



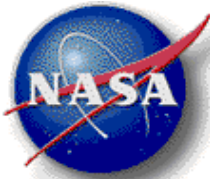
Overview of Graphical User Interface for ARRBOD (Acute Radiation Risk and BRYNTRN Organ Dose Projection)

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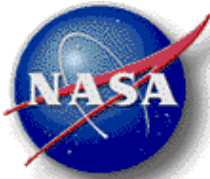
Brief Overview

- ❑ Acute Radiation Risk (ARR) and BRYNTRN with SUMDOSE codes are developed at NASA JSC.
- ❑ BRYNTRN is a Baryon transport code with an output data processing module of SUMDOSE written in FORTRAN; and ARR in C.
- ❑ A future version to estimate cancer risks will use FORTRAN/C++.
- ❑ The risk models (Organ dose, ARR, & Cancer) take the output from BRYNTRN as input for the calculations.
- ❑ BRYNTRN code operation requires extensive input preparation.
 - With GUI to handle input and output for BRYNTRN, the response models can be connected **easily** and **correctly** to BRYNTRN in **friendly** way.



Objectives

- Support of mission/spacecraft design and operational planning to manage radiation risks in space missions.**
- NASA trade studies of mission scenarios, shielding materials, masses and topologies for protection of astronauts from space radiation.**
- Proper shielding solutions to avoid ARR symptoms and to stay within the current NASA Dose limits.**
- Quantified evaluation of dose and ARR severity to guide alternative solutions for the determined objectives set by mission planners.**



Complexity and Innovation

- The integration of risk projection models of organ doses and acute radiation risk has been a key problem for human space applications.
- Baryon transport (BRYNTRN) code operation requires extensive input preparation.
- Only a graphical user interface (GUI) can handle input and output for BRYNTRN to the risk response models easily and correctly in friendly way.
- A GUI for the Acute Radiation Risk and BRYNTRN Organ Dose (ARRBOD) projection code provides seamless integration of input and output manipulations, which are required for operations of the ARRBOD modules: BRYNTRN, SUMDOSE, and the ARR probabilistic response model.
- A proof-of-concept for future integration of other risk projection models for human space applications.



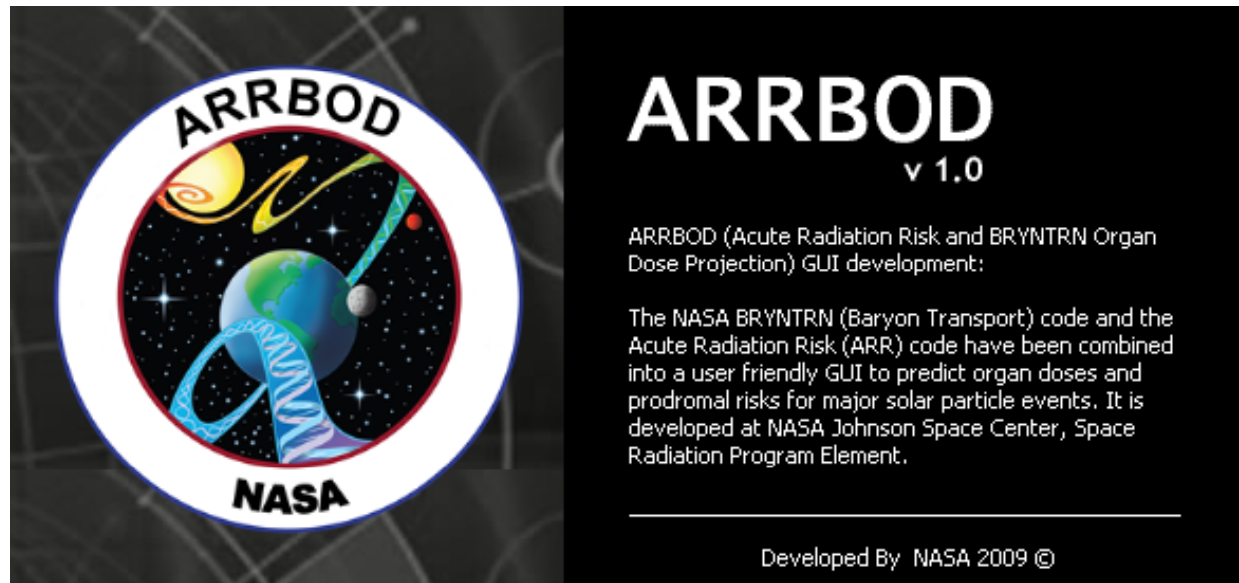
Applicability

- Mission and spacecraft designers**
- Aerospace engineers**
- Space operations in the Mission Operations Directorate (MOD)**
- Space biophysicists**

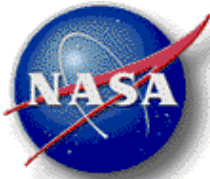


Release History

- ❑ **Beta version released to the testers in May 2009.**
- ❑ **Version 1 released to US citizens and ISS partner nations in March 2010.**



