



Conductor Manufacturing: Advances and Perspectives @SST

CCA Workshop 2025
Geneva, March 11th 2025



- 
- 01 Introduction to SST**
 - 02 SST' s Expansion Achievements So Far**
 - 03 Expansion Challenges**
 - 04 Future Outlook**

Our History

2011



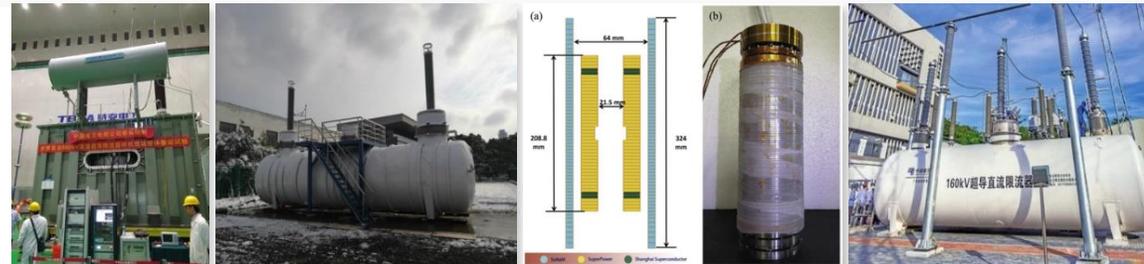
Spin-off from Shanghai Jiaotong University.

2012 - 2015



Tackled key scale-up challenges, achieved **mass production** of HTS in China.

2016 - 2019



Commercial sales established in China and kicked off in ROW.

2020 - 2022



Supported multiple national demonstration projects, and supplied to compact fusion projects overseas.

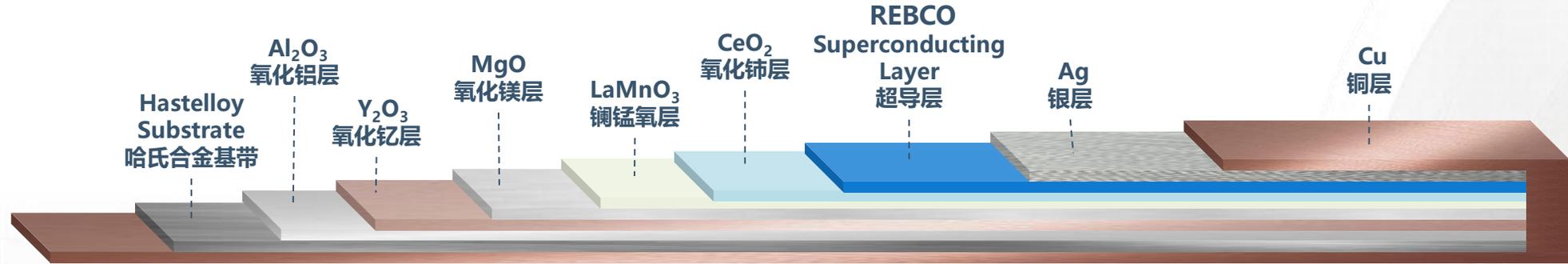
2023-NOW



Production expansion and continuous improvement in action. Persistent supply to worldwide customers.

Our Technology

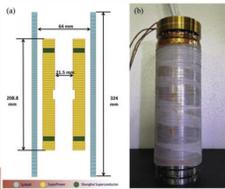
REBCO tape is manufactured by advanced reel-to-reel **Ion Beam Assisted Deposition (IBAD)** and **Pulsed Laser Deposition (PLD)** technologies.



E-Polishing R2R RF Mag. Sputter R2R IBAD R2R HT RF Mag. Sputter R2R PLD R2R DC Mag. Sputter Slitting Electroplating Lamination



Performance Well Proven in Applications



32.35T Superconducting Magnet CAS IEE

- World record breaking magnet at the time



19.4T Superconducting Magnet ASIPP

- First all-REBCO magnet in China, CICC-type



MRI Magnet Cambridge U



Compact Fusion-20T Commonwealth Fusion

- Large bore, 20T HTS high field magnet



Compact Fusion-DEMO4 Tokamak Energy

- All HTS Tokamak



Compact Fusion-HH70 Energy Singularity

- Successful manufacturing of HTS TF coil
- Success plasma demonstration



500kV AC Sat. iron-core type FCL Southern Grid

- Highest V FCL in the world



220kV AC Resistive FCL ZTT/CAS IEE/BJU

- First prototype of resistive FCL at transmission V level in China



160kV DC Resistive FCL Southern Grid

- Highest voltage and capacity worldwide at the time



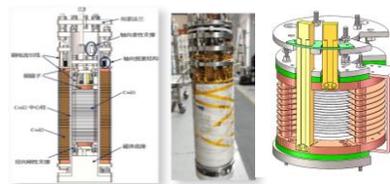
First 10kV superconducting AC cable in China Southern Grid/ZTT

- 400m, 10kV/43GVA
- In CBD Shenzhen



First 35kV superconducting AC cable in China State Grid/SECRI/SISC

- 1200m, 35kV/2200A
- In CBD Shanghai

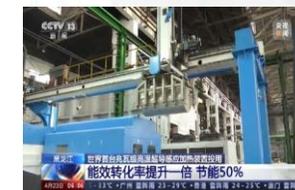


24.1T&26.8T All REBCO Magnet ASIPP/Tsinghua U

- First >20T densely wound all REBCO magnet



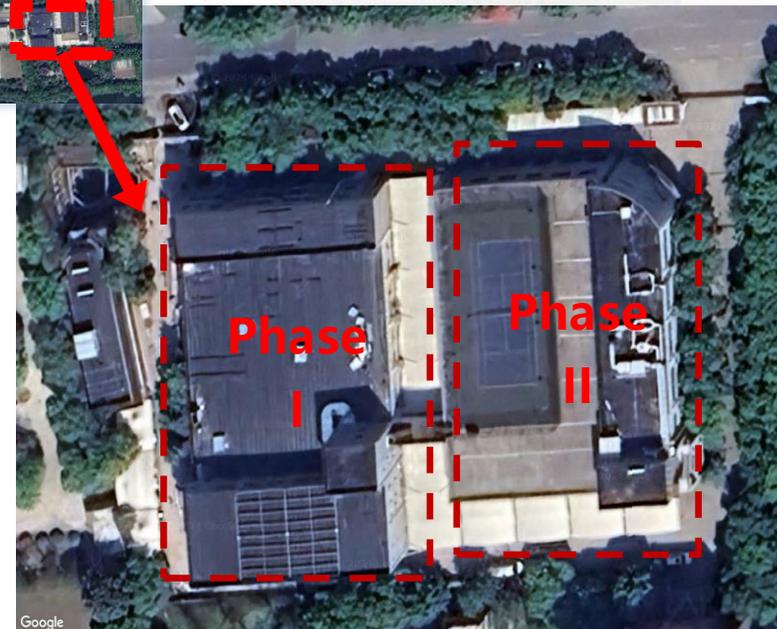
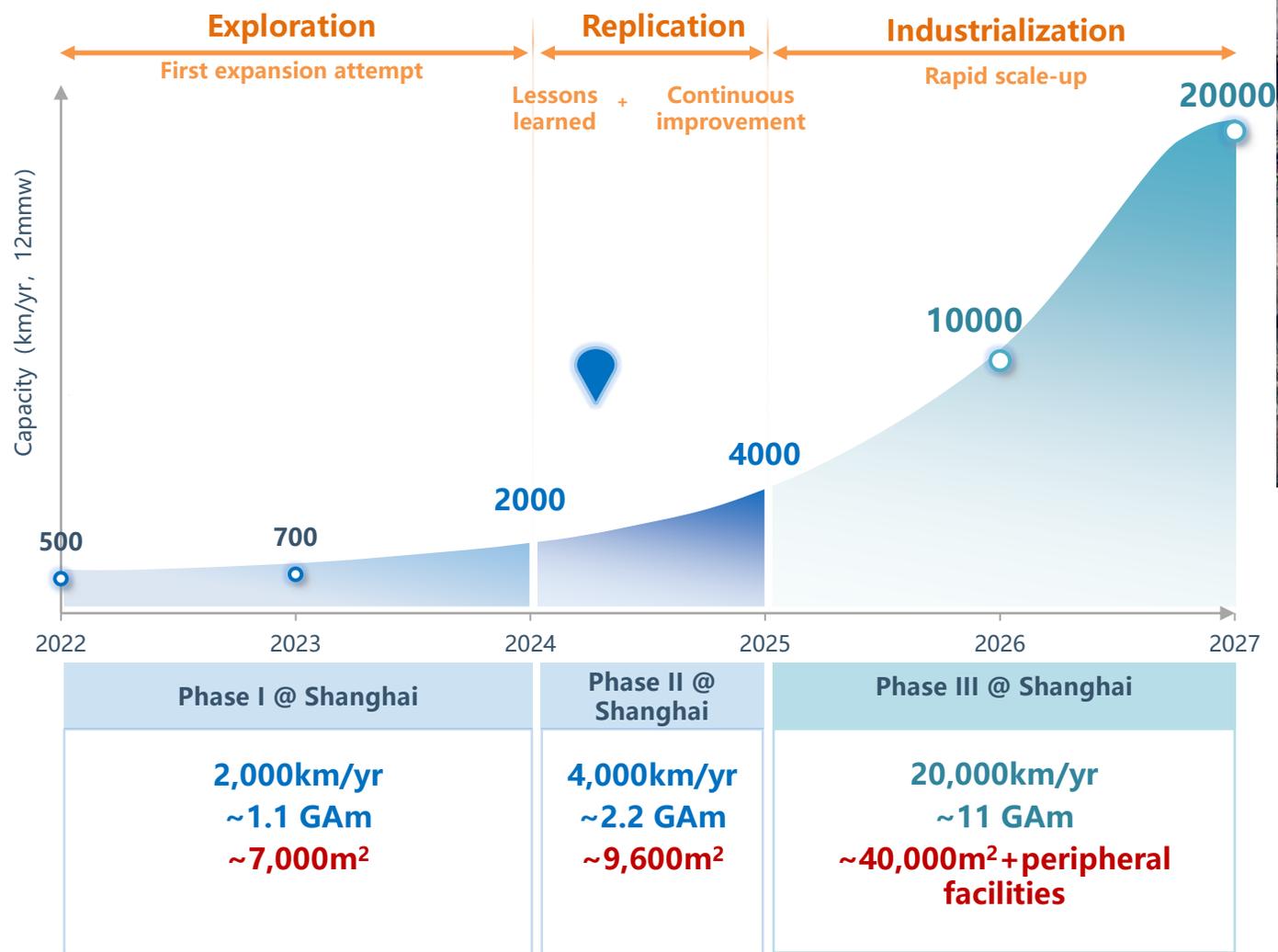
First all REBCO Mag Lev Train Demo in China CNRC



