

# How to Destroy Your Engine in One Minute



*Your presenter...*

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Technician of the Year (2008)

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The EGT Myth

How Healthy Is Your Engine?

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**Cylinder Break-In: Do It Right**

**What Is Preventive Maintenance?**

**Cylinder Work: Risky Business**

**It's Baffling**

**Where Fuel Meets Air**

**Benefits of Running Oversquare**

**How Mags Work...and Fail**

**Predictive Maintenance**

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Destroy Your Engine in One Minute

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# Detonation

## Pre-Ignition

**CHT**



# Detonation

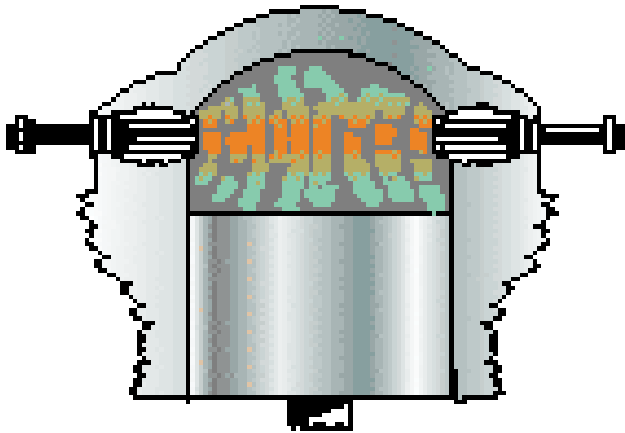
Excessive peak pressure and/or temperature

Localized, abnormally rapid combustion

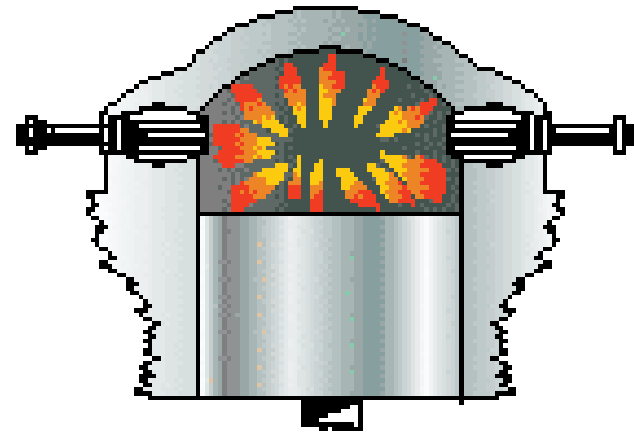
Shockwaves destroy boundary layer

Heavy detonation can result in melting of the piston and destruction of the cylinder in a matter of minutes

