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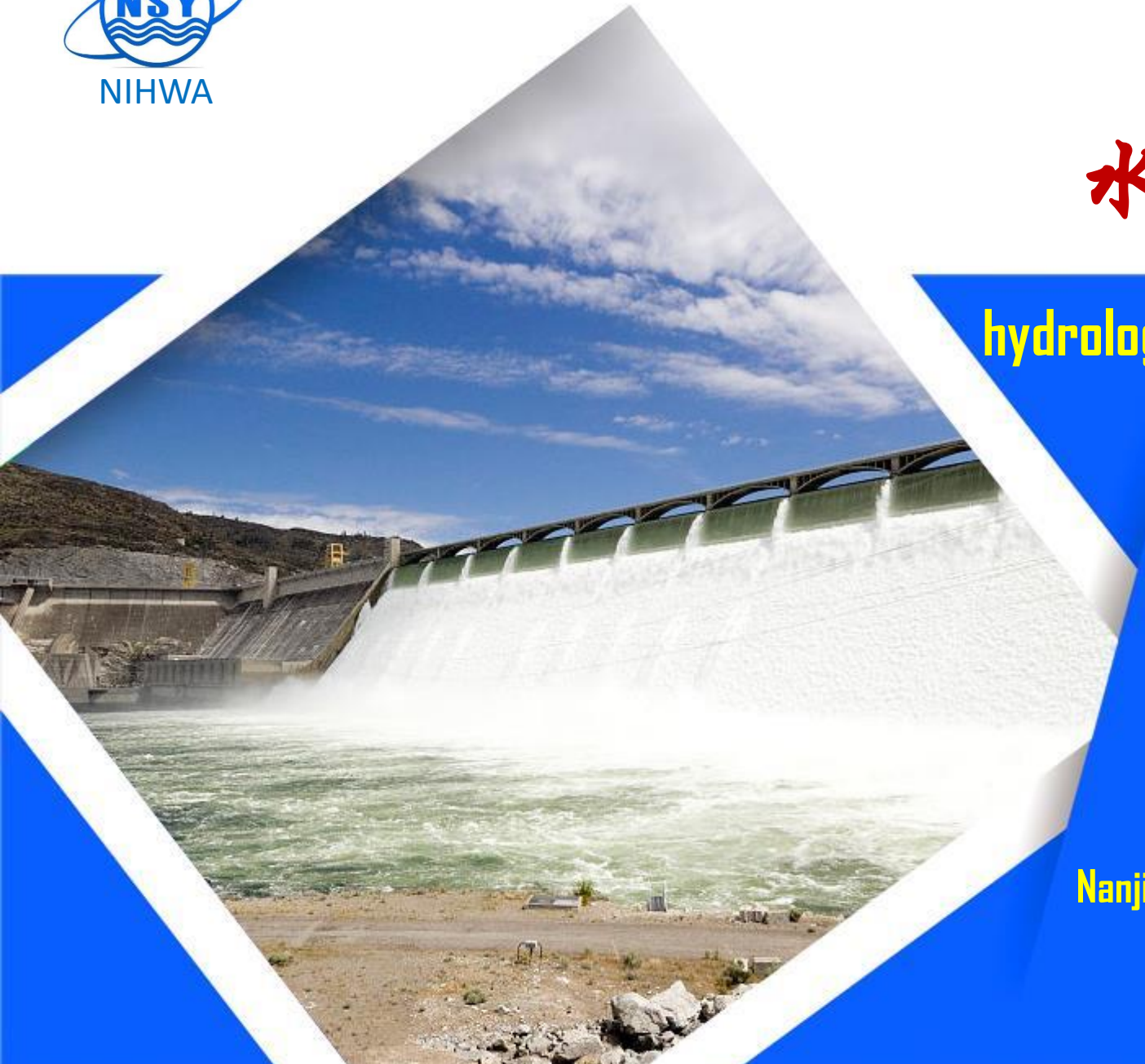

水文监测技术及装备

hydrological monitoring technology and instruments

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水文监测技术及装备

hydrological monitoring technology and instruments

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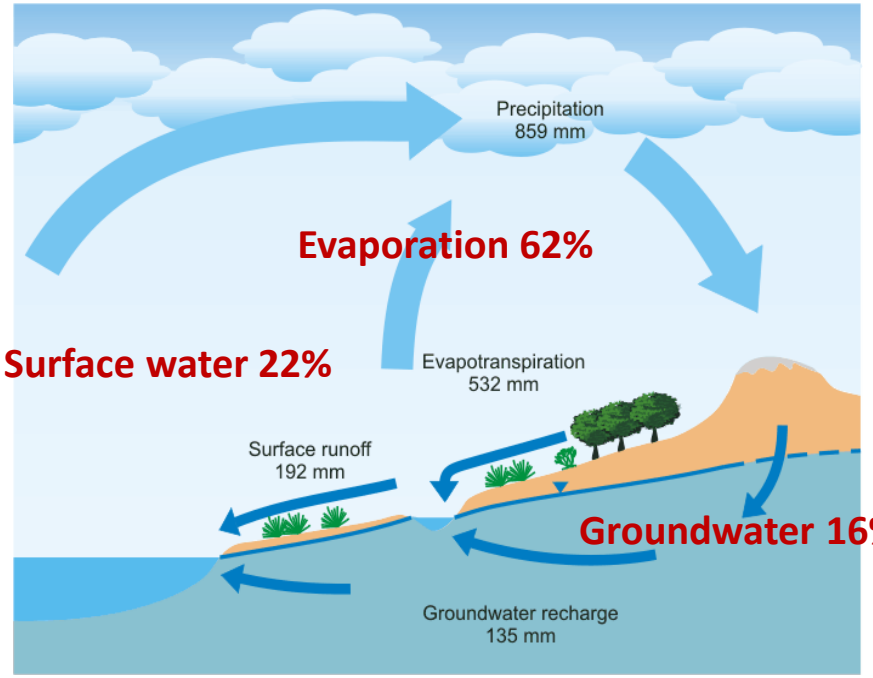
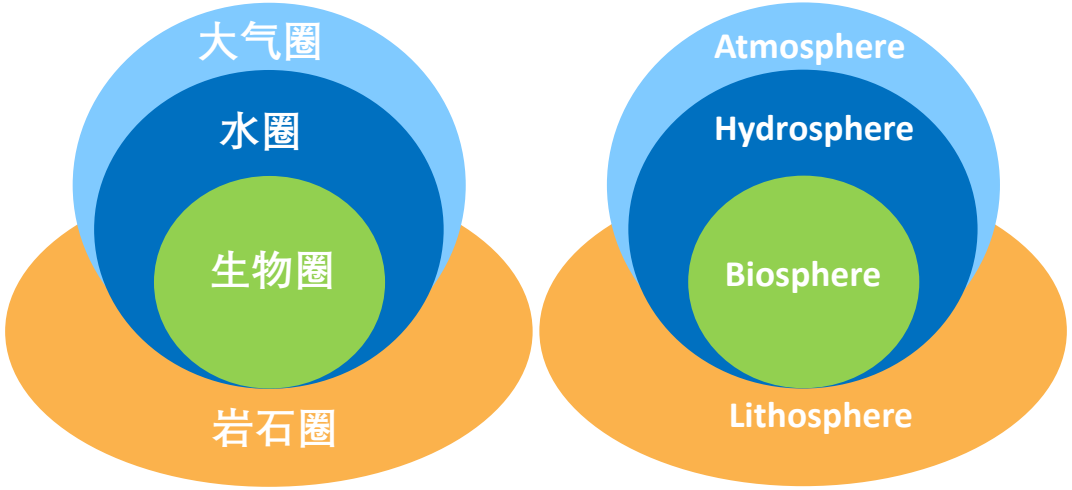
1 前言 Foreword

1.1 水文 Hydrology

水文指的是自然界中水的变化、运动等的各种现象。现在一般指研究自然界水的时空分布、变化规律的一门学科。"文"作自然界的现象讲，如"天文"。

Hydrology refers to changes, movements and other phenomena of water in the nature. Now it generally refers to a discipline studying the spatial and temporal distribution of water in the nature.





