

The Mints of Roman Silver Series during the Second Punic War

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Outline:

1. RR research team
2. Running projects
3. Main tools: Die Studies, Hoard investigation, Specific Gravity, Die axis
4. Expectations from SILVER



Myself in a nutshell



1963: Born in Casale Monferrato, Est Piedmont

1987: Master degree in **Electronic Engineering** from Politecnico di Torino
(summa cum laude, award for best student in his degree year)

1989 – present : CNR (Consiglio Nazionale delle Ricerche) employee

From 2001 Senior Researcher with IEIIT, a CNR Institute
in the field of ICT (Information and Communication Technologies).
It is located within Politecnico di Torino.

Specific field of research: **Semiconductor Laser Devices** and Applications.
This started since my master thesis, on 80's semiconductor lasers, that
received a National Telecom Award.

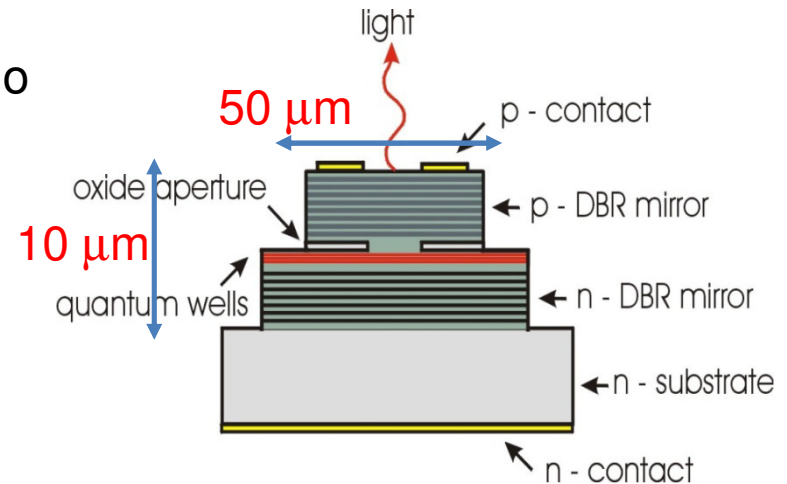


Vertical Cavity Surface Emitting Lasers (VCSELs)

SILVER Kickoff meet.
22-24 Jan. 2018

IEIIT-CNR, c/o Politecnico di Torino

From year 2000 I'm working on the simulation and design of VCSELs, **semiconductor lasers** emitting from 850 to 2500 nm for ICT applications, now having a share larger than 90% of the market.



Many applications

- **Datacom**
- Sensing (environment, mechanics, buildings, etc.)
- Laser mouse (VCSEL invented by me)
- Proximity sensors in Smart-Phones
- CD players, Laser Printers
- Inter and Intra-chip communication
- High Power (arrays per laser pumping)



1 cm



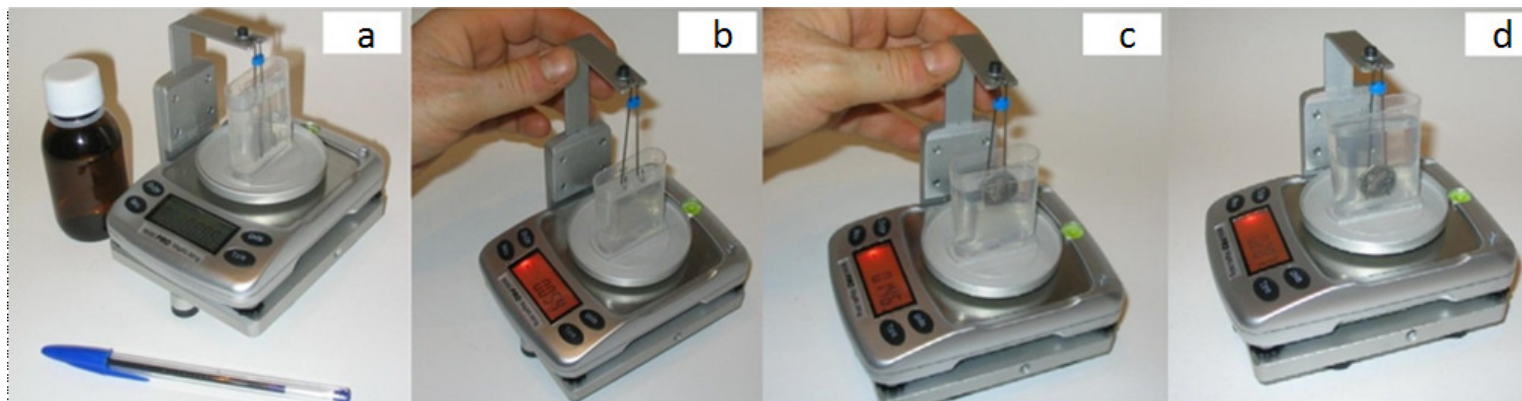
Ancient Numismatics: a childhood passion!

But only started in 2003, by purchasing my first denarii at eBay

- soon moving to the Roman Republican period
- since about 8 years focusing on the II Punic War silver coinage

My technical perspective since the beginnings prompted me to investigate as much as possible the **physical properties** of these coins:

1. weight statistics and their evolution with time and series (first paper in 2008)
2. fineness features via SG, with a self-made apparatus: ArchimeDe



Collaborations

From Roman Republican Coinage (Michael Crawford, 1974):

Two problems remain, one practical, one theoretical. The practical problem is that to count all the dies used to strike during the Republic would be the work of several lifetimes.

I think that numismatics, as also my professional field, has to be regarded as a **multidisciplinary science**, requiring both historical and technical background.

I'm a simple history passionate, so I rely on collaboration with friends who have the necessary background:

Roberto Lippi and Mark Passehl (AUS)



Die studies are the main ingredients to progress in the field.

The Second PW period comprises about 1/5 of all the RR series:
their die study has never been attempted so far.

Crawford rightly estimated in several lifetimes the time needed for this task.

I've developed a method that speed up considerably the work.

Nevertheless, my (today shorter) lifetime could be an obstacle to end it.
Moreover, not only the time is an issue, but also to need to have my work
crosschecked and have discussions and exchanges with other people.
Therefore I have a number of friend who give me a hand:

Olivier Legrand, Steve Brinkman, Alberto Campana, Richard Shaefer

All have coauthored one or more of my papers.



Ongoing PROJECTS

1. Corpus of the quadrigatus coinage (with Olivier Legrand)
2. Corpus of the Martial Aurei (with Alberto Campana)
3. Corpus of the Hannibalic coinage in Italy and Sicily (mainly performed by R. Lippi and A. Campana)
4. Corpus of the Victoriatus coinage, *about finished*
5. Corpus of the Denarius coinage, *still a few series missing* to cover the II PW period. Uncertainties remain on positioning some of the series
6. Investigation of the Denarius Reform (145-140BC, with Mark Passehl)
7. New arrangement of all the emissions within a **TIME-SPACE GRID**, accounting for the military needs and the commanders dislocations on the War theaters: R. Lippi, A. Campana, M. Passehl



**SILVER Kickoff meet.
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[illegible]

Hoard direct investigations

This is of primary importance to the progress of the field.