First MW-scale Superconducting Induction Heater in the world Lianovation

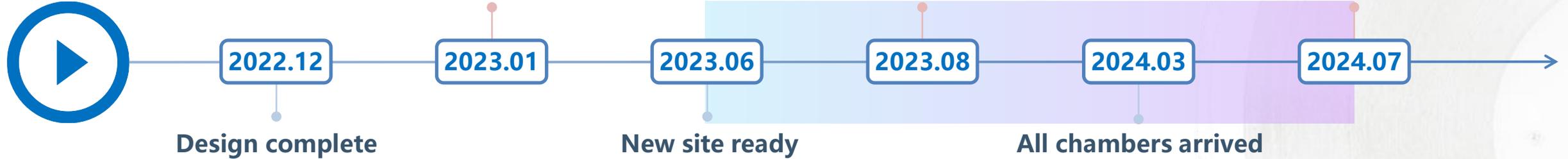
- 
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Expansion in Action



Phase I: First Attempt of Expansion

2022.07
START



Equipment upgrades applied during design for Phase I

- ~12 months from START to moving into new site;
- **Only 12 months** from new site becoming available till Phase I completion;
- Owing to SST' s autonomy to design and build its own equipment

Phase I: First Attempt of Expansion

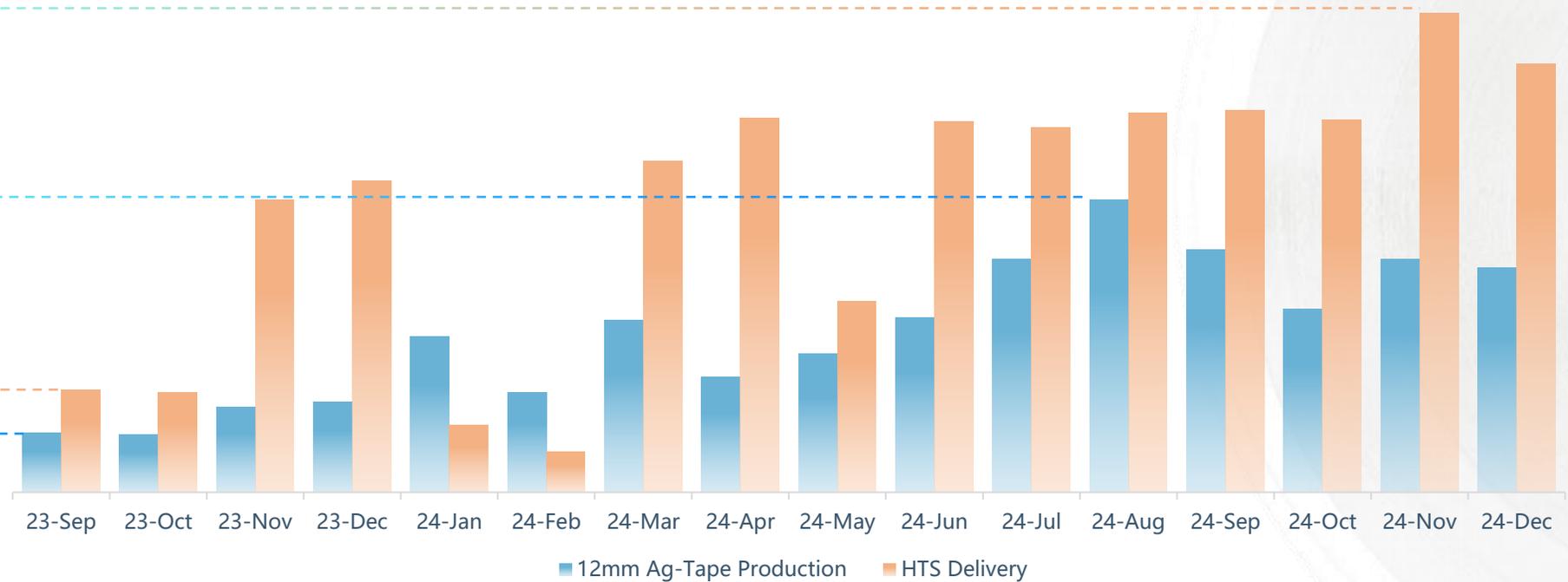
Major Equipment		2022 Number	2024 Number	Capacity/year
Upstream	Electropolishing Line	1	2	2,000 km 12mmw Ag-coated HTS
	Deposition for Buffer Layers	5	12	
	PLD (CeO ₂)	1	4	
	PLD (REBCO)	2	12	
	Ag Coating + Annealing	2	8	
Downstream	Slitting	2 MS	6 MS + 1 LS	2,500 km 4mmw 20um-Cu-plated HTS
	Electroplating	33m	33m * 16 * 2	or 17,500 km 4mmw 5um-Cu-plated HTS
	Lamination	2	12	2,500 km laminated or Sn-coated HTS
QC	MCorder	2	8	

Phase I: First Attempt of Expansion

2023.9-2024.12 Ag-Tape Production & HTS Delivery

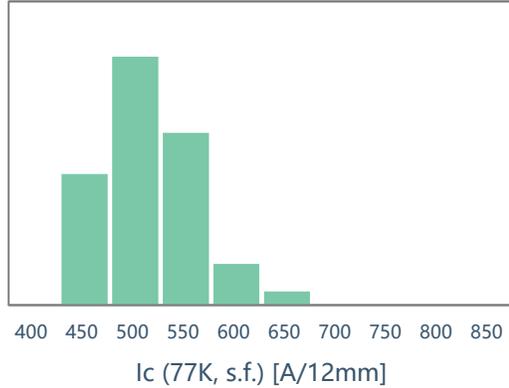
Downstream
production x5

Upstream
production x5

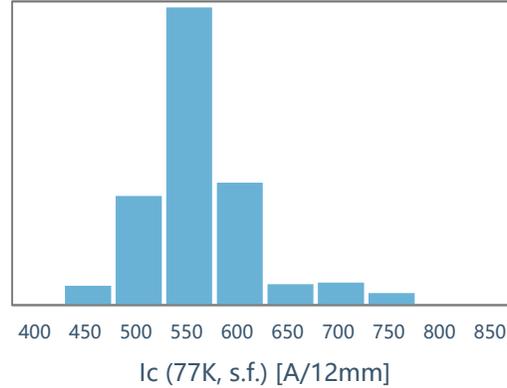


Phase I: First Attempt of Expansion

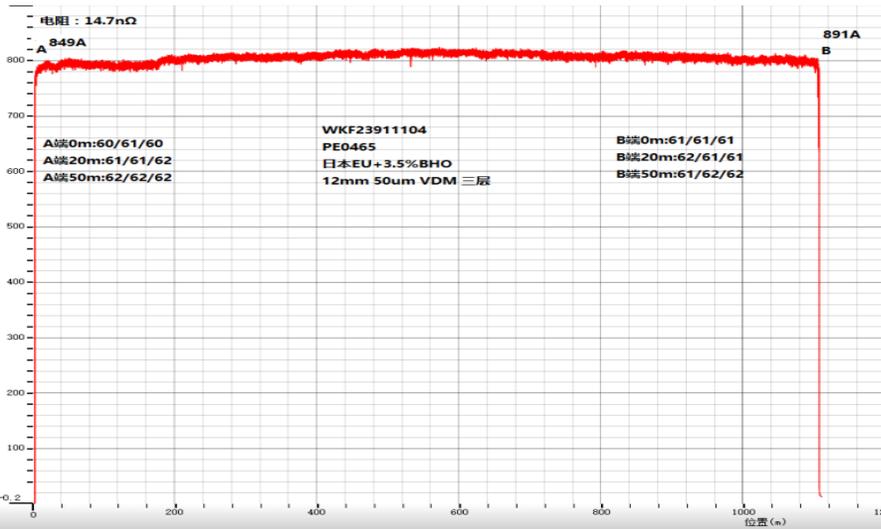
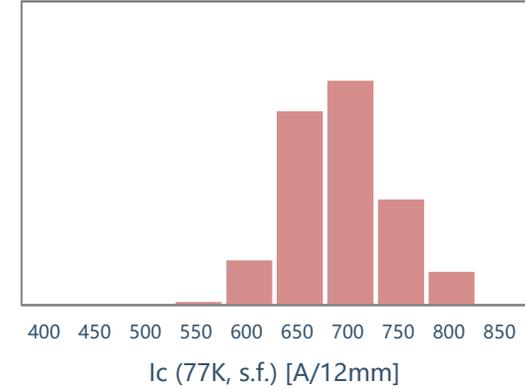
2022 Ic Distribution



