ISO 5820:2024-02 (E)

Microbeam analysis - Hyper-dimensional data file specification (HMSA)

Contents

Page

Foreword xi

Introduction xii

1 Scope 1

2 Normative references 1

3 Terms and definitions 1

4 Overview 1
4.1 Design Considerations 1
4.2 Binary and XML file pair 2
4.2.1 General 2
4.2.2 HMSA general structure 2
4.2.3 XML general structure 3
4.2.4 HMSA-XML association 3
4.3 Hyper-dimensional data 3

Table 1 — Dimensionality of common data types 3
4.4 Unicode and internationalization 4
4.5 Minimalism 4
4.6 Extensibility 4
4.7 What HMSA does not do 5

5 XML File Specification 6
5.1 XML general structure 6
5.2 XML specification 7
5.2.1 General 7
5.2.2 XML features not supported 7
5.2.3 XML conformance and validation 7
5.2.4 Character encodings 7
5.2.5 Byte order markers 8
5.2.6 Case sensitivity 8
5.3 XML declaration 8
5.3.1 General 8
5.3.2 XML `version` attribute 8
5.3.3 XML `character encoding` attribute 8
5.3.4 XML `standalone` attribute 8
5.4 Document `root` element 8
5.4.1 General 8
5.4.2 The `Version` attribute 9
5.4.3 The `XML:lang` attribute 9
5.4.4 The `UID` attribute 9
5.5 XML Parameter element formats 9
5.5.1 General 9
5.5.2 Numerical values 9
5.5.3 Arrays of values 10

Table 2 — Array type attribute values 10
5.5.4 Physical units 10
5.5.5 Alternative language attributes 11
5.5.6 Special characters 11
Table 3 — Non-permitted element or attribute characters 11
5.5.7 Ordering of elements 12
6 The <Header> list element 12
6.1 General 12
6.2 Header items are optional 12
6.3 The <Checksum> element 12
6.4 The <Title>, <Author> and <Owner> elements 13
6.5 The <Date>, <Time> and <Timezone> elements 13
6.6 The <ArbitraryData> element 13
6.7 Other optional header elements 14
7 The <Conditions> list element 15
7.1 General 15
7.2 Conditions are optional 15
7.3 Condition templates and classes 15
7.4 Condition identifiers 17
7.5 Typical conditions 17
8 The <Dataset> element 18
8.1 General 18
8.2 The <DataLength> and <DataOffset> elements 19
8.3 The <DatumType> element 19
Table 4 — <DatumType> elhement values 19
8.4 The <Dimensions> list element 20
8.4.1 General 20
8.4.2 Ordering of dimensions 20
8.4.3 Coordinate mapping equations 21
8.4.4 Identity and calibration of dimensions 22
8.5 The <IncludeConditions> list element 24
Annex A (normative) Condition templates and classes 25
A.1 General 25
A.2 <Instrument> 25
A.2.1 General 25
A.2.2 The <Manufacturer> and <Model> elements 25
A.2.3 The <SerialNumber> element 25
A.3 <Probe> 25
A.4 <Probe Class="EM"> 26
A.4.1 General 26
A.4.2 Required elements: 26
A.4.2.1 The <ProbeEnergy> element 26
A.4.3 Optional elements: 26

A.4.3.1 The <GunType> element 26
A.4.3.2 The <EmissionCurrent> element 26
A.4.3.3 The <FilamentCurrent> element 26
A.4.3.4 The <ExtractorBias> element 26
A.4.3.5 The <GunPressure> element 27
A.4.3.6 The <ProbeDiameter> element 27
A.4.3.7 The <ProbeCurrent> element 27
A.4.3.8 The <ProbeConvergenceAngle> element 27
A.4.3.9 The <Aperture> element(s) 27
A.4.3.10 The <Control> element(s) 27
A.4.3.11 The <LensCurrent> element(s) 27
A.5 <Probe Class="EM/SEM"> 28
A.5.1 General 28
A.5.2 Optional elements: 28
A.5.2.1 The <WorkingDistance> element 28
A.6 <Probe Class="EM/TEM"> 28
A.6.1 General 28
A.6.2 Optional elements: 28
A.6.2.1 The <ProbeMode> element 28
A.6.3 Example: 28
A.7 <Specimen> 29
A.7.1 General 29
A.7.2 The <Name> element 29
A.7.3 The <Description> element 29
A.7.4 The <Owner> element 29
A.7.5 The <Origin> element 29
A.7.6 The <Material> element 29
A.7.7 The <Coating> element 29
A.7.8 The <Thickness> element 30
A.7.9 Example: 30
A.8 <SpecimenEnvironment> 30
A.8.1 General 30
A.8.2 The <Pressure> element 30
A.8.3 The <Temperature> element 30
A.8.4 The <Medium> element 31

