

# The urgent metrological needs in dynamic measurement of China High-speed Railway

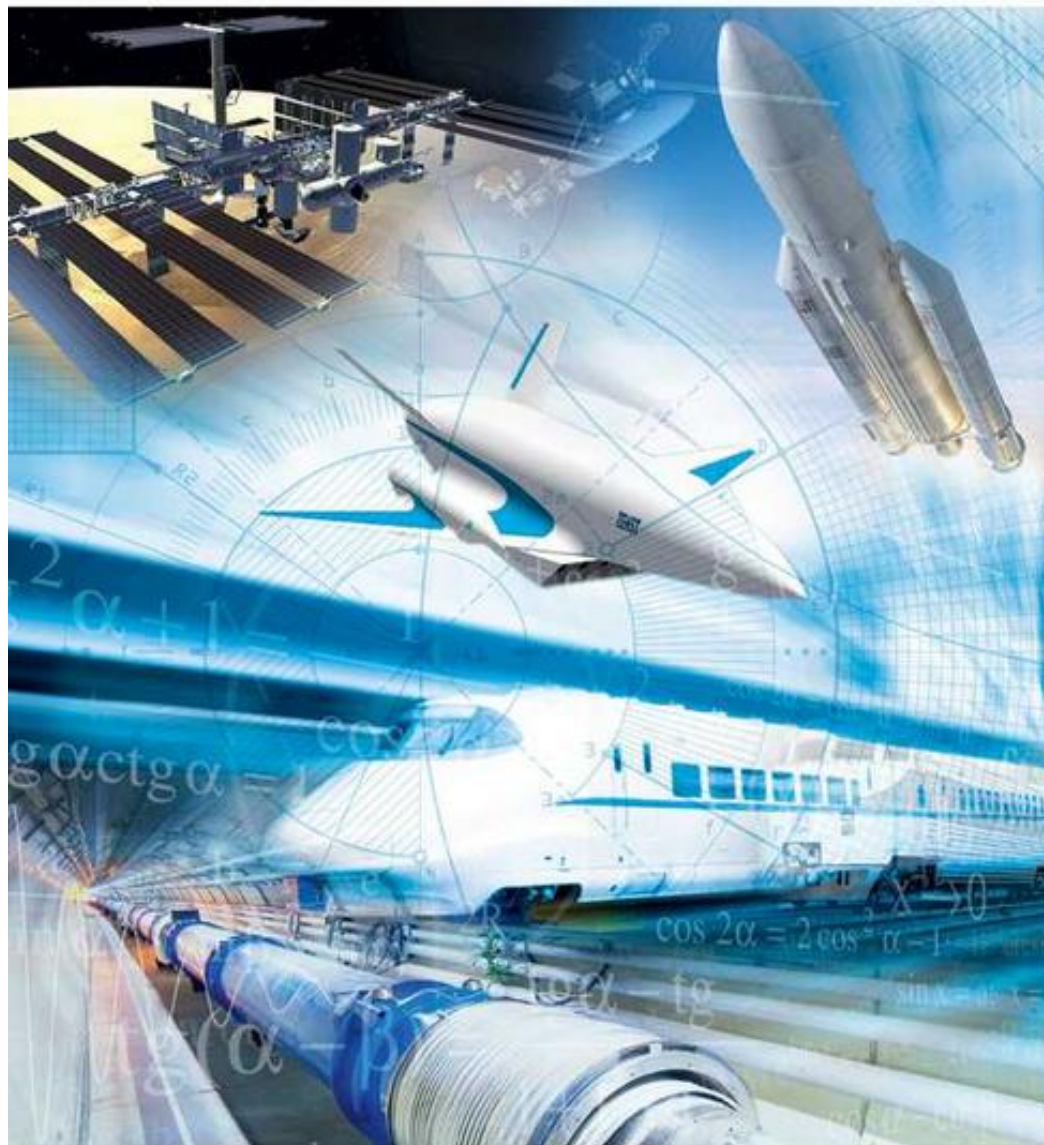
Qiao SUN

June 1, 2016

---

# Metrology

Measurements in a dynamic world



# Contents

**Investigation background**

**General information**

**Metrological needs**

**Research projects**

# Investigation background



Iron & Steel



Automobile



Manufacturing



Fiber & clothing



ship

## 1. 《National science and technology plan (2006—2020) 》

Prioritized subject: High speed rail transportation system and equipments

## 2. 《National revitalization plan for 10 major industries 》

《Equipment manufacturing industry》 —— High speed railway national wide and track transportation in major cities.

Petro



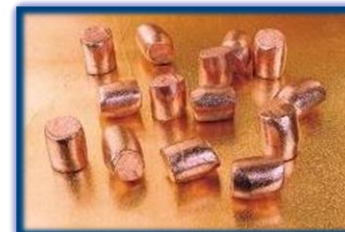
Light industry



Logistics



Metallurgy



Information



# Investigation background

## 中国成为世界上高铁运营里程最长的国家

中国

目前高速铁路的营业里程 **7531公里**

位居世界第一

2020年铁路营业里程将达**12万公里**以上

其中 新建高速铁路将达 **1.6万公里**以上



时间	高速铁路段	时速
2007年4月18日	京哈、京沪、京广等干线	200 - 250公里
2008年4月18日	京沪	380公里(最高)
2008年8月1日	京津城际铁路	350公里
2009年12月26日	武汉至广州	350公里
2010年12月3日	京沪高铁枣庄至蚌埠先导段联调联试和综合试验	486.1公里(最高)

1. The longest operation mileage for high speed train world wide. (2011)

2. Metro, Skyline and tram are well under development in major cities national wide.



## ● 中国地铁建设现状

目前,北京、上海、广州等12个城市有36条城市轨道交通线路正在建设,在未来10余年里,15个城市建设轨道交通线路总长约1700公里,总投资达到6200亿元。

# Investigation background

NIM, China has technical cooperation with China railway companies and research institutes for a long time.

查询结果 一机多测流程下载

<input type="checkbox"/> 全选	条码	仪器名称	单位名称	规格型号	编号	状态	证书编号	证书状态	预计完检	实际完检	类型	一机多测
<input type="checkbox"/>	Y003107200	加速度计	青岛四方车辆研究所有限公司	2220-0	13479	客户已取	LSzb2010-0043	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003107100	加速度计	青岛四方车辆研究所有限公司	2220-0	13478	客户已取	LSzb2010-0044	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003106500	加速度计	青岛四方车辆研究所有限公司	2220-0	13649	客户已取	LSzb2010-0050	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003107300	加速度计	青岛四方车辆研究所有限公司	2220-0	13480	客户已取	LSzb2010-0042	