

RDS_SPES (Sigla SPES_PV) Radiation Damage Study for SPES

Report on 2016 activity

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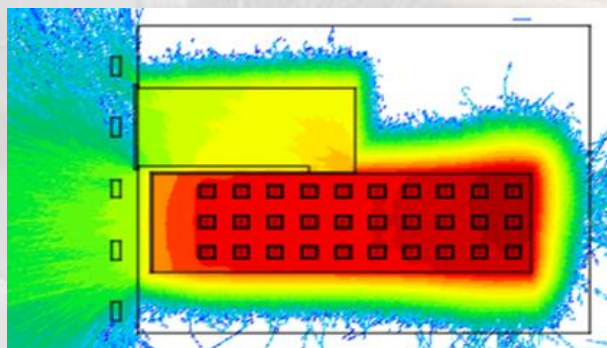
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RDS_SPES main activities in 2016

1_ Lubricant oils and greases **radiation stability tests** for use in the SPES Front-End



2_ **Activation calculations** of the SPES Front-End in operating conditions for mechanical **design** and **radiation protection** (MCNPX+CINDER, FLUKA)



3_ Calculation of the exhausted **Target Units repository shielding** for mechanical design and radiation protection (FLUKA)

Rad-hard tests of critical components in the Target & Ion Source unit (TIS) of SPES

10^{13} fissions/s

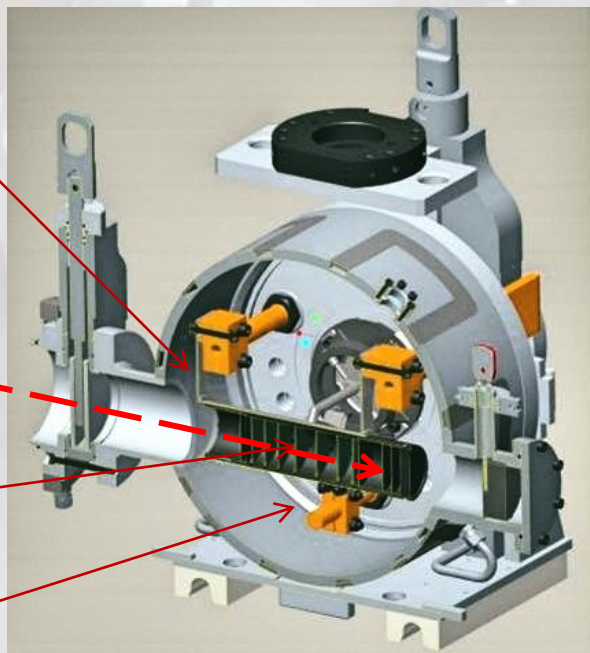
Non-metallic components: the most critical

TIS Heater
2000°C

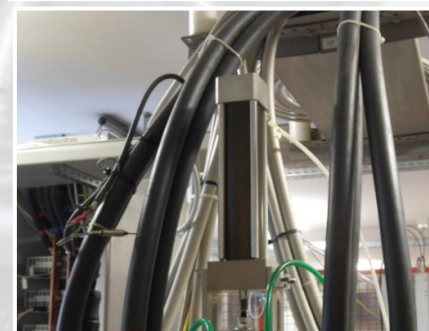
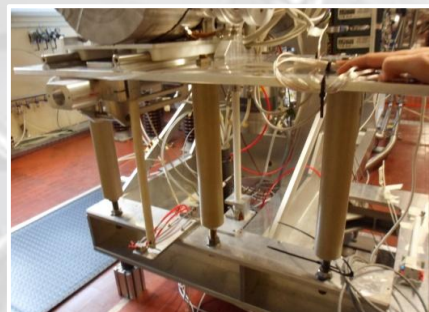
40 MeV protons
200 mA, 8 kW