1.2 新中国水文监测

Hydrological monitoring after the founding of the PRC


The Three Gorges

经过70多年努力，中国通过持续的水文测站的建设改造、完善升级，目前已初步建成空间分布基本合理、监测项目比较齐全的水文站网监测体系。水文监测也处于由传统方式向现代化方式转变的阶段，初步形成驻测、巡测、水文调查、应急监测相结合的水文监测体系，水文监测现代化水平稳步提升(几十万个各类站点，雨量最多）。

After more than 70 years of hard work for continuous construction, renovation, improvement and upgrading of hydrometric stations, China now has preliminarily established a hydrological station network monitoring system with roughly reasonable spatial distribution and relatively complete monitoring items. Hydrological monitoring is also in a stage of transitioning from traditional methods to modern methods, and a hydrological monitoring system that combines stationed surveys, tour gauging, hydrological surveys, and emergency monitoring has taken shape, and the level of modernization of hydrological monitoring has been improved steadily.

中国水利 CHINA WATER

中国水文 CHINA HYDROLOGY

1.3 水文监测内容 Content of hydrological monitoring

对江河、湖泊、渠道、水库的水位、流量、水质、水温、泥沙、冰情、水下地形和地下水资源，以及降水量、蒸发量、墒情等实施观测，并进行分析和计算

Observe rivers, lakes, channels, reservoirs, water level, flow, water quality, water temperature, sediment, ice regime, underwater topography and groundwater resources, as well as precipitation, evaporation, and soil moisture content, and conduct analysis and calculations

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水文监测技术及装备

hydrological monitoring technology and instruments

NIHWA

2.1 水文监测传感器 Hydrological monitoring sensor

多年来水文传感器技术没有令人振奋的成就，特别是声、光、电、雷达、卫星遥感等先进技术在水文监测中的应用日趋落后，对今后的进一步发展必将会有制约作用。

For many years, no exciting achievements in hydrological sensor technology have been made. Especially, the applications of advanced technologies such as sound, light, electricity, radar and satellite remote sensing in hydrological monitoring are getting more backward, which will certainly hold back the further development in the future.

序号	水文参数	传感器采用情况	Adoption of domestic sensors
1	水位 Water level	浮子式为主，雷达及超声波、磁致伸缩微浮子遥测水位计为辅，图像法监测水位技术目前日趋成熟。	Float-type is dominant, supplemented by radar, ultrasonic and magnetostrictive micro-float telemetering water level gauges, and the water level monitoring technology by the image method is getting more mature.
2	水深 Water depth	大量采用超声波测深仪	Ultrasonic sounders are widely used
3	流速 Flow rate	流速大量采用旋桨及旋杯式流速仪，流速流向一般采用电磁式流向仪、ADV等	Flow rate is widely measured by propeller-type current meter and cup-type current, and the flow rate and flow direction are generally measured by electromagnetic flow direction meter, ADV, etc.
4	流量 Flow	大量采用水工建筑物法和流速—面积法进行流量测验，仍采用传统的流速仪法；声学时差法测流系统、岸基雷达测流系统的、图像法测流等逐渐推广	The hydraulic structure method and flow rate-area method are widely used for flow testing, and the traditional current meter method is still used; the acoustic time difference method flow measurement system, shore-based radar flow measurement system, and image method flow measurement are gradually popularized.
5	降雨 Rainfall	大量采用翻斗式雨量计	Tilting rain gauges are widely used

2.1 水文监测传感器（续）Hydrological monitoring sensor（continued)

序号	水文传感器	传感器采用情况	Adoption of domestic sensors
6	蒸发 Evaporation	推广应用遥测蒸发器，基本可实现雨间蒸发连续观测问题	Promote the application of telemetering evaporators, which can basically solve the problem of continuous observation of evaporation between rains
7	土壤水分 Soil moisture	采用国产或进口组装FDR传感器，国产TDR已逐渐推广使用	Domestic or import assembled FDR sensors are used. The use of domestic TDR has been gradually popularized.
8	水质 Water quality	电极法及光学法已普遍应用在环保部门，水源地及水功能区采用的化学法部分传感器如COD-Mn、氨氮等实现国产化	The electrode method and optical method have been universally used in the environmental protection sector. Some of the sensors adopting the chemical method such as COD-Mn and NH3-N, which are used in water sources and water functional areas, have been localized.
9	风速风向 Wind speed and direction	大量采用风杯风速计、风向标传感器，并逐渐推广使用超声风速风向传感器及集成多参数一体化传感器	Cup anemometers and wind vane sensors are widely used, and ultrasonic wind speed and direction sensors and integrated multi-parameter sensors are gradually popularized
10	气压 Air pressure	少量采用振动筒压力传感器，大量采用硅电容压力传感器	Vibration cylinder pressure sensors are used in a small number, while silicon capacitive pressure sensors are widely used
11	水温Water temperature	数字式半导体温度计	Digital semiconductor thermometers

2 水文监测技术及装备 hydrological monitoring technology and instruments

2.2 降水监测 Precipitation monitoring

遥测雨量计

翻斗式雨量计　Tilting rain gauge

翻斗式雨（雪）量计 Tilting rain (snow) gauge

称重式雨（雪）量计 Weighing rain (snow) gauge

便携式光电雨量计Portable photoelectric rain gauge

粒谱仪（光学雨雪量计）Particle spectrometer (optical rain/ snow gauge)

雷达面雨量测量系统Radar surface rainfall measurement system

声波雨量计Acoustic rain gauge

轮盘式翻斗雨量计Wheel-type tilting rain gauge

移动雨量计校准　Mobile rain gauge calibrat

不同原理降水监测设备

《降水量观测仪器》(GB/T 21978)；

含：1.翻斗式雨量传感器 Tilting rainfall sensor

2.虹吸式雨量计 Siphon rain gauge

3.融雪型雨雪量计Snowmelt type rain and snow gauge

4.称重式雨量计 Weighing rain gauge

5.雨量显示记录仪 Rainfall display recorder

2.2 降水监测 Precipitation monitoring

1、称重时雨雪量计研制： Development of weighing rain (snow) gauge

解决：地面震动影响、沙尘影响、风的影响、数据漂移（自校正），实时消除温度漂移和压力信号漂移等。

Solution: impact of ground vibration, sand dust, wind, data drift (self correction), real-time elimination of temperature drift and pressure signal drift.

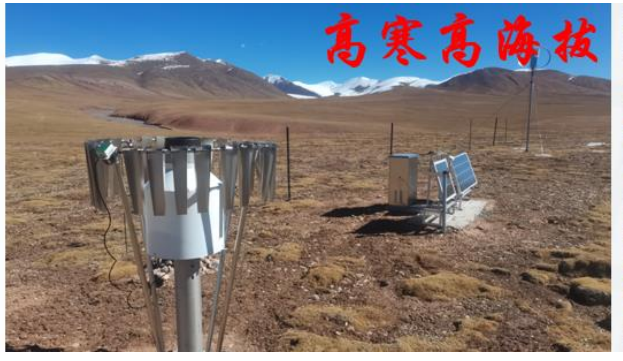
2、高精度雨量计改进：研制融雪的虹吸式高精度翻斗雨量计

Improvement of High Precision Rain Gauge

Development of siphon type high precision tipping bucket rain gauge for snow melting

翻斗式雨量传感器与虹吸装置组合；虹吸装置稳定自然雨强为“固定”雨强，减小翻斗式雨量计的计量误差；新型虹吸翻斗式雨量计在7mm/min 雨强下，其计量误差稳定在±2%以内

