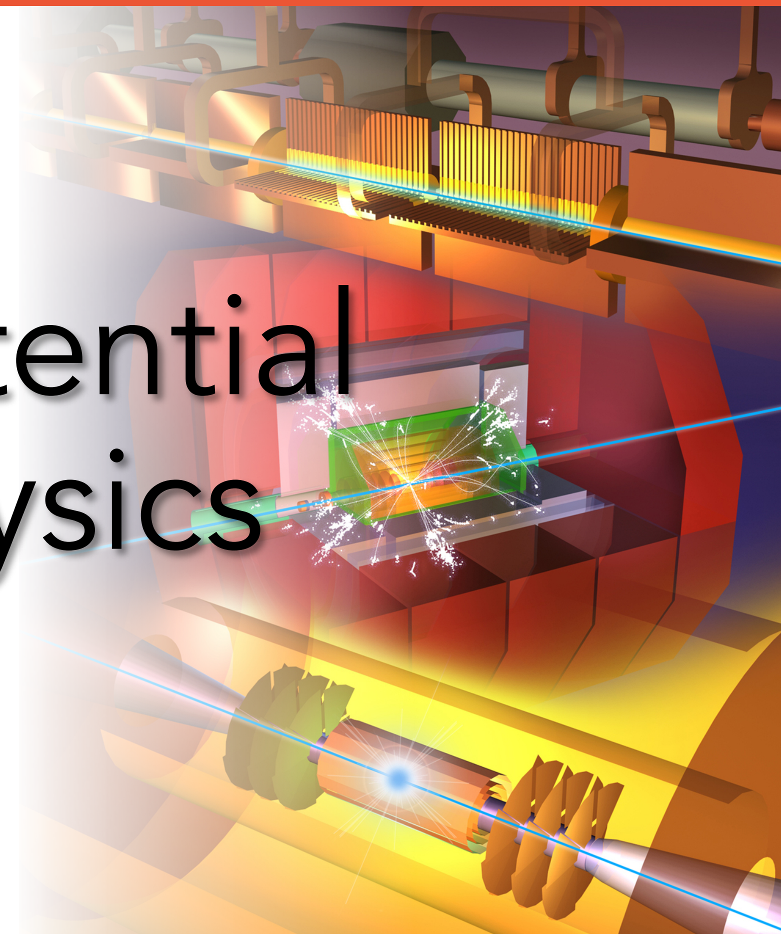
The CLIC Potential for New Physics



EPS-HEP2019, 12 July 2019

Aidan Robson, University of Glasgow
on behalf of the CLICdp Collaboration

Physics landscape

- Why are we not seeing new physics around the TeV scale?
  – is the mass scale beyond the LHC reach?
  – is the mass scale within LHC's reach,
    but final states are elusive?

- What we want from a next-generation collider:

  Address both possibilities:
  - precision measurements
  - sensitivity to elusive signatures
  - extended energy/mass reach

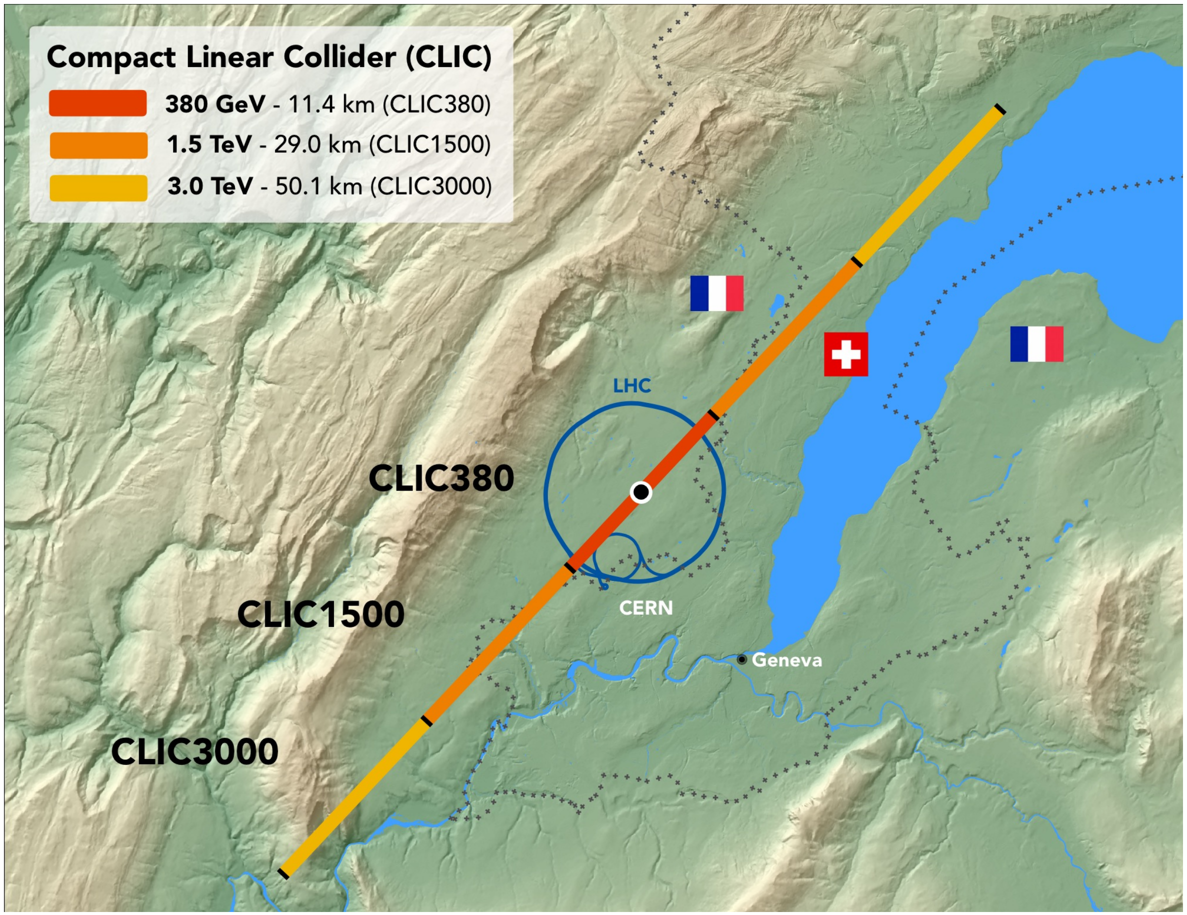
  Wide exploration potential:

  – in particular, full exploitation of new probes:

  exploration of EWSB phenomena; Higgs and top quark with precision significantly beyond HL-LHC, including Higgs self-coupling and possible existence of other particles coupling to Higgs

The Compact Linear Collider

- A high-luminosity, multi-TeV electron–positron collider
- Planned for construction at CERN in three energy stages:

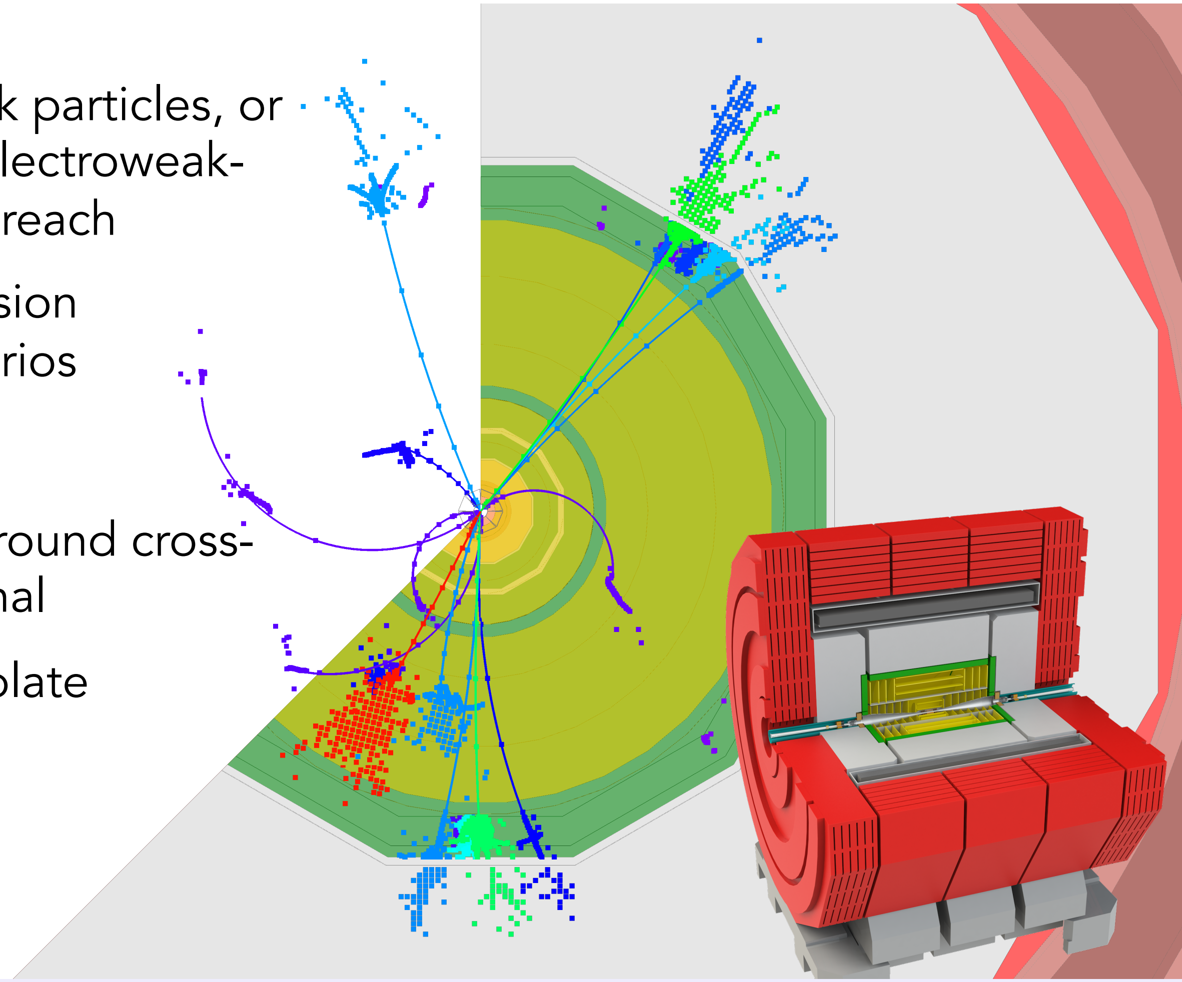


- 380GeV, focusing on precision Higgs boson and top-quark physics, starting around 2035
- 1.5 and 3TeV, expanding Higgs and top studies including Higgs self-coupling, and opening higher direct and indirect sensitivity to Beyond Standard Model (BSM)
- Nominal physics programme lasts for 25–30 years
- Benefit of linear machine: flexible Length/energy staging plan can be updated in response to developing physics landscape

New physics searches

- CLIC can probe TeV-scale electroweak particles, or particles that interact with the SM with electroweak-sized couplings, well above the HL-LHC reach
- Indirect searches: can interpret precision measurements in particular model scenarios
- Direct searches:
  - For standard final states, SM background cross-sections typically comparable with signal
  - Clean e^+e^- environment helps to isolate non-standard signatures

–> explore landscape for broad classes of theories

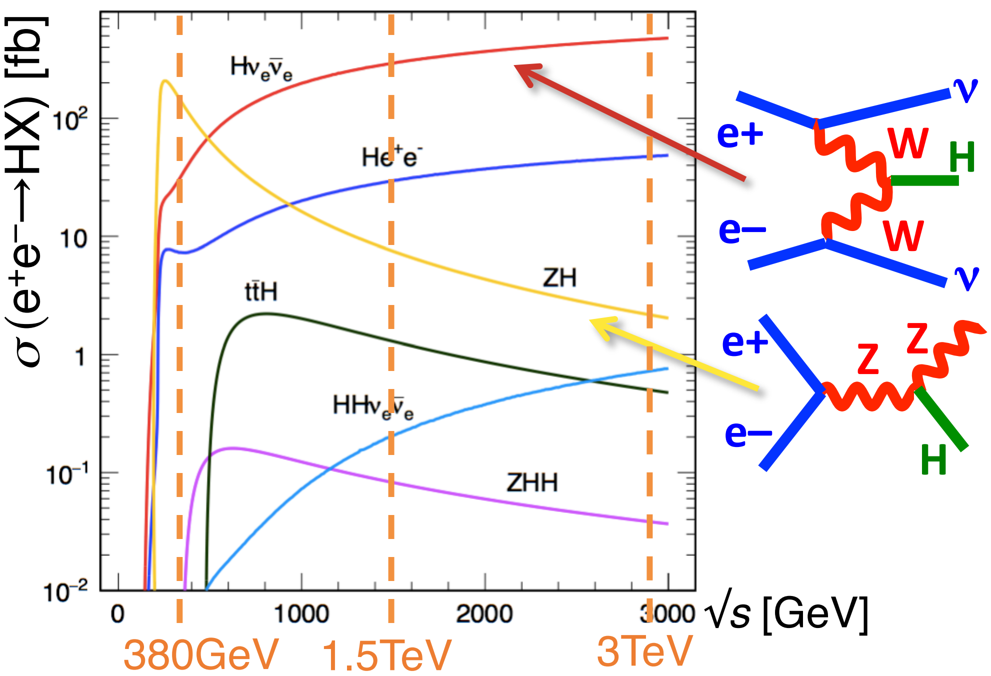


See poster by Emilia Leogrande "The CLIC Detector"
https://indico.cern.ch/event/577856/contributions/3420146/

Probing using known processes

- Precision Higgs physics:
  - Single-Higgs production

- Higgs studies are all full GEANT-based simulation studies including beam backgrounds

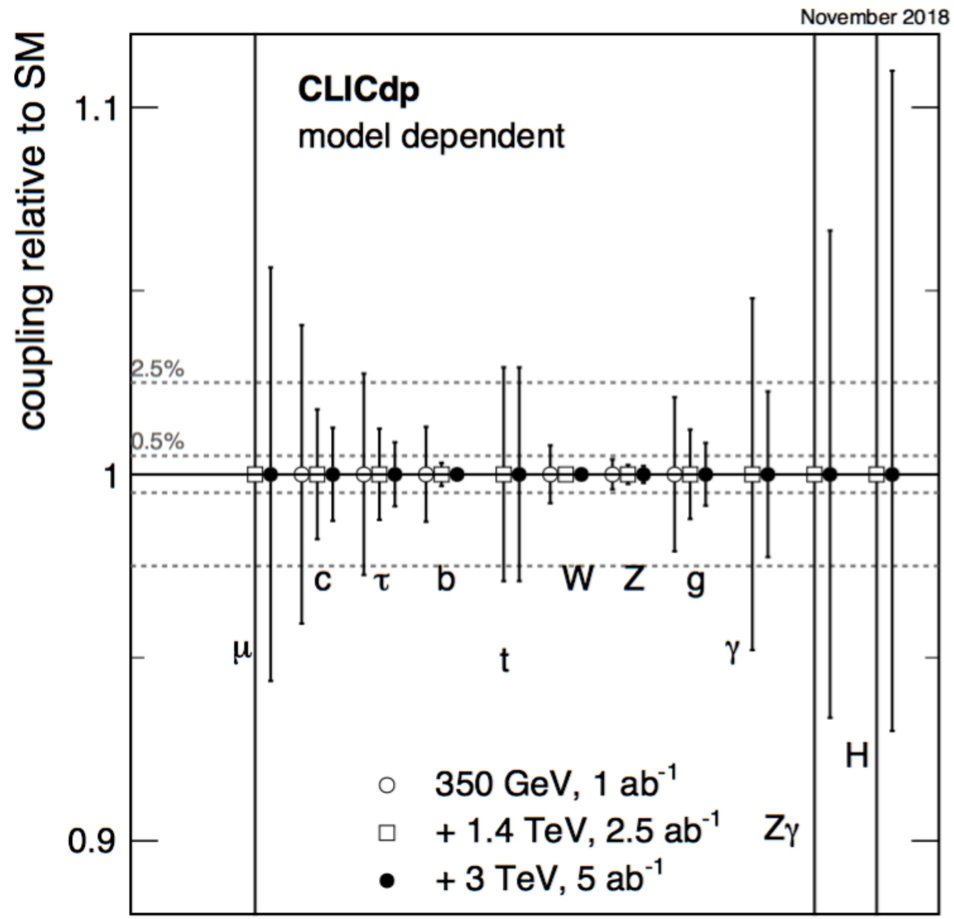


- Combine all 3 stages for best measurements
  –> global fit including correlations

