Introduction to PY 132

Math Review

Logs and Scaling

The Physics of Motion
PY132

Fall 2006

Animation of galloping horse from photographic study by Edward Muybridge. Read more...

This is a one-semester, self-contained, algebra-based course on Newtonian mechanics, including examination of the properties of fluids, waves, and sound. The basic knowledge is supplemented by special attention to the biomechanics of animals, including the concept of "scaling".

WWW: This course outline is maintained at: http://hep.bu.edu/~kearns/py132 (you are here!).

Instructors:

Prof. Ed Kearns
kearns@bu.edu
(617) 353-3425
PRB-255
office hours: MWF 3-4 PM PRB-255

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Schedule: See the web page at: **http://hep.bu.edu/~kearns/py132/schedule.html**.
HOMEWORK and QUIZ SOLUTIONS are posted here!
You may need to hit "reload" if your web browser is storing previously viewed pages.

Course grade:

- 15% Exam 1
- 15% Exam 2
- 15% Exam 3
- 10% Attendance, participation and exercises in discussion section
- 20% Homework assignments
- 20% Laboratory reports and notebook
- 5% Attendance and participation in lecture

Lectures: Monday, Wednesday, and Friday, 2 PM to 2:50 PM, SCI-115.
Be prepared to answer questions or work on exercises by reading and working ahead. Attendance is mandatory and unexcused absence will lower your participation grade.

Discussion:

2+13

- Section D1: PRB 150 Thursday 11-12
- Section D2: SOC B63 Thursday 1-2

Discussion sections are a required part of the course. The teaching fellow will supplement the lecture material, assist in problem solving, and help prepare you for exams. Conceptual exercises will be a graded part of each discussion section.

Laboratory:

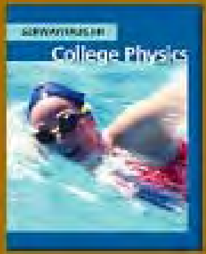
4+12

- Section L1: SCI basement Wednesday 10-12
- Section L2: SCI basement Wednesday 3-5

Laboratories are an important element of this course. Lab instructions will be handed out in lecture prior to each session. You should carefully read and prepare before the lab section meets, as that will allow you to make efficient use of your time during the session. You are expected to keep records and write your report in a bound lab notebook- no loose papers! You will hand in your lab notebooks for grading. Record data in pen in your notebook as you take it, and draw neat graphs of your measurements, with clear labels on all axes and a description of the data. With the instructor's permission, you may attend the other lab section for which you are not scheduled. There will be no makeup labs.

Here is a guideline for a good lab report: http://hep.bu.edu/~kearns/py132/lab-report.html

Text: College Physics, 7th Edition by Raymond A. Serway and Jerry S. Faughn



All you need is Volume 1. There is also larger book with Volumes 1+2 together, you do not need Volume 2 (Electricity and Modern Physics).

Optional Study Guide: Student Solutions Manual and Study Guide, Volume 1, by Gordon, Teague, and Serway ISBN: 0030348110

Exams:

- **Wednesday October 4**
- **Monday November 6**
- **Monday December 11**

Homework: Due in the TF box in SCI basement, each **Friday by 5 PM**.
The Honors/Bonus problem should be handed in separately to Prof. Kearns on Monday. Solutions are posted on the class schedule page (http://hep.bu.edu/~kearns/py132/schedule.html).

Office hours: Prof. Kearns' office hours will be after lecture, 3-4 PM, each MWF. Office hours will be in the conference room (PRB-261) next to his office (PRB-255). Office hours may also be arranged by appointment. See above for the TF office hours.

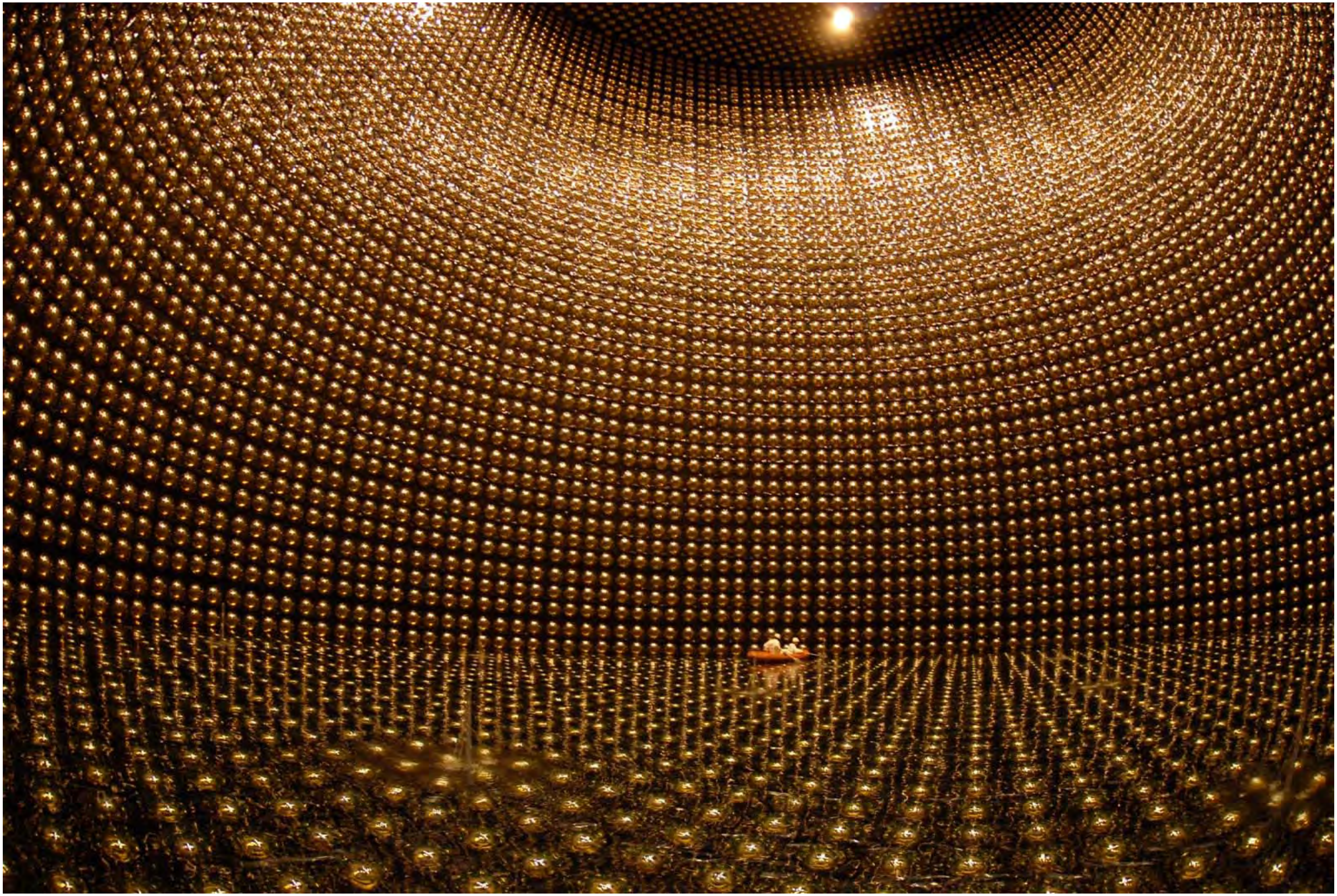
Other guidelines: All work submitted for a grade, including quizzes, exams, homework, and lab reports, must represent the effort and the personal understanding of the student. To achieve this understanding, collaboration on homework is acceptable, even encouraged, as long as the final written homework is the student's own attempt and not a copy of another students effort. Cooperation between lab partners is essential, however, each student should record and analyze data and observations in their own notebook. Please see the instructor if you are having difficulty with these guidelines. All work is due by the time and date required, and extensions will rarely be granted. In some instances, extensions will be allowed given good cause (sickness, unavoidable travel, or serious conflicts with deadlines in another class). Extensions must be granted in advance and documented in writing. This class is governed by the CAS Academic Conduct Code.

