

Current interruption performance of axial and radial magnetic field vacuum interrupters

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- Introduction
- Experimental results
- Analysis
- Conclusions

Introduction

Vacuum interrupter design

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Terminal disc

Insulator (ceramics)

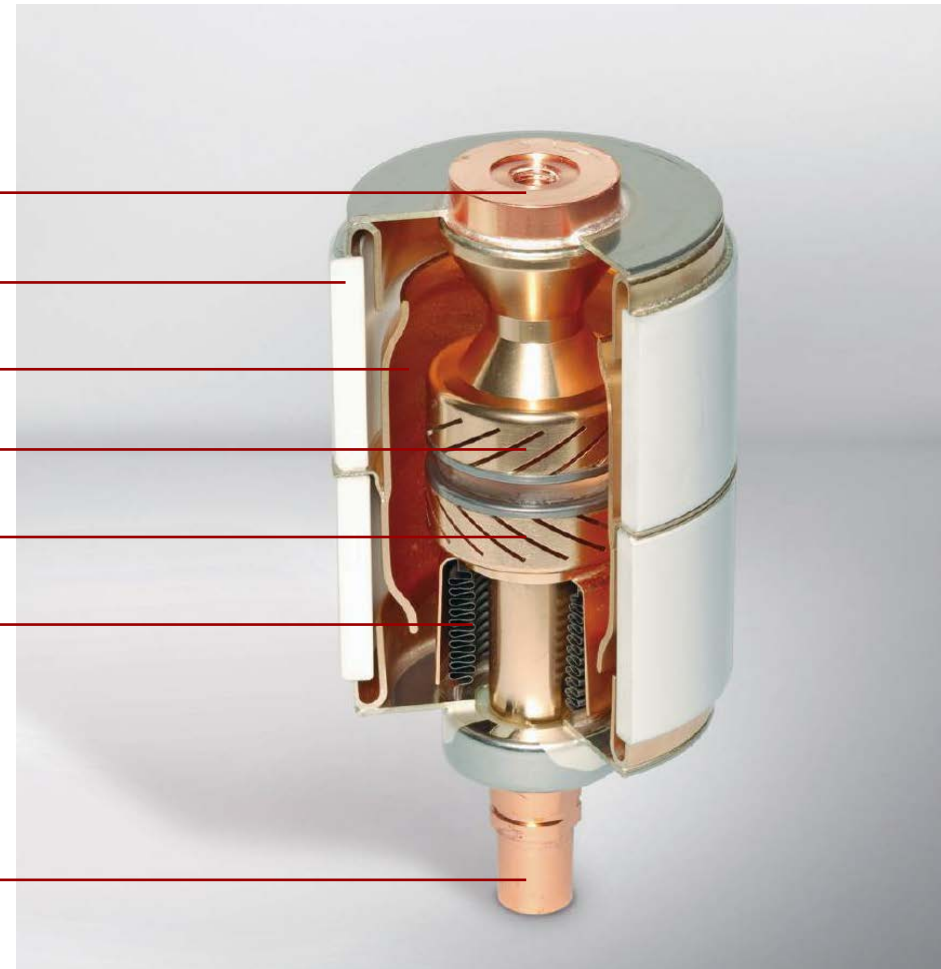
Arcing chamber made of copper

Fixed contact

Movable contact

Metal bellows

