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## Power Constrained Test Scheduling for 3D Stacked Chips: poster

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# Power Constrained Test Scheduling for 3D Stacked Chips

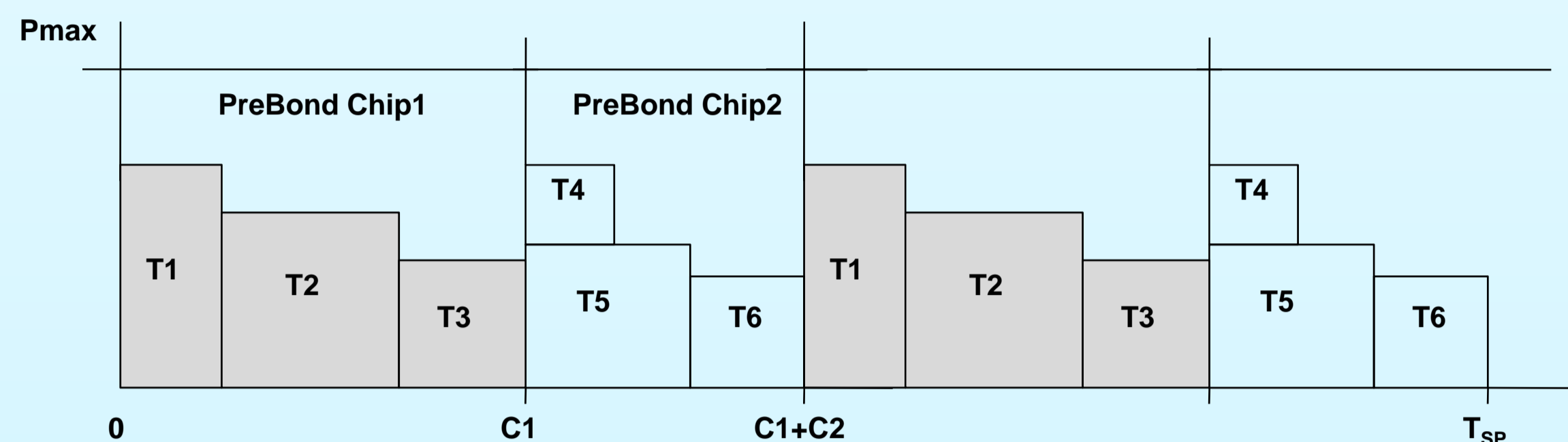
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## Purpose :-

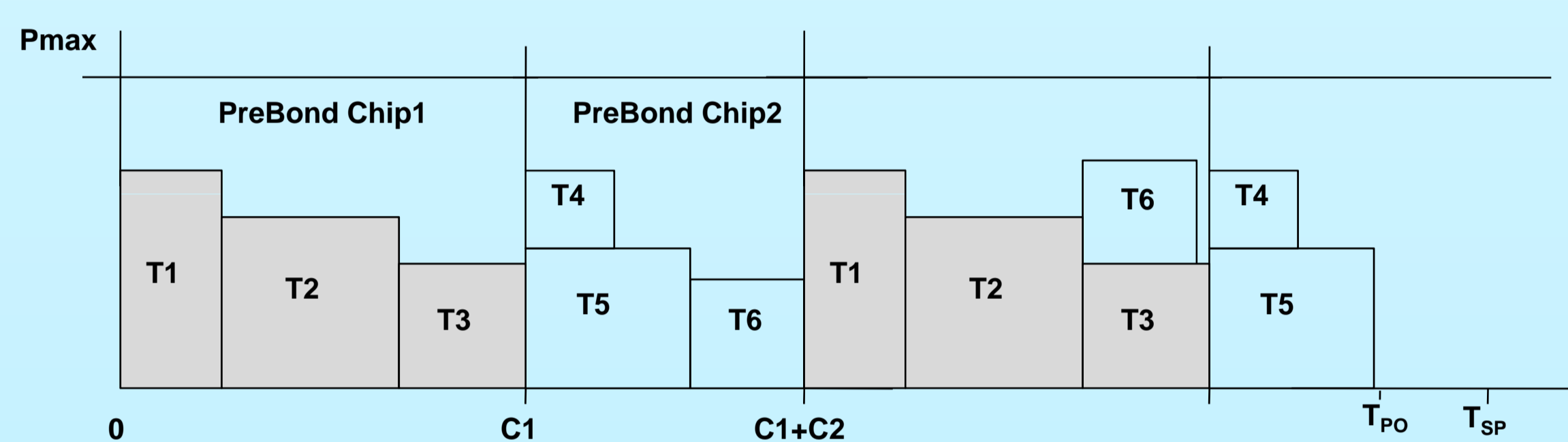
- ❖ Schedule core tests for stacked 3D chips
- ❖ Minimize the Test Application Time (TAT)
- ❖ A maximum power limitation
- ❖ The cost of control lines is considered

