Science & Integration Meeting

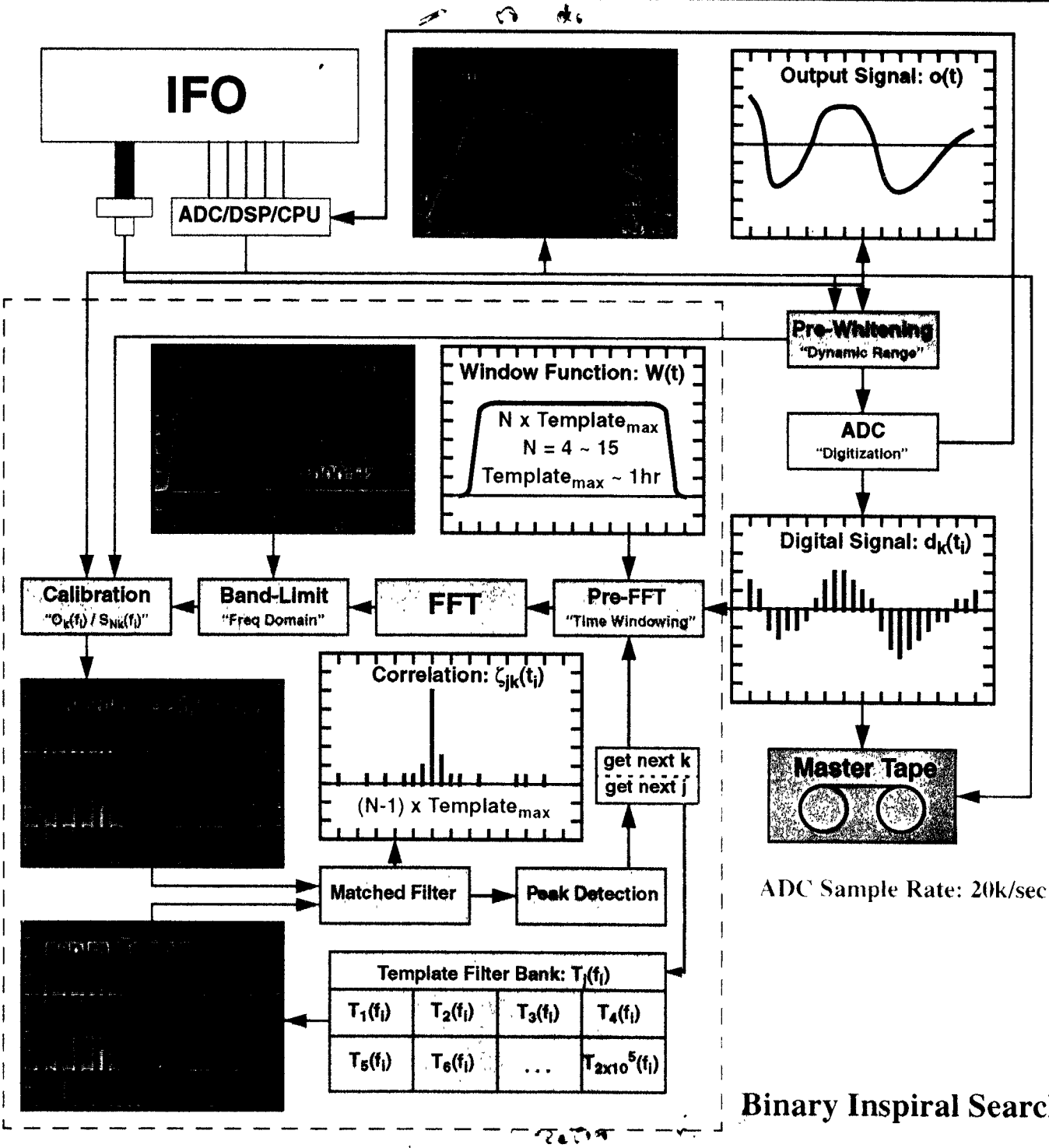
Agenda

- Information Management
  - ›› Electronic submission to DCC — Althouse
- LIGO Data Analysis
  - ›› Report from the MIT Data Analysis Meeting — Weiss
  - ›› Prototyping data analysis at CACR — Blackburn
  - ›› Forum to review baseline approach proposed to NSF — Lazzarini

