Comparative Studies of Bird Strike by Dummy Tests and Simulations

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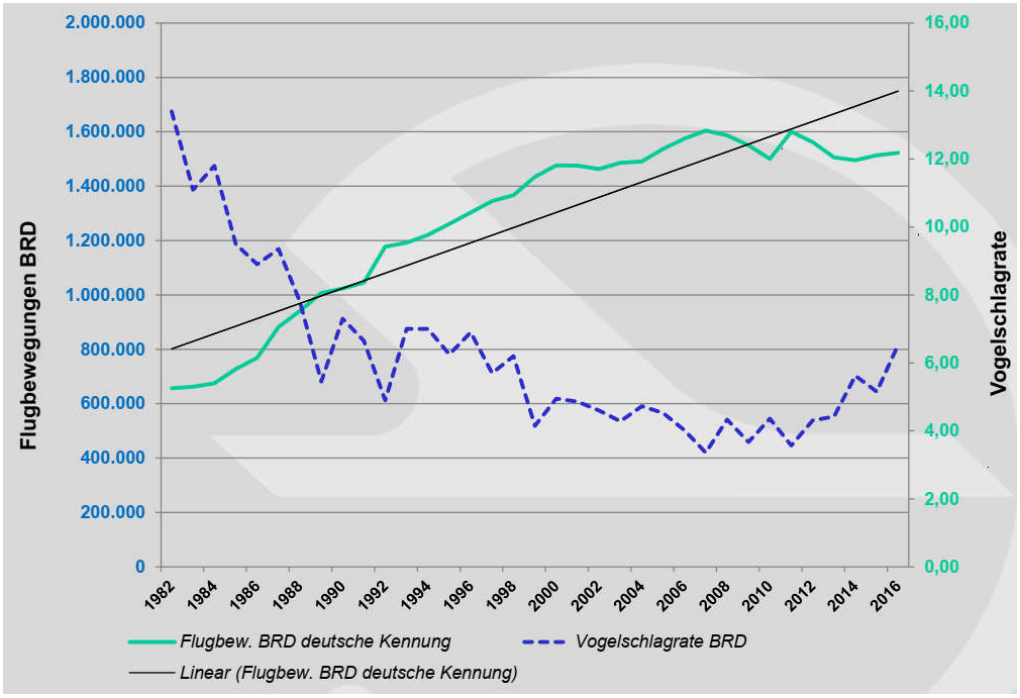
2. DUMMY.CRASHTEST.KONFERENZ. 08.-09.09.2022. Muenster, Germany.

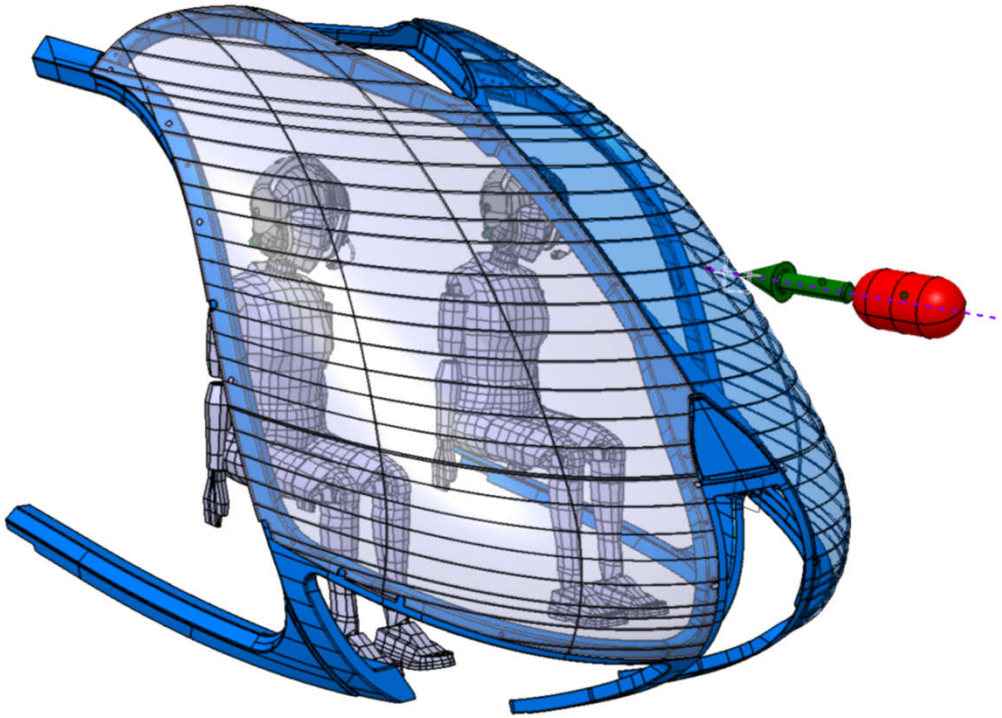
Bird Strike in Aviation – Incidents at Airports