A.8.5 Example: 31
A.9 <MeasurementMode> 31
A.9.1 Optional elements: 31
A.9.1.1 The <Control> element(s) 31
A.10 <MeasurementMode Class="TEM"> 32
A.10.1 General 32
A.10.2 Optional elements: 32
A.10.2.1 The <Aperture> element(s) 32
A.10.2.2 The <LensCurrent> element(s) 32
A.11 <MeasurementMode Class="TEM/Imaging"> 32
A.11.1 General 32
A.11.2 Optional elements: 32
A.11.2.1 The <Defocus> element 32
A.11.2.2 The <AcceptanceAngle> element 33
A.11.2.3 The <NominalMagnification> element 33
A.11.3 Example: 33
A.12 <Detector> 33
A.12.1 General 33
A.12.2 Optional elements: 33
A.12.2.1 The <Manufacturer> and <Model> elements 33
A.12.2.2 The <SerialNumber> element 33
A.12.2.3 The <SignalType> element 34
A.12.2.4 The <MeasurementUnit> element 35
A.12.2.5 The <CollectionMode> element 35
A.12.2.6 The <Distance> element 35
A.12.2.7 The <Area> element 35
A.12.2.8 The <SolidAngle> element 35
A.12.2.9 The <SemiAngle> element 35
A.12.2.10 The <Temperature> element 36
A.12.2.11 The <Elevation> element 36
A.12.2.12 The <Azimuth> element 36
A.12.2.13 The <DetectorName> element 36
A.12.2.14 The <Aperture> element(s) 36
A.12.2.15 The <Control> element(s) 36
A.12.3 Example: 37

A.13 <Detector Class="Camera"> 37
A.13.1 General 37
A.13.2 Base template: 37
A.13.3 Optional elements: 37
A.13.3.1 The <FocalLength> element 37
A.13.3.2 The <ExposureTime> element 37
A.13.3.3 The <FrameIntegration> element 37
A.13.3.4 The <Magnification> element 37
A.13.3.5 The <NumericalAperture> element 38
A.13.3.6 The <PixelSize> element 38
A.13.4 Example: 38
A.14 <Detector Class="CL"> 38
A.14.1 General 38
A.14.2 Base templates: 38
A.14.3 Optional elements: 38
A.14.3.1 The <DispersionElement> element 38
A.14.3.2 The <Grating-d> element 39
A.14.3.3 The <EntranceSlit> element 39
A.14.4 Example: 39
A.15 <Detector Class="WDS"> 39
A.15.1 General 39
A.15.2 Base templates: 39
A.15.3 Optional elements: 39
A.15.3.1 The <DispersionElement> element 40
A.15.3.2 The <Crystal-2d> element 40
A.15.3.3 The <RowlandCircleDiameter> element 40
A.15.3.4 The <PulseHeightAnalyzer> elements 40
A.15.3.5 The <Counter> element 41
A.15.3.6 The <WDSPosition> element 41
A.15.4 Examples: 41
A.16 <Detector Class="XEDS"> 42
A.16.1 General 42
A.16.2 Base templates: 42
A.16.3 Optional elements: 42
A.16.3.1 The <Technology> element 42

A.16.3.2 The <NominalThroughput> element 42
A.16.3.3 The <TimeConstant> element 43
A.16.3.4 The <StrobeRate> element 43
A.16.3.5 The <Window> element 43
A.16.3.6 The <GoldLayer> element 43
A.16.3.7 The <DeadLayer> element 44
A.16.3.8 The <ActiveLayer> element 44
A.16.4 Examples: 44
A.17 <Acquisition> 45
A.17.1 General 45
A.17.2 The <DateTime> element 45
A.17.3 The <SpecimenPosition> element 45
A.17.4 Position elements: 45
A.17.4.1 The <X>, <Y> and <Z> elements 45
A.17.4.2 The <EulerRotation> element 46
A.17.4.3 The <R> element 46
A.17.4.4 The <TotalTime> element 46
A.17.4.5 The <FrameCount> element 46
A.17.4.6 The <FrameTime> element 46
A.17.4.7 The <DwellTime> element 47
A.17.4.8 The <DwellTime_Live> element 47
A.18 <Sequence> 47
A.18.1 General 47
A.18.2 The <Control> element 47
A.18.3 Example: 48
A.19 <Calibration> 48
A.19.1 General 48
A.19.2 The <Quantity> element 48
A.19.3 The <Unit> element 49
A.19.4 <Calibration Class="Constant"> 49
A.19.4.1 General 49
A.19.4.2 The <Value> element 49
A.19.4.3 Example: 49
A.19.5 <Calibration Class="LinearDispersion"> 49
A.19.5.1 General 49

A.19.5.2 The <Gradient> element 49
A.19.5.3 The <Intercept> element 50
A.19.6 <Calibration Class="PolynomialDispersion"> 50
A.19.6.1 General 50
A.19.6.2 The <Coefficients> element 50
A.19.7 <Calibration Class="Explicit"> 50
A.19.7.1 General 50
A.19.7.2 The <Values> element 50
A.19.8 <Calibration Class="Intensity"> 51
A.19.8.1 General 51
A.19.8.2 The <Quantity> element 51
A.19.8.3 The <Unit> element 51
A.19.8.4 Example: 51
Annex B (normative) Units and prefixes 52
B.1 General 52
B.2 SI units 52
Table 5 — SI Units 52
B.3 SI-derived units 52
Table 6 — SI derived units 52
B.4 Non-SI units 53
Table 7 — Non-SI units 53
B.5 SI prefixes 54
Table 8 — SI magnitude prefixes 54
Annex C (normative) Unicode character substitutions 55
Annex D (informative) Example files 56
D.1 Optical micrograph 56
D.2 Single XEDS spectrum 57
D.3 SEM backscattered electron image 58
D.4 Conventional TEM image 60
D.5 Conventional electron diffraction pattern 62
D.6 SEM-XEDS hyper-spectral map 64
D.7 EPMA+XEDS+CL+BSE map 66
Annex E (Informative) Common dataset dimensions 70
E.1 General 70
E.2 <X>, <Y> and <Z> 70

E.3 <U> and <V> 70
E.4 <Position> 71
E.5 <Channel> 71
E.6 <Color> 71
E.7 <Rotation> and <Tilt> 72
E.8 <Focus> 72
E.9 <Measurement> 73