



Project **THESEUS**

**Tandem High Efficiency Solar Cells
Utilising III-V Semiconductors on
Silicon**

Project Coordinator:

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Partner:

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Partner:

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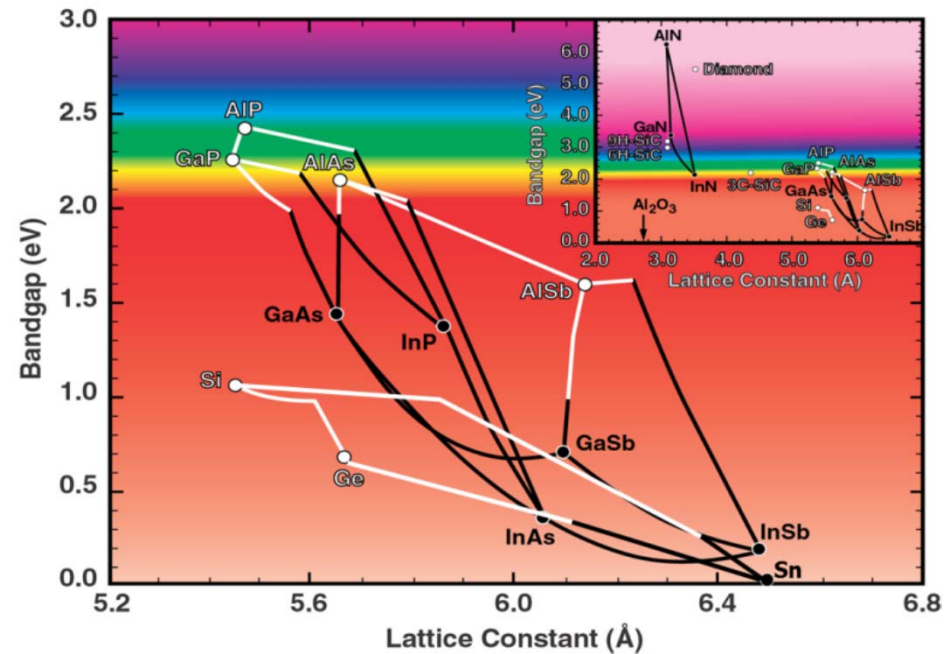
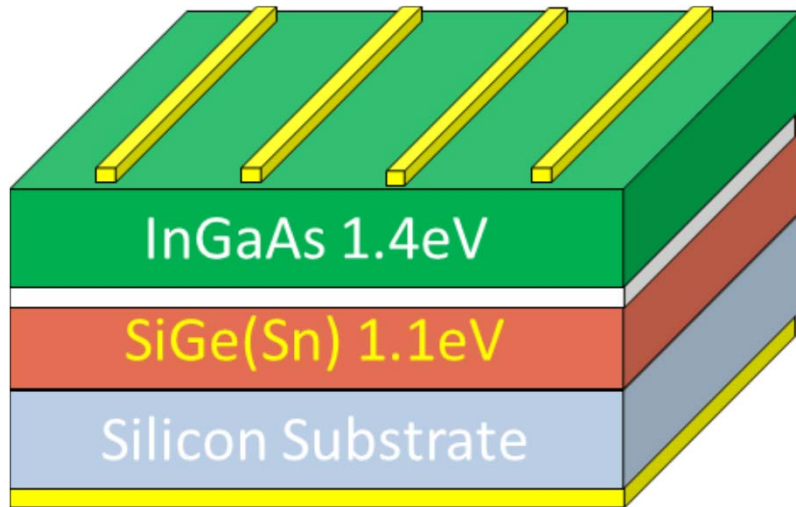


Project Introduction

Project **THESEUS**

| Part. No. | Participant organisation name | Short name | Country | Org. Type |
|-----------|-----------------------------------|------------|---------|------------|
| 1 (Coord) | IQE plc | IQE | UK | Large |
| 2 | Universidad Politecnica de Madrid | UPM | Spain | University |
| 3 | DHV Technology | DHV | Spain | SME |

- Key objective - demonstrate 2J tandem solar cells
- Utilising silicon substrates (one of the sub-cells)
- MOCVD growth of III-V semiconductors on Silicon
- Minimising the effect of mismatch between lattice parameter and thermal coefficient of expansion



- Maximise the solar cell performance
- CVD growth of SiGe and SiGeSn to allow Group IV sub-cell into the device architecture

Conversion efficiency at cell and module level

TARGETS

1. 25% (AM1.5G) for the solar cell and
2. 22% for the modules
3. On-sun testing in Madrid to confirm these numbers

