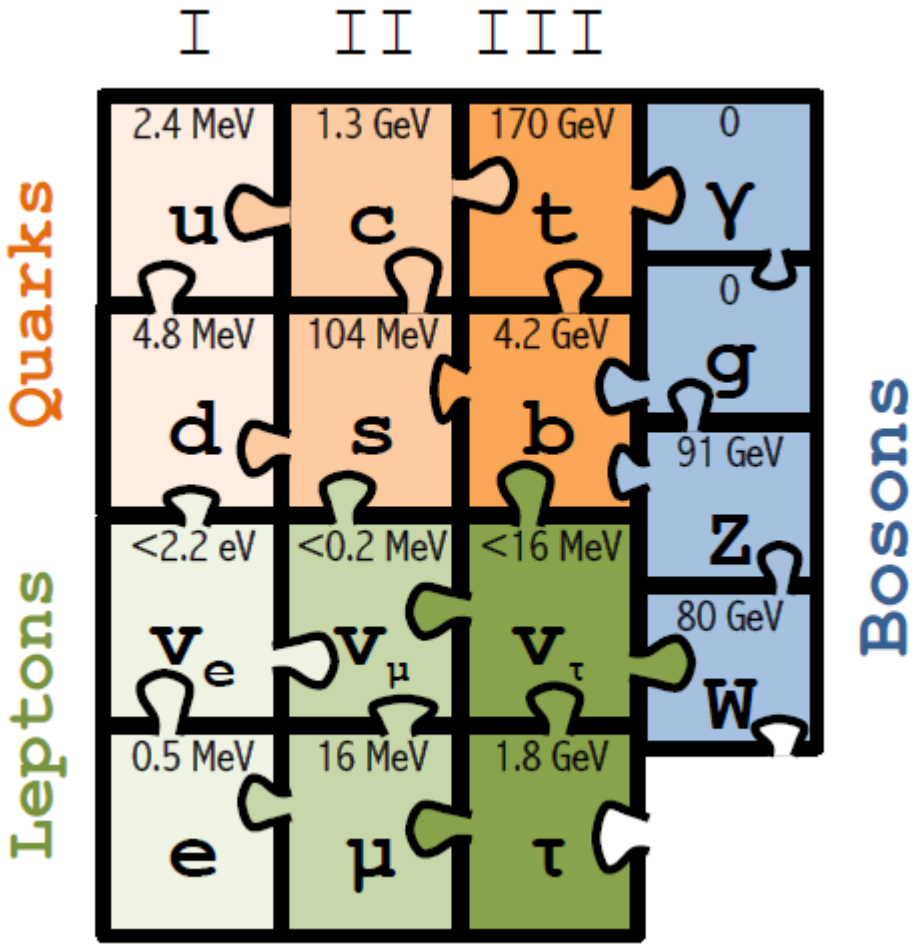
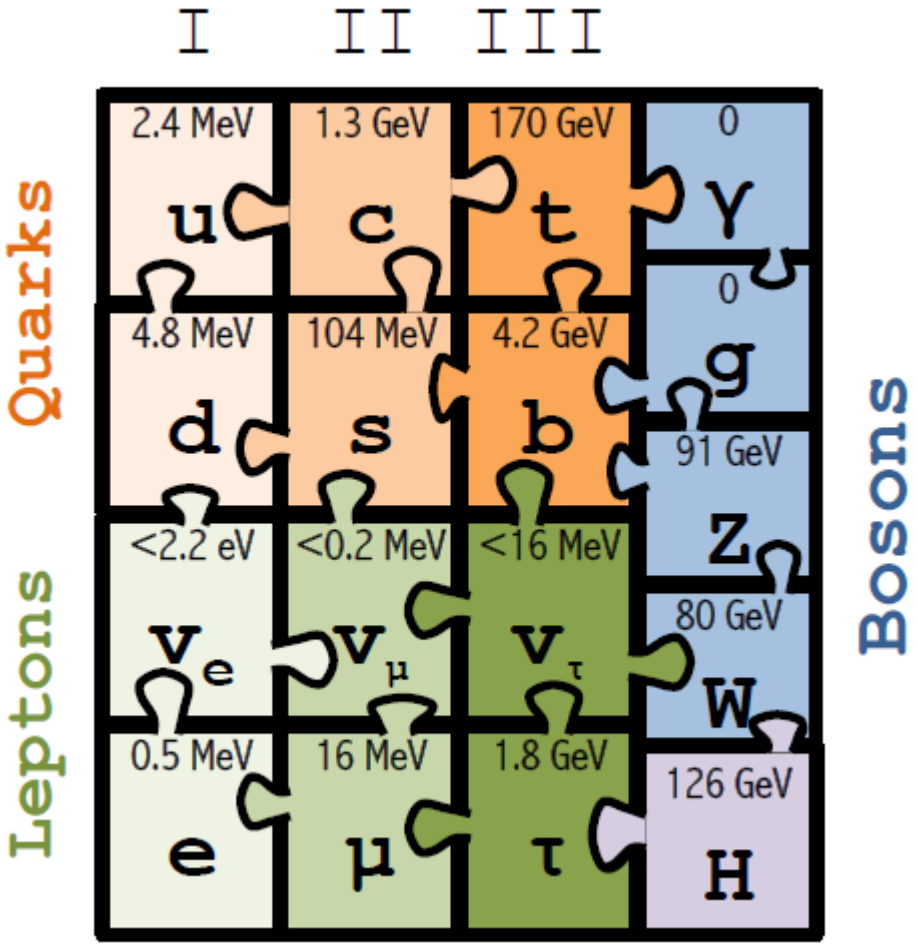
Experiments and detectors - Summary