Several new hoards of the War period have/are being published:

- 11) The Gallarate hoard, NC 163, 2013, pp 341-344, plates 55-58.
- 15) The Orzivecchi hoard and the beginning of the denarius, NC 2014, pp.1-15, Plate 1-4.
- 19) I quadrigati Apuli, in "Dal nomos al denarius", Notiziario 8, Portale Numismatico dello Stato, 2016, pp. 94-117 (online).
- 20) Il tesoretto di Roseto Capo Spulico, in "Dal nomos al denarius", Notiziario 8, 2016, pp. 118-121.
- 21) La "riscoperta" del tesoretto di Carbonara 1891, in "Dal nomos al denarius", Notiziario 8, 2016, pp.160-170.
- 22) PD. and S. Brinkman, An Early Roman Republic Denarius Hoard, Numismatic Chronicle 2016, pp. 368-376.
- 23) PD, O.Legrand, The Restored Selinunte 1891 Hoard and the other Quadrigati at Palermo Museum, NC 2016, pp. 359-367.
- 27) PDi and Phillip Davis, A Second Punic War Denarius Hoard, NC 2018
- 28) PD and Federico Carbone, The Ara Basilica hoard and more Victoriati from Paestum, NC 2018
- 29) An early Roman Republican denarius hoard in the Piancastelli collection? AIN 2018
- 30) Tivissa 1, Drieves, Valera Armuña de Tajuña e X4 (Cuenca-Ciudad Real): un aggiornamento dei tesoretti romani repubblicani del fronte iberico, Acta Numismatica 2018
- 31) PD and Angela Maria Manenti, The Serra Orlando (Morgantina) victoriati hoard: a detailed study of the coin types and parameters, submitted to RBN



Today Hoard Table:

RRC hoards

Spanish hoards

Catt	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	26	27	19	21	22	23	24	25	28	29	30	31	33	34	35	36	37	38	39	40	41	42	43			
Accur.	A	A	A	A	A	A	A	A	A	B	A	A	B	C	A	A	A	A	A	A	A	A	A	A	A	C	A	A	A	B	B	A	A	A	A	B	A	B	A	A	A	A	Accur		
Region	Sp	Si	Sp	Af	Si	Si	Si	Si	Ap	Ap	Si	Sp	It	Si	Si	Sp	Sp	Si	Sp	Sp	Sp	Si	It	It	It	Sp	It	Hr	Sp	Ap	Si	Sp	Sp	Sp	Sp	Sp	Sp	Sp	It	Si	It	It	It	Place	
Name	Utiel	Morg. 1956	Ebre-Segre	Cartagine	Morg. 1958	Enna A	Enna B	Agrigento	N-hoard	Taranto 1970	Morg. Mang.	Villarubia	Schaefer 98	Adrano Herst	Adrano Mang	Tivissa 1	Tivissa 4	Licata	Tivissa-Nogu	Valera	X4	Ucria	B-hoard	Tarquinia	Orzivecchi	Las Ansias	Piancastelli	Split	Cut-denarius	G-hoard	S-hoard TOT	Cuenca	Armuna	Drieves	D-hoard Tota	Jalance	Francoli	K-hoard	Mirabella	M-Hoard	Masera	Montecarotto			
Total	2	35	2	3	9	22	160	52	58	204	32	13	105	550	66	7	10	361	17	15	88	4	95	15	42	0	121	24	40	41	135	57	33	15	113	15	39	150	22	1168	178	463	4587		
RRC						214-210										209-206										205-202										post war						RRC			
Non RR	19		27	x		97	>200		10		88	7				22	9		14												14	22	5		x	10									
N.Id.																																	0			x									
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44/1						1	3		1										3																								4	44/1	
53/1					1							2				5			1																								2	53/1	
47/1	2	8	1		2	4	5				8				2			43	1			4		1		1					3				1									47/1	
44/2								34																																					44/2
44/3								2																																					44/3
44/4																																													44/4
44/7														297	8																													44/7	
44/7A		26			1	6			1									145	3			1				6					1				3								44/70-		
44/7B																		11				2																						44/72-	
72/2		1																																											72/2
NiC V					1	1																																							
44/6										68				11								2																						44/6	
44/6A			2			1	5		2		4			80	1			56	2			7		1		1				5		1		7										44/6 A	



Tools for die studies (from Dresden Colloquium, 2014)

- 1) Collected coin images and data are placed together in excel files
- 2) Die studies performed with the help of a home-made software



Each Line contains only one R/O pair

Singleton count:
automatic

Specimens per die
counts: human input

Die Studies Challenges & Approaches

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A **large** size issue (408 pieces):

Quadrigratus *RRC 28/3 (Pl.IV,5)* or Le Gentilhomme II B6



This is a **really large size** issue, with a high homogeneity in the die design.

The sample is so large because it incorporates the 270 pieces of 3 hoards of quadrigrati (Taranto).

Size becomes an issue for die study !



A computer-aided die-comparison tool

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Motivation: Long times for die-studying a sample

Simple model for spent time

Suppose sample size $n = 5$

The following comparison must be performed:

Coin	# of comparisons per side
1	4
2	3
3	2
4	1

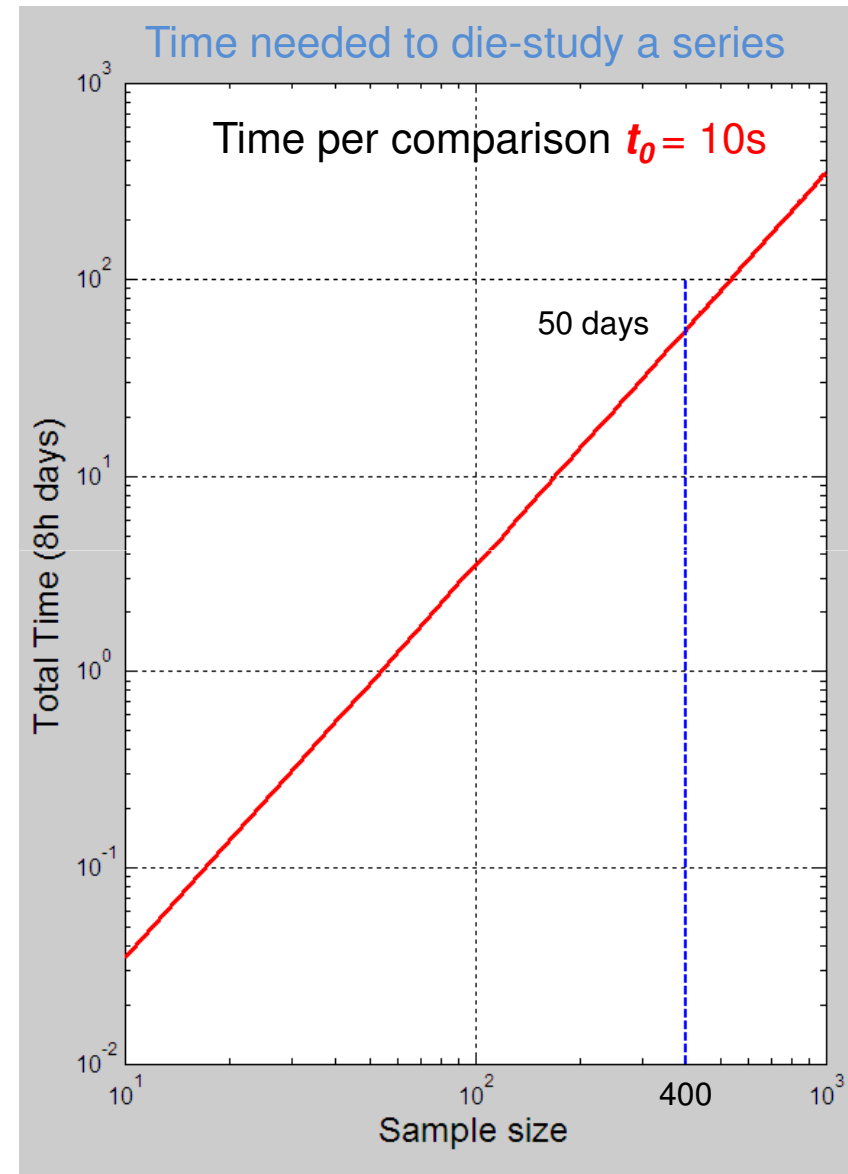
Total $10 = 5 \times 4 / 2 = n \times (n-1) / 2$

For a sample of size n

$$\text{Total Time} = n \times (n-1) \times t_0$$

Quadratic law!

one year work for an 1000 pieces



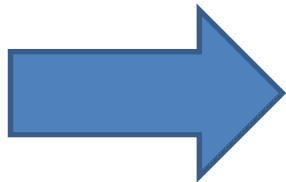
Need for some computer help.

Is that feasible?

How?

