



# CLIC detector & physics Status and Plans

*Marcel Vos, IFIC (UVEG/CSIC) Valencia,  
for the CLIC detector & physics collaboration*

*CLIC Workshop, CERN, january 2016*



LINEAR COLLIDER COLLABORATION



Compact Linear Collider

# CLIC detector & physics



CLICdp: 27 institutes in a light-weight collaboration structure

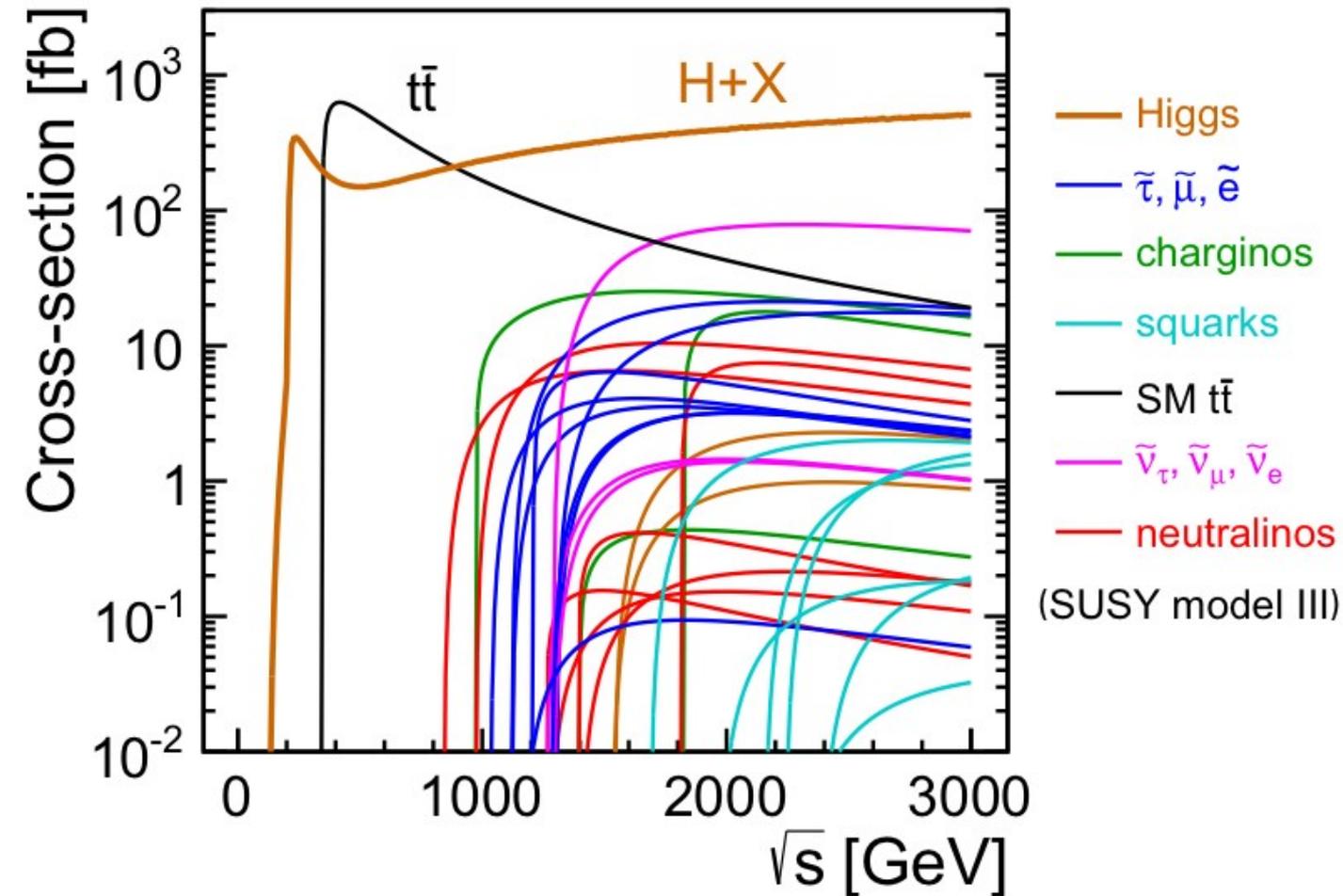
Strong synergy with other projects (esp. ILC)

Global effort with a center-of-gravity here at CERN



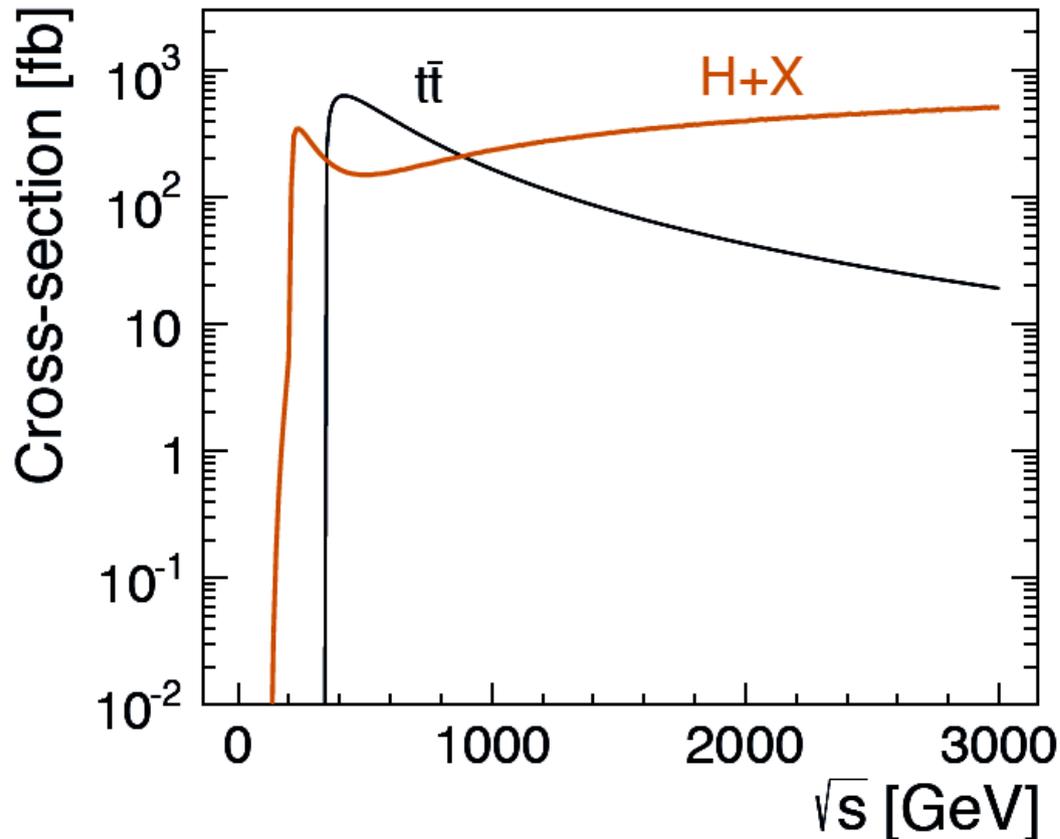
<http://cllcdp.web.cern.ch>

# CLIC physics

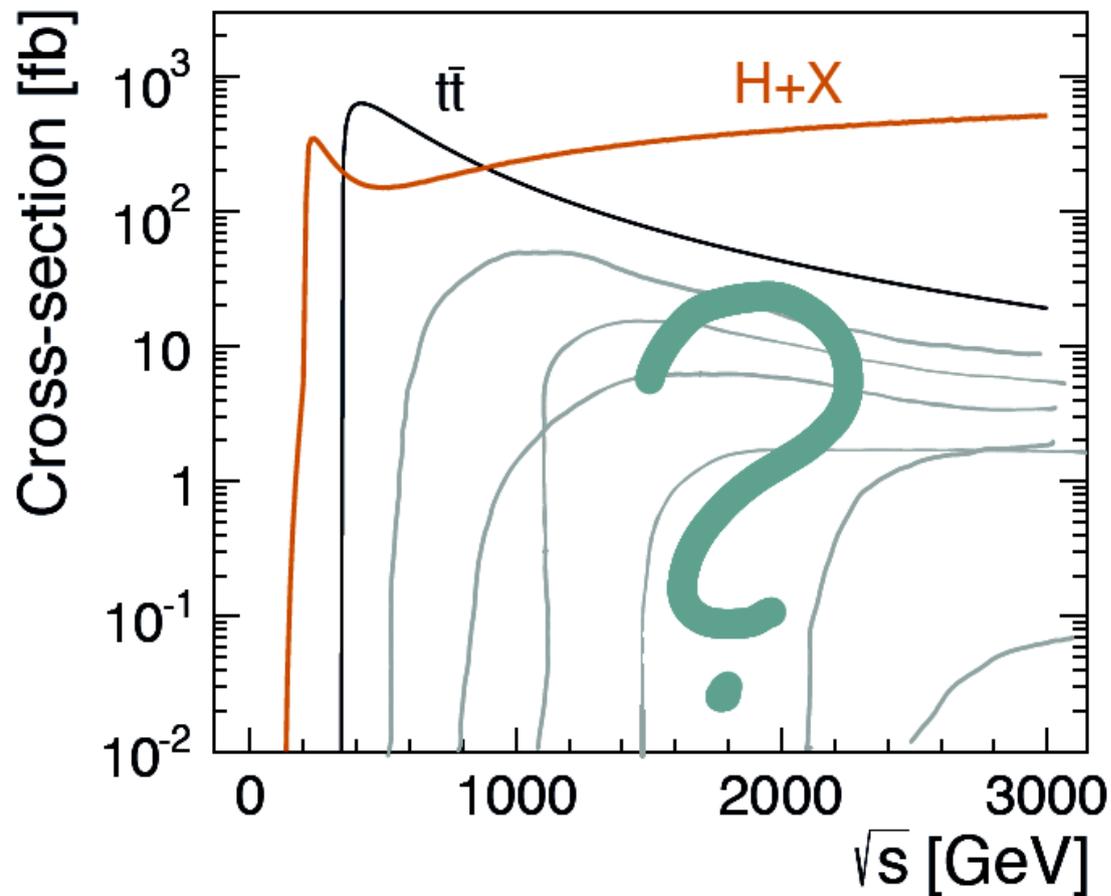


# Physics programme

CLIC has a “guaranteed programme” based on known particles and processes: a precise knowledge of couplings and properties of Z, W, H, t provides indirect sensitivity to BSM physics at very high scale



# Physics programme

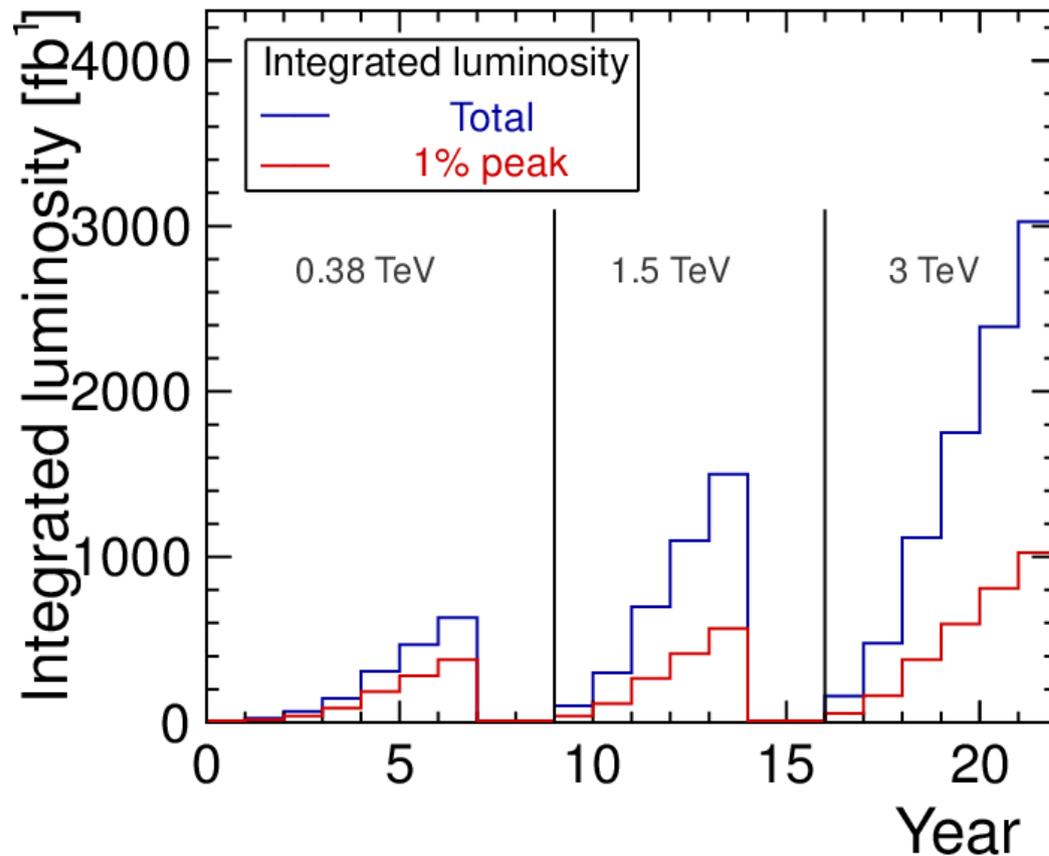


R&D for future colliders must be ready for the unexpected:  
enable direct production of new particles with mass up to  $\sqrt{s}/2$

# A tentative programme

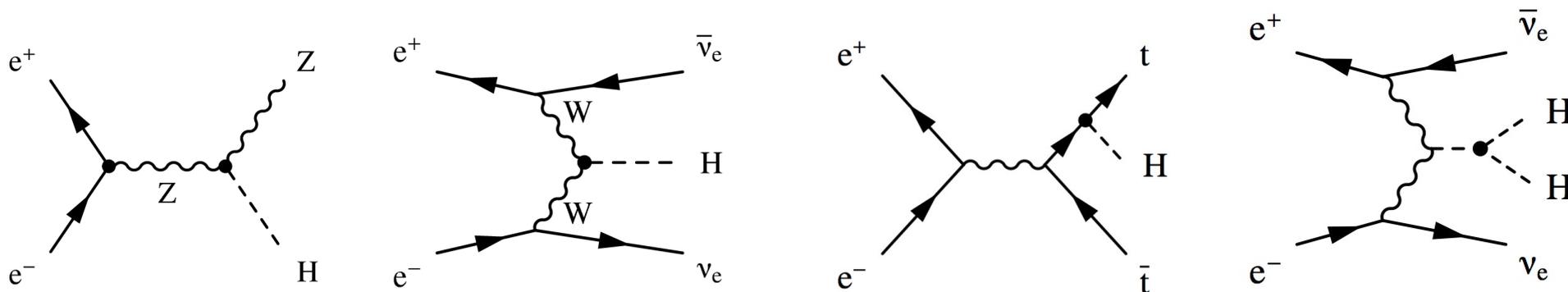
The CLIC programme envisages a start at relatively low energy (380 GeV), and quickly ramps up to ultimate lepton collider reach (1.5 TeV, 3 TeV)