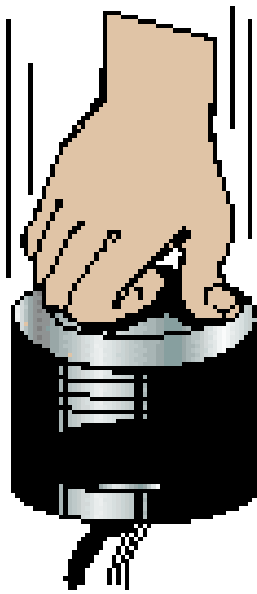
# Detonation



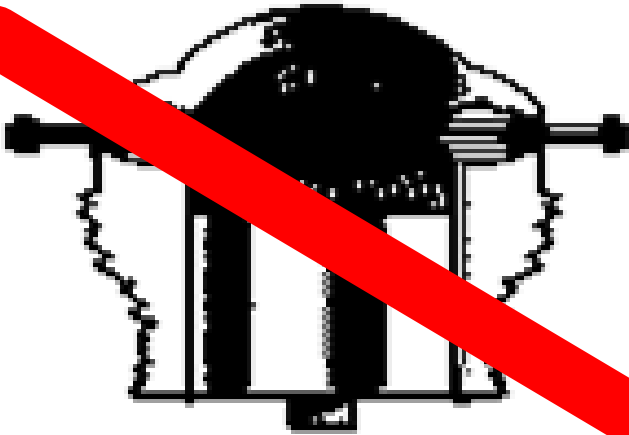
Normal Combustion



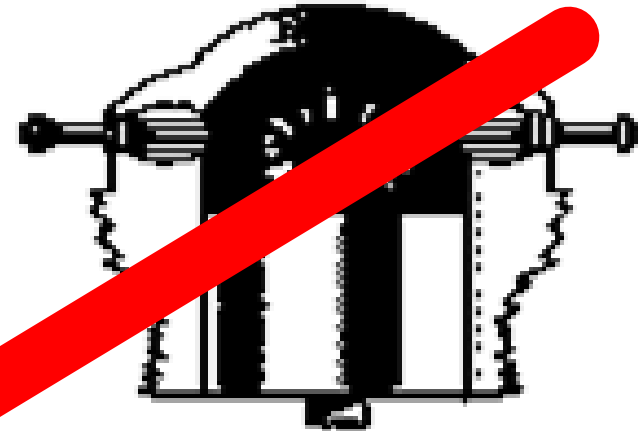
Explosion



# ~~Detonation~~



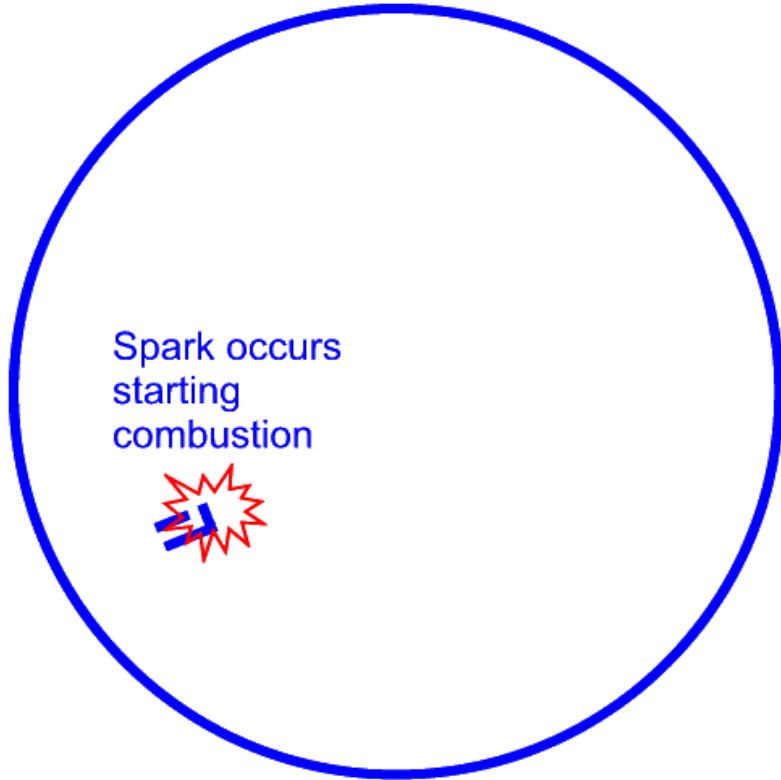
Normal Combustion



Explosion



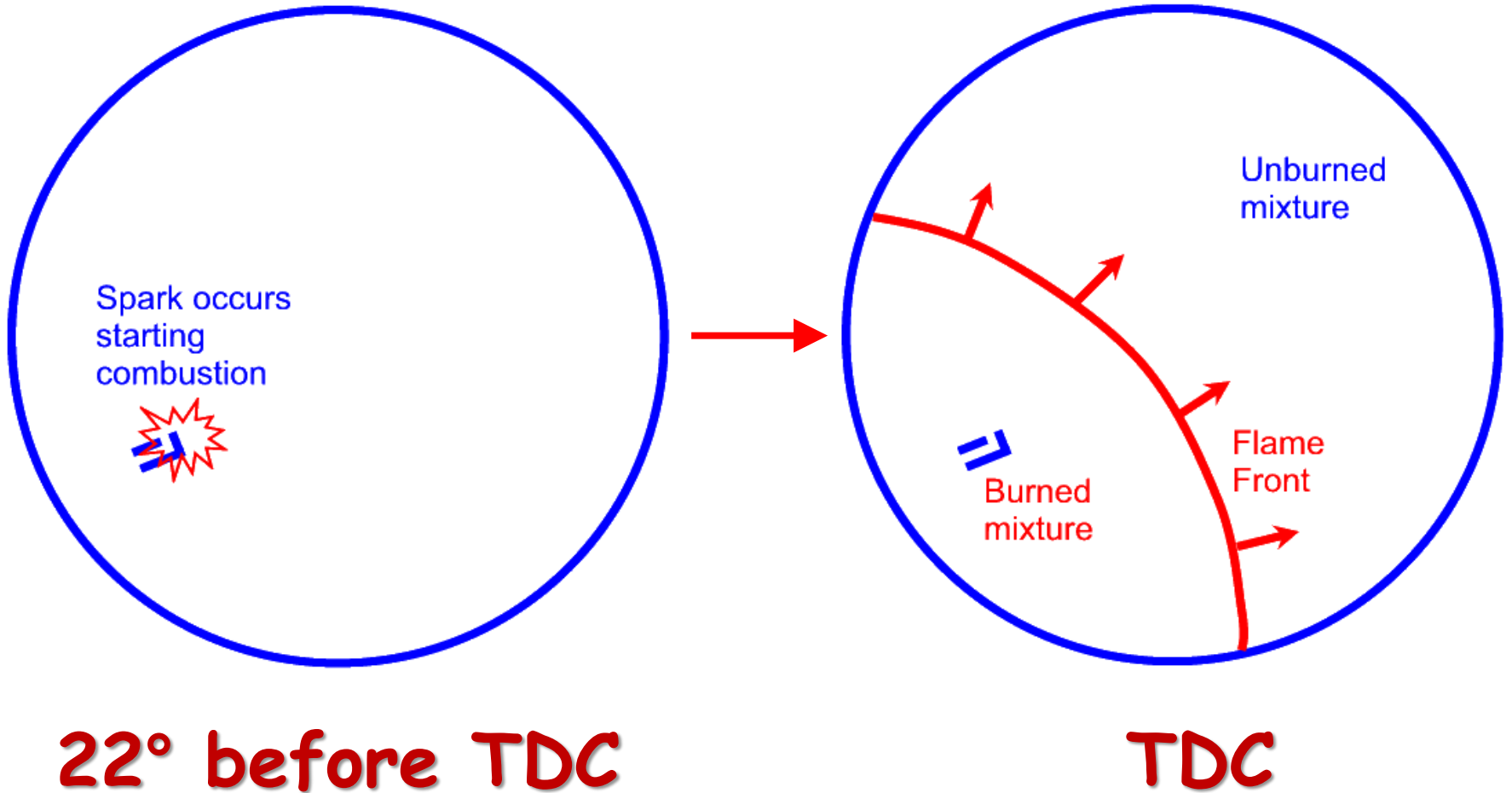
# Normal Combustion



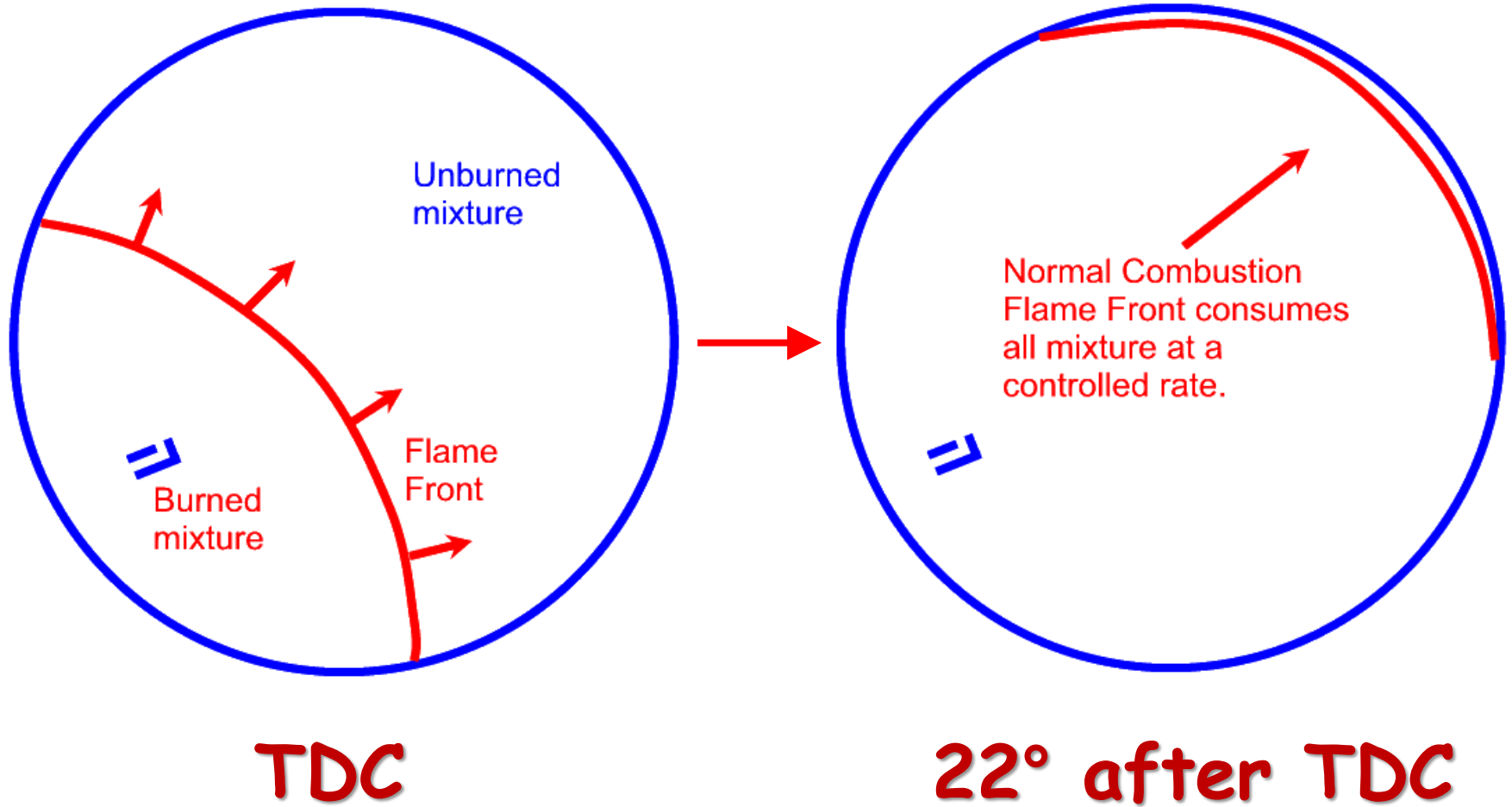
**22° before TDC**



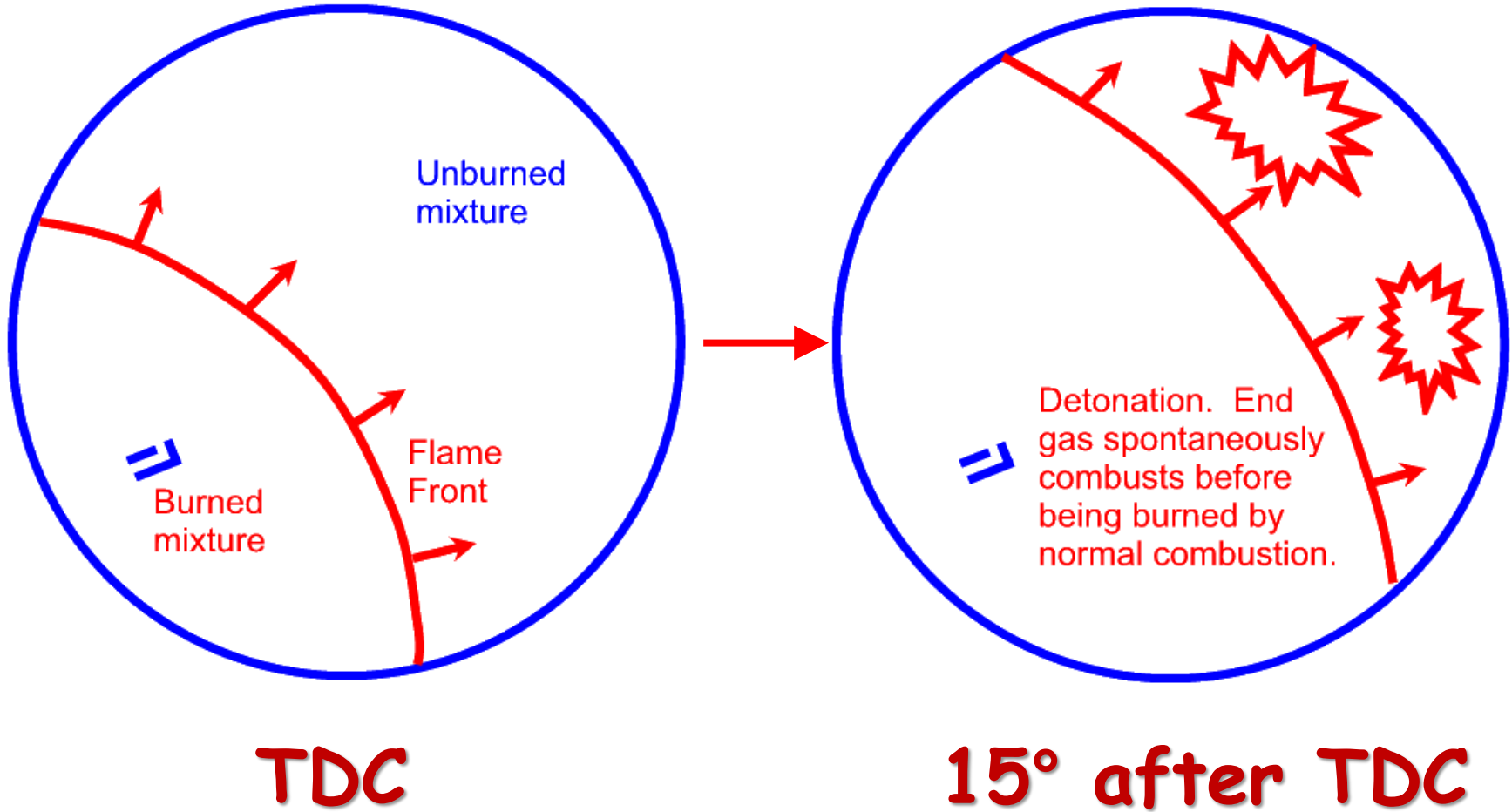
# Normal Combustion



# Normal Combustion

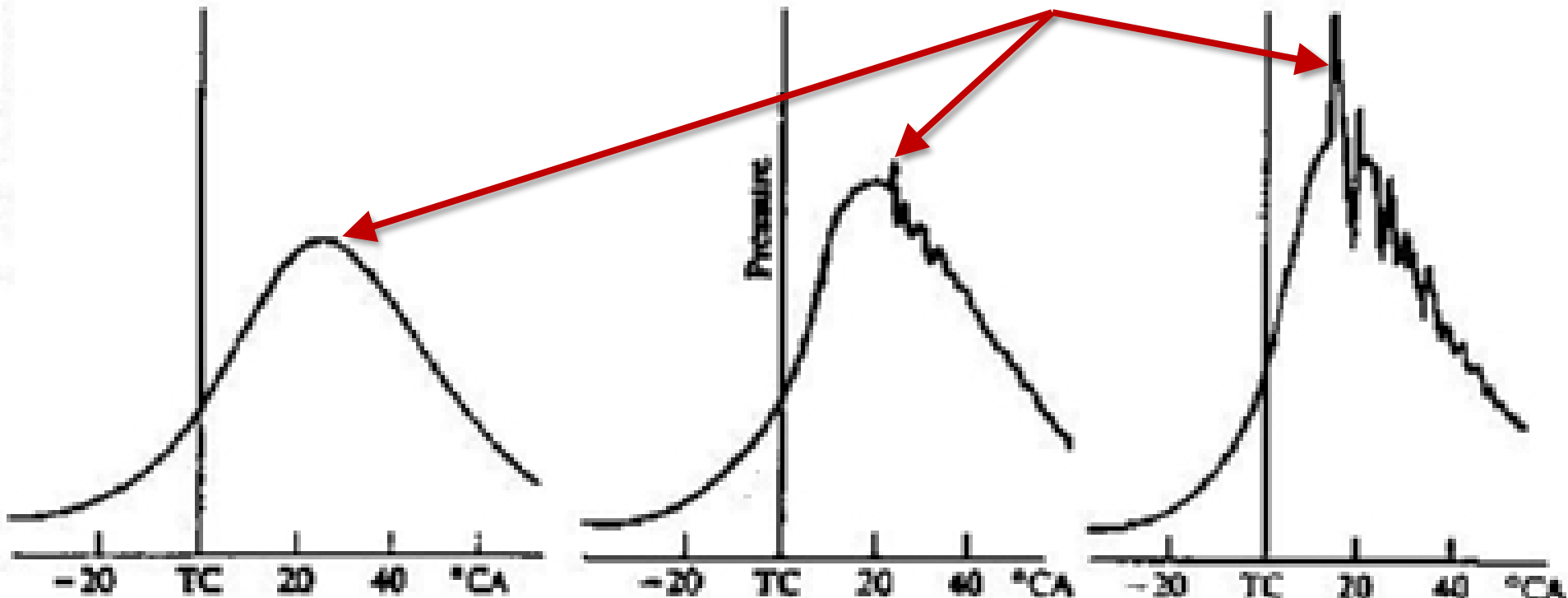


# Detonation



# Detonation

## Combustion Chamber Pressure



**Normal  
Combustion**

**Light  
Detonation**

**Heavy  
Detonation**

# Detonation

- Detonation comes in flavors from **light** to **medium** to **heavy**



- **Light detonation** isn't harmful, it just keeps the combustion chamber clean 😊
- **Heavy detonation** can damage spark plugs, pistons and cylinders if it isn't detected and controlled by the pilot 😞

# Pre-Ignition

Spontaneous ignition **prior to spark**

Something in the combustion chamber overheats and acts like a **glow plug** to ignite the fuel-air mixture prematurely

Premature combustion results in destructively high peak pressure and temperature that can **destroy your engine in one minute flat!**

# Detonation

and

# Pre-Ignition

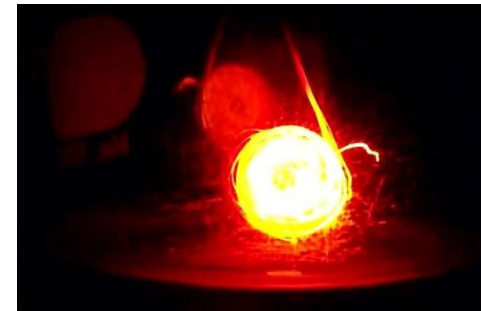
are distinctly different  
phenomena, BUT...

