# Towards an
# SI Reference Point

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BIPM

CCM

26.05.2023

# Agenda

- Background
- SI Reference Point
- Examples of use cases
- Outlook and open questions

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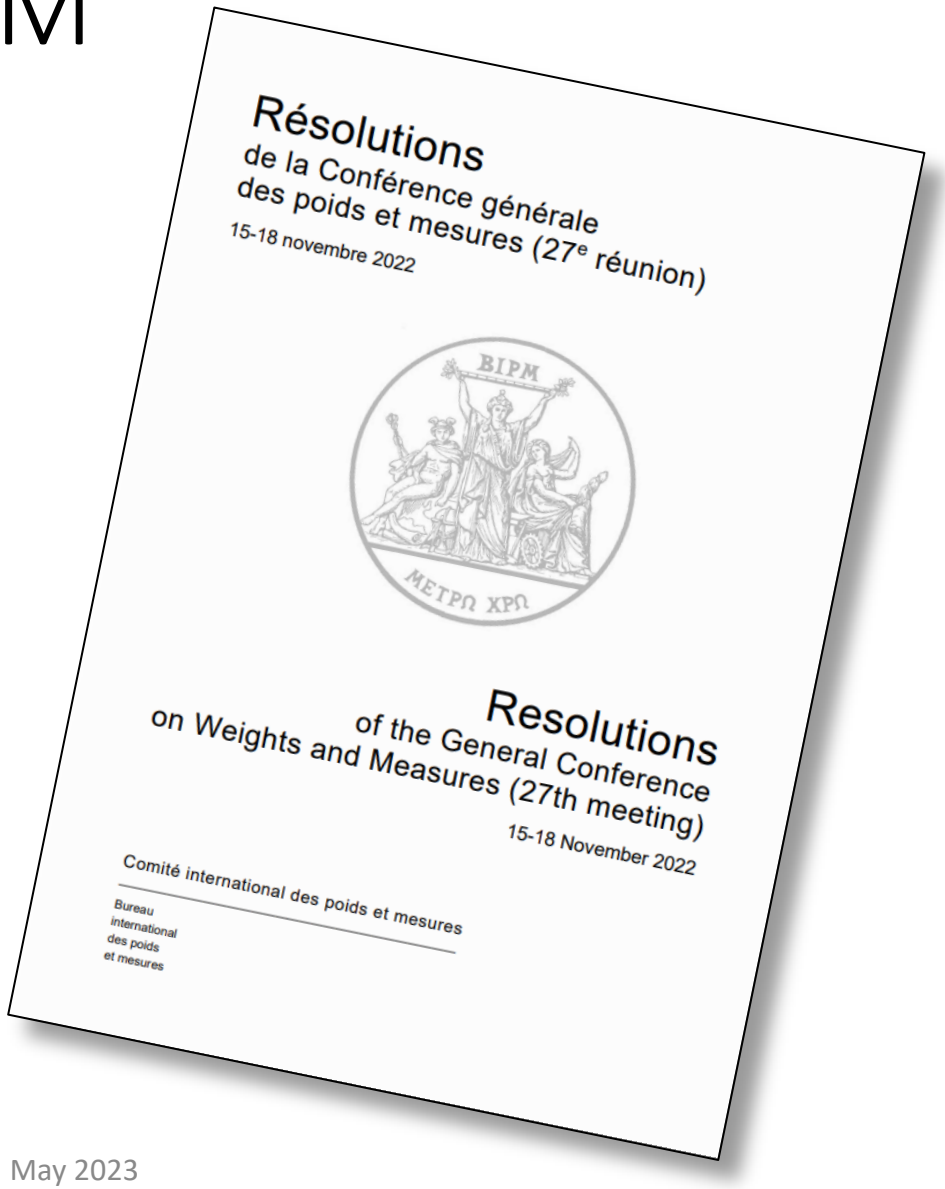
# Mandate by the 27th CGPM

**Resolution 2**
"On the global digital transformation and the International System of Units"

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# Resolution 2 of the 27th CGPM