*Expected soon: staging document, see talk by Eva Sicking on Friday*



*Note: benchmark studies were performed at 350 GeV and 1.4 TeV*

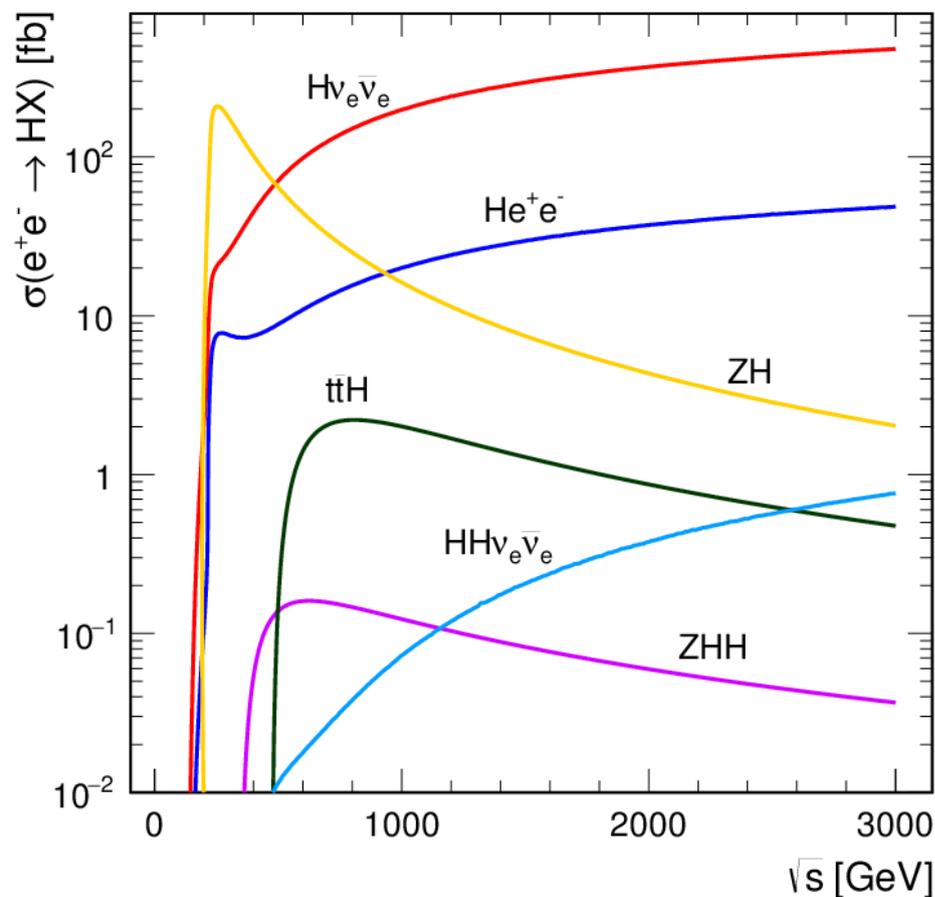
# Higgs physics



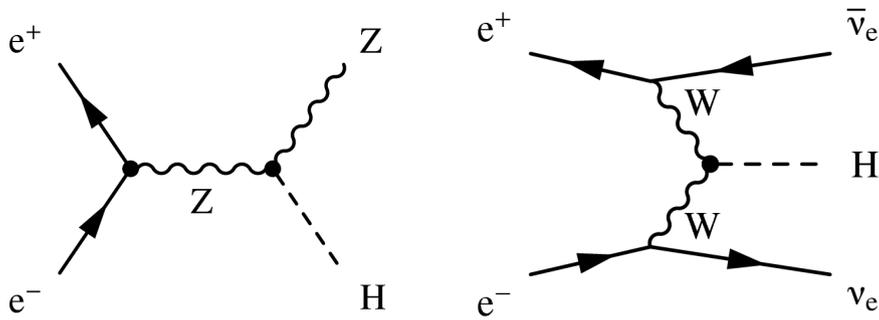
CLIC programme provides access to different Higgs boson production mechanisms:

- Higgstrahlung
- vector-boson fusion
- associated  $t\bar{t}H$  production
- di-Higgs production

*Expected soon: CLIC Higgs paper*



# Higgs physics at 350 GeV



Analysis of Higgsstrahlung and vector-boson fusion events provides model-independent measurement of Higgs couplings

$Z \rightarrow \mu\mu$ BR~3.5%	}	$\Delta(\sigma_{HZ}) = \pm 4.2\%$
$Z \rightarrow ee$ BR~3.5%		
$Z \rightarrow qq$ BR~70%		

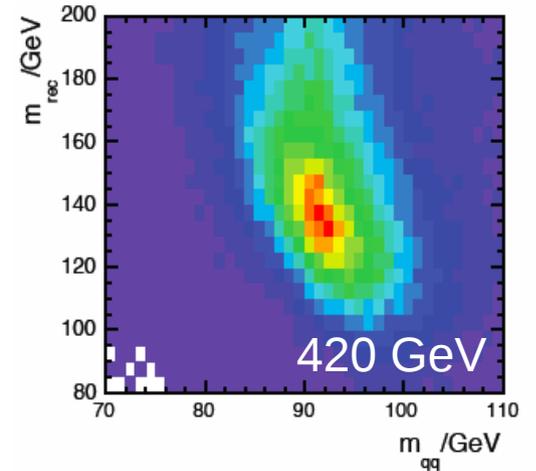
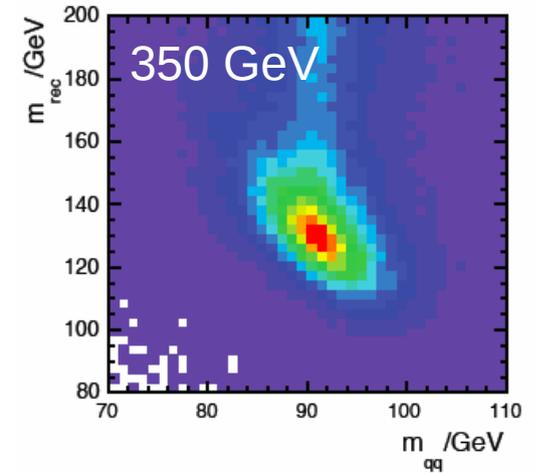
## New: hadronic recoil analysis

M. Thomson, CLICdp-Pub-2015-004, arXiv:1509:02853

$\Delta(g_{HZZ}) = \pm 0.8\%$   
 $BR(H \rightarrow inv) < 1\%$

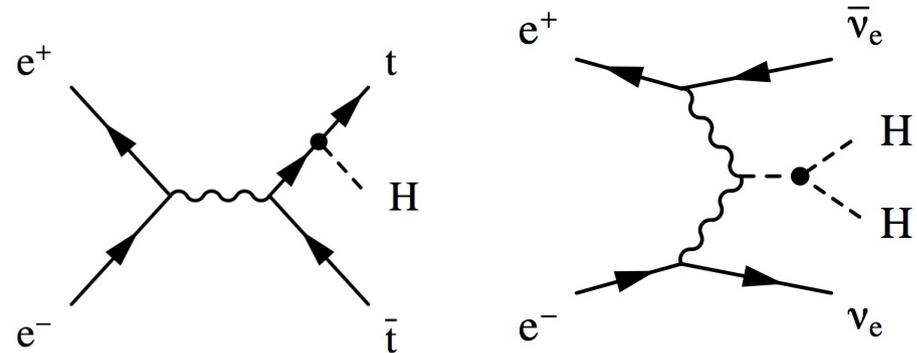
Jet energy resolution prefers 350 GeV over 420 GeV

Jet clustering and tagging performance prefers 350 GeV over 250 GeV



# Higgs physics

High-energy programme (1.4 – 3 TeV) provides opens up ttH production and di-Higgs production



## ttH production: $e^+e^- \rightarrow ttH$

- Extraction of top Yukawa coupling
- Best at  $\sqrt{s} \gtrsim 700$  GeV

### Projected precision:

- $\Delta(g_{Htt}) = \pm 4.5\%$  at 1.4 TeV

## Double-Higgs production:

### $e^+e^- \rightarrow HH\nu_e\nu_e$

- Simultaneous extraction of triple Higgs coupling,  $\lambda$ , and quartic HHWW coupling
- Needs high  $\sqrt{s} \gtrsim 1.4$  TeV

### Projected precision:

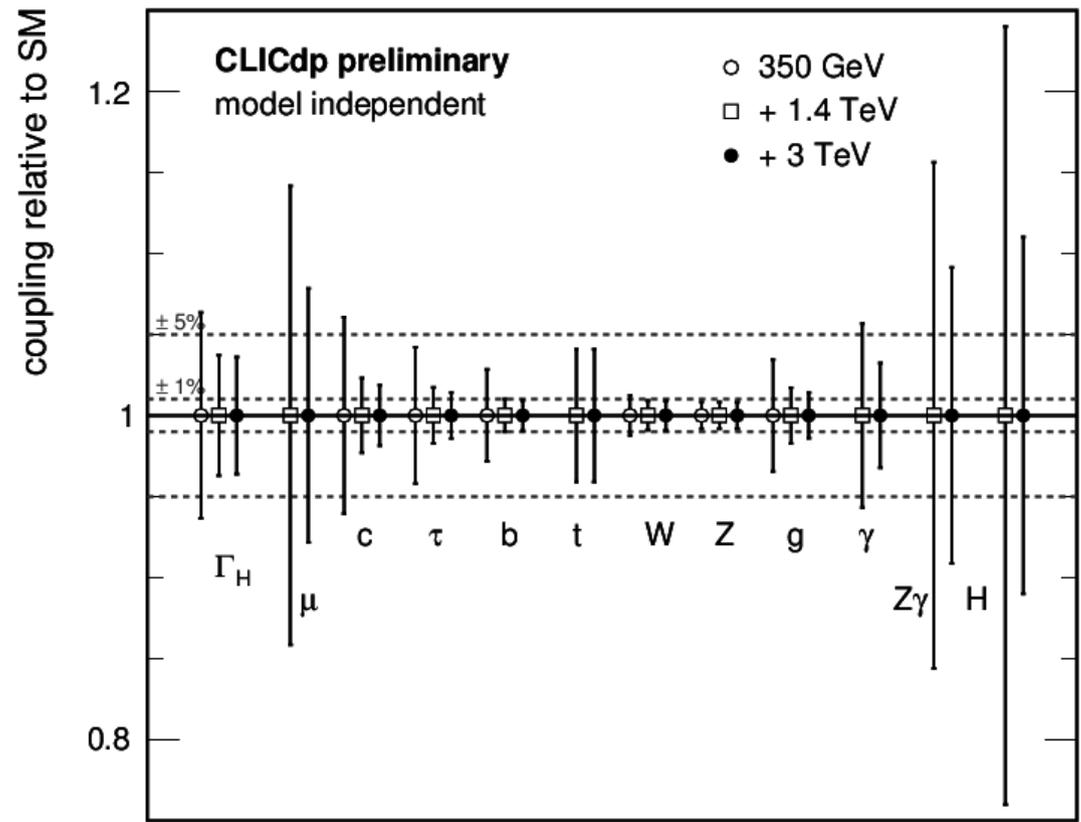
- $\Delta(\lambda) = \pm 10\%$  for 1.4 TeV and 3 TeV operation combined (incl. polarisation)

# CLIC's internal complementarity

CLIC improves on its own low-energy results for most couplings  
 first stage provides crucial model-independent Z coupling measurement, and  
 couplings to most fermions and bosons; higher-energy stages improve them,  
 and add t,  $\mu$ , g couplings

**NEW: result for Higgs paper  
 includes hadronic recoil analysis**

*See talk by Ph. Roloff*



*Model-independent: width is free parameter*

*Model-dependent: assuming SM decays*

*parameterizing perturbations as  $K$*

# CLIC's internal complementarity

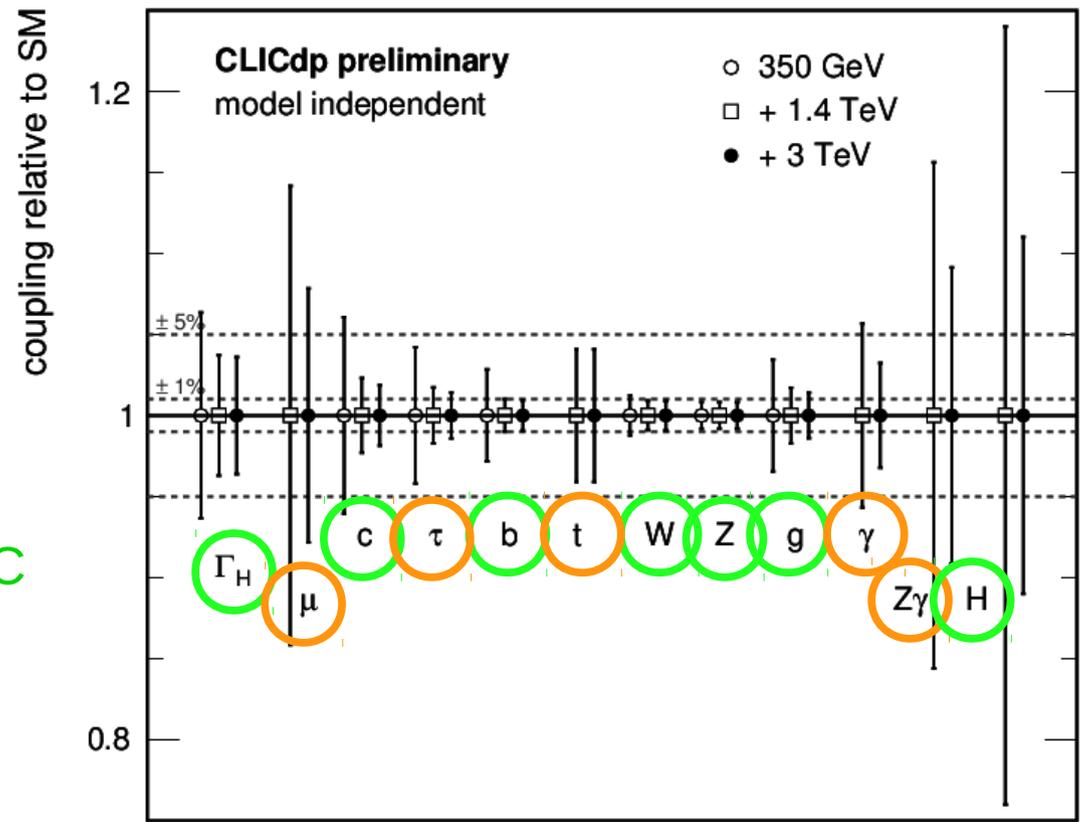
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 first stage provides crucial model-independent Z coupling measurement, and couplings to most fermions and bosons; higher-energy stages improve them, and add t,  $\mu$ , g couplings

**NEW:** result for Higgs paper includes hadronic recoil analysis

See talk by Ph. Roloff

 much more accurate than HL-LHC

 similar accuracy as HL-LHC



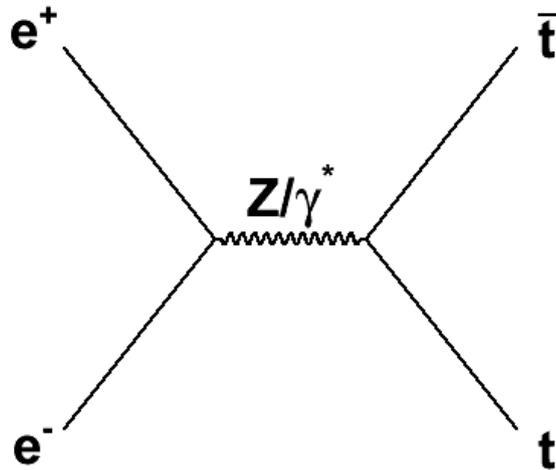
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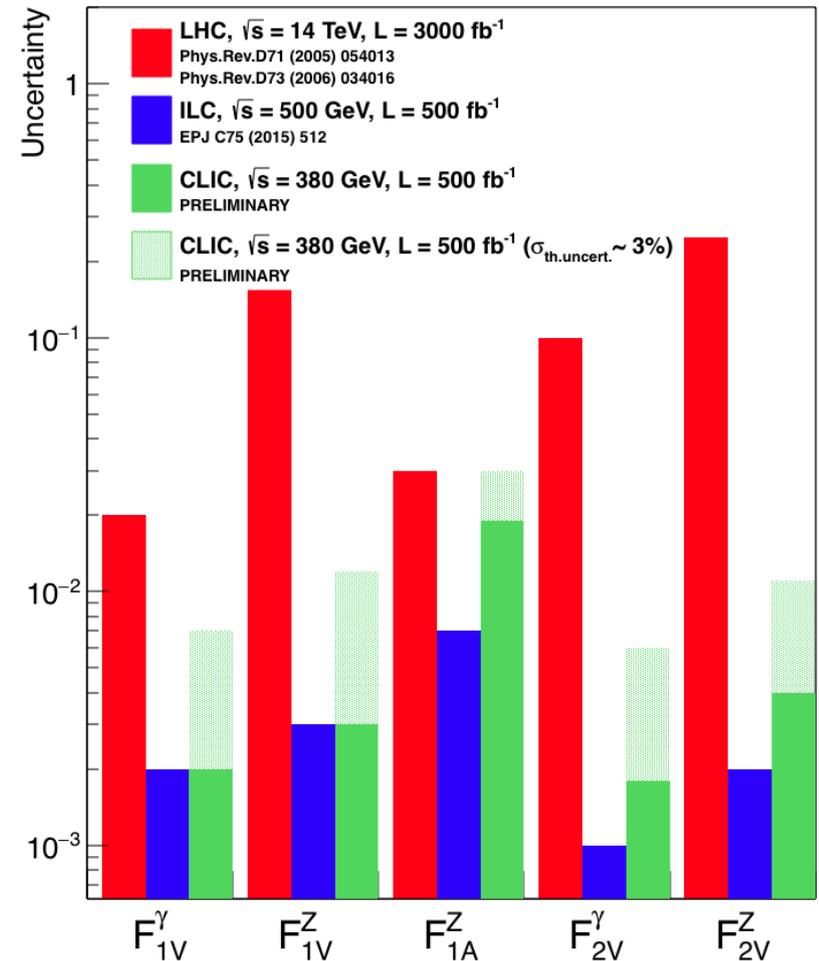
# Top quark physics

