Summary of the LoopVerein

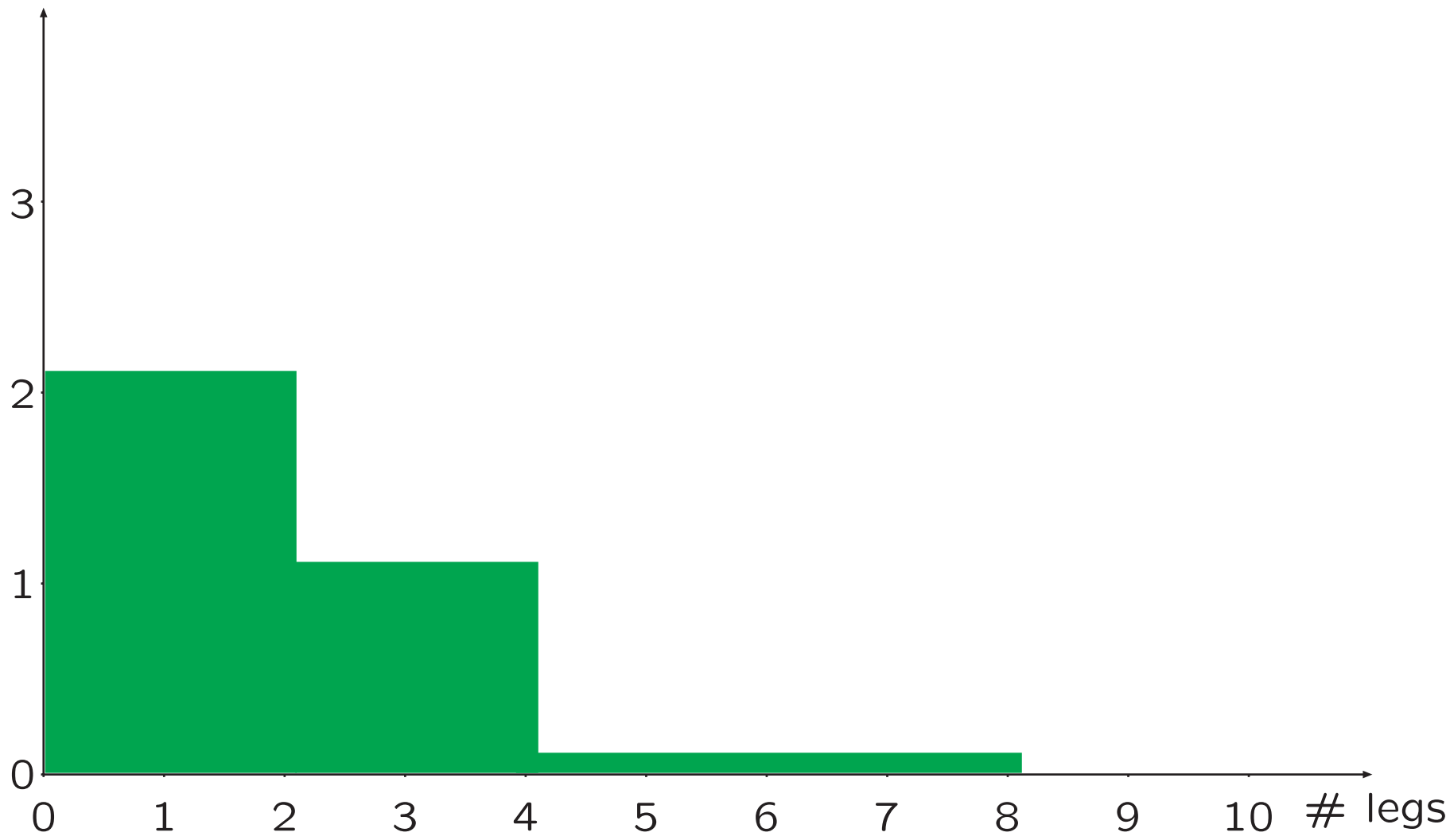
Sven Heinemeyer, CERN

Durham, 09/2004

time is short $\Rightarrow$ outline is simple (& the usual apologies)

- Status of the field
- Contributions in Durham
- What is needed for the future

Technique well established



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$\Delta\rho$ Δr, masses Bhaba $ee \to 4f + \gamma$

$1 \to 2$, $\sin^2\theta_{\text{eff}}$ $2 \to 3$

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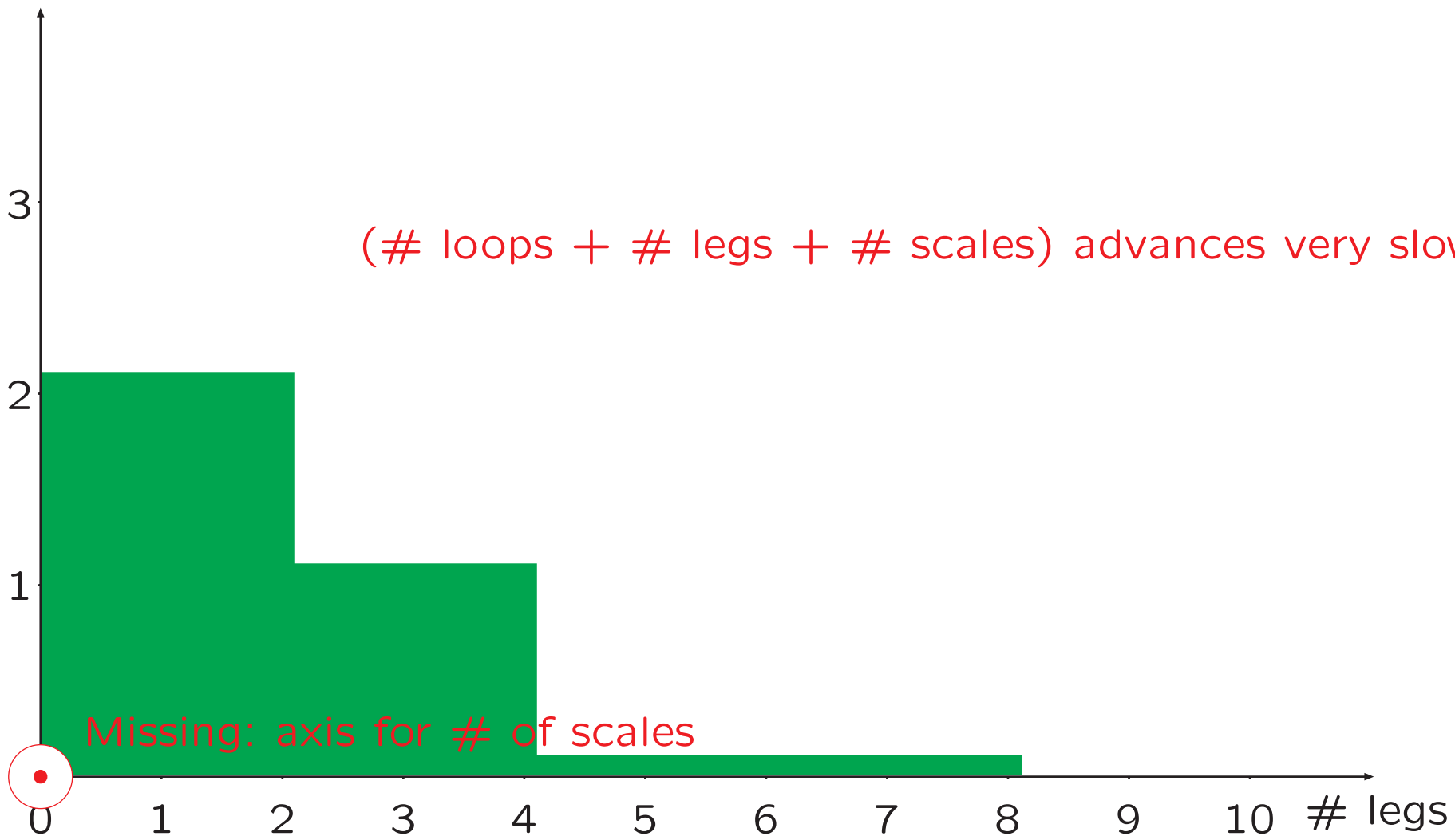

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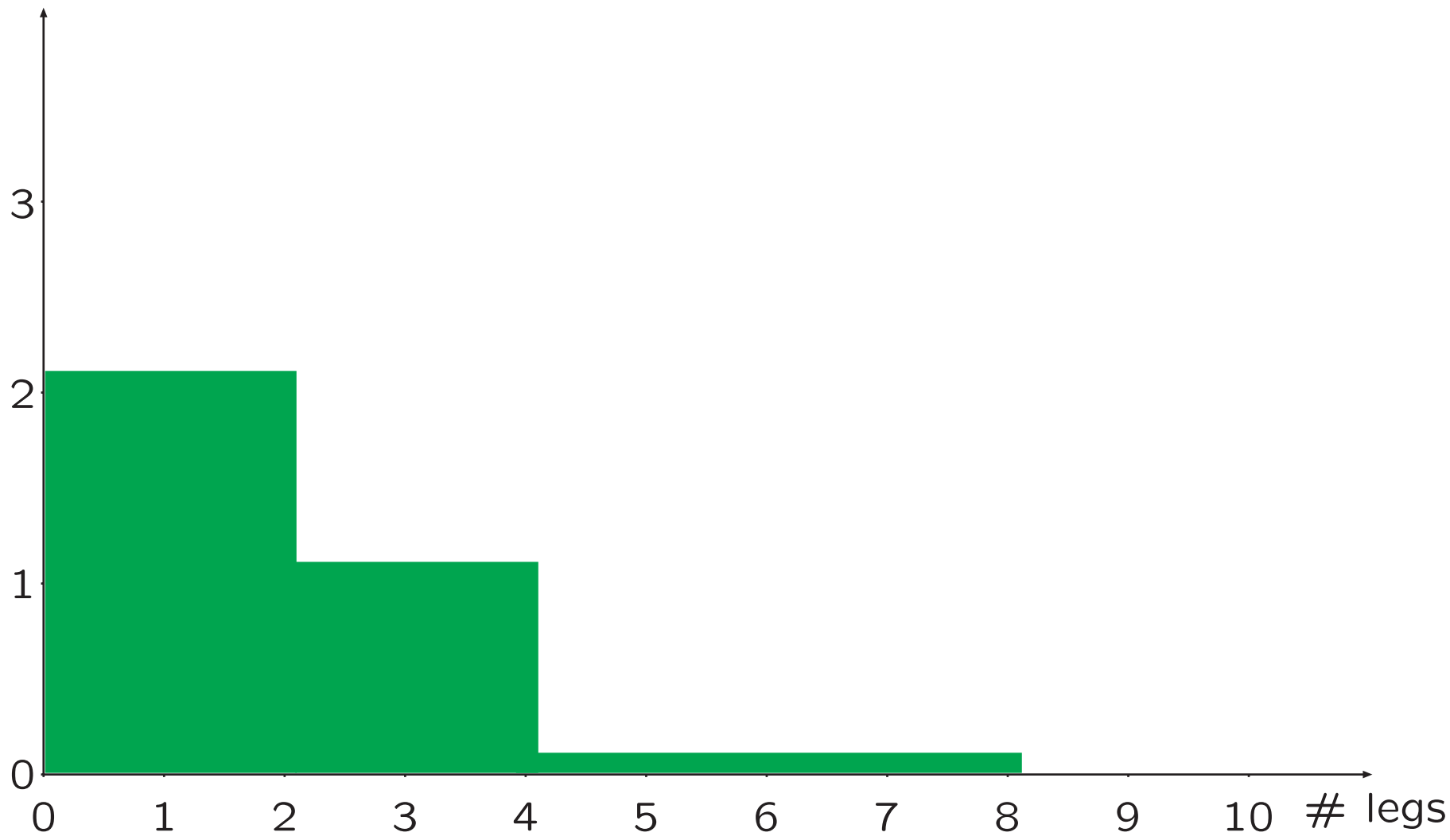