2023 Ic Distribution



2024 Ic Distribution

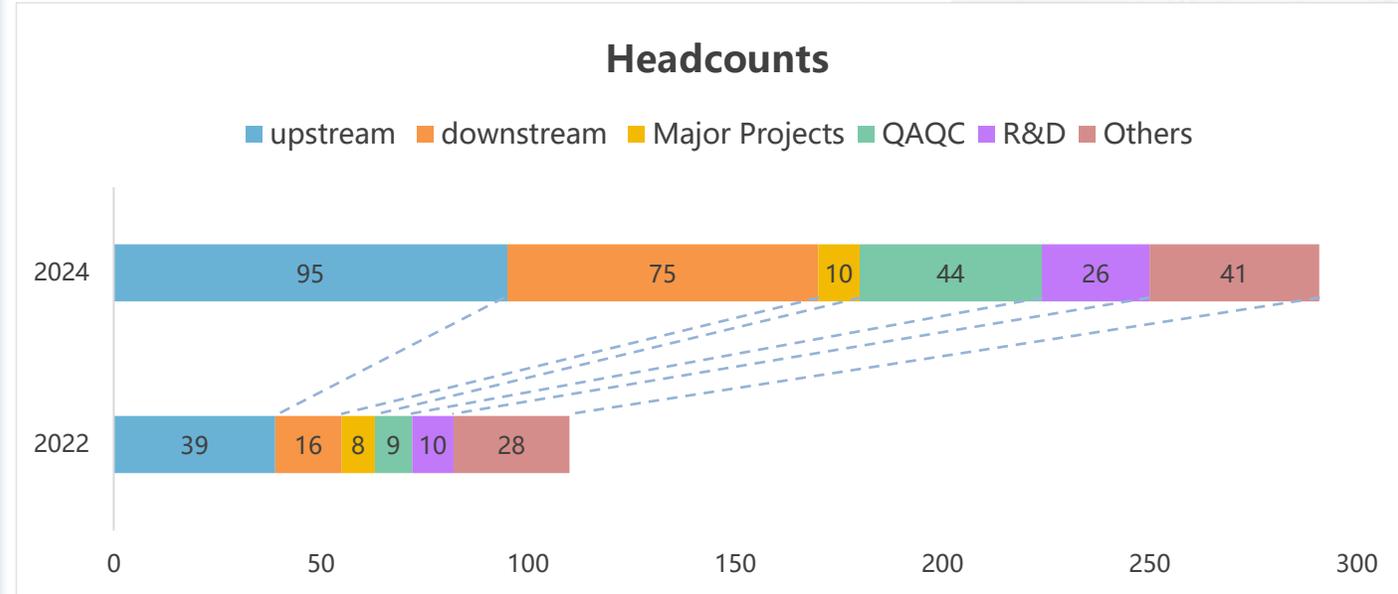


Meanwhile, our tape quality is also quickly improving:

- Mass product Ic range: **180-250 A/4mm @ 77K s.f.**
- Higher fraction of long pieces without dropouts
- Cu-plating homogeneity controlled with 1 micron

After restructuring, availability of capital has also empowered SST engineers to carry out extensive R&D, address the customer requirements one by one, and transfer the outcome into mass production.

Phase I: First Attempt of Expansion



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Challenges on Equipment Design

- Consolidating 10 years of know-how into the design of the new production line



- Improving ion source for IBAD

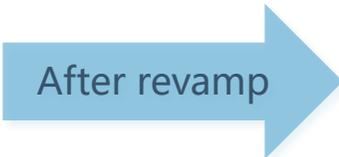


- Reducing the sizes for LMO deposition equipment

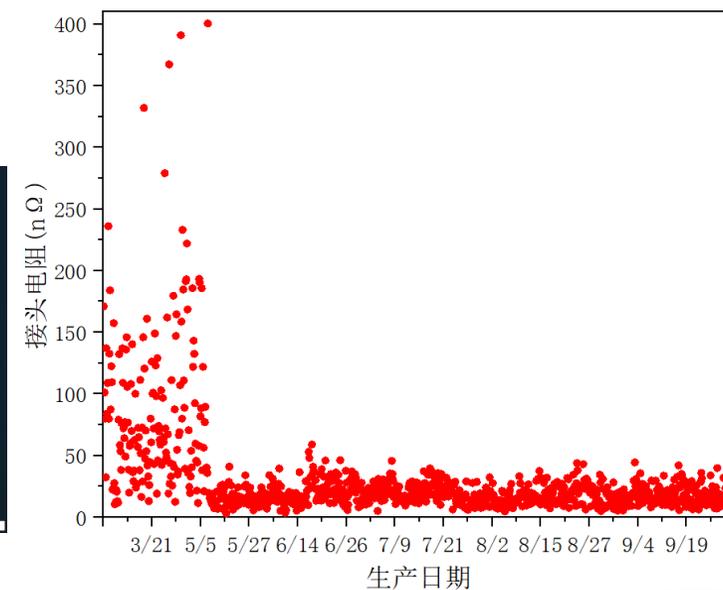
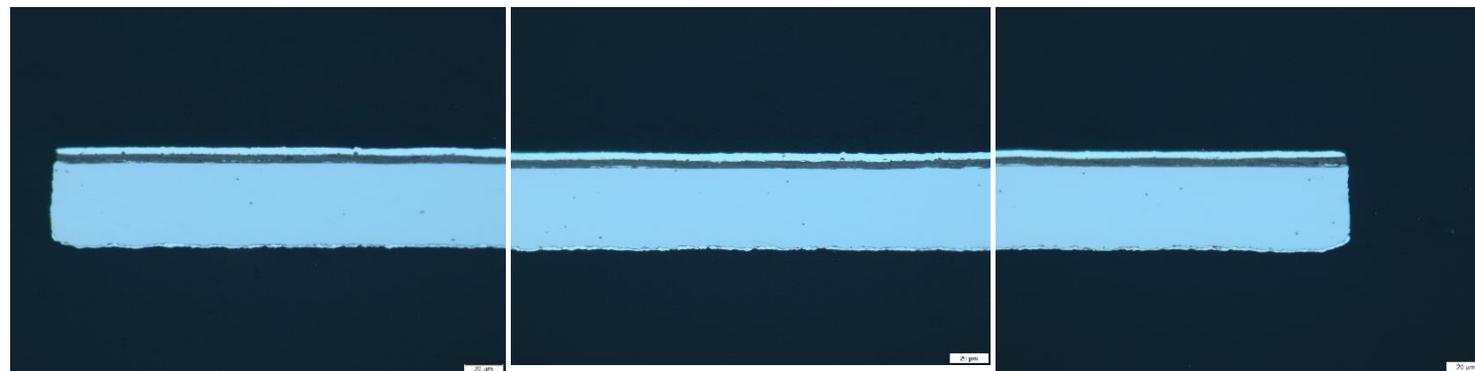
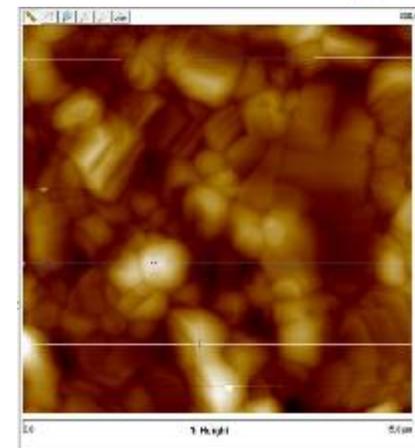
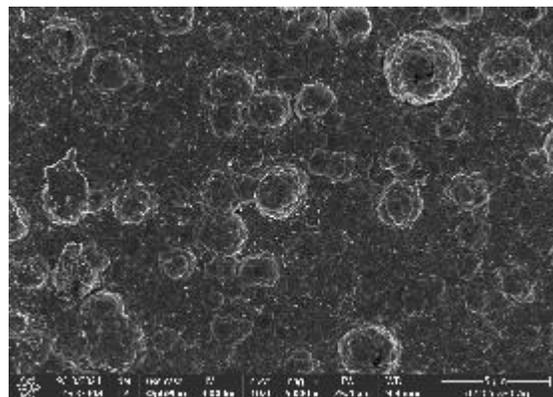
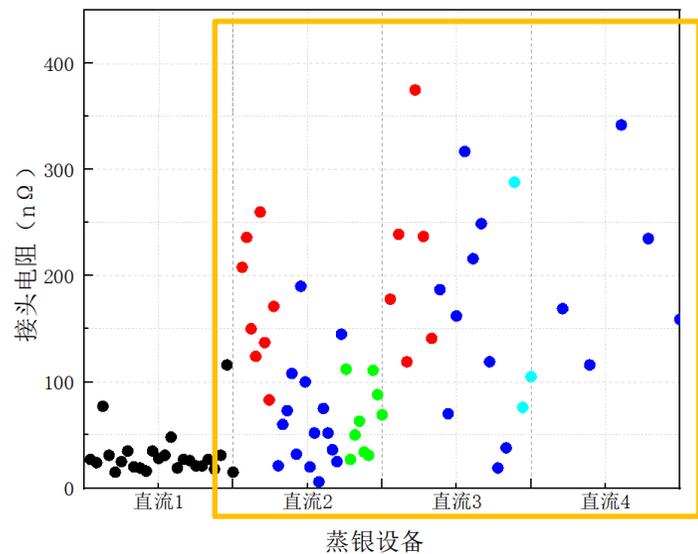


- 150K laser source for CeO₂ deposition is changed to 300C

- Standardization of processes: easier to operate, maintain and manage
- Standardization of parts: easier to maintain, replace and significant cost benefit
- Revamp equipment from the old production line



New design for Ag deposition didn't work as hoped!

