

# Monitoring showcases

by electrical resistance (ER)  
measurement

# why?

- to assess the risk of corrosion
- to improve preventive conservation policy
- to answer frequently asked questions:
  - “Is the showcase efficient to protect the collections against pollutants?”
  - “Is the environment better in a showcase than in another?”
  - “Is it possible to improve the conservation of the collections?”

# experimental

- the electrical resistance

- of a metallic probe
- increases as its cross section diminishes
- due to corrosion
  - span = 25 nm
  - accuracy  $\pm 0.5\%$  of the thickness
  - resolution 0,1%

ASTM G96, *Standard Guide for On-Line Monitoring of Corrosion in Plant Equipment (Electrical and Electrochemical Methods)*, ASTM International, West Conshohocken, USA

- benefits

- versatile
- on-line
- metal loss

- drawbacks

- time
- corrosion uniform

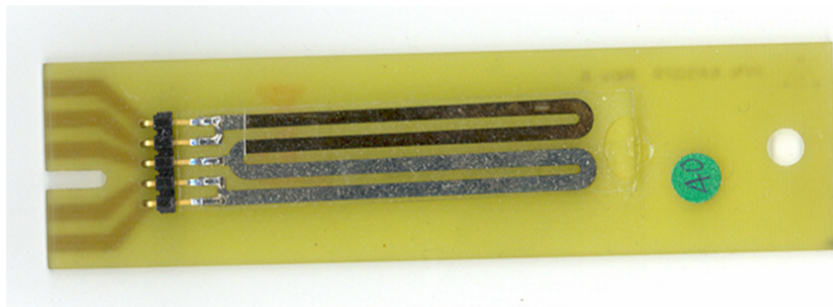


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# choice of the probes

- silver

- sensitive to
  - $\text{H}_2\text{S}$ , S,  $\text{Cl}_2$
- insensitive to
  - relative humidity
  - organic acids
  - VOC



- copper

- sensitive to
  - relative humidity
  - broad range of pollutants
- significant influence of
  - $\text{H}_2\text{S}$
  - $\text{SO}_2$
- little influence of
  - $\text{Cl}_2$ ,  $\text{NO}_2$  and  $\text{NH}_3$
- synergistic effect of
  - $\text{SO}_2$ ,  $\text{NO}_2$ ,  $\text{O}_3$

# interpretation of results comparison to other environments

- BnF
- Air & Espace
- Cluny
- Guimet
- Louvre
  - AGER
  - OA
  - Sculptures
- 19 showcases
- 7 galleries
- 6 stores
- 1 outdoors

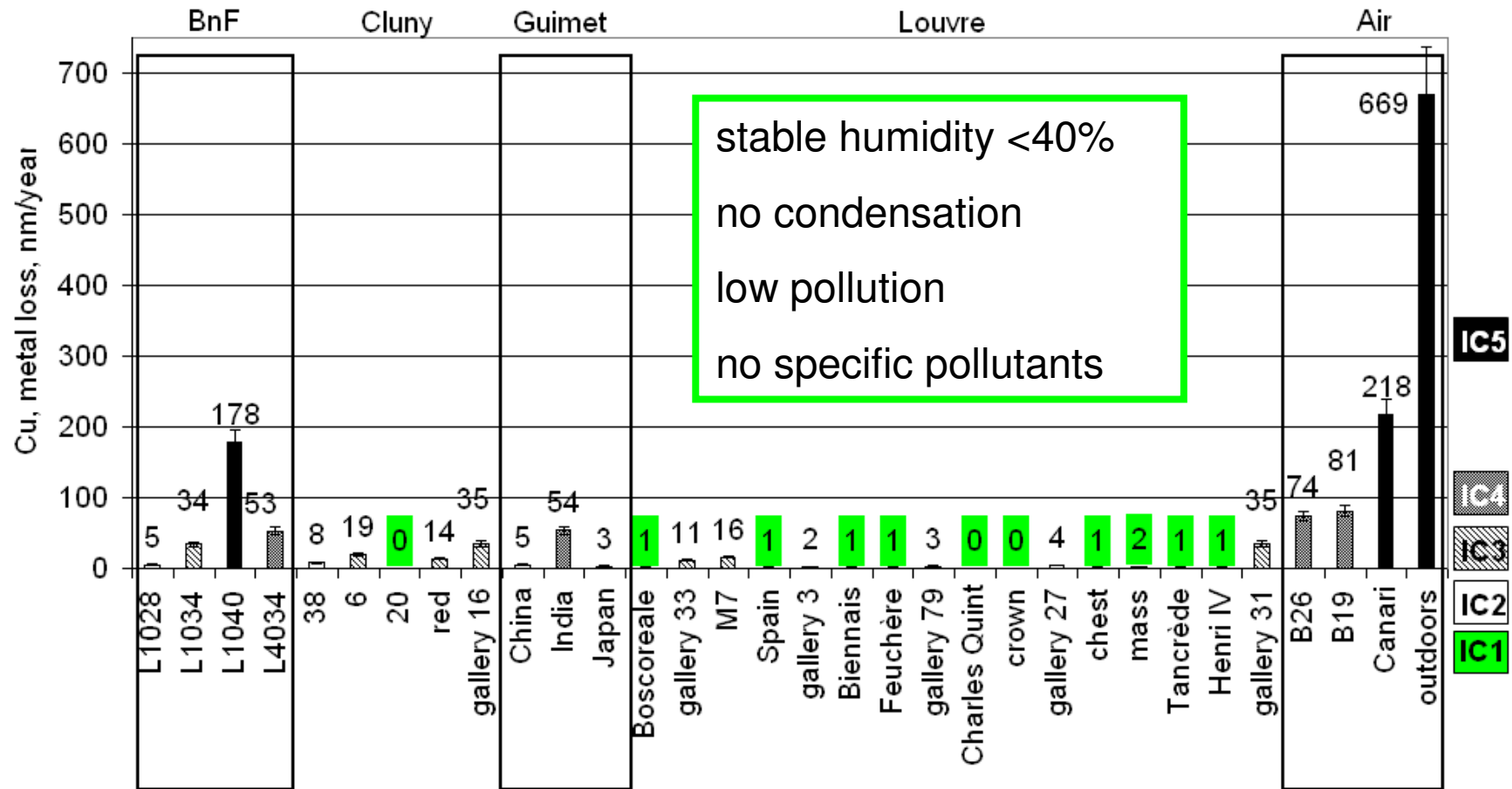
# interpretation of results

## ISO/DIS 11844 standard

nm/year	IC1	IC2	IC3	IC4	IC5
corrosivity	very low	low	medium	high	very high
silver	<2	<10	<43	96	<240
copper	<3	<11	<50	<112	<280

