

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