

- Perfect combination of wavelength dispersive and energy dispersive
- Performance rivals high power scan wavelength dispersive



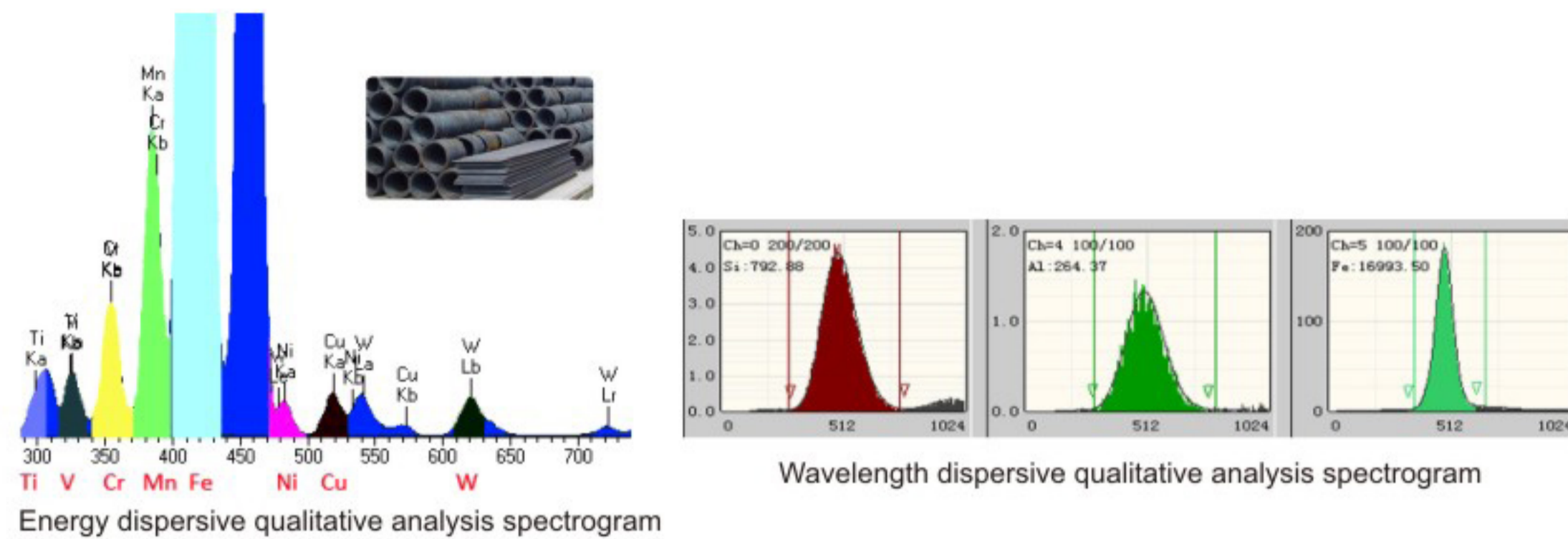
Skyray Skyray Instrument

Skyray Instrument Inc.
50 Braintree Hill Park, Suite 201,
Braintree, MA USA 02184
Tel: 617.202.3879 Fax: 781.519.4766
Website: www.skyrayinstrument.com