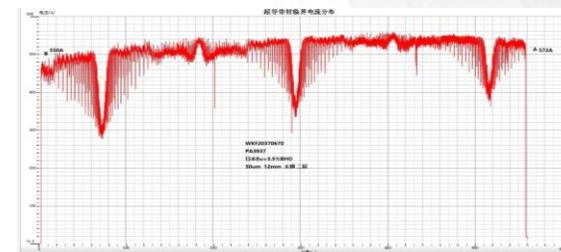
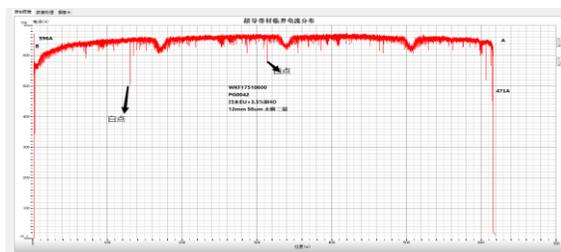
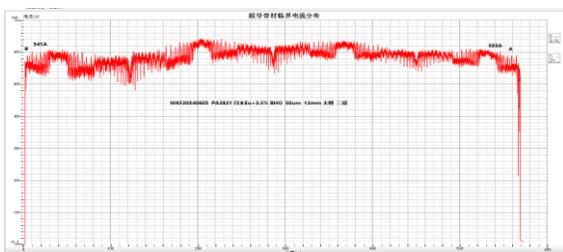
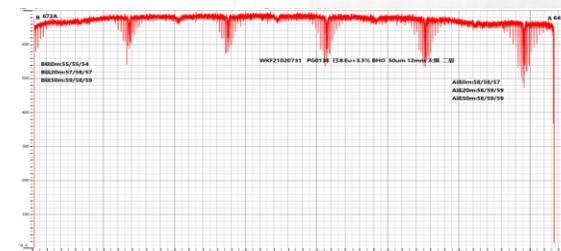
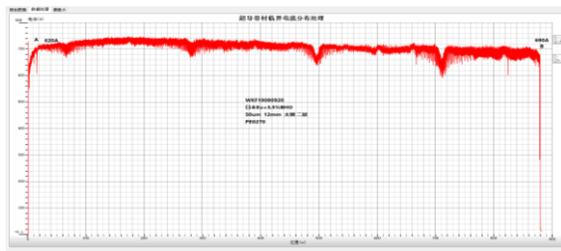
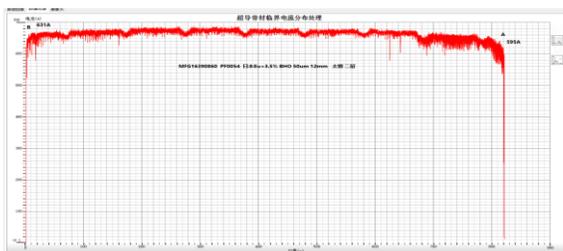
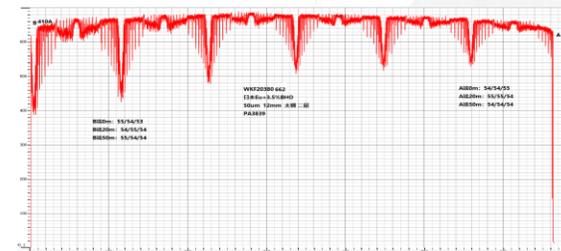
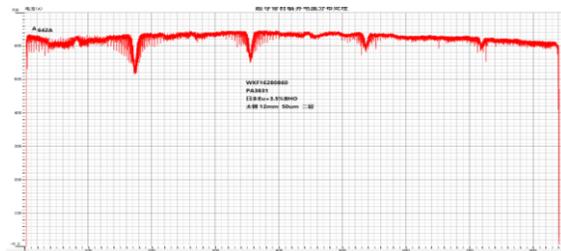
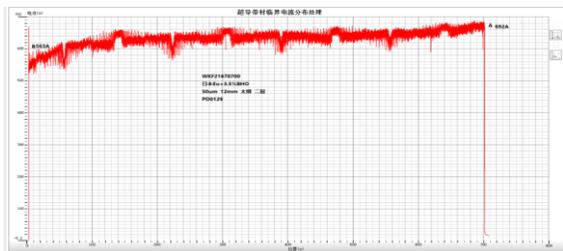


New design for CeO_2 deposition didn't work as hoped!

2024.1

2024.2

2024.3



13/81 pieces

21/67 pieces

47/161 pieces

Pa

PD

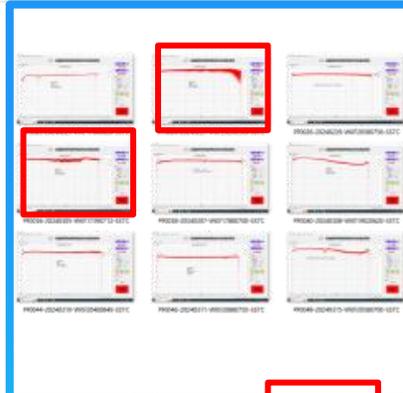
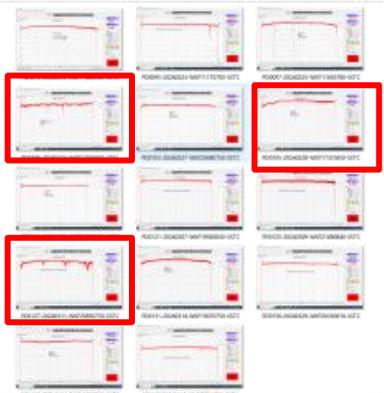
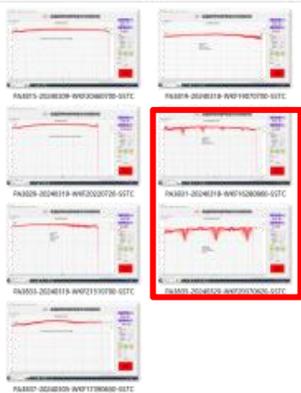
PE

PF

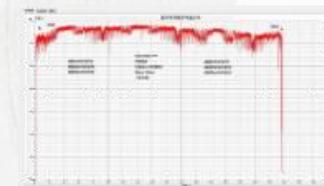
PG

PM

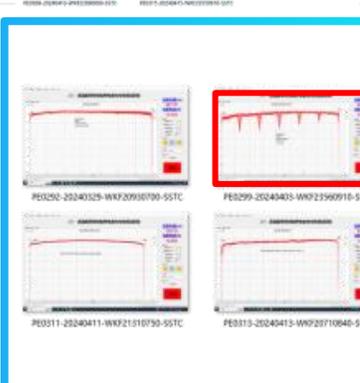
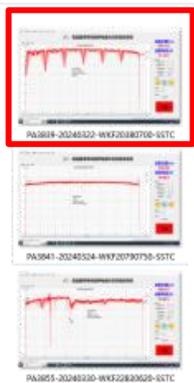
1c



