Chine *(Dunhuang)*
Calendrier
encre sur bambou, 63 av. J.-C.
Londres, The British Library

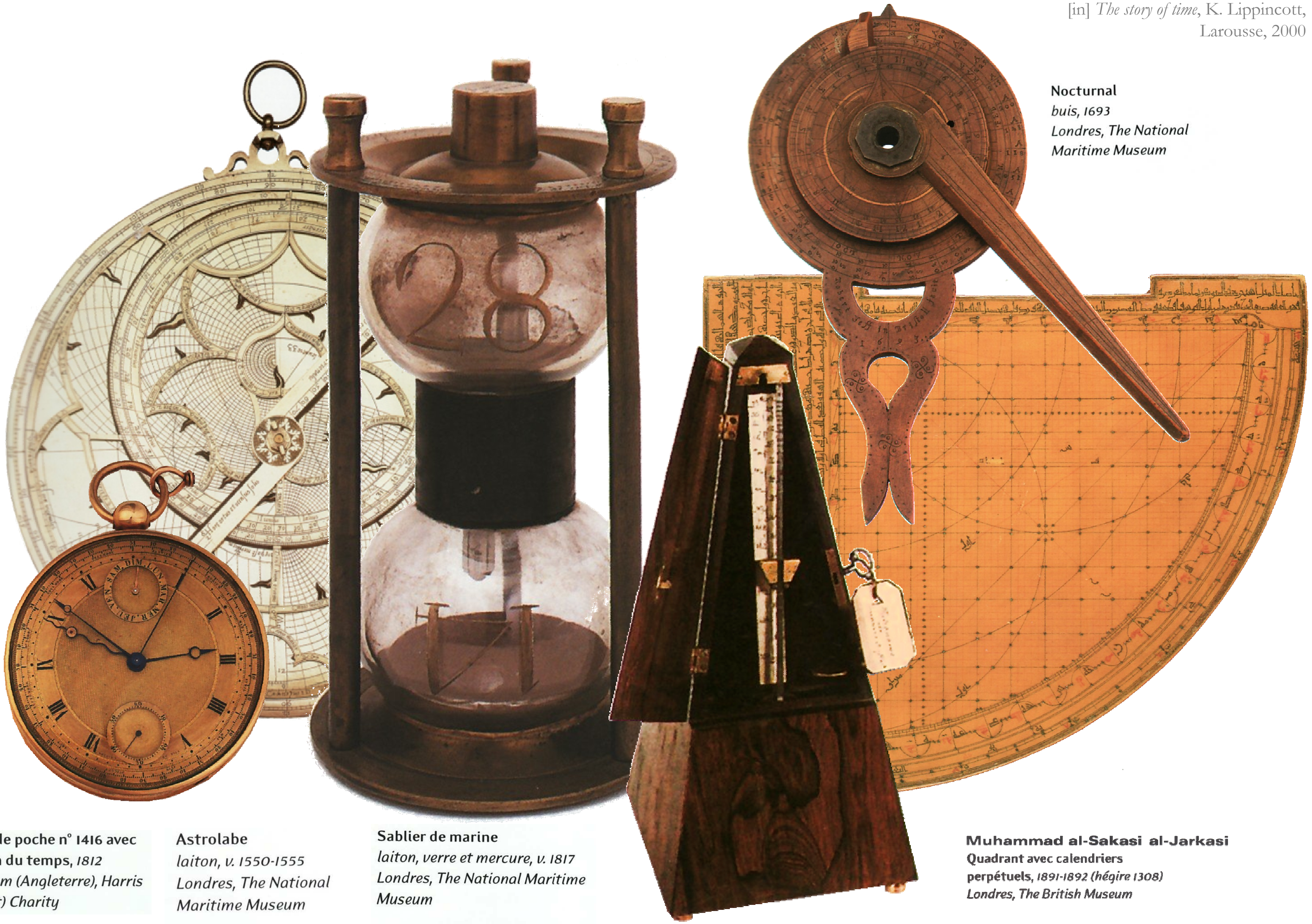
[in] K Lippincott, *The story of time*, Larousse, 2000

Time granularity
Behind everything simple is a huge tail of complicated

Iwona DUDEK,
CNRS, France
UMR 3495 CNRS/MCC MAP

We know how to measure time, but it doesn't guarantee that we are able to understand its nature.

U. Eco, *Time*, s. 13,
[in] *The story of time*, K. Lippincott,
Larousse, 2000



Nocturnal
buis, 1693
Londres, The National Maritime Museum

Montre de poche n° 1416 avec équation du temps, *1812*
Faversham (Angleterre), Harris (Belmont) Charity

Astrolabe
laiton, v. 1550-1555
Londres, The National Maritime Museum

Sablier de marine
laiton, verre et mercure, v. 1817
Londres, The National Maritime Museum

Muhammad al-Sakasi al-Jarkasi
Quadrant avec calendriers perpétuels, *1891-1892 (hégire 1308)*
Londres, The British Museum

Johann Maelzel, le métronome de Beethoven

[in] K Lippincott, *L'histoire du Temps*, Larousse, 2000

Suisse
Pendule de chevet lumineuse, *v. 1901*
Faversham (Angleterre), Harris
(Belmont) Charity
[in] K Lippincott, *L'histoire du Temps*, Larousse, 2000, Fig. 158

Simple

simple objective

simple problem

simple idea > solution

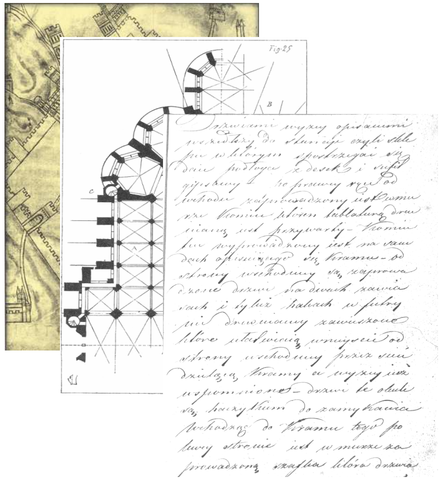
Complicated

Comparison of 25 historical calendars

Initial conclusions

Examples - visualisation of data
with multiple granularities (two case studies)

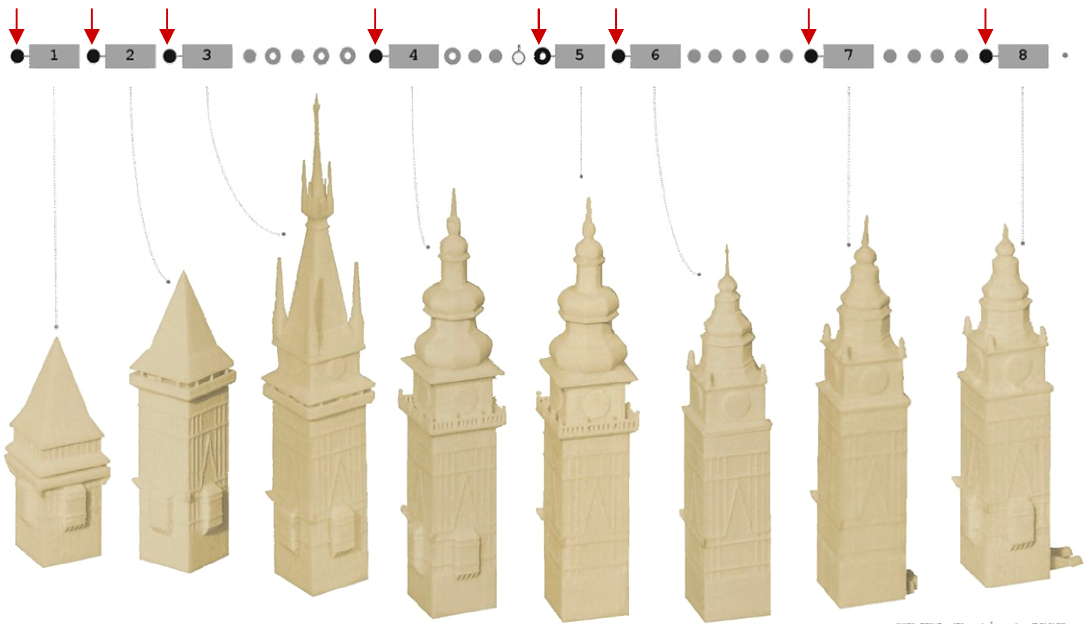
Final conclusions



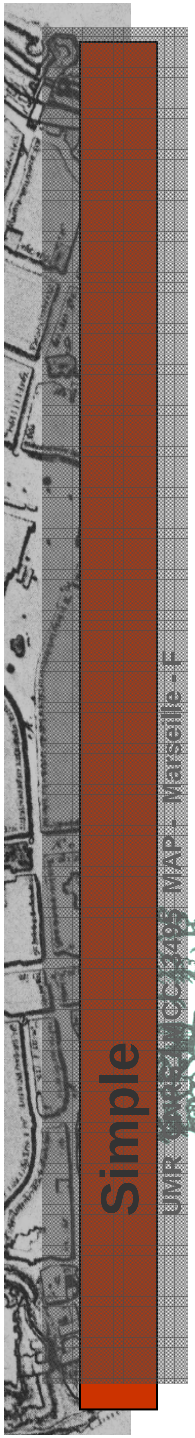
Scientific background

architect
history of architecture and urbanism
evolution of architectural artefacts

studying sources :
artefact itself (states, transformations …)



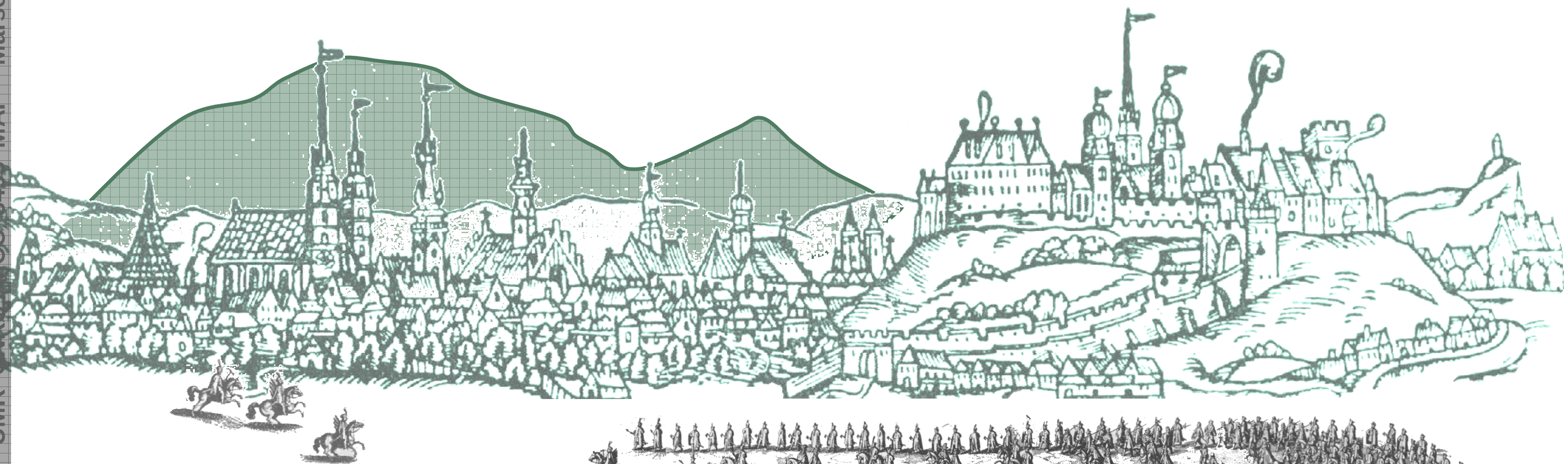
[CNRS, *Tactichronie*, 2009]

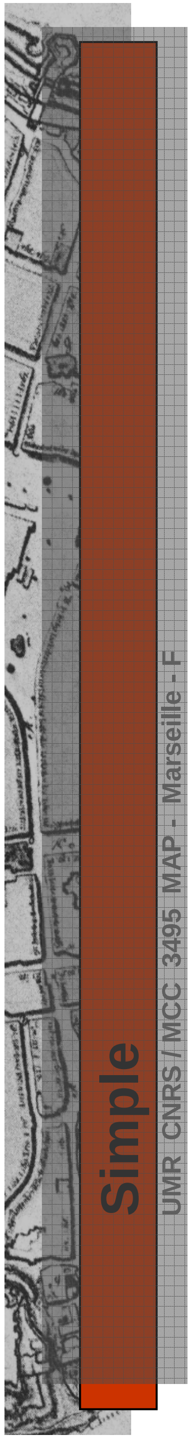


My scientific background

architect
history of architecture and urbanism
evolution of architectural artefacts

studying sources :
artefact itself (states, transformations …)
context (urban, historical, geographical, …)





Nature of historical data sets

XIIIth c

Mai 1450

15th July 1346

summer night 1702

every second Saturday morning
XVth c

heterogeneity
incompleteness
imprecision
lineage
etc.

