

# A Reactive Strategy for High-Level Consistency During Search

R.J.Woodward<sup>1,2</sup> B.Y.Choueiry<sup>1</sup> C.Bessiere<sup>2</sup>

<sup>1</sup>Constraint Systems Laboratory • University of Nebraska-Lincoln • USA

<sup>2</sup>CNRS • Université de Montpellier • France

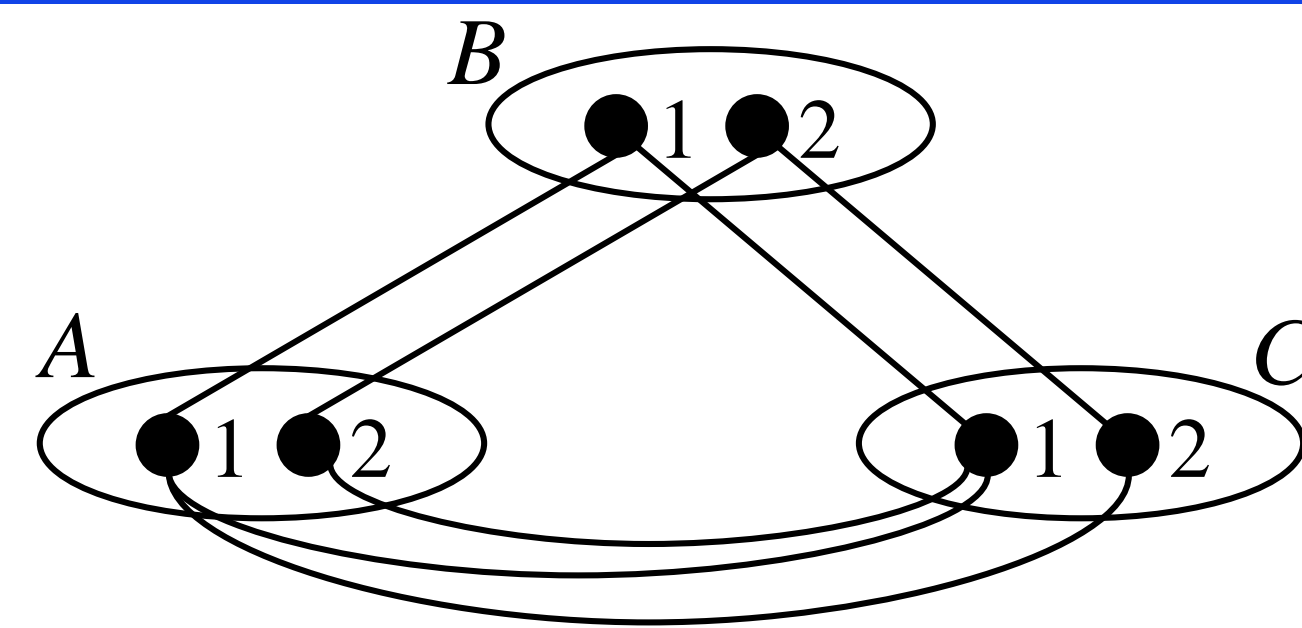
## 1. Background: Local Consistency

Variables:  $A, B, C$

Domains:  $\{1, 2\}$

With:  $A = B, B = C, A + C < 4$

$\{(A, 1), (B, 1), (C, 1)\}$  is a solution



**Generalized Arc Consistency (GAC)** ensures a value in the domain of a variable in the scope of a relation can be extended to a tuple satisfying the relation

