

HySPRINT INDUSTRY DAY:
New Frontiers in PV Research:
Emerging Perovskite Semiconductors

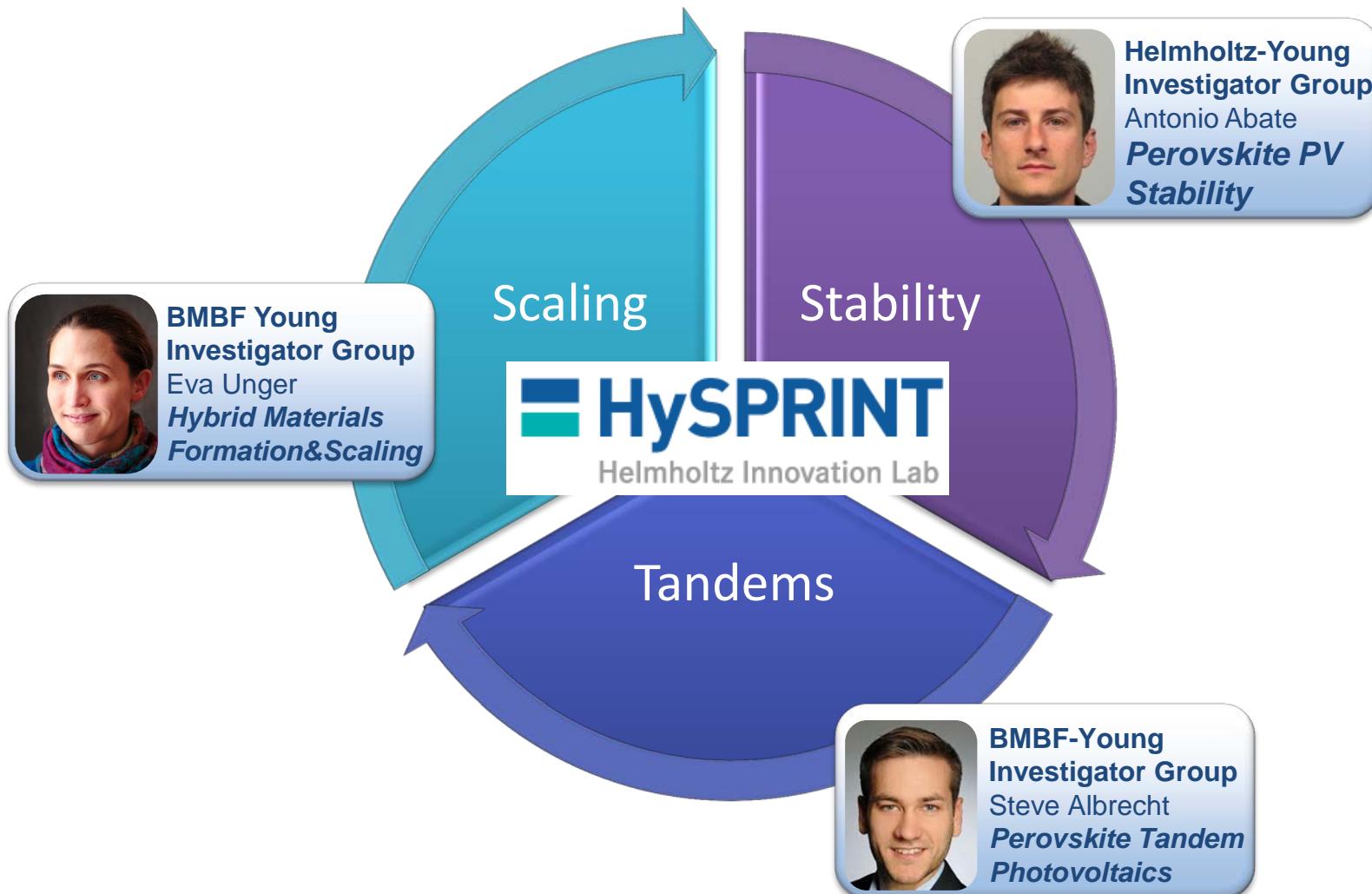
13th Oct 2017

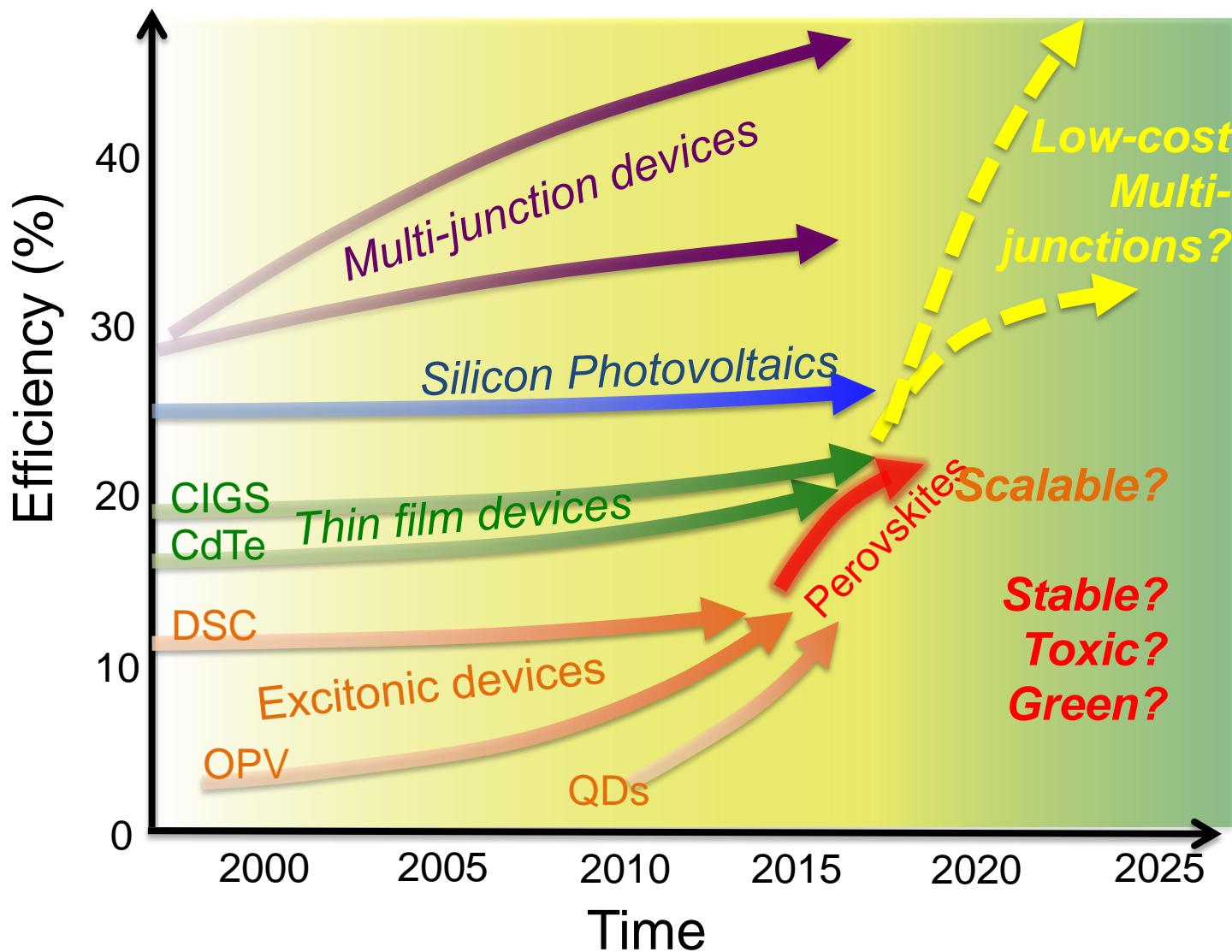
SCALING PEROVSKITE SOLAR CELLS

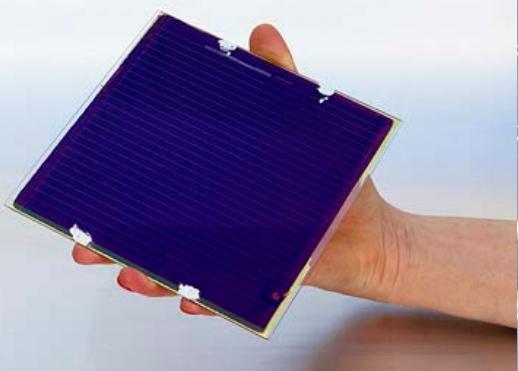
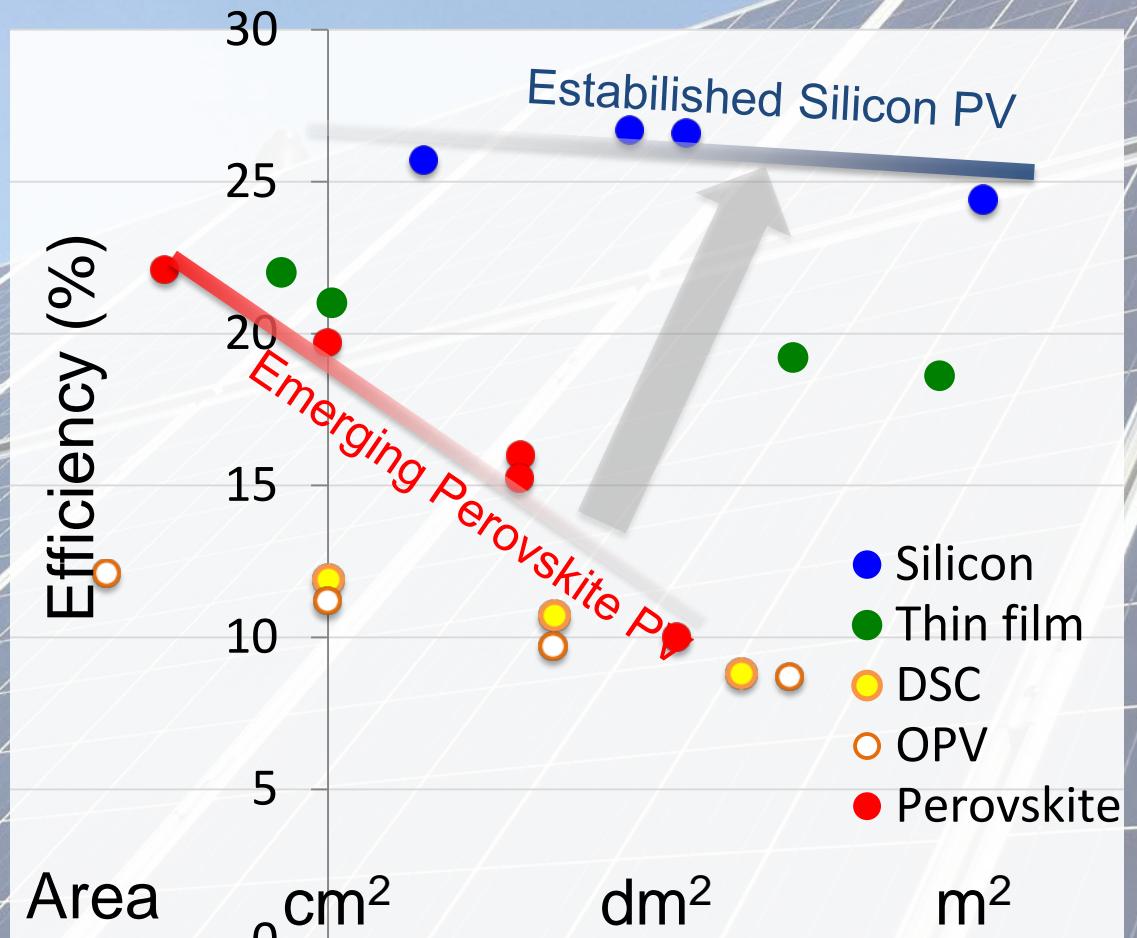
Eva Unger

Young Investigator Group Leader
