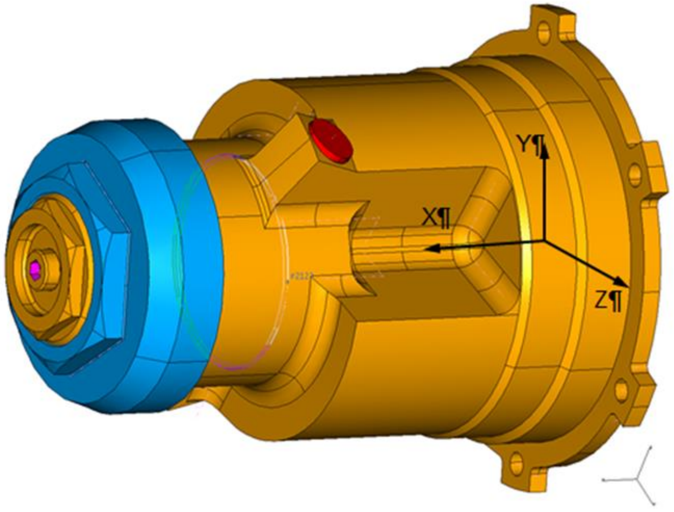
TRED

Temperature Dependability Reduced Viscous Deployment Damper



Christian Neugebauer
Christian Laa
RUAG Space
Noordwijk, 15.2.2019

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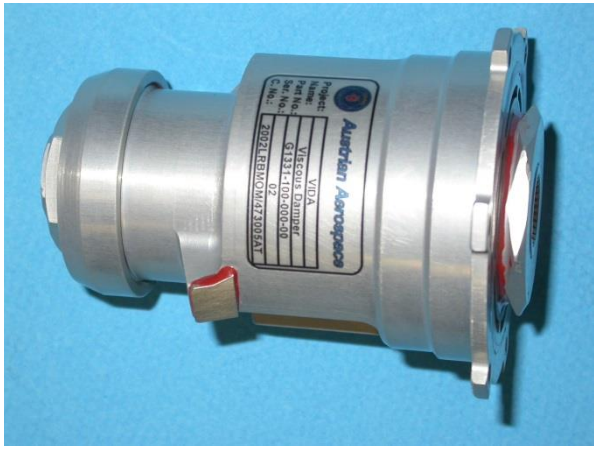
RUAG Viscous Deployment Damper
Description

The Viscous Deployment Damper

- provides speed-dependent resistive torque
- to a corresponding spring actuated mechanism
- in order to prevent high shock loads
- when the end stop of the mechanism is reached.



The Viscous Deployment Damper is a

- Small and lightweight
- passive

device.

Deployment angle is 90°, also 270° version is available.

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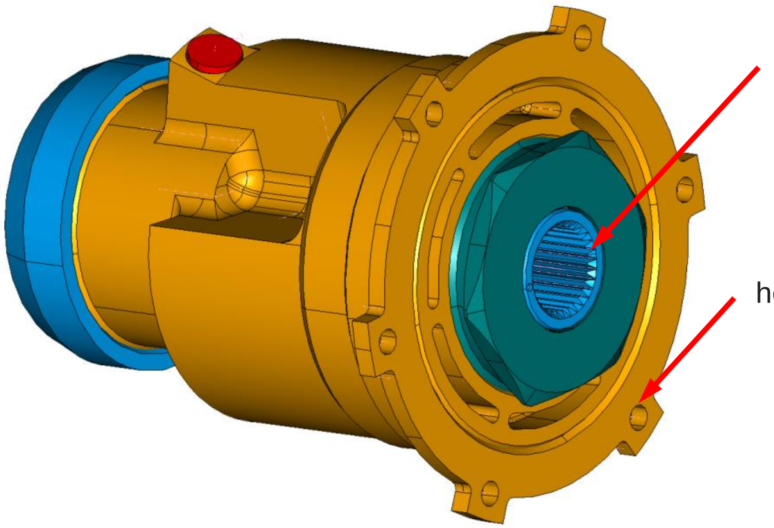
RUAG Viscous Deployment Damper
Description

- Maximum allowable input torque: Tmax = 35 Nm
- Mechanical Interface:



- Size: D = 63 mm, l = 81 mm
- Mass: m = 230 g

Note: RUAG Space also offers Eddy Current dampers for higher torque ranges.

