SCORED – SpaceCraft Object Risk Evaluation Database

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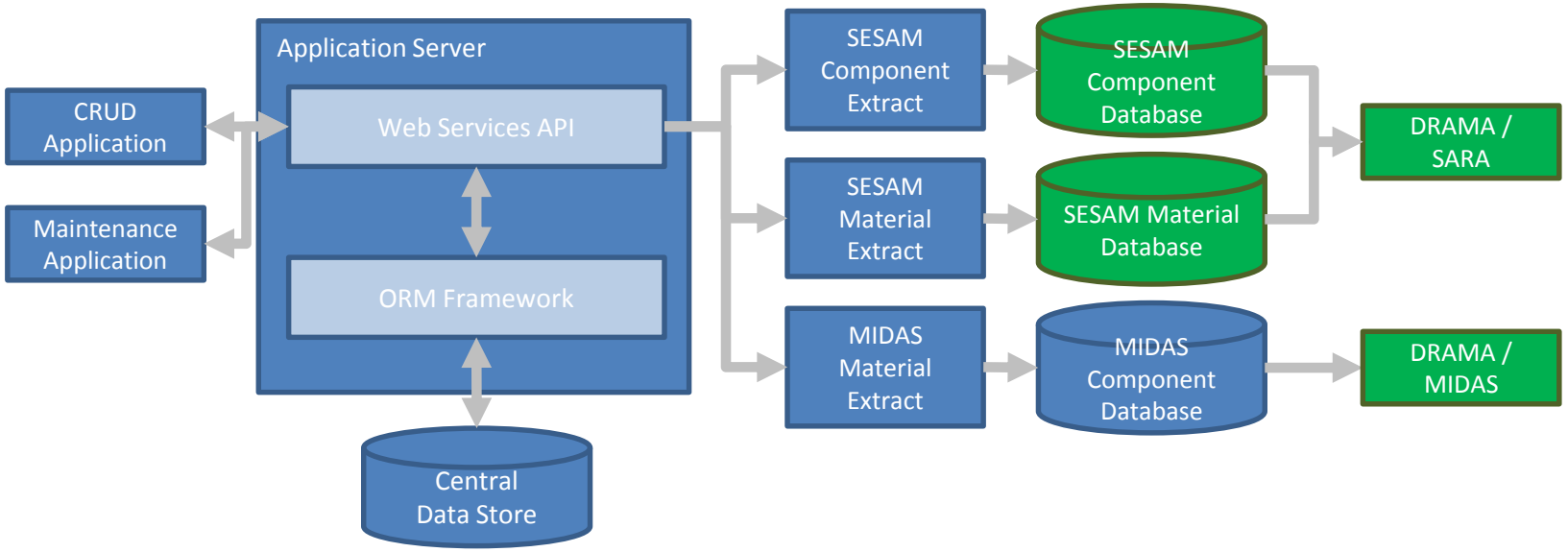
Objectives

- Improvement of Space Debris Risk Methodologies
  - Database of recommended models
    - Material level, component level, uncertainties
    - High current dependence on modeller
- Destructive Re-entry Analyses
  - How to model components for ground casualty risk assessment?
  - Database contains recommended material models
  - Database will contain standard models for specific components
    - Reaction wheel model has been derived for DRAMA / SAMj
    - Thruster model will be developed in this work
- Hypervelocity Impact Analyses
  - How to model the stack?
  - Database will contain standard models for specific components
    - Electronics box penetration
    - Harness (at a distance from panel)
    - Harness (connected to panel)

Three Tracks

Software	Flexible Database Model Export Functionality
Destructive Re-entry	Materials Database Components Database
Hypervelocity Impact	Materials Database Components Database