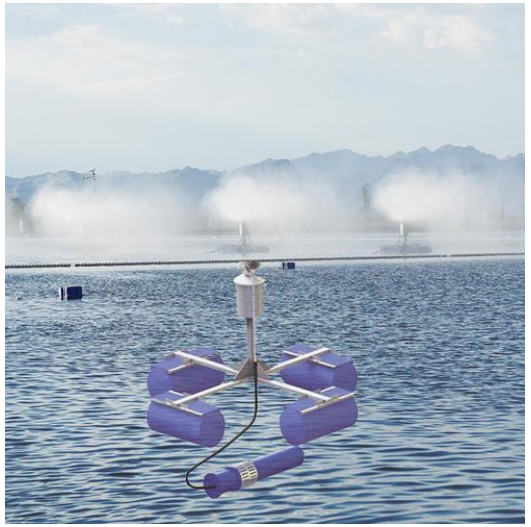
3、一体化雨雪量计研发



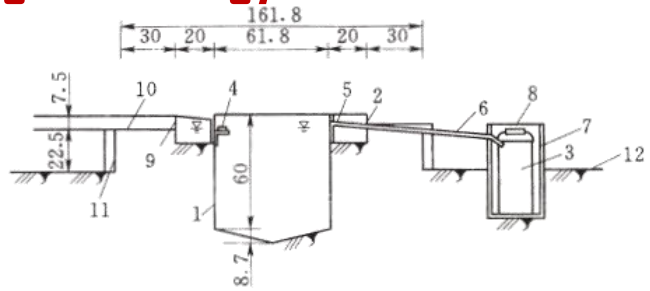
2.3 水面蒸发 water surface evaporation

- E601B 标准水面蒸发器 E601B standard water surface evaporator
- 口径20cm蒸发皿Ø20cm evaporating dish
- 使用水上漂浮蒸发器Evaporator floating on water

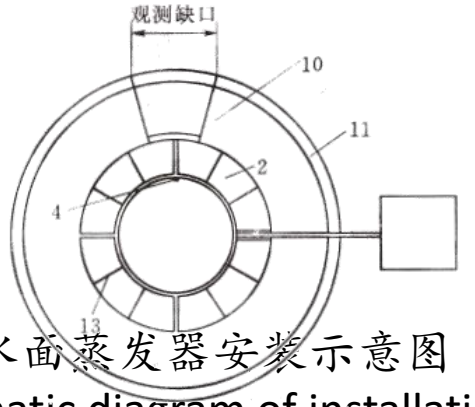
标准水面蒸发器
Standard water surface evaporator



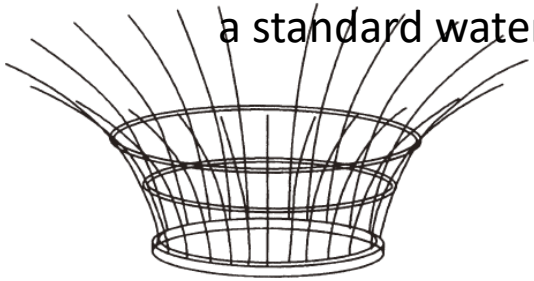
水上漂浮蒸发器Evaporator floating on water



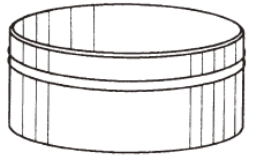
a)剖面图



标准水面蒸发器安装示意图
Schematic diagram of installation of a standard water surface evaporator



a)金属丝网圈



b)20cm 口径蒸发皿

20cm口径蒸发皿Ø20cm evaporating dish

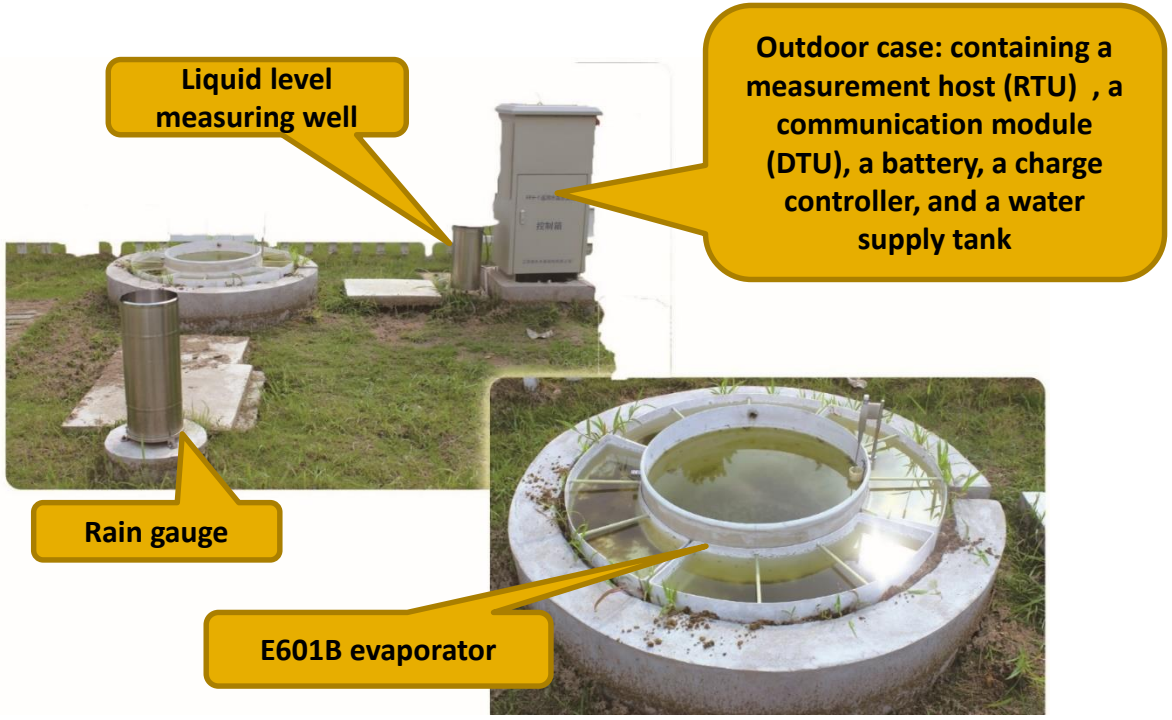
2 水文监测技术及装备 hydrological monitoring technology and instruments

水面自动蒸发
Automatic water surface evaporation

《水面蒸发观测规范》（SL630 -2013）

Standard for Observations of Water Surface Evaporation

(SL630 -2013)



全过程高精度水面蒸发量自动监测装置(长期稳定性实验)

High precision automatic monitoring device for water surface evaporation in the whole process

- 系统性能新指标New indicators of system performance

  1）分辨力Resolution： 0.1mm

  2）补水流量计精度：0.1%FS

  Accuracy of make-up water flowmeter 0.1%FS

  3）磁致伸缩传感器精度0.05%FS，分辨率0.024mm

- 解决降雨期蒸发皿的降雨量监测不准问题

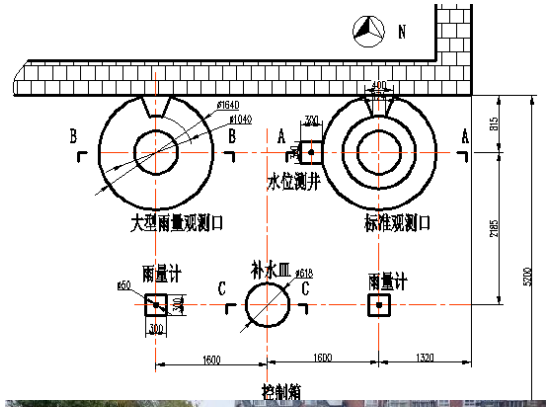
  Solve the problem of inaccurate rainfall monitoring of evaporation pan during rainfall period

  器口尺寸不一致、器口高度不一致、雨量监测设备的轮廓外形不一致

- 持续改进Continuous improvement

- 适用于北方冰期水面蒸发的自动监测

  Suitable for automatic monitoring of water surface evaporation in northern ice age



2.4 水位监测 Water level monitoring

1）《水位观测规范》Standard for Water Level Observation

2）《水深测量仪器》 Instruments for Water-depth Measurement（Hydrologic sounding rod，Acoustic sounder）

3）《水文监测设施设计规范》（Code for the Design of Hydrological Monitoring Facilities. 合并有：《水位观测平台技术标准》merged with: Technical Standard for Stage Observation Platform （SL 384—2007）