temporal indications are often inconsistent
in terms of granularity

Simple

Nature of historical data sets

`summer night 1702`

Objective :

store and query
without any additional approximations

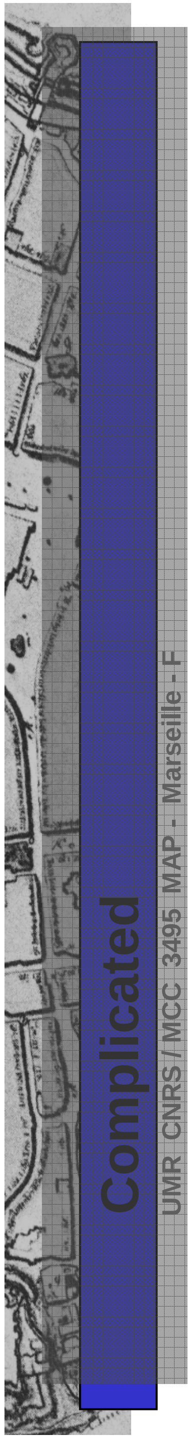
`…, week, month season, …`

Problem :

define chronon (the smallest temporal unit)
and granules (temporal aggregate, *e.g.* n chronons)

Idea :

start from how time is handled in general
(through calendars)



Comparison of 25 alternative calendars

covering a wide range of historic periods and cultures or civilisations

eleven key aspects of calendars:

- Japanese calendar (*Taiintaiyoreki*)
- Tibetan calendar
- Babylonian calendar
- Burmese calendar
- Chinese calendar
- Hebrew calendar
- Pre-Islamic calendar (*Džahilijja*)
- Symmetry454 calendar
- Incas calendar (solar)
- French republican calendar
- Egyptian calendar
- Soviet calendar
- Coptic calendar
- Julian calendar
- Gregorian calendar
- Byzantine calendar
- Roman calendar (republican)
- Inuit calendar
- Continental Celtic Calendar (*Gaulish Coligny calendar*)
- Muslim calendar (*Hijri*)
- Attic state calendar
- Maya and Aztec calendars (*Xiuhpohualli, Tonalpohualli*)
- Badí' calendar
- Incas calendar (lunar)
- Balinese Pawukon calendar

Comparison of 25 alternative calendars

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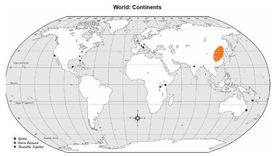
lunar solar lunisolar agricultural

1000 2000

604 1872-73



Comparison of 25 alternative calendars

covering a wide range of historic periods and cultures or civilisations

eleven key aspects of calendars:

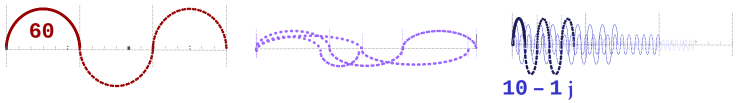
type

period and zone of usage

presence and type of cycles

year discretisation

in years cycles of nature in days

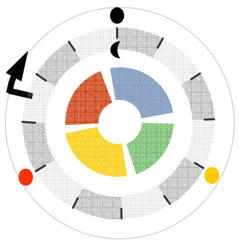


5 days 1 day

number of seasons

beginning of a year
14.IX

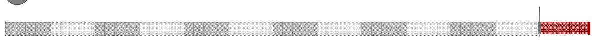
intercalation rhythm



number of days in a week

number of days in a common year

354

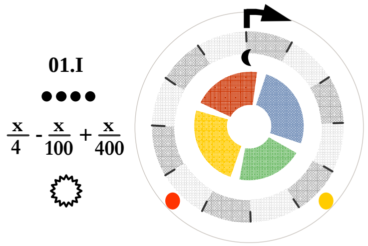


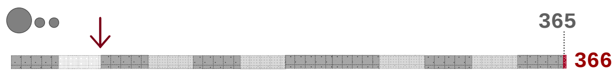
387 number of days in a leap year

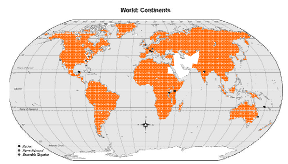
number of months in a common an a leap year
types of a month (duration)

beginning of a day midday midnight 23h sunset sunrise ? no data

Gregorian calendar



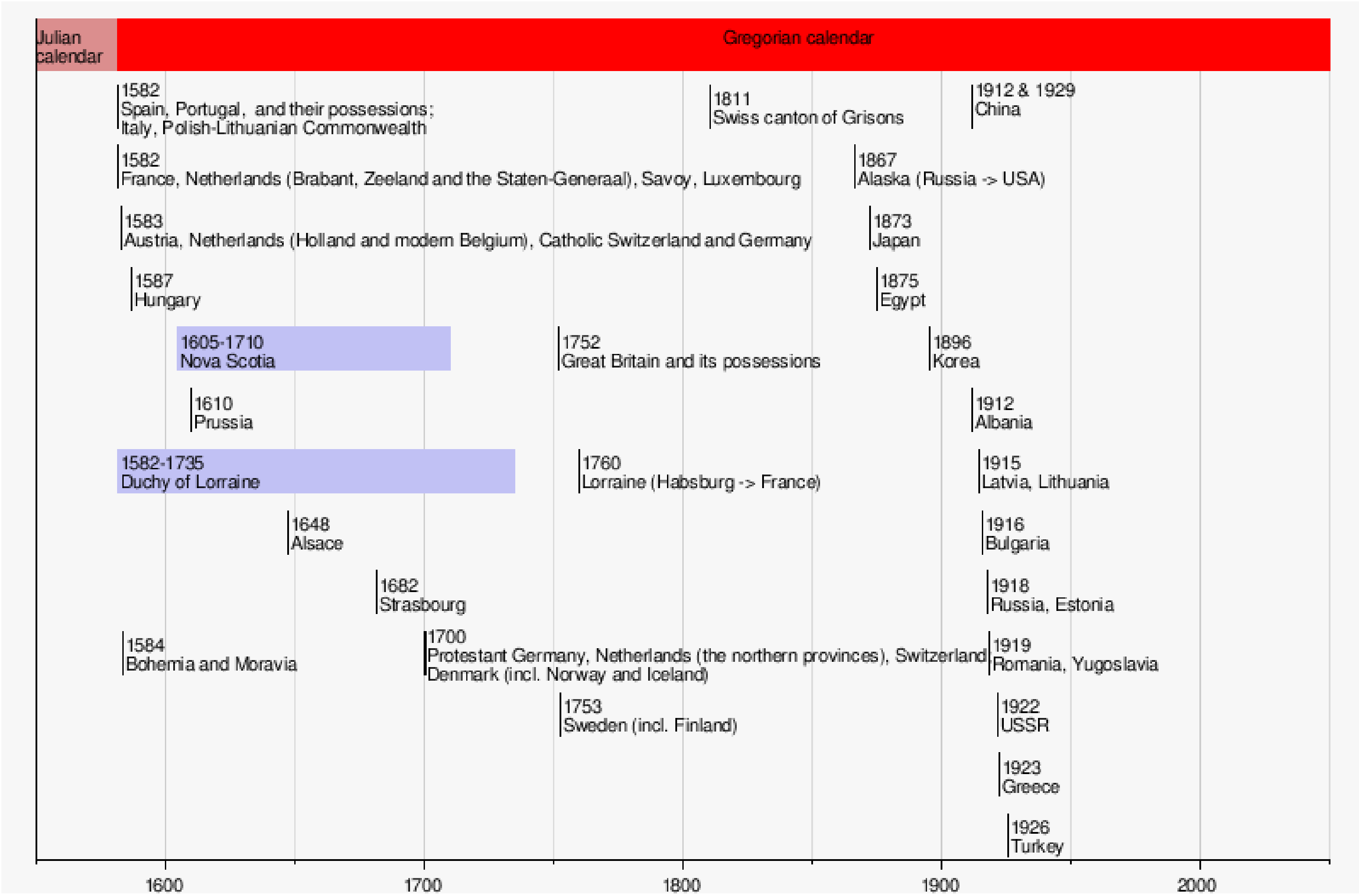




Pope Gregory XIII (Luigi Lilio), 24 February 1582 (a papal bull, *Inter gravissimas*)

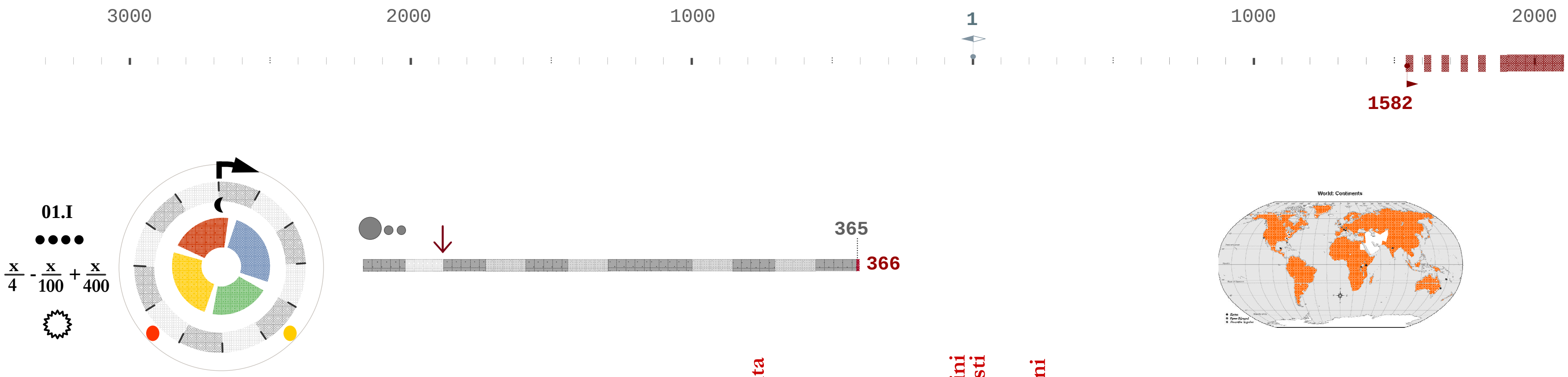
spring equinox - 11 March instead of 21 March (a drift of 10 days since Roman times)

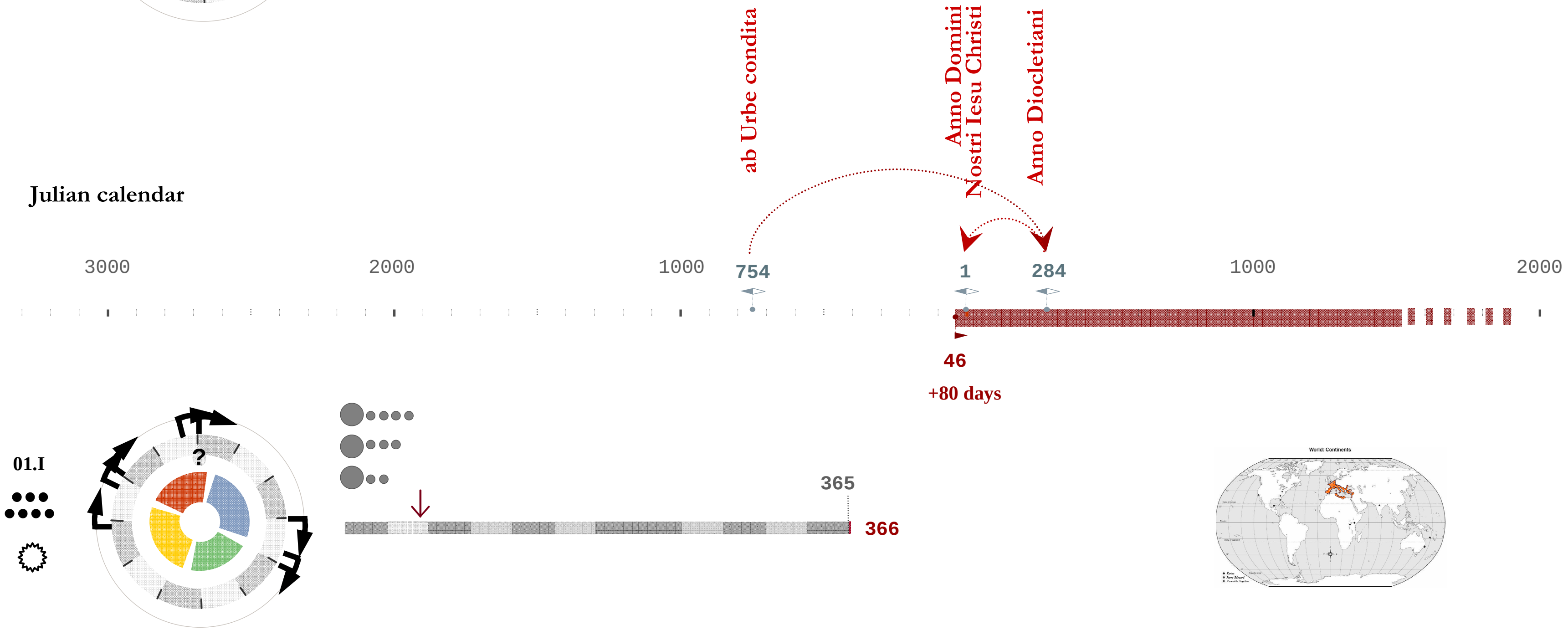
The reformed calendar was adopted later that year by a handful of countries, with other countries adopting it over the following centuries.



