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Sierra/SD – Its2Sierra – User's Manual – 5.18

Sierra Structural Dynamics Development Team

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ABSTRACT

The Integrated Tiger Series (ITS) generates a database containing energy deposition data. This data, when stored on an **Exodus** file, is not typically suitable for analysis within **Sierra Mechanics** for finite element analysis. The **its2sierra** tool maps data from the ITS database to the **Sierra** database.

This document provides information on the usage of **its2sierra**.

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Acknowledgments

The **Sierra/SD** software package is the collective effort of many individuals and teams. A core Sandia National Laboratories based **Sierra/SD** development team is responsible for maintenance of documentation, testing, and support of code capabilities. This team includes Dagny Beale, Gregory Bunting, David Day, Clark Dohrmann, Payton Lindsay, Justin Pepe, and Julia Plews.

The **Sierra/SD** team also works closely with the Sierra Inverse and Plato teams to jointly enhance and maintain several capabilities. This includes contributions from Ryan Alberdi, Wilkins Aquino, Brett Clark, Sean Hardesty, Clay Sanders, Chandler Smith, Adam Sokolow, Benjamin Treweek, Timothy Walsh, and Ray Wildman.

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Historically dozens of other Sandia staff, students, and external collaborators have also contributed to the **Sierra/SD** product and its documentation.

Many other individuals groups have contributed either directly or indirectly to the success of the **Sierra/SD** product. These include but are not limited to;

- Garth Reese implemented the original **Sierra/SD** code base. He served as principal investigator and product owner for **Sierra/SD** for over twenty years. His efforts and contributions led to much of the current success of **Sierra/SD**.
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1. INTRODUCTION

The Integrated Tiger Series (ITS) generates a database containing energy deposition data. This data, when stored on an **Exodus** file, is not typically suitable for analysis within **Sierra Mechanics** for finite element analysis. The **its2sierra** tool maps data from the ITS database to the **Sierra** database.

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2. COMMAND LINE

its2sierra is a command line tool to be run on a single process (serial execution). **its2sierra** requires the user to provide a valid Exodus file containing 'EDEP' and 'VOL' element variables. An Exodus file for the Sierra mesh is also required, as is an input file for the tool. A new Exodus containing the Sierra mesh with ITS element data is created.

The **its2sierra** tool is executed as:

```
its2sierra itsfile.exo inputsierra.exo outputsierra.exo its2sierra.inp
```

where

- **itsfile.exo** is the output file from an ITS run. It must contain EDEP and VOL element data.
- **inputsierra.exo** is an Exodus mesh suitable for FEA in Sierra-SD or Sierra-SM.
- **outputsierra.exo** is an Exodus mesh with the same mesh/geometry as inputsierra.exo, but with the EDEP from itsfile.exo.
- **its2sierra.inp** is an input file as described in Section 3.

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3. THE INPUT FILE

The **its2sierra** input file is used to specify mapping (sets of) blocks of elements between the ITS mesh and the Sierra mesh. Each section of the input file specifies an ITS block (or set of blocks) for which energies are mapped to a Sierra block (or set of blocks). Other parameters can be used to specify how that mapping is done. Table 3-1 lists the options in each block, and their defaults. Each section of the file begins with the keyword 'ITSBlocks' and ends with the keyword 'END'. Arbitrary numbers of sections may exist, and the text parsing is upper/lowercase agnostic.

Keyword	Purpose
ITSBlocks	Begins a section of its2sierra input. Lists ITS blocks to be used in this set
Mapping	Type of mapping to be used in this set Default = Blockwise 4.1 Option = Nearest_Neighbor 4.2
Sierra_Blocks	Lists Sierra blocks to be used in this set
Scale_Energy	Scales energy in the sierra mesh by this number Default = 1
Scale_Mesh	Scales the mesh geometry of the ITS mesh by this number Default = 1
itsBB	ITS bounding box length multiplier for nearest_neighbor mapping Default = 10
sierraBB	ITS bounding box length multiplier for nearest_neighbor mapping Default = 10
integration_point	Write energy data to Sierra integration points. Cannot be used with the keyword 'centroid'.
centroid	Write energy data to Sierra element centroids. Cannot be used with the keyword 'integration_point'.
END	Ends a set of ITS blocks

Table 3-1. – Input options for the `its2sierra` input file. Keywords and default values are given.