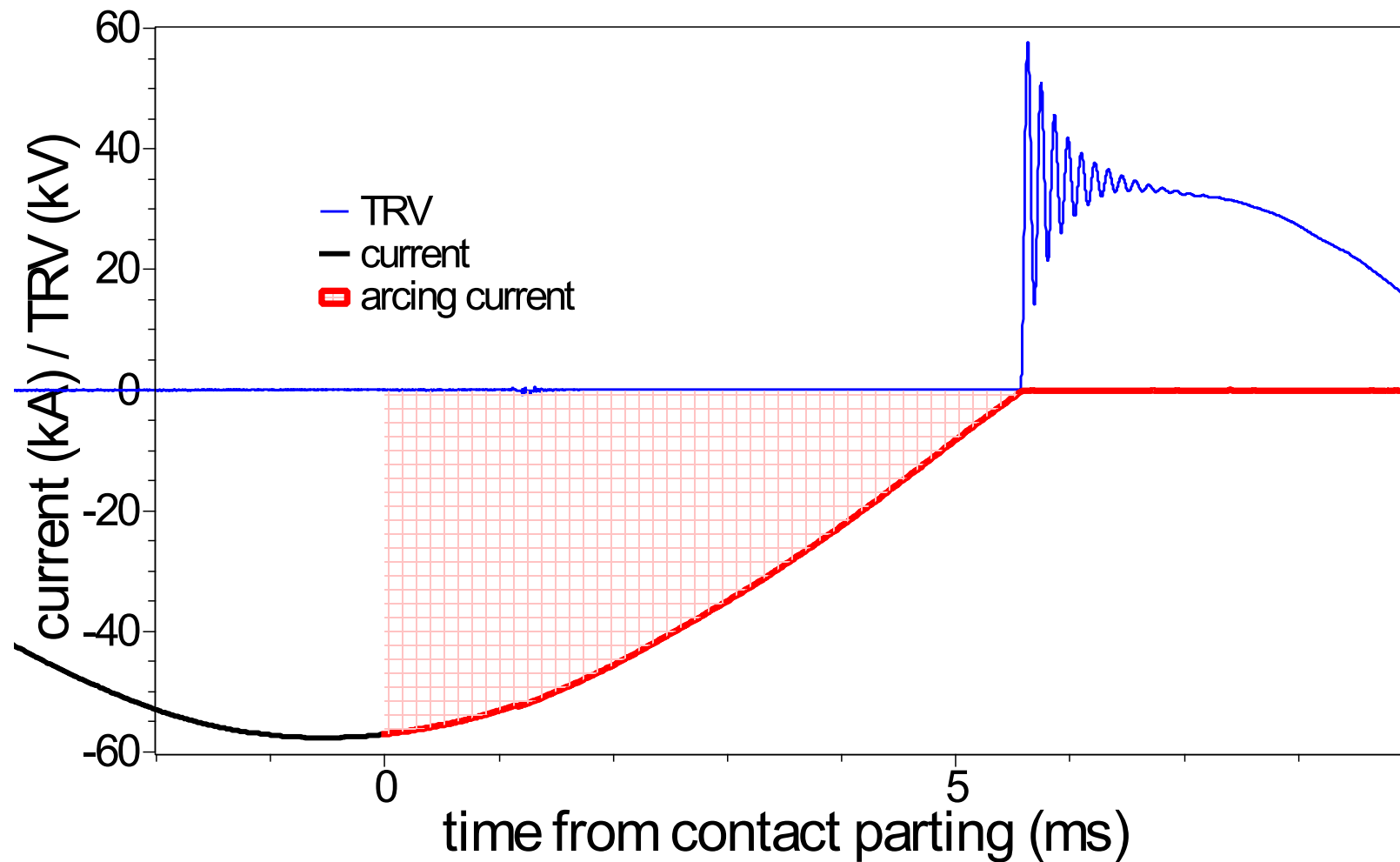
Operating and connecting bolt



Introduction

General example of a successful short-circuit interruption

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Introduction

Vacuum arc controlled by magnetic fields

$I > 10 \text{ kA} \Rightarrow$ Arc constriction (pinch-effect)

In order to avoid a local thermal contact overheating

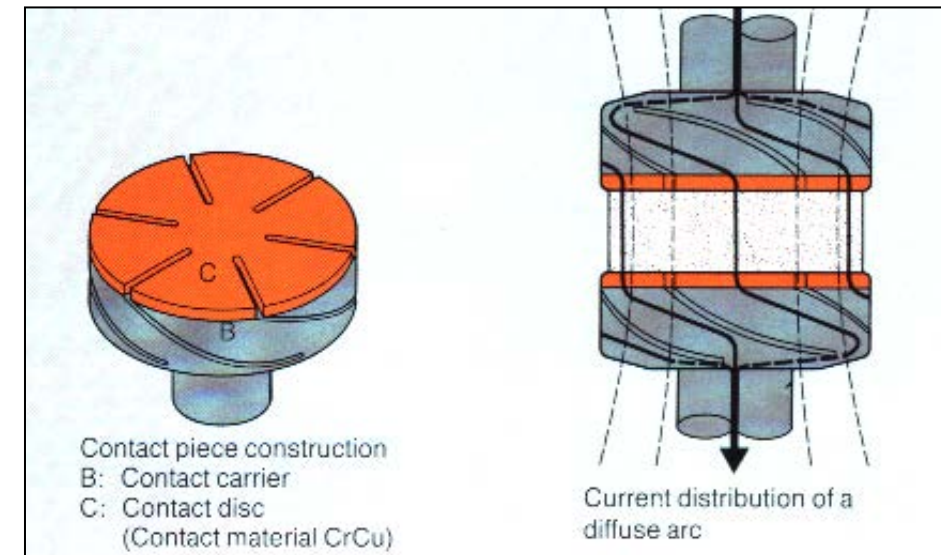
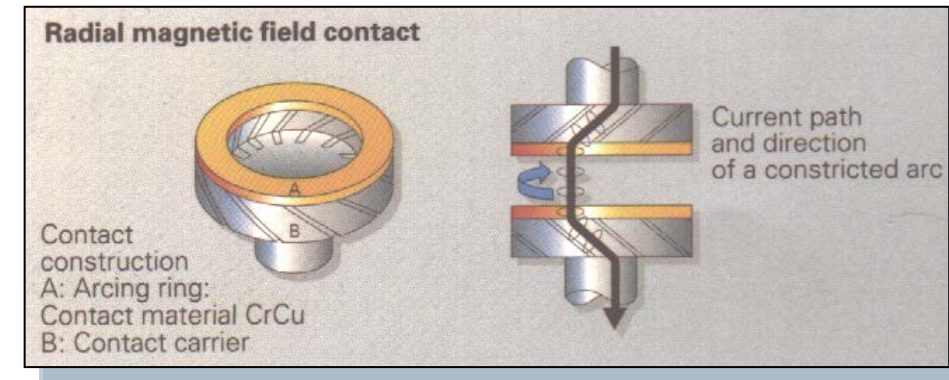
there are two possibilities:

