Open Geospatial Consortium

GeotechIE report

The 126th OGC Member Meeting

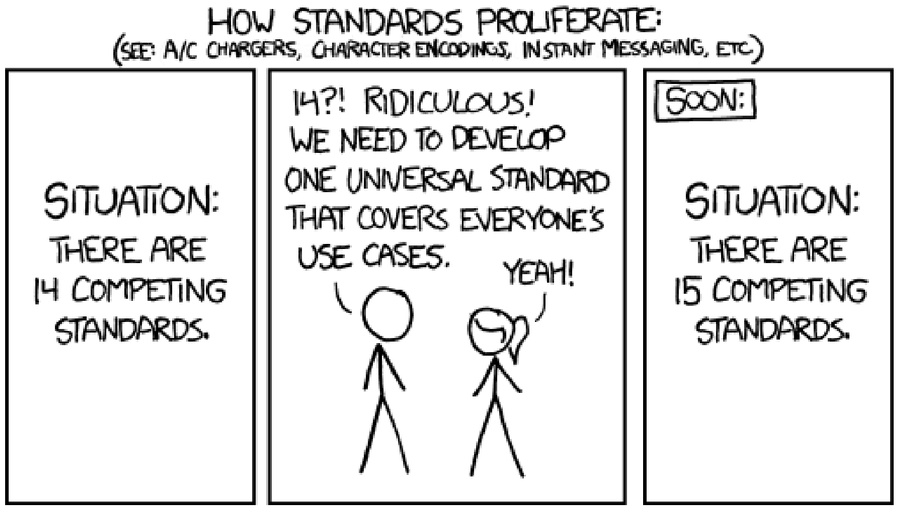
Hosted by

GEO | HUNTSVILLE

Mickael Beaufils, BRGM
7 June 2023

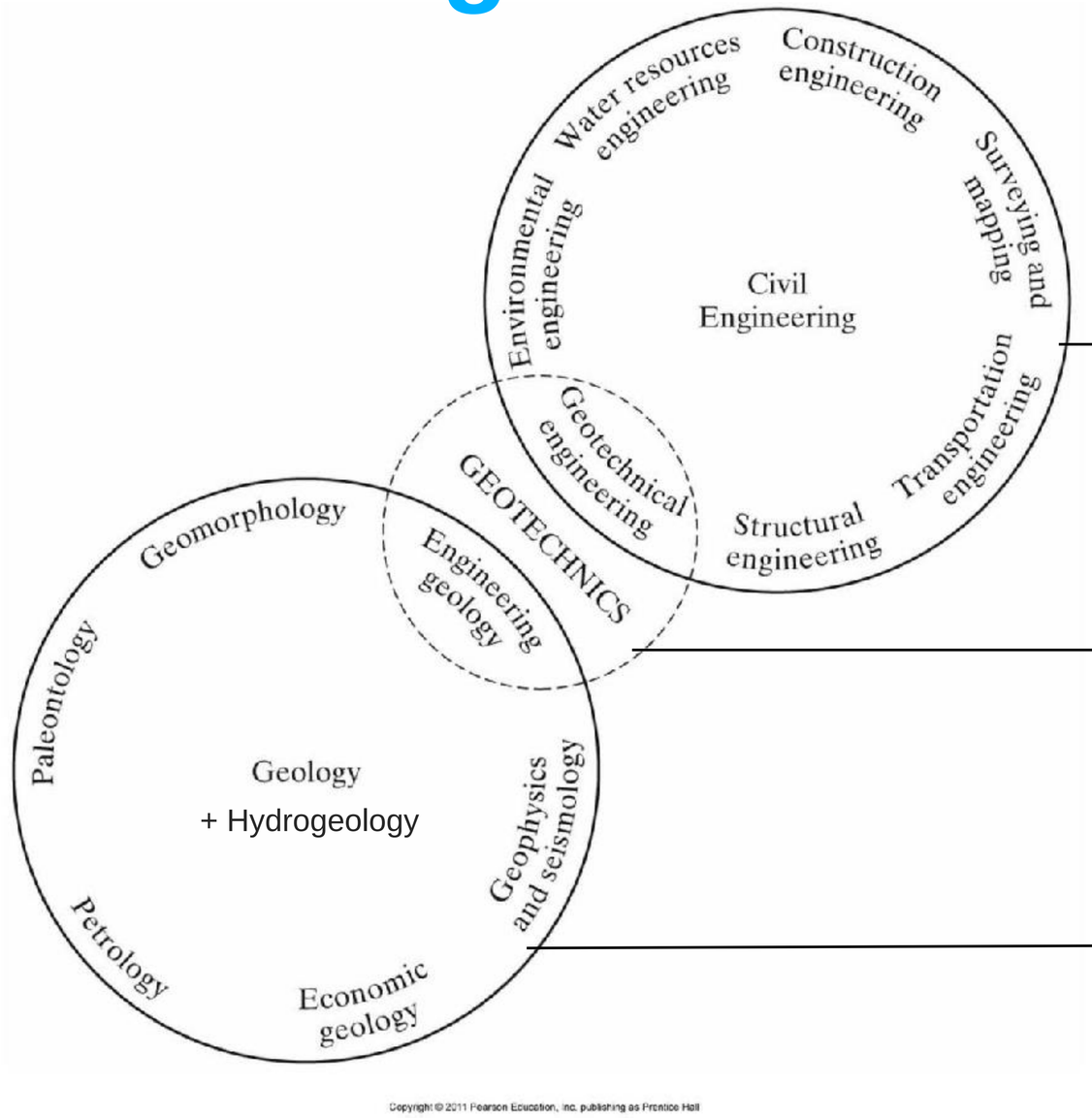
What is the Geotech Interoperability Experiment?

- An effort to federate the geotechnical community around standards
  - Enhance existing standards / Highlight complementarity



- An activity lead by the OGC Geoscience DWG (second IE after Borehole IE)
  - Started on February 2022
  - Estimated end in summer 2023

Motivation: Digital continuity for geotech



buildingSMART International — IFC

AGS — .ags

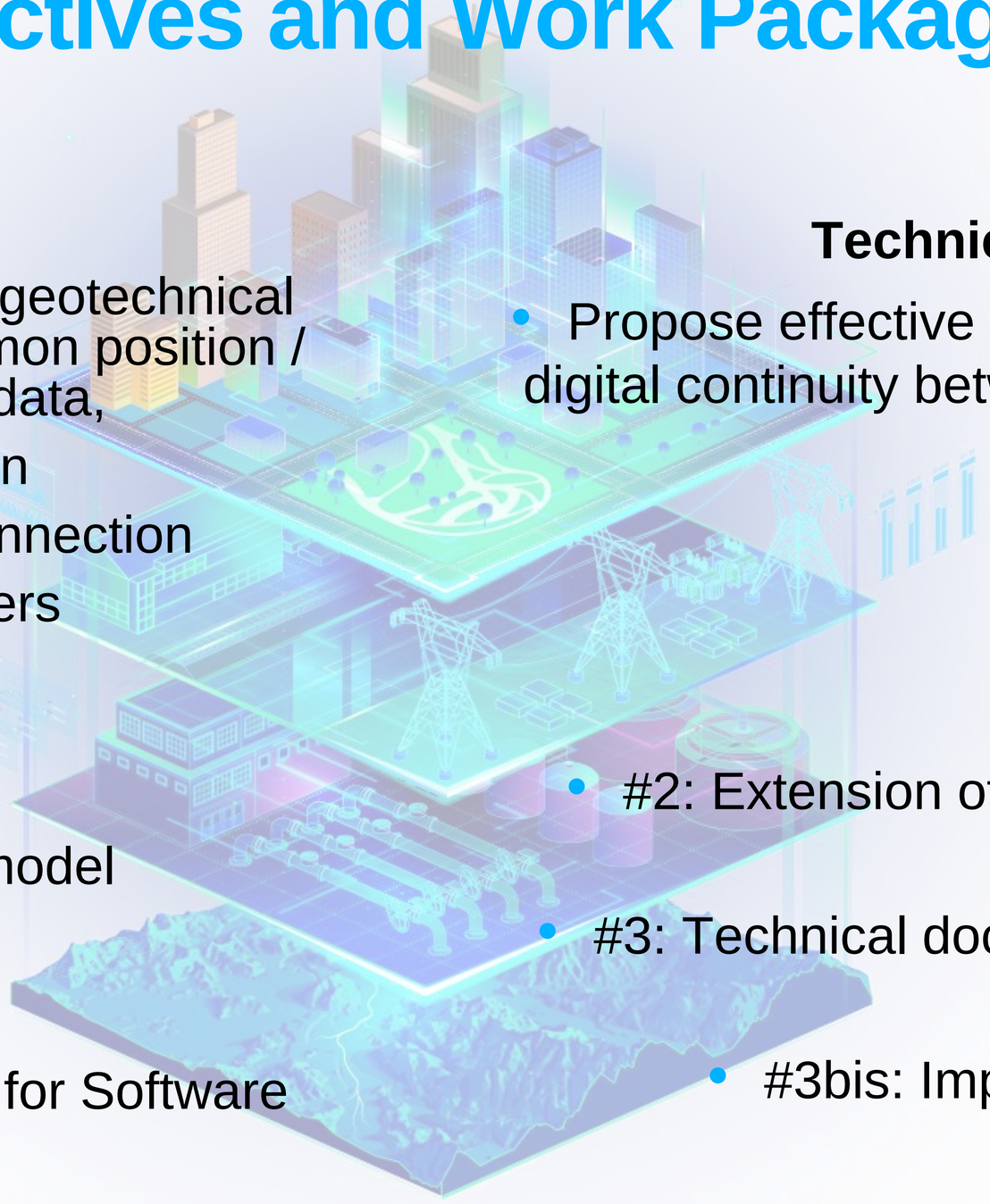
DiGGS Data Interchange for Geotechnical and Geoenvironmental Specialists — diggsml

IUGS International Union of Geological Sciences; CGI Commission for the Management and Application of Geoscience Information — GeoSciML