1d

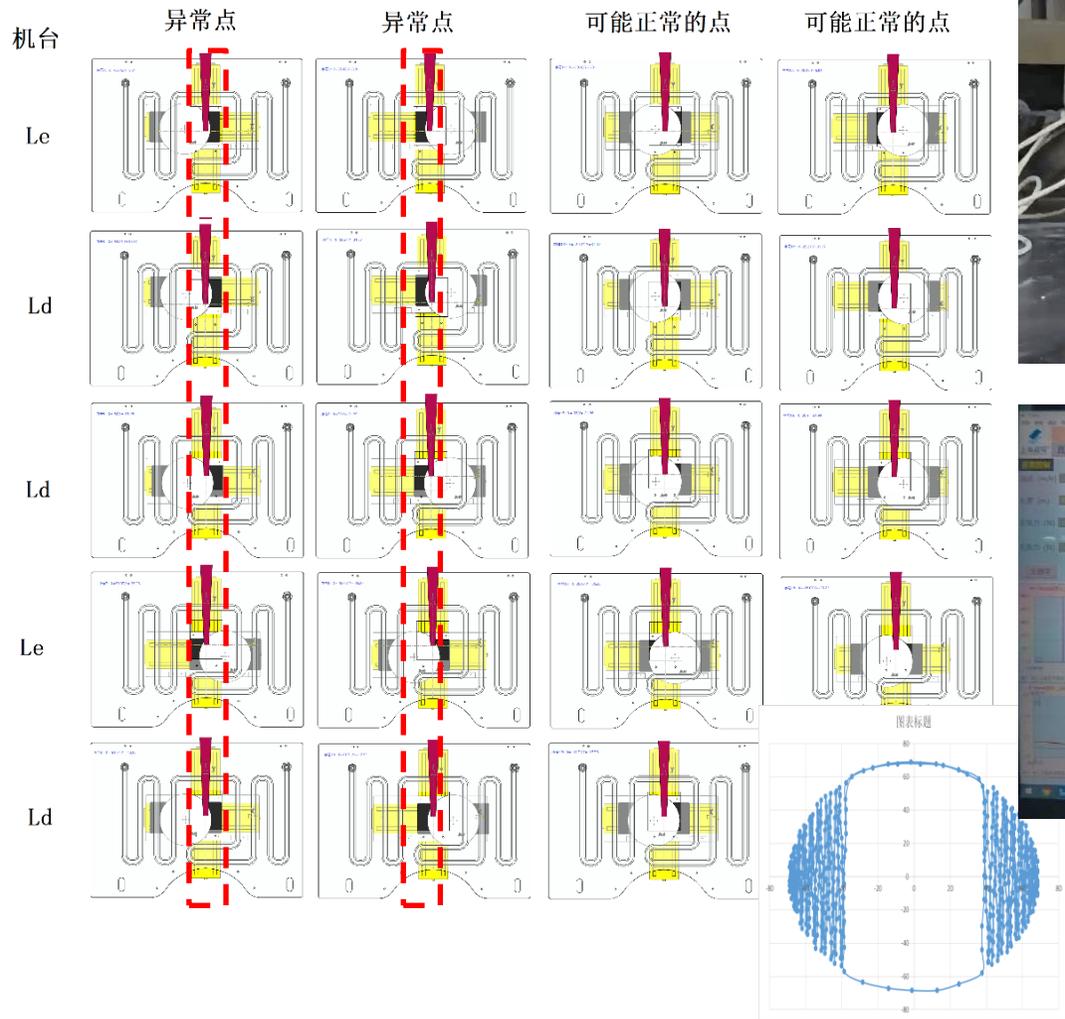


1e



Statistics as temporary solution

Process Input



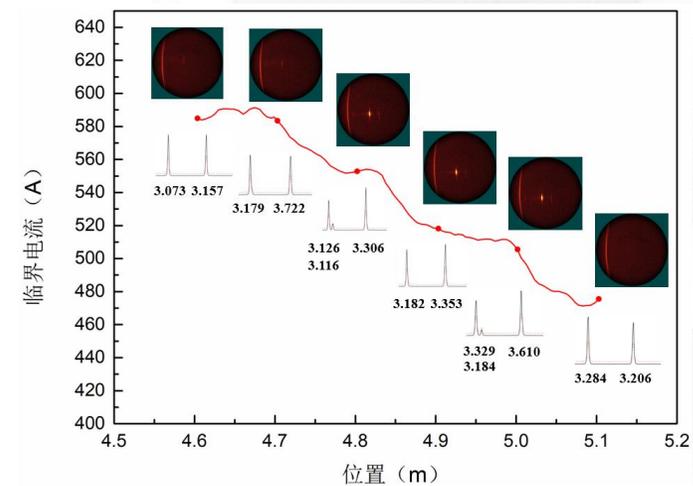
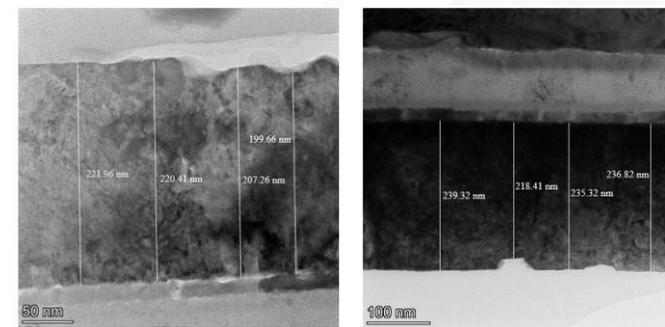
Equipment Input



Target Input



QC Input



Challenges on Equipment Installation

New suppliers brought new problems



Chamber falling during lifting



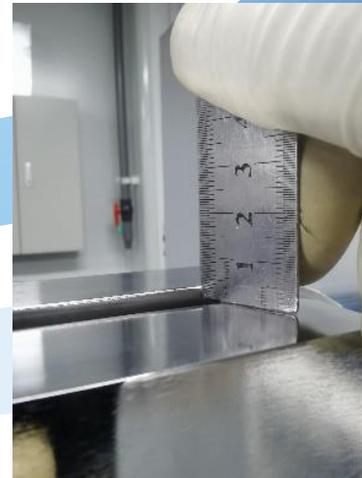
Chamber door flatness > 1mm



Very poor vertical variance of cooling plate



Difficult installation for elevated pumps



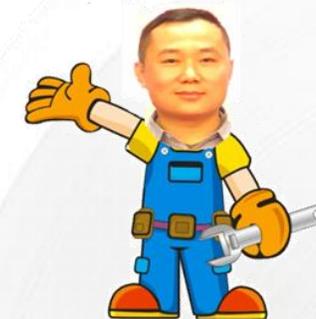
Misalignment of chamber door



Poor earthing caused motherboard to burn

Challenge on Operation

Steady operation means solving the problem faster than it occurs:
more proactive approach to identify the lifespan of the parts.



IBAD-MgO



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MS-LaMnO₃



.....



.....

PLD-CeO₂



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.....

.....

PLD-REBCO

Total 10

Total 36

Challenge on Operation

$Al_2O_3 + Y_2O_3$



R2R RF Mag. Sputter

MgO



R2R IBAD

LaMnO₃



R2R HT RF Mag. Sputter

CeO₂



R2R PLD

REBCO



R2R PLD

Ag



R2R DC Mag. Sputter

Window1

Window2

Window3

Window4

Window5

Window6

2024 Q1

Window1

Window2

Window3

Window4

Window5

Window6

2024 Q2

Challenge on Operation

$Al_2O_3 + Y_2O_3$



R2R RF Mag. Sputter

MgO



R2R IBAD

LaMnO₃



R2R HT RF Mag. Sputter

CeO₂



R2R PLD

REBCO



R2R PLD

Ag



R2R DC Mag. Sputter

Window1

Window2

Window3

Window4

Window5

Window6

2024 Q1

Window1

Window2

Window3

Window4

Window5

Window6

2024 Q2

Window1

Window2

Window3

Window4

Window5

Window6

2024 Q3

novel QC

Challenge on Product Tracking

- Time series data for Energy consumption/Operating conditions/Variables
- Operation warnings
- Plan for regular checking/maintenance/overhaul
- Predictive maintenance (CBM)

WORKFORCE

- Calculate manhours
- Overtime control
- Operator efficiency management

- Process record
- Production issue tracker
- Tape slitting strategy
- QC: Ic/Microscope/Thickness by Laser/Defect
- Video for final factory inspection
- Stocking and warehouse location
- Upstream and downstream data (raw material/outsourcing/end user)

EQUIPMENT

- Gather statistics for equipment operation
- Equipment MRO management (maintenance/repair/overhaul)



HTS TAPE

- Realtime tracking: location and status
- Digital processing record
- Product lifecycle management



Unlocking the Potential for RFID+

“Internet of Things”
+ “LLM”

Unlock
the power
of mass
data and
AI

Improve
yield,
efficiency
and
quality



Challenges on Environmental Control

主动公开

上海市浦东新区发展和改革委员会文件

沪浦发改张能审〔2023〕7号

关于上海超导科技股份有限公司第二代高温超导带材生产项目节能报告的评审意见

上海超导科技股份有限公司：
你单位报送的《上海超导科技股份有限公司第二代高温超导带材生产项目节能报告》
康威路777号超导带材生产
一、原则同意
二、预计年用电量（电力折标准煤
项目9

主动公开

上海市浦东新区发展和改革委员会文件

沪浦发改张能审〔2023〕7号

关于上海超导科技股份有限公司第二代高温超导带材生产项目节能报告的评审意见

上海超导科技股份有限公司：
你单位报送的《上海超导科技股份有限公司第二代高温超导带材生产项目节能报告》及相关材料收悉。该项目位于浦东新区康威路777号超导带材生产项目。经审查，具体意见如下：
一、原则同意该节能报告。
二、预计年用电量为1600.83万千瓦时，折算综合能源消费量（电力折标准煤系数按当量值1.229吨标准煤/万千瓦时计算）
项目代码：310155834756212022103101001