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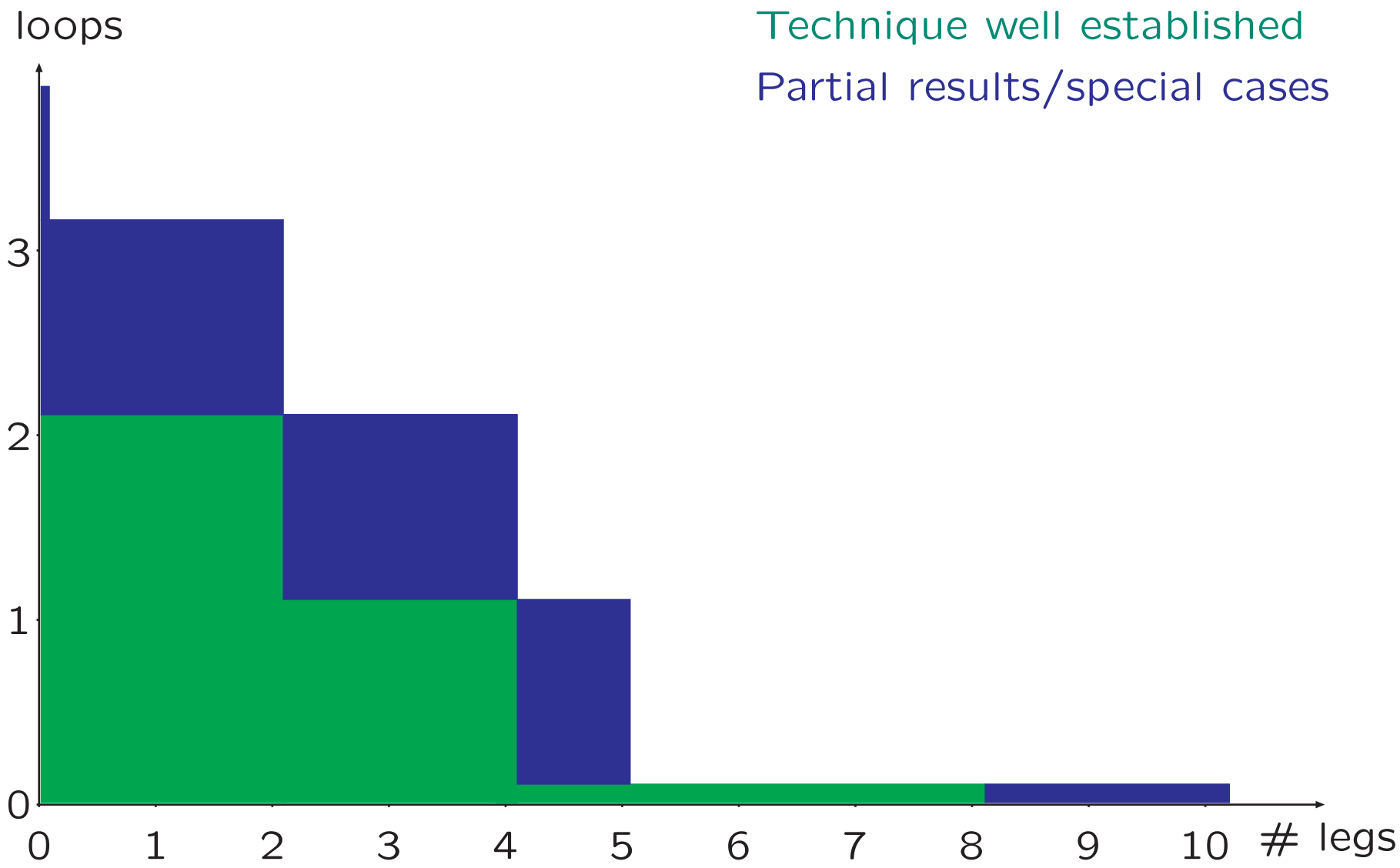
loops
Technique well established
Partial results/special cases
3
2
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0
0
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4
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6
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8
9
10
legs
vacuum graphs
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Δr, masses
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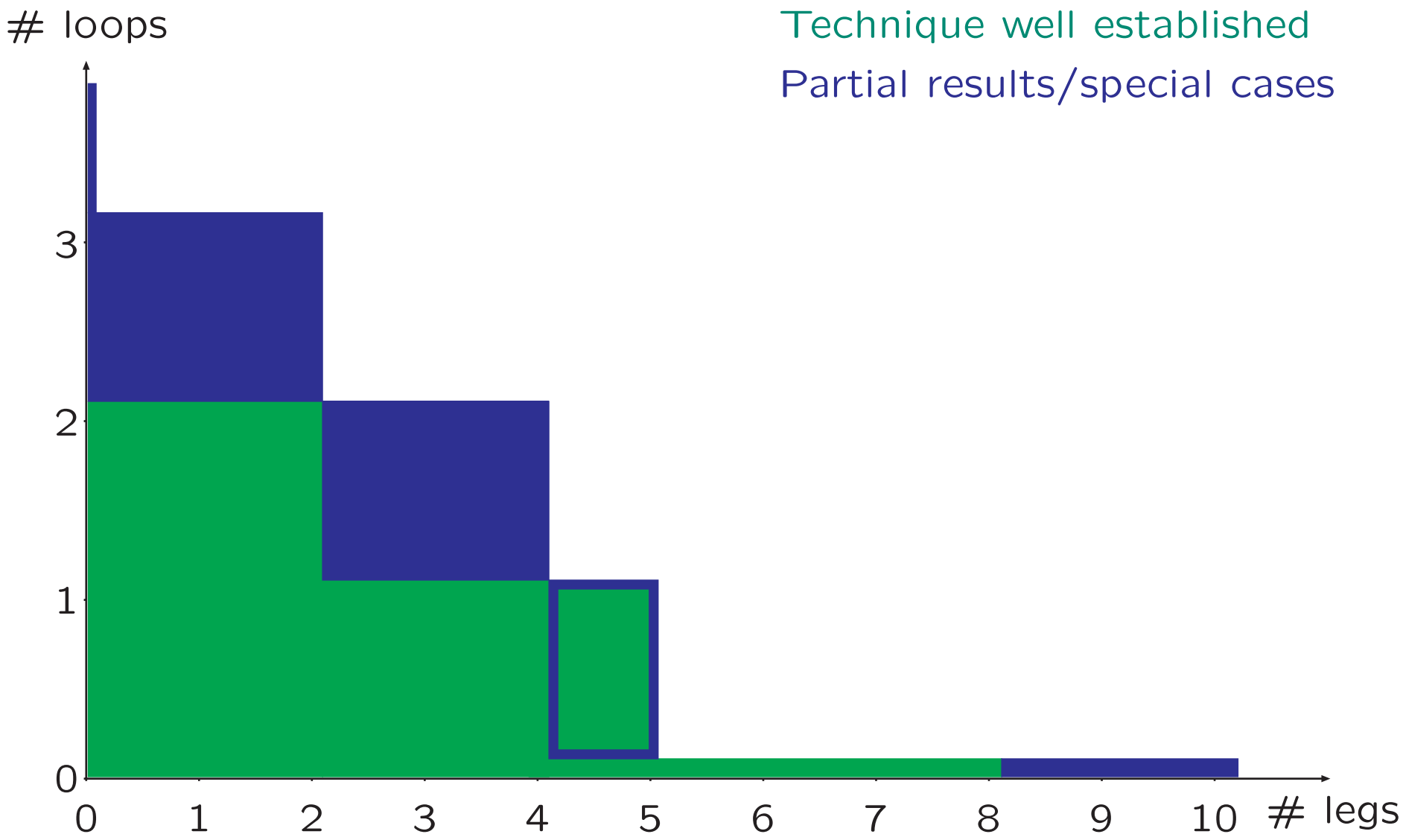
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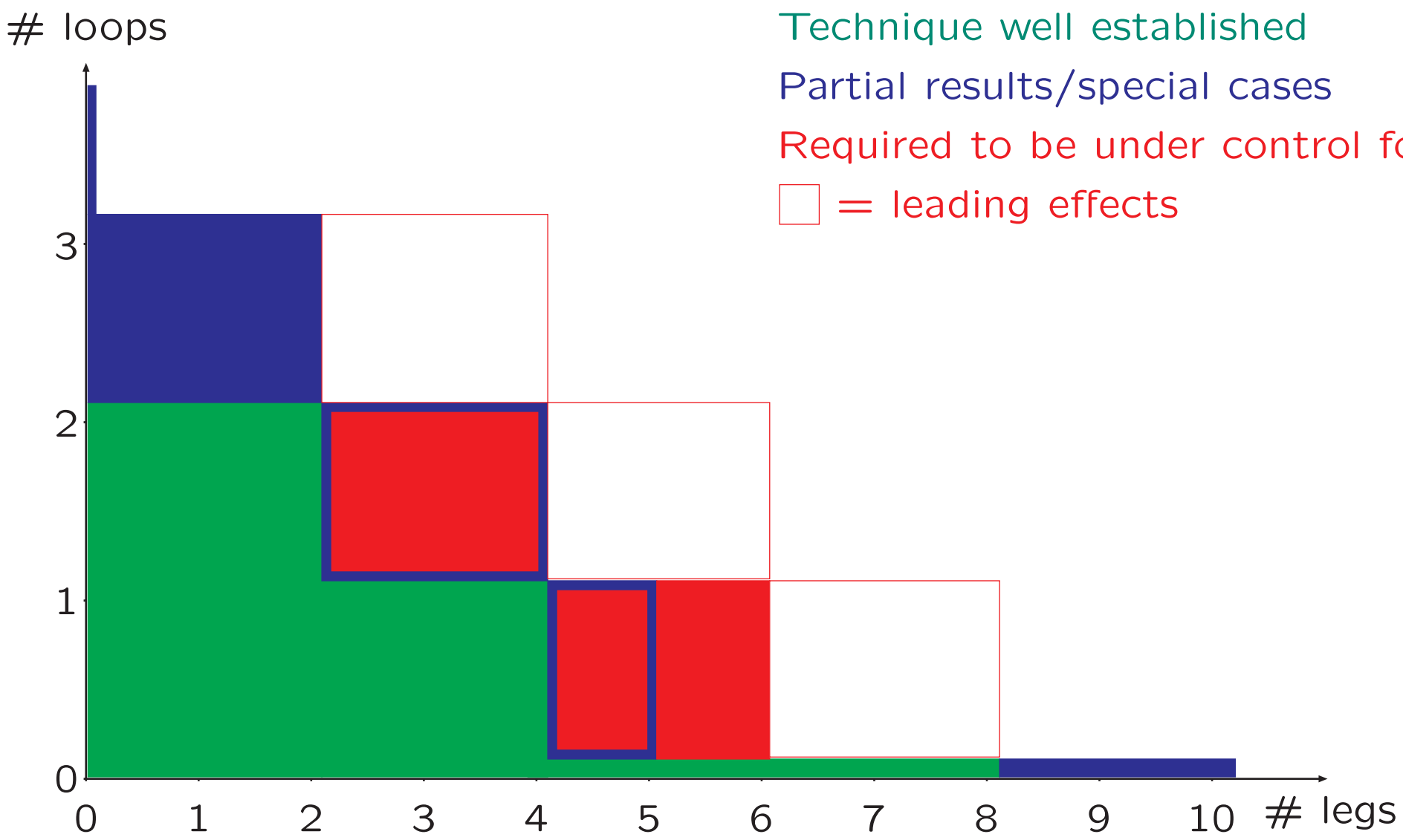
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Required to be under control for II
= leading effects
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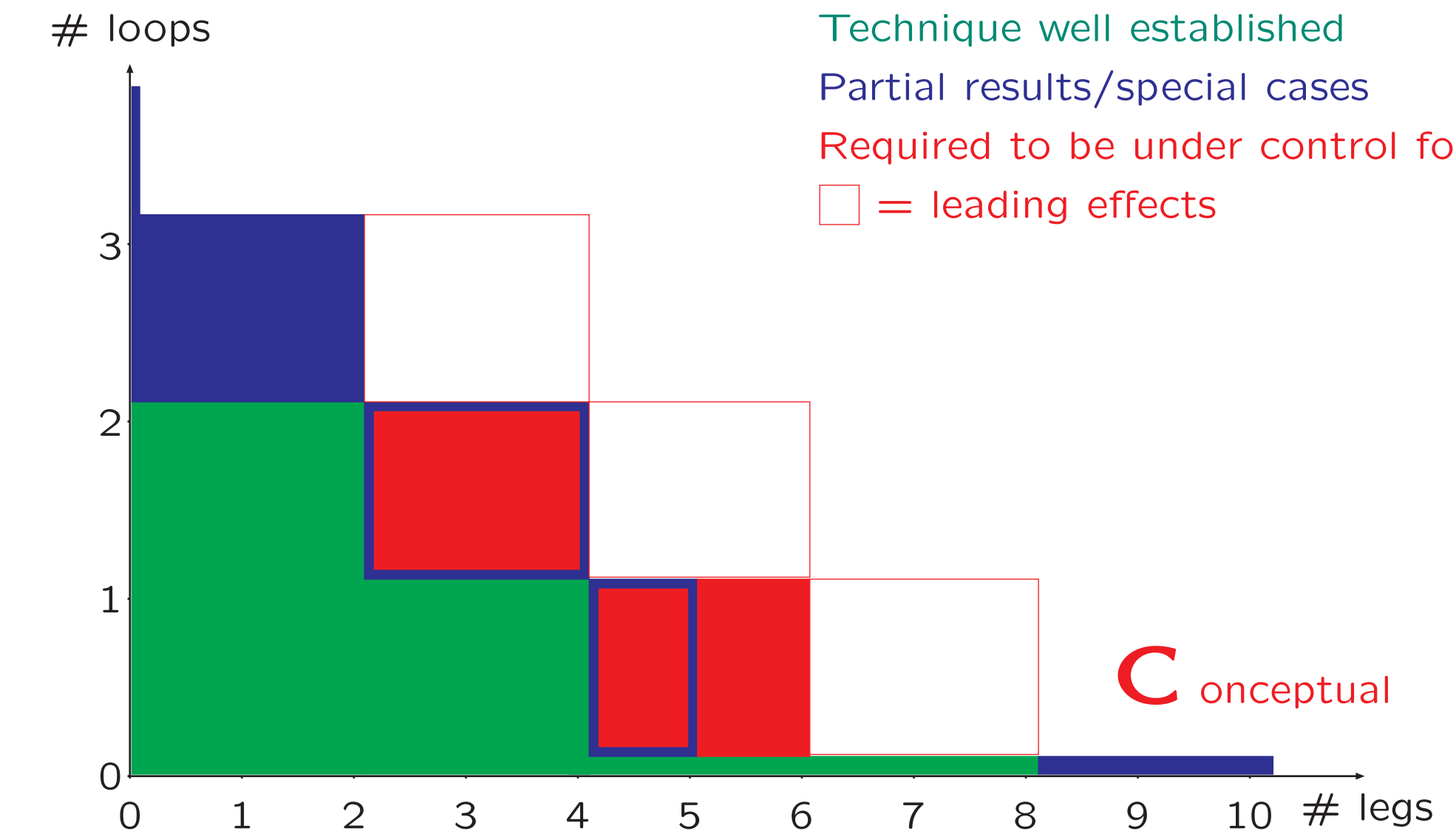
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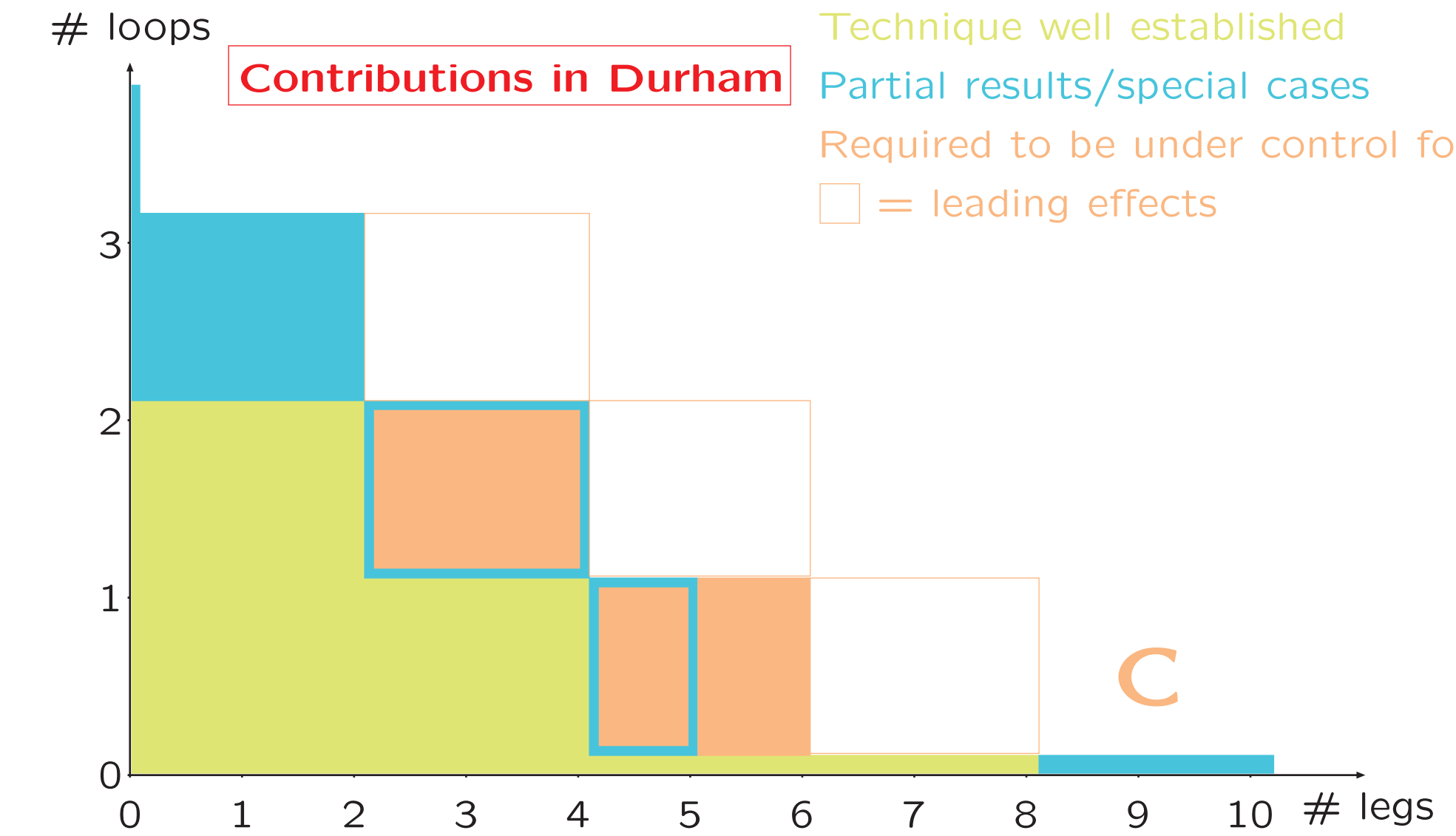