Open Geospatial Consortium — GroundWaterML2

NB: Non exhaustive list of existing formats and standards

Geotech IE objectives and Work Packages (reminder)



Community oriented goals

- Contribute to federate the geotechnical community around a common position / proposal for geotechnical data,
  - Scientific – IT connection
  - BIM – GIS and more connection
  - Users – Solution providers connection

Work packages:

- #1: Common conceptual model
- #4a: White paper
- #4b: Technical paper
- #5: Implementation Guide for Software Vendors

Technical oriented goals

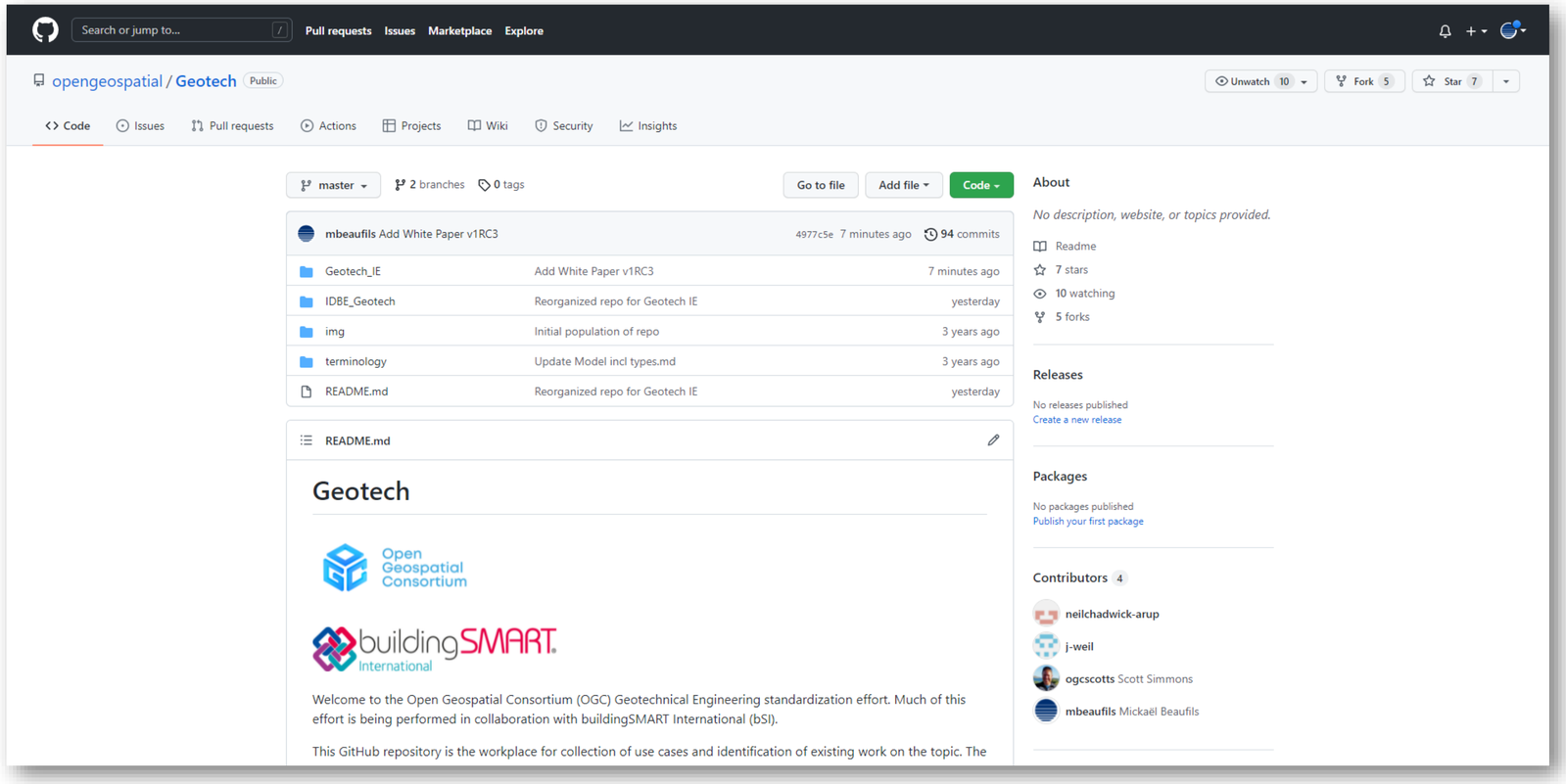
- Propose effective solutions to enable digital continuity between GIS and BIM

Work packages:

- #2: Extension of OGC Geoscience standards,
- #3: Technical documentation on the use of OGC APIs
- #3bis: Implementation forum

Image courtesy © ESRI

Work organization – “Workspace”



- Mail list: geotech.ie@lists.ogc.org
- GitHub: https://github.com/opengeospatial/Geotech
- Wiki: https://github.com/opengeospatial/Geotech/wiki

Focus of today

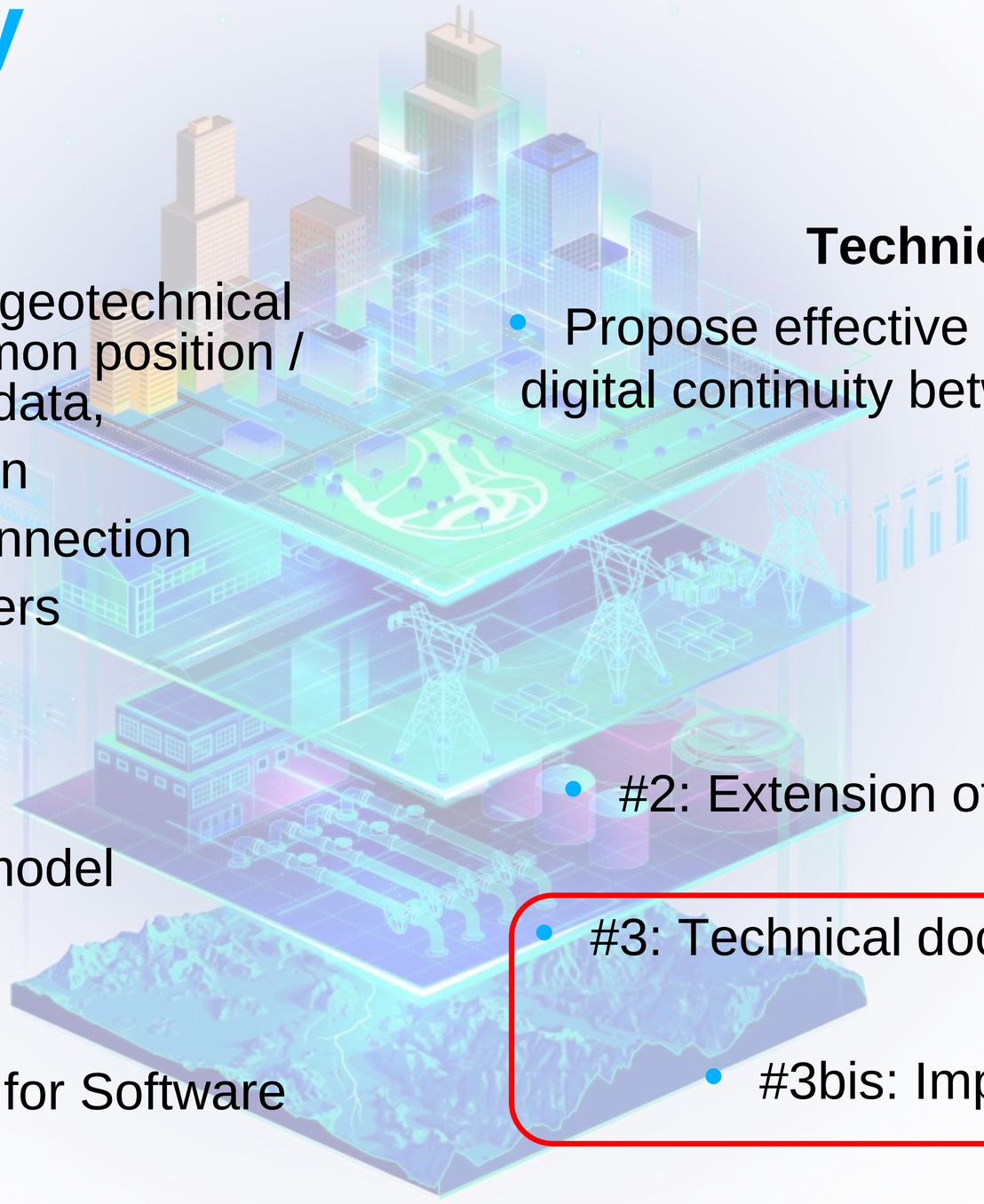


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Image courtesy © ESRI

#1: Contents of each book
(based on current discussion and cover intentions by the standards / formats)

	Objects	Associated properties
Book A: Investigations AGS DiGGS Open Geospatial Consortium buildingSMART International	**Observation Supports or Sampling Features** Borehole, Material Sample, Trial Pit, Observed Zone	**Observations and measurements** In-situ tests Laboratory tests Monitoring
Book B: Models and interpretations Open Geospatial Consortium buildingSMART International AGSi *	**Models and their (possible) components** GeologicUnit, Fault, Contact, Fold HydrogeologicUnit, FluidBody, FluidBodySurface, WaterBody GeotechnicalUnit, Discontinuity, Void HazardArea GeophysicalUnit?	**Interpretations**
Book C: Design solution Open Geospatial Consortium buildingSMART International	**GeotechSynthesis Model** Alignment, TypicalDesignArea, GeotechnicalZoneOfInfluence	**Interpretations / Projections**

* partial cover

Proposed OGC APIs for Geotech

	Objects	Associated properties
Book A	**Observation Supports or Sampling Features** Borehole, Material Sample, Trial Pit, Observed Zone	**Observations and measurements** In-situ tests Laboratory tests Monitoring
Book B	**Models and their (possible) components** GeologicUnit, Fault, Contact, Fold HydrogeologicUnit, FluidBody, FluidBodySurface, WaterBody GeotechnicalUnit, Discontinuity, Void HazardArea GeophysicalUnit?	**Interpretations**
Book C	**GeotechSynthesis Model** Alignment, TypicalDesignArea, GeotechnicalZoneOfInfluence	**Interpretations / Projections**