7 discs
 $^{238}\text{UC}_x$

HV 40 kV



Highly radioactive environment
intense neutron and photon fields



Orings, Lubricants, Insulators,
Cables, Optical Fibers, Motors

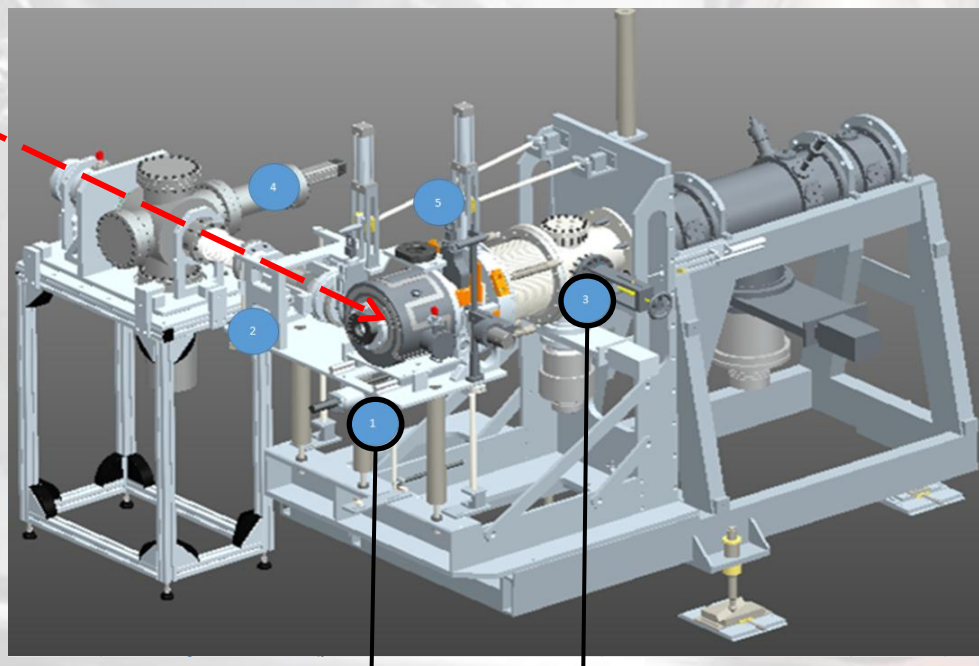
Elastomeric O-rings irradiation and testing campaign:

- *Forum Materiali INSTM 2016, Ischia* [Oral presentation]
- *Società Italiana di Fisica 2016, Padova* [Oral presentation]

Rad-hard Tests of Critical Components in the SPES Front-End

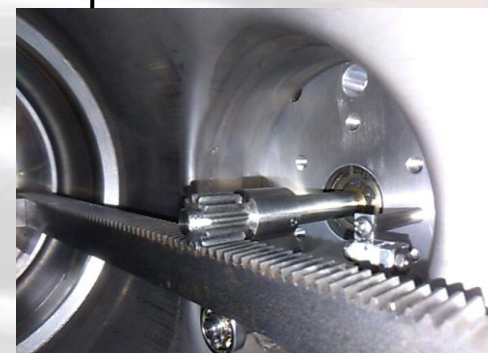
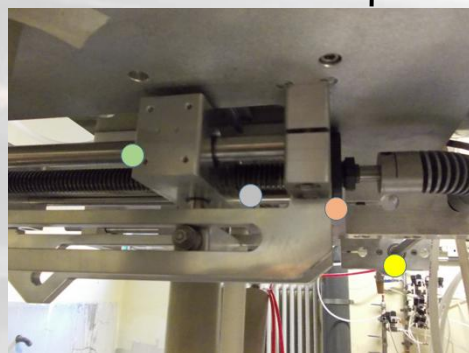
Lubricant greases
crucial for automatic
handlings:

1. TIS coupling
2. Proton tube coupling
3. Puller system
4. Diagnostic boxes
5. VAT valves system



The most radiation sensitive
except elastomers

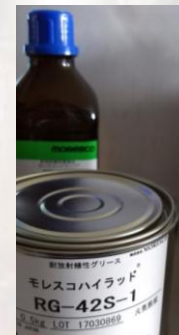
New protocol
to be developed



Development of an experimental Protocol for Oils and Greases Irradiation and Testing

1_ MARKET RESEARCH: wide selection of products

- Rad-hard (tested with photon fields) vs general purpose
- Vacuum and high load products
- ✓ Several interested companies: 22 giveaway samples



