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HIGH-DYNAMIC SUPERCONDUCTING LINEAR MOTOR

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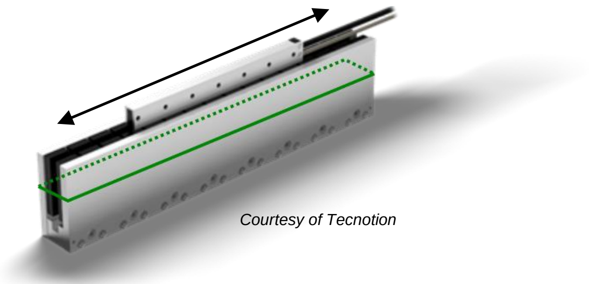
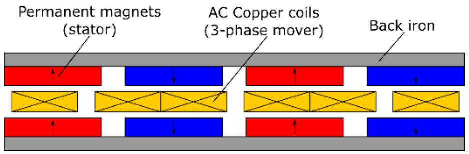
ASML VDL PRODRIVE TECHNOLOGIES
TU/e NWO Toegepaste en Technische Wetenschappen

INTRODUCTION

Conventional linear motor



Courtesy of Tecnotion



NdFeB magnets and alu racetrack coils

a_{max} : 320 m/s^2 (85 kg payload)

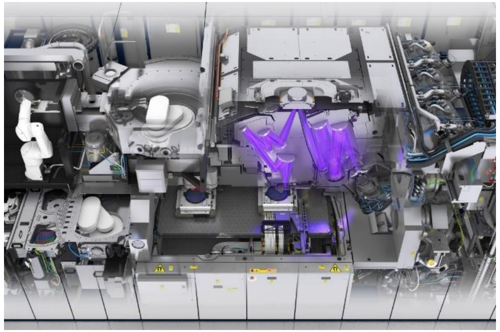
Material limits reached

Lithography: still **higher force-density** is desired

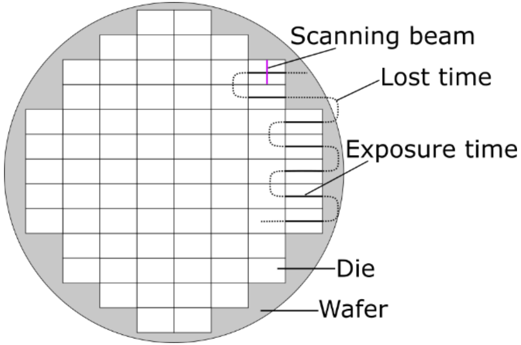
Many instances of de-acceleration

Increase stator field by replacing permanent magnets with DC superconducting electromagnets

Aim for 1000 m/s^2 in reticle stage



NXE3400, EUV lithography machine, courtesy of ASML



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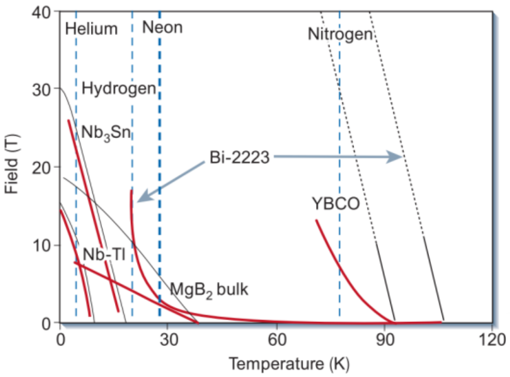
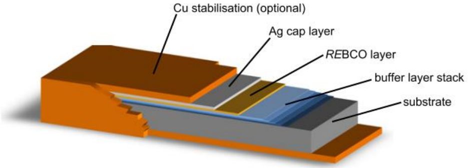
SUPERCONDUCTIVITY

- Higher magnetic field in air gap
- No dissipation
- Allows for larger air gap
- Wide temperature range
- Thermal stability
- Conductor development



Irreversibility field of common superconductors [1]

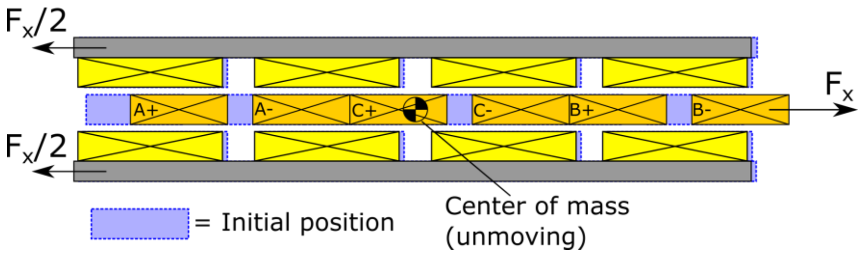


Composition of ReBCO coated conductor [2]

[1] Larbalestier, D., Gurevich, A., Feldmann, D. M., & Polyanskii, A. (2001). High-Tc superconducting materials for electric power applications. *Nature*, *414*(6861), 368–377. https://doi.org/10.1038/35104654
[2] C. Barth, G. Mondonico and C. Senatore, Supercond. Sci. Technol. 28 (2015) 045011

THERMAL CHALLENGE

- DC coils exposed to AC fields
  - Heavy AC loss near I_c
- Forces acting on coils
  - Vibrations disturb process
  - Balance mass is **free to move** (~5g)



- Refrigeration system must carry large heat load from rapidly moving object to cooler, while minimizing impact on motor and machine performance

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THANKS FOR YOUR ATTENTION

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