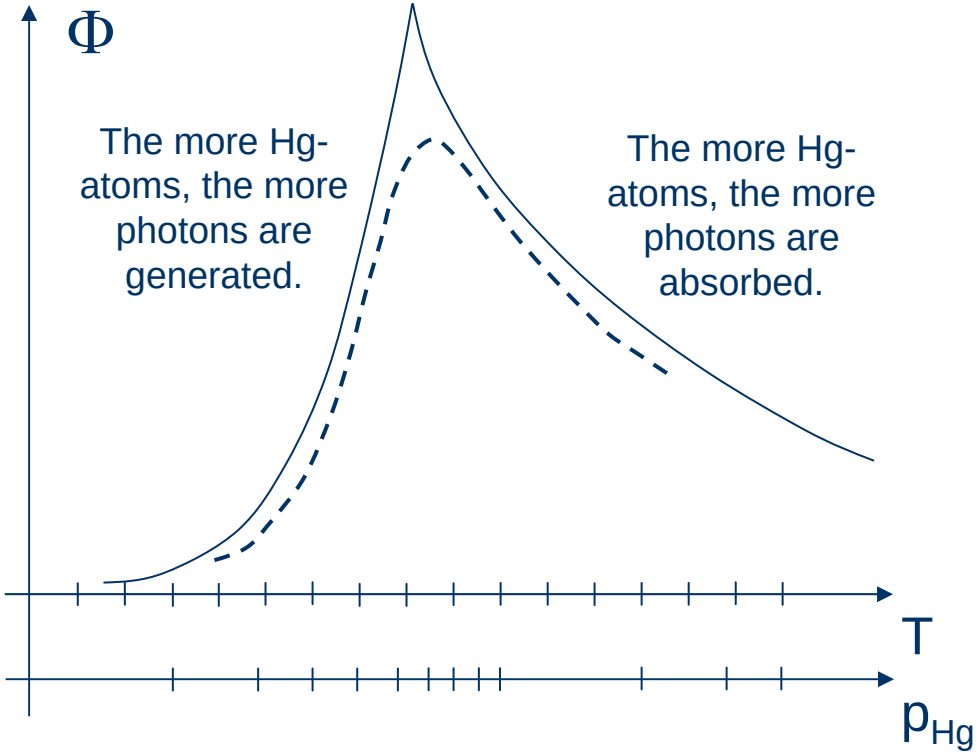
New technology:

T16mm(T5) HO Constant – fluorescent lamps with amalgam

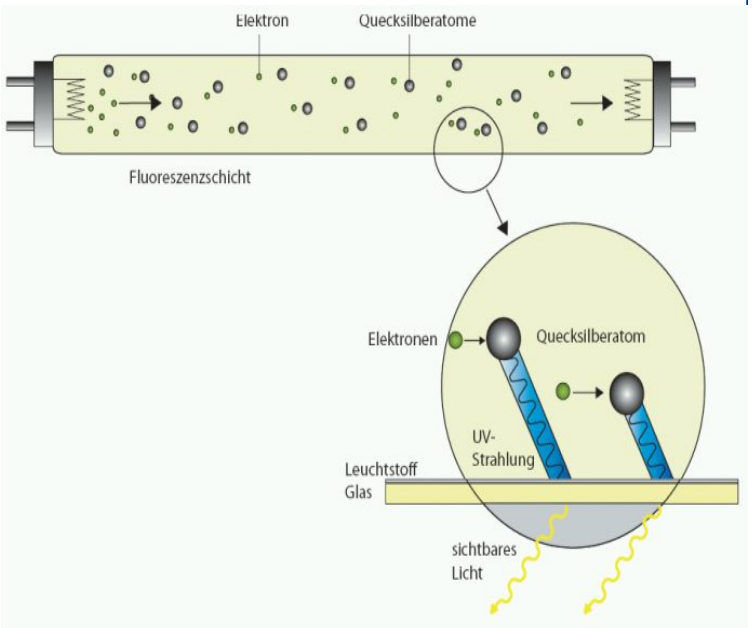
Basics, function and application

Basics 1: Low pressure Hg – discharge: generally

Influence of Hg-density (mercury atoms) to efficacy of a low pressure mercury discharge:



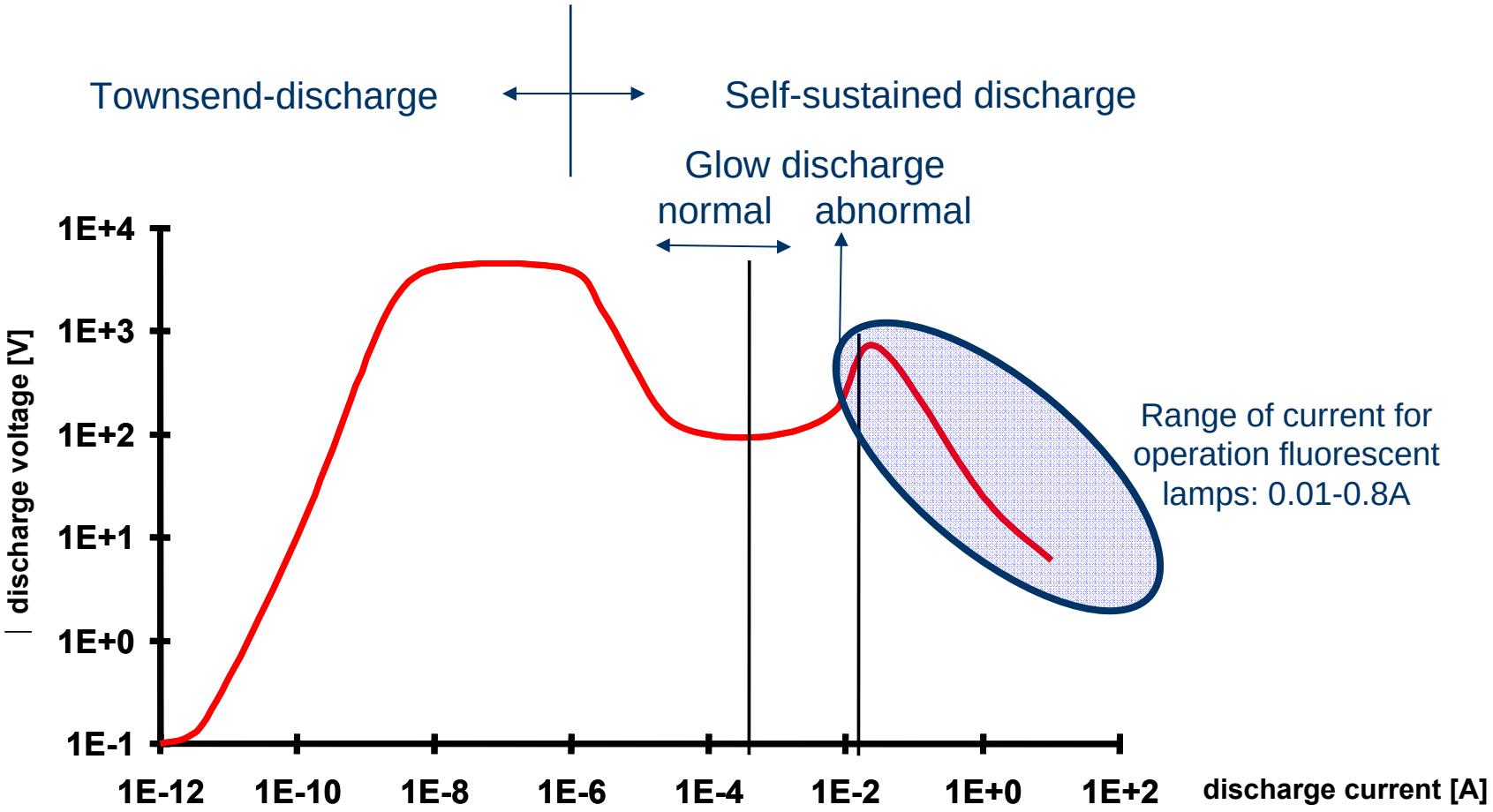
Basic process of the luminescence at low-pressure gas discharge in fluorescent lamps



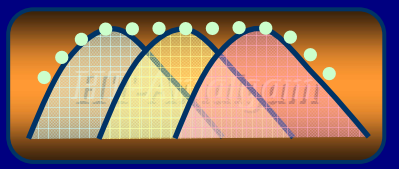
Entliehen aus http://www.baltensweiler.ch/lichttechapril05.pdf

Basics 2: operation modes fluorescent lamps

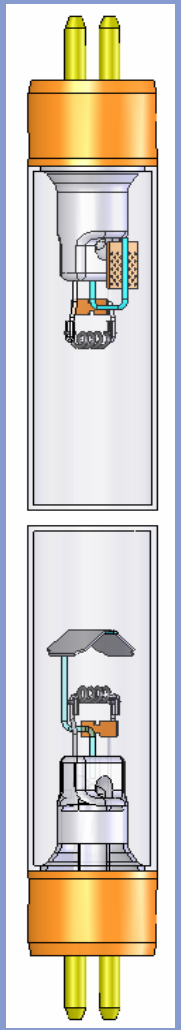
Discharge modes, indicated through the lamp current



Market requirement



T16mm(T5) Constant



HighTemperature Amalgam

A big disadvantage of fluorescent lamps: The extreme dependance of luminous flux and the ambient temperature.

