



## Electric Vehicle Batteries Made in Europe

Lighthouse Projects for EV Batteries Made in Europe

*Series Production of Li Ion Batteries*

Continental Powertrain HEV – Ralf Schmid – 30.11.2010

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### Series Production of Li Ion Batteries

*The Content*

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**Organization and Footprint**

**Actual Series HEV Battery Manufacturing**

**Future EV/HEV Battery Manufacturing (FUEL)**

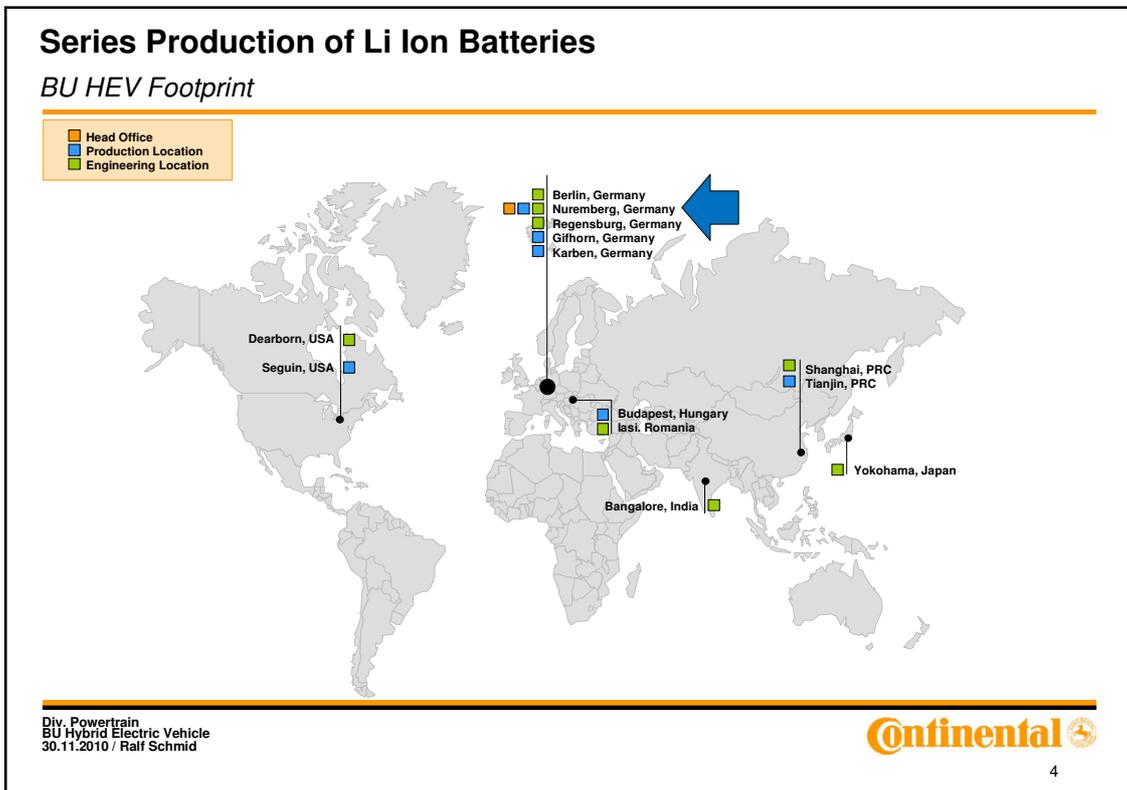
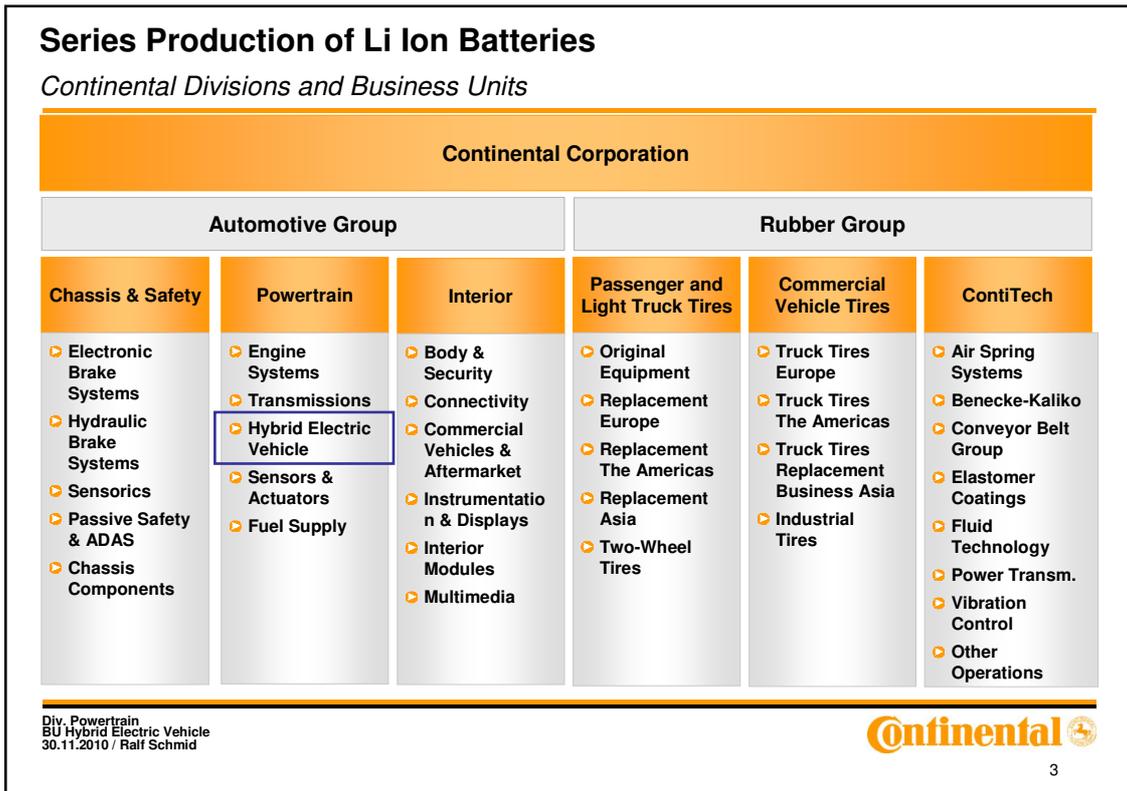
**Quality Aspects**