- ❑ **NASA TP-2010-216116 distributed to the managers and researchers at NASA centers and to the researchers at US academia/research institutes in March 2010.**



Development of Graphical User Interface for
ARRBOD
(Acute Radiation Risk and BRYNTRN Organ Dose
Projection)

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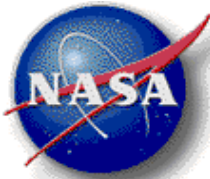
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Future Plans for Development and Use

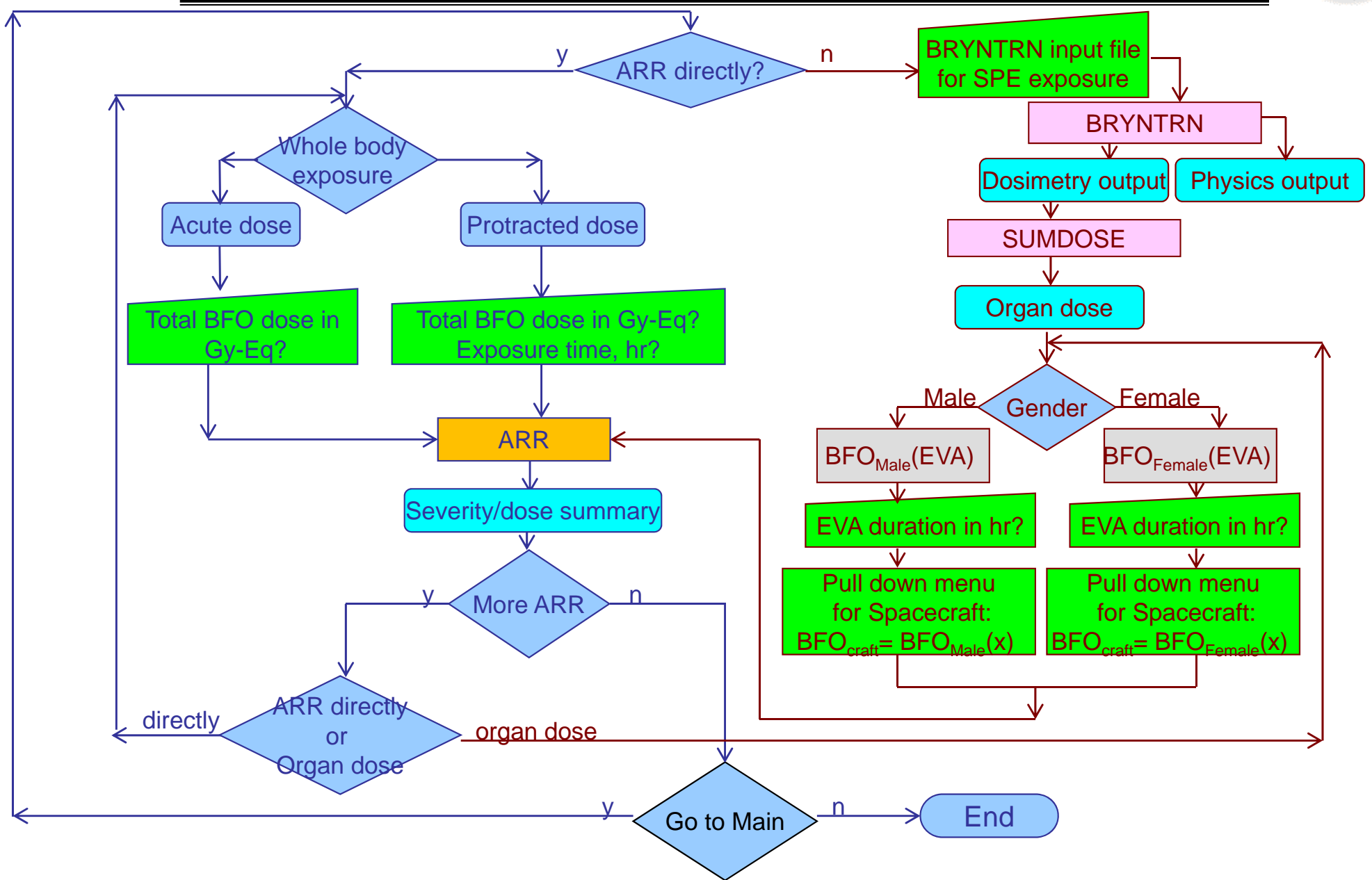
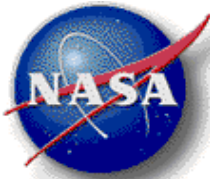


- Add functionalities**
 - Shield file supplied by user**
 - SPE spectra data files supplied by user**
- Add blood kinetics to ARR model.**
- Add cataract risk project based on NASA Study of Cataracts in Astronauts (NASCA) and NASA Space Radiation Laboratory (NSRL) data.**
- Add Probabilistic Risk Assessment (PRA) approach to SPE protection (Hazard function).**
- The deterministic method of ARRBOD to be evolved to GCR Event-based Risk Model (GERM) Space code for the description of time-dependent biophysical events with reduced uncertainty.**