“Hybrid Materials Formation and Scaling”
HySPRINT Innovation Lab Steering Committee

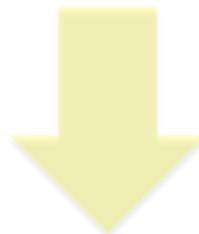
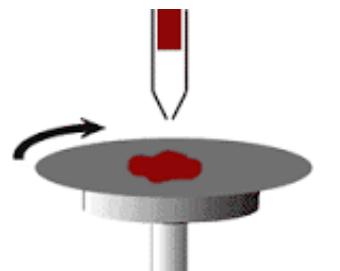
Affiliated with Lund University and Humboldt University Berlin



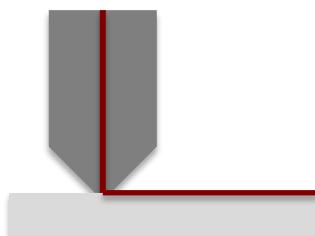




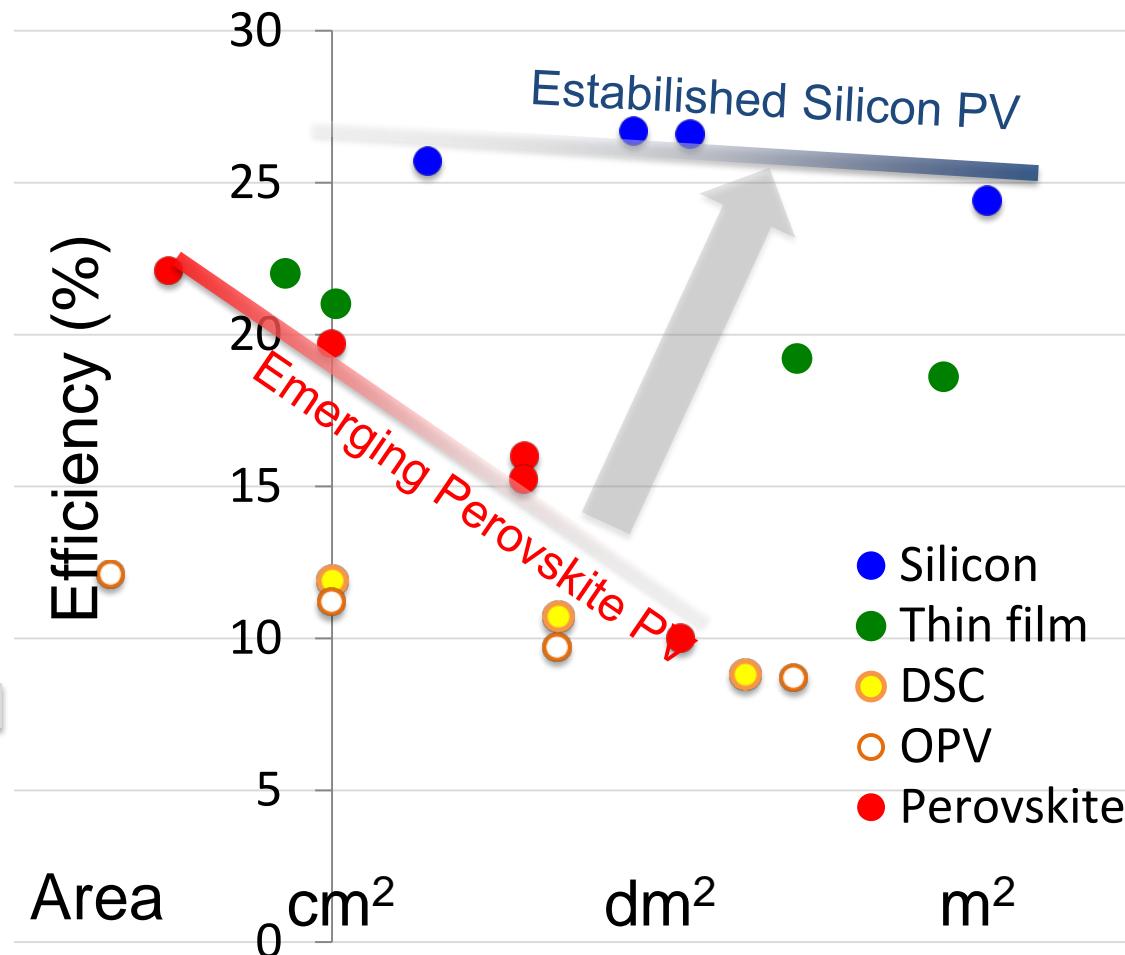
10% 156 cm^2 perovskite module from **Solliance**