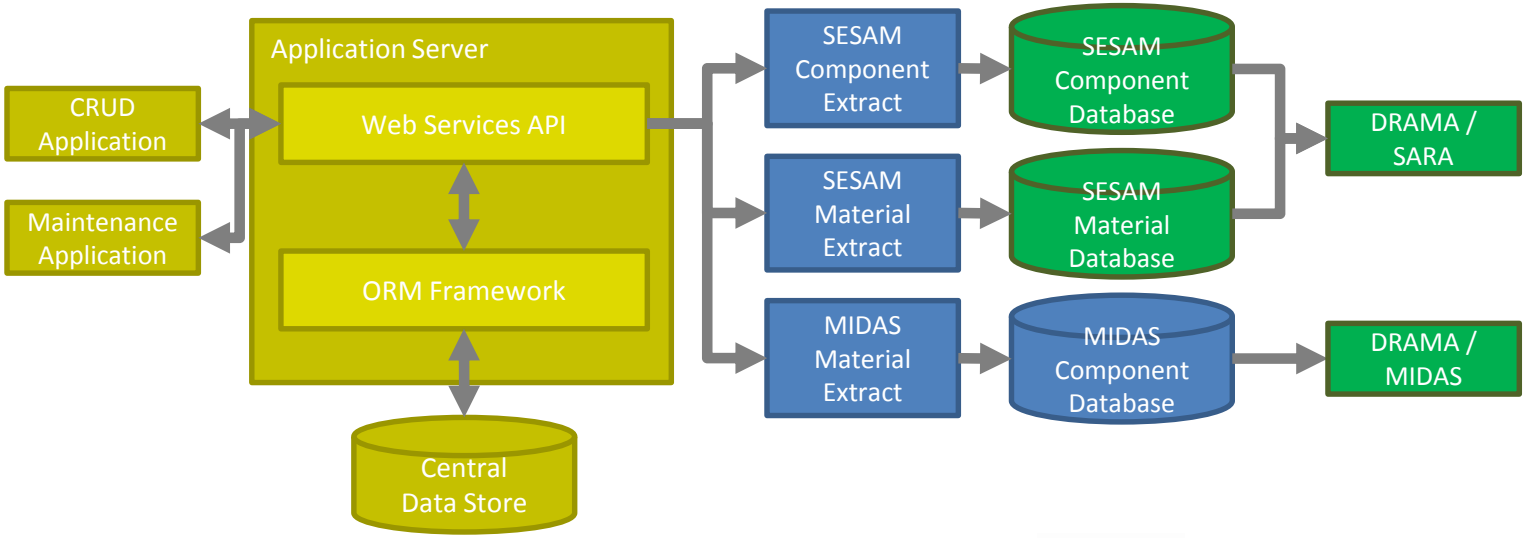
Software



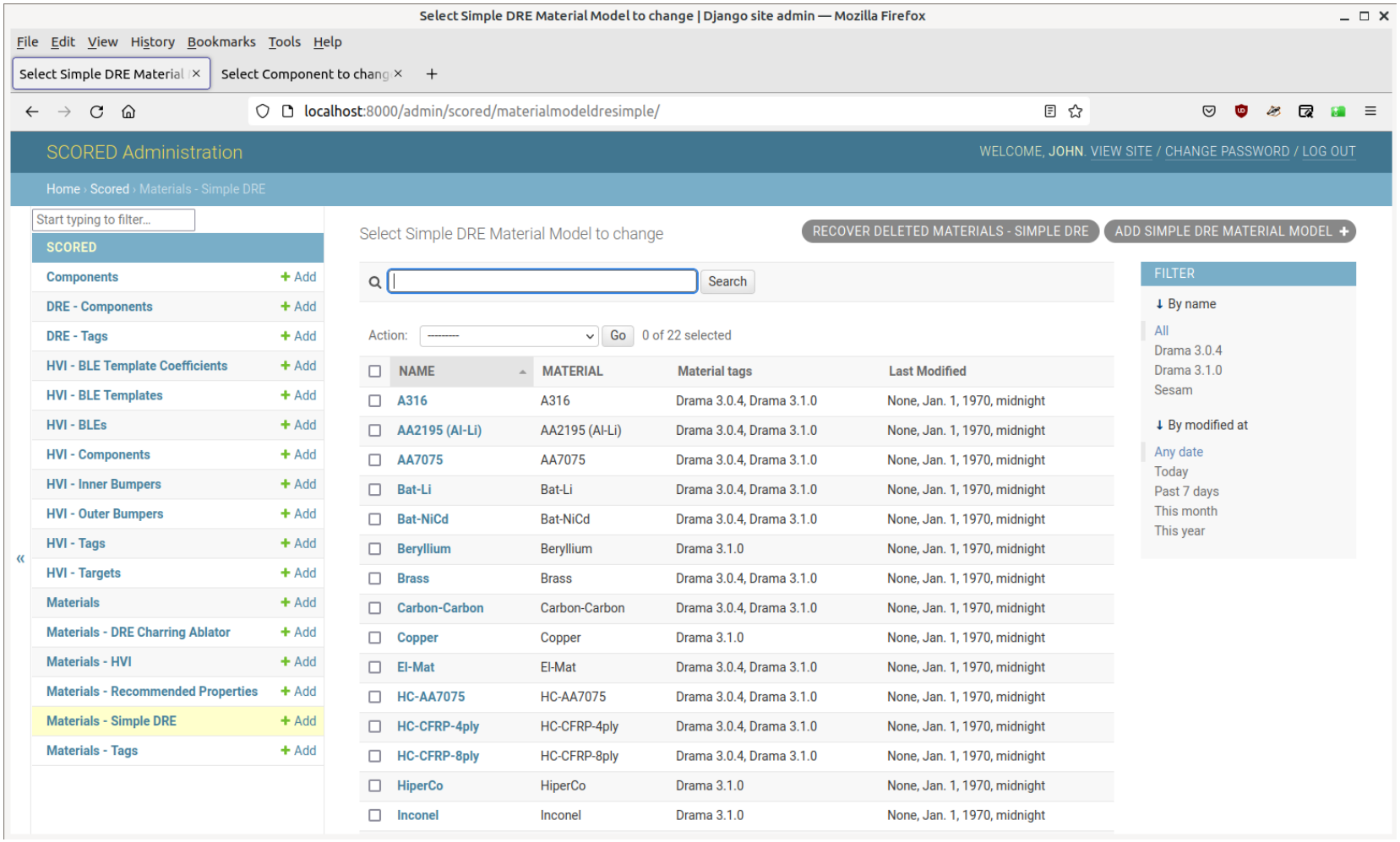
- Data is Planned to be Beyond DRAMA…
  - Database entry is not restricted to DRAMA capability
    - Written to be able to incorporate new findings from testing/research
  - Data can be used / Extractors can be written for more complex software
    - SAMj (destructive re-entry)
    - PIRAT (hypervelocity impact)