1994-1999: top mass predicted (LEP, mostly Z mass&width)
top quark discovered (Tevatron)
t'Hooft and Veltman get Nobel Prize



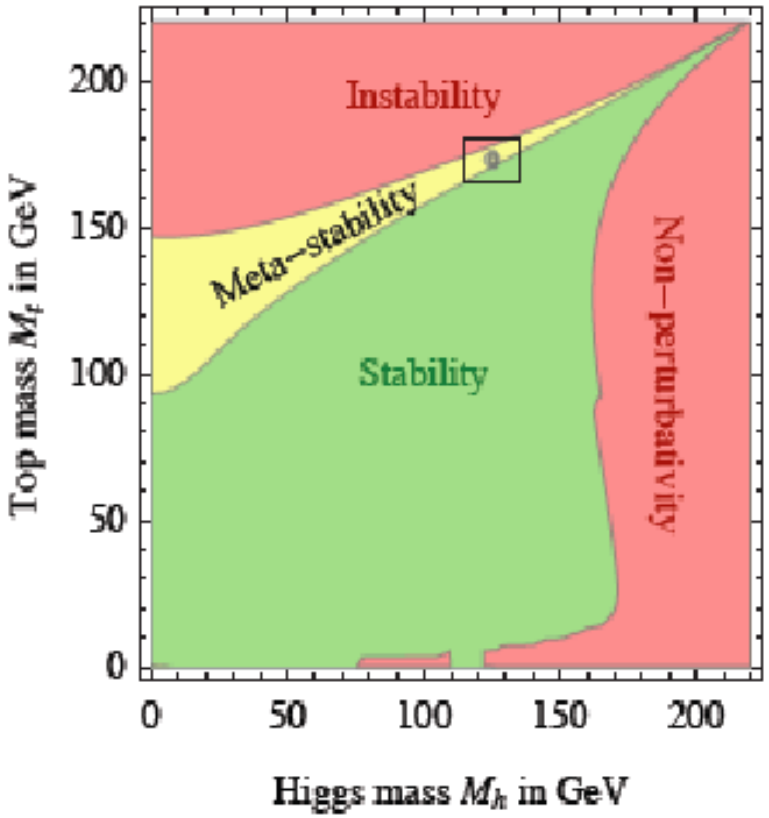
(c) Sfyrla

1997-2013 Higgs boson mass cornered (LEP H, M_Z etc +Tevatron m_t , M_W)
Higgs Boson discovered (LHC)
Englert and Higgs get Nobel Prize



(c) Sfyrla

Is it the end?


Instability
Meta−stability
Stability
Non−perturbativity
Top mass M_t in GeV
Higgs mass M_h in GeV
0
50
100
150
200

Is it the end?

Certainly not!

-- Dark matter

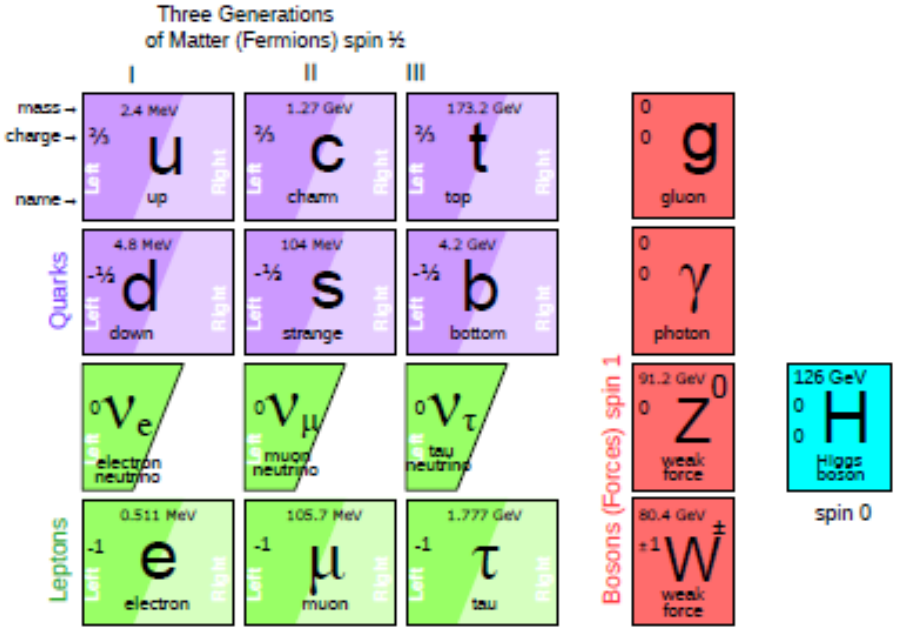
-- Baryon Asymmetry in Universe

-- Neutrino masses

are experimental proofs that there is more to understand.

