



**International**

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

**ISO 5820**

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

**First edition  
2024-02**



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

## Contents

Foreword.....	xi
Introduction .....	xii
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references .....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Overview.....</b>	<b>1</b>
<b>4.1 Design Considerations .....</b>	<b>1</b>
<b>4.2 Binary and XML file pair.....</b>	<b>2</b>
<b>4.2.1 General.....</b>	<b>2</b>
<b>4.2.2 HMSA general structure .....</b>	<b>2</b>
<b>4.2.3 XML general structure .....</b>	<b>3</b>
<b>4.2.4 HMSA-XML association .....</b>	<b>3</b>
<b>4.3 Hyper-dimensional data.....</b>	<b>3</b>
<b>Table 1 — Dimensionality of common data types .....</b>	<b>3</b>
<b>4.4 Unicode and internationalization.....</b>	<b>4</b>
<b>4.5 Minimalism .....</b>	<b>4</b>
<b>4.6 Extensibility.....</b>	<b>4</b>
<b>4.7 What HMSA does not do.....</b>	<b>5</b>
<b>5 XML File Specification .....</b>	<b>6</b>
<b>5.1 XML general structure .....</b>	<b>6</b>
<b>5.2 XML specification .....</b>	<b>7</b>
<b>5.2.1 General.....</b>	<b>7</b>
<b>5.2.2 XML features not supported.....</b>	<b>7</b>
<b>5.2.3 XML conformance and validation .....</b>	<b>7</b>
<b>5.2.4 Character encodings.....</b>	<b>7</b>
<b>5.2.5 Byte order markers .....</b>	<b>8</b>
<b>5.2.6 Case sensitivity .....</b>	<b>8</b>
<b>5.3 XML declaration.....</b>	<b>8</b>
<b>5.3.1 General.....</b>	<b>8</b>
<b>5.3.2 XML version attribute .....</b>	<b>8</b>
<b>5.3.3 XML character encoding attribute.....</b>	<b>8</b>
<b>5.3.4 XML standalone attribute.....</b>	<b>8</b>
<b>5.4 Document root element.....</b>	<b>8</b>
<b>5.4.1 General.....</b>	<b>8</b>
<b>5.4.2 The version attribute .....</b>	<b>9</b>
<b>5.4.3 The XML:lang attribute.....</b>	<b>9</b>
<b>5.4.4 The UID attribute .....</b>	<b>9</b>
<b>5.5 XML Parameter element formats.....</b>	<b>9</b>
<b>5.5.1 General.....</b>	<b>9</b>
<b>5.5.2 Numerical values .....</b>	<b>9</b>
<b>5.5.3 Arrays of values .....</b>	<b>10</b>

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

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> element 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

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

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

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

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

This is a preview of ISO 5820:2024. Click [here](#) to purchase the full version from the ANSI store.

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

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

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

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

A.19.5.2	The <Slope> 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

This is a preview of ISO 5820:2024. [Click here to purchase the full version from the ANSI store.](#)

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

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).