# Detonation

can morph into

# Pre-Ignition

...if it causes something to  
get hot enough to **glow**



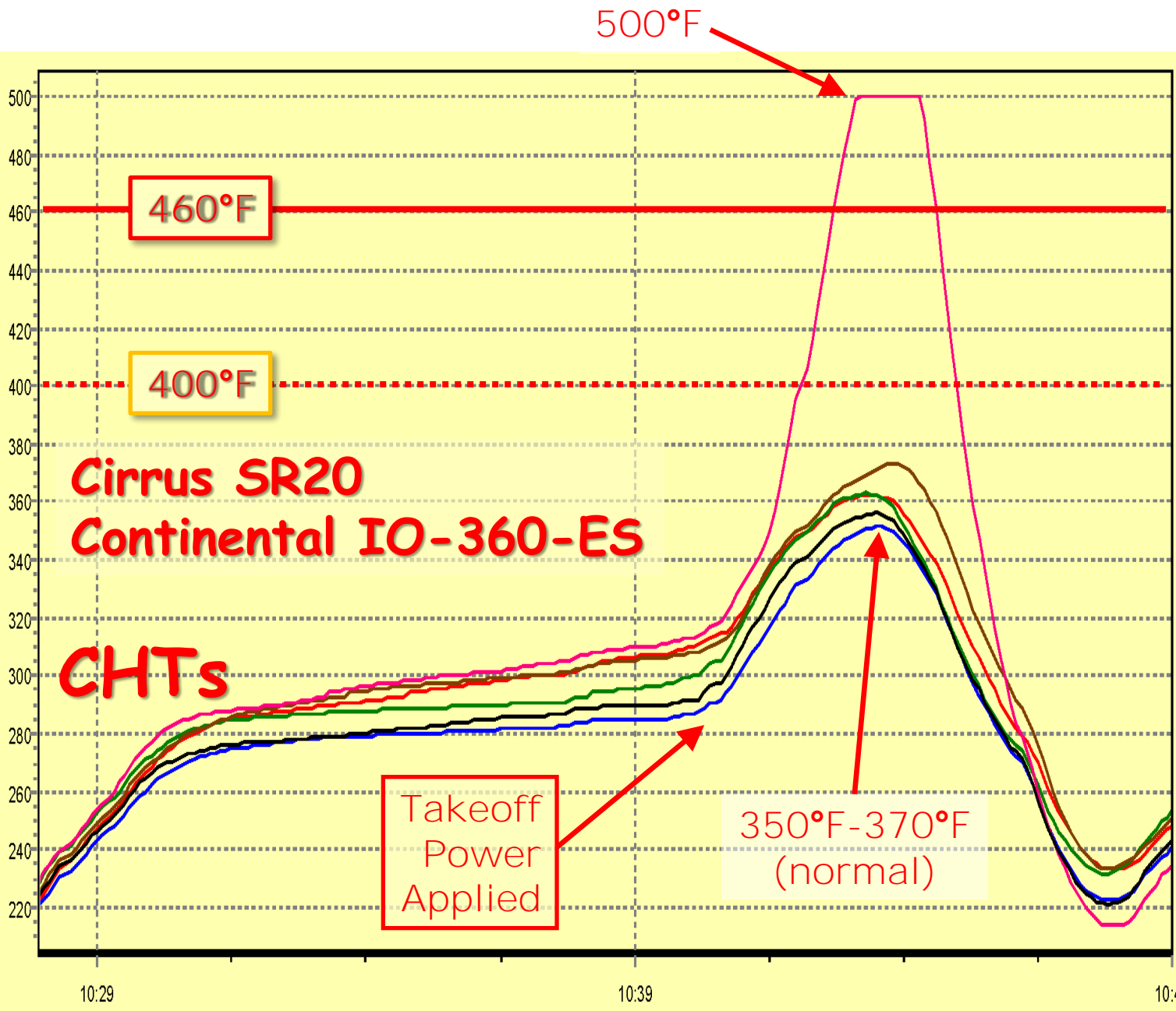


A thermal runaway  
that causes CHT to rise  
1°F/second or faster  
is almost certainly a  
pre-ignition event



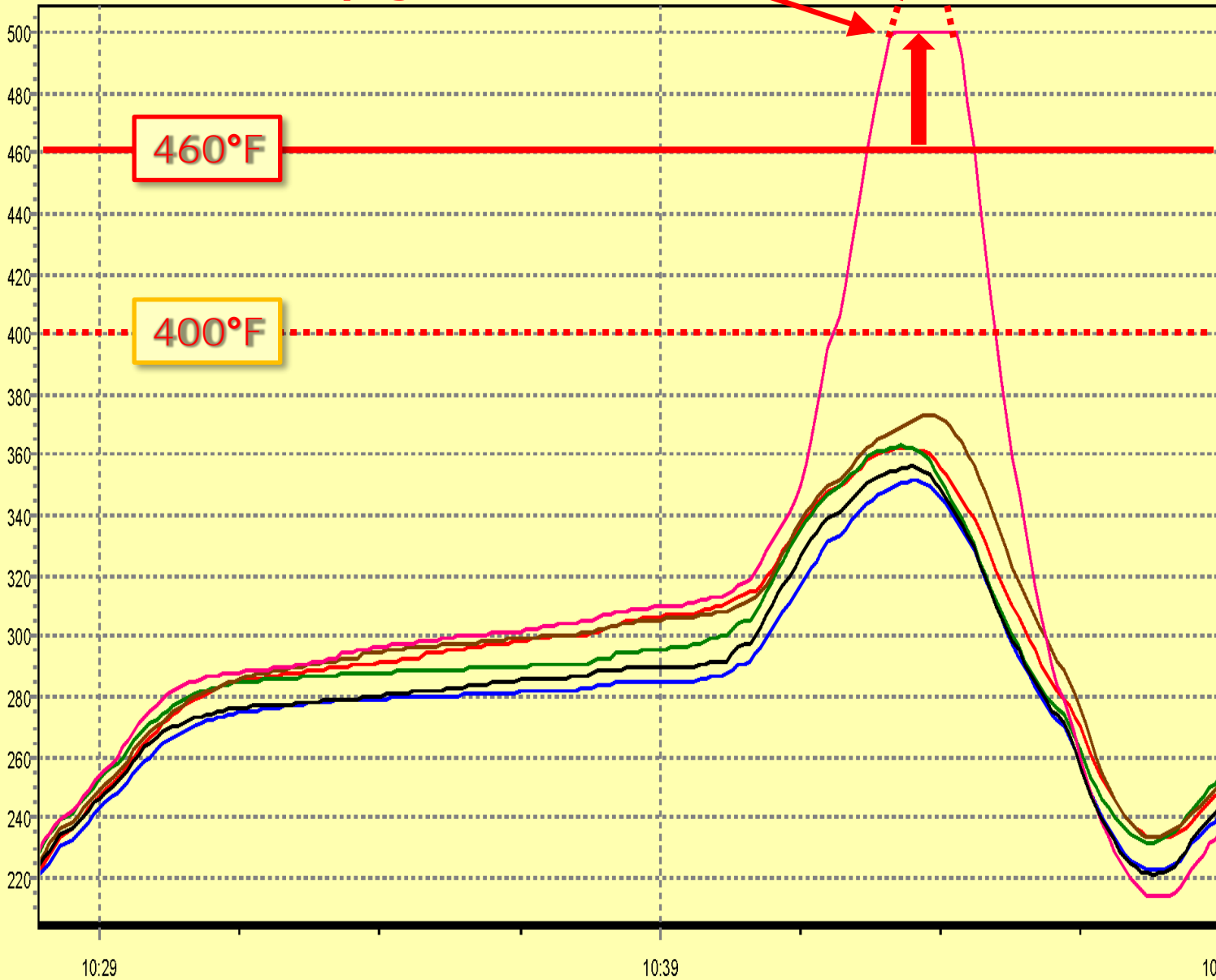
CHIT

- CHT1
- CHT2
- CHT3
- CHT4
- CHT5
- CHT6



Avidyne MFD  
"pegs" at 500°F

550°F?



- CHT1
- CHT2
- CHT3
- CHT4
- CHT5
- CHT6

Piston destroyed

550°F?

CHT rose >1°F/sec!

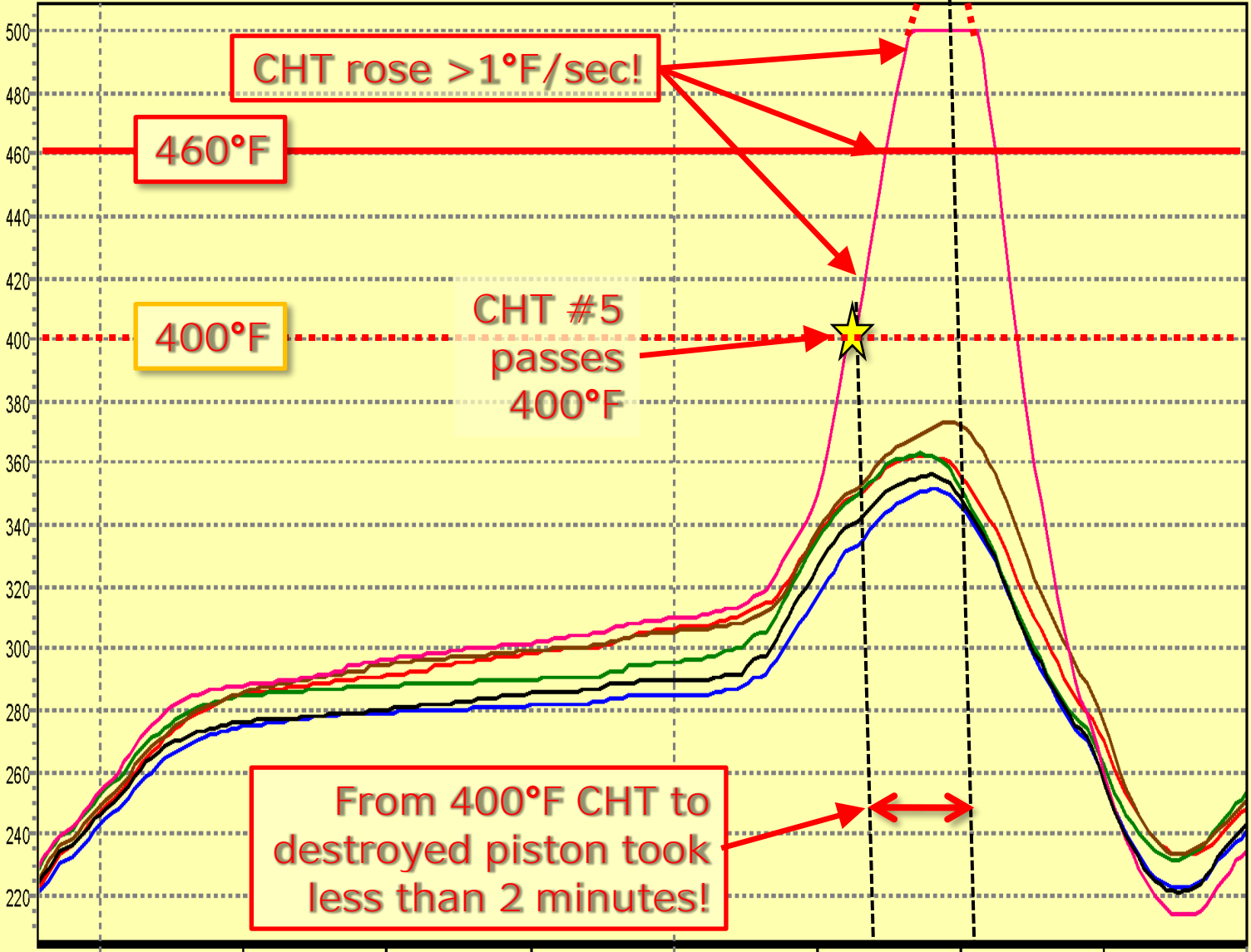
460°F

400°F

CHT #5 passes 400°F

From 400°F CHT to destroyed piston took less than 2 minutes!