<http://en.wikipedia.org/wiki/Gregorian_calendar>

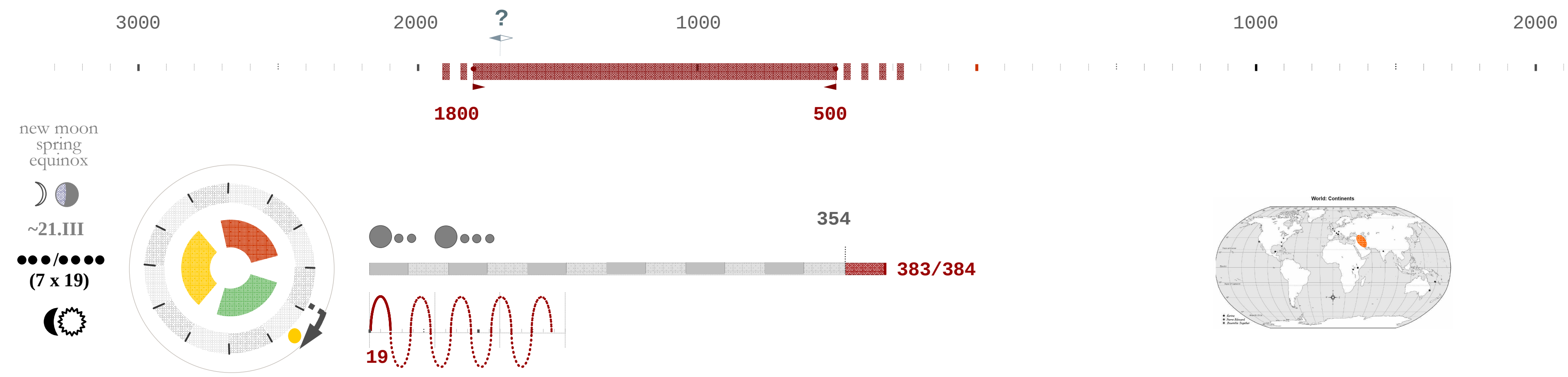
Gregorian calendar



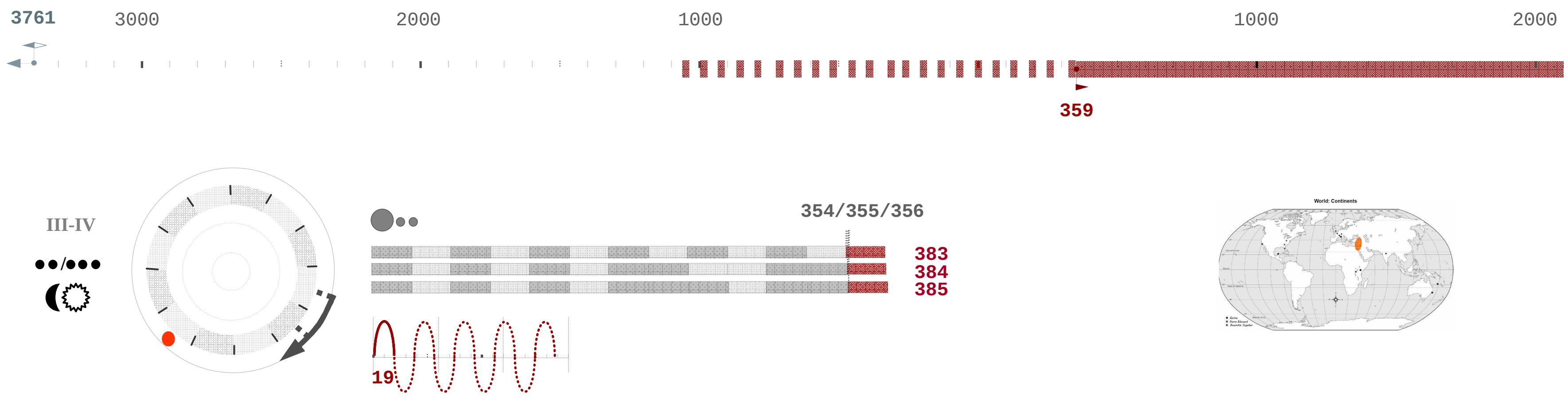


Julian calendar

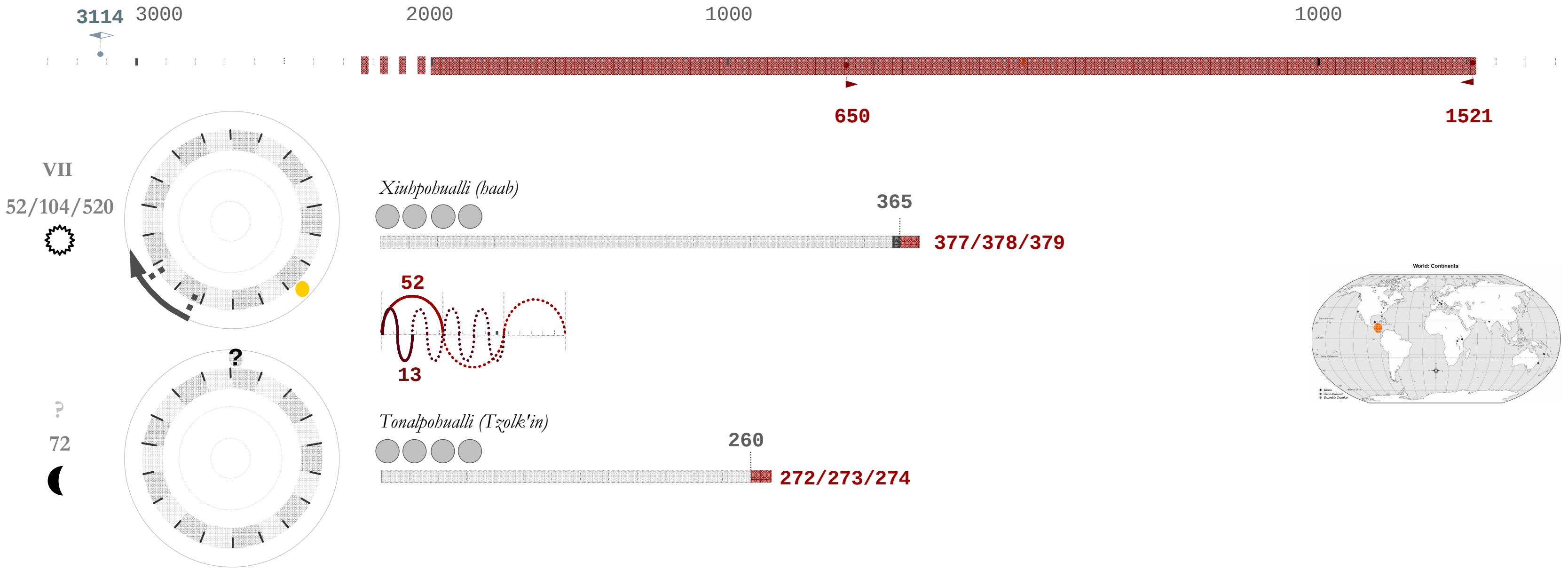
Babylonian calendar



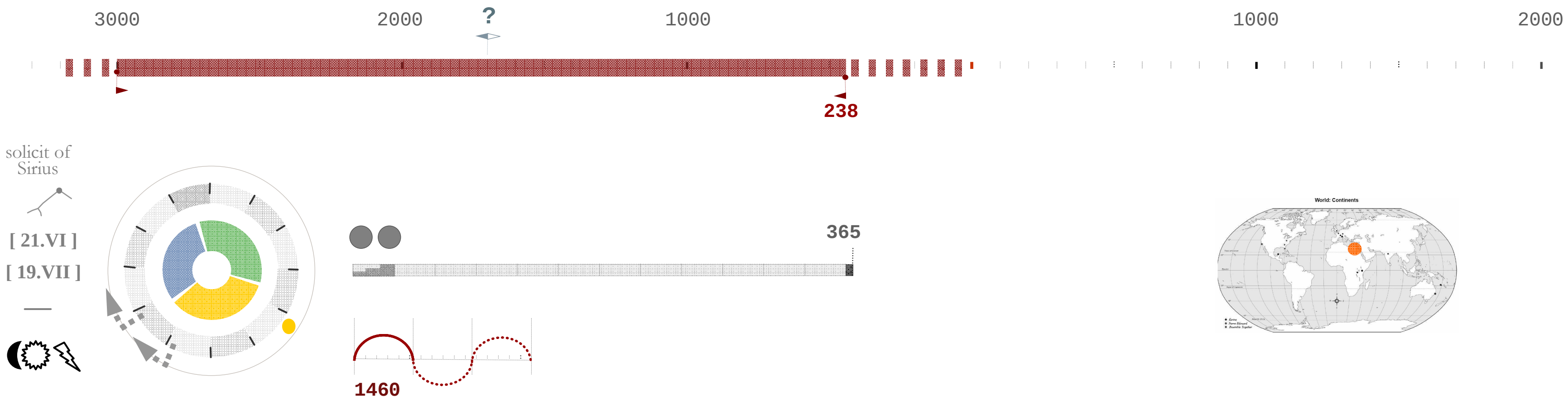
Hebrew calendar



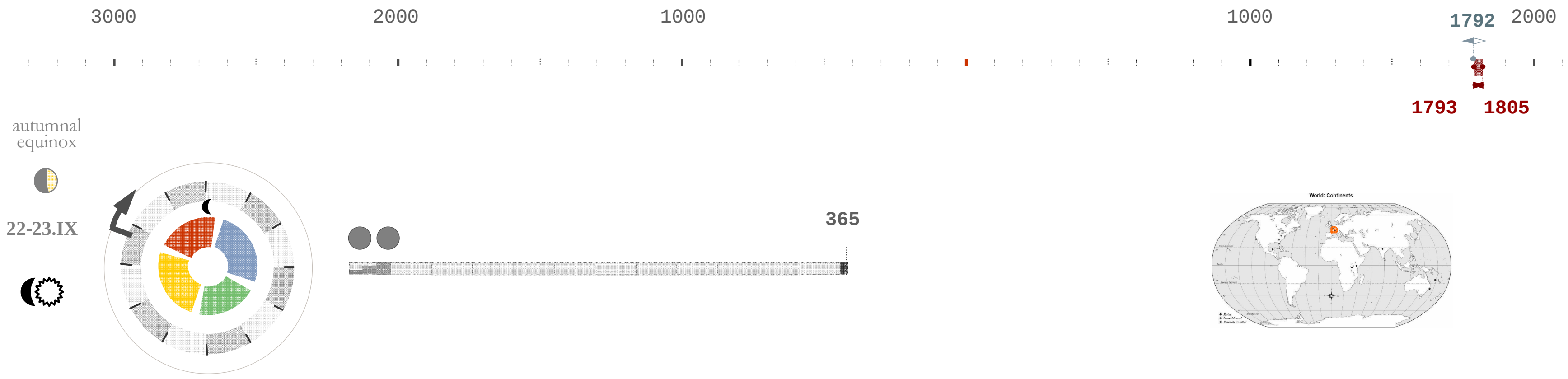
Maya and Aztec calendars



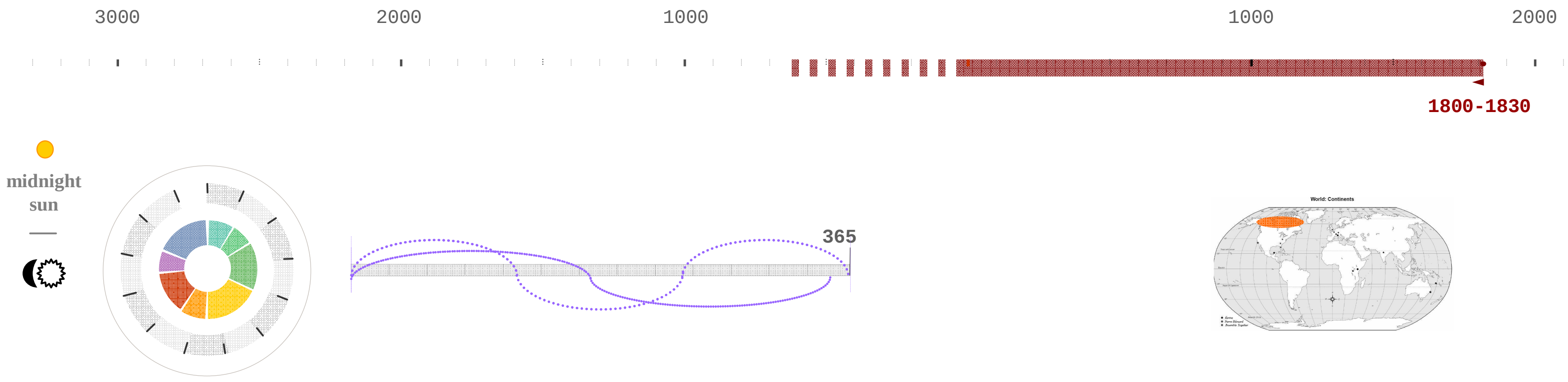
Egyptian calendar