Issues for fully numerical computer image comparison:

- 1) Images non always 1:1
- 2) Quality of old images not suitable (dot printing)
- 3) Images are frequently rotated.
- 4) Images can be easily taken from different angles (image distortion).
- 5) Light source for photos impinging from different directions
- 6) Coins produced by same dies can have different defects, banker marks, flan breaks, deposits, un-even patina, graffiti, be partly out of flan, etc.



This approach is discarded



Proposed approach:

ask the computer to do what the eyes cannot do, i.e.

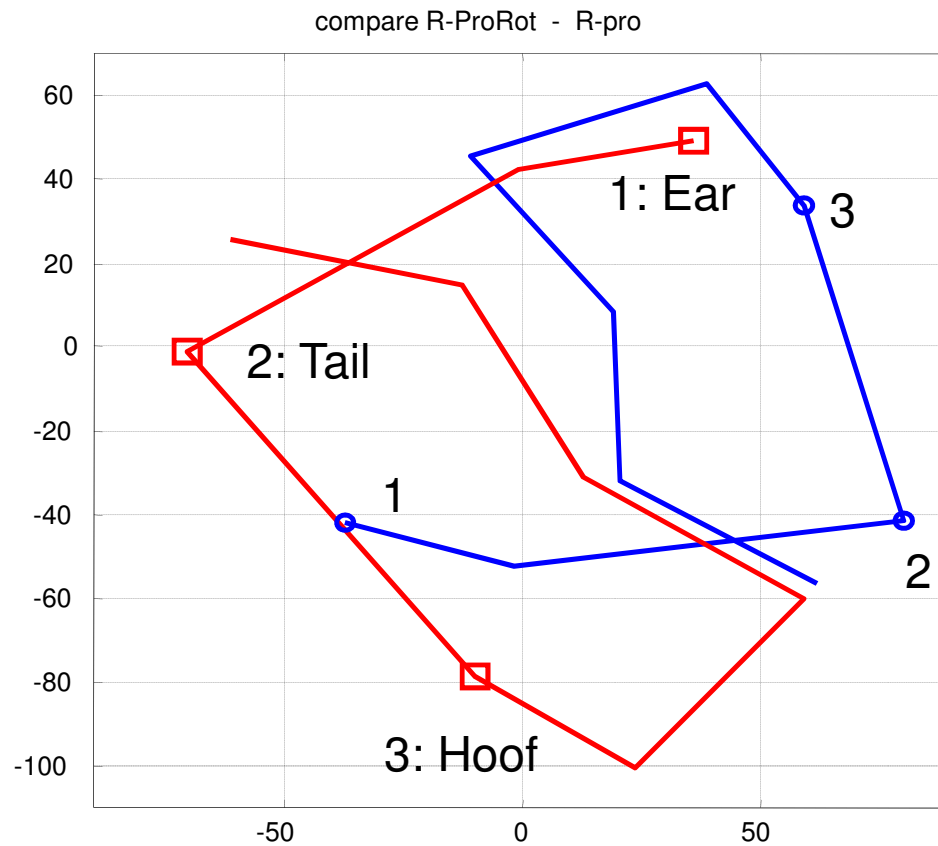


Measuring the distances between
significant points (Key Points) selected
and input by hand (see movie)

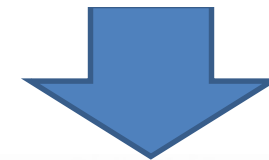


How does it work?

Example with same coin, rotated and squeezed



Key Points are forced to coincide
by rotations and scale deformation

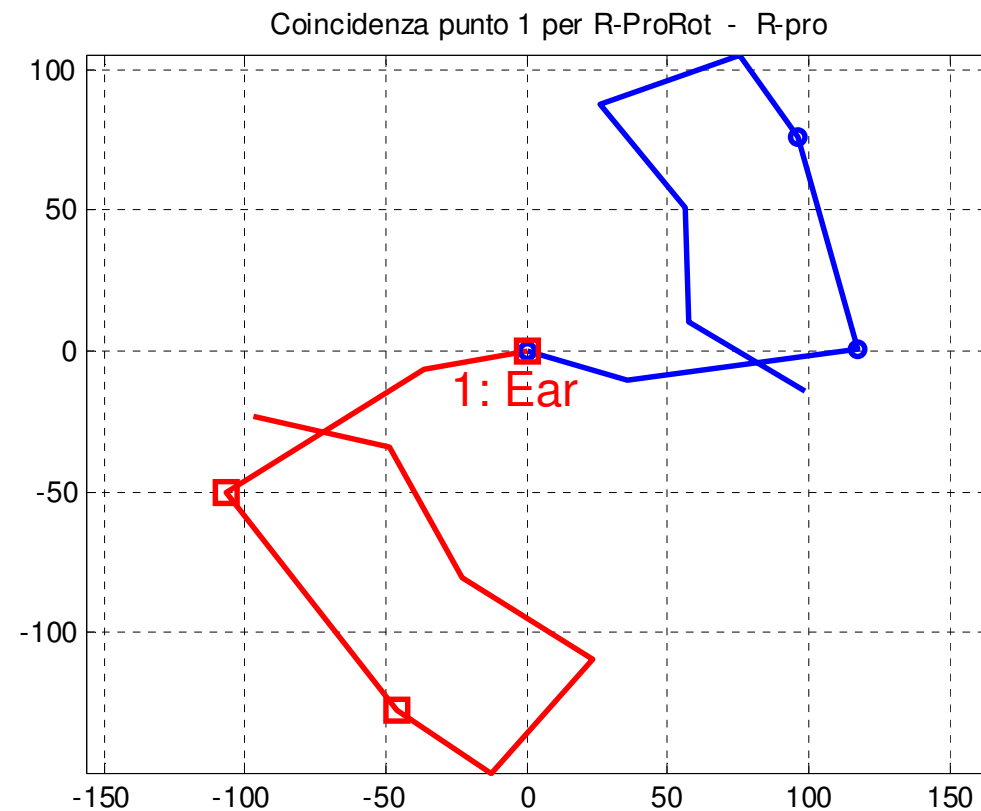


Coin rotated
and squeezed



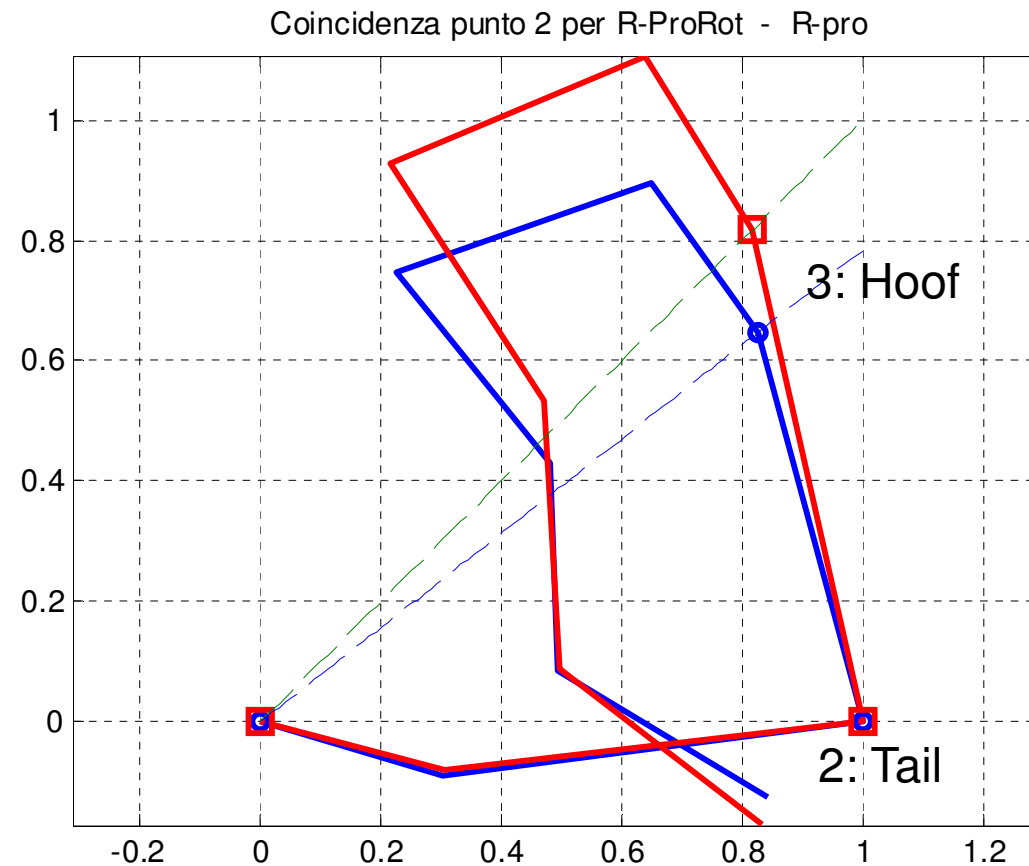
Step by step transformations

Step 1, **Points 1: Ear** are imposed to coincide in **(0,0)**
by a translation of coordinates