E.g., all values are GAC

**Singleton Arc Consistency (SAC)** removes 2 from domains of  $A, B, C$

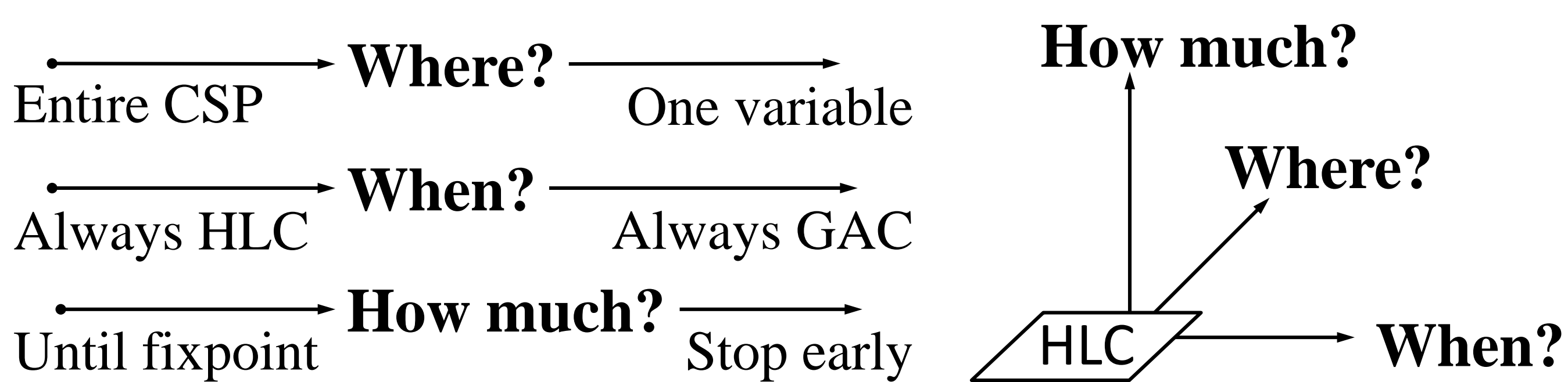
SAC is an example of a High Level Consistency (HLC)

**Enforcing consistency during search**

- The higher the consistency level, the stronger the pruning and the smaller the search space
- However, HLC can be costly in time and space

## 2. Our View

The challenge is decide **when, where, and how much** HLC to enforce during search