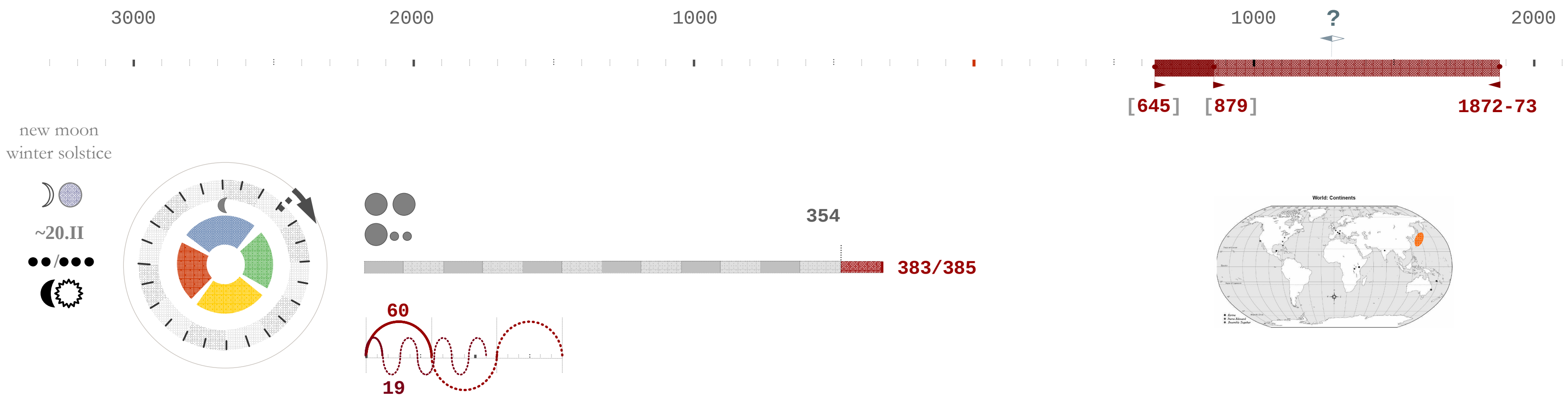
French republican calendar



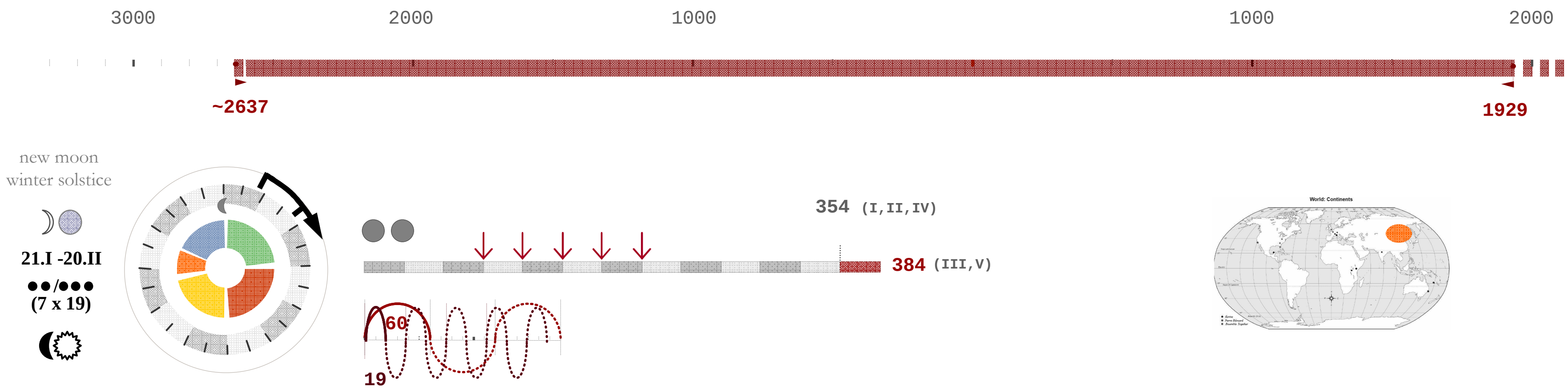
Inuit calendar



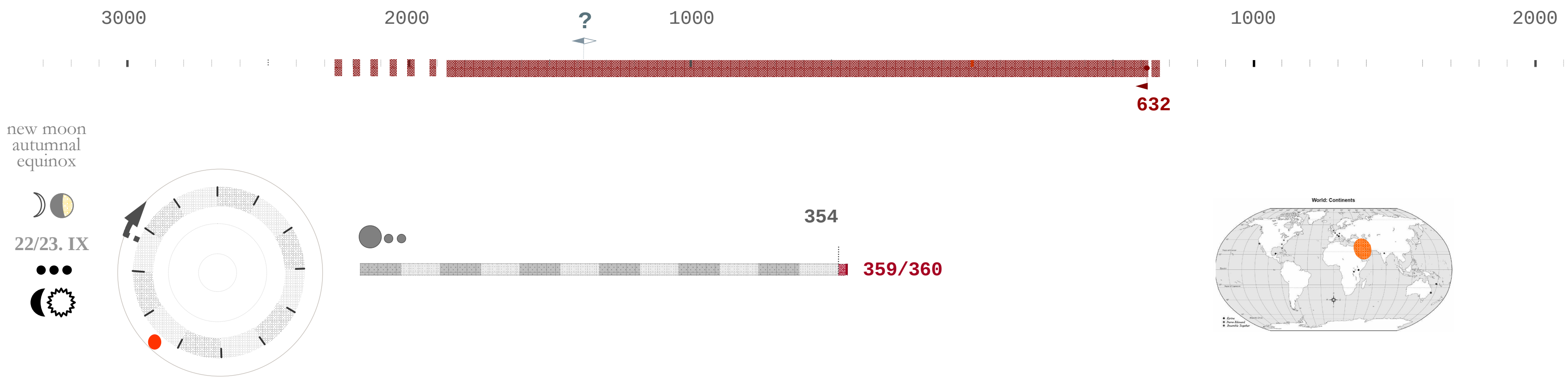
Japanese calendar (Taiintaiyoreki)



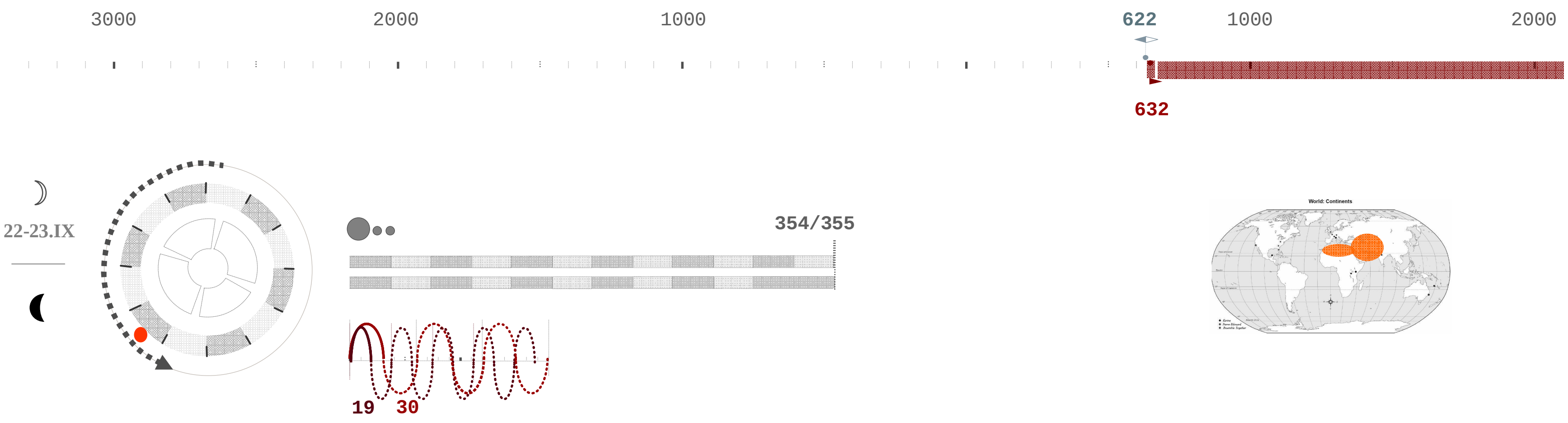
Chinese calendar (Taichu)



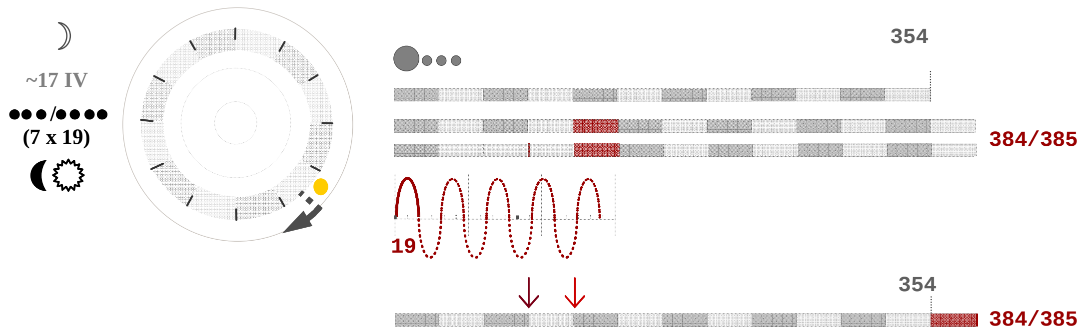
Pre-Islamic calendar (Dżahilijja)

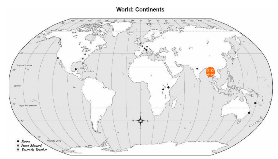


Muslim calendar (hijri)