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003107000	加速度计	青岛四方车辆研究所有限公司	2220-0	13477	客户已取	LSzb2010-0045	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003106700	加速度计	青岛四方车辆研究所有限公司	2220-0	13651	客户已取	LSzb2010-0048	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003106600	加速度计	青岛四方车辆研究所有限公司	2220-0	13650	客户已取	LSzb2010-0049	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003106900	加速度计	青岛四方车辆研究所有限公司	2220-0	13475	客户已取	LSzb2010-0046	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003106800	加速度计	青岛四方车辆研究所有限公司	2220-0	13652	客户已取	LSzb2010-0047	证书已取	2010-2-11	2010-1-28	检定	
<input type="checkbox"/>	Y003107400	加速度计	青岛四方车辆研究所有限公司	2220-0	13481	客户已取	LSzb2010-0041	证书已取	2010-2-11	2010-1-28	检定	

查询结果 一机多测流程下载

<input type="checkbox"/> 全选	条码	仪器名称	单位名称	规格型号	编号	状态	证书编号	证书状态	预计完检	实际完检	类型	一机多测
<input type="checkbox"/>	Y007312300	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0377	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312400	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0378	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312200	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0376	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312000	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取(退检)	----	----	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312100	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0375	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312500	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0379	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312800	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0382	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312900	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0383	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312600	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0380	证书已取	2010-7-8	2010-6-30	校准	
<input type="checkbox"/>	Y007312700	振动测试系统	中国铁道科学研究院	891/INV306U	/	导送已取	LSzd2010-0381	证书已取	2010-7-8	2010-6-30	校准	

# Investigation background

In 2011, NIM sent an investigation team to conduct on-site visit.