G960276-00-D
LIGO-~~G950000-00~~-M

LIGO DATA ANALYSIS

Science & Integration Meeting - MIT May 1996



ADC Sample Rate: 20k/sec

Binary Inspiral Search

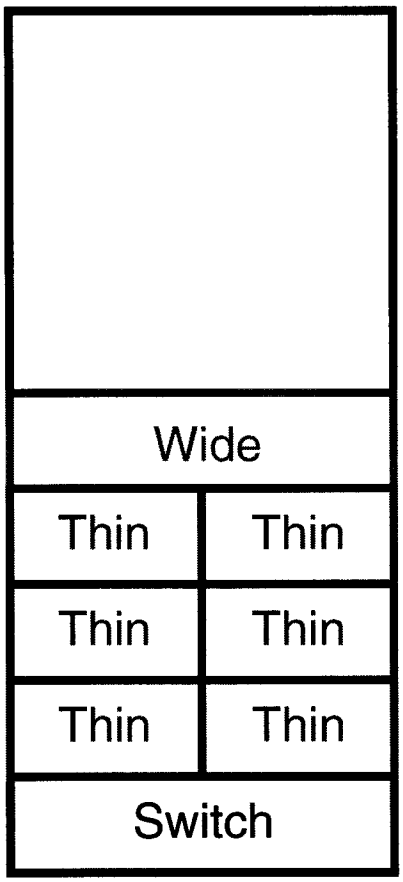
LIGO-G960000-00-M

IBM SP2 HARDWARE

Upgrade of Existing SP2 Frame/Node Hardware

Wide Node:
512MB RAM
2.2GB Disk
156 MFLOPS

Thin Node:
128 MB RAM
2.2 GB Disk
133 MFLOPS



Space for additional
8 Thin Nodes
or
4 Wide Nodes

Add 384MB RAM
bringing total to
512MB in Wide Node

Add 2MB of L2
Cache to each
of 6 Thin Nodes

Upgrade Switch &
Switch adapter cards

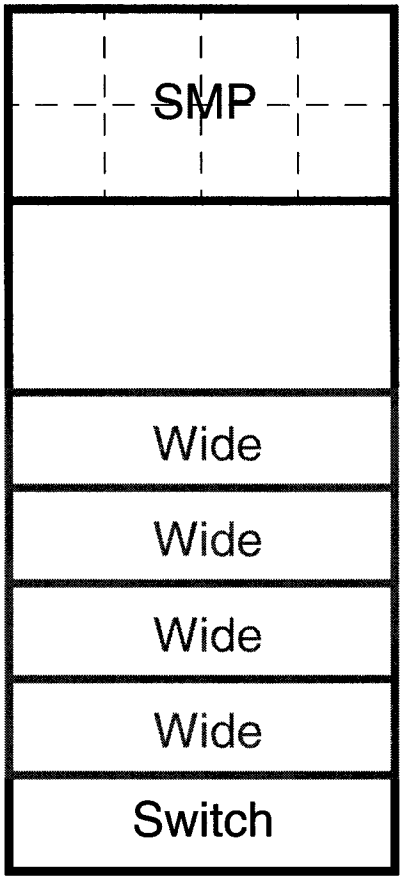
LIGO-G950000-00-M

IBM SP2 HARDWARE

Acquisition of New SP2 Frame/Node Hardware

SMP Node:
8x604CPUs
512MB RAM
4.4 GB Disk
8x23MFLOPS

2 Wide Node:
512MB RAM
2.2GB Disk
262 MFLOPS



Space for additional
4 Thin Nodes
or
2 Wide Nodes

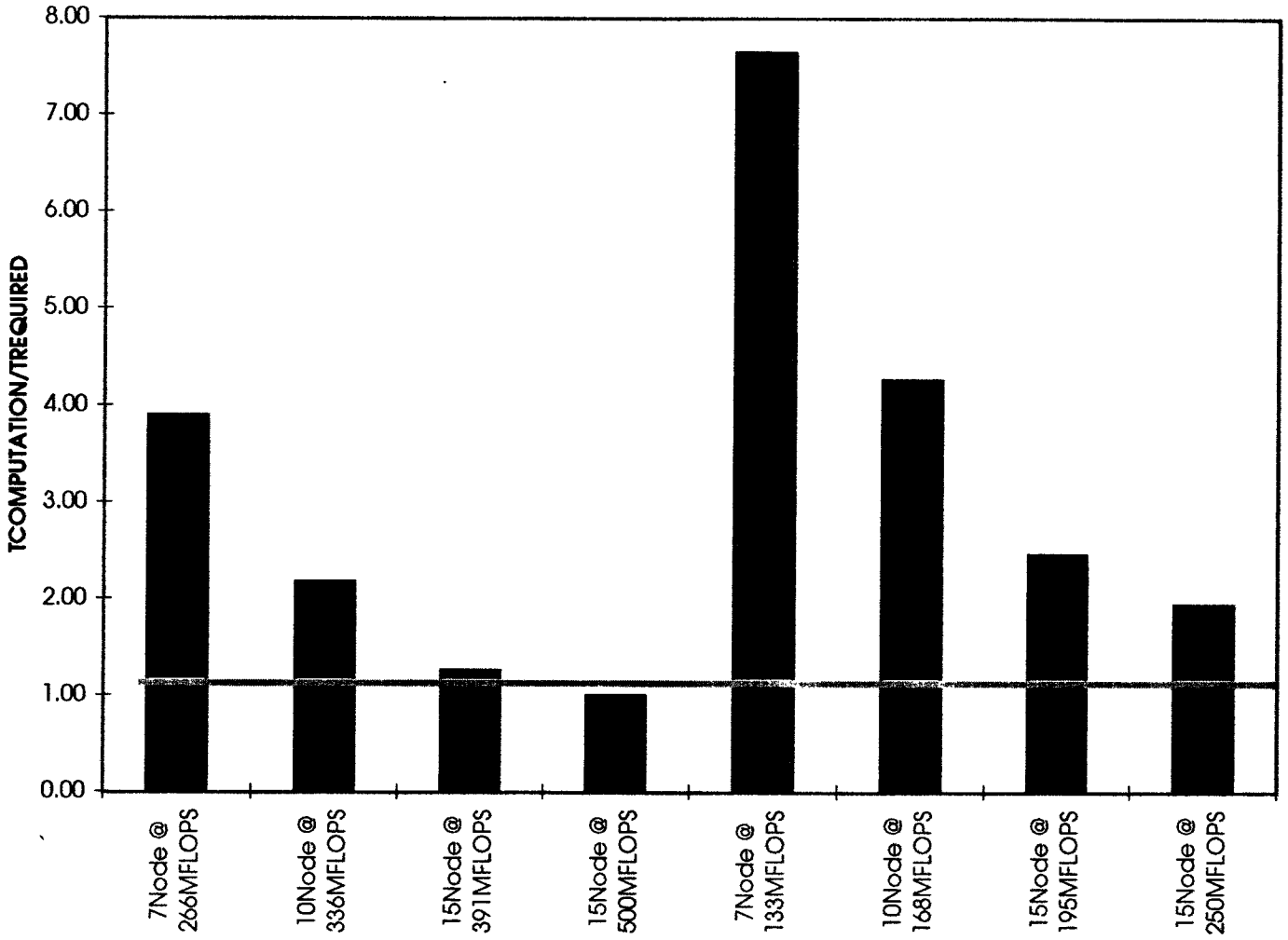
2 Wide Node:
256MB RAM
2.2GB Disk
262 MFLOPS

