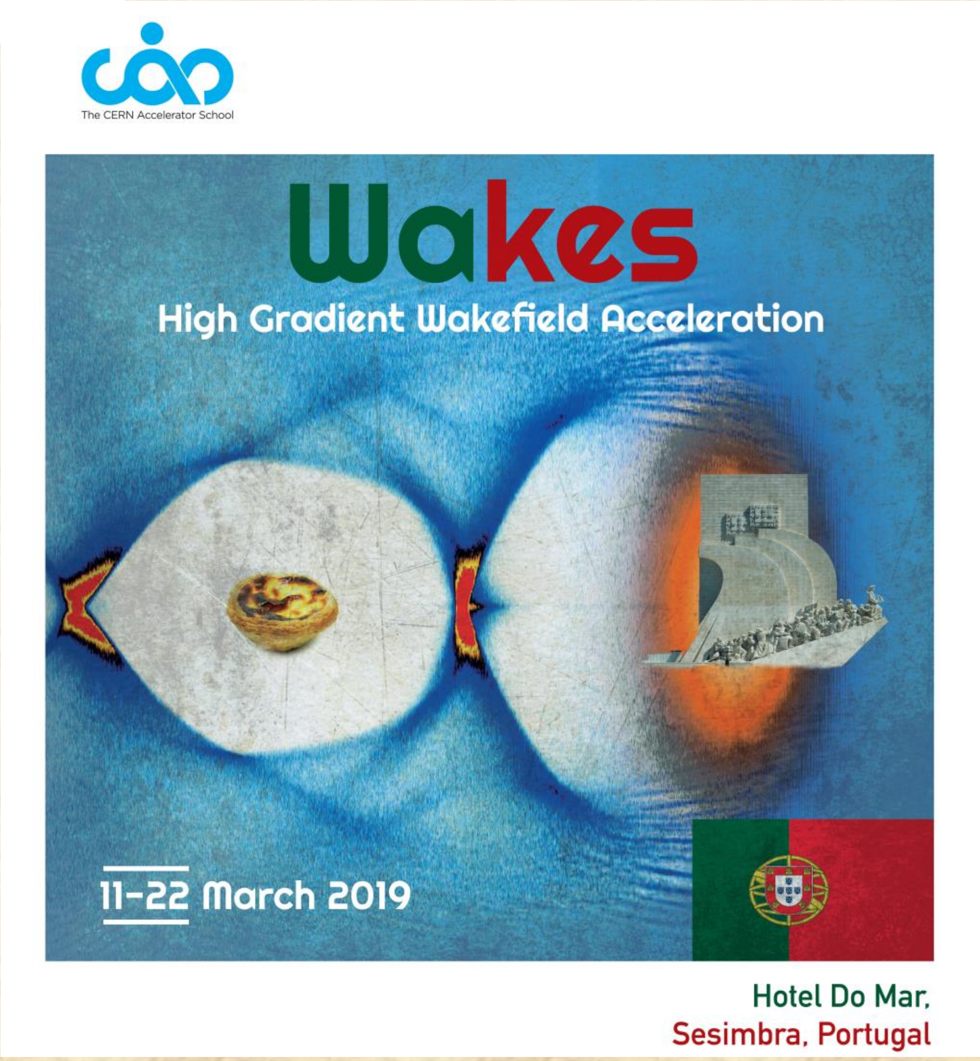
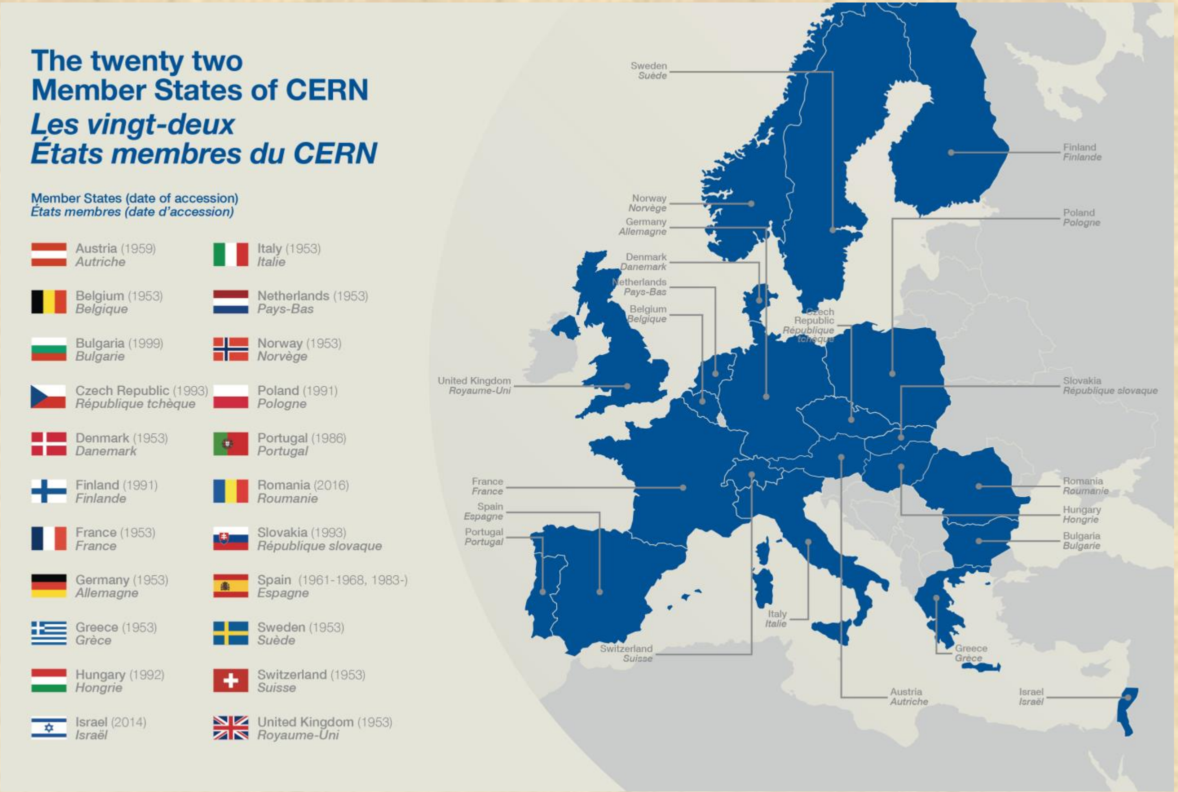
Welcome, Bien Venu, Hola, Herzlich Willkommen, Seja Muito Bem Vindo





*Since 1983 organisation of lecture series on **particle accelerators and colliders of all kinds***

… in all 22 CERN member states.

