

## 

**Kitware** 

#### Introduction to **OpenRadioss™** and ParaView

Marian Bulla François Mazen 8<sup>th</sup> of October 2024 - Director - OpenRadioss Community

- Director - Scientific Visualization

#### **Safe Harbor Statement**

This presentation and the accompanying oral commentary may contain "forward-looking" statements that are based on our beliefs and assumptions and on information available to us as of the date of this presentation. All statements other than statements of historical facts contained in this presentation, including statements regarding our future results of operations and financial position, customer lifetime value, strategy and plans, market size and opportunity, competitive position, industry environment, potential growth opportunities and our expectations for future operations, are forward-looking statements. The words "believe," "may," "might," "objective," "ongoing," "will," "estimate," "continue," "anticipate," "design," "intend," "expect," "could," "plan," "potential," "predict," "project," "seek," "should," "would" or the negative version of these words and similar expressions are intended to identify forward-looking statements. This presentation also contains non-GAAP financial measures. We have provided a reconciliation of such non-GAAP financial measures to the most directly comparable measures prepared in accordance with U.S. GAAP in the Appendix to this presentation.

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Democratizing Technology to Deliver More Power and Drive Better Decisions





### **Altair's Vision**

# **Computational intelligence** will drive innovation for a more connected, safe, and sustainable future



# Little bit of Theory... Implicit Method © Altair Engineering, Inc. Proprietary and Confidential. All rights reserved. $[K]{X_n} = \{F_{ext}(t_n)\}$ Cost (CPU) Implicit Explicit Complexity

Static / Elastic

Nonlinear Dynamic



#### Velocity

### **Explicit Flow Chart**

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7



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### INTRODUCTION TO RADIOSS



#### Little bit of History...

**ALTAIR** 



Source: Paul Du Bois: Presentation at the OpenRadioss Users meeting 2023 in Aachen (Germany)

### Little bit of History...

Industrial car crash simulations emerged in the mid 80<sup>th</sup> driven by a small community of talented enthusiasts that rapidly perceived the huge benefit to replace physical testing by computer simulations.

#### For instance, the first, worldwide, car to car crash simulation was run with Radioss in 1991.

With progress made on computer science, usage democratized and 30 years later, legacy codes like Radioss are extensively used for crash and impact in many industries, including automotive, defense, aerospace, railway, but also electronics and consumer goods, biomechanics...

# RADIOSS CRASH

Simulating Crash Reality... Now, with an Industrial Efficiency





#### Introducing OpenRadioss™

#### Altair® Radioss® simulation platform goes open source

Proprietary crash code development can no longer keep up with the rapid transformation in transportation industries.

#### **Our Vision**

- Accelerate innovation in the research community tremendous benefits consolidating activities around an industry proven code
- Maximize immediate synergy between leading edge research and industry frontiers
- Build a highly engaged and inclusive open-source community involving researchers, software developers, engineers, educators
- Facilitate knowledge and model exchange, enabling development of advanced safety and bio-medical models
- Ensure the future, advancing FEA technology and modernizing software platform



### **OpenRadioss – Accelerate Innovation**

#### **R&D** Collaborations in Strategic Domains

#### Materials and failure models

 Damage & materials models, for battery, glass, concrete, composite, tire, ...

#### **Biomechanics for Healthcare & Safety**

THUMS, Piper, Viva+, THOR

#### **Software Performance**

- Hardware, software & cloud providers
- AI and Machine Learning to speedup computation



Authors: Sahand Shamchi, Behzad V. Farahani, Marian Bulla, Stefan Kolling

Abstract:

Fluid-structure interaction of spherical pressure hull implosion in deep-sea pressure: Experimental and numerical investigati Link)

Published: 1 January 2024

Authors: Jiancai Zheng, Min Zhao



Abstract:

#### **OpenRadioss™** – The Open-Source Version of Radioss

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OpenRadioss on a Raspherry

Democratize usage of explicit dynamics, build an active community and accelerate innovation pace

Introduced 2 years ago...

	Country	Connections
	India	10
	United States	9,4
	China	4,1
C. ALL	Japan	22
	Germany	<b>( 7</b> 7
	Brazil	
	United Kingdom	
	Total	↑ 2

Fast growing since then!

GitHub.com/OpenRadioss statistics:

• 12000+ binary downloads

How to Install OpenRadioss . How to use OpenRadioss

Software-Development-Kit

from SourceCode for Linux.