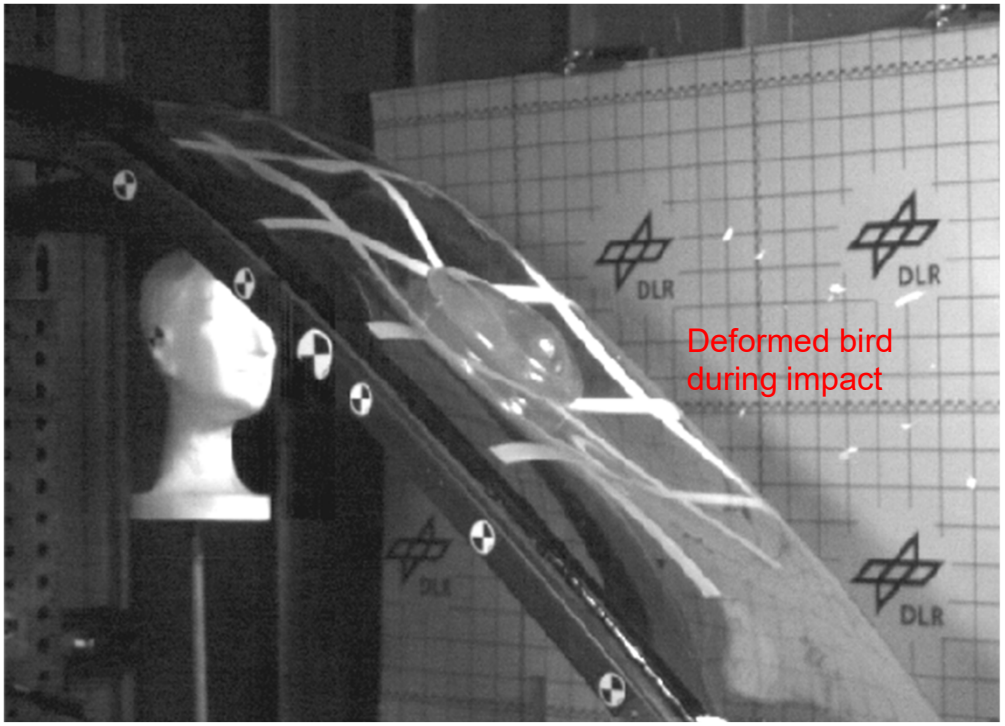
Source: DAVVL. Bird strike rate from 1982 to 2016 on German Airports.

The Application – Rotorcraft Canopy Under Bird Strike

Bird strike load case description



Bird strike test with deformation and strain measurement

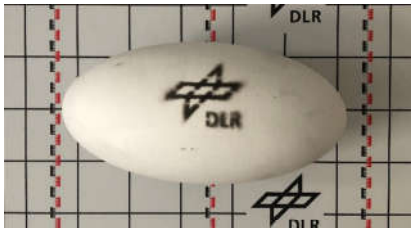


HeWiS - Helicopter Windshield Spherical, LuFo funded project 2010-2012

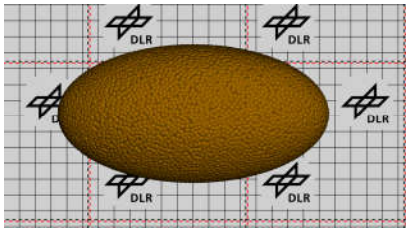
Motivation for the Study

- DLR invented regular shaped reinforced artificial bird
  - Patented DLR Reinforced Artificial Bird (DLRRAB) with gelatine based tissue substitute
  - Various regular shapes, tests with weights from 0.03 to 3.6 kg
  - Testing and application since 2010
- Crashtest Service GmbH invented biofidelic bird
  - Patented ALPHA biofidelic bird resembles the prepared real bird by CT scan created bone, tissue and organ substitute
  - First impact tests by DLR with instrumentation
- SAE G-28 initiative to develop an artificial bird being accepted replacing real birds for certification testing

