



## Improving efficiency and quality in development of coatings using high throughput technologies

## Contents

- **Introduction of Robert Bosch GmbH and Bosch Lab System**
- Modular concept for customized solutions
- Core formulation and application technology
- Characterization and measuring modules
- Application examples
- Summary



# Chemspec 2015 - RSC Symposium Right on Target

## Four business sectors

### Automotive Technology



### Industrial Technology



### Energy and Building Technology



### Consumer Goods



### Packaging Technology



**BOSCH**

## Packaging Technology – Four Business Units

### Pharma



### Confectionery & Food



### Liquid Food



### Packaging Services



## Market Fields of Custom Solutions

### Bosch Lab Systems

- Lab Automation & Handling
- R&D and Production Control:
  - Chemistry
  - Pharma
  - Diagnostics

+

### Pharma Custom Solutions

- Special Pharmaceutical Application and System based on Pharma and Packaging Technology
- Diagnostic Systems, Medical Devices, Special Automation and Handling

## EAS – Engineering and Application of Custom Solutions

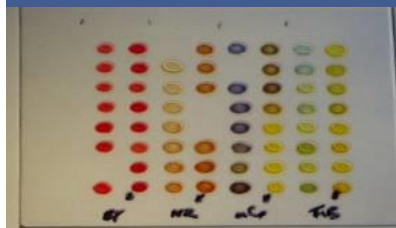


## EAS Lab Automation and Custom Solutions

### Robotics and Handling



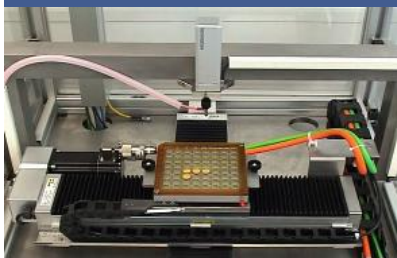
### Materials and Formulation



### Dosing Technology



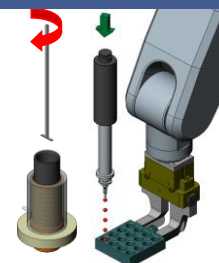
### Characterization



### Application and shaping



### Process technology



## Solutions and System integration

### Packaging Technology



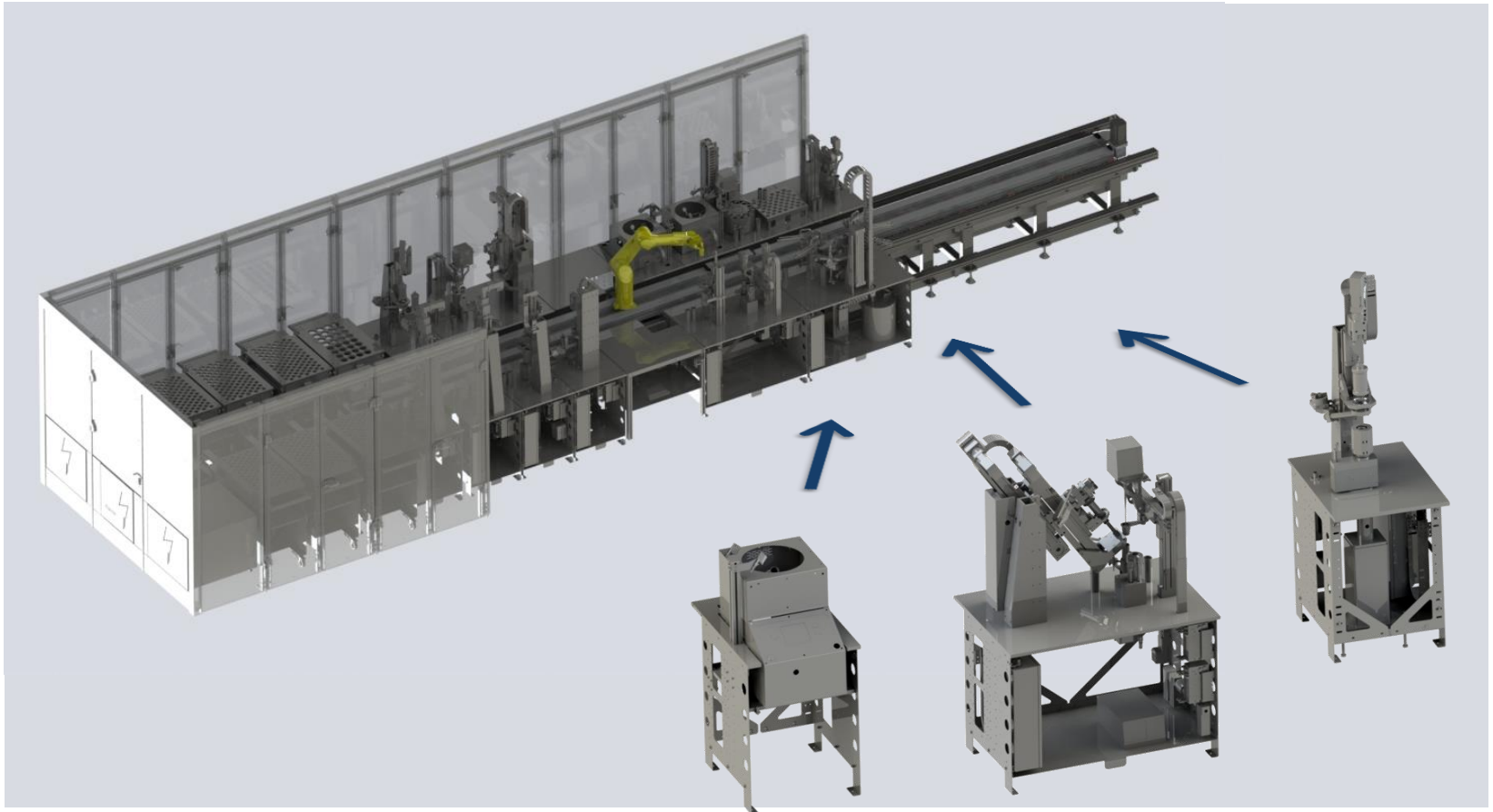
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## Modular Design of customized Systems



### Packaging Technology

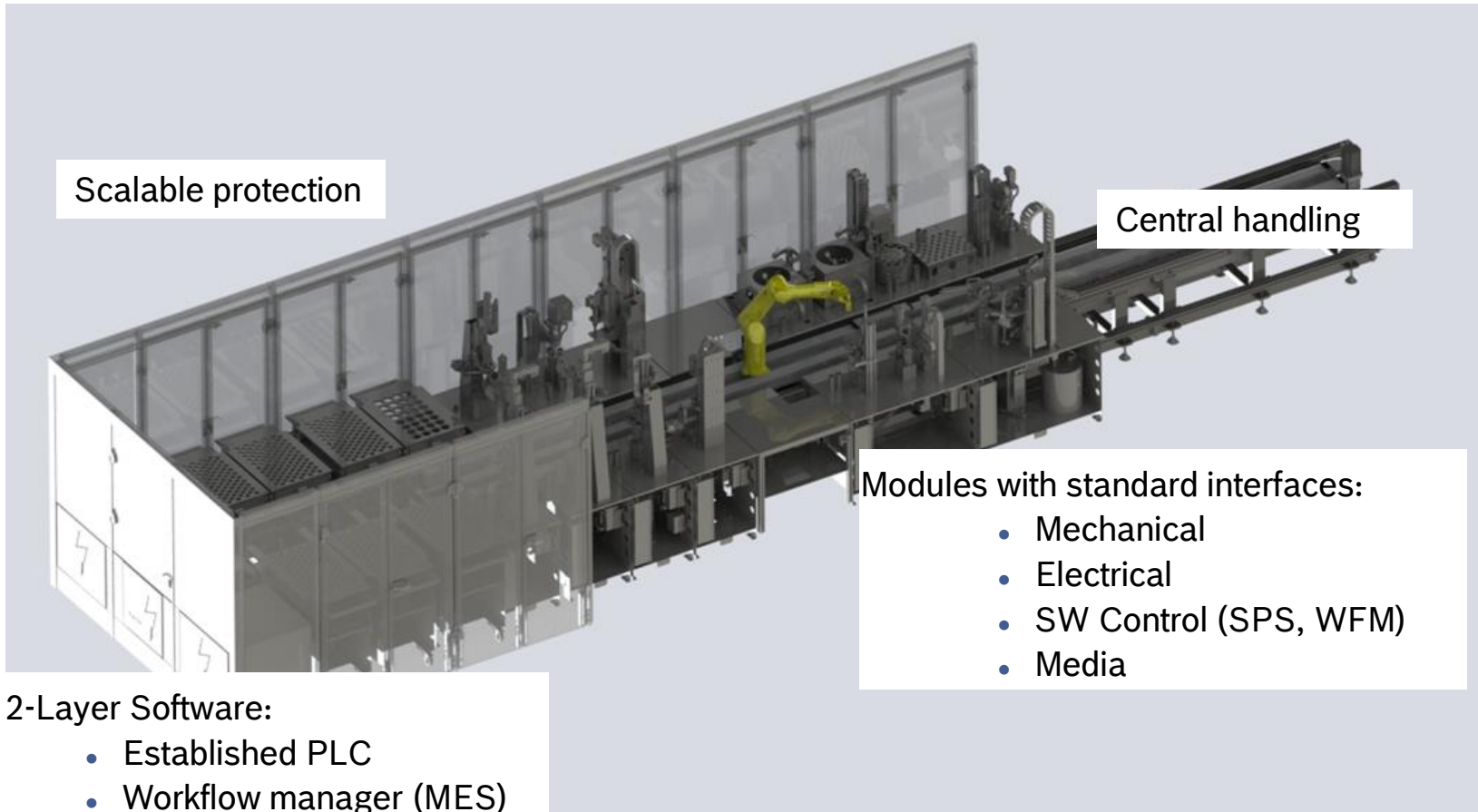
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## Modular System – here: linear axis with robot