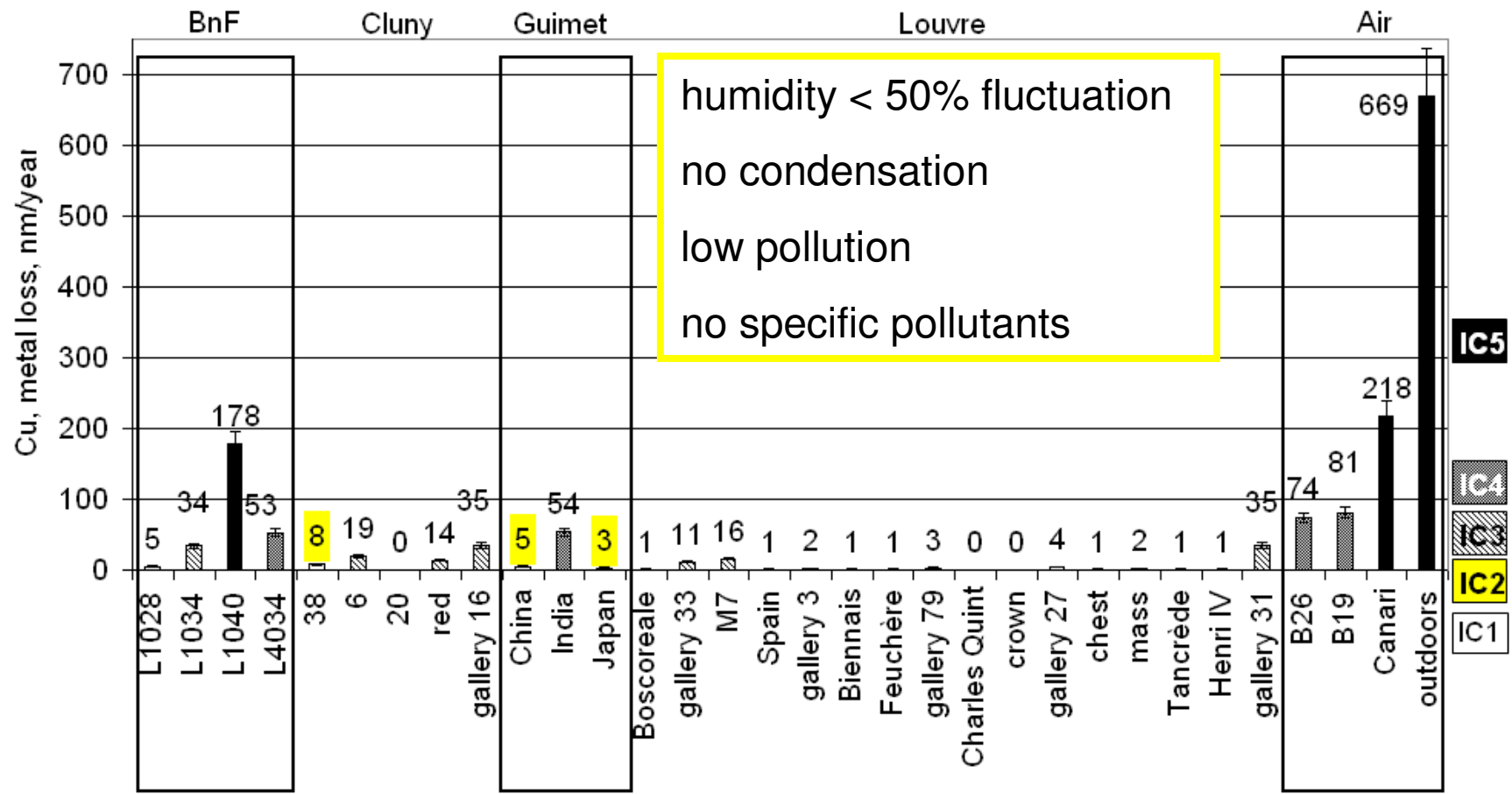
# copper, IC1 <3 nm/year

# 11 showcases: *very low corrosivity*



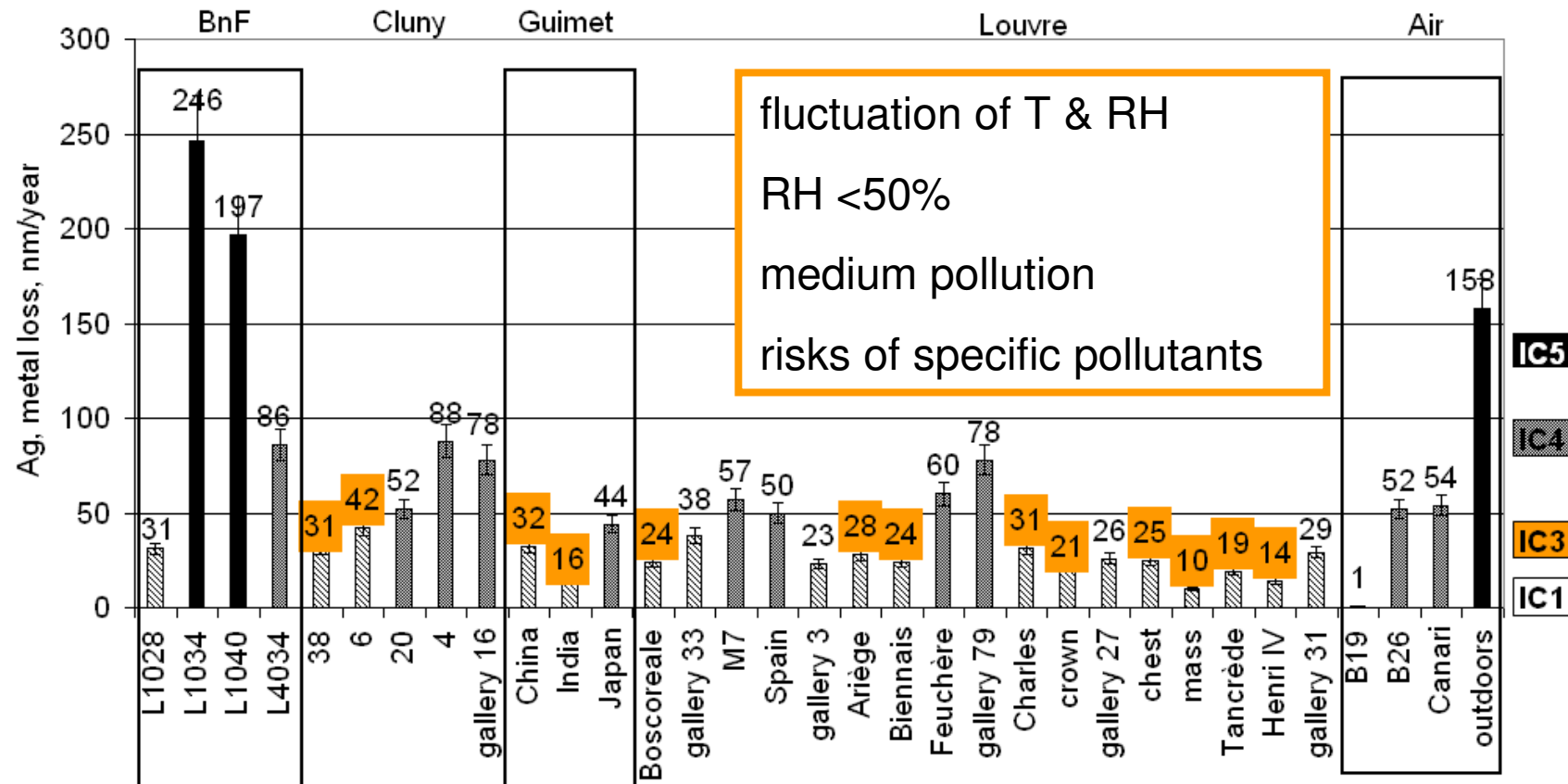
# copper, IC2 < 11 nm/year

## 3 