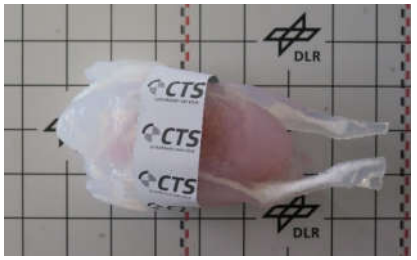
Participants of the Comparative Study



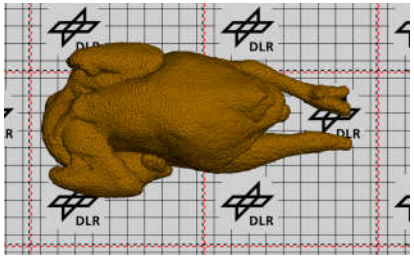
DLRRAB Mk2.3, 1.8 kg



DLR EWVT SPH, 1.8 kg



CTS Biofidelic bird, 1.8 kg



DLR EWVT SPH of Biofidel bird, 1.8 kg

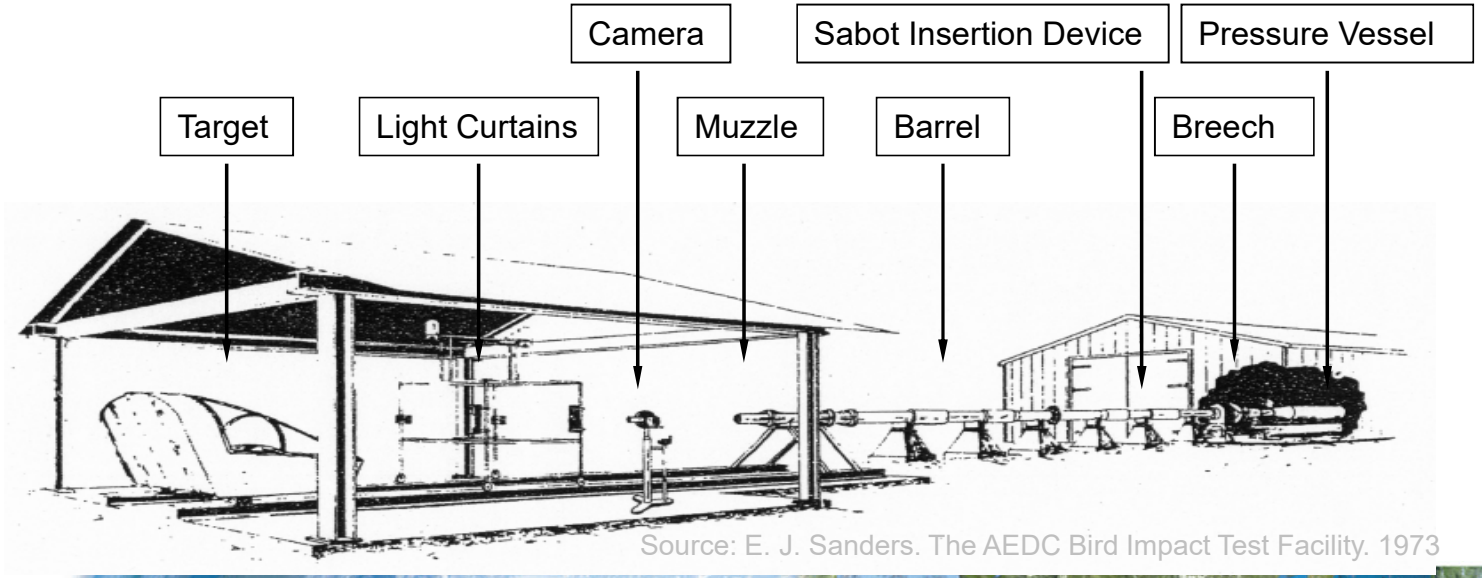

Real prepared bird, 1.8 kg

Source for EWVT bird modelling: M. Siemann, S. A. Ritt. Novel particle distributions for SPH bird-strike simulations. https://elib.dlr.de/121954/

Objective of the Study

- **DLRRAB** was already applied in **various projects**
- **Biofidelic bird** was tested for the **first time** with load measurement
- **Reference to real bird needed to show similarity of impact threat**

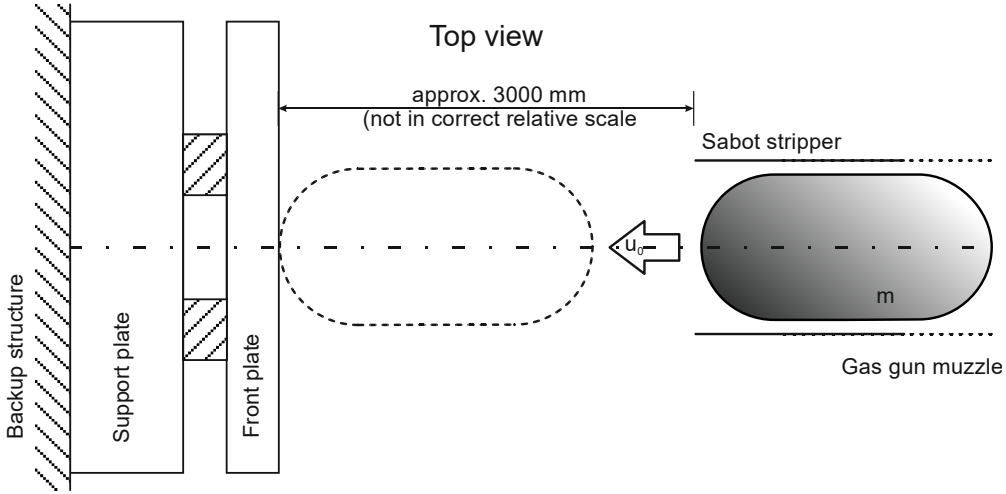
Sections of the Study
- Bird shape influences
- Launchability of the birds
- Loads measurement tests with normal impact
- Breakup of the birds