WDX400E
New generation of
X-ray Fluorescence Spectrometer

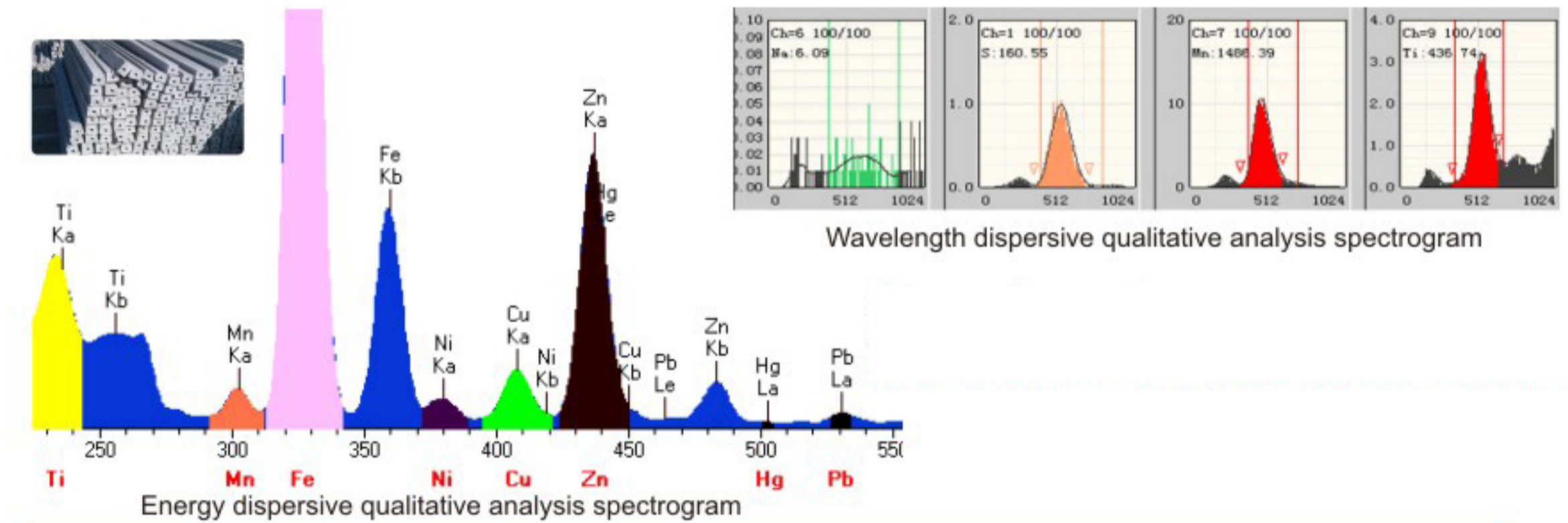
Rapid and qualitative analysis of various samples

Rapid and qualitative analysis spectrogram of steel (testing time is not more than 10S)



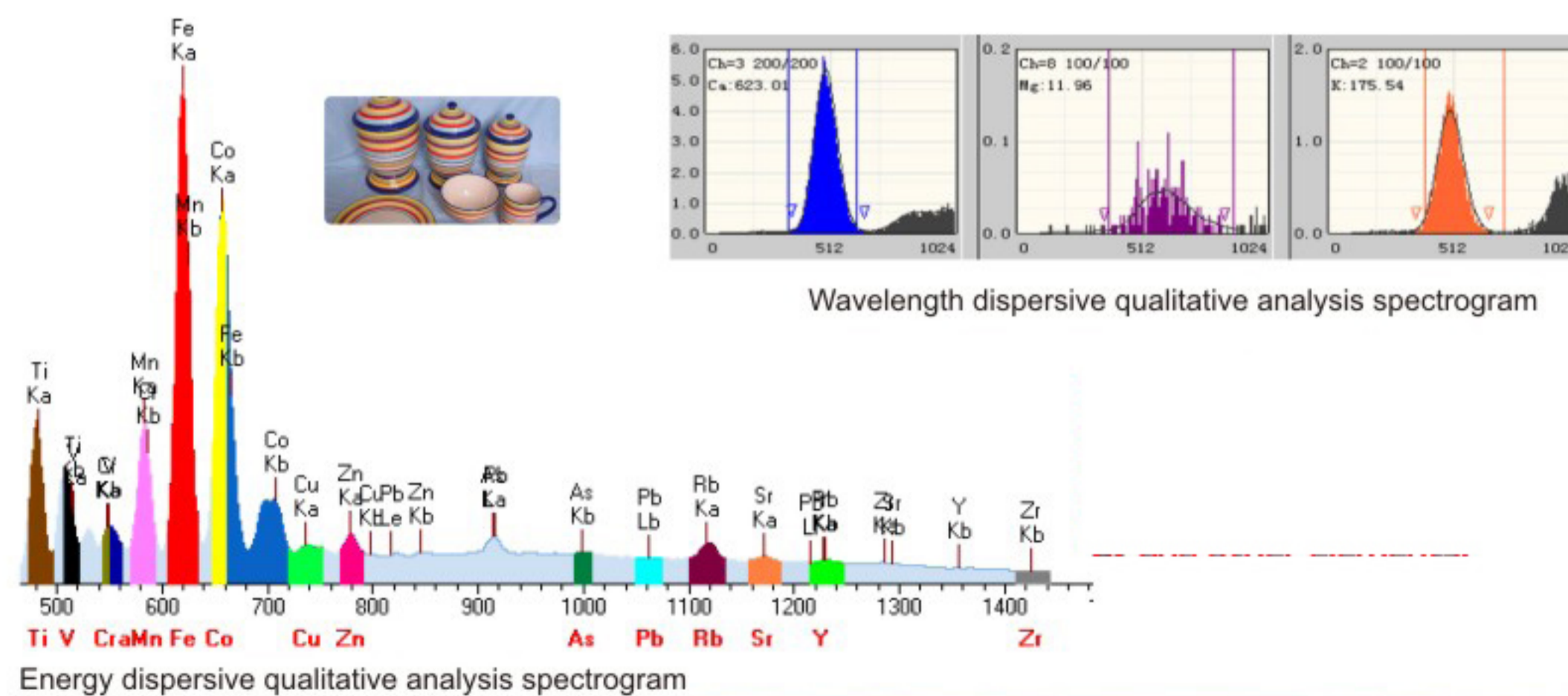
Comparison testing result of medium and low alloy steel sample											
Element	Al	Si	S	Ti	V	Cr	Mn	Ni	Cu	W	Fe
Real value (%)	0.43	1.76	0.038	0.53	0.47	0.6	2.13	0.56	0.53	0.87	Remains
Testing data of fixed channel wavelength dispersive			Testing data of energy dispersive								
WDX400E Wavelength Dispersive + Energy Dispersive	0.41	1.69	0.042	0.52	0.53	0.66	2.05	0.50	0.57	0.83	/
Higher power scan instrument	0.44	1.70	0.035	0.48	0.49	0.61	2.20	0.59	0.49	0.91	/