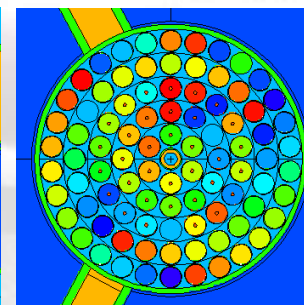
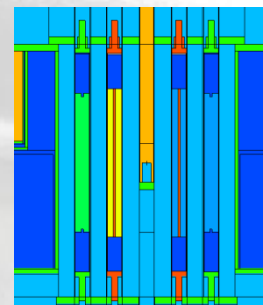
2_ MECHANICAL QUANTITIES/INSTRUMENTATION

- Viscosity for liquid oils [Viscometer]
- Consistency for semi-solid greases [Penetrometer]
- ✓ Instruments purchased & installed at LENA



3_ DOSIMETRY CALCULATIONS - MCNP:

- Neutron doses - LENA Reactor Central Thimble



Development of an experimental Protocol for Oils and Greases Irradiation and Testing

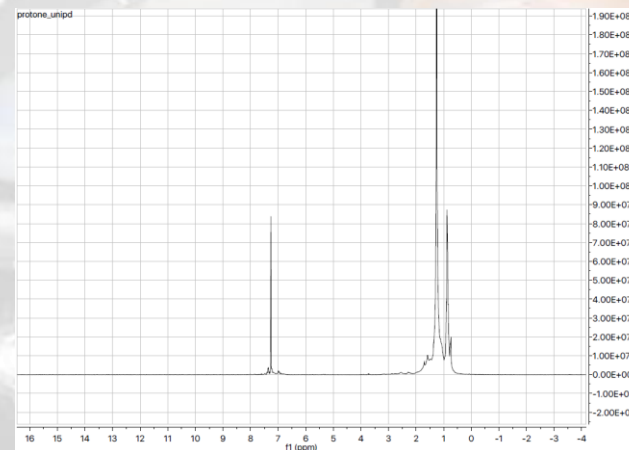
4_ PRELIMINARY TESTS:

- Composition (CHN analysis)
- Neutron Activation Analysis
- Radiation induced Gas Evolution (**critical amount**)
- Acid level of the developed gas (pH, **critical**)
- NMR analysis
- Cone-plate viscosity measurements



5_ CENTRAL THIMBLE IRRADIATION

- Customized Set-up (syringe + piston)
- First irradiation, 1h in C.T. (0.9MGy)
- Irradiation campaign ongoing



Cooperation with the European Spallation Source financing a PhD fellowship (Matteo Ferrari) at the Mechanical and Industrial Engineering Department of UniBs

SPES Front-End Activation and Radiation Protection Calculations with MCNPX+CINDER

Neutron and proton-induced activation on the Front-End components

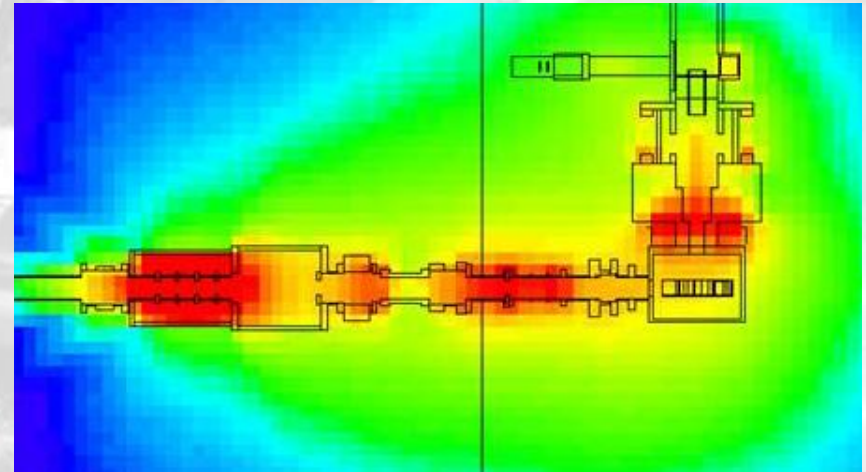
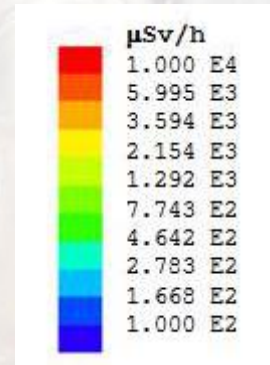
Implemented strategies for dose reduction