## Top quark pair production

-  $t\bar{t}Z$  coupling is a sensitive probe that may present sizeable deviations for BSM at 10-30 TeV



+top mass to 50 MeV,  $t \rightarrow cH$  to  $10^{-5}$   
 Coordinated effort towards a top paper  
 See talk by I. Garcia



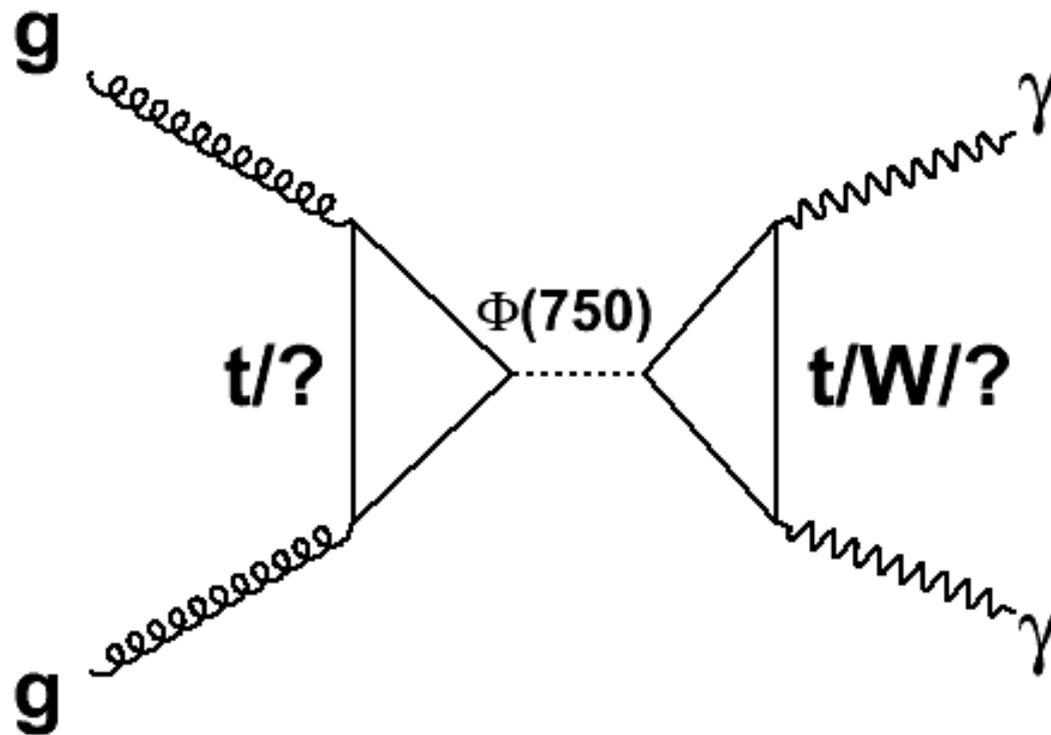
LC prospects are an order of magnitude better than LHC  
 500 GeV: larger boost and smaller theory uncertainty

# New physics: be prepared for surprises

From the LHC, with love: a new scalar with  $m=750$  GeV

The new state – if it exists - couples to photons, presumably through loops

So we might be seeing something like this:

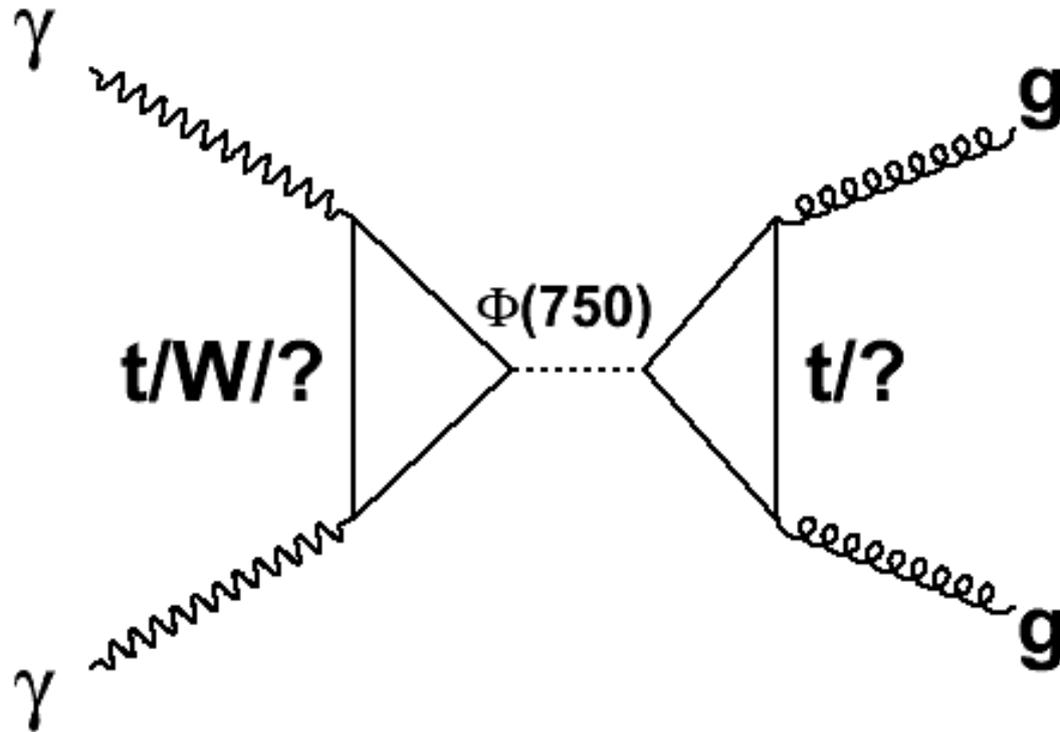


# New physics: be prepared for surprises

From the LHC, with love: a new scalar with  $m=750$  GeV

The new state – if it exists - couples to photons, presumably through loops

Then this other process should also have a sizeable rate:



# New physics: photons

A 1 TeV  $e^+ e^-$  collider + couple of lasers

= 750 GeV photon collider

Production rate expected to be  $O(100)$  fb

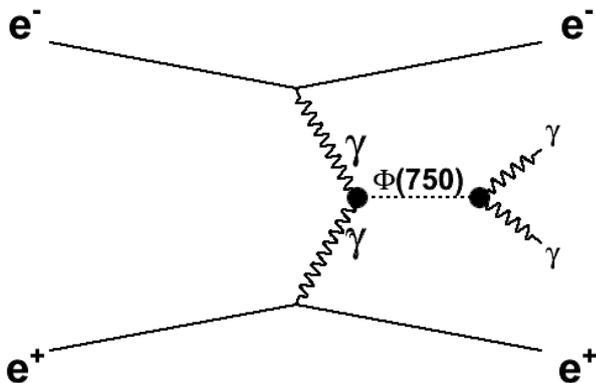
*F. Richard, private comm.*

*Ito, Moroi, Takaesu, arXiv:1601.01144*

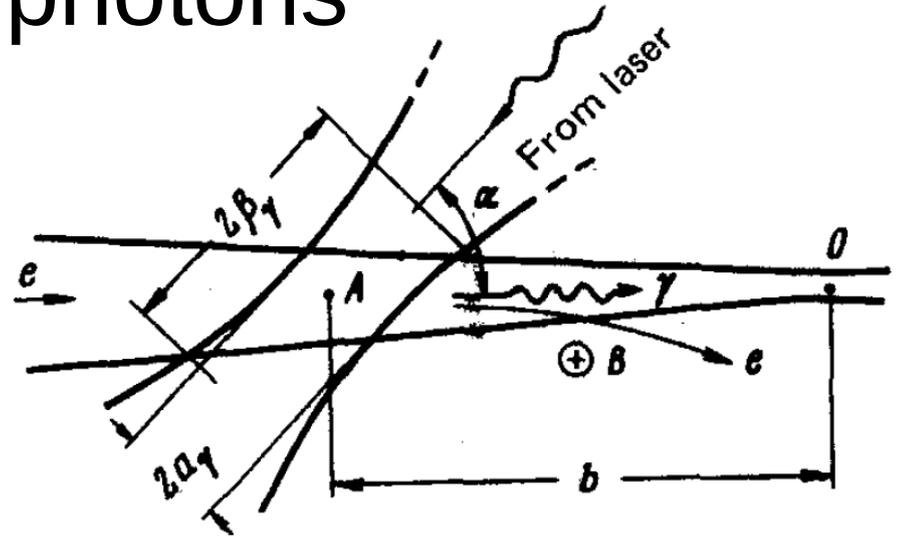
*Djouadi et al., arXiv:1601.03696*

CLIC  $\gamma\gamma$  option: <https://indico.cern.ch/contributionDisplay.py?contribId=145&confId=175067>

## Photon fusion at high energy collider



Sizeable cross-sections possible if photon dominates the  $\Phi(750)$  width  
Requires rather high energy (2 TeV)



*Ginzburg et al., NIM 205, NIM 219, JETP Lett. (early 80s)*  
*TESLA TDR, V. Telnov, JINST 9 (2014) 09 C0909*

# New physics: more speculative

A new scalar with  $m=750$  GeV can be many things:

- **If the new state couples to W or Z, vector-boson fusion production of such a heavy state requires a high-energy  $e^+ e^-$  machine**

Cross section typically  $O(1)$  fb at 2 TeV

- **If it is accompanied by, say, vector-like leptons**

these can be pair-produced if  $\sqrt{s} > 2m$

- **If it talks to the Standard Model (Higgs and top)**

sizeable deviations in precision measurements at “low” energy

*Illustration: Higgs couplings in several scenarios (with  $\Lambda = 1$  TeV)*

*Snowmass Higgs report (arXiv:1310.8361)*

*LCC physics WG is working out more specific cases*

Model	$\kappa_V$	$\kappa_b$	$\kappa_\gamma$
Singlet Mixing	$\sim 6\%$	$\sim 6\%$	$\sim 6\%$
2HDM	$\sim 1\%$	$\sim 10\%$	$\sim 1\%$
Decoupling MSSM	$\sim -0.0013\%$	$\sim 1.6\%$	$\sim -0.4\%$
Composite	$\sim -3\%$	$\sim -(3 - 9)\%$	$\sim -9\%$
Top Partner	$\sim -2\%$	$\sim -2\%$	$\sim +1\%$

# New physics: more speculative

A new scalar with  $m=750$  GeV can be many things:

**Potentially very rich phenomenology,**

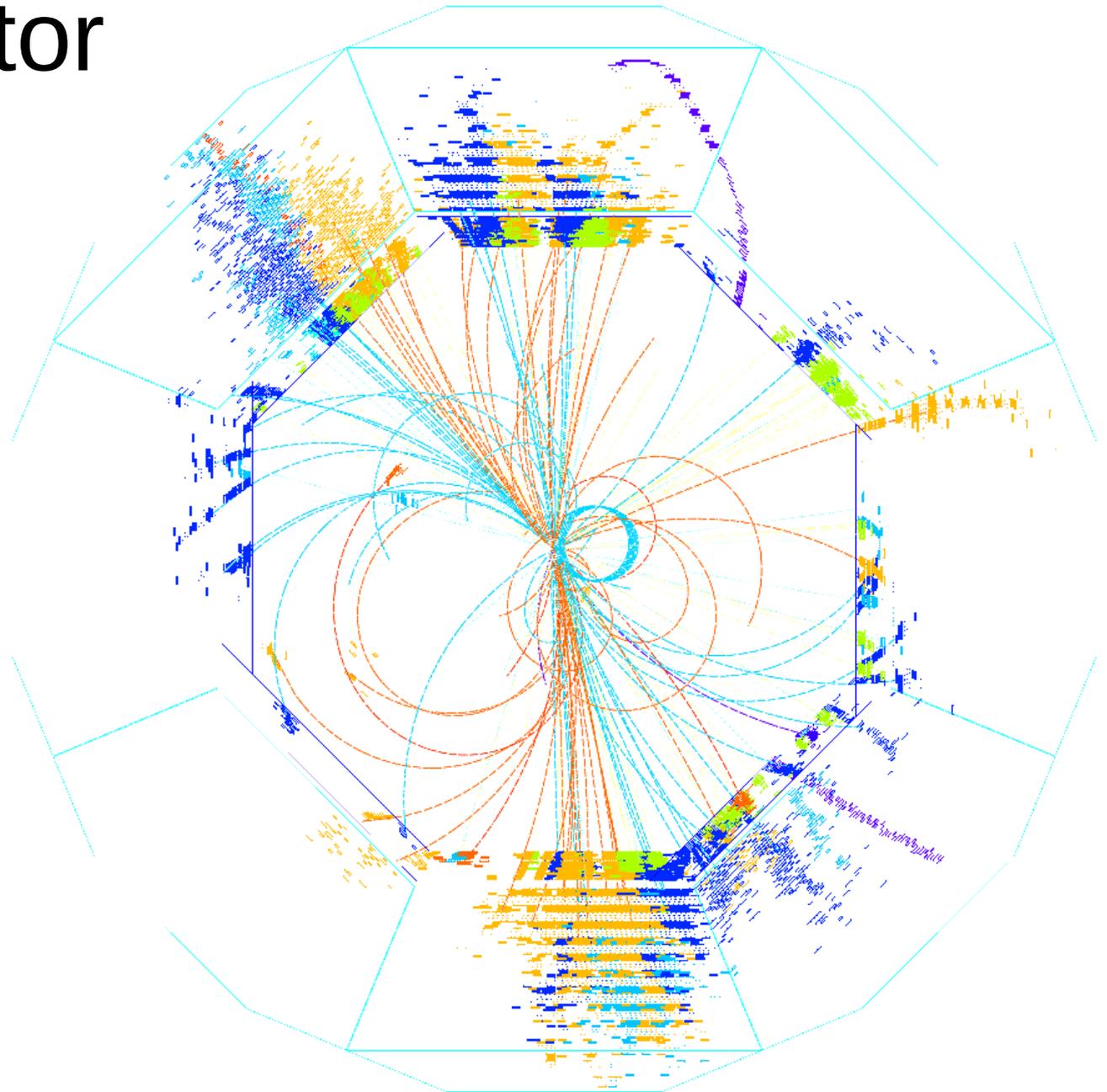
**both at low (250-500 GeV) and high energy (1-3 TeV)**