上海市张江科学城建设管理办公室

关于上海超导科技股份有限公司第二代高温超导带材生产项目申请核准污染物总量指标的函

浦东新区生态环境局：
近期，我办收到上海超导科技股份有限公司第二代高温超导带材生产项目污染物排放总量的申请，涉及的污染物指标具体情况如下：
上海超导科技股份有限公司位于康威路777号，主产第二代高温超导带材的生产，该项目总投资17000万元，项目工艺需新增 COD: 0.0956 吨/年，NH₃-N: 0.0022 吨/年，VOCs: 0.0628 吨/年，烟粉尘: 0.0065 吨/年。
为支持该项目建设，现向贵局申请由新区统筹调剂量 COD: 0.0956 吨/年，NH₃-N: 0.0022 吨/年，VOCs: 0.0628 吨/年，烟粉尘: 0.0065 吨/年。待新区建设项目“批项目核总量”相关文件确定发布后，我办将根据文件要求，尽快制定张江科学城十四五减排计划，并按计划中核准的时间节点归还统筹调剂量。特此致函，请予支持。

上海市张江科学城建设管理办公室
2023年1月4日

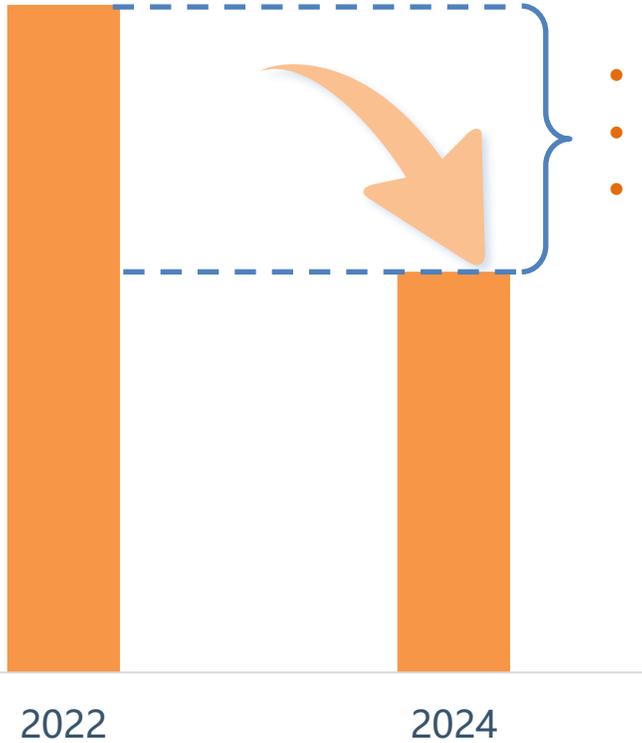


Challenges on Environmental Control

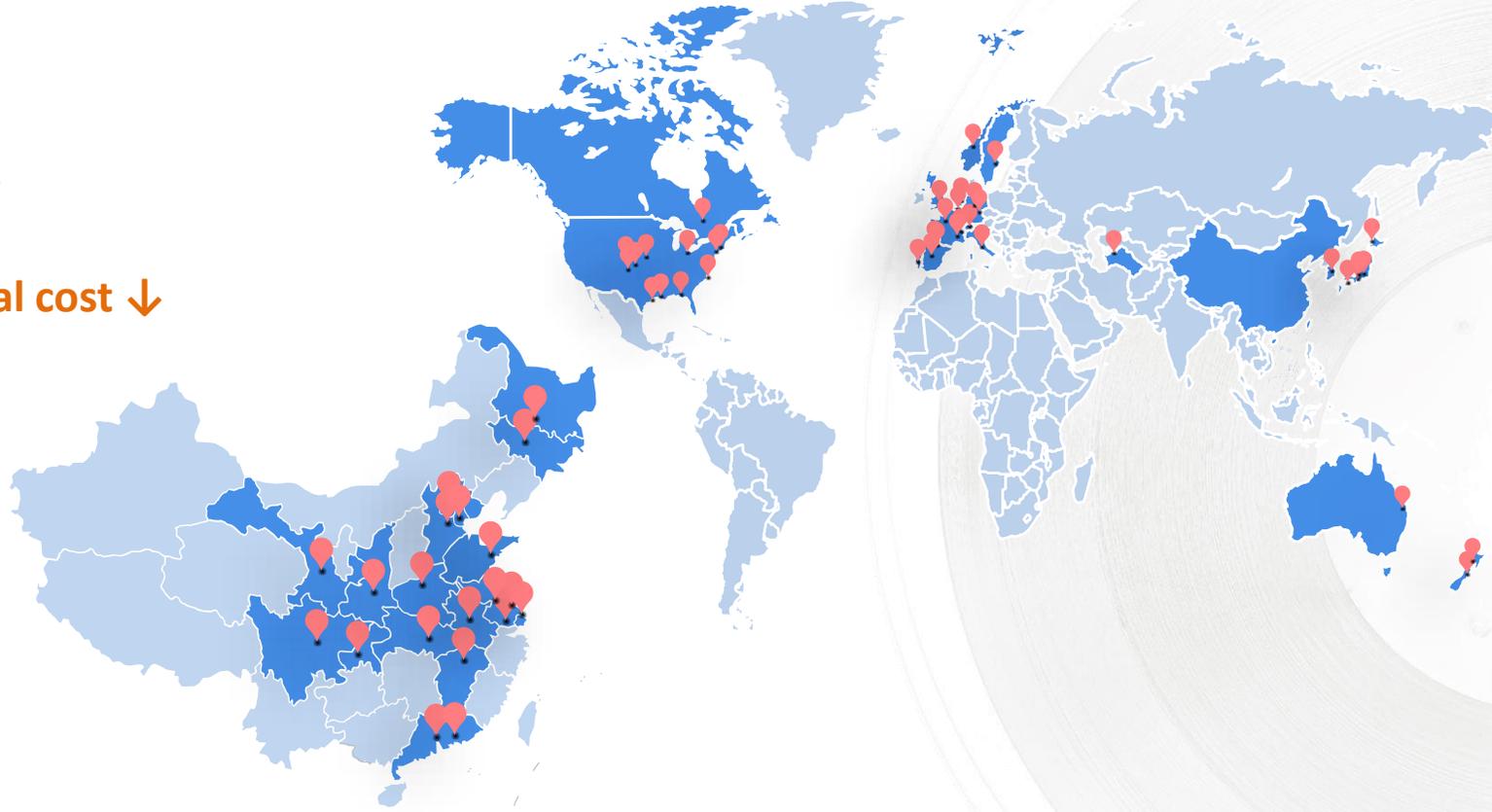
- 4/3电抛废水设备泡沫液位计断裂，更换新的泡沫液位计
- 4/8电抛废水陶瓷膜流量低，无法正常使用，拆卸陶瓷膜，使用高压气体对陶瓷膜进行疏通
- 4/19电抛低温蒸发设备1号压缩机低压异常，压力表显示0，拆卸发现**管道断裂冷却液泄露**导致
- 4/20添加冷却液之后，原因充入氟量过多，设备运载过程中电流过高导致
- 5/9电抛低温蒸发设备无故报**泡沫超高液位异常**，**泡沫液位计探头位置有破损**，导致触发异常
- 5/15电镀污水处理设备二级沉淀池pH值保持7.24无变化，导致碱泵一直工作，**二级沉淀池pH探头损坏**
- 5/21日电抛低温蒸发设备**陶瓷膜堵塞**，流量过低(50Hz/0.12m³/h)无法保证正常排水
- 5/25电抛低温蒸发设备中继桶液位异常(109.4%)导致原液泵无法正常工作，**液位传感器失灵**
- 5/26电抛低温蒸发设备一号压缩机过载异常报警，**过滤网全部堵塞**
- 6/5电镀污水处理**一级沉淀池计量泵堵塞**，拆卸后疏通计量泵管道
- 6/6电抛两台设备同时大量用水，导致箱体变形
- 6/11电抛污水处理陶瓷膜5、6电磁阀故障
- 6/12空压机故障停机，故障信息显示为排气温度高(100C°)，**油气桶少量缺油**
- 6/27电抛污水处理蒸发釜压力达不到要求，循环水箱超温(未报警)导致真空泵抽吸能力下降
- 7/5电抛低温蒸发系统压缩机持续高压异常，面板显示温度较高(43C°)
- 7/8空压机1号冷干机故障停机，重启短暂运行后仍自动停机，遮雨板影响散热，拆卸部分遮雨板
- 7/17纯水制备时受药桶内碱液浓度影响会导致纯水电导率不稳定
- 7/18电抛低温蒸发设备热泵温度过高导致1号压缩机高压异常报警，复位无法恢复工作
- 7/20空压机侧面开散热口，进一步为空压机散热问题提供保障
- 7/22废气处理一号风机吸力变小，清理一号淋洗塔内附着污垢
- 7/24电抛低温蒸发设备消泡剂进液故障导致泡沫液位异常造成设备停机
- 7/24电镀污水处理设备二级沉淀池1号排泥泵运行时漏水
- 7/25下雨导致电抛低温蒸发设备循环水箱液位传感器失灵，误报异常信息
- 7/30设备旁加装大型散热风扇，进一步为电抛污水处理设备散热问题提供保障
- 8/4废气处理2号风机管道漏气，焊接接头处裂口
- 8/8电抛低温蒸发设备泡沫液位异常，取出探头清理表面结垢
- 8/14空压机2频繁加载卸载运行，造成震动过大，修改加载卸载压力参数
- 8/29化学间排污水中含环保检测的杂质较多，改进排放方式，过滤粗密度杂质后再排放
- 8/30电镀污水处理设备压滤机油箱与压力表连接处漏油，更换压滤机油箱与压力表连接处油封
- 9/2早上两台污水在线监测设备都显示铅含量超标，需要做释。
- 9/4废气处理设备2号淋洗塔水泵异响，拆卸检查发现**轴承损坏导致轴体腐蚀**
- 9/12空压机油气桶顶部漏油
- 9/23空压机储气罐电磁阀控制器和线圈损坏
- 9/24电抛低温蒸发设备多次出现蒸发釜消泡异常，单次持续13秒左右
- 9/24污水处理设备集水池pH值偏高(9-12.3)，电抛低温蒸发设备排浓缩液并碱洗后**蒸馏水偏碱性进入电抛出水池。耦合淋洗塔大量杂质铵盐杂质**
- 9/19、9/22、9/25冷干机#1各无故断电一次，清理过滤网积尘和杂质
- 9/24电镀污水处理设备pH回调池pH值低于正常值(3.1)，疑似回调池加酸泵错误运行导致pH偏低，手动调节pH并清洗pH探头
- 9/25一号淋洗塔内过滤球及滋生物整体清理，清理后同频率下流速从30增长到35

