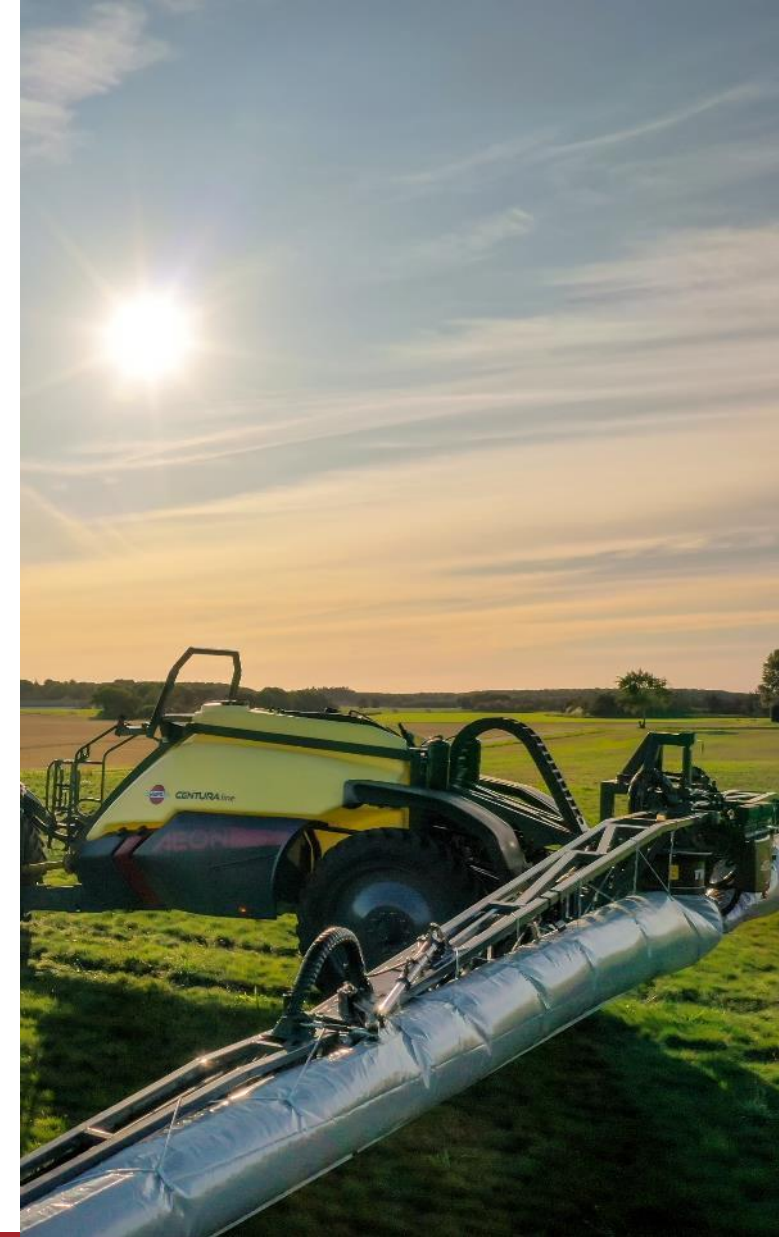


Is a specific testing protocol required for online and offline application systems?

Christoph Schulze Stentrop



The Sprayer



Content

- Agriculture 4.0 technology
- What are online and offline application systems
- Testing of online and offline application systems



What is agriculture 4.0 technology?

Connectivity & Communication

- ISOBUS
- TIM – Tractor Implement Management

Precision Farming

- GNSS – Globales Navigation Satellite System
- Camera track guidance
- Section Control
- Sensors / cameras crop status
- Sensors soil conditions –
- Automotive / autonomes farm machines
- Computer bases data analysis / Artificial Intelligence
- FMIS



What is agriculture 4.0 technology?