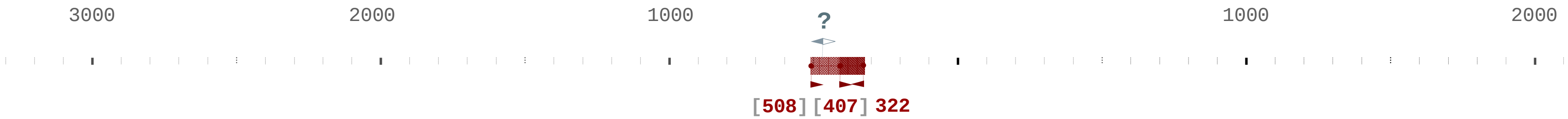


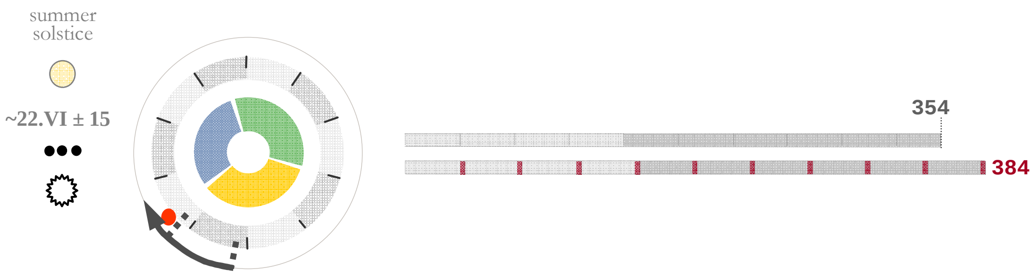
Burmese calendar

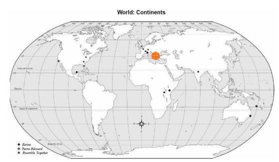




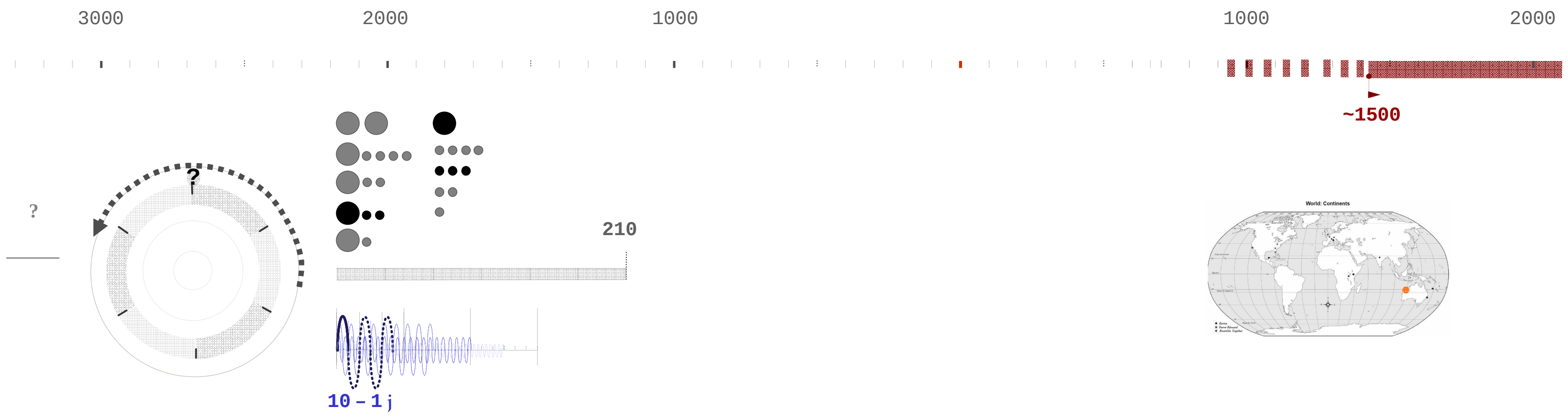
Attic state calendar



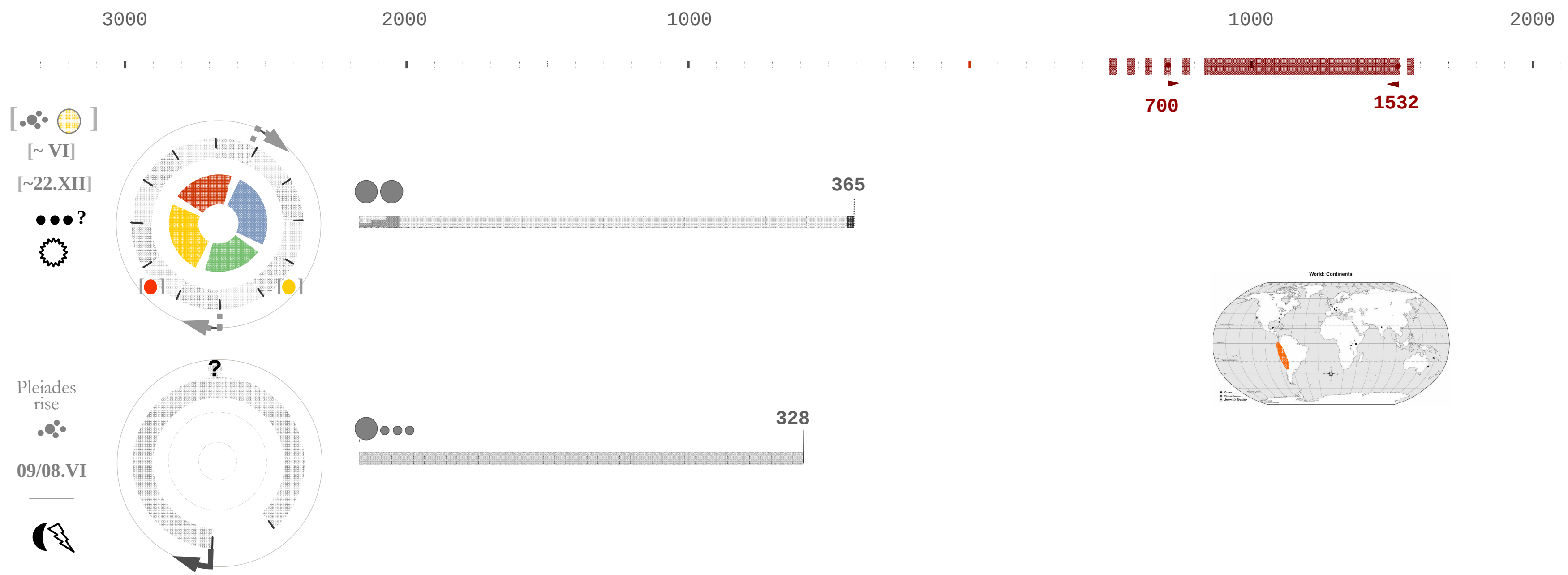


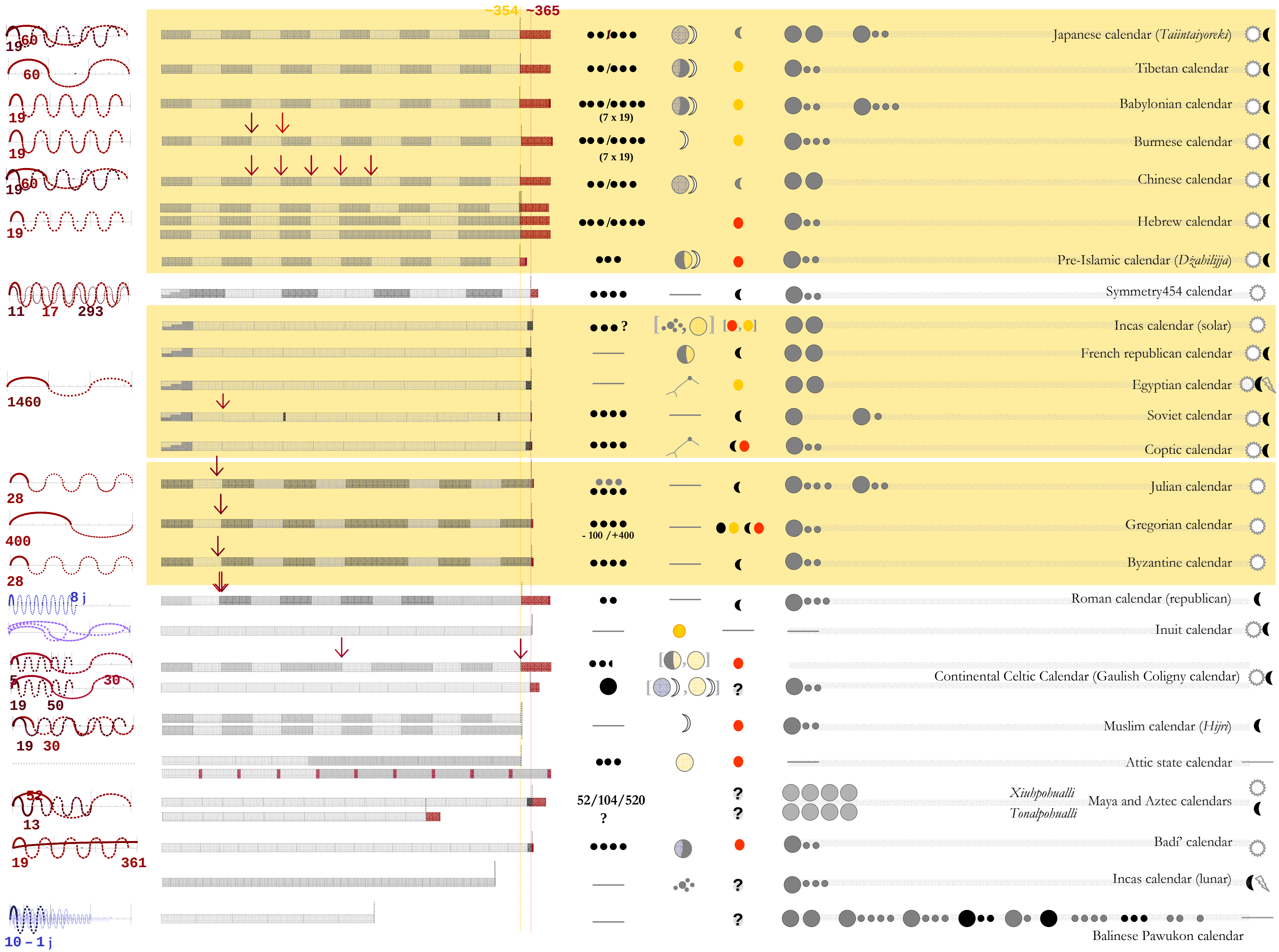


Balinese Pawukon calendar



Incas calendar





~354
~365
Japanese calendar (Taiintaiyoreki)
Tibetan calendar
Babylonian calendar
Burmese calendar
Chinese calendar
Hebrew calendar
Pre-Islamic calendar (Džahilijja)
Symmetry454 calendar
Incas calendar (solar)
French republican calendar
Egyptian calendar
Soviet calendar
Coptic calendar
Julian calendar
Gregorian calendar
Byzantine calendar
Roman calendar (republican)
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Continental Celtic Calendar (Gaulish Coligny calendar)
Muslim calendar (Hijri)
Attic state calendar
Xiuhpohualli
Tonalpohualli
Maya and Aztec calendars
Badí' calendar
Incas calendar (lunar)
Balinese Pawukon calendar
(7 x 19)
(7 x 19)
- 100 / +400
52/104/520
19
60
19
19
19
60
19
11
17
293
1460
28
400
28
8 j
5
30
19
50
19
30
52
13
19
361
10 – 1 j

Complicated

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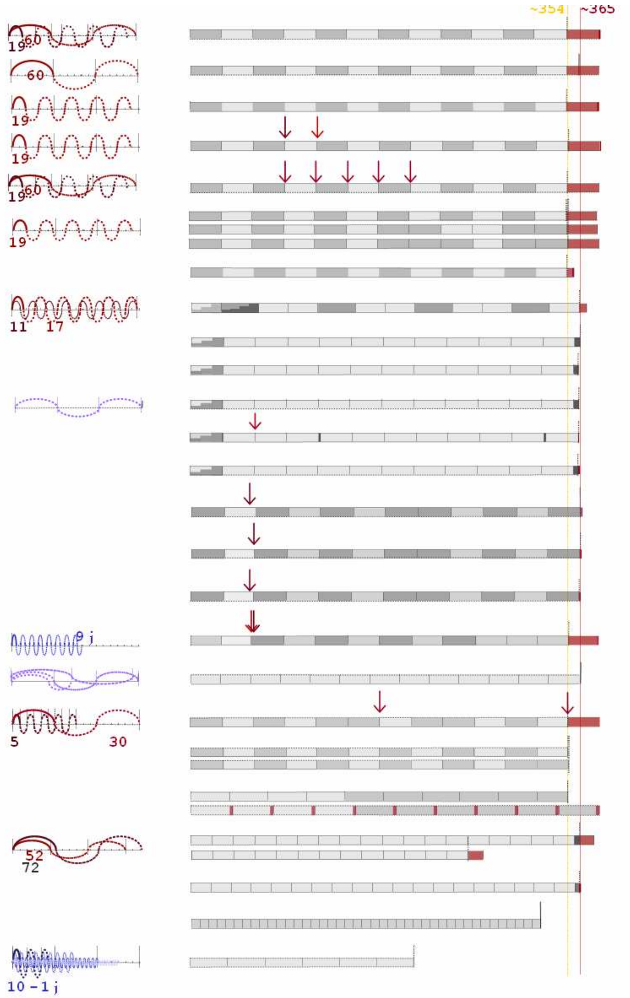
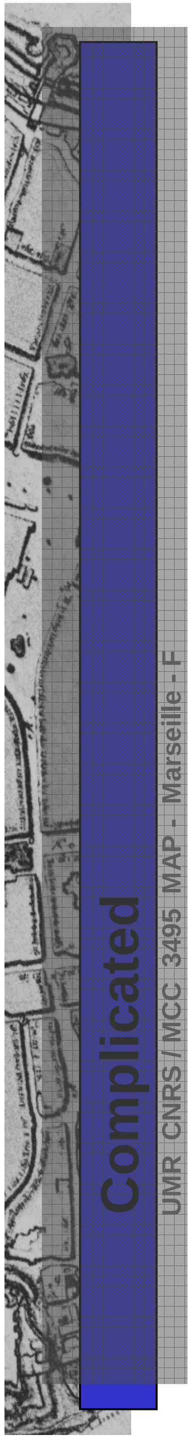
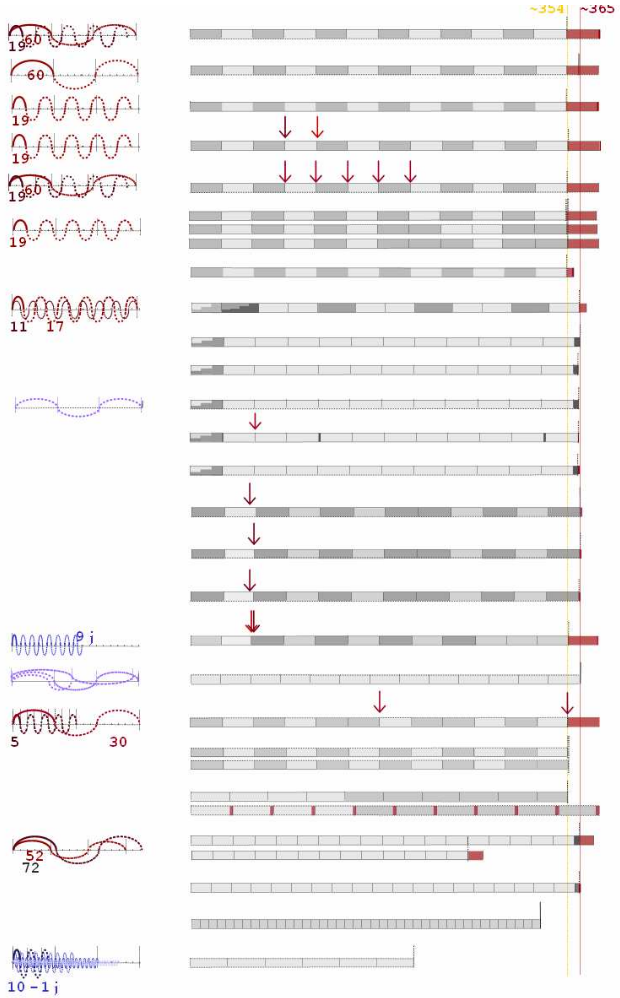