- Target for the project is TRL 5 - validated in a relevant environment (on-sun)
- Achieved by the reliability analysis on the tandem III-V/Si solar cells
- Manufacturing of prototype modules - Outdoor testing in Madrid by UPM

Project Challenges

Project **THESEUS**

Key Challenges – Epitaxial Growth of New Materials in III/V technology on Silicon:-

- The achievement of high quality SiGe buffer layers
- The growth of SiGeSn alloys with good PV material properties
- Growth of high quality III-V materials for the top cell already established by IQE and UPM
- Solar cell module manufacturing - demand for new developments to create a hybrid III-V/Si manufacturing technology
- Compatible with both material families and, at the same time, obtain the maximum potential of the device

Project Work Package Overview, Costs & Manpower

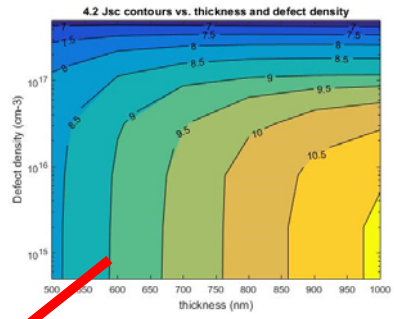
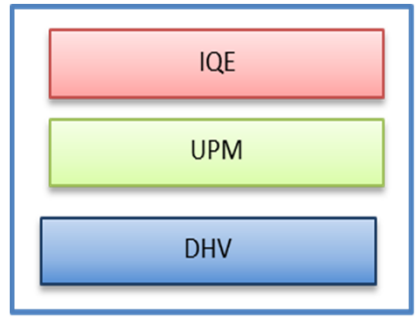
Project **THESEUS**

| WP No. | Work Package title | Lead Part. | Start M'th | End M'th |
|--------|--|------------|------------|----------|
| 1 | Project Management | IQE | 1 | 30 |
| 2 | CVD Growth of SiGe and SiGeSn on Silicon | IQE | 1 | 18 |
| 3 | MOCVD Growth of III-V Top Cell on Si-based bottom Solar Cell structure | UPM | 6 | 18 |
| 4 | Solar Cell Design, Fabrication & Test | UPM | 1 | 22 |
| 5 | Module Design & Assembly | DHV | 1 | 20 |
| 6 | Reliability Analysis | UPM | 20 | 27 |
| 7 | On-sun Module Testing | UPM | 26 | 30 |

| Partner | Personnel | Equipment | Materials | Sub-Co | Travel | Other | Overhead | Total Costs | PM Total |
|--------------|----------------|-----------|----------------|---------------|---------------|------------|----------------|----------------|-------------|
| 1: IQE PLC | 220,000 | 0 | 120,000 | 12,500 | 12,500 | 0 | 132,000 | 497,000 | 27.5 |
| 2: UPM | 66,000 | 0 | 7,400 | 0 | 1,000 | 600 | 0 | 75,000 | 20 |
| 3: DHV | 85,000 | 0 | 13,000 | 0 | 2,000 | 0 | 0 | 100,000 | 25 |
| Total | 371,000 | 0 | 140,400 | 12,500 | 15,500 | 600 | 132,000 | 672,000 | 72.5 |

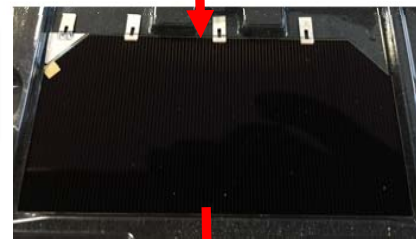
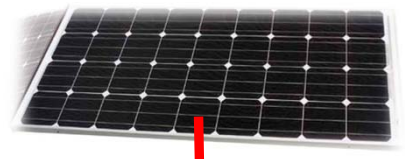
Project Workflow : Contributions of All Partners

Project *THESEUS*



WP4 - 3J Cell Design

WP1 - Project Management



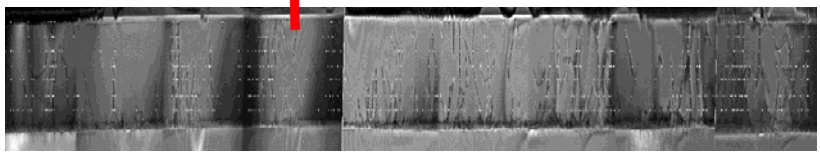
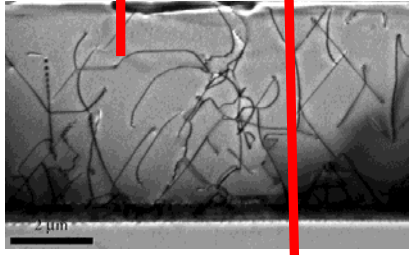
WP2 - Epitaxial growth of SiGe and SiGeSn on Silicon