- ◆ National science and technology plan



- ◆ National revitalization plan for industries



- ◆ NIM's CMCs

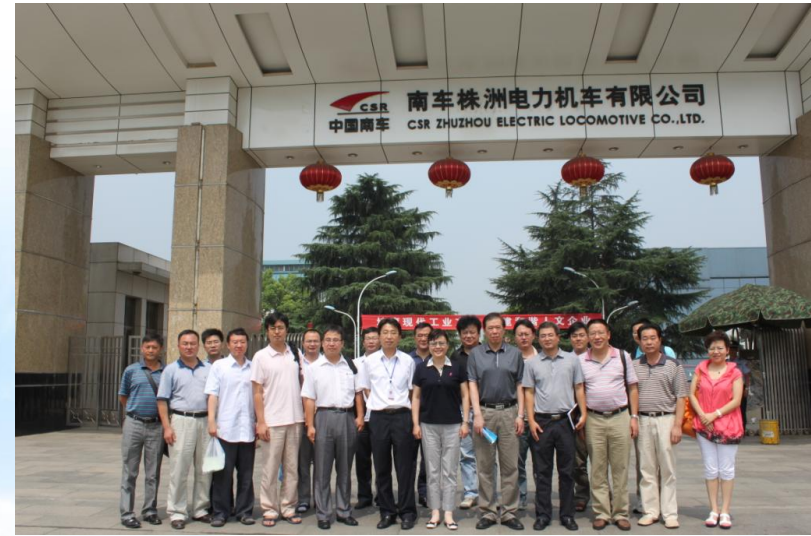
# General information

## ❖ Investigation time

- July, 2011

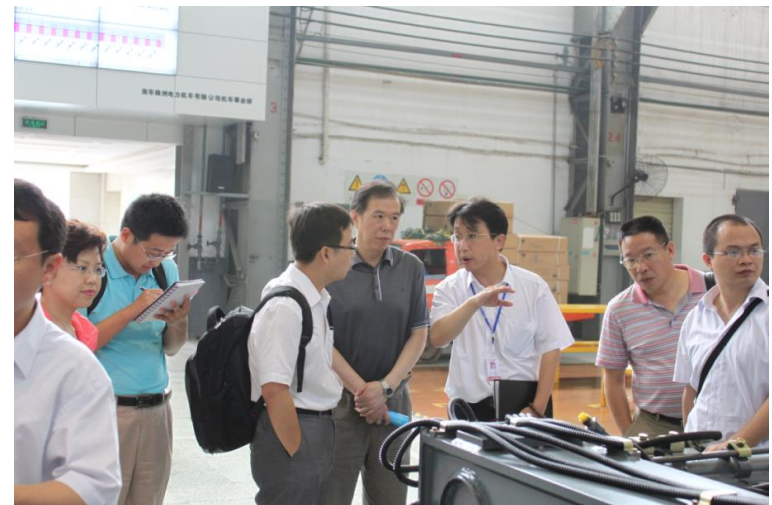
## ❖ Investigation team

- NIM, China
- Hunan Metrology and Test Institute



# General information

Institute	Experts	Expertise
NIM	9	Mass, force, acoustics, ultrasound, vibration, volume, electricity, traffic speed measurement, etc.