- CHT1
- CHT2
- CHT3
- CHT4
- CHT5
- CHT6

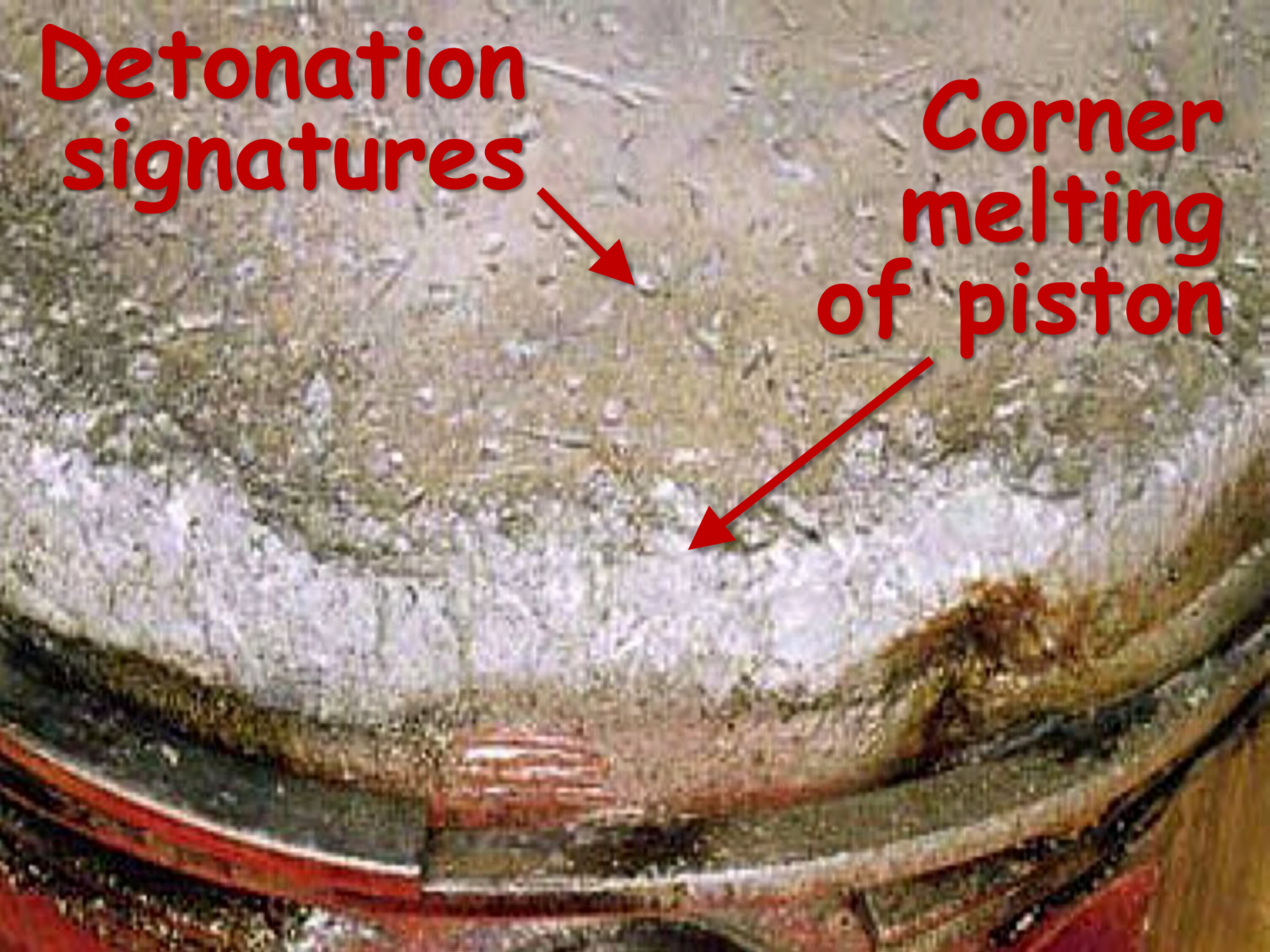




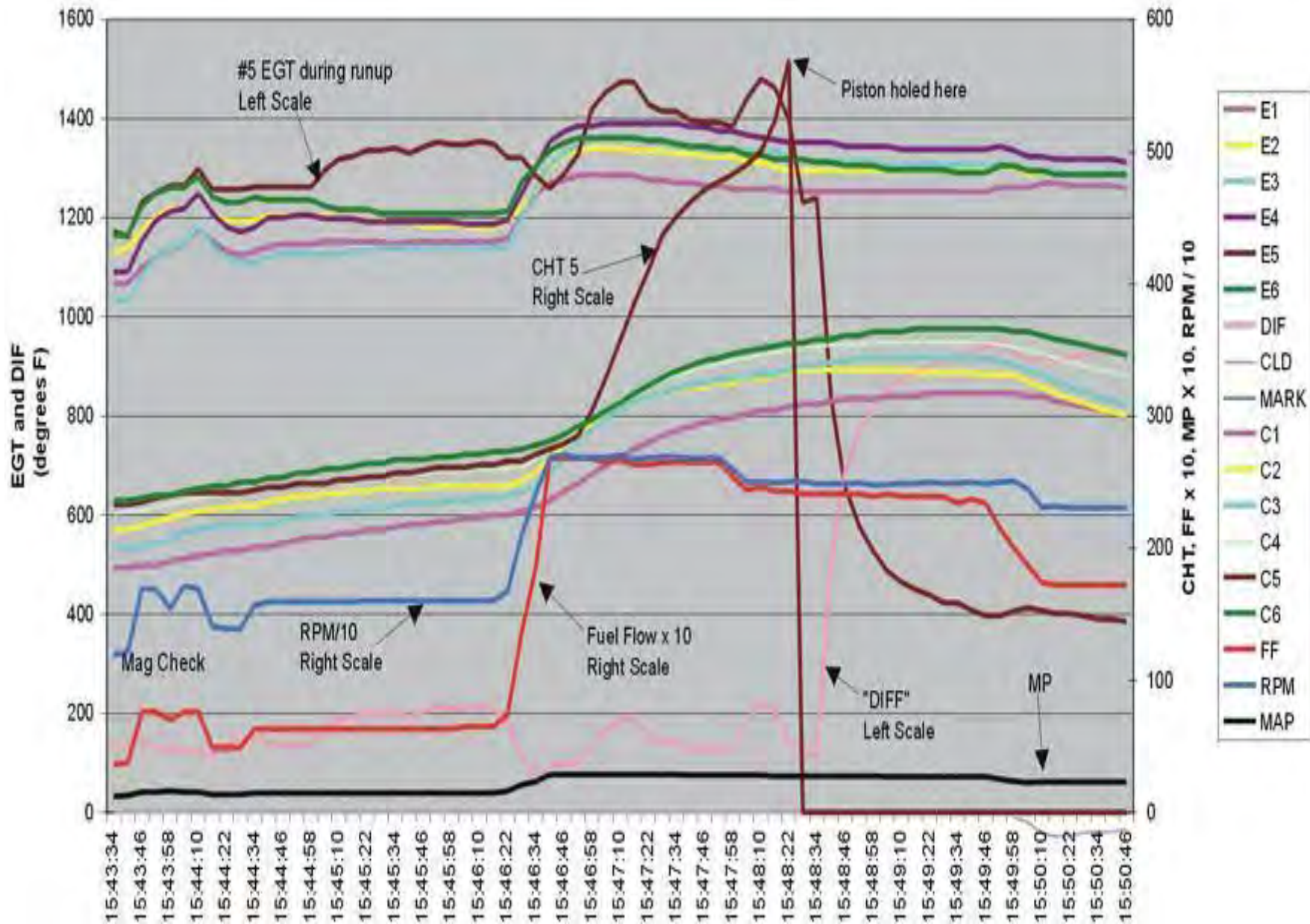
**Detonation signatures**

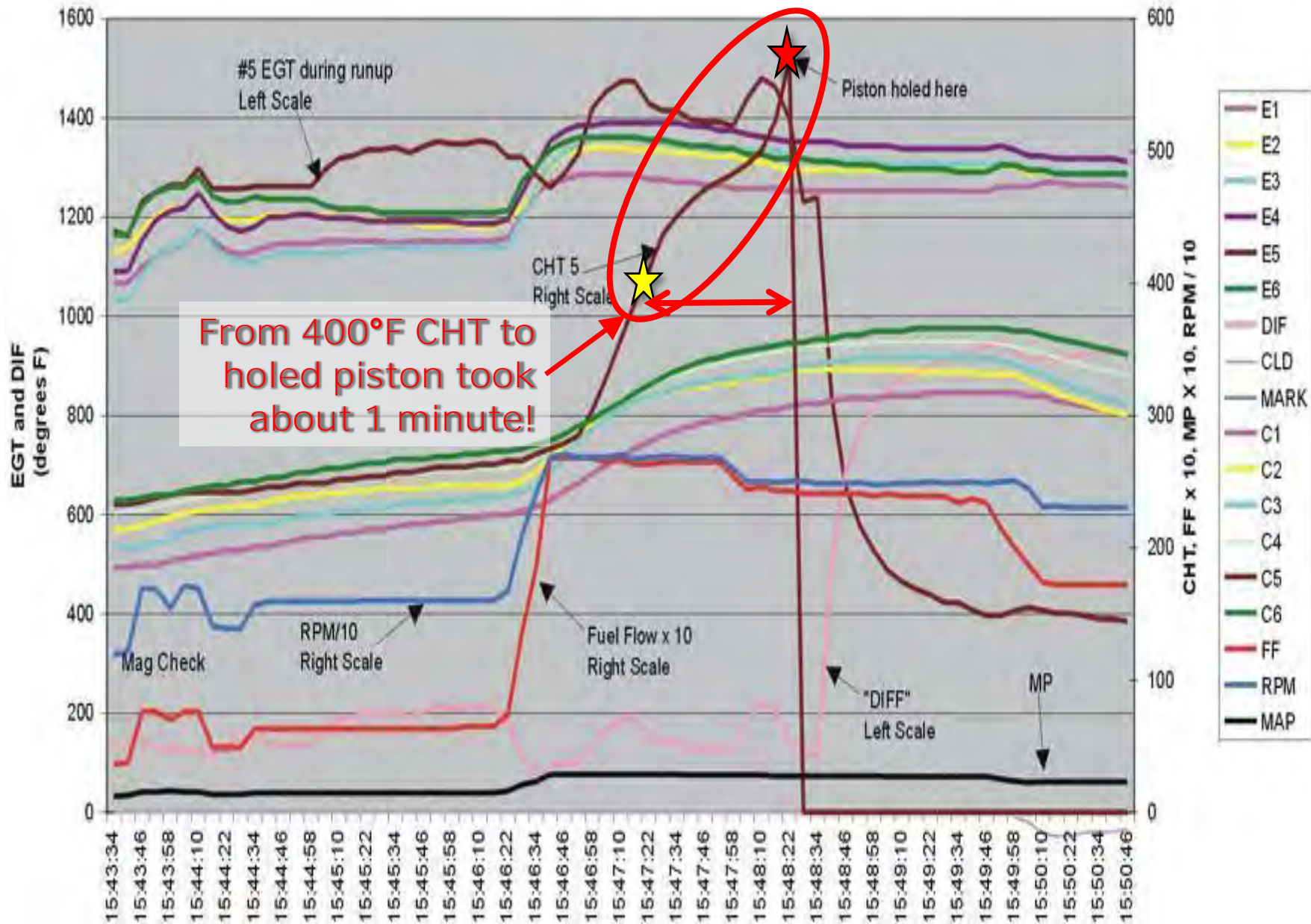


**Corner melting of piston**



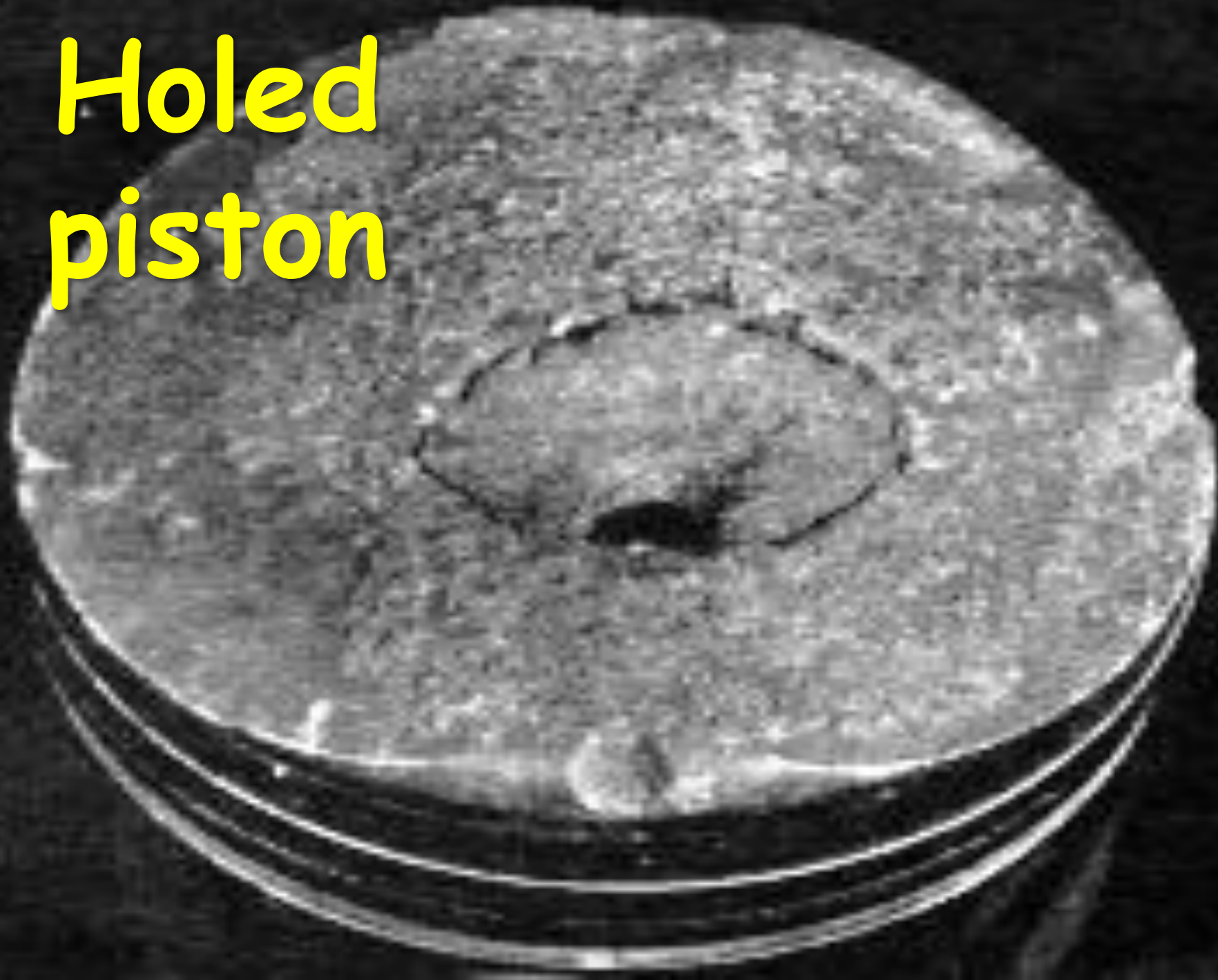