Scalable protection

Central handling

Modules with standard interfaces:

- Mechanical
- Electrical
- SW Control (SPS, WFM)
- Media

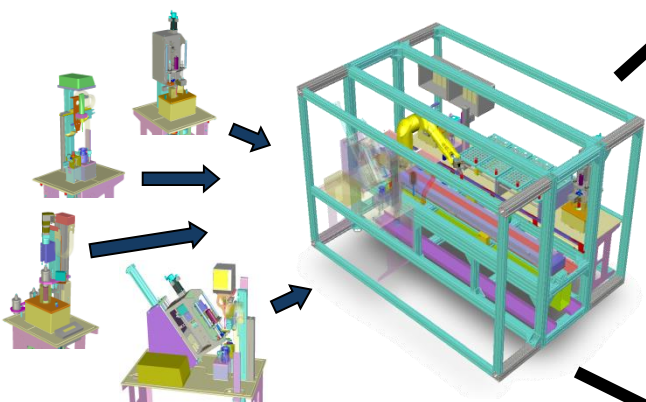
2-Layer Software:

- Established PLC
- Workflow manager (MES)

## Systems and machine concepts

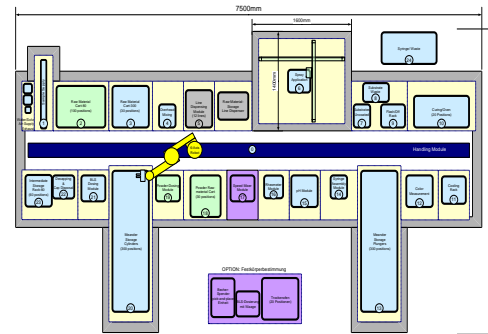
- Integrated Lab Systems (ILS)
  - Customized Solution with flexible robot handling
  - Standard Modules, Integration of lab instrumentation
  - Special modules
  
- Compact Lab Station (CLS)
  - Small systems without robot handling
  - Designed for starting with HTS and lab automation
  - Stepwise approach possible
  
- Spray application and measuring solutions
  - Stand-Alone (lab module)
  - Automated process
  - Integration possible

## Integrated Lab Systems (ILS)

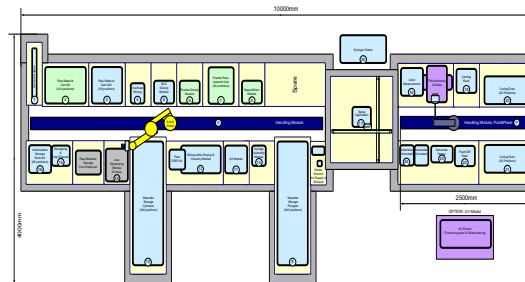


**Each module = Automation of standard lab process**

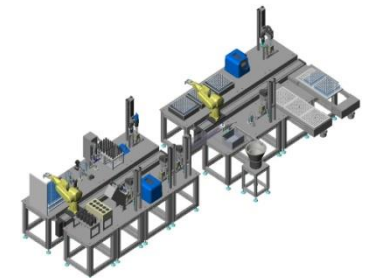
### Flexible Combination of Process Modules



### Depending on Workflow and Throughput

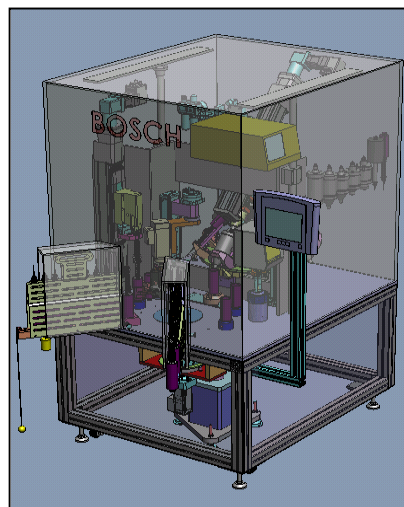


**Station A:  
"Formulation"**

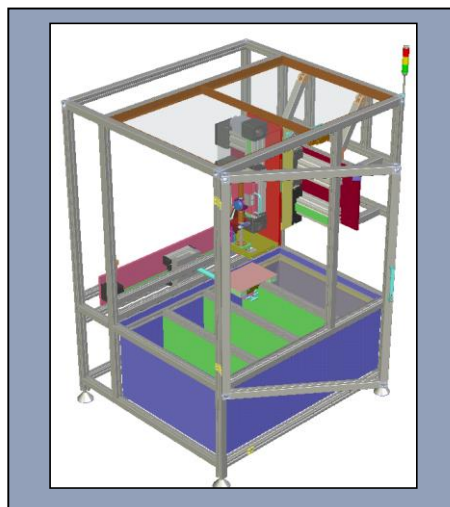


**Station B:  
"Characterization"**

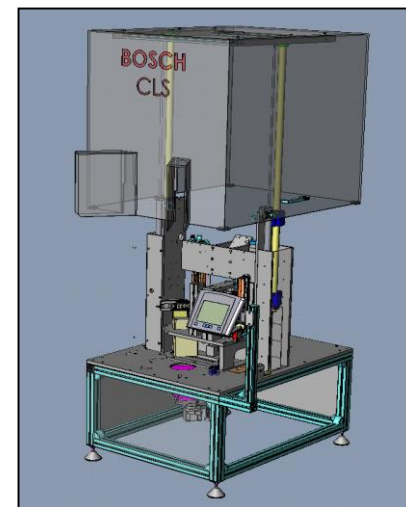
## Compact Lab Station (CLS)



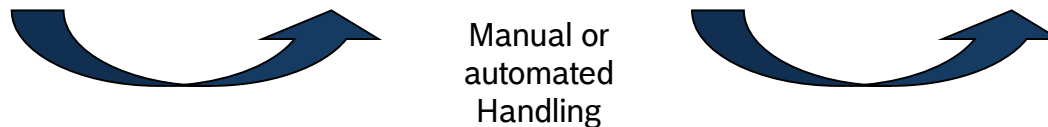
Formulation system



Spray application



Characterisation





## Packaging Technology

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# Progress in High Throughput Formulations

	At the beginning	Today
Dosing	Dispensing Water-like liquids Flowing powders	Pastes, Cremes, Binders Wet Powders, Spheres
Mixing	Shaking, Vortexing	High Shear, Milling
Sample Size	µl to ml (Arrays, plates)	As big as necessary, as small as possible
Sample Preparation	Only in combination with dispensing (filling cavities, dipping,..)	Standard preparation processes
Characterisation	Not available or special method (difficult correlations)	Integration oft standard and established tests
Workflows	Only Filling and mixing	Integrated Application and Characterisation