Processor data		**Implementation Details**	
High Nodes	**1**	SP2 OS OH (MB)	**30**
New Wide Nodes	**4**	Template search program	**2**
Old Wide Nodes	**1**	Noise spectrum(resident)	11.69
New Thin Nodes	**0**	S/N^2 space	11.69
Old Thin Nodes	**6**	Net Node Memory	**201**
Number of Nodes	**12**	Templates per node	1265
MB per node	**256**	Template MBytes per node	411
MB per node	**2000**	SWAPS per node	2.05
Effective MFLOPS per node	**132**	Templates per SWAP per node	618
		total seconds per swaps	**29.3**
DAQ Specifications		MB Discspace MARGIN per Node	**1589**
Sample Rate	**16384**		
Integerlength	**2**	**Calculation / analysis cycle**	
Number of IFOs (WA)	**2**	**Preprocessing**	
		I/O Xfer rate, MB/s	**14**
Science Requirements		Datastream I/O: Get data;seconds	0.83
Minimum mass (solar mass units)	**1.0**	FFT data -- MFLOP	150
Msun	**1.98E+30**	FFT N^2 -- MFLOP	150
mu	9.90E+29	Form FFT(data)/FFT(N^2) -- 1X+1+;4x+2X;2X	14.6
Mtot	3.96E+30	Total preprocessing -- MFLOP	314
Fmin (Hz)	**140**	Total preprocessing time	2.38
Speed Of Light	**3.00E+08**	**Correlation**	
G newton	**6.67E-11**	I/O Xfer rate, MB/s	**14**
Fsei	**70**	Datastream I/O: Get data;seconds	0.83
Inspiral time (s)	9.91	Form Kernal T(f)*S(f)/N^2(f) -- MFLOP--4 x+2+	8.77
		IFFT(kernal)	150
Analysis Details		Peak Detect/Form Output - real compare	1.5
Floatlength	4	Total correlation processing -- MFLOP	160
Complexlength	8	Total processing time per template	1.21
Number of templates per IFO	7590	Total swap time per node	29.34
Total templates	15180		
Window function	**36**	**Calculations per Time window**	
Resampling factor	**0.250**	MFLOP / node for templates+preproc+SWAP	202515
Net sample rate	4096	Total time per node per cycle	**1563**
Sample length (MS)	1.4612	Required GFLOPS per node to keep up	**0.64**
Data length (complex,MB)	11.69	Compute time to acquire time ratio	**4.507**
Max (complex) Template Length (MB)	0.32		36
Total template length (MB)	4929		
Forward step (fraction of Twindow)	0.028		
Time to calculate (s)	347		