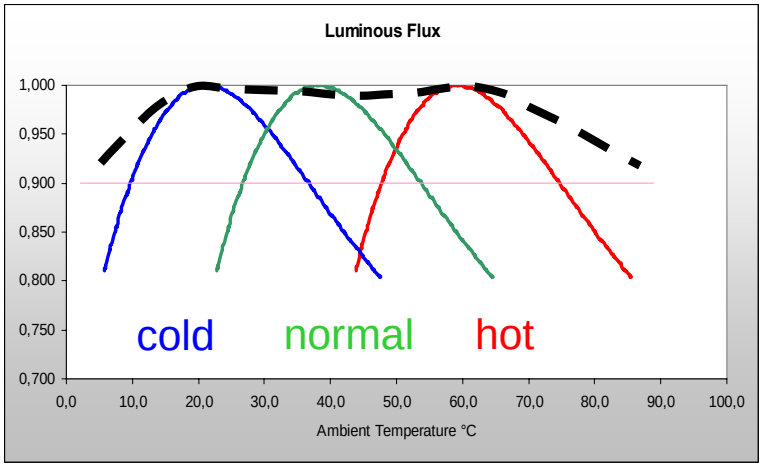
T16mm(T5) HO: max. luminous flux at 35°C, 90%-Range 25...50 °C

Not suitable for: Outdoor-Applications
open luminaries < 25°C
hot luminaries > 60°C

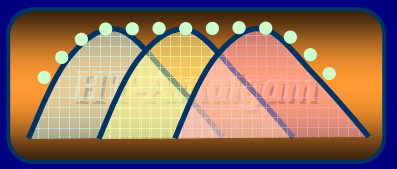
→ **HO Constant**

One type of lamp for
the whole temperature range

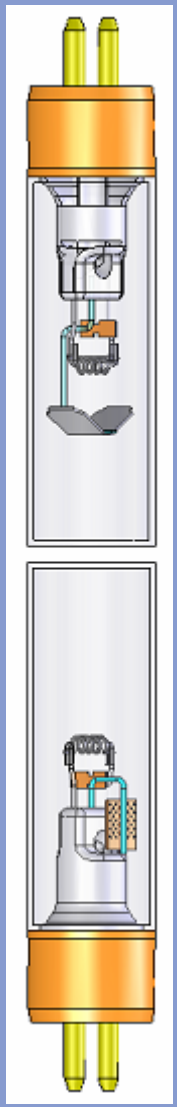
from 5°C up to >70°C



What is an Amalgam?



T5 Constant



Definition:

Mercury-Metal-Alloy
e.g. mercury (Hg) + silver (Ag), copper (Cu), indium (In), tin (Sn), bismuth (Bi)

used for T5 Constant:
25 mg indiumsilver + 2,5 mg mercury (dosed with „Hg-roof“)
Melting area: InAg+Hg: ca. 90 ... 140°C

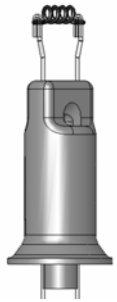
Usage:

- Tooth filling material (Hg>50%)
- Amalgam-lamps (Hg <= ca.10%)
  e.g. DULUX TE-IN, T5 Constant, DULUX L Constant

Function in the lamp:

- Controlling of the mercury vapour pressur

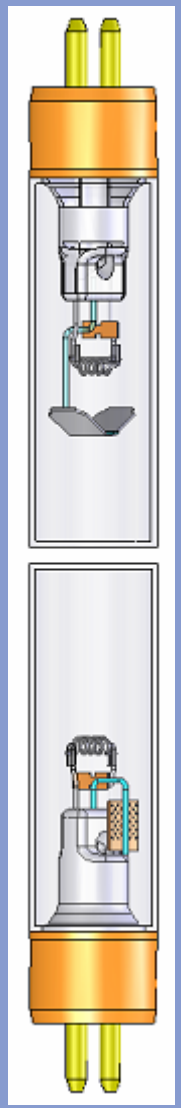
⟷ different to cold chamber technology



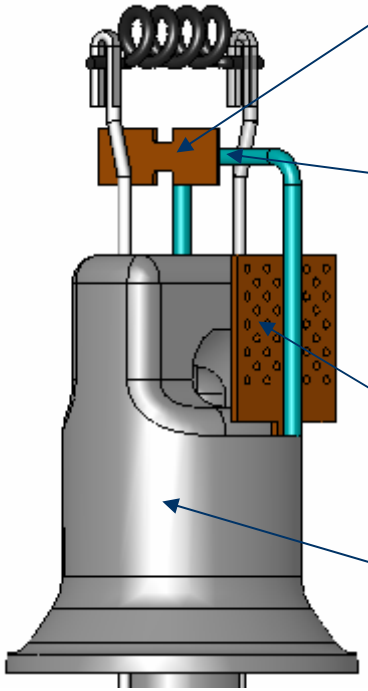
OSRAM

Mounting construction of the labeled side

T5 Constant



HO54W Constant



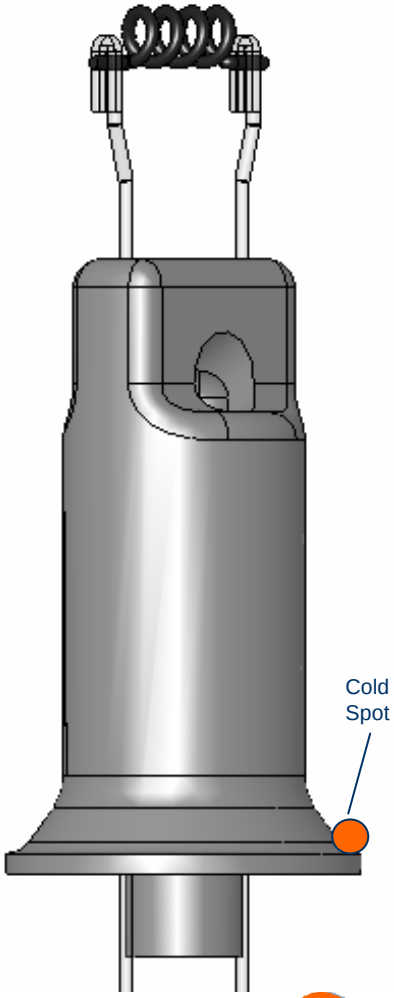
carrier for run-up amalgam:
1 mg In

holder

carrier for working
amalgam: 25 mg InAg

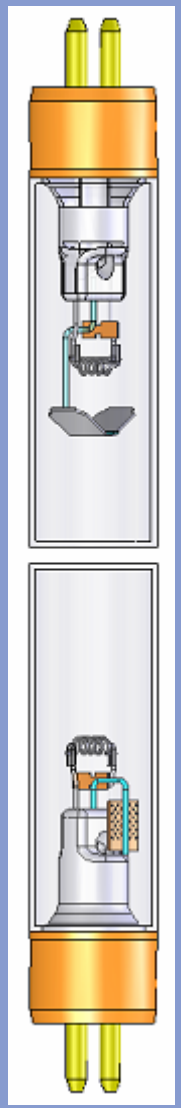
shorter lenght for
mount at Constant-lamps