- Movement of constricted arc on contact surface

\Rightarrow Radial Magnetic Field Contact (RMF)

- Prevention of arc constriction

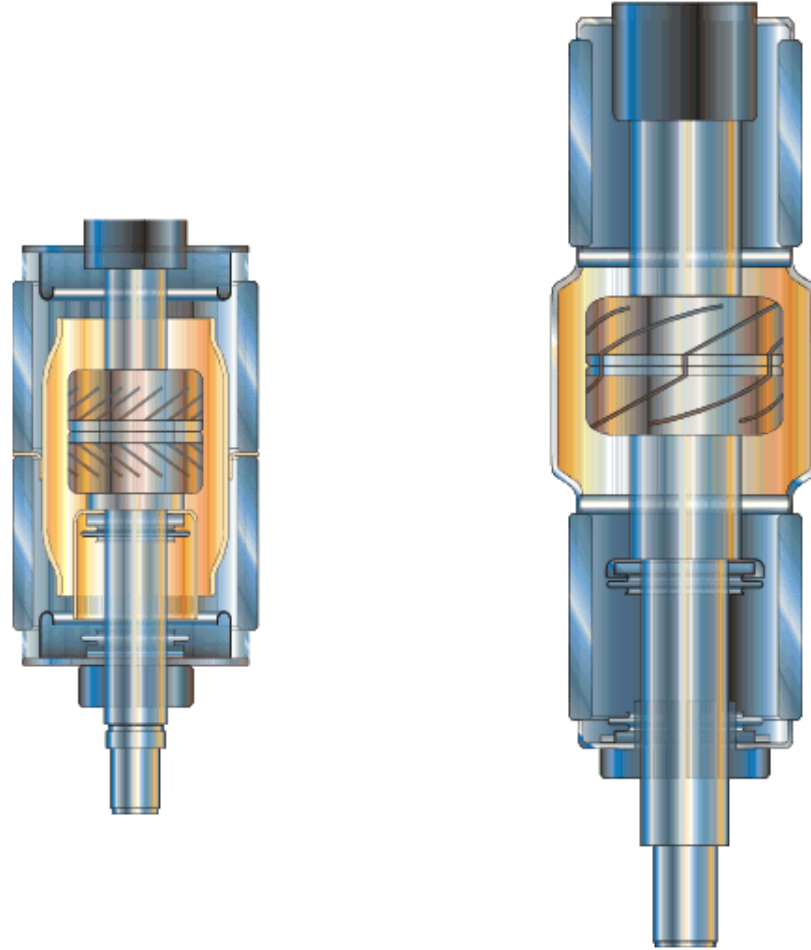
\Rightarrow Axial Magnetic Field Contact (AMF)