Served with: OGC API Feature OGC SensorThingsAPI

Implementation test

	Objects	Associated properties
Book A AGS DiGGS Open Geospatial Consortium buildingSMART International	**Observation Supports or Sampling Features** Borehole, Material Sample, Trial Pit, Observed Zone	**Observations and measurements** In-situ tests Laboratory tests Monitoring
Book B Open Geospatial Consortium buildingSMART International AGSi *	**Models and their (possible) components** GeologicUnit, Fault, Contact, Fold HydrogeologicUnit, FluidBody, FluidBodySurface, WaterBody GeotechnicalUnit, Discontinuity, Void HazardArea GeophysicalUnit?	**Interpretations**
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Served with:	OGC API Feature	OGC SensorThingsAPI

About OGC API Features and SensorThingsAPI

- Already existing material
  - API for INSPIRE
    - Studying the fitness of OGC API Features and SensorThings API as an INSPIRE Download service
  - To be extended with geotech examples

https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/api-inspire

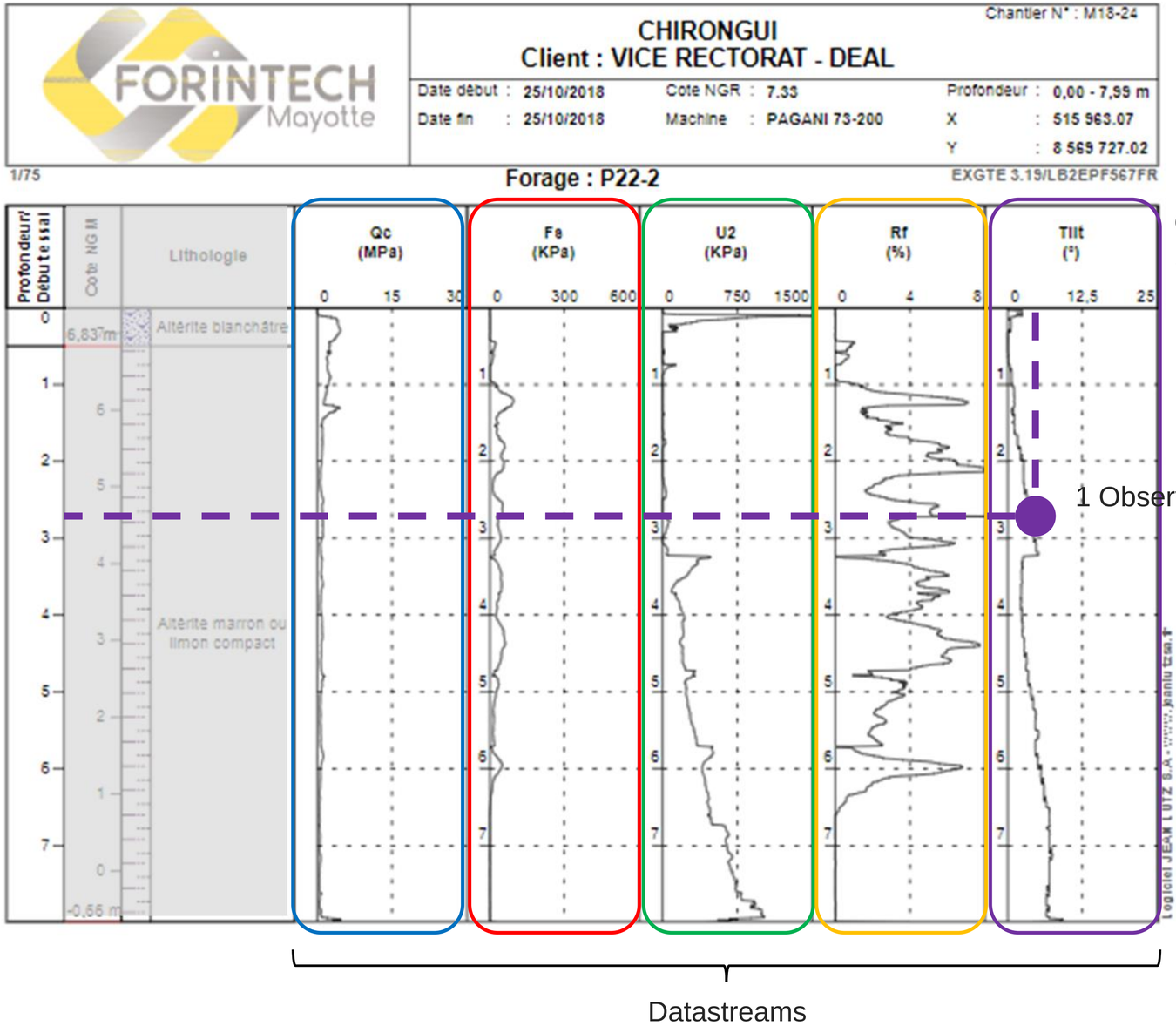
The borehole data journey to STA

- **Conceptual model:**
  - the conceptual alignement between ISO19148 (Linear Referencing) and ISO19156 (OMS) for the description of borehole data,
- **Logical / Physical model:**
  - adaptation of the SensorThingsAPI data model for the provision of borehole data
  - Application to some Geotech tests (CPT, SPT, Menard Pressuremeter),
- **Implementation level:**
  - the provision of a tuned FROST (Fraunhofer SensorThings API server) that implement this data model.

Sharing borehole logs

Some data about the test

At different depths



ObservedProperty
Unit of Measurement

1 Observation

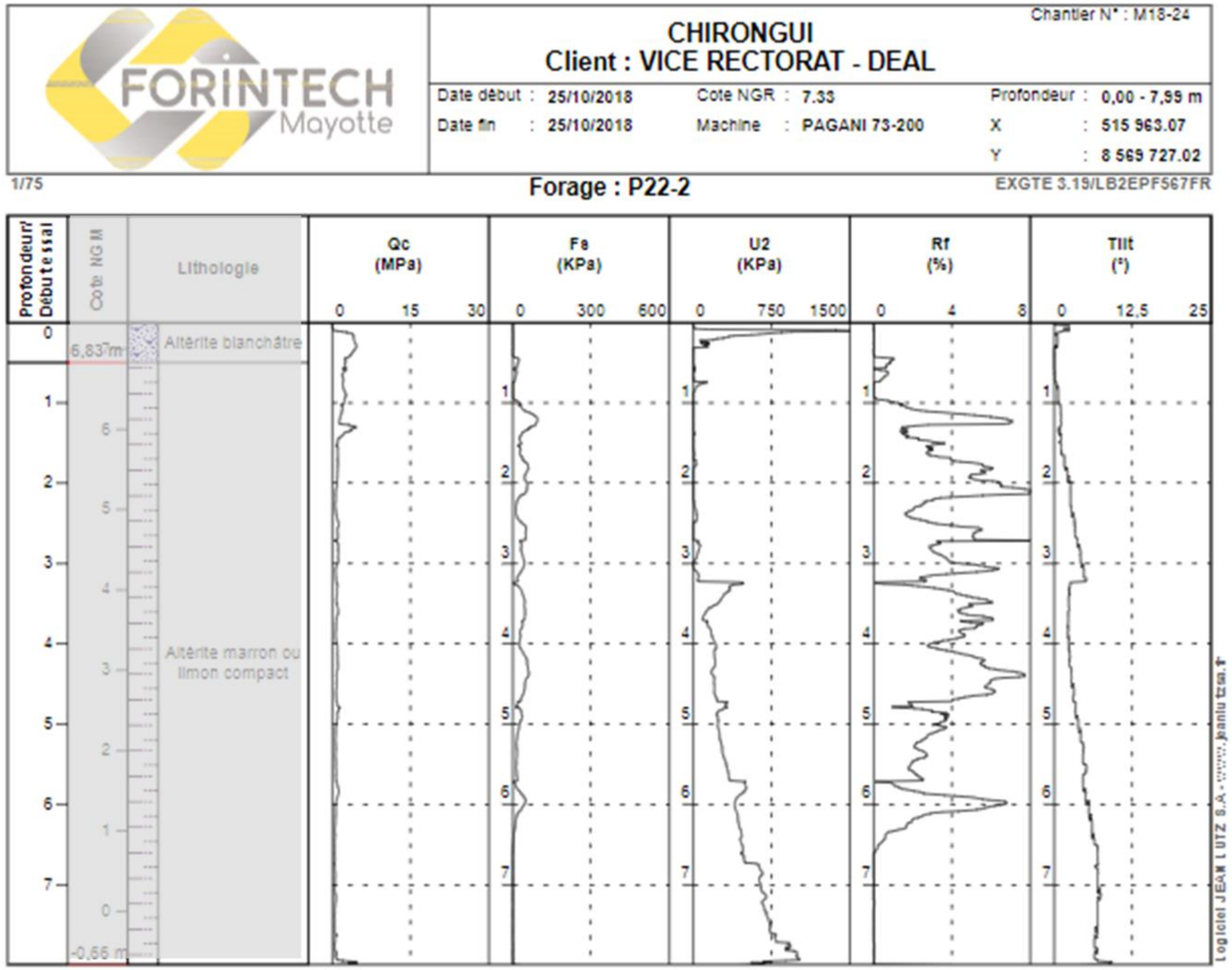
Datastreams

Application to some Geotech tests

- Three geotech in-situ tests
  - Cone Penetration Test (CPT)
  - Standard Penetration Test (SPT)
  - Menard Pressuremeter