**Holed  
piston**





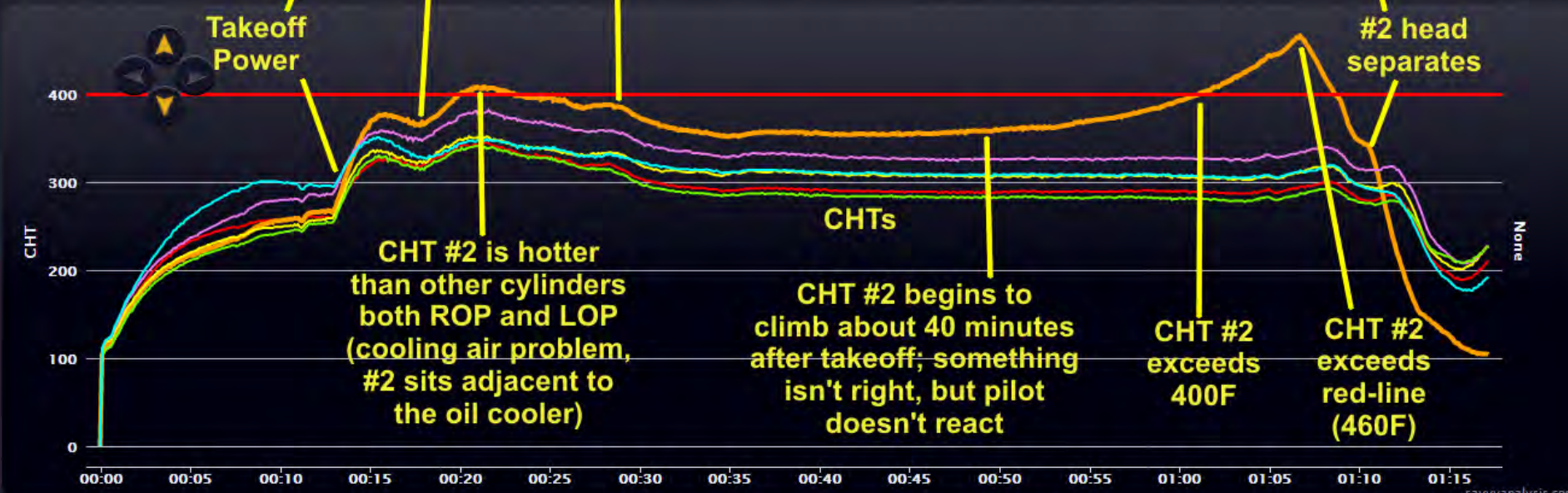
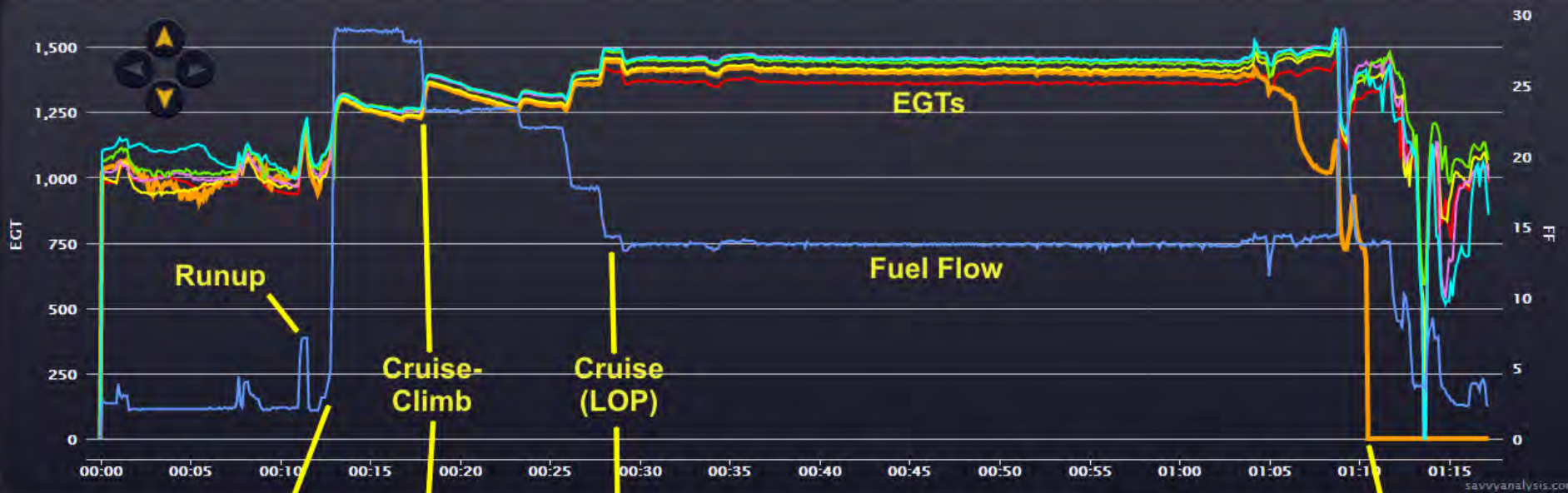
A thermal runaway that causes CHT to rise  $1^{\circ}\text{F}/\text{second}$  or faster is almost certainly a pre-ignition event.