Introduction

Examples of arc behavior on AMF and RMF contacts

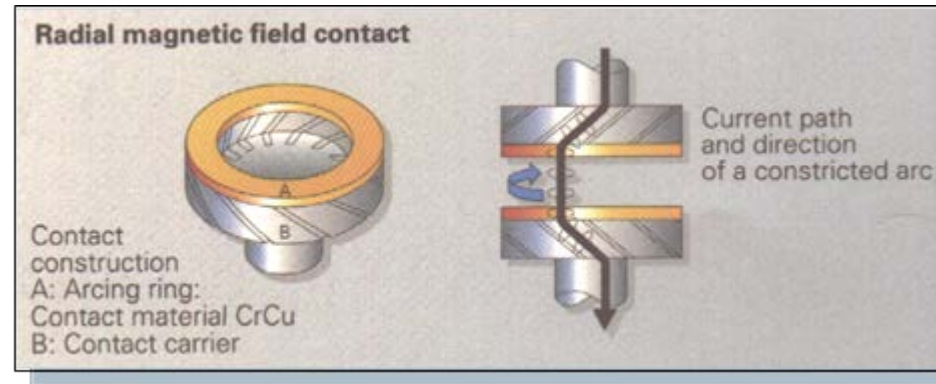
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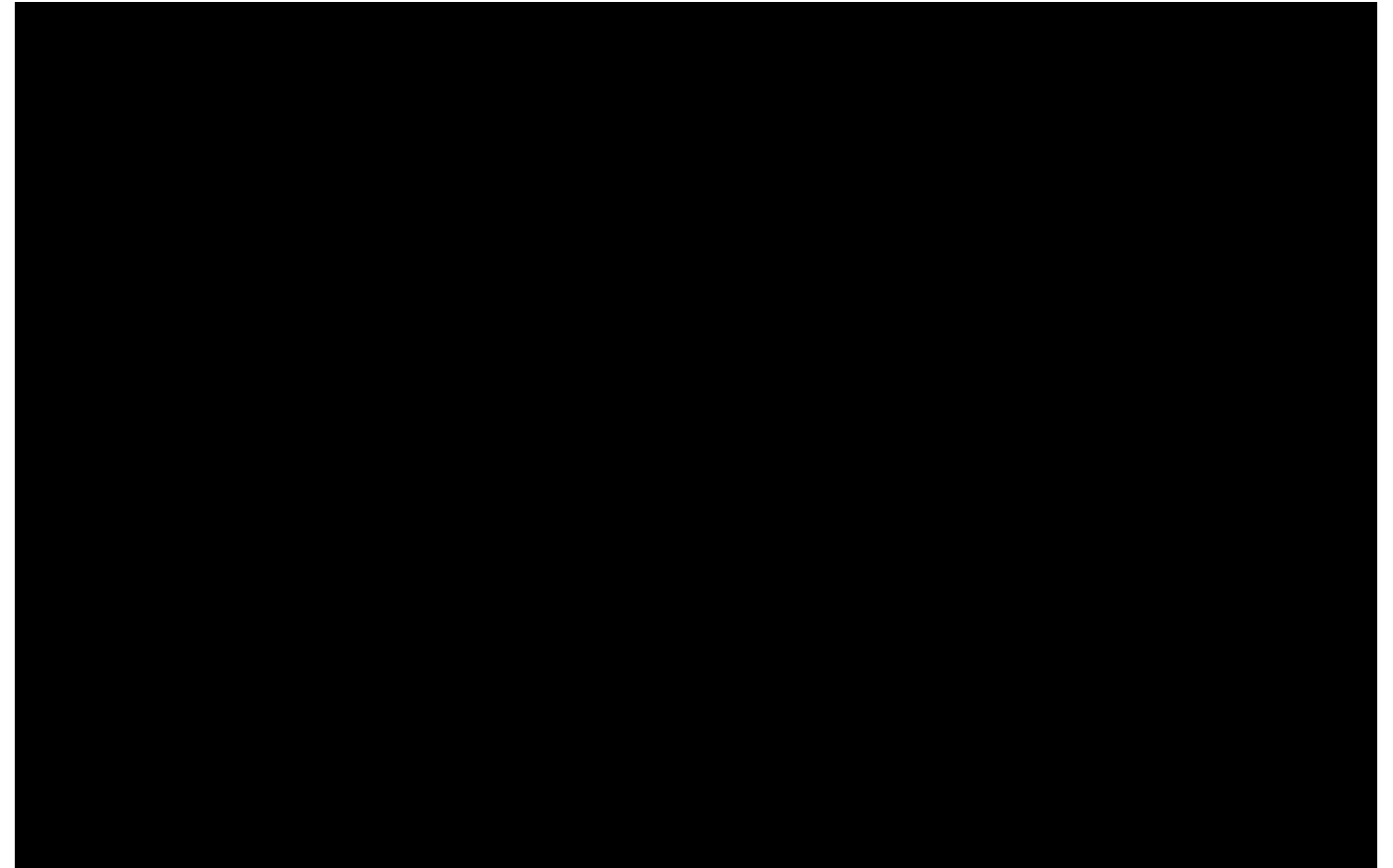
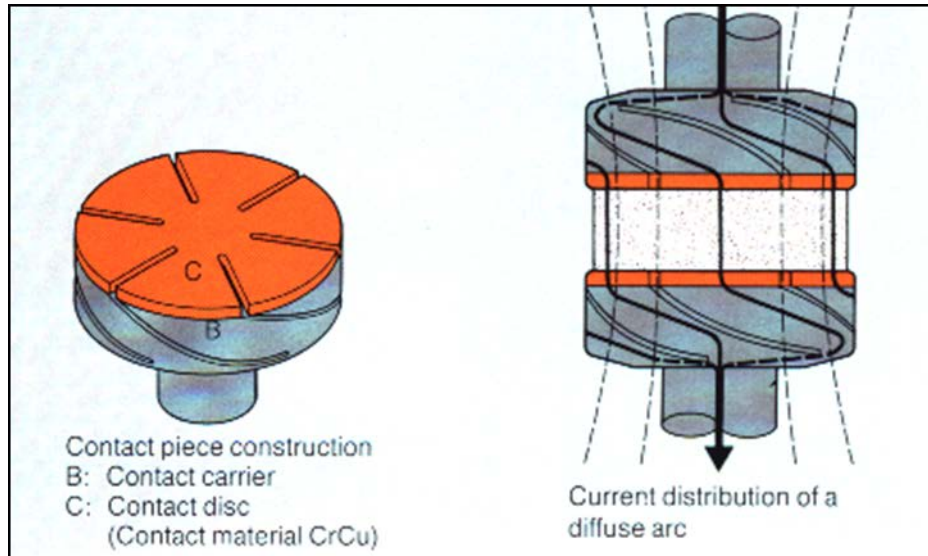
Moving constricted arc controlled by radial magnetic fields