- Technology for selective application and crop related dosing
 - Task-Controller Online- and Offline systems
- Section Control
- Single nozzle on/off
- Intelligent nozzle volume rate setting PWM / Cluster nozzle systems
- Load-Sensing hydraulic regulation of centrifugal pumps
- Multi-Product application – multi tank or direct injection
- Switching between broad and band-application
- Boom management systems
- Boom stability 3 D – horizontal movements
- Autofill systems
- AutoWash technology



Precise crop protection technologies for sustainable agriculture

Goals of the next stage in development to meet “Farm to Fork” (EU 50% PPP reduction)

1) Selective application of Plant Protection Product (PPP) instead of full-surface treatment

- Application of herbicides by means of weed detection (GoB, GoG)
- Band spraying with the field sprayer for row crops in early growth stages (over the row)

2) Needs-based dosing of PPPs with high resolution instead of uniform quantities

- Variable dosing per section or single nozzle level (PWM, H-Select)
- Dosage optimally adapted to variability and growth of (individual) crops (GoG, IR)

3) Reducing output with optimum base distribution at the target area

- Maximum drift reduction in conjunction with a finer droplet spectrum – not just very coarse droplet nozzles
- Better application systems – like Twin



SPOT Spray systems

On-line system



- Exxact Robotics



- John Deere



- Carbon Bee



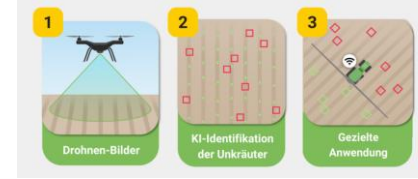
- Bilberry



- AMAZONE



Off-line system



BS SPOT[®]
SPRAY
SENSOR



On-line procedure (“in the field”)

- No time delay between recording and application
- No dependence on the availability of a service provider
- Fewer weather restrictions for spraying
- No additional time, effort and costs for data collection, processing and application-map creation
- Higher resolution and precision when capturing smaller plants and weeds
- Precise position and distance determination between plants and current nozzle position (“camera linked to nozzle”)


GEOSELECT



Off-line procedure (in the cloud)

- Required PPP quantity can be precisely determined before application
- No plant sensors and data processing technology necessary on the sprayer - low investment cost in hardware
- Maximum driving speed is not affected by data acquisition and processing
- Application map can be analyzed and adapted before the spray task
- No need to go if no spraying is needed (yes/no decision)

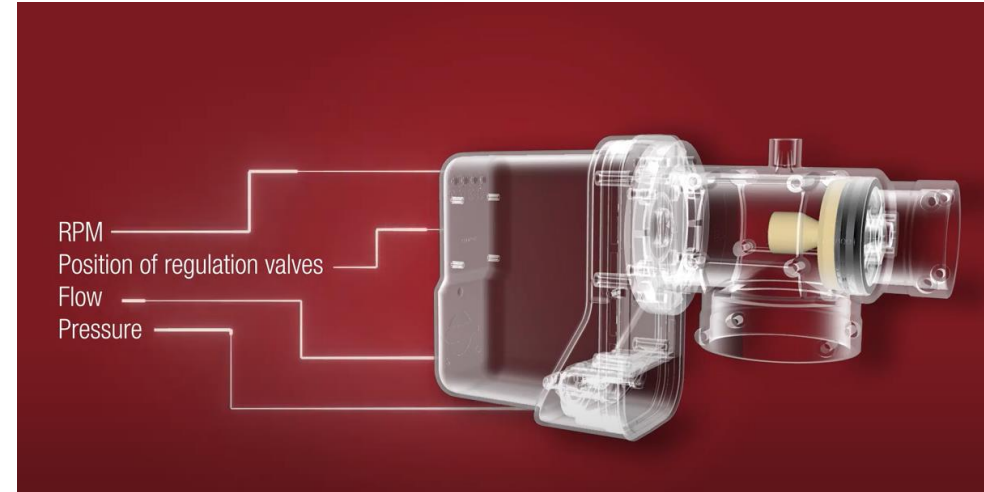


Technical requirements – Regulation DF4

- **Technology development**
- Combined pressure and flow measurement of the application rate
- **Constant pressure device**

Advantages and benefits

- Faster regulation of the application rate
- Instant and correct pressure at turn-on
- Higher accuracy of dosing
- Exact control of very low to high application rates



