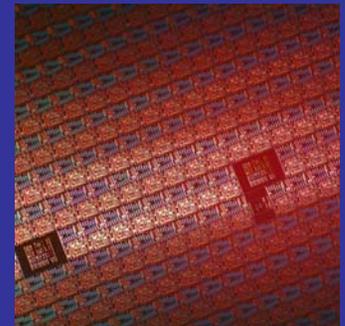




Accelerating the next technology revolution

# The EUV Mask Metrology Gap

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# EUV Mask Infrastructure Workshop



- In July, SEMATECH conducted a Workshop on EUV Mask Infrastructure attended by high-level decision makers from over 20 EUV stakeholders including
  - Chip manufacturers
  - Mask houses
  - Mask blank suppliers
  - Scanner suppliers
  - Metrology equipment suppliers
- Workshop Goal: highlight the lack of commercial actinic mask metrology infrastructure and obtain consensus on a path to close the gap
- Workshop Output:
  - Clear mandate: SEMATECH should form a Tool Consortium to fund the development of EUV actinic mask metrology equipment, but
  - Many open questions about which actinic tools are needed and when
  - Uncertain what funding model would be successful

# Working Groups



- Two working groups were formed to answer the questions raised at the workshop
- EUV Mask Infrastructure Technical Working Group (TWG)
  - Assess the capability of existing mask metro tools
  - Generate plan to support EUV pilot line in 2011 with existing tools
  - Determine the required specifications for HVM mask metrology tools
  - Develop an HVM plan for 2013 using actinic/optical metrology tools
- EUV Mask Infrastructure Business Working Group (BWG)
  - Establish credible business plan to fund actinic mask metrology tool development
  - Obtain funding support from EUV stakeholders for this plan

# EMI TWG Output



- Assessed the capability of a large number of metro tools
- Conclusion: pilot line needs can be met without actinic equipment
  - Substrate and Blank Inspection:
    - Existing substrate and blank inspection capability must be upgraded to 25nm sensitivity from ~35-40nm sensitivity today
    - DUV 193/199 nm patterned mask inspection tools need to be used for blank inspection
    - Blank suppliers must obtain access to optical pattern inspection tools
  - AIMS:
    - Print testing can satisfy AIMS need in the short term
  - Patterned mask inspection:
    - Capabilities to support pilot line (22 nm) already exist

# TWG Output: Required HVM Actinic Toolset



- Consensus (but not unanimous) capability requirement for HVM:
- Actinic Pattern Inspection (API):
  - For 22 nm hp in 2013, optical pattern inspection (OPI) can suffice with some additional development
  - Beyond 22nm hp, actinic pattern inspection (API) or some other advanced pattern inspection is required
- Actinic Blank Inspection (ABI):
  - Zero-geometry phase defects are too severe to ignore ABI
  - Need for ABI not proven but must develop now to mitigate risk (can stop if another solution becomes available)
- AIMS:
  - There is no viable HVM tooling scenario without an AIMS tool
- Improved high brightness source technology is key for all three tools