- c/b/W/Z couplings significantly more precise than HL-LHC already after 380GeV stage

Probing using known processes

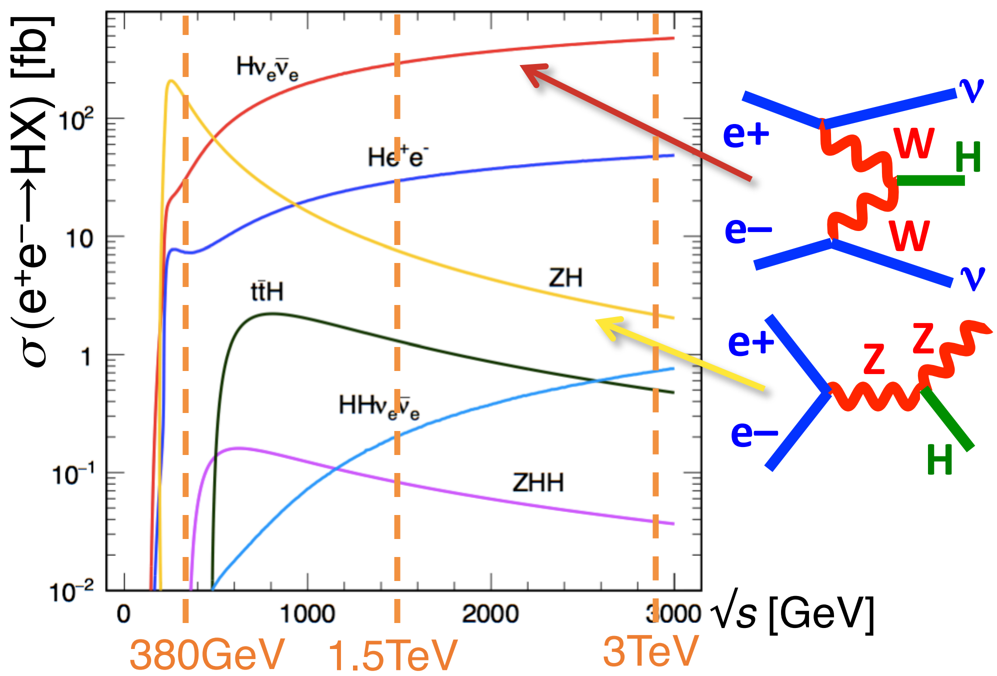
- Precision Higgs physics:
  - Single-Higgs production



- Precision ≲1% for most couplings

Based on Eur. Phys. J. C 77 475 (2017)
updated to new luminosity scenario arXiv:1812.01644

- Higgs studies are all full GEANT-based simulation studies including beam backgrounds

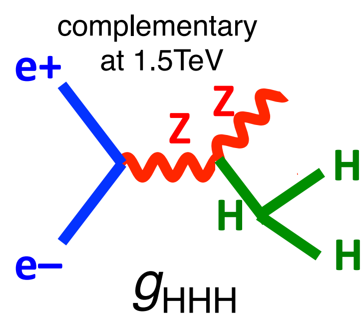


- Combine all 3 stages for best measurements –> global fit including correlations
- c/b/W/Z couplings significantly more precise than HL-LHC already after 380GeV stage

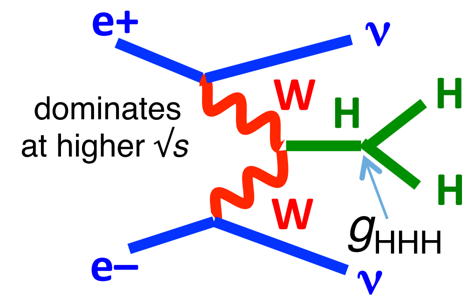
Probing using known processes

- Precision Higgs physics:
  - Single-Higgs production
  - HH production allows precise measurement of g_{HHH}

- Higgs self-coupling requires high-energy running



5σ observation at 1.4TeV stage



5σ observation at 3TeV stage

Template fit at 3TeV using two variables: M(HH) differential distribution and BDT score

Gives unrivalled sensitivity to Higgs self-coupling:

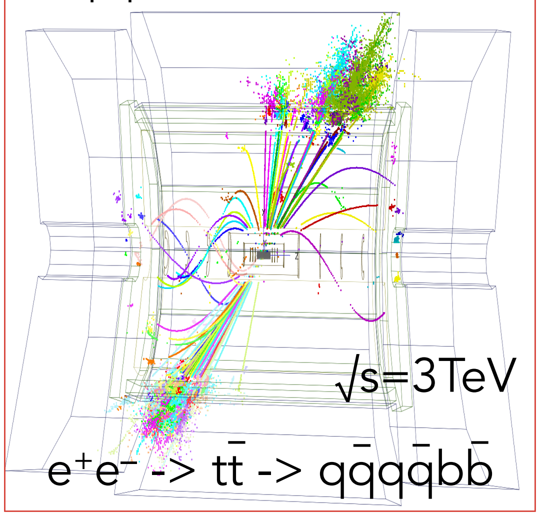
$$\Delta g_{HHH}/g_{HHH} = {}^{+11\%}_{-7\%}$$

See dedicated talk by Ulrike Schnoor in the Higgs sessions
https://indico.cern.ch/event/577856/contributions/3420199/

Probing using known processes

- Precision Higgs physics:
  - Single-Higgs production
  - HH production allows precise measurement of g_{HHH}
- Precision top-quark physics:
  - Cross-sections, asymmetries & optimal observables at all energies (necessary to disentangle effects), including boosted regime, ttH

First study of boosted top production in e^+e^-

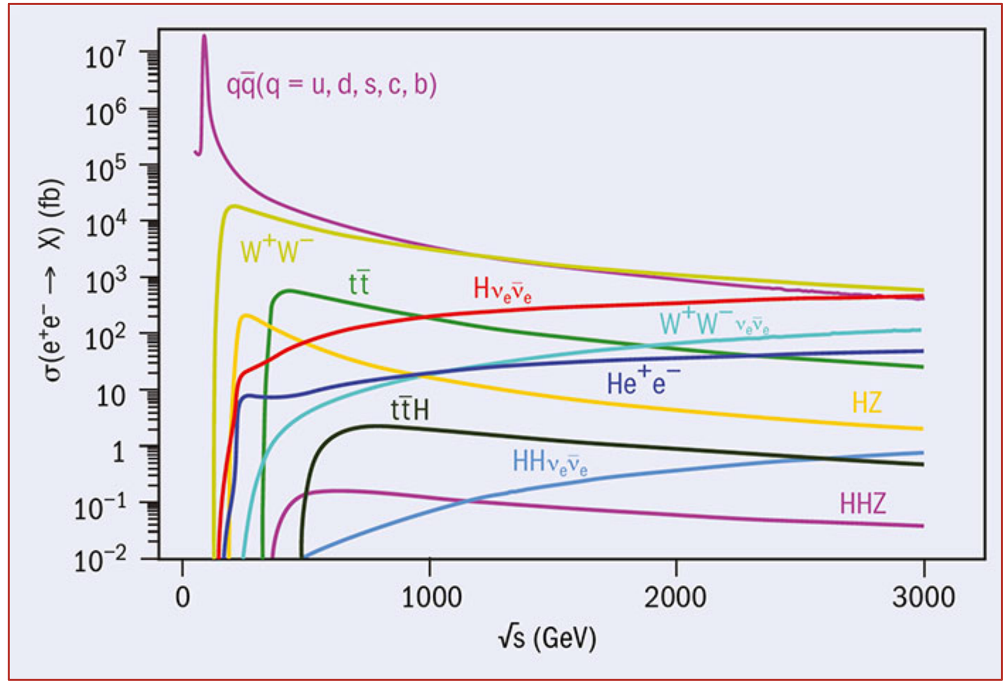


- Can probe CP-odd component of ttH coupling to $0.02<\Delta\sin^2\phi<0.08$ for full range of $\sin^2\phi$
- Benefit from electron beam polarisation

See dedicated talk by Filip Zarnecki in the top sessions
https://indico.cern.ch/event/577856/contributions/3420354/

Probing using known processes

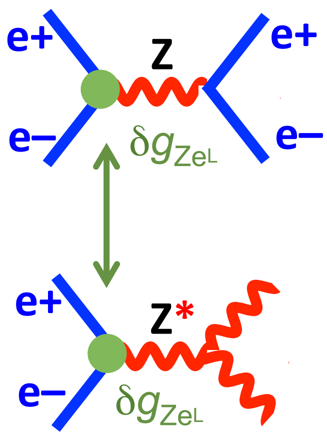
- Precision Higgs physics:
  - Single-Higgs production
  - HH production allows precise measurement of g_{HHH}
- Precision top-quark physics:
  - Cross-sections, asymmetries & optimal observables at all energies (necessary to disentangle effects), including boosted regime, ttH
- Precision two-fermion and multi-boson measurements



- BSM physics reach via precision measurements:

At low energy ($\sqrt{s}=m_Z$)

At high energy ($\sqrt{s}$=3TeV)



Imagine measuring $\left.\frac{d\sigma}{\sigma_{SM}}\right|_{\sqrt{s}=m_Z}$ ~10^{-4} => $\delta g_{Ze_L} \sim 10^{-4}$

Effect grows as s

$\left(\frac{3000}{91.2}\right)^2 \sim 1000$

same precision!

...equivalent to $\left.\frac{d\sigma}{\sigma_{SM}}\right|_{\sqrt{s}=3\text{TeV}}$ ~10% => $\delta g_{Ze_L} \sim 10^{-4}$

–> strongly benefit from high energies

Global sensitivity to BSM effects

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \sum_i \frac{c_i}{\Lambda^2}\mathcal{O}_i$$

Standard Model

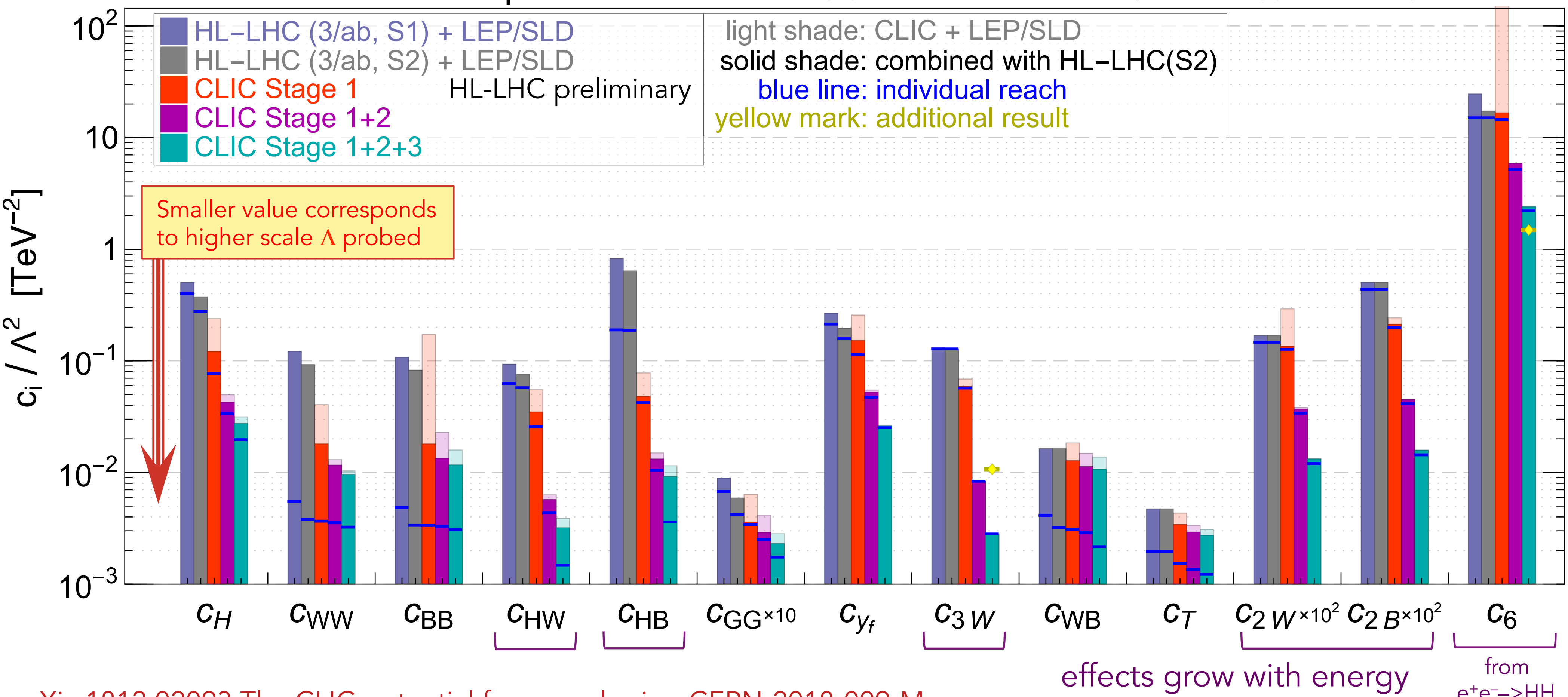
Scale of new decoupled physics

Dimension-6 operators

Put precision measurements together in global fits
Includes CLIC measurements of:
- Higgs
- Top
- WW
- $e^+e^- \to f\bar{f}$

Universal EFT fit

Strongly benefits from high-energy running

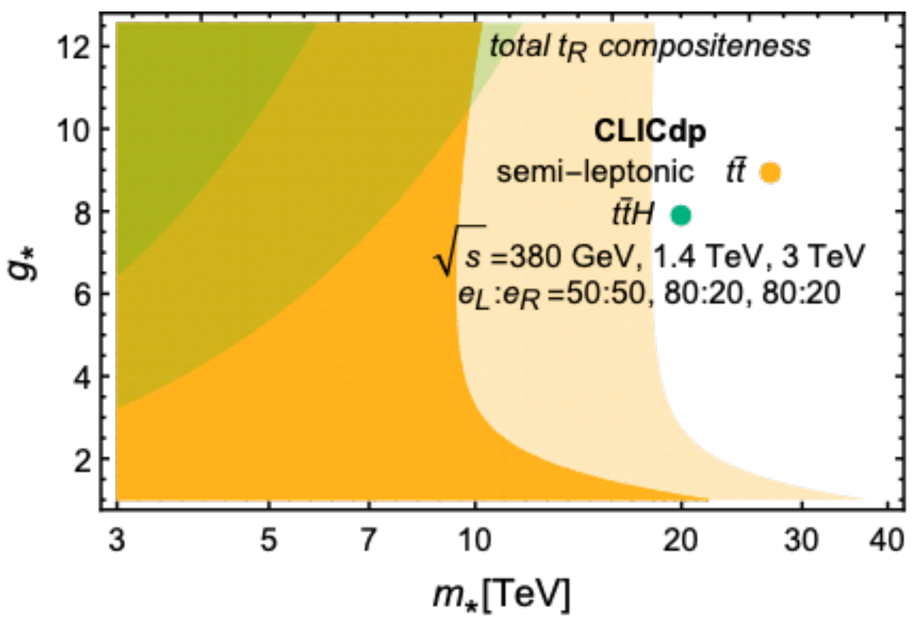


arXiv:1812.02093 The CLIC potential for new physics, CERN-2018-009-M

Higgs and top compositeness

◆ Composite Higgs or top would appear through SM-EFT operators – translate EFT limits into characteristic coupling strength g_* of composite sector and mass m_*