## Commonly Available Dosing Technology



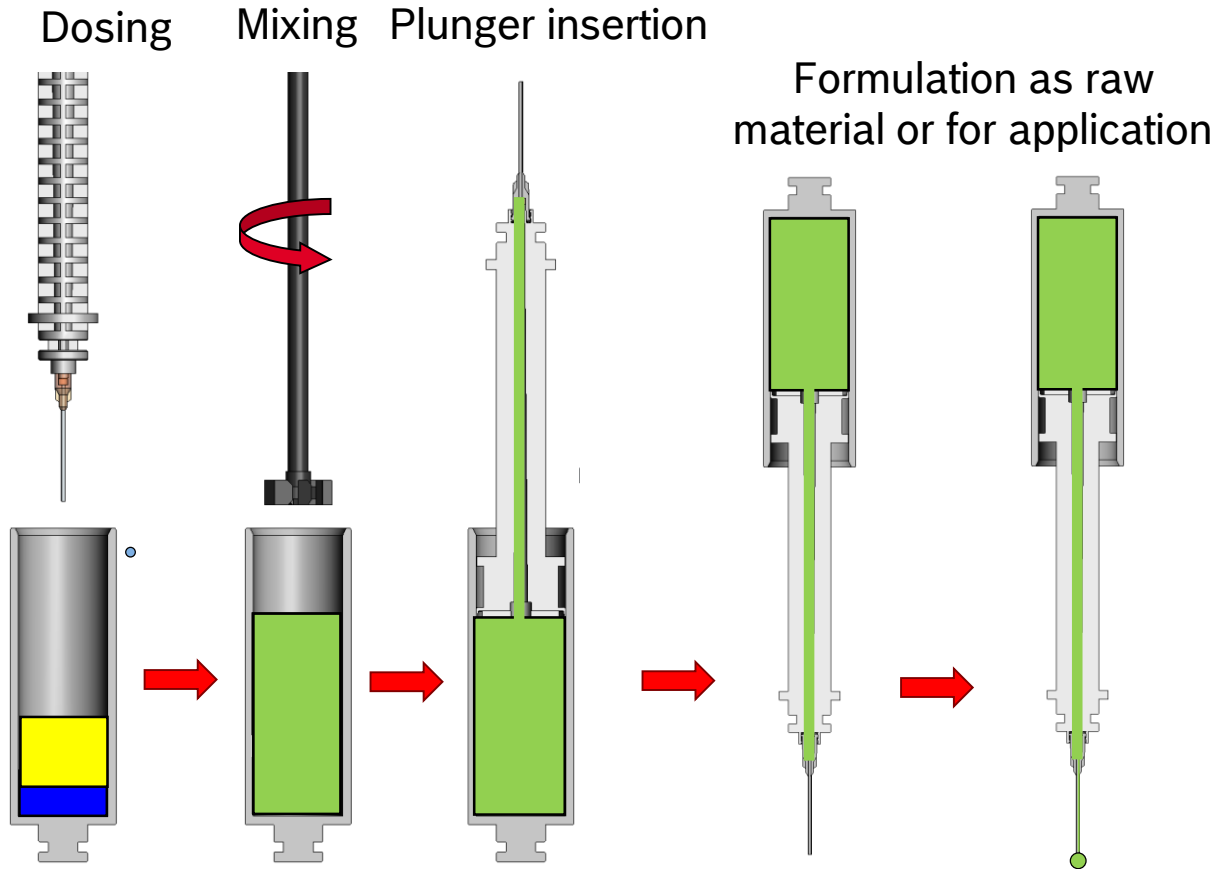
- Individual systems for high and low viscosity
- Either cleaning or individual systems for different materials
- Design dependent on dosing quantity

**and:**

- Dosing and application through aspiration of materials with complex calibration effort
- Does NOT work for materials with high viscosity!



## Functionality of the BLS-Syringe



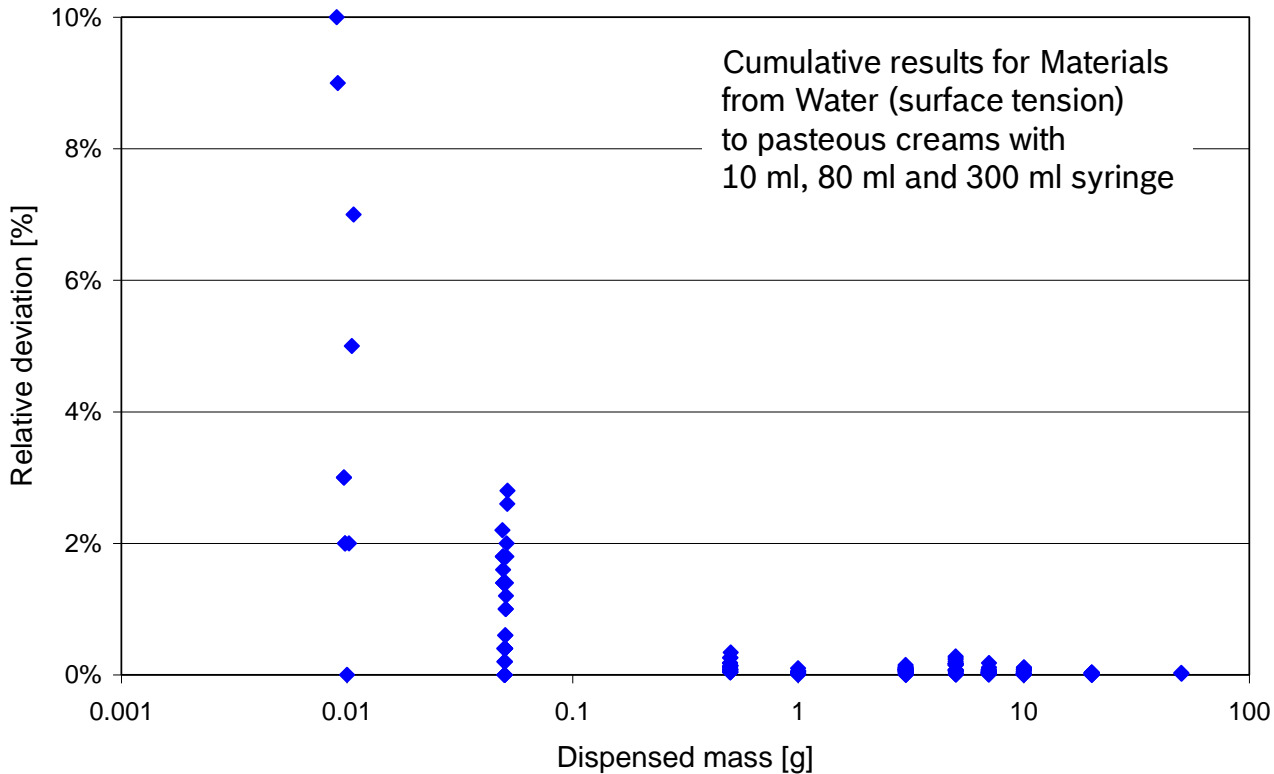
Disposable sample container **and** raw material container

## BLS-Dosing

- Gravimetric or volumetric dosing
- Combination with rheometer
  - Dosing under stirring
  - Viscosity adjustment



## BLS dispensing: Result overview



- Typically, very good dispensing accuracy
- Limits at very low dispensing amounts for big drop sizes