* *Introductory level lectures*
* *Advanced level courses*
* *Lectures on special topics*

… and our Special Topic is

High Gradient Wakefield Acceleration

Time Table of the School

Coffee & Cookies

Tea & Cookies

Time	Mo, 11.03.2019	Tu, 12.03.2019	Wed, 13.03.2019	Thu, 14.03.2019	Fri, 15.03.2019	Sat, 16.03.2019	Sun, 17.03.2	Mo, 18.03.2019	Tu, 19.03.2019	Wed, 20.03.2019	Thu, 21.03.2019	Fri.22.03.2
09:00h		Welcome & Opening *B. Holzer*	Introduction to plasma physics II *P. Gibbon*	Plasma sources I *J. Osterhoff*	Plasma sources II *J. Osterhoff*	Plasma wake generation (non-linear) *L. Silva*		Blow out regime *L. Silva*	Particle beam diagnostics *B. Marchetti*	electron sources from plasma I *B. Cros*	staging (incl. Synchr. & tolerances) *C. Lindstrom*	
10:00h	A	Conventional Acc. & their limits I *M. Ferrario*	Laser beam physics *L. Corner*	Plasma wake generation (linear) *Z. Najmudin*	Modelling and simulation I *J.L. Vay*	Modelling and simulation II *J.L. Vay*	E x	laser driver propag. in plasmas *S. Mangles*	Plasma diagnostics *J. Osterhoff*	Dielectrical Acc Structures (Theory) *N. Schoenenberger*	positron acc. in plasmas *S. Corde*	D E P
11:00h	R	Coffee	Coffee	Coffee	Coffee	Coffee	c	Coffee	Coffee	Coffee	Coffee	A
11:30h	R I V	Conventional Acc. & their limits II *M. Ferrario*	laser diagnostics *L. Corner*	Acceleration of e- in a plasma II *A. Thomas*	Injection extraction and matching I *M. Ferrario*	Modelling and simulation III *J.L. Vay*	u r	Beam driven (experiment) *E. Gschwendtner*	Beam driver propogation (beams) *R. Assmann*	electron sources from plasma II *B. Cros*	case study *A. Walker*	R T U
12:30h		Lunch	Lunch	Lunch	Lunch	Lunch	s	Lunch	Lunch	Lunch	Lunch	R
14:30h		Introduction & hist. overview *V. Malka*	Laser driven wakefields I *S. Karsch*		Injection extraction and matching II *M. Ferrario*	Mod & simul hands on II *J. Vieira, R. Fonsecca*	i o	Laser driven (experiment) *S. Mangles*	Beam driven systems (PWFA) I *P. Muggli*	Dielectrical Acc Structures (Exp) *N. Schoenenberger*	Radiation generation *F. Albert*	E
15:30h	D A Y	Introduction to plasma physics I *P. Gibbon*	Acceleration of e- in a plasma I *A. Thomas*	Free	Applications *Z. Najmudin*	Mod & simul hands on III *J. Vieira, R. Fonsecca*	n	case study *A. Walker*	Beam driven systems (PWFA) II *P. Muggli*	Discussion 2 *B. Holzer*	case study presentations *A. Walker*	D A Y
16:30h		Tea	Tea	Afternoon	Tea	Tea		Tea	Tea	Tea	Tea	
17:00h		Introduction to laser physics I *L. Corner*	Laser driven wakefields II *S. Karsch*		Discussion 1 *B. Holzer*	Seminar I *IST*		Seminar: Acceleration of protons & ions *L. Willingale*	case study *A. Walker*	case study *A. Walker*	case study presentations *A. Walker*	
18:00h		1 slide / 1 minute *B. Holzer*	case study Introduction *A. Walker*		Mod & simul hands on I *J. Vieira, R. Fonsecca*	case study *A. Walker*		case study *A. Walker*	Departure Gala Dinner: *19:00h*	case study *A. Walker*	Coherent X-rays and applications *M. Fajardo*	
20:00h		Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	Gala_Dinner	Dinner	Dinner	

Lunch

Dinner

Time Table of the School

Case Studies … It is YOUR turn !!!

Organiser: Andreas Walker

Details …

Time	Mo, 11.03.2019	Tu, 12.03.2019	Wed, 13.03.2019	Thu, 14.03.2019	Fri, 15.03.2019	Sat, 16.03.2019	Sun, 17.03.2	Mo, 18.03.2019	Tu, 19.03.2019	Wed, 20.03.2019	Thu, 21.03.2019	Fri.22.03.
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20:00h		Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	Gala_Dinner	Dinner	Dinner	

Welcome Drink Today

19:00h

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The famous CAS Questionnaire

- Students-Feedback-Sheet -

PLASMA WAKE ACCELERATION
CERN, Geneva, Switzerland
23-29 November, 2014

YOUR IMPRESSIONS OF THE PROGRAMME

Please mark each lecture with a number 1 to 5 in each of the three columns labelled "Level, Content and Presentation". The meaning of the numbers is as shown below. Please take the time to complete this sheet and leave it in the box provided in the Secretariat or mail it to Mrs. B. Strasser, CERN, CERN Accelerator School, DG Department, CH-1211 Geneva 23. Your answers are confidential.

LEVEL	CONTENT	PRESENTATION
1 – Much too low	1 – Completely uninteresting	1 – Very poor
2 – Low	2 – Uninteresting	2 – Poor
3 – Just right	3 – Of some interest	3 – Fair
4 – Too high	4 – Interesting	4 – Good
5 – Much too high	5 – Very interesting	5 – Very good

*** it is important**

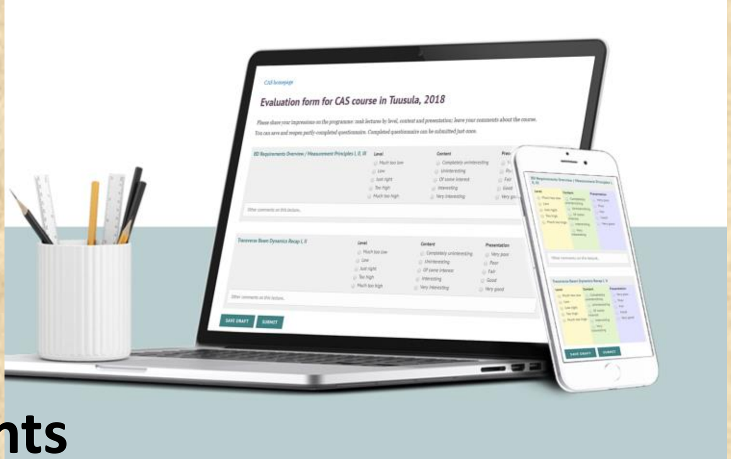
*** there are different scalings for level**
"3" = perfect

*** and content / presentation**
"5" = perfect

Example:
If you want to say
"super dooper great topic
& everything perfect"
you write 3/5/5