# BWG Output: Industry Realities

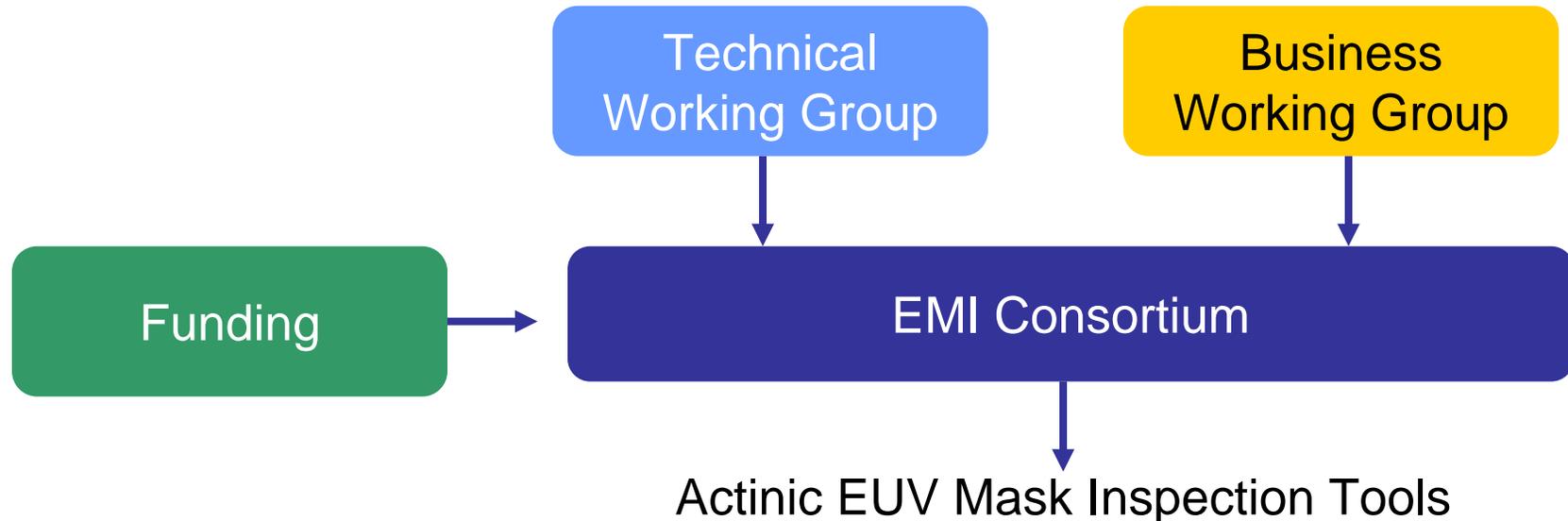


- Mask metrology equipment suppliers cannot fund actinic tool development alone
  - Cost is high, market size is small
- All segments of the EUV mask supply chain must contribute to the NRE development cost
  - Early investors pay NRE
  - Late investors pay more in form of royalties
- Blank Inspection tool market is extremely small and requires that blank purchasers bear most of the cost for actinic blank inspection tools
- AIMS market is fairly small and purchasers must bear large amount of NRE costs
- Pattern mask inspection market is large enough for tool maker and tool user segments to have comparable NRE contributions

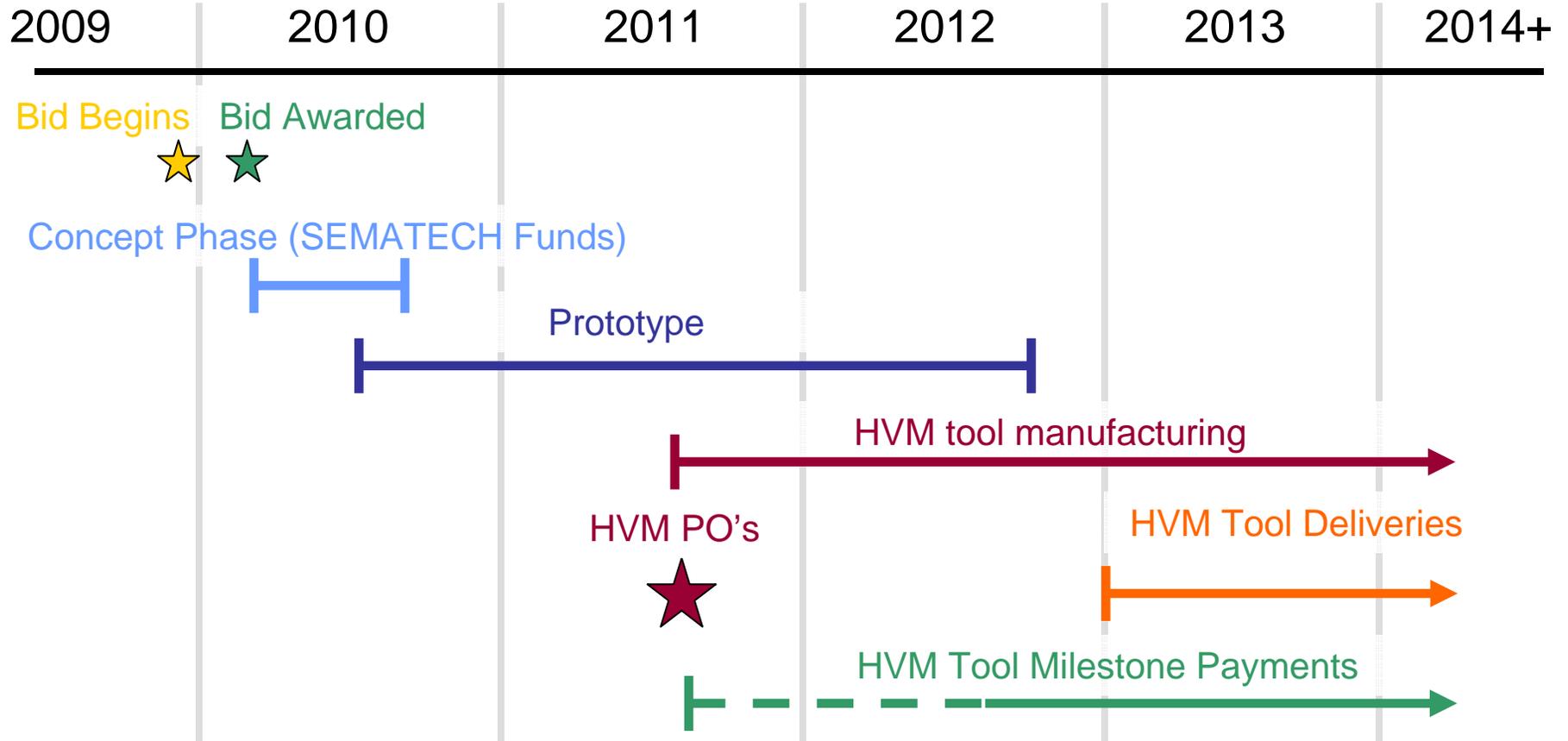


# Structure of the EUV Mask Infrastructure (EMI) Consortium

- TWG provides specifications for use in RFP
- BWG provides business plan and commitments from funding partners
- Consortium (SEMATECH + funders) opens bid for actinic tools and selects actinic tools to develop with consortium dollars
  - Estimate \$50M+ NRE for ABI development
  - Estimate \$50M+ NRE for AIMS development
  - Estimate \$30M NRE for API research phase, potentially \$120M-\$250M later