4）《水位测量仪器》（GB/T 1182）Instruments for Stage Measurement 包括：1.浮子式水位计、2.压力式水位计、3.声学水位计、4.电子水尺)

5）《水位计量标准装置校验方法》) Calibration Method of Water Level Gauge Test Equipment （GB/T 30952—2014）

2.4 水位监测 Water level monitoring

1 浮子式	1) 全量机械编码器水位传感器	**1 Float type** 1) Full-scale mechanical encoder water level sensor
	2) 小全量光学轴角编码器水位传感器	2) Small full-scale optical shaft encoder water level sensor
2 压力式	1) 压阻式压力水位传感器（投入式）	**2 Pressure type** 1) Piezoresistive pressure water level sensor (input type)
	2) 振弦式压力水位传感器（投入式）	2) Vibrating wire pressure water level sensor (input type)
	3) 电容式压力水位传感器（投入式）	3) Capacitive pressure water level sensor (input type)
	4) 气泡式压力水位计	4) Bubble pressure water level gauge
3 气介式	1) 超声波水位计	**3 Air-medium type** 1) Ultrasonic water level gauge
	2) 雷达水位计	2) Radar water level gauge
	3) 激光水位计	3)Laser water level gauge
	4) 声波水位计	4) Acoustic water level gauge
	5) 图像法水尺	5) Image-method staff gauge
4 液介式	1) 超声波水位计	**4 Liquid-medium type** 1) Ultrasonic water level gauge
5 电子水尺	1) 触点式电子水尺	**5 Electronic staff gauge** 1) Contact type electronic staff gauge
	2) 磁滞伸缩电子水尺	2) Magnetostrictive electronic staff gauge

2.4 水位监测 Water level monitoring

下一步Next R&D：

高精度的雷达、图像视频水位计：

High precision radar water level gauge

Video water level gauge (at night, in rain, etc.)

水位量程：0.5～35m; 精度：0.002m；

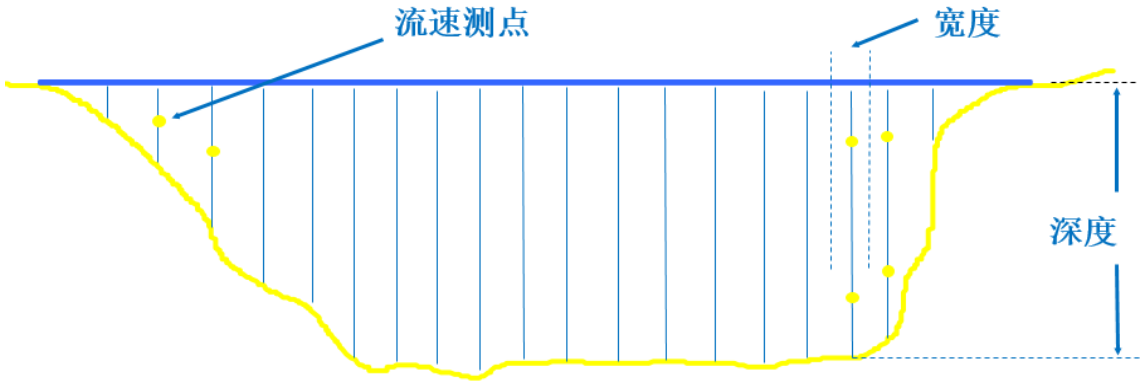
长期稳定性:Long term stability

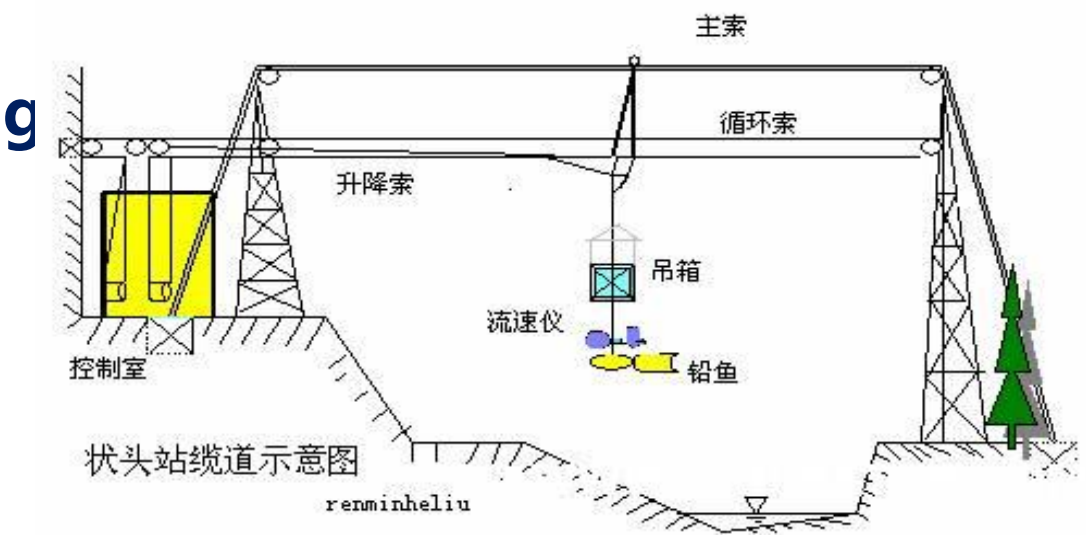
斜测水位计: Measuring method of inclination water level gauge

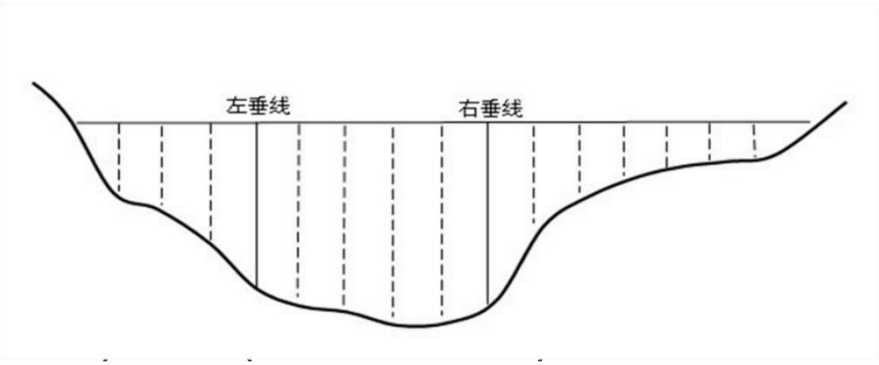
2.5 明渠流速、流量监测
Open channel flow rate and flow monitoring

流速-面积法流量测验
flow rate-area method

传统流速仪法流量测验







- Q(流量)=V(平均流速）*W(断面）Q (flow) =V (average flow
- V---------断面流速分布V---------Sectional flow rate distribution
- W---------断面随水深变化--------W-Sectional changes with water depth
- 断面还会有冲淤There will be erosion and siltation on the cross section

2.5.1 接触式流速监测设备Contact type current monitoring device

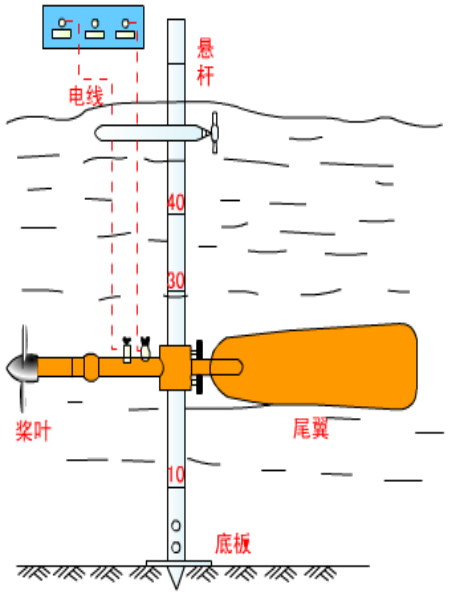
(1) 转子式流速仪

Rotating-element current meter

旋杯式：0.02m/s ～ 1m/s　Cup type:

旋桨式：0.04m/s ～ 15m/s　Propeller type

旋杯式流速仪
Cup-type current meter



(2) 声学多普勒流速仪 Acoustic Doppler current meter

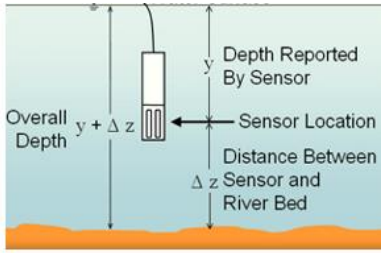
流速测量范围：0.001～4.5m/s

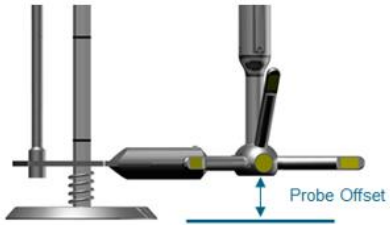
Flow rate measuring range：0.001～4.5m/s

分 辨 率：0.0001m/s　Resolution

准 确 度：实测流速±1%，

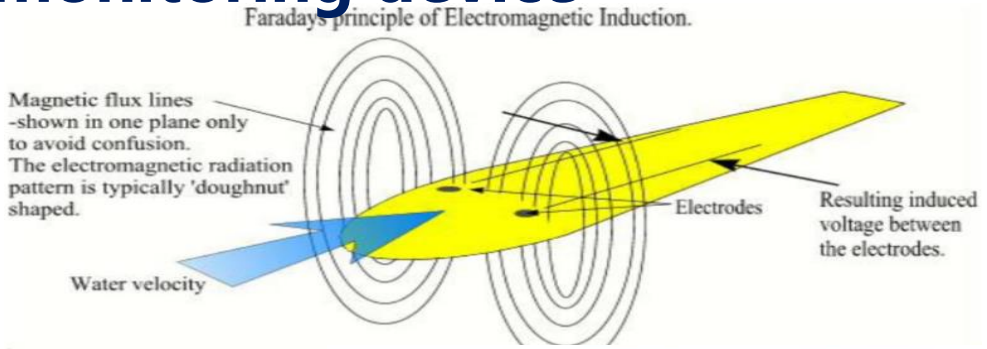
Accuracy: Measured flow rate±1%, ±0.0025m/s





2.5.1 接触式流速监测设备Contact type current monitoring device

(3) 电磁式流速仪Electromagnetic current meter



电磁流速仪是基于法拉第电磁感应定律研制而成的，可用来测量水及多种导电液体的流速。由于没有运动部件，此类仪器可以在浅水、低速中测速，也很少受水环境、水质影响。

The electromagnetic current meter was developed based on Faraday's law of electromagnetic induction. It can be used to measure the flow rate of water and a variety of conductive liquids.This type of instrument can measure the speed in shallow water at a low speed, and is rarely affected by the water environment and water quality.

测量范围：流速测量0.005m/s～10m/s（分辨率5mm/s）；
测量精度：±1.0%FS;
Measuring range: Flow rate measurement 0.005m/s~10m/s (resolution 5mm/s);
Measuring accuracy: ±1.0%FS;

2 水文监测技术及装备 hydrological monitoring technology and instruments

2.5.1 接触式流速监测设备Contact type current monitoring device

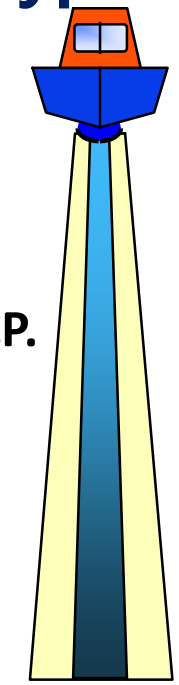
（4）ADCP

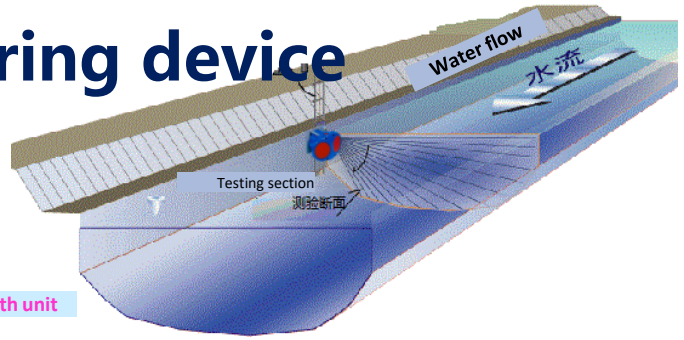
- ADCP：分为水平ADCP和垂直ADCP。

  horizontal ADCP and vertical ADCP.