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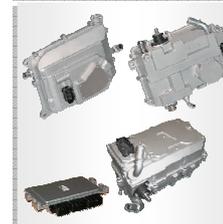
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## Series Production of Li Ion Batteries

*BU HEV Product Portfolio*

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Power Net System	Energy Storage	Power Electronics	Electric Machine
 <p><b>Power Net System</b> → DC/DC + DLC or Lilon battery</p> <p><b>Functions:</b> → Reasonable regen. Braking → peak power supply → Stable 14V board net → Energy on demand</p>	 <p><b>Battery</b> → Battery system → Battery Management Control → Cell Supervision Circuit</p> <p><b>Functions:</b> → Lilon Energy Management for HEV/EV → Battery Management → Cell supervising → Thermal Management</p>	 <p><b>Electronic Control Unit for electric propulsion system</b> → Single Inverter for synchronous &amp; asynchronous machines → High power DC/DC Converter → Hybrid- / EV controller</p> <p><b>Functions:</b> → E-Machine control → Voltage conversion from hybrid energy storage to standard board net</p>	 <p><b>Electric machines for HEVs and EVs</b> → Induction machine (ASM/IM) → Permanent magnet synchronous machine (PSM) → Externally excited synchronous machine (SM)</p> <p><b>Functions:</b> → pos. or neg. torque</p>