# General information



- ◆ Presentations and heated technical discussions



# General information

## ❖ Typical manufacturer

- Electrical train locomotive



- Core manufacturer company of former China South Railway
- Area 2.25 squared kilometers, capital 13+ billion, staff 8000
- Products: various train locomotives

电力机车



城轨车辆



动车组



新兴产业

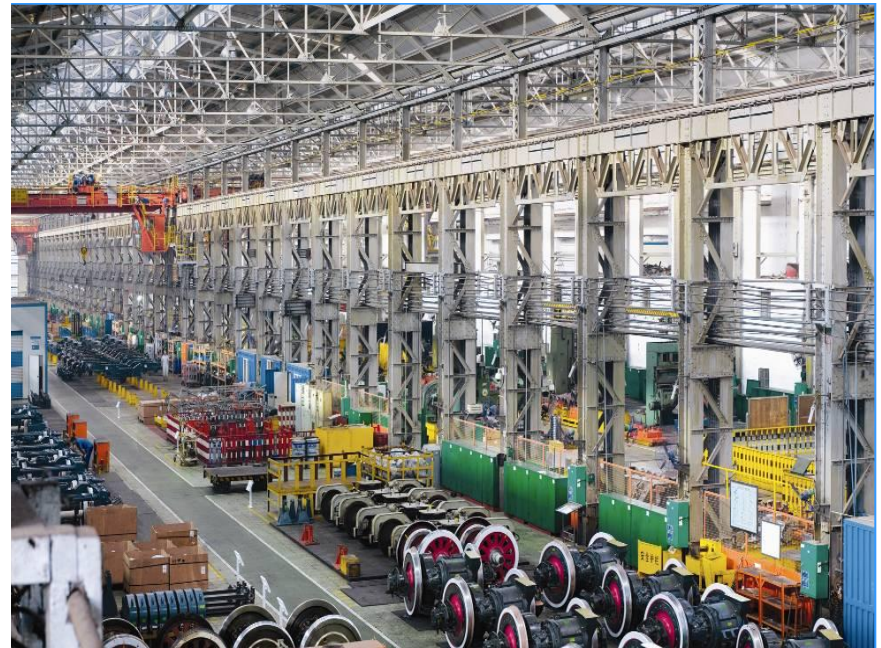


# General information

## ❖ Typical manufacturer

- Electrical train locomotive

- Annual product capability 1200+, the world largest locomotive assembly factory



# General information

## ❖ Typical institute

- CSR research institute



# Metrological needs

- **Dynamic force measurement and traceability**
- **Shock resistant material evaluation**
- **Noise measurement on operational high speed train**
- **Velocity measurement and traceability of high speed train**
- **Vibration parameter measurement of magnetic suspension train**
- **Depression of locomotive electrical and magnetic disturbance**
- **Train wheel adhesive coefficient calibration**
- **Measurement of working volume of locomotive compressor**

# Metrological needs

## ❖ Shock resistant material evaluation

- Material and structure is vital for train safety
- Shock resistance test of windshield glass is crucial
- Specifications : speed range 100km/h ~ 1000km/h , speed deviation 1%



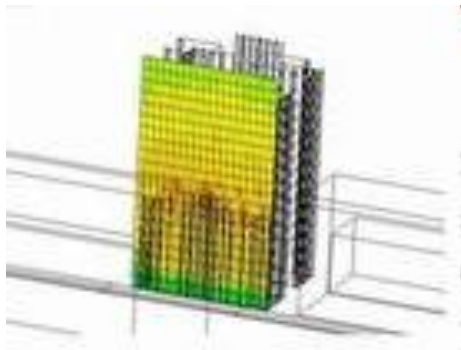
# Metrological needs

- ❖ **Velocity measurement and traceability of high speed train**
  - **Requirement :**
    - **Common train 100~160km/h ;**
    - **Inter city train 160~200km/h ;**
    - **High speed train 200~400km/h ;**
    - **Extra high speed train 400km/h.**
  
  - **Operation speed is crucial parameter for train control system.**
  
  - **Rotational speed sensor, Radar sensor applied.**

# Metrological needs

## ❖ Noise measurement on operational high speed train

- Wheel-rail noise is the main source caused by vibration, shock and rotation.
- Noise features in time domain and frequency domain.



