

# 「英語での物理の授業」 に向けての試み

## Teaching Physics in English

(A Report on Our Experiences in the Physics Class)

平成26年8月理科実験研修会にて

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宮城県仙台第一高等学校

# 1 はじめに

Introduction

# 2 本校の教育課程と指導対象生徒

Curriculum and Students

# 3 教材・教具

Teaching Materials and Instruments

# 4 授業方法・内容

Teaching Methods and Contents

# 5 授業の様子

Classroom Environment

# 6 現状と課題

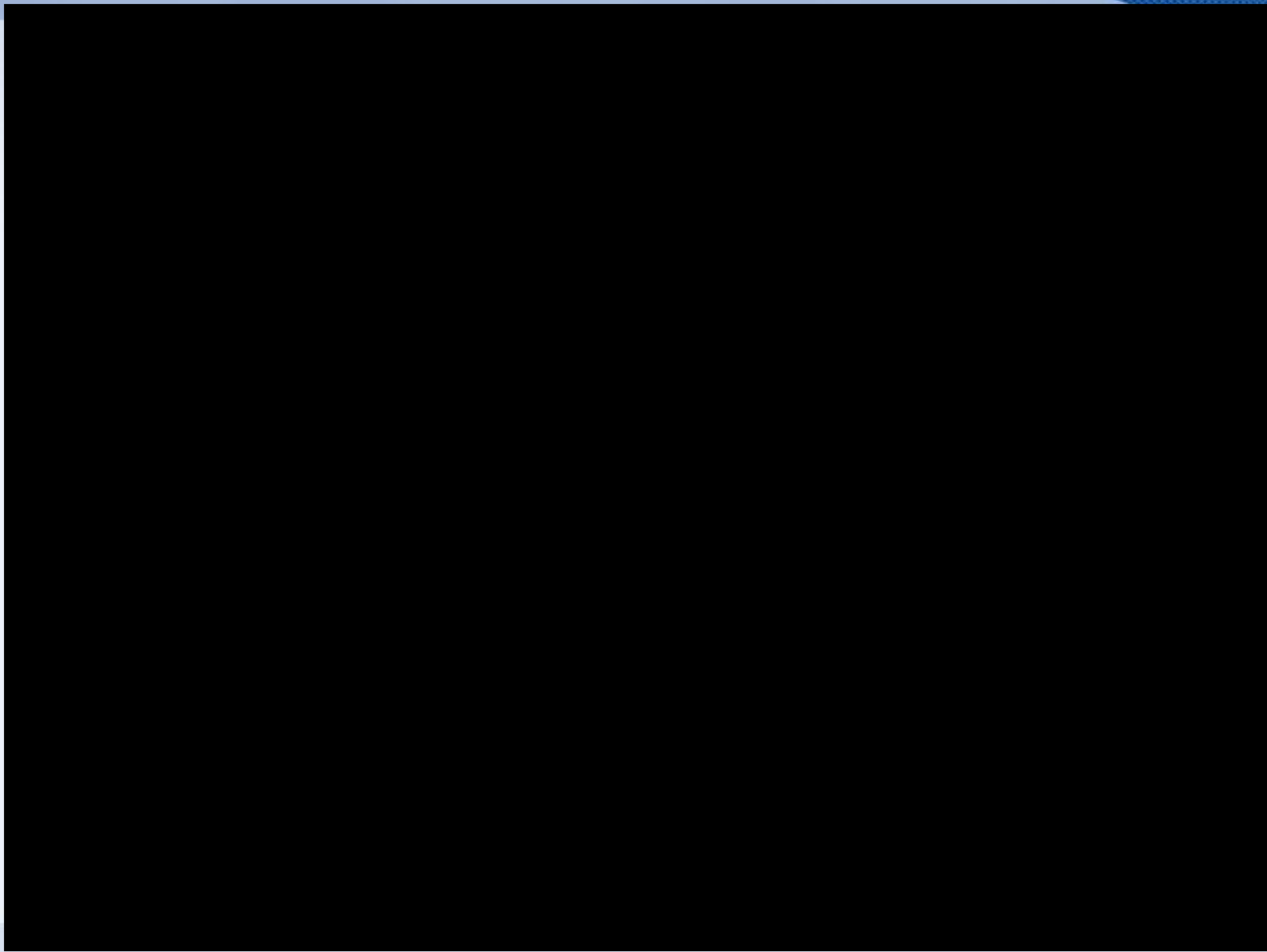
Present Conditions and Problems

## ★ 英国ケンブリッジ大学海外研修報告(写真)

# 1 はじめに (Introduction)

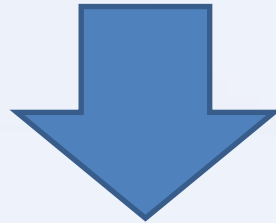
- 国際大会での生徒の英語による発表 (iCAN'11)  
Students' Presentation in English





# 1 はじめに (Introduction)

- 「SSH(Science)」+「SGH(Global)」
- 科学リテラシーかつ国際的素養を身に付けたグローバルリーダーの育成  
Globally Competent Leader with Scientific Literacy



**英語で物理を・・・「科学英語」+「実践英語」**

Physics in English・・・English for Science and Practical English

**学び方の指導, きっかけづくり**

Teach How to Learn, Give a Clue to Learn

# 2 本校の教育課程と指導対象生徒

## (物理関係) Curriculum and Students

教科	科目	1年				2年		3年	
		文系	理系	理系	理系	文系	理系	理系	
理 科	SS理科総合		4						
	SS物理Ⅰ			4					
	SS物理Ⅱ						4		
	SS化学Ⅰ			3					
	SS化学Ⅱ						4		
	SS生物Ⅰ			4	4			0	
	SS生物Ⅱ						4		
	SS地学Ⅰ								
	SS地学Ⅱ								
	理科総合発展								
	化学研究								
	生物研究								
地学研究									

1年次  
物理分野①単位  
(SS理科総合4単位)

2年次理系  
④単位  
(SS物理Ⅰ)