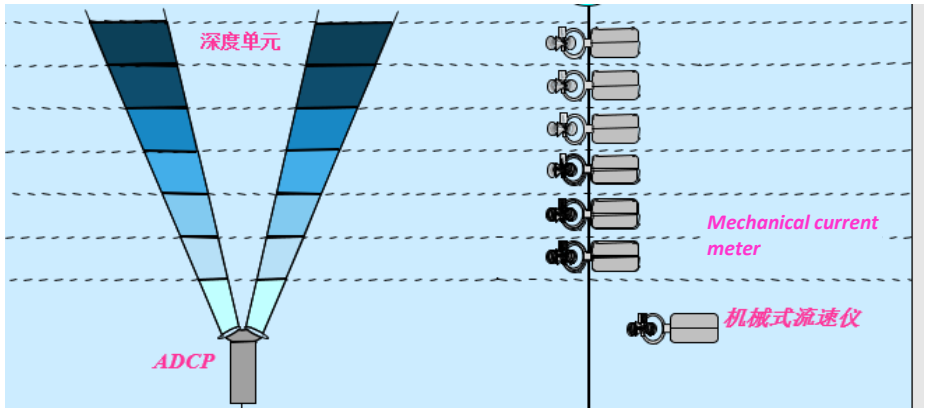
- 最小流速：0.1m/s

  Minimum flow rate: 0.1m/s

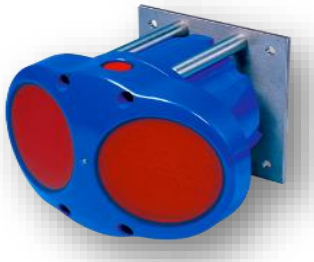




走航ADCP



垂向ADCP
Vertical ADCP

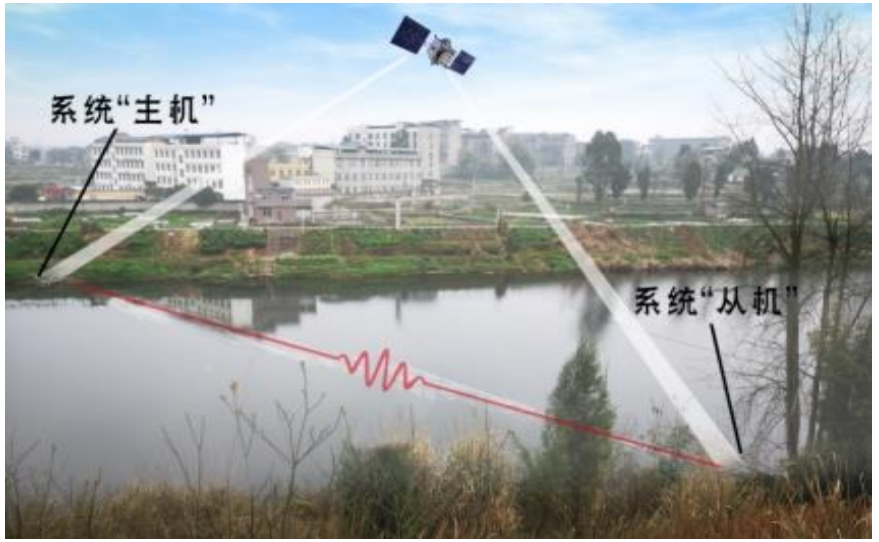


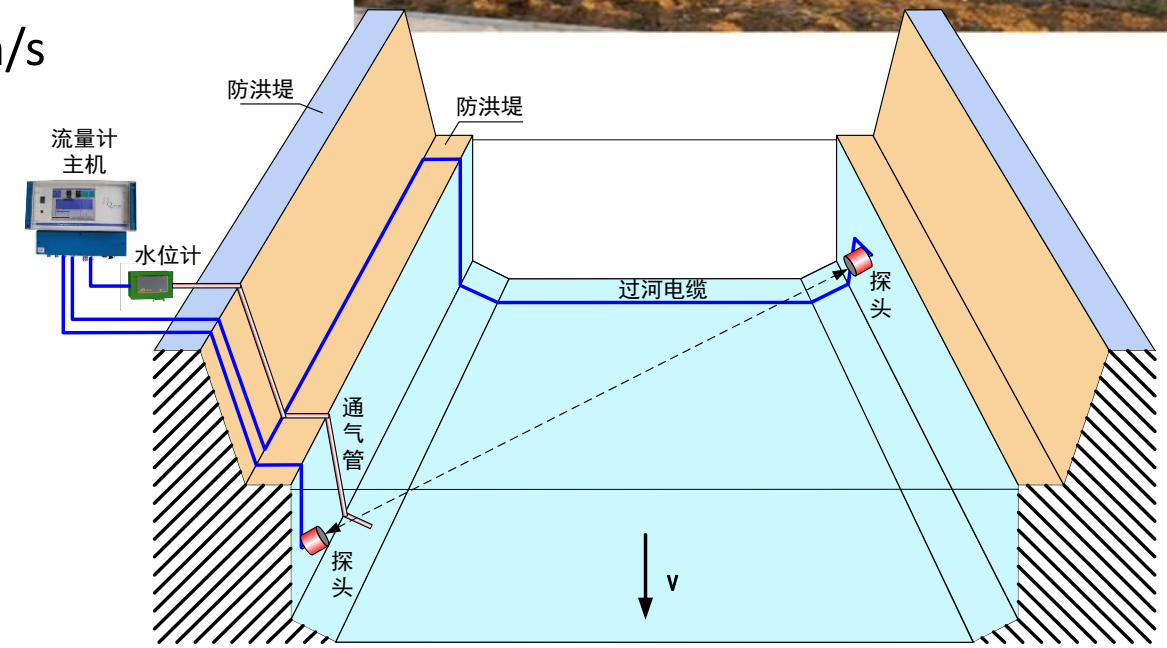
水平ADCP
Horizontal ADCP

2.5.1 接触式流速监测设备Contact type current monitoring device

（5）超声波时差法Ultrasonic time difference method

- 超声波无线时差法
  Ultrasonic wireless time difference method
- 超声波有线时差法
  Ultrasonic time difference method
- 最小流速：0.1m/s。 Minimum flow rate: 0.1m/s





2.5.2 非接触式流速监测设备 Non-contact current monitoring device

(1) 手持式电波流速仪

Handheld electric wave current meter

雷达枪特有的感应系统，可专门用于补偿雷达枪到目标的垂直方向的余弦误差，无须人工设置。

The unique sensing system of the radar gun can be specifically used to compensate the cosine error of the vertical direction from the radar gun to the target, without manual setting.

最小速度	1 f/s (0.3 m/s)
Minimum speed	1 f/s (0.3 m/s)
测量精度	5% of reading
Measuring accuracy	5% of reading

2.5.2 非接触式流速监测设备 Non-contact current monitoring device

(2) 点流速雷达波流速仪Radar point flow measurement device

□**点流速雷达测流设备：**多普勒原理，适合利用跨河桥体、立杆桁架、缆道行车、跨河桁架进行非接触式断面点流速监测，尤其适合山区中高水位的断面流量监测和高洪应急监测。一般不小于0.3m/s、0.5m/s。

According to the Doppler principle, it is suitable for cross-river bridges, riser trusses, cableway travelers, and cross-river trusses, especially suitable for cross-sectional flow monitoring and high flood emergency monitoring in mountainous areas with medium and high water levels. Minimum flow rate: 0.5m/s.

桥体安装
Bridge installation

立杆桁架
Riser truss

缆道行车
Cableway traveler

2.5.2 非接触式流速监测设备 Non-contact current monitoring device

(3)侧扫雷达 Side scanning radar

侧扫雷达测流设备：采用非接触式雷达多普勒技术。

Scanning radar flow measurement device according to the Doppler principle

最小流速：0.2m/s。 Minimum flow rate: 0.2m/s.

设备工作频率范围： **400.150/406.000 MHz** 选择其中一个频点工作

Range of equipment operating frequency: 400.150/406.000 MHz, select one of the frequency points for operation

2.6 土壤墒情监测Soil Moisture Content Monitoring

墒，指土壤适宜植物生长发育的湿度。墒情，指土壤湿度的情况。

Soil moisture, means the moisture in the soil, which is suitable for plant growth and development and means the condition of soil moisture.

土壤含水量=水分重/烘干土重×100%　　Soil moisture content = moisture weight /weight of dried soil × 100%;

如下几类原理和方法：　the following principles and methods

1）烘干法　　Drying method

2）电阻法　　Resistivity method

3)负压法　　Negative pressure method

4)中子法　　Neutron method

5)频域反射法　　Frequency domain reflection method (FDR)

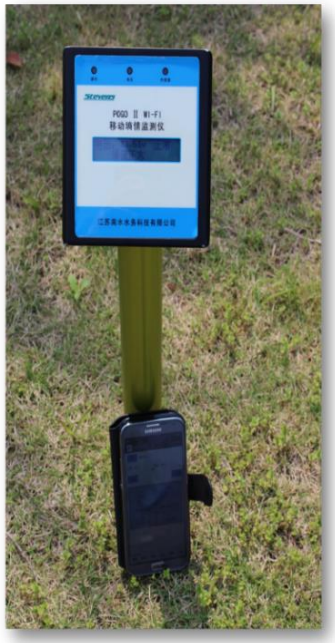
6)时域反射法　　Time domain reflection method (TDR)

7)时域传输法　　Time domain transmission method (TDT

2.6.1 FDR频域反射法墒情监测传感器
FDR soil moisture monitoring sensor

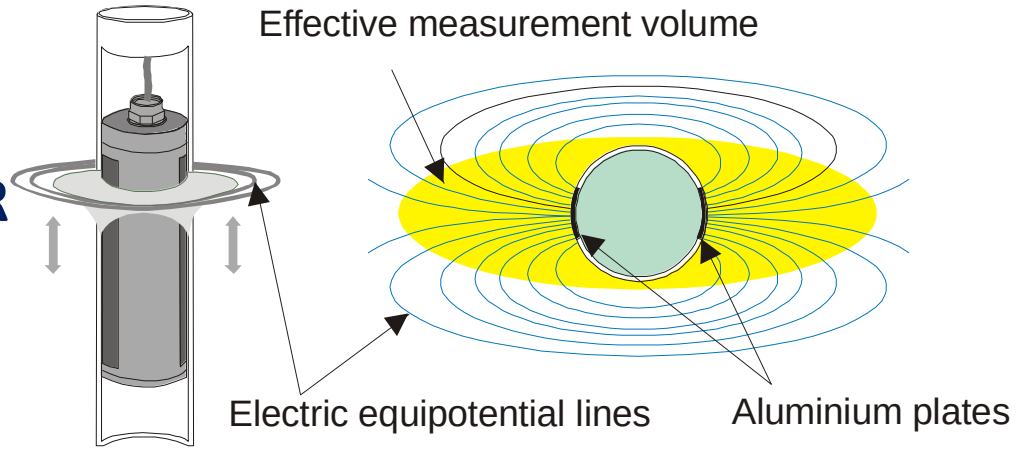
因FDR墒情传感器在测量电路上易于实现，因此造价比较低，目前市场上这种FDR墒情传感器产品比较多，主要有两种类型，一种是插针式的，适用点式测量土壤水分；另一种是管式的多层次测量探头，常用于测量一个纵向剖面。

Because the FDR soil moisture sensor can be implemented easily in a measuring circuit, the cost is relatively low. At present, there are many kinds of FDR soil moisture sensors on the market. They are mainly classified into two types, one is a pin type, which is suitable for point measurement of soil moisture; the other is a tubular multi-layer measuring probe, which is often used to measure a longitudinal section.