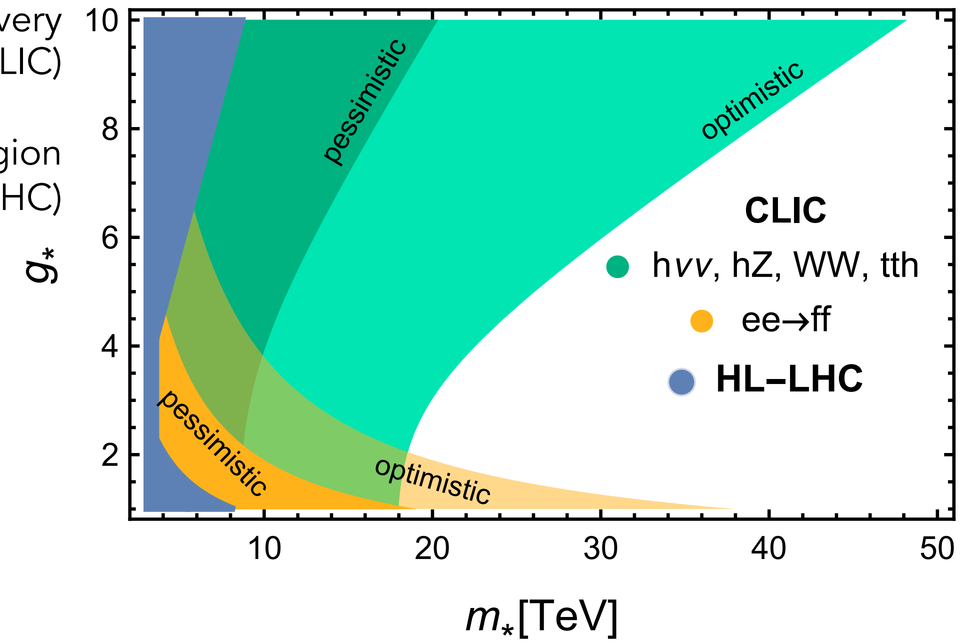
Top compositeness



5-σ discovery regions (CLIC)

exclusion region (HL-LHC)

Higgs compositeness



CLIC can ***discover*** top or Higgs compositeness up to ~10TeV compositeness scale (~30 – ~50TeV in favourable conditions) – above what HL-LHC can ***exclude***

arXiv:1812.02093 The CLIC Potential for New Physics

Dark matter

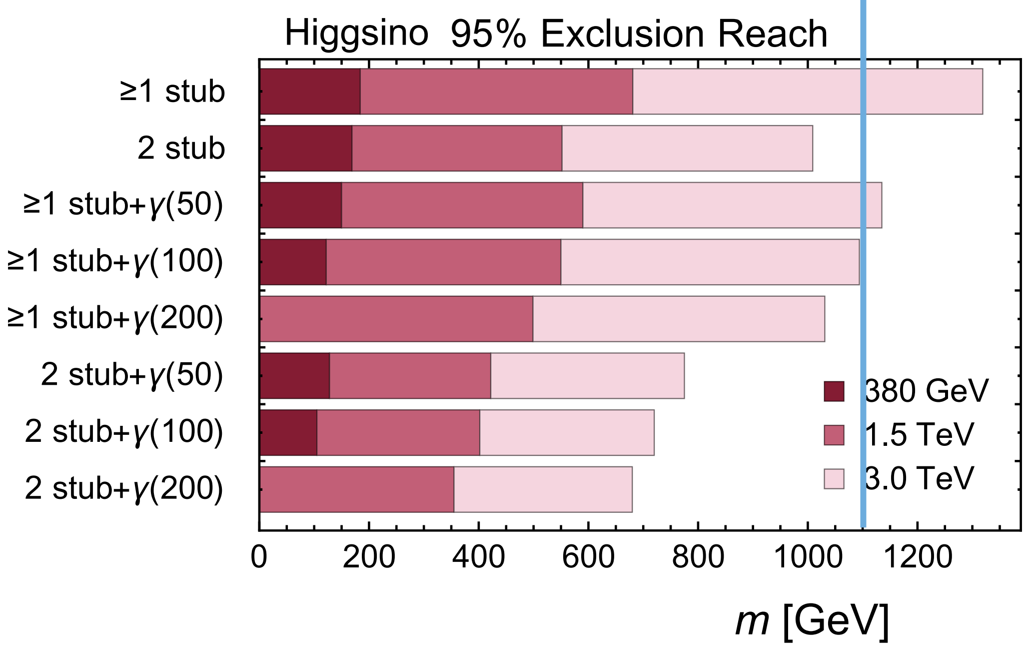
Higgsino:

WIMP dark matter candidate, connected to weak scale naturalness, and gauge coupling unification

When other superpartners decoupled:
$\chi^\pm$ slightly heavier than χ^0
$\chi^\pm \to \pi^\pm \chi^0$ **leaving 'disappearing track' in detector**

reach Higgsino mass of 1.1TeV, required for DM relic mass density – even with some level of background

diverse experimentally

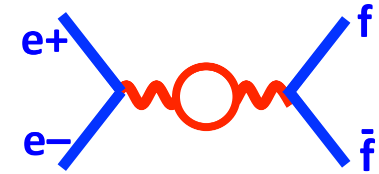


Electroweak precision tests:

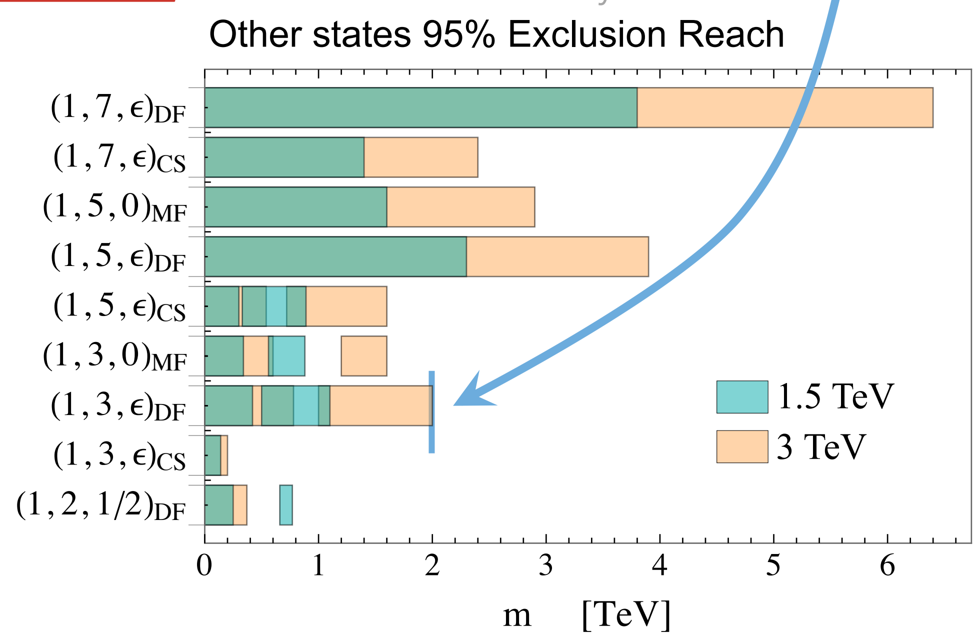
arXiv:1810.10993 - Di Luzio, Gröber, Panico

Precision measurements of $d\sigma/d(\cos\theta)$ in $e^+e^- \to f\bar{f}$

sensitive to new states
–> exclude mass ranges



e.g. for *n*=3 Dirac fermion, *m*=2TeV saturates DM relic mass density: can be excluded by CLIC

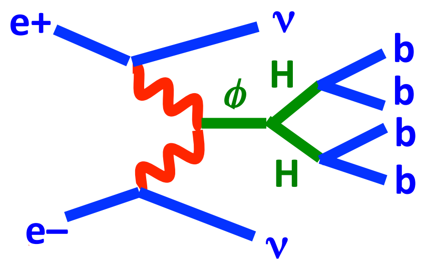


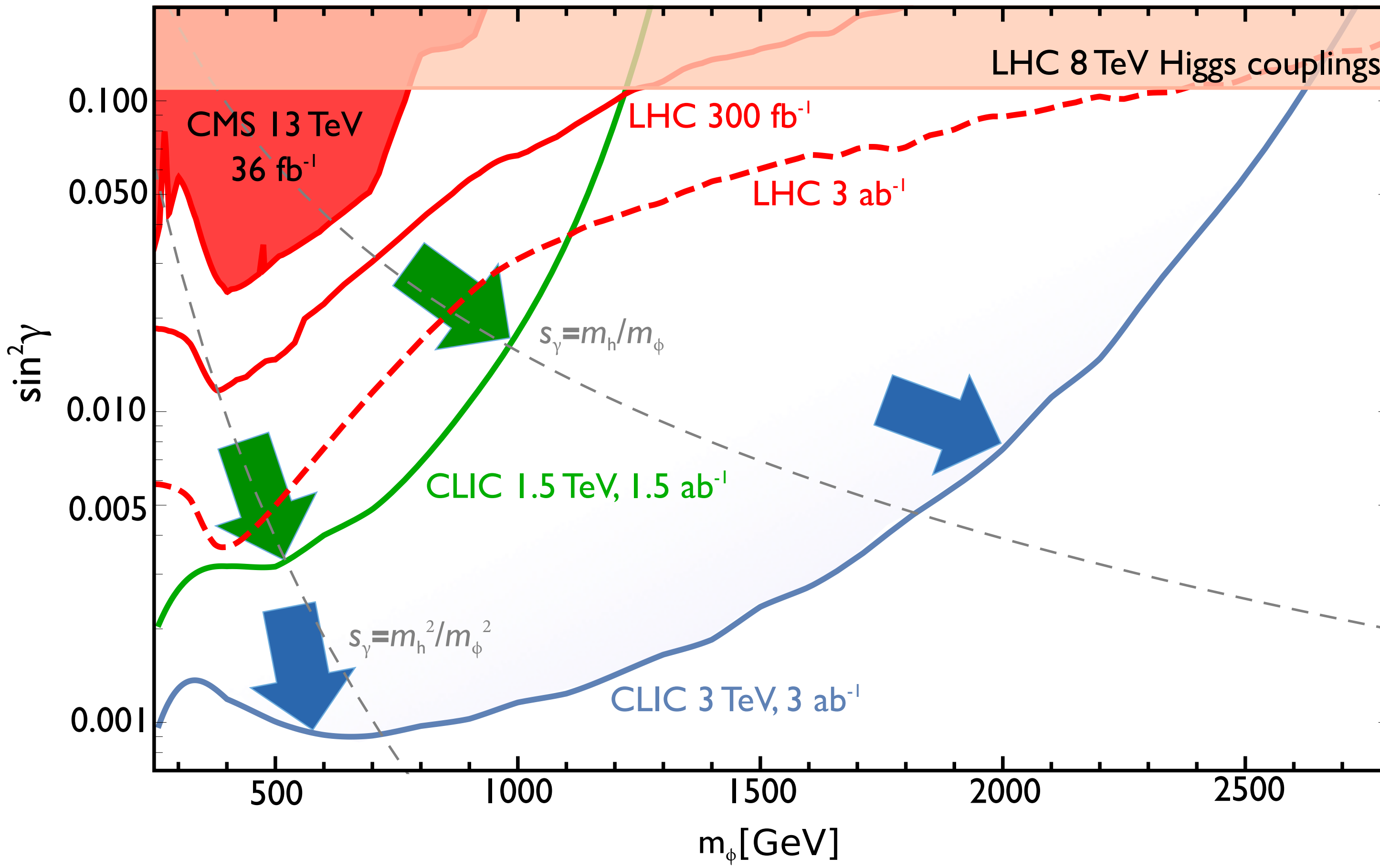
DF=Dirac Fermion, MF=Majorana Fermion, CS=Complex Scalar
SU(3)xSU(2)xU(1) representation; different *n*-tuplet multiplicities

arXiv:1812.02093 The CLIC Potential for New Physics

Higgs + heavy singlet

Direct search for real scalar singlet ϕ :





$$h = h_0 \cos\gamma + S \sin\gamma$$

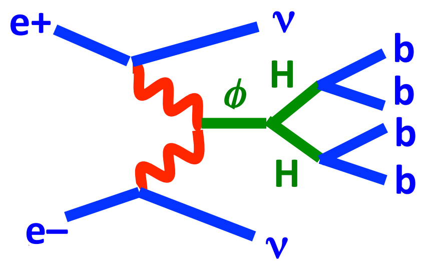
$$\phi = S \cos\gamma - h_0 \sin\gamma$$

γ is mixing angle of SM-like Higgs (m_h=125GeV), and singlet-like state ϕ

arXiv:1807.04743 – Buttazzo, Redigolo, Sala, Tesi
arXiv:1812.02093 The CLIC Potential for New Physics

Higgs + heavy singlet

Direct search for real scalar singlet ϕ :



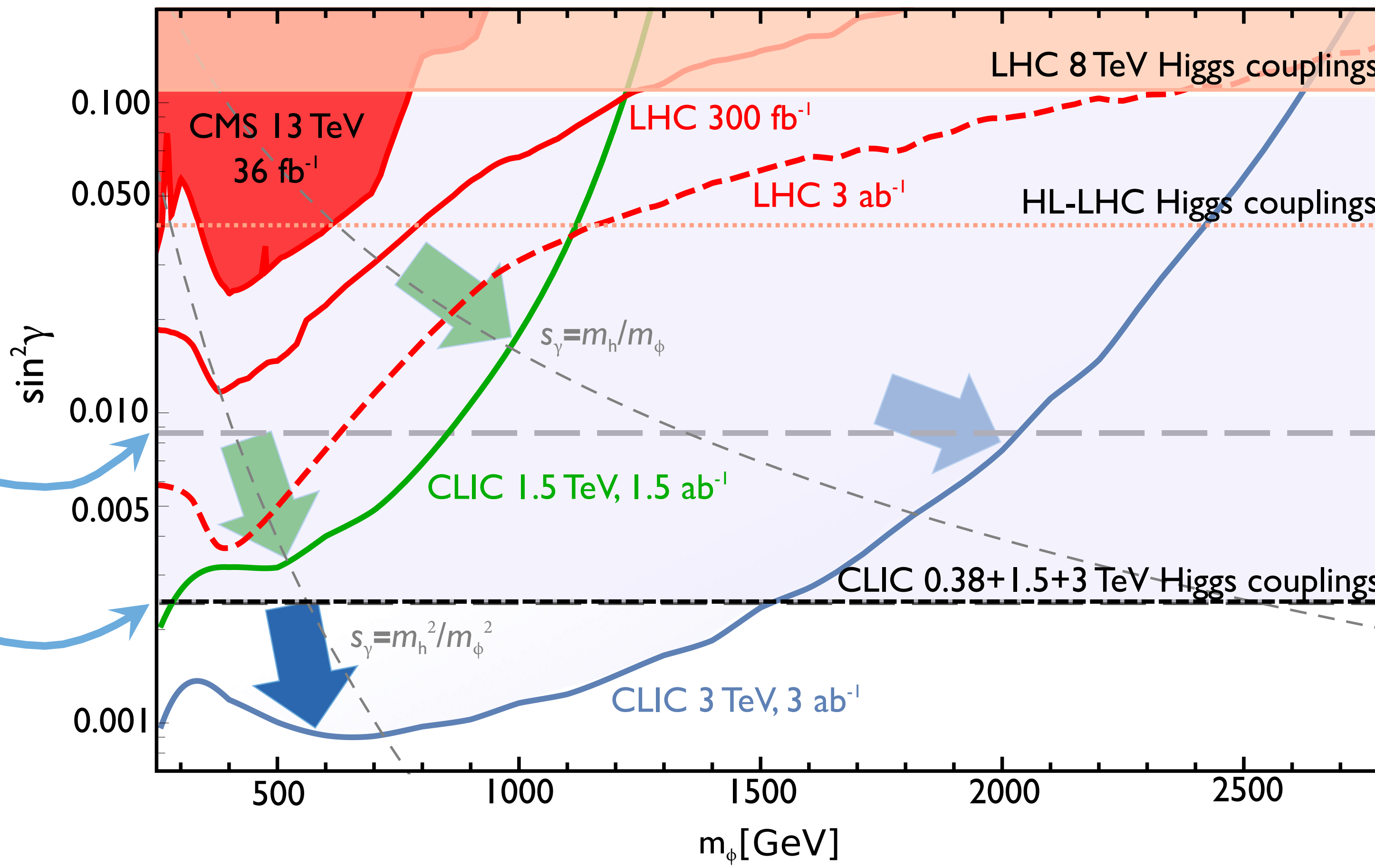
Complementary:

Indirect search using Higgs couplings

arXiv: 1608.07538

$\sin^2\gamma$<0.9% 95% CL (380GeV)

$\sin^2\gamma$<0.24% 95% CL (380GeV+1.5TeV+3TeV)



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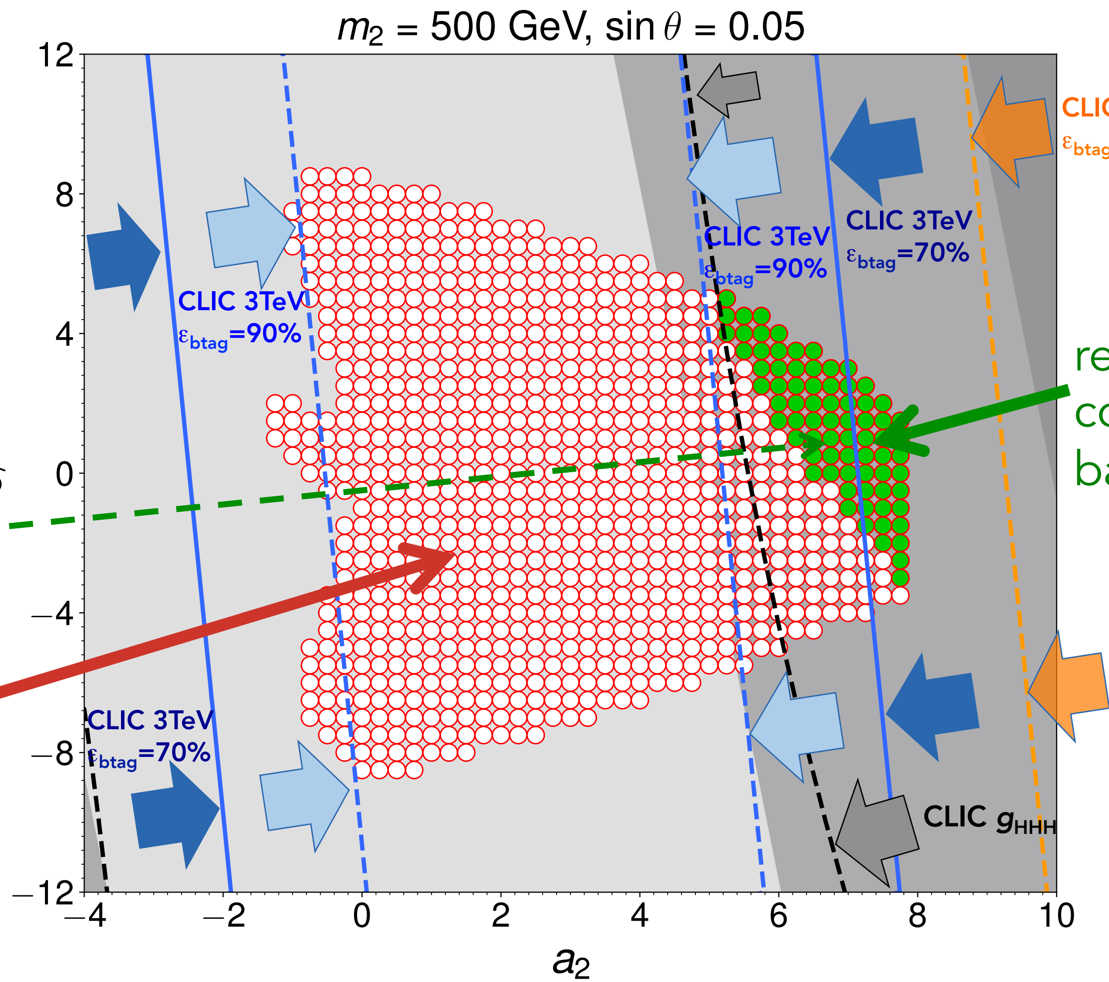
arXiv:1807.04743 – Buttazzo, Redigolo, Sala, Tesi

arXiv:1812.02093 The CLIC Potential for New Physics

Baryogenesis

arXiv:1807.04284 No, Spannowsky
arXiv:1812.02093 The CLIC Potential for New Physics

- We observe a matter-dominated universe
- For baryogenesis to account for this, need to add something to the SM
- EW phase transition required to be first order
- Explored for CLIC in the Higgs+singlet model:
resonant di-Higgs searches
Higgs self-coupling g_{HHH}
- Sensitive to the interesting region



regions compatible w/ unitarity, perturbativity, and absolute stability of the EW vacuum

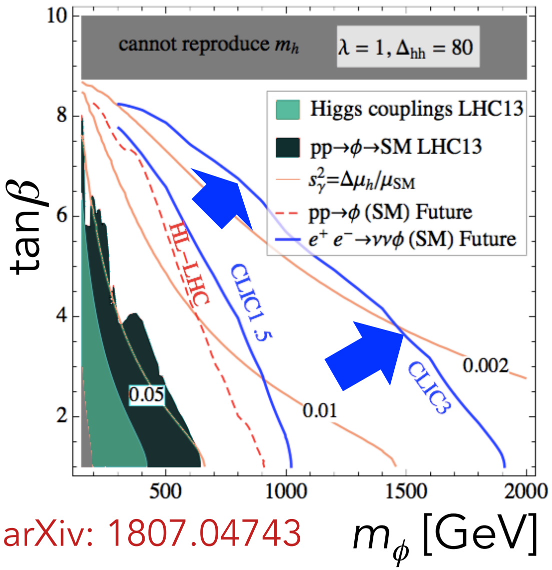
regions also compatible with baryogenesis

well-constrained by CLIC Higgs self-coupling (black) and CLIC resonant di-Higgs searches at 1.5TeV and 3 TeV

a_2 and b_3/v are parameters of the temperature-dependent effective potential; m_2 and θ are the singlet mass and mixing

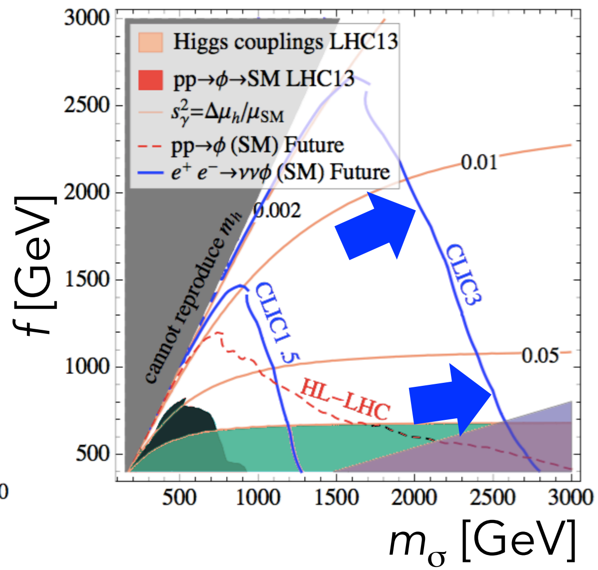
HL-LHC not sensitive at this low mixing sinθ=0.05

Interpretations and full programme



arXiv: 1807.04743

Higgs + singlet as **NMSSM**



Higgs + singlet as **Twin Higgs** model

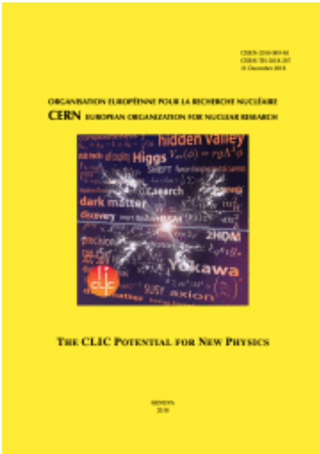
- Precision Higgs couplings and self-coupling
- Precision electroweak and top-quark analysis
- Sensitivity to BSM effects in the SMEFT
- Higgs and top compositeness
- Baryogenesis
- Direct discoveries of new particles
- Extra Higgs boson searches
- Dark matter searches
- Lepton and flavour violation
- Neutrino properties
- Hidden sector searches
- Exotic Higgs boson decays

Large theory community involved:
CLIC Physics Potential Working Group

Many more studies in:

The CLIC Potential for New Physics (250 pages)

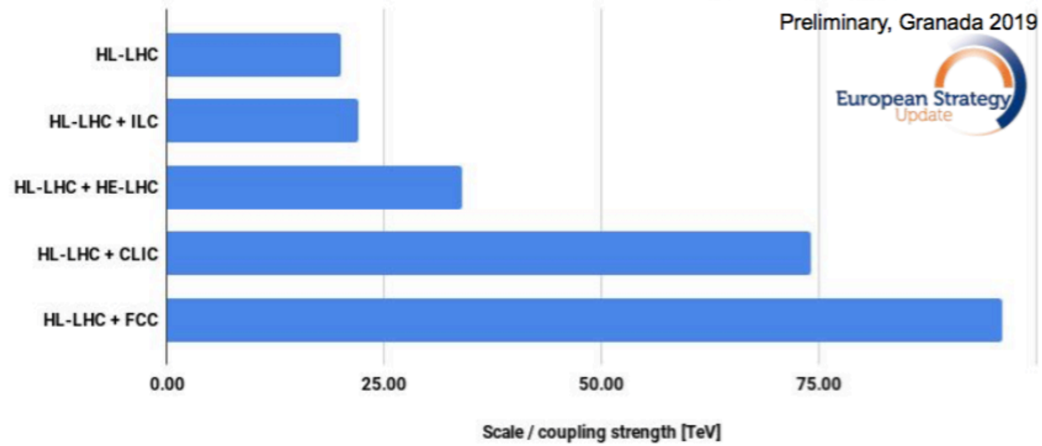
arXiv:1812.02093 CERN-2018-009-M



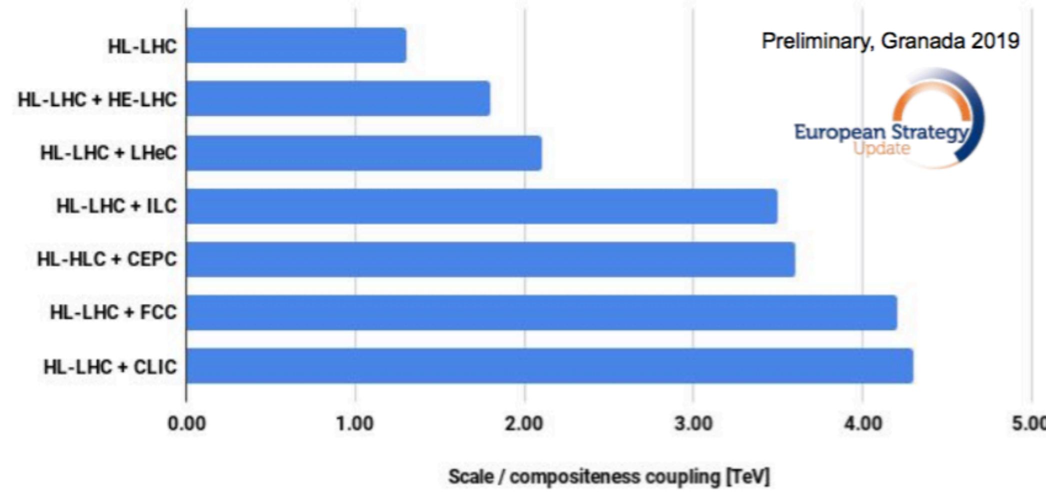
European Strategy for Particle Physics

Efforts to synthesize prospects from different proposed colliders for European Strategy development, shown in Open Symposium in May

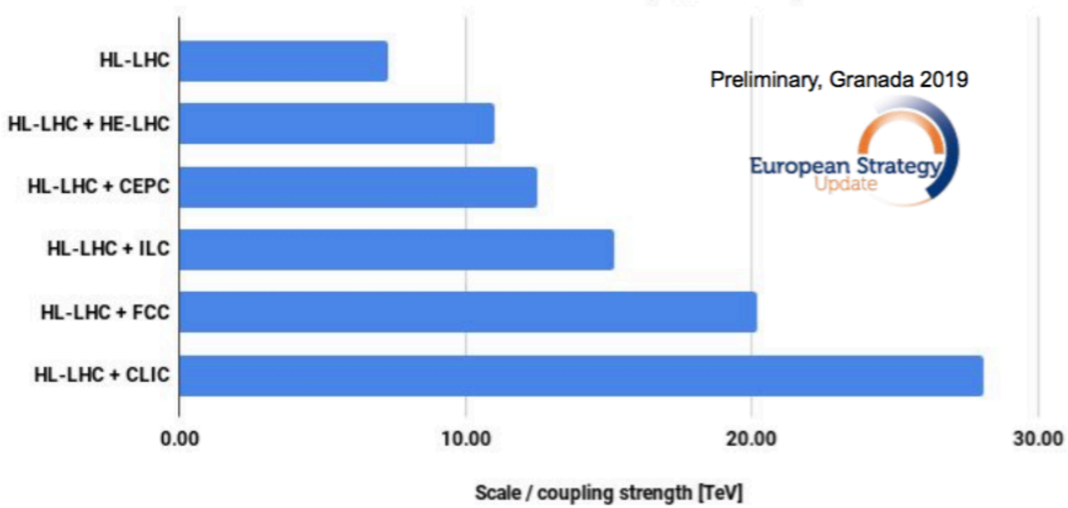
95% CL scale limits on 4-fermion contact interactions (W couplings)



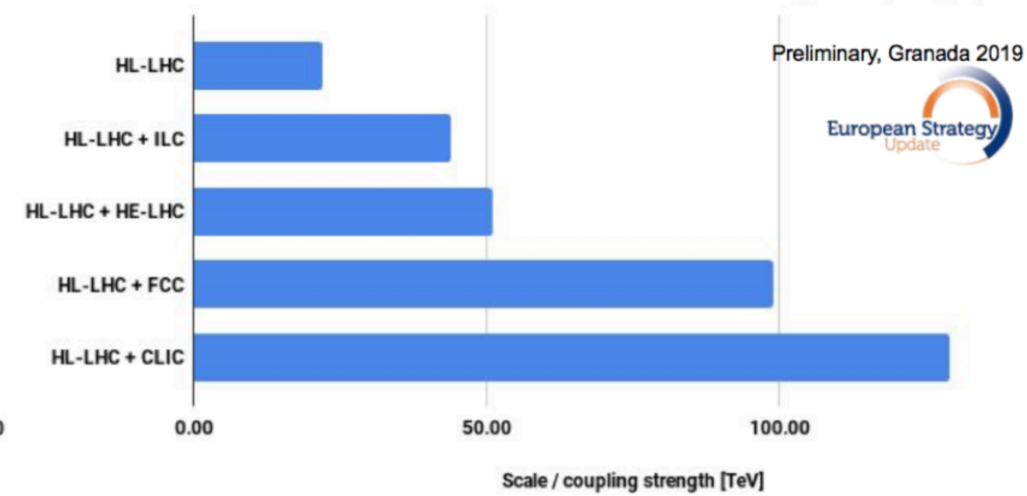
95% CL limits on compositeness scale (O_H operator)