showcases: *low corrosivity*



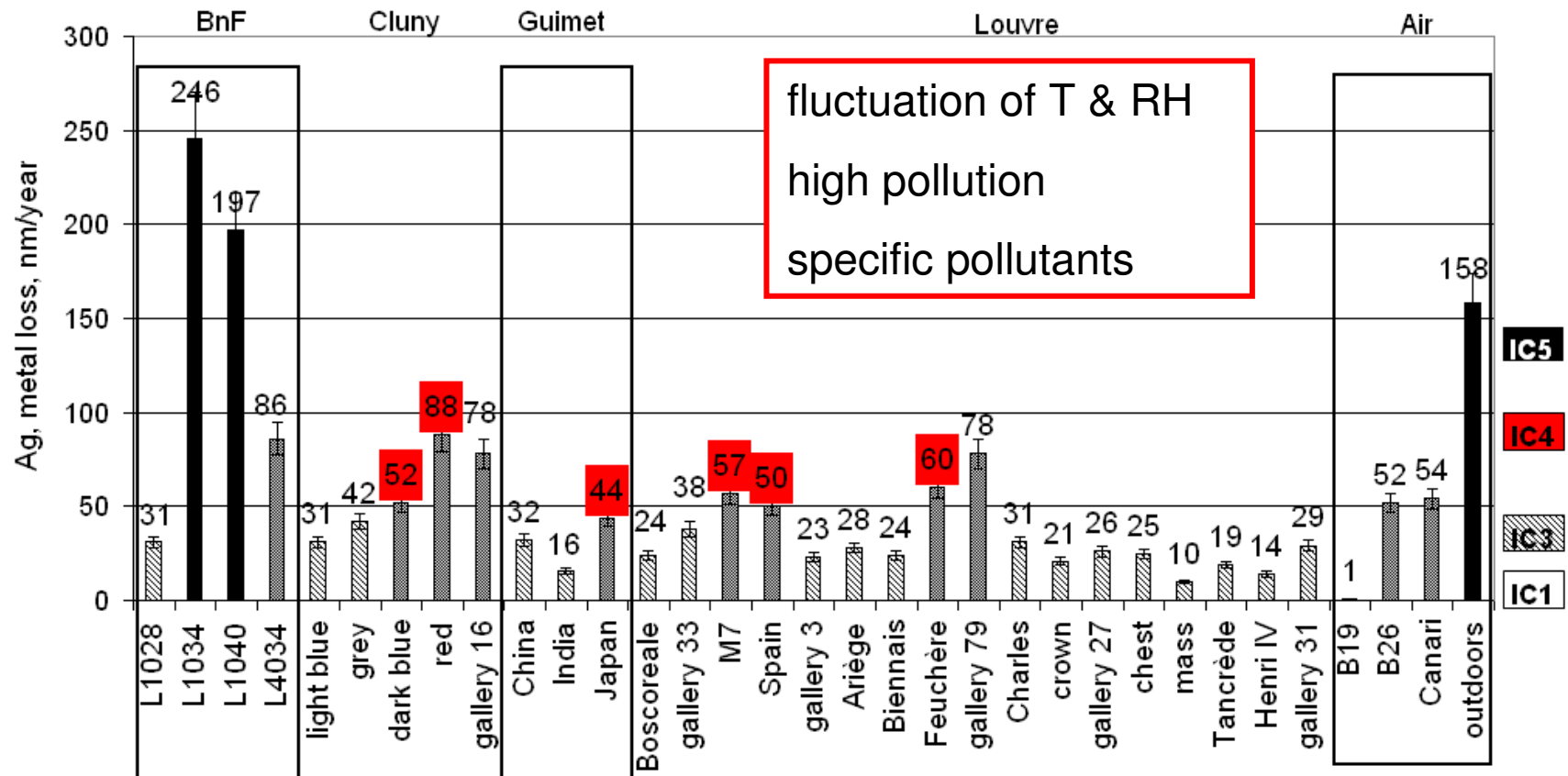
# silver, IC3 <43 nm/year

## 13 showcases: *medium corrosivity*



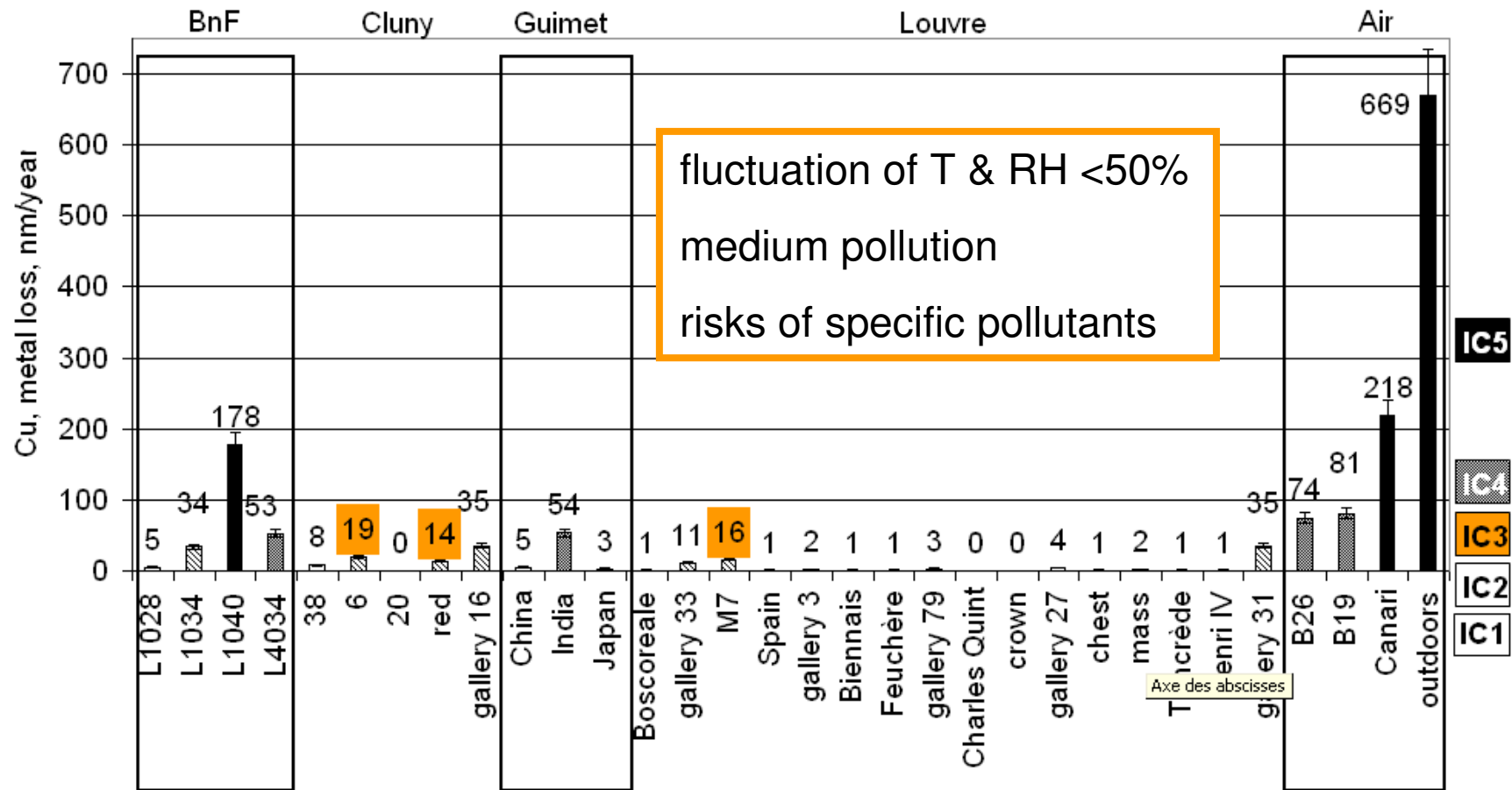