2 水文监测技术及装备 hydrological monitoring technology and instruments

2.6.2 TDR时域反射法墒情监测
Soil moisture content monitoring by TDR



适用于野外无人值守或作为巡检设备使用。适用于各种土壤体积含水率的测量，土壤容重在1.1-1.7范围内，不超过土壤饱和含水率的测量精准高达0.1%，绝对误差小于2%

It is suitable for unattended operation in the field or used as routing inspection equipment. It is suitable for the measurement of various soil volumetric moisture contents. The soil bulk density is in the range of 1.1-1.7, and the measuring accuracy when the soil moisture content does not exceed the saturated soil moisture content is as high as 0.1%, and the absolute error is less than 2%.

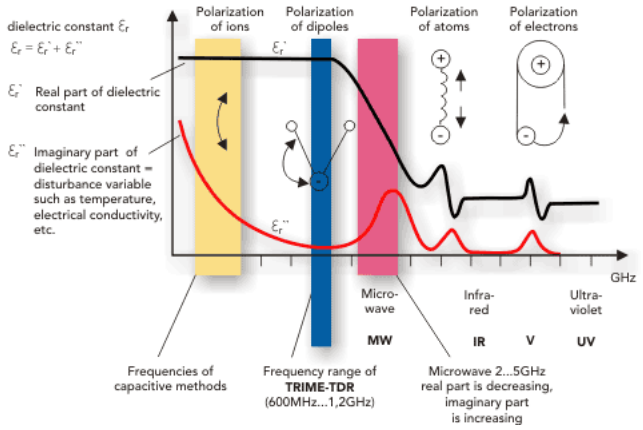
2.6.3 TDR与FDR比较 Comparison between TDR and FDR

TDR技术通过测定电磁波在土壤中固定的传输线路上的传输时间确定介电常数，由于电磁波的传输速度很快，TDR要精确测定时间达100皮秒，因此**TDR的电路成本较高，但TDR受土壤盐分（只要不削弱电磁波的传输）和温度的影响小；**

FDR中时间测量的精度要远远低于TDR技术，因此，**电路成本低，输出信号可转换成直流电压信号；但对土壤的盐分和温度很敏感。**

The TDR technique determines the dielectric constant by measuring the transmission time of electromagnetic waves on a fixed transmission line in the soil. Due to the high transmission speed of electromagnetic waves, TDR has to accurately measure the time up to 100 picoseconds. Therefore, **the circuit cost of TDR is higher, but TDR is less affected by soil salinity (as long as it does not weaken the transmission of electromagnetic waves) and temperature.**

The accuracy of time measurement in FDR is much lower than that of the TDR technique, **so the circuit cost is low and the output signals can be converted to DC voltage signals; however, it is sensitive to the salinity and temperature of the soil.**



2.7 泥沙分类 Classification of sediment

- 1. 床　　沙：组成河床表面的静止泥沙，又称河床质。特点：静止、较粗；
- 2. 推移质：沿河床滑动、滚动及跳跃前进的泥沙。特点：运动间歇性、可与床沙交换、速度较水流慢；
- 3. 悬移质：被水流携带、远离床面悬浮于水中运动的泥沙。特点：颗粒细，与水流速度基本相同。

- 1. Bed sediment: The static sediment on the surface of the river bed, also known as bed load. Features: static and coarse;
- 2. Traction load: The sediment that slides, rolls and jumps along the river bed. Features: movement is intermittent, it can exchange with bed sediment, and its speed is lower than that of the current;
- 3. Suspended load: The sediment that is carried by the current and suspended in the water and moves away from the bed surface. Features: The particles are fine, and the speed is basically the same as that of the current.

密度、容重、比重、粒径、沉降粒径、级配……

Density, bulk density, specific gravity, particle size, fall diameter, characteristic values…