## Test Scheduling Modes :-



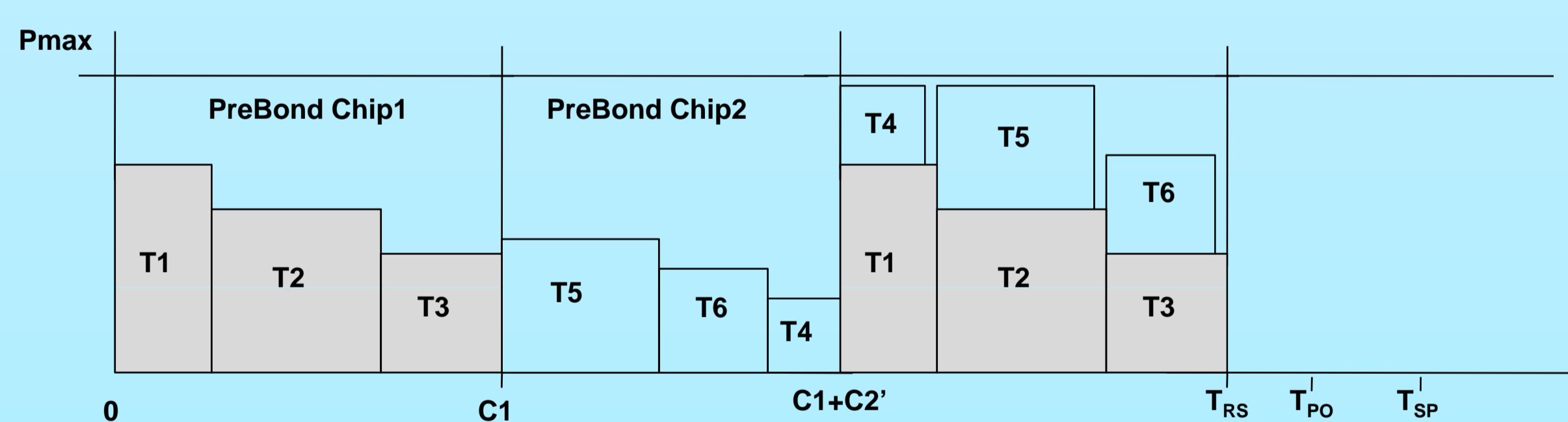
### Serial Processing (SP)

- Pre-bond test schedules of each chip are performed serially in post-bond
- Minimizing pre-bond requirement for control lines for each chip, the overall number of control lines remain at a minimum



### Partial Overlap (PO)

- In post-bond, power compatible sessions of pre-bond are performed concurrently
- The number of sessions for each chip still remains the same, hence the number of control lines required also remain at a minimum, the same as SP



### ReScheduling (RS)

- Sessions are split in pre-bond, such that they can be performed concurrently with sessions of other chips in post-bond, thus reducing the overall test time
- Each split of session requires an additional control line

Pre-bond tests in SP are scheduled as per: V. Muresan *et al.* Greedy Tree Growing Heuristics on Block-Test Scheduling Under Power Constraints, *JETTA*, 2004.

## Experimental Results :-

	Chip1					Chip2				Chip1 & Chip2				TAT				Incr. in control lines
	Pre-bond Test					Pre-bond Test				Post-Bond Test				Pre-bond + Post-bond				
	T <sub>SP</sub>	T <sub>PO</sub>	T <sub>RS</sub>	R (%)		T <sub>SP</sub>	T <sub>PO</sub>	T <sub>RS</sub>	R (%)	T <sub>SP</sub>	T <sub>PO</sub>	T <sub>RS</sub>	R (%)	T <sub>SP</sub>	T <sub>PO</sub>	T <sub>RS</sub>	R (%)	
Z	300	300	300	0	Z	300	300	300	0	600	560	560	6.7	1200	1160	1160	3.3	0 (6)
L	1374	1374	1374	0	L	1374	1374	1592	-15.9	2748	2107	1592	42.1	5496	4855	4558	17.1	3 (36)
M	26	26	27	-3.8	M	26	26	27	-3.8	52	52	48	7.7	104	104	102	1.9	20 (10)
Z	300	300	300	0	L	1374	1374	1374	0	1674	1374	1374	17.9	3348	3048	3048	9.0	0 (16)
Z	300	300	300	0	M*	520	520	520	0	820	780	780	4.9	1640	1600	1600	2.4	0 (8)
L	1374	1374	1374	0	M**	1040	1040	1040	0	2414	1824	1824	24.4	4828	4238	4238	12.2	0 (18)