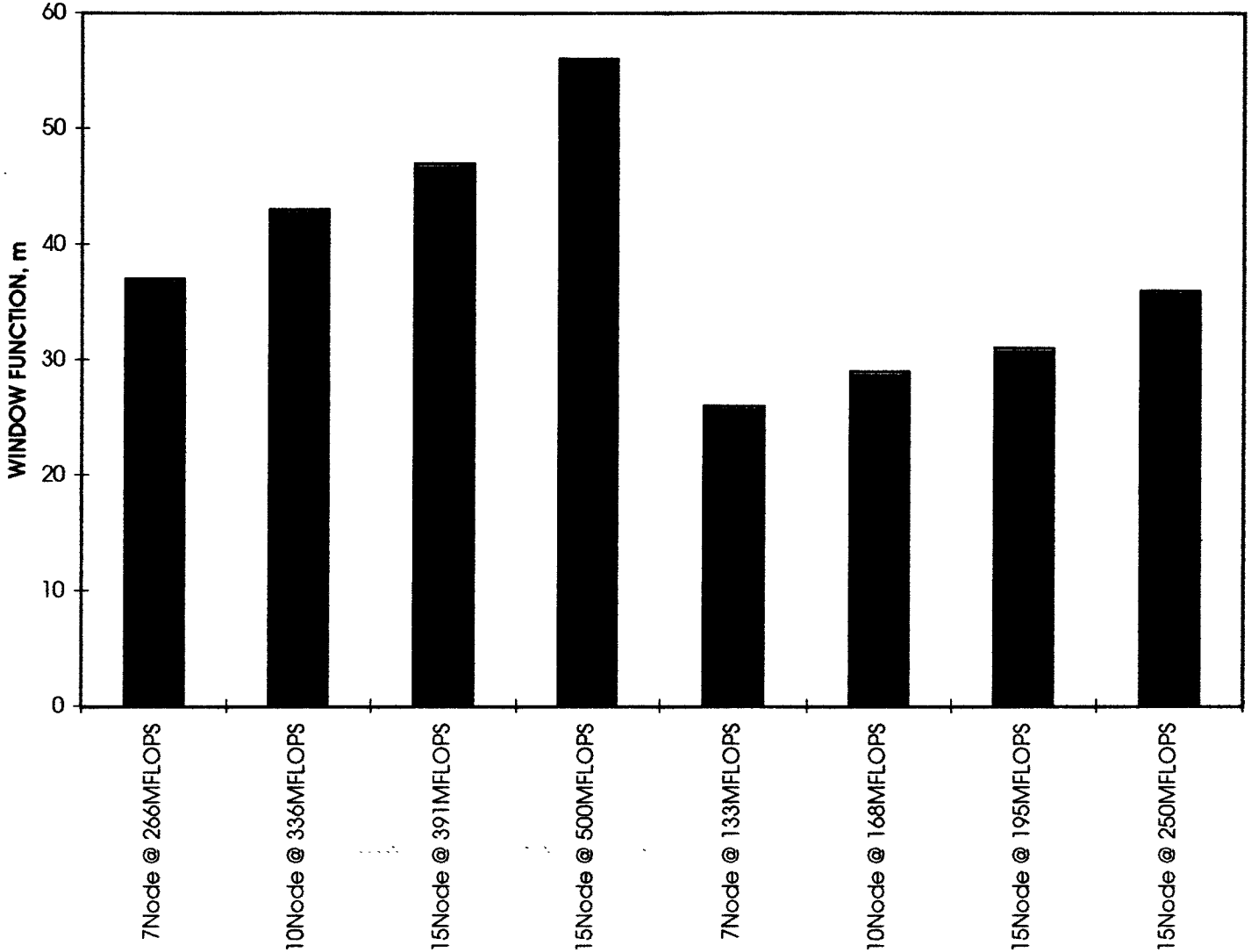
Processor data		**Implementation Details**	
High Nodes	**1**	SP2 OS OH (MB)	**30**
New Wide Nodes	**4**	Template search program	**2**
Old Wide Nodes	**1**	Noise spectrum(resident)	4.77
New Thin Nodes	**0**	S/N^2 space	4.77
Old Thin Nodes	**6**	Net Node Memory	**214**
Number of Nodes	**12**	Templates per node	296
MB per node	**256**	Template MBytes per node	39
MB per node	**2000**	SWAPS per node	0.18
Effective MFLOPS per node	**132**	Templates per SWAP per node	1619
		total seconds per swaps	**2.8**
DAQ Specifications		MB Discspace MARGIN per Node	**1961**
Sample Rate	**16384**		
Integerlength	**2**	**Calculation / analysis cycle**	
Number of IFOs (WA)	**2**	**Preprocessing**	
		I/O Xfer rate, MB/s	**14**
Science Requirements		Datastream I/O: Get data;seconds	0.34
Minimum mass (solar mass units)	**1.7**	FFT data -- MFLOP	57
Msun	**1.98E+30**	FFT N^2 -- MFLOP	57
mu	1.70E+30	Form FFT(data)/FFT(N^2) -- 1X+1+;4x+2X;2X	6.0
Mtot	6.78E+30	Total preprocessing -- MFLOP	120
Fmin (Hz)	**140**	Total preprocessing time	0.91
Speed Of Light	**3.00E+08**	**Correlation**	
G newton	**6.67E-11**	I/O Xfer rate, MB/s	**14**
Fsei	**70**	Datastream I/O: Get data;seconds	0.34
Inspiral time (s)	4.04	Form Kernal T(f)*S(f)/N^2(f) -- MFLOP--4 x+2+	3.58
		IFFT(kernal)	57
Analysis Details		Peak Detect/Form Output - real compare	0.6
Floatlength	4	Total correlation processing -- MFLOP	61
Complexlength	8	Total processing time per template	0.46
Number of templates per IFO	1776	Total swap time per node	2.80
Total templates	3551		
Window function	**36**	**Calculations per Time window**	
Resampling factor	**0.250**	MFLOP / node for templates+preproc+SWAP	18276
Net sample rate	4096	Total time per node per cycle	**141**
Sample length (MS)	0.5960	Required GFLOPS per node to keep up	**0.13**
Data length (complex,MB)	4.77	Compute time to acquire time ratio	**1.000**
Max (complex) Template Length (MB)	0.13		36
Total template length (MB)	470		
Forward step (fraction of Twindow)	0.028		
Time to calculate (s)	141		