TITLE	LEVEL	CONTENT	PRESENTATION
Introduction & Historical Overview			
Accelerator Physics & Limitations I, II			
Introduction to Plasma Physics I, II			
Introduction to Laser Physics & High Power Lasers			
Plasma Wake Generation (Linear)			
Acceleration of e- in a Plasma			
Plasma Wake Generation (Non-Linear)			
Blow Out Regime			
Laser Driven Systems			
Beam Driven Systems			
Plasma Injection Schemes			
Injection Extraction & Matching			
Modelling and Simulations I, II			
Beam Driven Propagation (Beams)			
Beam Driven Propagation (Lasers)			
Bream Driven Plasma Acceleration (Experiment)			
Plasma Diagnostics			
Particle Beam Diagnostics I, II			
Radiation Generation			
Plasma Sources			
Laser Driven (Experiment)			
Applications			

Online Evaluation Form:



Access to web-form is granted to participants using the email addresses indicated in their Indico registrations

Step 1:

email with the link has been sent to all participants

If you did not receive the email, contact Anastasiya.Safronava@cern.ch

Step 2:

to login use the same email account; it will certainly work for CERN and for Google accounts, but not only

If you can not login, contact Anastasiya.Safronava@cern.ch

<u>Solutions</u>: provide your Google account if you have one, or a temporary CERN account will be created for you

One Slide, One Minute

for the fun of it

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20:00h		Dinner	Dinner	Dinner

Thanx to all volonteers !!

It will be super relaxed …. And will last indeed ONE MINUTE per presentation !!

The chair person will try his best to stay on time.

We owe our sponsors a debt of gratitude

For their financial and moral contribution to our student grants.

ARIES
EuroNNac
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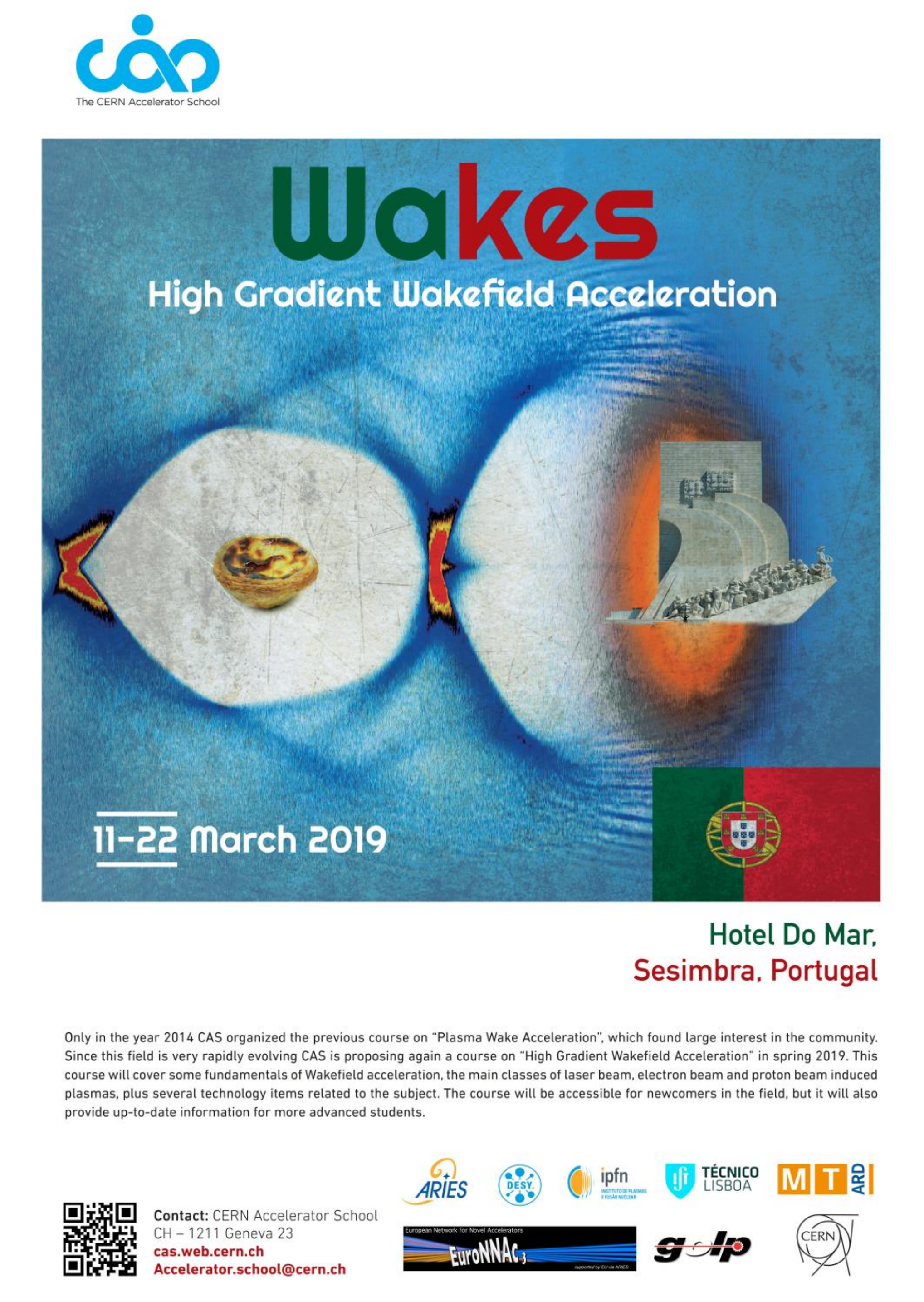
Ecole Polytechnique
et al.



Last Remark:

in case of any questions / comments / problems ...

talk to / call

Bernhard Holzer 0041-75411-1056
Delphine Rivoiron 0041-75411-4977
Maria Filippova

And finally:

A great Thank You to the Speakers for a tremendous effort that they did preparing their lectures

And to YOU, the students for the tremendous effort that lies in front of you !!

So far so good.

And WHY all that ????