# Metrological needs

## 1 Solved

- ◆ Noise measurement on operational high speed train

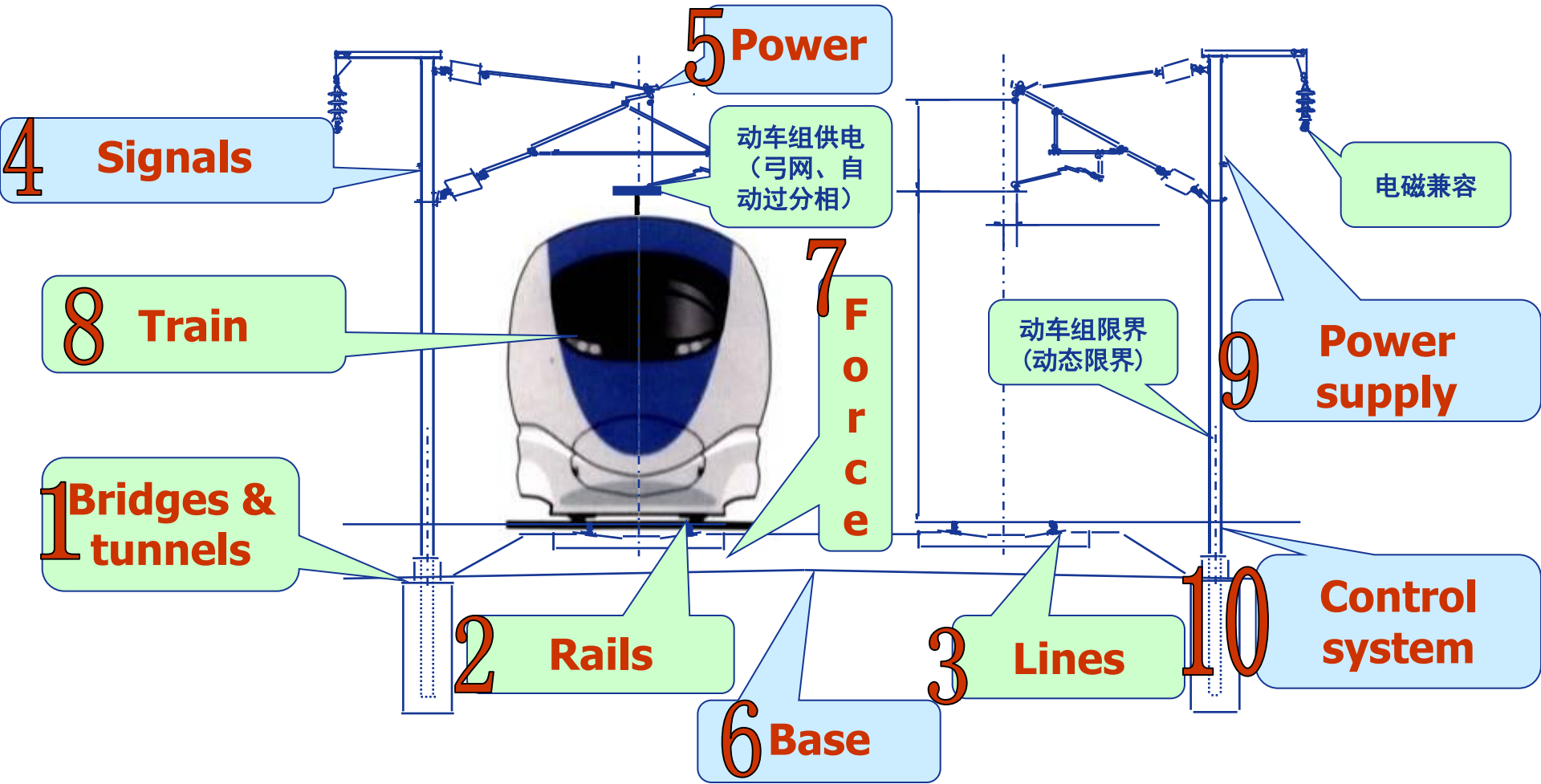
## 2 Not yet

- ◆ Velocity measurement and traceability of high speed train
- ◆ Depression of locomotive electrical and magnetic disturbance
- ◆ Measurement of working volume of locomotive compressor