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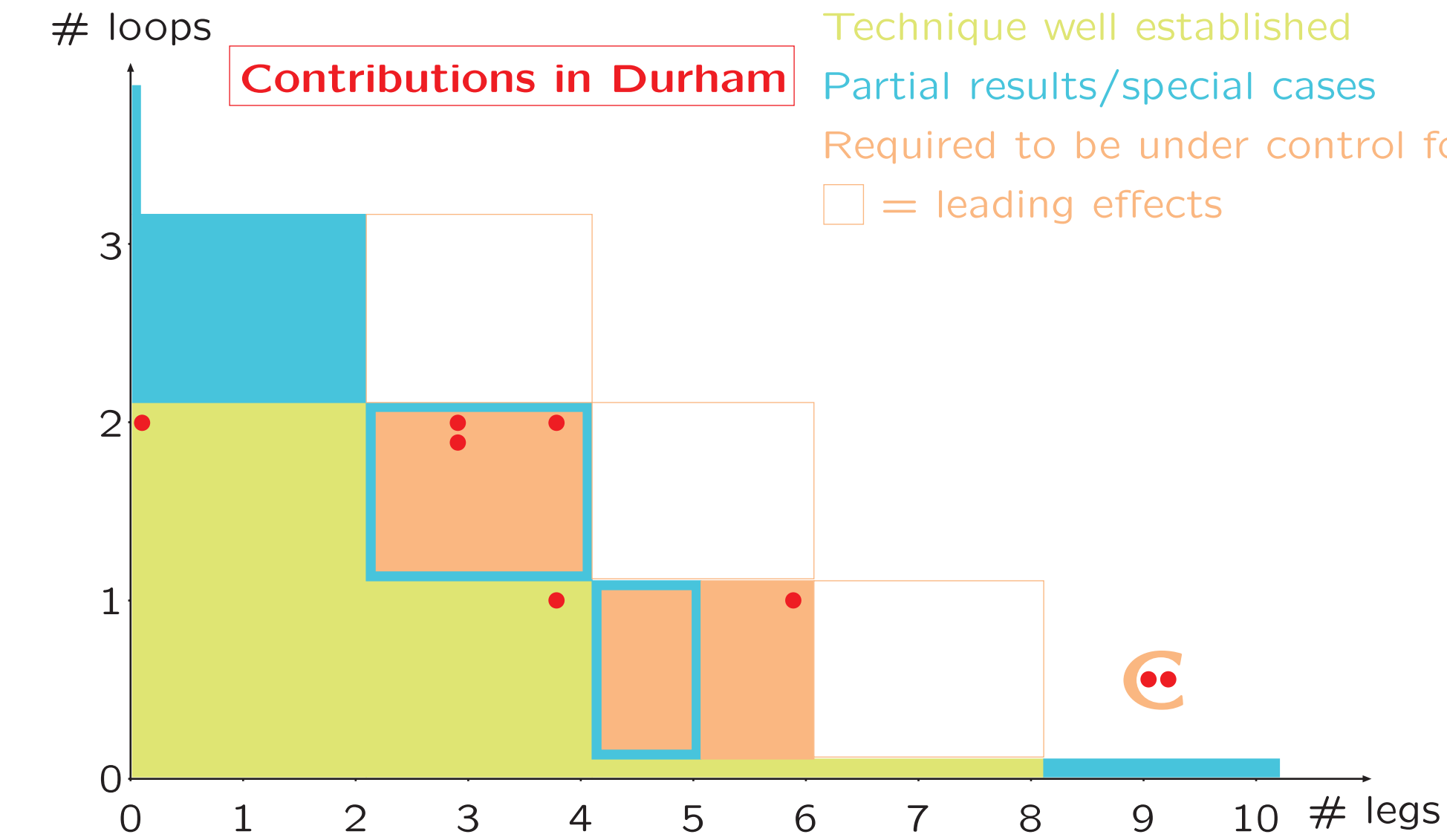

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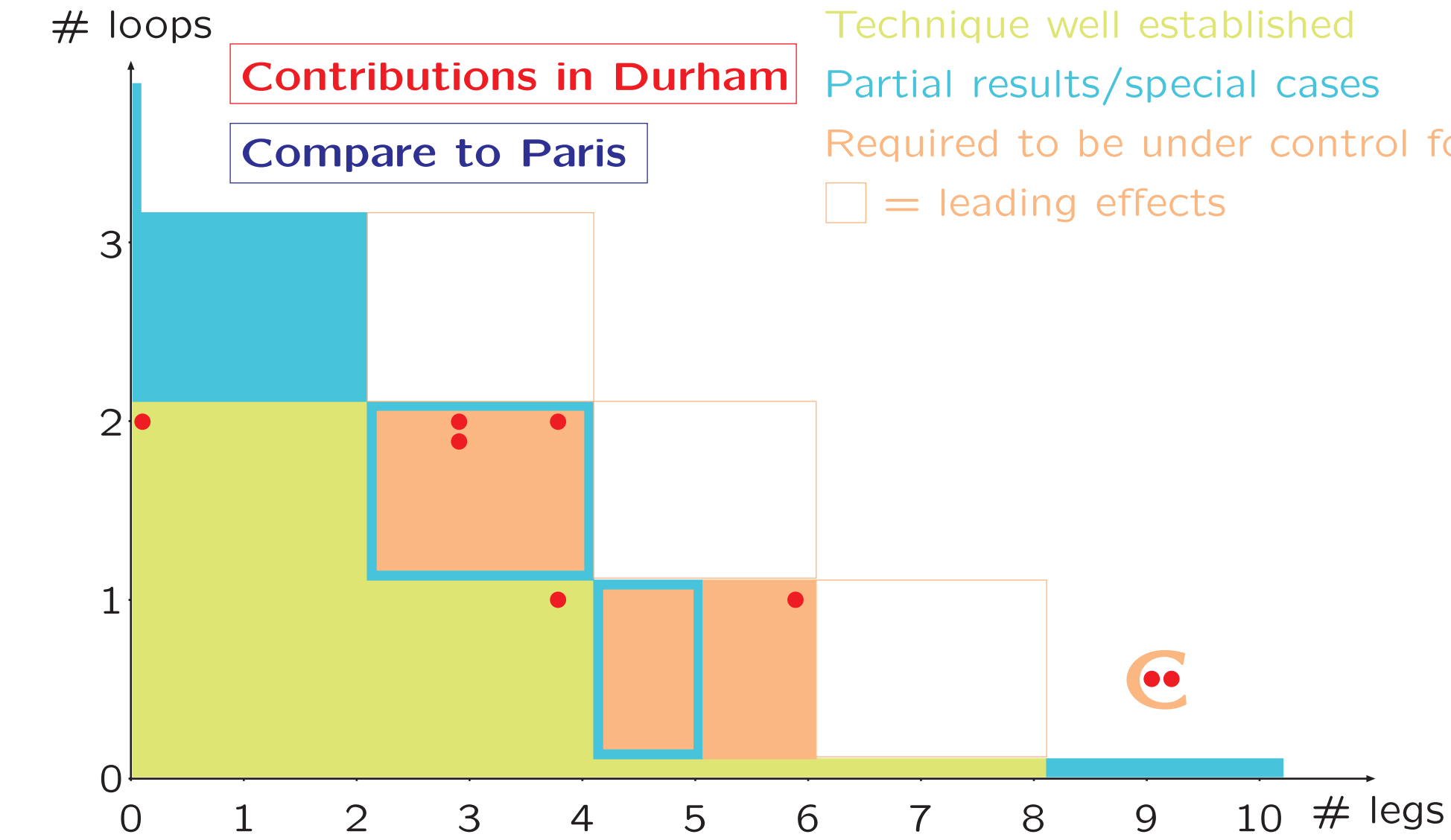

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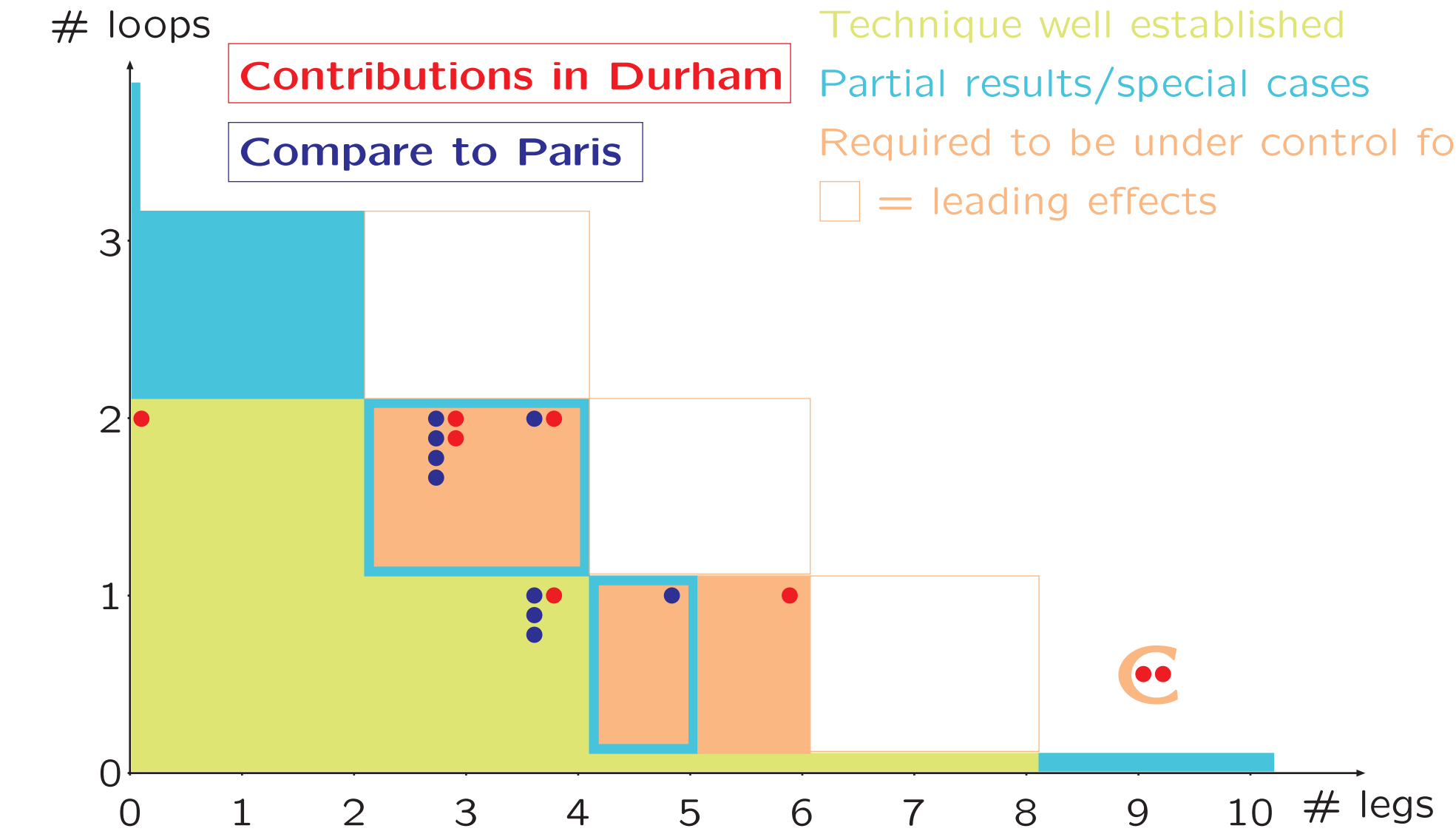