*Djouadi, Ellis, Godbole, Quévellion, arXiv:1601.03696*

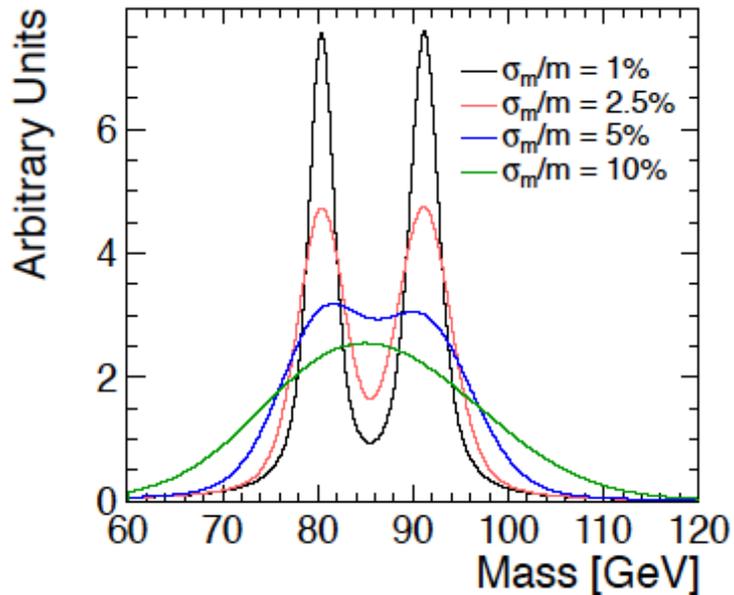
*“If the discovery is confirmed, it will shine a new light on options for possible future colliders, placing a premium on those with sufficient energy to produce the new particles, while also suggesting a new motivation for precision low-energy experiments.”*

*See talks by F. Simon, M. Berggren for more conventional new physics prospects*

# CLIC detector



# CLIC detector requirements



## ★ momentum resolution:

endpoints, Higgs recoil mass, Higgs  $\rightarrow \mu\mu$

$$\sigma_{p_T} / p_T^2 \sim 2 \times 10^{-5} \text{ GeV}^{-1}$$

## ★ jet energy resolution:

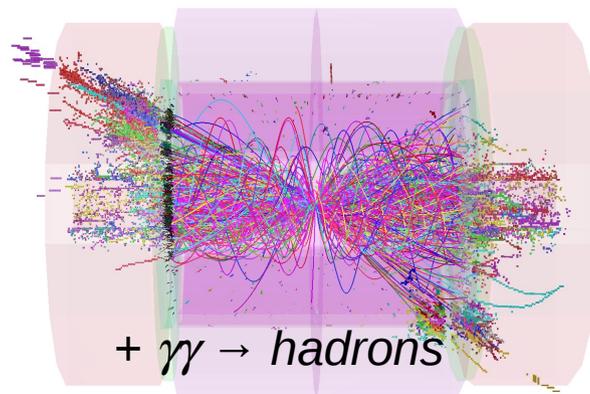
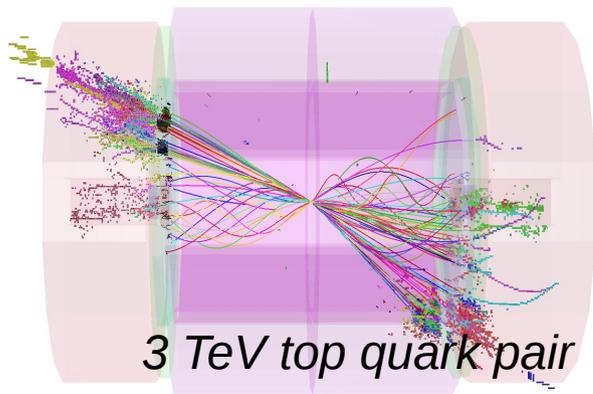
W/Z/h di-jet mass separation

$$\frac{\sigma_E}{E} \sim 3.5 - 5 \% \quad (\text{for high-E jets})$$

## ★ impact parameter resolution:

c/b-tagging, Higgs BR

$$\sigma_{r\phi} = 5 \oplus 15 / (p[\text{GeV}] \sin^{\frac{3}{2}} \theta) \mu\text{m}$$



**+ time stamping for  $\gamma\gamma \rightarrow \text{hadrons}$  and pair production**

# CLIC Detector Concept

## Adapt the ILC concepts to a single CLIC detector

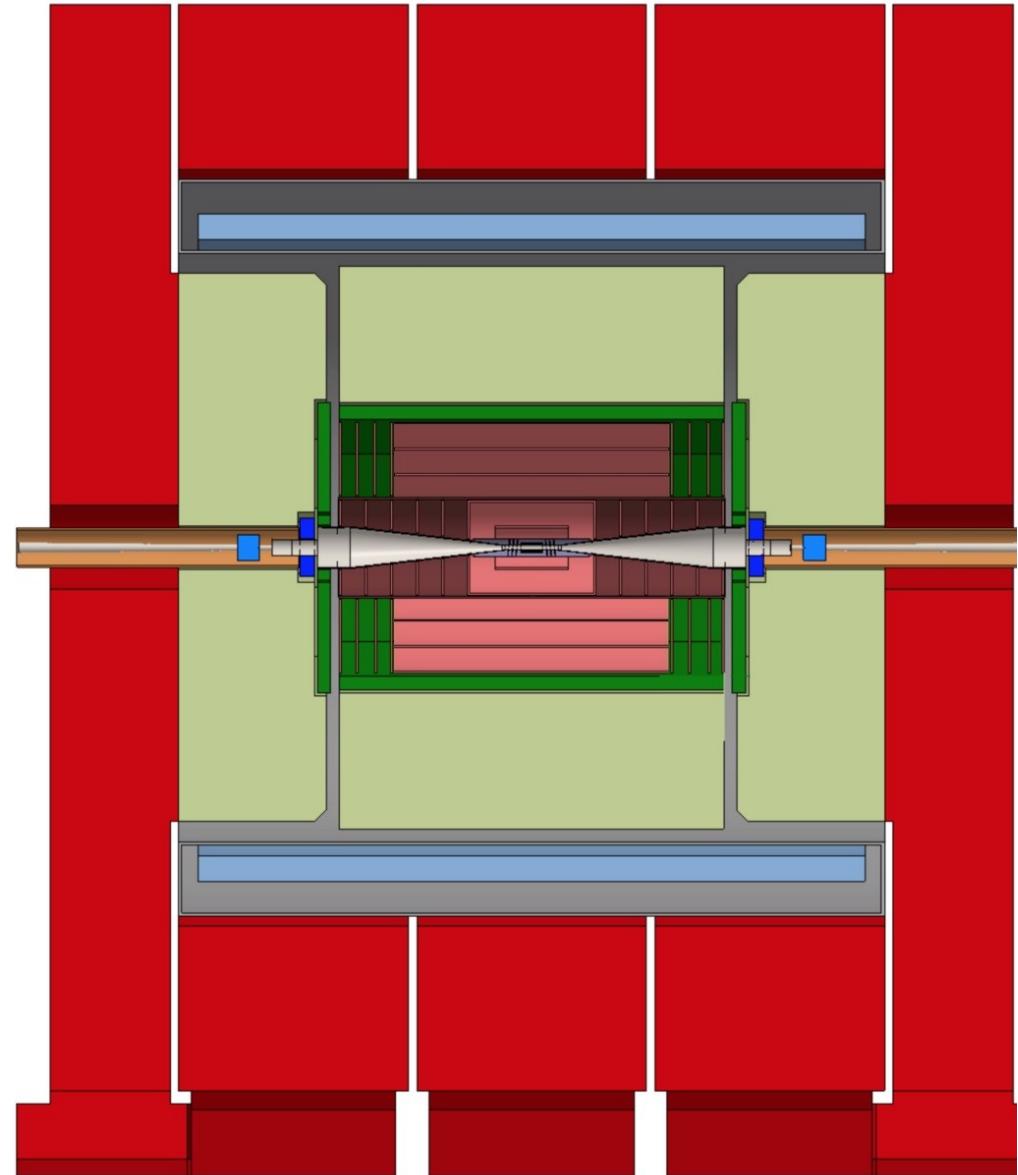
- 4 Tesla solenoid
- highly granular and **deep** calorimeter ( $1+8\Lambda$ )
- low-mass **silicon** tracking system
- precision vertexing (**starting at  $R=3$  cm**)
- precise **10 ns time stamping**
- **QD0 outside detector (forward coverage)**

### For overview:

CLIC CDR, arXiv:1202.5940

### For up-to-date details:

Marko Petric, Friday plenary session



# New Detector Design

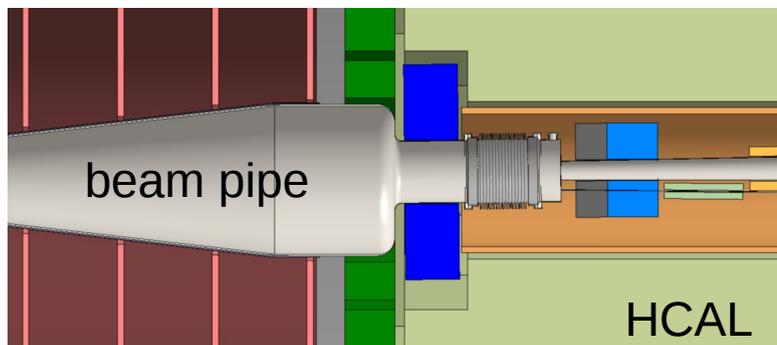
Position of final quadrupole QD0 represents a trade-off

- QD0 inside detector → maximal luminosity
- QD0 outside detector → forward coverage (important at high energy!)