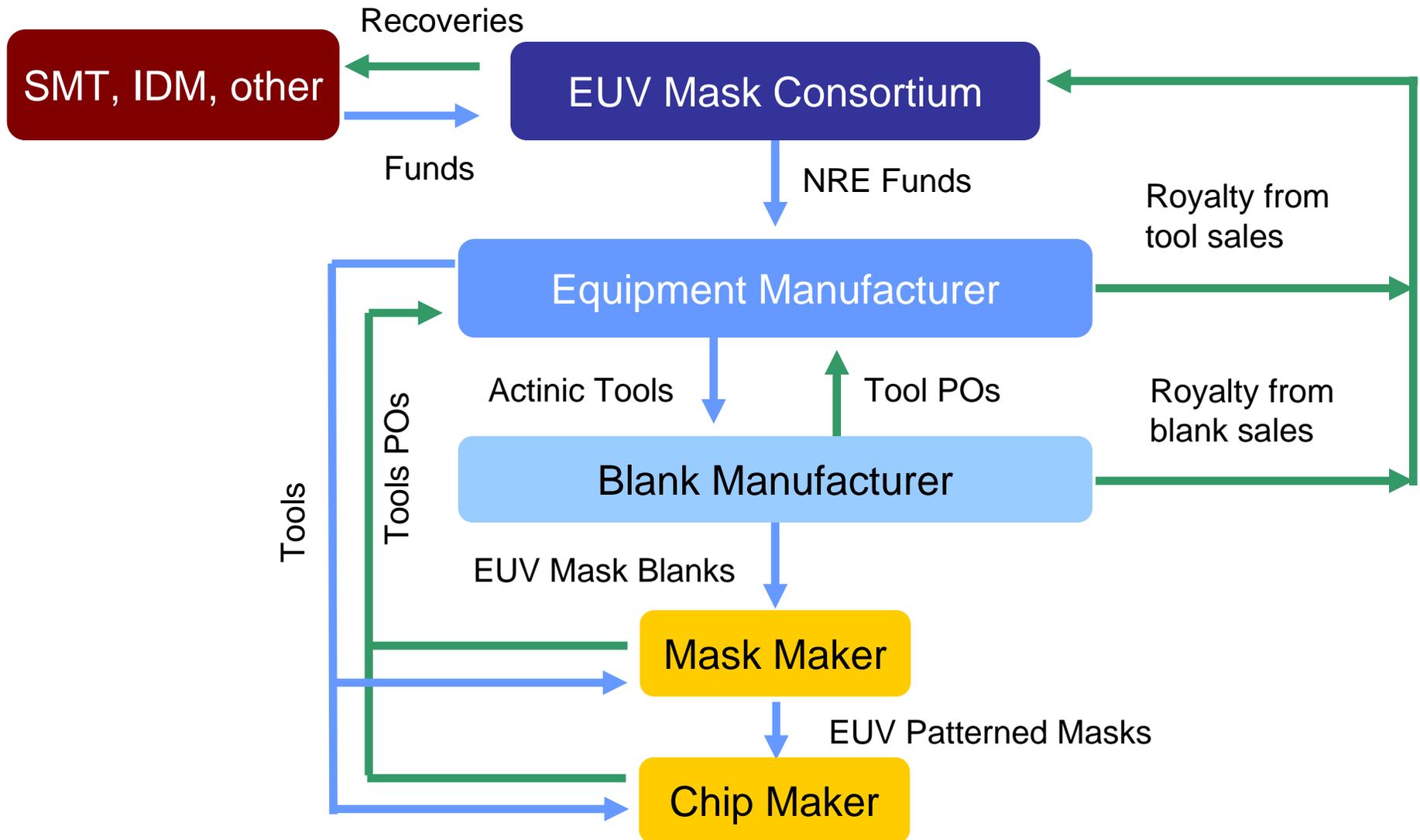
# Sample Tool Development Timeline



Concept: ~few \$M (highest risk, needed to maintain insertion timing)

Funders: payments spread over 2010, 2011, 2012

# General Funding Model



# Summary



- SEMATECH is forming an actinic mask metrology tool funding consortium
- EMI TWG has determined that
  - Actinic tools are not needed for pilot line in 2011
  - ABI is needed for HVM EUV to mitigate risk
  - AIMS is required for HVM EUV
  - API or other advanced PMI is required in 2015
- EMI BWG believes that more than \$130M+ is required to develop ABI and AIMS, and to start API development
  - SEMATECH has funds committed *today* to support this
  - Equipment suppliers cannot fund actinic tool development
  - EUV users must fund tool development
  - Proposed funding models recover NRE through blank and tool sales



Thank you for your kind attention!  
Questions?