The Physics of Motion
PY132

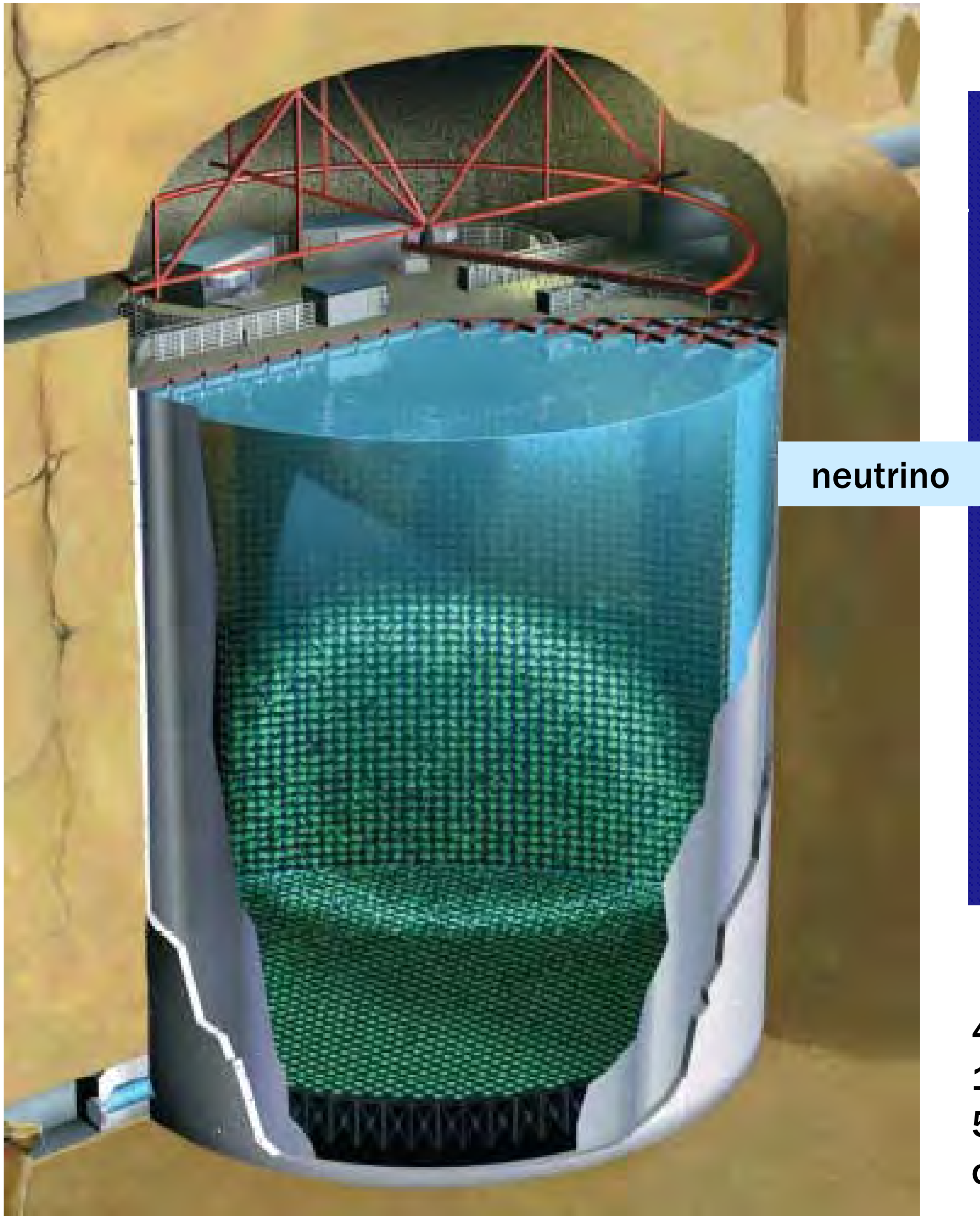
Fall 2006 Schedule

The material for a given chapter is started on Friday of the previous week, and is completed on Monday and Wednesday of the week listed. ***Students should be sure to read the chapter before the Monday lecture!***