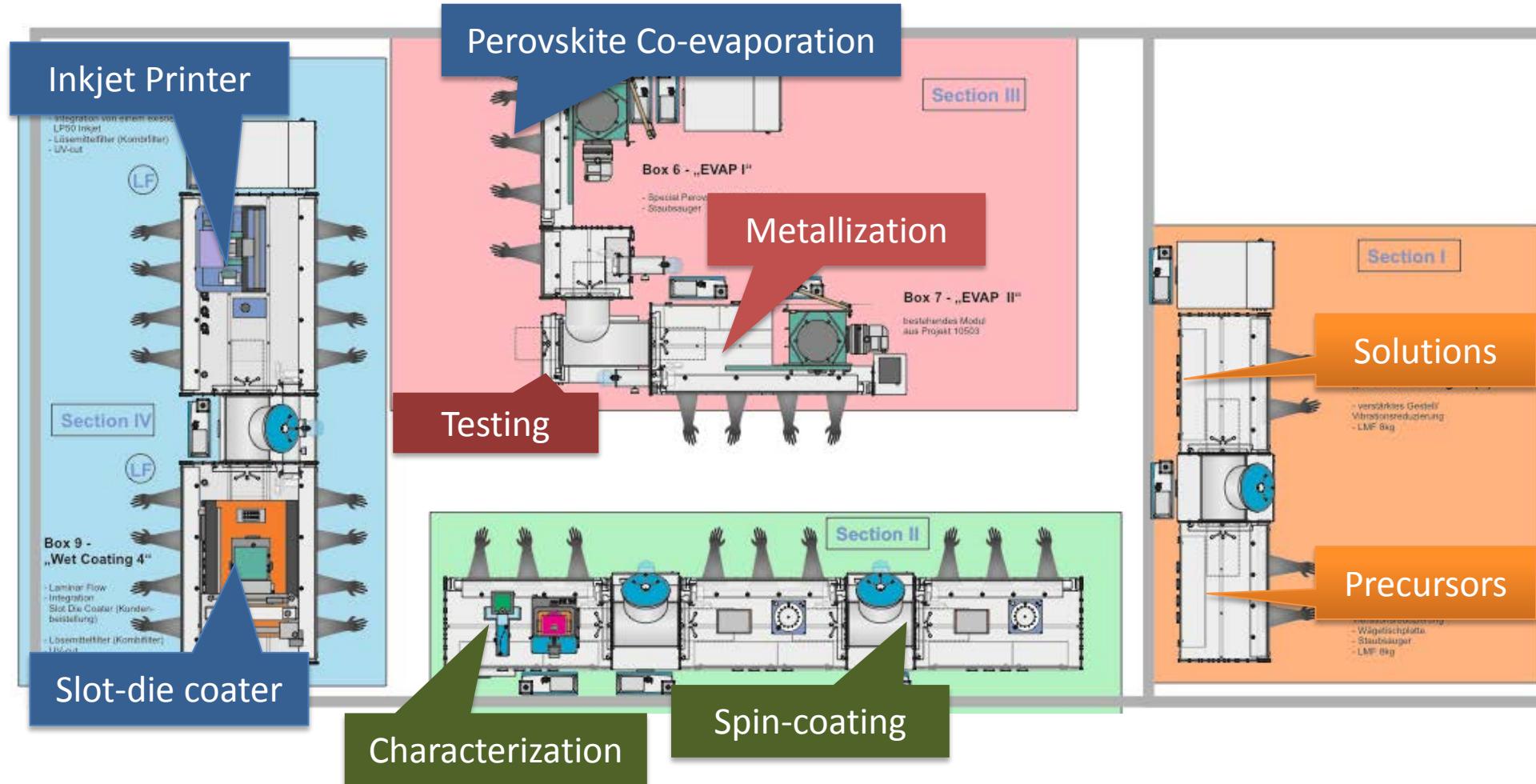
(Co)evaporation

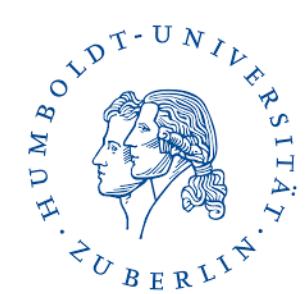
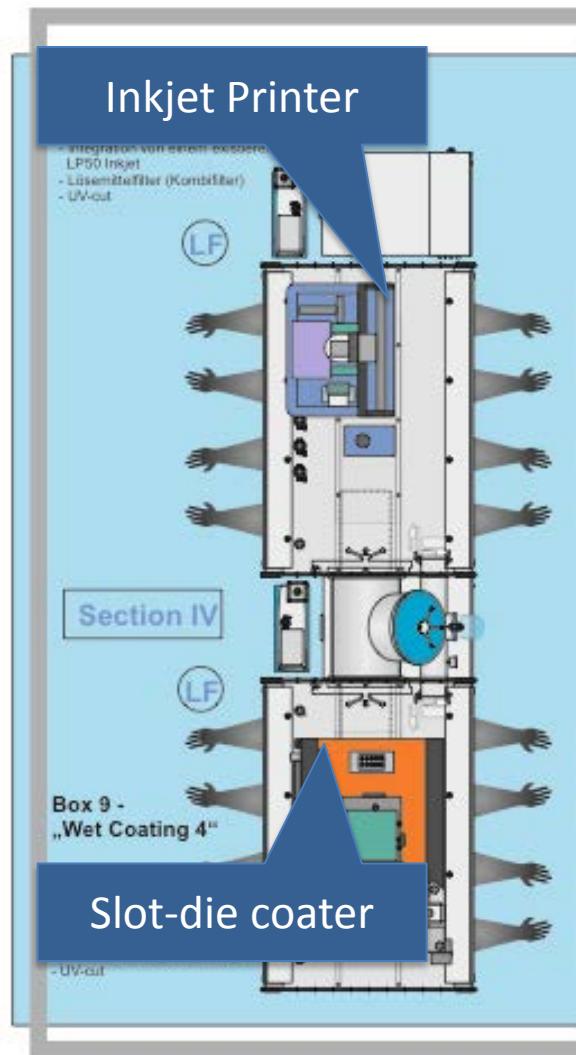