# silver, IC4 <96 nm/year

## 6 showcases: *high corrosivity*



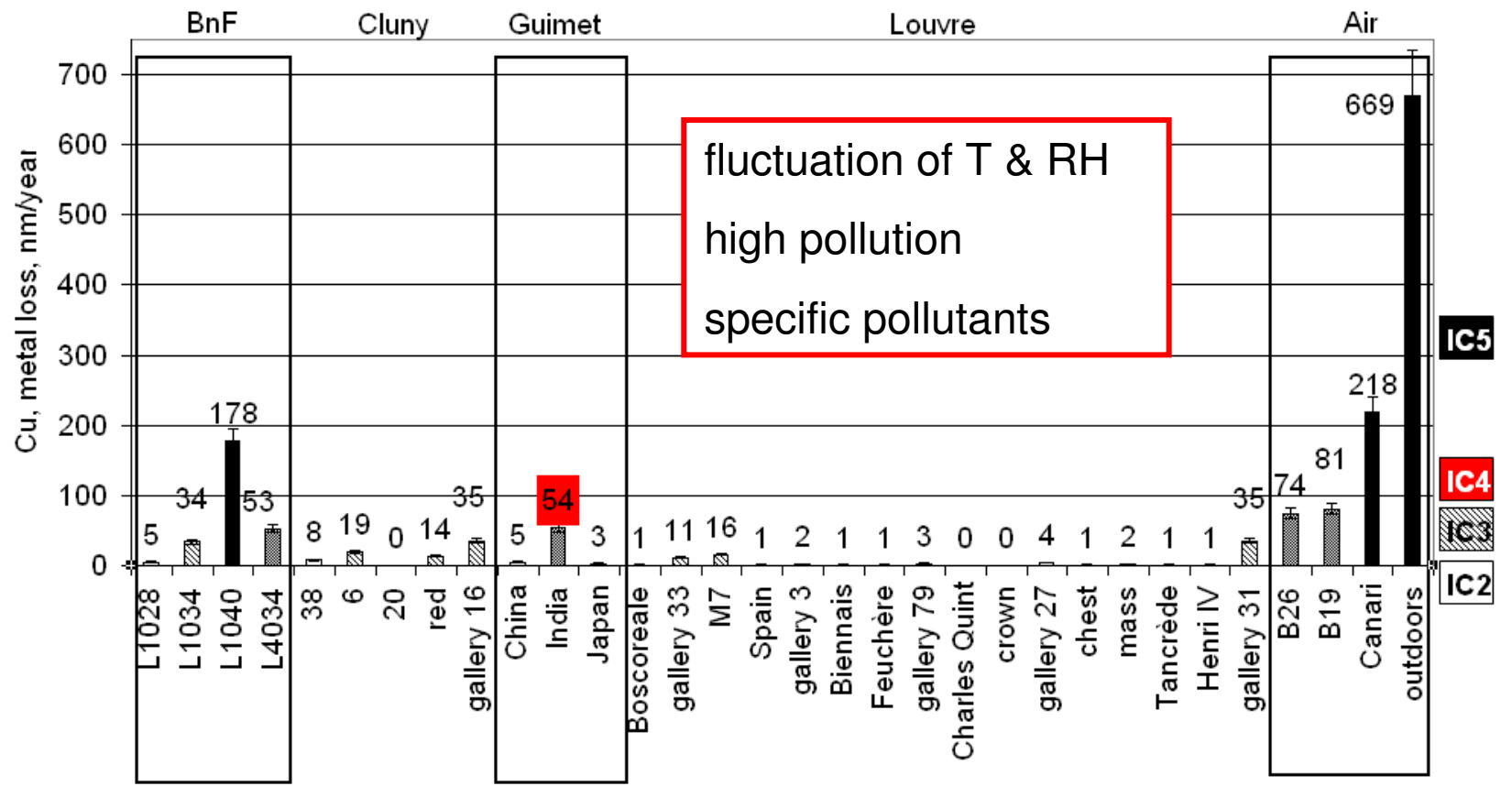
# copper, IC3 < 50 nm/year

## 3 showcases: medium corrosivity



# copper, IC4 < 