Rapid and qualitative analysis spectrogram of cement raw meal (testing time is not more than 18S)



Comparison result of environmental cement sample testing							
Element	Na(%)	Mg(%)	Al(%)	Si(%)	K(%)	Ca(%)	
Real value (%)	0.48	3.43	4.35	13.41	0.68	42.36	
Testing data of fixed channel wavelength dispersive							
WDX400E Wavelength Dispersive + Energy Dispersive	0.44	3.21	4.13	13.30	0.61	42.43	
Higher power scan instrument	0.51	3.34	4.56	13.36	0.73	42.20	
Element	Ti(%)	Fe(%)	Pb(ppm)	Cd(ppm)	Zn(ppm)	Cu(ppm)	Ni(ppm)
Real value (%)	0.24	1.37	1402	159	5380	2341	2193
Testing data of energy dispersive							
WDX400E Wavelength Dispersive + Energy Dispersive	0.24	1.41	1382	167	5289	2378	2231
Higher power scan instrument	0.22	1.44	1436	149	5258	2297	2148

Rapid and qualitative analysis spectrogram of ceramics (testing time is not more than 15S)



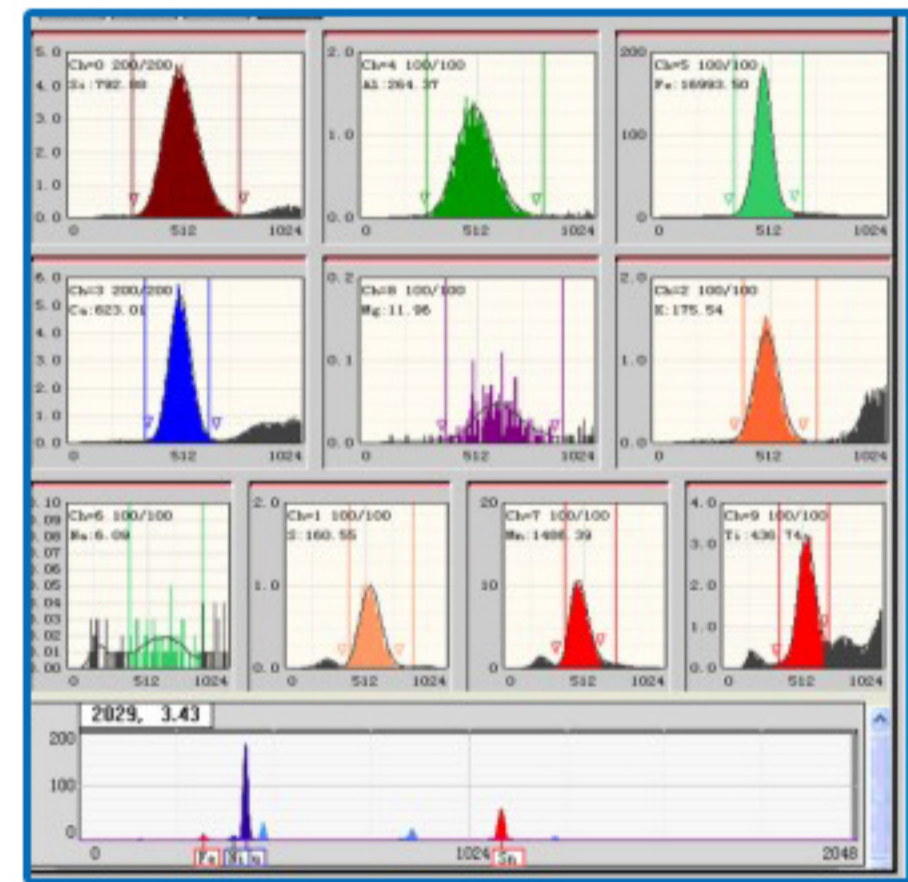
Comparison result of ancient ceramics sample testing											
Element	Na	Mg	Al	Si	P	K	Ca	Ti	Ba	Mn	Fe
Real value (%)	0.7727	1.6031	12.7221	63.3547	0.0071	4.7128	7.2536	0.3709	0	1.4043	7.4935
Testing data of fixed channel wavelength dispersive						Testing data of energy dispersive					
WDX400E Wavelength Dispersive + Energy Dispersive	0.771	1.593	12.69	63.26	0.007	4.65	7.31	0.37	0	1.46	7.44
Higher power scan instrument	0.768	1.623	12.76	63.41	0.0073	4.678	7.213	0.364	≤0.001	1.446	7.531
Element	Co	Cu	Zn	As	Pb	Rb	Sr	Zr			
Real value (%)	0	0.0882	0.0448	0	0	0.0133	0.014	0.052			
Testing data of energy dispersive											
WDX400E Wavelength Dispersive + Energy Dispersive	0	0.085	0.049	0	0	0.012	0.015	0.049			
Higher power scan instrument	≤0.001	0.0910	0.051	≤0.001	≤0.001	0.013	0.014	0.057			

Simultaneous analysis for full element with low X-ray tube power

With 400W X-ray tube power, WDX400E gives the high power scan channel requiring more than 3000W X-ray tube power a solution. **Qualitative analysis:** 1. It usually takes more than 10 minutes to have qualitative analysis when scan channel qualitative analysis needs changing θ angle and 2θ angle of crystal and incidence continuously to analyze elements in samples one by one. 2. Energy dispersive qualitative analysis chamber adopts full-spectrum direct reading, which usually takes seconds to produce qualitative result. **Quantitative analysis:** 1. Because scan channel analyzes elements one by one, in order to reduce testing time, high power X-ray tube is used to improve excitation rate and ensure testing accuracy. Some samples need 30-40 minutes. WDX400E analyzes all elements simultaneously in enough testing time, so it uses small power X-ray tube.

Simultaneously having quantitative analysis for several kinds of elements solves the problems that fixed channel equipment tests a few elements.