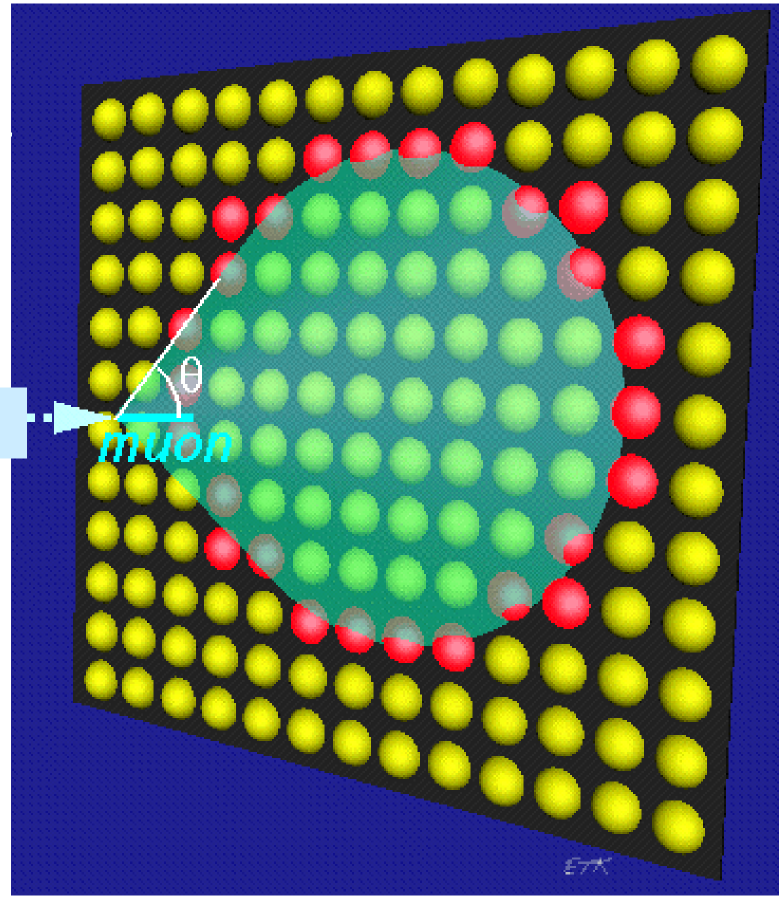
	Week 1 Sept. 6-8	**Introduction, Math Review** Reading: Chapter 1 Lab: no lab Homework: no homework
	Week 2 Sept. 11-15	**Motion in One Dimension** Reading: Chapter 2 Lab: Walking and Running Homework 1
	Week 3 Sept. 18-22	**Vectors and Two Dimensional Motion** Reading: Chapter 3 Lab: Projectile Motion (room B9) Homework 2
	Week 4 Sept. 25-29	**The Laws of Motion** Reading: Chapter 4 Lab: Constant Acceleration Homework 3
	Week 5 Oct. 2-Oct. 6	**Exam I** **WEDNESDAY Oct. 4: Exam I covers chapters 1-4.** Reading: Chapter 1-4 Lab: no lab Homework 4 no homework



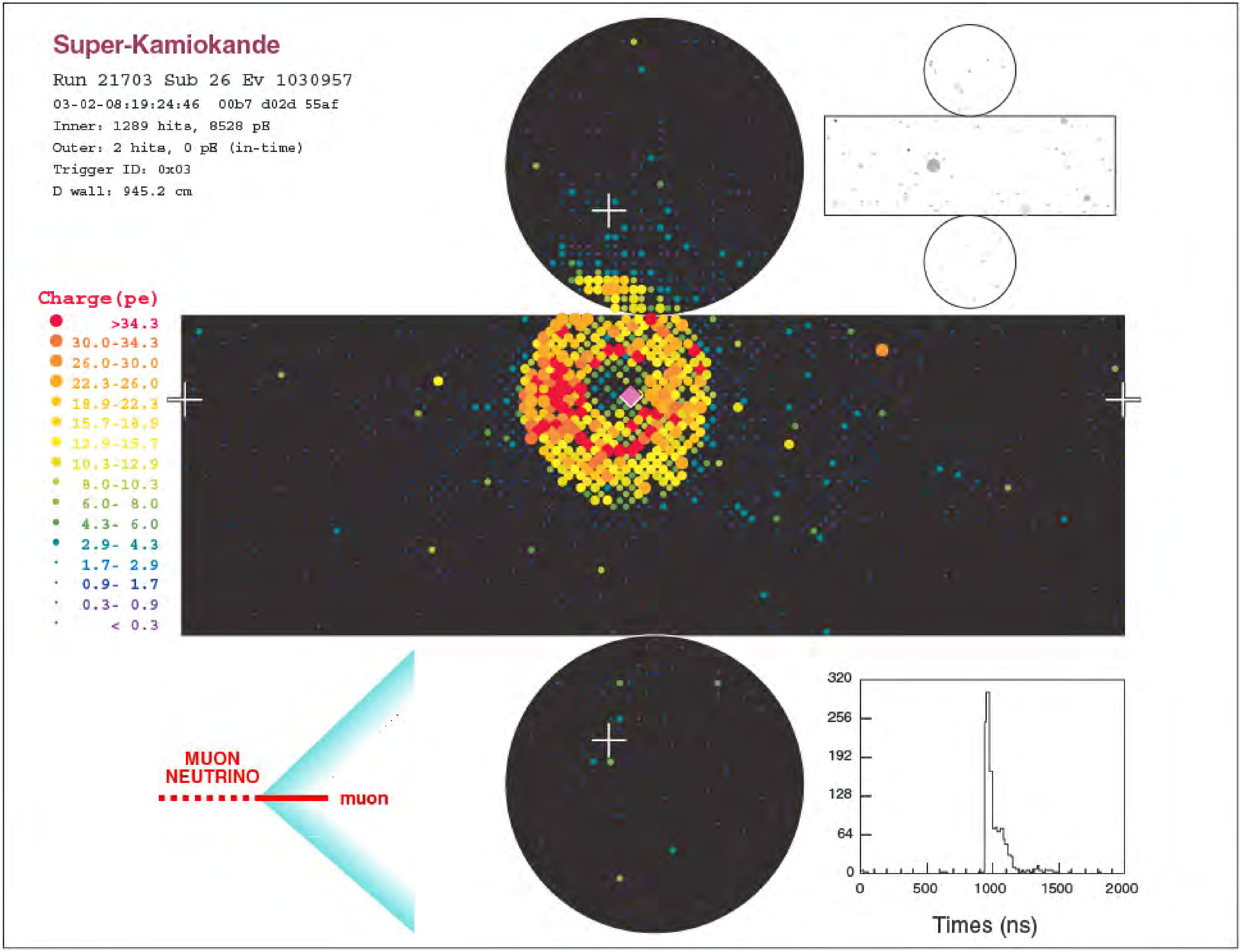
Super-Kamiokande – Neutrino Detection Experiment / Nucleon Decay Experiment