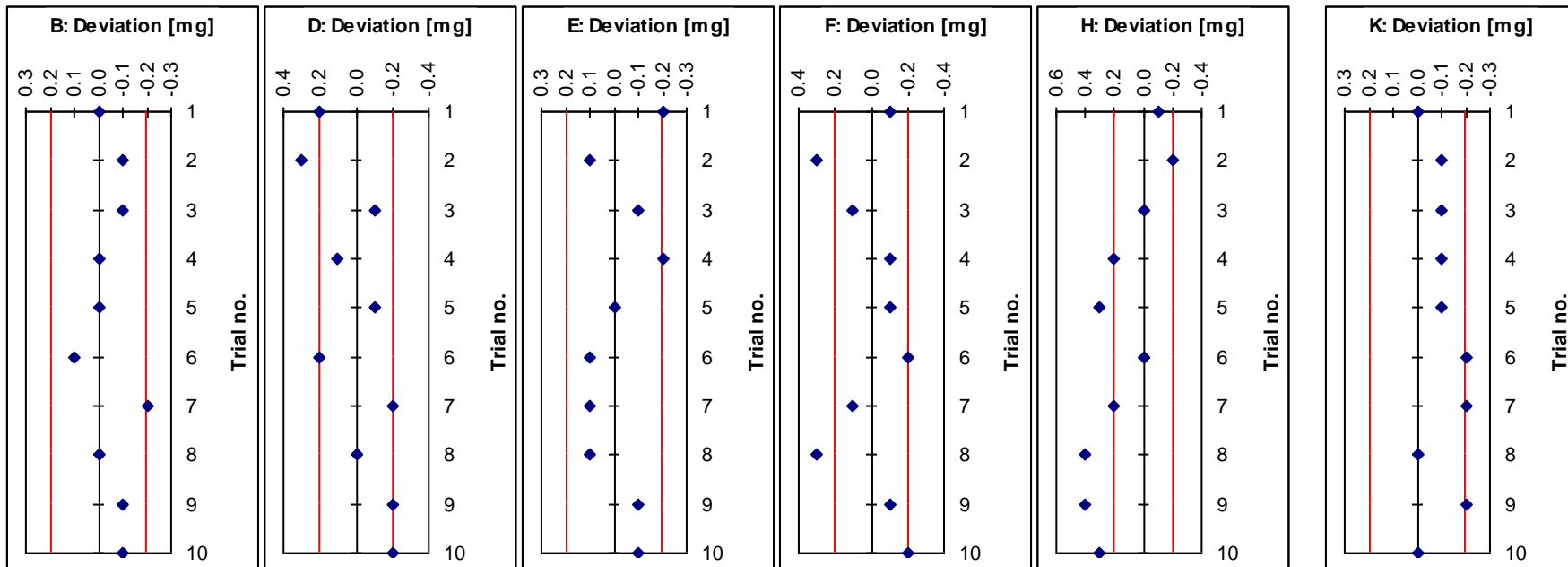
# Powder Dosing using the Auger Dosing Module

- Different dosing-augers depending on the flowing characteristics of the powder
- Dosing algorithm optimised for accurate dosing even when using high dosing speed