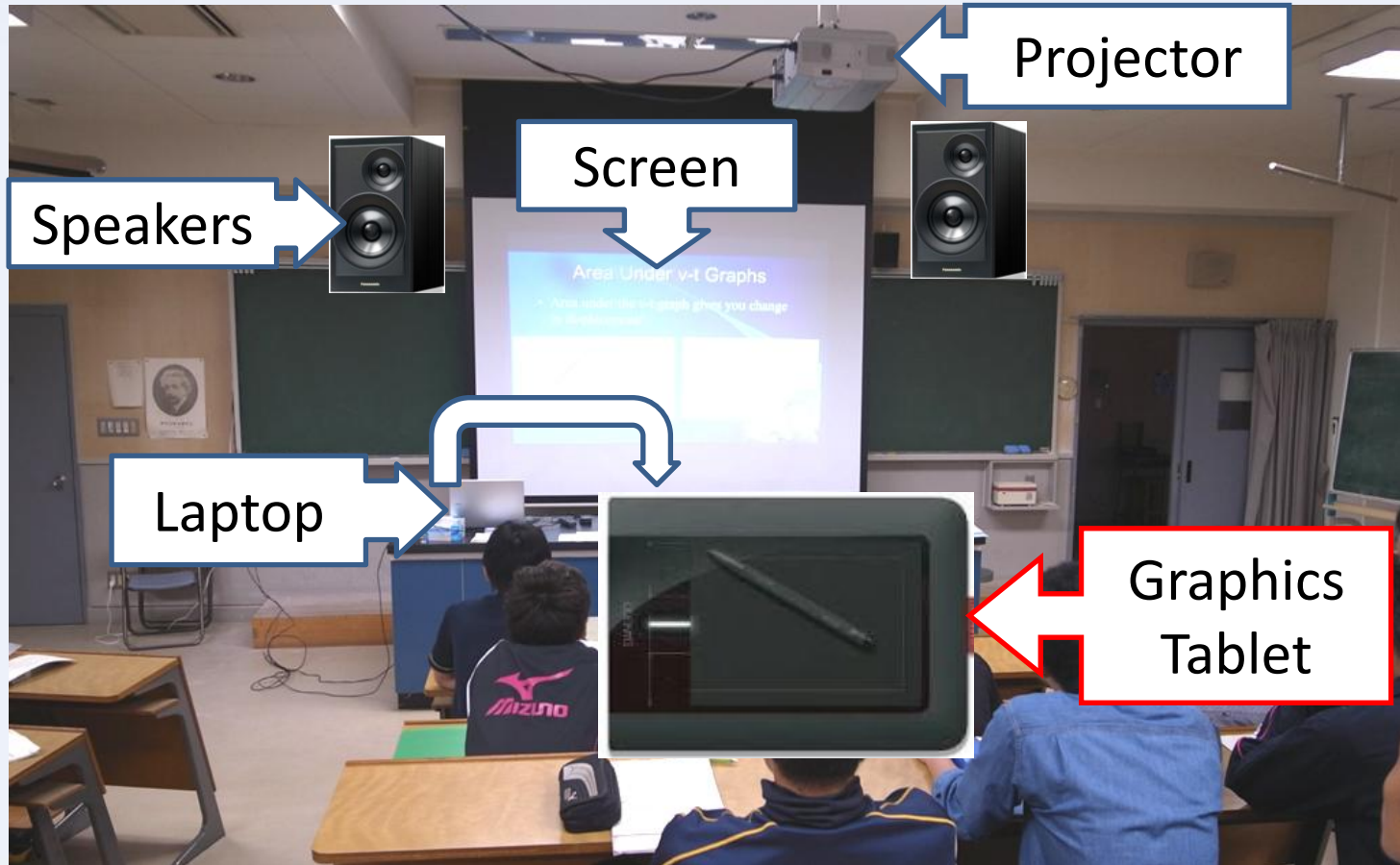
3年次理系  
④単位  
(SS物理Ⅱ)

『SS物理Ⅰ』④単位中  
日本語3単位, 英語1単位  
4クラス161名(男124, 女37)

すべて, SSHの研究開発に係る学校設定科目

### 3 教材・教具 (Teaching Materials and Instruments)

## PHYSICS LECTURE ROOM



### 3 教材・教具 (Teaching Materials and Instruments)

Textbook:  
"Regents Physics Essentials"

For high school  
students  
in **New York**



APhysics.com

REGENTS PHYSICS

- [Introduction](#)
- [Math Review](#)
- [Kinematics](#)
  - [Defining Motion](#)
  - [Graphing Motion](#)
  - [Kinematic Equations](#)
  - [Free Fall](#)
  - [Projectile Motion](#)
  - [Kinematics Quiz](#)
- [Dynamics](#)
  - [Newton's 1st Law](#)
  - [Newton's 2nd Law](#)
  - [Newton's 3rd Law](#)
  - [Friction](#)
  - [Ramps and Inclines](#)
  - [Dynamics Quiz](#)
- [Circular Motion & Gravity](#)
  - [Uniform Circular Motion](#)
  - [Gravity](#)
  - [Circular Motion Quiz](#)
- [Momentum](#)

Regents Physics

*"Whoever wants to understand much must play much." -- Gottfried Benn, German physician, 1886-956*

Welcome to Regents Physics, an introductory course in high school physics designed to prepare students for the New York State Board of Regents Physics Exam.

Key topics in the course include mechanics, electricity and magnetism, and selected modern physics concepts.

Throughout the course, a wide variety of sample problems are provided from previous years' [Regents Physics Exams](#).

In addition to a scientific calculator, metric ruler, and protractor, students are given on the table.

Topics of Study

テキスト  
ビデオ  
練習問題+用紙  
指導例  
(すべてダウンロード可)



## 4 授業方法・内容 (Teaching Methods and Contents)

### (1) 通常授業

テキスト：“Regents Physics Essentials”

### (2) ゲーム(物理用語の復習)

Flash Card, CROSSWORD PUZZLE, BINGO GAME

### (3) 特別授業(June 11-12, 2014)

QuarkNet Workshop:

International Linear Collider (国際リニアコライダー)

Cosmic Rays(宇宙線)

についてのワークショップ

### (4) 生徒(グループ)によるプレゼン

“Short Physics Presentation”

## 4 授業方法・内容 (Teaching Methods and Contents)

### 通常授業の内容 Contents:

(すべて日本語での既習内容)

#### Chapter 1: Introduction

What is Physics?