## 3. Our Solution

PREPEAK<sup>+</sup>, a simple and effective reactive strategy that

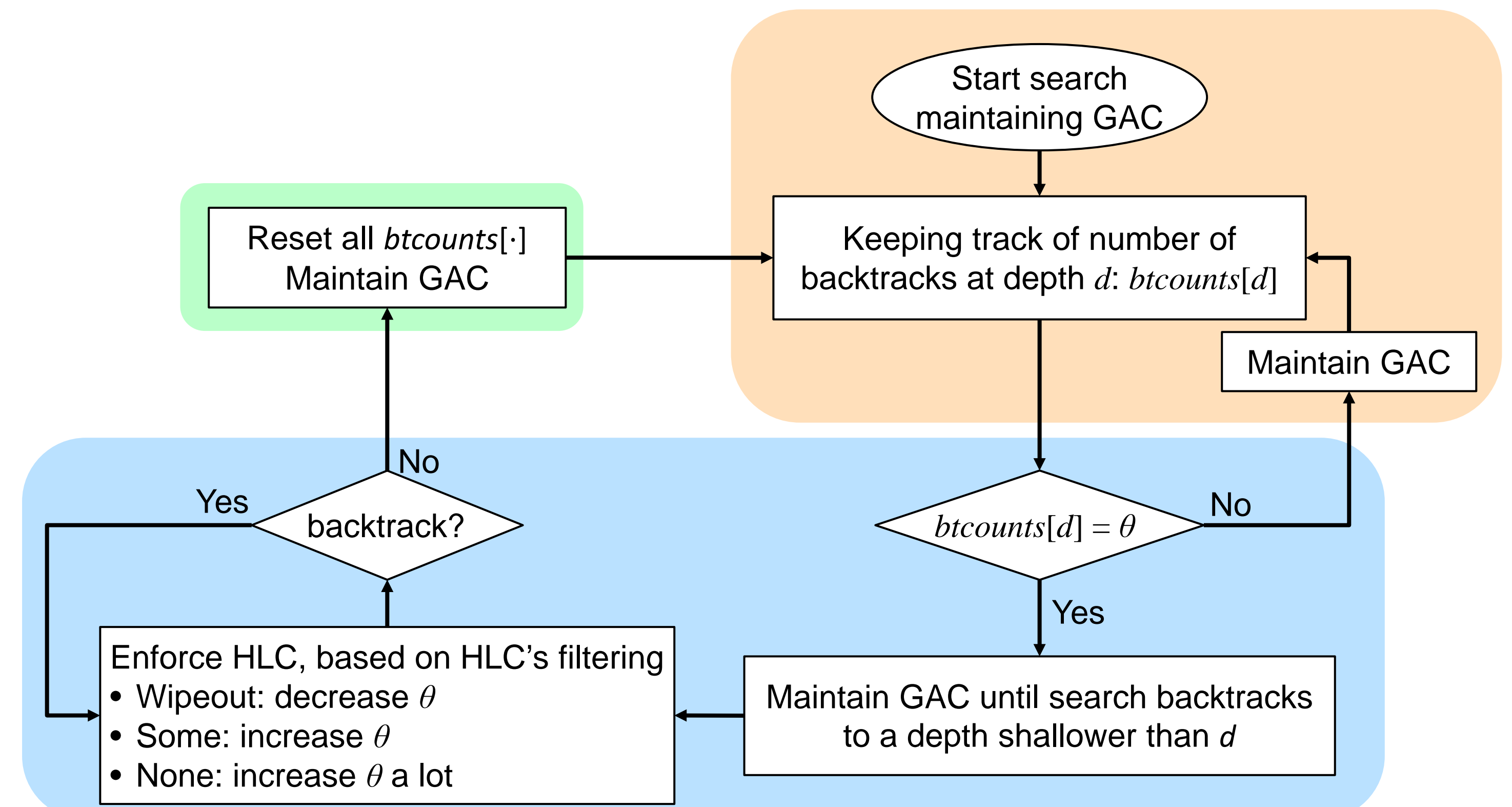
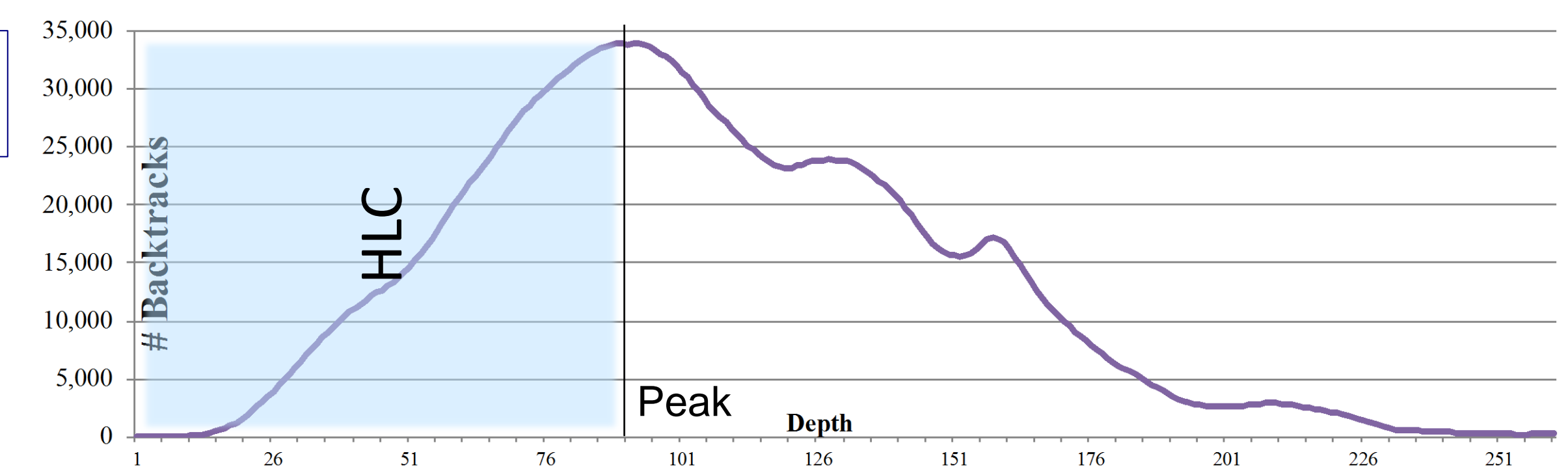
- Monitors search performance
- When search starts thrashing, triggers an HLC
- Then, conservatively reverts to GAC

We validate PREPEAK<sup>+</sup>

- With POAC as HLC (stronger than SAC) [Bennaceur+ CP 2001]
- Using the APOAC algorithm [Balafrej+ AAAI 2014]