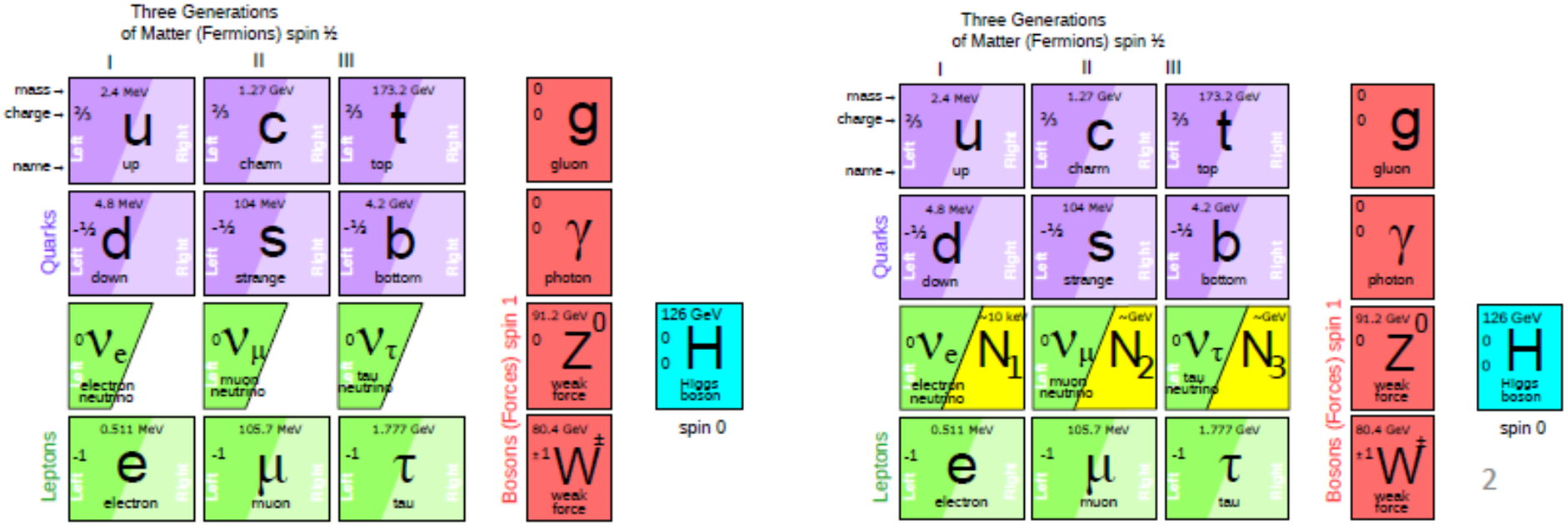
We must continue our quest

at least 3 pieces are still missing



Since 1998 it is established that neutrinos have mass and this very probably implies new degrees of freedom