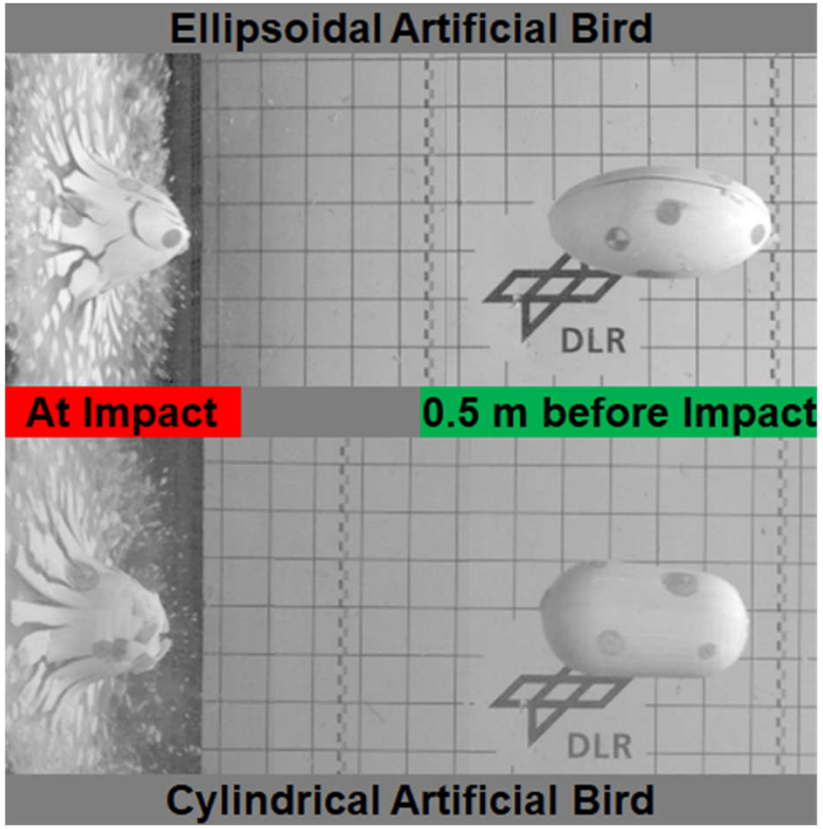


Source: E. J. Sanders. The AEDC Bird Impact Test Facility. 1973

Influence by Bird Shape

- Dummy bird shape derived from ornithological data but not yet standardised. In practice, typically
  - cylindric shape for static structures
  - ellipsoidal shape for rotating structures
- Shape has in influence on the transient load transfer

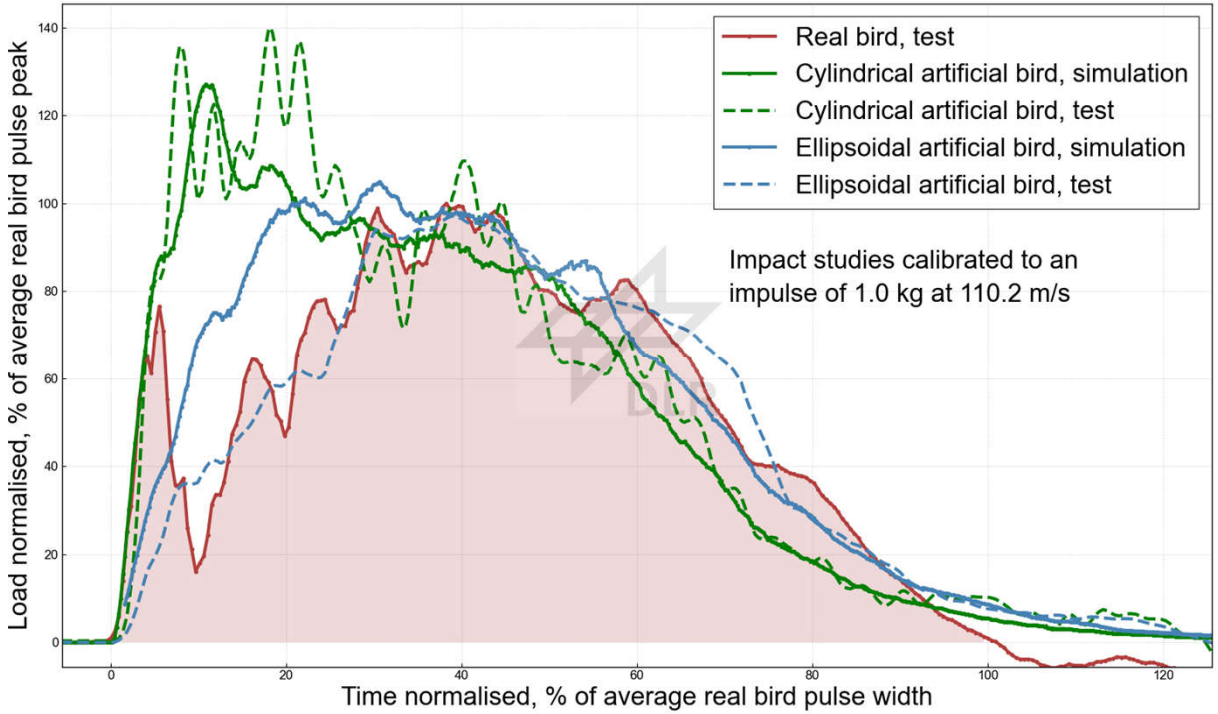




Bird normal impact, 1.0 kg at 110 m/s

Influence by Bird Shape

- Study with simulated birds, tested real & dummy bird models



Identical measurement system for real bird, artificial birds, and simulated birds

Scaling to a reference momentum for a certain loadcase characterised as $p_r = m * v$
here: m = 1.8 kg, v = 90 m/s

Normalisation of force and time against real bird impact

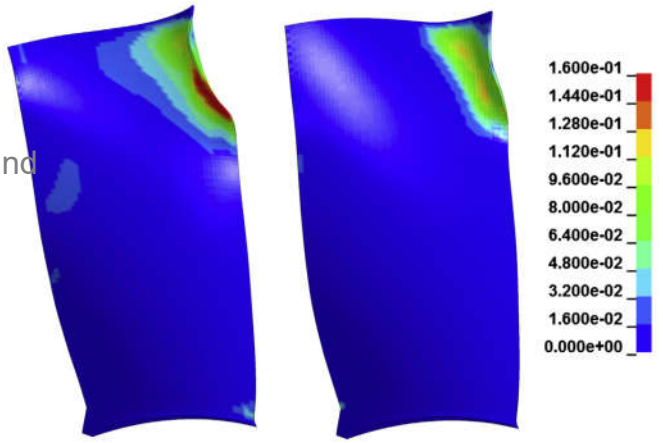
Objective: Comparability of load transfer