## new CLIC detector model:

R (HCAL) decreased, 500 → 250 mm

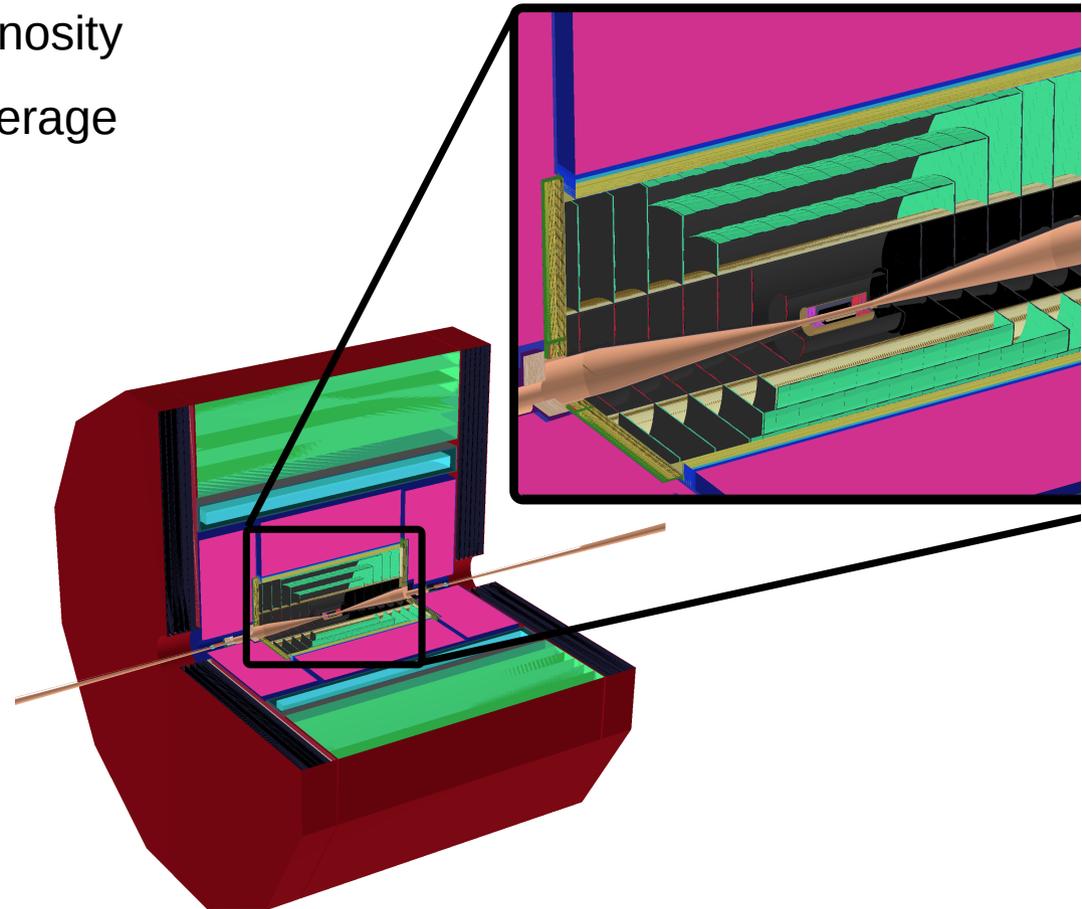
$L^* = 6$  m, minor loss of luminosity



tracker

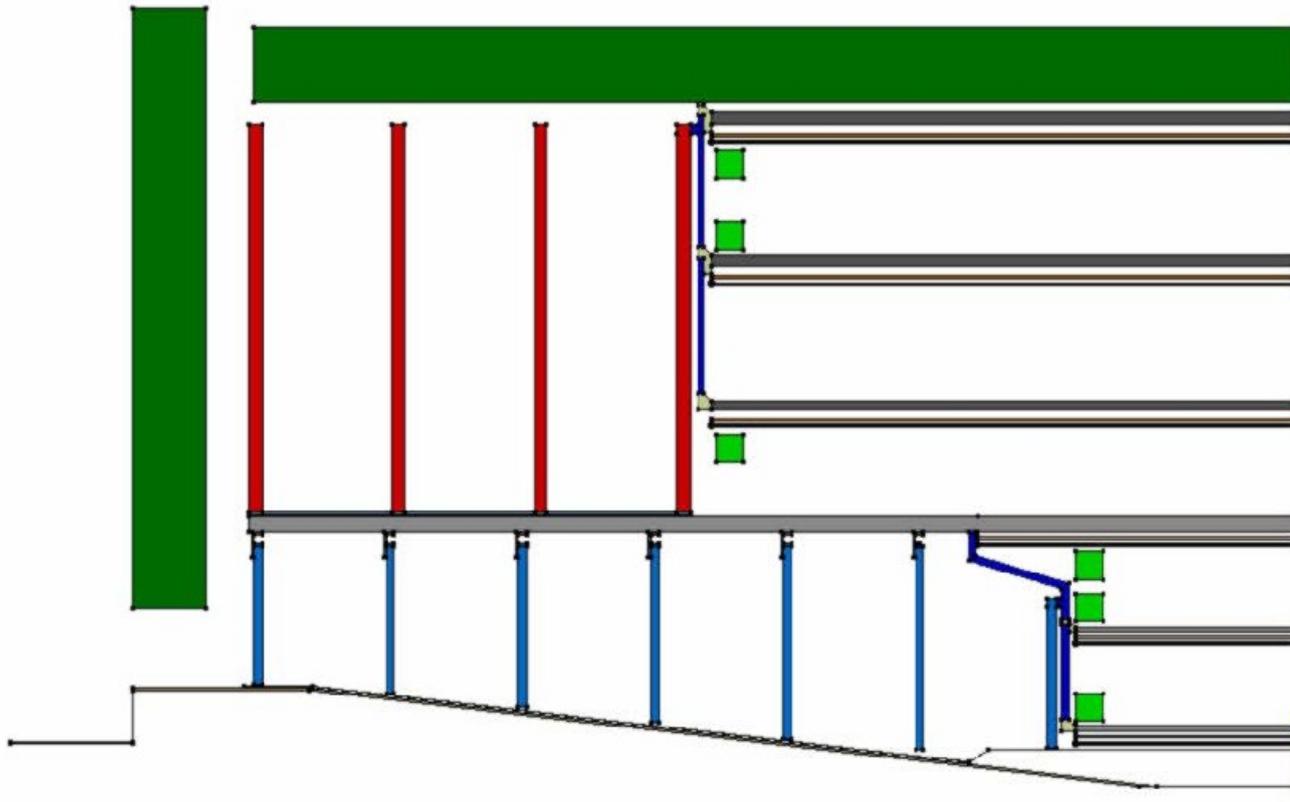
ECAL

HCAL

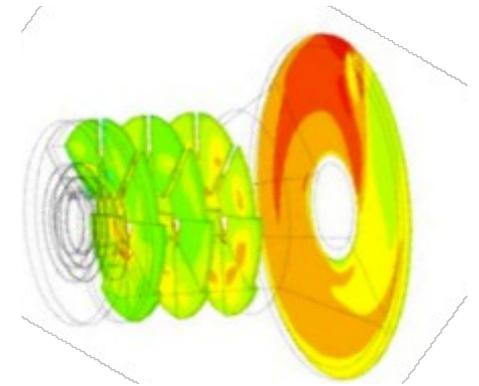


*See talk by Marko Petric*

# New tracker layout



Increased realism from engineered studies of services: power, supports, cooling

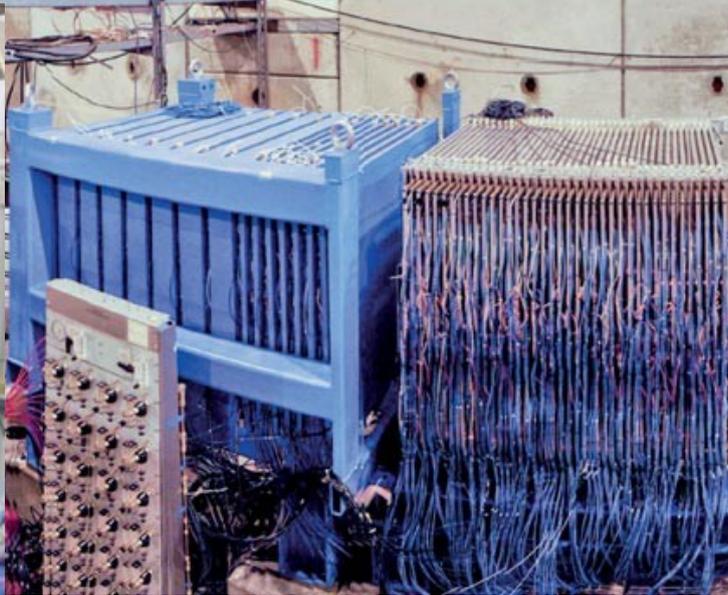


## All-silicon tracker, divided in an inner and outer system

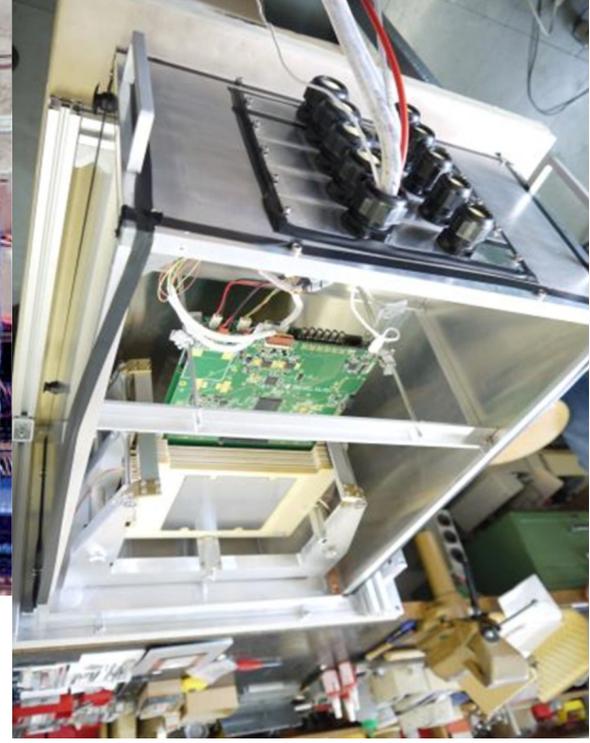
- 3 short + 3 long barrel layers
- 7 inner + 4 outer endcaps

} At least 8 hits (Vertex + Tracker) for  $> 8^\circ$

# CLIC Detectors: calorimetry



**CALICE**

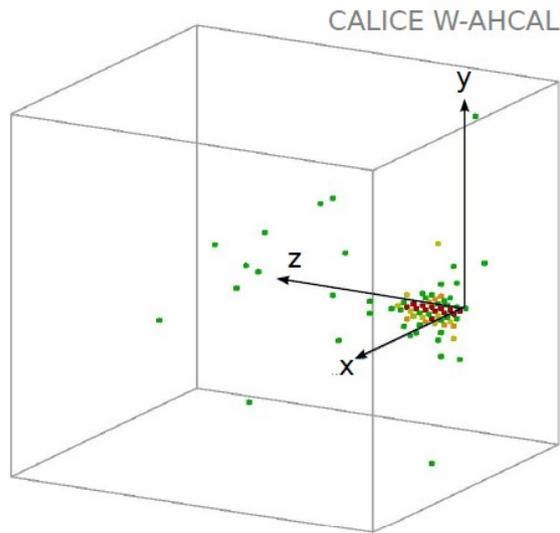


**FCAL**

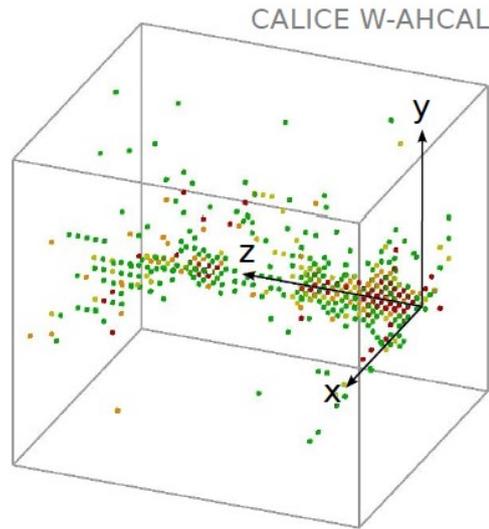
## **Ultra-granular calorimeters: from science fiction to science**

The **CLICdp** group contributes to the **CALICE** and **FCAL** R&D collaborations, which have constructed and tested ultra-granular SiW EM calorimeters, a 1 m<sup>3</sup> prototype ScW hadronic calorimeter and forward calorimeter prototypes

# CLIC detectors: calorimetry



EM shower

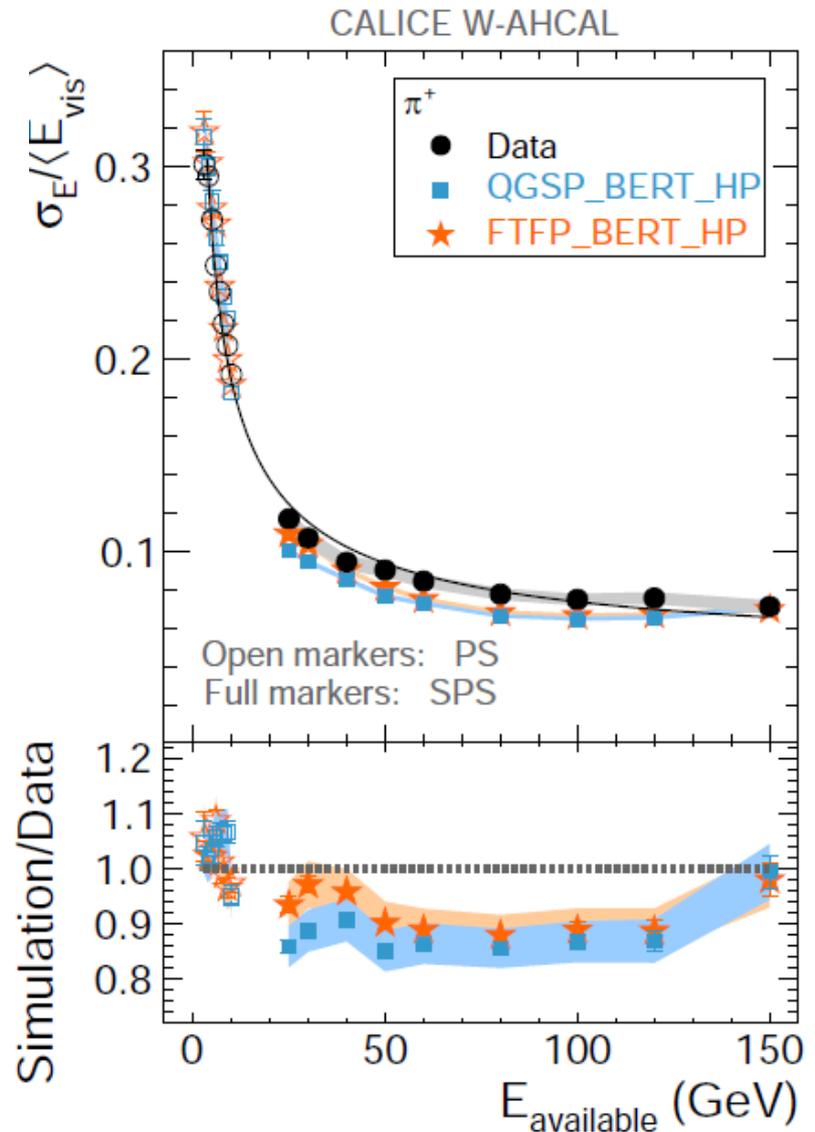


hadronic shower

Unique opportunity to understand hadronic shower (longitudinal profile, time structure)

*CALICE, JINST10 (2015) 12, P12006*

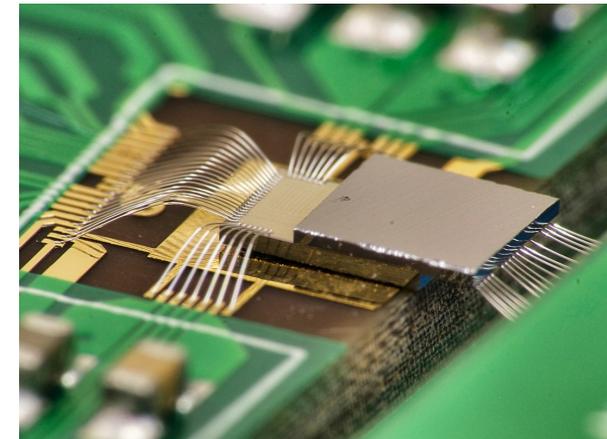
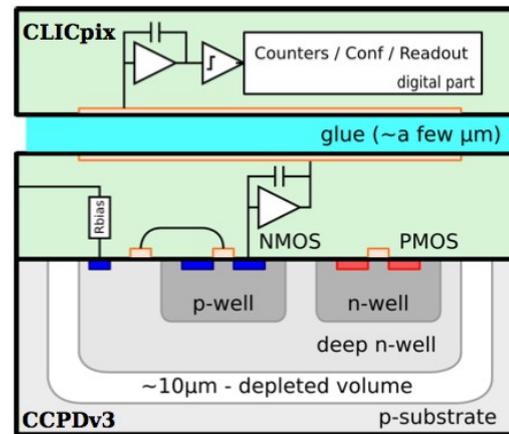
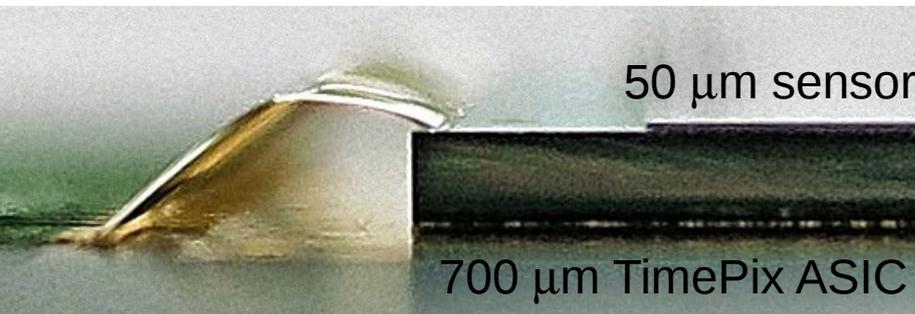
See contributions in this workshop:  
*F. Sefkow (CALICE), M. Manelli (CMS)*



# Vertex detector/tracker

**Hybrid pixels & active R&D on CMOS, active, 3D integrated, SOI,...**  
(precise & fast within a challenging material budget)

*CLICpix*  
(evolution of TimePix to  $25 \times 25 \mu\text{m}^2$  pixels)



*capacitive signal connection to CMOS detector*

Can we build a demonstrator that meets all challenging specifications  
– 10 ns time stamping,  $3.5 \mu\text{m}$  resolution, low power,  $0.2\% X_0/\text{layer}$ ?

*presentation by M. Campbell in this session*  
*See also: review by N. Wermes*

# Reconstruction software

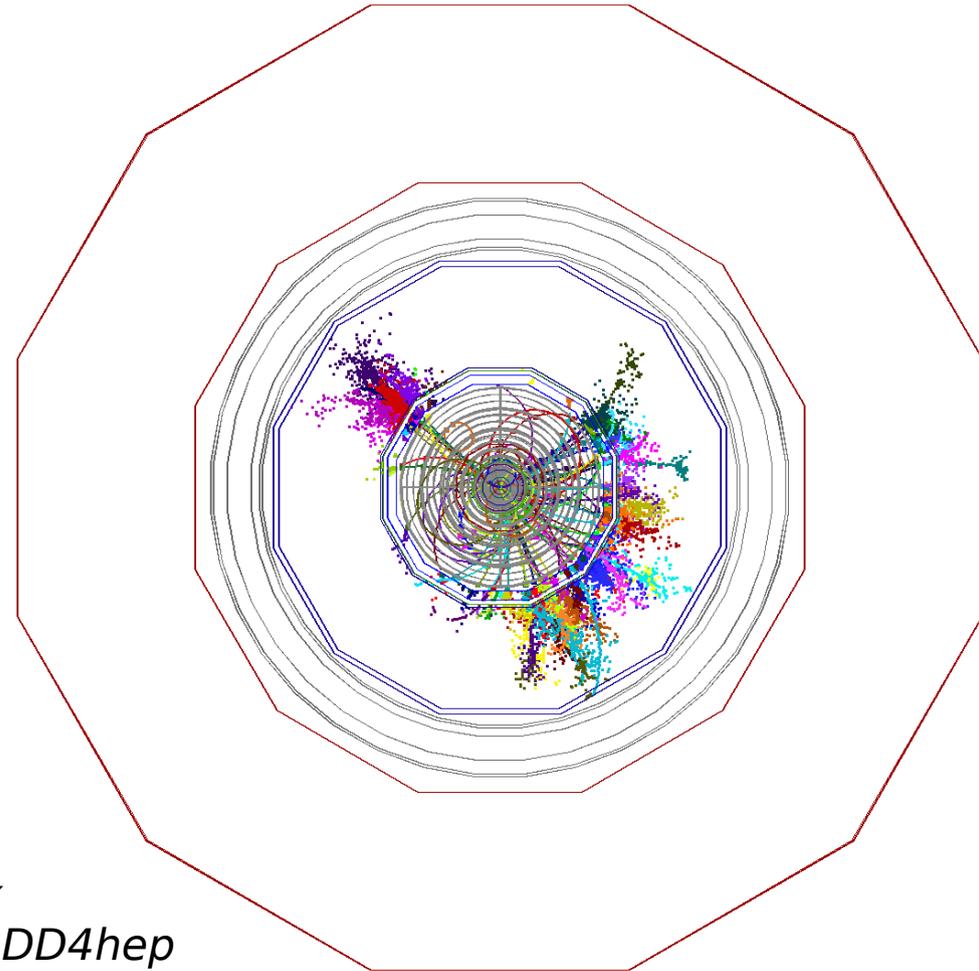
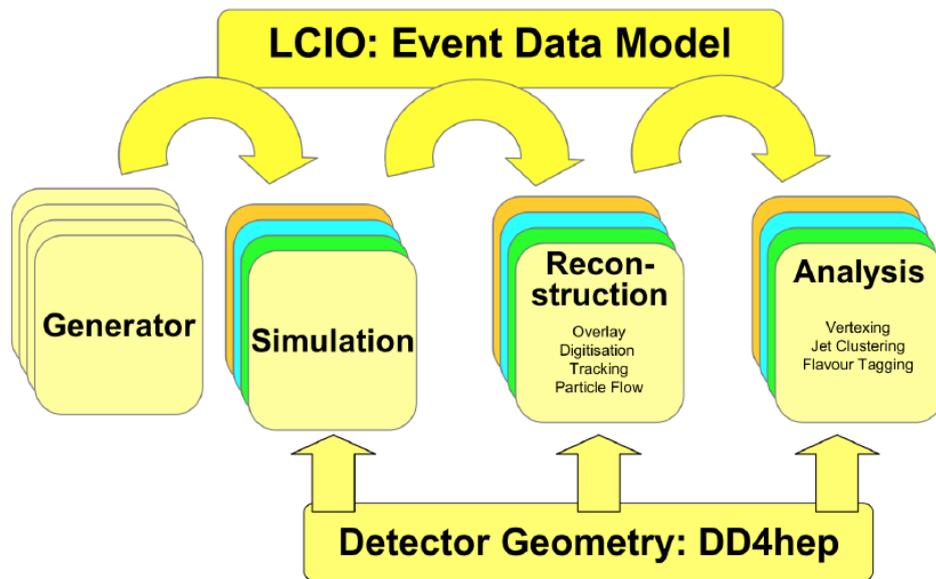
- Track reconstruction in dense jets
  - Adopt solutions from LHC
- Particle flow “under pressure”
  - Confusion limits high-energy resolution
- Jet reconstruction with background
  - New algorithms

overlap with LHC experiments

FCC-hh is forced to find solutions

# Track reconstruction

Continuous improvement of **Linear Collider software** for simulation/reconstruction  
Strong common ILD/CLICdp effort. Emphasis: **DD4hep** and **track reconstruction**