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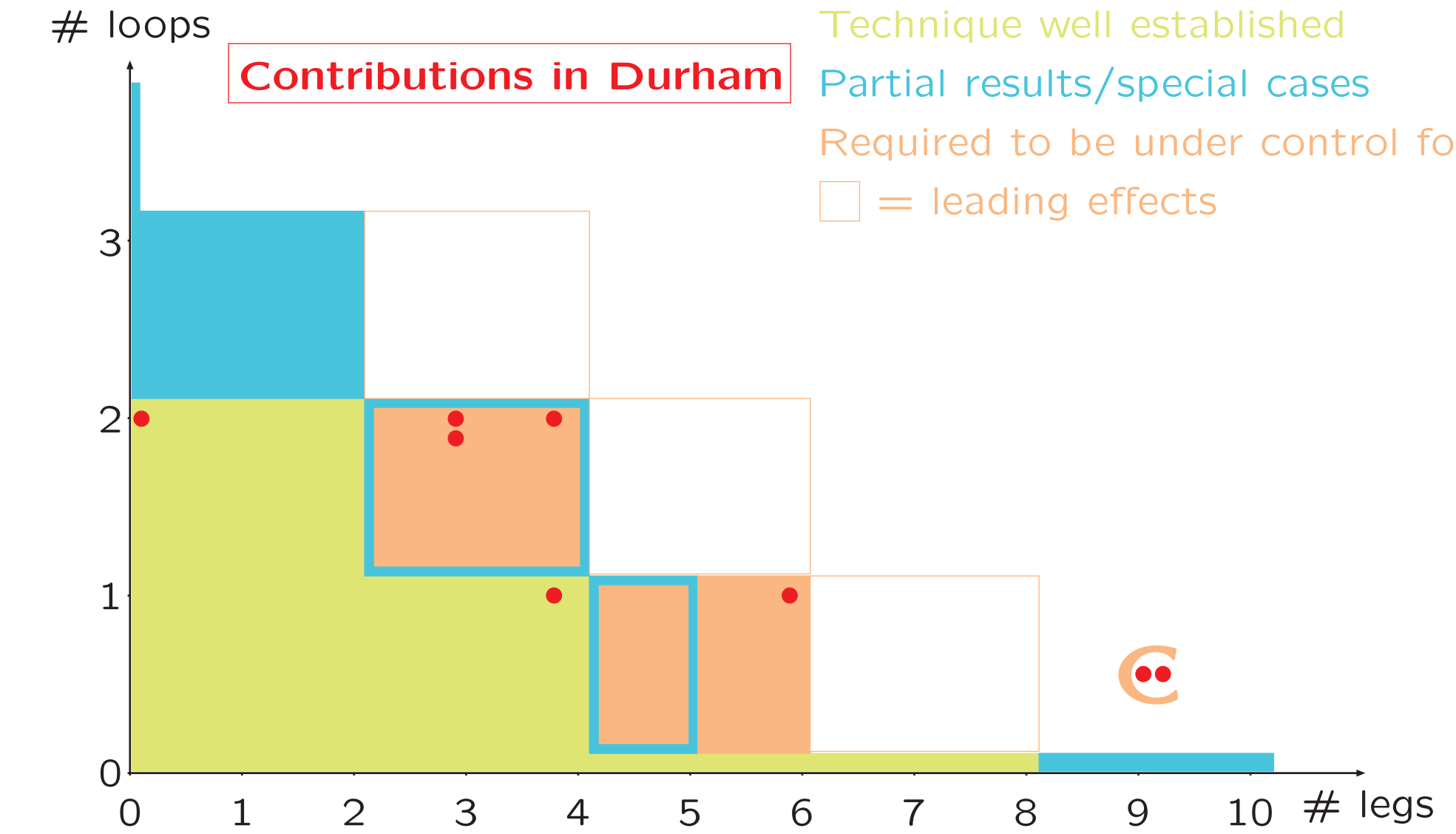

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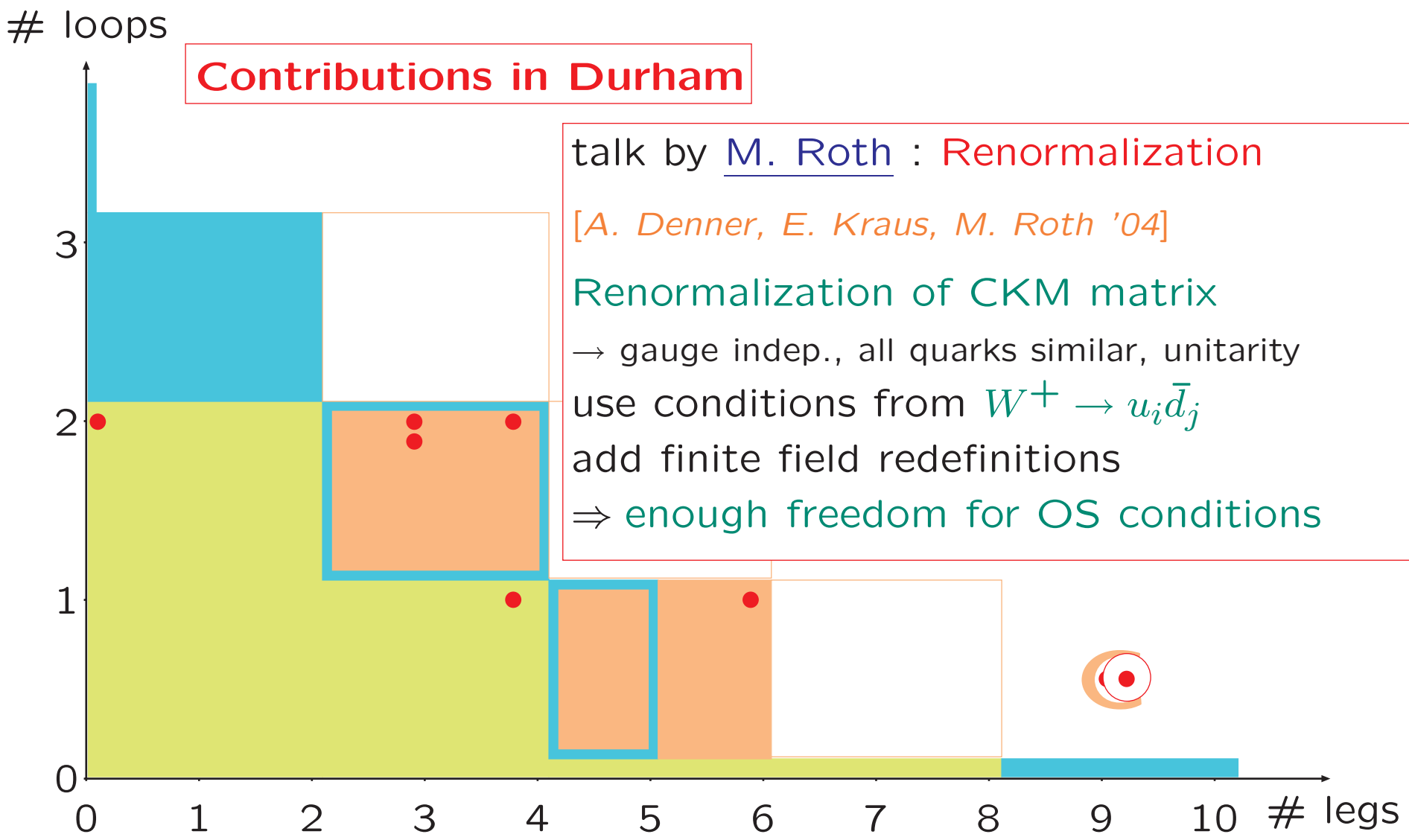
Contributions in Durham



talk by M. Roth : Renormalization

[*A. Denner, E. Kraus, M. Roth '04*]

Renormalization of CKM matrix

→ gauge indep., all quarks similar, unitarity

use conditions from $W^+ \to u_i \bar{d}_j$

add finite field redefinitions

⇒ enough freedom for OS conditions

vacuum graphs $\Delta\rho$

self-energies Δr, masses

$2 \to 2$, $1 \to 3$ Bhaba

$1 \to 2$, $\sin^2\theta_{\text{eff}}$

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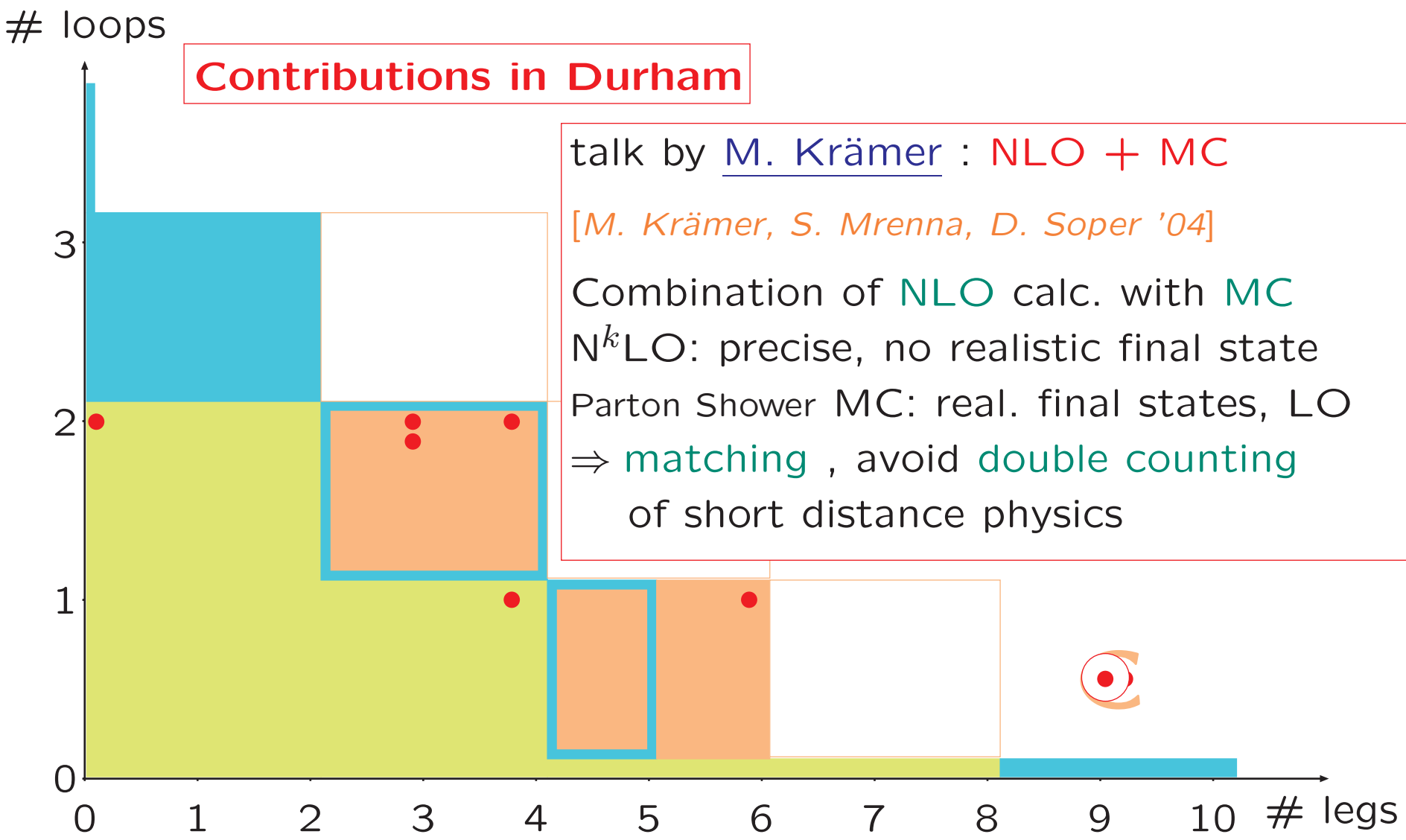

talk by M. Krämer : NLO + MC

[*M. Krämer, S. Mrenna, D. Soper '04*]

Combination of NLO calc. with MC

N^{k}LO: precise, no realistic final state

Parton Shower MC: real. final states, LO

$\Rightarrow$ matching , avoid double counting of short distance physics

vacuum graphs $\Delta\rho$ self-energies Δr, masses $1 \to 2$, $\sin^2\theta_{\text{eff}}$ $2 \to 2$, $1 \to 3$ Bhaba $2 \to 3$ $ee \to 4f$ $ee \to 4f + \gamma$ $ee \to 6f$