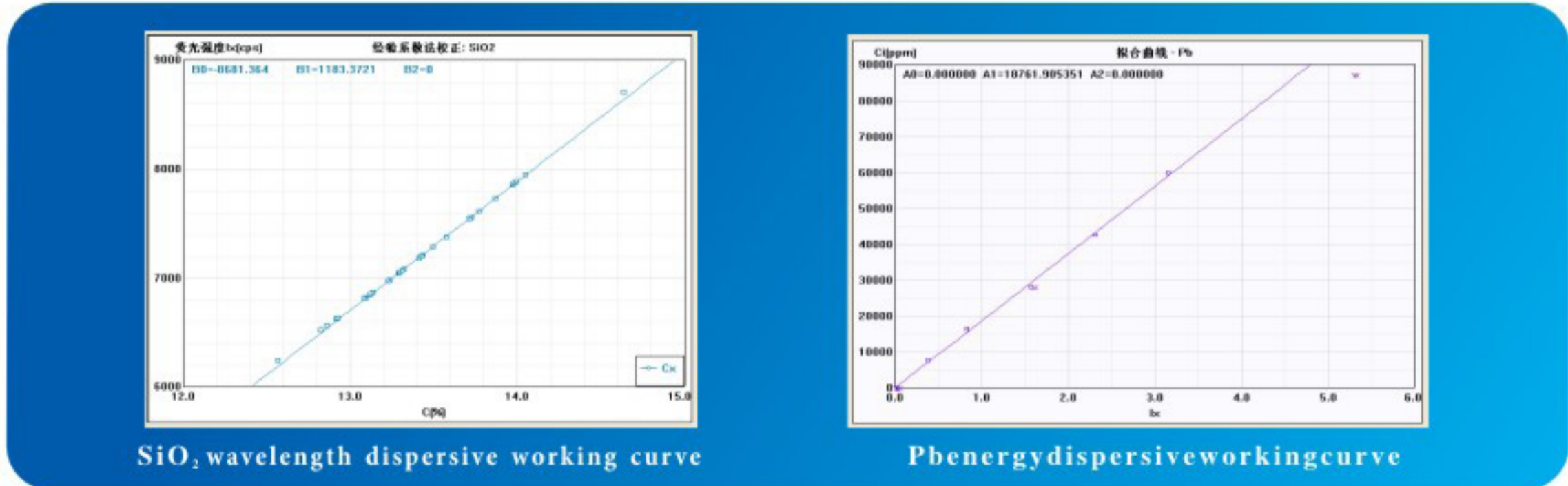
Energy dispersive detector can analyze several kinds of elements one time, and with wavelength dispersive fixed channel it can test more elements. The testing efficiency and ability are more than those of high power scan wavelength dispersive equipment. It is more convenient to operate.



Adopting respective advantage of wavelength and energy dispersive gives separate testing for light and heavy elements, thus it improves testing accuracy and efficiency.

A. Main advantage of energy dispersive: 1. Full-spectrum direct reading, fast qualitative and quantitative speed. 2. SDD detector has high efficiency and resolution. 3. Simultaneously test dozens of elements. 4. High sensitivity of medium and heavy elements. **B. Main advantage of wavelength dispersive:** 1. Light-splitting theory; higher resolution of elements, especially light elements; avoid interruption of high-order line. 2. Because fluorescence yields less, testing efficiency of light elements can be increased by increasing power, changing optical path structure. 3. Because of more advantages in light elements, WDX400E adopts wavelength dispersive in light elements, and energy dispersive in heavy elements.

Testing examples



**Repeated testing results of GBW07249 polymetallic nodule minerals.
(21 testing results in succession)**

Constituent	Na ₂ O	Al ₂ O ₃	MgO	SiO ₂	P ₂ O ₅	S	Cl	K ₂ O	As	CaO	Co	Cu	Fe(T)	Mn(T)	Mo	Ni	Pb	TiO ₂	V	Zn
Standard value	2.12	3.53	2.00	13.3	0.73	0.18	0.85	0.68	179	2.81	0.35	0.28	18.71	33.63	371	0.36	948	1.71	588	563
Unit	%	%	%	%	%	%	%	%	ppm	%	%	%	%	%	ppm	%	ppm	%	ppm	ppm
	Testing data of fixed channel wavelength dispersive										Testing data of energy dispersive									
Average value	2.11	3.51	2.02	13.30	0.70	0.19	0.86	0.68	176.58	2.82	0.36	0.27	18.73	33.63	369.83	0.36	946.83	1.74	586.83	562.17
max	2.15	3.55	2.05	13.35	0.73	0.21	0.89	0.71	182	2.89	0.39	0.31	18.78	33.68	376	0.49	956	1.77	595	568
min	2.07	3.47	1.96	13.26	0.67	0.17	0.83	0.66	171	2.76	0.32	0.24	18.69	33.56	363	0.32	942	1.68	580	556
SD	0.026	0.025	0.027	0.028	0.019	0.013	0.021	0.015	3.343	0.033	0.023	0.022	0.025	0.035	4.196	0.025	4.448	0.027	5.408	3.614

Unique energy dispersive secondary collimator design greatly lowers testing background of energy dispersive, and improves sample detection limit and testing accuracy.

400W cannot be used in ordinary energy dispersive equipment, however, through unique secondary collimator design, dispersive background can be reduced, testing signal-to-noise ratio can be greatly improved and testing performance can be greatly improved; meanwhile the testing efficiency can be highly ensured.