112 nm/year

## 1 showcase: high corrosivity



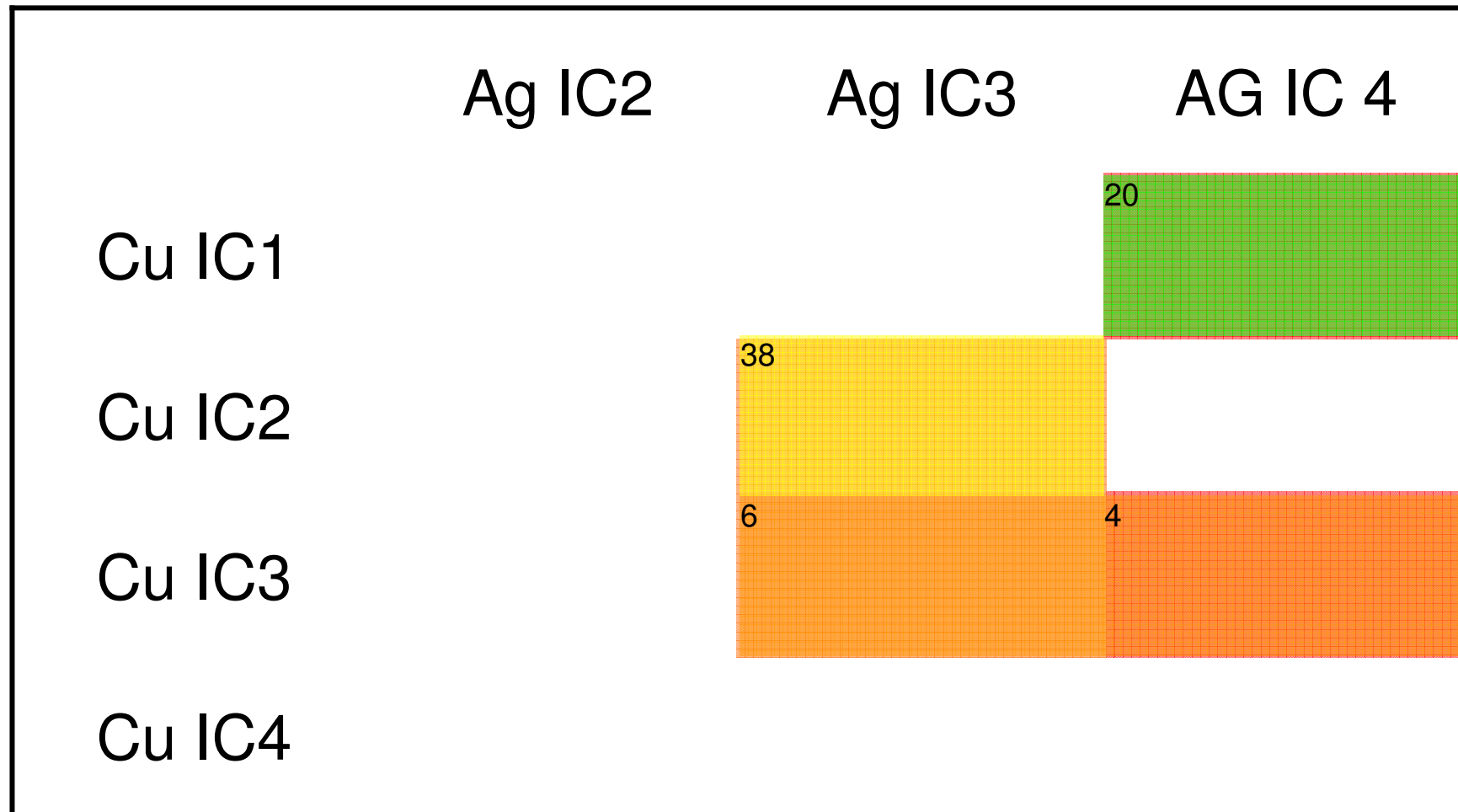
# summary

	Ag IC2	Ag IC3	AG IC 4
Cu IC1		8	3
Cu IC2		2	1
Cu IC3		1	2
Cu IC4	1		