at least 3 pieces are still missing

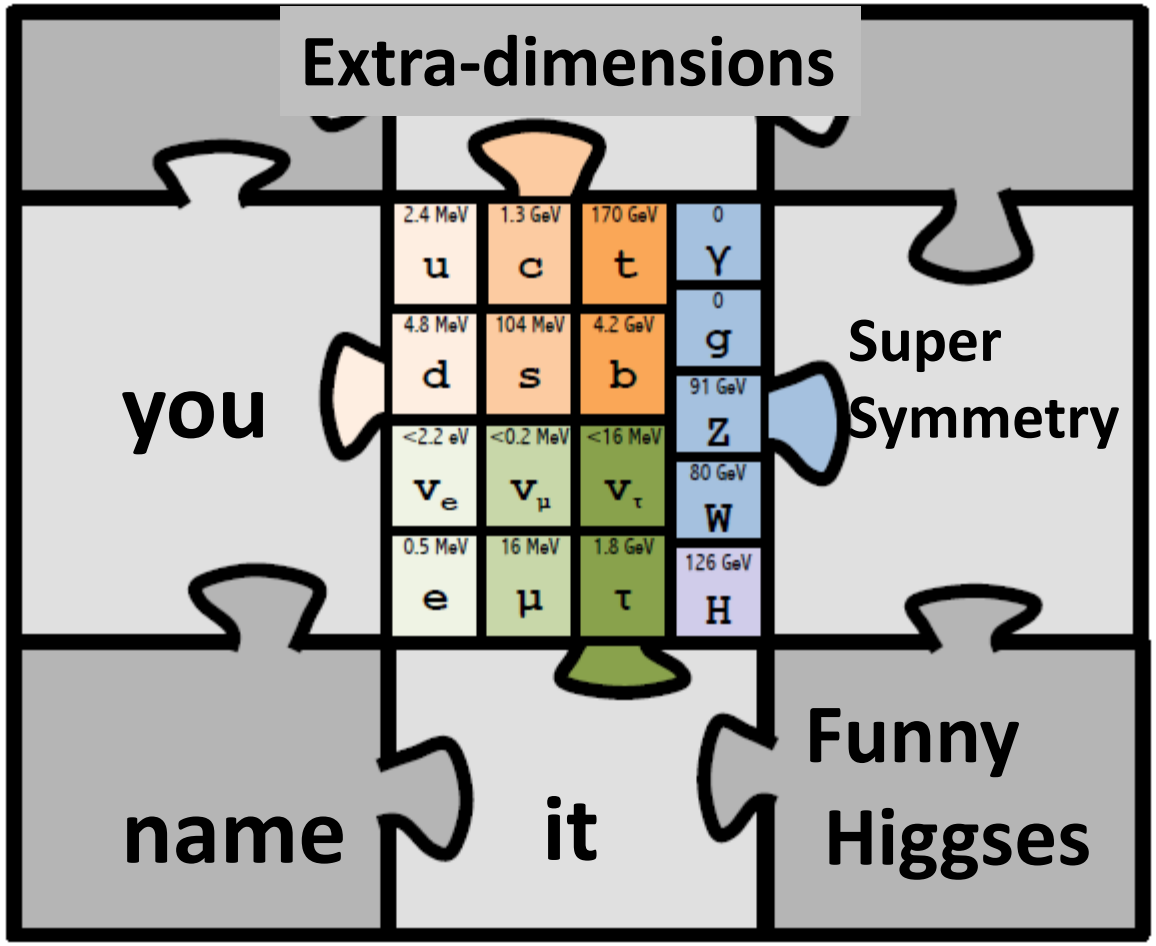


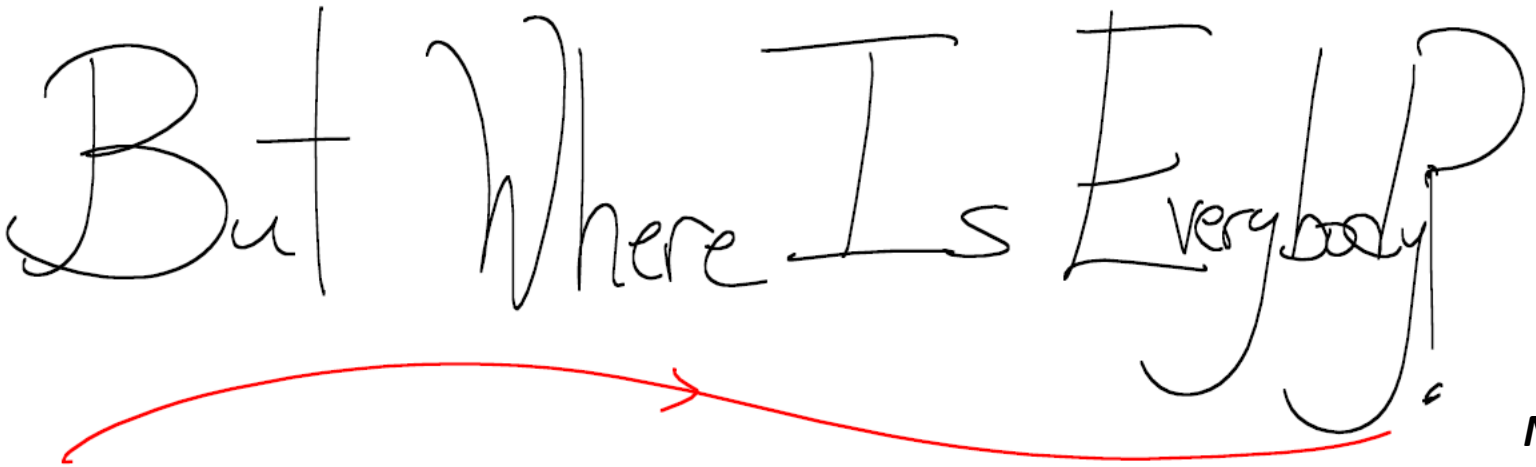
Since 1998 it is established that neutrinos have mass and this very probably implies new degrees of freedom

➔ «sterile», very small coupling to known particles completely unknown masses (eV to ZeV), nearly impossile to find.

.... but could perhaps explain all: DM, BAU,ν-masses

or perhaps new world(s) of SM replicas





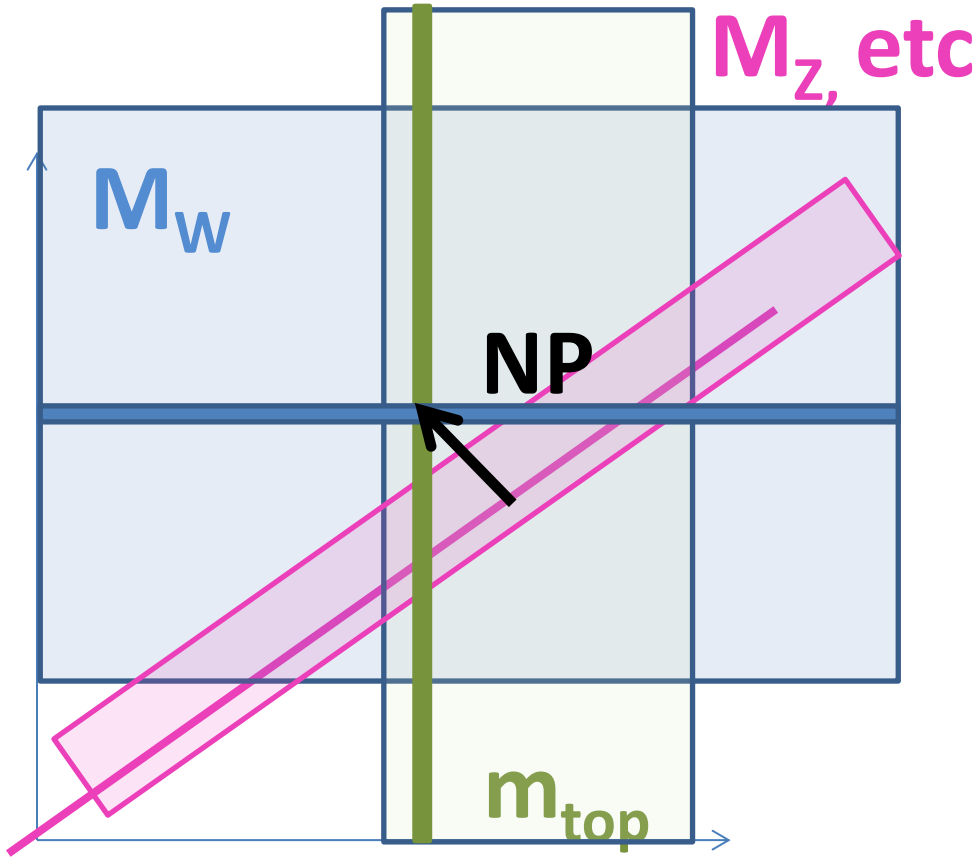
Nima

Nima

At higher masses -- or at smaller couplings?

