ESPPU Granada

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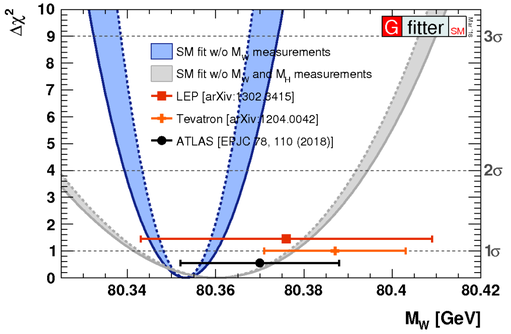
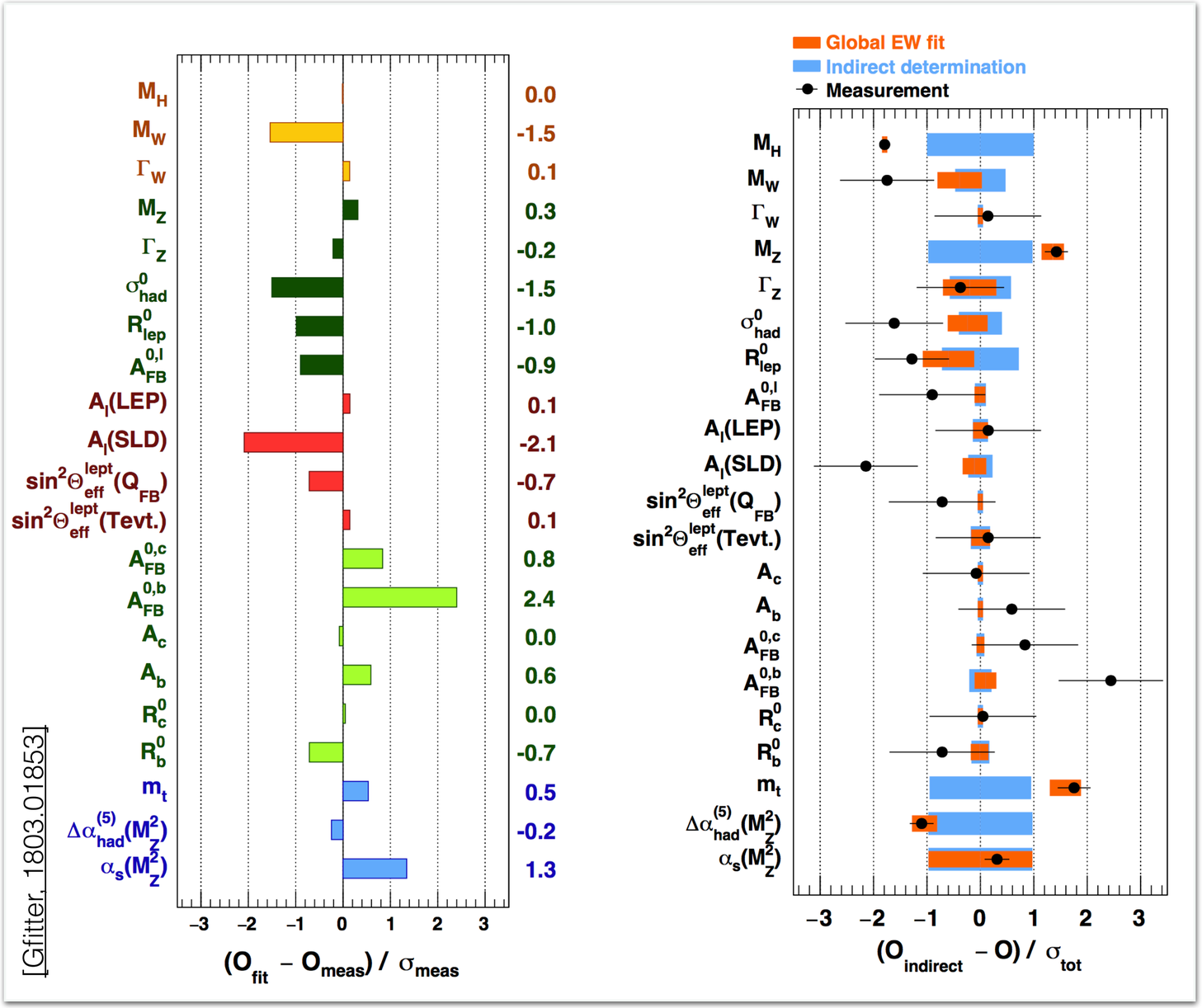
[Picture of the cloud chamber at the CERN Microcosm. Courtesy of P.F. Butti]