Technical specification comparison between Wavelength dispersive+ energy dispersive and scan X-ray fluorescence spectrometer			
Item	WDX400E	Scan X-ray fluorescence spectrometer	Remark
Detector	Wavelength dispersive: Adopts gas flow counter and sealed counter Energy dispersive: Adopts international advanced SDD silicon drift semi-conductor cooling detector made in USA; SNE (signal to noise enhancer) developed by Skyray is attached.	Adopts serial system of gas flow counter and scintillation counter.	
Amplifier circuit	Integrated design of amplifier and detector; improve testing efficiency and enhance anti-interference ability of the instrument.	Integrated design of amplifier and detector	
X-ray fluorescence tube anode	Rh anode (X-ray tubes of different anodes can be replaced according to testing requirement).	Different anodes of different equipments.	
X-ray tube structure	Small power end window diffraction anode; ceramic insulation; thickness of beryllium window :75um	End window diffraction anode; ceramic insulation; thickness of beryllium window: 75um (different design of different suppliers)	
X-ray tube power	400W	More than 3000W	
X-ray tube cooling method	Cooling; small size, cycle (small volume; in-built, do not need to set outside)	Cooling of large power cycle (cooling device is outside set and need extra purchase)	
X-ray tube high voltage power	Tube voltage(Max): 50Kv; tube current(Max): 8mA	Tube voltage(Max): ≥50Kv; tube current(Max): ≥60mA(different configurations of different suppliers)	
X-ray irradiation method	Down-lightening method(Vertical lightening)	Down lightening and top lightening(fixed angle lightening; different design of different suppliers)	
Auto spin device of sample	Yes	Yes	
Control method of the instrument	Independent and auto control of lower computer; data communication of upper computer(more stable instrument control, data transfer and processing)	Most use single chip machine control; some manufacturers use lower computer control.	
Spectrum gathering method	9 kinds of light elements fixed channel spectrum testing + energy dispersive direct gathering method; and multi-channel MCA technology is used to test real-time demonstration of spectrum	Single scan or scan+ a few fixed channel light elements spectrum peak gathering method	
Dispersive crystal	Different plane crystals are used in spectrum, including man-made multi-layers film, PET, Ge crystal, InSb, LiF crystal to test 9 kinds of elements testing; every element needs one pc testing crystal.	Usually more than 5 kinds of crystal auto switch are adopted to meet the requirement of testing dozens of elements.	
Resolution of energy dispersive detector	Resolution reaches 139±5eV(Obtained by using Fe55 when counting rate is 1000/S)	No	
Analysis range	Na-U	B-U	
Ability to analysis	Simultaneous analysis of dozens of elements	Analyze dozens of elements	
Sample type	Solid, powder, liquid; no requirement of shapes	Solid, powder and liquid can be tested; and no requirement of shapes.	
Testing method	Simultaneous analysis of dozens of elements; every element can gather enough data according to setting time.(Therefore, if testing the same sample, the required X-ray tube power is much less than scan wavelength dispersive X-ray fluorescence analyzer)	Test dozens of elements one by one; usually every element needs seconds; X-ray tube (usually more than 3000W) asks high power to meet the requirement of testing accuracy.	
Goniometer system	No goniometer, therefore no mechanical moving error	Goniometer is needed for precise match of θ angle of incidence X-ray fluorescence and 2θ of exit X-ray. Therefore, the scan X-ray fluorescence will cause machinery moving error	
Testing time	Setting according to customers' requirement, generally 60-300S.	Testing time for every element can be set individually; because of qualitative analysis in order, less testing time is asked for reducing the whole process testing time.	
Testing accuracy	Testing accuracy is better than scan equipment, because simultaneous testing of fixed channel and energy dispersive ensure there is enough testing time; in addition, there is no goniometer system.	Only X-ray tube of high power can be used to improve testing accuracy.	
Qualitative analysis ability	It usually takes seconds to give samples full spectrum qualitative analysis by simultaneous qualification of dozens of elements and combining powerful qualitative analysis function of software.	Qualitative analysis of sample elements on by one; it usually takes over 600S for dozens of elements.	
X-ray tube working range	High voltage:20-50Kv; current reaches 8mA at most.(Set by software according to customers' requirement)	High voltage: 20-60Kv; current range is different according to suppliers.	
Analysis software	Perfect combination of wavelength dispersive and energy dispersive software; independent working; instruments and various testing parameters can be flexibly used for various samples analyzing. Chinese and English software are open to you.	Wavelength dispersive analysis software; some manufacturers set the interface in English, so it is not convenient.	
Application field	Metallurgy, minerals, construction material, oil and chemistry, environmental protection testing and first-time analysis in other industries. Meanwhile, it can be used in many research and testing institutes.	For research and testing institutes	