WP3 - Epitaxial growth III-V on Si Solar cells

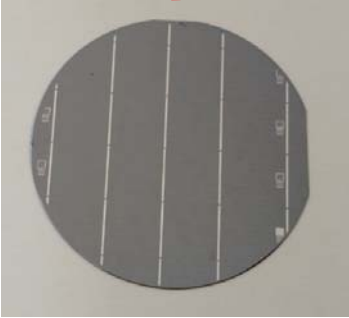
WP4 - Cell Fabrication & Test

WP5 - Module Design & Assembly

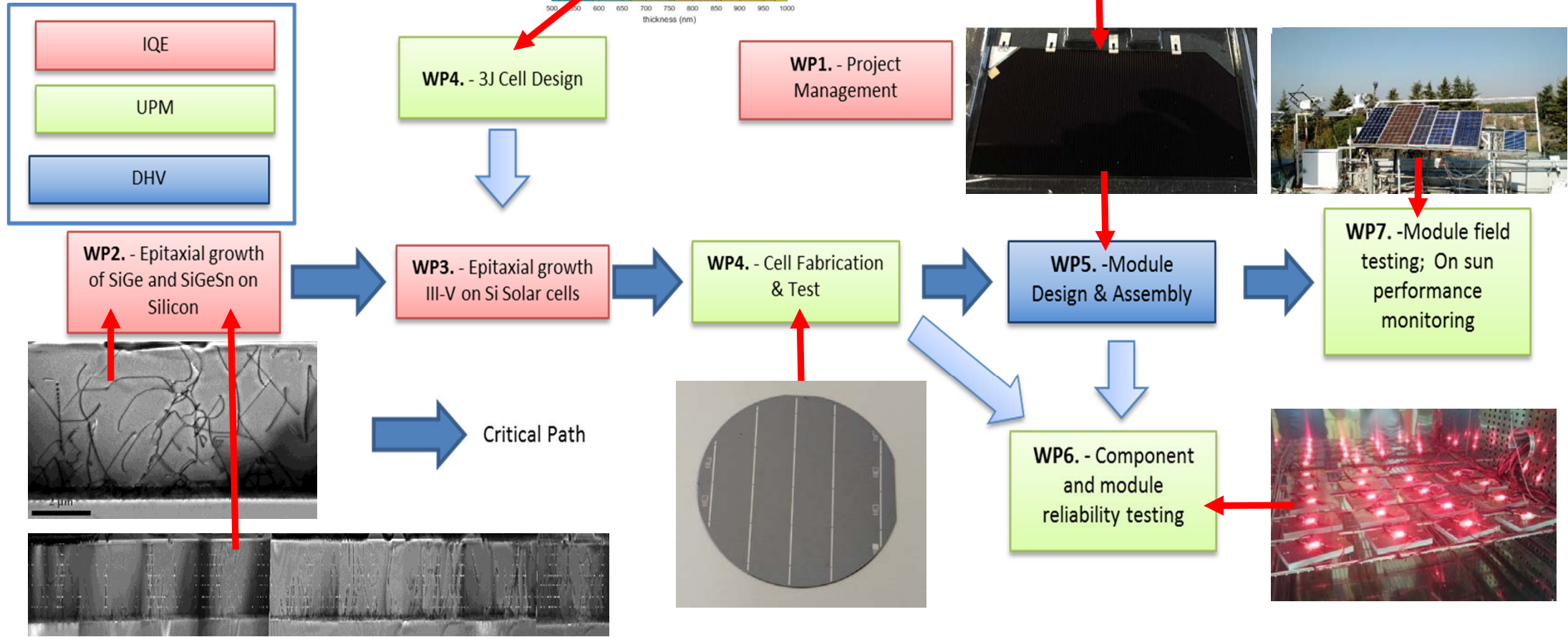
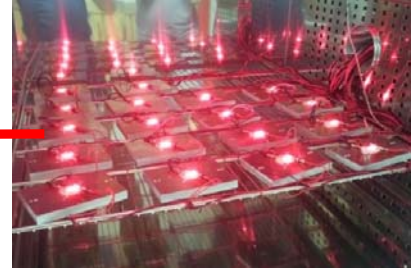
WP7 - Module field testing; On sun performance monitoring