95% CL scale limits on contact interactions (O_W term)



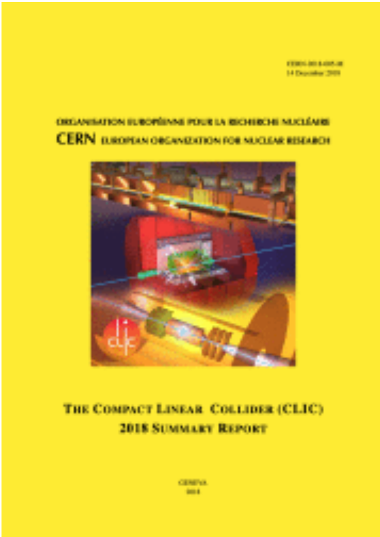
95% CL scale limits on 4-fermion contact interactions (Y couplings)



From J. Alcaraz, EWSB Dynamics and Resonances
https://indico.cern.ch/event/808335/contributions/3365188/attachments/1843613/3023844/Alcaraz_BSM1.pdf

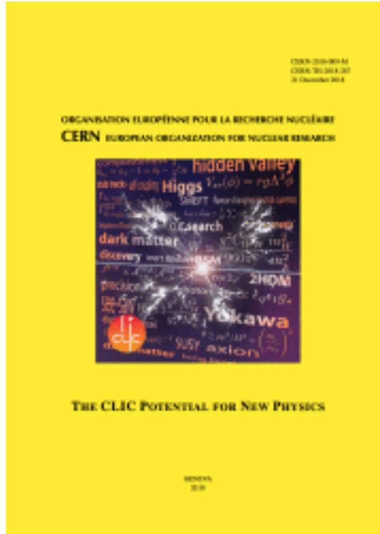
–> CLIC highly competitive

CLIC reports



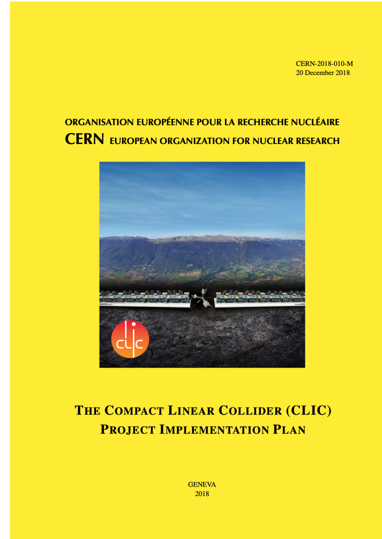
[CERN-2018-005-M](http://dx.doi.org/10.23731/CYRM-2018-002)

http://dx.doi.org/10.23731/CYRM-2018-002



[CERN-2018-009-M](http://dx.doi.org/10.23731/CYRM-2018-003)

http://dx.doi.org/10.23731/CYRM-2018-003



[CERN-2018-010-M](http://dx.doi.org/10.23731/CYRM-2018-004)

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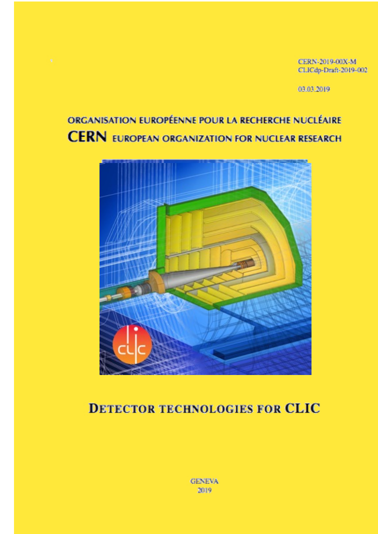
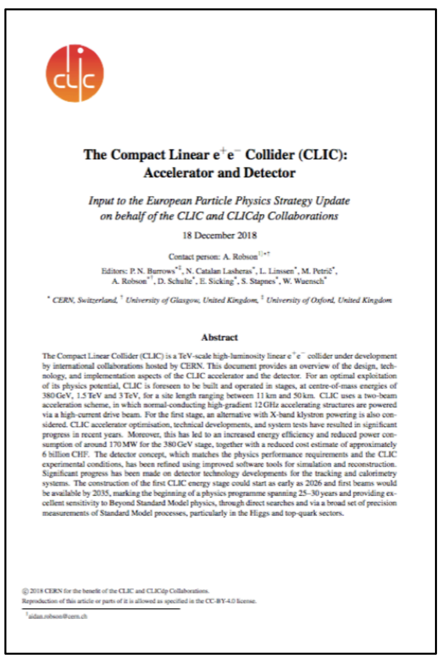


[CERN-2019-001](http://dx.doi.org/10.23731/CYRM-2019-001)

http://dx.doi.org/10.23731/CYRM-2019-001



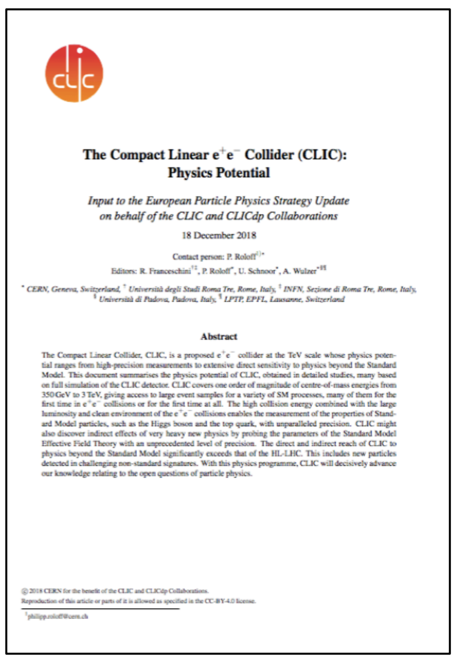
The Compact Linear e^+e^- Collider (CLIC): Accelerator and Detector

Input to the European Particle Physics Strategy Update on behalf of the CLIC and CLICdp Collaborations

18 December 2018

Contact person: A. Robson

Abstract



The Compact Linear e^+e^- Collider (CLIC): Physics Potential

Input to the European Particle Physics Strategy Update on behalf of the CLIC and CLICdp Collaborations

18 December 2018

Contact person: P. Roloff

Abstract

Four CERN Yellow Reports:

- The CLIC 2018 Summary Report
- The CLIC Potential for New Physics
- The CLIC Project Implementation Plan
- Detector Technologies for CLIC

Two formal ESU submissions

Many supporting notes and papers

Available at:
http://clic.cern/european-strategy

CLIC perspective

- CLIC is a mature project with an attractive timescale, ready to start construction in ~2026, with first collisions ~2035
- The main accelerator technologies have been demonstrated and the detector concept and detector technologies R&D are advanced
- The coupling of lepton collider precision and multi-TeV energies gives a physics case that is broad and profound, from precision Higgs and top measurements, and their interpretation in new physics scenarios, to direct BSM searches

- **CLIC is the best option for a future collider at CERN**

  http://clic.cern/european-strategy

Backup

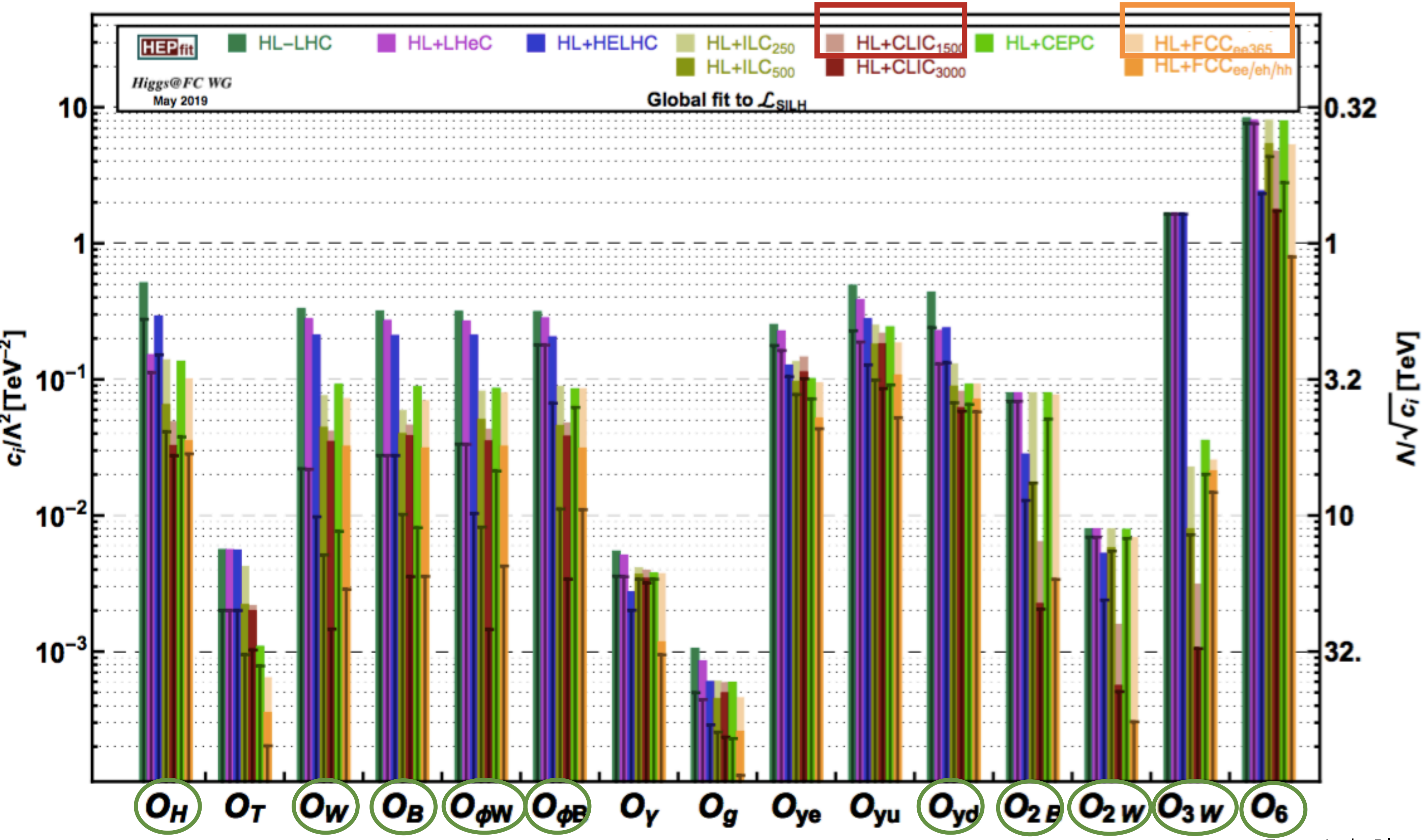
New Physics Reach

Table 2: Indicative CLIC reach for new physics. Sensitivities are given for the full CLIC programme covering the three centre-of-mass energy stages. All limits are at 95% C.L. unless stated otherwise. Details on many of these examples are given in [9].

Process	HL-LHC	CLIC
Higgs mixing with heavy singlet	$\sin^2\gamma < 4\%$	$\sin^2\gamma < 0.24\%$
Higgs self-coupling $\Delta\lambda$	$\sim 50\%$ at 68% C.L.	$[-7\%, 11\%]$ at 68% C.L.
BR(H $\to$ inv.) (model-independent)		$< 0.69\%$ at 90% C.L.
Higgs compositeness scale m_*	$m_* > 3$ TeV (> 7 TeV for $g_* \simeq 8$)	Discovery up to $m_* = 10$ TeV (40 TeV for $g_* \simeq 8$)
Top compositeness scale m_*		Discovery up to $m_* = 8$ TeV (20 TeV for small coupling g_*)
Higgsino mass (disappearing track search)	> 250 GeV	> 1.2 TeV
Slepton mass		Discovery up to ~ 1.5 TeV
RPV wino mass ($c\tau = 300$ m)	> 550 GeV	> 1.5 TeV
Z' mass (SM couplings)	Discovery up to 7 TeV	Discovery up to 20 TeV
NMSSM scalar singlet mass	> 650 GeV ($\tan\beta \leq 4$)	> 1.5 TeV ($\tan\beta \leq 4$)
Twin Higgs scalar singlet mass	$m_\sigma = f > 1$ TeV	$m_\sigma = f > 4.5$ TeV
Relaxion mass (for vanishing mixing)	< 24 GeV	< 12 GeV
Relaxion mixing angle ($m_\phi < m_H/2$)		$\sin^2\theta \leq 2.3\%$
Neutrino Type-2 see-saw triplet		> 1.5 TeV (for any triplet VEV) > 10 TeV (for triplet Yukawa coupling $\simeq 0.1$)
Inverse see-saw RH neutrino		> 10 TeV (for Yukawa coupling $\simeq 1$)
Scale $V_{LL}^{-1/2}$ for LFV $(\bar{e}e)(\bar{e}\tau)$		> 42 TeV

From arXiv: 1812.07986

EFT fit results



From J. de Blas

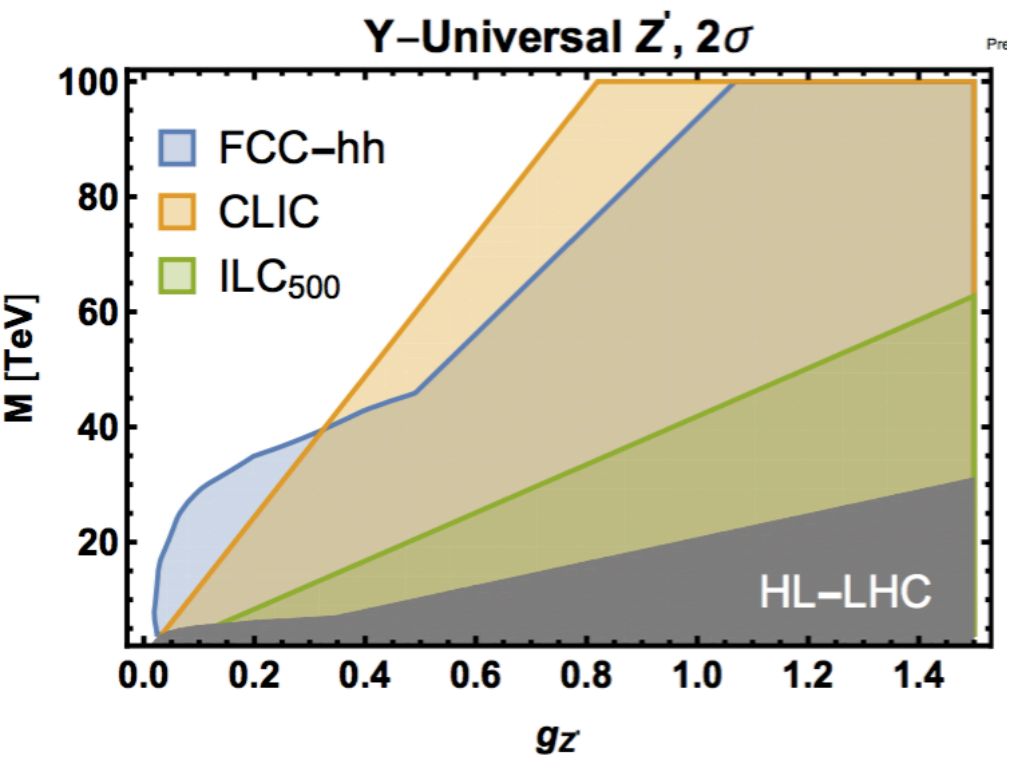
Highlighted where CLIC1500 more sensitive than FCCee – benefit of high energy