## 3 Will be

- ◆ Dynamic force measurement and traceability
- ◆ Shock resistant material evaluation
- ◆ Depression of locomotive electrical and magnetic disturbance
- ◆ Train wheel adhesive coefficient calibration

# Research projects



## CRH380 key technology



# Research project 1



**CRH3C**  
**332km/h**



**Extra high-speed of 500km/h**

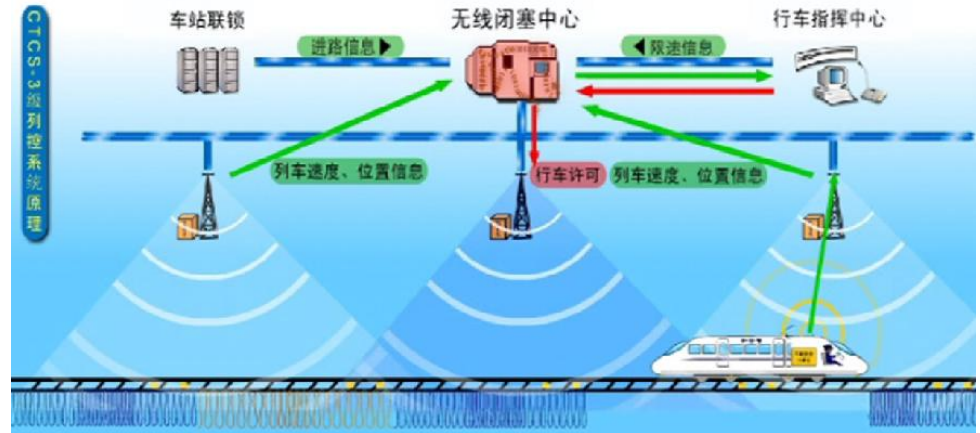


# Research project 1



Test platform for 600km/h operation speed

- For 300km/h and higher
  - Overspeed 2km/h warning
  - Overspeed 5km/h **braking**
  - Overspeed 15km/h **forced braking**
- Operation speed should be measured accurately anywhere and anytime for the sake of operation safety

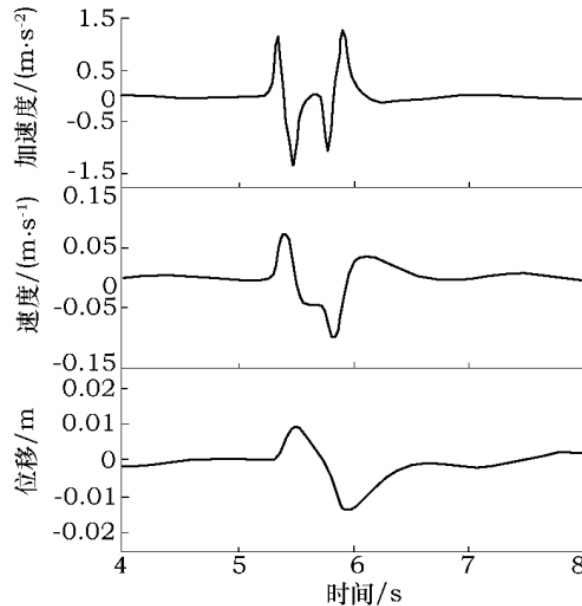


# Research project 1

- **Accurate measurement of operation speed**
  - Dual Radar
  - Calibration system for dual Radar
  