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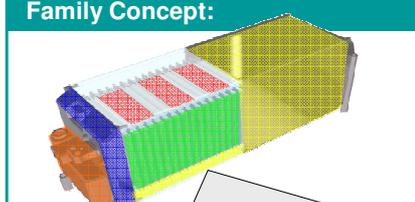
## Series Production of Li Ion Batteries

*Li-Ion Battery Systems*

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Family concept was developed in order to target small hybrid vehicles up to power full electric vehicles

**Family Concept:**



**Different Applications:**


↔


Systems for hybrid vehicle      Systems for electric vehicle

Safety component, Sensors	Battery Management Controller	GSC	GSC	GSC	GSC	Battery module (Cell module)	Integration + Mechanic + Cooling
<b>Basic</b>						<b>Application</b>	

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### Realized Battery Systems



Li-Ion Energy Pack	ELF1-1	ELF2-20	ELA2-40	ELF2-60*	ELF3-105	ELF4-55	ELF4-60
Project Status	Series	B-Sample	B-Sample	B-Sample	A-Sample	A-Sample	A-Sample
Max. power discharge @ 10s / 20 °C	19 kW	20 kW	40 kW	60 kW	105 kW	55 kW	60 kW
Nominal Voltage	122 V	126 V	302 V	333 V	360 V	366 V	390 V
Capacity	6 Ah	5,5 Ah	5,5 Ah	5,5 Ah	40 Ah	45 Ah	50 Ah
Volume approx.	13 l	12 l	45 l	50 l	120 l	90 l	110 l
Weight approx.	26 kg	25 kg	45 kg	60 kg	180 kg	140 kg	175 kg
Nominal energy (typically useable)	800 Wh (ca. 250Wh)	730 Wh (290 Wh)	1.700 Wh (680 Wh)	1.830 Wh (730 Wh)	14.400 Wh (10.800 Wh)	17.200 Wh	18.300 Wh



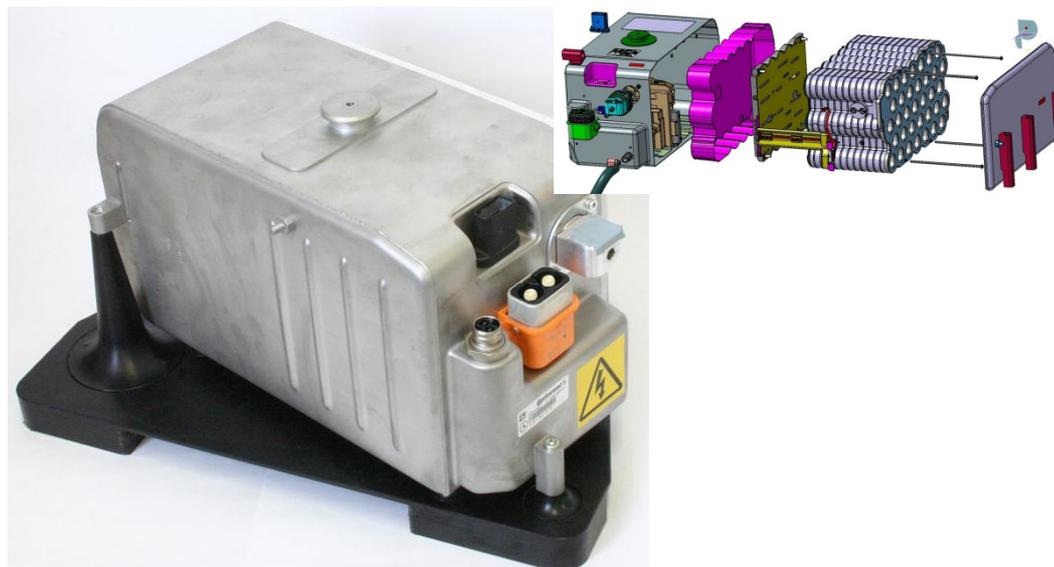
\* Truck application

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### Actual Product ELF1-1 – Launched 2008 at Continental in Nuernberg/Germany