The 27th CGPM encourages

- the CIPM to continue its outreach and engagement initiatives to ensure that the Metre Convention naturally extends its role as the globally accepted **anchor of trust for metrology into the digital era**,

- the CIPM to undertake the **development and promotion of an SI Digital Framework**, …

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# Work Programme of the BIPM

**Digital Transformation and New Digital Services**

- …
- To develop the **SI Reference Point** that will underpin the SI in the future digitalized world
- …
- To enable **machine-actionable** access to the data and online tools provided by the BIPM

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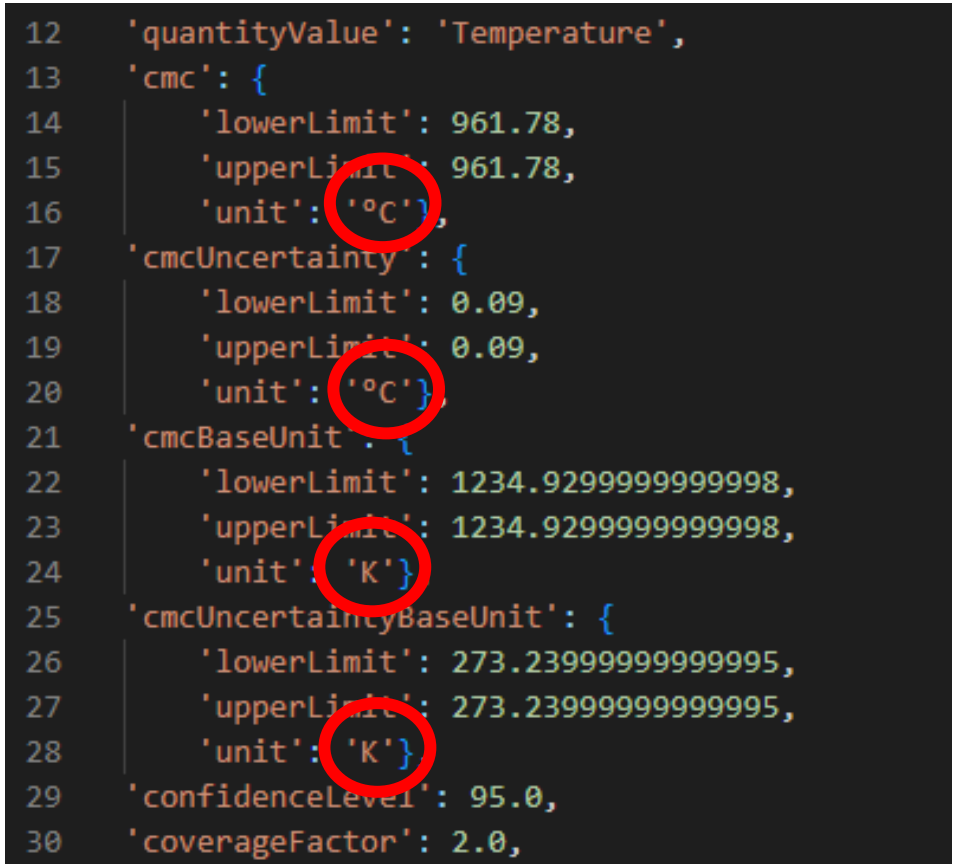
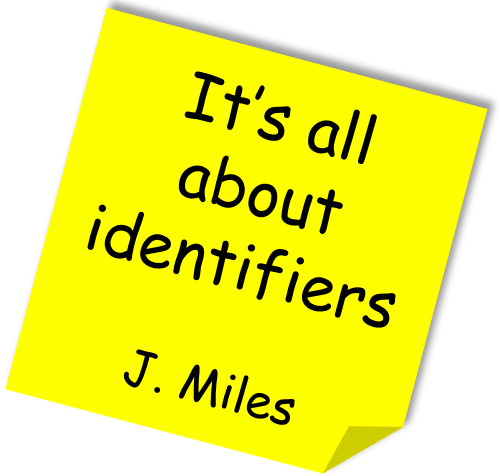
# Example: KCDB API