- **Specifications**
  - Speed measurement range (20-500) km/h
  - Expanded uncertainty 0.3km/h (  $k=2$  )
  - Function frequency (8-50) GHz

# Research project 2

## 1. Airborn disturbance



会车时的车体横向加速度、速度和位移曲线



Air pressure

Airborne disturbance

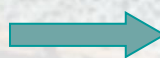


Horizontal and vertical vibration

## 2. Wheel-rail disturbance



W-R disturbance

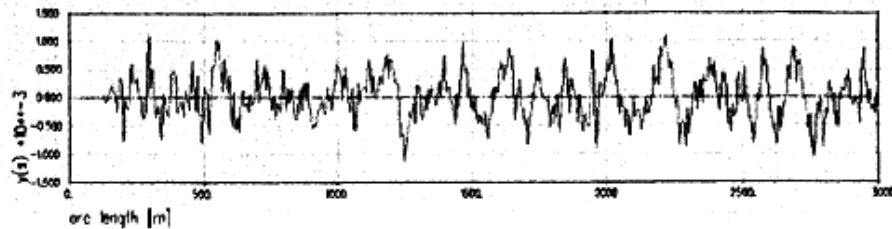


Bogie vibration

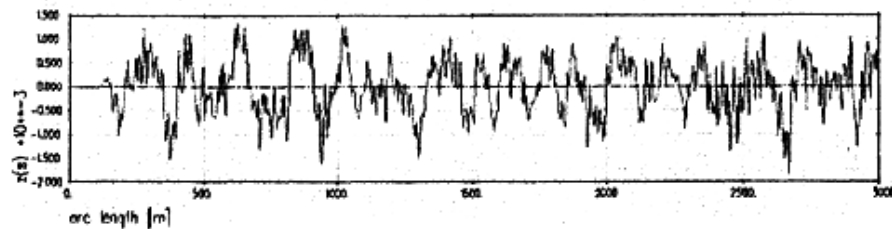


Coach vibration

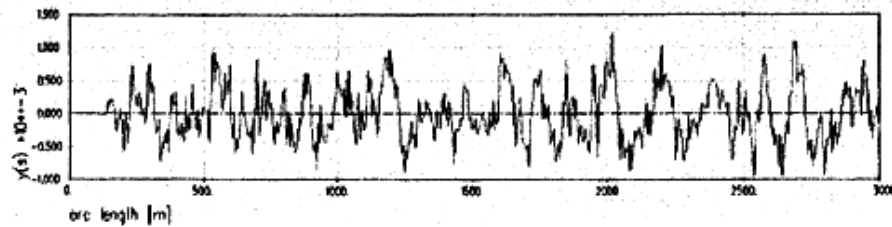
# Research project 2



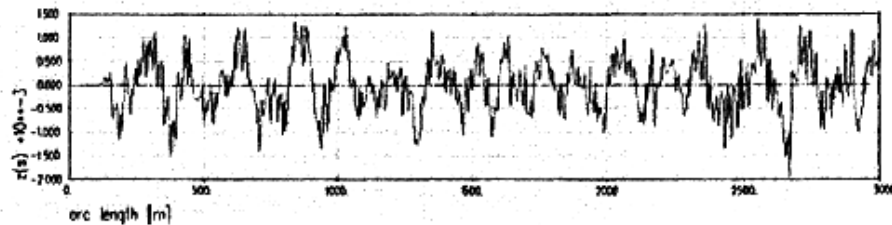
a. 右轨横向不平顺



b. 右轨垂向不平顺



c. 左轨横向不平顺



d. 左轨垂向不平顺

图 国内某高速铁路实测轨道谱



➤ Higher speed, higher vibration

# Research project 2

- **Vibration measurement for high speed train**
  - Research on measurement method and devices for high speed train features
  - On-site measuring for large test devices
  
- **Specifications**
  - Frequency range 1 Hz~10 kHz with expanded uncertainty of 2.0% ( $k=2$ )

**Thanks !**