Configuration	Effective MFLOPS	F.O.M.=Tcomp/Treq	Min Mass @ F.O.M.=1	Optimum m, T= m*Tc
7Node @ 266MFLOPS	1862	3.90	1.63	37
10Node @ 336MFLOPS	3360	2.18	1.32	43
15Node @ 391MFLOPS	5865	1.26	1.09	47
15Node @ 500MFLOPS	7500	1.00	1.00	56
7Node @ 133MFLOPS	931	7.65	2.07	26
10Node @ 168MFLOPS	1680	4.27	1.68	29
15Node @ 195MFLOPS	2925	2.46	1.38	31
15Node @ 250MFLOPS	3750	1.94	1.27	36

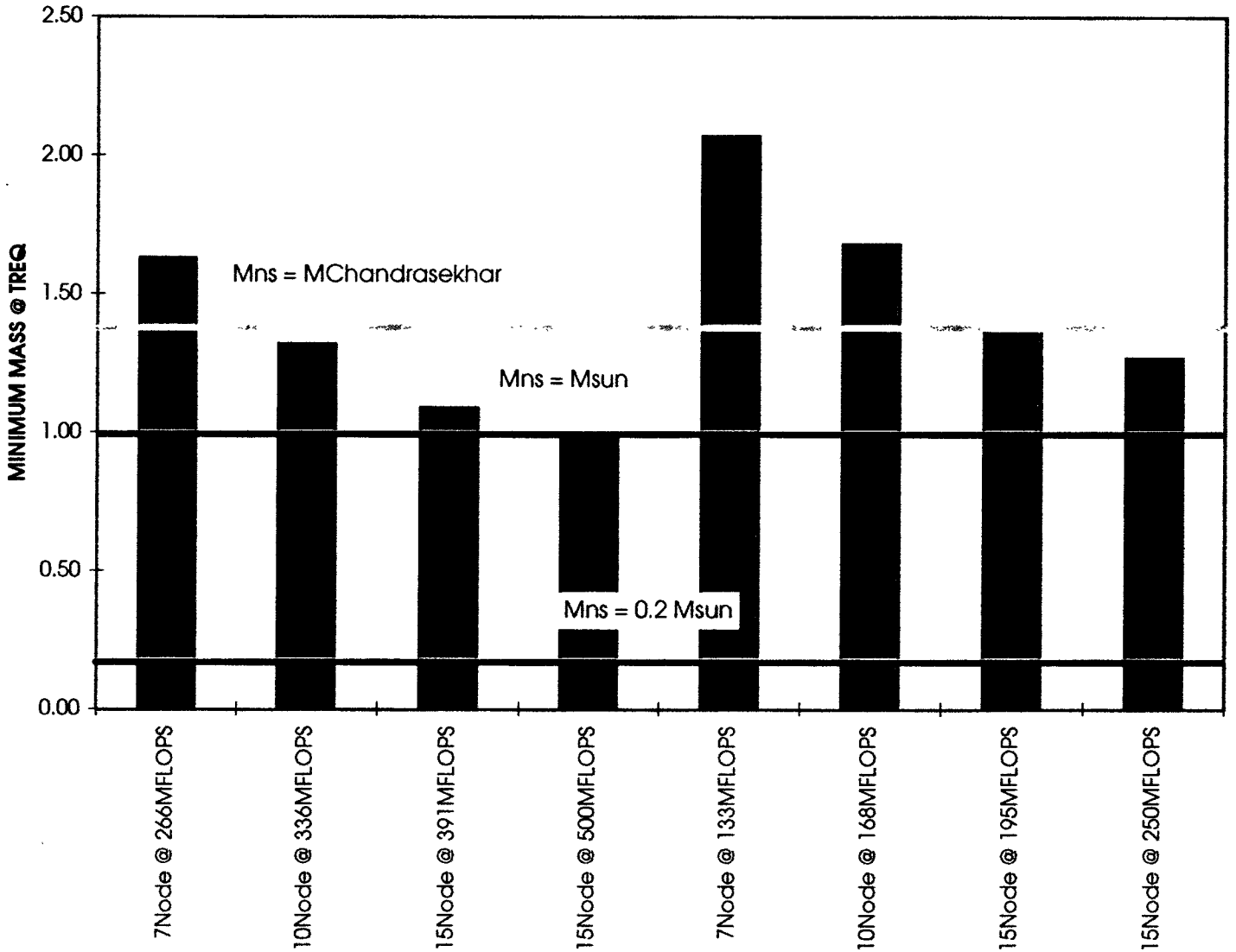
IBM SP2 PERFORMANCE ESTIMATES FOR LIGO NS-NS SEARCHES
Computation Time to Real Time Ratio for Mns = Msun