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- Overall I/O Sequences of Risk Calculations**
 - Output of ARR Sickness Severity Levels**
 - Output of Organ Dose for SPE Exposure**
 - References**

Overall I/O Sequences of Risk Calculations



ARR Sickness Severity Levels



Severity level	Upper Gastrointestinal Distress (UG)	Fatigability and Weakness (FW)
1	No effect	No effect
2	Upset stomach, clammy and sweaty, mouth waters	Somewhat tired with mild weakness
3	Nauseated, considerable sweating, swallows frequently to avoid vomiting	Tired with moderate weakness
4	Vomited once or twice, nauseated, and may vomit again	Very tired and weak
5	Vomited several times, including the dry heaves, severe nauseated, and will soon vomit again	Exhausted with almost no strength

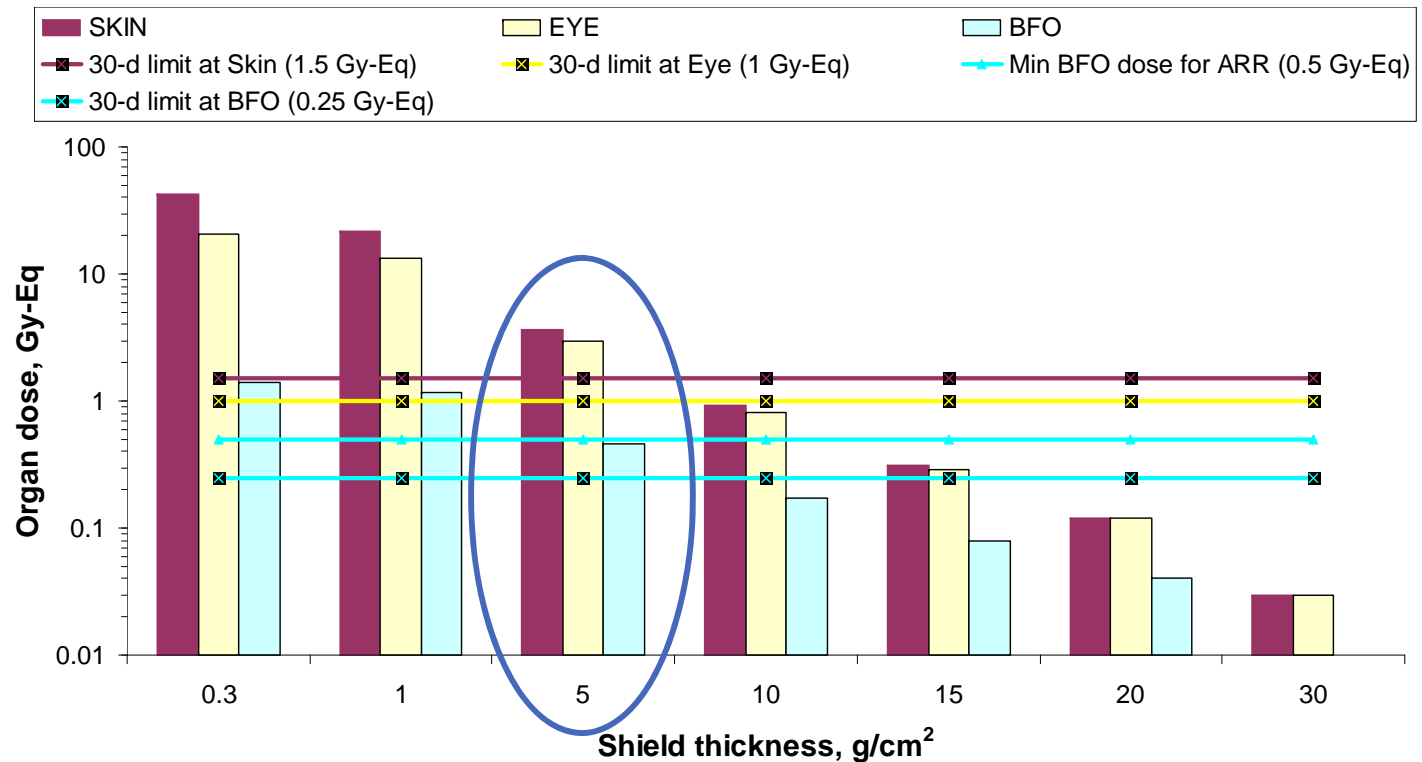


NASA limit for organ dose BRYNTRN/SUMDOSE Output

Exposure limit by NASA*	Organ dose, Gy-Eq
30-d limit at Skin	1.5
30-d limit at Eye	1.0
30-d limit at BFO	0.25
Min BFO dose for ARR	0.5

*National Research Council/National Academy of Sciences (NRC/NAS), Committee on the Evaluation of Radiation Shielding for Space Exploration. *Managing space radiation risk in the new era of space exploration*, the National Academies Press; 2008.

1972 King SPE, Male



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