Slot-die coating
& Inkjet printing



3 scalable deposition techniques for up to 100 cm²

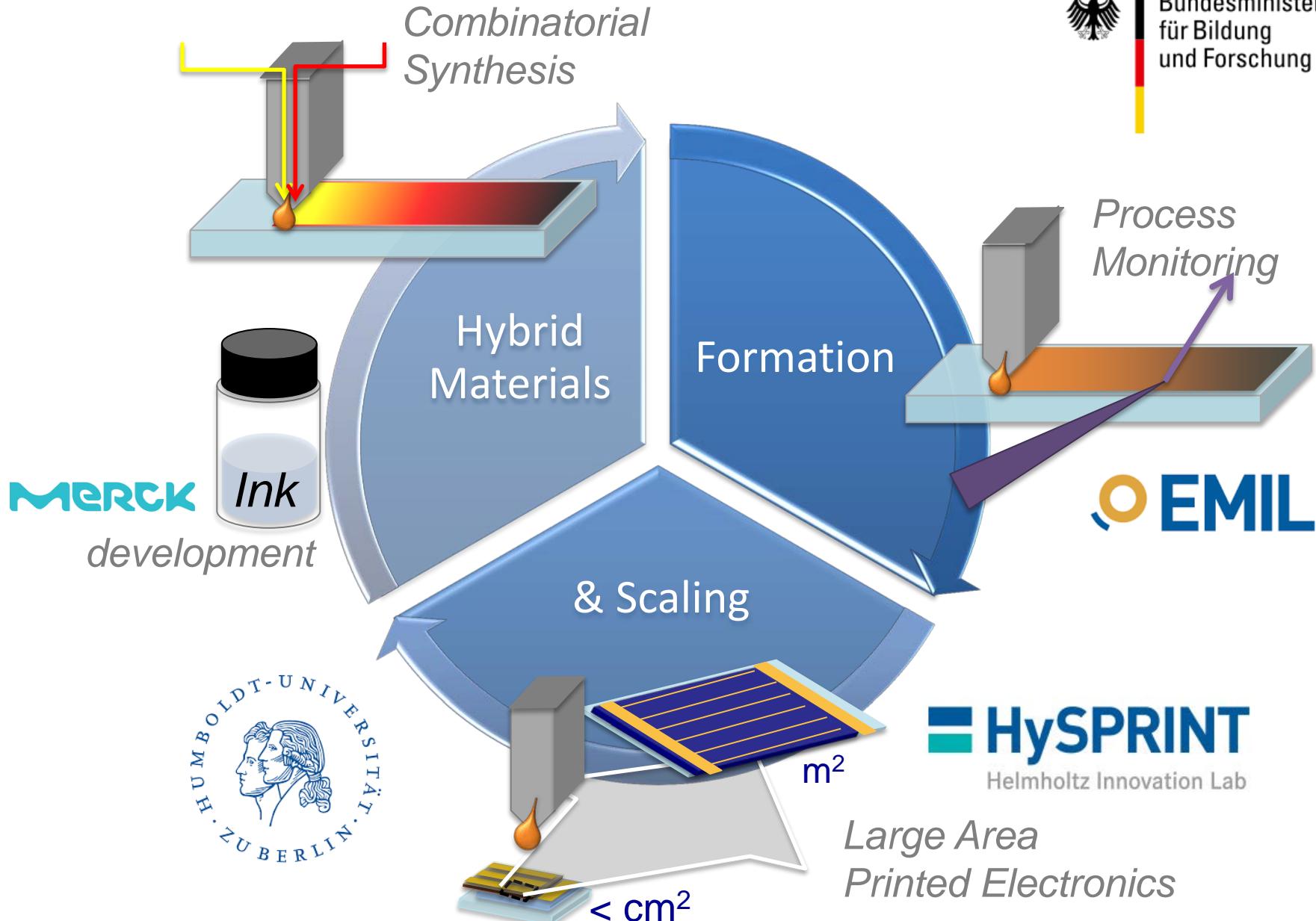


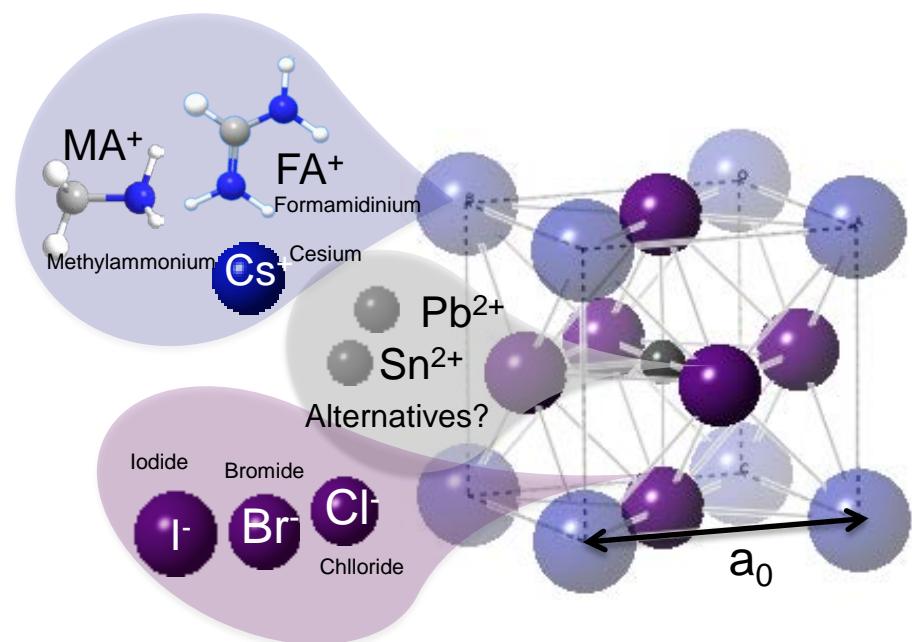


Industrial
collaborator?

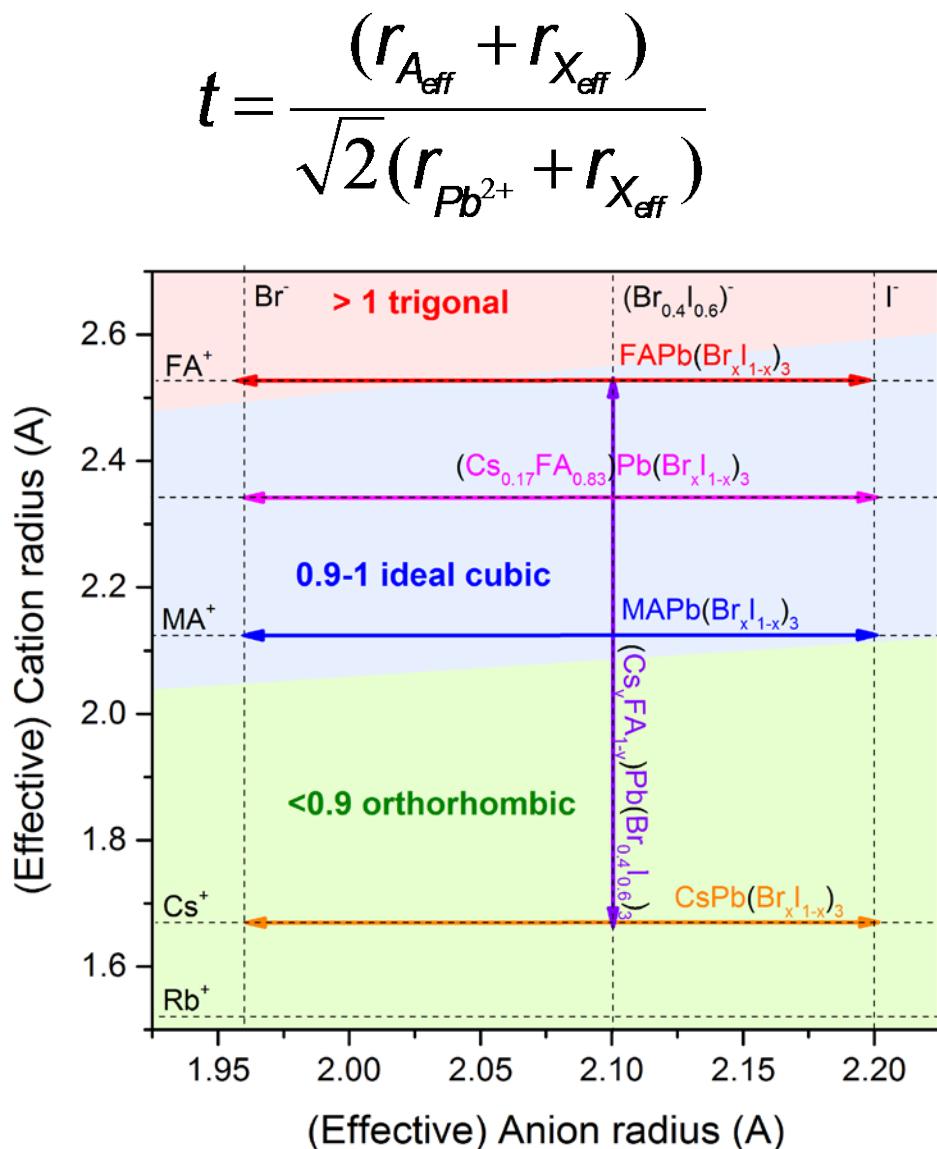


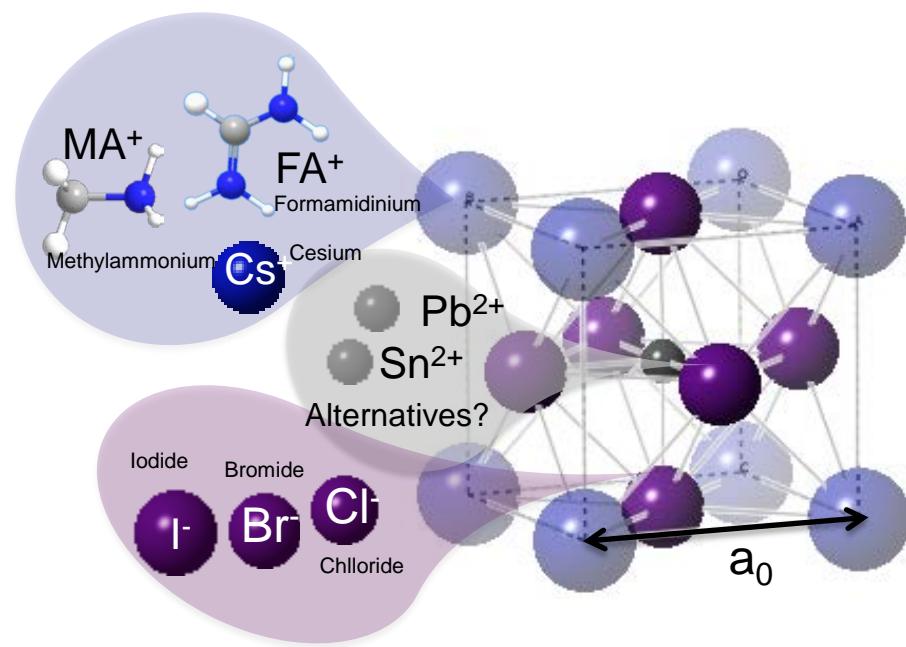
Bundesministerium
für Bildung
und Forschung