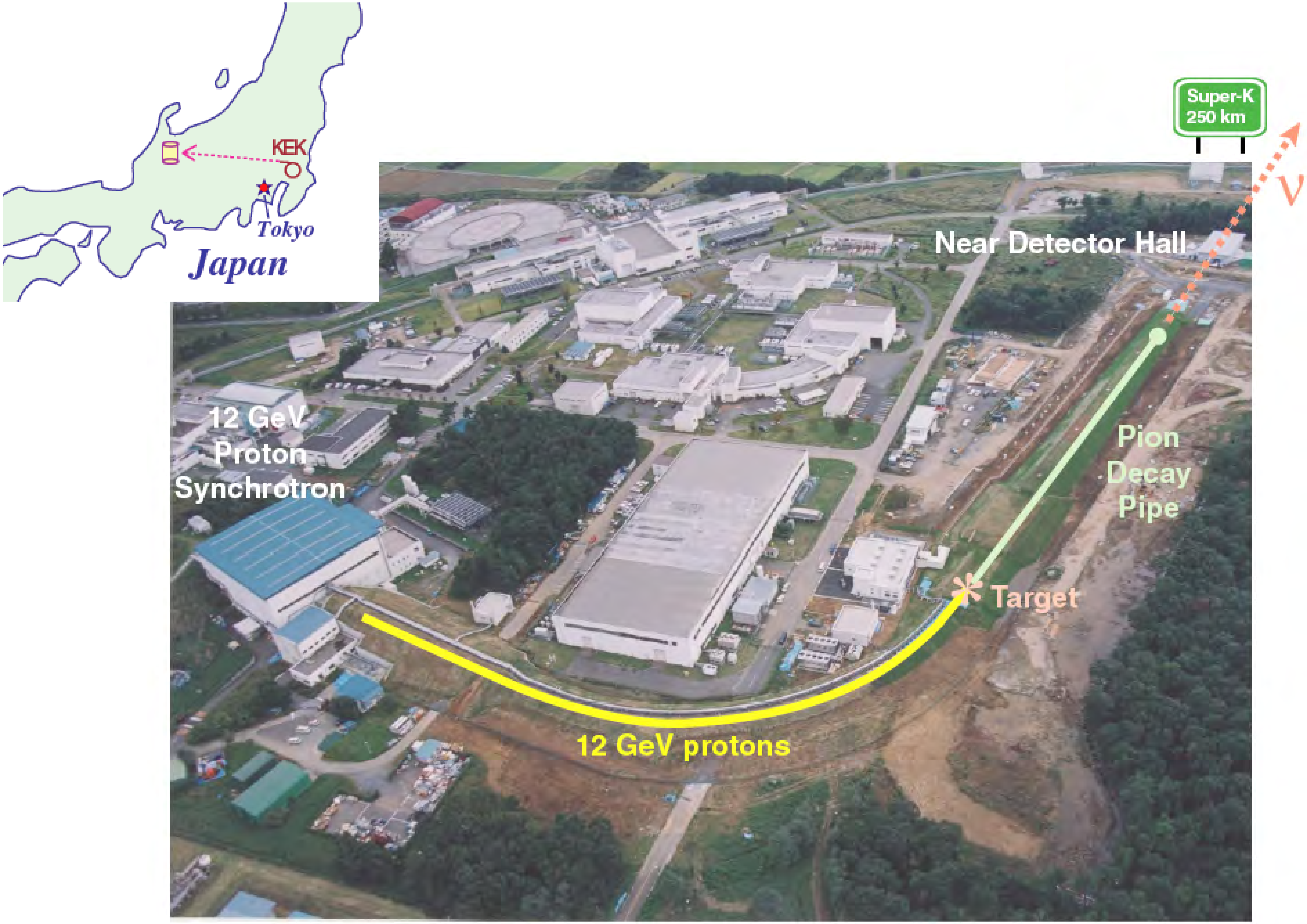
Cherenkov Radiation



40m tall x 40m diameter
11,100 photomultiplier tubes
50000 tons water
optical attenuation length ~100m

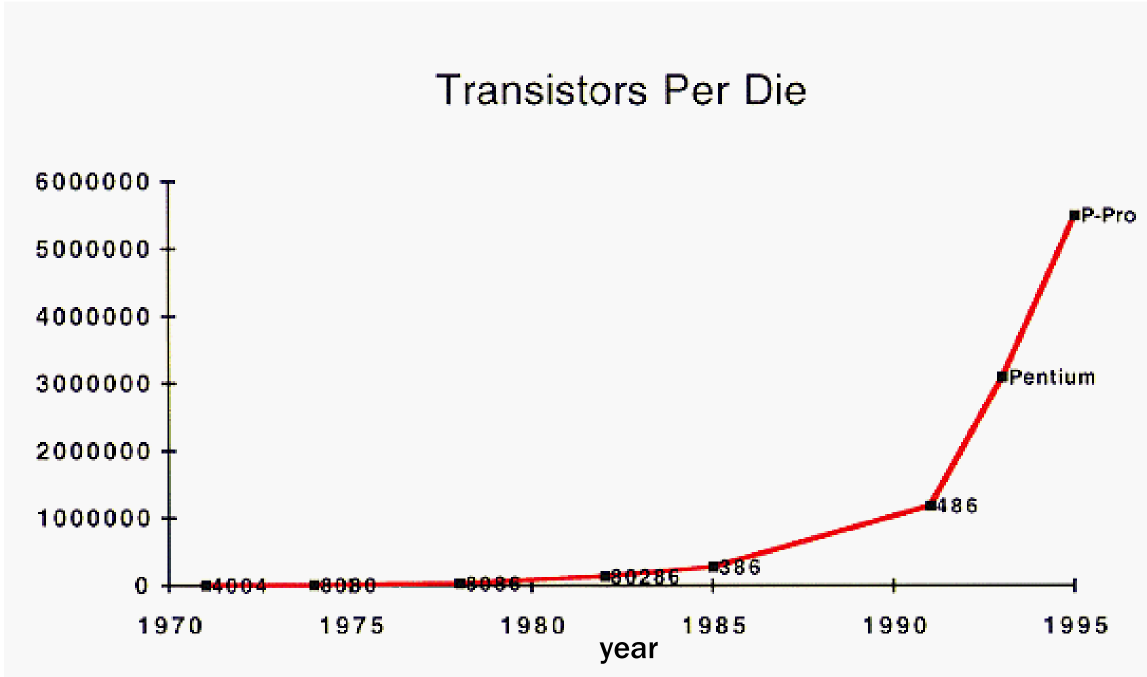


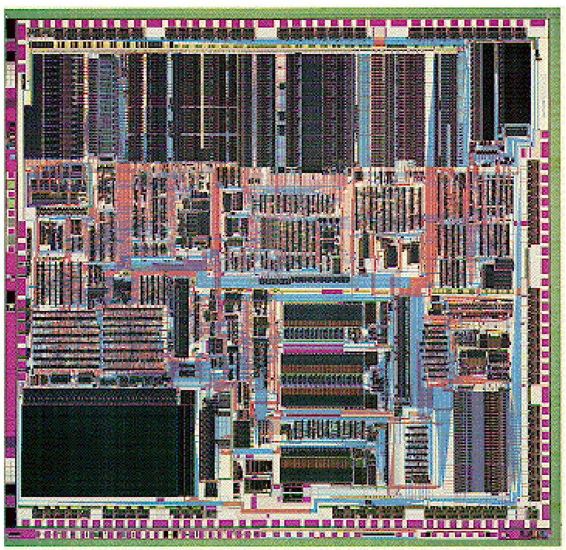
Super-Kamiokande
Run 21703 Sub 26 Ev 1030957
03-02-08:19:24:46 00b7 d02d 55af
Inner: 1289 hits, 8528 pE
Outer: 2 hits, 0 pE (in-time)
Trigger ID: 0x03
D wall: 945.2 cm
Charge(pe)
>34.3
30.0-34.3
26.0-30.0
22.3-26.0
18.9-22.3
15.7-18.9
12.9-15.7
10.3-12.9
8.0-10.3
6.0- 8.0
4.3- 6.0
2.9- 4.3
1.7- 2.9
0.9- 1.7
0.3- 0.9
< 0.3
MUON
NEUTRINO
muon
320
256
192
128
64
0
0
500
1000
1500
2000
Times (ns)