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Diffuse arc controlled by axial magnetic field



Experimental data from short-circuit testing

48mm AMF and 45mm RMF
at $U_r=24\text{kV}$ and 11mm gap

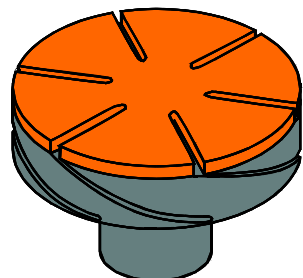
contact	pass	fail	total
AMF	146	51	197
RMF	252	38	290

62mm AMF at different
voltages and contact gaps

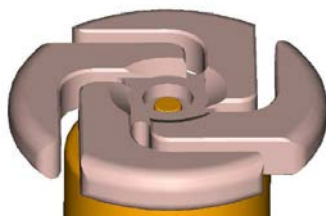
voltage (kV)	gap (mm)	pass	fail	total
17.5	7	85	26	111
24	7	19	5	24
30	7	14	10	24
36	7	15	9	24
38	14	71	18	89
36	19	323	87	410

Synthetic testing was a key component of these tests – allowed many failures to interrupt

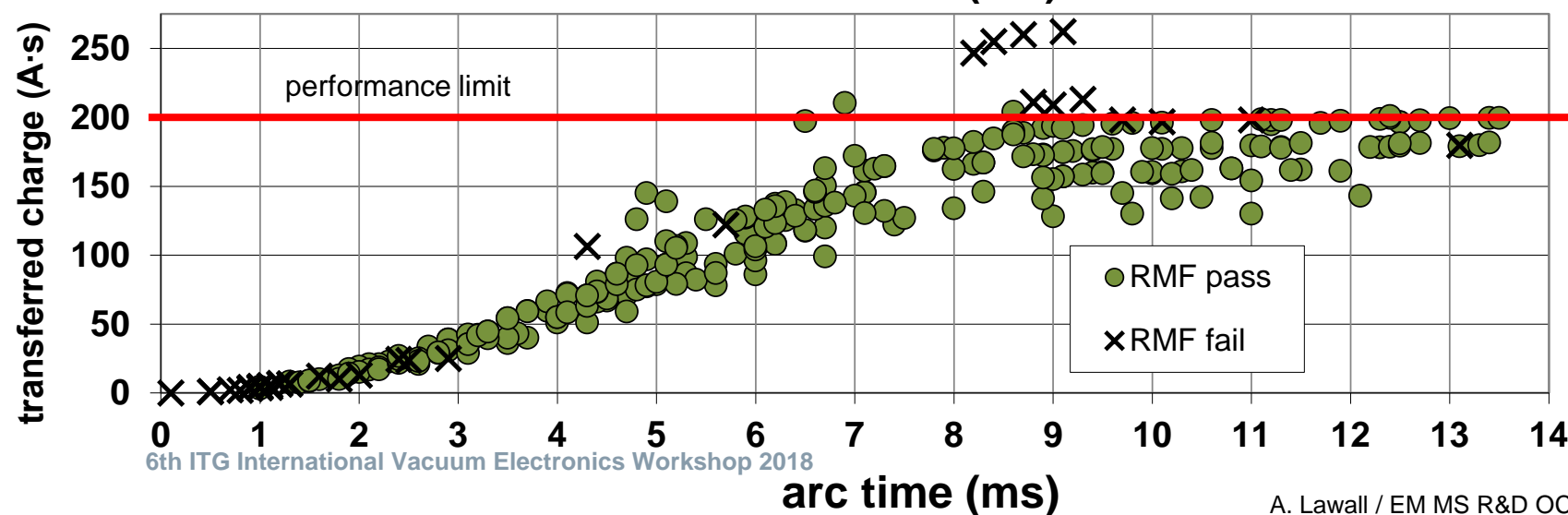
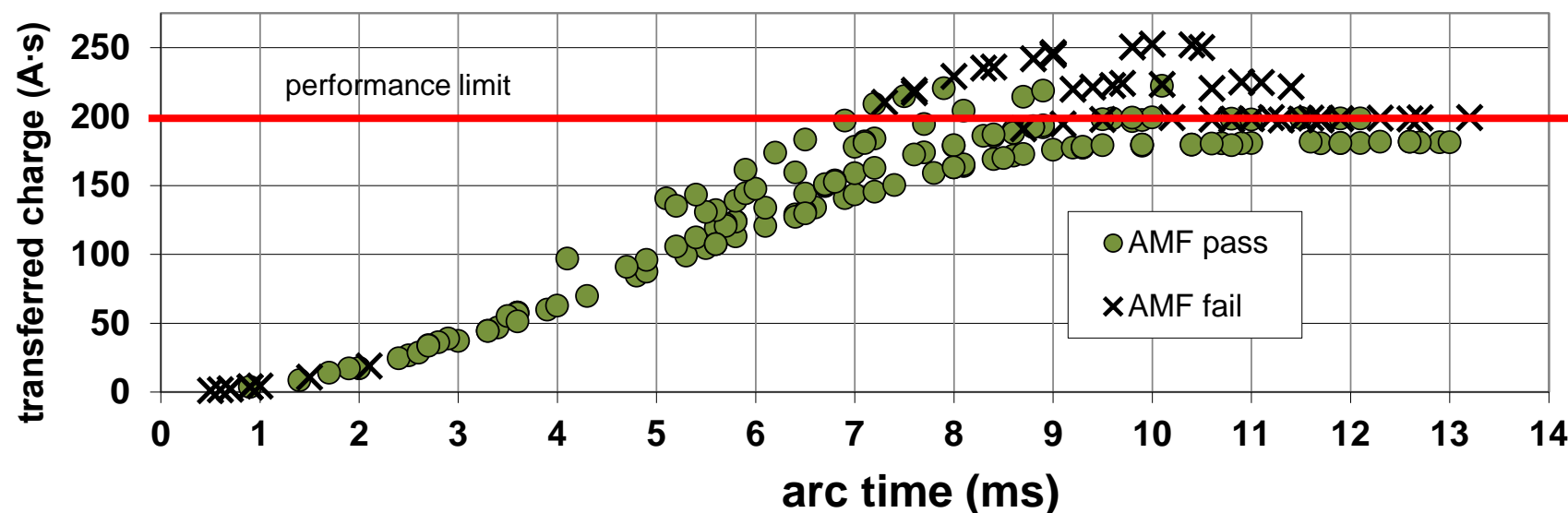
Interruption performance of 48mm AMF and 45mm RMF