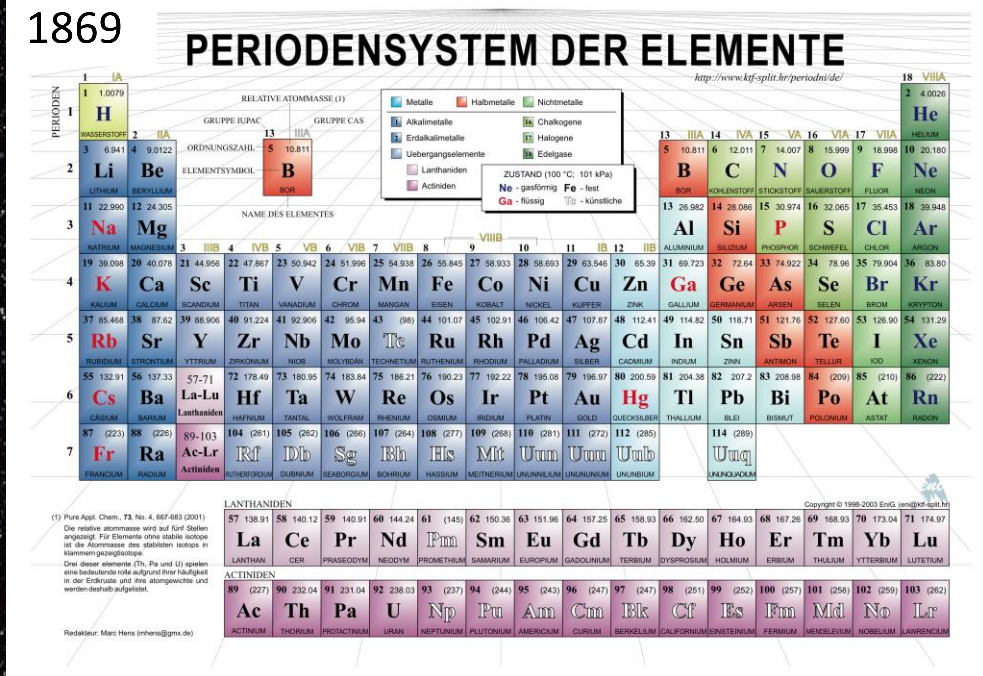
Future Accelerators

Bernhard Holzer,
CERN, ABP & CAS

A Short Introduction … LOL

In the end and after all … : We try to explain the structure of the "hadronischen matter" in the Universe.
In short words: What is going on up there ???

1869



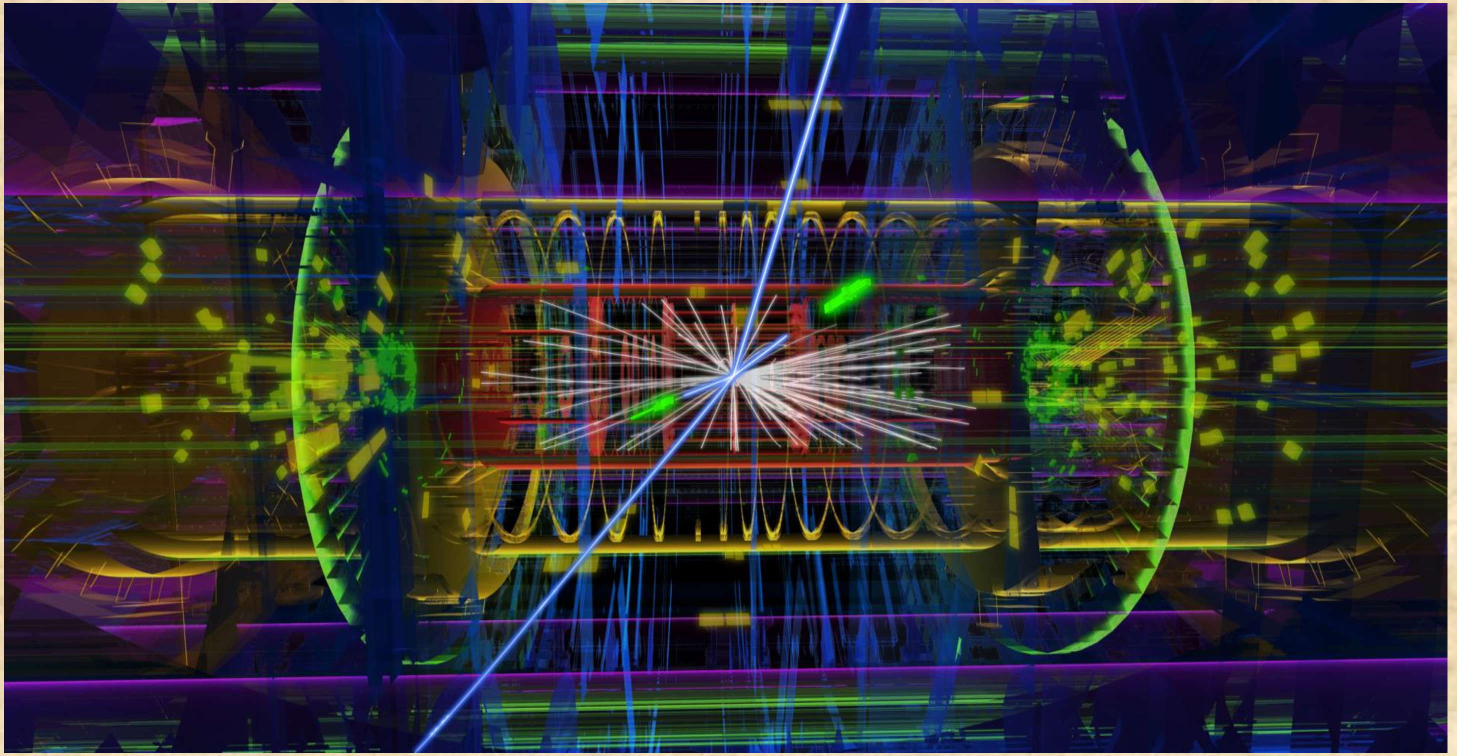
$E=mc^2$, $\lambda=h/p$

1.) Where are we ?

**** Standard Model of HEP***
**** Higgs discovery***

... and why all that ??

High Light of the HEP-Year 2012 / 13 naturally the HIGGS



ATLAS event display: Higgs => two electrons & two muons

$$E = m_0c^2 = (m_{e1} + m_{e2} + m_{\mu 1} + m_{\mu 2})*c^2 = 125.4\ GeV$$

2.) Where do we go ?