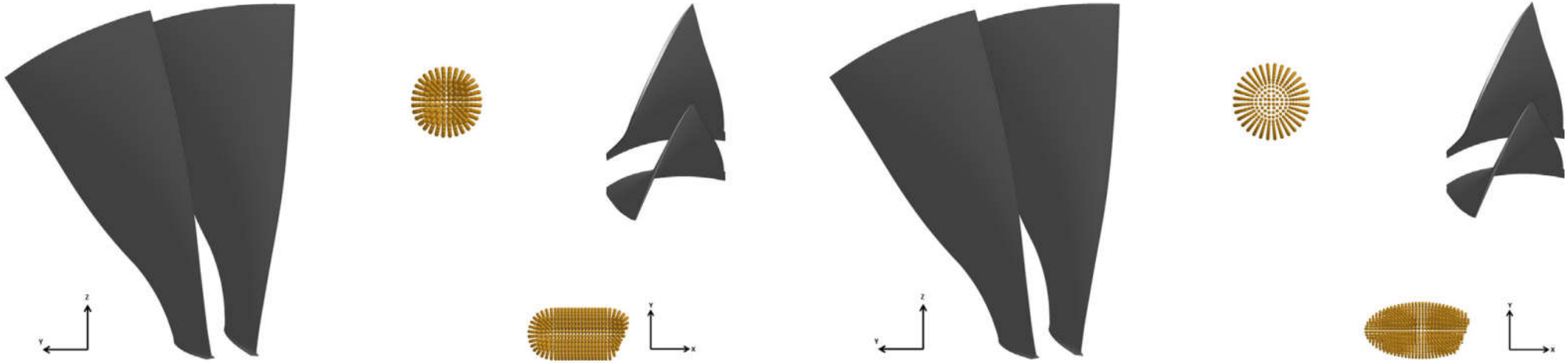
Source: S. A. Ritt, F. Höfer, J. Oswald, and D. Schlie. Drone Strike on a Helicoper Canopy Demonstrator. In: Proceedings of the 47th European Rotorcraft Forum, 2021

Influence by Bird Shape

- Load transfer can lead to different deformation level or pattern

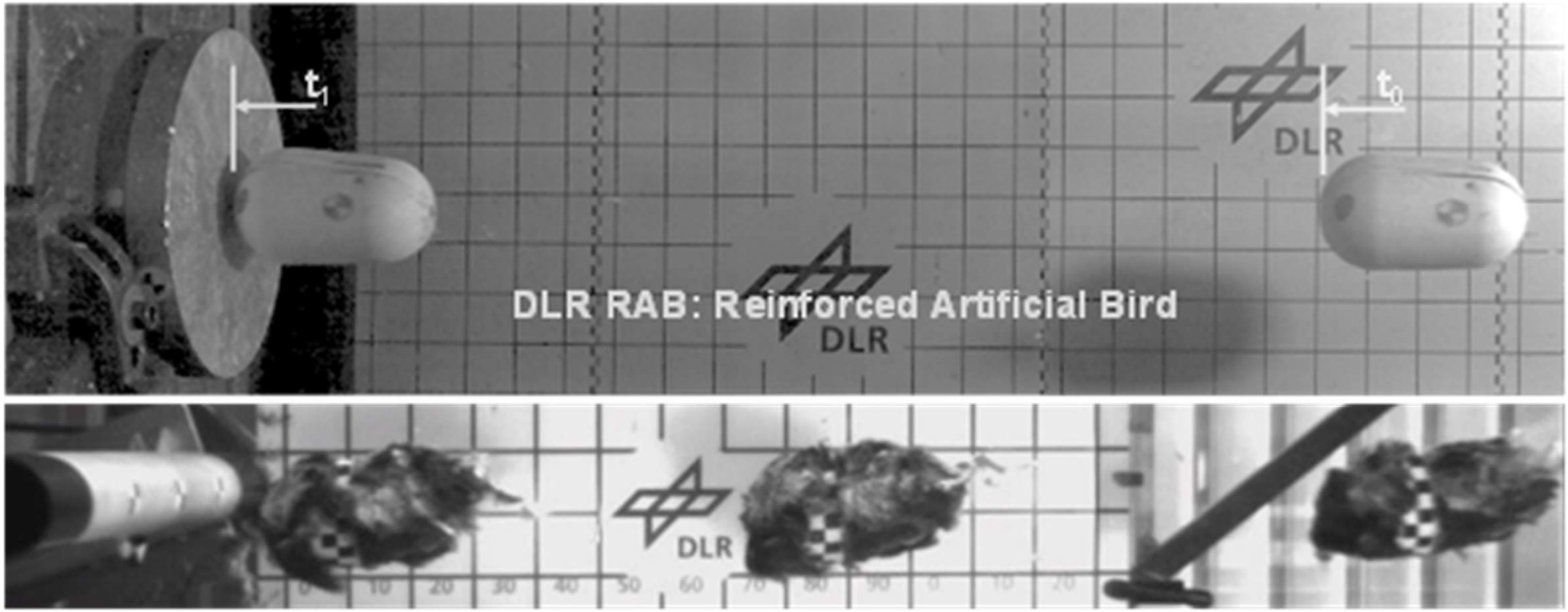
Effective strain by hemispherical bird (left) and ellipsoidal (right)