Current response



```
'quantityValue': 'Temperature',
'cmc': {
    'lowerLimit': 961.78,
    'upperLimit': 961.78,
    'unit': '°C'},
'cmcUncertainty': {
    'lowerLimit': 0.09,
    'upperLimit': 0.09,
    'unit': '°C'},
'cmcBaseUnit': {
    'lowerLimit': 1234.9299999999998,
    'upperLimit': 1234.9299999999998,
    'unit': 'K'},
'cmcUncertaintyBaseUnit': {
    'lowerLimit': 273.23999999999995,
    'upperLimit': 273.23999999999995,
    'unit': 'K'},
'confidenceLevel': 95.0,
'coverageFactor': 2.0,
```

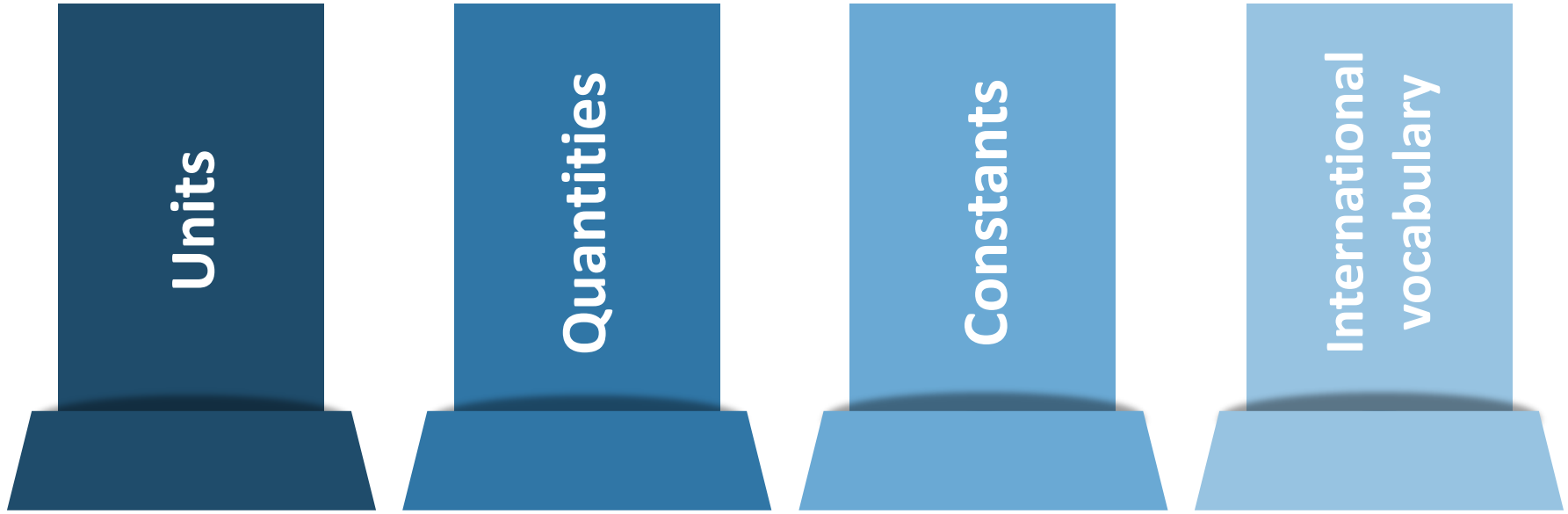
https://www.bipm.org/kcdb/




Human readable

Units expressed as **string**

# The Interoperability Plane: Interoperability and Reusability




**BIPM core references**


**VIM** | **SI brochure** | **GUM**

# The Interoperability Plane: Interoperability and Reusability


## Content

**Units**

- Symbol
- Definitions (of SI Base units (EN/FR)
- Validity dates of definition
- Defining CGPM