2.7 泥沙监测 Sediment monitoring

1）振动法测沙 Measure sediment by the vibration method

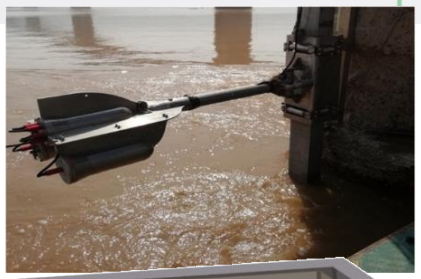
2）光电法测沙 Sediment monitoring

3）超声波法测沙 Sediment measurement by the ultrasonic method

超声反射法 Ultrasound reflection method

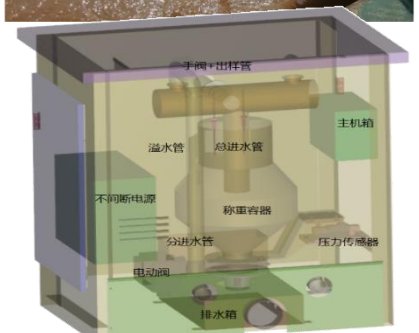
超声衰减法 Ultrasonic attenuation method

4）同位素测沙仪 Isotope sand meter



5）称重式泥沙含量自动测量仪

Weighing type sediment content automatic measuring instrument

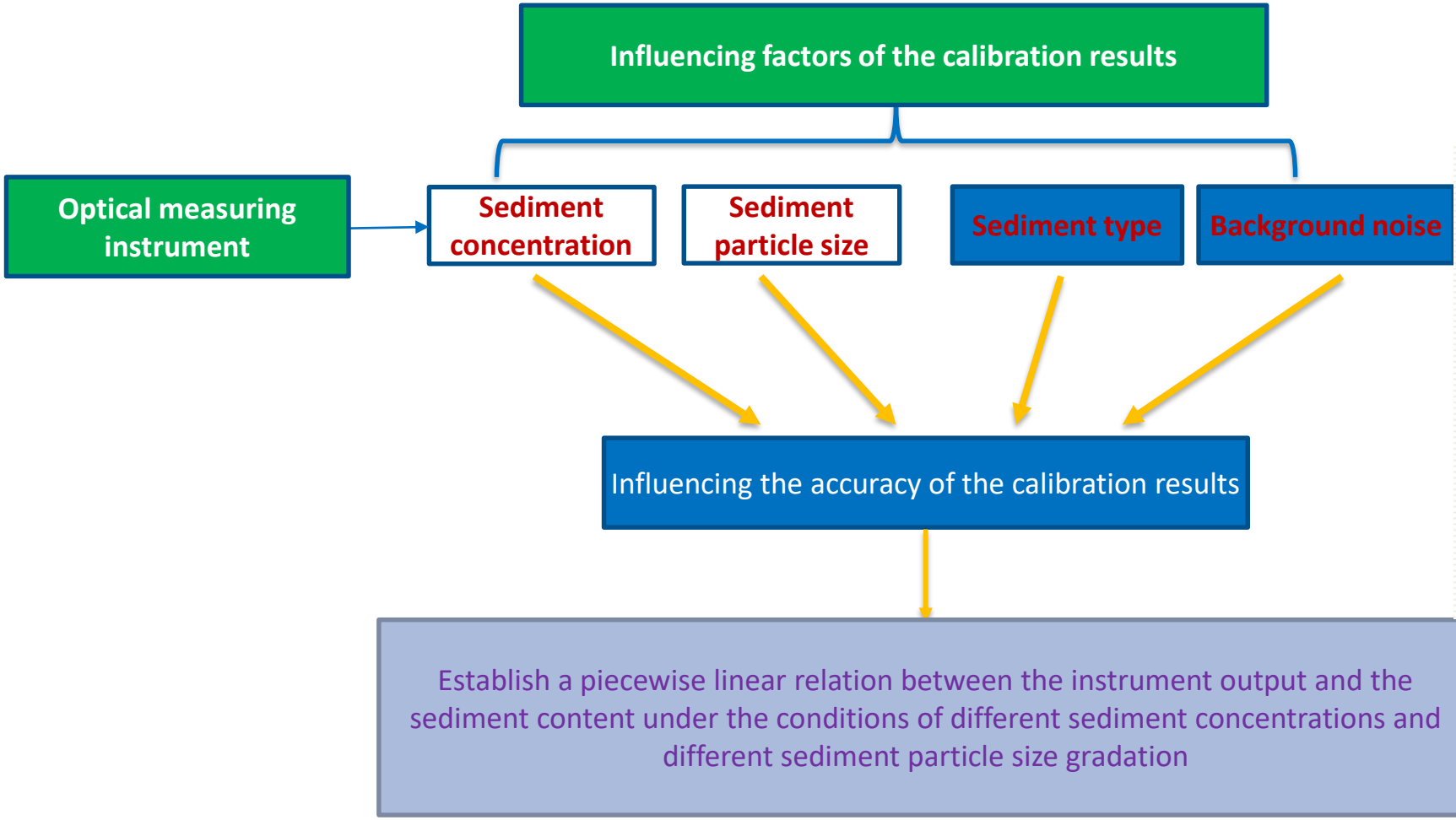


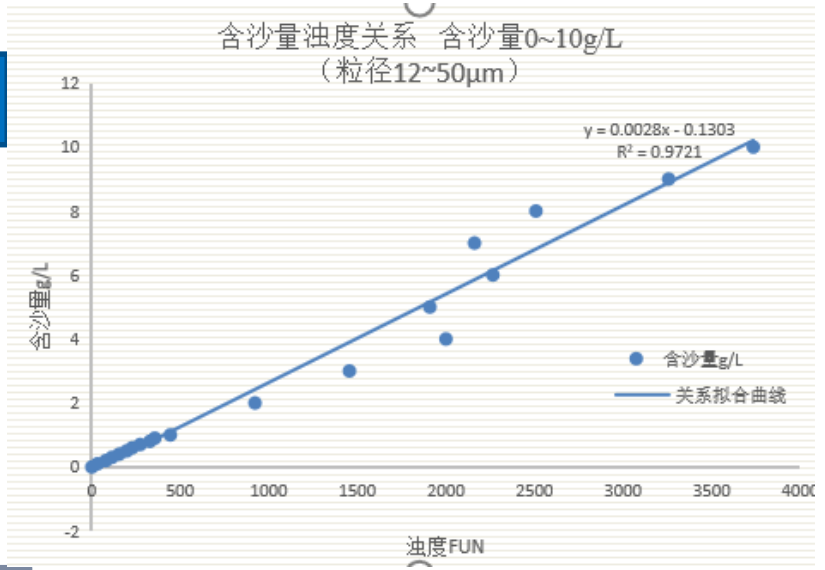
6）图像法 Image method

实验室还有筛分、电阻、颗分等多种分析研究方向

2.7 泥沙监测 Sediment monitoring

率定实验影响因素 Influencing factors of the calibration experiment





2.8 水质监测 Water quality monitoring

□《地表水环境质量标准》 Water quality monitoring The Environmental Quality Standards for Surface Water includes 109 monitoring parameters in total, such as five routine parameters, NH3-N, TP, lead and mercury heavy metal. Most of them can only be analyzed in the laboratory through manual sampling.

水质九参数一体化厢式在线监测站

Integral box-type nine water quality parameters online monitoring station

□完整的水样采集和沉沙系统

□九种水质参数的测量系统

常规五参数：水温、pH、溶解氧、浊度和电导率、氨氮、总磷（TP）、总氮（TN）、高锰酸盐指数

□ With a complete water sample collection and sedimentation system

□ With a system for measuring nine water quality parameters

Five routine parameters: water temperature, pH, DO, turbidity and electric conductivity, NH3-N, TP, TN and permanganate index

03

——CONTENTS——

水文监测技术及装备

hydrological monitoring technology and instruments

NIHWA

3 新研制 New development

3.1 新要求 New requirements

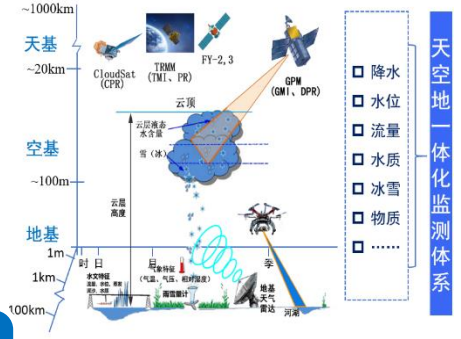
当前水文现代化建设对水文监测的迫切需求

The urgent needs of the current modernization of hydrology for hydrological monitoring

- 全自动监测Automatic monitoring
- 全要素监测Full-factor monitoring
- 全量程监测Full-range monitoring
- 全过程监测Full-process monitoring
- 一体化integrated monitoring
- 应急监测 Emergency monitoring
- 长期稳定性 Long term stability

3 新研制 New development

3.2 天空地一体化监测体系 Space-air-ground integrated monitoring system



构建天空地嵌套式监测体系

监测技术手段	设备运行保障	标准化和质控

Establish a space-air-ground nested monitoring system

Technical means of monitoring	Equipment operation guarantee	Standardization and QC

天基遥感：降水、水位、流量、雪盖、水储量变化等

Space-based remote sensing： precipitation, water level, flow, snow cap, water storage change, etc.

空基遥感：要素类型：水位、流量、水质等

Air-based remote sensing： element types: water level, flow, water quality, etc.

地基监测：降水、水位、流量、土壤水、蒸发、水质等

Ground-based remote sensing: precipitation, water level, flow, soil water, evaporation, water quality, etc.

3 新研制 New development

3.3 正在开展的研发工作 Ongoing Development

（1）水位监测： Water level monitoring

视频水位计（不同环境下） Video water level gauge

高精度的雷达水位计：High precision radar water level gauge

斜测水位计 Measuring method of inclination water level gauge

（2）流速流量： Flow rate

点流速雷达流速监测 Flow rate monitoring by point flow rate radar

高性能视频在线流量监测 High-performance video online flow monitoring

无线时差法 Ultrasonic wireless time difference method

冰期测流 Ice age current measurement…

3 新研制 New development

3.3 正在开展的研发工作 Ongoing Development

（3）降雨监测：Rainfall monitoring

称重时雨雪量计研制 Development of weighing rain (snow)

地面震动影响、沙尘影响、风的影响、数据漂移（自校正），实时消除温度漂移和压力信号漂移等。

Impact of ground vibration, sand dust, wind, data drift (self correction), real-time elimination of temperature drift and pressure signal drift.

高精度雨量计改进 研制融雪的虹吸式高精度翻斗雨量计 Improvement of High Precision Rain Gauge

Development of siphon type high precision tipping bucket rain gauge for snow melting

一体化雨雪量计 Integrated rain and snow meter

（4）蒸发监测： Evaporation

全过程高精度水面蒸发量自动监测装置(长期稳定性实验）

High precision automatic monitoring device for water surface evaporation in the whole process

适用于北方冰期水面蒸发的自动监测

Suitable for automatic monitoring of water surface evaporation in northern ice age

3 新研制 New development

3.3 正在开展的研发工作 Ongoing Development

（5）泥沙监测： Sediment monitoring

基于水平固定式ADCP的悬移质泥沙含量在线监测系统

Online monitoring system for suspended sediment content based on horizontal stationary ADCP

多仓泥沙采样器 Multi bin sediment sampler

泥沙率定 Sediment calibration

光电法测沙 Photoelectric method for sand measurement

（6）水质： water quality monitoring

小型化水质监测装置Miniaturized water quality monitoring deviceRainfall monitoring

（7）其它：

三维水动力学模型实时数据同化Real-time data assimilation for 3D hydrodynamic models

多源监测信息融合与应用Multi-source monitoring information fusion and application

数字孪生水文站Digital twin hydrological station

一体化应急监测装置Integrated emergency monitoring device

计量及溯源Measurement and traceability

NIHWA
Since1940
南京水利水文自动化研究所

感谢聆听！

Thank you for listening

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