- Measurements at regular depths along a borehole: BoreholePointFOI

CPT template



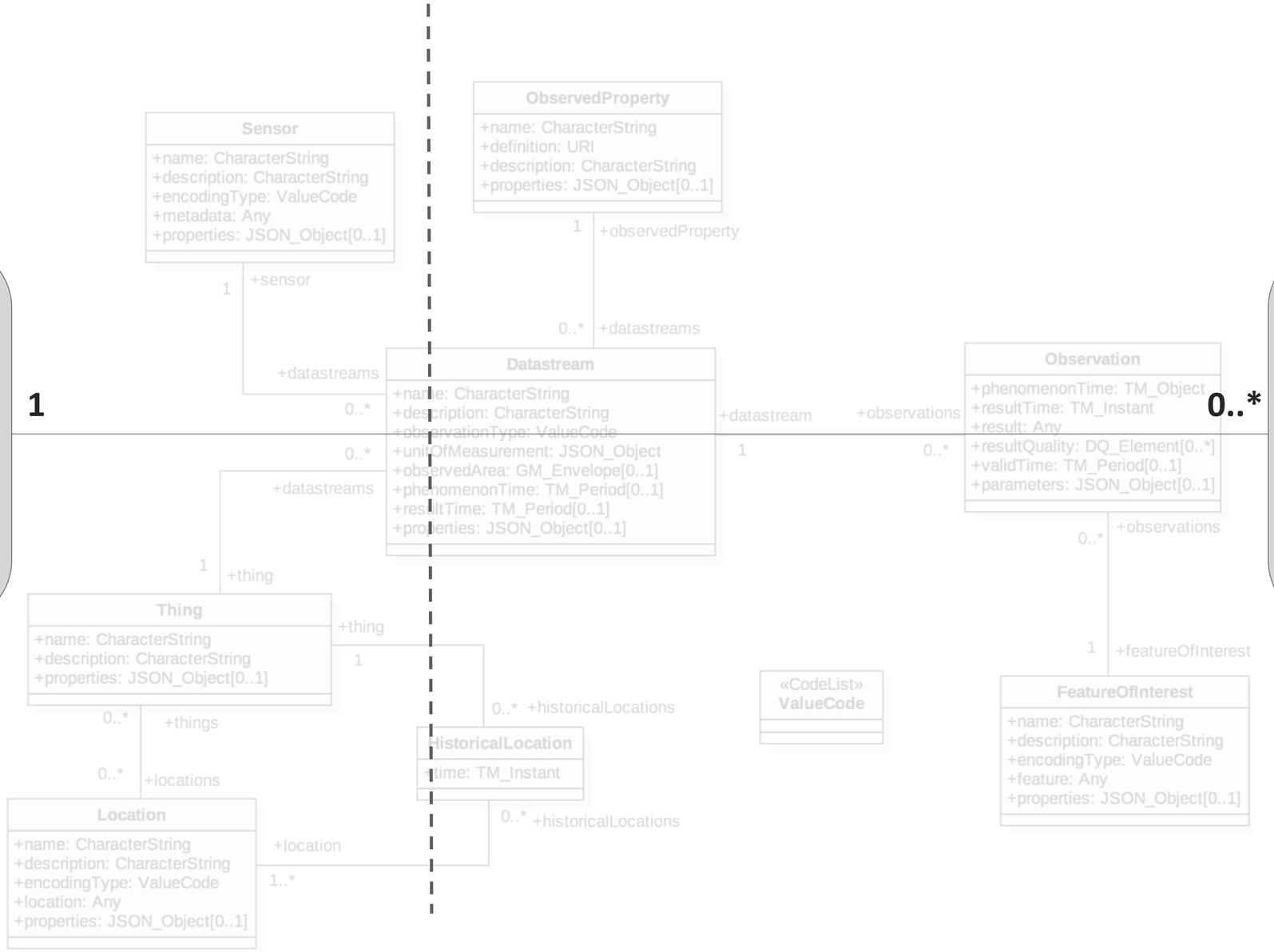
- SensorType: CPT
- ObsProp:
  - Here Qc, Fs, U2, Rf, Tilt
  - Also possible : U1, U3, alpha, qt, ft, Rf, Rft, γ, σv, qn, Δu2, uo, Bq, Rfn
- Type of FOI:
  - BH_HolePointFOI

How to declare Geotech tests with STA?

Test description

- Type of test
- Who? When? Where ?

1



0..*

Observations or measurements from the test

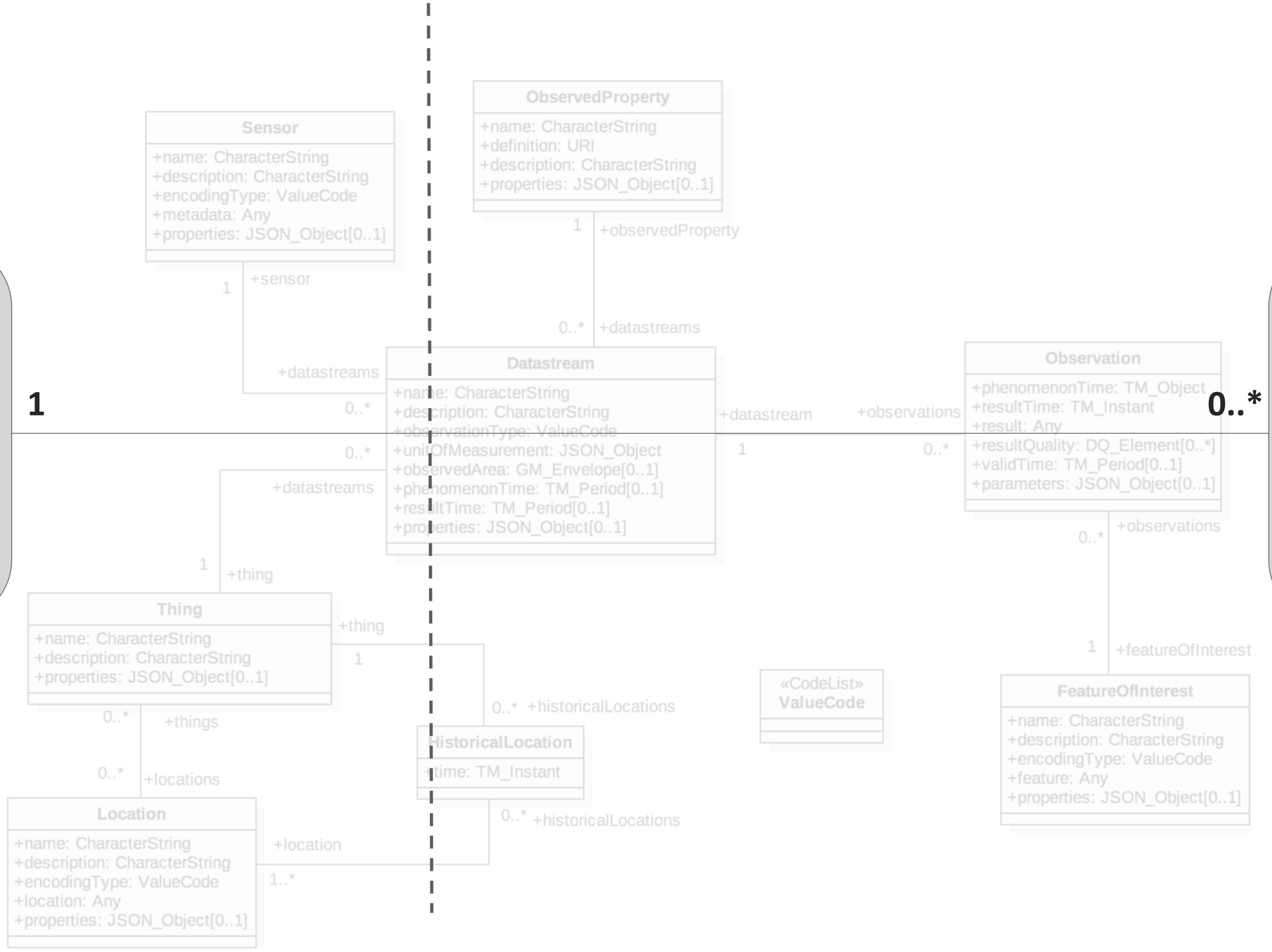
- The values obtained for each observed properties

Classical geotech data provision

Test description

- Type of test
- Who? When? Where ?