**Prefixes**

- Symbol
- Multiplication factor

## Status

- Prototype available
- Being tested together with other modules

**BIPM core references**


VIM

SI brochure

GUM

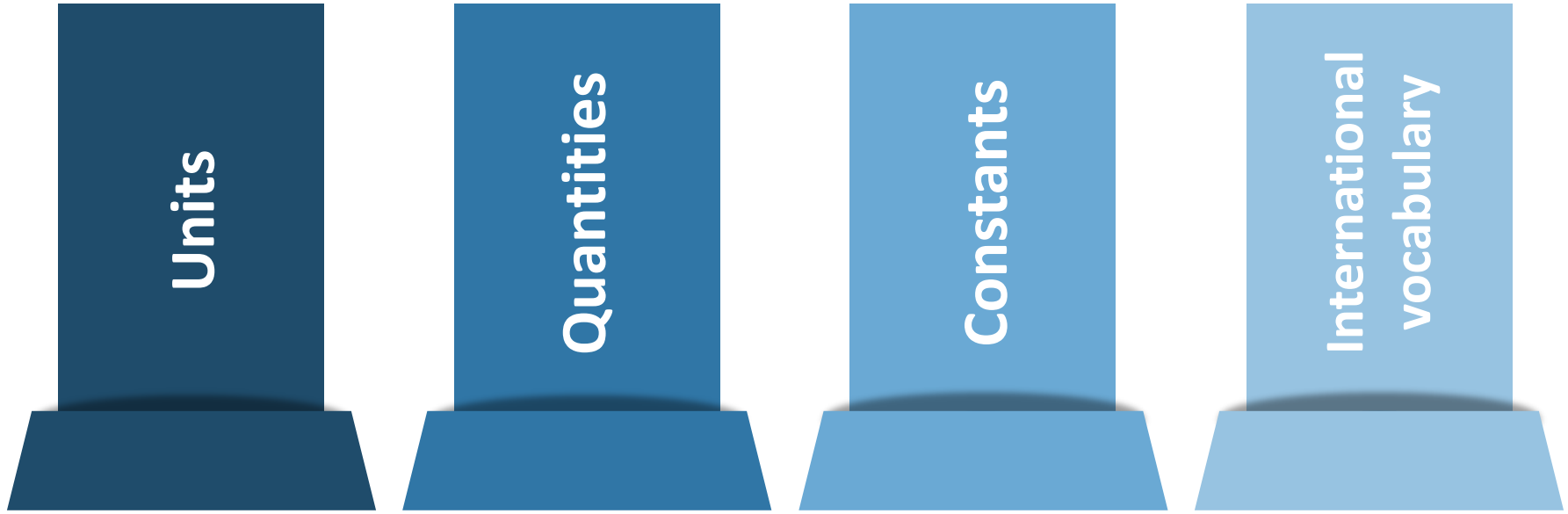
# The Interoperability Plane: Interoperability and Reusability


```
1107  ###  http://si-digital-framework.org/SI#second1967
1108  SI:second1967 rdf:type owl:NamedIndividual ,
1109                        SI:Definition ;
1110                SI:hasDefiningAuthority <http://si-digital-framework.org/SI#13th_CGPM> ;
1111                SI:hasDefiningText "La seconde est la durée de 9 192 631 770 périodes de
1112                                   "The second is the duration of 9192631770periods of th
1113                SI:hasEndValidity "2019-05-19"^^xsd:date ;
1114                SI:hasStartValidity "1967-05-20"^^xsd:date .
1115
1116
1117  ###  http://si-digital-framework.org/SI#second2018
1118  SI:second2018 rdf:type owl:NamedIndividual ,
1119                        SI:Definition ;
1120                SI:hasDefiningAuthority <http://si-digital-framework.org/SI#26th_CGPM> ;
1121                SI:hasDefiningText "La seconde, symbole s, est l'unité de temps du SI. El
```