Comparison of 25 alternative calendars

What we noticed :

- each historical calendar has its own specific granularity
- similar mechanisms of time discretisation
  year, month, week, day …
- different quantification
  different number of days in month, week, year
- historical calendars are subject to change over time
  including in terms of granularity
- importance of cultural aspect and way of life
- presence of cycles - natural or calendar based





Comparison of 25 alternative calendars

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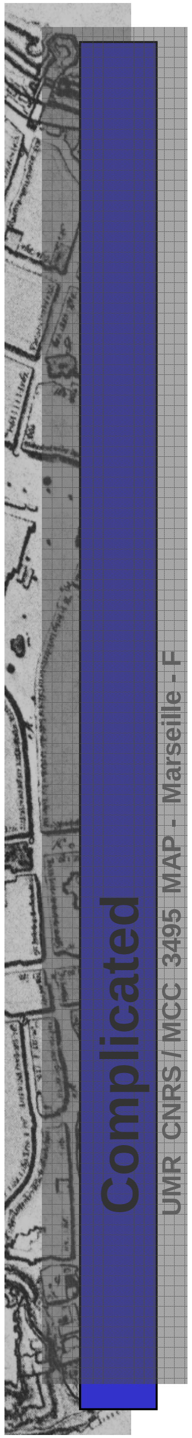
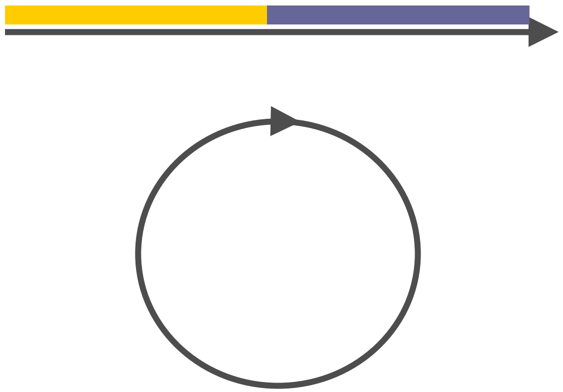
  different number of days in month, week, year
- historical calendars are subject to change over time
  including in terms of granularity
- importance of cultural aspect and way of life
- presence of cycles - natural or calendar based
- independence of cycles of nature
- recurrent phenomenon – discontinuity of time in calendars due to human manipulation

Example:

80 additional days in year 46 BC,
11 days less in 1582 AD (in Rome, Fréjus … but not Strasbourg or London …)





Case studies

- succession of calendars for a given place
- underline presence of cycles
- show temporal indications
  with their own, imperfect granularity

Case studies

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Generic framework for visualising time with multiple granularities

two case studies

- chapel of St Anne in Southern Alps (2400 m AMSL)
  France

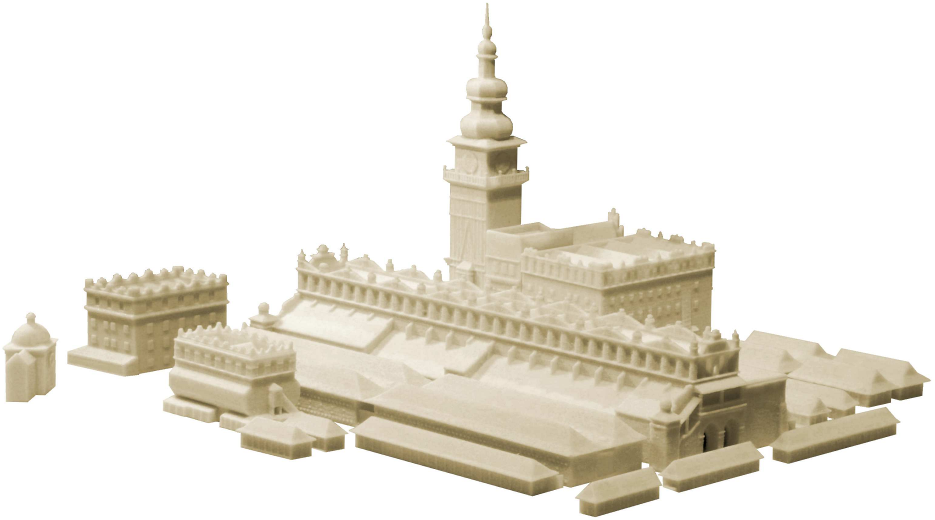
Case studies

UMR CNRS / MCC 3495 MAP - Marseille - F

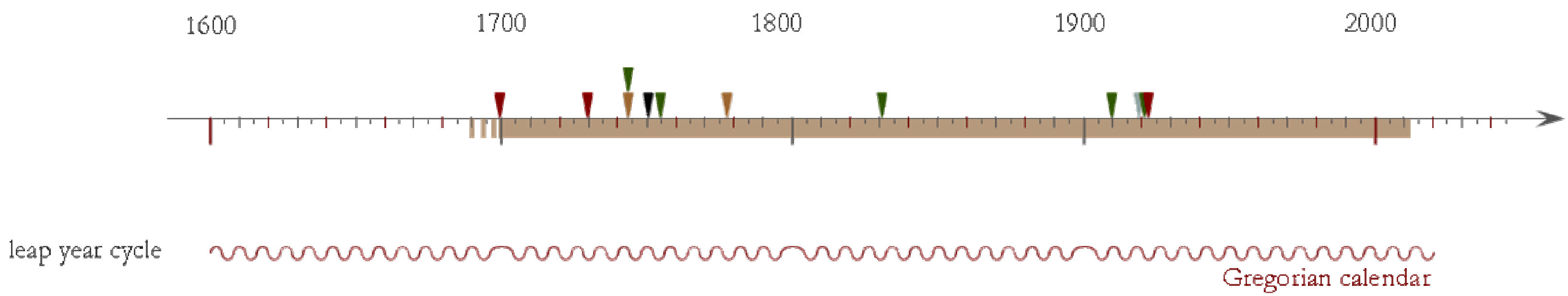
Generic framework for visualising time with multiple granularities

two case studies

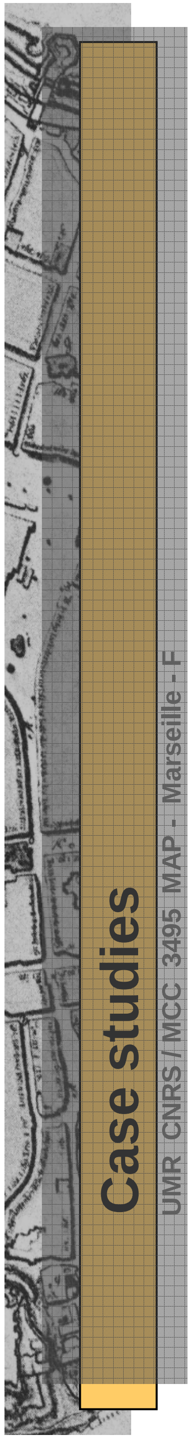
- belfry of an ancient town hall in Kraków, Poland

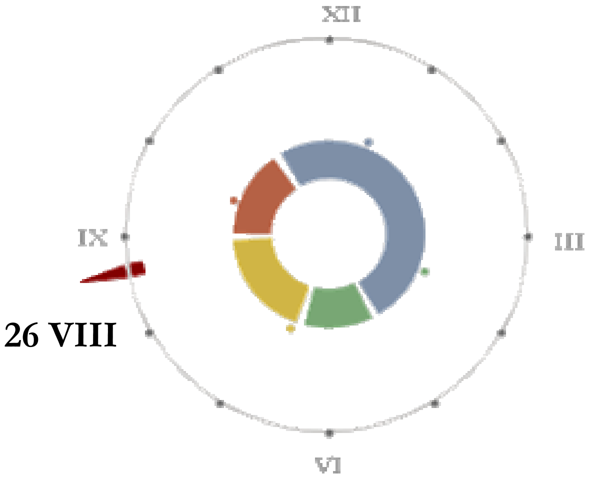


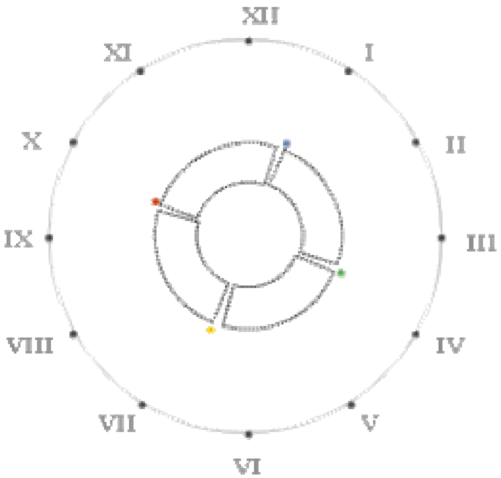
chapel of St Anne in Southern Alps



- timeline visualisation
- colours - types of events/processes
- overall lifetime of the chapel
- Gregorian calendar period





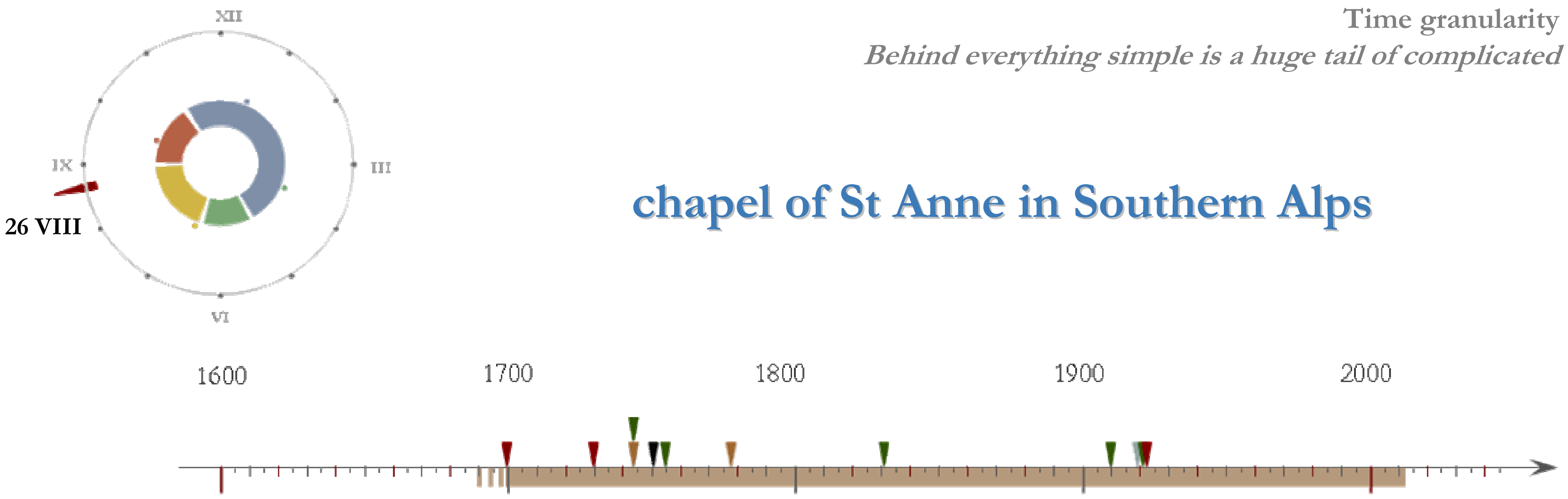


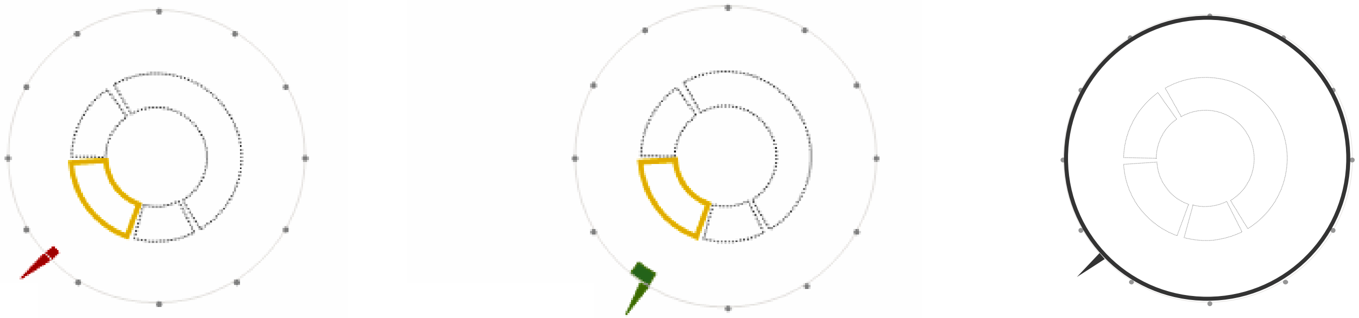
chapel of St Anne in Southern Alps

- cyclic events are represented in a clock–like manner
- meteorological seasons do not coincide with astronomical seasons - winter is the longest season (average season length - fuzzy cyclic behaviour)
- annual pilgrimage to the chapel