➔ • Essential for Online System

➔ • Essential for Offline System



Technical requirements – Boom Fluid system electrical

Technology – PrimeFlow

- Section or Auto Nozzle Control
- Nozzle on/off response 200 to 400 msec

Advantages and benefits

- Wide speed range with constant dosing and drop size
- Variable application rate with constant application quality
- Uniform longitudinal distribution without gaps



• Not possible for Online System



• Essential for Offline System



Technical requirements – Boom Fluid system pneumatic

Technology – Active Air

- Section Control
- Nozzle on/off response 100 msec

Advantages and benefits

- Wide speed range with constant dosing and drop size
- Variable application rate with constant application quality
- Uniform longitudinal distribution without gaps



• Not possible for Online System (only Sections)



• Essential for Offline System



Technical requirements – Boom Fluid system H-Select

Technology – Cluster nozzles

- Individual Nozzle Control
- Pulse width modulation (PWM) – 20 Hz
- Curve compensation
- Fast nozzle on /off response 90 msec
- Rate adjustment for 8 sections

Advantages and benefits

- Wide speed range with constant dosing and drop size
- Variable application rate with constant application quality
- Control of the application rate per individual nozzle possible
- Droplet size and flow can be adjusted completely independently
- Uniform longitudinal distribution without gaps



• Essential for Online System



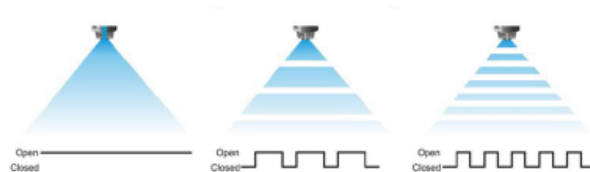
• Not absolutely necessary for Offline System



Technical requirements – Boom Fluid System PWM

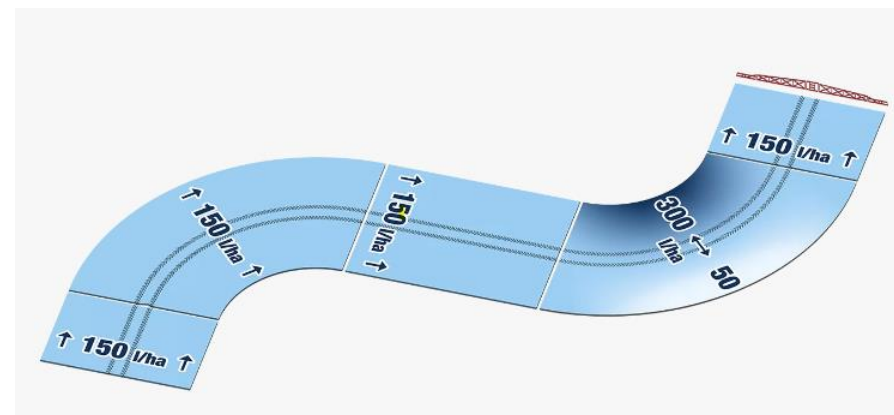
Technology – PULSE System

- Individual Nozzle Control
- Pulse width modulation (PWM) – 20 Hz
- Curve compensation
- Fast nozzle on /off response 90 msec
- Rate adjustment for 8 sections



Advantages and benefits

- Wide speed range with constant dosing and drop size
- Variable application rate with constant application quality
- Control of the application rate per individual nozzle possible
- Droplet size and flow can be adjusted completely independently
- Uniform longitudinal distribution without gaps



• Essential for Online System



• Not absolutely necessary for Offline System



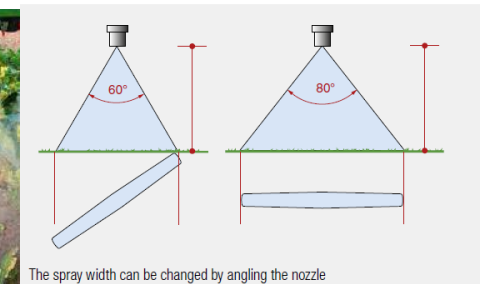
Technical requirements – Nozzle Selection