HO54W Standard

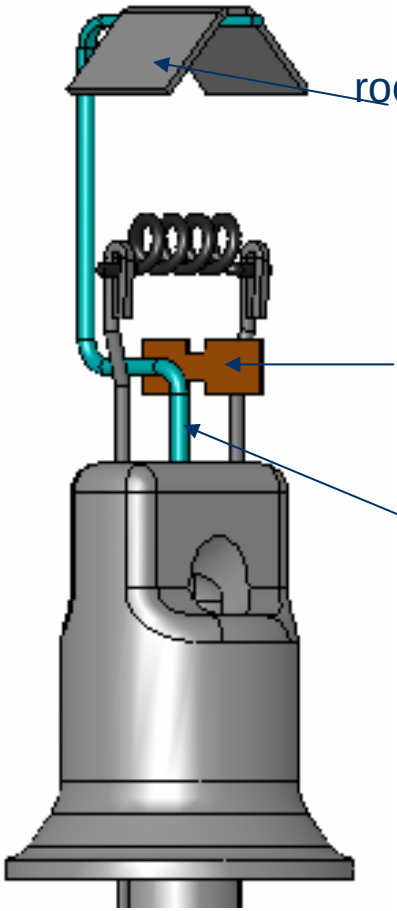


Mounting construction of the not labeled side

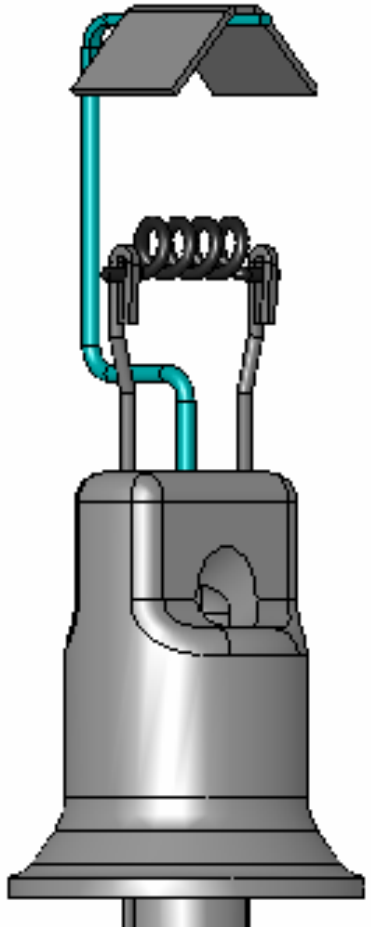
T5 Constant



HO54W Constant

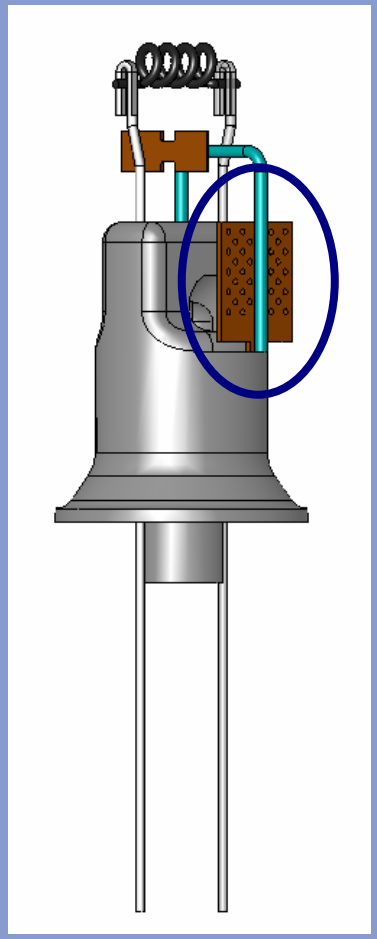


HO54W Standard

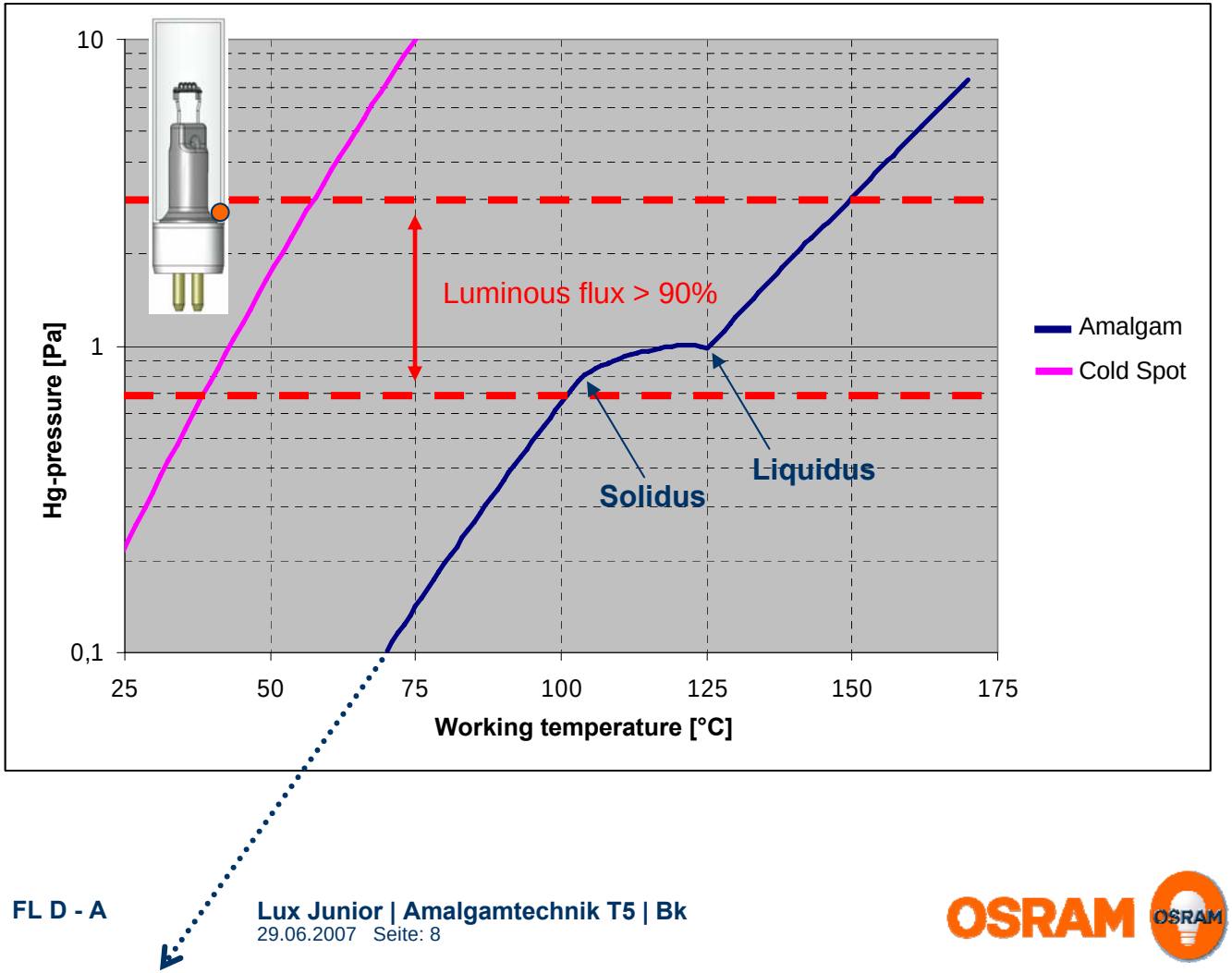


Function of the working amalgam 1

Working amalgam 25mg InAg

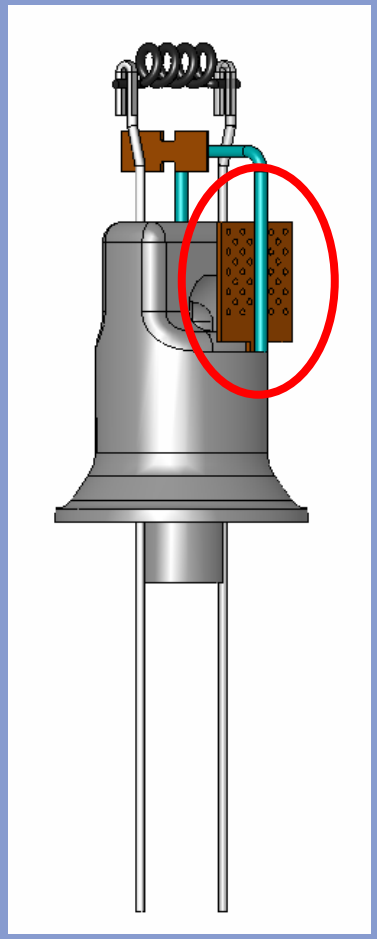


Hg-mercury pressure:

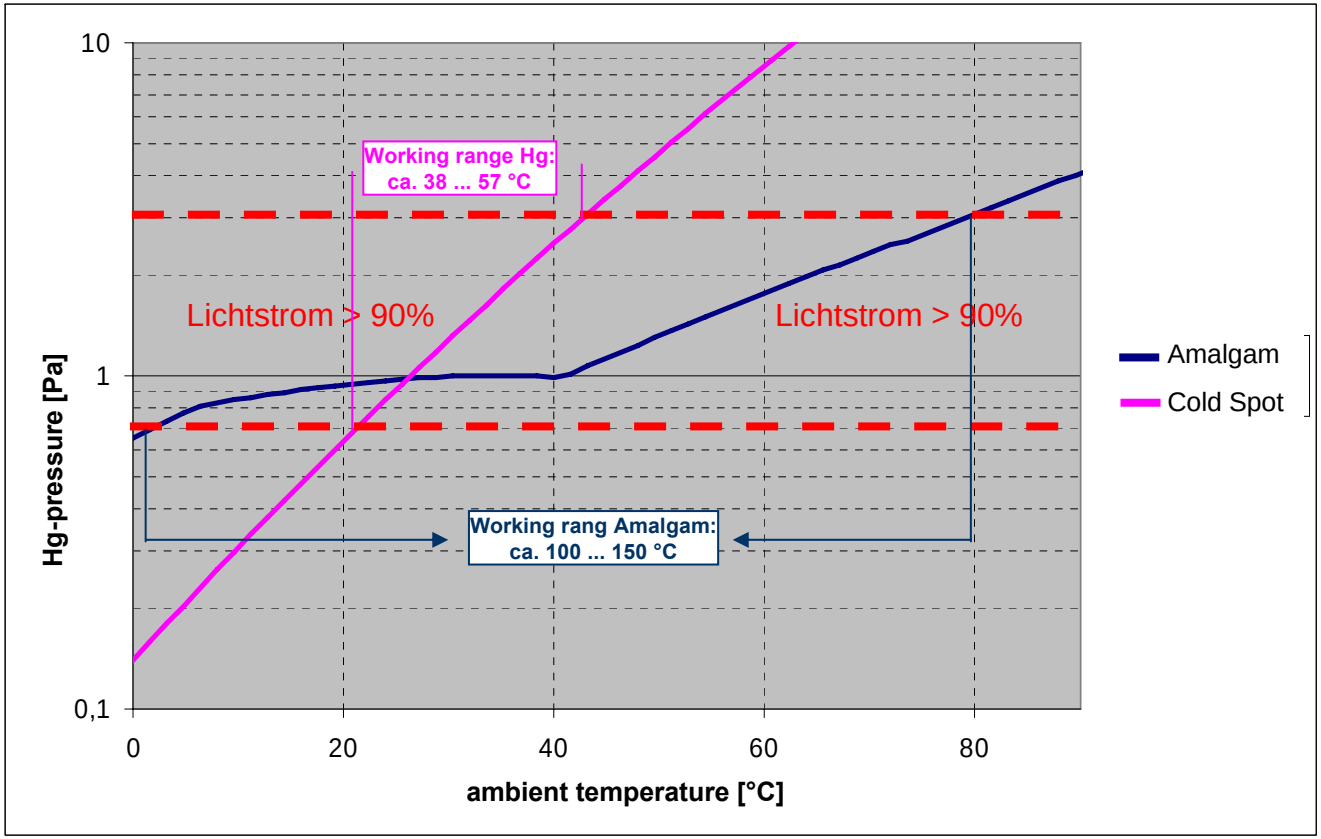


Function of the working amalgam 2

Working amalgam 25mg InAg

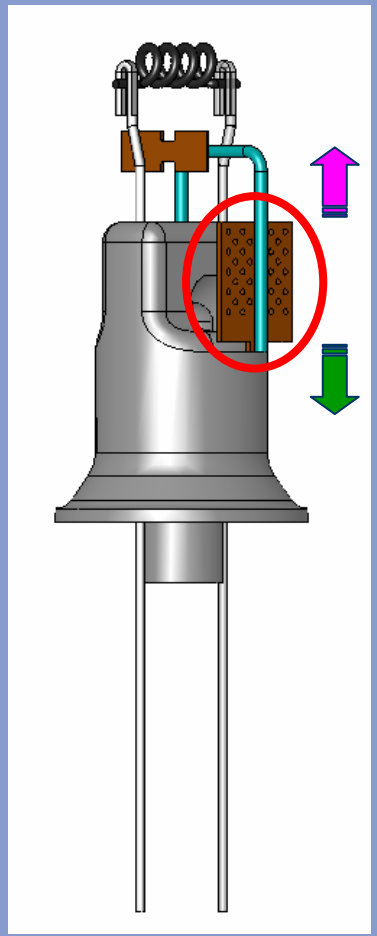


Hg vapour pressure:

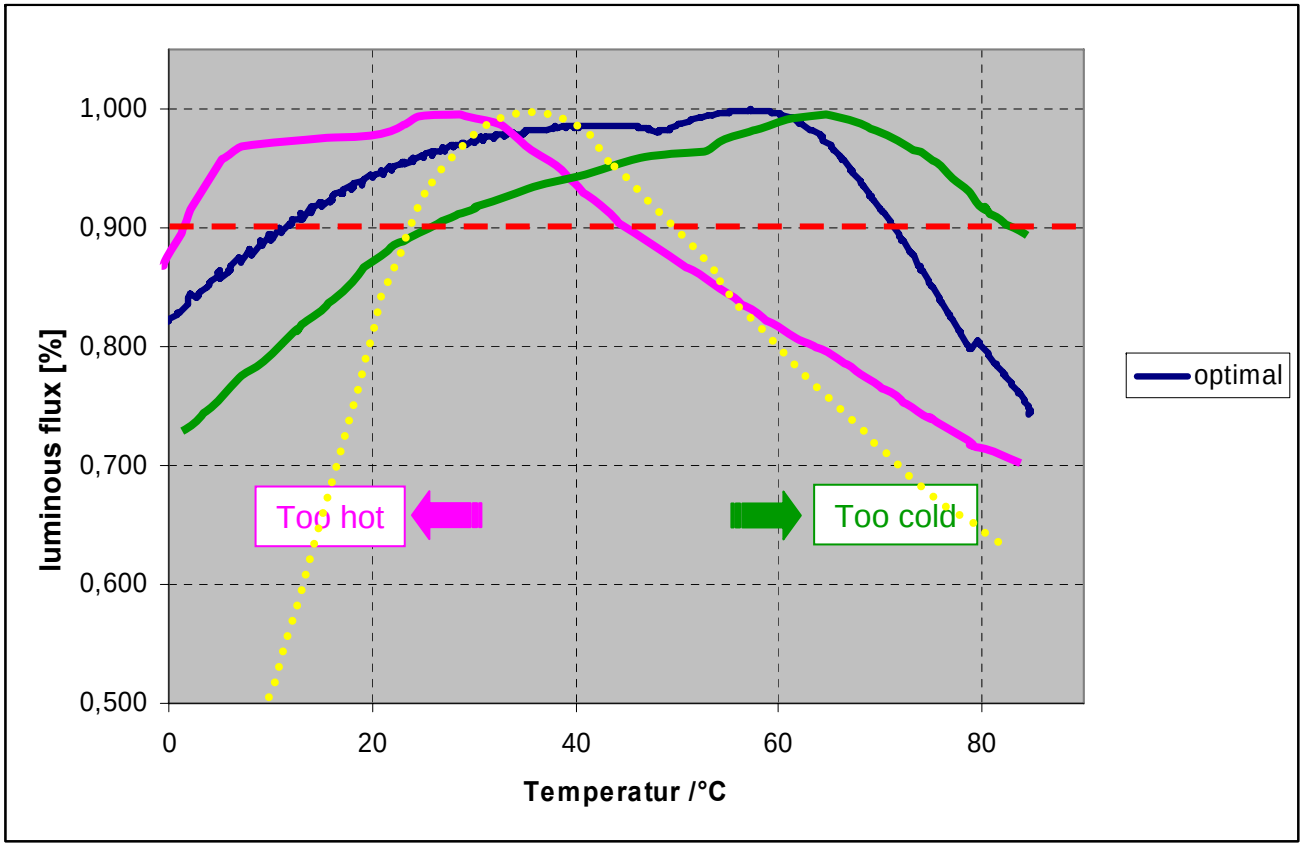


Function of the working amalgam

Working amalgam 25mg InAg

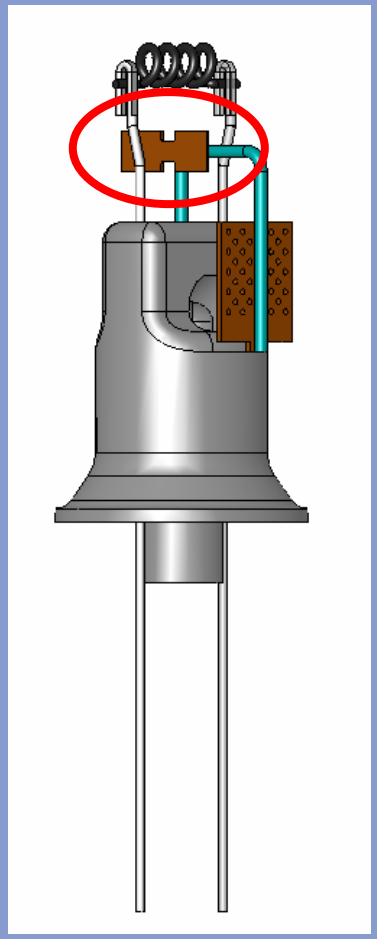


Luminous flux vs. Ambient temperature:

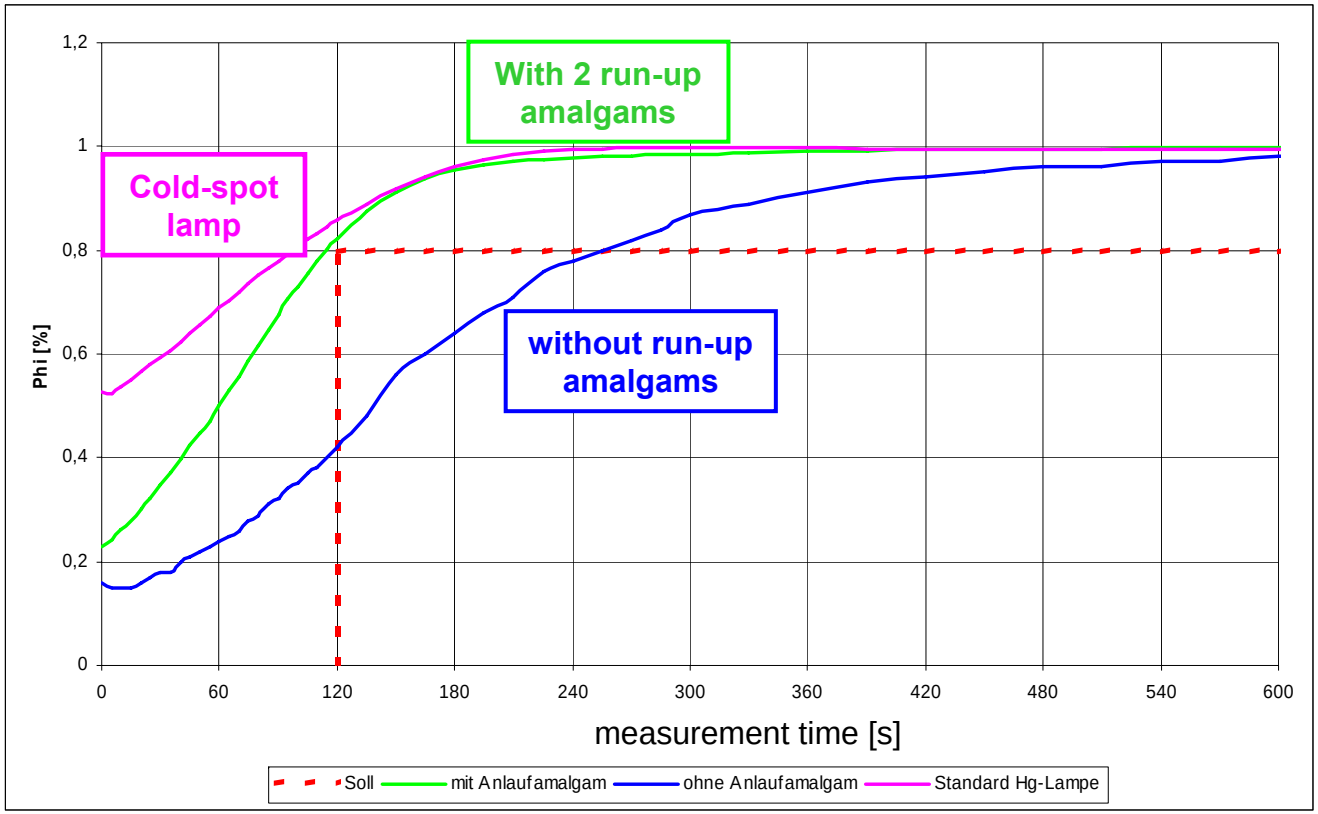


Function of the run-up amalgam

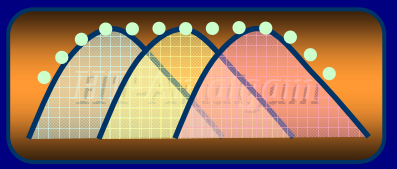
Run-up amalgam 1mg In

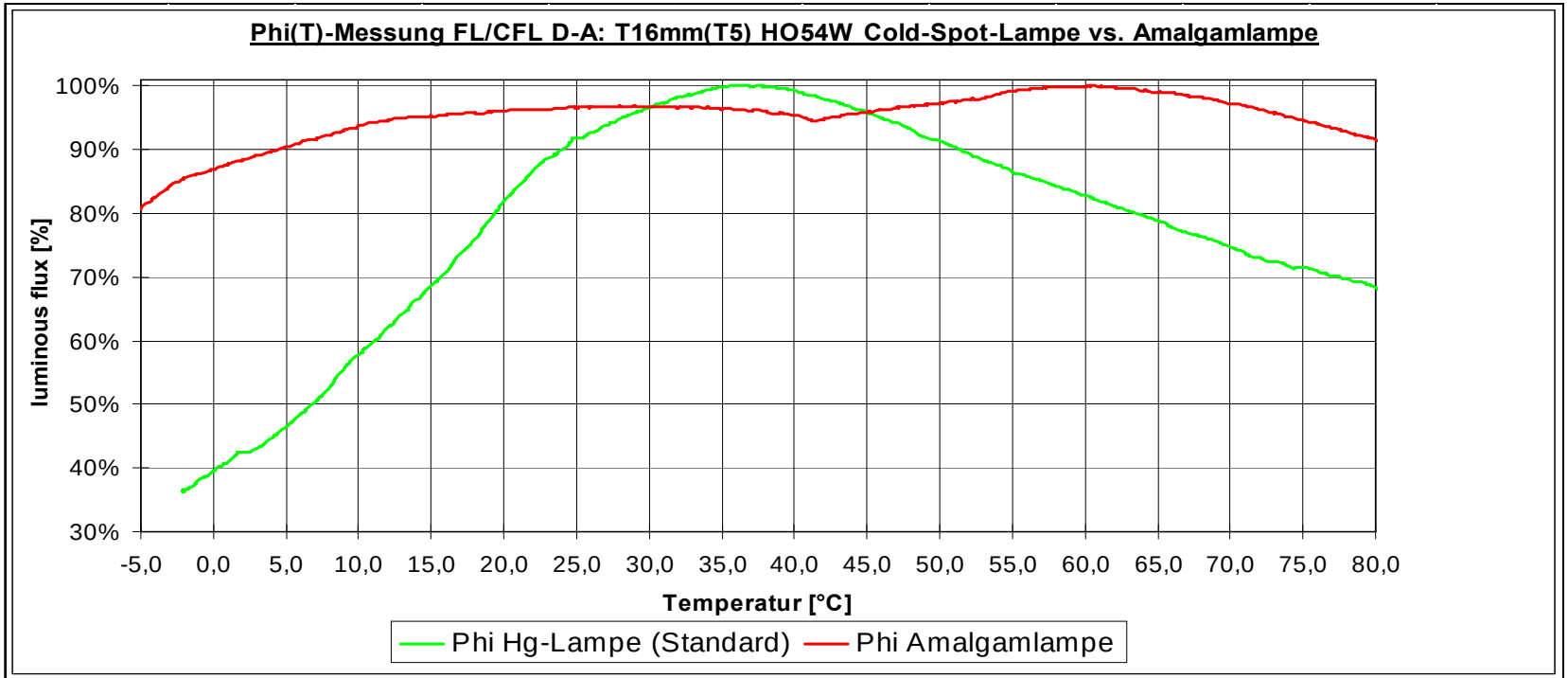


Rising of the luminous flux after 30min Off-time:



Phi(T)-charts: comparison of a 54W Constant-lamp vs. Standard-lamp





Datei:	Vergleich_T16HO54W_HgLp_vs__AmalLp.xls
Lampentyp:	T16 HO
Brennlage:	waagrecht
Versorgung:	235,0V, 25000,0Hz, U Versorgung konstant
Vorschaltgerät:	IEC 60081: HO 54W - 235V, Widerstand 255 Ohm
Temperaturprofil:	Standard
Versuchsnr.:	Sc02212 Amal575

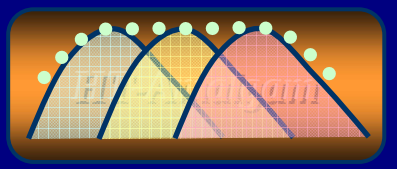
Bemerkung: Vergleichsmessung Standard-Hg-Lampe vs. Amalgam-Lampe

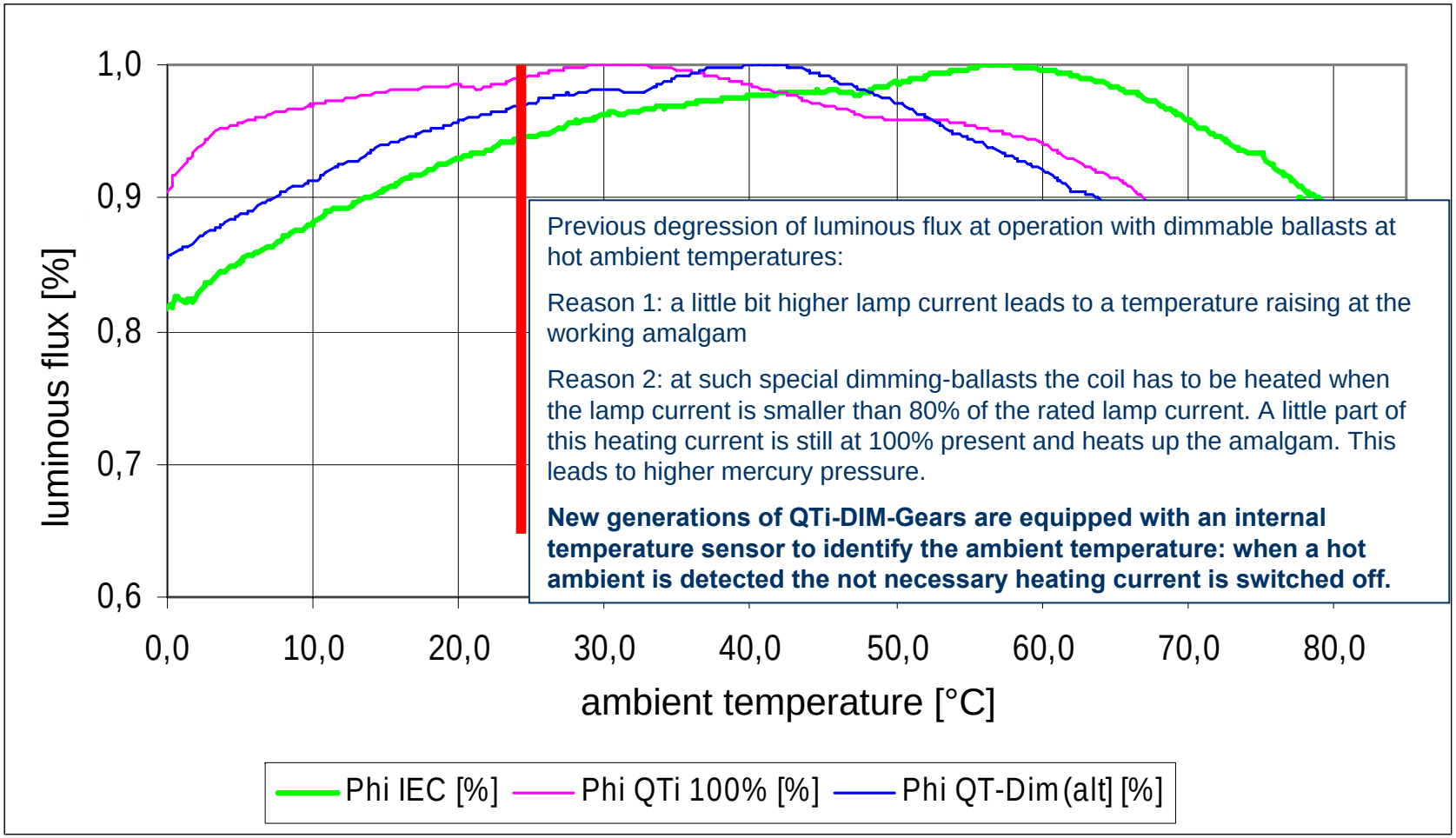
Broader 90%-area of luminous flux due to:

1.) thermal seperation of the Hg vapor source from ambient temperature

2.) usage of a HT-amalgam with adapted and broadened phase intersections with nearly constant Hg vapour pressure (patented)

Phi(T)-chart with dimmable ballast: 54W Constant at QTi-DIM amd QT-DIM-ECG at 100%





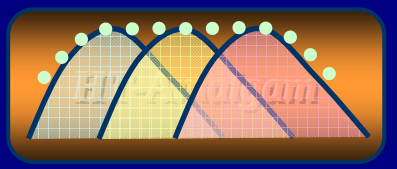
Previous degression of luminous flux at operation with dimmable ballasts at hot ambient temperatures:

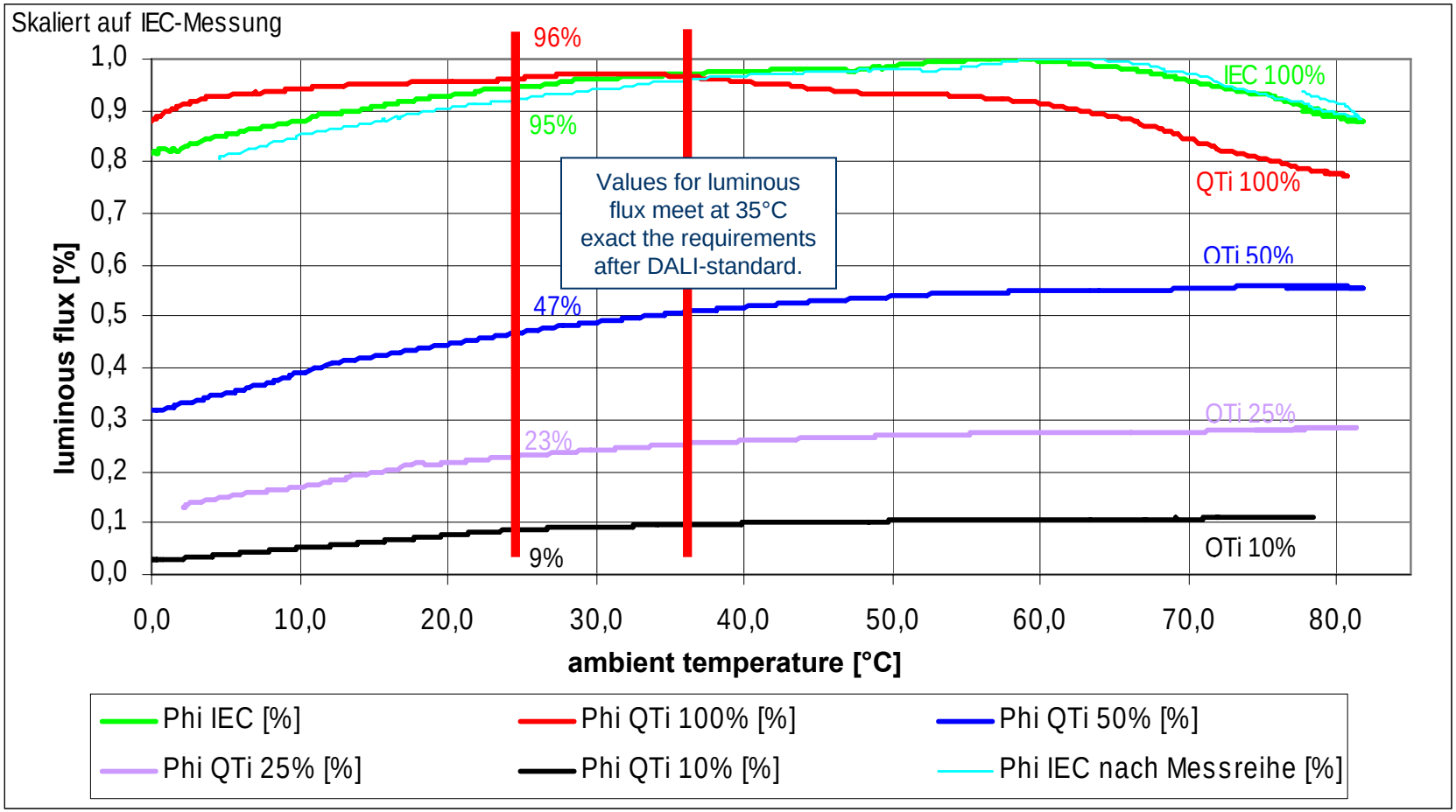
Reason 1: a little bit higher lamp current leads to a temperature raising at the working amalgam

Reason 2: at such special dimming-ballasts the coil has to be heated when the lamp current is smaller than 80% of the rated lamp current. A little part of this heating current is still at 100% present and heats up the amalgam. This leads to higher mercury pressure.

New generations of QTi-DIM-Gears are equipped with an internal temperature sensor to identify the ambient temperature: when a hot ambient is detected the not necessary heating current is switched off.