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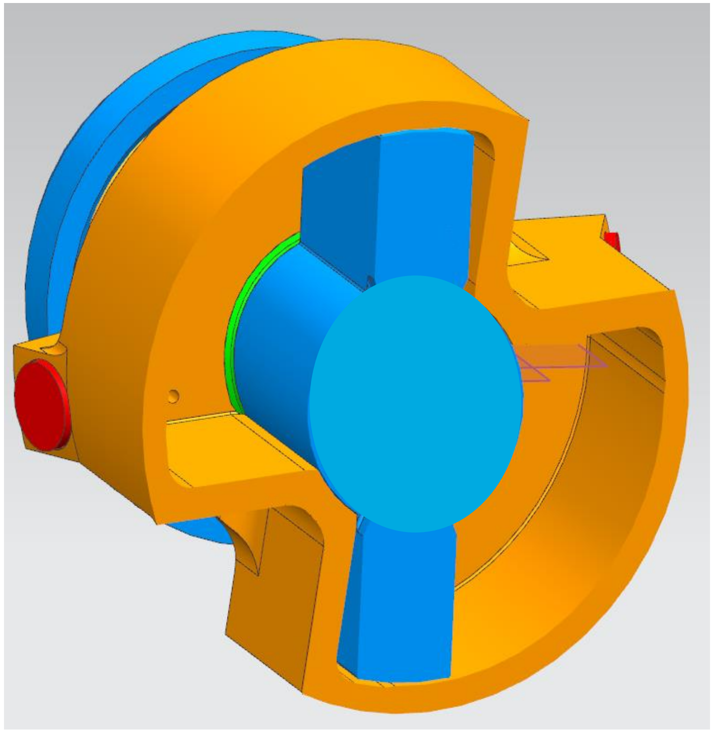
RUAG Viscous Deployment Damper
Working principle

The Viscous Deployment Damper consists of housing and rotor.

When turned, the rotor forces highly viscous working fluid through narrow gaps.

The resistive torque thus generated is proportional to shaft angular rotation rate and fluid viscosity.



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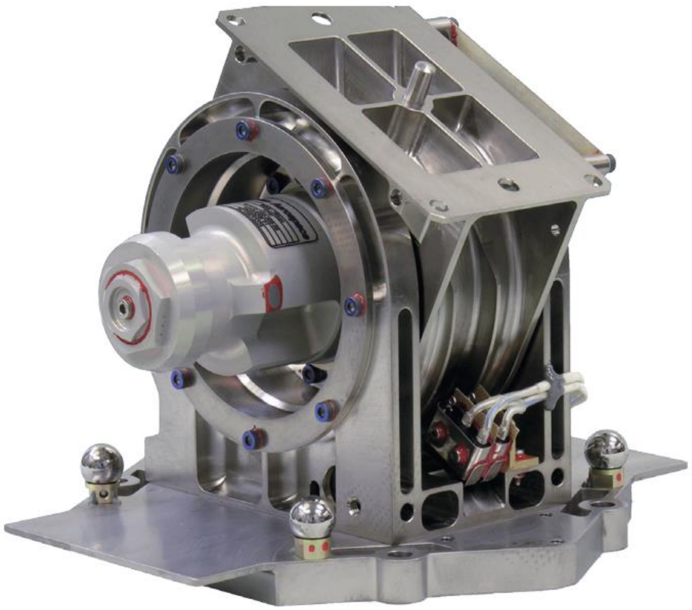
RUAG Viscous Deployment Damper
Example Applications

Boom deployment

Reflector deployment

etc.



65 viscous deployment damper flight models delivered.

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TRED Viscous Deployment Damper
Requirements

Temperature range:

- Operational temperature range: -30°C / +50°C
- Non-operational temperature range: -150°C / +150°C

Temperature dependent change of the viscosity of the liquid causes different damping rate / deployment time depending on temperature.