**Detonation** produces a CHT rise that's slower

EGT

All Odd Even EGT1 EGT2 EGT3 EGT4 EGT5 EGT6 FF

FF



CHT

All Odd Even CHT1 CHT2 CHT3 CHT4 CHT5 CHT6

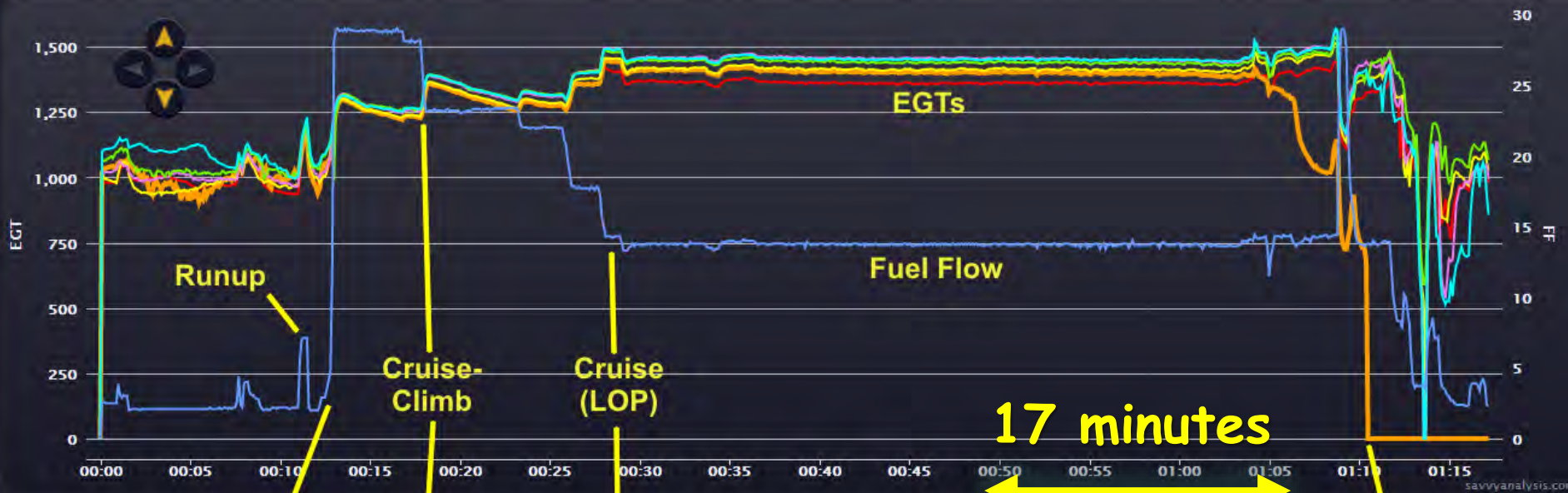
None



EGT

All Odd Even EGT1 EGT2 EGT3 EGT4 EGT5 EGT6  
FF

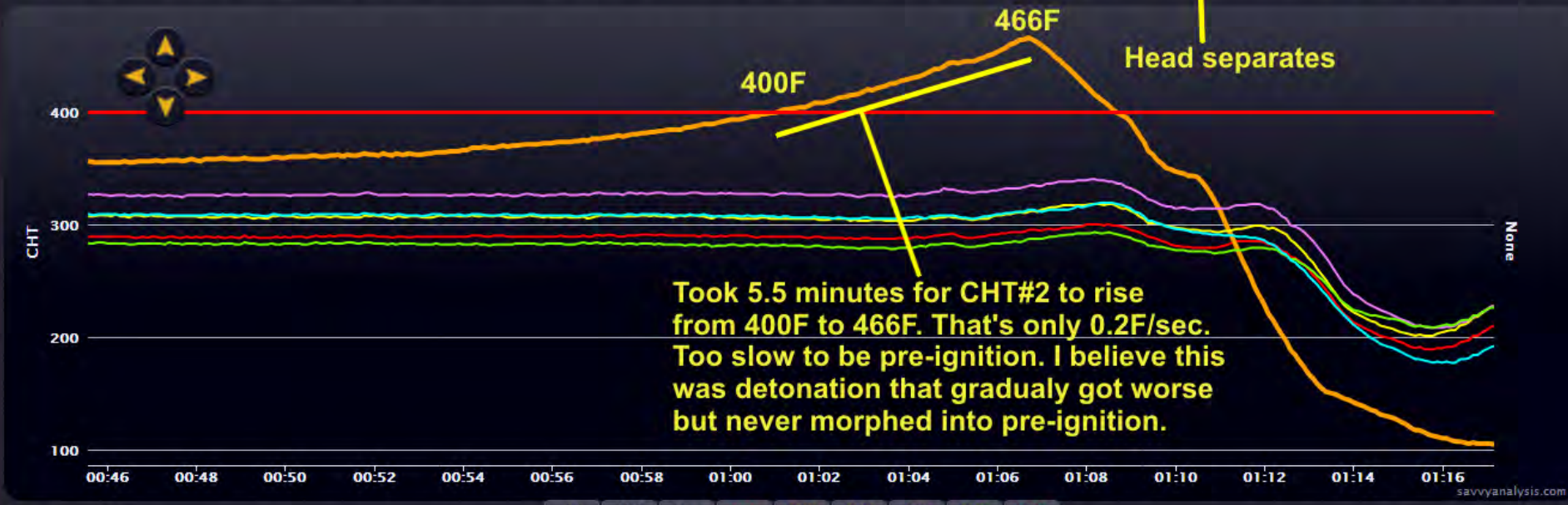
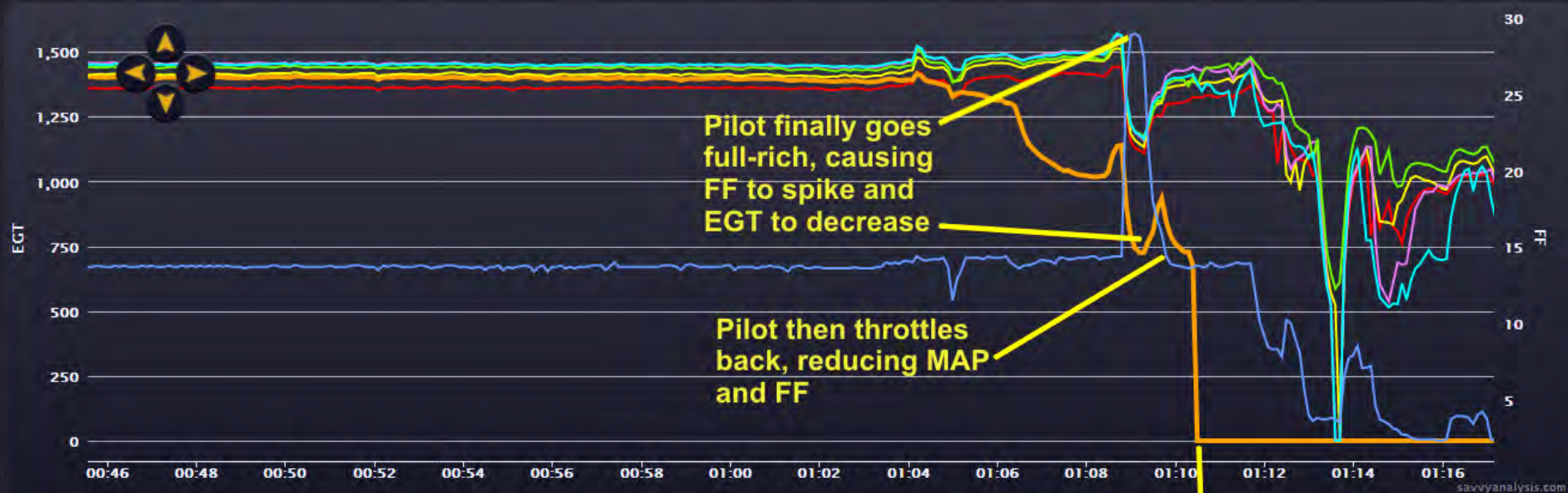
FF



CHT

All Odd Even CHT1 CHT2 CHT3 CHT4 CHT5 CHT6

None

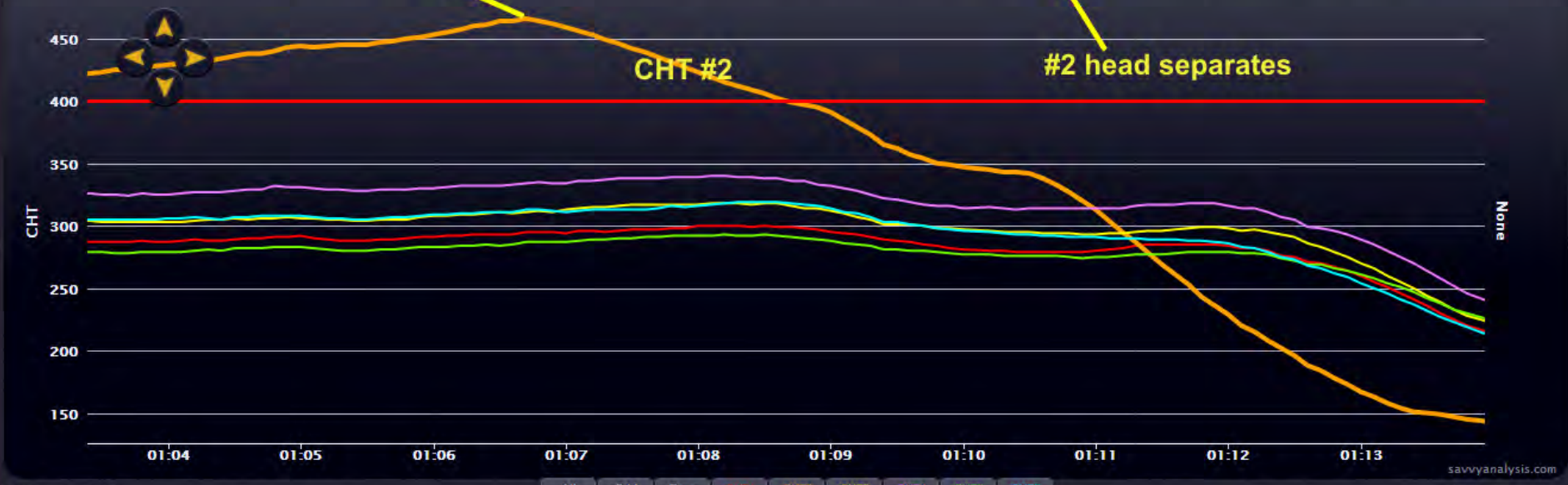
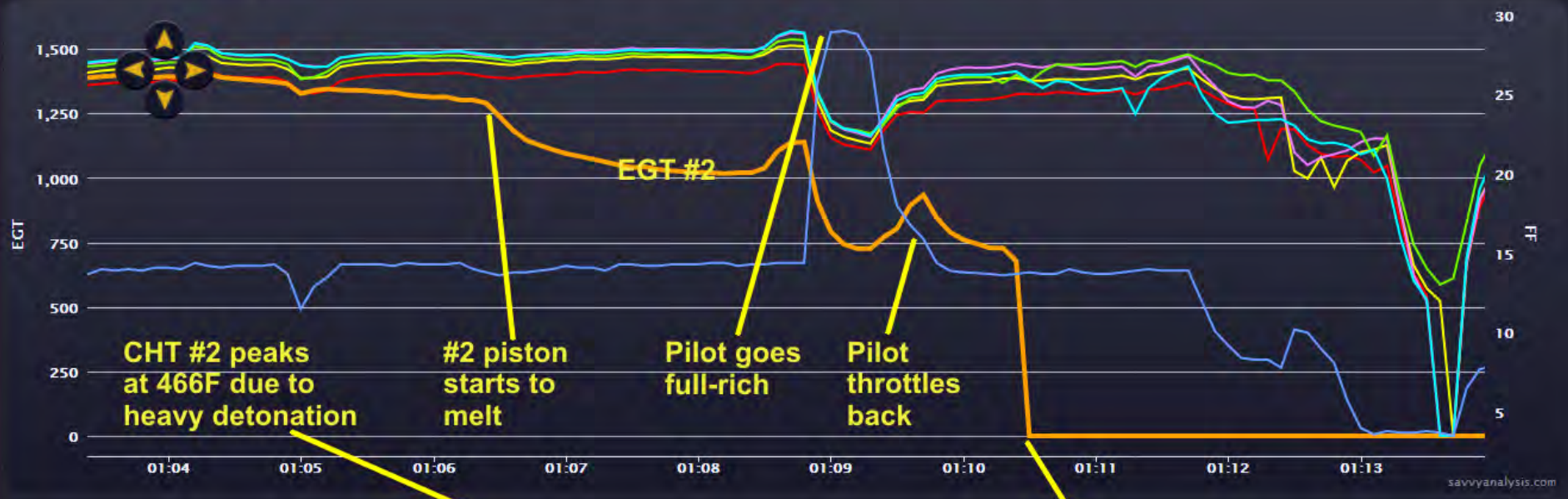