**BIPM core references**


**VIM** | **SI brochure** | **GUM**

# The Interoperability Plane: Interoperability and Reusability

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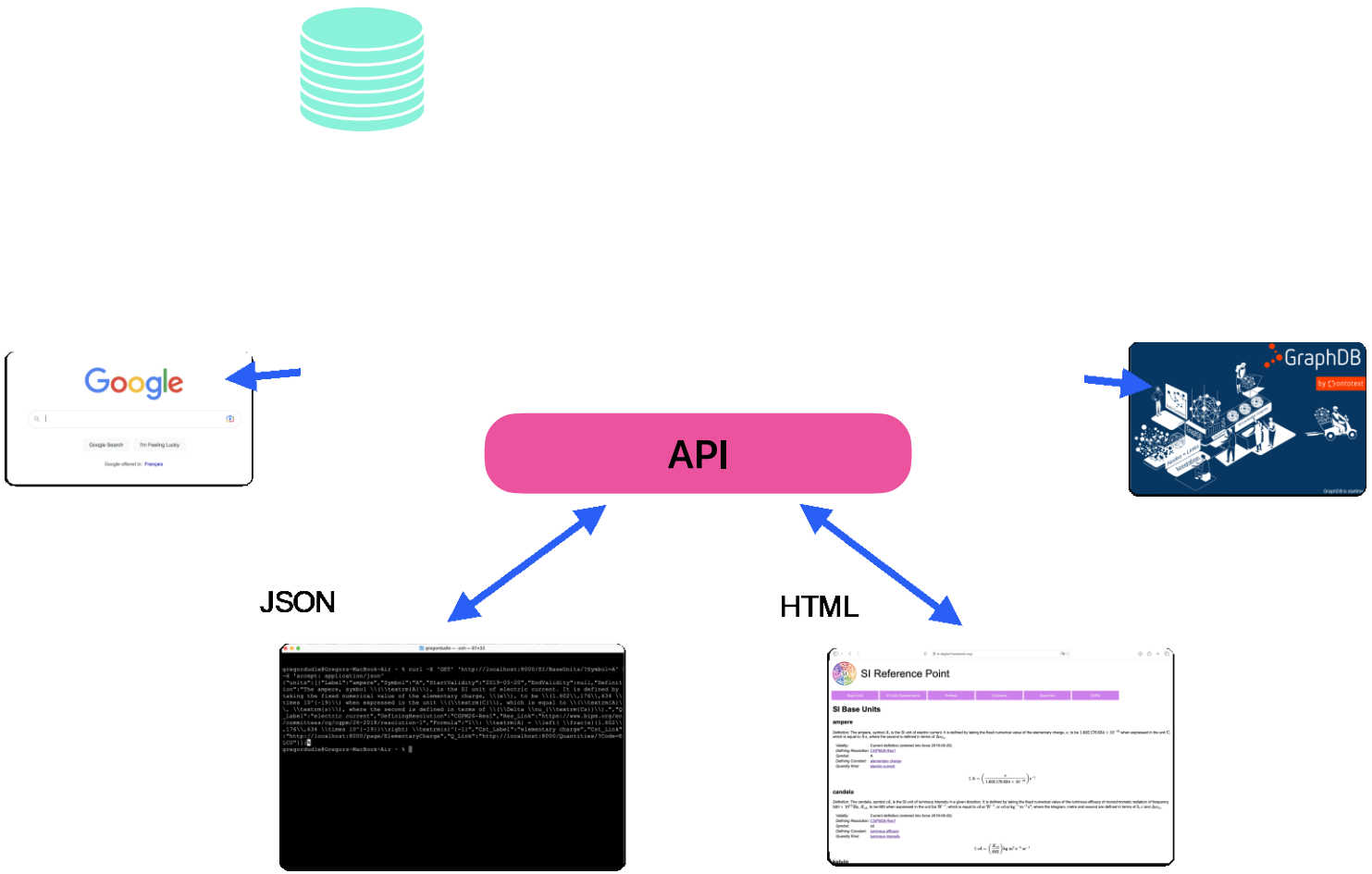
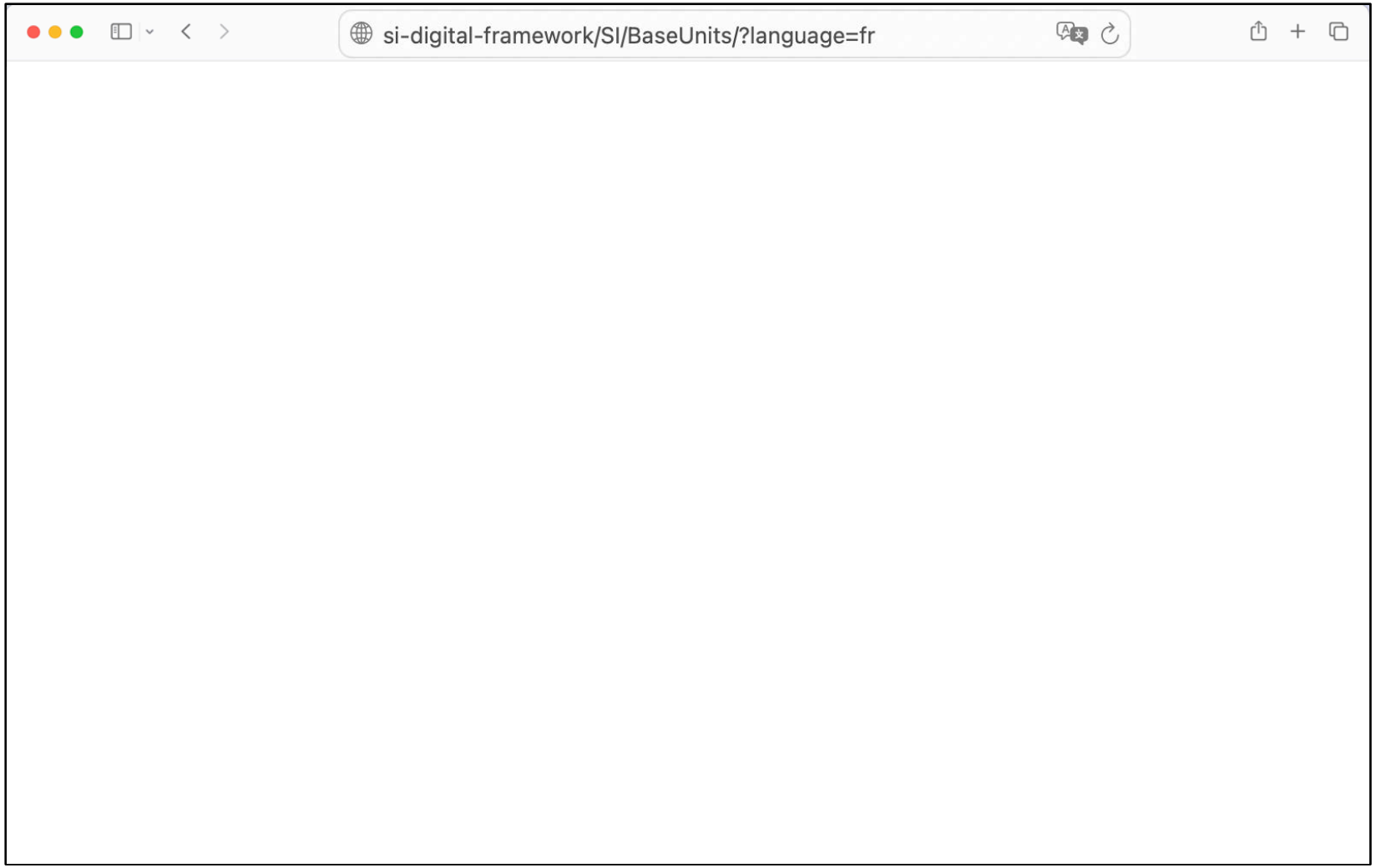
# Data Model