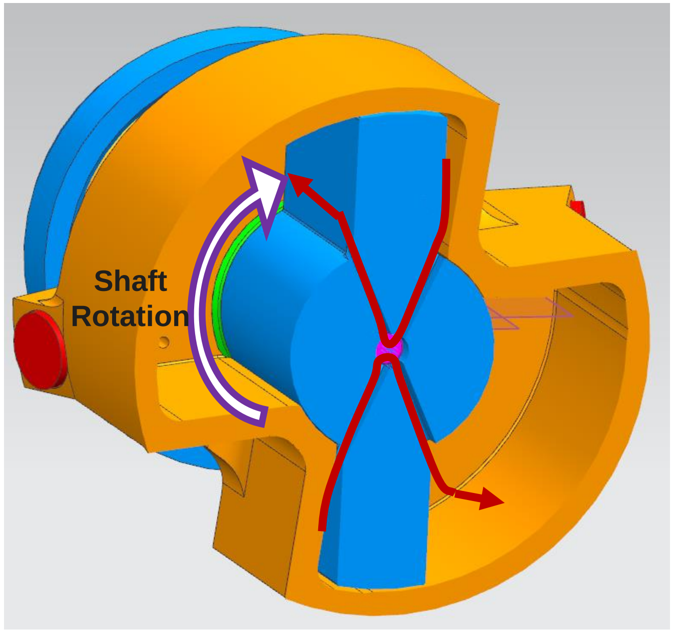
Standard Design: Damping rate at low temperature is 6x damping rate at high temperature:

-30°C	1260 Nms/rad
+25°C	315 Nms/rad
+50°C	210 Nms/rad

Factor 6x shall be reduced for TRED, target value < 2x.

TRED Viscous Deployment Damper
Design Concept

- Bypass channels open at low temperature and close at high temperature to compensate higher viscosity by increased flow cross section.