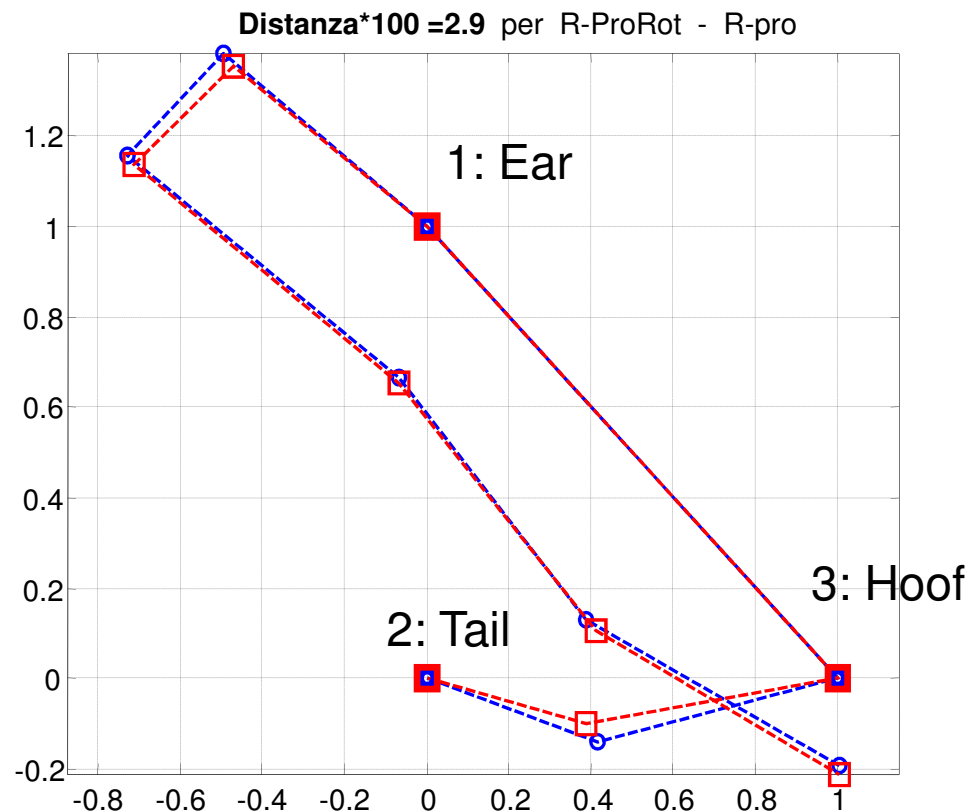


Step 2, **Points 2: Tail** are imposed to coincide in **(1,0)** by rotation and rescaling

Step 3, **Points 3: Hoof** are imposed to coincide in **(0,1)** by rotation and rescaling



Die-LIKENESS (DL) = 2.9%

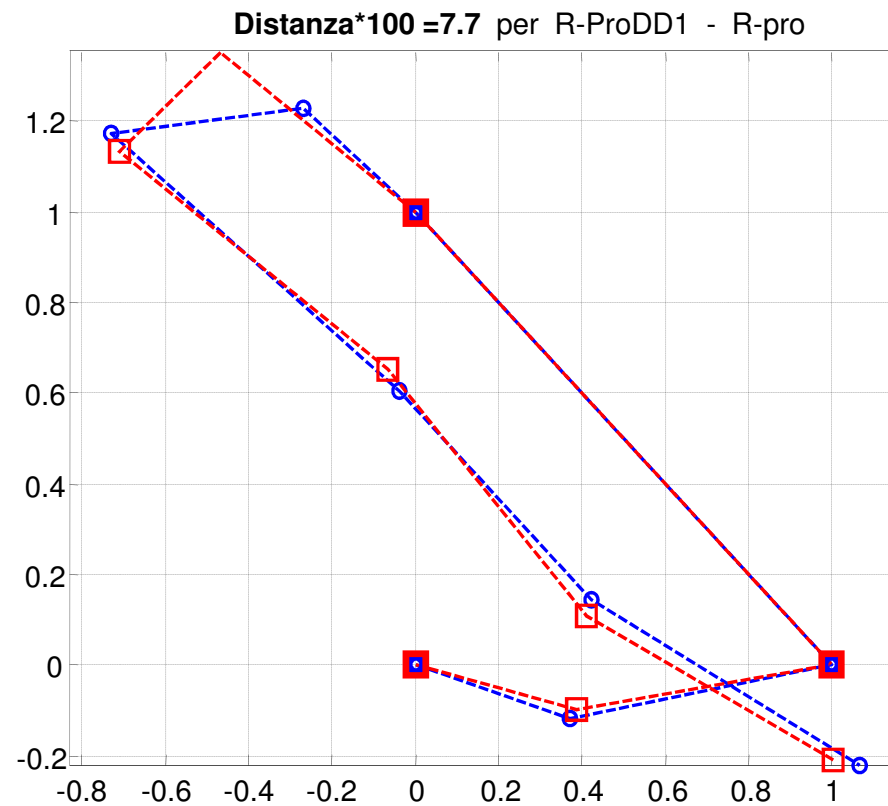


1. Points 1,2,3 define **a new system of normalized coordinates** where the distances between the two dies are measured
2. The **DISTANCE** is defined by the mean value of the distances of the remaining points. Different points are chosen to form the reference system, and a mean value of the DISTANCES used to MEASURE the **die-LIKENESS (DL)**.
3. The procedure is subject to errors during the input of the points: a mean value of DL 3% is found.
4. The **DIE LINKs** are found for die-LIKENESS values in the range 2-6%.



Example of die match failure

Die-LIKENESS (DL) = 10%



Final decision taken my human examination of pieces with $DL < 6$ or the 10 pieces with the lowest DL.