Phi(T)-Charts: 54W Constant with ECG QTi-DIM in different dimming positions

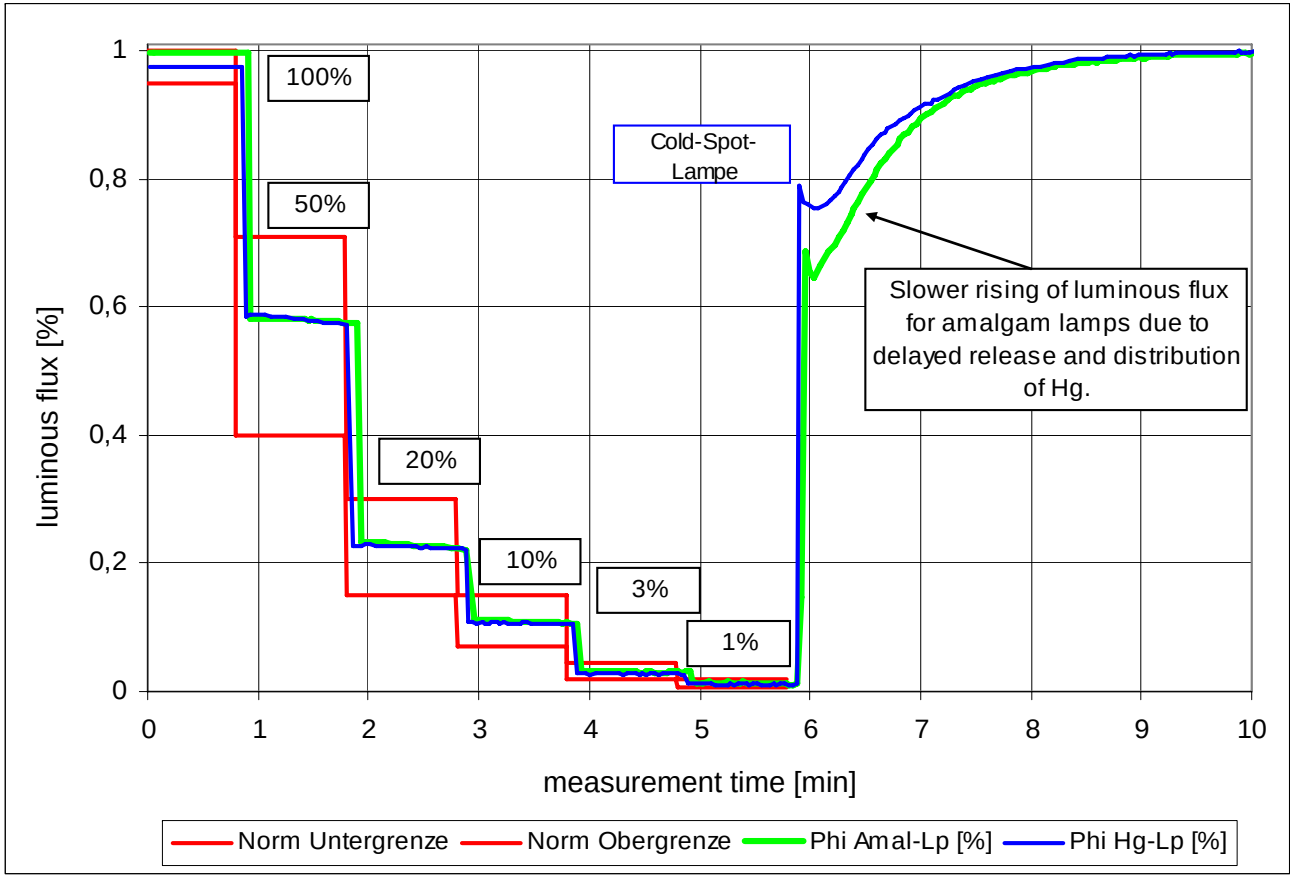




Dauer je Messung 24h: 4h Stabilisierung bei 80°C, dann decrementieren der Temperatur (5°C/h)

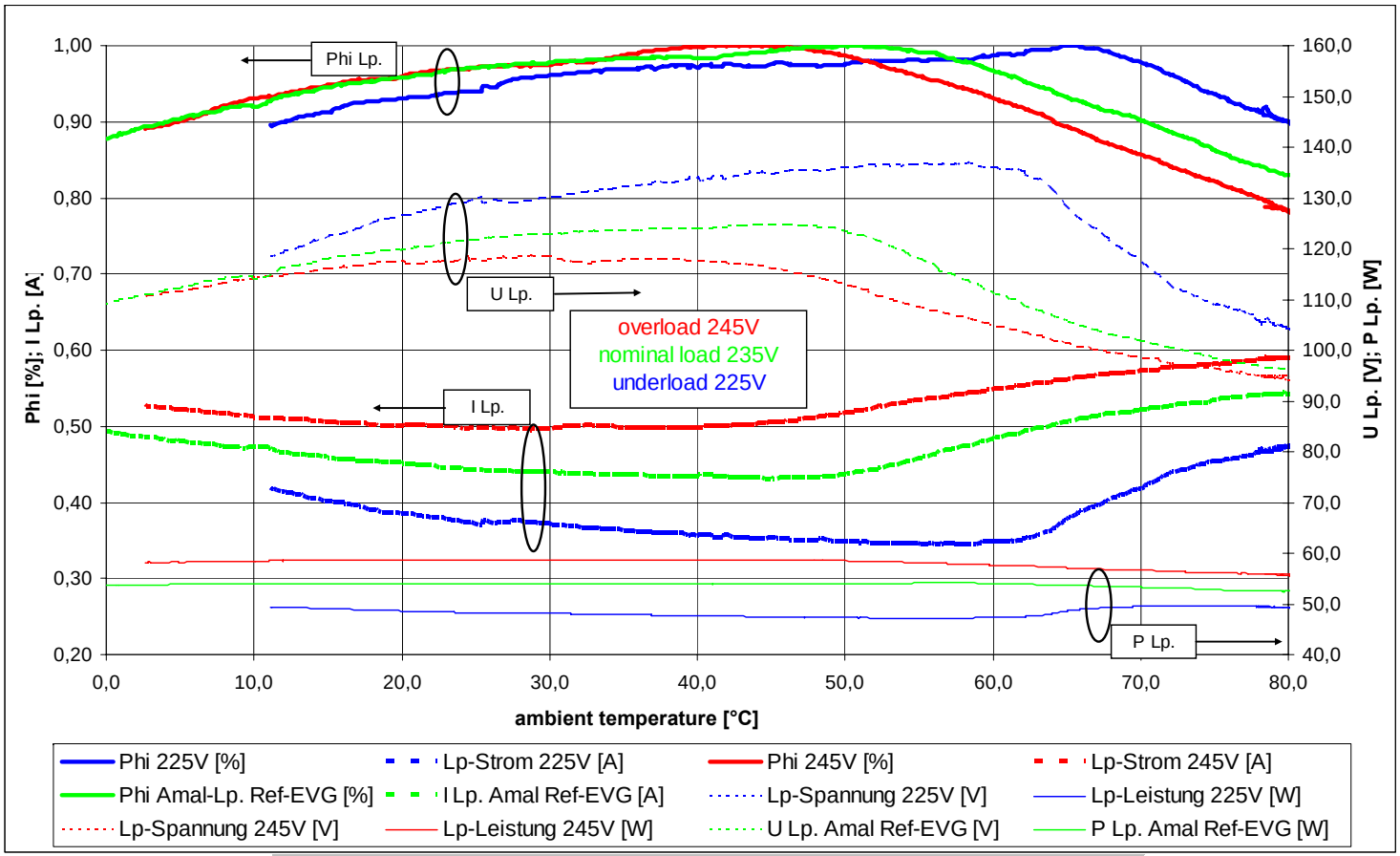
Comparison of linearity: luminous flux 54W Constant- and Cold-Spot-Type when dimmed with QTi

DALI-conformity demands for dimming systems defined areas (for luminous flux).



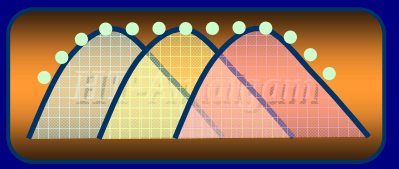
Lampen wurden 20h stabilisiert und bei 25°C wie in Dali-Testsequenz G.4.2.1 "Logarithmic dimming curve„ beschrieben stufenartig gedimmt.

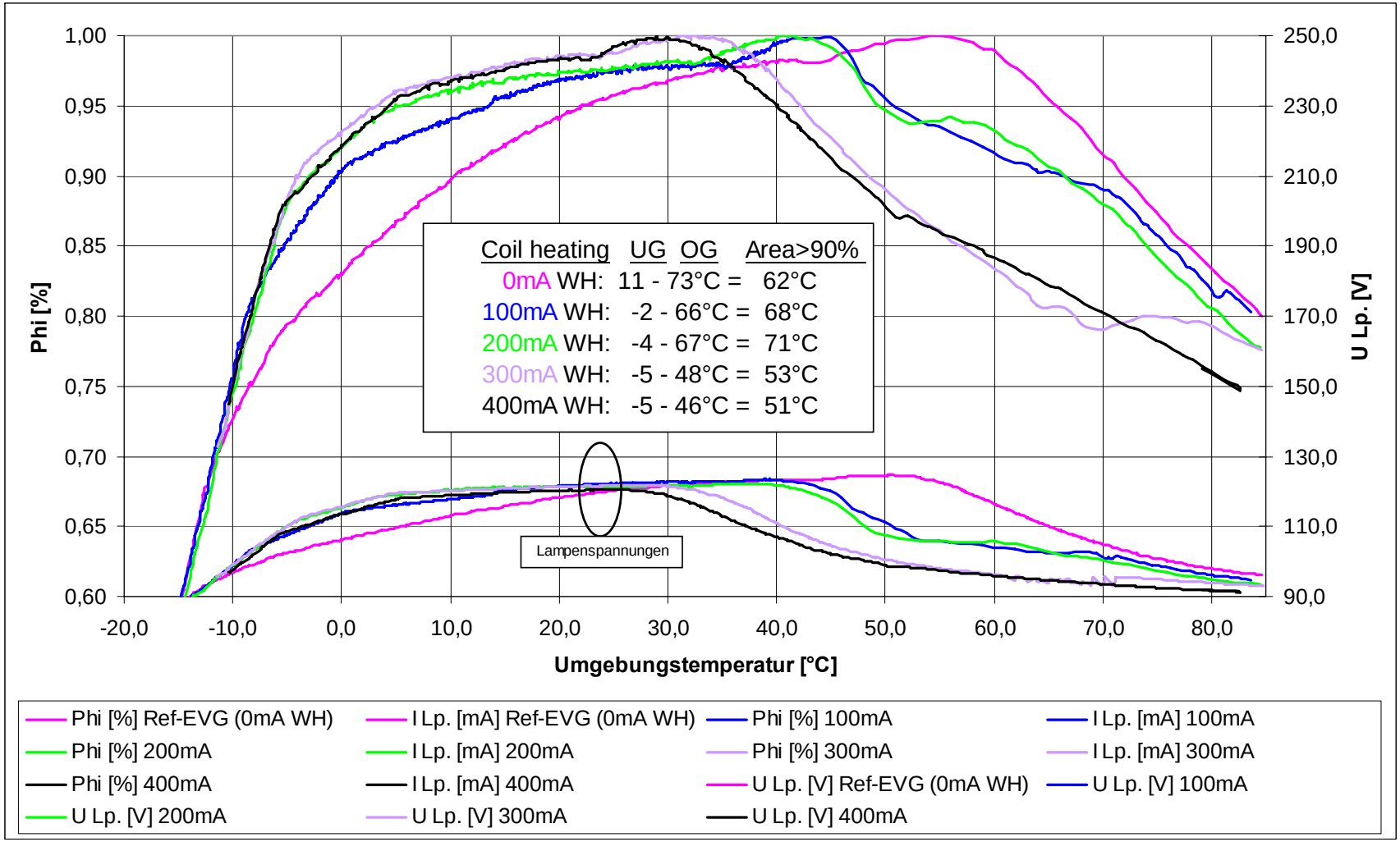
Constant 54W Amalgamlamp with overload / underload (at IEC-Ref-Gear)



