Active Project (2015 - 2015)

# Online Simulation of Radiation Track Structure Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)

## ABSTRACT

Space radiation comprises protons, helium and high charged and energy (HZE) particles. High-energy particles are a concern for human space flight, because they are no known options for shielding astronauts from them. When these ions interact with matter, they damage molecules and create radiolytic species. The pattern of energy deposition and positions of the radiolytic species, called radiation track structure, is highly dependent on the charge and energy of the ion. The radiolytic species damage biological molecules, which may lead to several long-term health effects such as cancer. Because of the importance of heavy ions, the radiation community is very interested in the interaction of HZE particles with DNA, notably with regards to the track structure. A desktop program named RITRACKS was developed to simulate radiation track structure. The goal of this project is to create a web interface to allow registered internal users to use RITRACKS remotely.

## ANTICIPATED BENEFITS

### To NASA funded missions:

There are many NASA funded investigators that are doing ground experiments using HZE particles, which need to know the track structure to help them optimize beam selection or design experiments to reduce radiation uncertainty and develop countermeasures. However simulation of radiation track structure is difficult and require significant expertise. The program RITRACKS provides track structures to investigators who don't have this expertise. The existing desktop version of RITRACKS is able to do that, but a web-based version could be more practical for users by allowing them to access detailed track structure information remotely, which would help them design their experiments.


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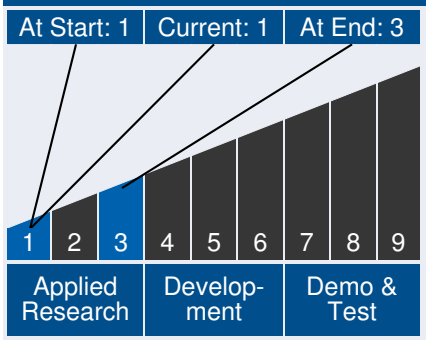
### Technology Maturity




### Management Team

**Program Director:**

- Douglas Terrier

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**To NASA unfunded & planned missions:**

Astronauts in NASA unfunded and planned missions will also be exposed to space radiation. The project is relevant to them as well.

**To other government agencies:**

Government agencies dealing with ionizing radiations may be interested by this project as well. One example of government agency is the Nuclear Regulatory Commission. In nuclear reactors, the interaction of the radiation with water of the cooling system lead to the formation of radiolytic species that interact with the components of the reactor, leading to corrosion in the components of the system. To provide a better understanding of the radiation interactions may help to mitigate this problem. The Armed Force Radiobiology Institute, which is developing countermeasures to radiation injury, may also be interested.

**To the commercial space industry:**

Astronauts using commercial space flights will also be exposed to space radiation. The project is relevant to them as well.

**To the nation:**

In addition to their importance in space radiation, ions have demonstrated important advantages over conventional X-ray or Gamma-ray radiation currently in use for medical radiotherapy. One major advantage is the possibility to get more control over the dose delivered to tumors. These ions may also be more effective than conventional radiation in killing cancer cells. Therefore many ions therapy centers are being build. Researchers in radiotherapy might benefit from the online version of the code.

## DETAILED DESCRIPTION

During a Mars mission, astronauts are expected to be exposed to ionizing radiations for many months. Space radiation differs

### Management Team *(cont.)*

**Program Executive:**
- Douglas Terrier

**Program Manager:**
- Ronald G Clayton

**Project Manager:**
- Ianik Plante

**Principal Investigator:**
- Ianik Plante

significantly from radiation commonly used on Earth for medical usage, so that their health effects are poorly understood. There are many NASA funded investigators that are doing ground experiments using HZE particles, who need to know the track structure to help them optimize beam selection or design experiments to reduce radiation uncertainty and develop countermeasures. However simulation of radiation track structure is difficult and require significant expertise. The program RITRACKS provides track structures to investigators who don't have this expertise. The existing desktop version of RITRACKS is able to do that, but a web-based version could be more practical for users by allowing them to access detailed track structure information remotely, which would help them design their experiments.

The first step will be to get access to the NASA development server. The technology basically requires five parts: 1) to set up a database of users on a server; 2) a web page with scripts to allow access to registered users (access control); 3) a web page to input simulation parameters; 4) scripts to execute RITRACKS on a server; 5) web pages to display results, including a 3D visualization interface. Most scripts will be written in the web language PHP. The visualization interface will be using WebGL, which is the web-based version of the well know visualization language OpenGL This funding is requested mostly to demonstrate the feasibility of this project.

The product deliverable will be a web-based version of the code RITRACKS. Each user will have its own account and will be able to save track structure simulations. Simulation results such as the radiation Linear Energy Transfer (LET) and calculations of the radial dose will be shown. An important part of RITRACKS is the 3D visualization interface, which will also be implemented. Following calculations, the user will be able to download the track structure information and the track image.