Software - Django

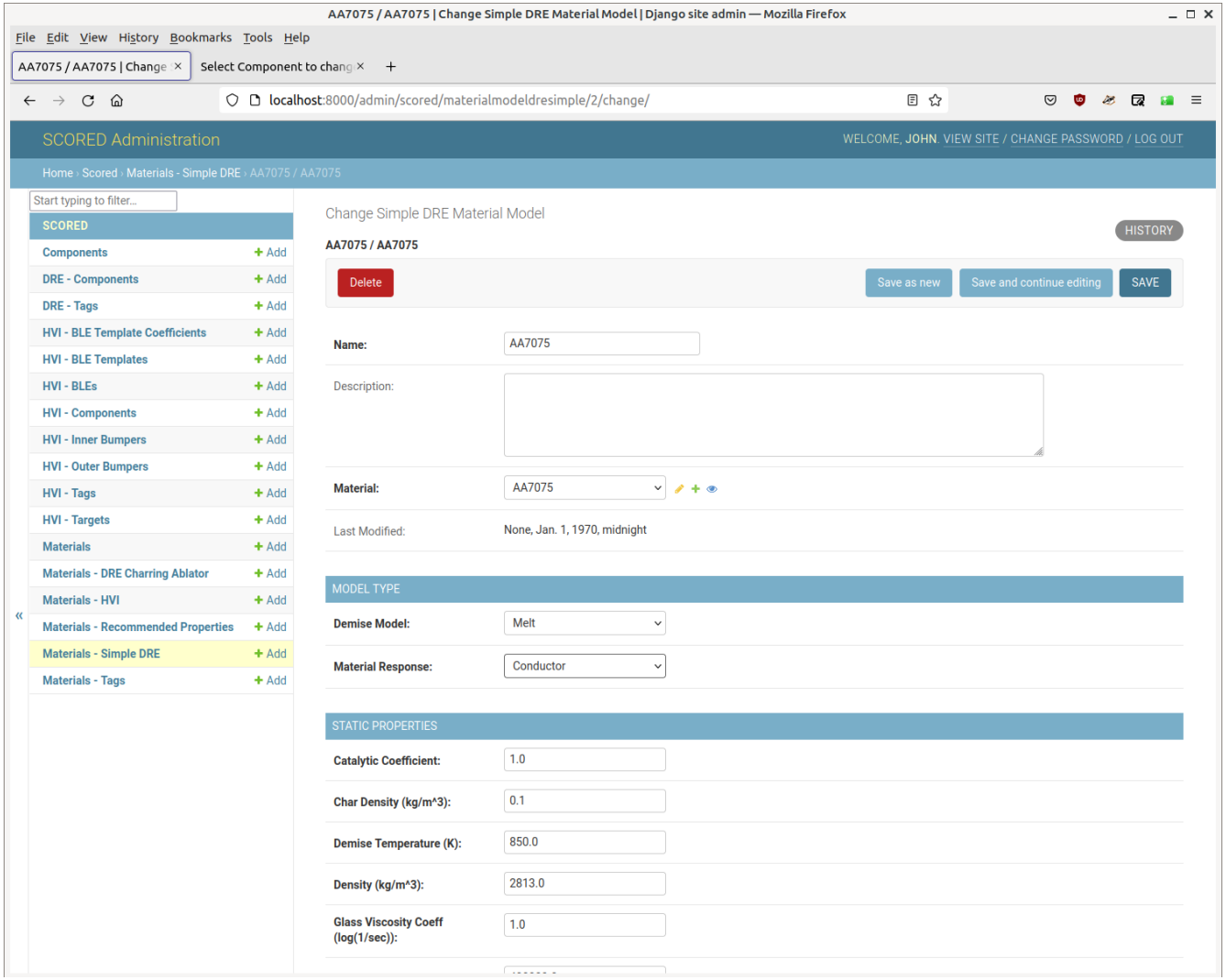
- Database agnostic RDBMS interface
  - Supports MariaDB, MySQL, Oracle, PostreSQL, SQLite
- Object Relational Mapping
- Simple form based CRUD application
- Simple form based housekeeping application
- Web Services API