Potential discoveries at FCC-ee set the experimental challenges

Precision

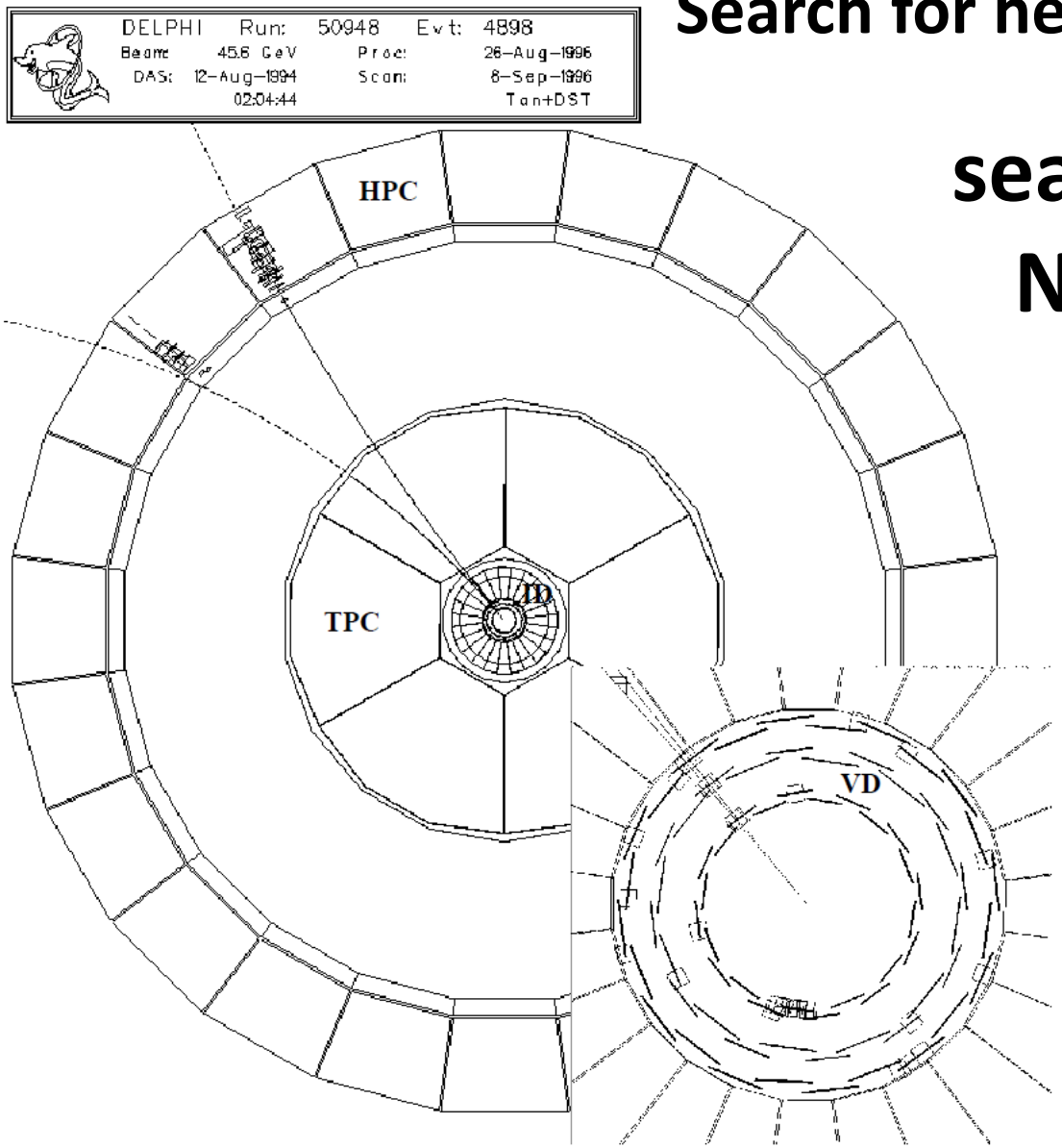


Rare processes

invisible or exotic Higgs decays
Invisible or exotic Z decays
Anomalies in W or top decays
etc...