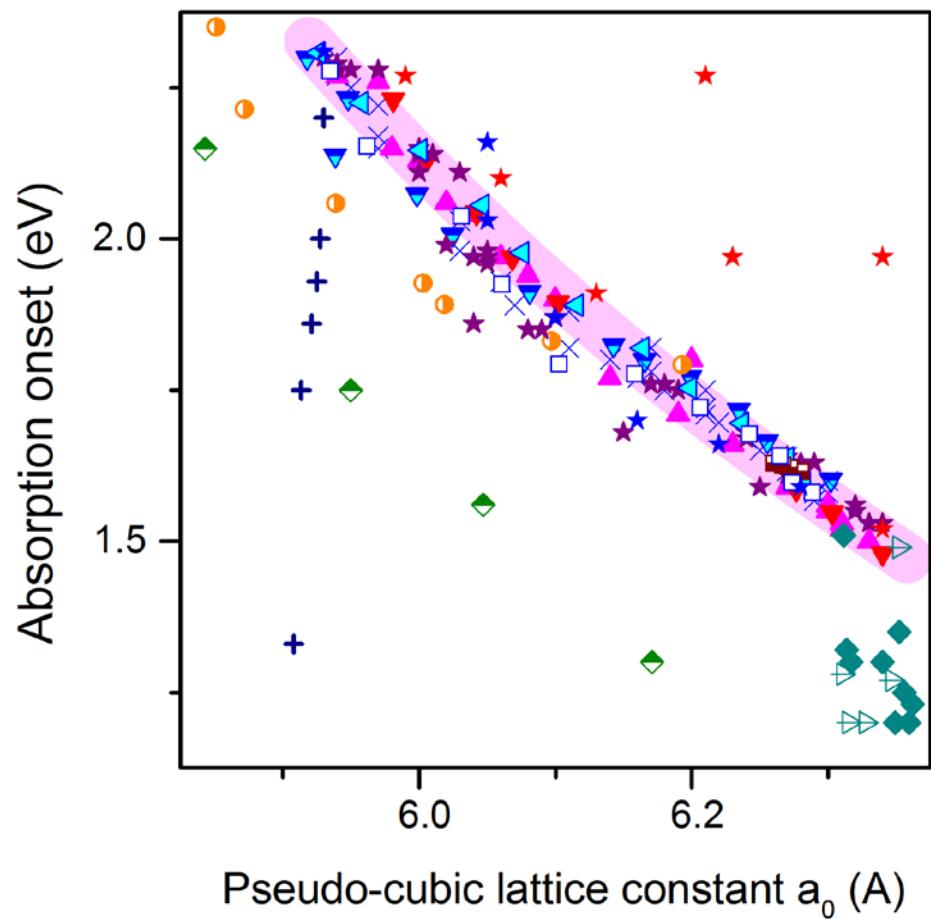


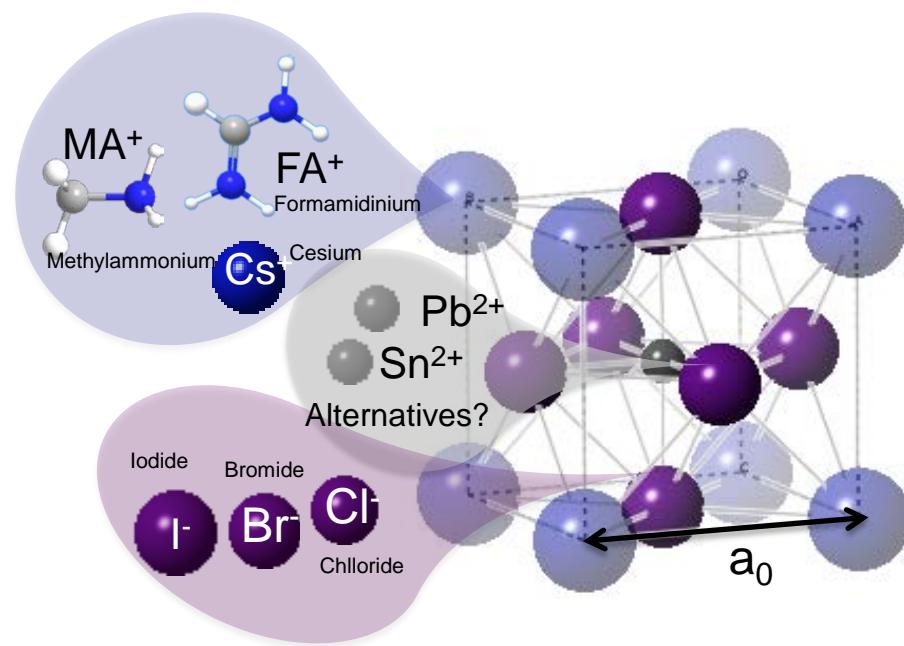
Ionic radii	
r_{Cs^+}	= 1.67 Å
r_{MA^+}	= 2.15 Å
r_{FA^+}	= 2.52 Å
$r_{\text{Pb}^{2+}}$	= 1.19 Å
$r_{\text{Sn}^{2+}}$	= 1.10 Å
r_{Cl^-}	= 1.81 Å
r_{Br^-}	= 1.96 Å
r_{I^-}	= 2.20 Å



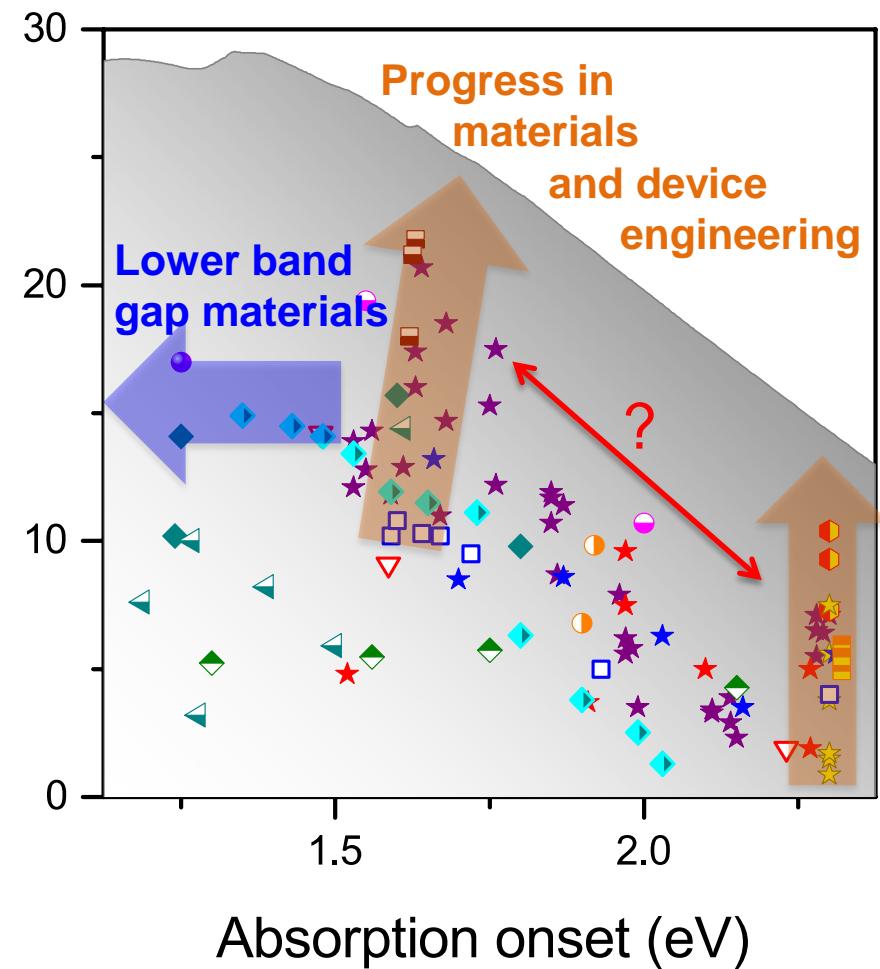


Pb-based perovskites:
Absorption onset depends
on lattice parameter



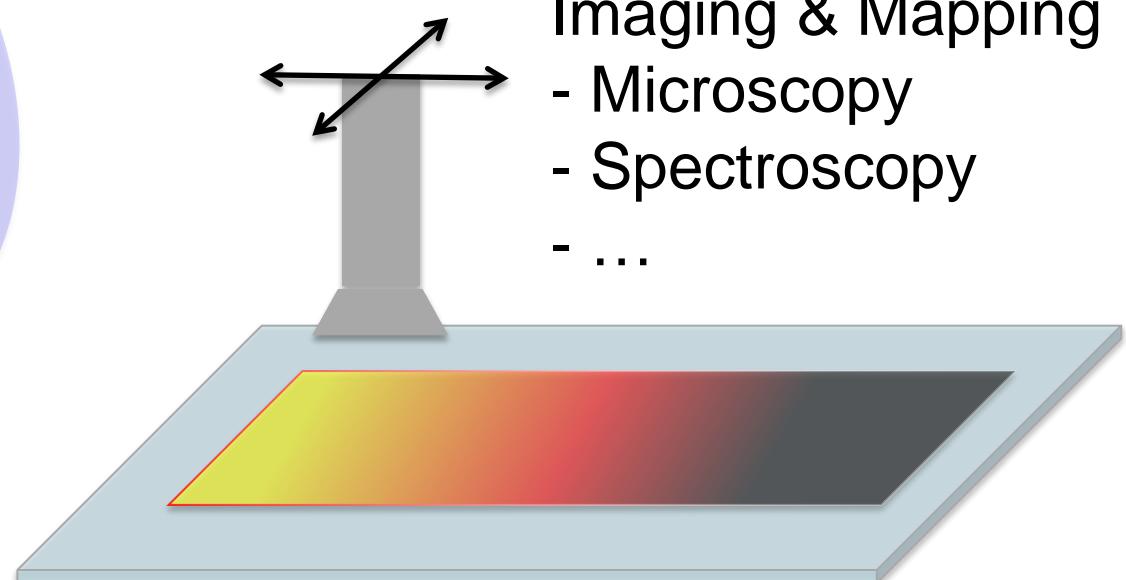
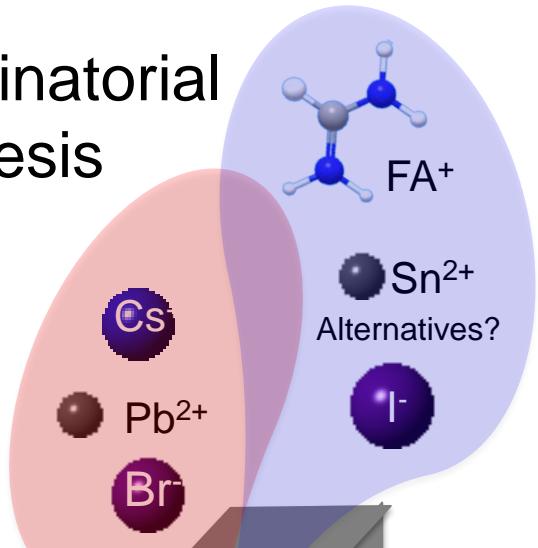


