunker layout with cable feeds, remote control to test equipment possible, etc,...
- Whole irradiation chamber thermally stabilized $\pm 0.2^{\circ}\text{C}$
- Larger test volume resulting in large variation of dose rate
- Exclusive concrete bunker without interference with other irradiations
- Measurement equipment close in precision climate chamber



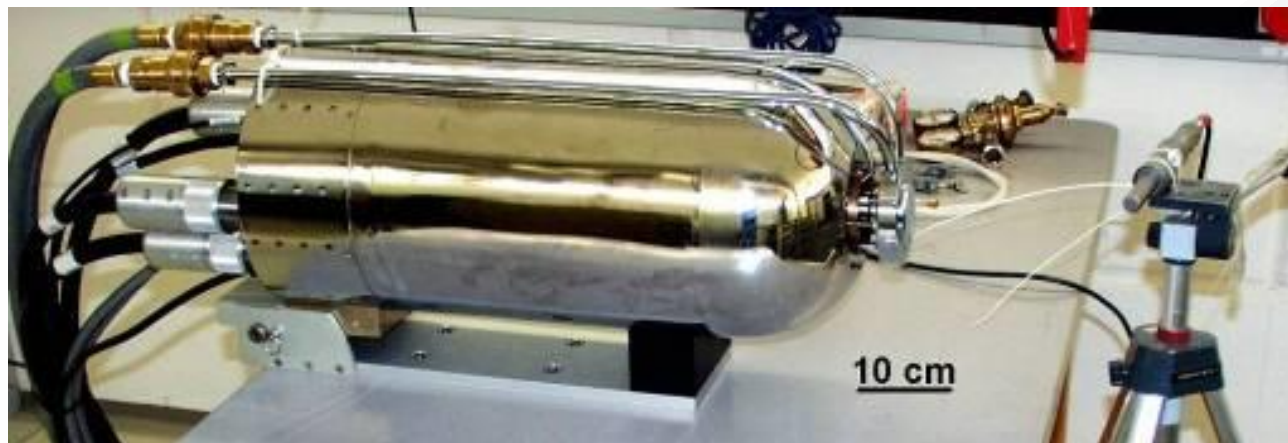
Co-60 High-Dose Tests (passive)

- @ BGS (Wiehl) close to Fraunhofer
- @ Goal: tests in the MGy range (& large volume)
- @ Only passive radiation tests possible
(some possibilities for 'small' samples)



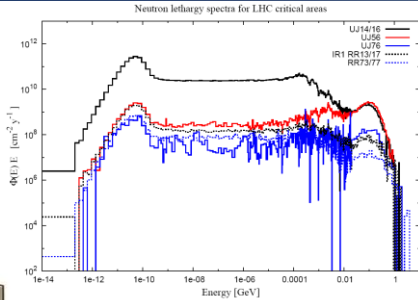
Neutron Generator (DD Tests)

- Neutron generation via fusion reaction
 - $T(d,n)^4He \quad E_n \cong 14 \text{ MeV}$
 - $D(d,n)^3He \quad E_n \cong 2.6 \text{ MeV}$
- 14 MeV: Source particles $< 4 \times 10^{10} \text{ n/s}$ in 4π
Fluence of 10^{13} n/cm^2 after several hours
- 2.5 MeV: About a factor of 100 less
- 14 MeV–n in Si are twice effective as 1 MeV–n
- Fluence and dose measured with activation foils and fission chambers

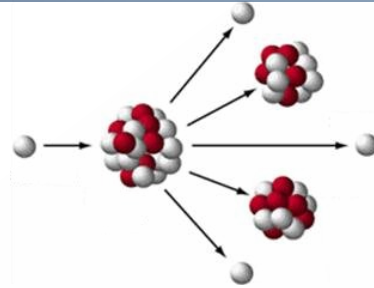


- ⊙ Demand for radiation test campaigns (TID, DD) is **steadily increasing**
- ⊙ **Time and man-power constraints** are a frequent issue for equipment groups
- ⊙ Individual contracts are lengthy and total volume exceeds 200kCHF/y envelope
- ⊙ Proposal of **blanket contract with Fraunhofer** (maximum volume of 700kEUR/3y) accepted by Finance Committee (March 2013)
- ⊙ **Contract in iteration** with Fraunhofer on-going

Test 'Life-Cycle'



Expected Radiation Environment
(levels, spectra, etc.)



Component-Equipment Selection

Definition of Test Requirements

In-House?
External Facility?
Outsourced?

Test Specification Document

Setup & Test Campaign

Analysis & Reporting

Acceptance for CERN Application
Additional Test Requirements?