#### Chapter 2: Math Review

Metric System

Significant Figures

Scientific Notation

Scalars and Vectors

#### Chapter 3: Kinematics

Defining Motion

Graphing Motion

Kinematic Equations

Free Fall

Projectile Motion

#### Chapter 4: Dynamics

Newton's 1st Law of Motion

Free Body Diagrams

Newton's 2nd Law of Motion

Newton's 3rd Law of Motion

Friction

Ramps and Inclines

#### Chapter 5: Work, Energy & Power

Energy & Power

Work

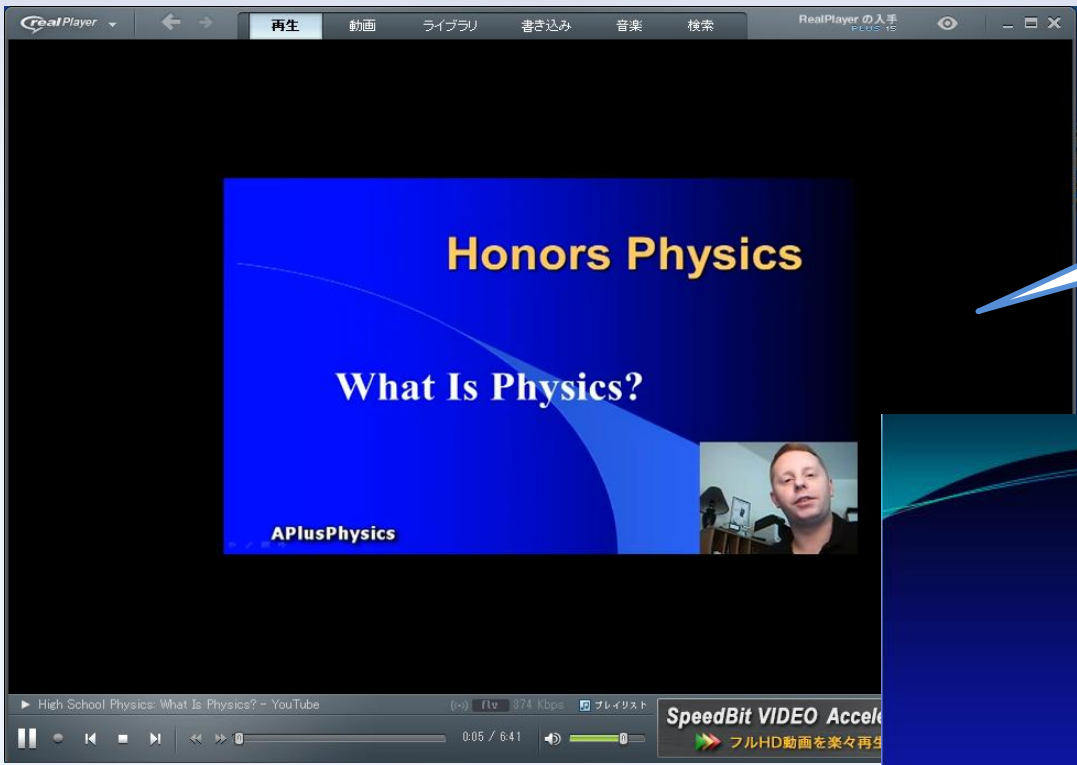
Power

Types of Energy

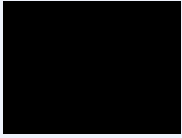
Springs

Conservation of Energy

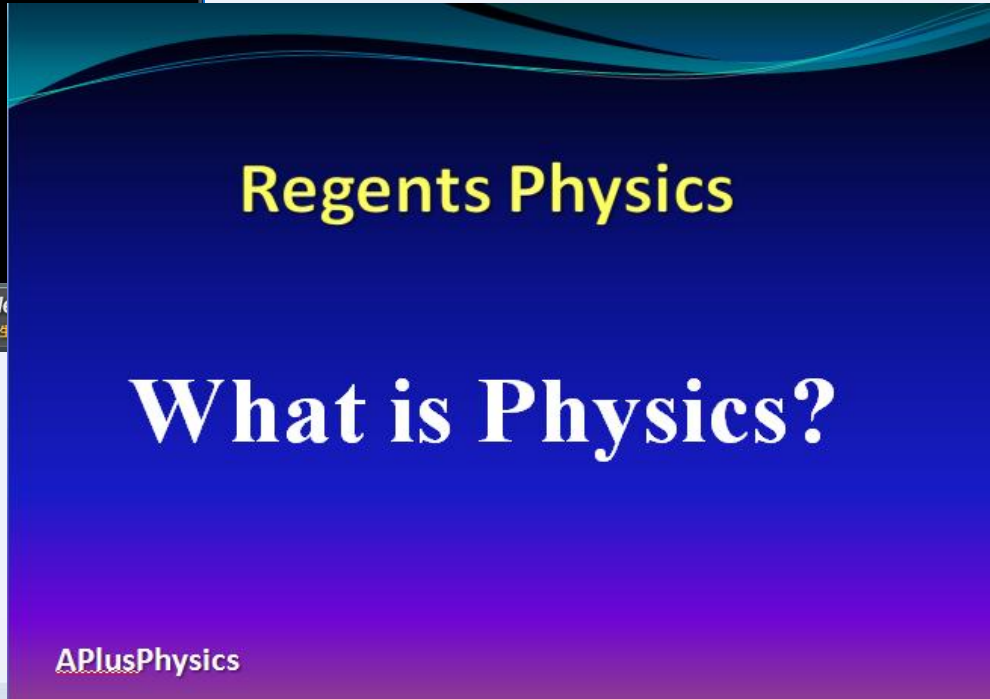
# 4 授業方法・内容 (Teaching Methods and Contents)



Video from  
"APlusPhysics.com"