Comparison of large data sets allows appreciation of general trends and limitations.





Combinatorial Synthesis



Imaging & Mapping
- Microscopy
- Spectroscopy
- ...

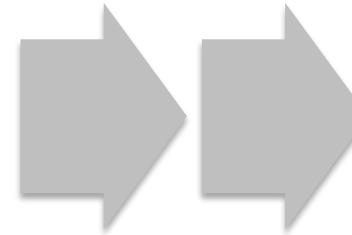


1) Ink development

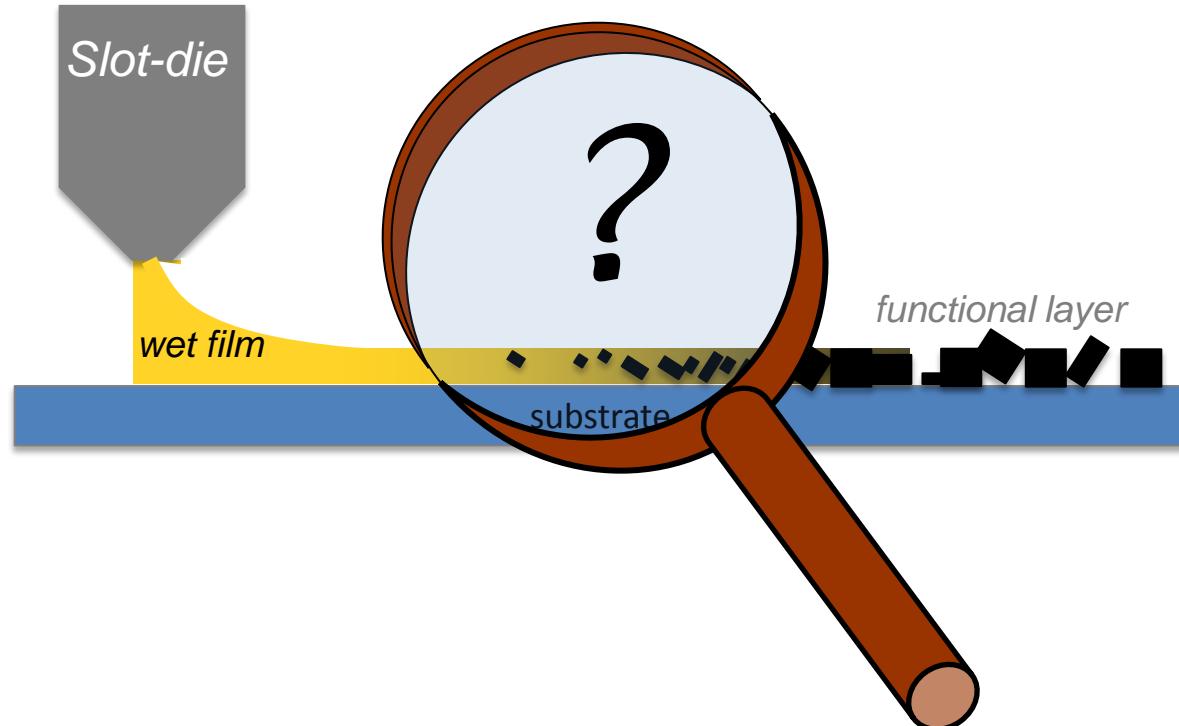
- precursors
- solvents
- additives

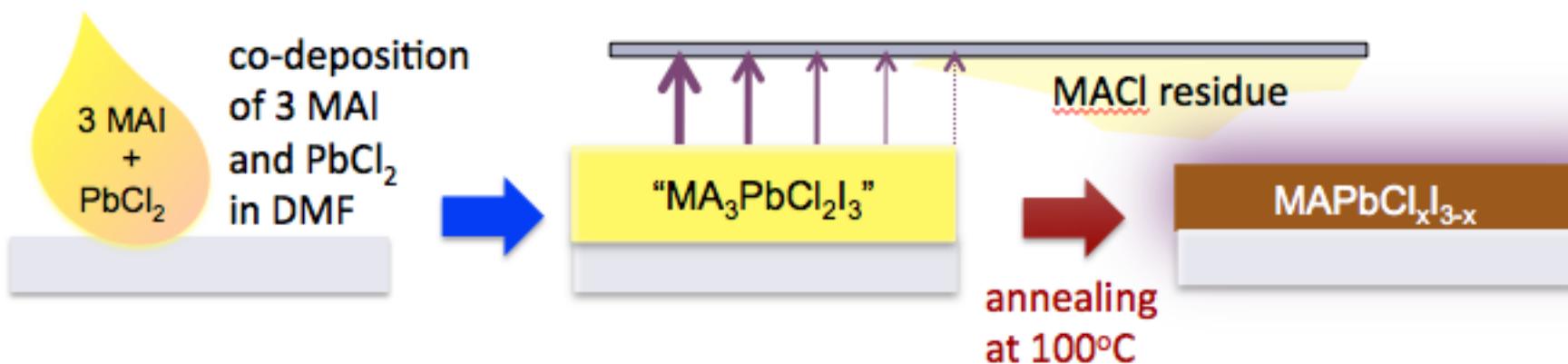
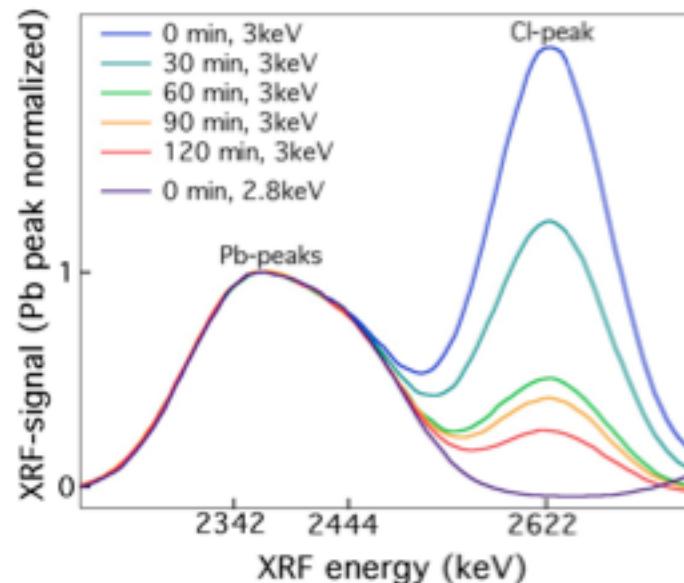
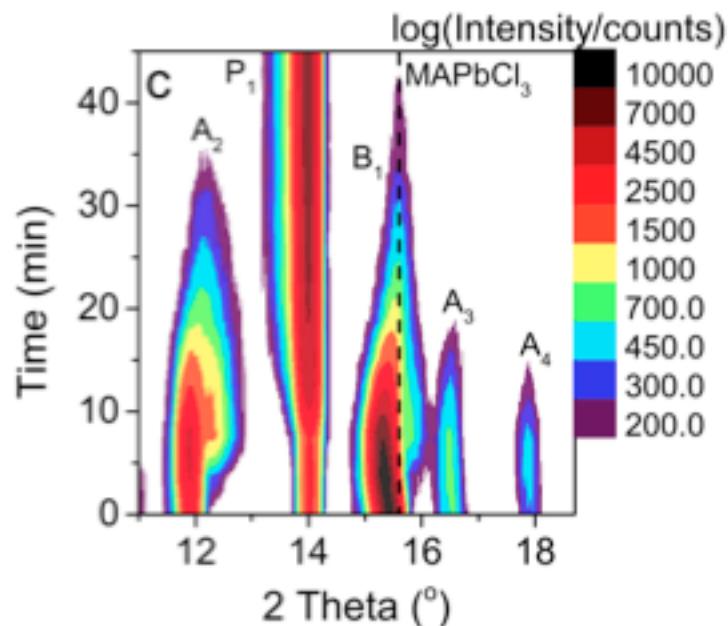
2) Process optimization