*CLIC vertex  
detector in DD4hep*

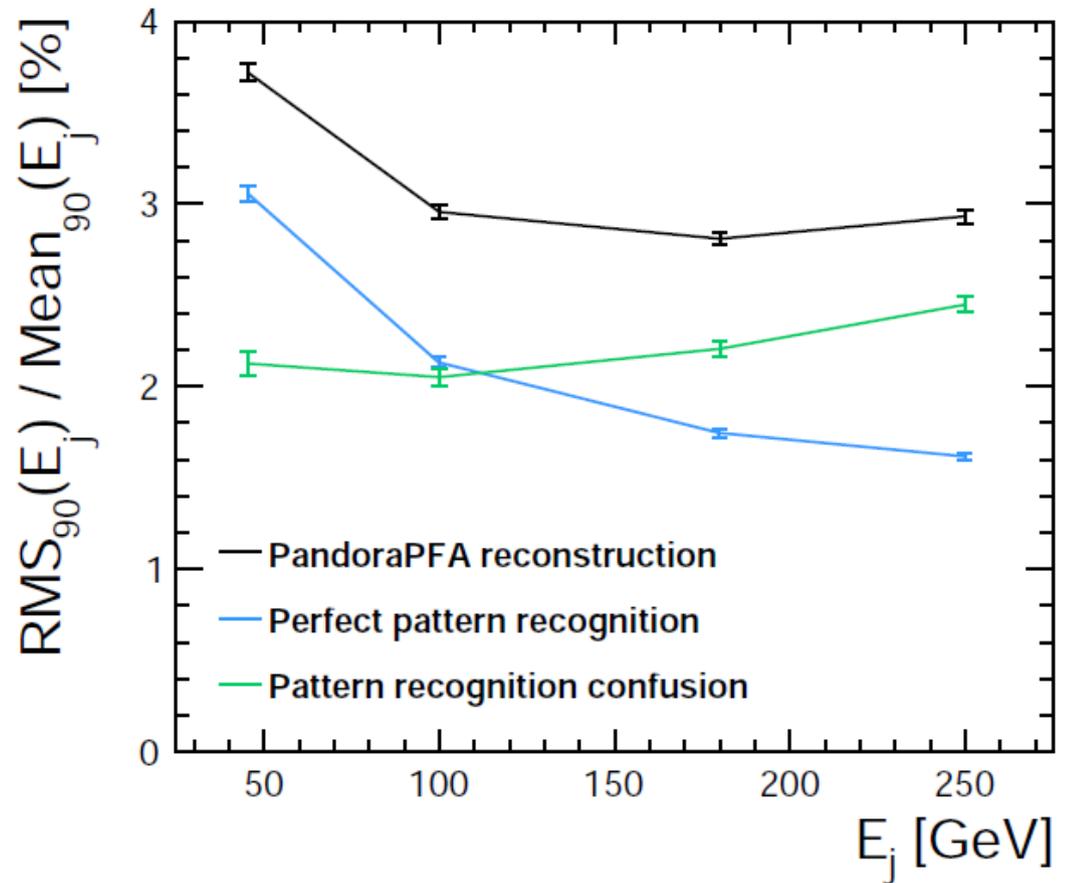
*CLIC event simulated, reconstructed,  
visualised with DD4hep*

# PFA/jet reconstruction

Pandora Particle Flow

*EPJC75 (2015) 9, 439*

- Energy resolution:  $\Delta E/E \sim 3\%$
- Powerful jet substructure analysis



- Excellent jet reconstruction performance in 50-250 GeV range
- Confusion degrades energy resolution at TeV scale
- Clustering limits performance of 4, 6 and 8-jet final states (vvHH, ttH)

# Summary

- CLIC's low-energy stage provides very competitive precision Higgs and top physics, probing new physics at very high scales
- CLIC opens up the possibility of  $e^+e^-$  collisions with  $\sqrt{s} \gg 1$  TeV, giving access to  $t\bar{t}H$  and  $HH$  production and extending the direct discovery reach
- In the next years the CLIC detector and physics collaboration will:
  - finalize a realistic detector model (~2016)
  - pursue detector R&D for the most challenging components (calorimetry, vertexing)
  - complete physics case studies on Higgs, top and BSM physics (~2017)providing inputs for the next European Strategy discussion (2019/20)

See: Lucie Linssen's talk on Friday

# CLICdp plans up to next European Strategy

## CLICdp reports serving as ingredients for a summary report:

- 2015 CLIC re-baselining report †
  - In preparation, together with accelerator. Draft by end-2015. Publication tbc.
- The 2015 CLIC detector model †
  - Nearly complete draft exists. Technical note.
- The CLIC Higgs physics overview publication of 2015 †
  - Nearly finished. End-2015. Publication
- An overview of CLIC top physics
  - Foreseen CLIC top physics publication in 2016/2017?
- Extended BSM studies (hopefully motivated by LHC discoveries)
  - Foresee publication in 2017?
- CLIC R&D report => with main CLIC technology demonstrators
  - Summary report, 2017, Note or Publication tbc.
- Plan for the period ~2019-2025 in case CLIC would be supported by next strategy
  - 2017/2018, Note to be included in the CLIC input report for the Strategy

# choice of lower CLIC energy stage (1)



## Guaranteed physics case #1: Higgs physics

**HZ production**

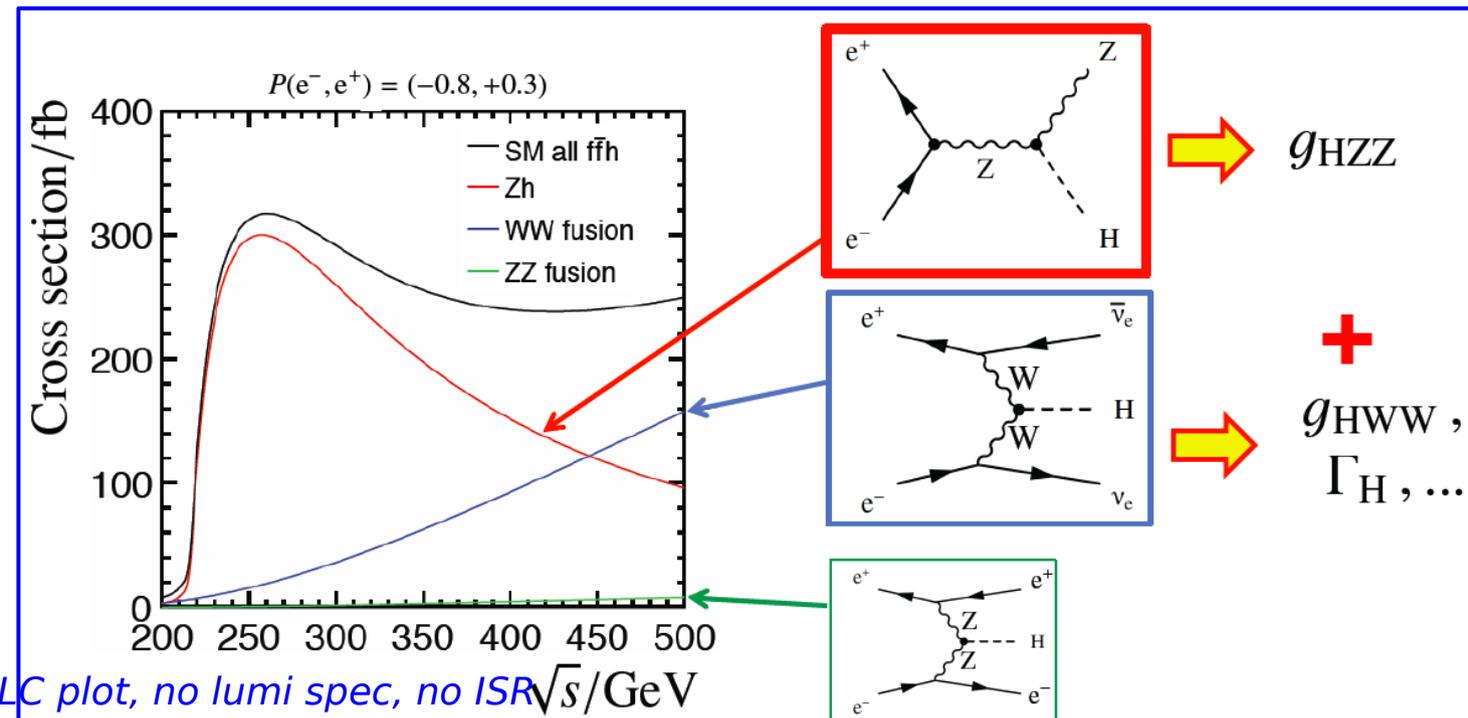
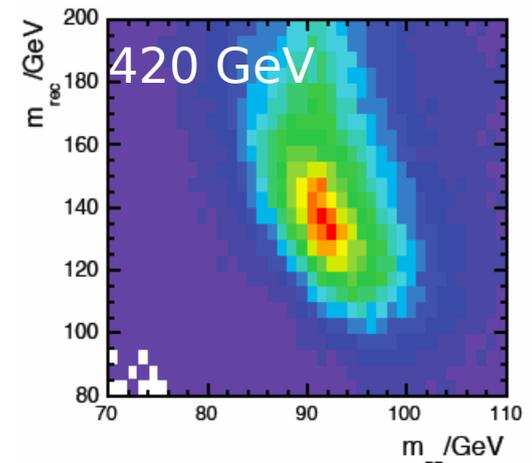
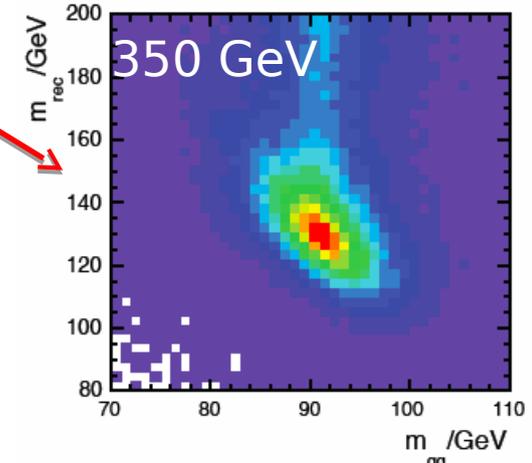
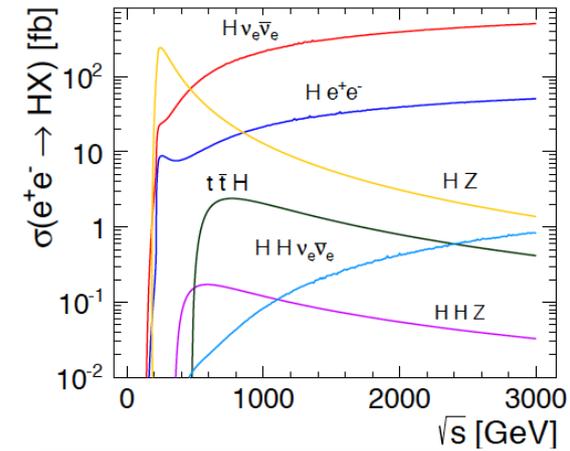
$$\Rightarrow \sqrt{s} \sim 250 - 450 \text{ GeV}$$

**Recoil mass measurement**

$$\Rightarrow \sqrt{s} < 400 \text{ GeV}$$

**HH from WW fusion**

$$\Rightarrow \sqrt{s} > 350 \text{ GeV}$$

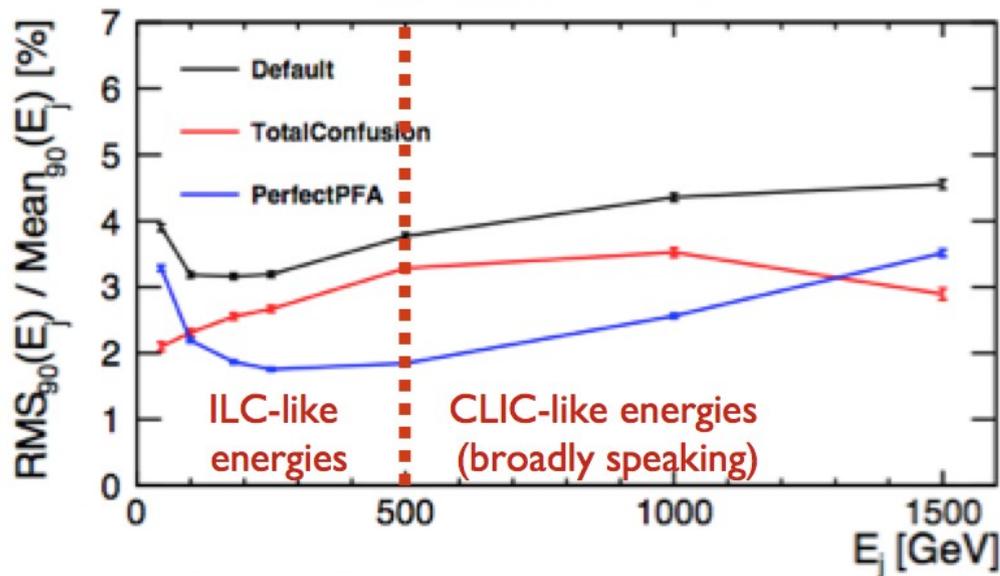


CLIC plot, no lumi spec, no ISR  $\sqrt{s}$  / GeV

# CLIC jet reconstruction

High-energy performance dominated by confusion in PFA pattern recognition

Improvements in software may change (and indeed have changed) the overall picture in a qualitative fashion!