-- high statistics
-- redundancy
-- full acceptance
-- theory precision
-- Accelerator (E_{beam})

Search for heavy neutral leptons



search $e^+ e^- \rightarrow \nu N$

$N \rightarrow \nu(\gamma/Z)^* \rightarrow$ monojet

Find: one event in $4 \times 10^6 Z$:

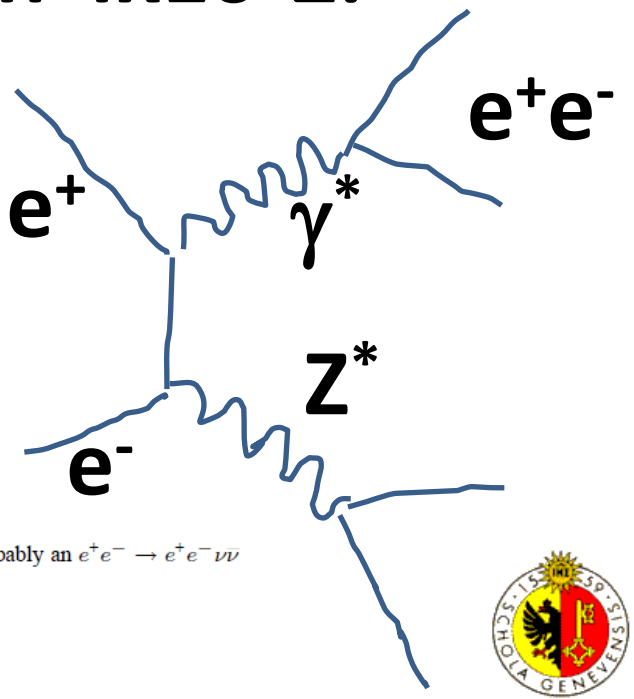
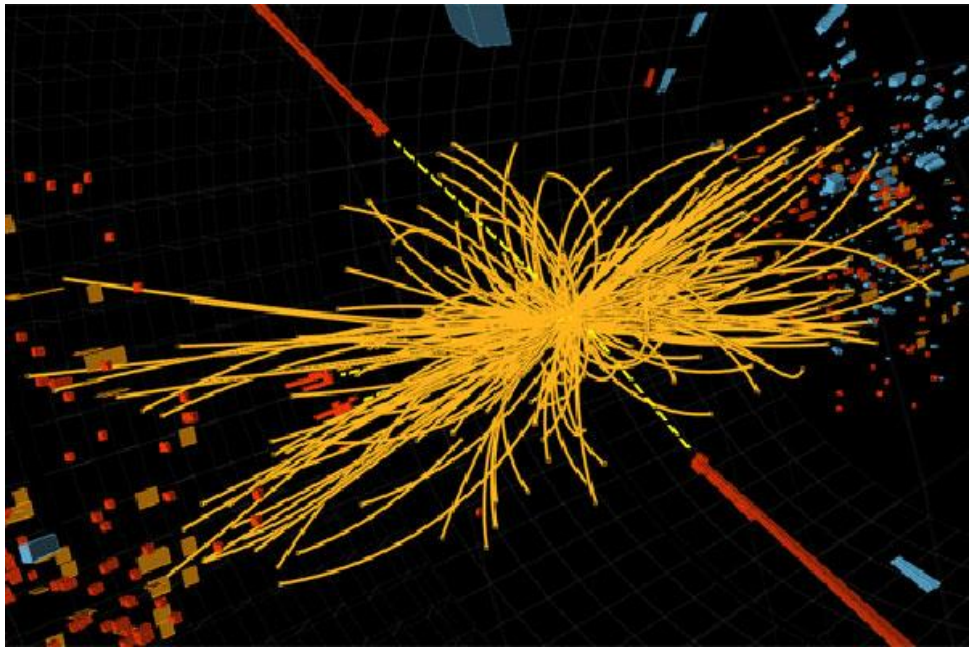


Fig. 3. Surviving event in the monojet search. It has an invariant mass of 300 MeV/c^2 and a missing p_t of 6 GeV/c and is probably an $e^+e^- \rightarrow e^+e^-\nu\nu$ interaction

Culture shocks

LHC discovery



FCC-ee discovery

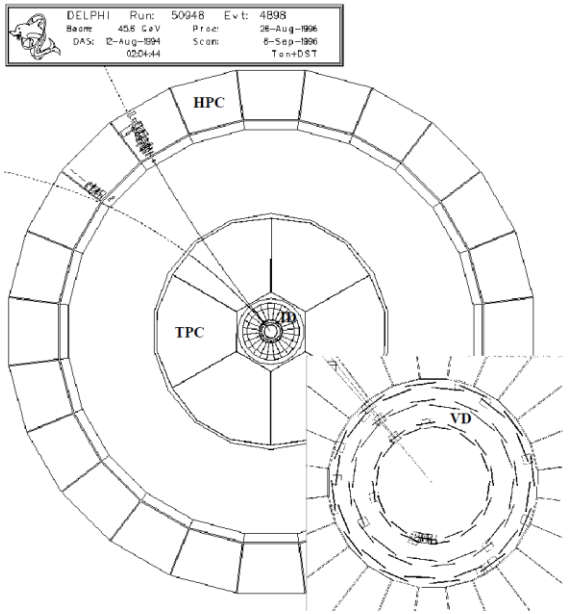


Fig. 3. Surviving event in the monojet search. It has an invariant mass of 300 MeV/c^2 and a missing p_t of 6 GeV/c and is probably an $e^+e^- \to e^+e^-\nu\bar{\nu}$ interaction

20-100 events per bunch Xing

1 event per 1000-10000 bunch Xings

so, you don't need a trigger?

<u>YES WE DO</u>➔ if you want to see one such event in $10^{8\text{-}12}$ Z's
you better have two or three redundant triggers for it
as this could be due to accidentally missing parts of the detector
at $10^{-9 \text{ to } 12}$ level!