Significant Achievements Brought About by Phase I

Cu-plated Cost Reduction >40%



- Efficiency ↑
- Scale factor
- Raw material cost ↓



2023, 2024



130⁺
Customers
in China

50⁺
Customers
in ROW

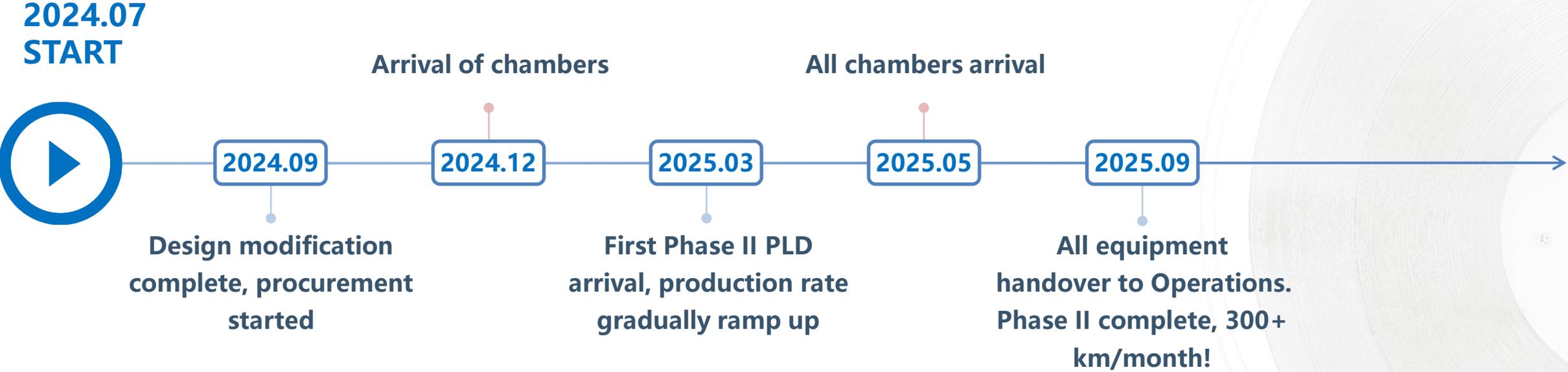


48 M\$
Chinese Sales

6 M\$
ROW Sales

- 
- 01 Introduction to SST**
 - 02 SST' s Expansion Achievements So Far**
 - 03 Expansion Challenges**
 - 04 Future Outlook**

Phase II: Quick Replication of Expansion Success

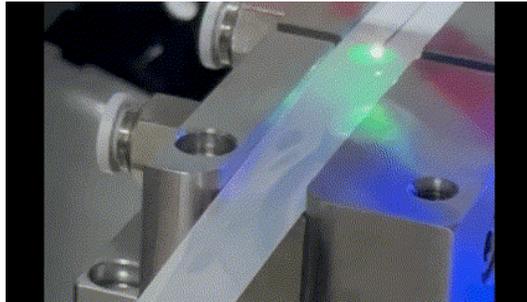


Phase II Cost Reduction Anticipated:

- 1. Raw material
- 2. Supply chain of equipment
- 3. Advanced QC techniques

2025 Product Development #1: Laser Slitting and Striation

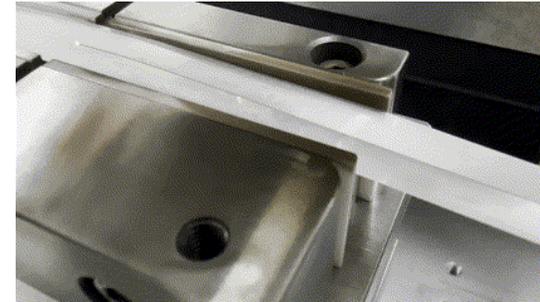
- Complete optimization for all laser slitting set-up, select the winner, multiply and apply to commercial production.



UltraViolet (343nm)



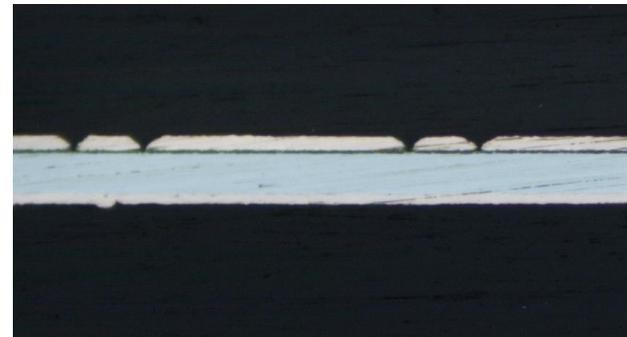
Green (515 nm)



InfraRed (1030 nm)

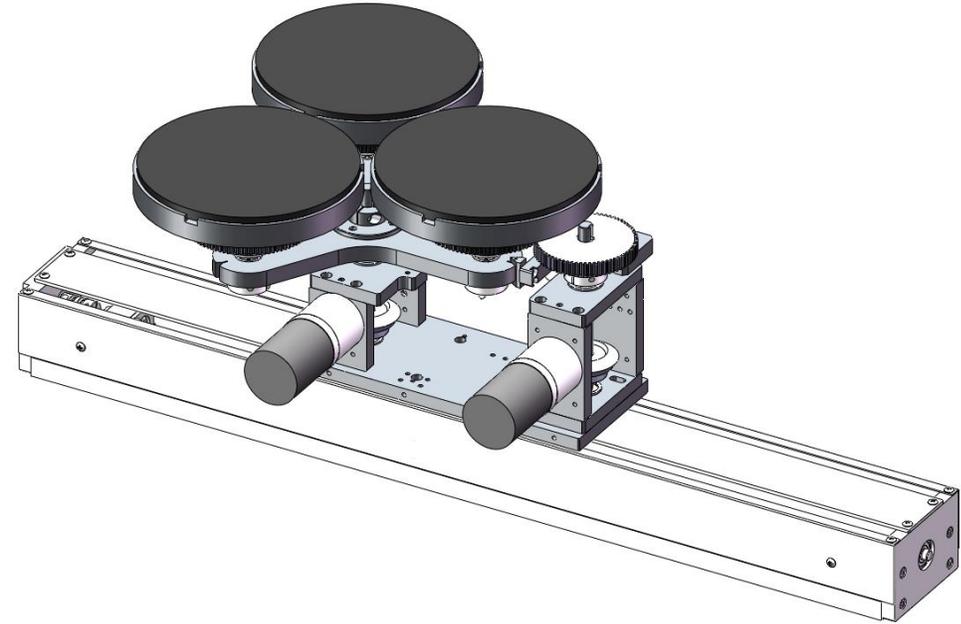


- Start to optimize laser set-up for mass production of striated tapes



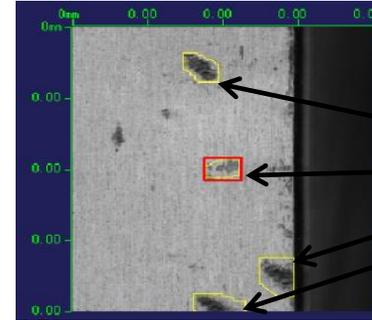
2025 Product Development #2: Higher Pinning REBCO

- R&D target production accomplished in house
- Carry out high throughput experiments in search for high performing pinning formula for PLD