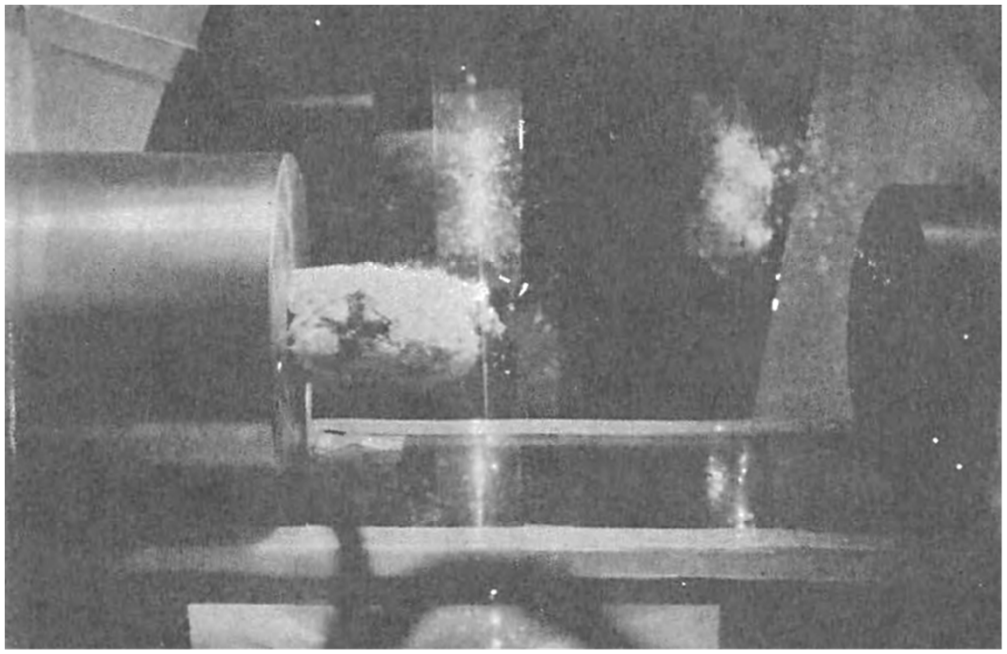
Source: Vignjevic et al. 2013: Effective strain by hemispherical bird (left) and ellipsoidal (right)

Launchability: From Real Bird to DLRRAB

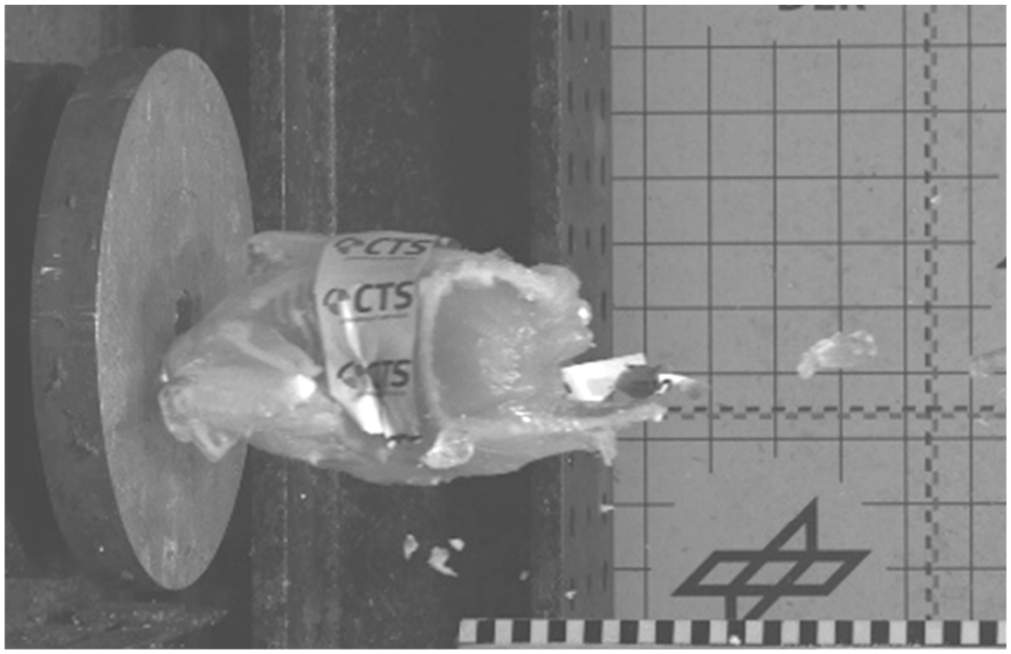


Higher-TE – High Lift Enhanced Research – Trailing Edge, LuFo funded project 2007-2013