Lepton collider physics, experiments, detectors - Second floor - M2 193 (14:00-18:20)

- **Conveners: Janot, Patrick; Blondel, Alain**

time	title	presenter
14:00	Introduction	JANOT, Patrick
14:20	Plans for Working Groups 1 & 2: EW physics at the Z pole, and di-boson physics	TENCHINI, Roberto BLONDEL, Alain
14:40	Plans for Working Group 4: Top quark physics	AZZI, Patrizia
15:00	Plans for Working Group 5: QCD and gamma gamma physics	D'ENTERRIA, David SKANDS, Peter
15:20	Plans for Working Group 6: Flavour Physics	MONTEIL, Stephane
15:45	Coffee break	
16:15	Plans for Working Group 8: Experimental Environment	BACCHETTA, Nicola
16:35	Plans for Working Group 10: Online software and computing	LEONIDOPOULOS, Christos
16:55	Plans for Working Group 11: Detector Designs	ROLANDI, Gigi
17:15	Possible synergies with CLIC detectors	LINSSEN, Lucie
17:40	A TPC for ee-FCC (TLEP) ? A follow-up.	SCHWEMLING, Philippe
18:05	MC codes for FCC-ee	JADACH, Staszek

Experimental Physics WBS (coordinators A. Blondel, P. Janot)

- Study the properties of the Higgs and other particles with unprecedented precision

Electroweak Physics at the Z pole	Di-boson Physics m_W measurement	H(126) Properties	Top Quark Physics
R. Tenchini	R. Tenchini	TBA	P. Azzi

QCD and γγ Physics	Flavour Physics	Exp'tal signatures of New Physics
D. d'Enterria	S. Monteil	TBA

- Develop the necessary tools — Understand the experimental conditions

Offline Software and Computing	Online Software and Computing	Exp'tal Environment
TBA	C. Leonidopoulos	N. Baccheta
Synergy with FCC-hh		Synergy with FCC-hh

- Set constraints on the possible detector designs to match statistical precision

Detector Designs
G. Rolandi

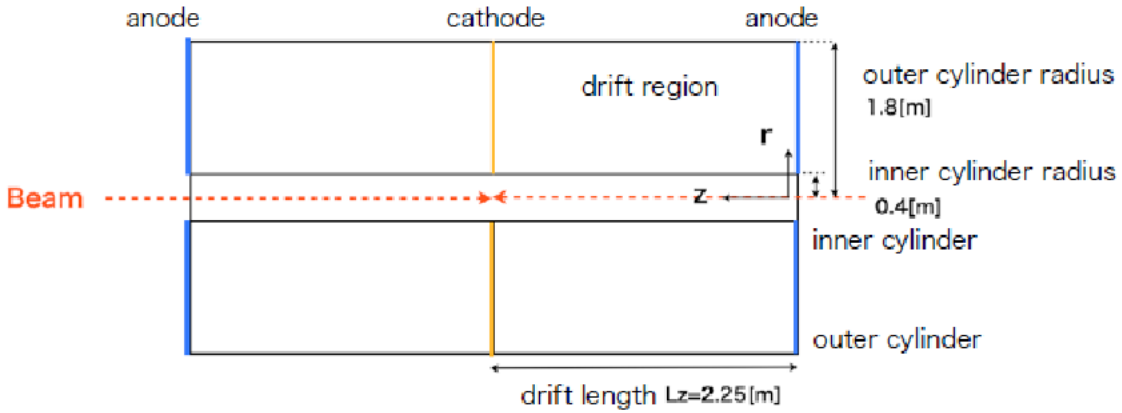
Synergy with linear collider detectors

conveners jobs is to assemble collaborators and find co-conveners in a global way