EGT

All Odd Even EGT1 EGT2 EGT3 EGT4 EGT5 EGT6

FF

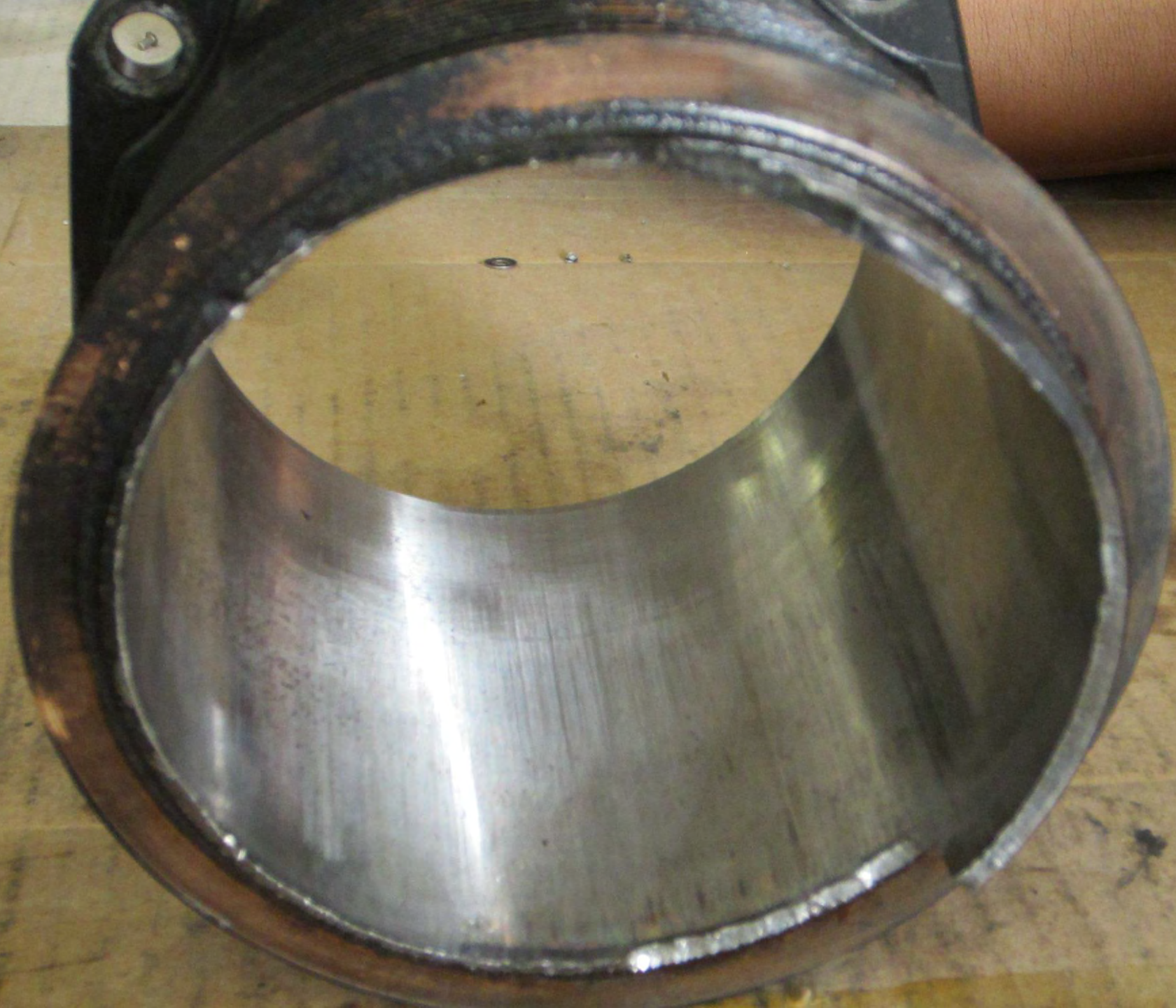


CHT

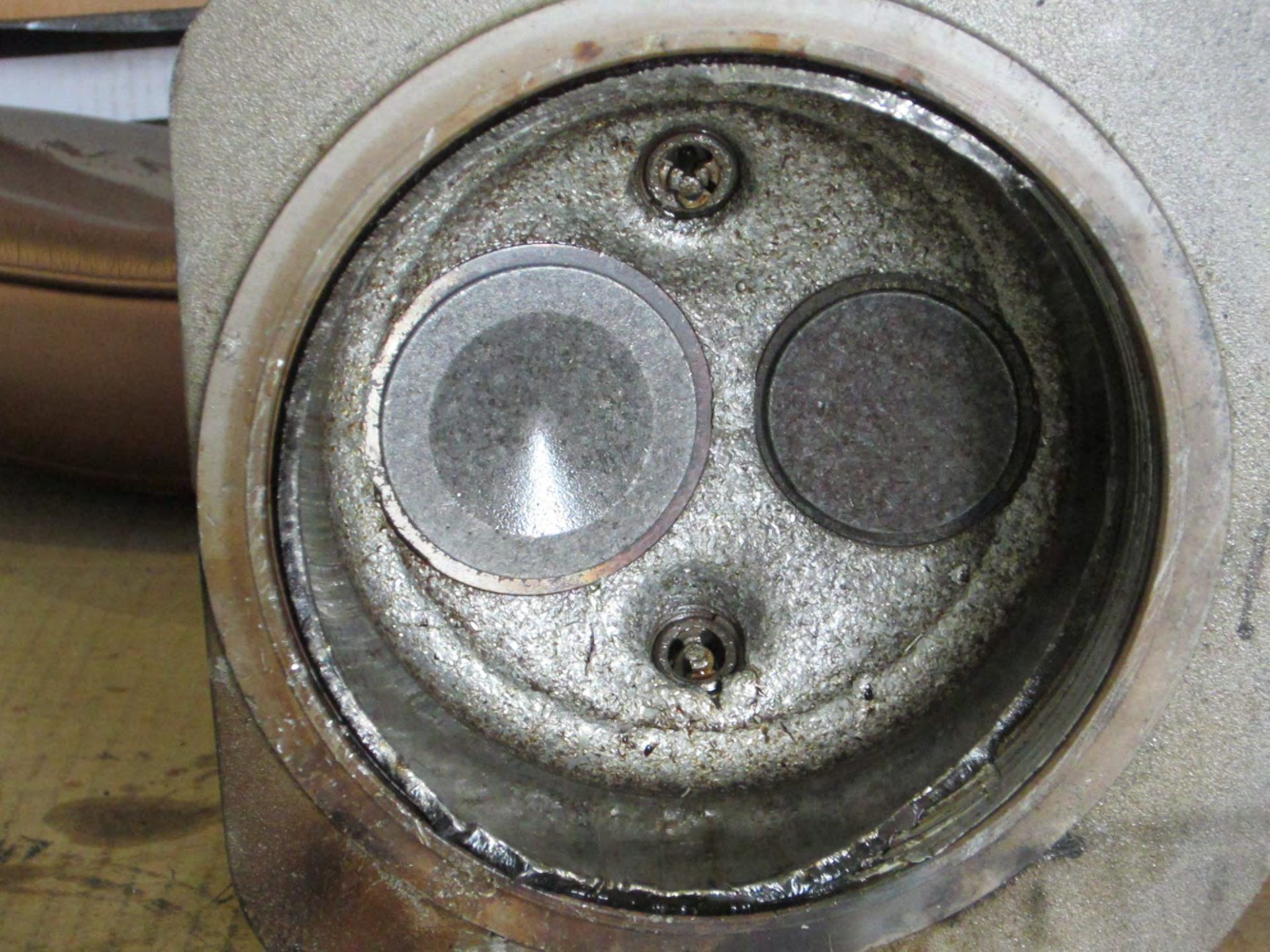
All Odd Even CHT1 CHT2 CHT3 CHT4 CHT5 CHT6