Launchability: From Real Bird to Biofidelic Bird



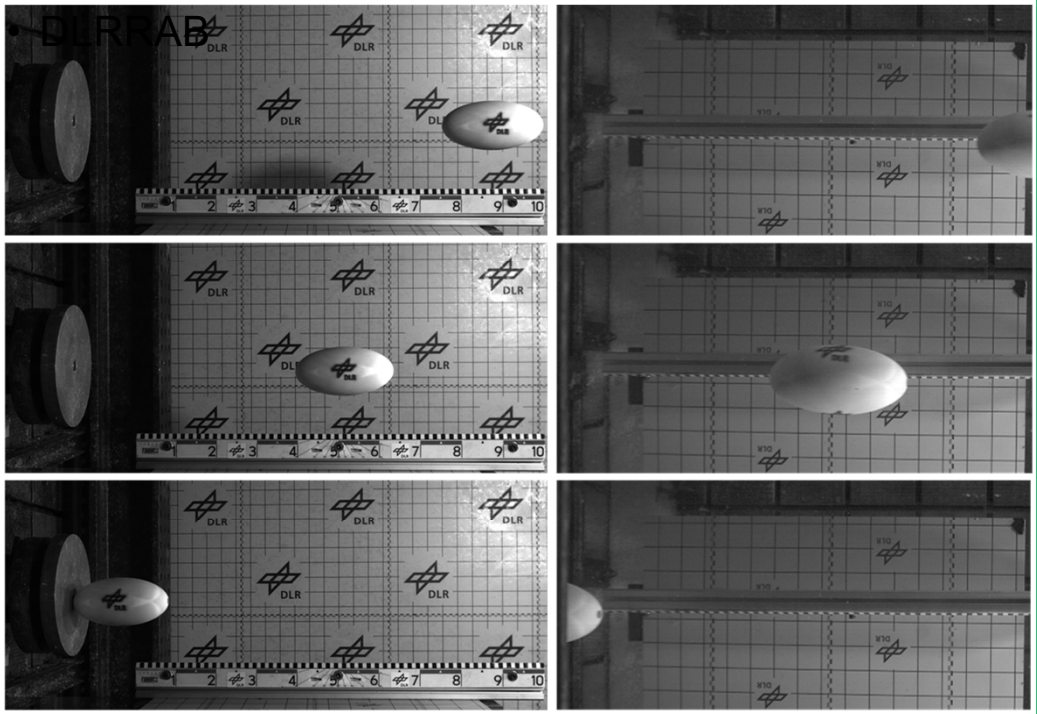
AFFDL-TR-75-5, Shot 4984, 86.0 m/s, optical high speed frame of real (prepared) bird (1975)



Biofidelic 1 test at 91.5 m/s, optical high-speed frame (2022)

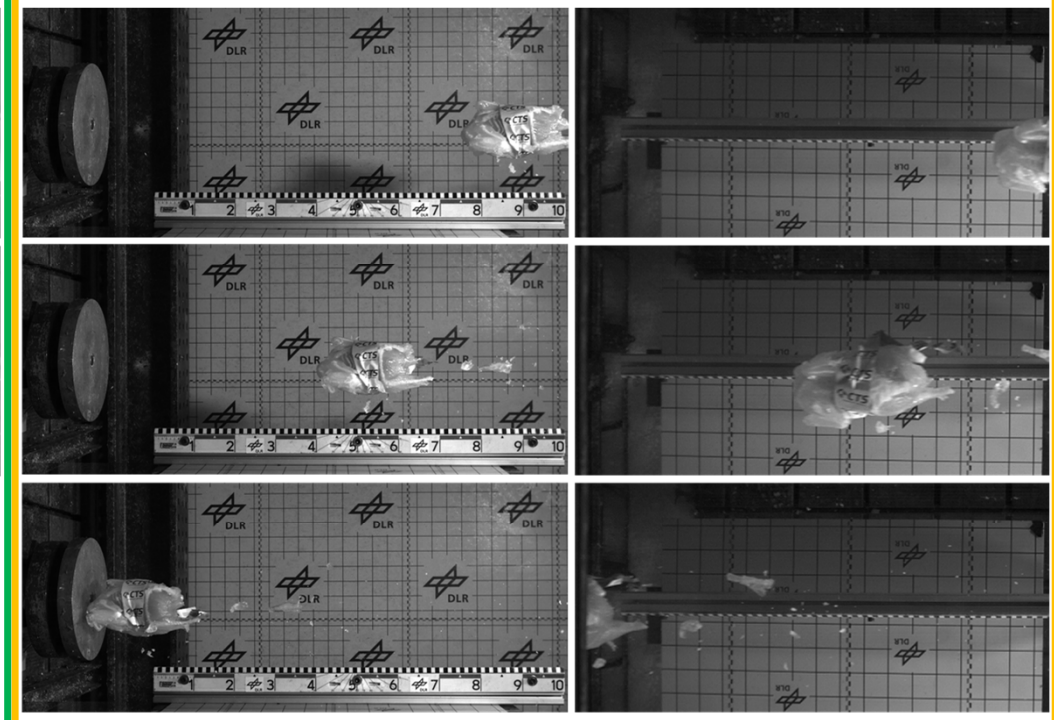
Launchability: Flight Behaviour in two Perspectives