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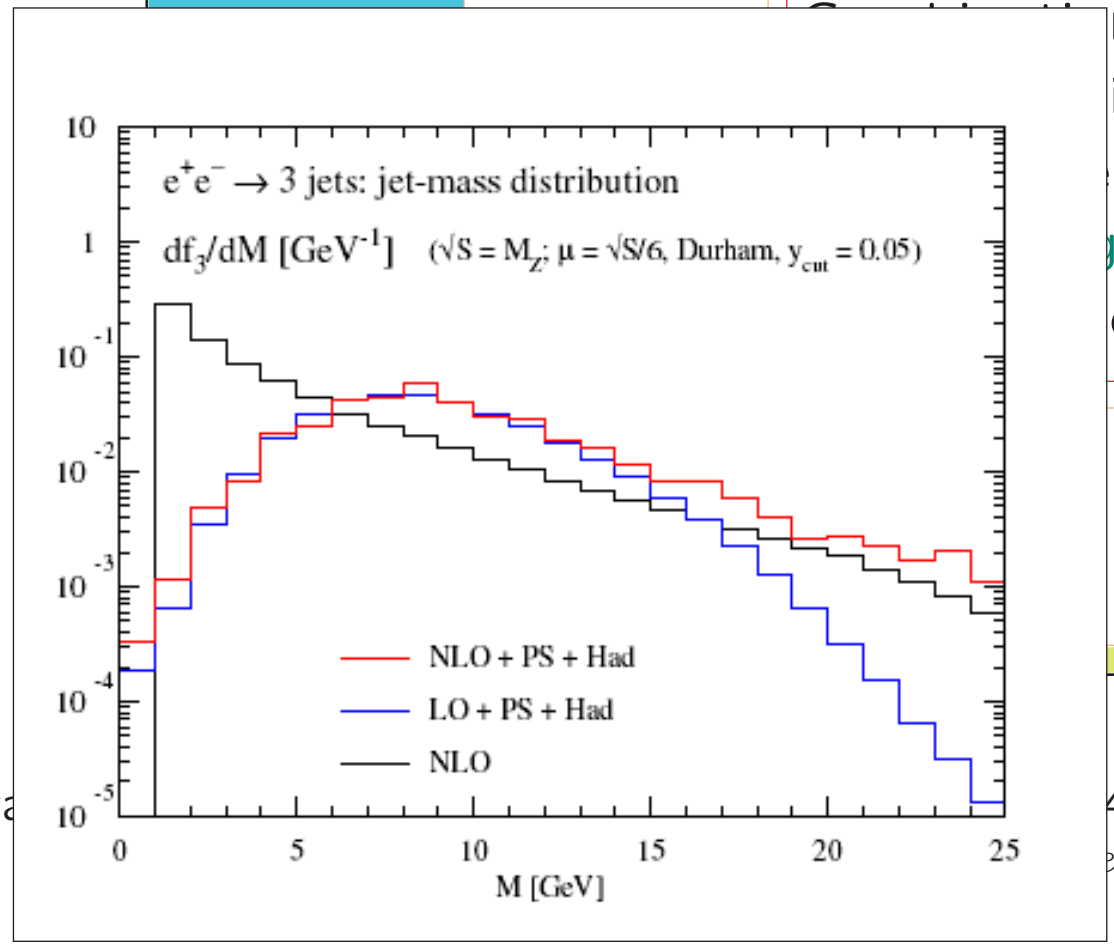
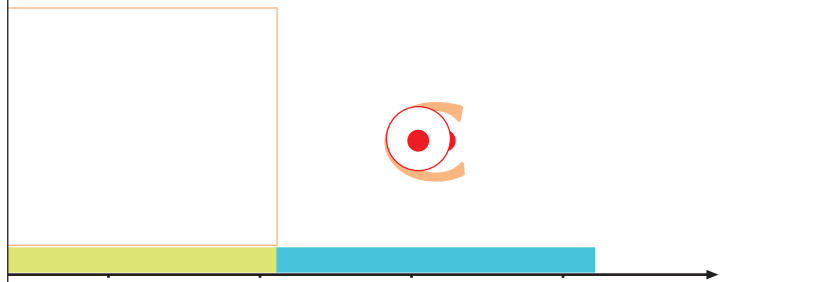
distance physics



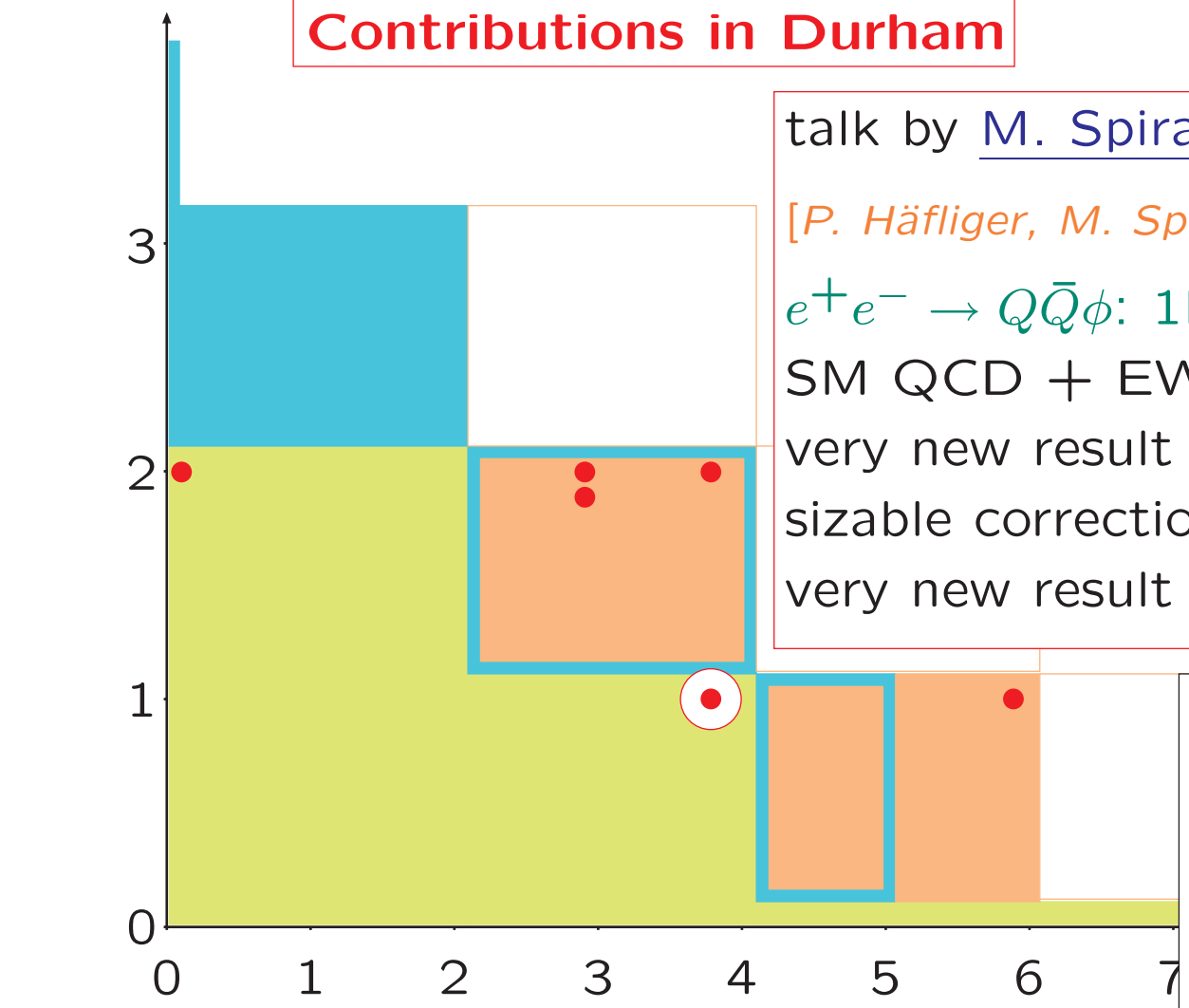


va

$4f$ $ee \to 6f$

$ee \to 4f + \gamma$

Contributions in Durham



talk by M. Spira : 1 loop, $1 \to 3$, MSSM

[*P. Häfliger, M. Spira '04*]

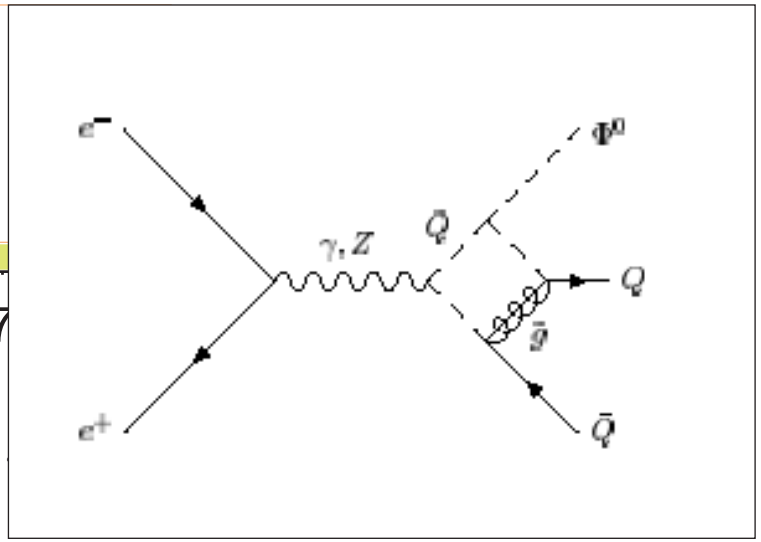
$e^+e^- \to Q\bar{Q}\phi$: 1L SUSY QCD, $\phi = h, H, A$

SM QCD + EW known (and relevant)

very new result $\Rightarrow$ only SPS 5, 1b

sizable corrections: $\mathcal{O}(\pm 10\%)$

very new result $\Rightarrow$ checks remain tbd



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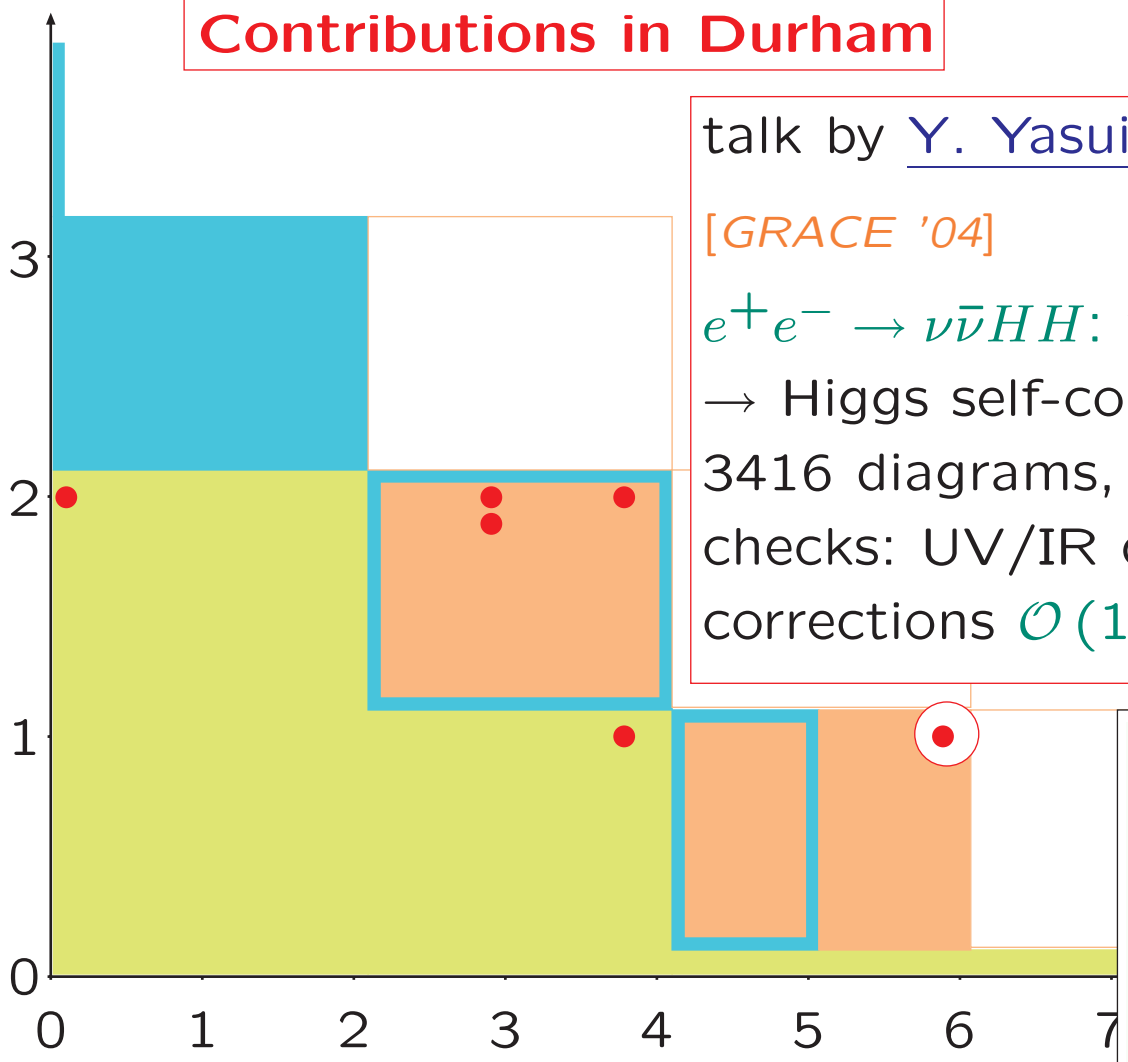


talk by Y. Yasui : 1 loop, $2 \to 4$, SM

[*GRACE '04*]

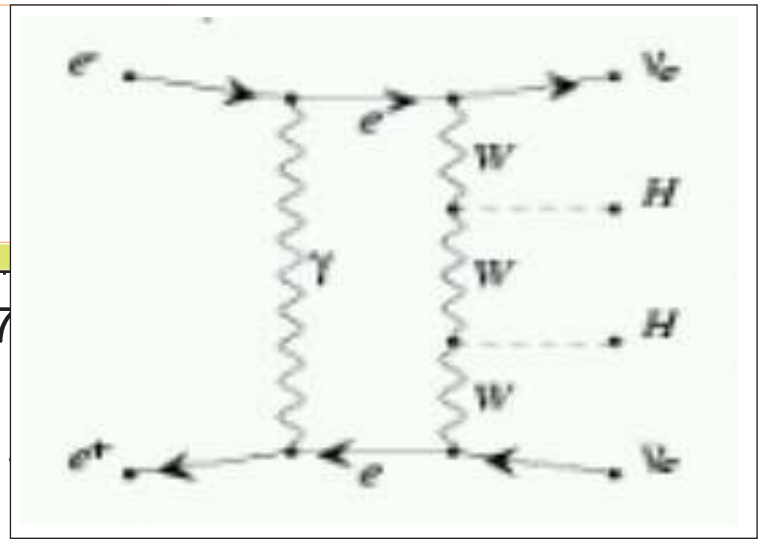
$e^+e^- \to \nu\bar{\nu}HH$: first full EW $2 \to 4$

$\to$ Higgs self-coupling measurement

3416 diagrams, 218 Pent. 74 Hex.

checks: UV/IR div., gauge par. independ.

corrections $\mathcal{O}(10\%)$ (top-loop in HHH)



loops

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ms, 218 Pent. 74 Hex.