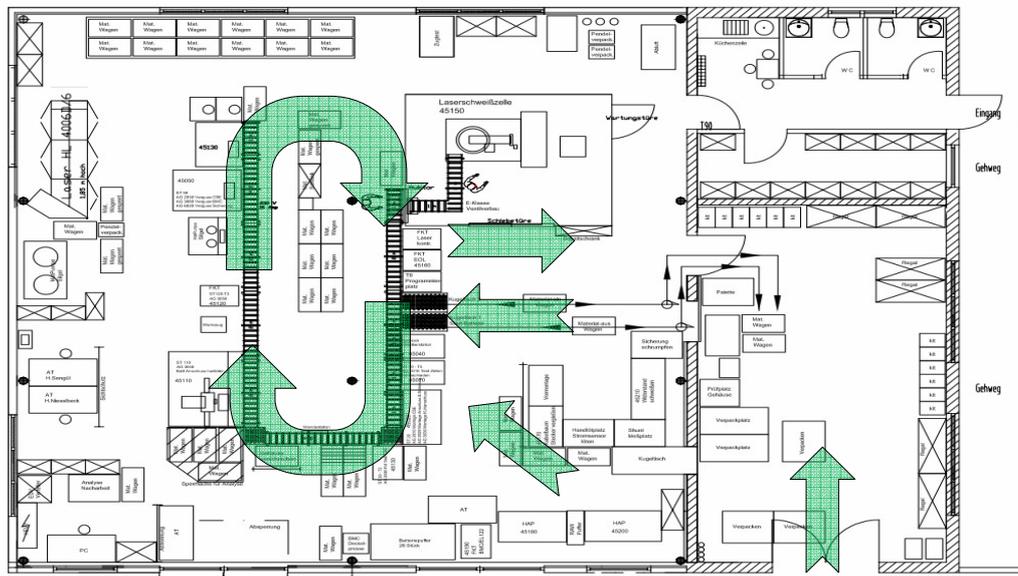


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ELF1-1 Manufacturing Layout/Material Flow (Lean Approach)



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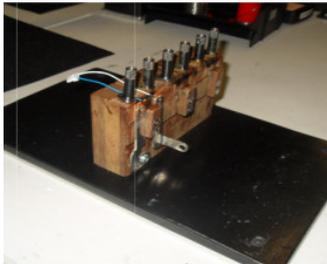


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## Series Production of Li Ion Batteries

Pre-Assembly

Shunt Assembly



DCDC Bus Bar Welding



Fuse/Relais/BMC Assembly



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### Pre-Assembly

Pre-Assembly Housing with BMC (Pick to Light)



Electrical Pre Test



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### Assembly

Incomming Electrical Cell Test / Start Traceability



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### Assembly

#### Assembly of the CSE (cell supervision electronics, Fuse, Electrical Test)



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## Series Production of Li Ion Batteries

### Assembly

#### Assembly of the Housing with the Cell Block – Welding the Battery Connection



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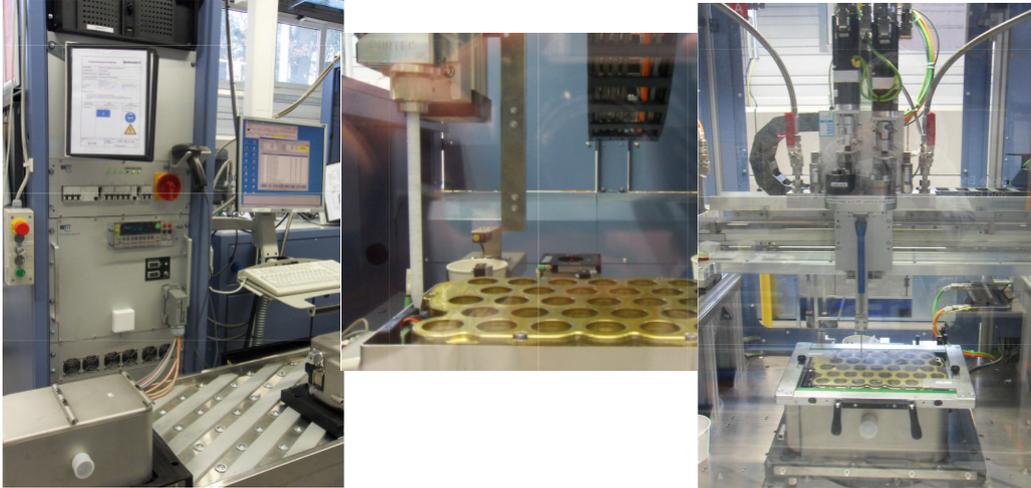