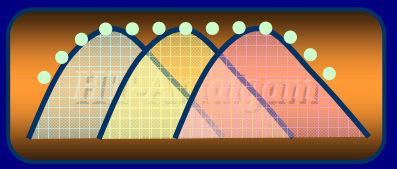
Daten:		Breite 90%	U max [V]	I max [mA]	P max [W]
IEC nominal 235V:		66°C	125	549	54,2
underload 225V:		68°C	137,2	477	49,7
overload 245V:		60°C	118,9	592	58,8

Consequences of permanent coil heating to the thermal behavior of a HO54W Constant

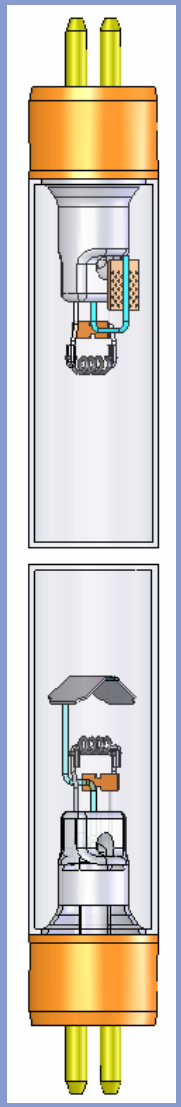




Summary



T5 Constant



Advantage of T5 HO Constant with amalgam:

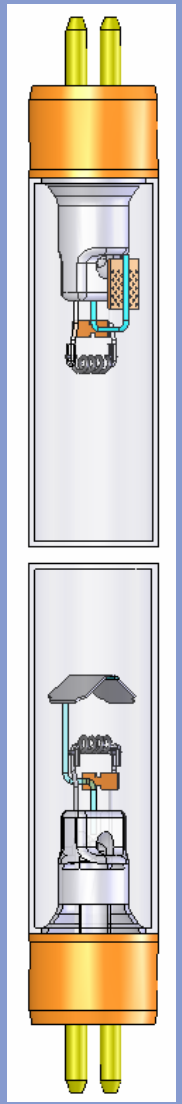
- \+ Luminous flux > 90% from 10°C – 70°C ambient temperature
- \+ Stable light color over the whole temperature range
- \+ Higher light output at 25°C (ca. 5%)
- \+ Longer bright surface (no long mount at marked side)
- \+ In future higher wattages possible (z.B. VHO120W)

Limitations to standard cold-spot-lamps T5:

- \+ Slower lumen run-up behavior
- \+ Limeted dimability with unsutiable Dim-ECG‘s

End

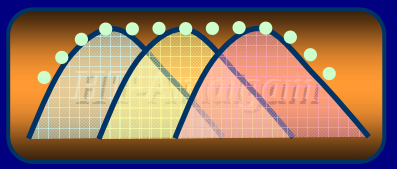
T5 Constant



Thank you for attention!

Vielen Dank für Ihre Aufmerksamkeit!

Abstract (german)



Leuchtstofflampen gehören zu den wichtigsten und effizientesten Lichtquellenarten. Ein großer Teil des in der heutigen Zeit künstlich erzeugten Lichts wird mit Hg- Niederdruckentladungslampen erzeugt.

In den letzten Jahren hat sich eine neue Familie von stabförmigen Lampen mit einem Außendurchmesser von nur *16mm* etabliert *(T5)*. Der maximale Lichtstrom dieser Lampen wird bei einer Temperatur von ca. 35°C erreicht, was den meisten Anwendungen gerecht wird. (Vergleich zu *26mm*-Lampen *(T8)*: Maximum bereits bei ca. 20°C - 25°C, dies führt in Leuchten bei Raumtemperatur durch die Eigenerwärmung zu einem Verlust im Lichtstrom.)

Eine Weiterentwicklung stellt der neue Lampentyp *T16mm HO Constant* dar, hier ist ein effizienter Einsatz über einen erweiterten Temperaturbereich unter Verwendung der Amalgamtechnologie möglich. Somit sind Anwendungen in Bereichen sowohl mit hohen als auch niedrigen Umgebungstemperaturen realisierbar, welche bisher nicht effizient mit Leuchtstofflampen betrieben werden konnten.

Der temperaturabhängige Lichtstrom von herkömmlichen Lampen des Typs *T26mm und T16mm* durchläuft ein Maximum, welches durch den Quecksilberdampfdruck bestimmt ist.

Einerseits werden bei geringeren Temperaturen weniger UV-Quanten erzeugt. Andererseits werden bei zu hohen Temperaturen die erzeugten UV-Quanten von der hohen Menge Quecksilberatome wieder absorbiert.

Dieses unerwünschte Temperaturverhalten kann durch die Amalgamtechnologie vermieden werden.

Das Amalgam wirkt als Quecksilbersenke und stellt zusätzlich den Hg-Dampfdruck ein.

Durch Auswahl eines geeigneten Amalgams wird der für Leuchtstofflampen technisch benötigte Quecksilberdampfdruck deutlich erweitert.

Somit kommt es zu einer Aufweitung des Temperaturbereichs, in dem der Lichtstrom mehr als 90% des Lichtstrommaximums beträgt. Diese Breite des Temperaturbereichs beträgt für Standardlampen *T16mm HO* ca. 27°C, für Amalgamlampen *T16mm HO Constant* > 65°C.

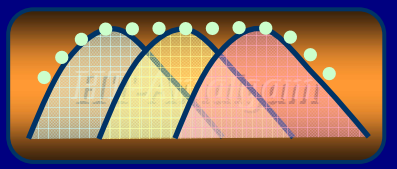
Die Verbreiterung des Temperaturbereichs wird durch zwei Effekte bestimmt. Zum einen ist das den Dampfdruck bestimmende Element (Amalgam) von der Kolben- und damit von der Umgebungstemperatur thermisch entkoppelt. Zum anderen erstreckt sich der fest-flüssig-Phasenübergang des verwendeten InAg6Hg10 Amalgams beim optimalen Dampfdruck über einen Arbeitstemperaturbereich von ca. 25°C.

Es werden Konstruktionsmerkmale zur Dampfdrucksteuerung präsentiert und der Zusammenhang zwischen dem Abstand Amalgamträger-Wendel erklärt.

Zur Erhöhung der Geschwindigkeit des Lichtstromanstiegs beim Einschalten der Lampe wird ein sog. Anlaufamalgam verwendet, dessen Funktionsweise ebenfalls erläutert wird.

Weiterhin werden verschiedene Lichtstrom-Umgebungstemperatur-Abhängigkeiten für unterschiedliche Lampenbetriebsarten aufgezeigt. Abschließend wird auf das Dimmverhalten des neuen Lampentyps eingegangen.

Abstract (english)



Fluorescent lamps are one of the most important and high efficient light sources. A large part of the artificial light nowadays is made by such low pressure discharge lamps.

During the last years a new kind of tubular fluorescent lamps with an outer diameter of *16mm* was established *(T5).* The maximum luminous flux of these lamps is reached at an ambient temperature of 35°C, which is advantageously in most applications. In contrast, fluorescent lamps with an outer diameter of *26mm (T8)* this maximum is reached at 20°C to 25°C. Due to the intrinsic heating in luminary, this yields to a loss of the luminous flux at room temperature.

A further development represents the lamp type *T16mm HO Constant*, an efficient application over a broad temperature range with the amalgam technology is possible. Thus, applications used at low and high ambient temperatures and high efficiency are realizable.

The temperature-depending luminous flux of conventional lamps *T26mm* and *T16mm* passes through a maximum affected by the vapor pressure of the mercury.

On the one hand, the generation of UV-radiation at lower temperatures decreases. On the other hand, the UV-quanta are absorbed by a high amount of evaporated mercury at high temperatures.

This undesirable behavior can be avoided by using amalgam-technology.

Amalgam-technology acts as a mercury sink and adjusts the mercury vapor pressure.

Choosing a suitable amalgam provides the needed vapor pressure of mercury for a broadened temperature range.

Therefore, the temperature range in which the luminous flux shows values higher then 90% of its maximum, is expanded. The width of this range is about 27°C for standard lamps *T16mm HO* and about 65°C for the *T16mm HO Constant*.