Software - Django

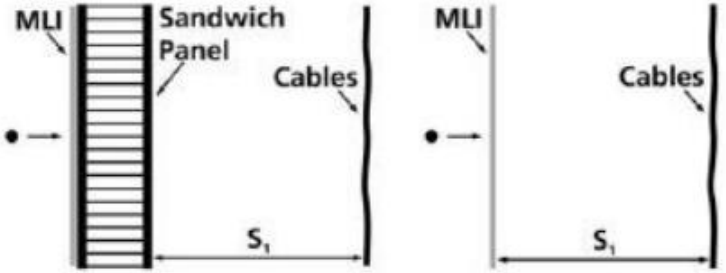


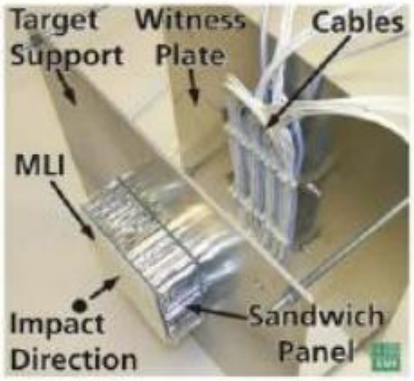
Software - Django



Hypervelocity Impact

- HVI effect is based on Ballistic Limit Equations (BLEs)
  - Range of existing BLEs
  - Selection is important
  - Database output will guide the user on which BLE
    - Selection of coefficients for component type
    - Use of parameters
    - Validity ranges
- Model for Harness to be Developed
  - Some data exists on harness impact at a distance from a wall





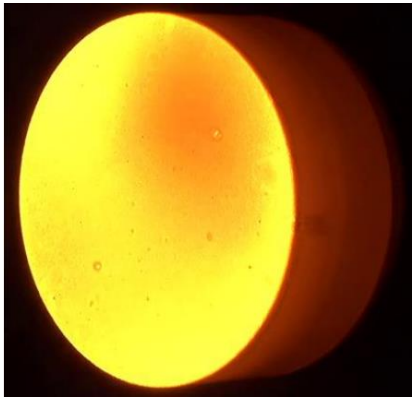
Hypervelocity Impact

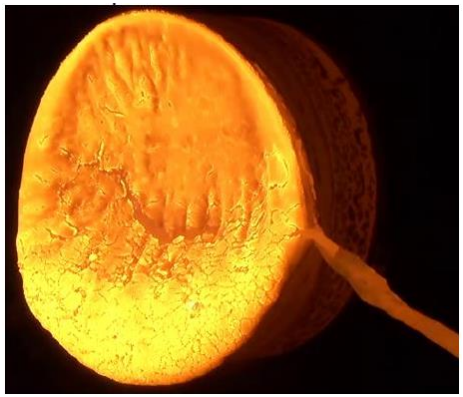
- Harness Model
  - Initial model for impact at a distance from wall to be constructed
  - Hydrocode simulations (FGE EDEN tool) to rebuild
  - Apply EDEN to case of harness attached to panel
  - Combined BLE to be constructed
- Implementation into Database
  - Demonstration of process of creating a database entry