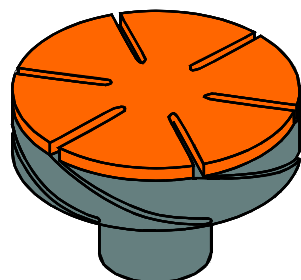
AMF contact



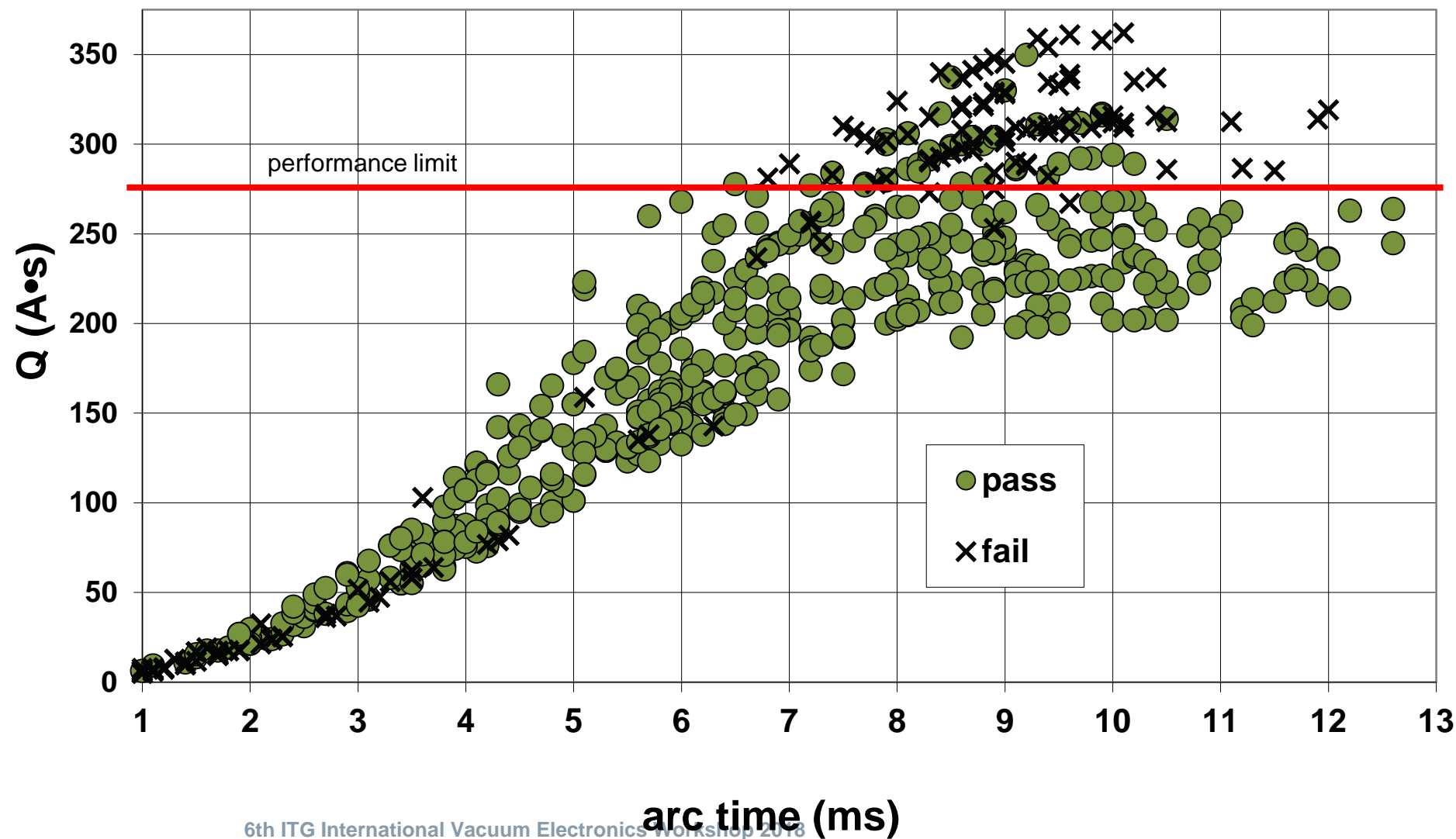