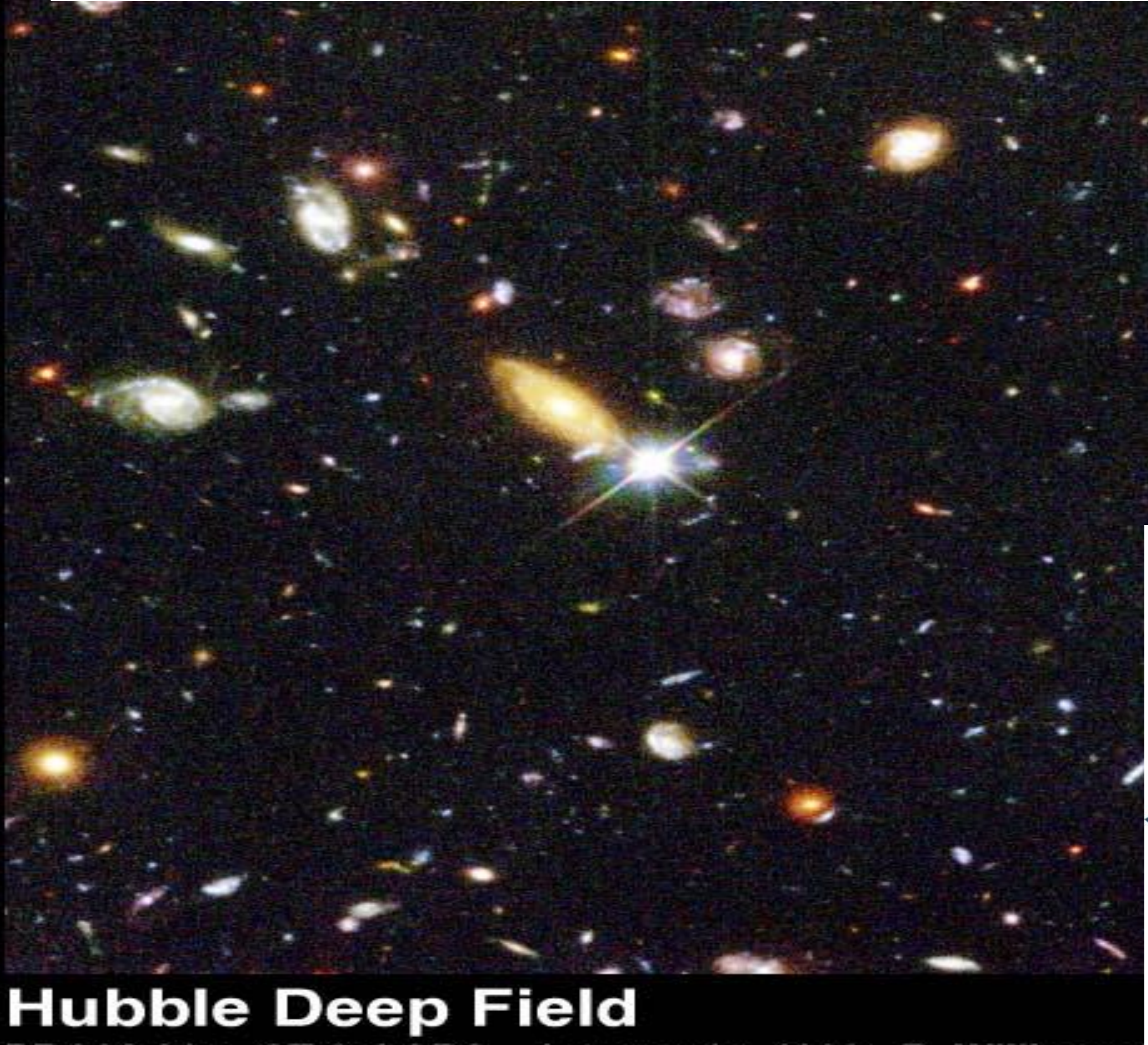
**** Physics beyond the Standard Model***

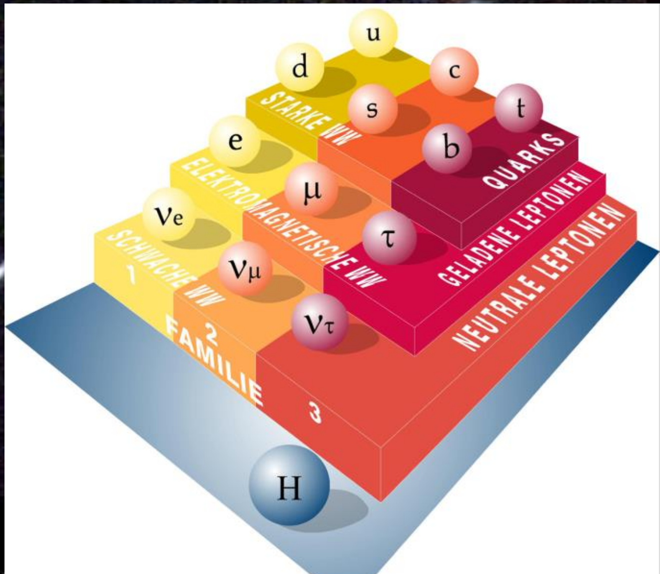
**** Dark Matter / Dark Energy***

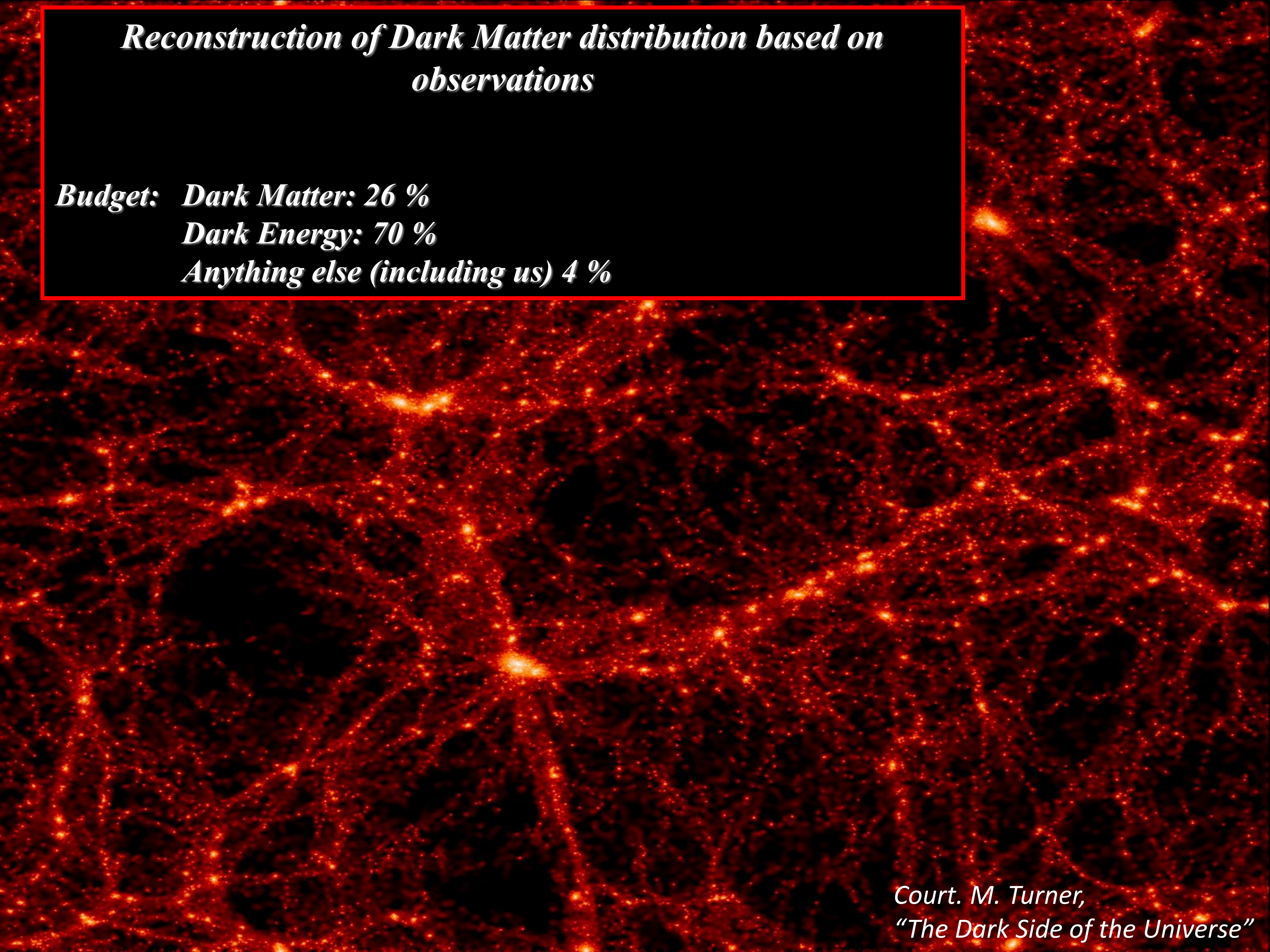
What's next ???