250+ forks & 2500+ contributions, including 100+ code fixes

How to Install the

Development Tools n

How to Postprocess

OpenRedious Results - Part



How to use GitHub and the

OpenPadiore Repository

#### What is Radioss ?

Crash & Safety in Automotive

ALL DI



Safety barriers models:



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Safety dummy models:





#### Altair<sup>®</sup> Radioss<sup>®</sup> – Proven Crash & Impact Simulation Software



Large Scale Computing and Parallelization



**ALTAIR** 

### Altair<sup>®</sup> Radioss<sup>®</sup> & OpenRadioss<sup>™</sup> The Industry Standard Open Platform for Crash & Impact

C	)penRadioss™ Open-	Source Ver	sion A	Itair <sup>®</sup> Radioss <sup>®</sup> Commercial Version
•	Source code publicly accessible https://github.com/OpenRadioss Upstream version, with contribut worldwide community Precompiled Linux & Windows e builds with no license check Support from the community, via	from: ions from a fast-gro xecutables to run la forum	wing • • •test	Commercial releases with extensive QA, professional support, documentation and maintenance priority Available under Altair Units license Encrypted models for dummies & barriers Channels valuable community contributions into industrial release
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### Altair Radioss & OpenRadioss – /FAIL/SYAZWAN Example



#### **OpenRadioss**"

Implementation of a New Ductile Failure Surface Model and Damage Estimation of Stamped Parts based on Strain Histories

Mohd Syazwan Bin Abdul Samad | PhD Student | Universiti Tun Hussein Onn Malaysia

OpenRadioss Workshop | Meet'Up Paris | 22 November 2022

Altair <sup>®</sup> Radioss <sup>®</sup>	© → Referen	ce Guide + St	arter Input	Materials +	Failure M
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Example of SYAZWAN failure criterion fit

Originally developed in OpenRadioss

Released in Altair Radioss 2022.3



#### **OpenRadioss Users Day 2023**

OpenRadioss user meeting: FH Aachen, University of Applied Science: Aachen, June 27th, 2023



**OpenRadioss Technical Presentations** 

#### Archive of the event proceedings

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Biörn Adamski I CIO Managing Director, EMEA

Fast-track to OpenRadioss with Rocky Linux on Oracle Cloud



Dr. Robert Bollig | Cornelis Networks HPC Solution Architect

Delivering Leadership Performance with Open-Source Software: OpenRadioss™ and Cornelis™ Omni-Path Express™



Kang Zhao | Simright CEO

Input Format Conversion of OpenRadioss: Practice and Use Cases



Eric Leguiniou | Altair Senior Vice President, Radioss Development

Opening of The 2nd OpenRadioss Users Meeting



Prof. Dr.-Ing Peter Dahmann Prof. Dr.-Ing. Thilo Röth | FH Aachen University

Keynote Presentation: Todays FEM-Education at FH Aachen and living Altair-Cooperation



Vincent Dampure | Altair Product Manager, Crash

HyperWorks for Radioss Structural Impact and Vehicle Safety Applications



Daniel Campos Murcia | DatapointLabs **CAE Engineer** 

Beyond Standards: Material Testing and Processing for Successful Simulations of Foam Materials



Paul Du Bois Independent Engineer

Challenges in Material Modeling of Metals and Polymers



David Lecomber | ARM Senior Director, HPC

The Development of OpenRadioss Support for Arm (CMB)



Senior Consultant, Head of Business Development, MBSE

The Altair Environment



Technology Associate Professor Aerospace Structures & Materials

Design for Crashworthiness





Challenges and Current Developments Towards



Elham Sahraei | Temple University Associate Professor & Director of Electric Vehicle Safety Lab

Modeling Deformation and Failure of Lithium-ion Batteries Using OpenRadioss



Virtual Human Modeling for Health Applications

Director and Research Director

OpenRatioss | Users' Meeting | Aachen | 27 June 2023 Lukas Laarmann | FH Aachen Research Associate, Structural Design & Crash

Evaluation of eVTOL Crashworthiness using fullvehicle crash simulations



Audience : 150+ attendees (in-person + remote)

Dr. Axel Haenschke | CPS Consulting

End-to-End S Workflows Model Built Open Radioss

Robert O'Bara | Kitware, Inc.

Development, MBSE

CMB Kitware

Senior Consultant, Head of Business

Supporting End-to-End Simulation Workflows

Using Computational Model Builder (CMB)

**K**kitware

The Tool-set to Implement the Virtual Tire Lab in

### **OpenRadioss Users Day 2024**

#### Hosted by Professor Elham Sahraei

#### Temple University, Philadelphia

#### September 26th



#### **Electric Vehicle Safety Lab (EVSL)**

We strive to make transportation safer!