KEK
Tokyo
Japan
Super-K
250 km
ν
Near Detector Hall
12 GeV
Proton
Synchrotron
Pion
Decay
Pipe
Target
12 GeV protons

Scientific Prefixes

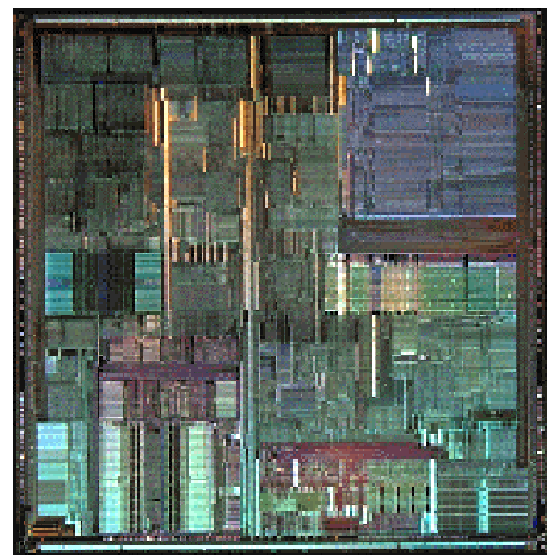
Prefix	Symbol		
yotta	Y	1,000,000,000,000,000,000,000,000	10^{24}
zetta	Z	1,000,000,000,000,000,000,000	10^{21}
exa	E	1,000,000,000,000,000,000	10^{18}
peta	P	1,000,000,000,000,000	10^{15}
tera	T	1,000,000,000,000	10^{12}
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
hecto	h	100	10^{2}
deca	da	10	10^{1}
(none)		1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	m	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}
femto	f	0.000000000000001	10^{-15}
atto	a	0.000000000000000001	10^{-18}
zepto	z	0.000000000000000000001	10^{-21}
yocto	y	0.000000000000000000000001	10^{-24}





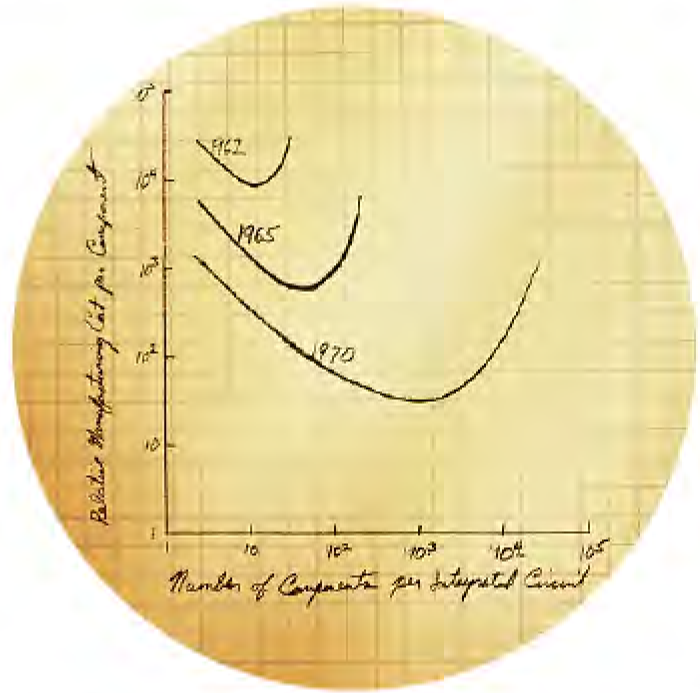
Intel 8086 (1978)

Microprocessor	Year of Introduction	Transistors
4004	1971	2,300
8008	1972	2,500
8080	1974	4,500
8086	1978	29,000
Intel286	1982	134,000
Intel386™ processor	1985	275,000
Intel486™ processor	1989	1,200,000
Intel® Pentium® processor	1993	3,100,000
Intel® Pentium® II processor	1997	7,500,000
Intel® Pentium® III processor	1999	9,500,000
Intel® Pentium® 4 processor	2000	42,000,000
Intel® Itanium® processor	2001	25,000,000
Intel® Itanium® 2 processor	2003	220,000,000
Intel® Itanium® 2 processor (9MB cache)	2004	592,000,000



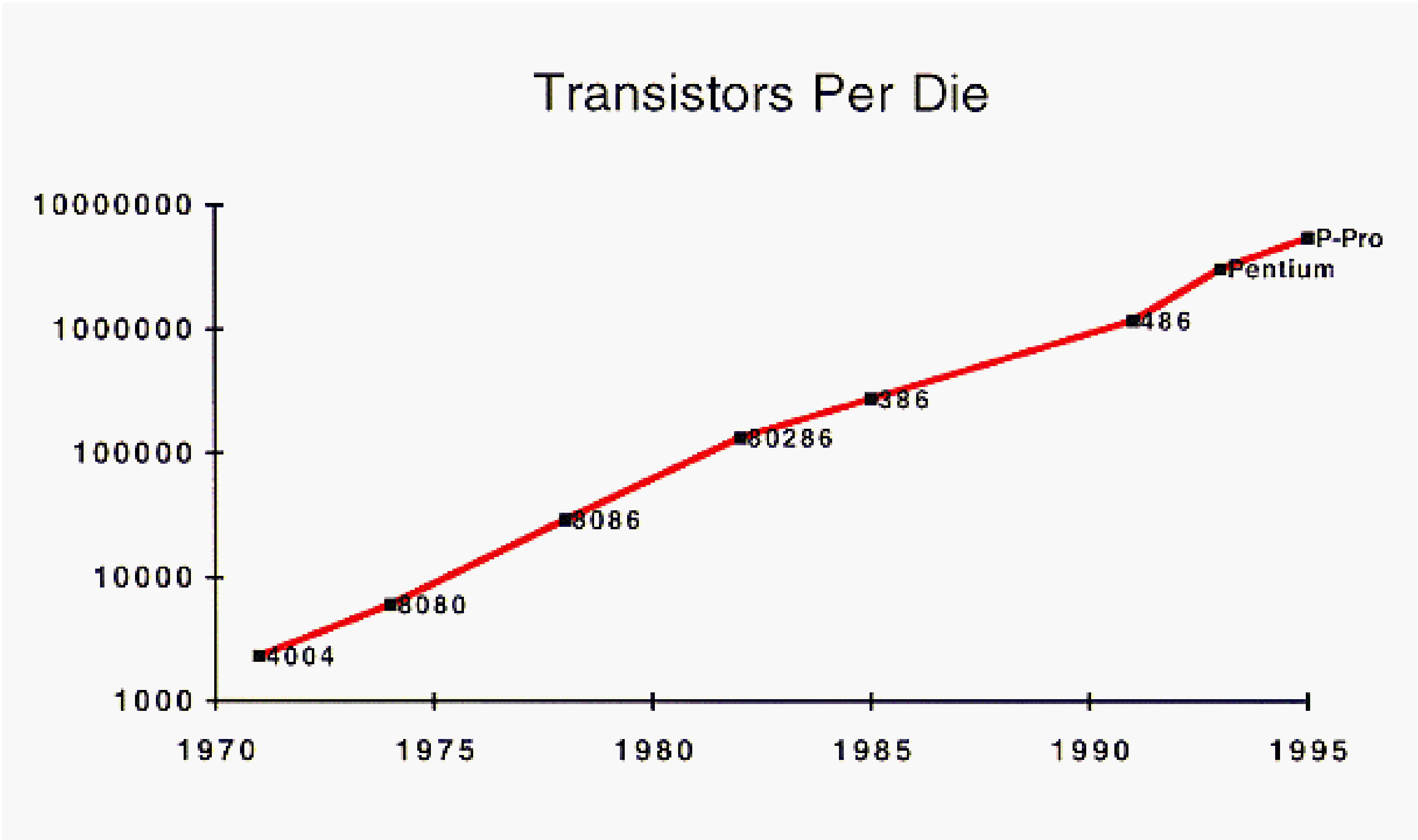
Intel Pentium Pro (1995)