- process parameters
- in-line post-treatment

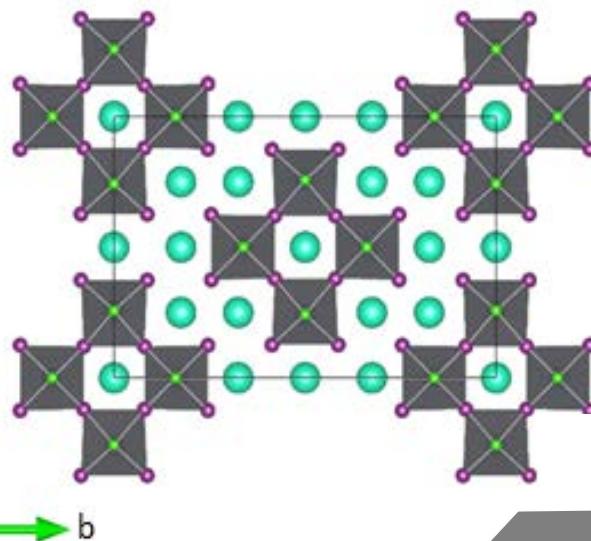


High quality
perovskite
layers?



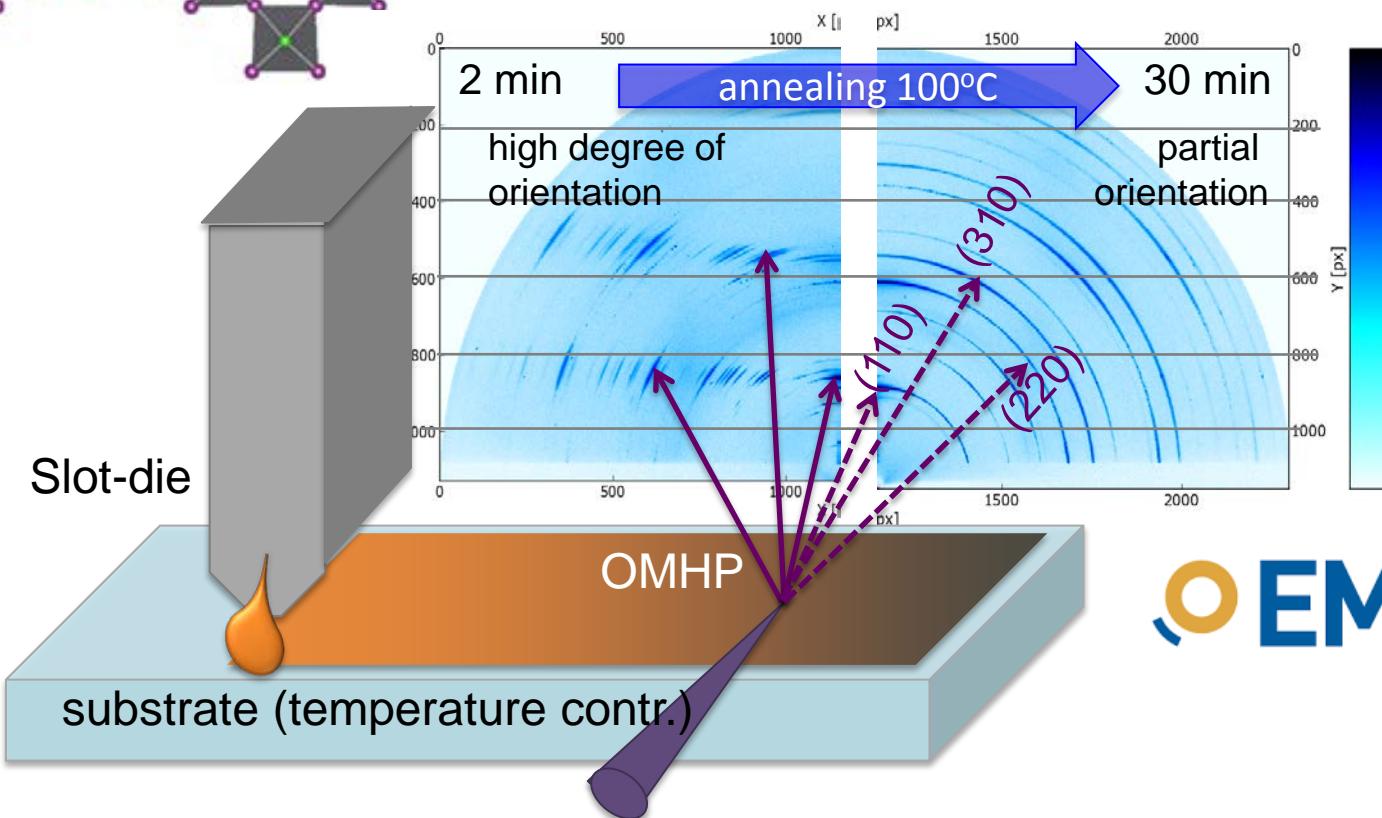


d)



Data beamtime 2014 at SSRL¹

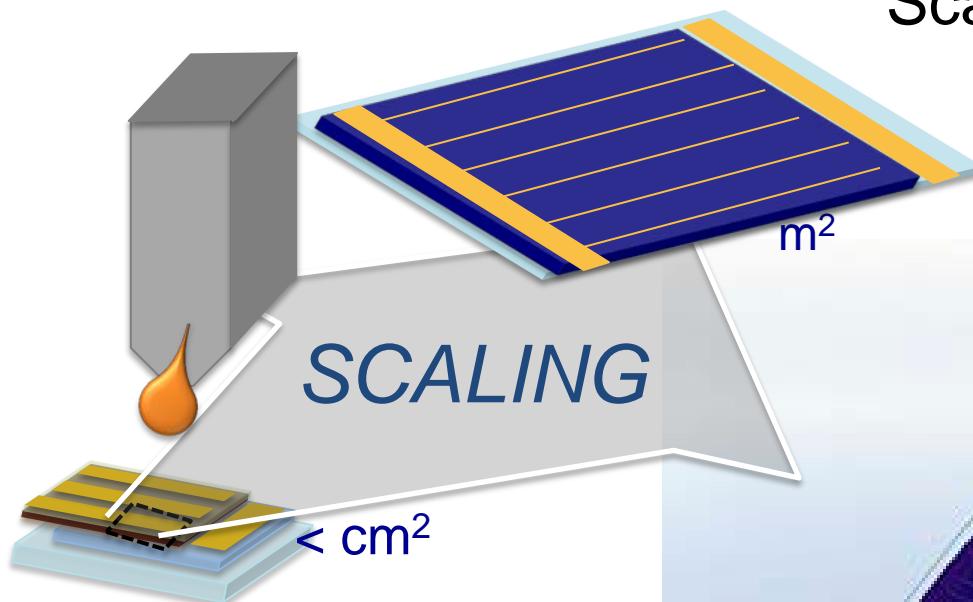
NOW we know the structure
of the intermediate phase!²