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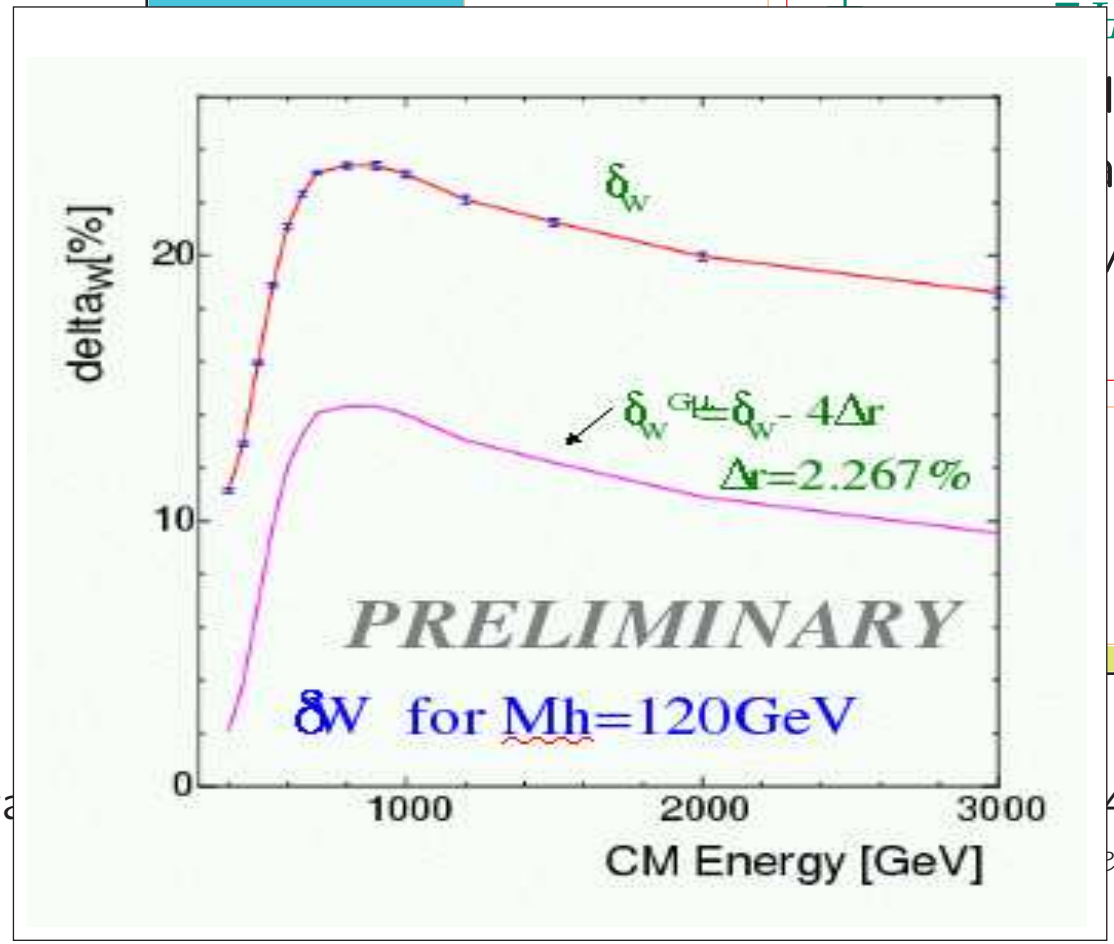

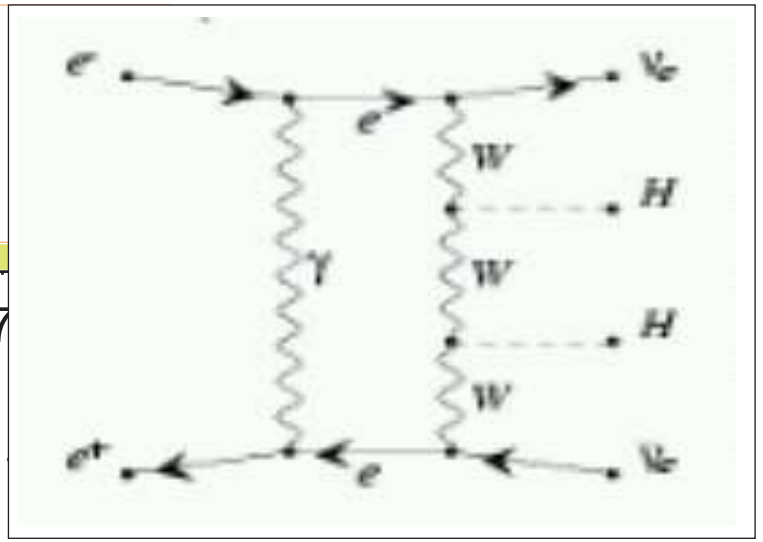

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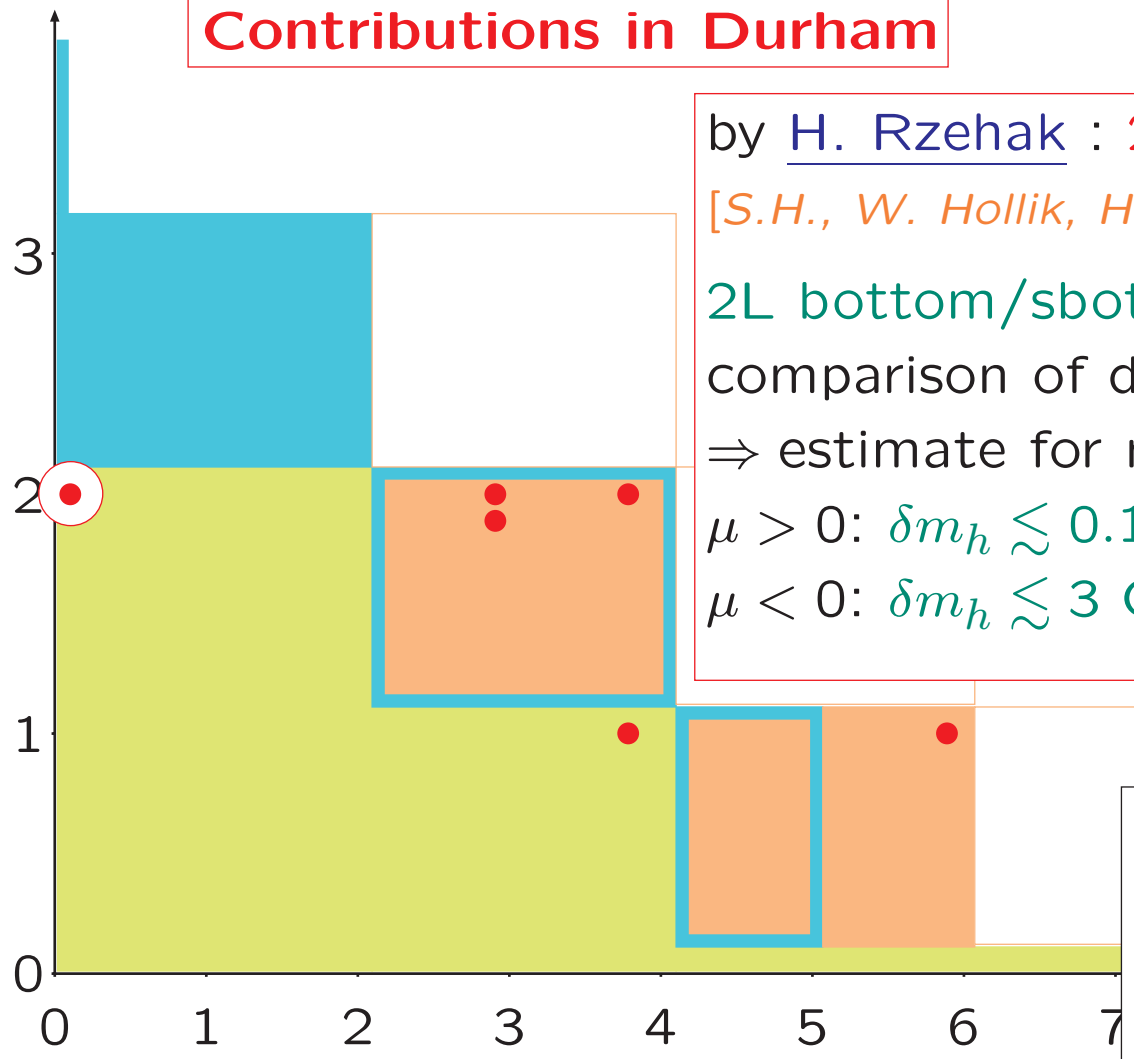


by H. Rzehak : 2L vacuum, MSSM + Ren.

[*S.H., W. Hollik, H. Rzehak, G. Weiglein '04*]

2L bottom/sbottom corr. to m_h: $\mathcal{O}(\alpha_s\alpha_b)$

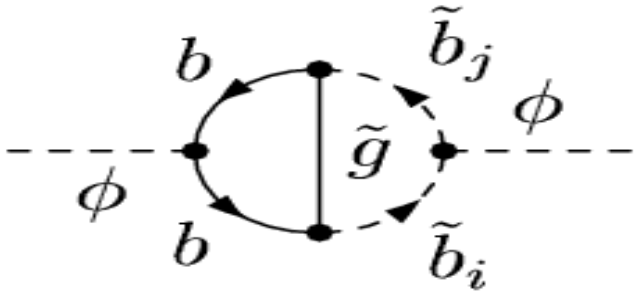
comparison of diff. renormalizations

$\Rightarrow$ estimate for missing higher-order corr.

$\mu > 0$: $\delta m_h \lesssim 0.1$ GeV

$\mu < 0$: $\delta m_h \lesssim 3$ GeV $\Rightarrow$ 3L needed

LC: $\delta m_h^{\rm exp} = 0.05$ GeV



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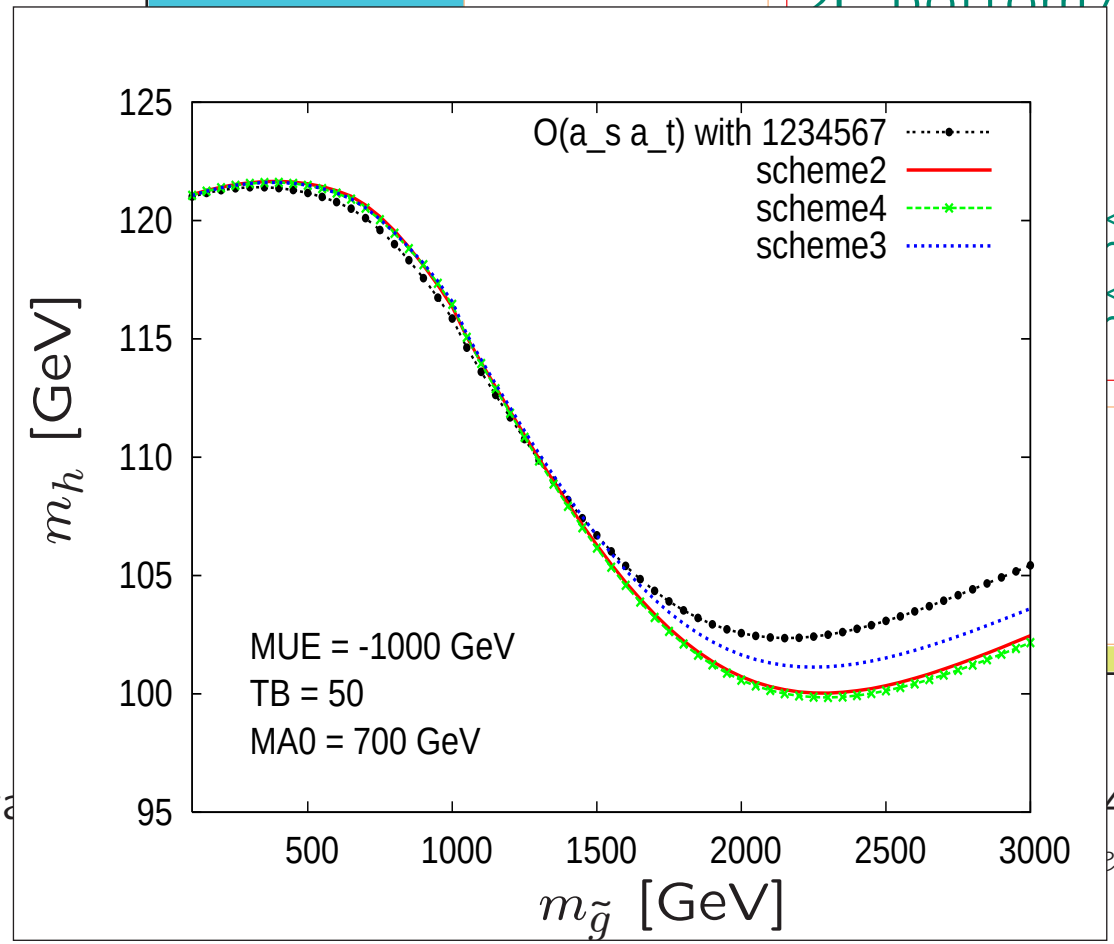