People Publications Collaborations Current Openings Photo Gallery Research News



#### EVSL was featured in the launching video of **OpenRadioss**

Radioss has programmed Professor Sahraei's short circuit and failure criteria in Radioss Commercial software. Sahraei criteria was also included in the OpenRadioss package.

https://altair.com/newsroom/news-releases/industry-proven-altair-radioss-finite-elementanalysis-solver-now-available-as-open-source-solution

Recent Posts

EVSL was featured in the launching video of OpenRadioss



#### A transformational Change – Compatibility with LS-DYNA

AA 👌

#### Input compatibility: LS-DYNA input models directly read by Radioss

- Multi-year development: initial focus on crash & impacts
- Continuous improvement & expansion toward FSI
- Adapting Radioss to user needs and experience
- Mixed input format support

#### • Supported cards described in the Reference guide

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#### **OpenRadioss**<sup>™</sup>

#### Example: Using the LS-Dyna model format

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### A transformational Change – Compatibility with LS-DYNA

# Working towards output compatibility to seamlessly use Radioss in LS-DYNA workflow

D3plot support based on open-source community project

#### **Future plans**

- Expand compatibility to Binout format
- HDF5 format





LS-DYNA input example from Aerospace Working Group (AWG) run with Radioss



### **Human Body Models Collaborations**

#### **GHBMC Radioss version**

Altair partners with Elemance & Virginia Tech University



#### **Open-source models**

Projects with the **OpenRadioss** community to support HBM for Auto & Rail, and Aero





ALTAIR

#### VIVA+ Human Body Model

✓ Y x

- Collaboration between Altair and OVTO VIVA+
- From the v1.1.0 release, VIVA+ LS-DYNA input models are compatible with OpenRadioss and Altair Radioss v2024
- Running the HBM with Radioss is as simple as including it in your Dyna format model
- It can also be included in Radioss 'block format' models ('/INCLUDE\_LS-DYNA')





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### **Multidisciplinary Collaborations**

- Battery pack modelling
- Lightweight materials, aluminum alloys, composite
- Biomechanics, biomaterials, free human models & safety tools
- Defense
- Advanced numerical methods
- HPC, many-cores CPU scalability, accelerators
- AI/ML, ROM
- DevOps, CI/CD, API, Cloud
- Co-simulation & interoperability with third party software

'I can see the enormous potential, Radioss open-source feature will make easier for people like me to contribute in a way that is fine tuned to the needs of customers and I'll be happy to do that!' Paul du Bois

Early adopters are enthusiastic Many collaboration opportunities between Research and Industry

Since the official announcement, this strong interest is confirmed by the high traffic toward **openradioss.org** and **github.com/OpenRadioss** with new contributors and users joining the community everyday!



### **OpenRadioss** – Build an Active Community

- 3<sup>rd</sup> users' event in Philadelphia ٠ with 300+ registrations!
- Steering committee to shape the ٠ future of the code
- Newsletter published twice a year ٠ registration from openradioss.org
- LinkedIn community group •
- YouTube community channel
  - $\oplus$ www.voutube.com/@OpenRadiossCommunity
  - ഉ 320 subscribers



- 10 videos
- $\sim$ 8,483 views

Joined Aug 30, 2023



Earn an Active Group badge





Pierre Jean Arnoux Director of LBA & Research Director **Gustave Eiffel University Aix Marseille University** 

Marian Bulla **OpenRadioss Community** 





Nicolas Vallino Research Engineer & Expert in transient dynamics simulations Safran Tech

Saulo G.P. Castro Associate Professor Aerospace, Structures & Materials **Delft University of Technology** 



Dr.-Ing, Axel Hänschke 25+ years of experience at Ford Head of Business Development

**CPS** Consulting



**Eric Leguiniou** SVP Radioss & Solver HPC Altair

#### 486 members

Including Piush Patel and 367 other connections



Invite connections



#### **Live Demo**

- Pre-Processing OpenRadioss model with HyperMesh
- Starting OpenRadioss model
- Converting animation files to ParaView VTK
- Opening OpenRadioss results in **ParaView**

## Hand over to François ...



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** OpenRadioss Starter	**
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** Non-linear Finite Element Analysis Software	**
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** Windows 64 bits, Intel compiler *	**
** Double Precision Version	**
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** OpenRadioss Software	**
** COPYRIGHT (C) 1986-2024 Altair Engineering, Inc.	**
** Licensed under GNU Affero General Public License.	**
** See License file.	**
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KINEMATIC COND:	.4262E+02	0.67	\$
INTEGRATION:	.3177E+03	4.98	\$
ASSEMBLING	.5474E+03	8.58	*
OTHERS (including I/O):	.9060E+03	14.20	\$
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Anim file conversion to vtk complete

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TH File Being Converted is CellPhone\_2024\_10\_08\_aT01

T01 TO CSV CONVERTER

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** CONVERSION COMPLETED
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# **THANK YOU**

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