Assistant equipments	Cooling device	In-built oil cycle cooling device; additional purchase is not needed.	Cooling water device with large power is needed; additional purchase is needed.	Necessary devices
	Gas flow	P10 gas of high purity	P10 gas of high purity	Necessary devices
	Tablet Press	Special tablet press of X-ray fluorescence	Special tablet press of X-ray fluorescence	Necessary devices
	Vibromill	Special vibromill of X-ray fluorescence	Special vibromill of X-ray fluorescence	Necessary devices
	Fusing machine	Special fusing machine of X-ray fluorescence (temperature is over 1250 ℃)	Special fusing machine of X-ray fluorescence(temperature is over 1250 ℃)	Necessary devices
Requirement for installation environment	Requirement for installation place	Require stable power voltage, and avoid interference of strong electro-magnetic wave; stable and firm platform with movable and fix device; fewer requirements for ambient environment.	Stable power voltage to avoid strong electro-magnetic; Stable and secured platform.	
	Earthing requirement	Floating design, no wire requirement	Excellent wire, otherwise the instrument will work out of order.	
	Ambient temperature	25-30 ℃(air-conditioner configuration)	25-30 ℃(air-conditioner configuration)	
	Ambient humidity	≤ 70%	≤ 70%	
	Power voltage	220±5V(for factory and lab)	Tri-phase; 380V	
Comprehensive evaluation	Total power of the instrument	Not more than 2000W(include computer, printer, vacuum pump etc)	Not less than 6000W(include computer, printer, cooling-water machine, vacuum pump etc)	
	Requirement for staff	Professional design and require less to a staff	Require much to a staff	
	Performance/cost ratio	High performance/cost ratio	Low performance/cost ratio	
	Market price	Less than 1million RMB	More than 1.5 million RMB	Without assistant devices
	After sale service	It is researched, developed and sold by Skyray; be conformed to the requirement of domestic customers.	Imported from foreign country; high maintenance, service cost, but service quality is not good as WDX400E.	

Technical Specifications

- High voltage 400W (50KV8mA) .
- X-ray tube: 400W thin Be end window X-ray tube made by Varian company, Rh anode (Pd anode optional)
- Tube voltage and tube current stability in 12 hours: more than
- Measurable elements: 10 arbitrary elements from Na to U.
- Detector: gas flow proportional detector + sealed proportional detector; 10 paths 1024 channels independent pulse height analyzer
- Vacuum system: independent pumping station for easy maintenance with highest vacuum lower than 8 Pa
- Gas flow system: high-accuracy gas density stabilizer with pressure stability up to ±0.003 KPa.
- Pre-amplifier: Pre-amplifier of fast speed improves testing efficiency and testing accuracy of the instrument.
- MCA: Digital MCA multi-channel amplitude collector improves testing efficiency greatly.
- AC 220V power supply: 2KVA AC purified stabilized voltage power supply
- Analysis accuracy: η -1 (24 hours, percentage content) $\leq 0.05\%$.
- Testing time of unit sample:(include time of sample replacing and vacuuming), not more than 3-5 minutes.
- Temperature control precision in constant temperature chamber: setting value $\pm 0.1^\circ\text{C}$.

Functions

- Rapid and non-destructive analysis of powder sample and lump sample
- Fast analyzer of compacted powder, fused beads and lump material
- Multi-channel digital MCA has greatly improved the measurement efficiency, which benefits not only the instrument debugging and failure diagnosis but also enhances the measurement accuracy and stability.

Compared with sequential instruments with higher power, WDX 400 has the advantages as below:

- reaching adequate measurement accuracy with smaller power and equivalent measurement time;
- prolonged service life of X-ray;
- fewer failures in high voltage supply,
- lower maintenance costs of the overall instrument,
- no wearing problem of goniometer as fixed channels adopted.
- performance of energy dispersive device is up to the level of high power scan instrument.