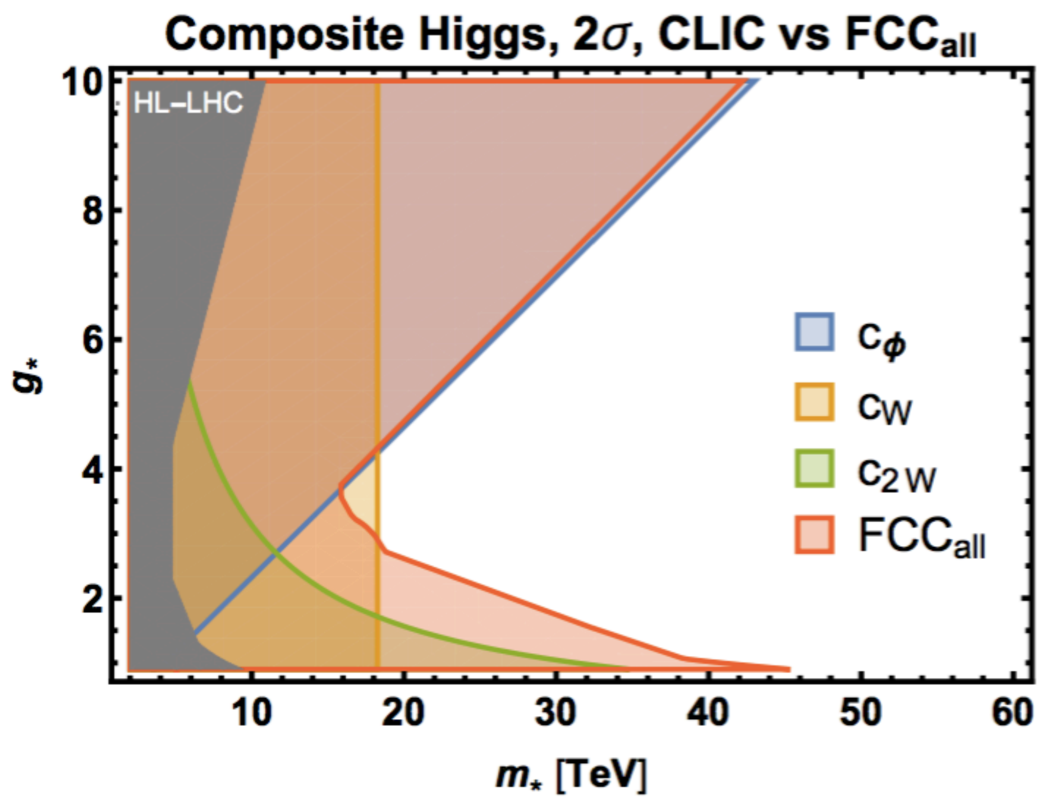
European Strategy for Particle Physics

Efforts to synthesize prospects from different proposed colliders for European Strategy development, shown in Open Symposium in May

Preliminary, Granada 2019

Wider programme; compare CLIC and FCChh:





From A. Wulzer

Hidden Valley models

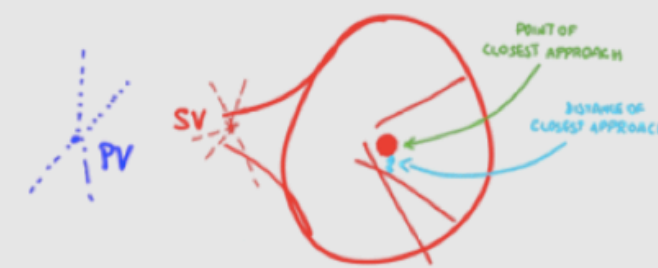
CLICdp Full Simulation

Hidden Valley Displaced Vertex

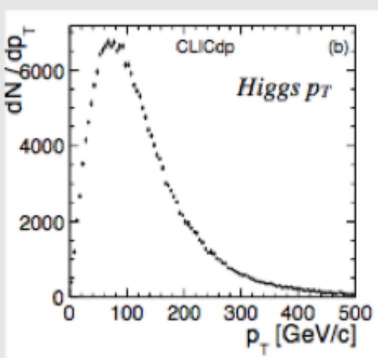
CLICDP-NOTE-2018-001

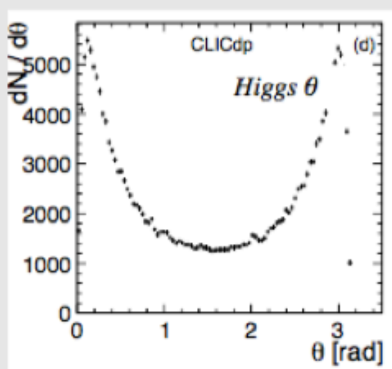
$e^+e^- \to h\,\nu\nu$ | $h \to \pi_V\,\pi_V$ | $\overset{c\beta\gamma\tau_0}{\cdots\cdots}$ | $\pi_V \to bb$

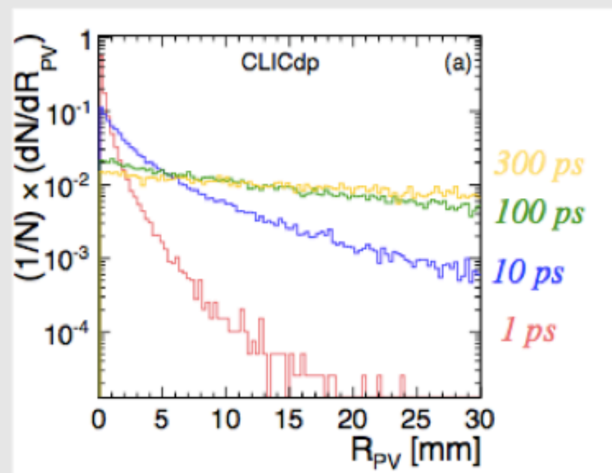
Point Of Closest Approach +
Distance Of Closest Approach



Process	π_v^0 lifetime [ps]	π_v^0 mass [GeV/c^2]	cross section [pb]
$h^0 \to \pi_v^0\pi_v^0$	1,10,100,300	25,35,50	$0.42 \cdot BR$
$e^+e^- \to q\bar{q}$	-	-	2.95
$e^+e^- \to q\bar{q}\nu\bar{\nu}$	-	-	0.55
$e^+e^- \to q\bar{q}q\bar{q}$	-	-	1.32
$e^+e^- \to q\bar{q}q\bar{q}\nu\bar{\nu}$	-	-	0.07







Franceschini & Michael Spannowsky - LCWS 2018 - U. Texas Arlington - https://agenda.linearcollider.org/event/7889/

From R, Franceschini

Hidden Valley models

CLICdp Full Simulation

Hidden Valley Displaced Vertex

CLICDP-NOTE-2018-001

$e^+e^- \to h\,\nu\nu$ $h \to \pi_V\,\pi_V$ $\overset{c\beta\gamma\tau_0}{\cdots\cdots}$ $\pi_V \to bb$

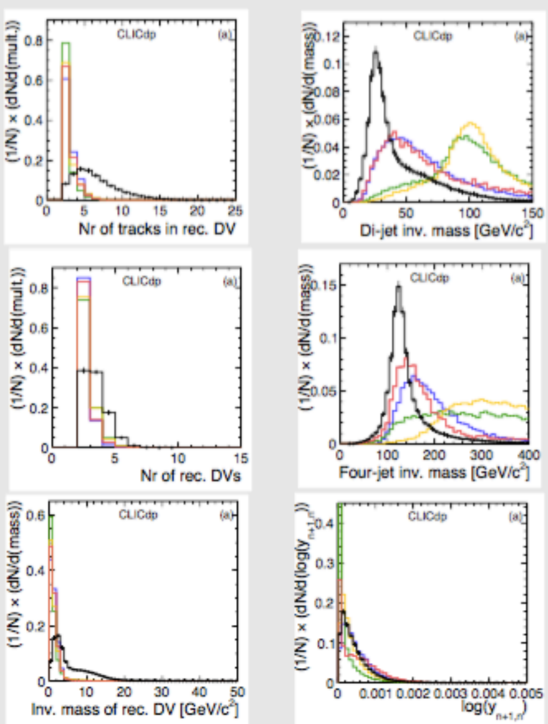
N=4 exclusive k_T jets

qq *qqνν* *qqqq* *qqqqνν*

# of tracks

# of DV

Mass of DV

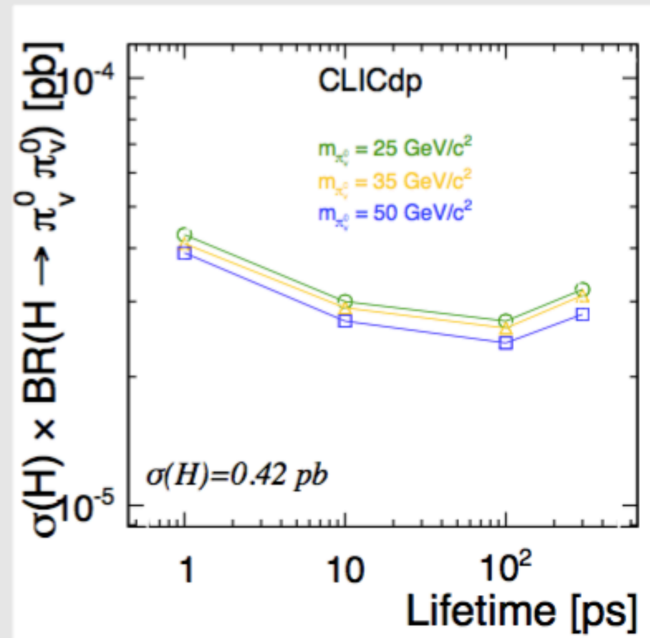


Mass of jj

Mass of 4j

Jets y_{34} and y_{23}

Boosted Decision Tree: $\varepsilon_S \gtrsim 0.1$



Roberto Franceschini & Michael Spannowsky - LCWS 2018 - U. Texas Arlington - https://agenda.linearcollider.org/event/7889/

From R, Franceschini

Collaborations

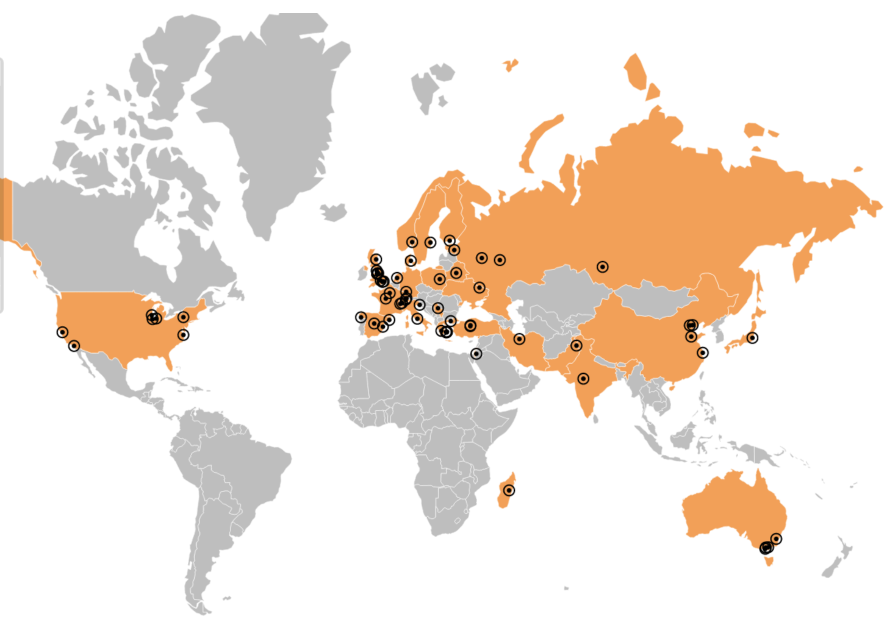
http://clic.cern/

CLIC accelerator collaboration
~60 institutes from 28 countries

CLIC accelerator studies:
- CLIC accelerator design and development
- (Construction and operation of CLIC Test Facility, CTF3)

CLIC detector and physics (CLICdp)
30 institutes from 18 countries

Focus of CLIC-specific studies on:
- Physics prospects & simulation studies
- Detector optimization + R&D for CLIC



CLIC

2013 – 2019

Development Phase
Development of a project plan for a staged CLIC implementation in line with LHC results; technical developments with industry, performance studies for accelerator parts and systems, detector technology demonstrators

2020 – 2025

Preparation Phase
Finalisation of implementation parameters, preparation for industrial procurement, pre-series and system optimisation studies, technical proposal of the experiment, site authorisation

2026 – 2034

Construction Phase
Construction of the first CLIC accelerator stage compatible with implementation of further stages; construction of the experiment; hardware commissioning

2020
Update of the European Strategy for Particle Physics

2026
Ready for construction

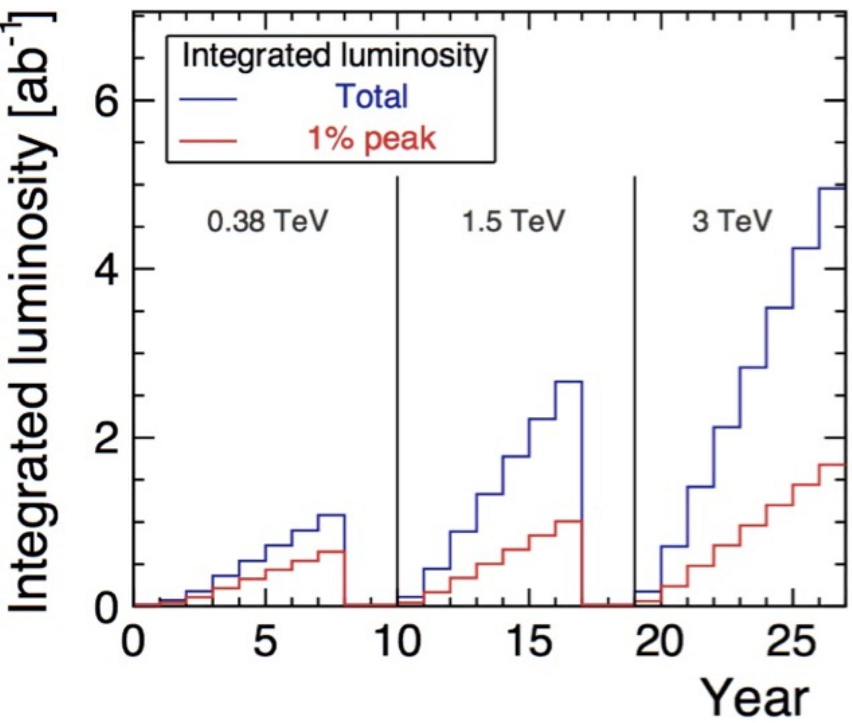
2035
First collisions

CLIC Staging

3 pillars of the CLIC physics programme:

- Higgs physics
- Top-quark physics
- Beyond Standard Model physics

Staging scenario designed around this



- Physics programme extends over 25–30 years
- Ramp-up and up-time assumptions consistent with other future projects arXiv:1810.13022, Bordry et al.
- Electron polarisation:

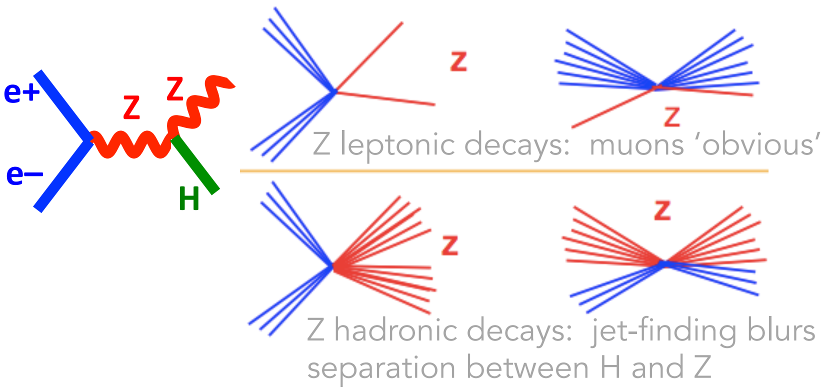
–enhances Higgs production at high-energy stages
–provides additional observables sensitive to NP
–helps to characterise new particles in case of discovery

Baseline polarisation scenario adopted:

			$P(e^-) = -80\%$	$P(e^-) = +80\%$
Stage	$\sqrt{s}$ [TeV]	$\mathscr{L}_{int}$ [ab^{-1}]	$\mathscr{L}_{int}$ [ab^{-1}]	$\mathscr{L}_{int}$ [ab^{-1}]
1	0.38 (and 0.35)	1.0	0.5	0.5
2	1.5	2.5	2.0	0.5
3	3.0	5.0	4.0	1.0

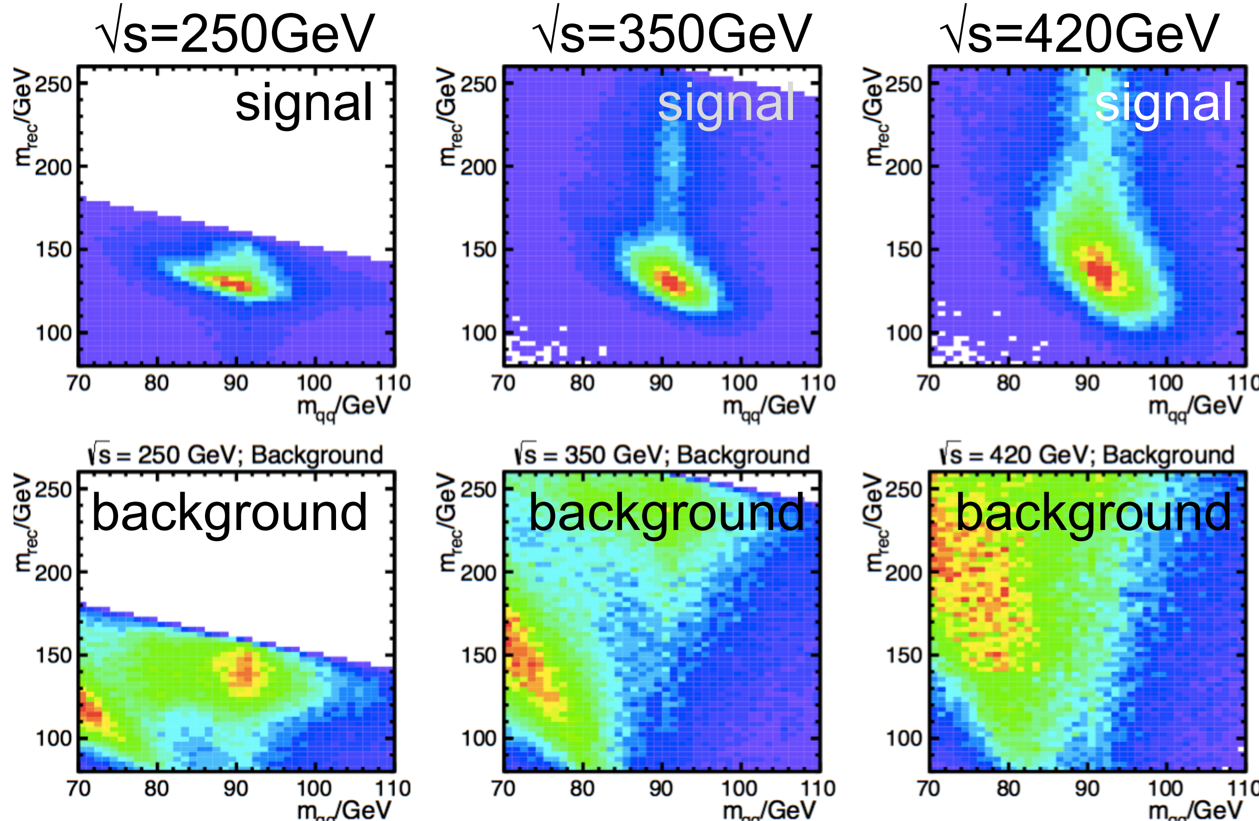
Choice of 380 GeV

- Precise determination of g_{HZZ} from ZH recoil measurement at initial stage crucial for Higgs couplings at all energy stages



- Use Z hadronic decays for extra statistics
- At 250GeV the background to Z hadronic is more signal-like
- At 420GeV the cross-section is lower and jet energy resolution worse
- In between gives best precision for H

$\sqrt{s}$	L_{int}[ab^{-1}]	σ(ZH)[fb]	$\Delta\sigma$(ZH)
250	1	136	±2.6%
350	1	93	±1.3%
420	1	68	±1.9%



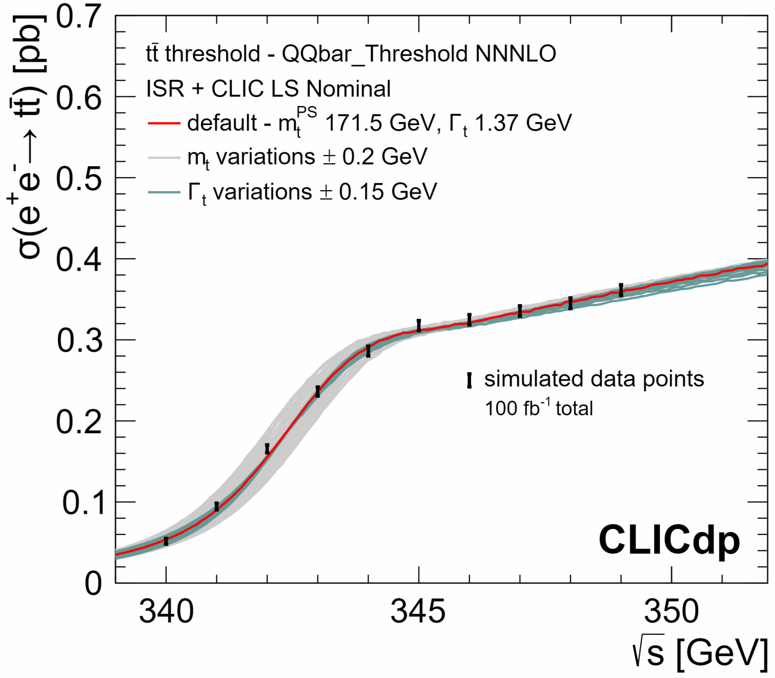
Eur. Phys. J. C 76 (2016) 72

- Overall, 380GeV using Z hadronic is as good for Higgs as 250GeV using Z leptonic
- Top cross-section increases after threshold; plateau begins around 380GeV
- Higgs favours slightly lower energy (σ(ZH) falling); top favours slightly higher energy ($\sigma(t\bar{t})$ still rising)

–> 380GeV is optimal initial energy for e^+e^-

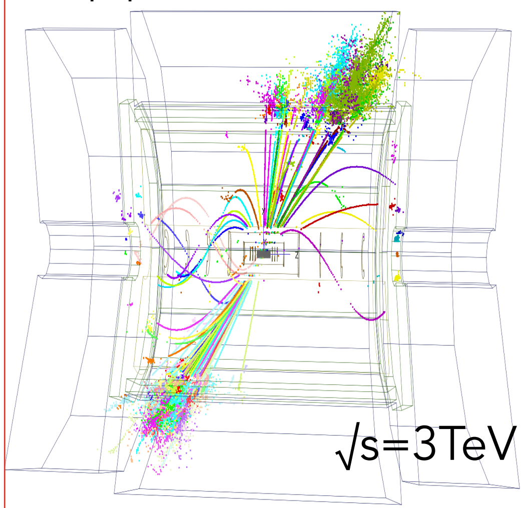
CLIC Physics at the initial stage

- Initial stage $\sqrt{s}$=380GeV
  - **Precision top-quark physics:**



- Intending threshold scan near $\sqrt{s}$=350 GeV (10 points, ~1 year) as well as main initial-stage baseline $\sqrt{s}$=380GeV
- sensitive to top mass, width and couplings
- observe 1S 'bound state', Δm_t ~ 50 MeV

First study of boosted top production in e^+e^-



e^+e^- -> $t\bar{t}$ -> $q\bar{q}q\bar{q}b\bar{b}$

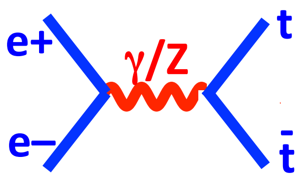
- Top pair-production cross-section, both polarisations ~1%
- Top forward-backward asymmetries ~3–4%

- Statistically optimal observables for top EWK couplings

  –> all input to global fits

–> initial and high-energy stages are very complementary

Polarisation provides new observables

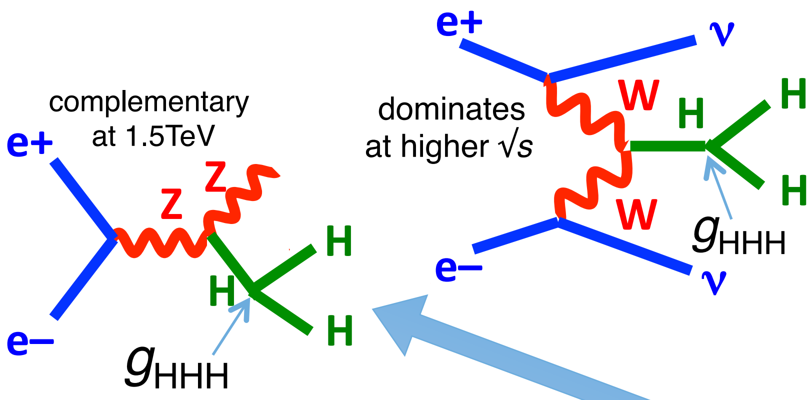


Top-quark physics at CLIC arXiv:1807.02441 [in journal review]

–> Guaranteed physics case at initial stage

Higgs self-coupling

- Higgs self-coupling requires high-energy running

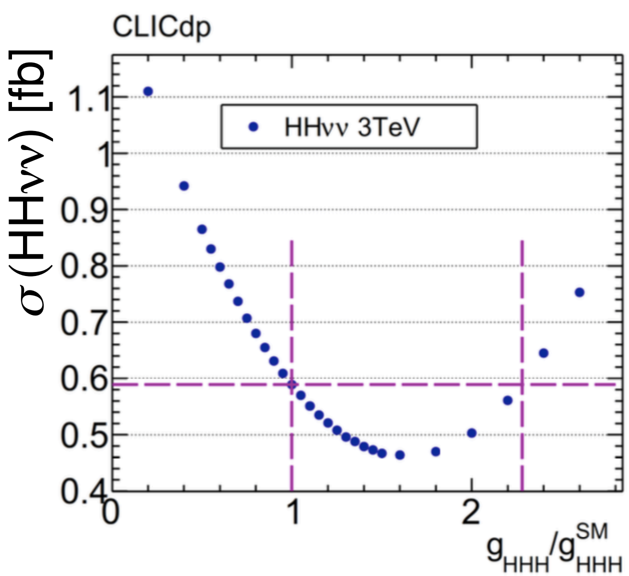


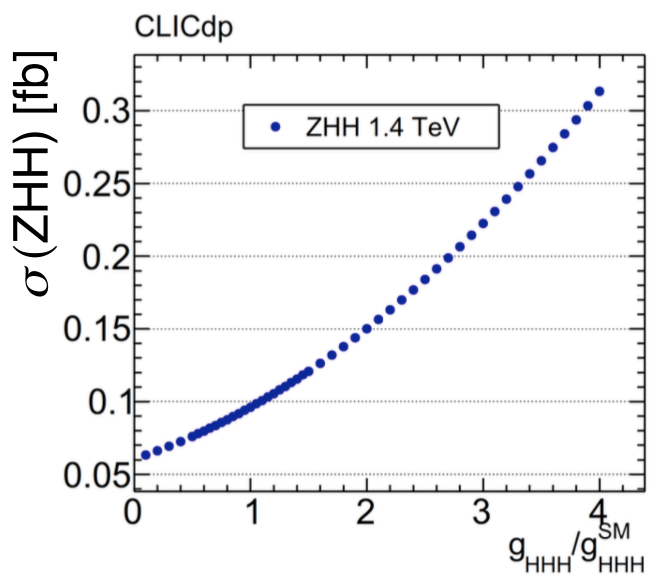
Double Higgs and self-coupling:

	1.4TeV	3TeV
$\sigma(HH\nu_e\bar{\nu}_e)$	>3σ EVIDENCE $\frac{\Delta\sigma}{\sigma}$ = 28%	>5σ OBSERVATION $\frac{\Delta\sigma}{\sigma}$ = 7.3%
$\sigma(ZHH)$	>5σ OBSERVATION	
g_{HHH}/g_{HHH}^{SM}	1.4TeV: –34%, +36% rate-only analysis	1.4 + 3TeV: **–7%, +11%** differential analysis

arXiv:1901.05897

- Direct access to two processes that behave differently with non-SM values of self-coupling:





Template fit at 3TeV using two variables: *M*(HH) differential distribution and BDT score

Gives unrivalled sensitivity to Higgs self-coupling:

$$\Delta g_{HHH}/g_{HHH} = {}^{+11\%}_{-7\%}$$

See dedicated talk by Ulrike Schnoor in the Higgs sessions

Interpretations and full programme

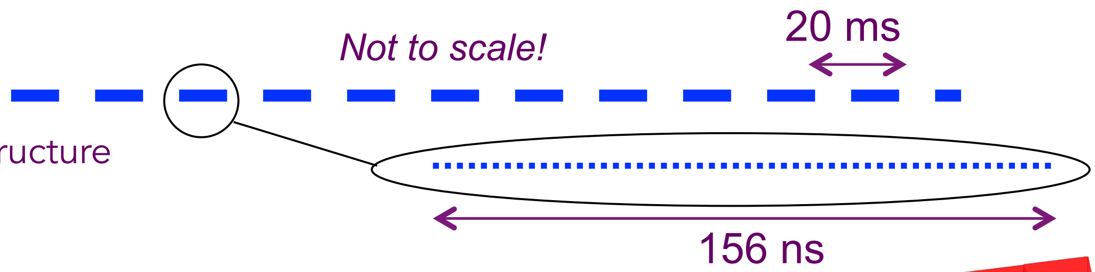
FCC-hh has (unsurprisingly) the best mass reach for new resonances, in general:
– For new Z′ bosons via direct production with couplings ~weak coupling size
– For W′, gravitons, strongly-coupled resonances, vector-like quarks, ...