1

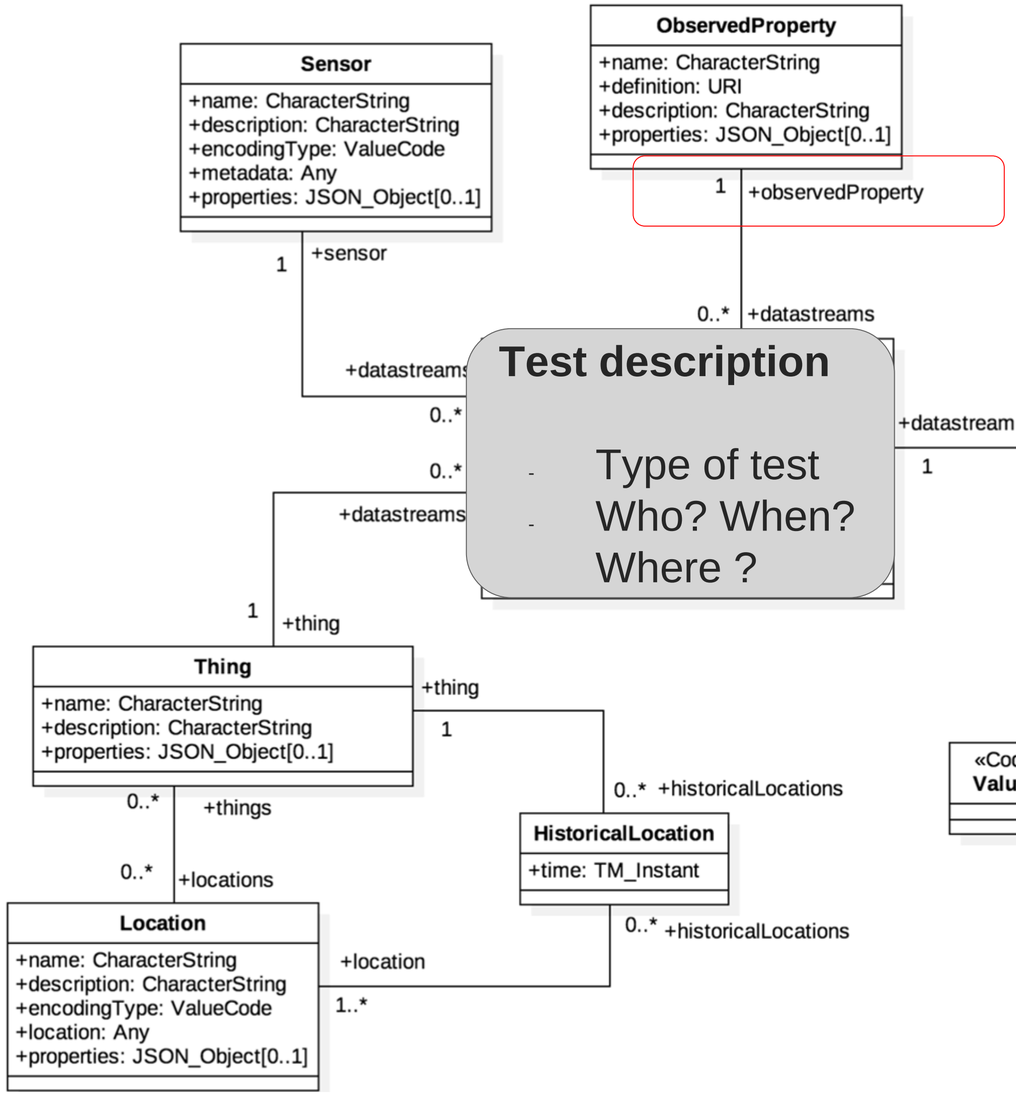


0..*

Observations or measurements from the test

- The values obtained for each observed properties

Option 1 : Test = DataStream

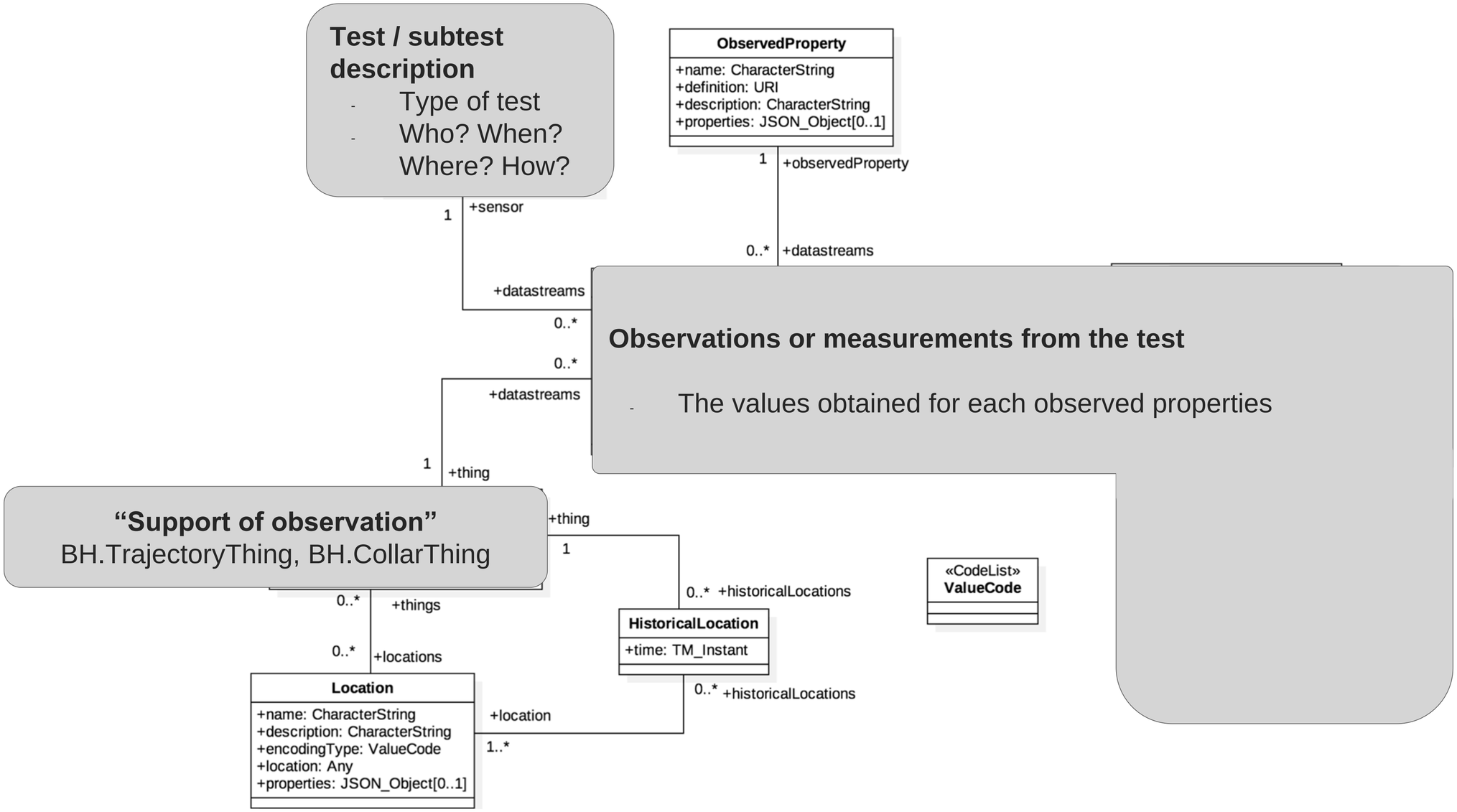


main issue : not valid for multi observed properties test

Observations or measurements from the test

- The values obtained for each observed properties

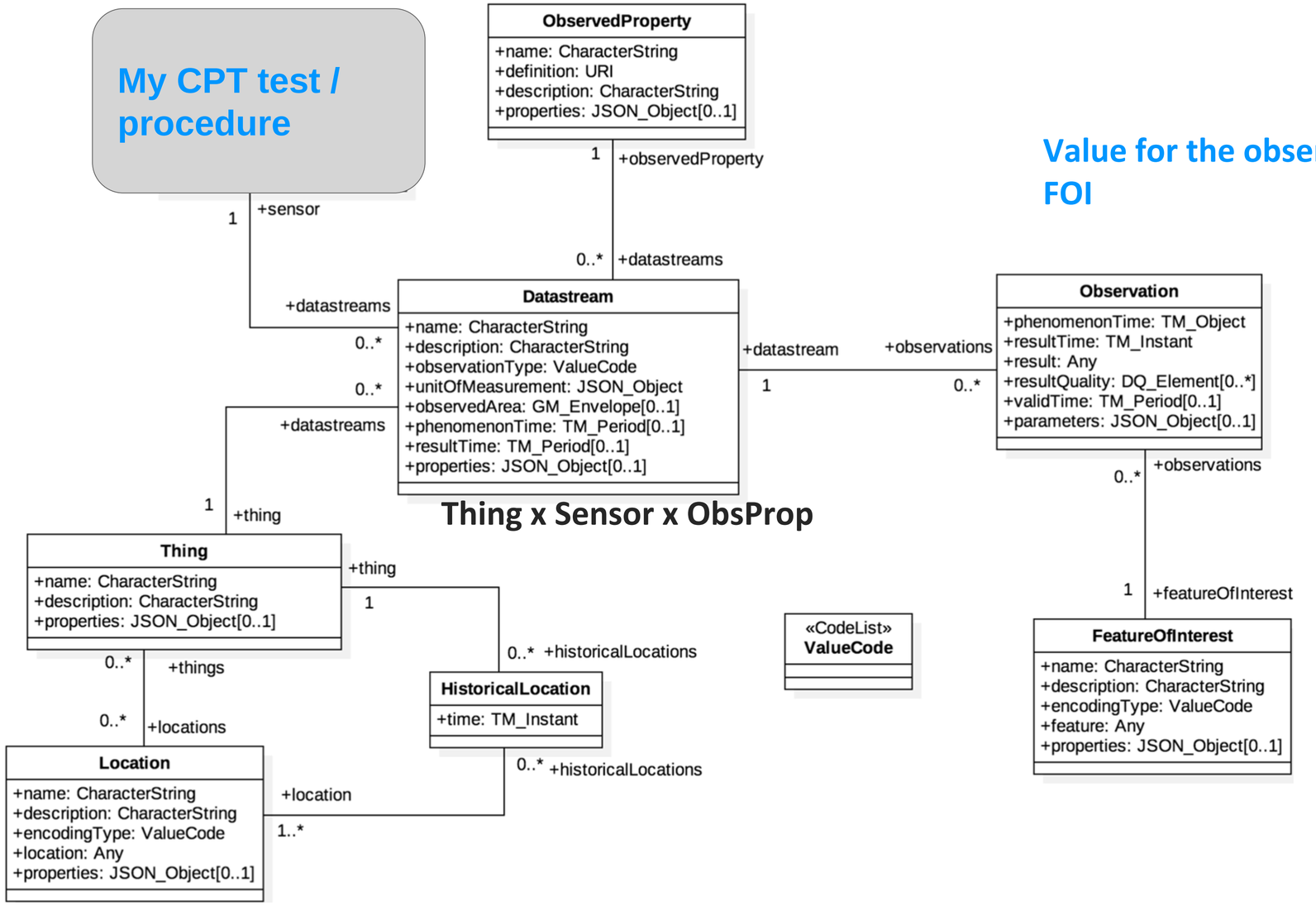
Option 2 : Test = Sensor



CPT design options 1: 1 procedure for CPT

/!\ Still one ObsProp per DataStream

qc, fs, u1, u2, u3, alpha, qt, ft, Rf, Rft, gamma, sigmav, qn, deltau2, uo, Bq, Rfn, U2Divqc, qc-u2, Dist