Moore's Law

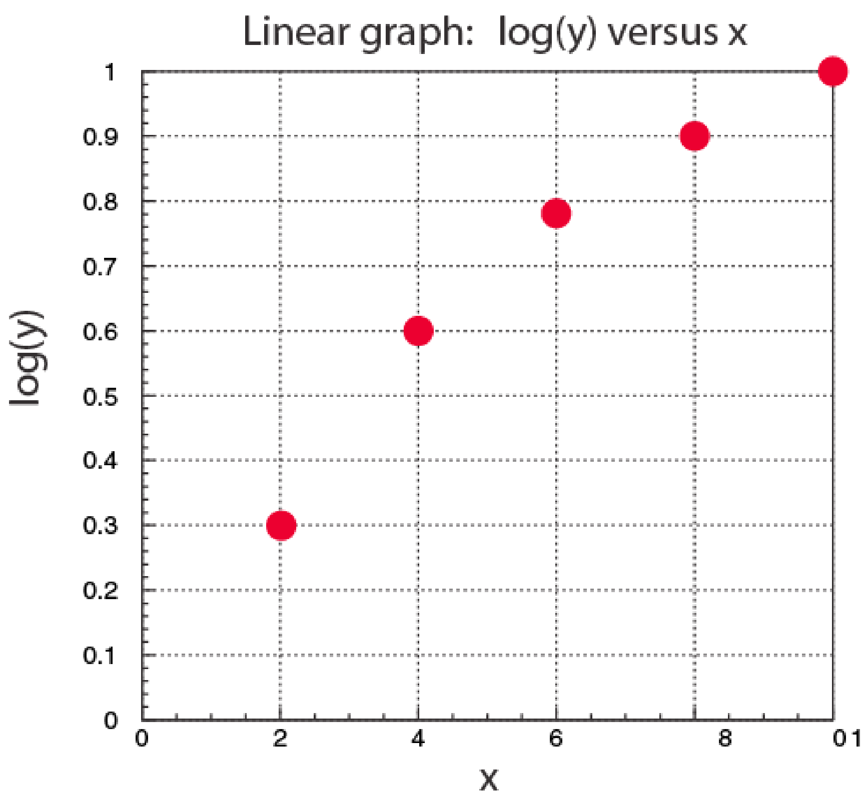


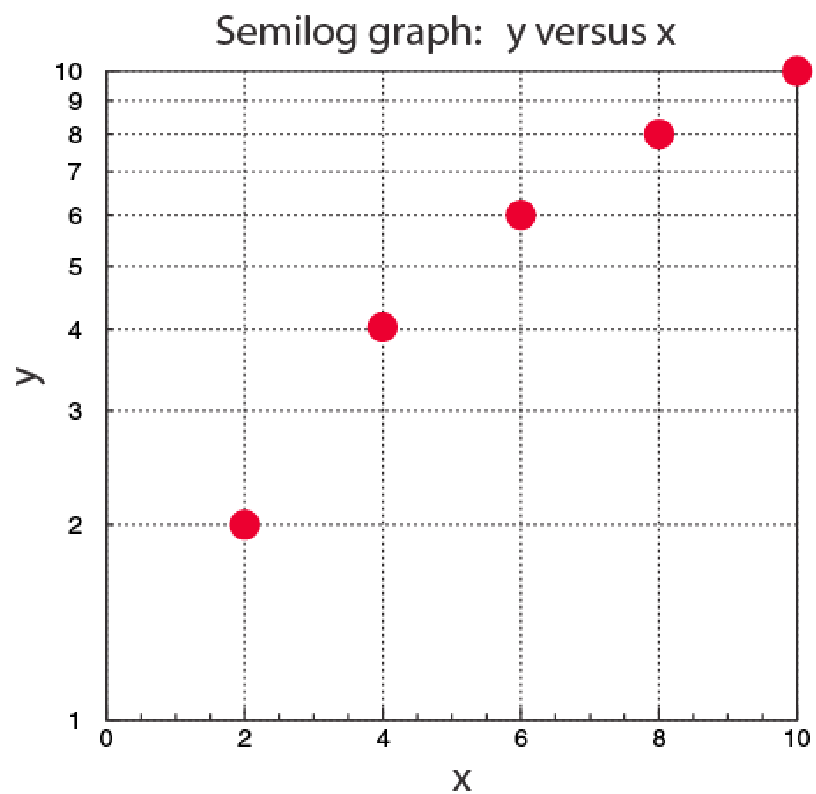
In 1965, Gordon Moore sketched out his prediction of the pace of silicon technology. Decades later, Moore's Law remains true, driven largely by Intel's unparalleled silicon expertise.

According to Moore's Law, the number of transistors on a chip roughly doubles every two years. As a result the scale gets smaller and smaller. For decades, Intel has met this formidable challenge through investments in technology and manufacturing resulting in the unparalleled silicon expertise that has made Moore's Law a reality.