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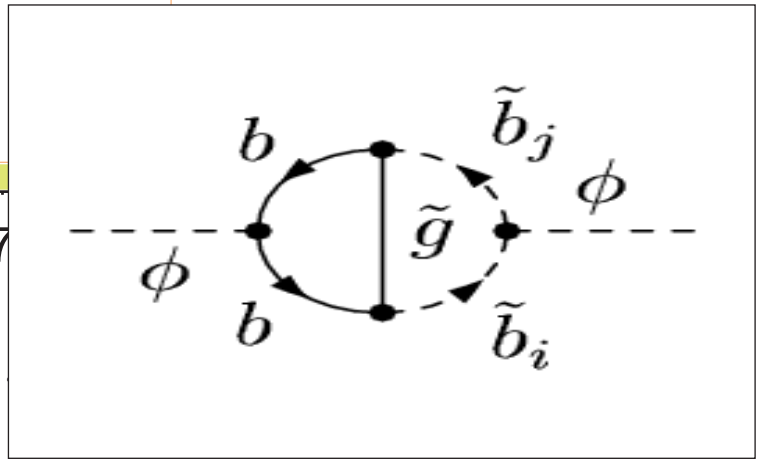

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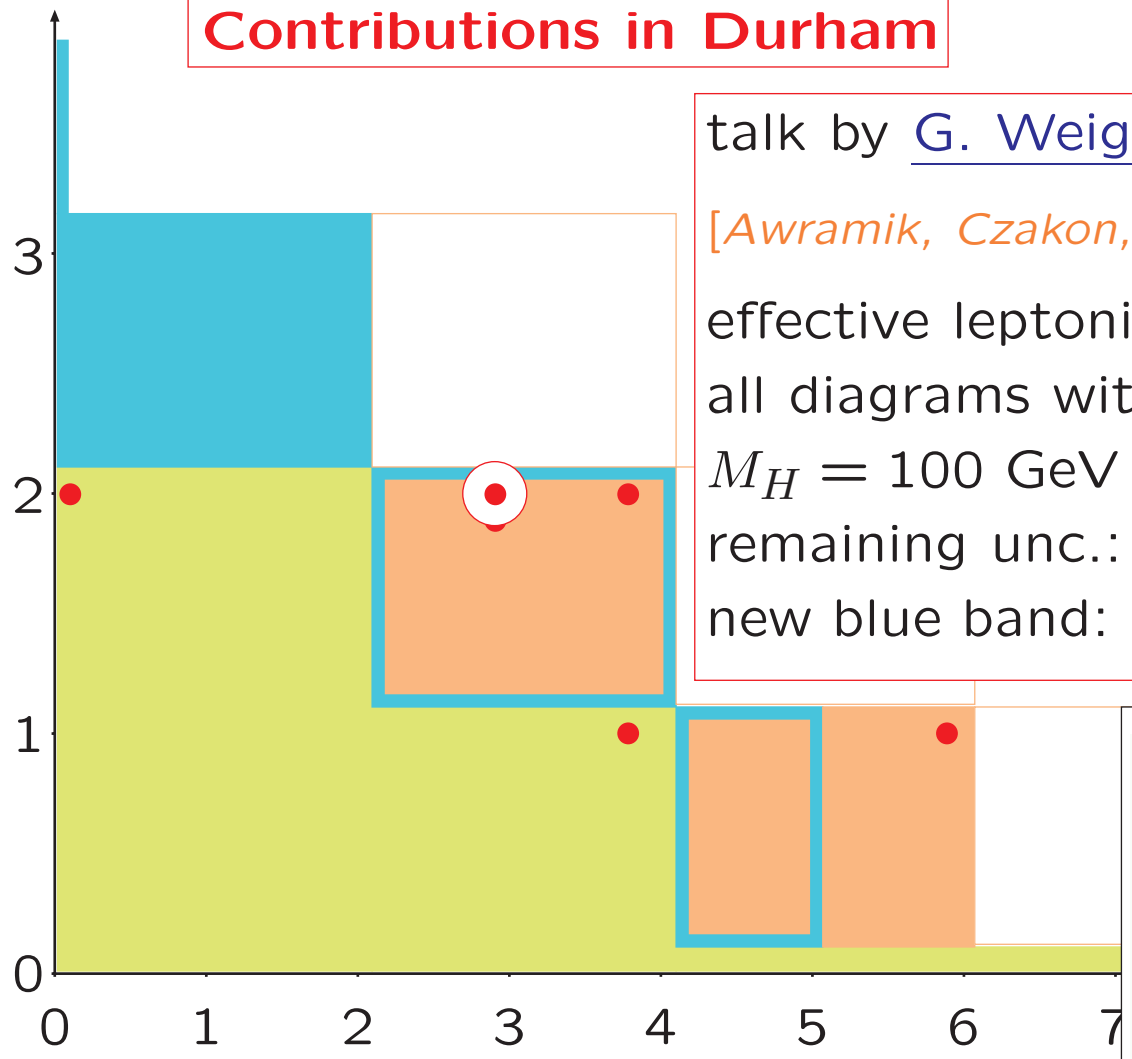


talk by G. Weiglein : 2 loop, $1 \to 2$, SM

[*Awramik, Czakon, Freitas, Weiglein '04*]

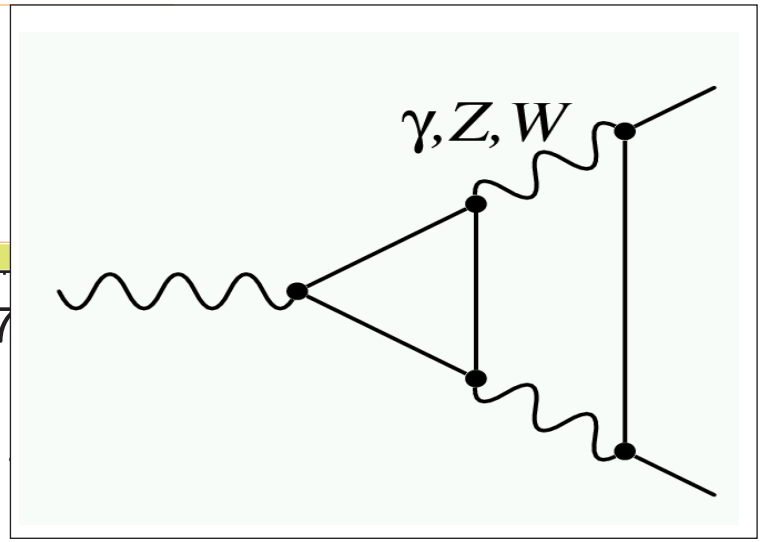
effective leptonic mixing angle $\sin^2\theta_{\rm eff}$

all diagrams with a closed fermion loop

$M_H = 100$ GeV $\Rightarrow \delta \sin^2\theta_{\rm eff} = -4.5 \times 10^{-5}$

remaining unc.: $\delta \sin^2\theta^{\rm theo}_{\rm eff} = \pm 5 \times 10^{-5}$

new blue band: $M_H < 260$ GeV @ 95% CL



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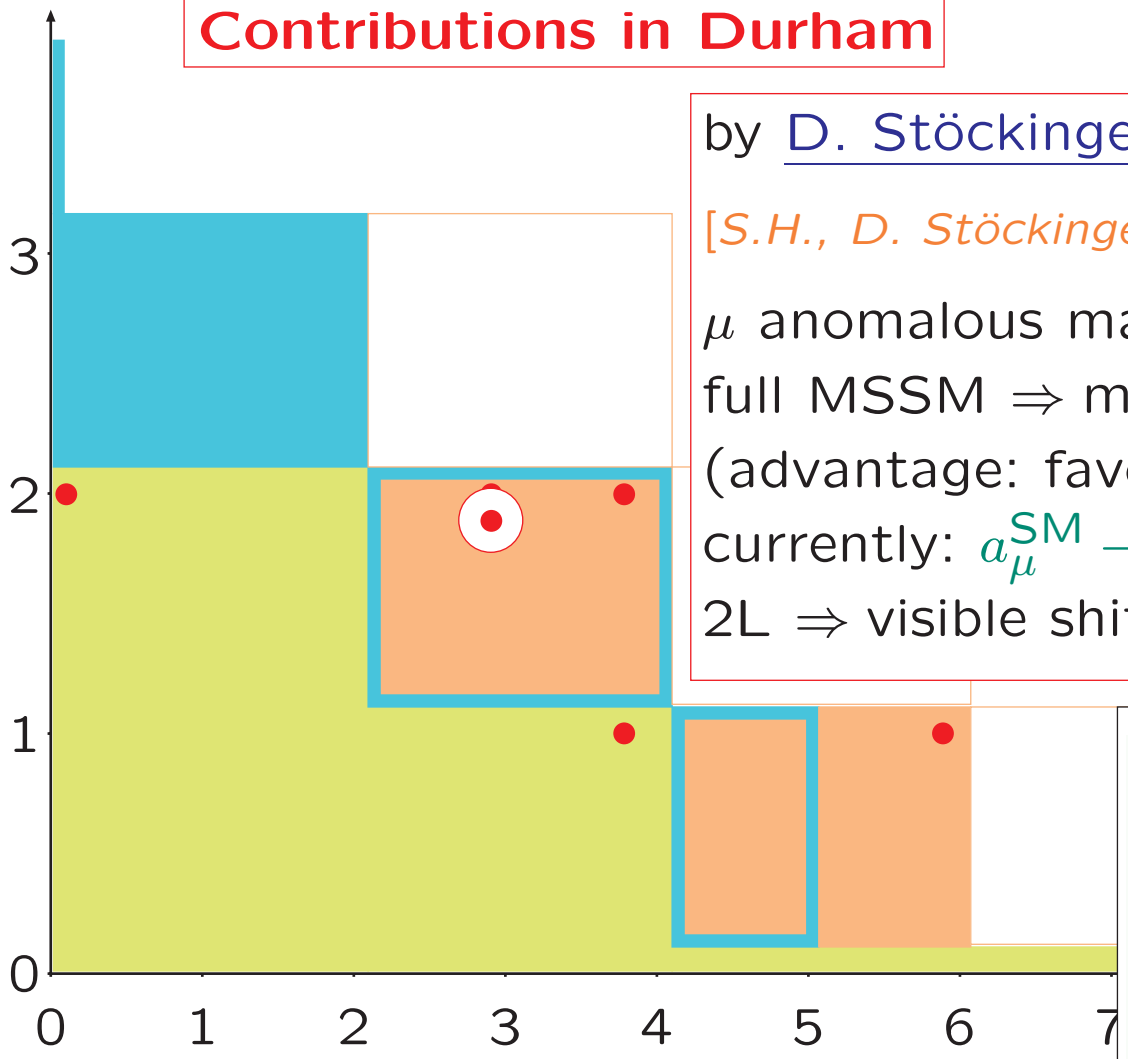


by D. Stöckinger : 2 loop, $1 \to 2$, MSSM

[*S.H., D. Stöckinger, G. Weiglein '04*]