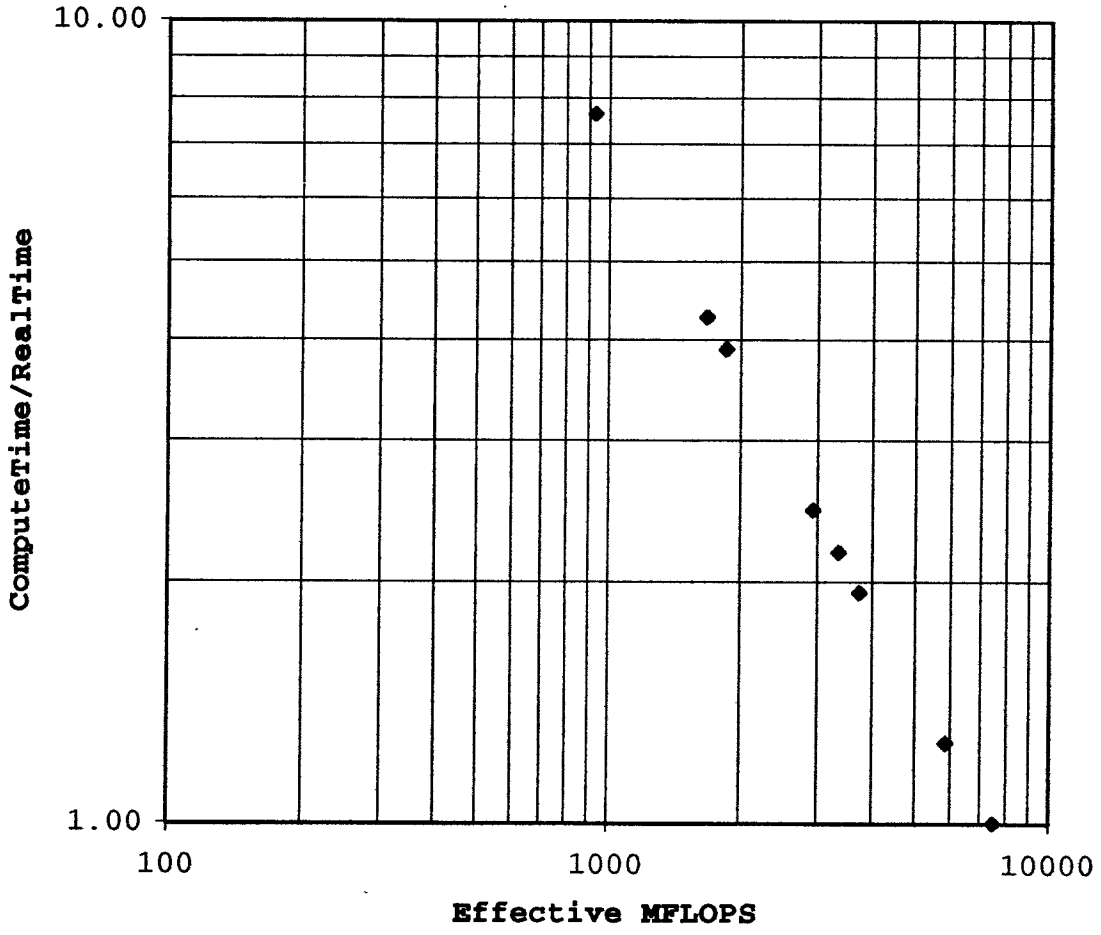
IBM SP2 PERFORMANCE ESTIMATES FOR LIGO NS-NS SEARCHES
Windowing Function: Time Series Length = m * Coalescence Time