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### Assembly

#### Testing with parallel Charging, Potting, Curing



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### Assembly

#### Laser Welding of the Housing (Stainless Steel)



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### *Assembly*

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#### **EOL Test, Flashing of the Application Software**



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### *Safety Measures*

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- ✓ **Special Training for High Voltage / working with Li Ion Batteries (ext/int)**
- ✓ **Avoiding any Short Circuits through the whole manufacturing process**
- ✓ **Fire safety measures**
- ✓ **Evacuation Plan**
- ✓ **Extensive Training + Re-Training**

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## Series Production of Li Ion Batteries

*Future Battery Manufacturing – Partially BMBF supported*







ZF-Friedrichshafen AG    ads-tec GmbH

Home

Ziele

Projekt

Partner

Aktuell

Kontakt

### FUEL - future goes electric

Li-Ionen Batterien für Hybridfahrzeuge

**Projekt**  
ZF, Continental und ads-tec entwickeln für ein vom Bundesministerium für Bildung und Forschung (BMBF) gefördertes Projekt Komponenten für Lithium-Ionen-Batterien für... mehr

**Ziele**  
"Ziel von FUEL ist es, innovative Fertigungstechnologien zu entwickeln und diese auf das neue Produkt Li-Ionen-Energiespeicher für Lastkraftwagen und Busse ... " mehr

GEFÖRDERT VOM



Bundesministerium für Bildung und Forschung



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*Future Battery Manufacturing*

Baugruppen und Komponenten	Produktionstechnik	Test und Validierung
Li-Ionen-Zelle (Softpack) incl. Ableiter und Querbalken 2 Zellen + 1 Kühlblech = Bi-Pack x 6	Automatisiertes Nieten und Kleben	900 V Test
Zell-Überwachungs-Elektronik incl. Flexboard x 1	Automatisiertes Zuführen, Positionieren, Arbeiter kontaktieren, Flexboardanschluss	900 V Test
x 3	Elektronik und Flexboardmontage	900 V Test
Elektromechanik Schütze, Stecker, Kabel etc. Steuerelektronik Gehäuse Kühlung etc.	Komponenten-Endmontage, Leiter- und Kühlungsverbindungen	900 V Test Funktionsprüfung 100% Qualifizierung: - Schutzklasse - Dauerfestigkeit - Prozessfähigkeit
<b>Fahrzeug-Hybridsystem</b>		
AP 1	AP 2	AP 3
NKW Speichersystem: Komponenten ZF, Continental	NKW Speichersystem: Produktionstechnik ads-tec, Continental	Testverfahren, Validierung u. Systemdemonstration ZF, ads-tec, Continental
<div style="background-color: #0056b3; color: white; padding: 5px; margin: 0 auto; width: 80%;"> <b>FUEL</b>                      Koordination: Continental                 </div>		



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### Future Battery Manufacturing

- **The present market of hybrid systems for commercial vehicles doesn't provide any battery solution based on soft-pack / coffee-pack formatted Li-Ionen cells**
- **Assembly technologies need to be developed and to be feasible for high volume production**
- **Simultaneous engineering is demanded for energy storage systems and the assembly processes**



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### Future Battery Manufacturing