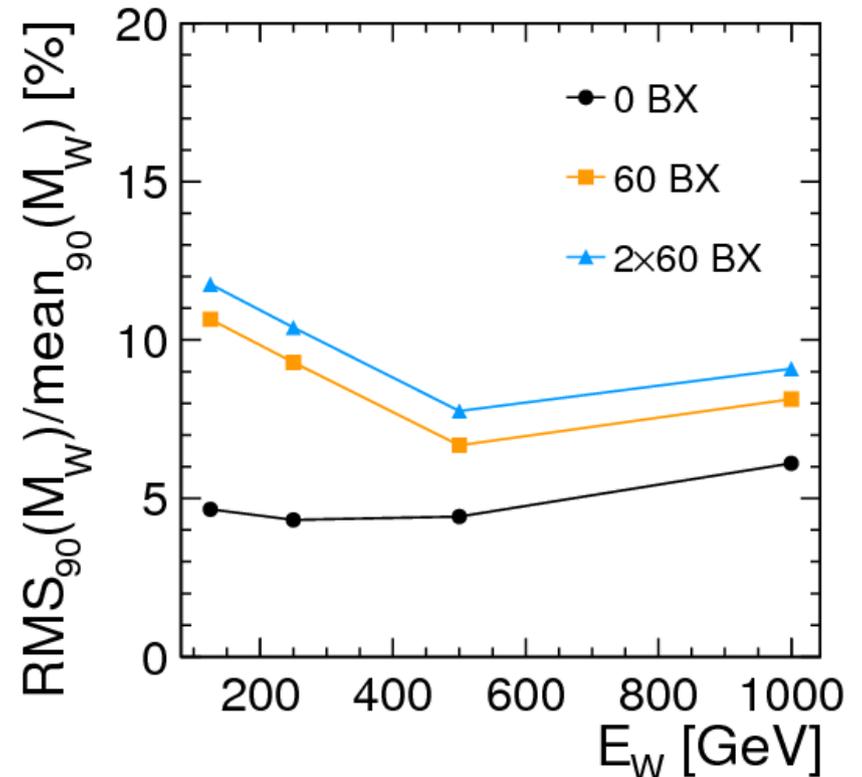
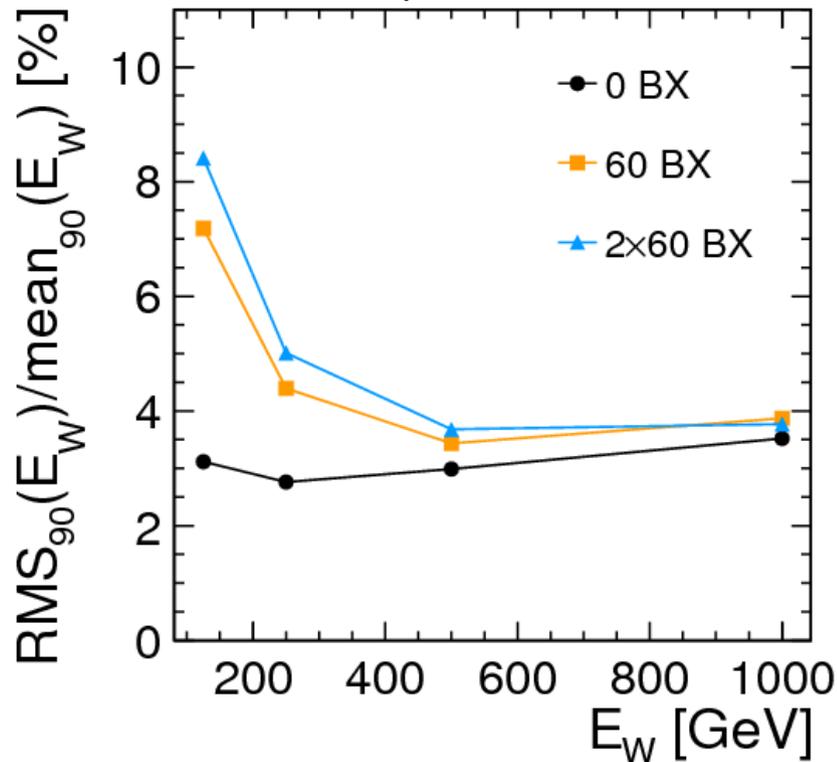


Reap the rewards of this approach with detector optimisation studies...

Jet energy resolution (with **intrinsic energy resolution** and **confusion** terms) as a function of jet energy, for  $45 \text{ GeV} \leq E_j \leq 1.5 \text{ TeV}$

# Impact of background on jets

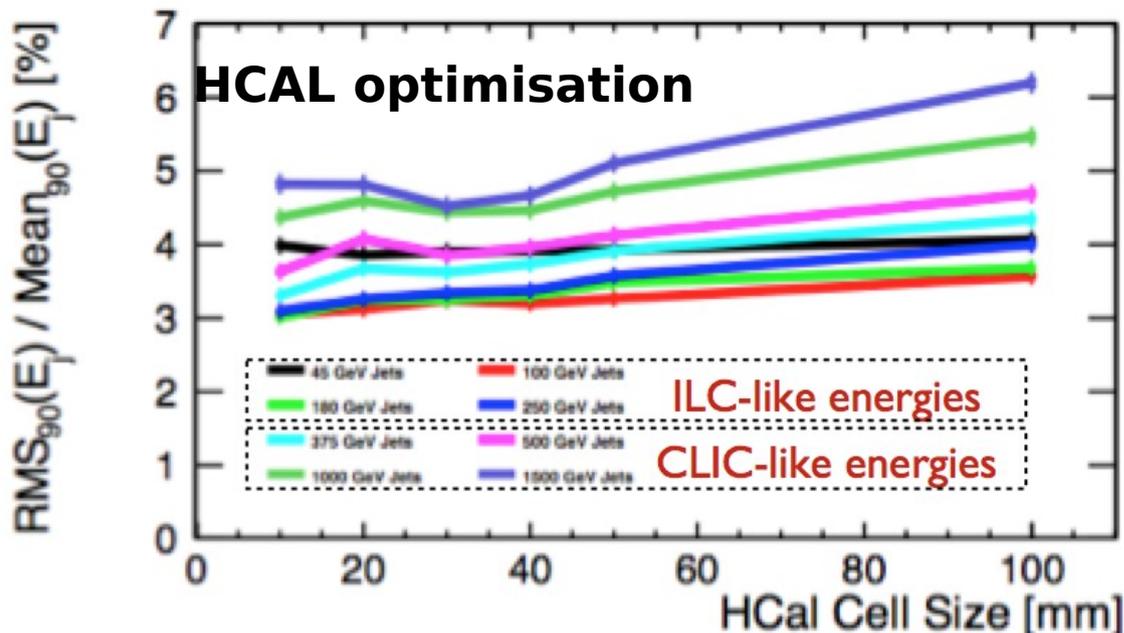
$e^+e^- \rightarrow W^+W^- \rightarrow l\nu q\bar{q}$  events at CLIC at 3 TeV with  $W$  energies of 100, 250, 500 and 1000 GeV  
Overlay 60 (120) BX worth of  $\gamma\gamma \rightarrow$  hadrons, select in-time reconstructed particles, remove lepton  
Reconstruct long. inv.  $k_t$  jets exclusively ( $N=2, R=0.7$ )



Energy resolution at high energy is not too badly affected, but can deteriorate strongly at low energy. Mass resolution suffers.

[CLIC CDR, Marshall, Münnich & Thomson, arXiv:1209.4039],  
See also: M. Boronat et al., PLB750 (2015) 95-99

# Pandora ILC/CLIC synergies



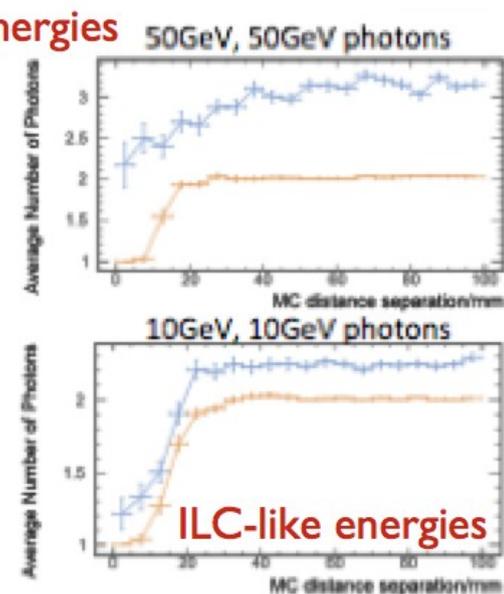
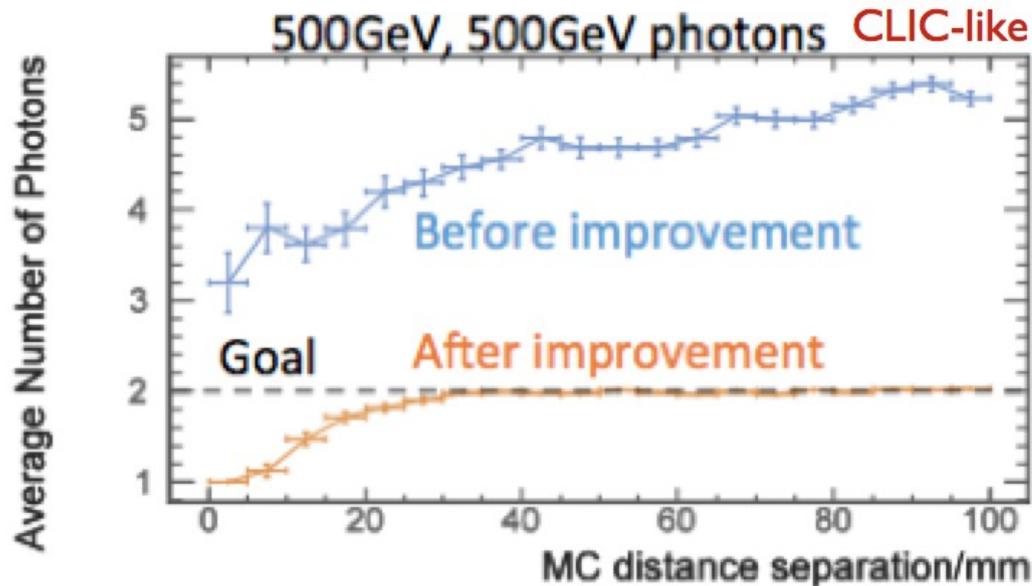
Jet energy resolution vs HCAL cell size, for  $45 \text{ GeV} \leq E_j \leq 1.5 \text{ TeV}$

(The Devil's in the detail for these kinds of plots)

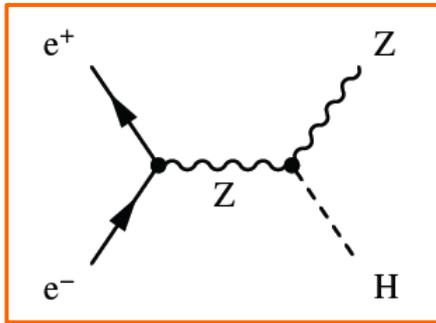
HCAL Timing Cuts: 10 ns  
 ECal Timing Cuts: 20 ns  
 Hadronic Energy Truncation:  $10^6 \text{ GeV}$   
 Software: ilcsoft\_v01-17-05  
 Digitiser: ILDCaloDigi, without new realistic options,  
 Calibration: As documented in PandoraAnalysis v02-00-00

## Photon reconstruction

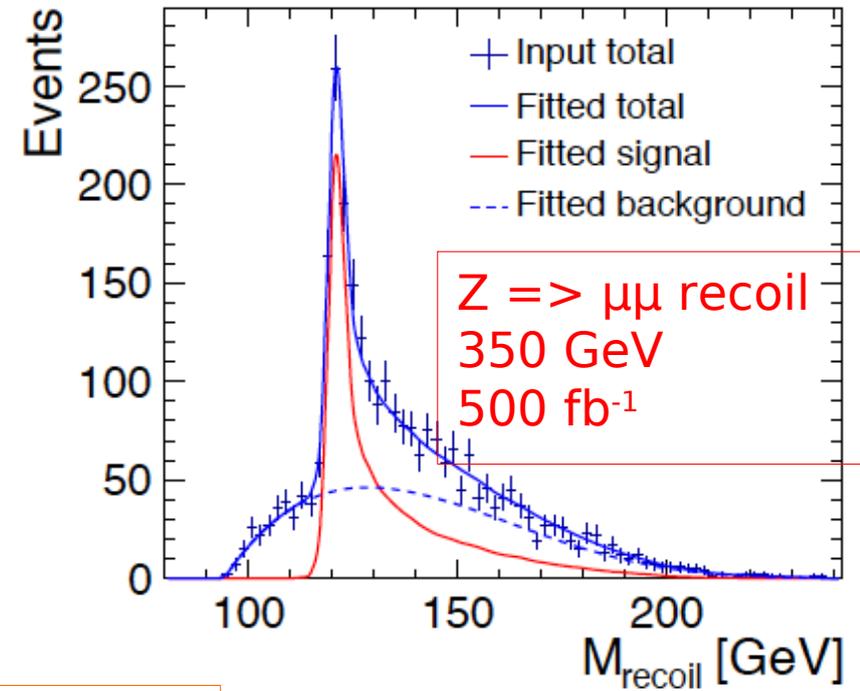
e.g. photon fragment removal algorithms



# Higgsstrahlung $e^+e^- \rightarrow HZ$ @ 350 GeV



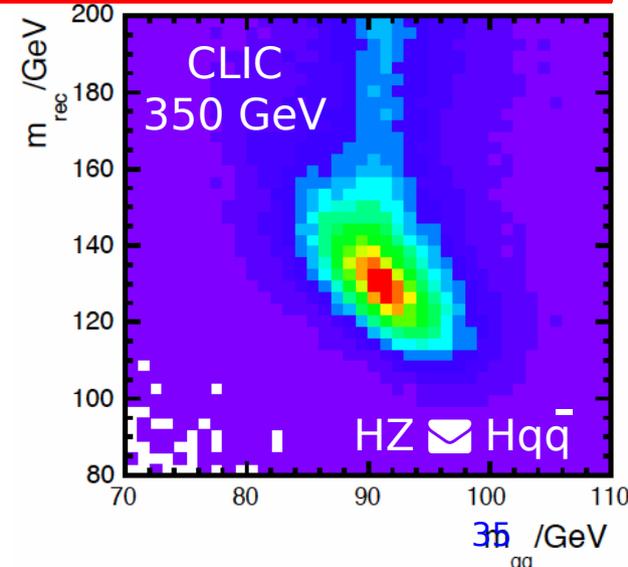
**HZ** events, selected through **Z recoil**  
**model-independent** measurement  
 $\Rightarrow g_{HZZ}$  coupling and Higgs mass



Z => $\mu\mu$ BR~3.5%	very clean	} $\Delta(\sigma_{HZ}) = \pm 4.2\%$
Z => ee BR~3.5%	very clean	
Z => qq BR~70%	almost model independent	$\Delta(\sigma_{HZ}) = \pm 1.8\%$

$\Delta(g_{HZZ}) = \pm 0.8\%$

HZ  $\rightarrow Hq\bar{q}$ : better precision found at 350 GeV than at 250 GeV or 420 GeV (trade-off between detector resolution and physics bkg)

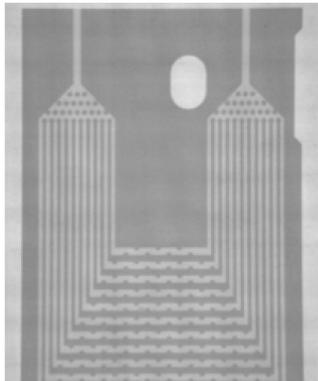
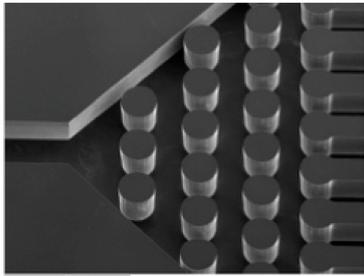