Technology – Nozzle

- 50 cm nozzle space (PrimeFlow, PulseSystem, ActiveAir)
- 25 cm nozzle space / 80°
- Spray angle 110° nozzle – allow also broad application
- Injector flat fan – standard nozzles for all spray jobs – drift reducing and good overlap
- Band spraying nozzle – even distribution – correct dosing also with single nozzle application – angling allows smaller swatch

Advantages and benefits

- Coarse drops have a better ballistic – faster to target – better hit rate
- TWIN would allow a good ballistic – but demands a standard nozzle position
- Chemical dose on target is better with true overlap application



• Online System depending on nozzle



• 1 m section – spot width 195 cm



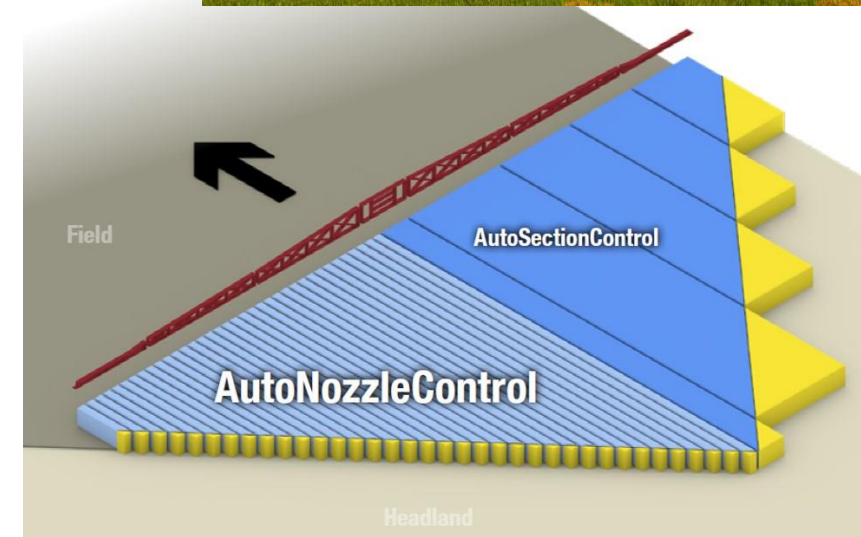
Technical requirements – GPS Section / Auto Nozzle Control

Technologie

- Automatic part-width section control on/off (GNSS)
- Shutdown at field boundaries or distance requirements
- Adjustable overlap

Advantages and benefits

- Minimal overlap or gaps
- Saving of PPP (approx. 5 to 10%)
- Avoidance of application outside the target area
- Allows spraying at night
- Higher ease of use and easier operation



• Essential for Online System



• Needed for TC-GEO



• No Needed for GEO Select



Technical requirements – Boom management

Technologie

- Sensor controlled height guidance of the boom
- Automatic control of height (A) and inclination (B/D)
- Distance measurement to the ground, crop or in hybrid mode
- Automatic lifting/lowering at headlands ???

Advantages and benefits

- Optimum nozzle height and best distribution
- Minimization of drift risk
- Improvement of crop penetration and spray coating
- More ease of use and higher area performance



• Essential for Online System



• Essential for Online System



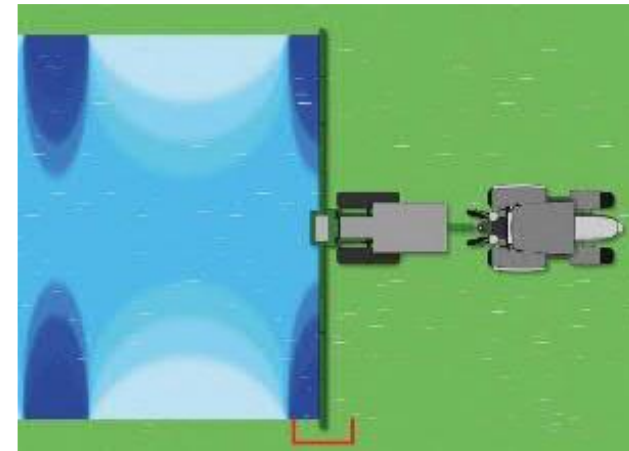
Technical requirements – Geopositioning per nozzle