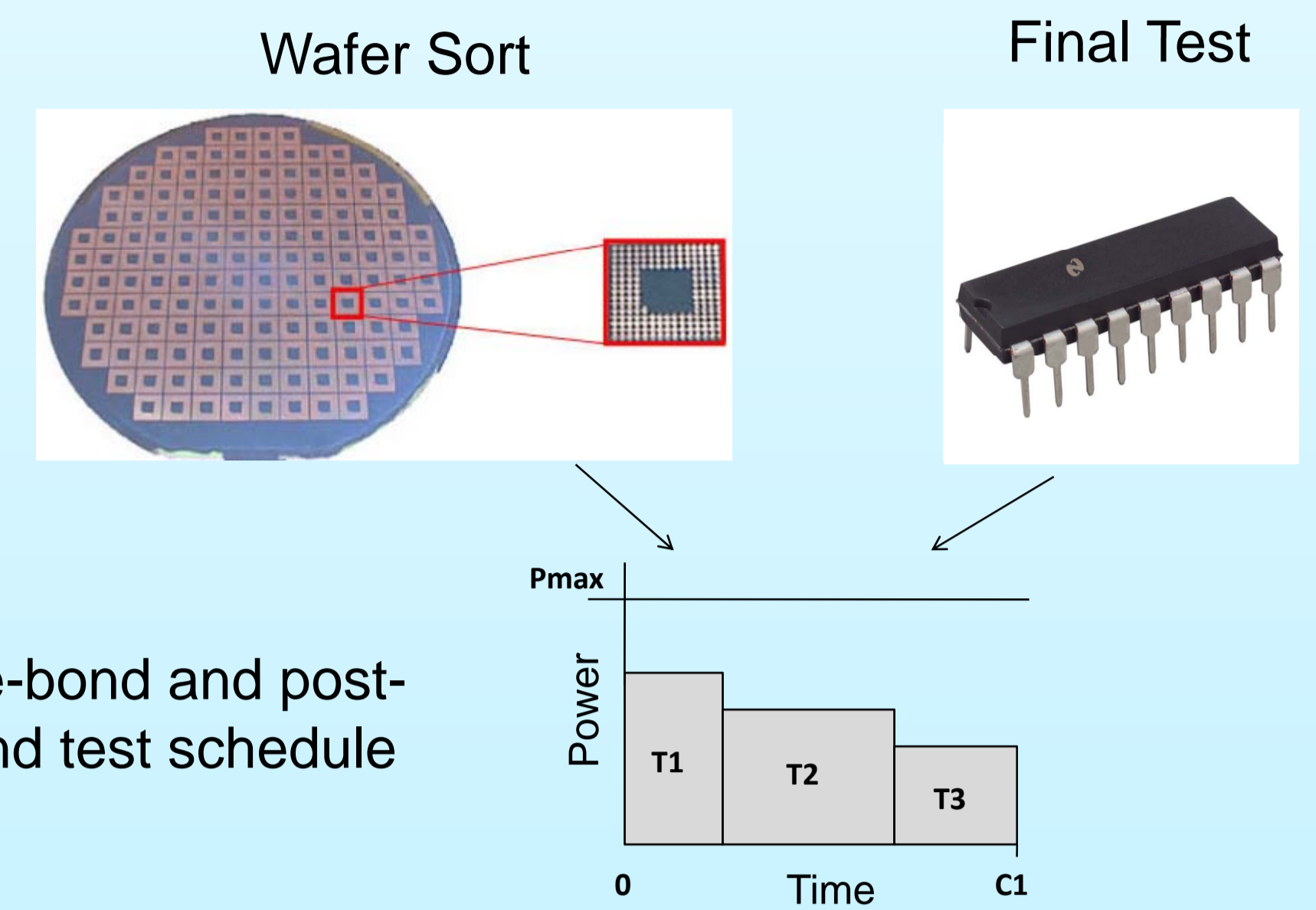
Z: ASIC Z, L: System L, M: Muresans' Design ; SP: Serial Processing, PO: Partial Overlap, RS: ReScheduling, R: Reduction (test time)