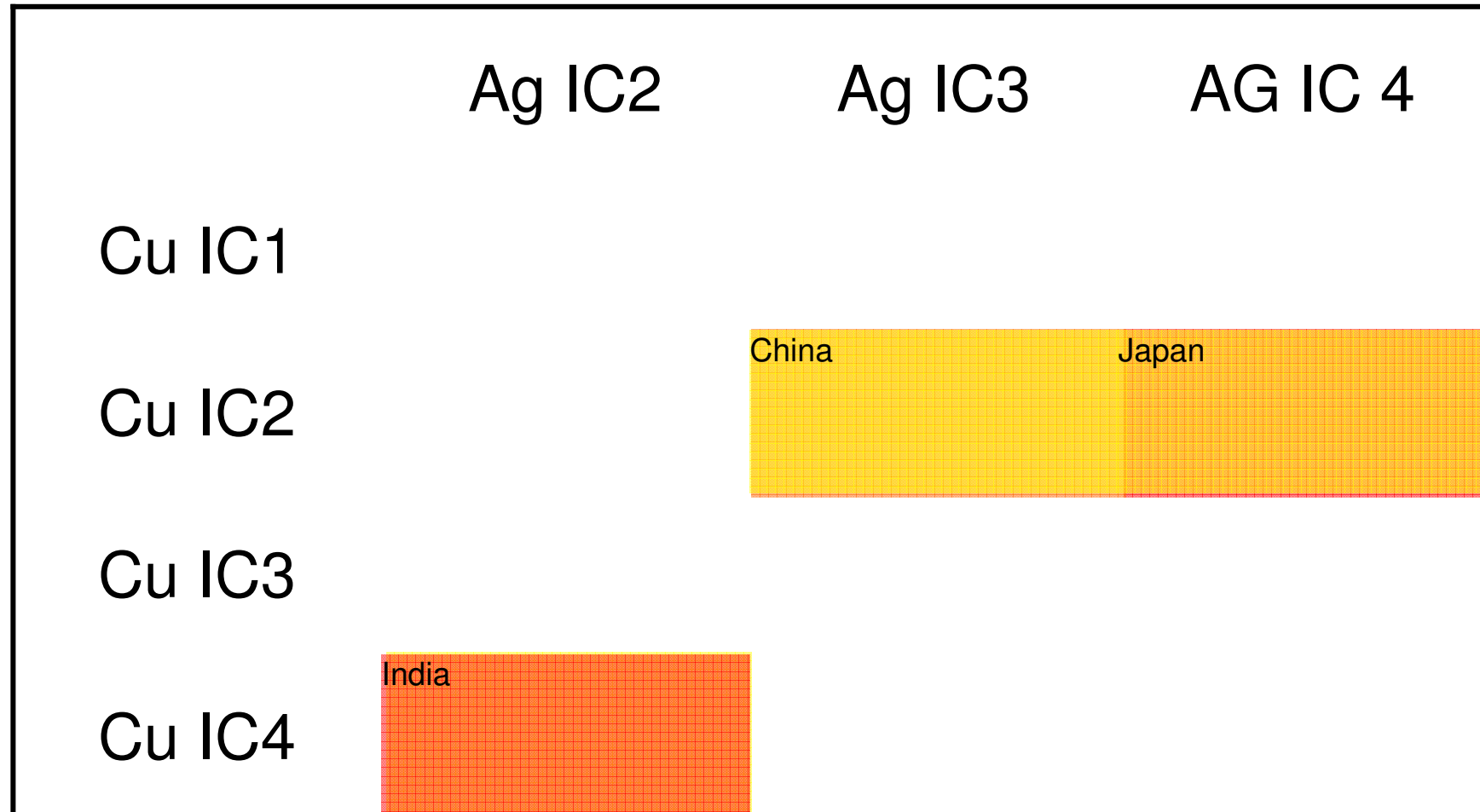
# Louvre

	Ag IC2	Ag IC3	AG IC 4
Cu IC1		Boscoreale Biennais Charles Quint crown Tancredi chest mass Henri IV	Spain Feuchère
Cu IC2			
Cu IC3			M7
Cu IC4			