Time granularity
Behind everything simple is a huge tail of complicated

chapel of St Anne in Southern Alps





16 VII 1699

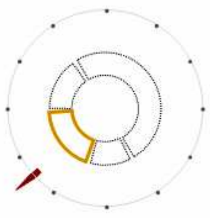
"sommes allés en procession au lac de La Doux à cause de la sècheresse ..."

beginning of VII 1909

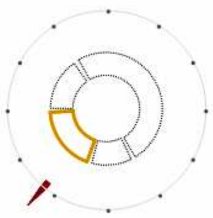
au commencement de juillet des réparations

1751

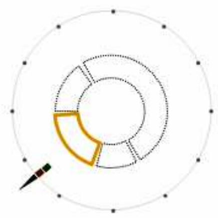
mention pour la première fois de la fête de sainte Anne, le lac et la chapelle sont connus sous le nom de La Doux



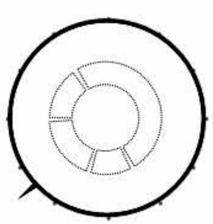
16 VII 1699



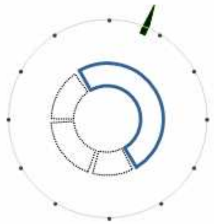
07 VII 1729



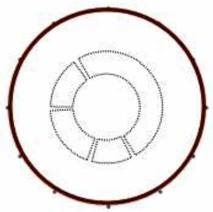
18 VII 1743



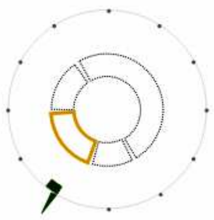
1751



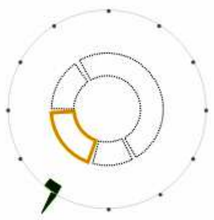
24 XII 1753



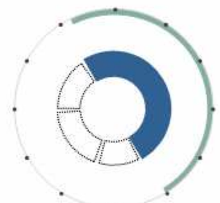
1776



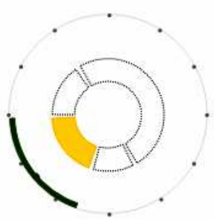
beginning of VII 1831



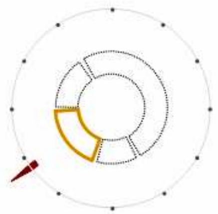
beginning of VII 1909



winter 1918-1919



summer 1920



26 VII 1921

chapel of St Anne in Southern Alps

16 VII 1699

07 VII 1729

18 VII 1743

1751

24 XII 1753

1776

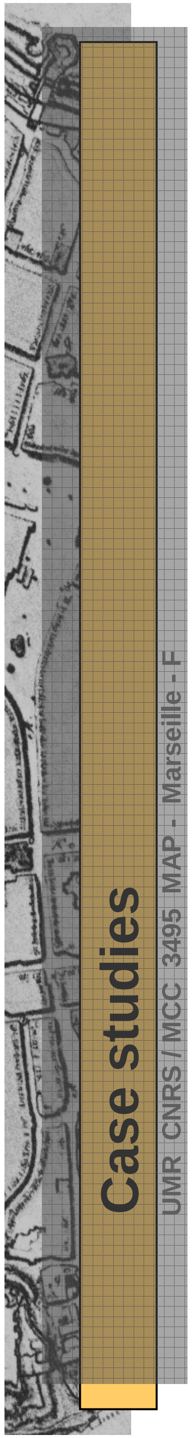
beginning of VII 1831

beginning of VII 1909

winter 1918-1919

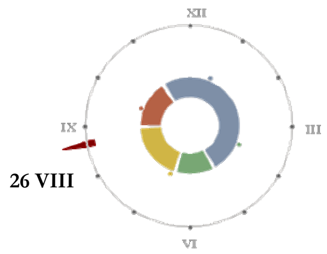
summer 1920

26 VII 1921

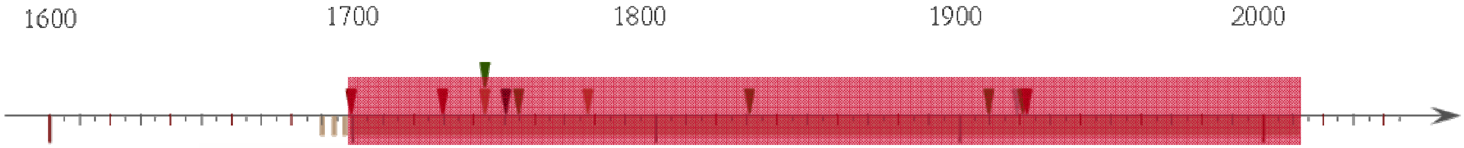


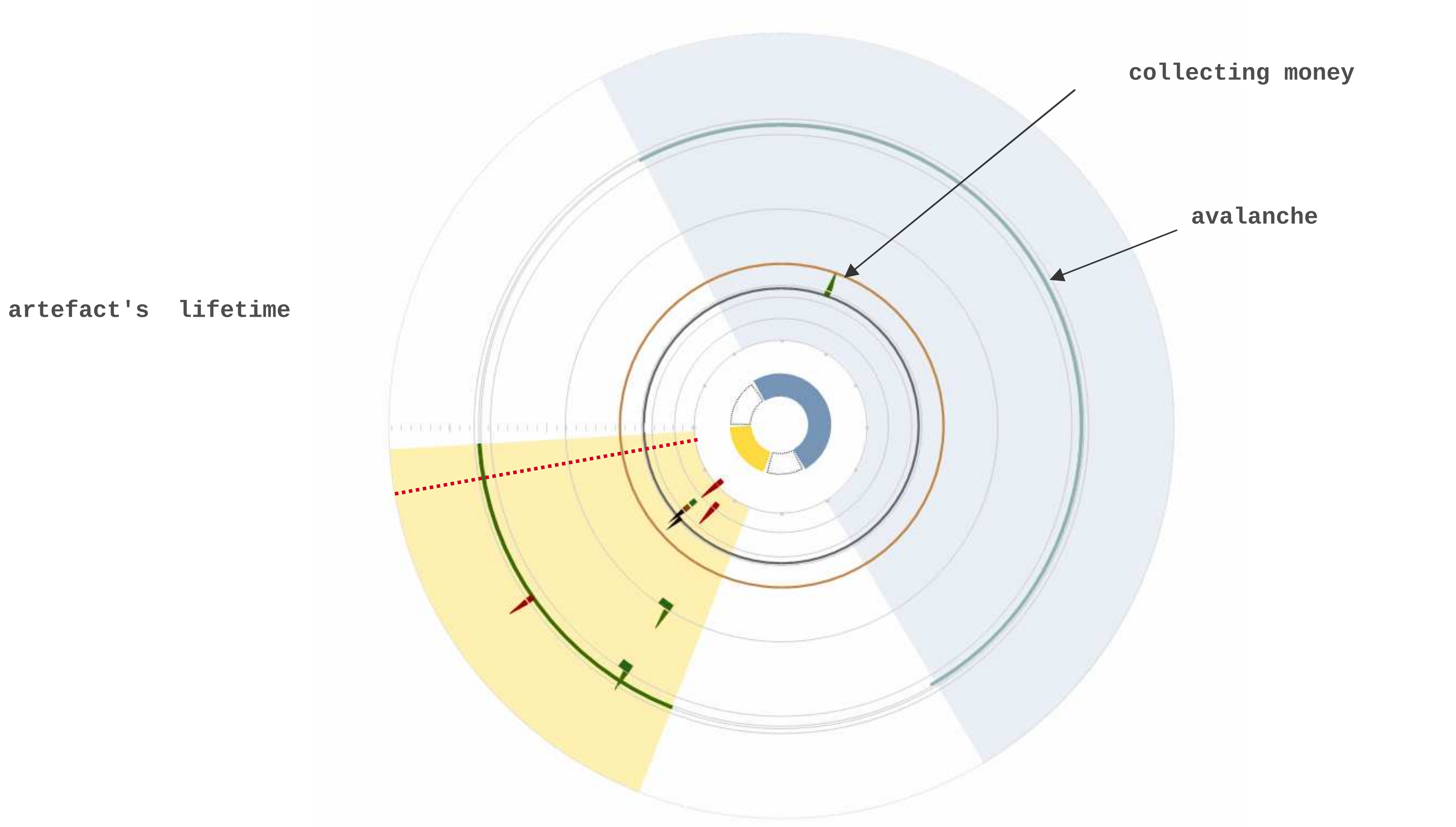
Time granularity

Behind everything simple is a huge tail of complicated



chapel of St Anne in Southern Alps



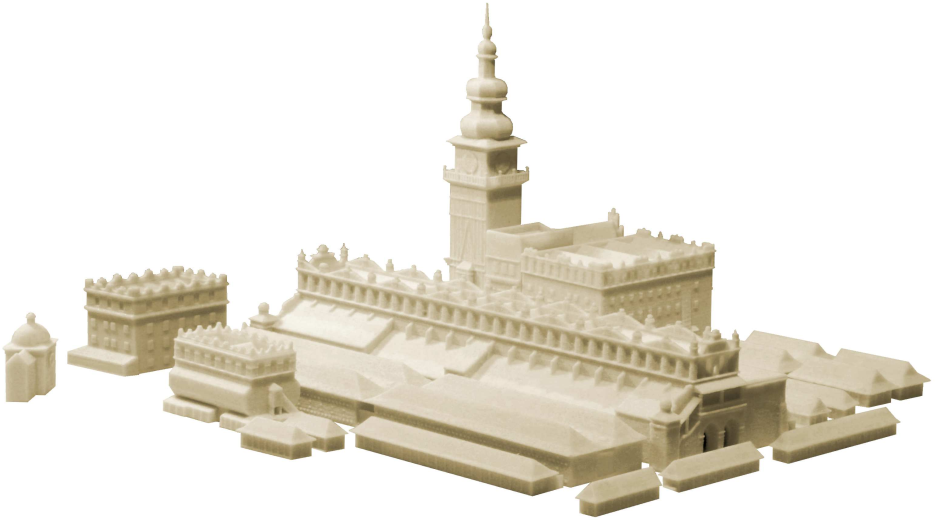


Case studies

UMR CNRS / MCC 3495 MAP - Marseille - F

tower of an ancient town hall in Kraków

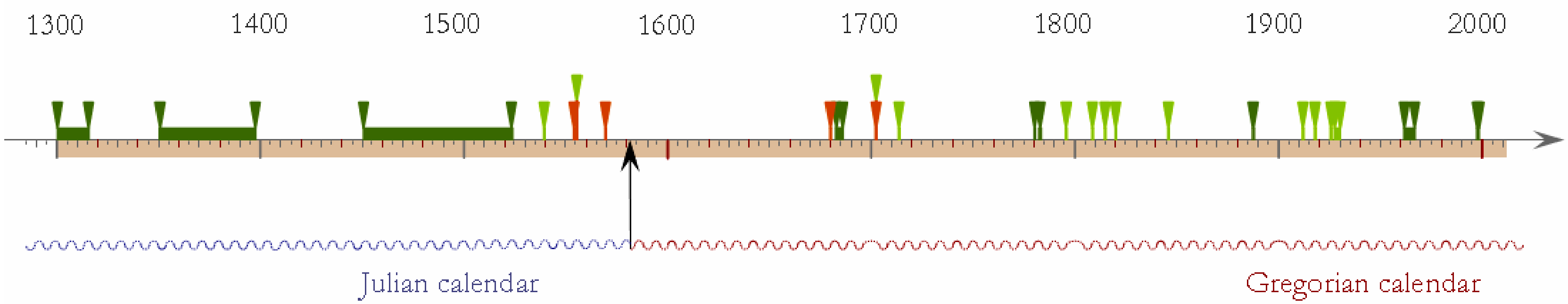
- fires of Cracow's town hall tower



Case studies

UMR CNRS / MCC 3495 MAP - Marseille - F

tower of an ancient town hall in Kraków

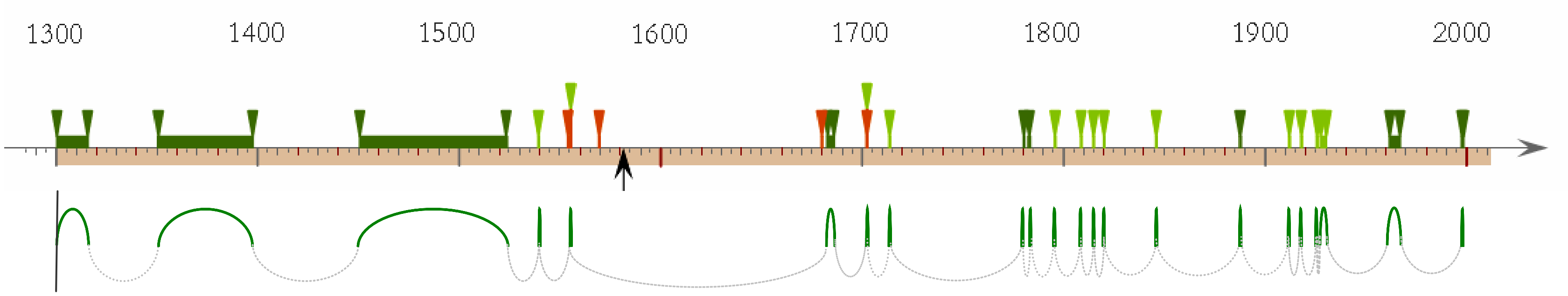


- any annual cyclic event for this artefact
- lifetime of this artefact traverses two calendars
- seasons moving (a rough approximation)
- meteorological seasons do not coincide with the astronomical seasons