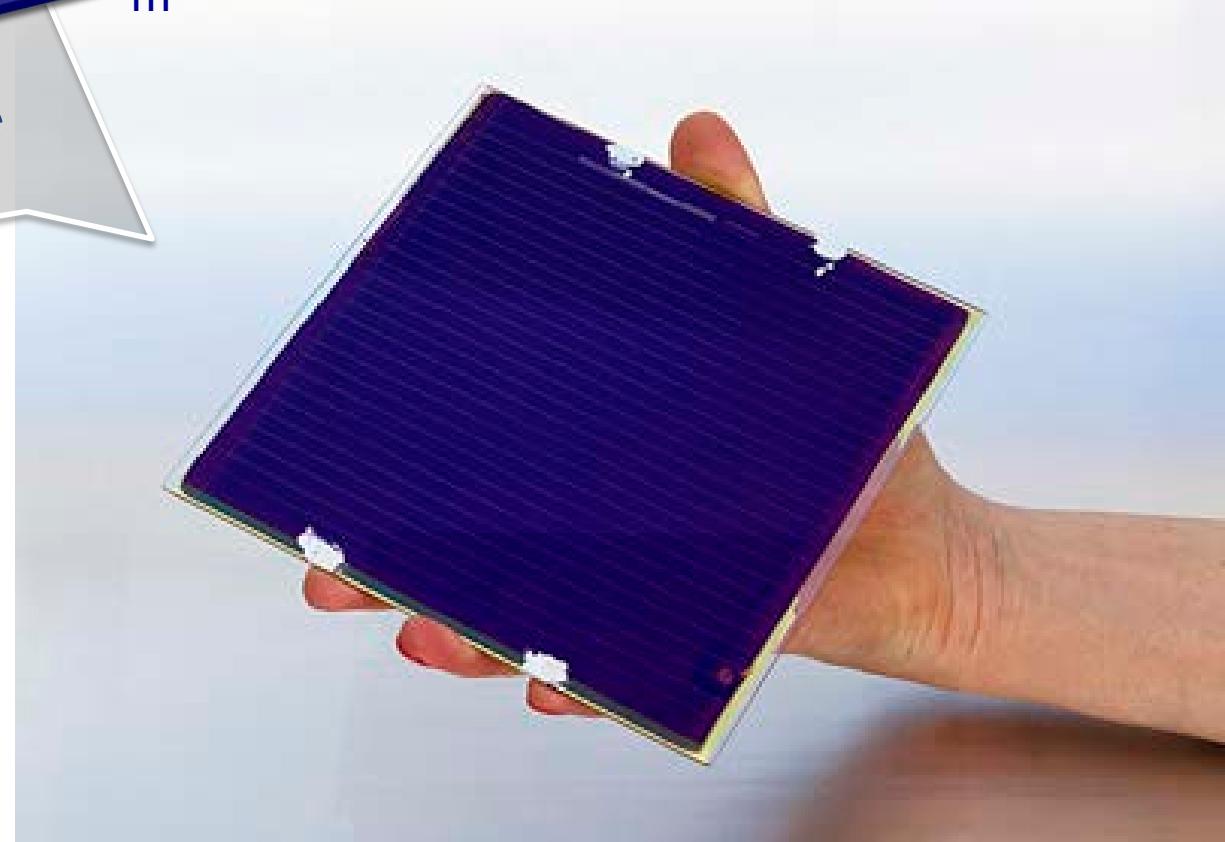
¹Unger et al., Chem. Mater. (2014)

²Stone et al. (submitted to Nature Chem.)

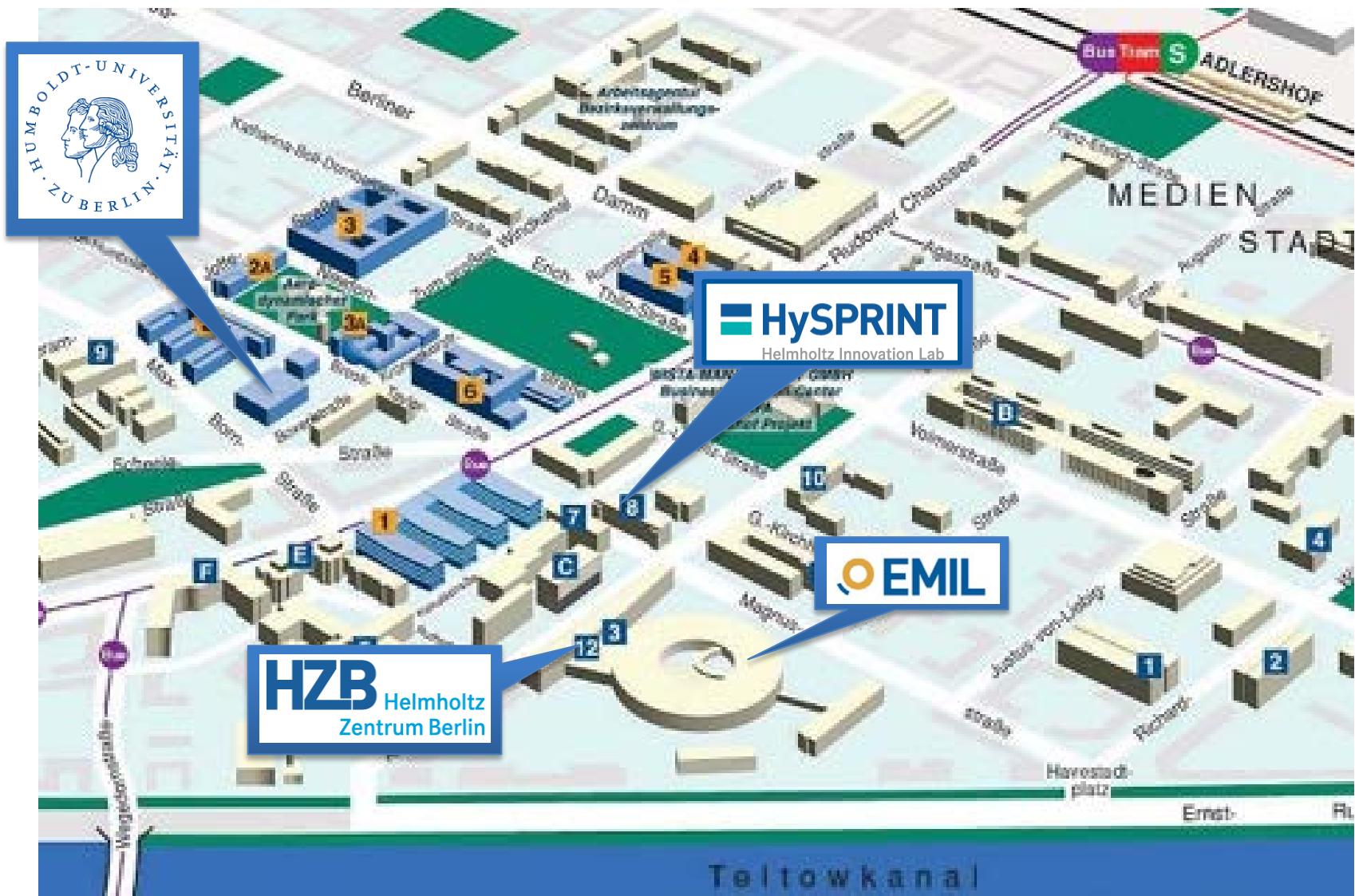
Scaling devices to larger areas!



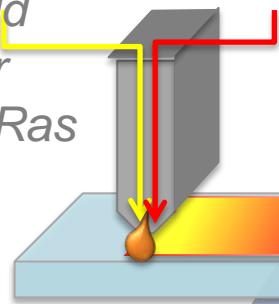
Yes, we can (too)!



10% 156 cm² perovskite module from **Solliance**



Thomas Unold
Susan Schorr
Daniel Abou-Ras



Aboma Merdasa

Klara Suchan
Ivan Scheblykin



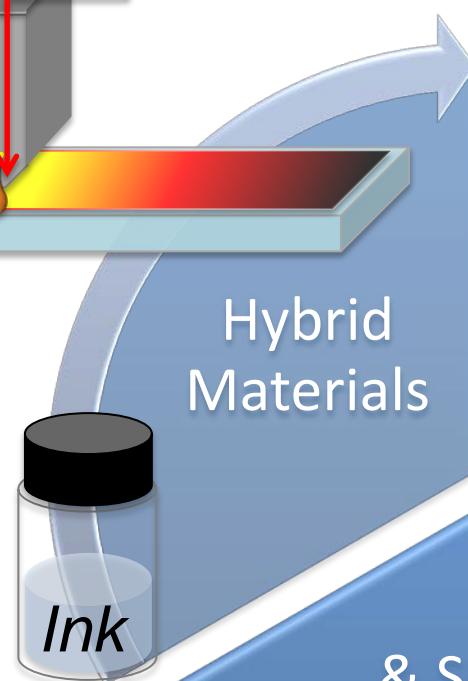
Katrin Hirselandt
Steffen Braunger

MERCK

Carolin Rehermann

Emil List-Kratochvil

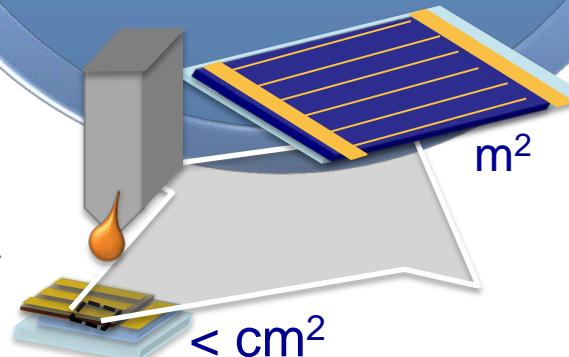
INN



Hybrid
Materials

Formation

& Scaling



EMIL

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