RMF contact



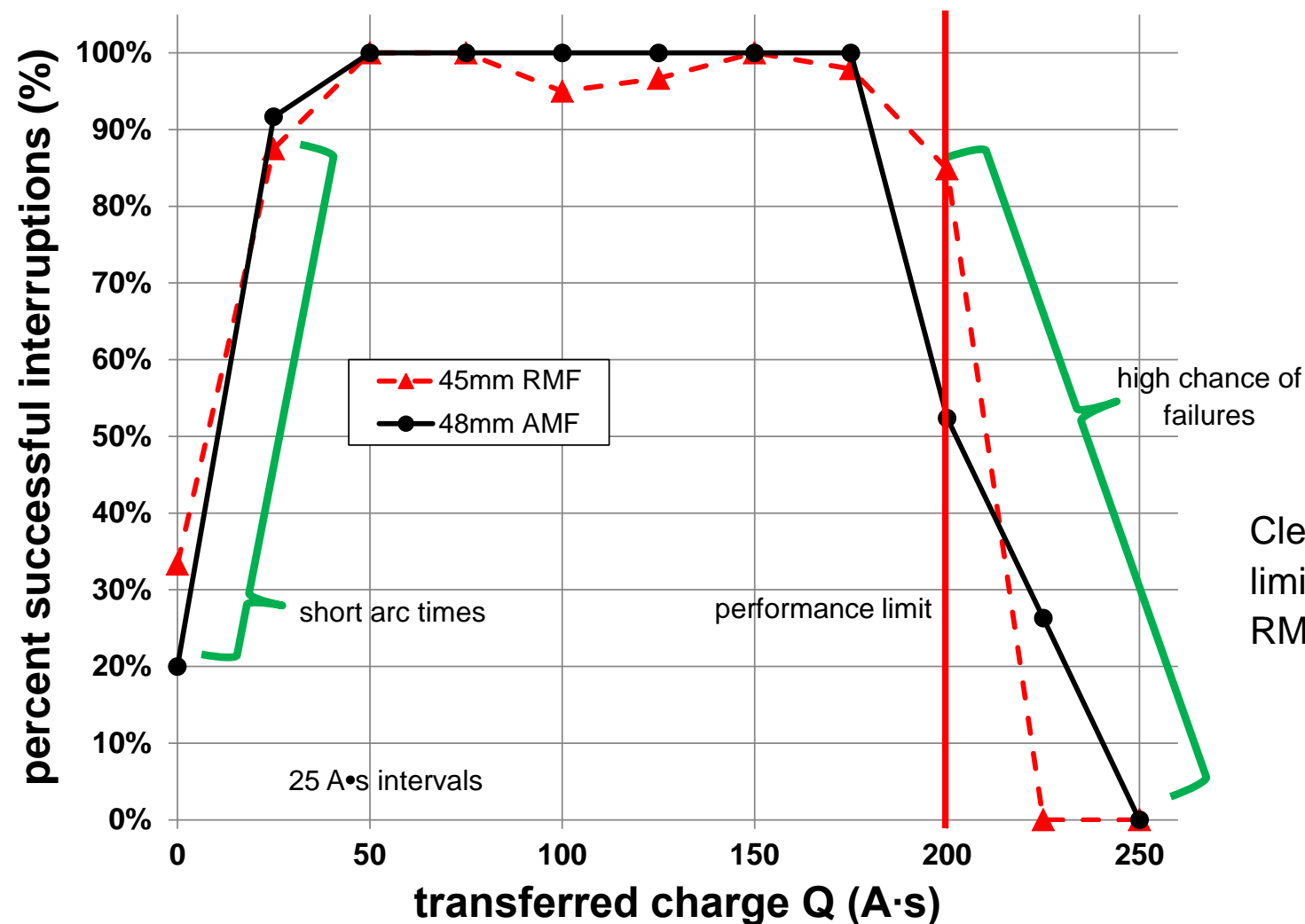
Early tests of interruption performance of 62mm AMF