Knowledge Graph

# Querying the Knowledge Graph: HTML response

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# Querying the Knowledge Graph: JSON response

```
curl -X 'GET' \
 'http://localhost:8000/SI/BaseUnits/?language=en&date=2023-03-06&Symbol=A' \
 -H 'accept: application/json'
```

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# Examples of use cases

# The Data Plane: Findable and Accessible

User-driven applications

NMI applications

BIPM registry and portal services

BIPM digital references

BIPM core references

Measurement services

Others

Others

International Metrology Resource Registry

Digital Calibration Certificates (DCCs)

Others

KCDB: CMCs

KCDB: KCs, SCs

JCTLM database

UTC data

New services

...

Standard frequencies data

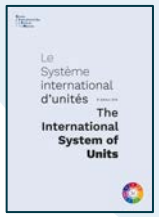
Temperature scales data

Data for realizing the kilogram

Data for realizing other SI units

...

Encoding line




SI brochure + Agreed realization protocols

Fundamental constants data

# Example: KCDB API

Current response

```
12    'quantityValue': 'Temperature',
13    'cmc': {
14        'lowerLimit': 961.78,
15        'upperLimit': 961.78,
16        'unit': '°C'},
17    'cmcUncertainty': {
18        'lowerLimit': 0.09,
19        'upperLimit': 0.09,
20        'unit': '°C'},
21    'cmcBaseUnit': {
22        'lowerLimit': 1234.9299999999998,
23        'upperLimit': 1234.9299999999998,
24        'unit': 'K'},
25    'cmcUncertaintyBaseUnit': {
26        'lowerLimit': 273.23999999999995,
27        'upperLimit': 273.23999999999995,
28        'unit': 'K'},
29    'confidenceLevel': 95.0,
30    'coverageFactor': 2.0,
```

https://www.bipm.org/kcdb/

It's all about identifiers

J. Miles

## Human readable

Units expressed as **string**

## Machine actionable

Units expressed by
Uniform Resource Identifiers (URI)

```
463   ###  http://si-digital-framework.org/SI#degree_Celsius
464   SI:degree_Celsius rdf:type owl:NamedIndividual ,
465                                 SI:SIUnitSpecialName ;
466                       SI:hasSymbol "°C"^^xsd:string .
467
```

# Example of use cases: KC report


```
"Solvent concentration of the solution / (mol.dm-3)": "0.2",
"Carrier concentration of the solution / (µg.g-1)": "CeCl3:20",
"Density of the solution / (g.cm-3)": null,
"Relative activity of impurities contained into the solution": "Negligible",
"Comments on impurities contained into the solution": null,
"Mass of the solution /g": "3.50917, 3.50687",
"Number of the radium source used by the SIR": "1, 1",
"Equivalent activity measured by the SIR / MBq": "132.28, 132.38",
"Relative standard uncertainty (SIR contribution) of the equivalent activity / 1e-4"
"Comments on the SIR measurement": null,
"Combined standard uncertainty of the equivalent activity / MBq": "1.58, 0.78",
"Number of the equivalent activity measurement retained for the degree of equivalenc
"Specified equivalent activity for the degree of equivalence": null,
"Specified equivalent activity for the key comparison reference value": null,
"Comments on the equivalent activity": null,
"Initials of the person who entered the data plus the date": "SJ (09/04/2020)",
"Initials of the person(s) who verified the data plus the
"Status of the data": "Published with the key comparison
```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## Machine actionable response

Using identifiers from **SI Ref Point**

```
###  http://si-digital-framework.org/SI#becquerel
SI:becquerel rdf:type owl:NamedIndividual ,
                      SI:SIUnitSpecialName ;
             SI:isUnitOfQuantityKind SI:activity_referred_to_a_radionuclide ;
             SI:hasSymbol "Bq"^^xsd:string .
```