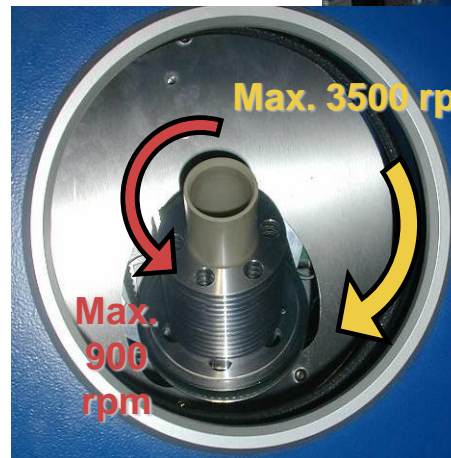
## Dispensing of 6 reference powders

- Target amount: **10 mg**
- Required tolerance: **0.2 mg**

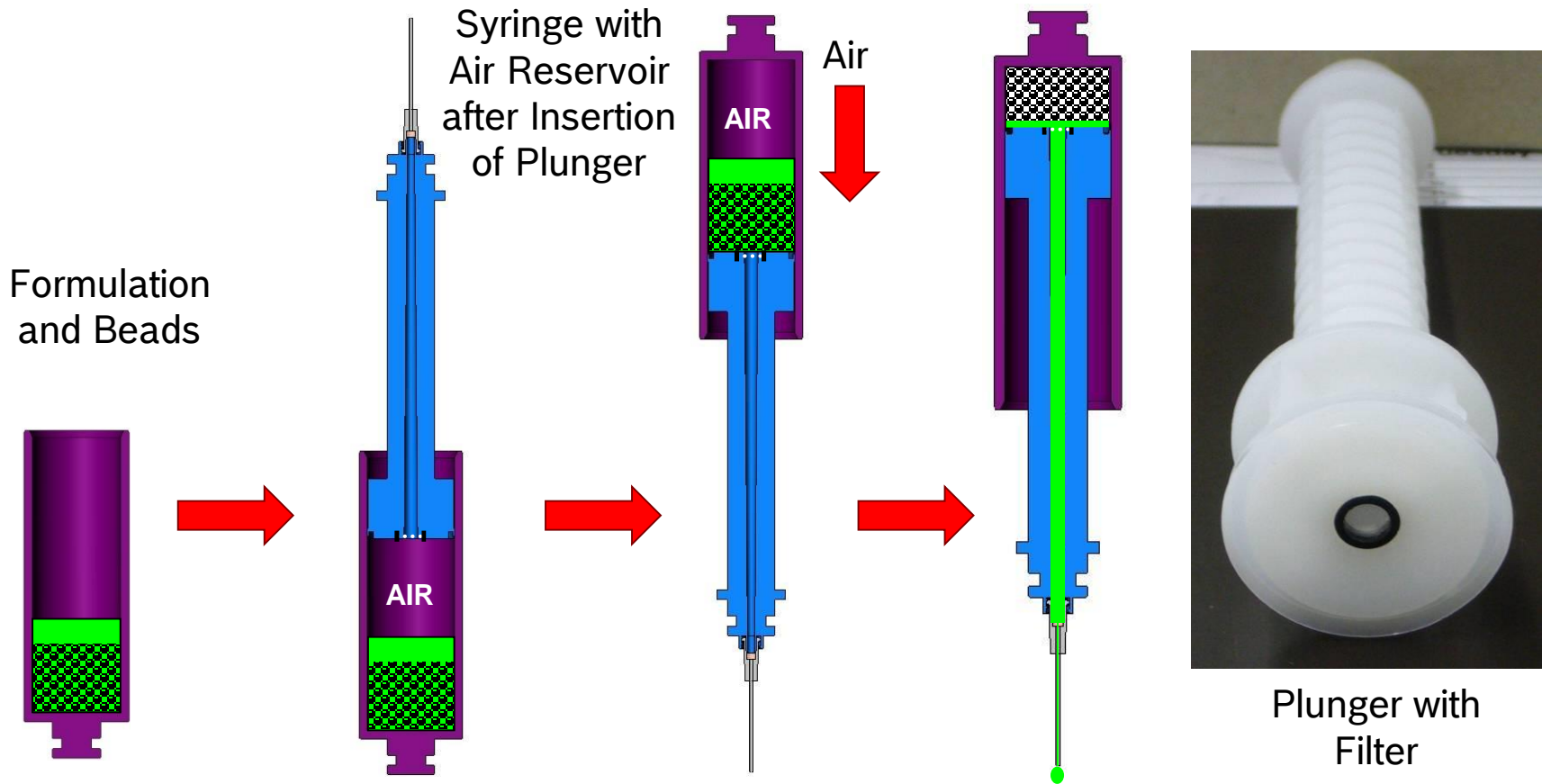


## High Shear Mixing/Dispersing

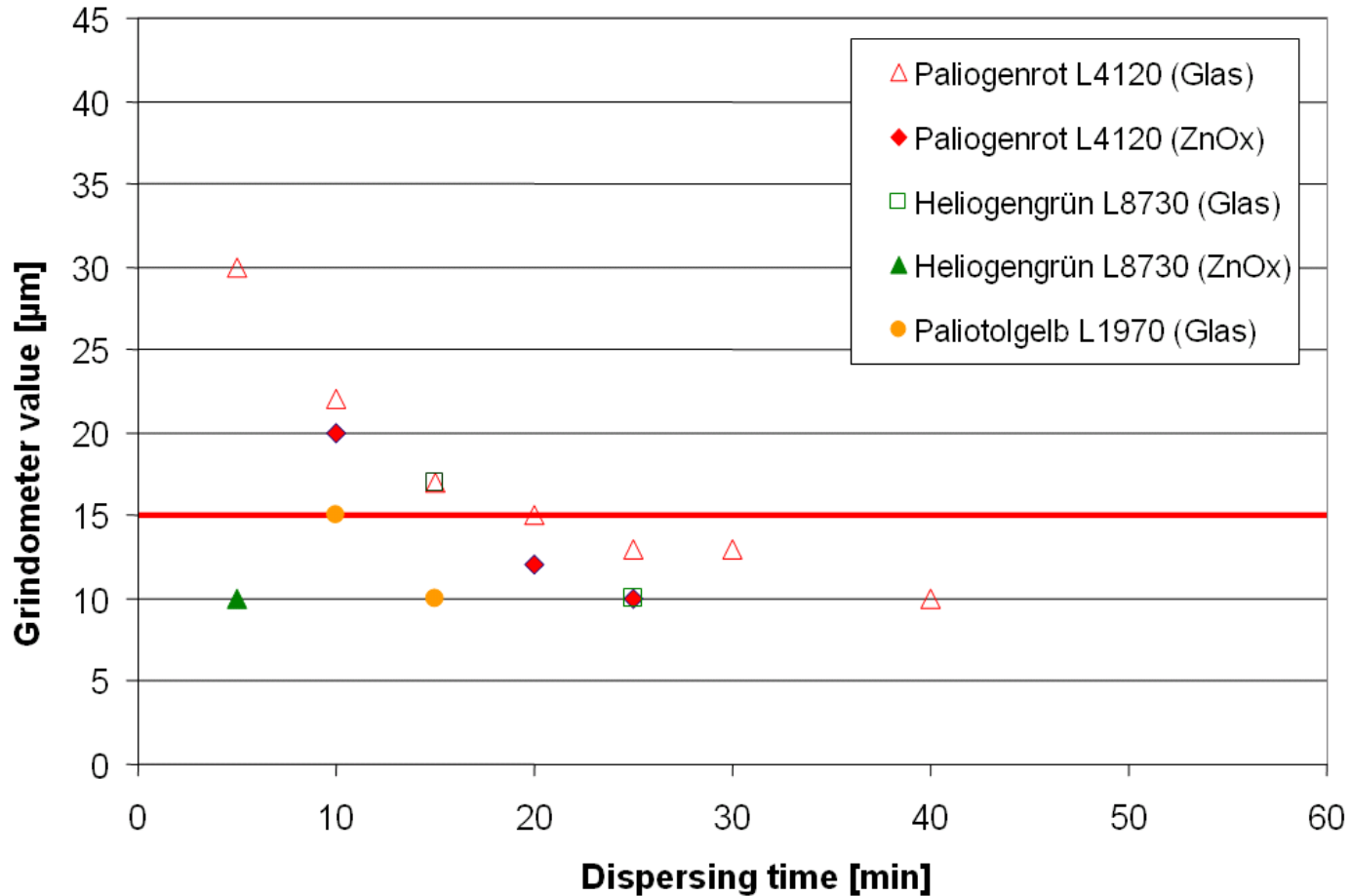
- SpeedMixer
- Mixing by planetary movements
- No cleaning required
- Milling by addition of beads/spheres
- Short dispersion times
- Degassing in seconds