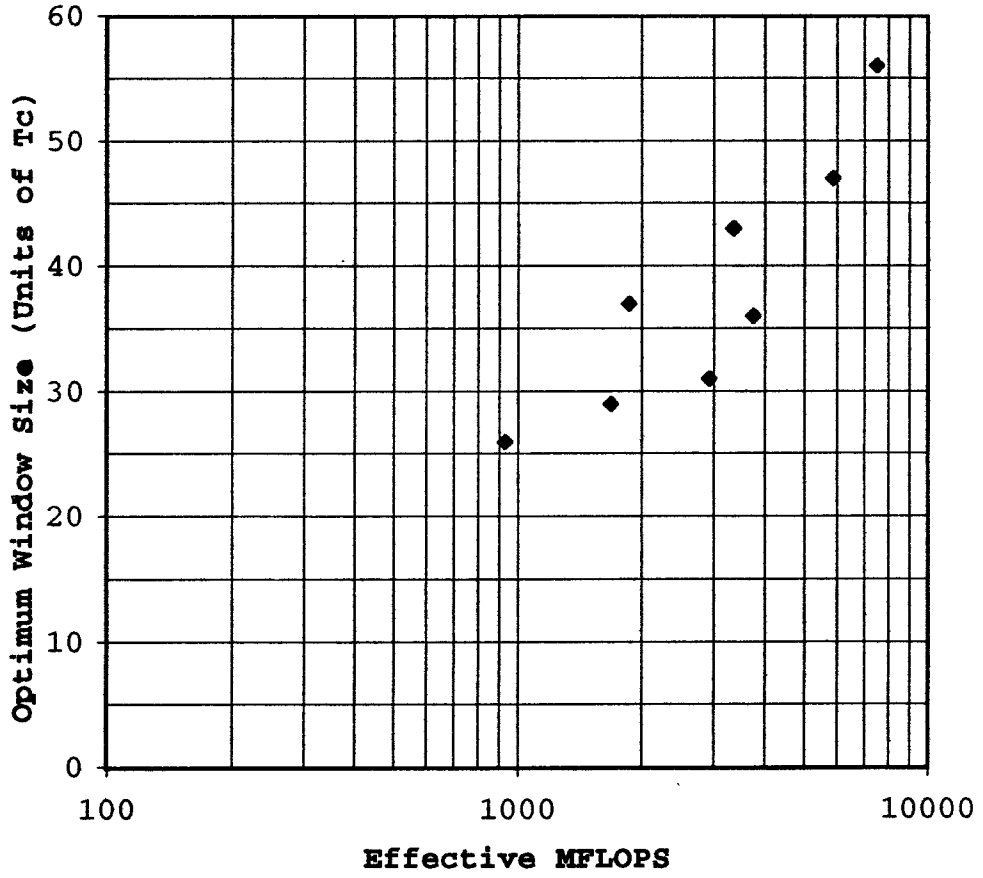
IBM SP2 PERFORMANCE ESTIMATES FOR LIGO NS-NS SEARCHES
Minimum Detectable NS Mass in Real Time



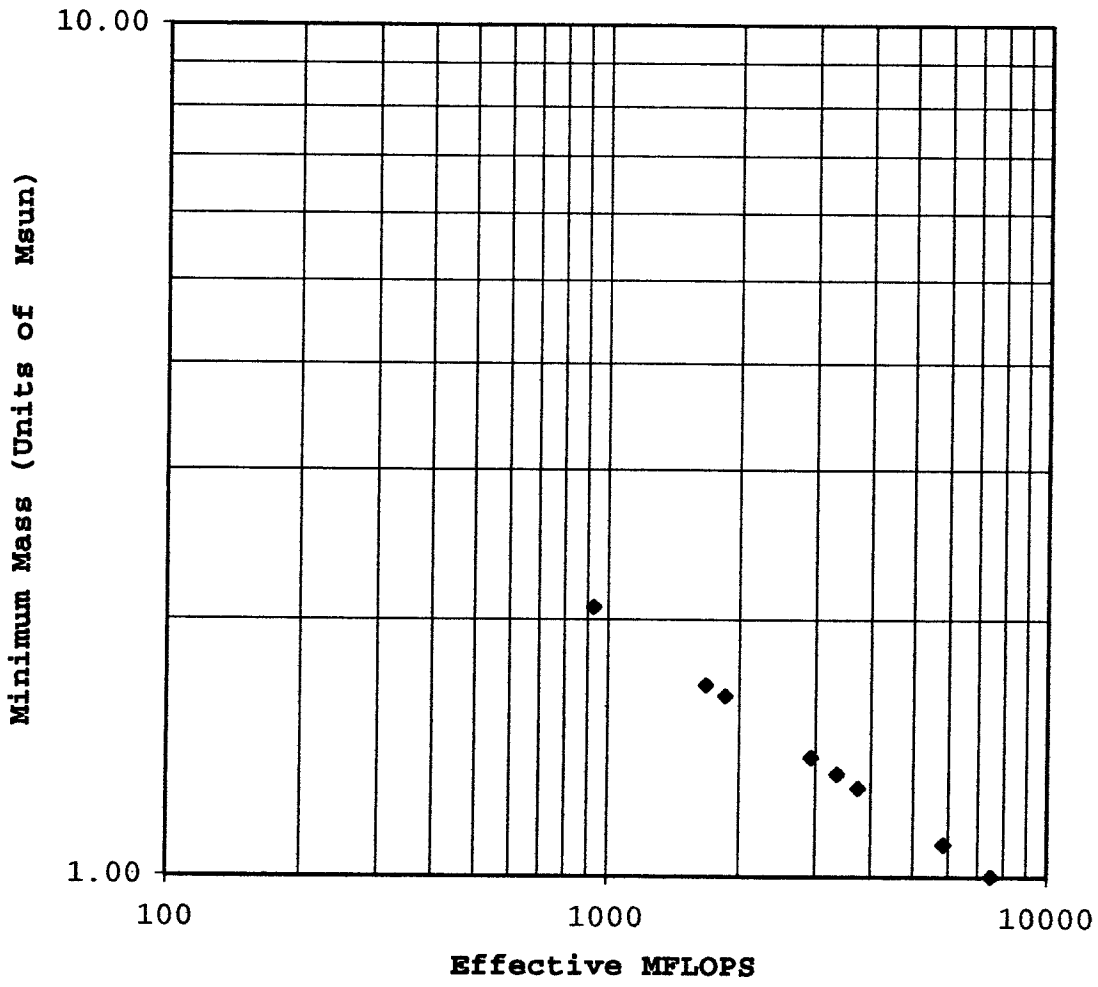
Compute Time vs. Effective MFLOPS for Mns = 1 Msun