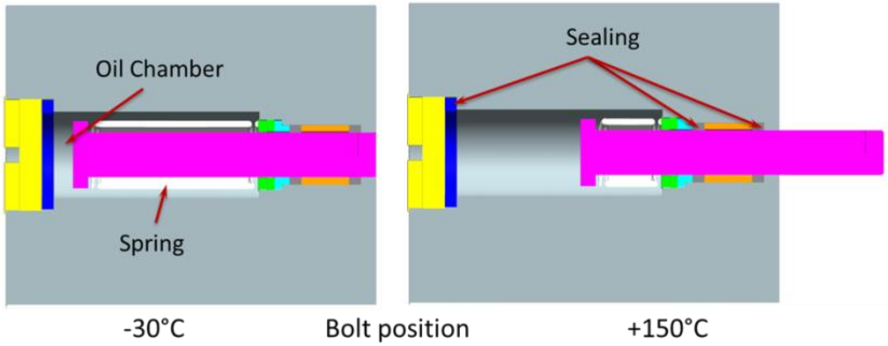


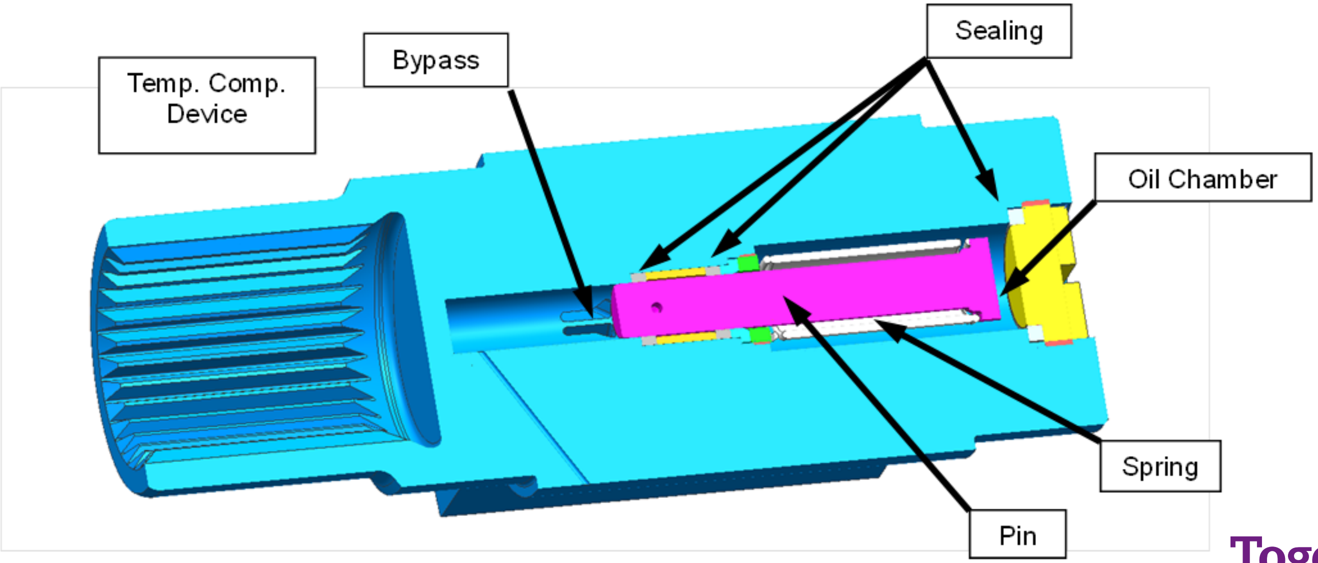
- Bypass channels opened / closed by valve = axial moving pin.

TRED Viscous Deployment Damper
Valve Actuation

Valve = axial moving pin

- pushed by thermal expansion of volume of liquid at high temperature
- pulled back by spring at low temperature





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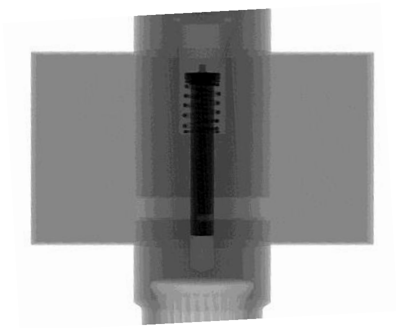
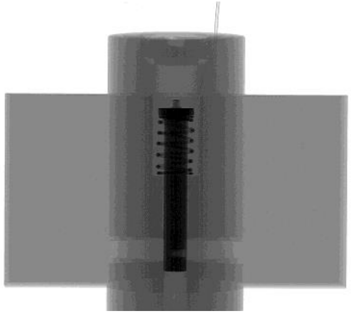
TRED Viscous Deployment Damper
Valve Breadboard

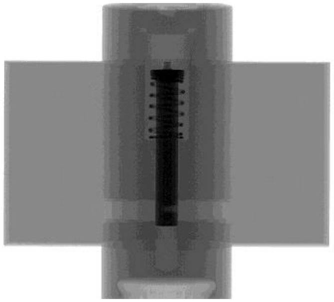
Verification of pin motion by X-ray pictures