RS shows significant test time reductions wrt SP and PO

## Introduction :-

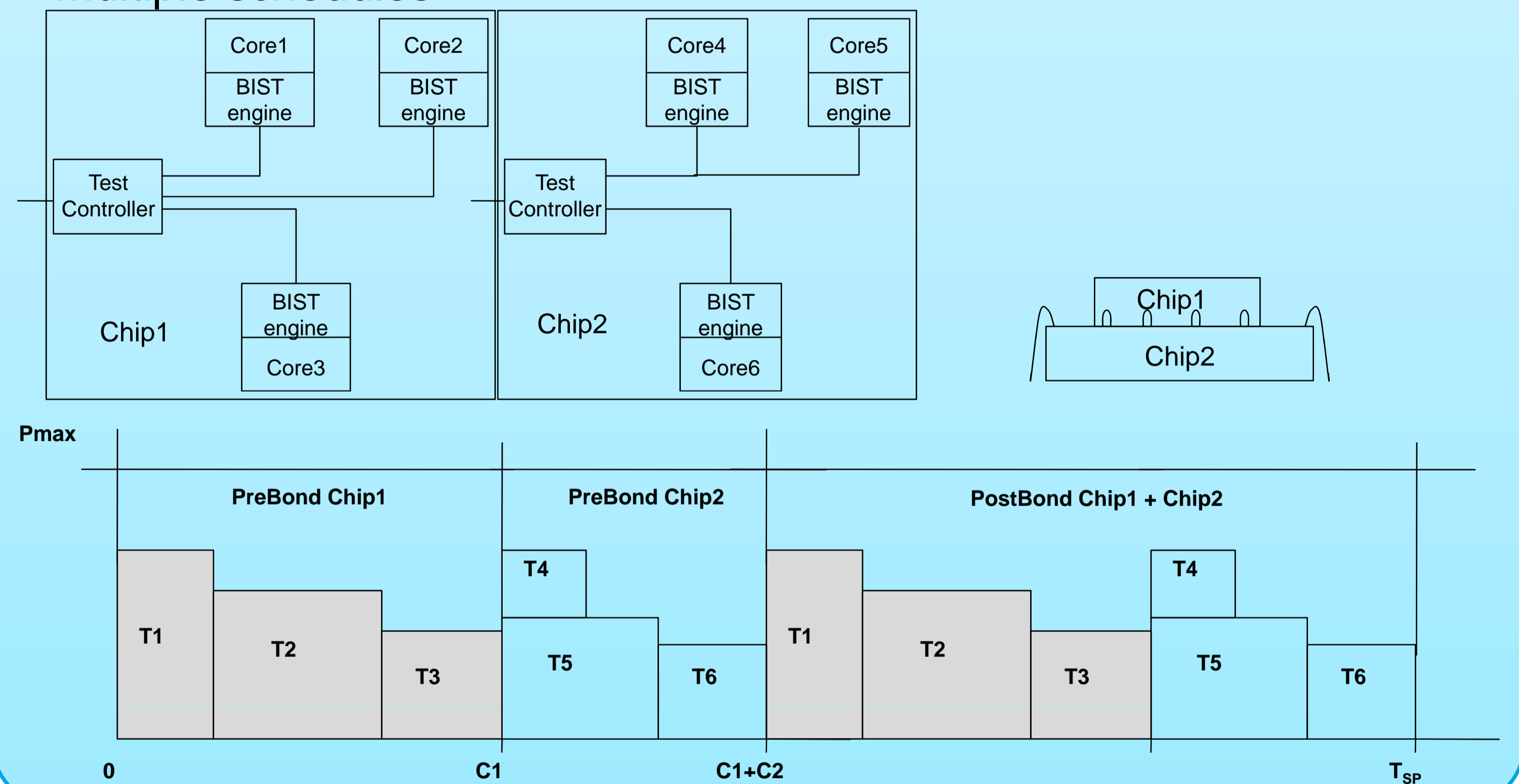
### Non Stacked Chip Testing

- Two stages
  - Wafer sort
  - Final test
- Single schedule



### 3D Stacked Chip Testing

- Two stages
  - Pre-bond (individual chips)
  - Post-bond (all chips combined)
- Multiple schedules



## Principle :-

The main objective of the algorithm implemented for ReScheduling are:

- Minimum number of splitting of sessions (wrt SP test schedules)
  - This helps in keeping the number of control lines to a minimum.
- The minimum TAT is accepted which has an acceptable number of control lines

The objective is attained by:

- Considering two pre-bond sessions at a time, which belong to two different chips
  - This preserves the sessions defined by SP to the maximum possible extent, since all tests in the stack are not considered individually
- Reductions in test time for all possible session pairs is calculated and tabulated, TAT<sub>RS</sub> is obtained by maximizing the sum of the time reductions by mutually exclusive session pairs, from the table.

The problem has a large solution space, hence a greedy heuristic was applied, which has an overall complexity of  $O(N \log N)$  for N sessions

## Conclusions :-

- ❖ Testing of stacked 3D chips is different from non-stacked chip testing, as the same test schedule does not hold good in pre-bond and post-bond stages
- ❖ Splitting of sessions  $\Rightarrow$  Increase in Number of Control Lines  $\Rightarrow$  Increased Cost
- ❖ ReScheduling focuses on minimal splitting of pre-bond sessions
- ❖ Experimental results depict up to 42% reduction in post-bond test time and 17% in overall test time