PPT based on the Video

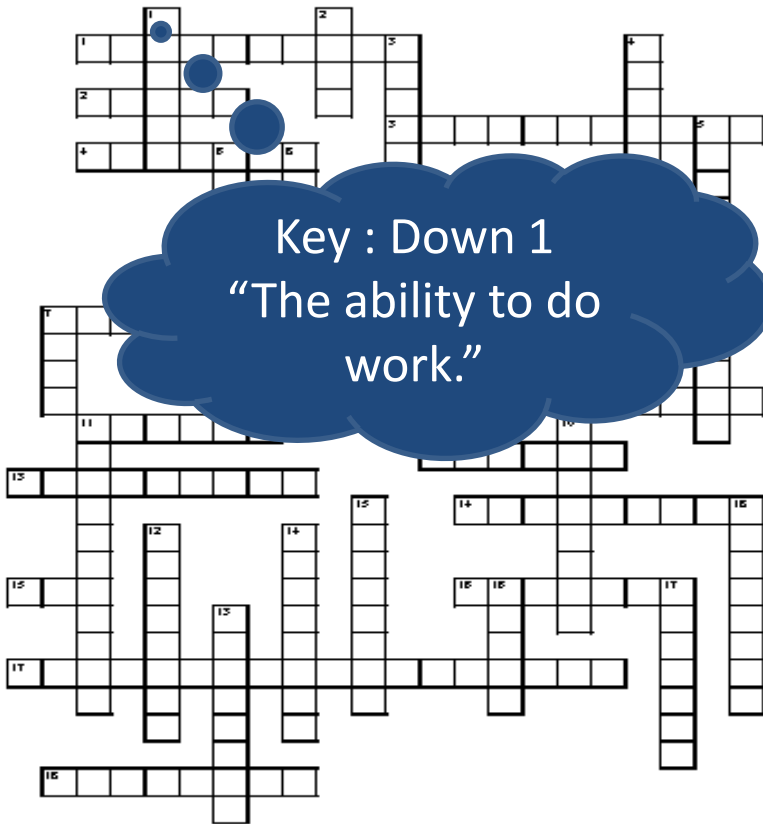


# 4 授業方法・内容 (Teaching Methods and Contents)

## CROSSWORD PUZZLE

(Physics Vocabulary)

Physics Vocabulary Crossword puzzle



Key : Down 1  
"The ability to do work."

## BINGO GAME

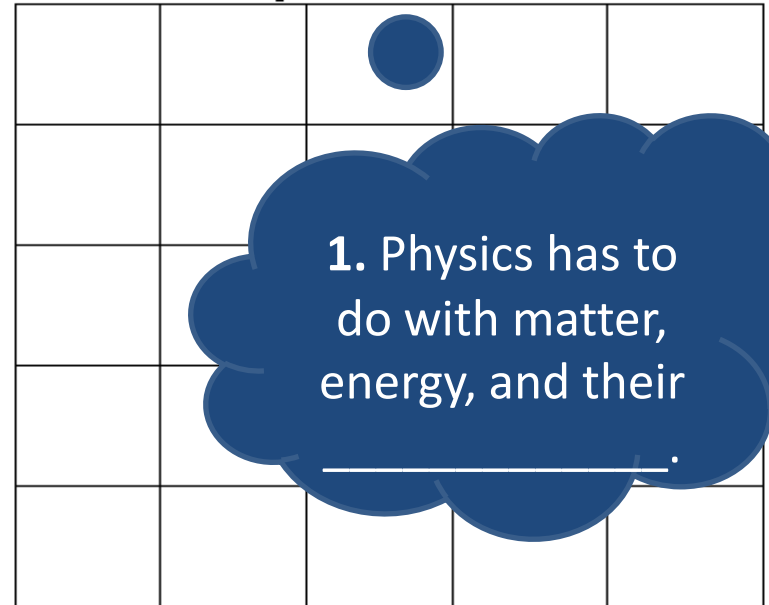
(Physics Vocabulary)

Physics Vocabulary BINGO Game 1

Vocabulary words are:

position / average velocity / acceleration / slope / area / motion graph /  
particle diagram / displacement / average speed / perpendicular / vertical /  
horizontal / movement / mass / matter / interaction / rest / work / energy /  
square root / radius / equation / sig. figs. / scientific notation / scalar / vector /  
negative / positive / SI system / kilometer / time

Write in the circles the vocabulary words you pick. Listen to your teacher for the definition or the definition read from a Power Point slide. If you get one correct, mark an "X" in the corner of the square. **WIN BINGO with 5 in a row!**



1. Physics has to do with matter, energy, and their \_\_\_\_\_.

## 5 授業の様子① (Classroom Environment)



## 5 授業の様子② (Classroom Environment)



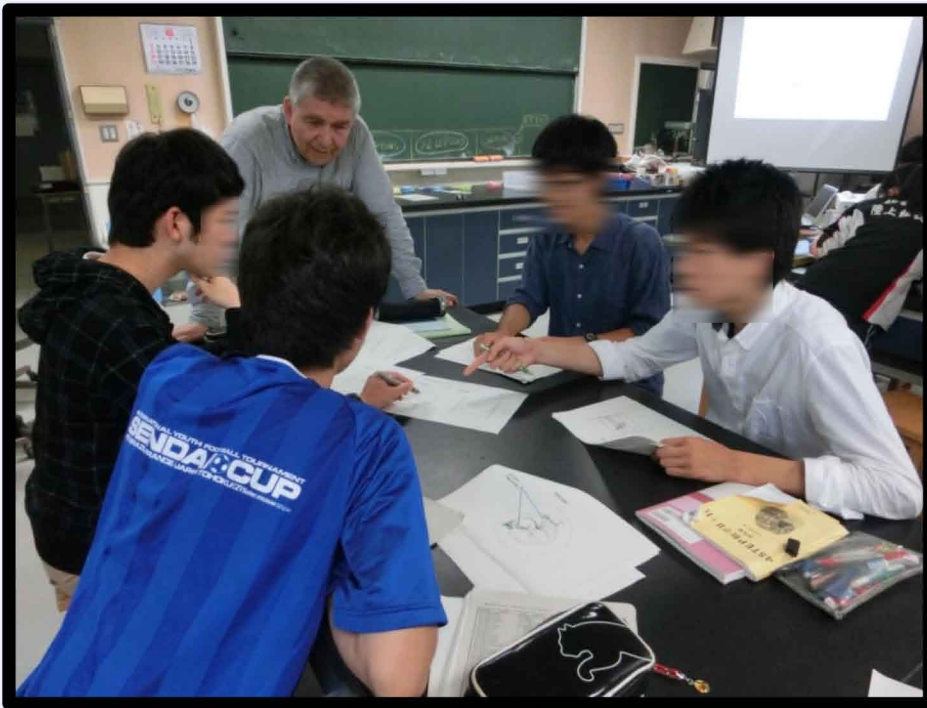
## 5 授業の様子③ (Classroom Environment)