## How to separate the milling beads from the formulation?

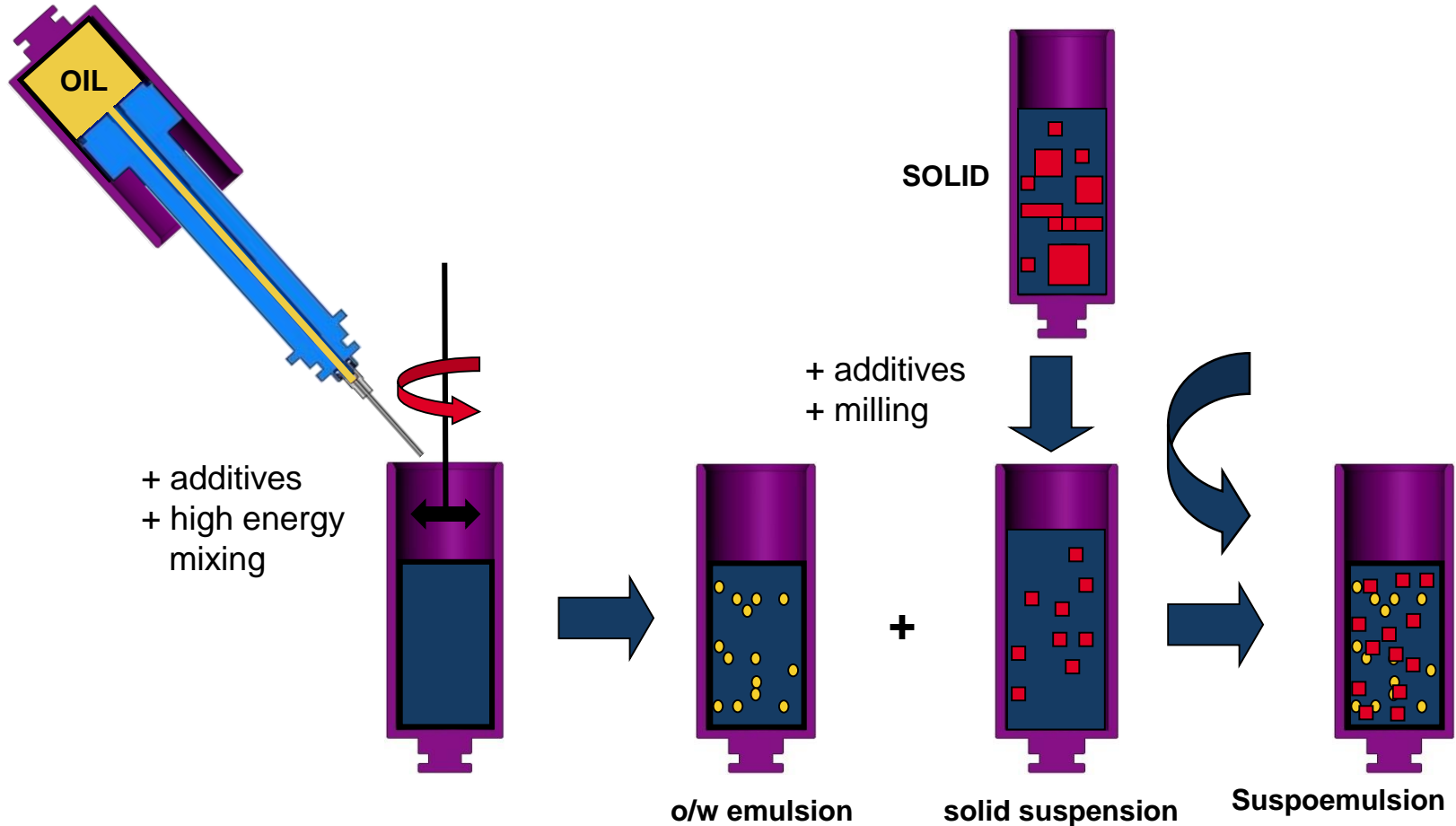


## Dispersing in the BLS-Syringe by a speedmixer



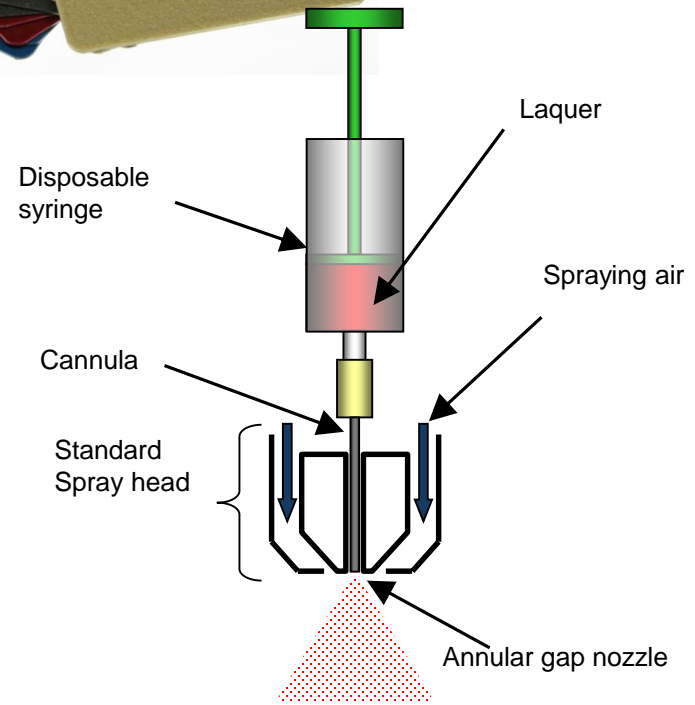


# Overview possible formulation technologies

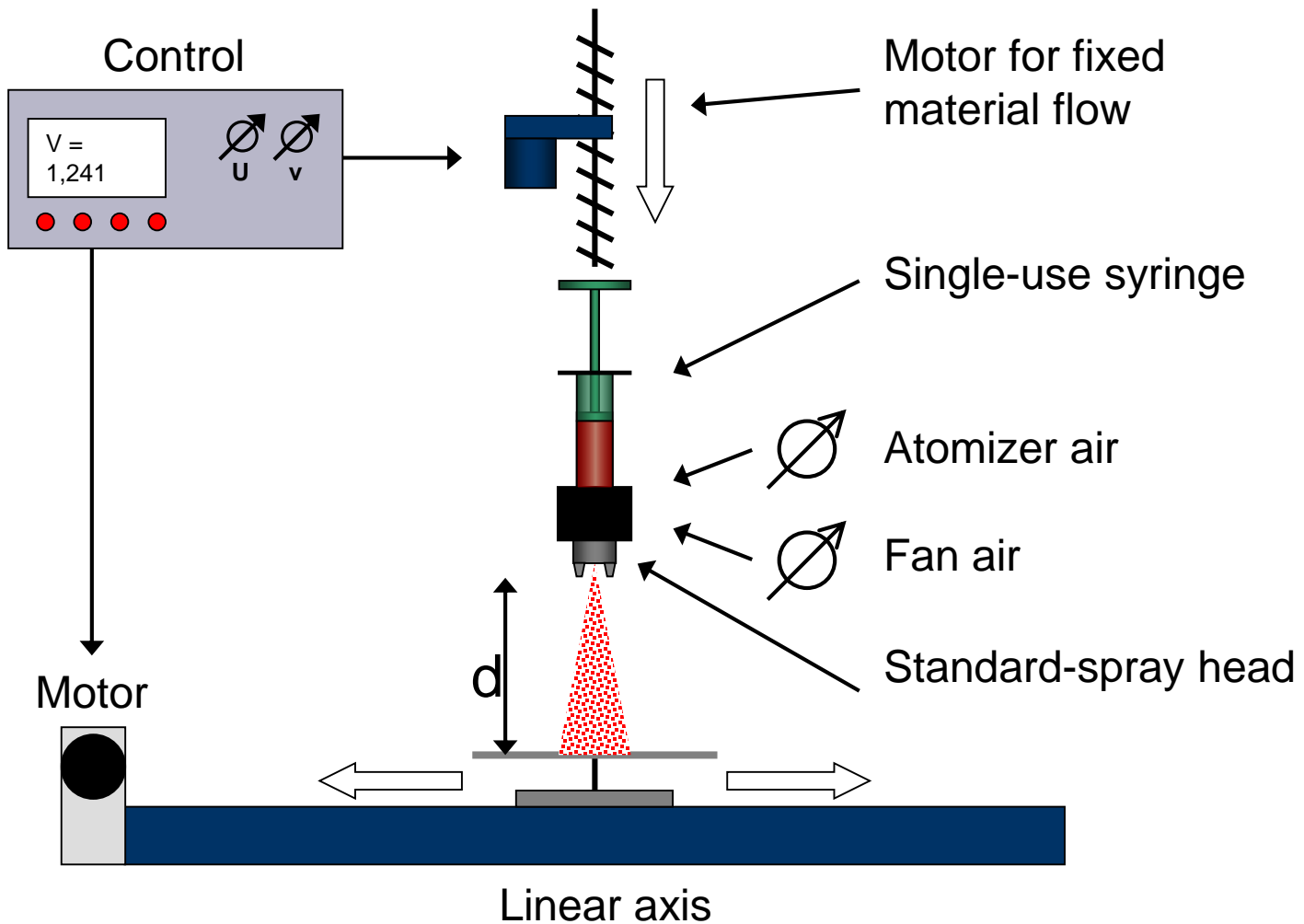


## 10 years of BLS-Spray Application

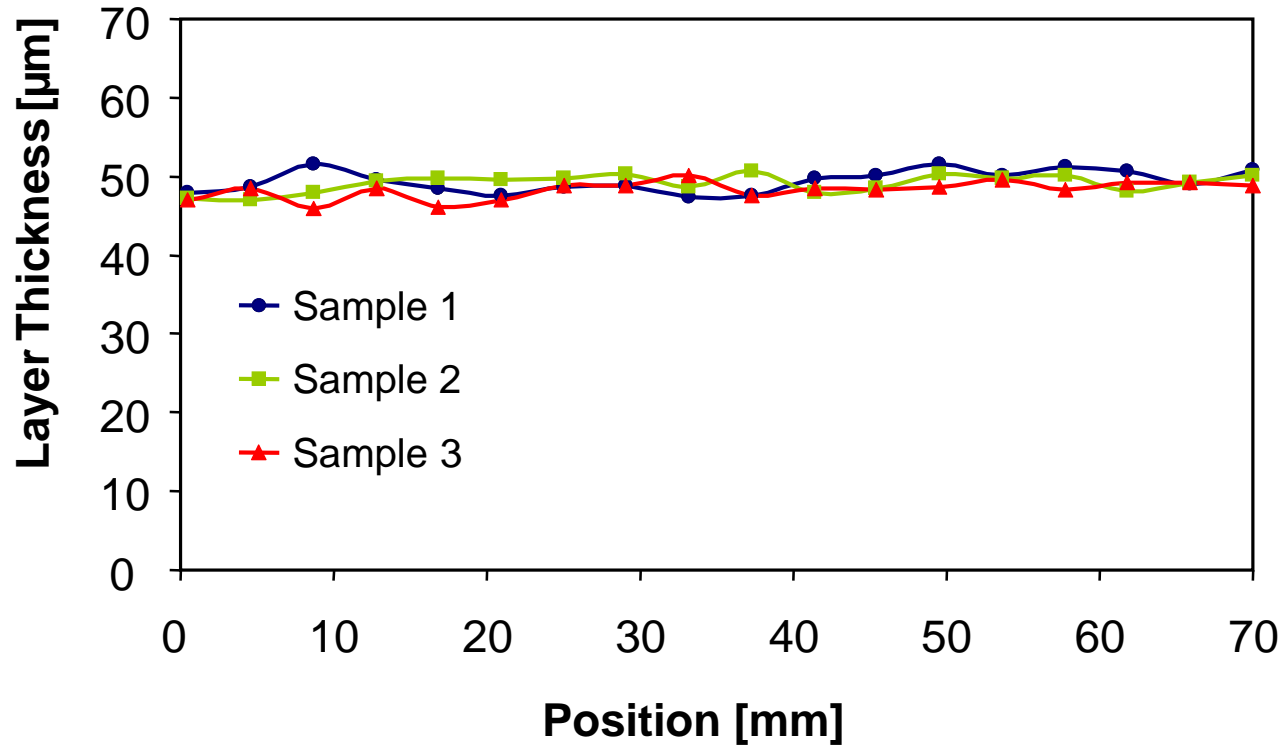
- Cleaning free spray application
- Highly reproducible spray application
- Use of standard or BLS-syringes possible
- Used in R&D and QC



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## Reproducibility of Layer Thickness (enamel primer)



# Reliability of HT-Sprayapplication

Steps		Standard Spray System	BLS-System
1 x	Thickness [ $\mu\text{m}$ ]	10 +/-1	8 +/-1
	$\Delta E$ (each substrate)	0,48 +/- 0,11	0,24 +/- 0,07
	$\Delta E$ (diff. substrates)	0,65 +/- 0,21	0,63 +/- 0,09
2 x	Thickness [ $\mu\text{m}$ ]	13 +/-1	9 +/-1
	$\Delta E$ (each substrate)	0,18 +/-0,07	0,17 +/-0,04
	$\Delta E$ (diff. substrates)	0,42 +/-0,09	0,38 +/-0,03