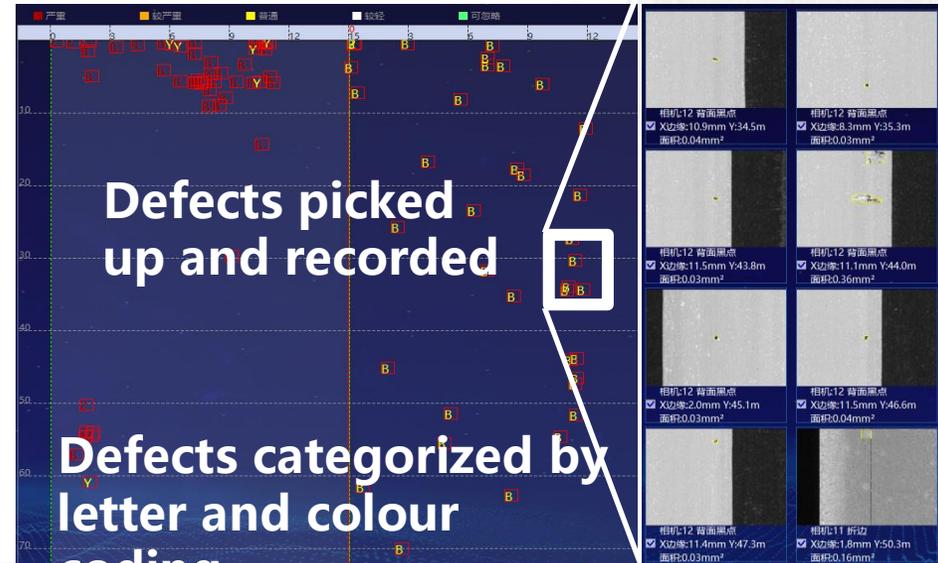


2025 Product Development #3: Longer Piece Length

- Reduce defects that lead to dropouts, increasing effective piece length



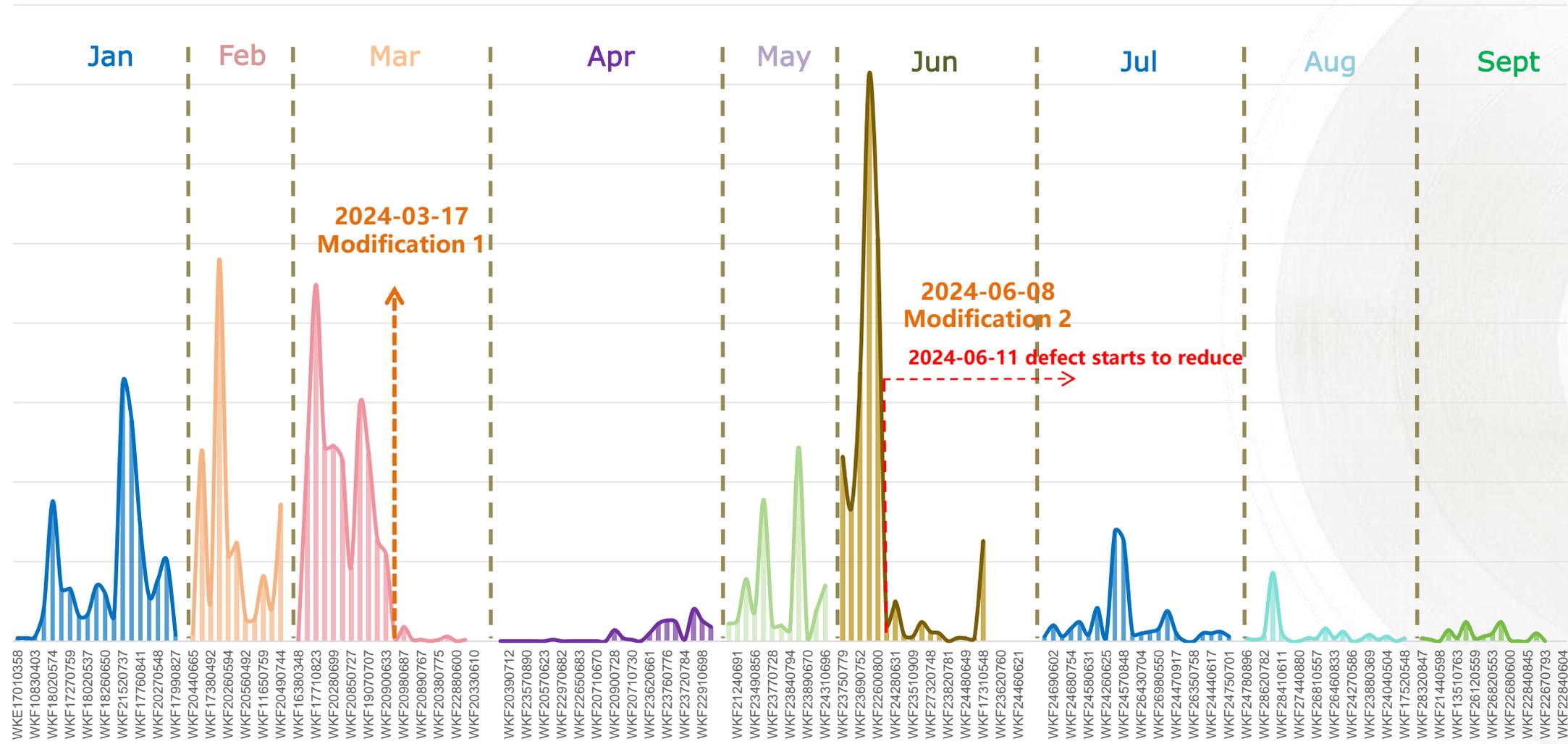
AI picking up microscopic defects on tape surface



■ 严重
 ■ 较严重
 ■ 普通
 ■ 较轻
 ■ 可忽略

2025 Product Development #3: Longer Piece Length

>1mm white spot PLD4

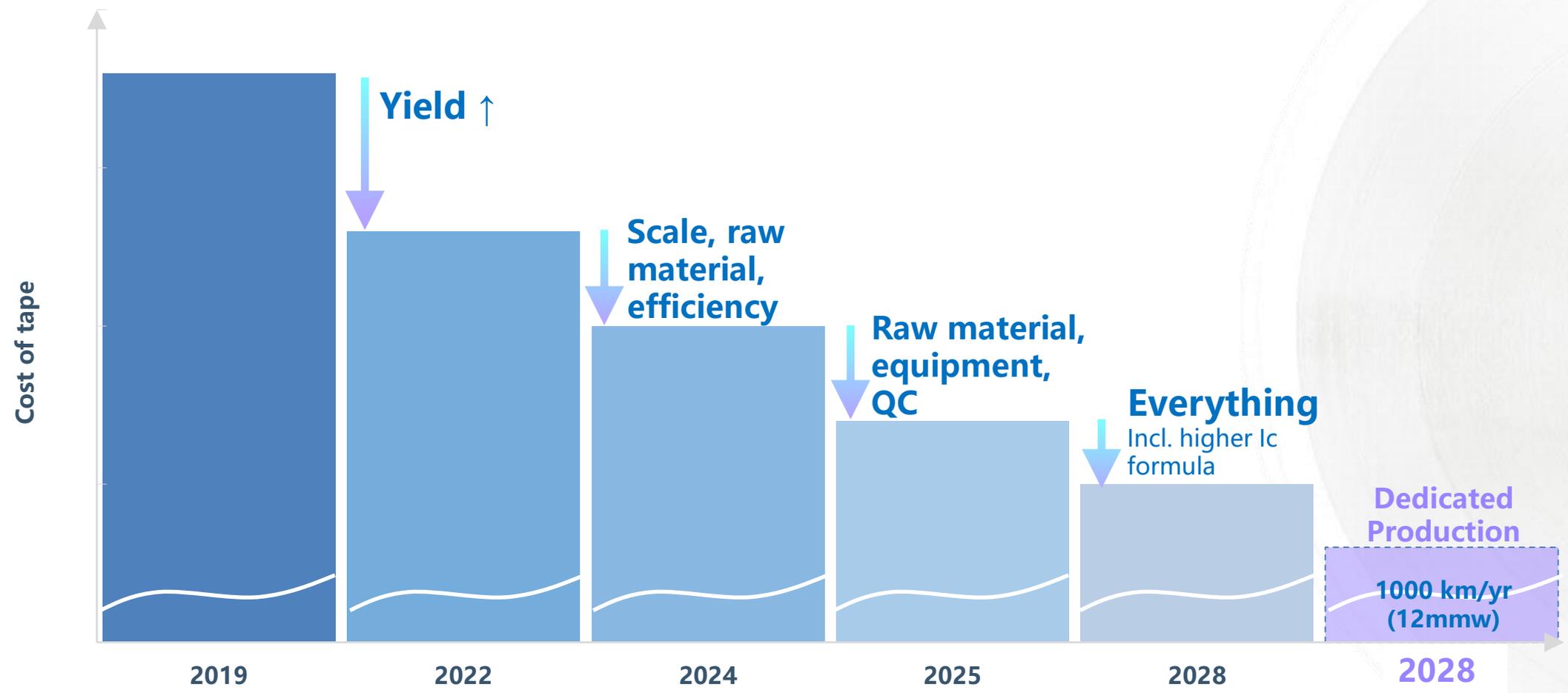


The REAL Industrialization

- Raise capital from the Chinese primary and secondary capital markets, triggering funding for Phase III expansion;
- Currently in frequent discussion with local government to settle land lease and permitting.



Cost Reduction Roadmap



Conclusion and Outlooks

- SST is a relatively young company in REBCO industry, but has progressed quickly and gone through steep learning curve.
- SST REBCO tapes are fully commercialized: > 5000 km (4mm equivalent) supplied over 2020-2024, another 5000 km anticipated in 2025.
- The product's quality and robustness are fully demonstrated: successful projects in all kinds of applications; a competitive supplier to worldwide developments.
- Large volume production by IBAD + high speed PLD: 2000 km 12mmw capacity available now, 4000 km to be available in 2025 Q4.
- SST is new to expansion project management and has accumulated lots of lessons learned in this process. Phase II will significantly benefit from these lessons learned, but soon we will move onto the next level of challenges at Phase III.
- HTS pricing has come down and will keep coming down at SST.



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