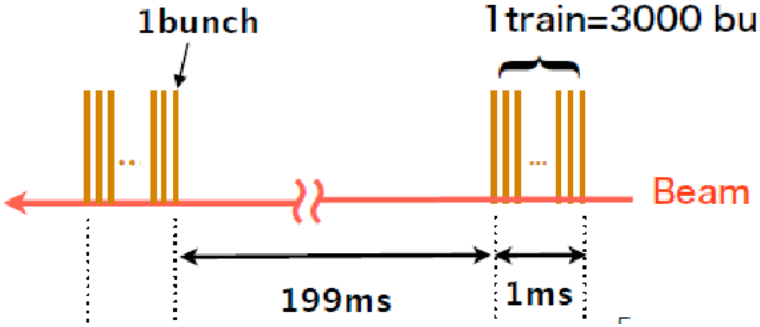
A few highlights

TPC structure

Arai Daisuke
2012/February/23 @ WP meeting



ILC beam structure



1bunch

2×10^{10}

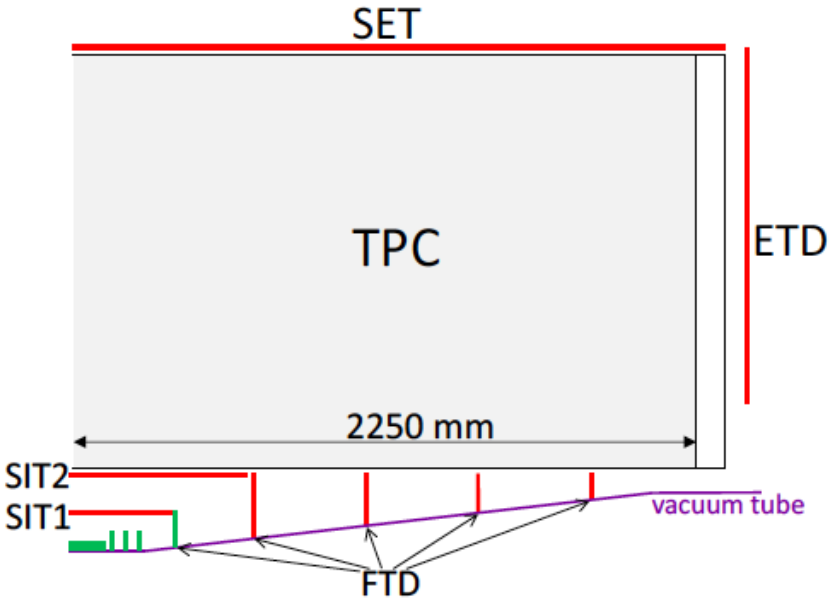
electron and positron

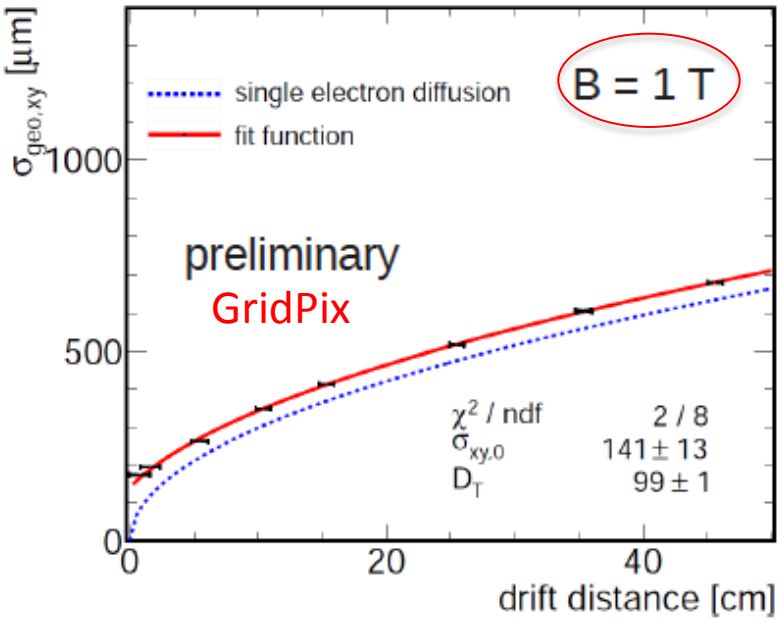
ILD TPC can be used for TLEP

→main differences: time structure continuous

EM bkg from beamsstrahlung benign

Do you want a TPC for FCC-ee ? (1)





- Momentum resolution (B=4T):
  - TPC only : $\delta(1/p_T) \sim 8.\ 10^{-5}$ /GeV
  - SET+TPC+SIT+VTX: $\delta(1/p_T) \sim 2.\ 10^{-5}$ /GeV

↙ TPC resolution dominated by diffusion ↖
While resolution of Si detectors will profit from from technology advances.

- #pads/#time buckets: ~2.10^6 / 1000 per endcap
- Pad size/#pad rows: ~1 mm x 4-6 mm / ~200 (standard readout) PAD

- Point resolution: in rϕ: < 100 µm ; in rz: ~ 0.5 mm
- 2-hit resolution: in rϕ: ~ 2 mm ; in rz: ~ 6 mm
- dE/dx resolution: ~ 5% (based on LEP TPC experience)

LEP MC programs from Krakow group
with the important US component: B.F.L Ward, S.Yost!

Contact persons will tell you where to look for source code which compiles under modern Linux:

- **KKMC** for $e^-e^+ \to f\bar{f} + n\gamma$,
  $f = \mu, \tau, \nu, u, d, s, c, b, \quad n = 0, 1, 2 \ldots \infty$
  contact: S. Jadach, stanislaw.jadach@cern.ch
- **TAUOLA** for τ decays and **PHOTOS** for extra photons emission $\in$ KKMC and other programs, including LHC!
  contact: Z. Wąs, zbigniew.was@cern.ch
- **BHLUMI** for small angle $e^-e^+ \to e^-e^+$
  contact: S. Jadach, stanislaw.jadach@cern.ch
- **BHWIDE** for large angle $e^-e^+ \to e^-e^+$
  contact: W. Płaczek, wieslaw.placzek@uj.edu.pl
- **KORALW** for $e^-e^+ \to 4f$, **YFSWW** $e^-e^+ \to W^-W^+ \to 4f$
  contact: M. Skrzypek, maciej.skrzypek@ifj.edu.pl
- **YFSZZ** for $e^-e^+ \to ZZ \to 4f$
  contact: W. Płaczek, wieslaw.placzek@uj.edu.pl

Very brief summary and lessons of session:

1. excellent engagement of working group conveners

2. need for common software and event generators
   will make common request to CERN-PH

3. need for face-to-face discussions
   -- will continue (and intensify) monthly VCs
   -- will seek to organize informal workshops
   -- MDI essential (beam energy, L*, SR and BS background, etc)

4. paradox: the «discovery» working groups
   (Higgs and new physics) are in want of conveners! Dont be shy.

5. connection to linear collider effort started (L. Linssen) very
   positively. Will act towards ILC detector groups.

6. Optimism that precision QED calculations can be improved with
   new computing power and tools

7. Many opportunities to collaborate at world-wide level.