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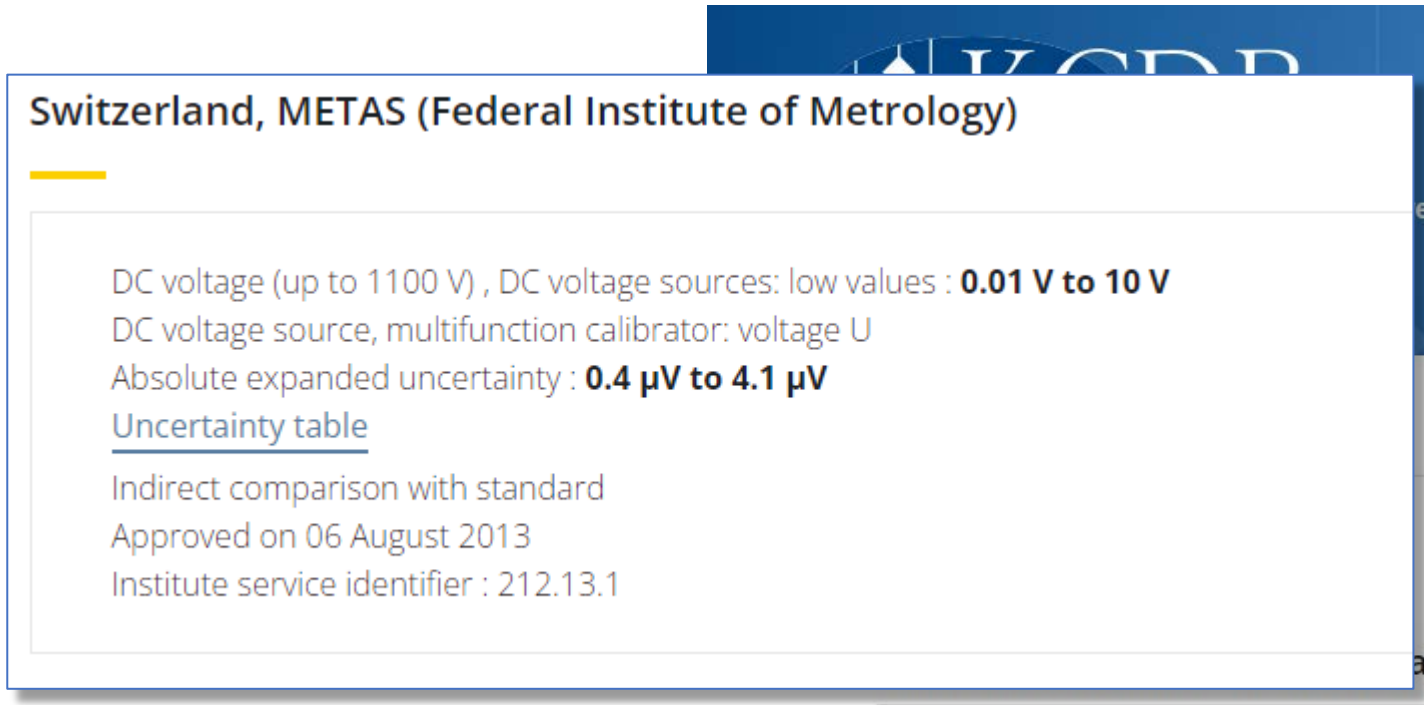
# Other identifiers: CMCs




HTML response

EURAMET-EM-CH-00000GFM-1

→ Advanced search



JSON response

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# Possible usage of the identifier of CMCs

## CIPM MRA Logo and statement

**France, LNE-LCM/Cnam (Conservatoire National des Arts et Métiers/Laboratoire Commun de Métrologie)**

Items for defining ITS-90 , Temperature : **660.323 °C**
Aluminium for SPRT
Absolute expanded uncertainty : **2.4 mK**
Comparison with a cell
Pressure-controlled heat pipe furnace Service provided by the LNE-INM
Approved on 18 May 2004
Institute service identifier : CMT

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# CMCs

- Identifier of every CMC exists
  (check quick guide how to know the identifier)
- CMC is machine accessible, reusable
- Identifier could be used by NMIs
  (e.g on NMI's homepage, on certificates)

# What's next

**Quantities**

- First focus on quantities in CMC
- CCM maintains many service categories
- Need to identify which quantity is related to each individual service
- Need to identify description for every quantity
  (e.g. in ISO 80000, IEC, others?)

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# Summary

- **Resolution 2 of the 27th CGPM** on the global digitalization of the SI
- PrototypBIPM is working on several building blocks to establish a **SI Digital Framework**
- e of **machine readable SI Brochure** is being tested with other modules
- Next steps include **references for Quantities**
  Interaction with experts of the specific field required

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