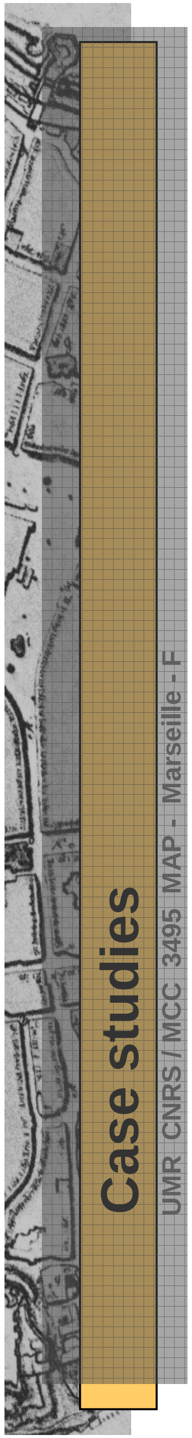
Case studies

UMR CNRS / MCC 3495 MAP - Marseille - F

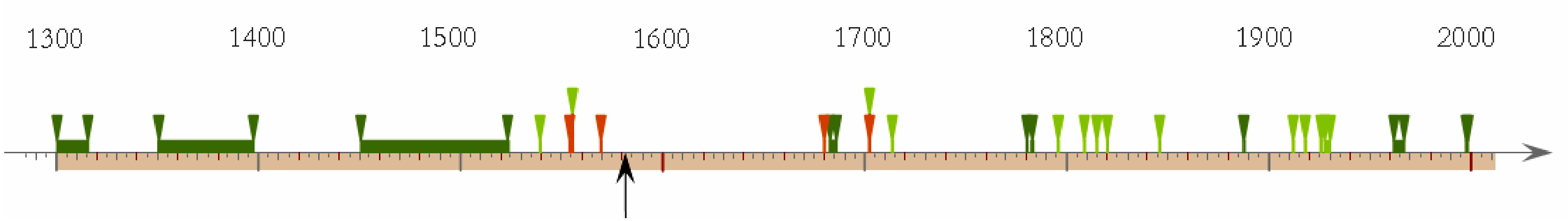
tower of an ancient town hall in Kraków

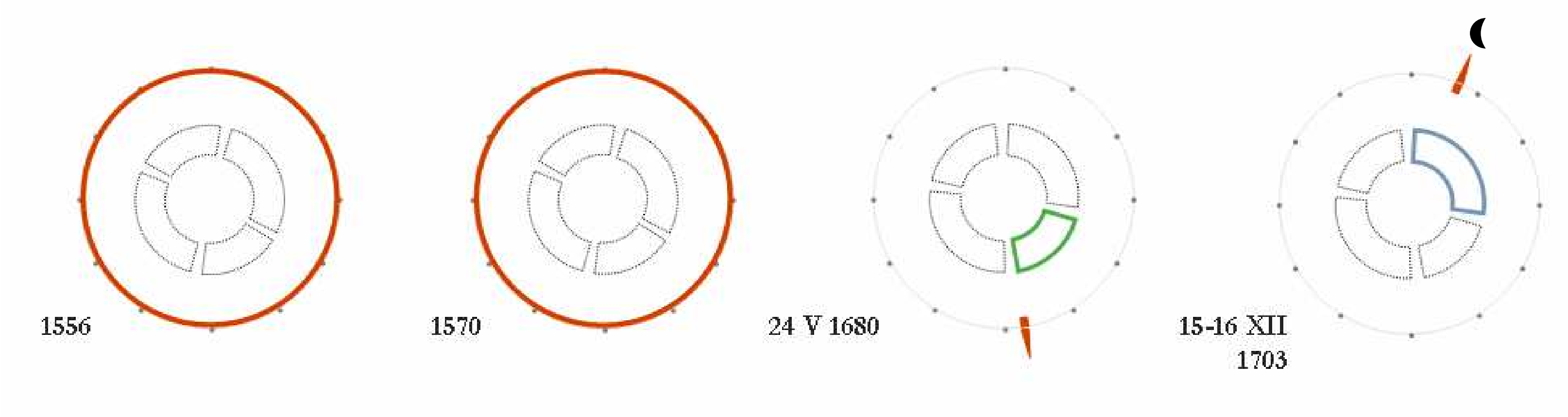


- any cyclic event for this artefact
- rhythm of transformations/reparations



tower of an ancient town hall in Kraków



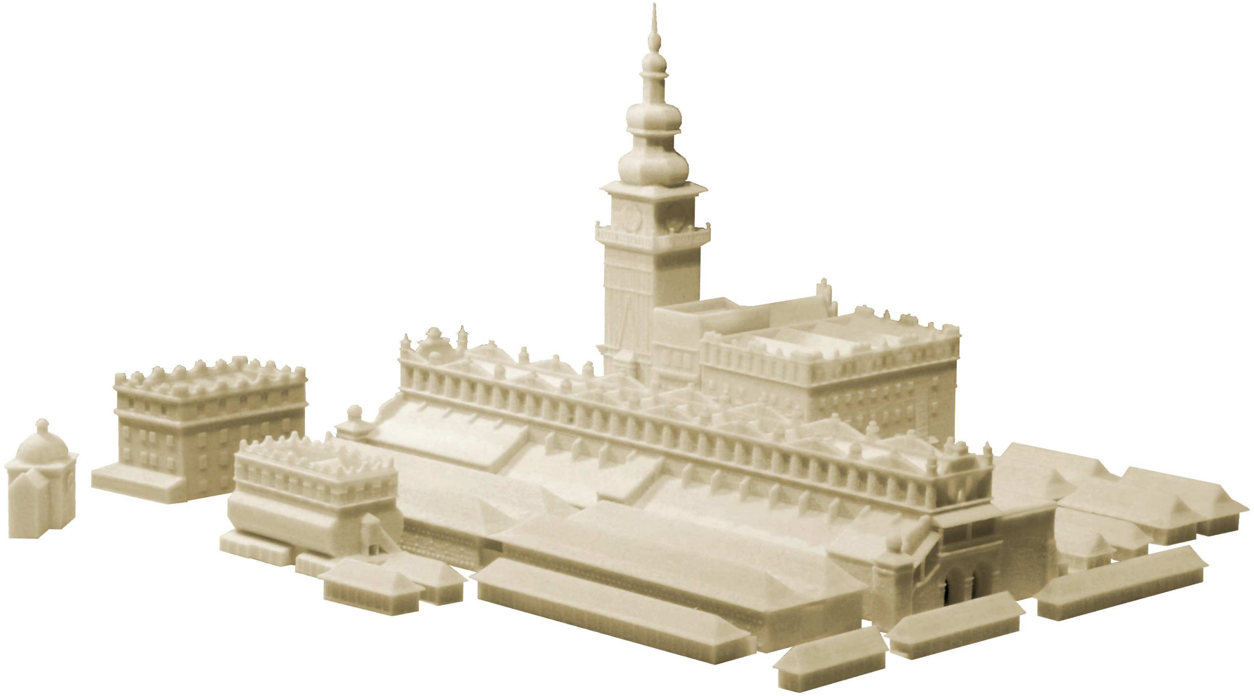


a fire of an artefact is generally short event (in a scale of year)

oldest historical sources are less precise in terms of temporal granularity

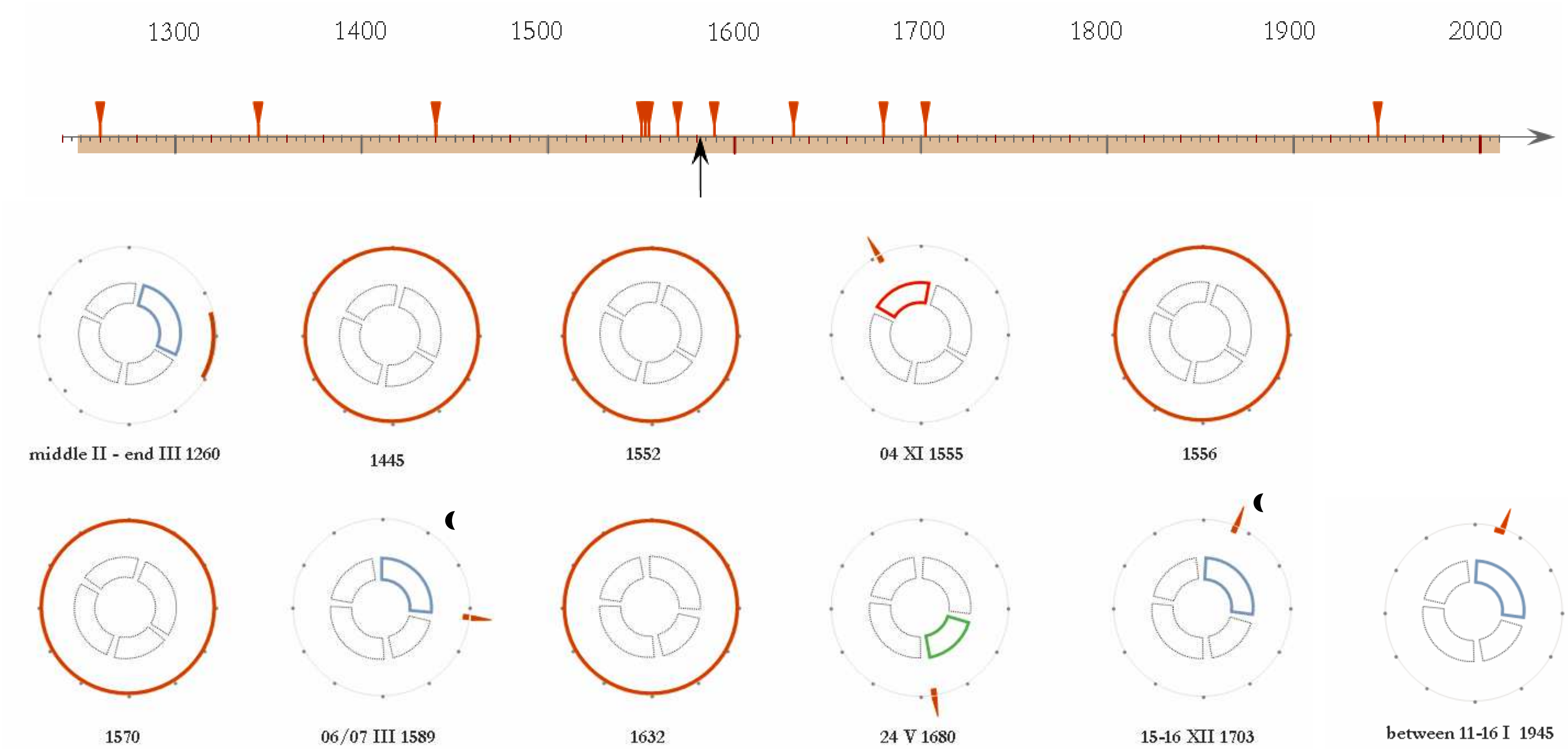
buildings that furnished the Main Market Square in Cracow

- fires at the Market Square



oldest historical sources are less precise terms of temporal granularity

buildings that furnished the Main Market Square in Cracow



oldest historical sources are less precise terms of temporal granularity

Chine, chronomètre
à gnomon
(gnomon reconstitué),
II^{e} – I^{er} s. av. J.-C.

[dans] K Lippincott, *L'histoire du Temps*, Larousse, 2000

Conclusions

- each historical calendar has its own specific granularity – one model ?
- depending on where changes over time occur, the analysis may require different visual instruments - 'tailored' to the local conditions (in particular to the succession of calendars with various - sometimes local - time discontinuities, cycles of seasons, time granulation, *etc.*)
- study of cyclic and fuzzy periodic behaviour may help in better understanding data sets we handle in the context of historical sciences
- the day/night notion could appear as the smallest common time interval ('universal chronon') within reach when wanting to compare calendars – however exceptions here exist (e.g. in Inuit's calendar)

Chine, chronomètre
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[dans] K Lippincott, *L'histoire du Temps*, Larousse, 2000

If we deal with the notion of the time in our research

it is worth to take some time to think about "*time*".