Destructive Re-entry

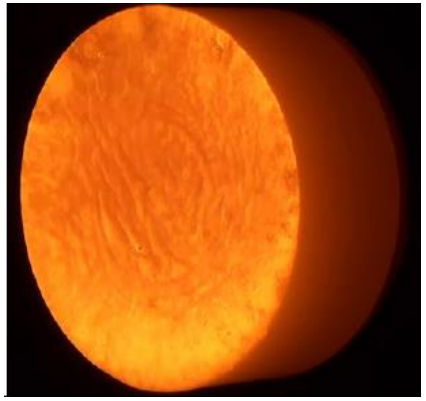
- Development of Thruster Model
  - Scrap 1N thrusters obtained from ArianeGroup
  - Plasma wind tunnel test campaign
    - Material testing
      - Haynes 25
      - Inconel 718
    - Parts testing
    - Mock-up nozzle testing to understand scaling
    - Complete thruster testing
- First Campaign Complete
  - Analysis ongoing

Destructive Re-entry



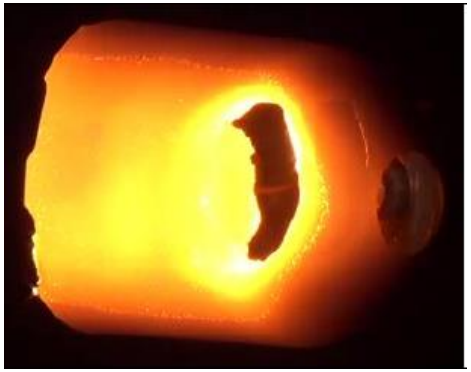


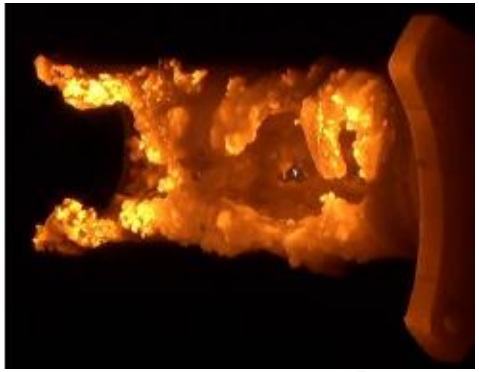
- Haynes 25
  - Does not melt at melt temperature
    - Surface temperature >200^{0}C above
  - Very strong oxide layer
    - Insulates material, holds liquid inside
    - Had to go to maximum power in L2K to release melt
      - Much higher than expected
    - Melt model is not appropriate – proxy model required
    - Reasonably low catalycity material
- Inconel 718
  - Has strong oxide layer
  - Does melt when it is supposed to
    - Still high temperature
  - Existing models are reasonable
  - Emissivity is high (0.9)

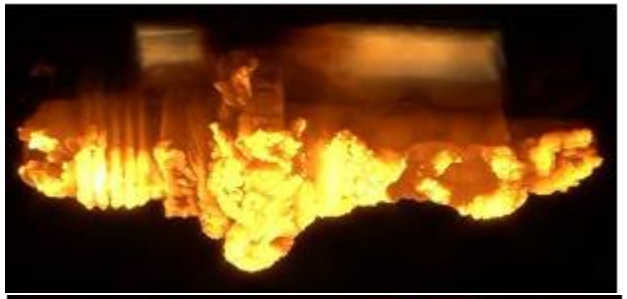


Destructive Re-entry

- Thruster Parts
  - Titanium tubing
    - Small radius – fast melt
    - Not major risk
  - Haynes 25 parts
    - Different behaviour for thin and thick material
      - Thin material tears at melt temperature
      - Thick material has thick protective oxide
    - Different models required
  - Very low demisability







Conclusions

- Spacecraft Object Risk Evaluation Database
  - Hypervelocity impact
  - Destructive re-entry
- Database
  - Based on Django / Python
- Hypervelocity Impact
  - Models for electronics boxes
  - New models for harness
- Destructive Re-entry
  - Existing models
  - New models for thruster
    - New test-validated material models for Haynes 25 and Inconel 718