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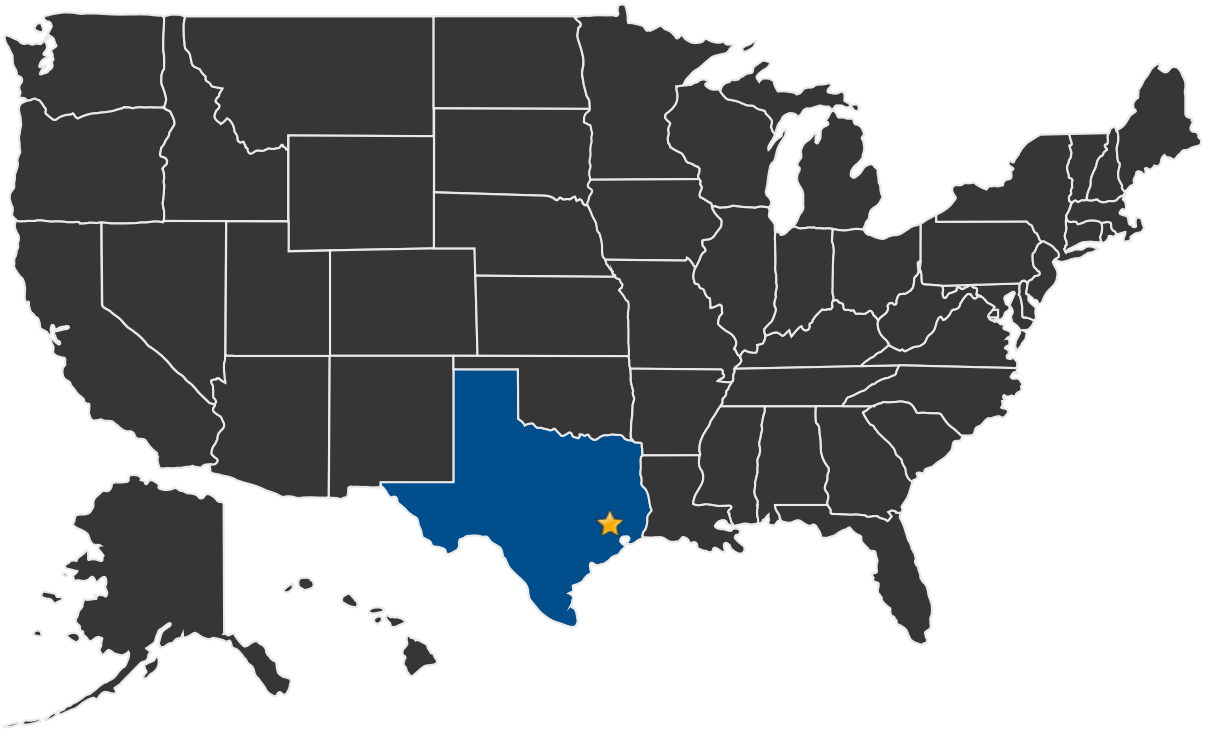
## U.S. LOCATIONS WORKING ON THIS PROJECT



U.S. States With Work

**Lead Center:**
Johnson Space Center

**Other Organizations Performing Work:**

- Wyle Science, Technology and Engineering Group

**Contributing Partners:**

- Wyle Science, Technology and Engineering Group

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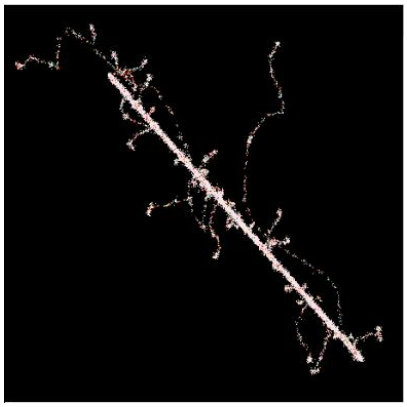
## IMAGE GALLERY



*Carbon ion track, 10 MeV/u*

## DETAILS FOR TECHNOLOGY 1

### Technology Title

Online simulation of radiation track structure

### Technology Description

This technology is categorized as a software compiler for engineering, design, modeling, or analysis

The stochastic simulation of ionizing radiation track structure require specialized programs and expertise. This technology will allow users to have access to the track structure simulation program RITRACKS (Relativistic Ion Tracks) from a remote web location, without the need to download or install a program.

### Capabilities Provided

This technology will allow users to generate stochastic radiation track structures on a web server from a remote location. The web interface will give capabilities similar to those of the original desktop version of RITRACKS. An important part is the visualization interface, which will be done by using new web browser capabilities.

Because the users will have to go through a registration process, it will be possible to have a better control over the users than via the release of a downloadable version of the software.

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## Potential Applications

This techonology may be of interest for scientists working with heavy ions to help them design experiments. Those that should be the most interested are those working with particle accelerators and those doing research in ion radiotherapy.