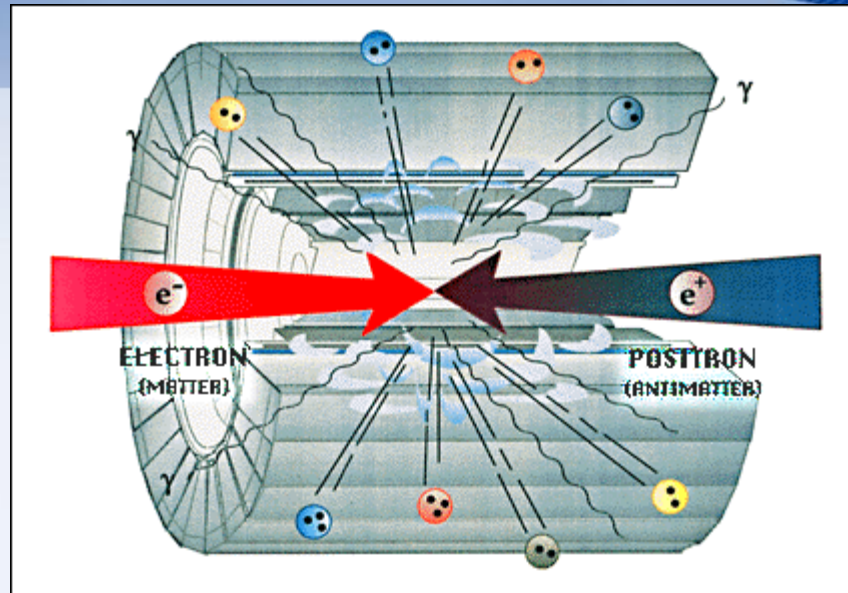
## 5 授業の様子④ (Classroom Environment)

QuarkNet-ILC Workshop:  
International Linear Collider (国際リニアコライダー)  
についてのワークショップ June 11-12, 2014

特別授業







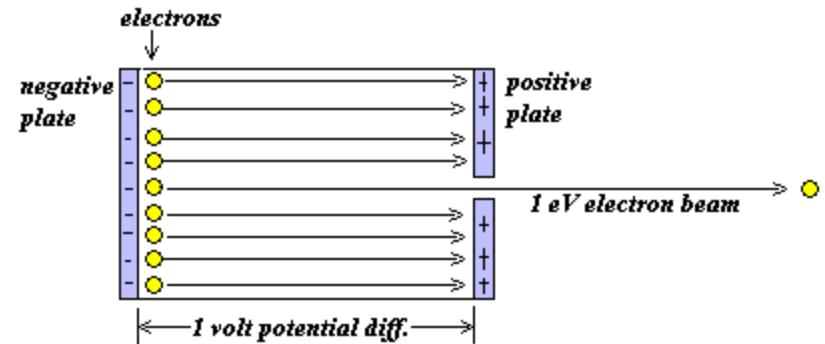
# Accelerating to the ILC

Student view of the International Linear Collider



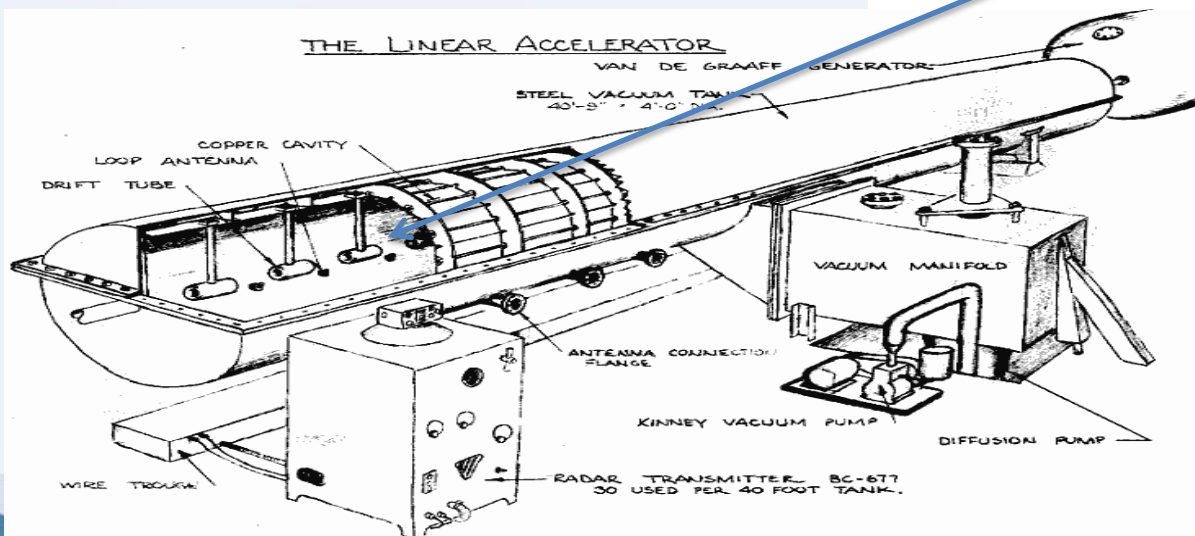
# Accelerating electrons

- We know this technology
- Electrons attracted to positive, repelled by negative
- Using repeated stages and high voltage, we can give electrons a lot of energy



## The "Evatron"

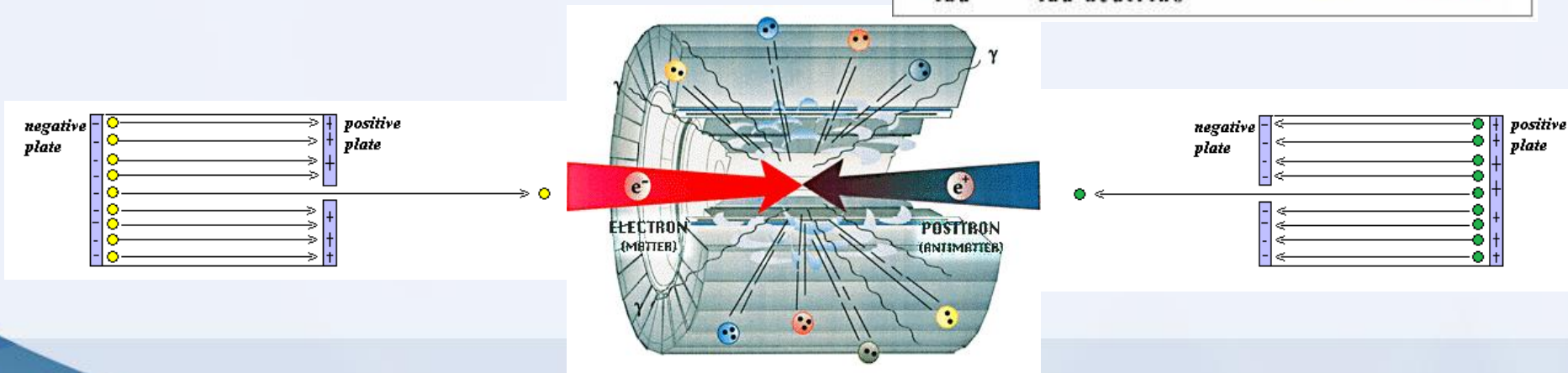
Electrons accelerated across a 1 volt (1 J/C) potential difference each gain  $1.6 \times 10^{-19}$  J, or 1 electron-volt (eV) of kinetic energy.