# Cluny



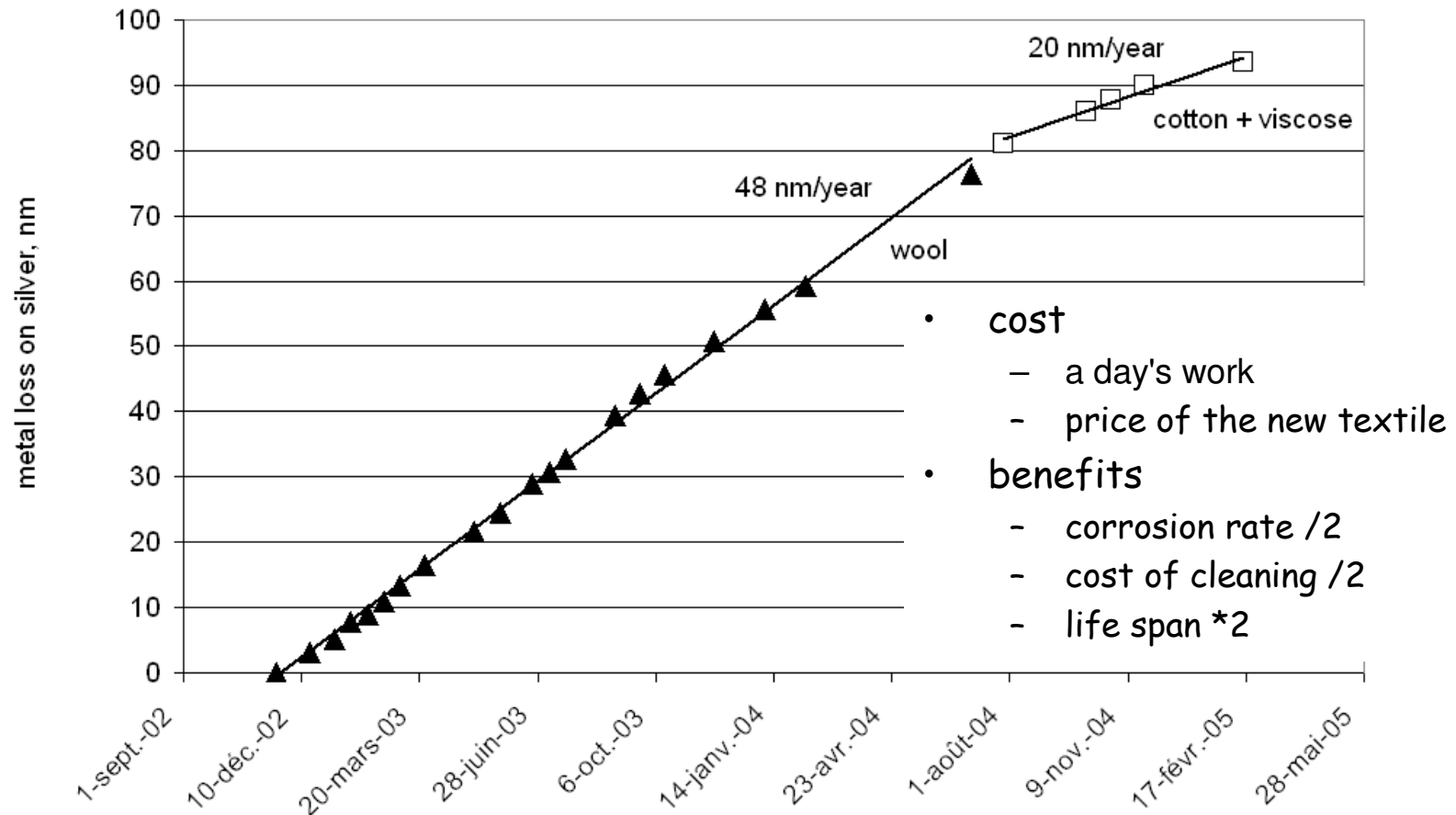
# Guimet



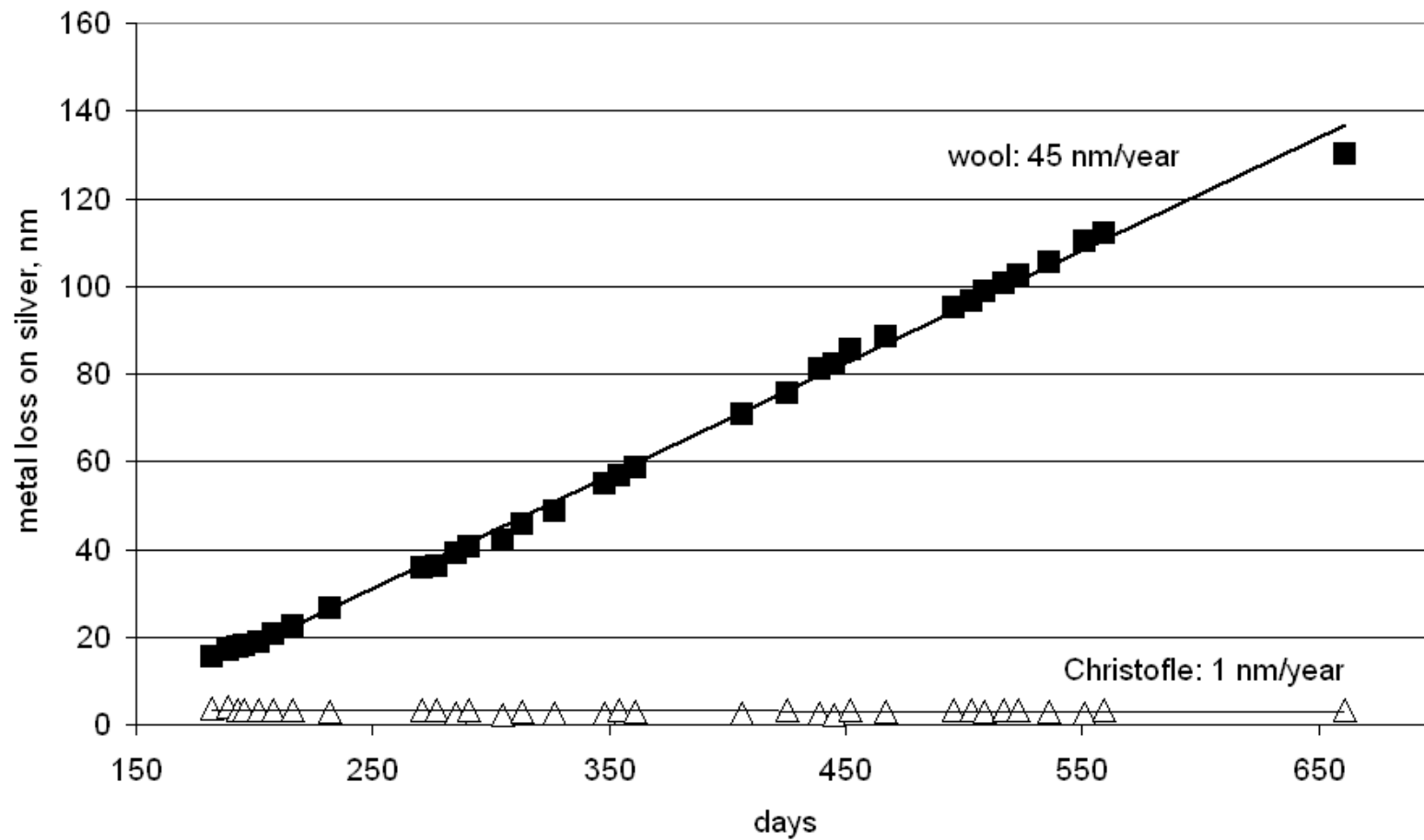
# correct critical points

- *Use good materials*
  - Limoges
- *Replace 'ugly' materials by good ones*
  - Louvre
  - Cluny
- *Display the objects on a scavenger*
  - Riom
- *Set absorbents near the objects*
  - Boscoreale
  - Arts décoratifs
- *Protect the object with a coating*