- Shielding for scattered protons to reduce activation
- Material substitution (e.g. steel is avoided when possible)
- Lead shield for collimators

✓ Dose rates reduced to acceptable levels for maintenance and inspection planned procedures

➤ Ongoing improvements

- More realistic beam description



Dose Rates after 1 year of operation + 15 cooling days
SPES Front-End model realized with MCNPX

SPES-Note-WPB06_04_0004

A residual activation Study on the SPES Front-End: Dosimetry and Radiation Protection Calculations

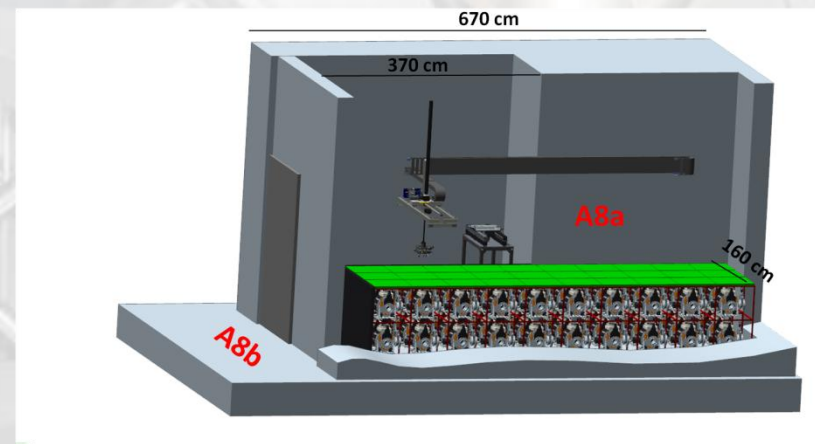
TIS Units Activation and Dosimetry Calculations for SPES Storage Site with FLUKA

Temporary Repository for the exhausted Activated TIS units

Automatic handling + 5 years cooling period

Dosimetry Calculations for **Storage Design**:

- TIS positioning – dynamic use
- Material choice for shielding (lead + concrete)
- Shielding thickness definition
- Door design for vehicle entrance
- Strategies to reduce doses



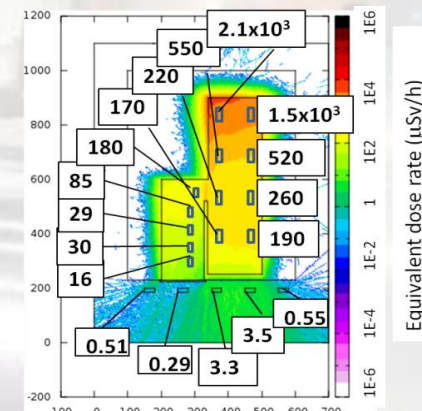
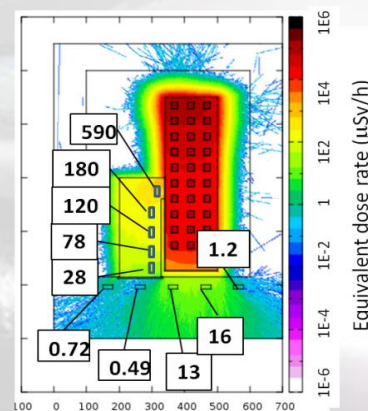
➤ Dose rates

✓ $< 100 \mu\text{Sv/h}$ vehicle access corridor A8a

✓ $< 15 \mu\text{Sv/h}$ external corridor A8b

➤ Strategies for dose reduction in the site

Additional internal shielding



SPES Internal Report – 10/05/2017 [Draft]

Simulazione con codice Monte Carlo Fluka del deposito temporaneo di TIS unit attivate provenienti dal Front-End di SPES, allo scopo di calcolare l'equivalente di dose ambientale nei punti di accesso del personale in prossimità dell'area