- ⊙ Qualification tests of **optical fibers** (production testing) [EN/EL]
- ⊙ **RadFet** calibration campaign [EN/STI]
- ⊙ **Currently two combined campaigns (active + passive)**

Measurement	Type	Campaign	Dose Levels	Dose Rate	Volume	#ofSteps	Total Cost [EUR]
Piezo Sensors	Active	Fraunhofer 1	<1.3 MGy	0.3 Gy/s (Air)	-	continuous	85000
Survey Sensors	Active	Fraunhofer 1	<0.5 Mgy	0.1 Gy/s (Air)	-	continuous	
Optical Sensor Head	Active	Fraunhofer 1	<0.5 Mgy	0.1 Gy/s (Air)	-	continuous	
Piezo Sensors	Passive	Fraunhofer 2	0/1/5/10MGy	9 KGy/h (H2O)	small	3	49000
High-Level Dosimeters	Passive	Fraunhofer 2	0/0.1/0.3/1/3/10MGy	9 KGy/h (H2O)	medium	5	
Optical Sensor Head & Feed Through	Passive	Fraunhofer 2	3MGy	9 KGy/h (H2O)	medium	1	
Magnet material samples	Passive	Fraunhofer 2	0.1/1/5/10	9 KGy/h (H2O)	large	3	
Survey Sensors (2nd model)	Passive	Fraunhofer 2	0.1/0.3/1/5	9 KGy/h (H2O)	small	4	
Additional1 (e.g. polymers)?	Passive	Fraunhofer 2		9 KGy/h (H2O)	medium		
Additional1 (e.g. cable feedthroughs)?	Passive	Fraunhofer 2	0.1/0.3/1	9 KGy/h (H2O)	large	3	

- ⊙ **Aim: combine as many tests as possible**
- ⊙ **New contract:**
 - ⊙ will bring **costs further down**
 - ⊙ **ensure the availability of the facilities and Fraunhofer**

- RadFET** additional measurements under biased conditions [EN/STI] (G. Spiezia)
- RadMon** components, e.g. ADC (full box) [EN/STI] (G. Spiezia)
- LED safety lights** up to some 100kGy (active or passive) [EN/EL] (J.M. Foray)
- IT/Fire Beacons** up to 100kGy (ideally active) [IT/CS] (A. Pascal, A.G. Molero)
- Fire detection/alarm system: diode active, functional test on switch [GS/ASE] (M. Dole)
- Polymers & Resin samples** to high doses (10MGy), **partly under cryogenic conditions** [TE/MSC] - Insulation samples + Cryo (E. Fornasiere)
- Flexible pipes** (passive up to some MGy) [TE/MSC] Magnet hoses/feeds (D. Schoerling)
- Small components** for collimation (motors, switches) -> Passive to several MGy [EN/STI] (A. Masi)
- LT1084 regulator** active measurement up to ~1kGy [TE/MPE] (R. Denz, J. Steckert)
- Components used for new power converter design** (several) up to few hundred Gy (to be decided if active or passive) [TE/EPC] (Y. Thurel, A. Dinius, S. Uznanski)
- Survey equipment** (passive only) -> for cable MGy to be clarified, additional: motor/gearbox optional [BE/MPE] (M. Sosin)
- Humidity sensor**: [EN/CV] (R. D. Ecclestone)
- labeling** verification -> interested? [EN/EL] (C. Crommelinck)
- components interesting for **EAirrad** [EN/STI] (J. Mekki, M. Brugger)
- possible requirement for **BPM components** for xCheck – analysis ongoing [BE/BI] (G.J. Focker)
- vacuum instrumentation** – if cross-check on ‘new’ equipment is required [TE/VSC] (G. Pigny)
- RF equipment**– to be discussed in context of JPARC tests [BE/RF] (M. Paoluzzi)

- ⊗ First specification documents received
- ⊗ Iteration on few points required
- ⊗ Missing ones get 'urgent'
- ⊗ Will create dedicated website (sub-site of RadWG)
- ⊗ Trip to Fraunhofer scheduled for April 10th (input before!)

	Component/System	Contact (Group)	Target Dose (+Rate)	Specification Document	Defined Slot	Comments
Active	RadFets	<i>G. Spiezie (EN/STI)</i>	varying	ready		additional measurements
	RadMon components	<i>G. Spiezie (EN/STI)</i>	1kGy (IDR)	in work		particular interest on ADC life-time
	IT/Fire Beacons	<i>A. Molero (IT/CS)</i>	100kGy	ready		open discussion for specification document
	LED safety lights	<i>J.M. Foray (EN/EL)</i>	100kGy			setup ready
	LT1084 regulator	<i>R. Denz (TE/MPE)</i>	1kGy (IDR)			clarifying possible ELDRS
	Humidity sensor	<i>R. Ecclestone (EN/CV)</i>	100kGy			setup ready
	BPM components	<i>G. Focker (BE/BI)</i>	10kGy (tbc)			
	Vacuum instrumentation	<i>G. Pigny (TE/VSC)</i>				
	Power-converter components	<i>S. Uznanski (TE/EPC)</i>	0.5-1kGy	ready		first iteration on selection
	Fire alarm system	<i>M. Dole (GS/ASE)</i>	100kGy			only the diode active
Special	polymer & resin samples	<i>E. Fornasiere (TE/MSC)</i>	10MGy (steps)			77K same samples as current campaign
Passive	flexible pipes	<i>D. Schoerling (TE/MSC)</i>	10MGy (steps)			
	collimation components	<i>A. Masi (EN/STI)</i>	10MGy (steps)	ready		various components
	survey equipment	<i>M. Sosin (BE/MPE)</i>	1-10MGy			cable, motor, gearbox, ...
	EAirrad equipment	<i>J. Mekki (EN/STI)</i>	1MGy			cables, motors, tbd...
	RF equipment	<i>M. Paoluzzi (BE/RF)</i>	10-100kGy			to be confirmed
	Fire alarm system	<i>M. Dole (GS/ASE)</i>	100kGy			call point (check before after only)