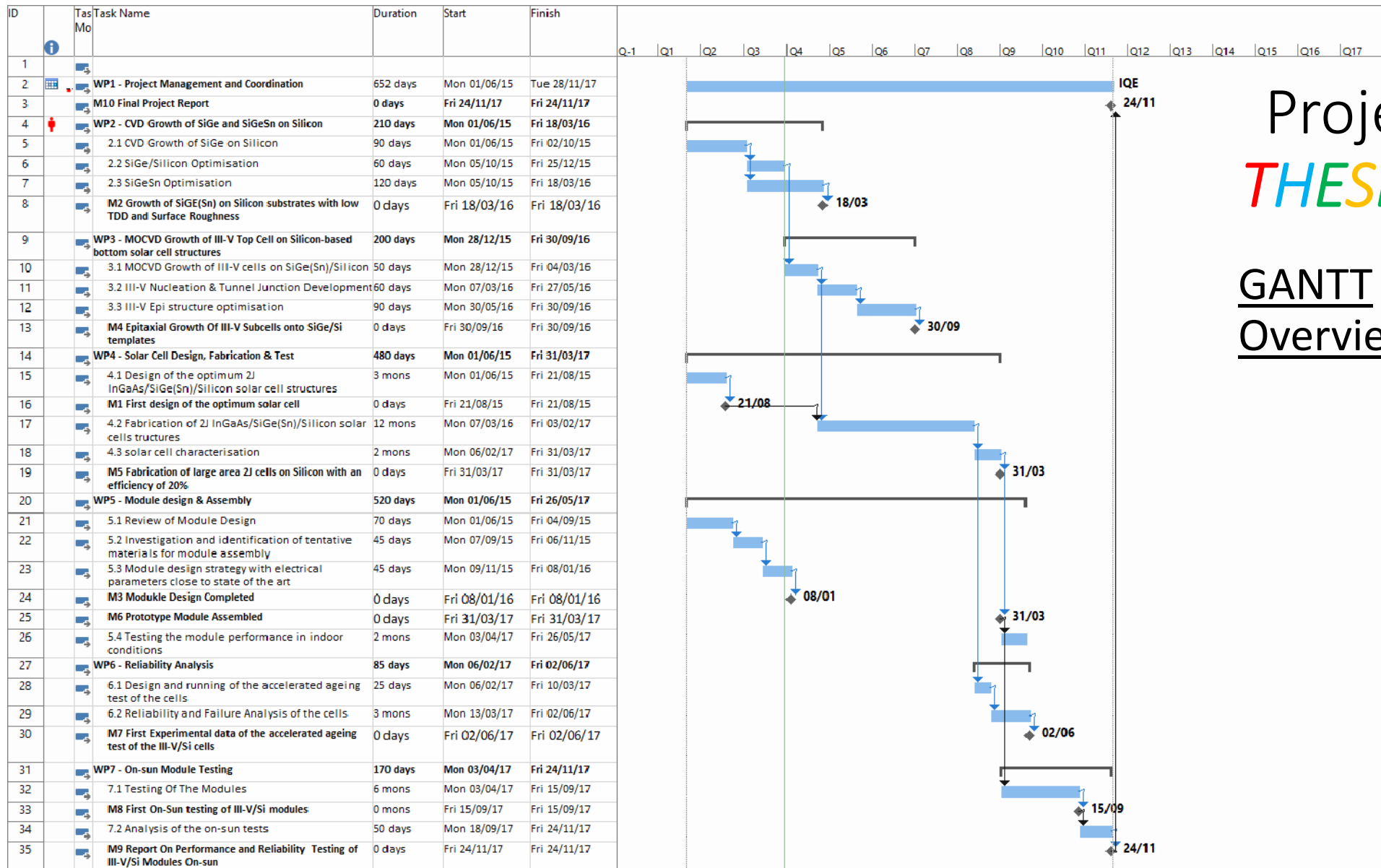


Critical Path



WP6 - Component and module reliability testing





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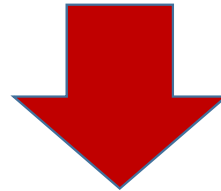
GANTT Overview

Project Issues

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- Alignment of Project Start (and end!)
 - Start times are usually staggered
 - Different National Agencies have varying approaches to “Negotiation”
 - Kick-Off Meetings can be “outside” of eligible costs for some partners

- Meeting Duplication
 - Reporting of Progress, Deliverables and Milestones variable
 - Meetings are often duplicated in country of origin in addition to EU-based meetings



Coordinate Project Starts

Avoid duplication:

- acceptance by National Agencies of EU meeting progress reports and conclusions
- simplified claims process in National Agencies