Pieces are shown on PC screen in this way:

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DL=2.9%



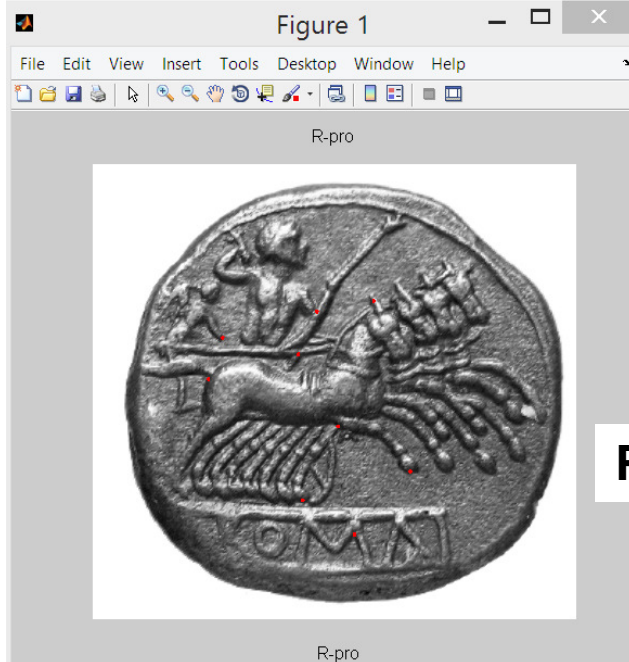
DL=3.8%



DL=8%



DL=10%



PC SCREEN

Reference specimen



Simple model for spent time

For a sample of size n

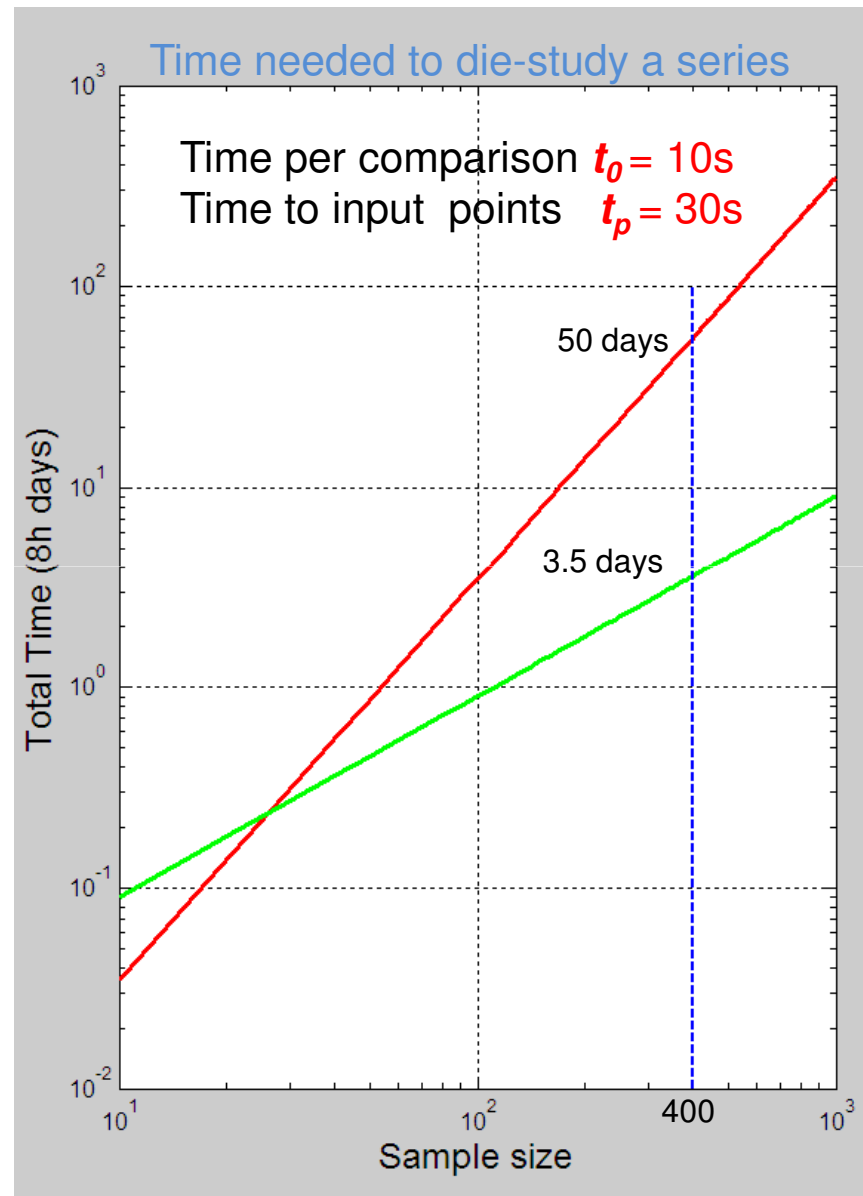
Comparisons/per side = $n \times 10$

$$\text{Total Time} = 2 \times n \times (t_p + 10 \times t_o)$$

Times increases only linearly!

This results in **10 days** instead of **one year** for a 1000 piece series.

For the 408 quadrigati: **3.5 days**



Outcomes of Die Studies

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1. More precise definition of issues:

➡ defines which styles belong to the **same issues**, which are **separate issues** as **RRC 44 and 53/2**.

2. More precise hoard classification (Spanish case)

Identification of
all the pieces in
the Drieves hoard.
Only 4 out of 13 were
identified so far.



Fig.5b: Tesoro di Drieves ed identificazione dei frammenti; vedere Tabella 1 per le referenze e le relazioni degli esemplari di riferimento (in cornice). Il segno di uguaglianza al centro indica un legame di diritto e rovescio. Dimensioni fuori scala.

SG investigation and statistics

SG (**Specific Gravity**) is an “old” numismatic tool, but with little credit, especially for silver. Main reason is: **Silver Surface Enrichment**.

This topic is treated in full in:

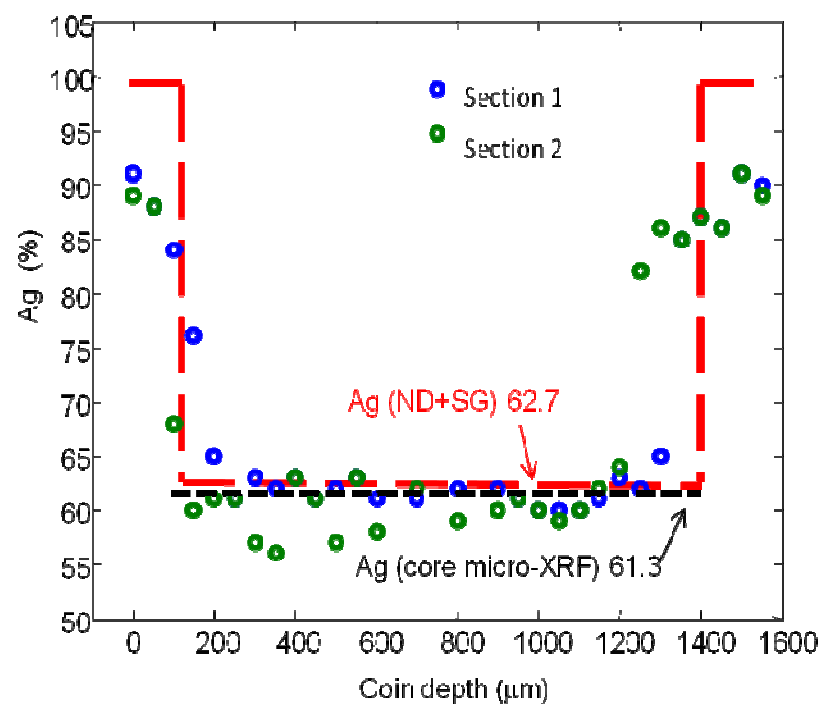
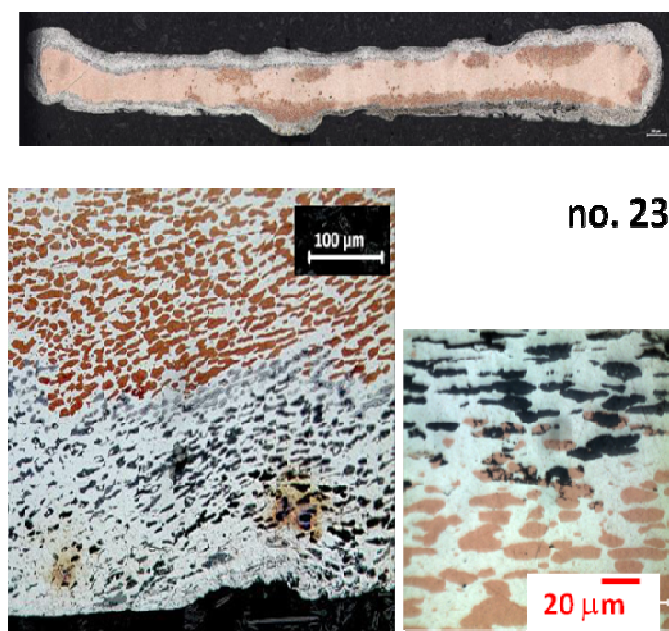
PD, **Jacopo Corsi**, et al. "Average and core silver content of ancient debased coins via neutron diffraction and specific gravity", Archaeological and Anthropological Sciences, March 2017