- ◉ **Work package AP I:** Development of components and functions of Li-Ionen for hybrid commercial vehicles
- ◉ **Work package AP II:** Development of manufacturing processes for assembly of Energy storage systems based on soft-pack Li-Ion cells.
  1. **Automatical Bi-Pack assembly,**
  2. **Stacking to cell module formates**
  3. **Connector welding process (e.g. Resistance-, Laser- ultra sonic welding)**
  4. **Assembly and contacting of CSE (cell supervising electronic)**
  5. **Back end assembly of entire energy storage system**
- ◉ **Workpackage AP III:** Test und Validation of Li-Ionen batteries and components and manufacturing processes.
- ◉ **Ensure process capabilities and component reliability over lifetime.**

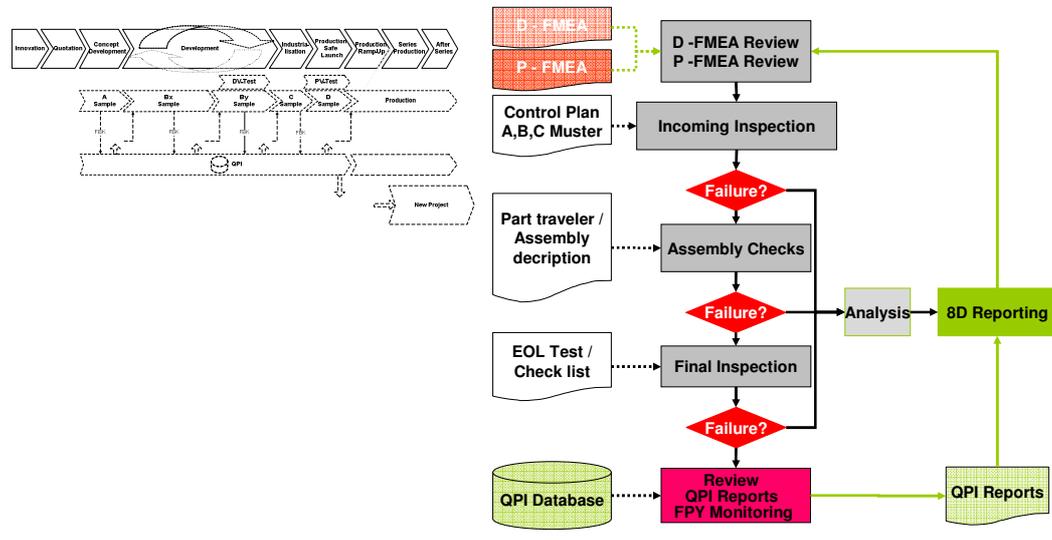
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Lessons Learned and Data Collection from day ONE!



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Build Quality Reports with FPY Tracking starting with the First Samples!

Continental BAS+ GM&Suzuki\_Gamma\_2 03.12.2009

### DELIVERY & COMPLAINT

### FAILURE PARETO

### TOP 5 ACTION

NO.	TOP 5	5 P NO.	FAILURE	ACTION
1	AG 2005 Stator Q-Inspection and E-Test 2	119	insufficient distance between doghouse and thermistor cable requested from supplier requested thermistor sleeve position nok	improvement of tying patterns gauge to position sleeve implemented
2	AG 2160 EOL-Test an leakage test	120	- Thermistor cable broken	improvement of tying patterns
		110	- Scratches in doghouse surface	improvement of measuring fixture
3	AG 2020 Shrinking stator lamination stack in front housing	108	-Stator could not be shrinked in sufficiently	fixture adjusted
		120	- broken Thermistor cable - concentricity/pilot OD after shrinking out of specification	improvement of tying patterns under investigation

### FIRST PASS YIELD

YRT=29,14% YNORM= 81,42% ZSI= 2,4

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### Series Production of Li Ion Batteries

*Reducing Waste*

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**RTY = 0.955\*0.97\*0.944 = 87.4%**

45,000 ppm wasted

95.5% Yield

30,000 ppm wasted

97% Yield

56,000 ppm wasted

94.4% Yield

**Hidden Factory: Rework/ scrap**

**RTY reflects the quality level of all single processes!**

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*Key is....*

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**QUALITY IS KEY!**

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**Thank you for your Attention**