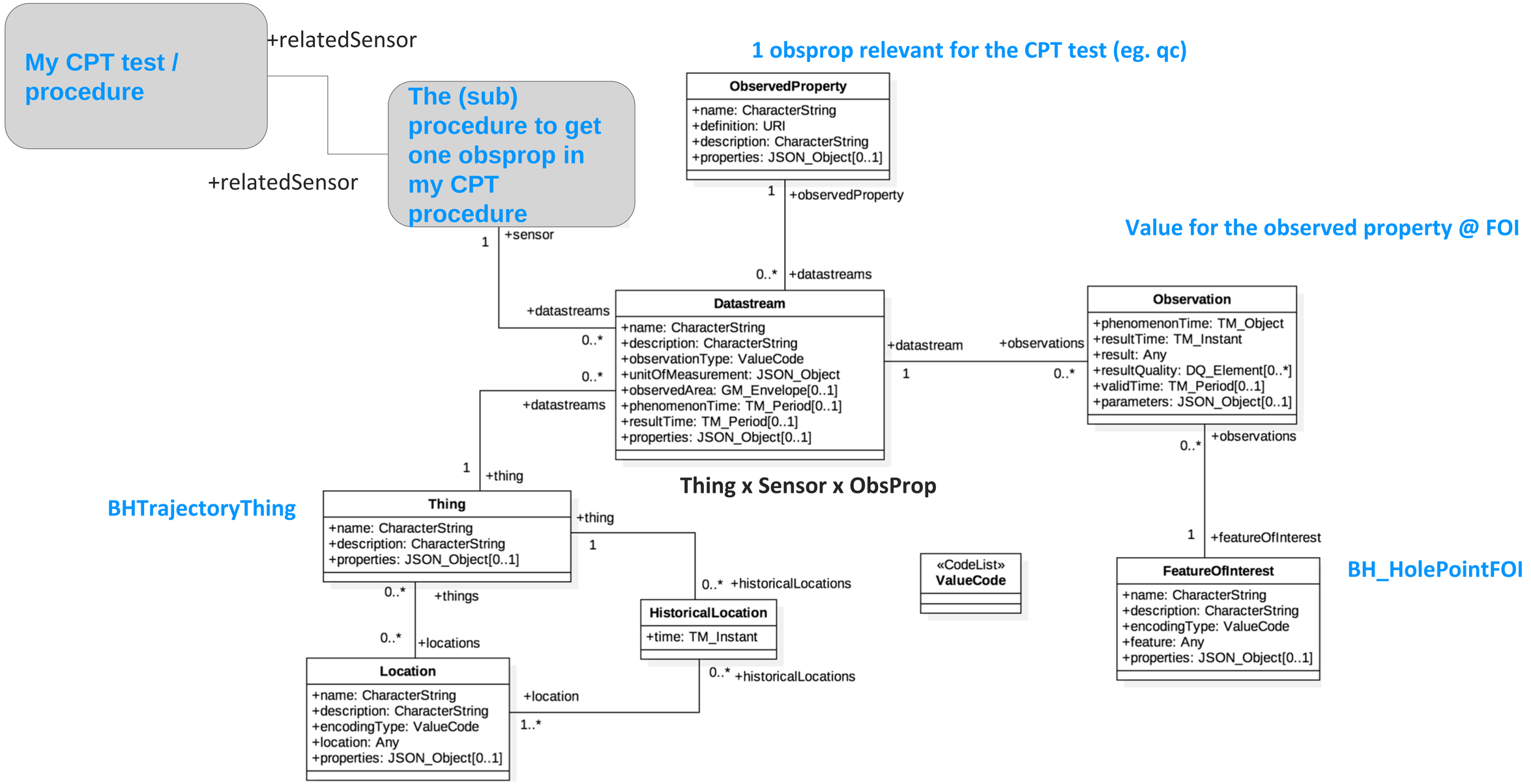


Value for the observed property @ FOI

BHTrajectoryThing

BH_HolePointFOI

CPT design option 2 : detailed procedure



Queries

Get a list of all the geotechTests in this STA (supposing the STA only contains Geotech tests) :

- https://[FrostGeotechServerAddress]/v1.1/Sensors

Get a list of all the geotechTests that are of type CPT

- https://[FrostGeotechServerAddress]/v1.1/Sensors?$filter=sensortype eq ‘https://data.geoscience.fr/ncl/Proc/86’

Get the description of one test by ID:

- https://[FrostGeotechServerAddress]/v1.1/Sensors(xxx)

Queries

Get the list of the available DataStreams associated to my Geotechtest

- https://[FrostGeotechServerAddress]/v1.1/Sensors(xxx)/Datastreams

Get the description of one DataStream associated to my Geotechtest

- https://[FrostGeotechServerAddress]/v1.1/Datastreams(yyy)

Get the observations from this DataStream

- https://[FrostGeotechServerAddress]/v1.1/Datastreams(yyy)/Observations

Other ideas?

STA Geotech instance

https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/FROST-GeoTech/v1.1

https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/FROST-GeoTech/v1.1/Datastreams(2)/Observations

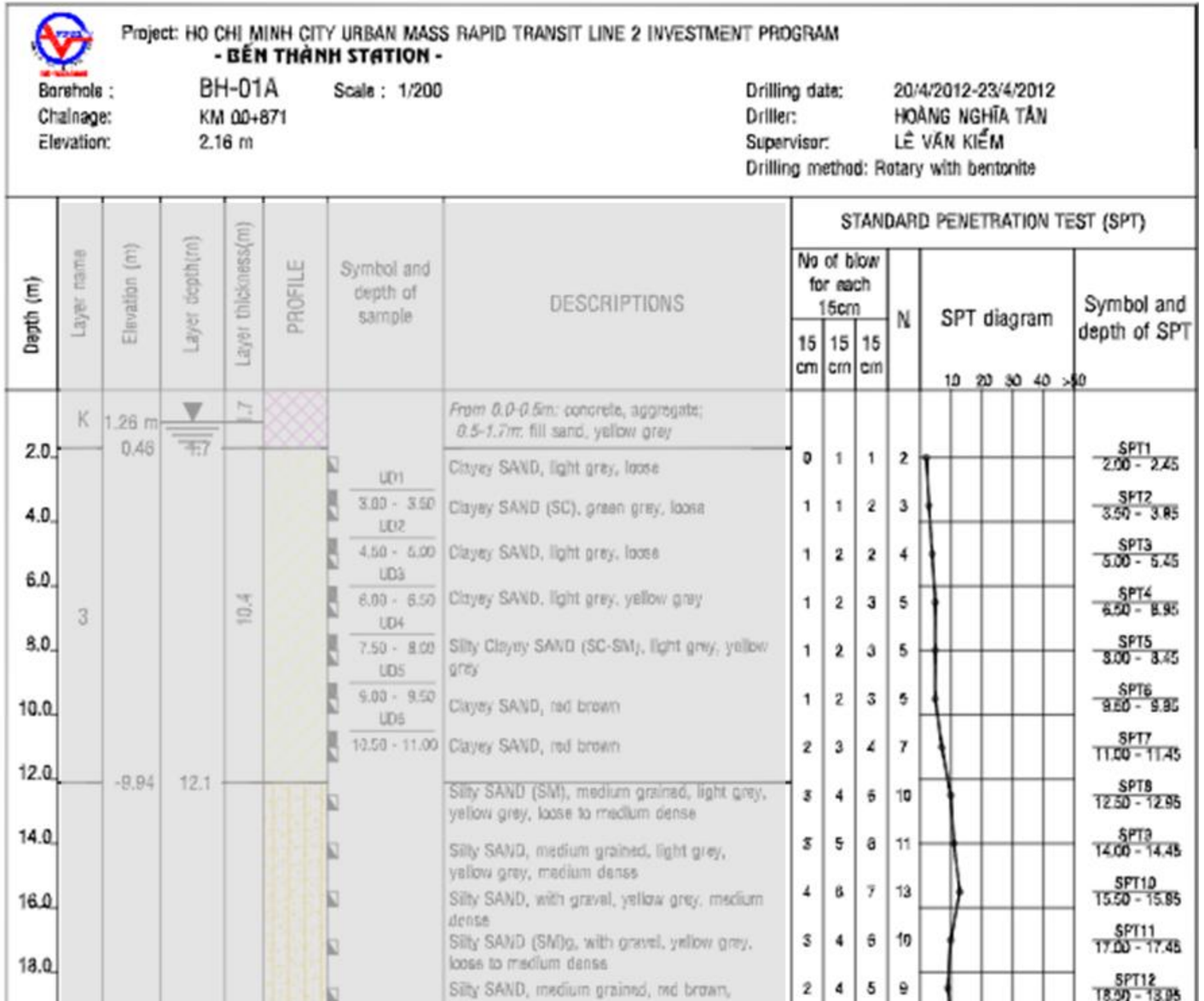
https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/FROST-GeoTech/v1.1/Datastreams(2)/Observations?$expand=BhHolePointFoi($expand=BhSampling)

https://ogc-demo.k8s.ilt-dmz.iosb.fraunhofer.de/FROST-GeoTech/v1.1/Datastreams(2)/Observations?$select=result,phenomenonTime&$expand=BhHolePointFoi($select=name;$expand=BhSampling($select=atPosition))

Discussion

Other queries?