Transistors Per Die
10000000
1000000
100000
10000
1000
1970
1975
1980
1985
1990
1995
4004
8080
8086
80286
386
486
Pentium
P-Pro

year





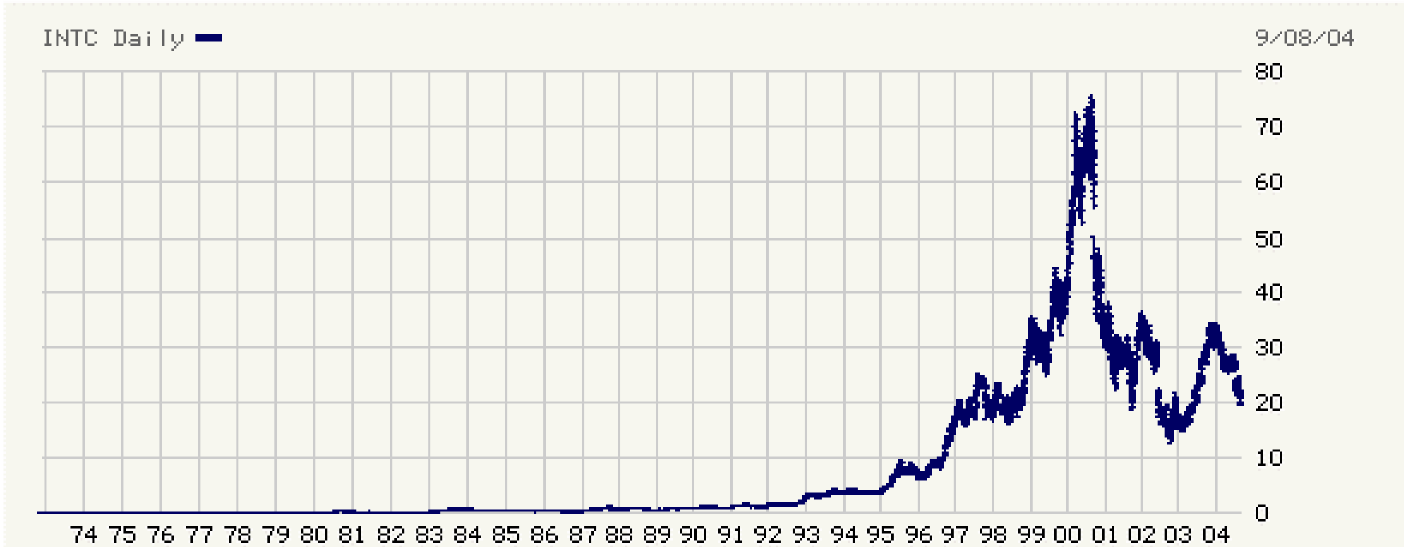
X	Y	log(y)
2	2	0.301
3	3	0.477
4	4	0.602
5	5	0.699
6	6	0.778
7	7	0.845
8	8	0.903
9	9	0.945
10	10	1

When you work with a semi-log graph, "it takes the log" for you.
If both axes are logarithmic, it is called a log-log graph.

In lab:

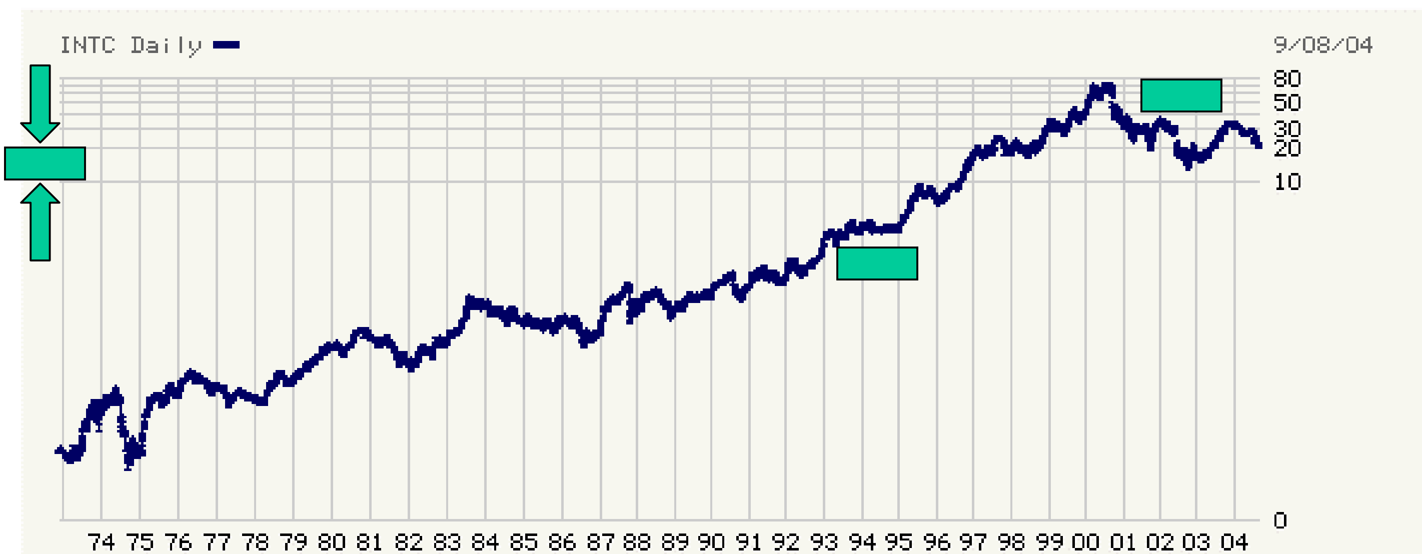
- Label your axes
- Include units (eg. cm, seconds)