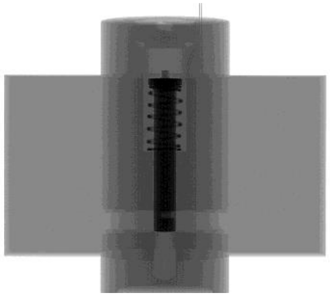
95°C



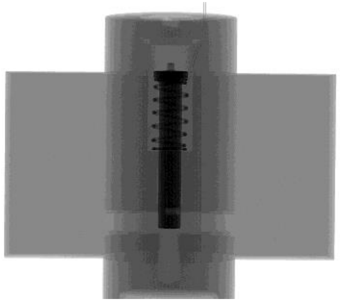
75°C



60°C



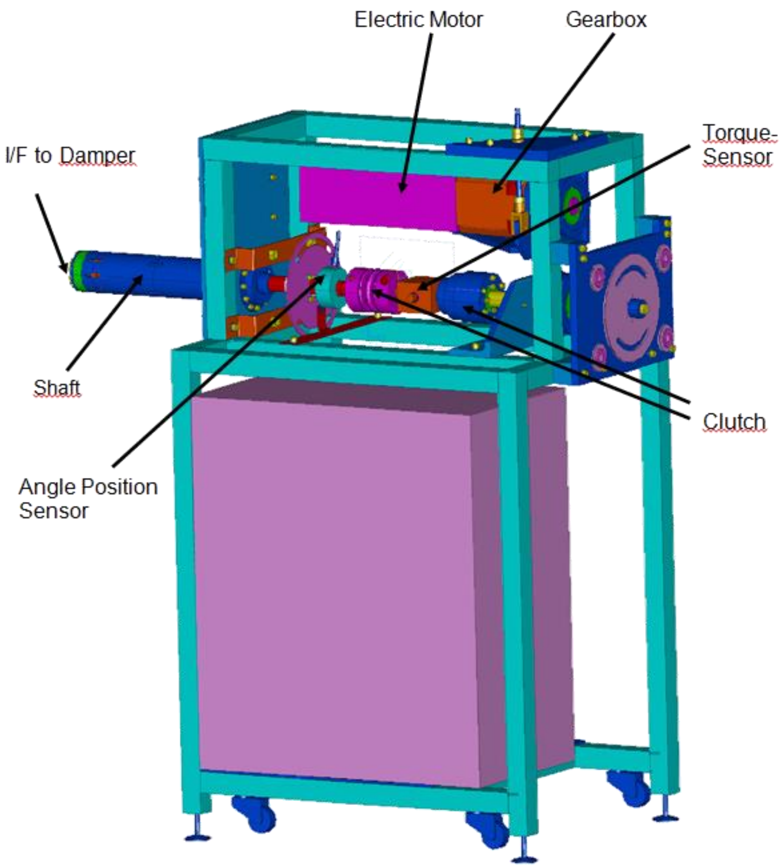
40°C

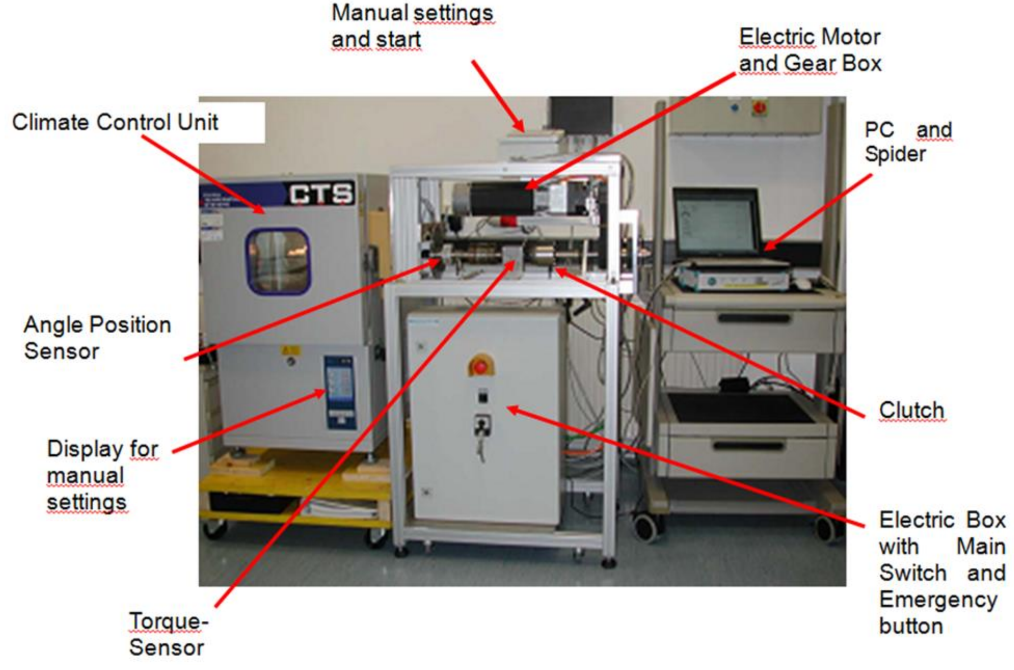


22°C

TRED Viscous Deployment Damper
Performance Testing

- Damper test facility at RUAG Space Vienna





Damper inside thermal chamber

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TRED Viscous Deployment Damper
Performance Test Results