Mapping for SPT



Project: HO CHI MINH CITY URBAN MASS RAPID TRANSIT LINE 2 INVESTMENT PROGRAM
- BẾN THÀNH STATION -

Borehole : BH-01A Scale : 1/200
Chainage: KM 00+871
Elevation: 2.16 m

Drilling date: 20/4/2012-23/4/2012
Driller: HOÀNG NGHĨA TÂN
Supervisor: LÊ VĂN KIỂM
Drilling method: Rotary with bentonite

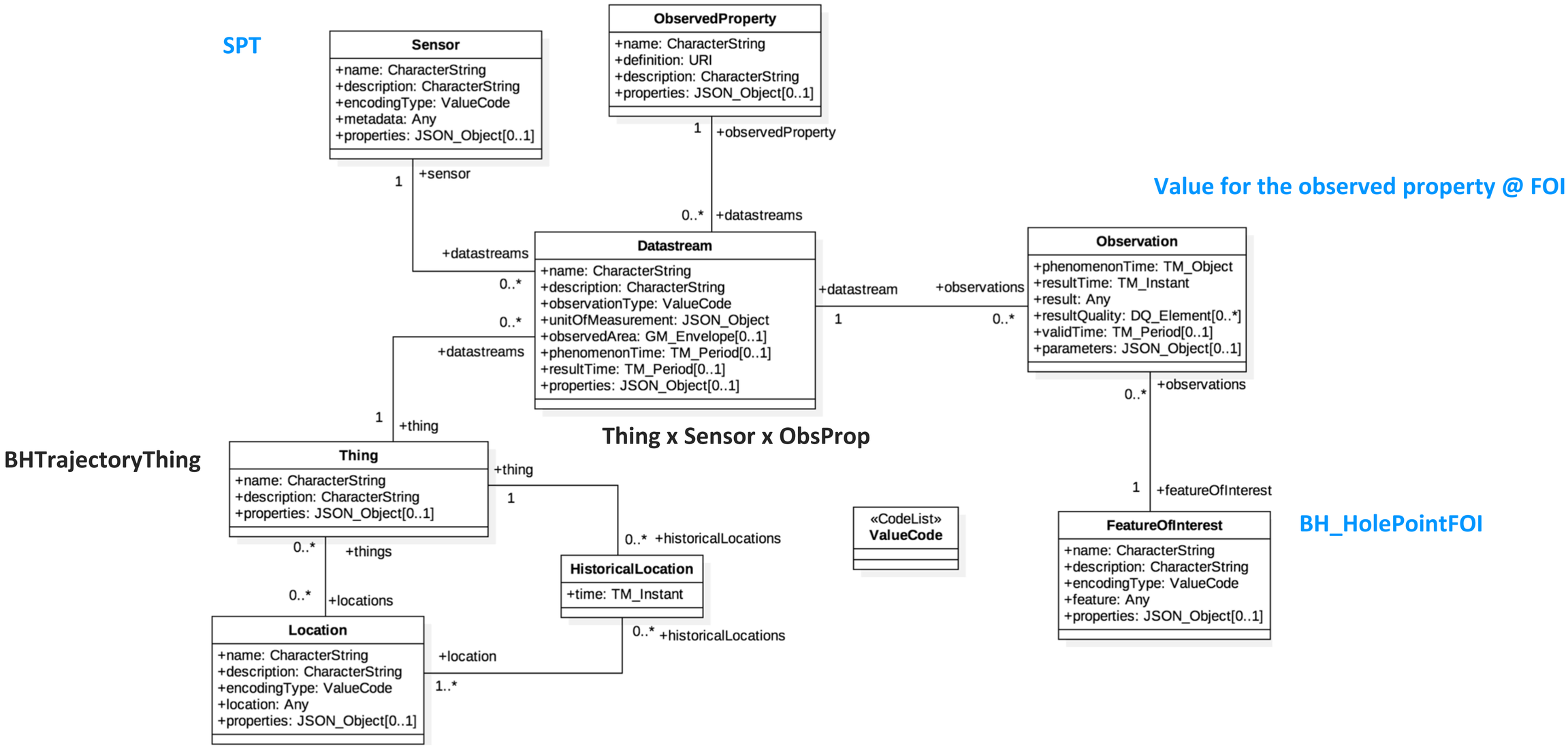
Depth (m)	Layer name	Elevation (m)	Layer depth(m)	Layer thickness(m)	PROFILE	Symbol and depth of sample	DESCRIPTIONS	STANDARD PENETRATION TEST (SPT) No of blow for each 15cm: 15 cm	15 cm	15 cm	N	SPT diagram (10 20 30 40 >50)	Symbol and depth of SPT
	K	1.26 m	1.7	1.7			From 0.0-0.5m: concrete, aggregate; 0.5-1.7m: fill sand, yellow grey						
2.0		0.46				UD1	Clayey SAND, light grey, loose	0	1	1	2		SPT1 2.00 - 2.45
4.0						3.00 - 3.50 UD2	Clayey SAND (SC), green grey, loose	1	1	2	3		SPT2 3.50 - 3.95
6.0						4.50 - 5.00 UD3	Clayey SAND, light grey, loose	1	2	2	4		SPT3 5.00 - 5.45
	3			10.4		6.00 - 6.50 UD4	Clayey SAND, light grey, yellow grey	1	2	3	5		SPT4 6.50 - 6.95
8.0						7.50 - 8.00 UD5	Silty Clayey SAND (SC-SM), light grey, yellow grey	1	2	3	5		SPT5 8.00 - 8.45
10.0						9.00 - 9.50 UD6	Clayey SAND, red brown	1	2	3	5		SPT6 9.50 - 9.95
12.0		-9.94	12.1			10.50 - 11.00	Clayey SAND, red brown	2	3	4	7		SPT7 11.00 - 11.45
							Silty SAND (SM), medium grained, light grey, yellow grey, loose to medium dense	3	4	6	10		SPT8 12.50 - 12.95
14.0							Silty SAND, medium grained, light grey, yellow grey, medium dense	5	5	6	11		SPT9 14.00 - 14.45
16.0							Silty SAND, with gravel, yellow grey, medium dense	4	6	7	13		SPT10 15.50 - 15.95
18.0							Silty SAND (SM)g, with gravel, yellow grey, loose to medium dense	3	4	6	10		SPT11 17.00 - 17.45
							Silty SAND, medium grained, red brown,	2	4	5	9		SPT12 18.50 - 18.95

- SensorType: SPT
- ObsProp:
  - N, InsertionDepth
- Type of FOI:
  - BH_HolePointFOI

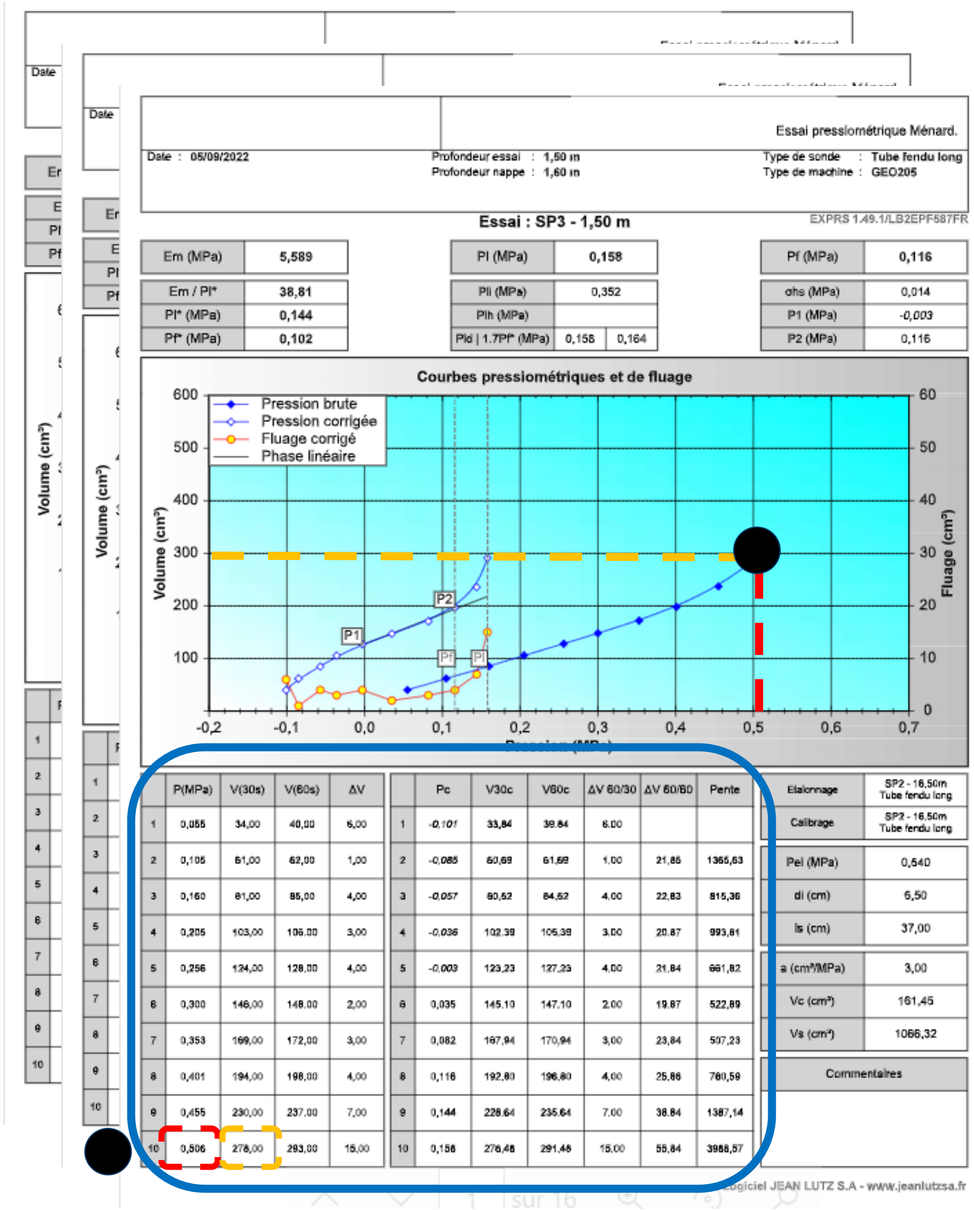
SPT

No, N1, N2, N, insertionDepth

SPT



Mapping for Menard Pressuremeter



Essai pressiométrique Ménard.