None



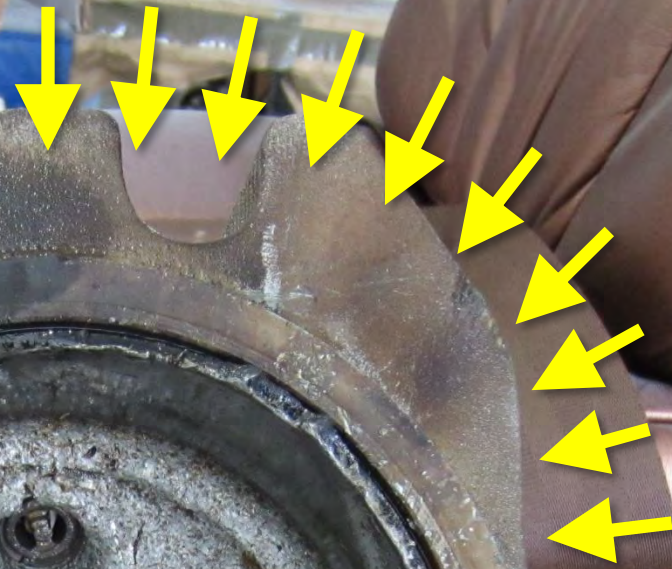




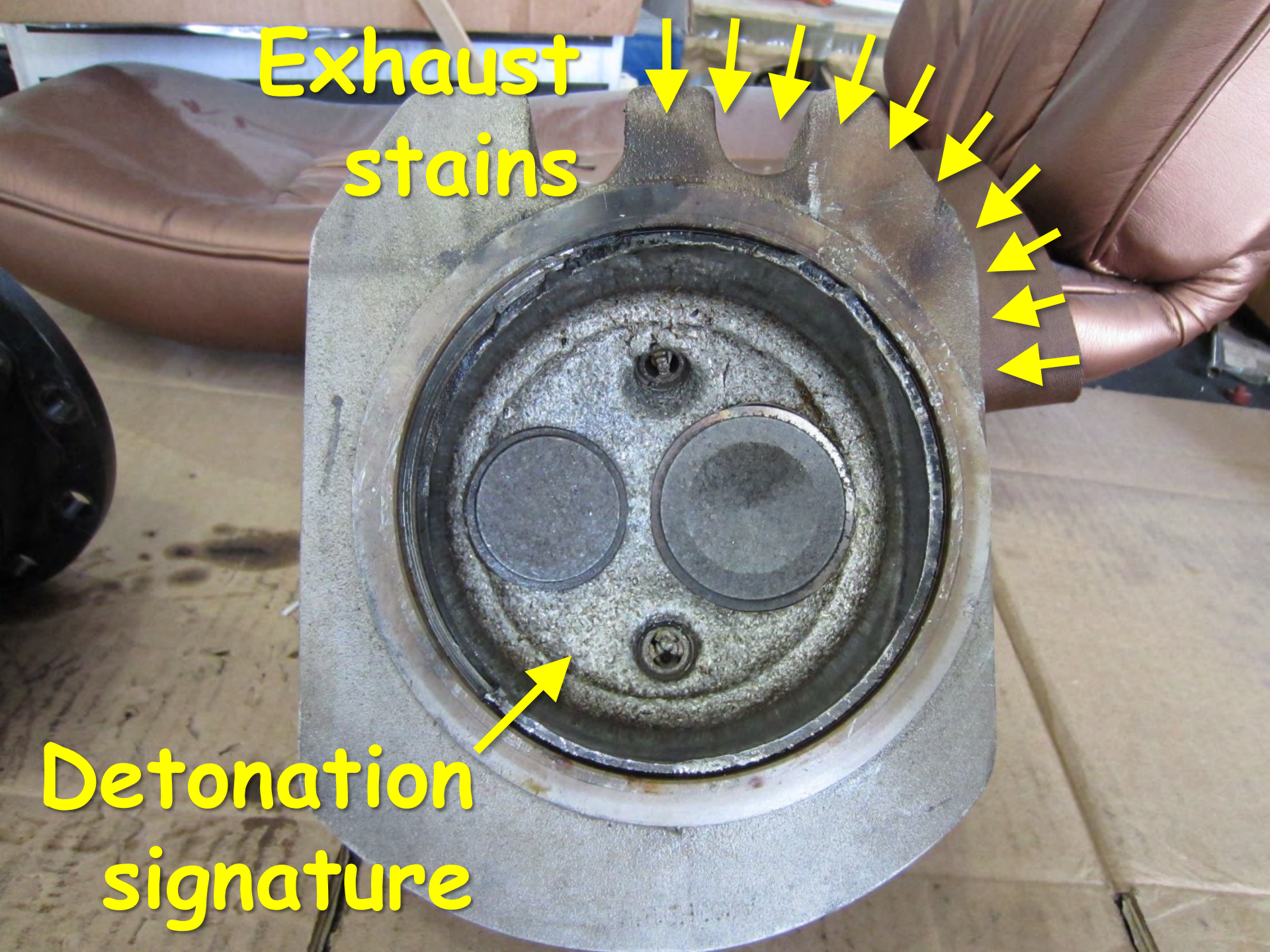




**Exhaust  
stains**



**Detonation  
signature**

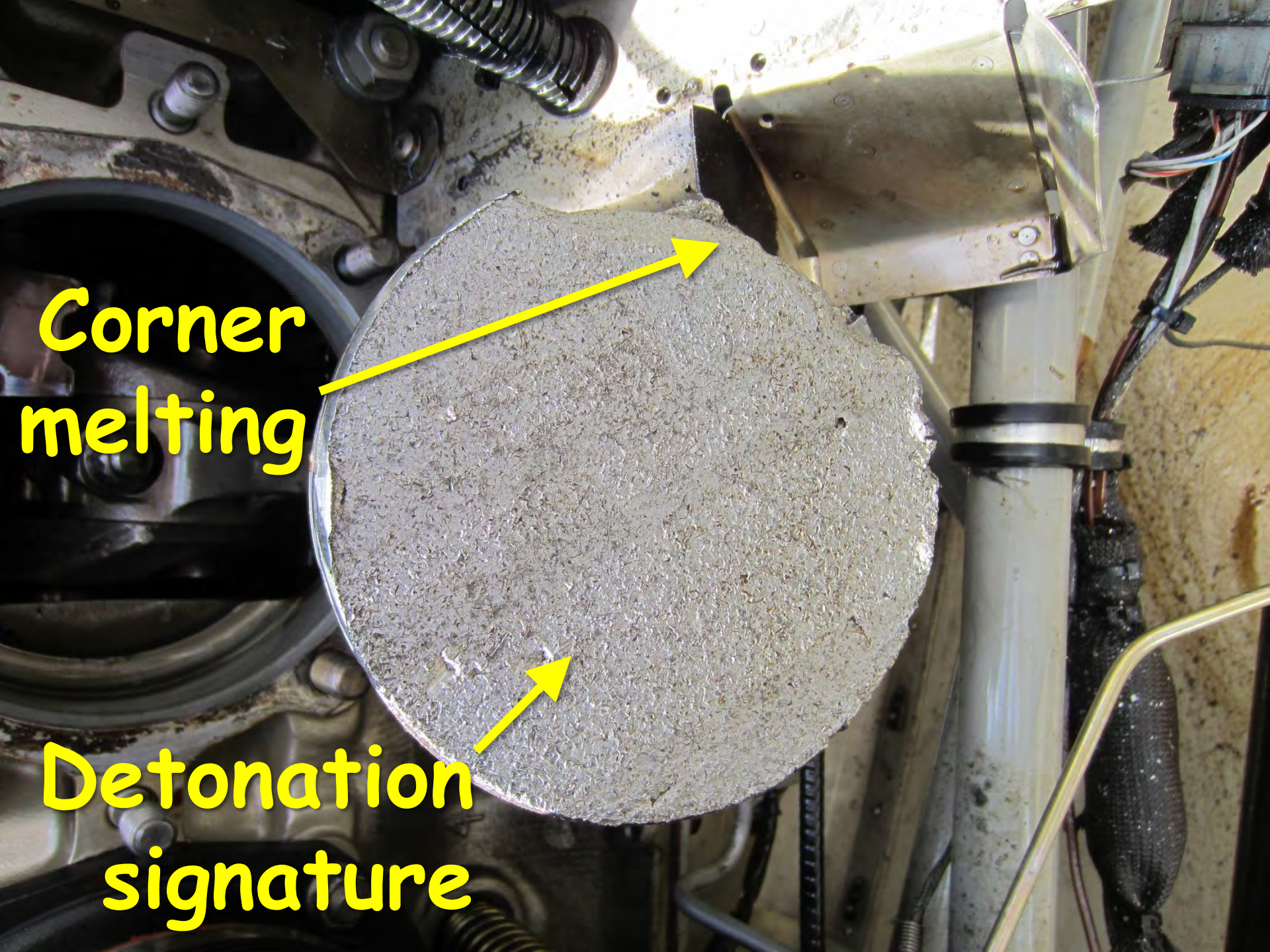




**Corner  
melting**



**Detonation  
signature**







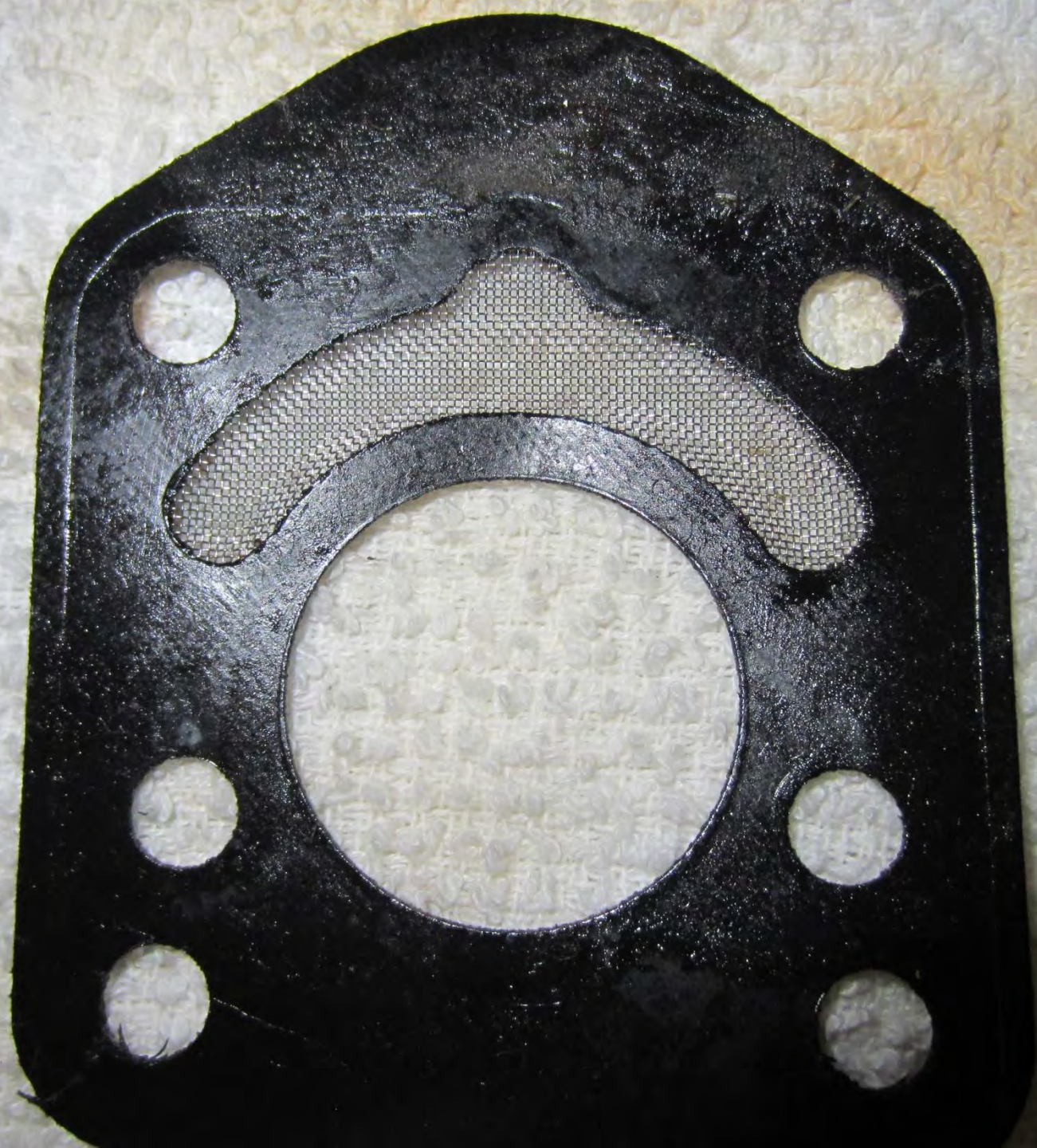


















# Takeaways...



# Takeaways...

Every piston aircraft needs to have a **digital engine monitor** installed to instrument the CHT of every cylinder

Without one, there's little chance you'll know about these events until it's too late to save the engine





# Takeaways...

Every pilot needs to establish maximum acceptable CHT levels and be prepared to take immediate action if reached



The ones I use in my airplane:

- **Yellow alert:** 380°F ... Do something!
- **Red alert:** 400°F ... Do something NOW!!!

# Takeaways...

It is extremely helpful to have a digital engine monitor with **user-programmable alarms**

Some engine monitors support this, some don't

Fancy engine monitors certified for primary instrument replacement usually don't



# Takeaways...

If CHT reaches 400°F and is rising rapidly, you may have only **one minute** to save your engine from destruction

- **Throttle back to idle IMMEDIATELY!!!**
- Once CHT is below 400°F, add power to the extent necessary to sustain controlled flight and land ASAP



# Takeaways...

Once on the ground, arrange to have the following performed (at minimum):

- Borescope all cylinders, looking for detonation signatures and corner melting
- Cut open the oil filter and inspect it for metal







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Tu 1000 #7

Tu 1300 #7

**We 0830 #7**

**We 1130 #7**

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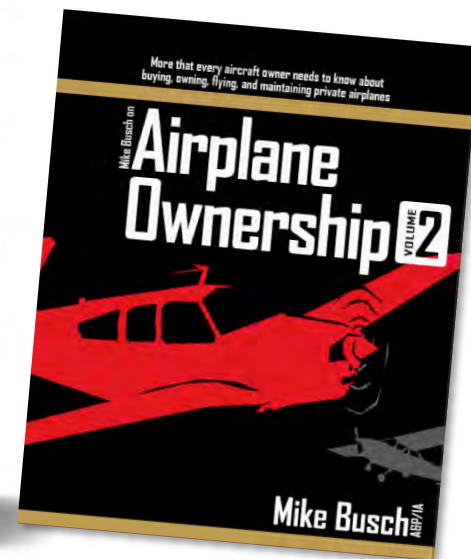
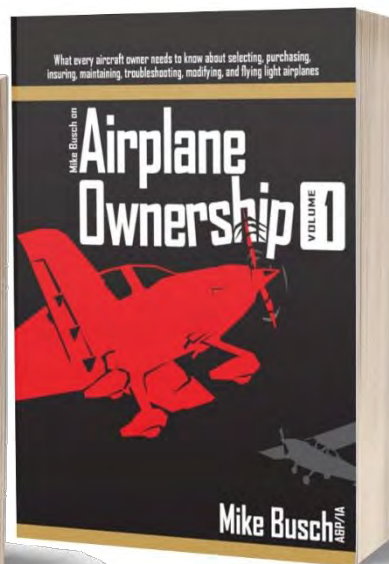
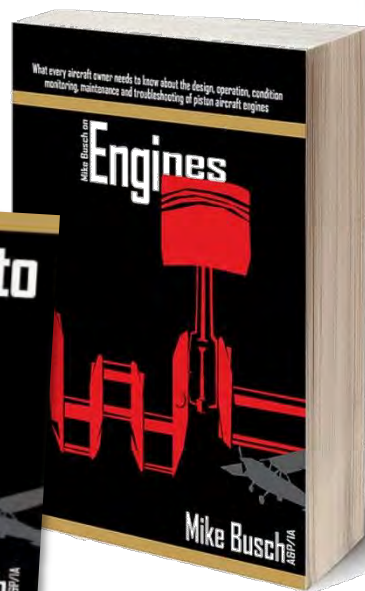
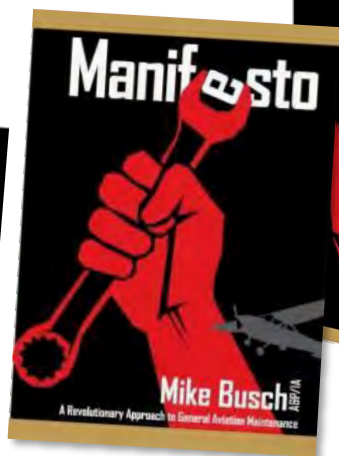
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# Questions?



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