# Accelerating electrons and positrons

- Every matter particle has an antimatter partner
- Positrons are antimatter electrons
- We can collide them at high energy
- We build detectors to measure the results of these collisions: new particles!

Quarks		Anti-quarks	
$u$ up	$d$ down	$\bar{u}$	$\bar{d}$
$t$ top	$b$ bottom	$\bar{t}$	$\bar{b}$
$s$ strange	$c$ charm	$\bar{s}$	$\bar{c}$
Leptons		Anti-leptons	
$e$ electron	$\nu_e$ electron neutrino	$e^+$ positron	$\bar{\nu}_e$
$\mu$ muon	$\nu_\mu$ muon neutrino	$\bar{\mu}$	$\bar{\nu}_\mu$
$\tau$ tau	$\nu_\tau$ tau neutrino	$\bar{\tau}$	$\bar{\nu}_\tau$



# The Large Electron-Positron collider

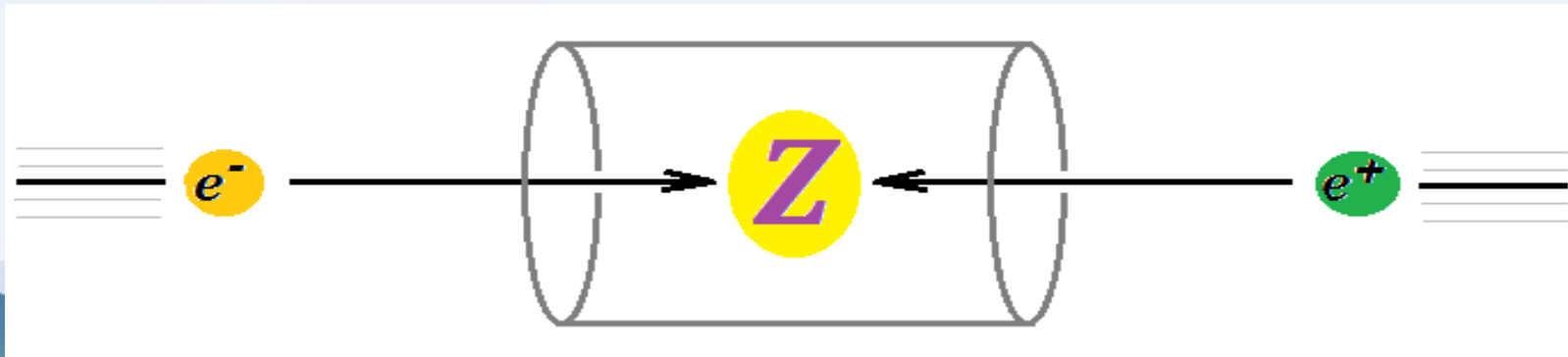
- CERN, 1989-1998 (near Geneva)
- 100 m underground circular tunnel (now used by Large Hadron Collider, LHC)
- Precise measurements of Z and W bosons
  - produced by electron-positron collisions
  - Energy of collisions makes particles

The Standard Model

	Fermions			Bosons	
Quarks	<i>u</i> up	<i>c</i> charm	<i>t</i> top	$\gamma$ photon	Force carriers
	<i>d</i> down	<i>s</i> strange	<i>b</i> bottom	<i>Z</i> Z boson	
Leptons	$\nu_e$ electron neutrino	$\nu_\mu$ muon neutrino	$\nu_\tau$ tau neutrino	<i>W</i> W boson	
	<i>e</i> electron	$\mu$ muon	$\tau$ tau	<i>g</i> gluon	
				Higgs boson	