Date : 05/09/2022 | Profondeur essai : 1,50 m | Profondeur nappe : 1,60 m | Type de sonde : Tube fendu long | Type de machine : GEO205

Essai : SP3 - 1,50 m

EXPRS 1.49.1/LB2EPF587FR

Em (MPa)	5,589
Em / Pl*	38,81
Pl* (MPa)	0,144
Pf* (MPa)	0,102

Pl (MPa)	0,158	
Pll (MPa)	0,352	
Plh (MPa)		
Pld | 1.7Pf* (MPa)	0,158	0,164

Pf (MPa)	0,116
ohs (MPa)	0,014
P1 (MPa)	-0,003
P2 (MPa)	0,116

Courbes pressiométriques et de fluage

Pression brute
Pression corrigée
Fluage corrigé
Phase linéaire

Volume (cm³) | Fluage (cm³) | Pression (MPa)

	P(MPa)	V(30s)	V(60s)	ΔV
1	0,055	34,00	40,00	6,00
2	0,105	61,00	62,00	1,00
3	0,150	81,00	85,00	4,00
4	0,205	103,00	106,00	3,00
5	0,256	124,00	128,00	4,00
6	0,300	146,00	148,00	2,00
7	0,353	169,00	172,00	3,00
8	0,401	194,00	198,00	4,00
9	0,455	230,00	237,00	7,00
10	0,506	278,00	293,00	15,00

	Pc	V30c	V60c	ΔV 60/30	ΔV 60/60	Pente
1	-0,107	33,84	39,84	6,00		
2	-0,085	60,69	61,69	1,00	21,85	1365,63
3	-0,057	80,52	84,52	4,00	22,83	815,36
4	-0,036	102,39	105,39	3,00	20,87	993,81
5	-0,009	123,23	127,23	4,00	21,84	661,82
6	0,035	145,10	147,10	2,00	19,87	522,89
7	0,082	167,94	170,94	3,00	23,84	597,23
8	0,116	192,80	196,80	4,00	25,86	760,59
9	0,144	228,64	235,64	7,00	38,84	1387,14
10	0,158	276,48	291,48	15,00	55,84	3988,57

Etalonnage	SP2 - 16,50m Tube fendu long
Calibrage	SP2 - 16,50m Tube fendu long
Pel (MPa)	0,540
dl (cm)	6,50
ls (cm)	37,00
a (cm³/MPa)	3,00
Vc (cm³)	161,45
Vs (cm³)	1066,32

Commentaires

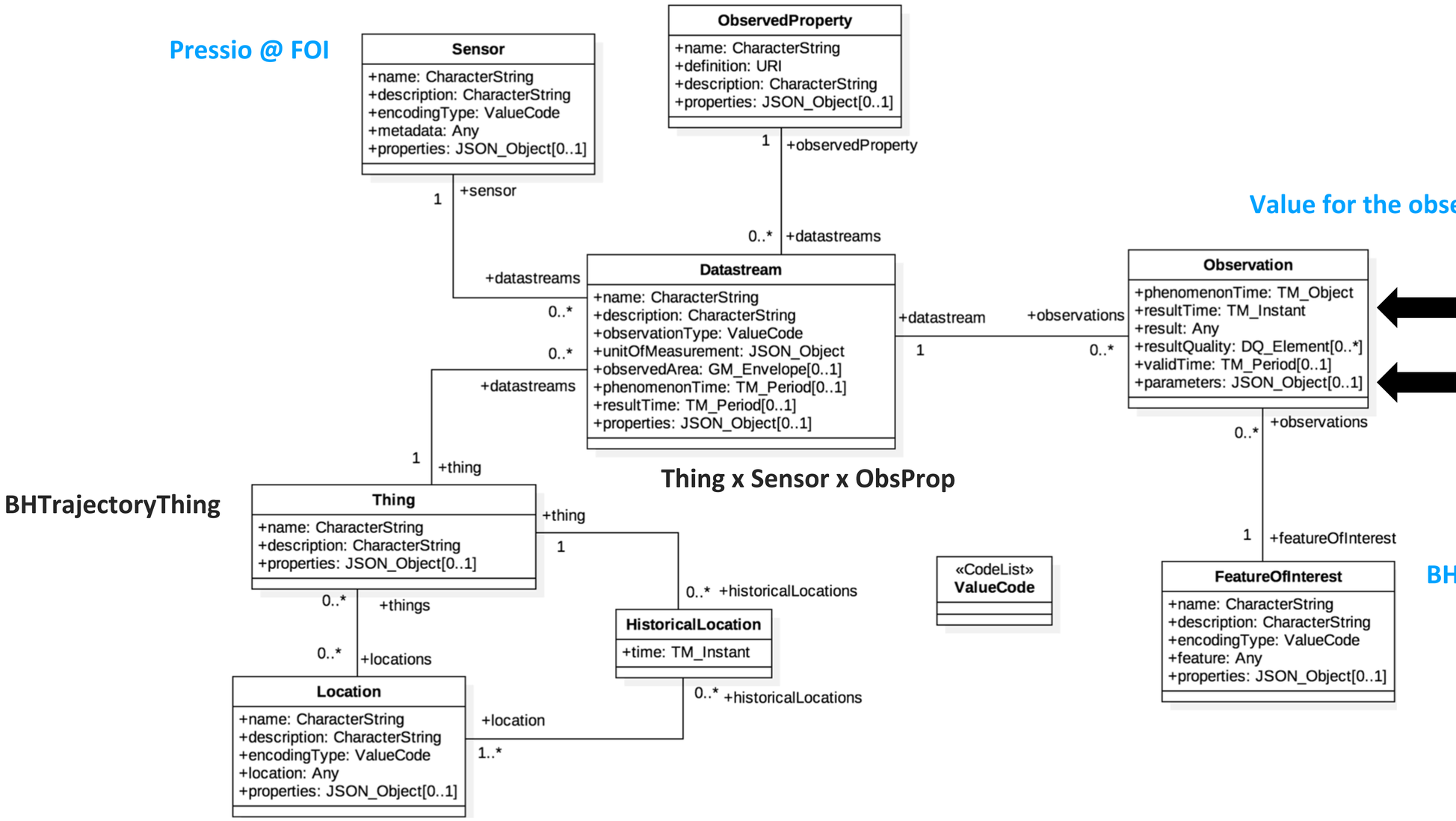
Logiciel JEAN LUTZ S.A - www.jeanlutzsa.fr

- SensorType:
  - Menard Pressuremeter
- ObsProp:
  - Pr1, Pr15, Pr30, Pr60, Vr1, Vr15, Vr30, Vr60, P, V, mi, DeltaV(60-30)
- Type of FOI:
  - BH_HolePointFOI
- How to deal with the different pressure steps?
  - Option 1: different Time Instants
  - Option 2: as parameter

Menard Pressuremeter

Pr1, Pr15, Pr30, Pr60, Vr1, Vr15, Vr30, Vr60, P, V, mi, DeltaV(60-30)

Pressio @ FOI

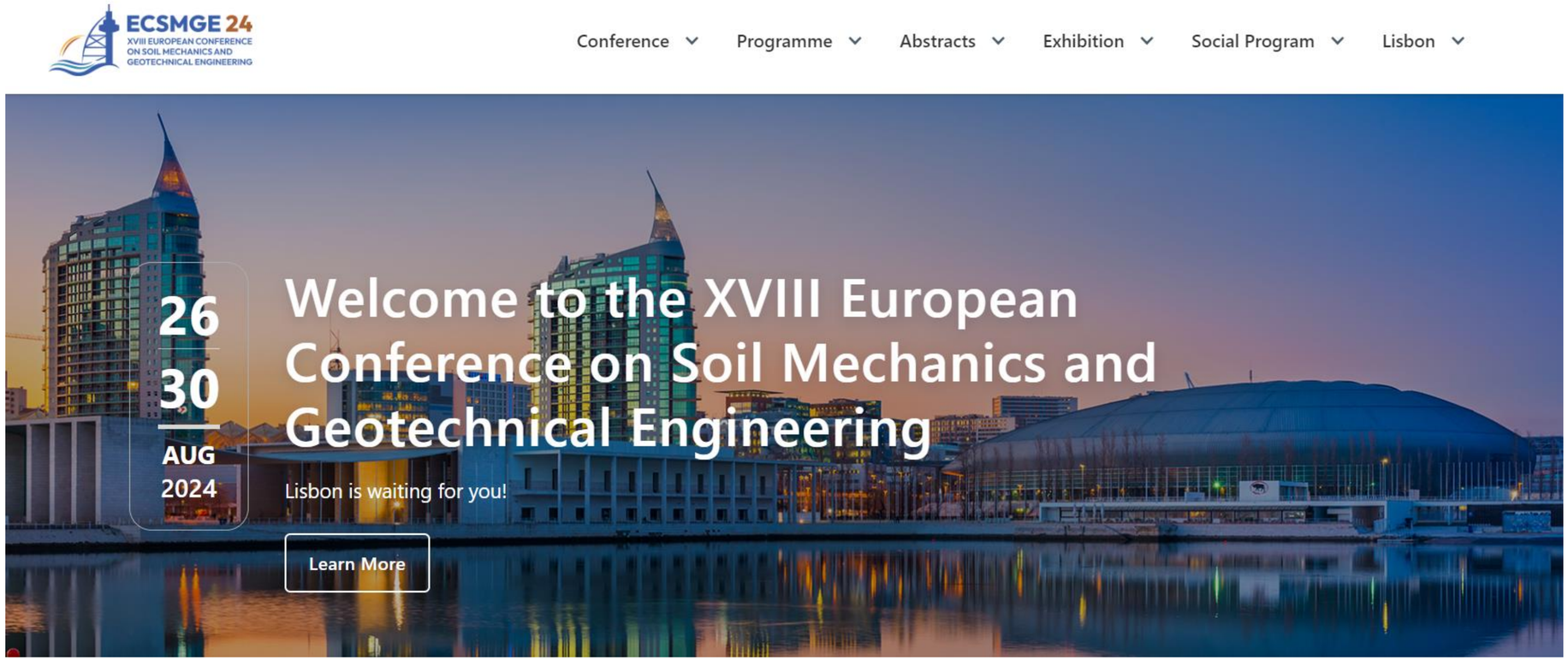


Discussion

Atterberg Limits test

- Let’s talk about MaterialSamples / Specimen

News from ISSMGE TC222



- Discussion to have a workshop dedicated to BIM and Digital Twins for Geotech