A factor of two increase depends on where you are on the graph

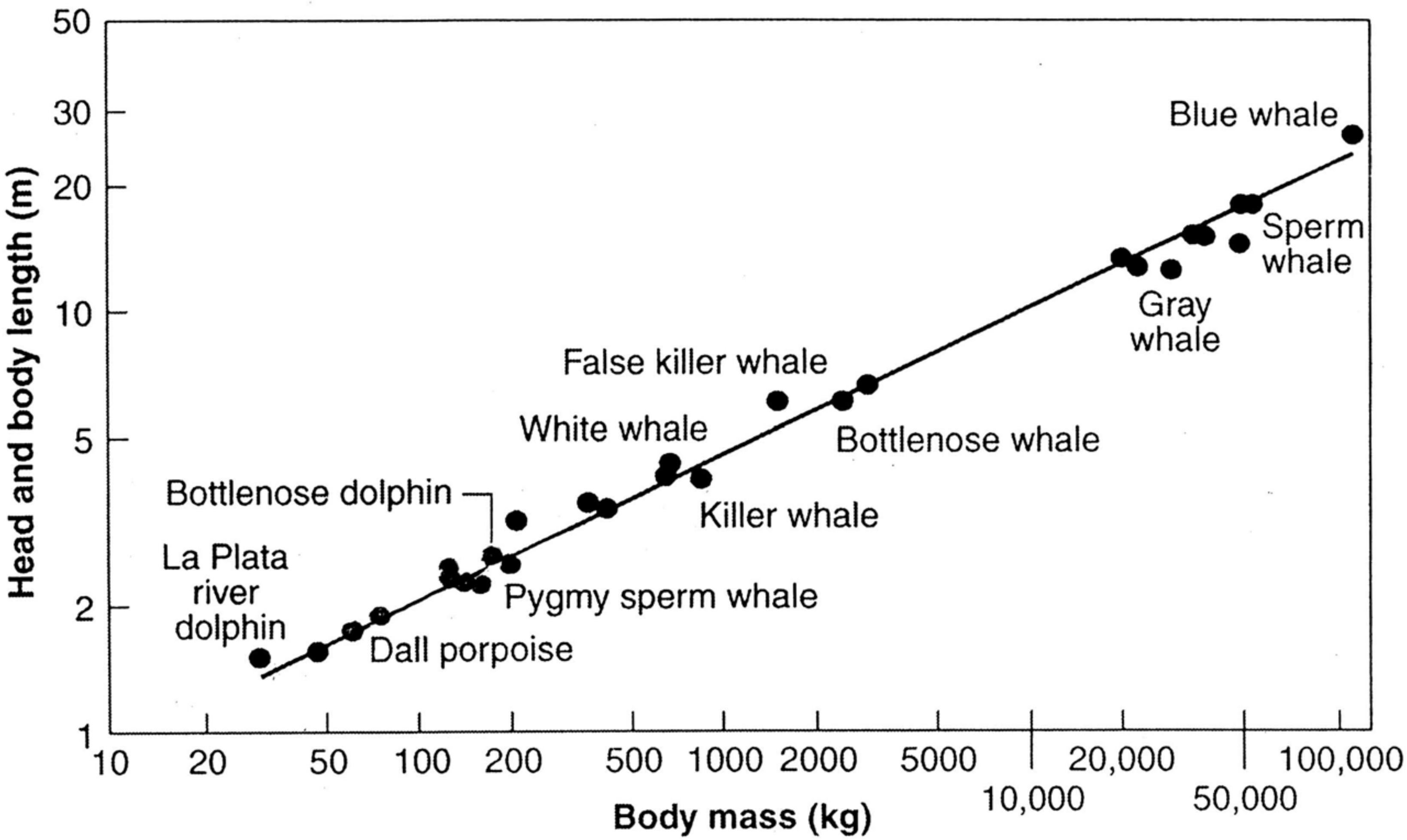


Stock price

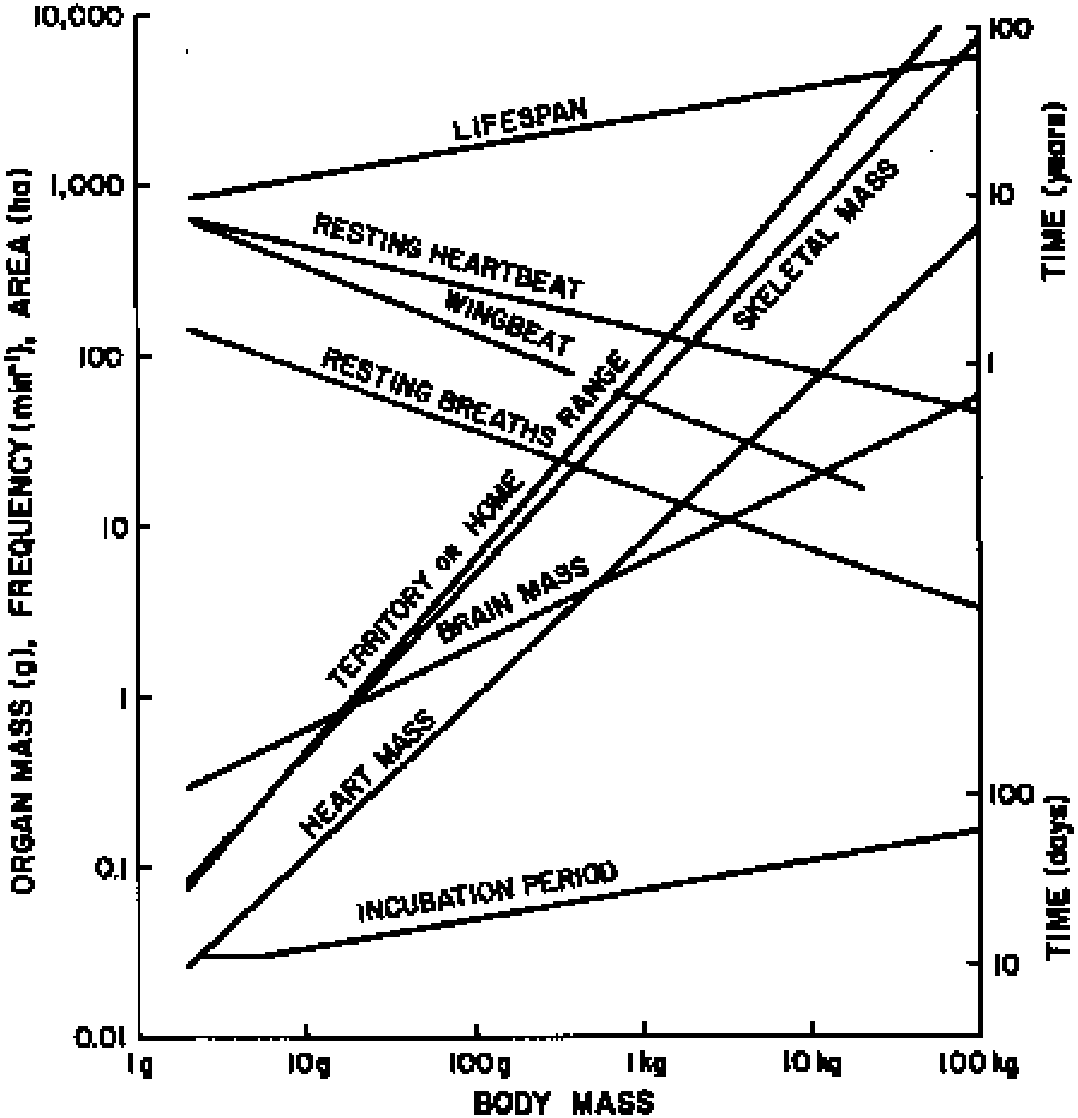
This vertical distance is a factor of two on price anywhere on the graph



year



Head and body length (m)
50
30
20
10
5
2
1
Blue whale
Sperm whale
Gray whale
False killer whale
White whale
Bottlenose whale
Bottlenose dolphin
Killer whale
La Plata river dolphin
Pygmy sperm whale
Dall porpoise
10
20
50
100
200
500
1000
2000
5000
10,000
20,000
50,000
100,000
Body mass (kg)



Allometry in Birds