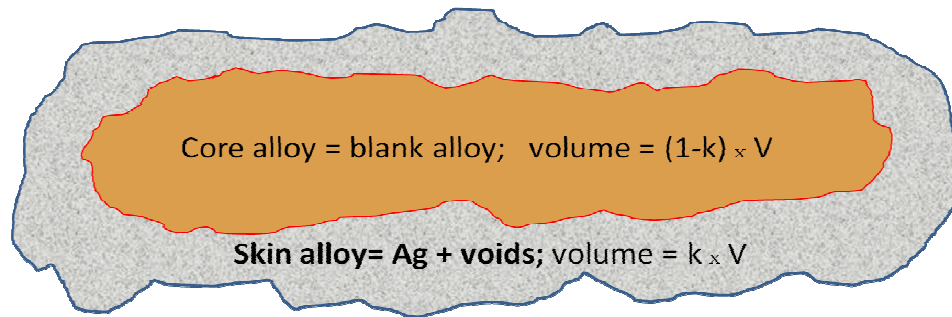
A sample of 43 silver coins (mostly victoriati, with a few drachms and denarii) have been investigated from two sides: **SG and neutron diffraction (at ISIS, UK)**.



A few samples, of no numismatic value, have been cut and micro-XRF applied on different sections.

Typical examples are:

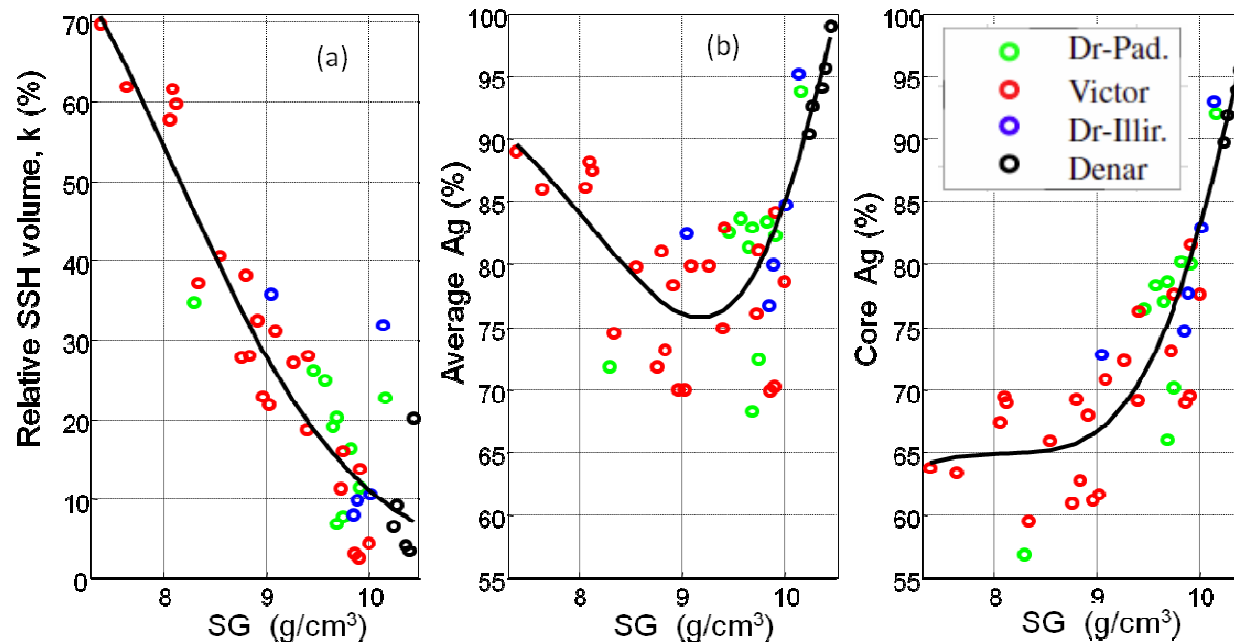




Adopting a simple model, referred to as “complete depletion model”, simple expressions can be derived which relate the **two unknown quantities** (**SSE fraction k** and **core fineness x**) with the **two measured quantities**: SG and **average fineness $x(\text{neutron})$** .

$$x = \frac{\bar{x} + \rho \sigma_{Cu} - 1}{1 - \rho \Delta \sigma}$$

ND data



Value and limitations of SG

Nobody trusts SG and believes that SG can be useful.

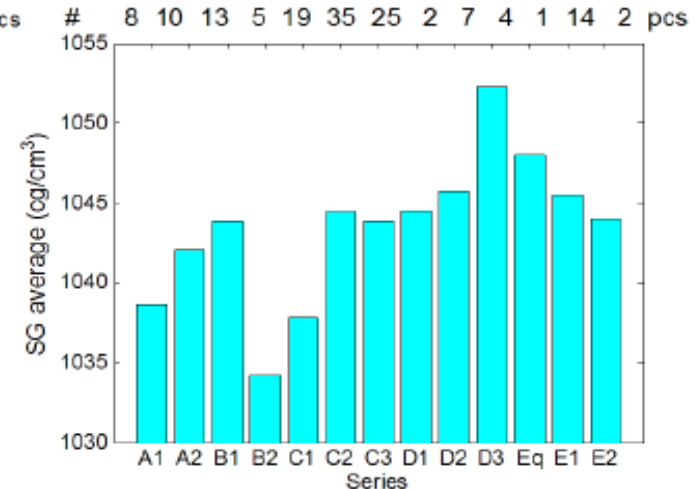
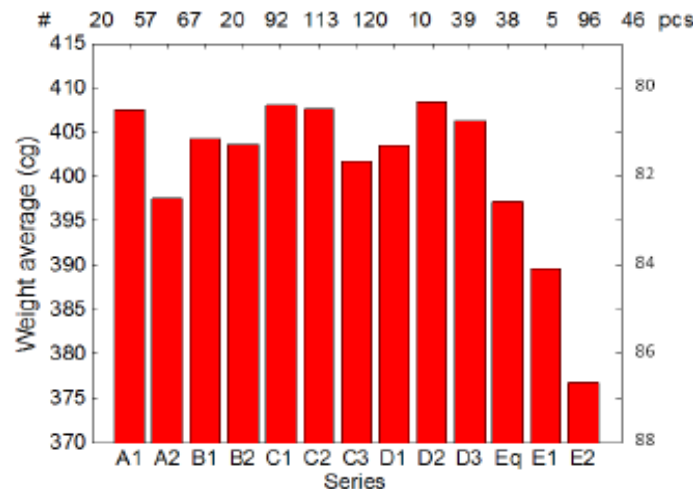
I'm perfectly aware that it does not gives all the answers:

- 1) its precision is limited to 2-3%
- 2) it cannot provide any trace component

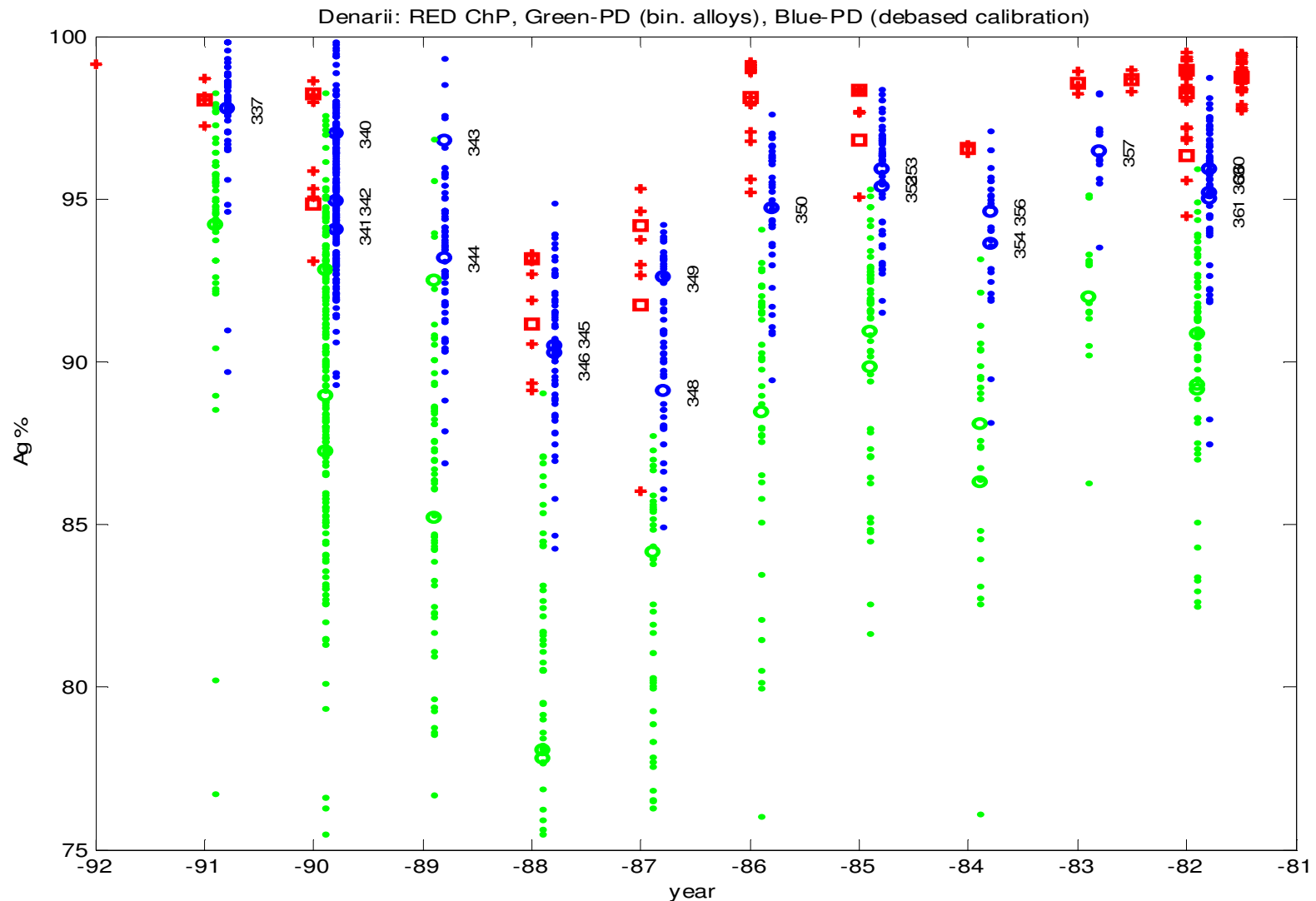
Its advantages:

- 1) fast, inexpensive and portable everywhere: CAN be RUN by everyone
- 2) helpful for Spanish Victuriatus Coinage, with much higher SG.
- 3) it is good to spot major problems in coinages, so that more refined tools can be applied where needed
- 4) for the Second Punic War period it is a precious help and reveals the crisis periods

Groups
of 53/2



Comparison between core fineness of the Social War issues from the Cosa hoard sample (about 500 coins, measured in 3 days):
SG (calibrated, **Blue**, binary, **green**) and **laser ablation**, which tends to slightly overestimate the parameter.



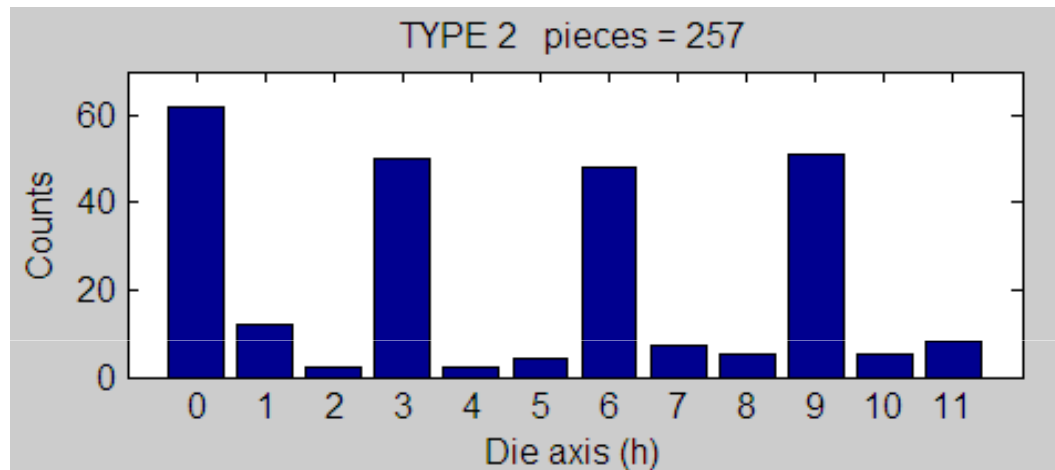
A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R	S	T	U		
	RRC	Den	RR C	RRC Rev	Wt cg	#	SG	#	Obv DIES	Rev DIES	Size	Co	Cr	R/O %	CIo	CIr	Exp. Obv.	Exp. Rev.		
1	44/5	D	1	100	125	397	382	10,40	73	292	256	292	453	59	52	88	1,6	1,8	925	919
2	44/6	Q	2	100	125	209	411	10,27	31	277	307	139	618	77	74	111	2,2	2,0	562	625
3	45/1	D	1	10	12	416	17	10,40	3	7	7	7	19	79	89	100	4,0	4,0	1	1
4	45/2	Q	2	10	12	216	40	10,39	5	19	23	10	70	96	94	100	4,0	4,0	1	1
5	45/3	S	4	10	12	104	10	10,13	3	5	5	1	11	82	73	100	2,0	2,0	1	1
6	46/1	D	1	10	12	398	34	10,35	7	16	15	16	39	85	85	94	2,4	2,6	26	25
7	46A	D	1			438	4	10,46	1	2	2	2	4	100	75	100	2,0	2,0	3	4
8	47A	Q	2			207	7	10,35	3	3	2	2	9	89	100	67	3,0	4,5	4	2
9	47/2	S	4	1	1	98	3			2	2	1	5	100	100	100	2,5	2,5	2	2
10	50/2	D	1	20	25	421	81	10,30	5	47	46	47	104	85	78	98	2,2	2,3	81	89
11	51/1	D	1	10	12	424	12	10,20	2	4	5	4	12	83	75	125	3,0	2,4	8	11
12	52/1	D	1	10	12	437	20	10,45	3	8	9	8	25	100	88	113	3,1	2,8	9	14
13	53/2	D	1	100	125	400	650	10,39	108	678	700	678	998	48	44	103	1,5	1,4	2716	2845
14	54/1	D	1	10	12	415	58	10,41	6	47	53	47	75	59	51	113	1,6	1,4	154	178
15	55/1	D	1	10	12	396	9	10,40	4	9	9	9	10	20	20	100	1,1	1,1	85	85
16	57/2	D	1	60	75	403	255	10,43	29	262	346	262	451	65	40	132	1,7	1,3	1061	1557
17	58/2	D	1	60	75	402	124	10,42	37	61	68	61	153	82	80	111	2,5	2,3	109	122
18	59/1	D	1	20	25	417	67	10,34	18	59	65	59	82	45	39	110	1,4	1,3	267	295
19	60/1a	D	1	20	25	419	66	10,41	13	47	57	47	86	71	55	121	1,8	1,5	132	176
20	60/1b	D	1			401	5		0	5	4	5	5	0	40	80	1,0	1,3	25	18
21	60/1c	D	1			377	5	10,45	1	2	3	2	5	80	60	150	2,5	1,7	5	8
22	62/1	Q	2	10	12	407	22	10,39	8	7	10	4	24	96	92	143	3,4	2,4	9	13
23	62/1	Q	2	10	12	407	22	10,39	8	7	10	4	24	96	92	143	3,4	2,4	9	13

Total of 650 pieces with SG



Die-Axis: sometime an important parameter!