HZ  $\Rightarrow Hq\bar{q}$  also gives access to invisible Higgs decay

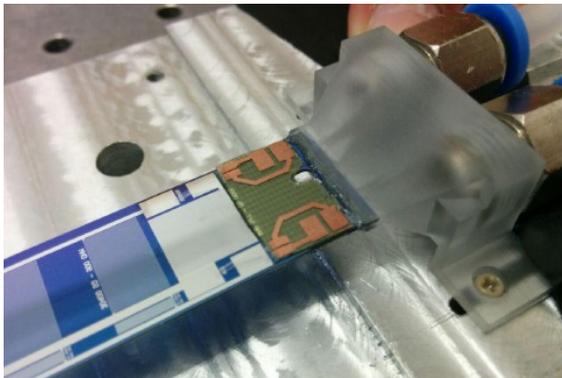
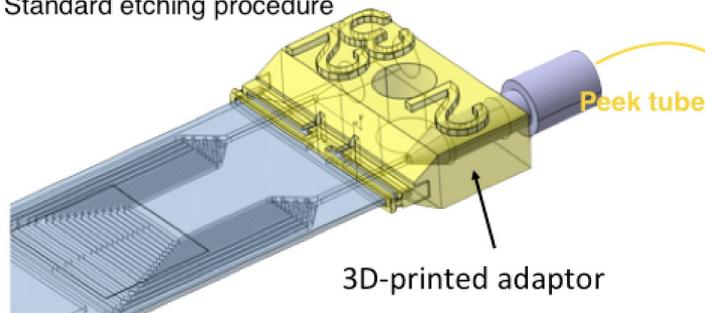
# Vertex engineering



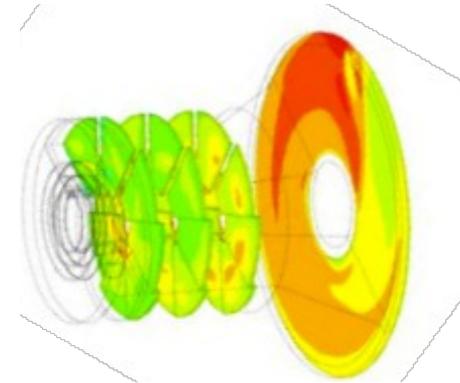
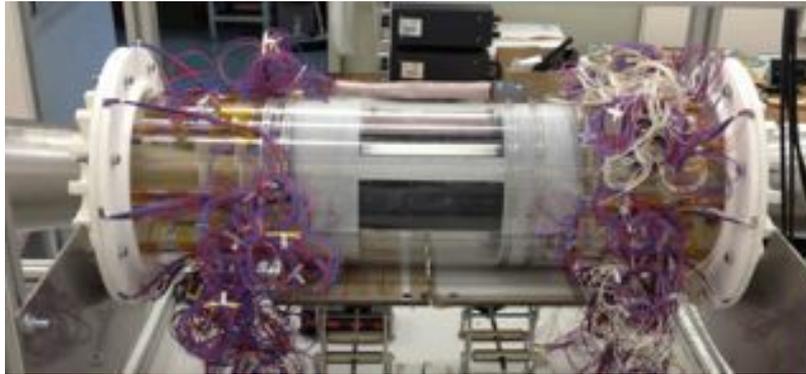
## micro-channel cooling



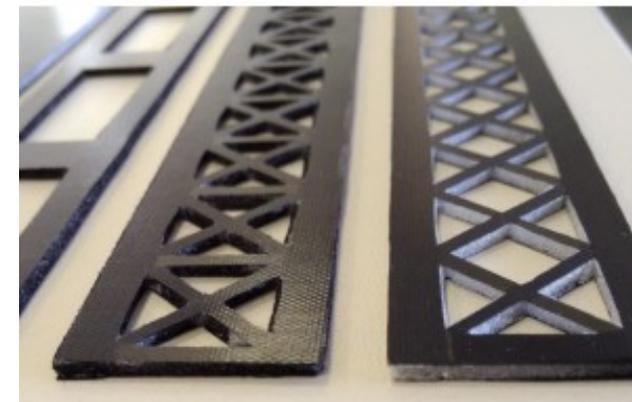
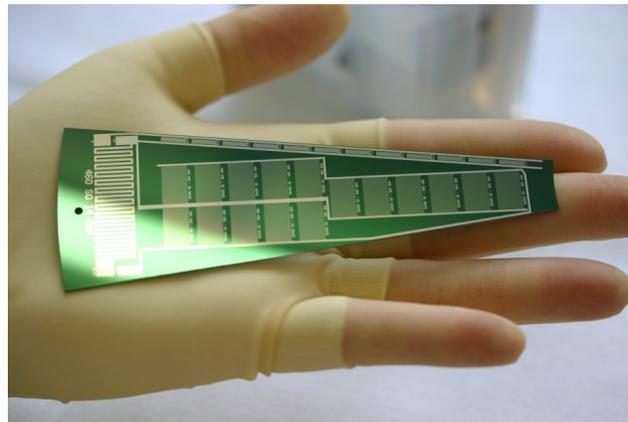
Micro-channel pattern in handle wafer  
Standard etching procedure



## air cooling simulations/tests

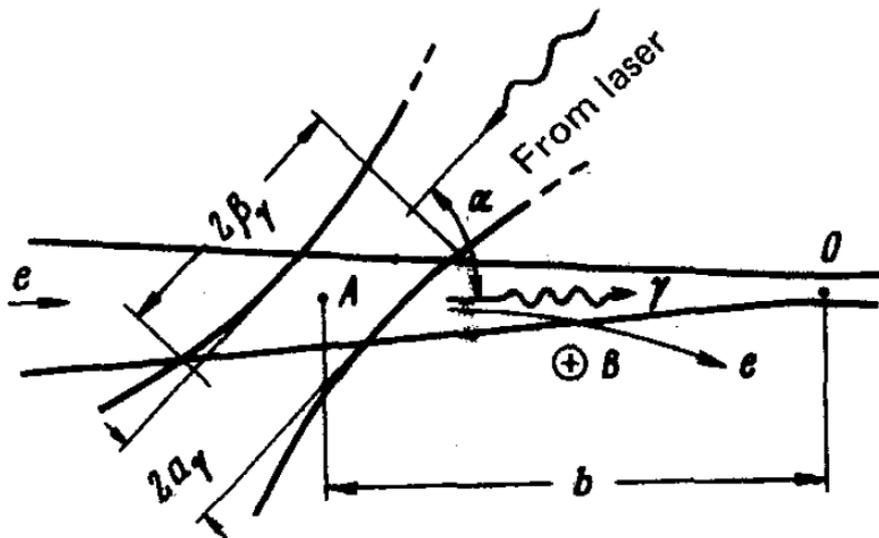


## thin supports



# Photon Collider

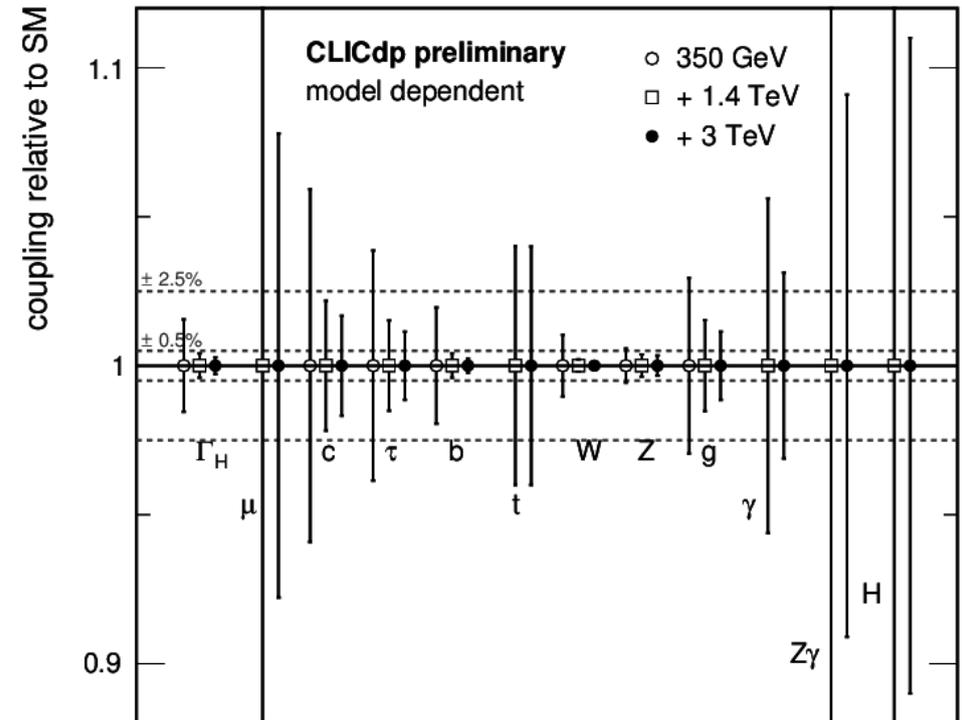
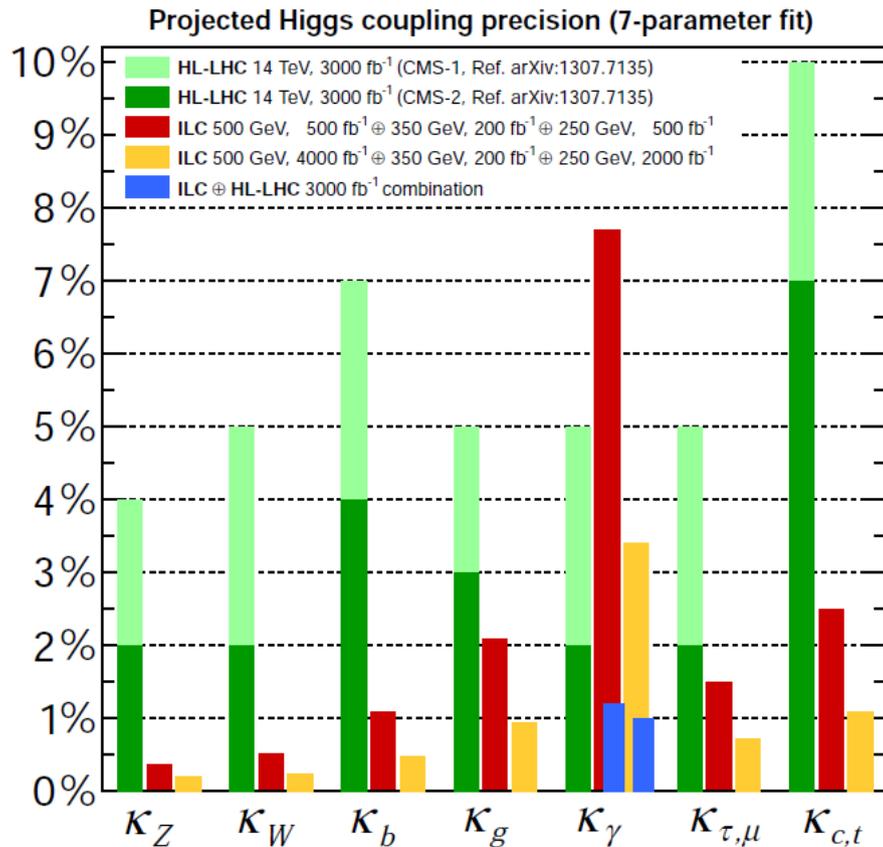
- Idea goes back to Novosibirsk in the early 1980s
- Extensively studied in TESLA TDR and still part of the ILC TDR design considerations. See V. Telnov, JINST9 (2014) C09029



High-energy, high-lumi electron beam transfers its energy to photons from a laser through Compton back-scattering

Resulting photon beam has  $E_\gamma \sim 0.8 E_b$  and a luminosity that's not too different from the parent  $e^+e^-$  collider

# Higgs couplings - comparisons



Channel	Measurement	Observable	Statistical precision		
			350 GeV 500 fb <sup>-1</sup>	1.4 TeV 1.5 ab <sup>-1</sup>	3.0 TeV 2.0 ab <sup>-1</sup>
ZH	Recoil mass distribution	$m_H$	120 MeV	—	—
ZH	$\sigma(\text{HZ}) \times BR(\text{H} \rightarrow \text{invisible})$	$\Gamma_{\text{inv}}$	0.6%	—	—
ZH	$\text{H} \rightarrow \text{b}\bar{\text{b}}$ mass distribution	$m_H$	tbd	—	—
Hv <sub>e</sub> $\bar{\nu}_e$	$\text{H} \rightarrow \text{b}\bar{\text{b}}$ mass distribution	$m_H$	—	40 MeV*	33 MeV*
ZH	$\sigma(\text{HZ}) \times BR(\text{Z} \rightarrow \ell^+ \ell^-)$	$g_{\text{HZZ}}^2$	4.2%	—	—
ZH	$\sigma(\text{HZ}) \times BR(\text{Z} \rightarrow \text{q}\bar{\text{q}})$	$g_{\text{HZZ}}^2$	1.8%	—	—
ZH	$\sigma(\text{HZ}) \times BR(\text{H} \rightarrow \text{b}\bar{\text{b}})$	$g_{\text{HZZ}}^2 g_{\text{Hbb}}^2 / \Gamma_H$	0.85%	—	—
ZH	$\sigma(\text{H} + \text{X}) \times BR(\text{H} \rightarrow \text{c}\bar{\text{c}})$		10.7%	—	—
ZH	$\sigma(\text{H} + \text{X}) \times BR(\text{H} \rightarrow \text{gg})$		4.1%	—	—
ZH	$\sigma(\text{HZ}) \times BR(\text{H} \rightarrow \tau^+ \tau^-)$	$g_{\text{HZZ}}^2 g_{\text{H}\tau\tau}^2 / \Gamma_H$	6.2%	—	—
ZH	$\sigma(\text{HZ}) \times BR(\text{H} \rightarrow \text{WW}^*)$	$g_{\text{HZZ}}^2 g_{\text{HWW}}^2 / \Gamma_H$	5.1%	—	—
ZH	$\sigma(\text{HZ}) \times BR(\text{H} \rightarrow \text{ZZ}^*)$	$g_{\text{HZZ}}^2 g_{\text{HZZ}}^2 / \Gamma_H$	tbd	—	—
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \text{b}\bar{\text{b}})$	$g_{\text{HWW}}^2 g_{\text{Hbb}}^2 / \Gamma_H$	1.8%	0.4%	0.3%
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \text{c}\bar{\text{c}})$	$g_{\text{HWW}}^2 g_{\text{Hcc}}^2 / \Gamma_H$	—	6.1%	6.9%
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \text{gg})$		—	5.0%	4.3%
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \tau^+ \tau^-)$	$g_{\text{HWW}}^2 g_{\text{H}\tau\tau}^2 / \Gamma_H$	—	4.2%	4.4%
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \mu^+ \mu^-)$	$g_{\text{HWW}}^2 g_{\text{H}\mu\mu}^2 / \Gamma_H$	—	38%	25%
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \gamma\gamma)$		—	15%	10% <sup>†</sup>
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \text{Z}\gamma)$		—	42%	30% <sup>†</sup>
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \text{WW}^*)$	$g_{\text{HWW}}^4 / \Gamma_H$	tbd	1.0%	0.7% <sup>†</sup>
Hv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{Hv}_e \bar{\nu}_e) \times BR(\text{H} \rightarrow \text{ZZ}^*)$	$g_{\text{HWW}}^2 g_{\text{HZZ}}^2 / \Gamma_H$	—	5.6%	3.9% <sup>†</sup>
He <sup>+</sup> e <sup>-</sup>	$\sigma(\text{He}^+ \text{e}^-) \times BR(\text{H} \rightarrow \text{b}\bar{\text{b}})$	$g_{\text{HZZ}}^2 g_{\text{Hbb}}^2 / \Gamma_H$	—	1.8%	2.3% <sup>†</sup>
t $\bar{\text{t}}$ H	$\sigma(\text{t}\bar{\text{t}}\text{H}) \times BR(\text{H} \rightarrow \text{b}\bar{\text{b}})$	$g_{\text{Htt}}^2 g_{\text{Hbb}}^2 / \Gamma_H$	—	8%	tbd
HHv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{HHv}_e \bar{\nu}_e)$	$g_{\text{HHWW}}$	—	7%	3%
HHv <sub>e</sub> $\bar{\nu}_e$	$\sigma(\text{HHv}_e \bar{\nu}_e)$	$\lambda$	—	32%	16%
HHv <sub>e</sub> $\bar{\nu}_e$	with -80% e <sup>-</sup> polarization	$\lambda$	—	24%	12%

*CLIC Higgs coupling  
measurements  
Overview for Higgs paper  
as per 18-01-2016*