A sample input file is given in Figure 3-1.

```
// its2sierra input file example
itsblocks = 1 3 7
        mapping = nearest_neighbor
        sierra_blocks = 2 4 8
        scale_energy = 1
        scale_mesh = 0.0254 #Convert units of ITS mesh
        itsBB = 20
        sierraBB = 10 #Same as default
        integration_point
end

// Second input section
itsblocks = 2
        mapping = blockwise
        sierra_blocks = 3
        scale_energy = 1
        scale_mesh = 0.0254
        centroid
end
```

Figure 3-1. – Sample input file for `its2sierra`. The Sierra mesh consists of four blocks numbered $\{2, 3, 4, 8\}$. The ITS mesh has four blocks numbered $\{1, 2, 3, 7\}$. Comments are specified with either '//' or '#'.

4. THEORY

4.1. Blockwise Algorithm

The 'blockwise' algorithm assigns a uniform energy density to Sierra mesh. As such, it does not preserve *any* gradient information. The total energy (sum of density × volume) of all ITS blocks in the input section is distributed uniformly to the Sierra blocks listed in the section. The destination blocks in the structural mesh are all assigned the same energy density, determined from their total volume to conserve energy.

4.2. Nearest Neighbor Algorithm

For each Sierra output point location (centroids or integration points), the 'nearest neighbor' (NN) algorithm finds the nearest ITS data point and maps the energy directly (no interpolation). The nearest neighbor search is done using axis aligned bounding boxes. The length of each side of the bounding boxes defaults to 10 times the cube root of the element volume, or $10\,V^{1/3}$. The factor of 10 can be changed in the input file through the parameters `itsBB` and/or `sierraBB`.

4.3. Energy conservation

It is important that the total energy of the ITS mesh is conserved when transferred to the Sierra mesh. **its2sierra** computes a scaling factor that is applied to the mapped energy on the Sierra mesh. The scaling factor is applied after the mapping is complete to ensure energy conservation. The closer the scaling factor is to unity, the better the energy transfer between meshes.

4.4. Diagnostic information

4.4.1. Energy scaling

Energy scaling information is written to both standard output and the file 'EnergyScalingStatistics.txt'.

4.4.2. ITS data point usage

The file ‘itsUsageStatistics.txt’ archives a list of ITS block numbers and element numbers for which the energy input was not used in the mapping to the Sierra mesh.

5. EXAMPLE

Figure 5-1 depicts an ITS mesh (20 node hexahedrons) with EDEP data. **its2sierra** is run with the input file specified in Figure 5-2. The Sierra mesh consists of quadratic wedge and hex elements. The mapped energy is show on the wedge and hex elements in Figures 5-3 and 5-4, respectively.

For further information see the SierraSD Design Manual.

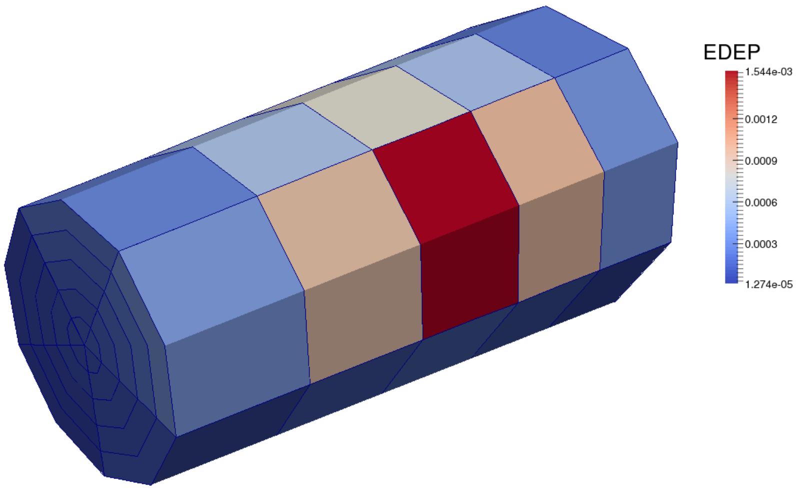

Figure 5-1. – ITS model with EDEP energy.

```
// its2sierra input file example
itsblocks = 1
        mapping = nearest_neighbor
        sierra_blocks = 1 2
        scale_energy = 1
        scale_mesh = 1
        integration_point
end
```