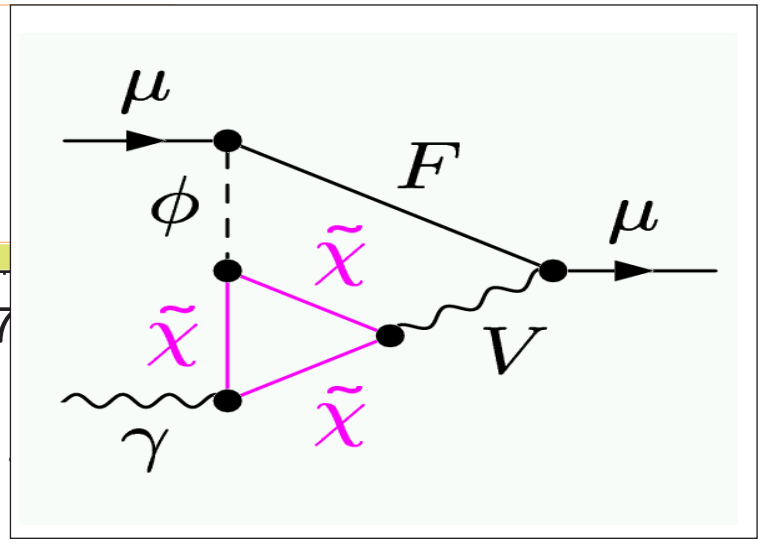
μ anomalous magnetic moment: $(g-2)_\mu$

full MSSM $\Rightarrow$ many scales

(advantage: favorite kinematic situation)

currently: $a_\mu^{\rm SM} - a_\mu^{\rm exp} \approx 25 \pm 9 \times 10^{-10}$

2L $\Rightarrow$ visible shift in MSSM prediction



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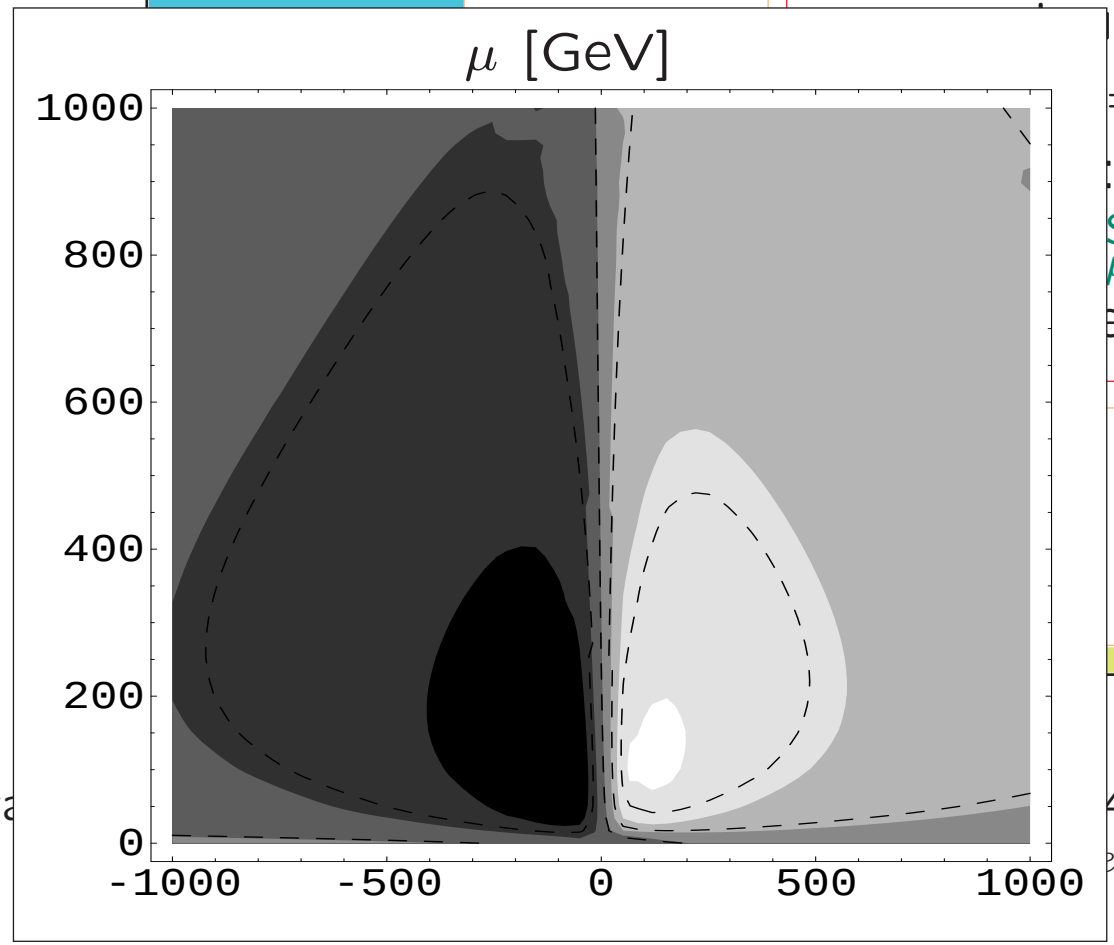

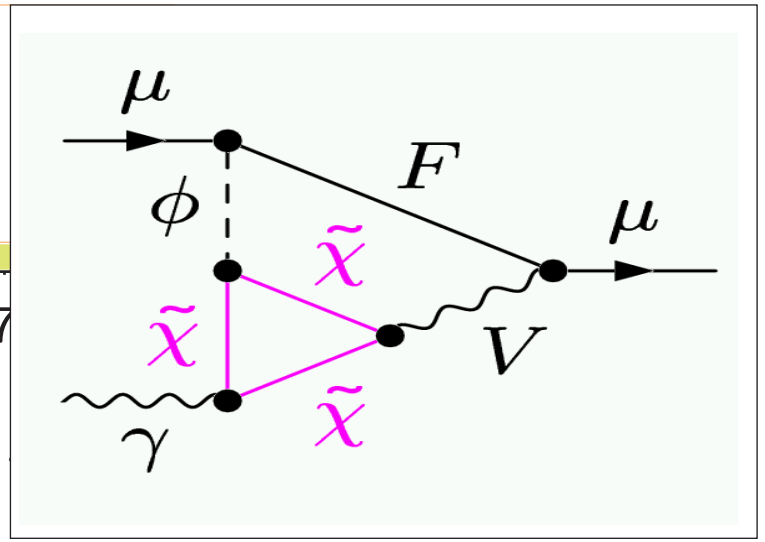

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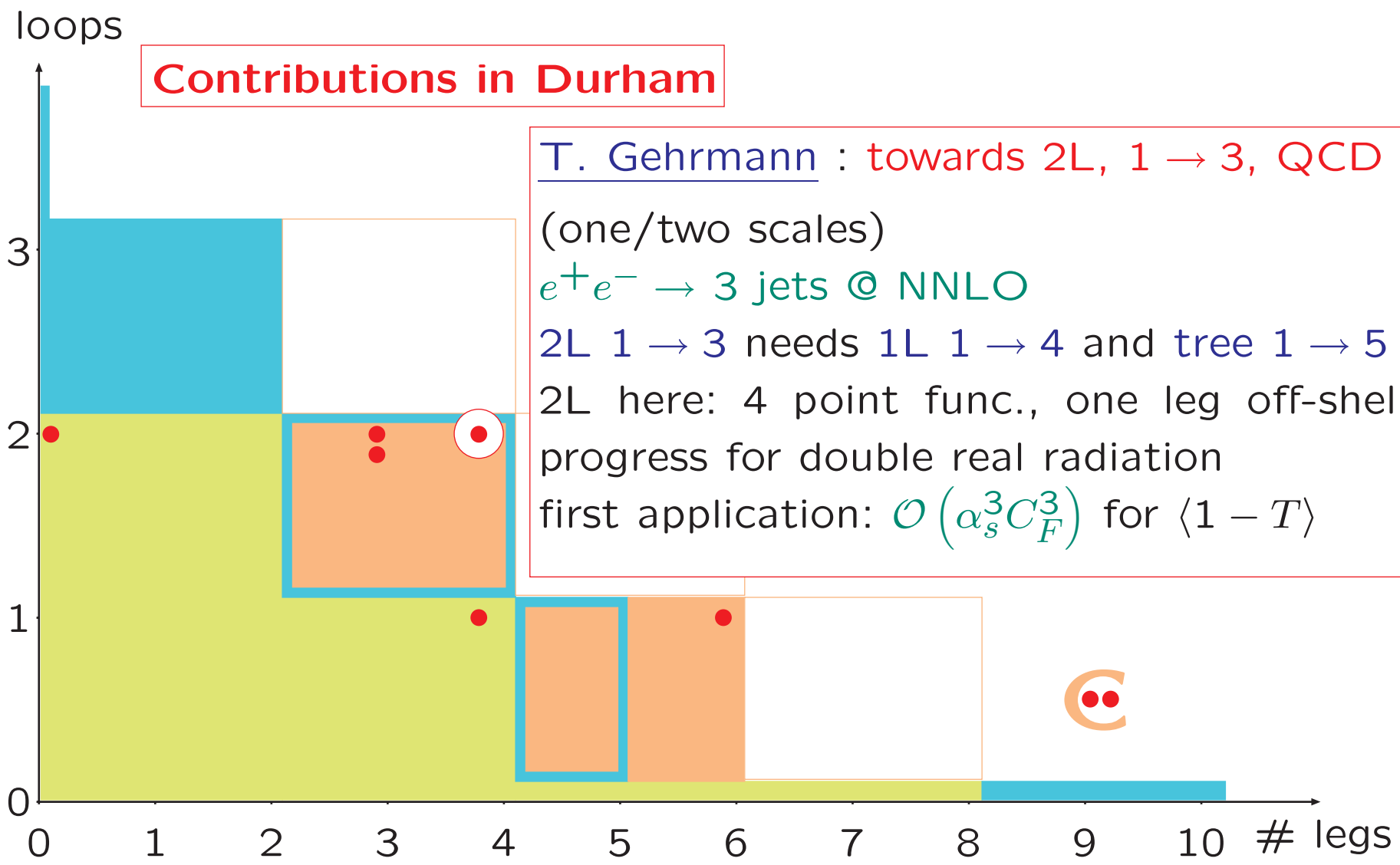

T. Gehrmann : towards 2L, $1 \to 3$, QCD

(one/two scales)

$e^+e^- \to 3$ jets @ NNLO

2L $1 \to 3$ needs 1L $1 \to 4$ and tree $1 \to 5$

2L here: 4 point func., one leg off-shell

progress for double real radiation

first application: $\mathcal{O}\left(\alpha_s^3 C_F^3\right)$ for $\langle 1 - T \rangle$

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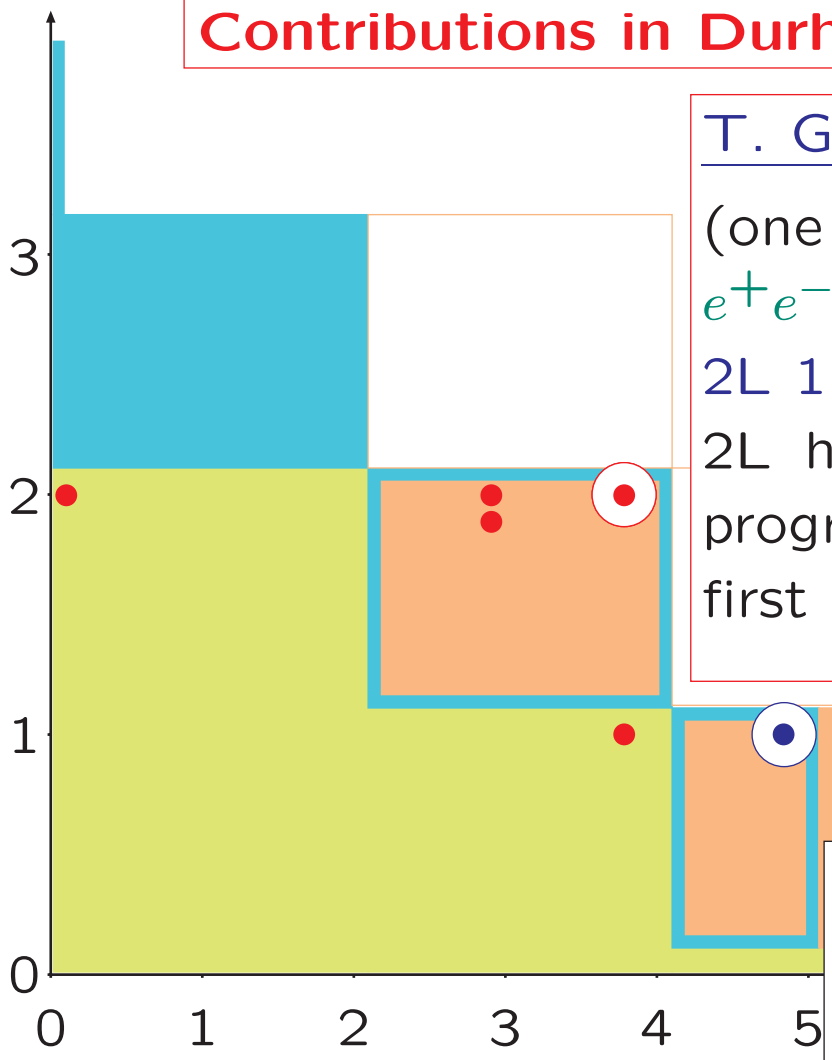

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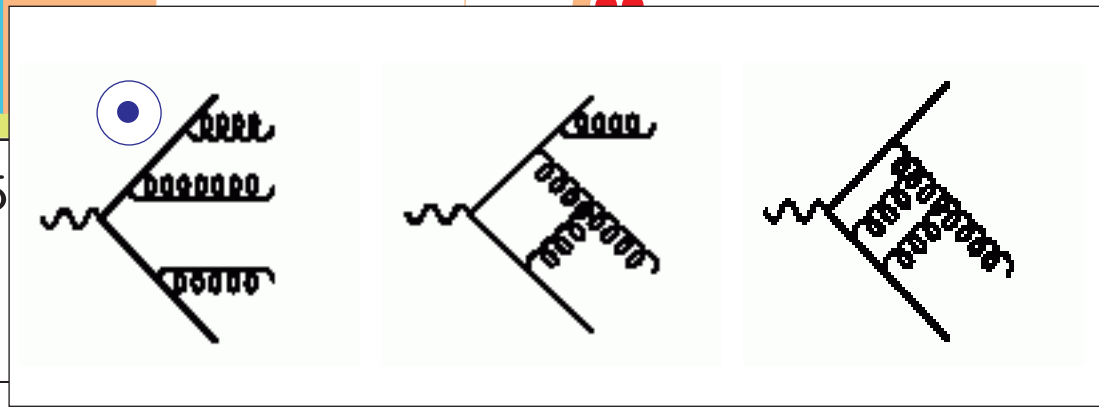

Experimental situation:

Current/future Experiments
→ provide high accuracy measurements !

Theory situation:

measured observables have to be compared with theoretical predictions
(of your favorite model)

Measured data is only meaningful if it is matched with
theoretical calculations at the same level of accuracy

The great LC precision would be redlworthless without theory calculations

We have to start **NOW** to achieve necessary accuracy in time

Theoretical calculations should be viewed as an essential part of all future High Energy Physics programs