DLRRAB



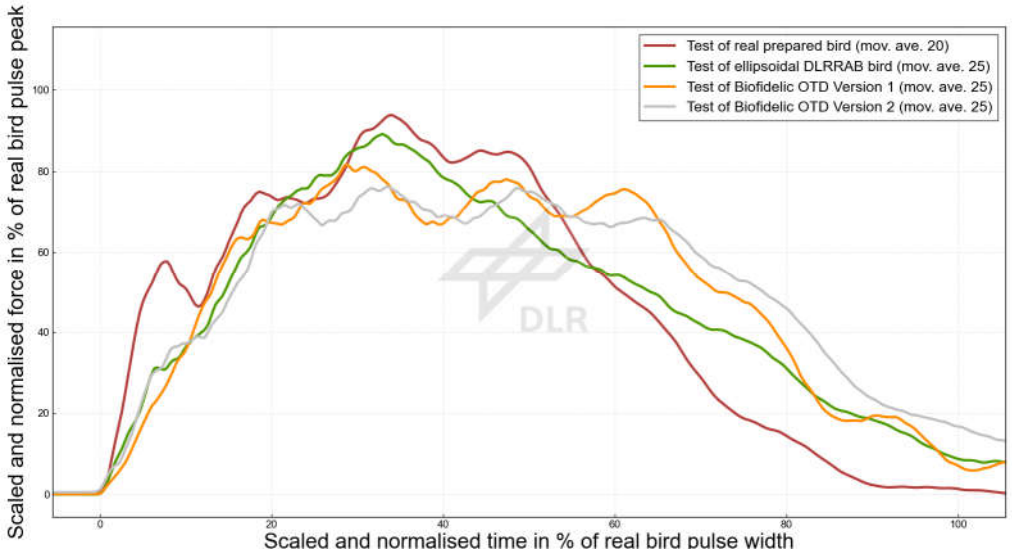
Side view Top view

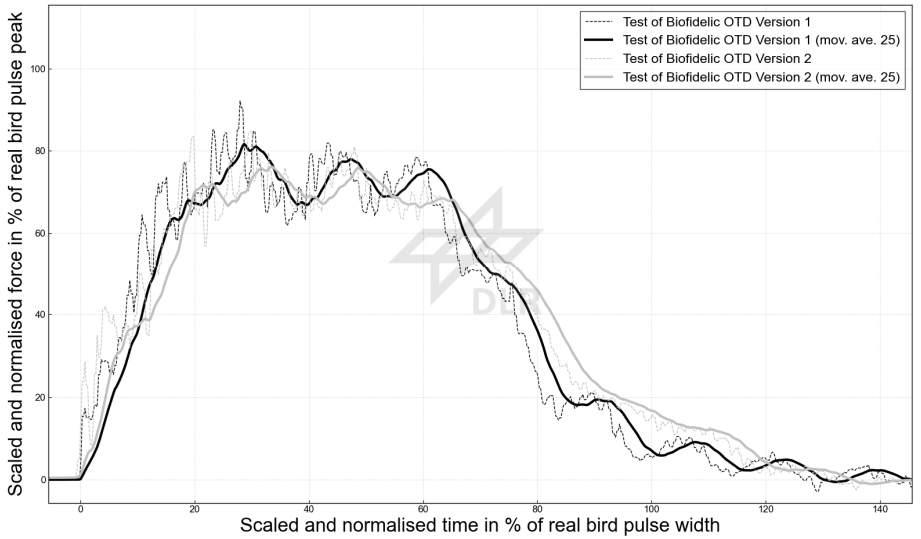
Biofidelic OTD



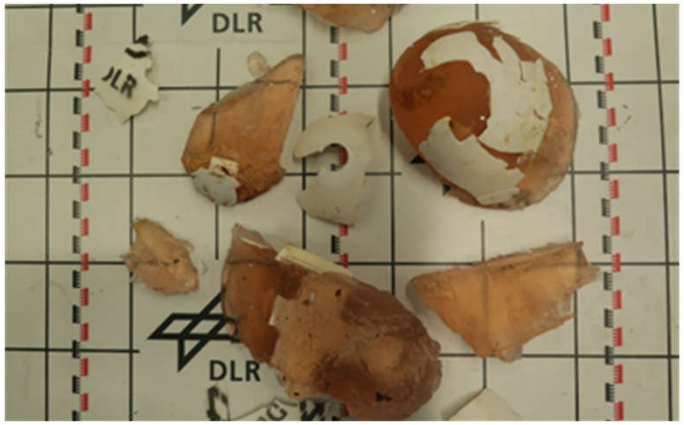
Side view Top view

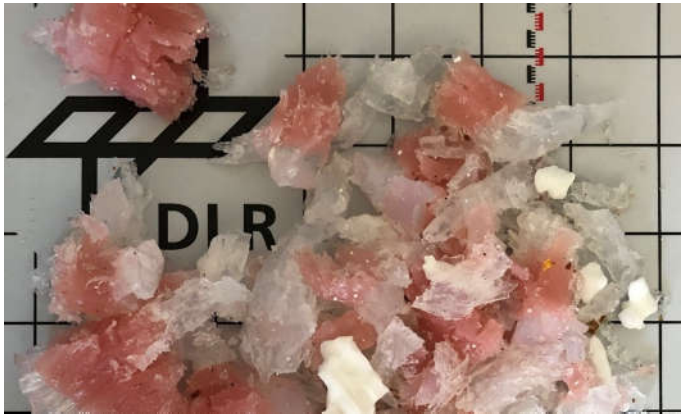
Loads Measurement Tests under Normal Impact





Breakup of the Birds: Status of the Birds Before and After Impact





Summary and Outlook

- Discussed were influences on the impulse transfer by bird strike on structures
  - Shape influences
  - Launchability of the birds with possible variation of attitude prior to impact
- Classification of artificial bird approaches
- The study presented a test setup with rigid target to measure transient bird strike forces
- The measurement system was used to compare equal weight and equal speed bird models
  - DLR legacy data of prepared real birds
  - DLRRAB artificial bird in ellipsoidal shape
  - CTS ALPHA biofidelic bird
- Launching and first transient measurements of biofidelic bird against reference tests

- The work will continue on
  - testing with compliant targets
  - modelling the artificial bird approaches

Thank you for your attention!

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Source: ABC News Photo Illustration, 27.03.2009

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Federal Ministry for Economic Affairs and Climate Action

Clean Sky 2 JOINT UNDERTAKING