Dark Matter & Dark Energy

Physics beyond the Standard Model






Reconstruction of Dark Matter distribution based on observations
Budget: Dark Matter: 26 %
Dark Energy: 70 %
Anything else (including us) 4 %
Court. M. Turner,
“The Dark Side of the Universe”

Considered Future High Energy Frontier Colliders

Circular colliders:

FCC (Future Circular Collider … Euro-Circol)

- ***FCC-hh: 100 TeV proton-proton cm energy***
- ***FCC-ee: Potential intermediate step 90-350 GeV lepton collider***

Linear colliders

- ***ILC (International Linear Collider): e^+e^-, 500 GeV cms energy, Japan considers hosting project***
- ***CLIC (Compact Linear Collider): e^+e^-, 380GeV - 3TeV cms energy, CERN hosts collaboration***

High Gradient Wake Acceleration Techniques

- ***Plasma Acceleration***
  - ***Particle driven***
  - ***Laser driven***
- ***Dielectrical Structures***

FCC-ee Collider

The next Generation e+/e- Ring Collider

100km

Around the pre-alps

4.) Push for higher energy: FCC

**** increasing the ring size***

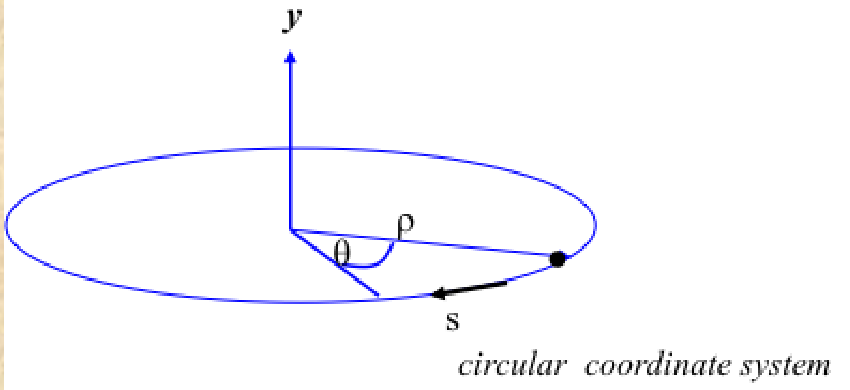
**** limited by Synchrotron Radiation***

**** and RF Power***

studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines.

Maximum Beam Energy in a Storage Ring:

For a given magnet technology it is the size of the machine that defines the maximum particle momentum ... and so the energy



Condition for an ideal circular orbit:

Lorentz force $F_L = e\,v\,B$

centrifugal force $F_{centr} = \dfrac{\gamma m_0 v^2}{\rho}$

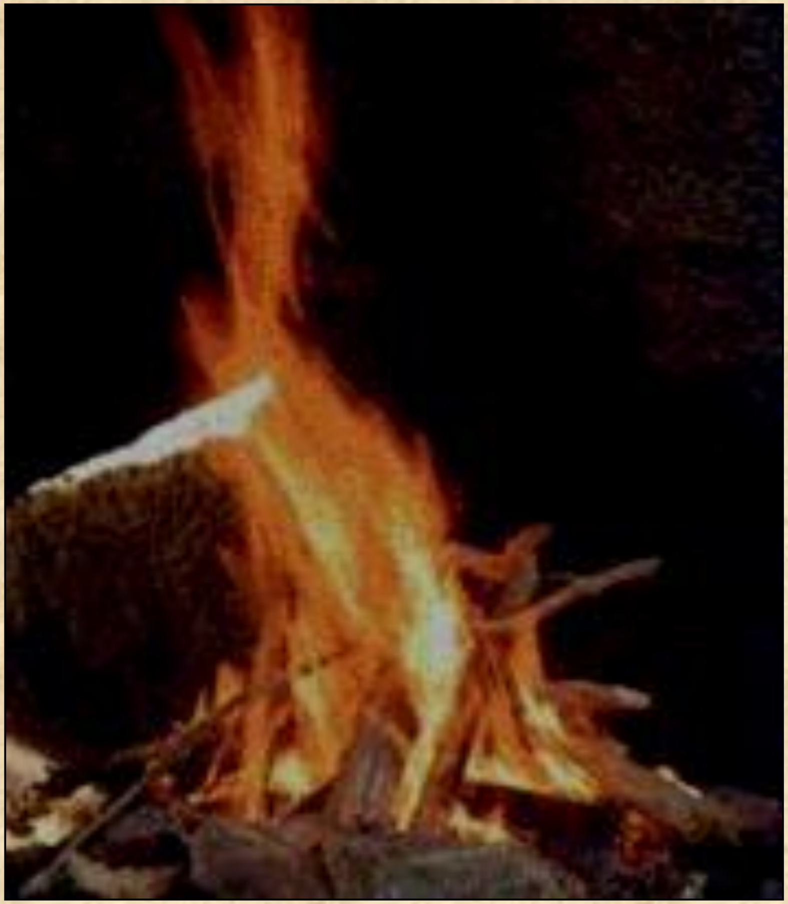
$$\frac{\gamma m_0 v^2}{\rho} = e\,v\,B$$

$$\frac{p}{e} = B\rho$$

$B\rho$ = "beam rigidity"

The maximum particle momentum is given by the field strength B and the storage ring size $2\pi\rho$

Synchrotron Radiation



ca 400 000 v. Chr.: Mankind discovers the Fire

Synchrotron Radiation

In a circular accelerator** charged particles loose energy* ***via emission of intense light.