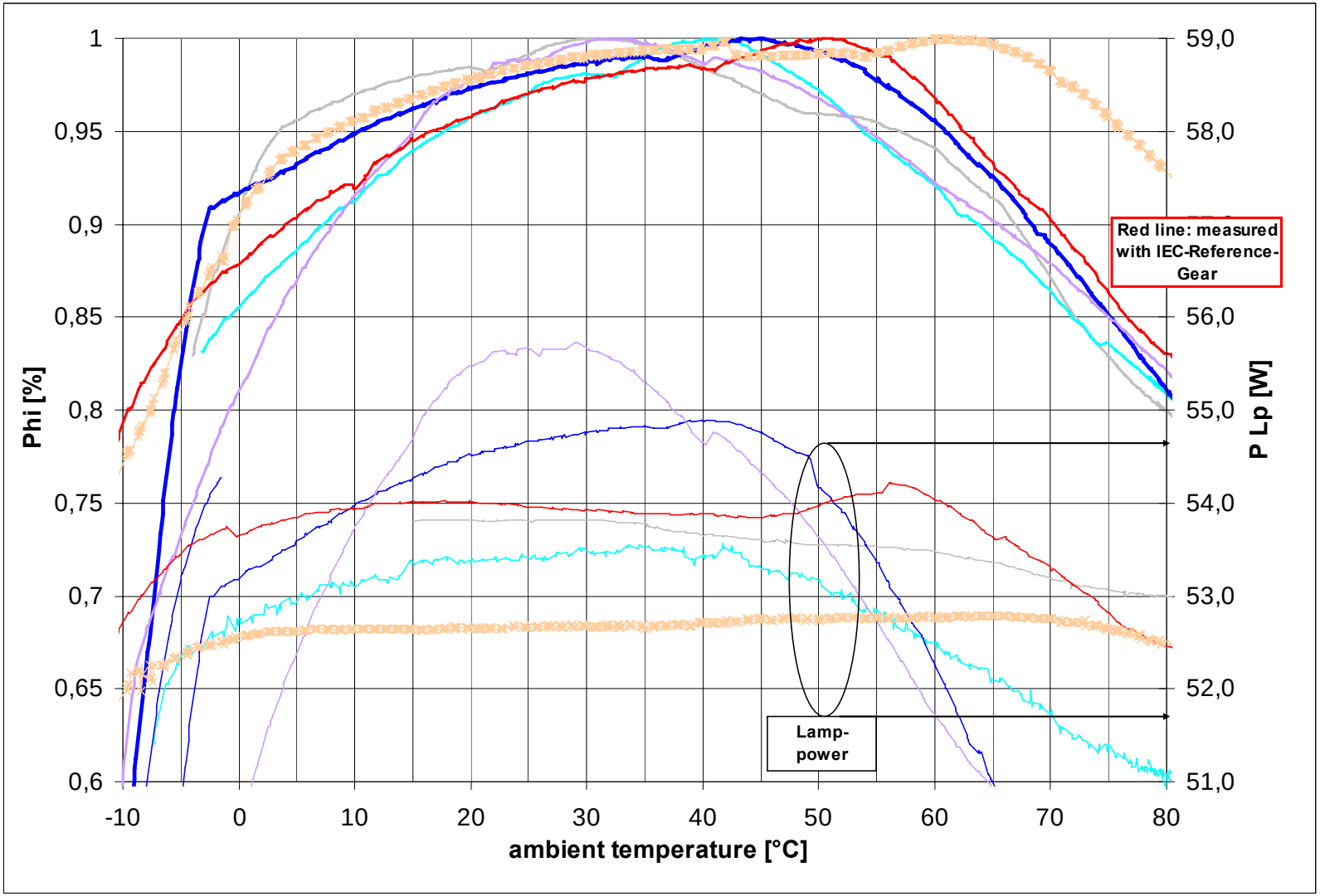
This broadening of the temperature range can be explained by two effects. On the one hand, the vapor pressure affecting amalgam is thermally decoupled from the glass tube and, therefore, from the ambient temperature. On the other hand, at optimum vapor pressure the solid-liquid-phase transition of the used InAg6Hg10 amalgams extends over a working temperature range of about 25°C.

Vapor pressure controlling manners are presented and the correlation between the distance of the amalgam carrier and the coil are explained.

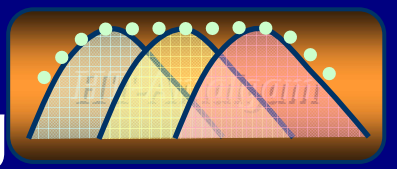
For a faster raising of the luminous flux during the lamp-starting, a separately start-up amalgam is used. The operating mode of which is exemplified.

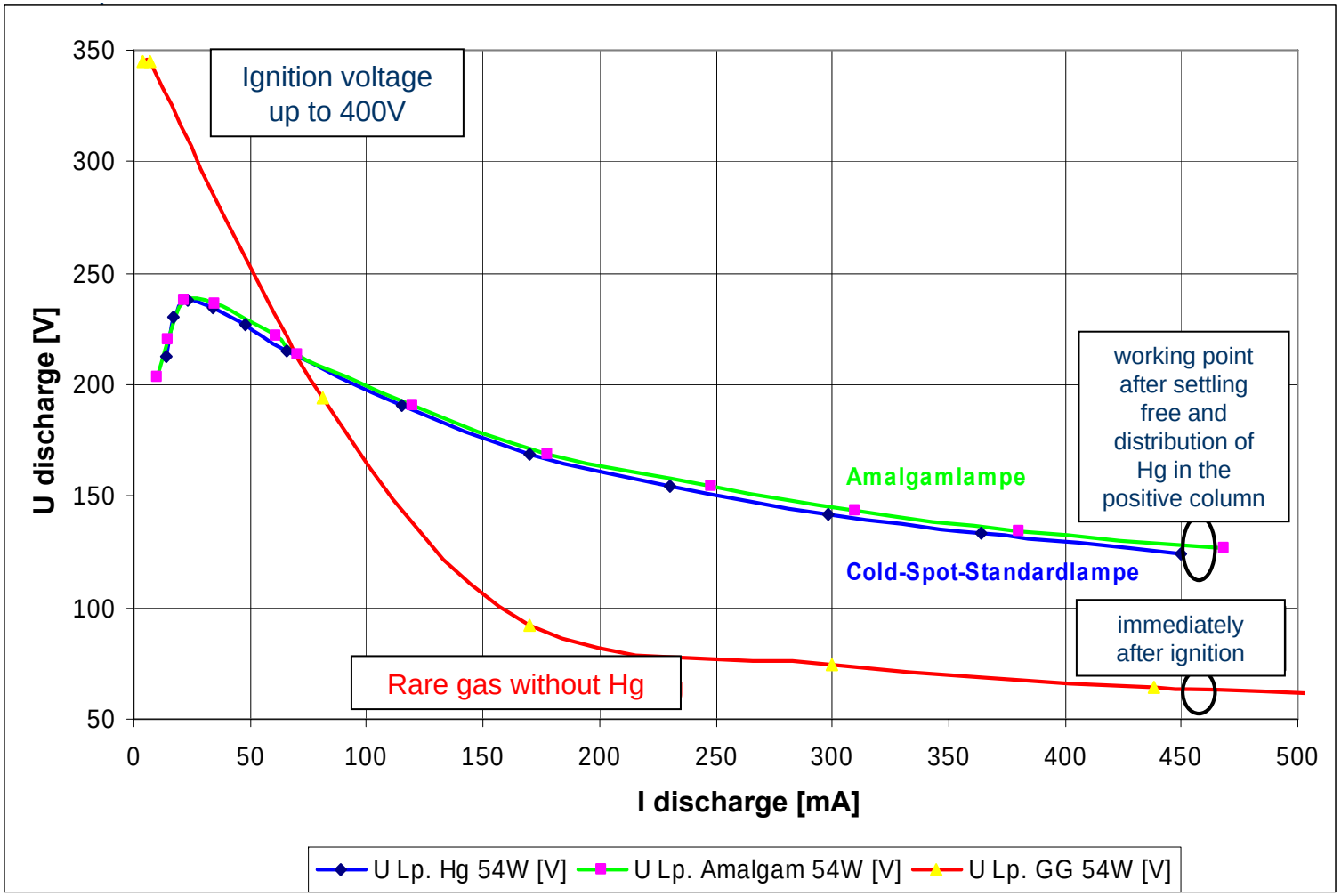
Furthermore, different dependencies between the luminous flux and the ambient temperature for different lamp operation modes are shown. Finally, the behavior of the new lamp type in dimming applications is presented.

Backup 1: Phi(T) Constant 54W with different ECG‘s

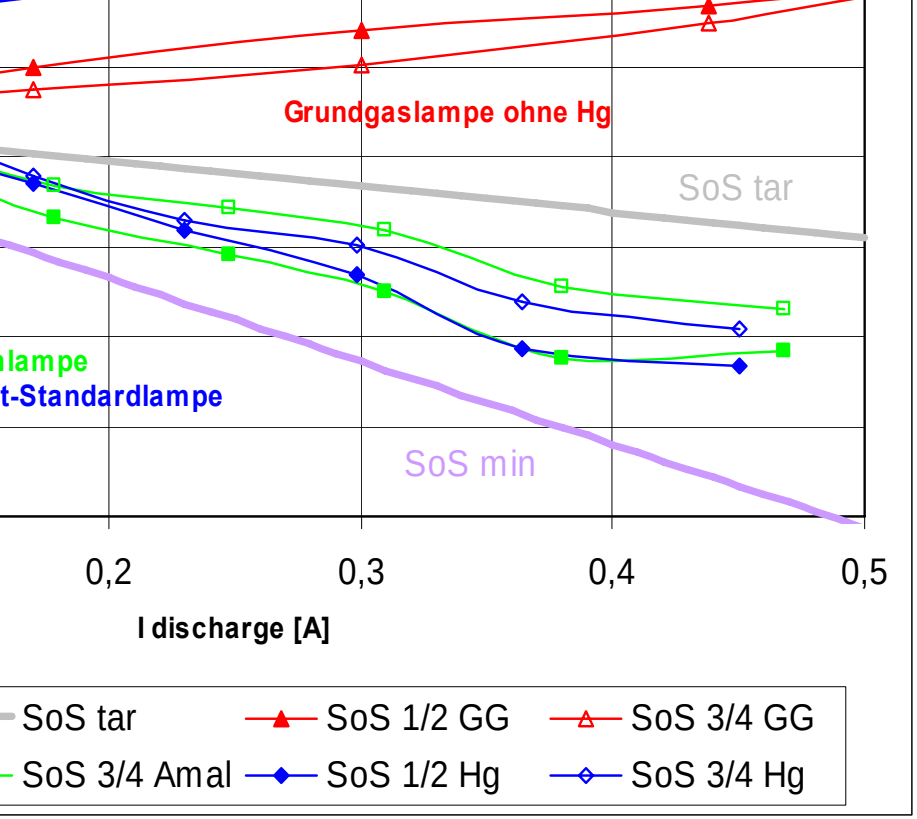


Backup 2: U/I-Chart HO54W: raregas-, amalgam- and cold-spot-lamps at dimming





Backup 3: Dimming: coil heating after SoS at 54W raregas-, amalgam- and Hg-lamps at QTi-DIM



Pin currents are all in allowed area, no blackening due to underheating at dimming operation takes place.