Temperature Compensation of Damping Rate
for different Shaft designs (cw … clockwise, ccw … counter-cw)

- Damper **w/o compensation** (no bypass)

  ≈ **6** for -30°C ⇒ +50°C

Torque [Nm]	Between -30°C / +50°C	
	Ratio cw	Ratio ccw
25	5.65	5.56
20	5.77	5.69
15	5.86	5.81
10	5.97	5.90

- TRED Damper **Shaft C** (bypass x-section 2x1.35 mm²)

  ≈ **4.5** for -30°C ⇒ +50°C

Torque	Between -30°C / +50°C	
[Nm]	Ratio cw	Ratio ccw
25	4.26	4.13
15	4.51	4.48
10	4.69	4.70
5	4.88	4.91

- TRED Damper **Shaft A** (bypass x-section 2x4.05 mm²)

  ≈ **3** for -30°C ⇒ +50°C

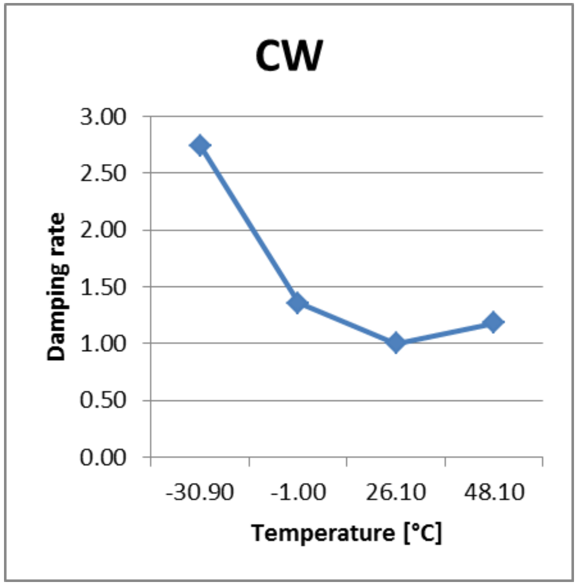
Torque	Between -30°C / +50°C	
[Nm]	Ratio cw	Ratio ccw
20	2.75	2.63
10	3.03	3.01
5	3.50	3.48

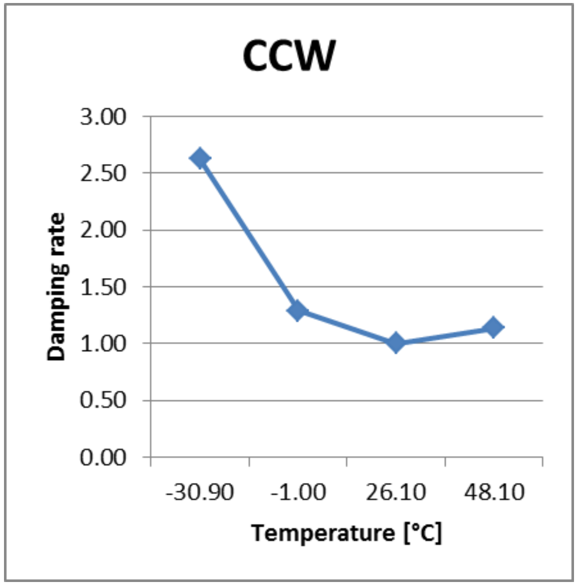
TRED Viscous Deployment Damper
Performance Test Results

Damping Rate over Temperature for TRED Damper with shaft A

- Ratio is <2 for temperature range 0°C … 50°C
- Ratio is <3 for temperature range -30°C … 50°C

Damping rate change for input torque 20 Nm





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TRED Viscous Deployment Damper
Conclusion

Summary:

- Reliable temperature compensation has been verified
- Compensation <3 over whole temperature range has been achieved