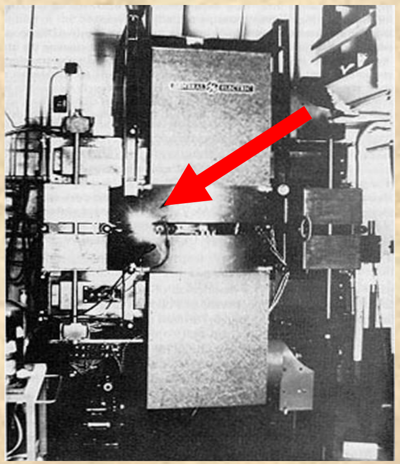
$$P_s = \frac{2}{3}\alpha\hbar c^2 \frac{\gamma^4}{\rho^2}$$ ***radiation power***

$$\Delta E = \frac{4}{3}\pi\alpha\hbar c \frac{\gamma^4}{\rho}$$ ***energy loss***

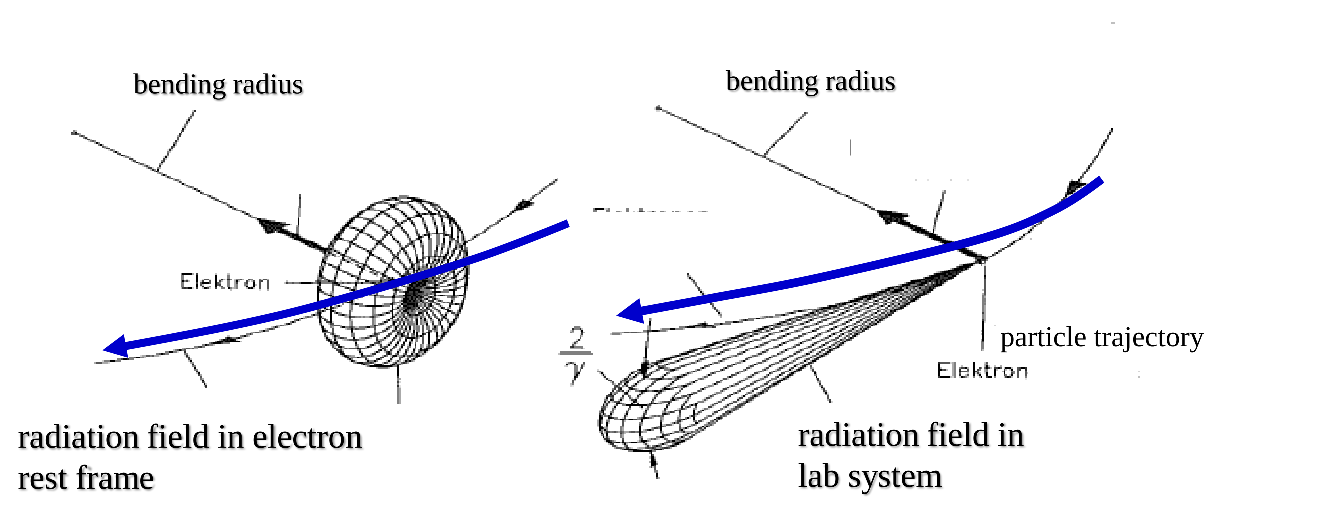
$$\omega_c = \frac{3}{2}\frac{c\gamma^3}{\rho}$$ ***critical frequency***

$$\alpha \approx \frac{1}{137}$$

$$\hbar c \approx 197\ MeV\ fm$$



1946 observed for the first time in the General Electric Synchrotron



court. K. Wille

5.) Push for higher lepton energy

**** go linear***
**** higher acceleration gradients***

CLIC ... a future Linear e+/ e- Accelerator

„C“-LIC ... = CERN ... or „compact“

50 km

CLIC parameter list

Description [units]	500 GeV		3 TeV
Total (peak 1%) luminosity	2.3 (1.4)$\times10^{34}$		5.9 (2.0)$\times10^{34}$
Total site length [km]	13.0		48.4
Loaded accel. gradient [MV/m]	80		100
Main Linac RF frequency [GHz]		12	
Beam power/beam [MW]	4.9		14
Bunch charge [10^9 e^+/e^-]	6.8		3.72
Bunch separation [ns]		0.5	
Bunch length [μm]	72		44
Beam pulse duration [ns]	177		156
Repetition rate [Hz]		50	
Hor./vert. norm. emitt. [$10^{-6}/10^{-9}$m]	2.4/25		0.66/20
Hor./vert. IP beam size [nm]	202/2.3		40/1

CLIC: Normal conducting RF system

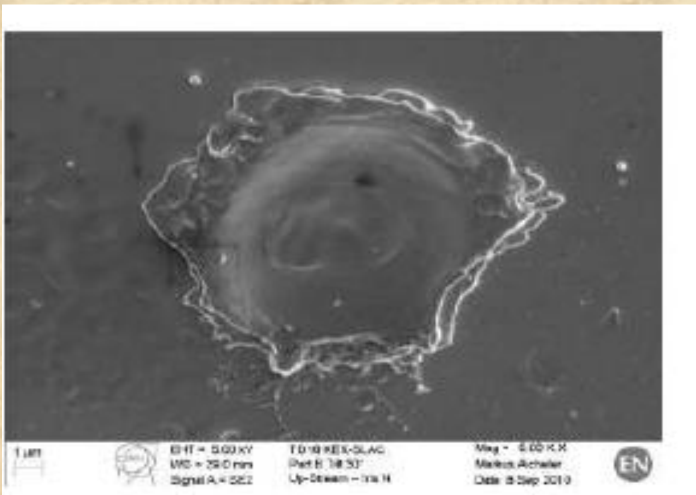
challenge: running at the break down limit

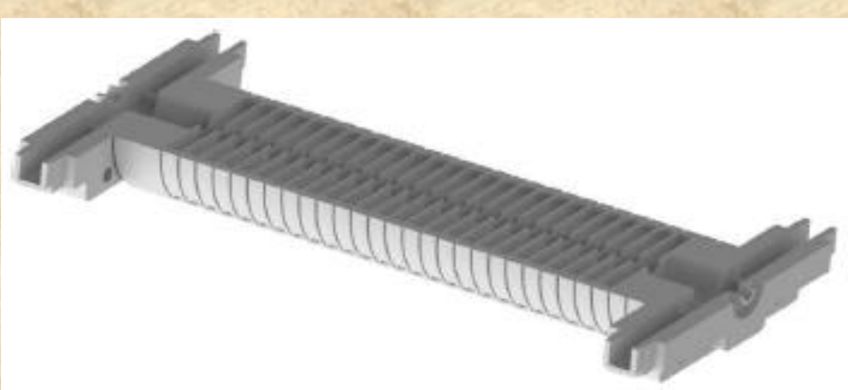
Accereration Gradient 100MV/m studied & optimised since years

"how far can we go and how much can we optimise such a future accelerator before we reach technical limits and how can we push these limits ?"

they have impact on

- ***=> the accelerator performance (luminosity)***
- ***=> beam quality***
- ***=> and the accelerating structure itself***