Technologie

- GPS positioning on the boom
- RTK correction needed

Advantages and benefits

- Compensation of longitudinal movements of the boom
- Better longitudinal and transverse distribution of the spray fluid
- Prerequisite for precise and selective application



• Not needed on Online System



• Needed on big booms and high speed



Technical requirements – Maps

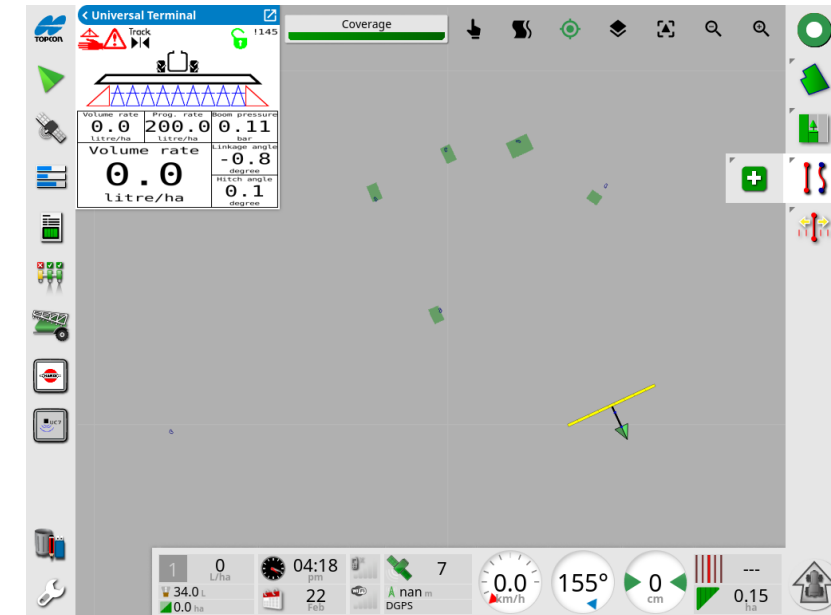
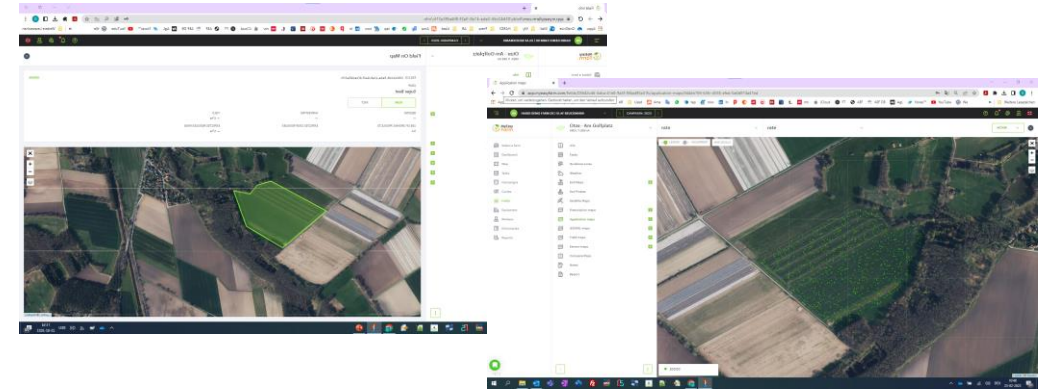
Technologie

ISOBUS

- Taskdata ISOXML (ISOBUS terminal)
- Shape files (ISOBUS terminal)

GeoSelect

- GeoSelect format



• Not needed on Online System



• Needed



Testing of online and offline application systems

- The systems are complex and need to be calibrated and installed by experts
- The inspection should be limited to the level of standard sprayers
- Decisions and definitions are required – spot or broad application
- High-end electronic systems allowing cloud based reporting – could be used for inspection