# materials

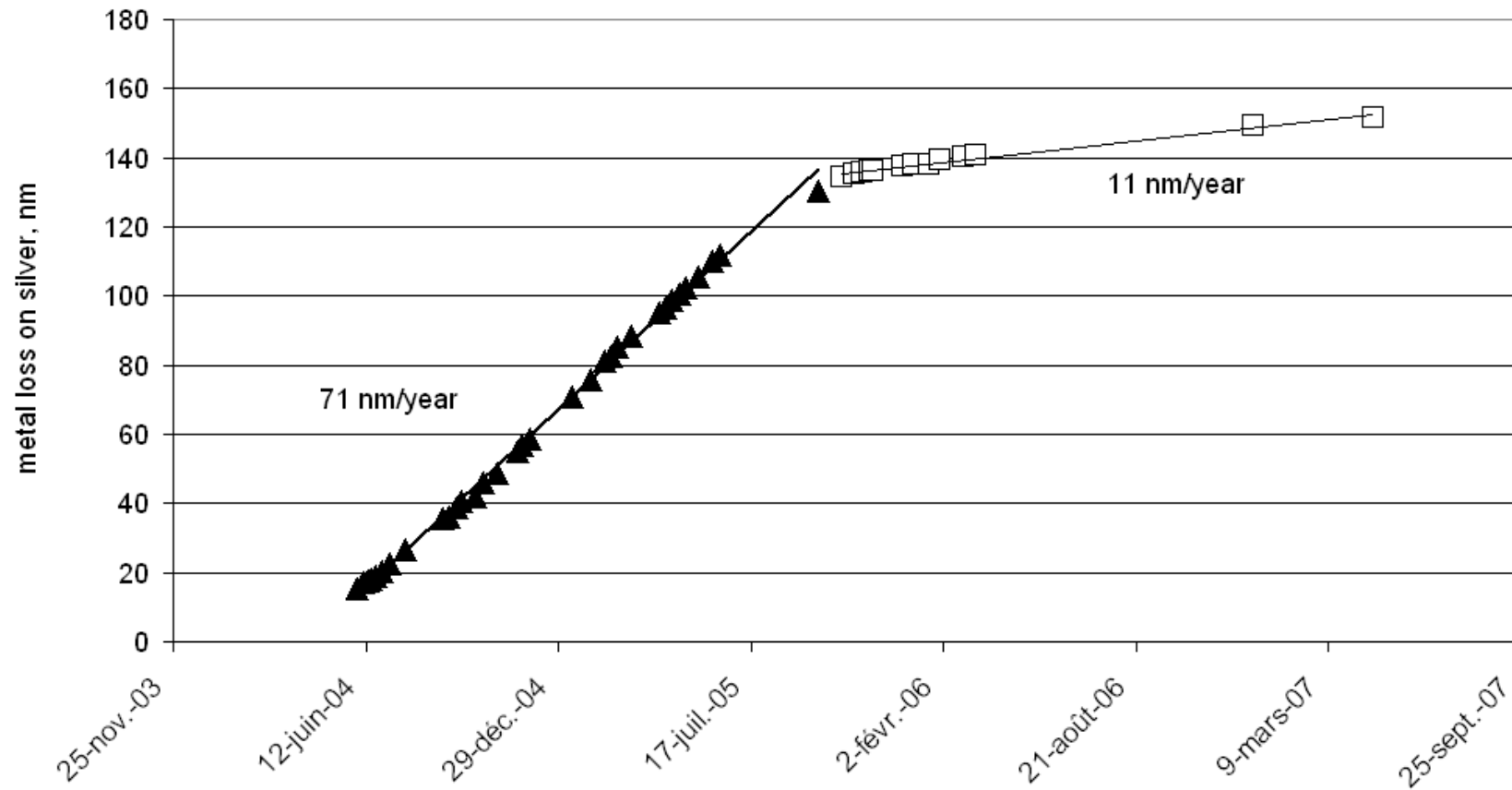


# scavenger



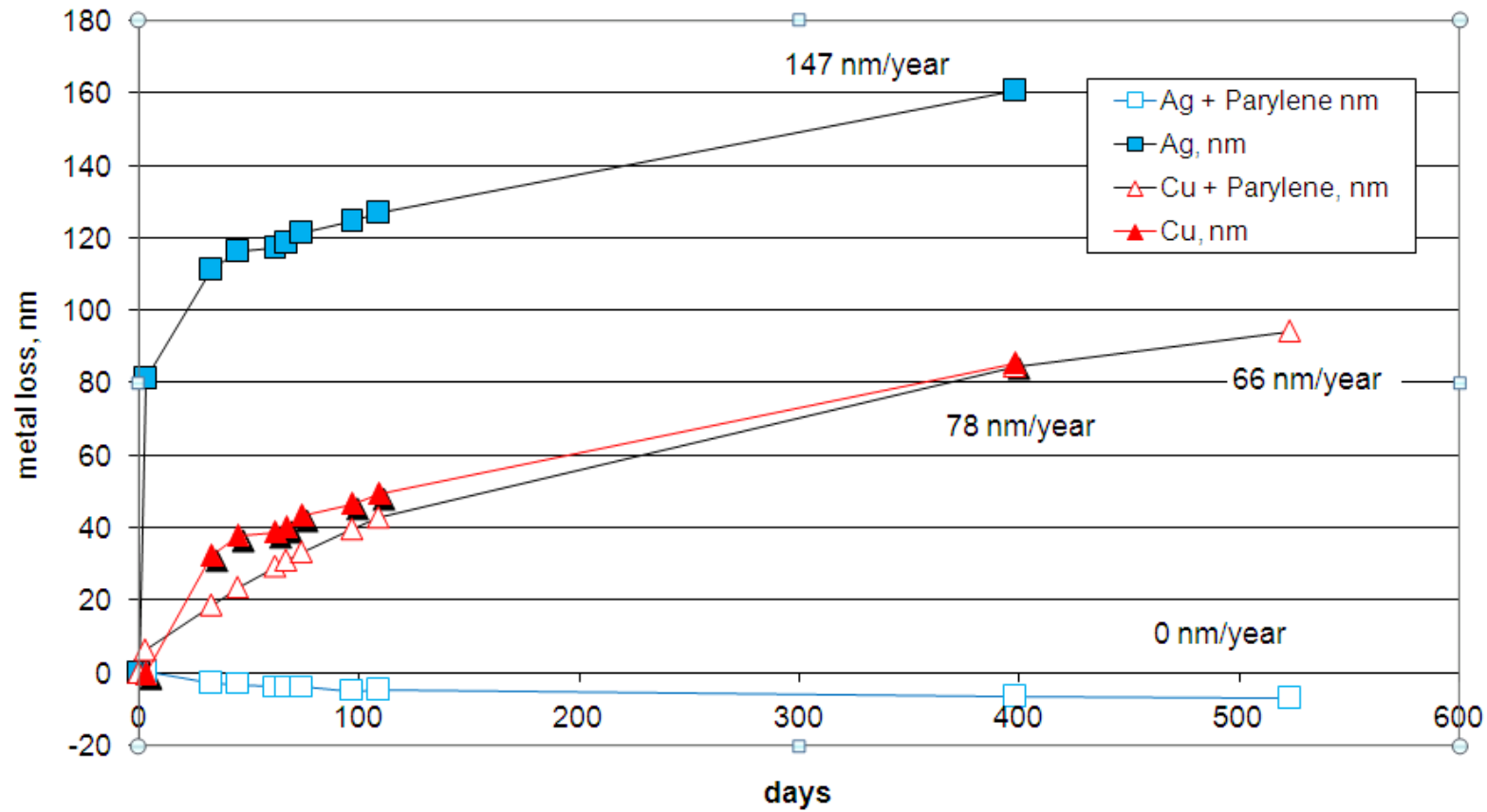
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# absorbents



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# coating



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# suppliers



- Automated corrosion sensors as on-line real time process control tools (CORRLOG)
  - Co-operative Research Project, Sixth Framework Programme
  - Horizontal Research Activities Involving SMEs, Co-Operative Research, Contract no. 018207, 09/2005–02/2008
- Protection of cultural heritage by real-time corrosion monitoring (MUSECORR)
  - Collaborative Project, Small or medium-scale focused research project
  - Theme 6 Environment, Activity 6.3. Environmental technologies
  - Sub-activity 6.3.2. Protection, conservation and enhancement of cultural heritage, including human habitat
  - Area 6.3.2.2. Networking, knowledge transfer and optimisation of results in cultural heritage
  - ENV.2008.3.2.2.1 Framework conditions to enhance most promising prototypes

# acknowledgements



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- Cost D42 EnviArt