Die-Axis of this series (only the 3 Taranto hoards, 257 pieces):



Marked preference for alignments at the quarters:
a special die-holder might be the origin

Some Victoriatus series and also some denarius (like 58/2) have similar behavior, indicating a probable same mint.



Expectations from SILVER

To make **elemental analyses**, sometimes complementary to silver isotope analyses, on aimed series, to verify or discard the guesses which led to the actual, but still in progress, TIME-SPACE GRID of the silver production during the War.

A few examples follow:

- 1) **Apulian quadrigati**
- 2) **Hispanic RR coinage**
- 3) **Padan Massalian Drachm imitations**

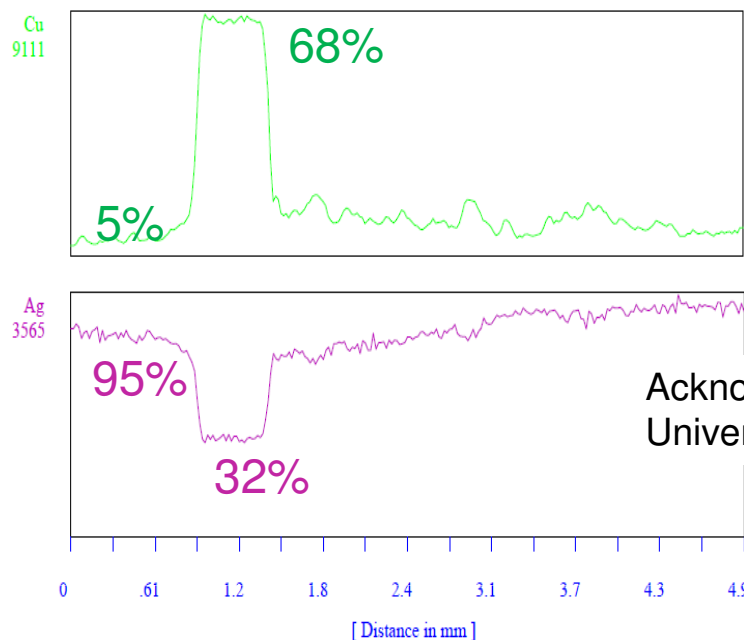


Apulian quadrigati

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Image from the inside of the instrument (μ -XRF)



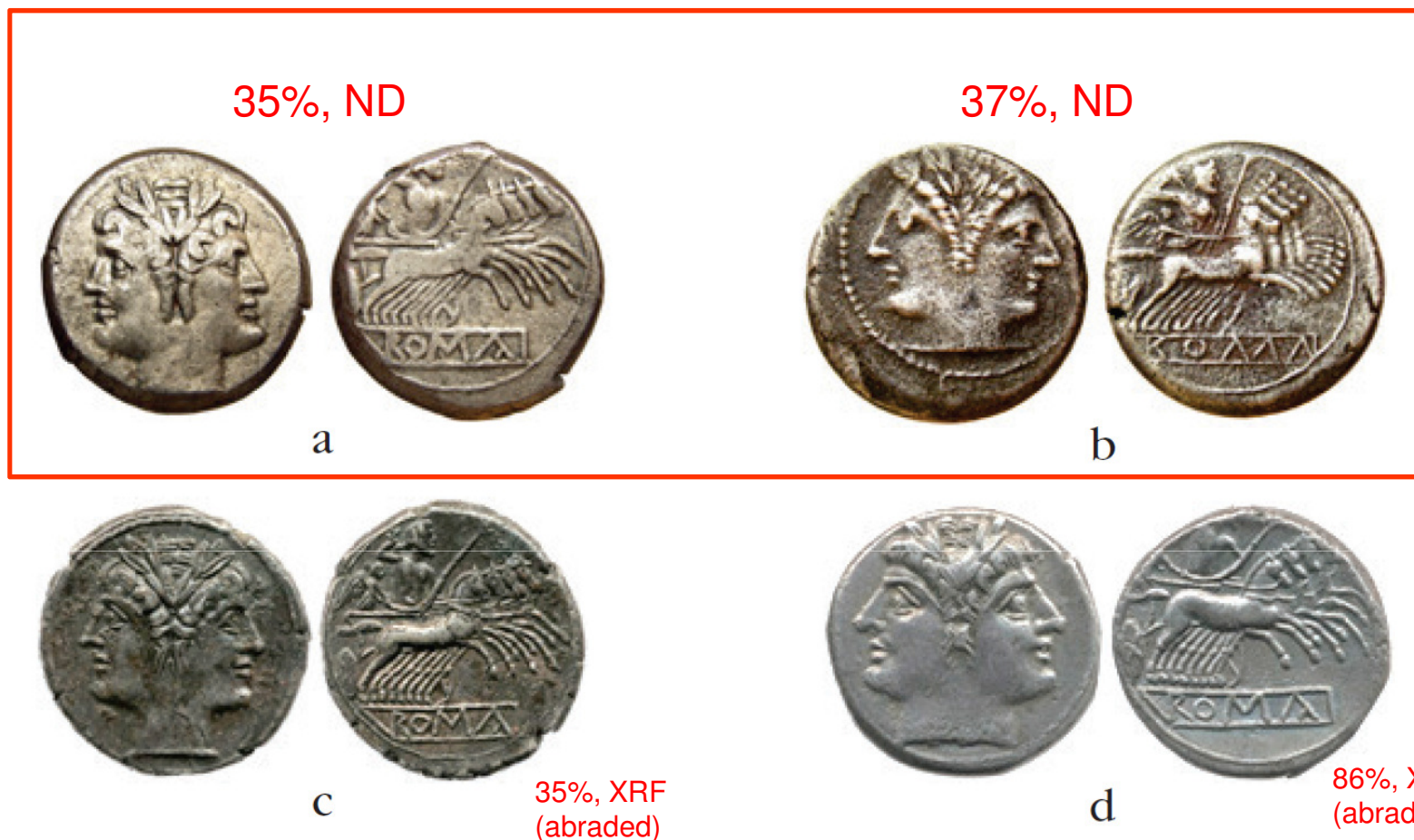
Acknow: Alessadro Re,
Universita di Torino

Extensive analyses needed to understand this
STILL ENIGMATIC coinage.

1) Were all the series produced at the same place
(silver)?

Only two other coins measured by ND give same
results of about 35% average (J. Corsi).





TAV. 6 – MUSEO NAZIONALE ARCHEOLOGICO DI TARANTO. Esemplari il cui metallo è stato misurato con varie tecniche. Diffrazione di neutroni (Jacopo Corsi): a, Inasta 51 (76) 5,32 g, 9,15Ps, Ag 35%; b, Tintinna 30 (1005) 5,2 g, 9,00Ps, Ag 37%. XRF con abrasione (DUNCAN HOOK, BM): c, British Museum 1931,0502.1 5,28 g Ag 35%; d, BM 1930,0619.3 5.40 g, Ag 86%. XRF con abrasione (Clausthal University)

What is the relationship between these two series ???





c



MQ3-47



d



MQ1-52



Hispanic RR coinage

possibly the first SILVER coin purchase

1



RRC 90/1 Cazlona hoard (Castulo), Bibliothèque nationale de France, Rep-1972 (Ailly 802), 6,34g, 23,5mm, 6h, 10,52sg, 6h

2



RRC 90/(3), 1,33g, 13mm, 10,48sg, 0h;

3



RRC 90/(4), 0,35g, 10,54sg, 6h

4



RRC 90/(5), 0,20g, 3h



Vico149,129: 0,48g, 10.57sg, 2h
Just received by Vico and available
for all the SILVER investigations.



IS THIS SILVER the same as the rest of Hispanic coinage?
Can we say that coins 3 and 4 belong to the same series
as 1 and 2 ????

Padan Massalian Drachm imitations

with Jacopo Corsi



Where comes this silver from?