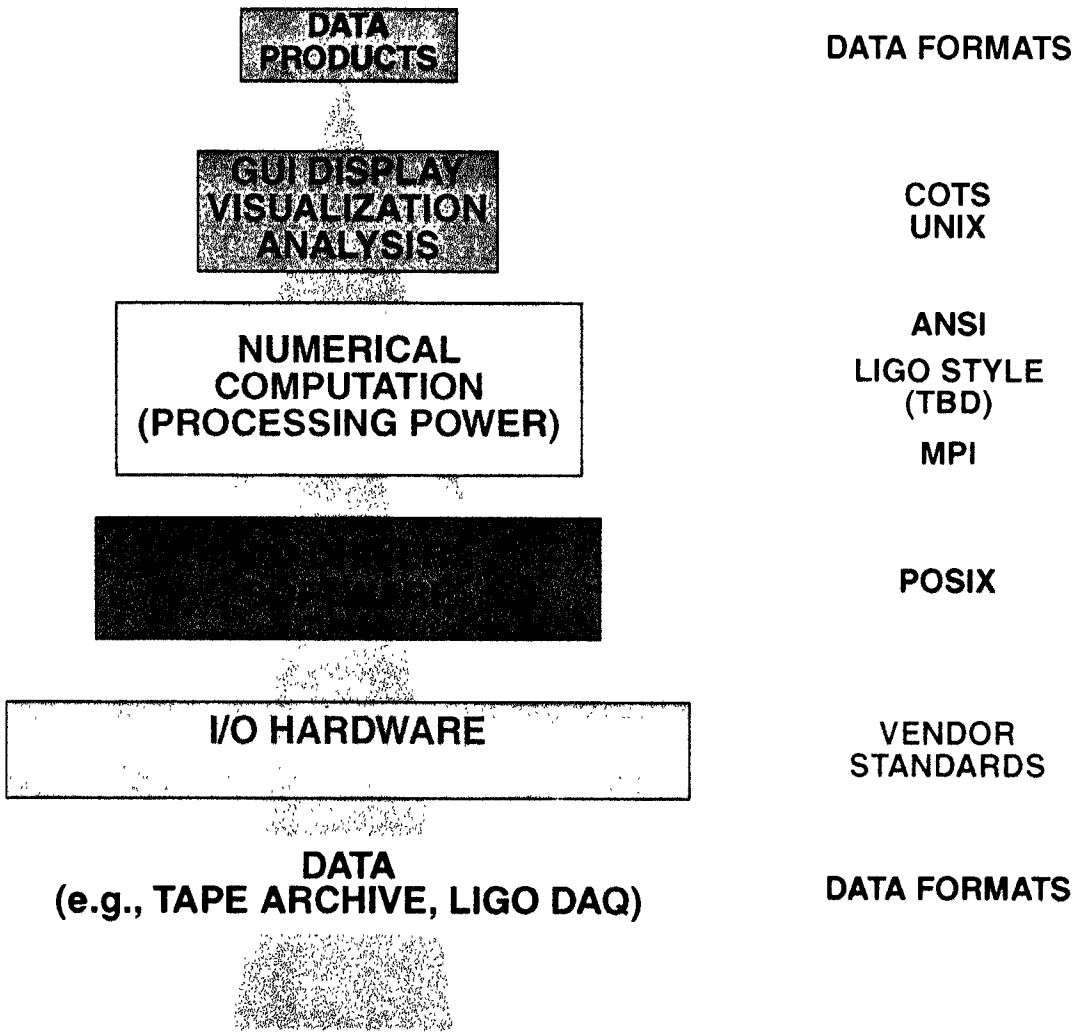
Optimum Window Length vs.Effective MFLOPS



Minimum Mass @ Real Time vs. Effective MFLOPS



LIGO Standards



- Software libraries are modular,addressing various analysis functions: analysis/visualization; computation; I/O; etc.
- Limit the sources of potential platform-dependent occurrences of software routines to low-level (standardized) drivers