AMF contact

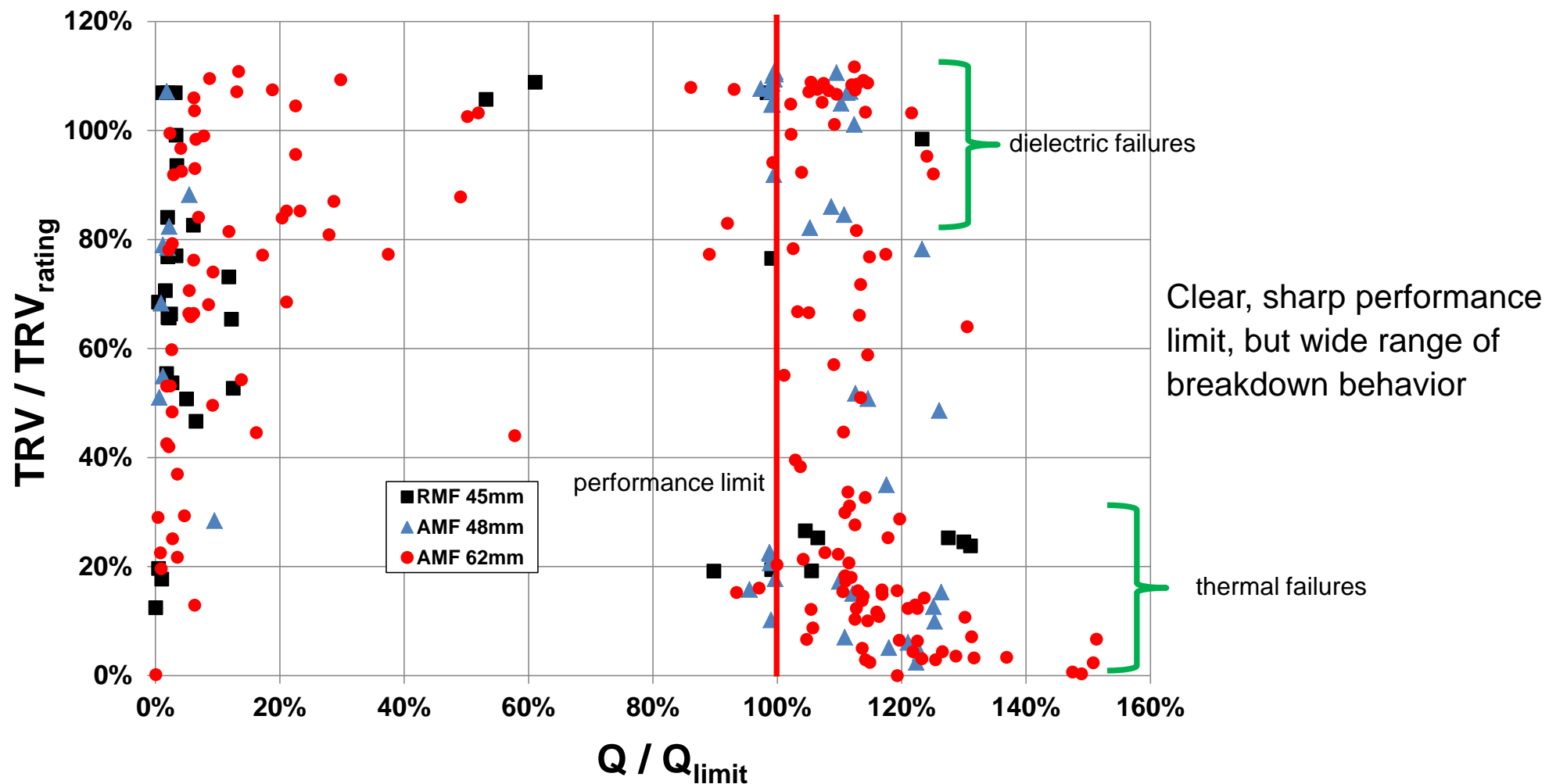


Interruption performance vs. transferred charge for 45-48mm AMF and RMF



Clear, sharp performance limit for both AMF and RMF designs.

TRV breakdown voltages as a function of transferred charge



Conclusions

- Measured the interruption performance limit of AMF and RMF contacts in vacuum interrupters.
- Both contact designs behaved similar.
 - Sharp boundary between high and low chance of successful interruption.
 - Similar contact diameters had very similar performance limit, for both AMF and RMF designs.
- When exceeding the performance limit, various failure mechanisms appeared.
 - Included both thermal and dielectric failure modes, as well as behavior in between the two.
 - This behavior appeared for both contact systems, and for different contact sizes.

Thank you for your attention!



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