Figure 5-2. – **its2sierra** input file for a single ITS block of Hex20 elements. The Sierra mesh consists of two blocks: Hex20 elements and Wedge15 elements. Nearest neighbor mapping is used, and data is output at the integration points.

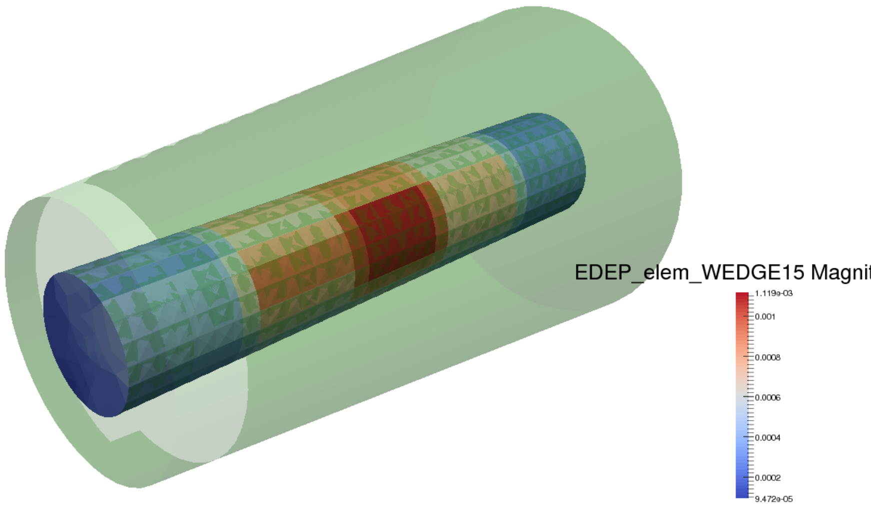

Figure 5-3. – Wedge15 elements in the Sierra model with mapped ITS energy.

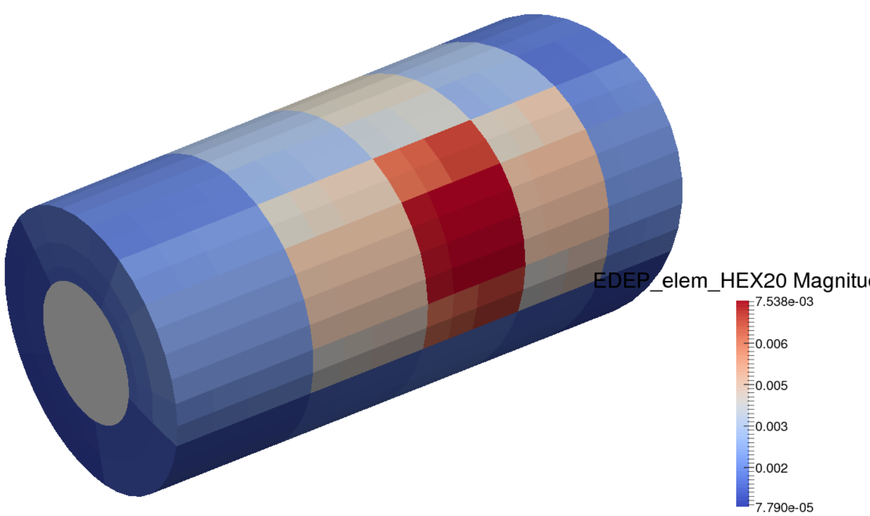

Figure 5-4. – Hex20 elements in the Sierra model with mapped ITS energy.

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