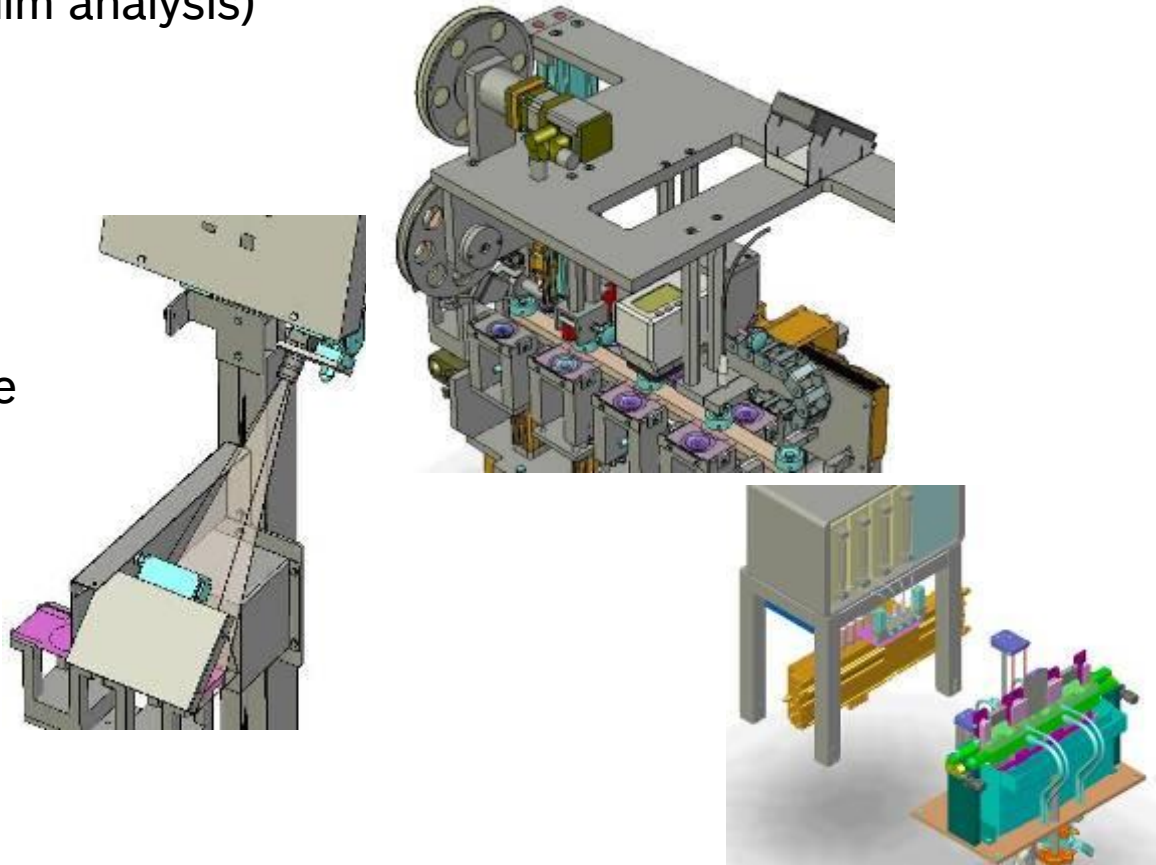
## Characterisation of the formulation



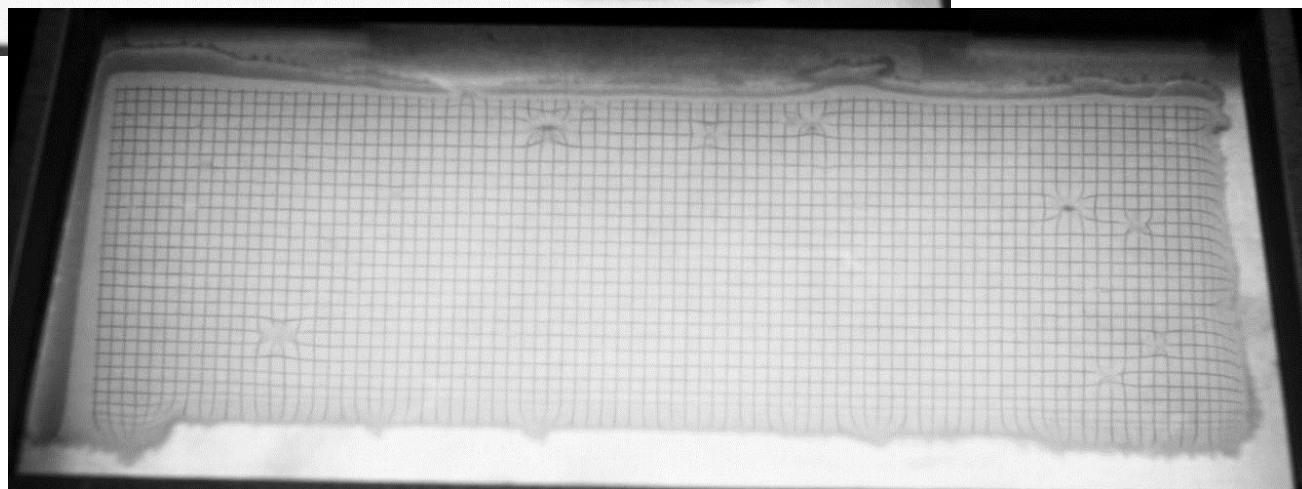
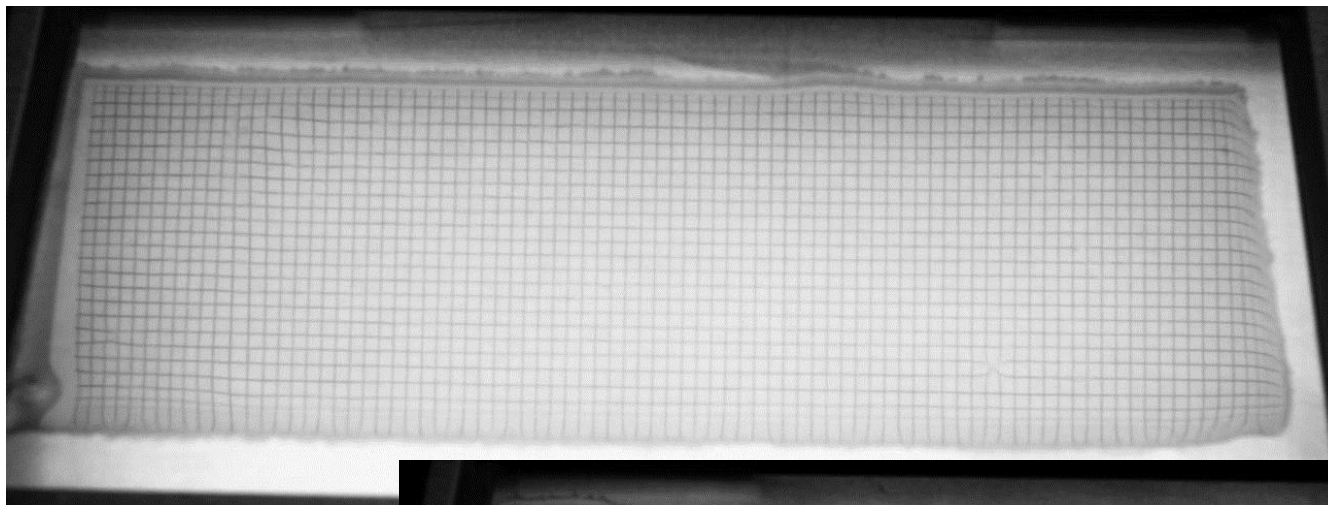
Rheometer, pH and particle size measuring, gel time

## Characterisation of substrates

- Spray quality (wet film analysis)
- Thickness
- Colour
- Gloss
- Haze
- DoI
- Chemical resistance
- Scratch resistance
- Cross hatch test
- Hardness testing
- Surface tension
- Drying time
- Rub-Out-Test
- Mandrel bending