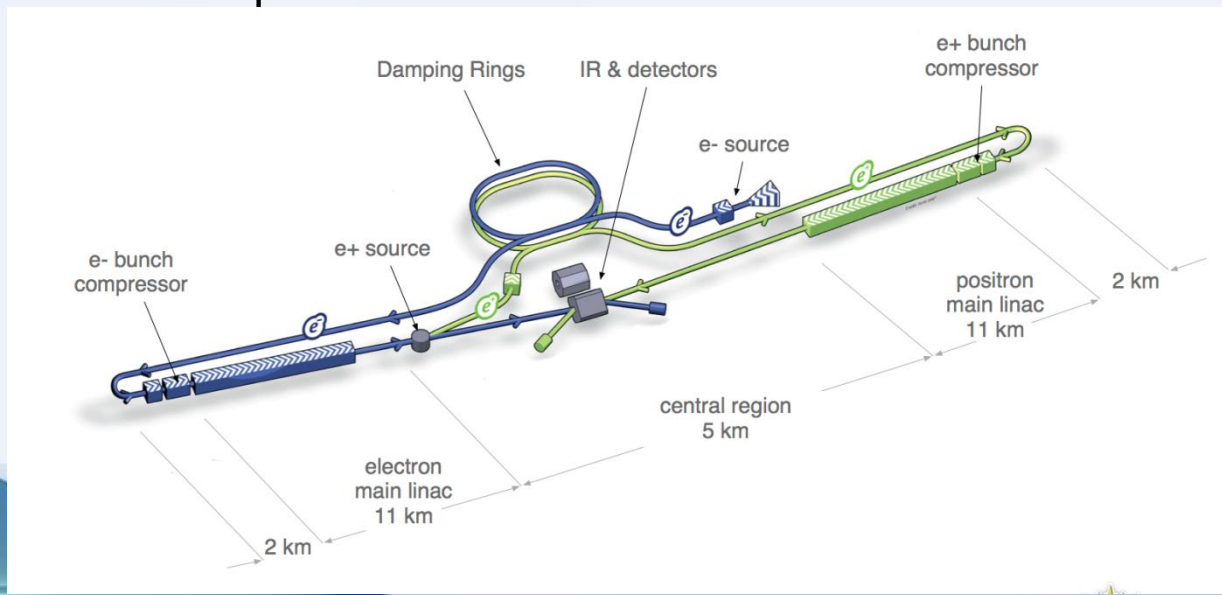
SOURCE: AAAS

*Not yet discovered in LEP!*



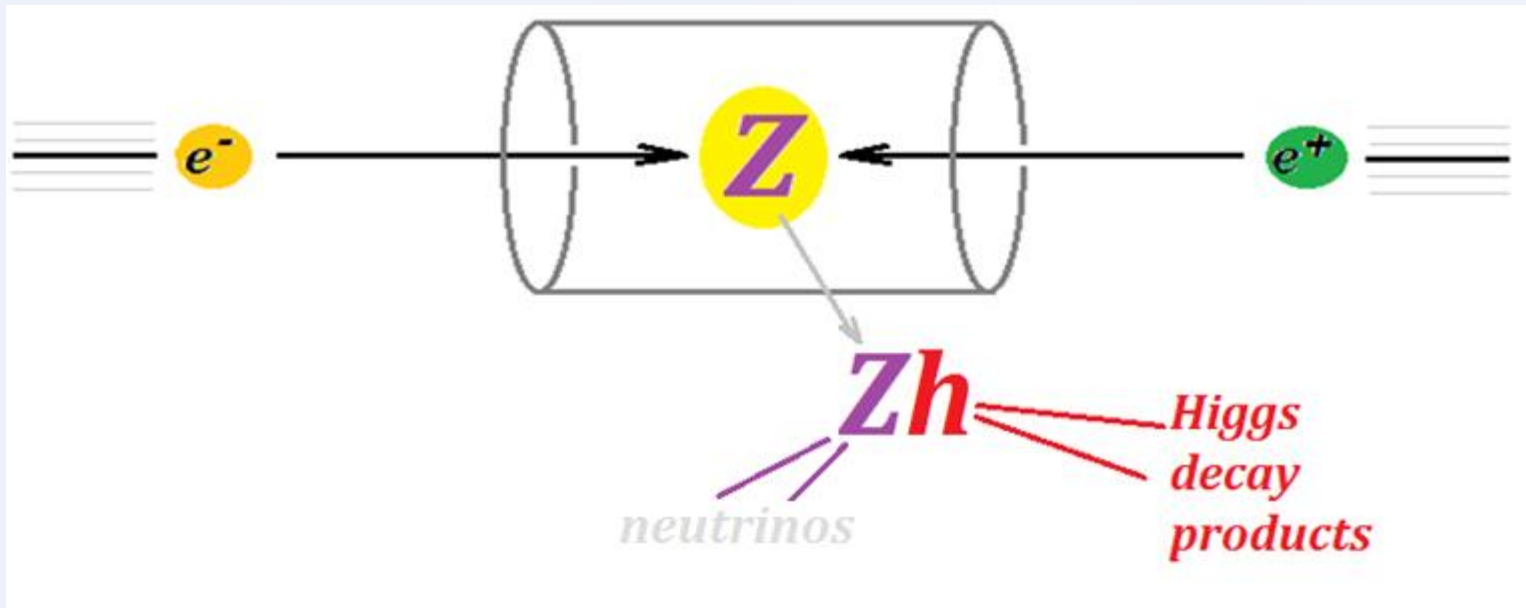
# Next step: International Linear Collider

- LEP made precise measurements of the Z boson
- After LEP, the very important Higgs boson was discovered in the Large Hadron Collider (LHC) in 2012
- The International Linear Collider (ILC)
  - will be another electron-positron collider
  - can make precision measurements of the Higgs
  - is planned for Tohoku.

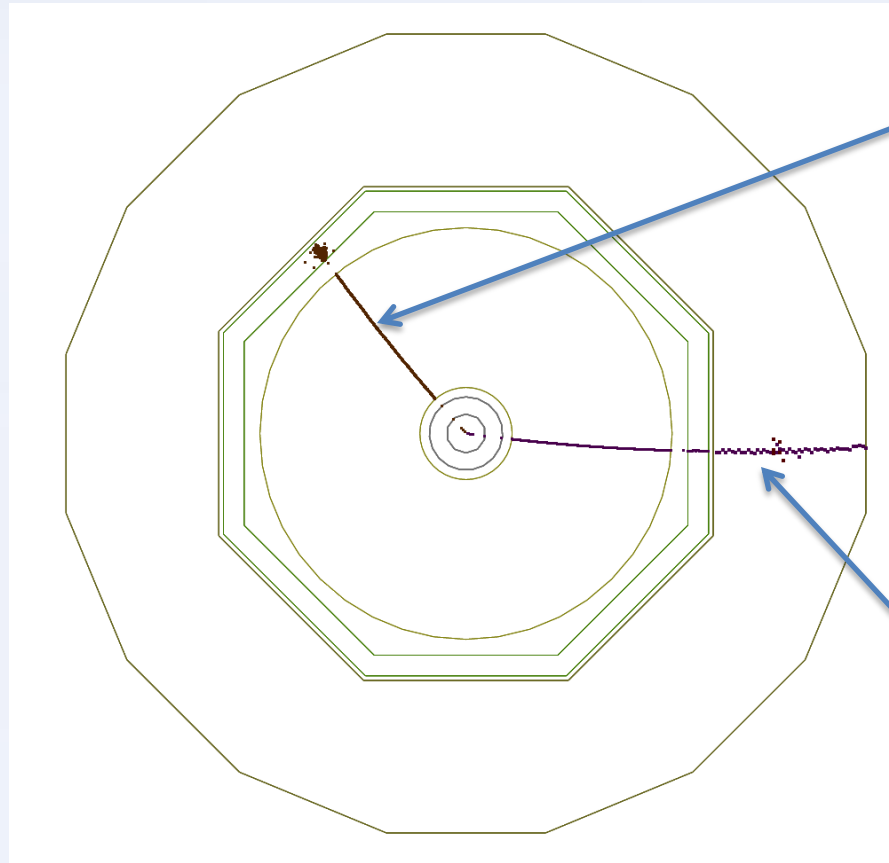


# We can study the Higgs!

- The electron-positron collision makes a high-energy Z boson
- The Z boson radiates a Higgs boson
- Both decay – but sometimes Z decays to neutrinos, which we cannot detect
- Higgs decays can be seen and we can study them



Front view:

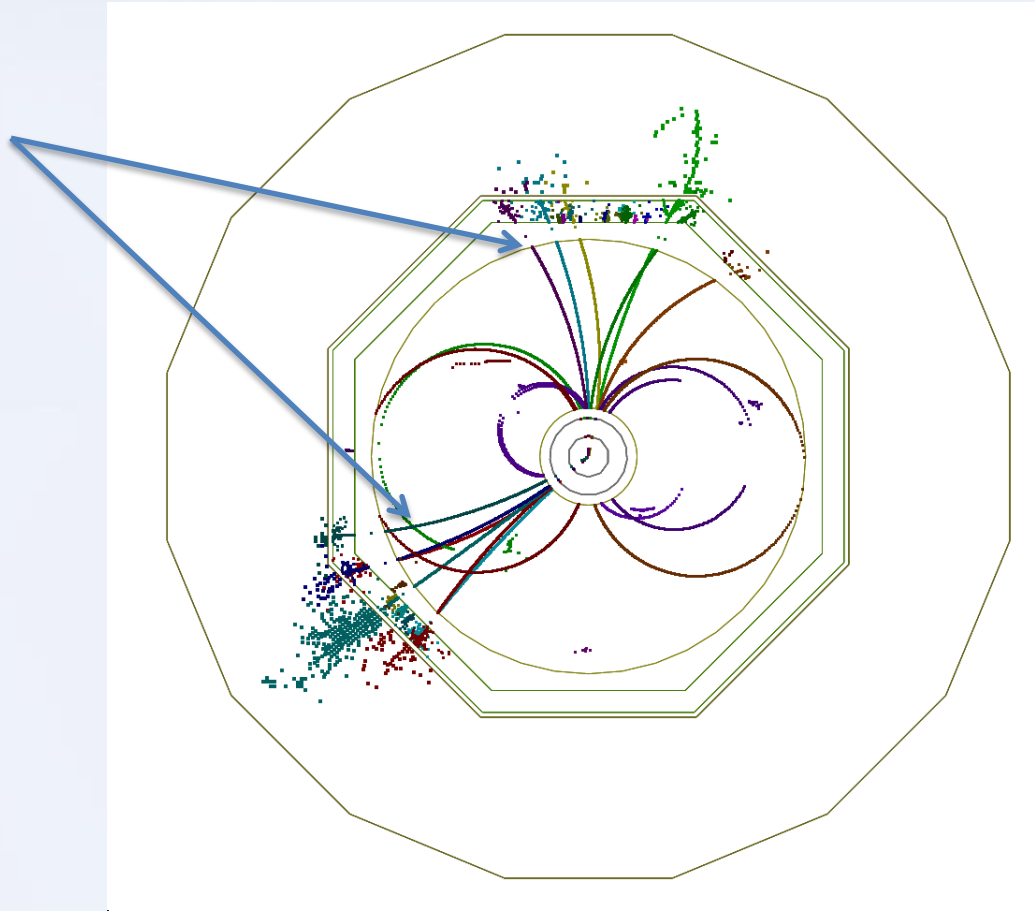


*lepton (electron)  
from Higgs  
decay*

*lepton (muon)  
from Higgs  
decay*

Front view:

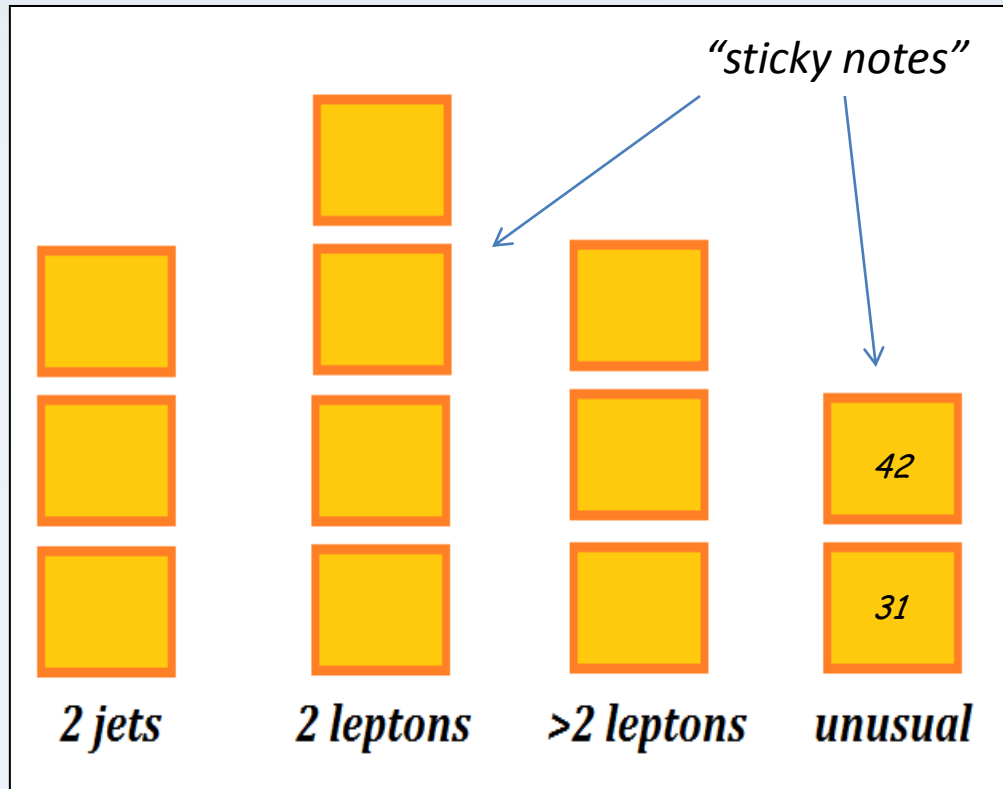
*jets from  
Higgs decay*





# We will make a chart on the wall

- 2 jets
- 2 leptons
- > 2 leptons
- unusual
  - write event ID#



*This is how ILC physicists will study Higgs boson decays (but they will use computers).*

## 5 授業の様子⑤ (Classroom Environment)

QuarkNet e-Lab Workshop: Cosmic Ray(宇宙線)  
についてのワークショップ June 11-12, 2014 (放課後)

特別授業





## 5 授業の様子⑥ (Classroom Environment)

### 生徒(グループ)によるプレゼン “Short Physics Presentation”



## 6 現状と課題 (Present Conditions and Problems)

能力, 関心, 意欲に大きな格差

Large Differences in Abilities, Interests and Will

遊び気分

Partly for Enjoyment



- 他教科(外国語科, 情報科, 数学科, 「学術研究」等)との協力 Cooperation with Other Teachers

- 各種国際交流事業の活用 International Exchange

☆ 生徒の価値観(受験勉強中心)の変革

Change/Shift Students' Mindset