CLIC highly competitive for new physics via contact interactions:
– For new Z′ bosons with couplings > 1 (above the weak coupling size)
– For 2fermion - 2boson contact interactions ($e^+e^- \to ZH$ channel)
– New physics scales from deviations in Higgs couplings

From J. Alcaraz, EWSB Dynamics and Resonances
https://indico.cern.ch/event/808335/contributions/3365188/attachments/1843613/3023844/Alcaraz_BSM1.pdf

Collider environment

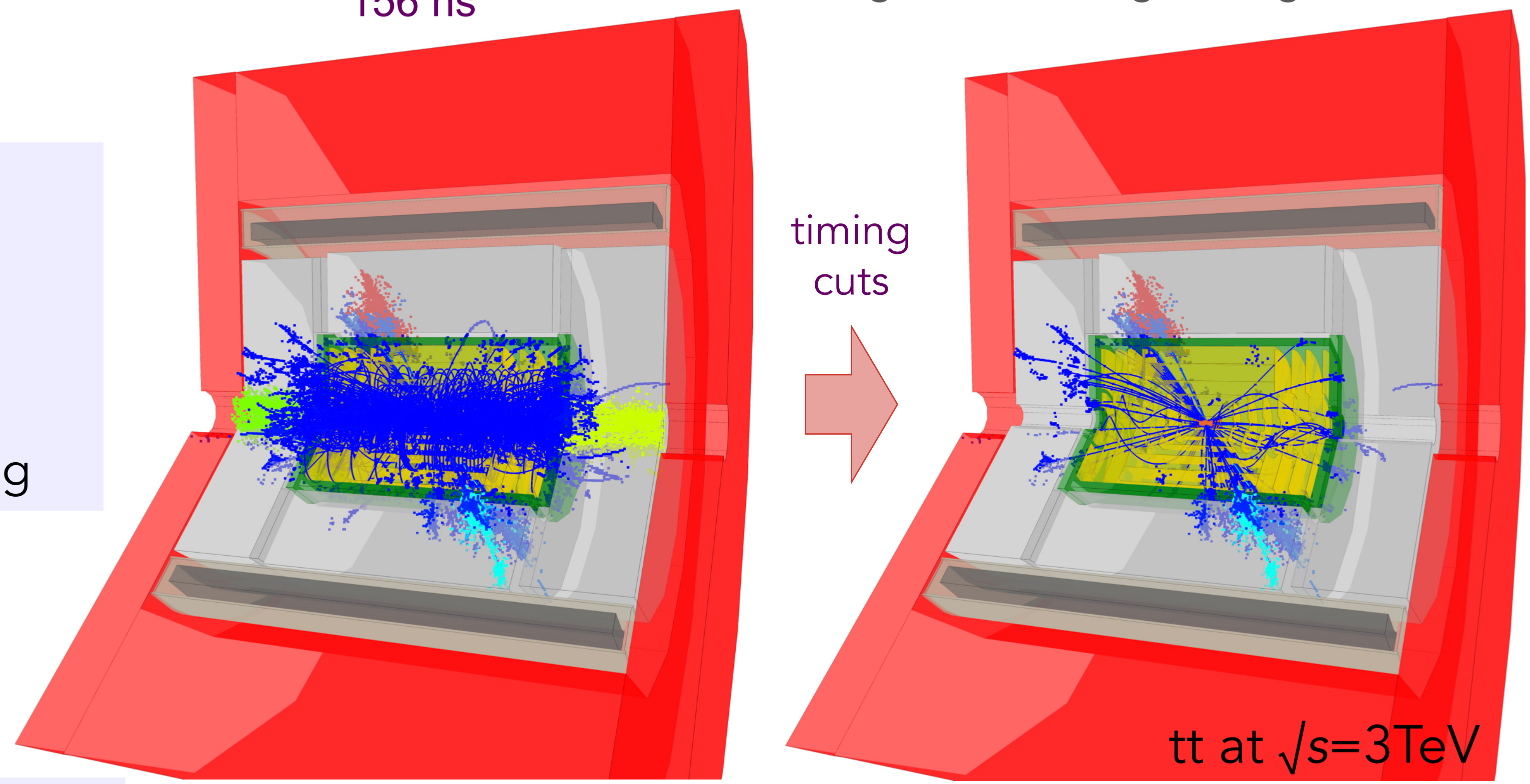
CLIC
Beam structure
at 3TeV



High bunch charge density
–> beam-related backgrounds
small effect at $\sqrt{s}$=380GeV
large effect at high energies

Precise timing required for beam background rejection

1ns in calorimetry,
5ns in vertexing/tracking



CALICE / FCAL

High precision:
- jet energy resolution
  –> fine-grained calorimetry
- momentum resolution
- impact parameter resolution

$\sigma(E)/(E)$ ~ 3.5% for E>100GeV
$\sigma(p_T)/p_T^2$ ~ 2x10^{-5} GeV^{-1}
$\sigma_{d0} \sim 5 \oplus 15/(p[\mathrm{GeV}]\sin^{3/2}\theta)$ μm

CLICdp vertexing/
tracking programme

CLICdet

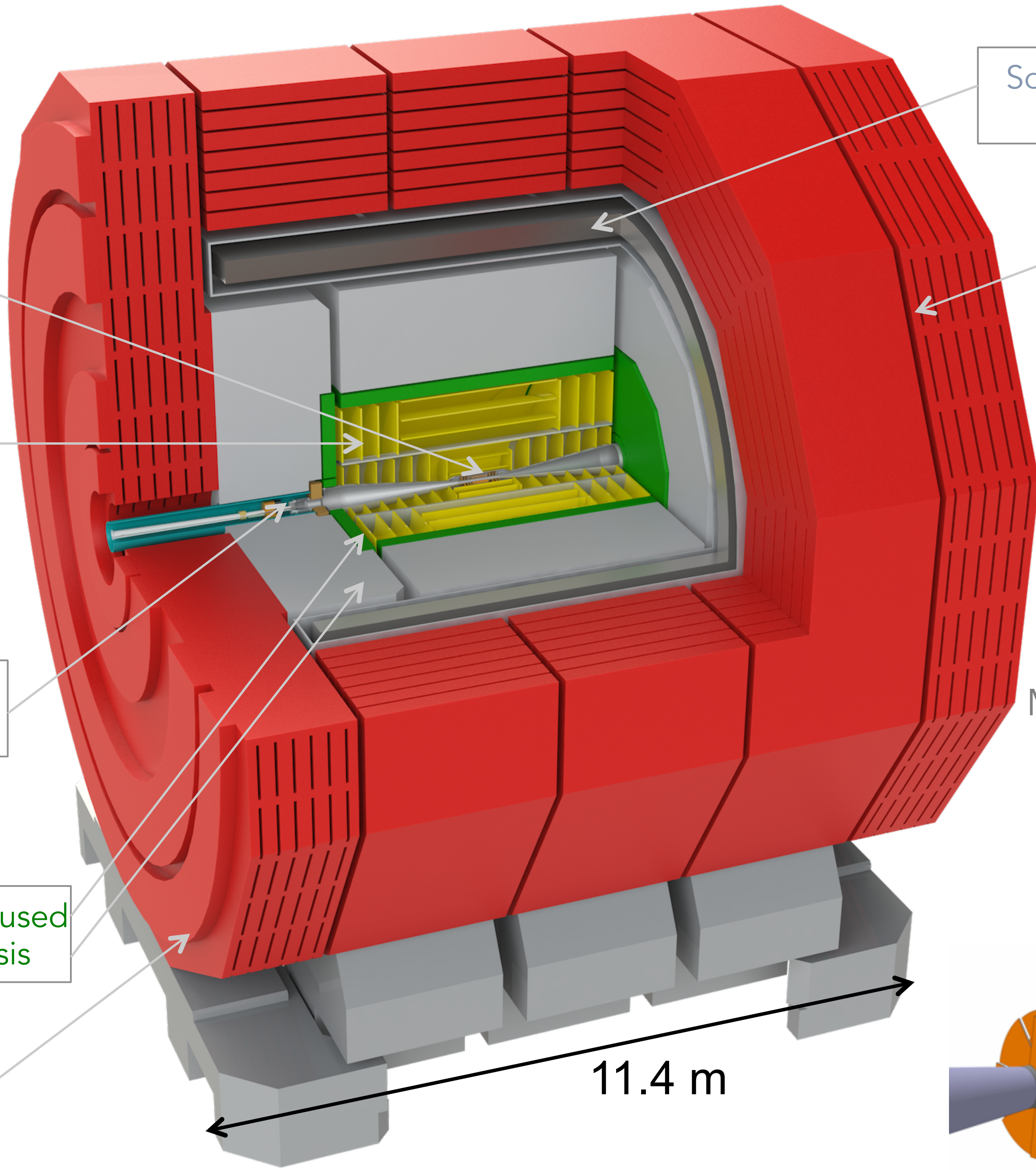
Ultra low-mass vertex detector with 25μm pixels

Main tracker, silicon-based (large pixels and/or strips)

Forward region with LumiCal and BeamCal

Fine-grained calorimetry used for Particle Flow Analysis

End coils for field-shaping



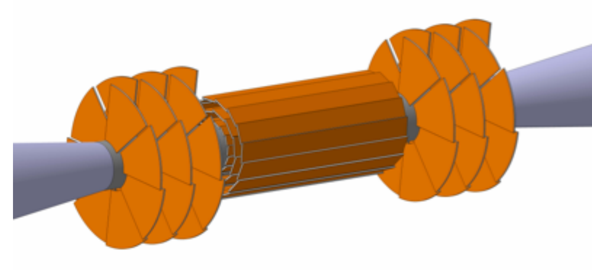
Solenoid magnet
B=4T

Return yoke (iron) with detectors for muon ID

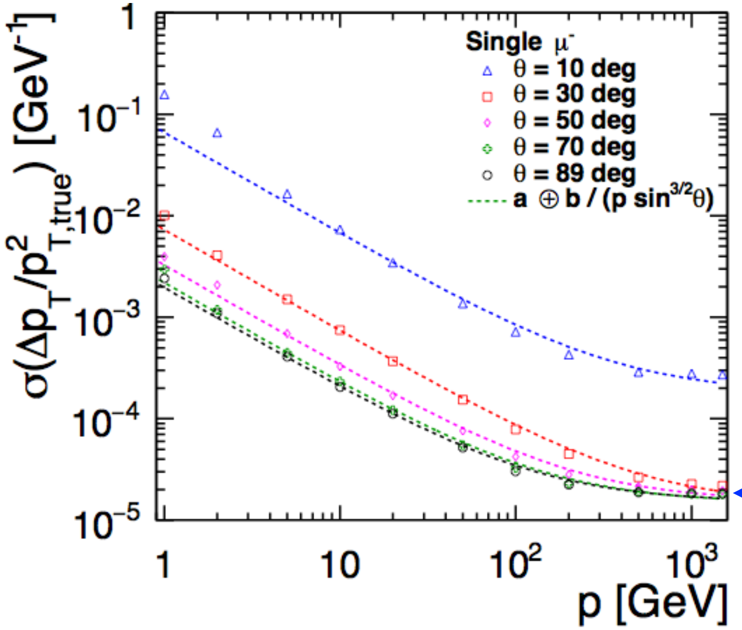
Triggerless readout

Tracker
spatial resolution: 7μm
Material: 1–2% X_0 / layer

Vertex detector
spatial resolution: 3μm
Material: 0.2% X_0 / layer
–> forced air cooling

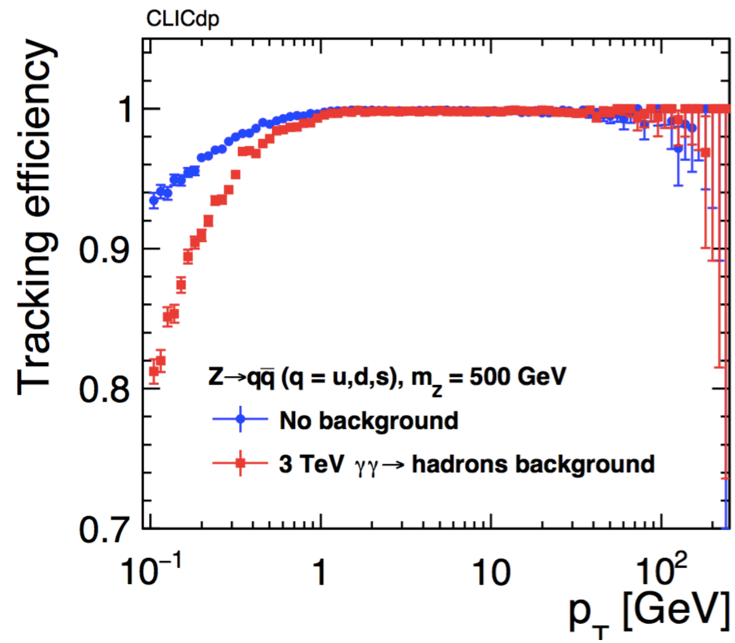


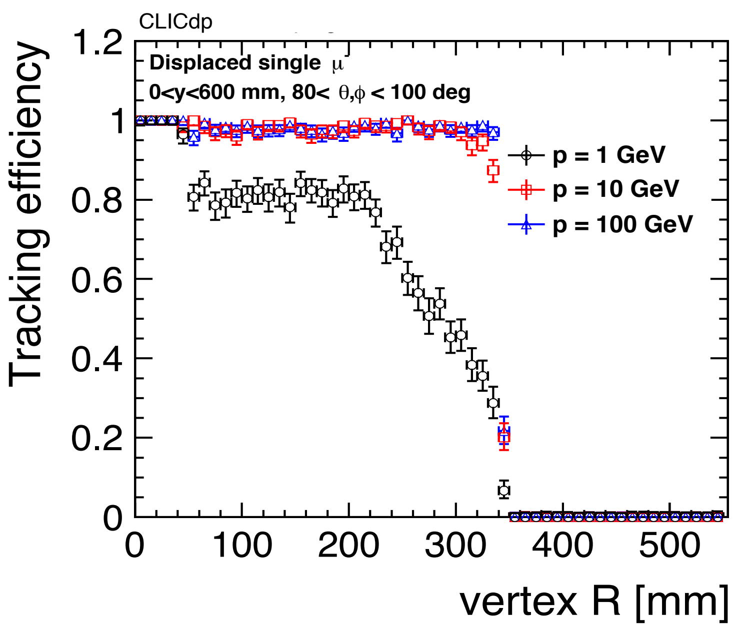
CLICdet Performance



performance goal: 2×10^{-5}

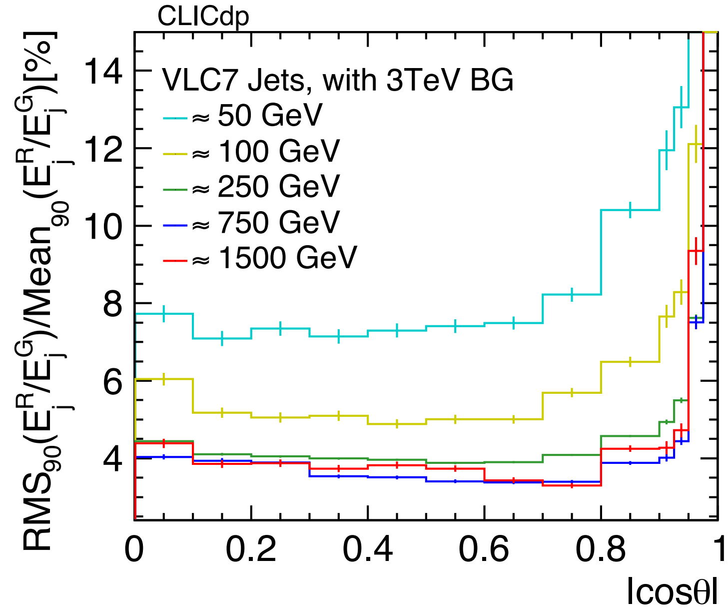
Full characterization of the detector model in arXiv:1812.07337





Displaced track reconstruction

Achieve jet energy resolution target in presence of beam backgrounds



Software tools developed/ maintained by the CERN group and widely used

iLCDIRAC DD4hep