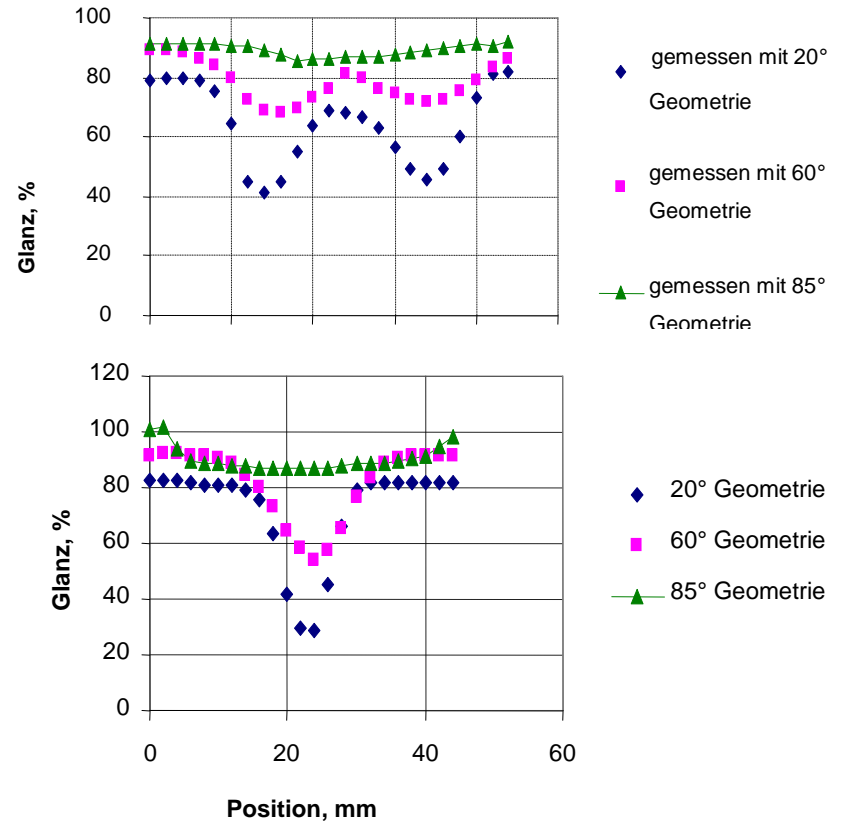


## Wet Films





## Chemical resistance



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# Reproducibility of formulations and applications

## Test group A

- 71 samples/students
- Pigment powder
- Doctor blading
- 2 years

## Test group B

- 32 samples/ 1 expert
- Pigment powder
- Doctor blading
- 5 days

## Test group C

- 50 samples/ 1 expert
- Pigment preparation
- Doctor blading
- 3 days

## Test group D

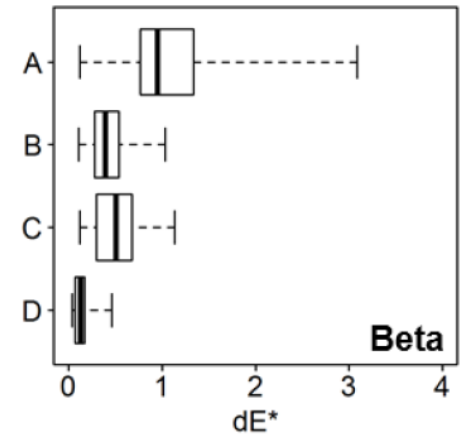
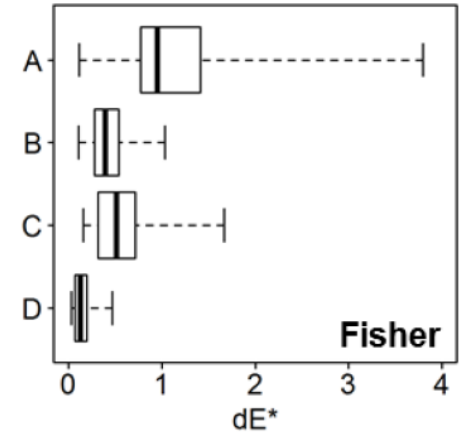
- 50 samples/ robot
- Pigment preparation
- Spray application
- 1 day

## Variance of Colour E:

Vol of A: 800

Vol of B,C: 40

Vol of D: 1

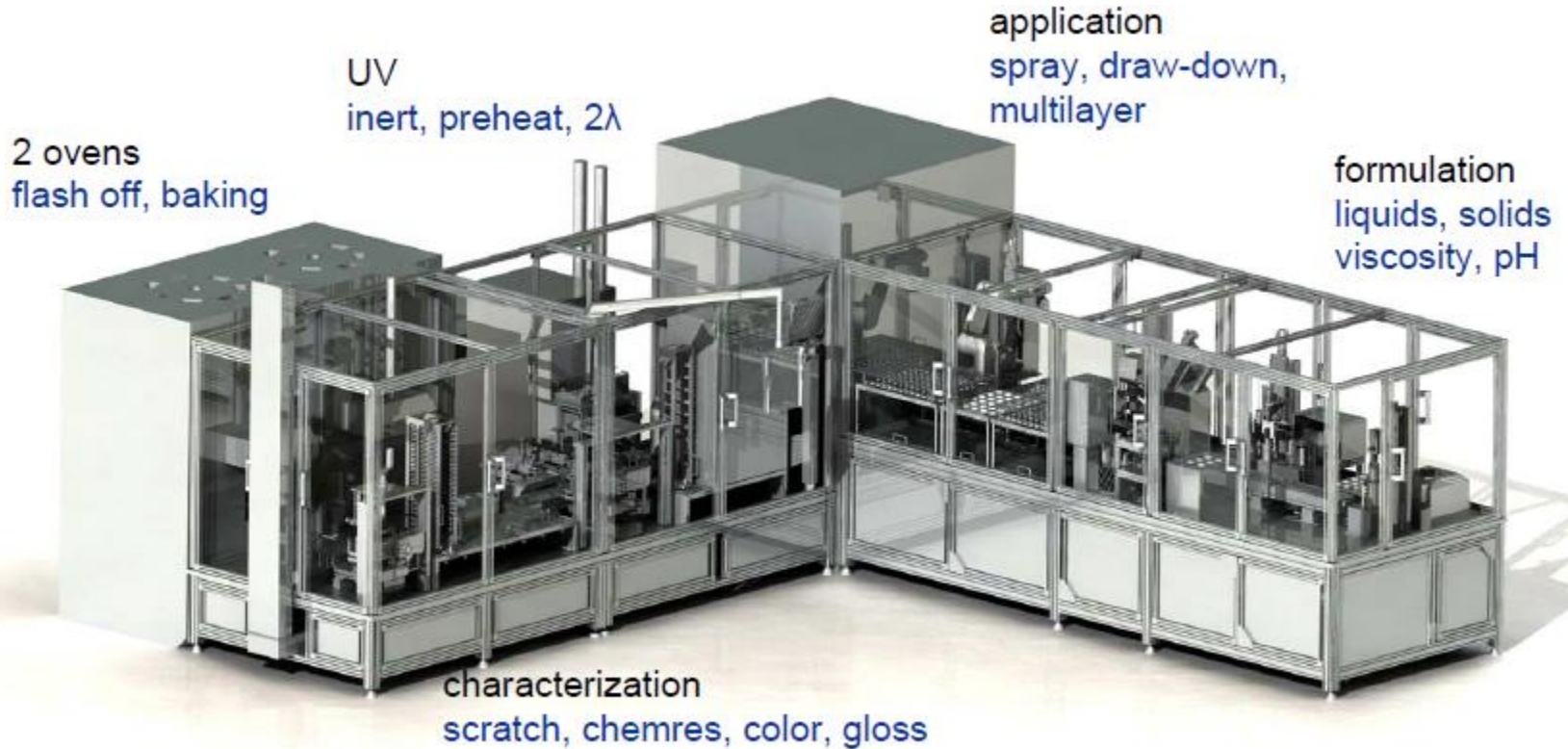


## Stand-alone spray booth in Quality control

- Improved filtering system
- Fast exchange system for syringes and substrates
- 200 samples and application per shift
- Starting with correlation of large number of existing spray application with BLS-spray cabin
  - Use of 1 standard spray head for all products
  - Pre-defined standard process parameters for each product



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Thank you for your attention!



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