## 4. PREPEAK<sup>+</sup>

**When**



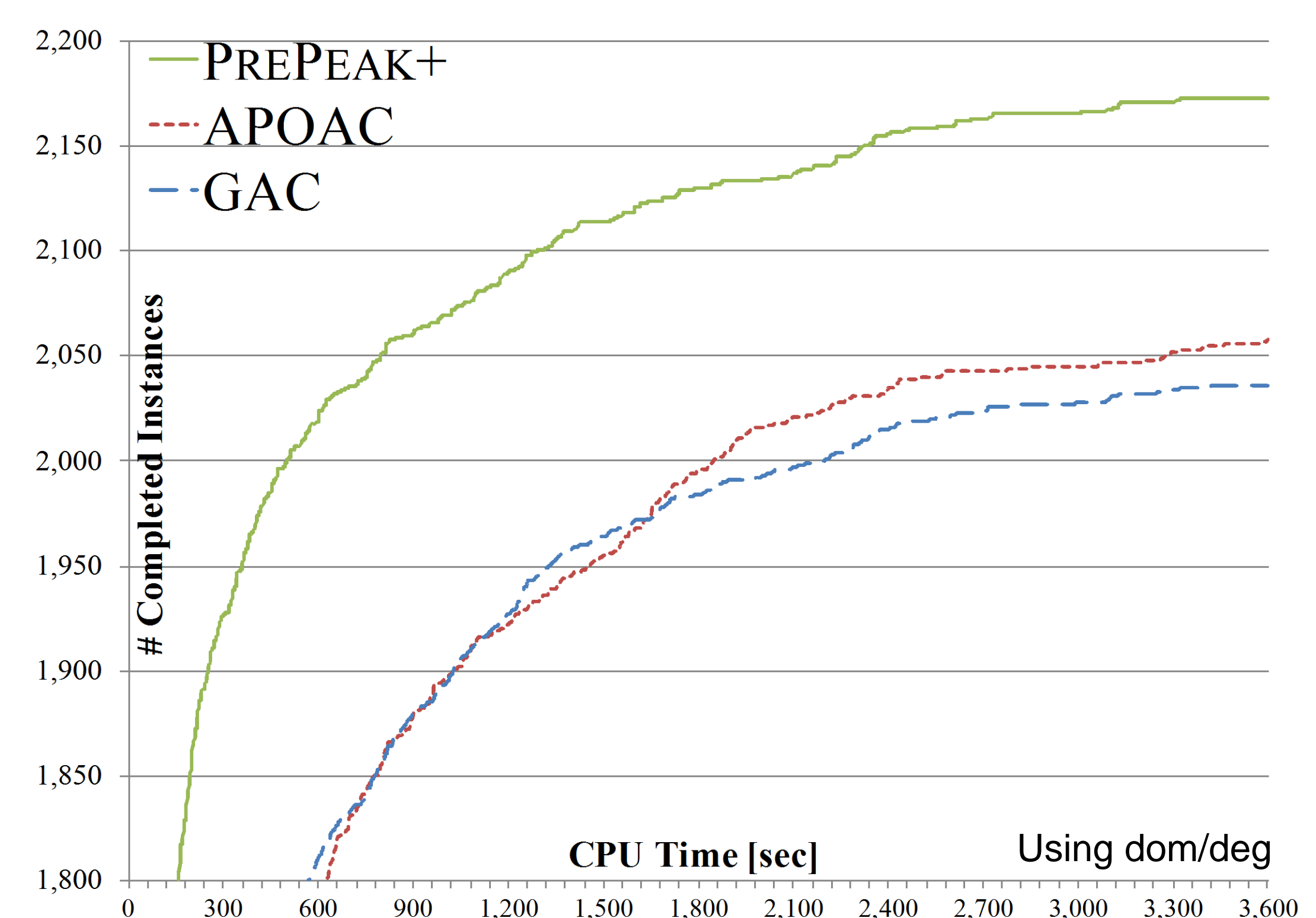
**How Much**

Terminate HLC as soon as either:

- Half the propagation queue is processed or
- HLC has consumed a total CPU time  $\frac{q}{2} \cdot \text{TIME}(\text{GAC})$

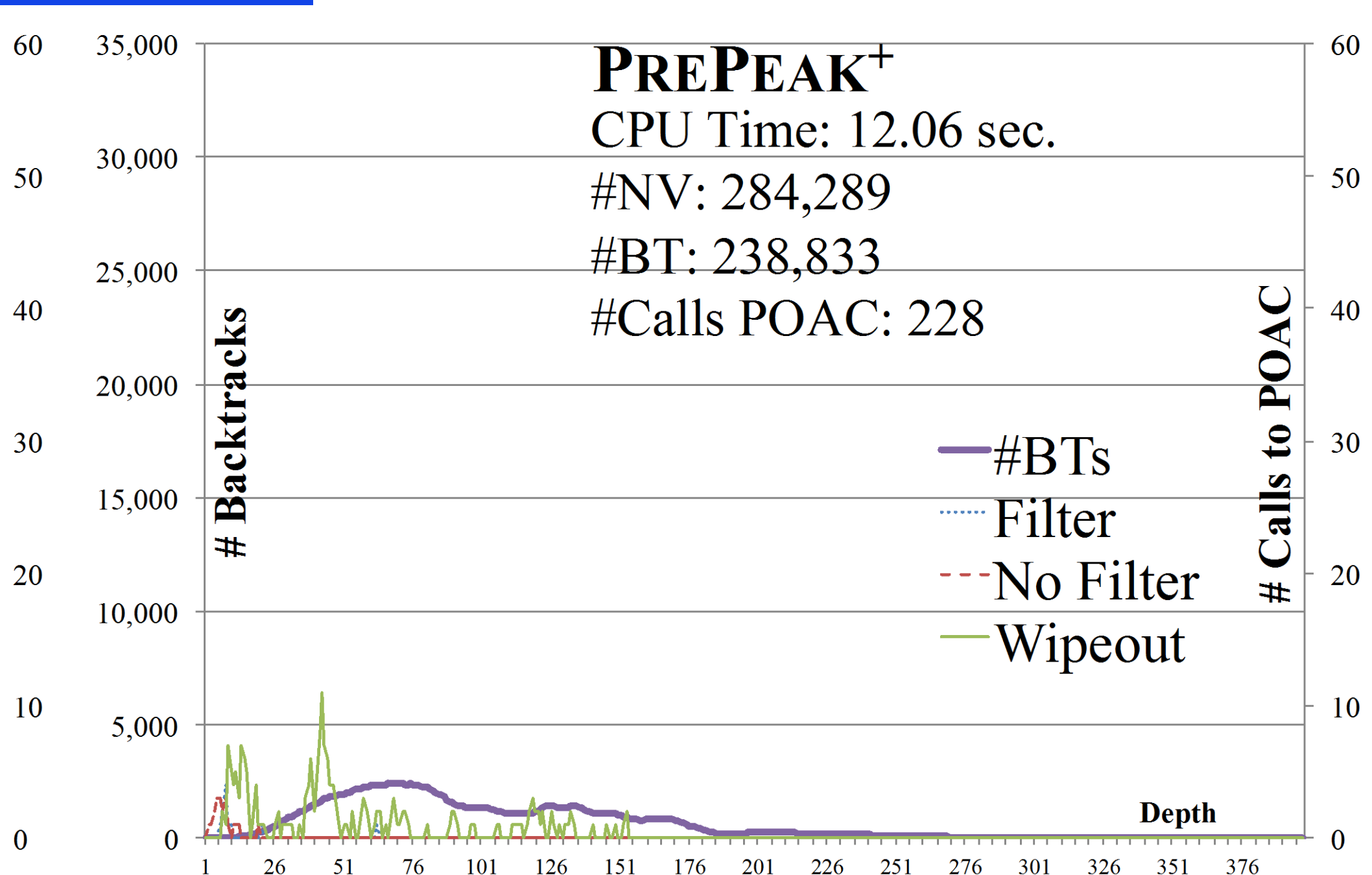
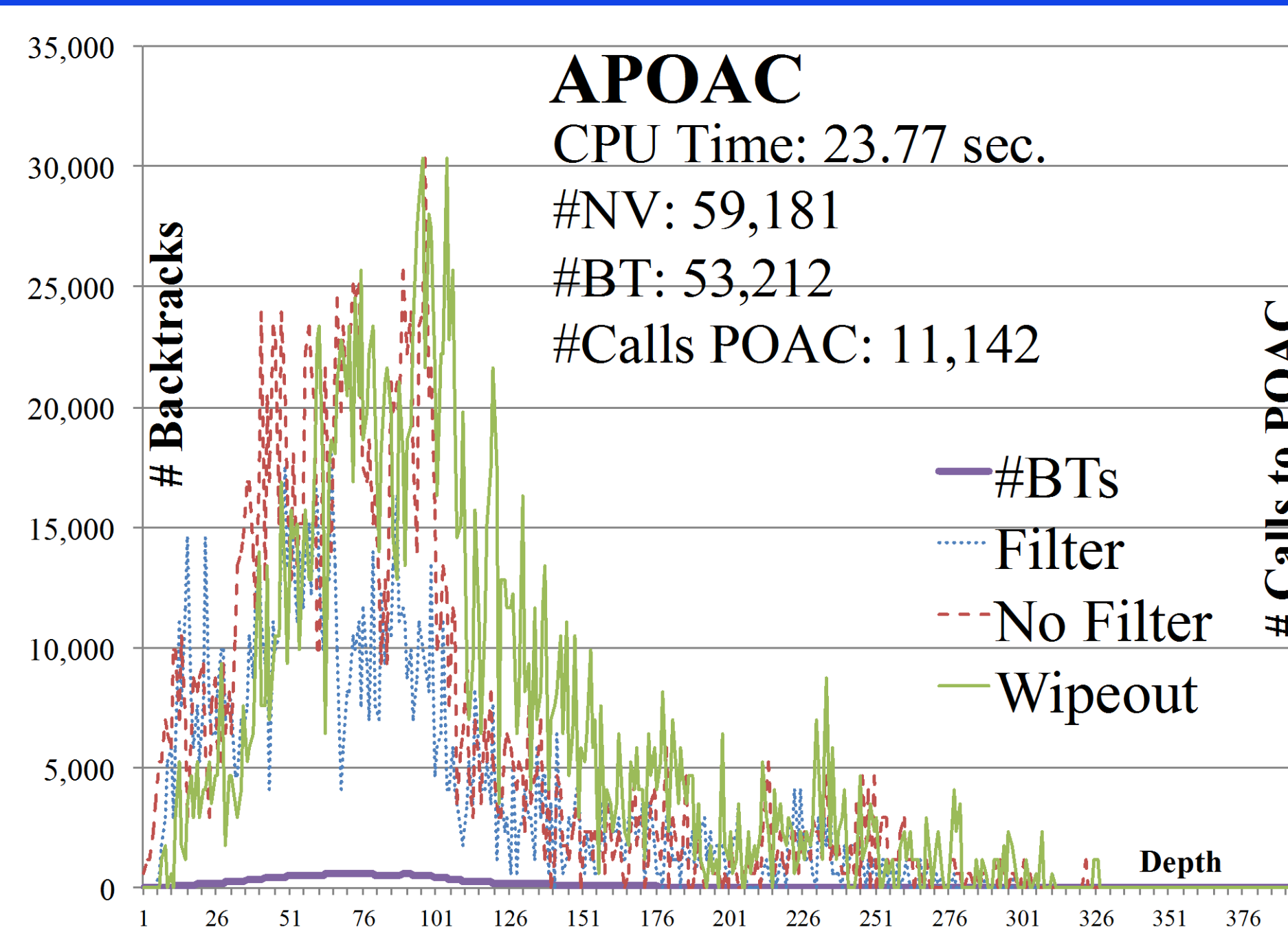
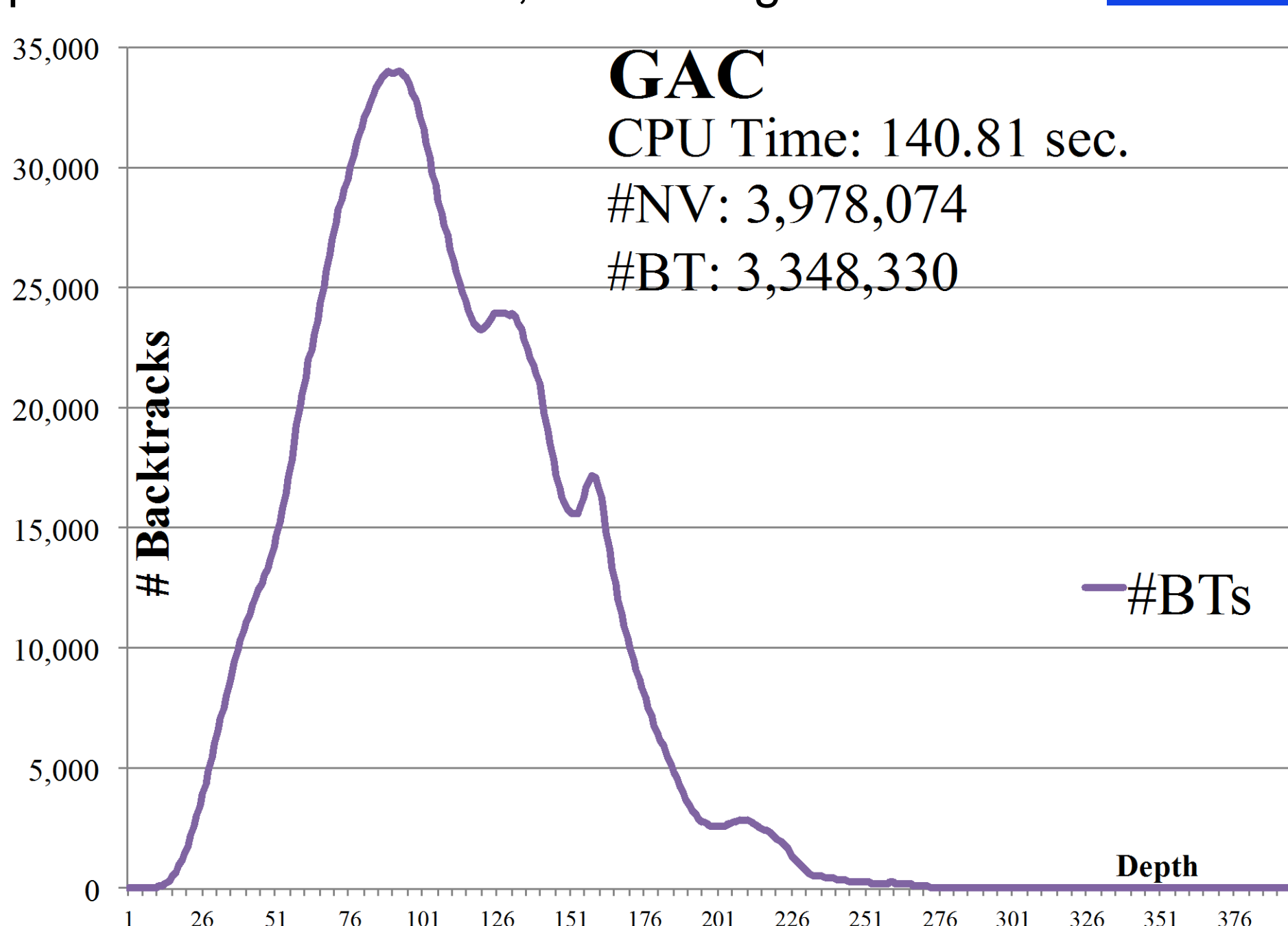
**PREPEAK<sup>+</sup> = PREPEAK + 'How Much'**

## 5. Empirical Evaluations



## 6. Visualization [Howell+ XAI 2018]

pseudo-aim-200-1-6-4, dom/wdeg



Experiments conducted on equipment of Holland Computing Center (UNL)

Research support:

NSF Grants No. RI-111795 and RI-1619344

NSF Graduate Research Fellowship Grant No.1041000 and Chateaubriand Fellowship (R.J. Woodward)

ANR projects Demograph (ANR-16-CE40-0028) and Contredo (ANR-16-CE33-0024) (C. Bessiere)