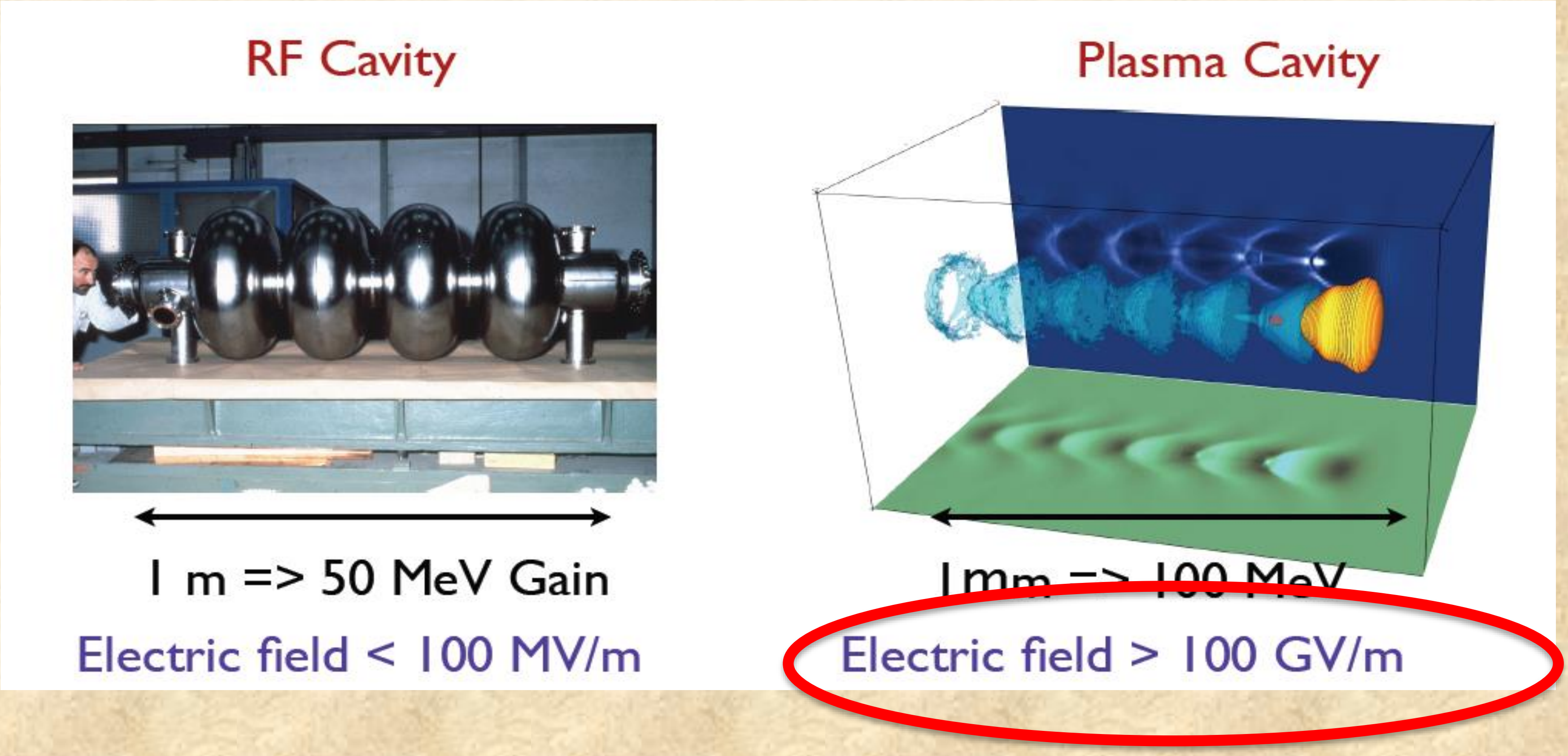




6.) Push for higher energy

**** higher acceleration gradients***
**** new acceleration techniques***

Plasma Wake Acceleration:
Push for highest acceleration gradient

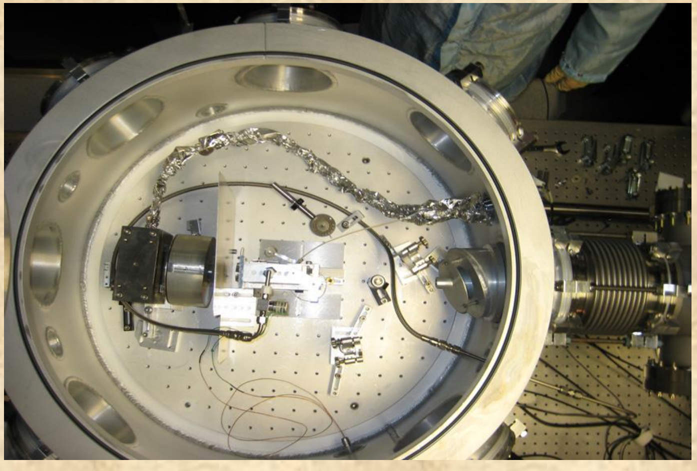


Study of High Gradient Acceleration Techniques

***P**lasma **W**ake **A**cceleration*
particle beam driven / LASER driven

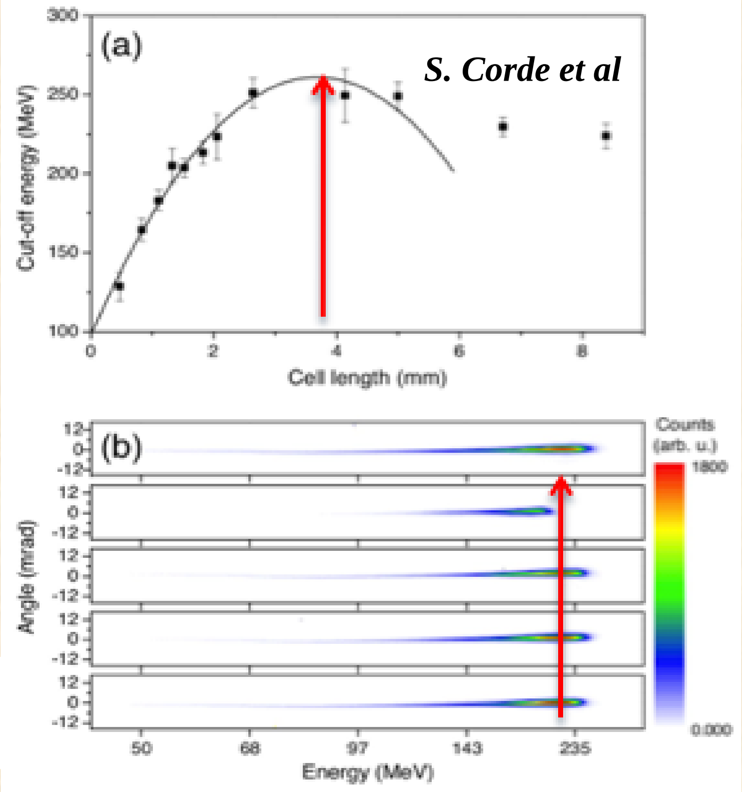
Incoming laser pulse (or pulse of particles) creates a travelling plasma wave in a low-pressure gas
Plasma wake field gradient accelerates electrons that 'surf' on the plasma wave

Field Gradients up to 100 GeV /m observed



Plasma cell Univ. Texas, Austin
E_e =2 GeV

$$\Delta E / \Delta s = 200\, MeV / 4 mm = 50\, GeV / m$$



Open questions in particle physics

Dark matter & Energy

… on which energy scale to look for it ?

Physics beyond the standard model

... Lepton or Proton colliders ?

Beam dynamics aspects

... Circular or linear ?

Technical aspects

... Traditional, sc / nc or PWA ?