Precision tests of the SM

- EW fits

Used values:
mH = 125.0 ± 0.2 GeV
mW = 80.379 ± 0.013 GeV
mt = 172.47 ± 0.68 GeV

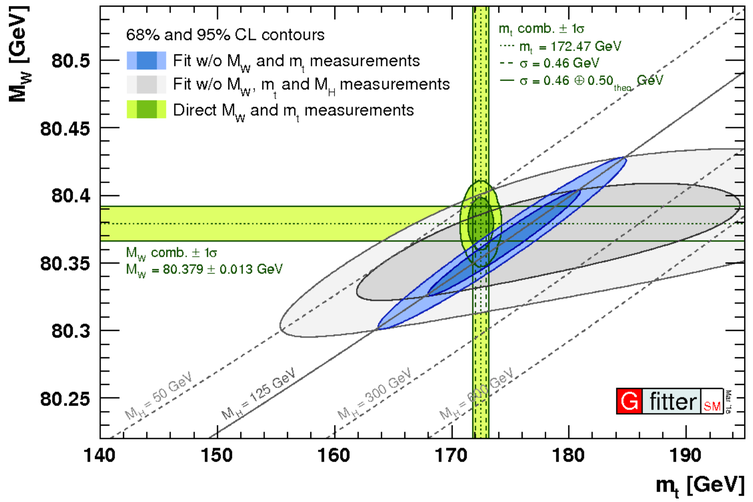




What can HL-LHC do?

- W and top mass are key parameters of the SM
- Motivation for low PileUp run: 200 pb-1 of Low PU data (μ~2) at 14 TeV
  - 5-10 weeks of running —> ~3MeV (stat only)
  - Exp syst assumed to be at same level of Stat uncertainty
  - PDF unc ~4MeV with ultimate PDF)
- Goal Δm(W)~6MeV (extended coverage+combination+ultimate PDF)
  - PDF syst can go down to ~2MeV with LHeC PDF set

P. Azzi



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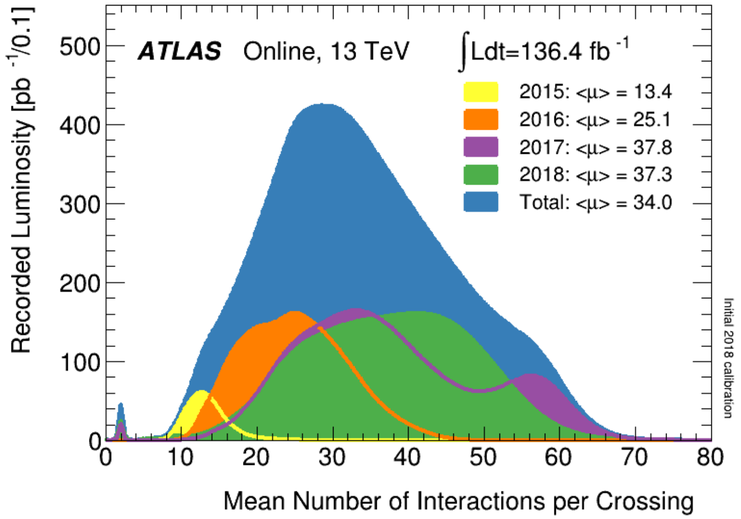


W mass:

- goal is ~6 MeV
- PDF precision important

Top mass:

- Several methods explored
- Precision range: 0.2-1.2 GeV
- Relation to pole mass unclear for most precise methods

Method:	$t\bar{t}$ lepton+jets	t-channel single top	$m_{SV\ell}$	J/ψ	$\sigma_{t\bar{t}}$
Δm_{top} (GeV):	0.17	0.45	0.62	0.50	1.2

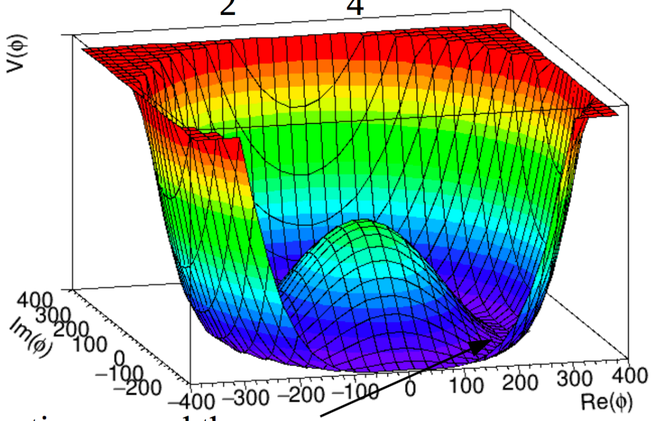
Standard →ℓ+jets measurement | Statistically dominated

Limited by theory uncertainty and luminosity measurement

B. Heinemann

Higgs potential: measurement of the self coupling

- Higgs potential: $V(\Phi)=\frac{1}{2}\mu^2\Phi^2+\frac{1}{4}\lambda\Phi^4$

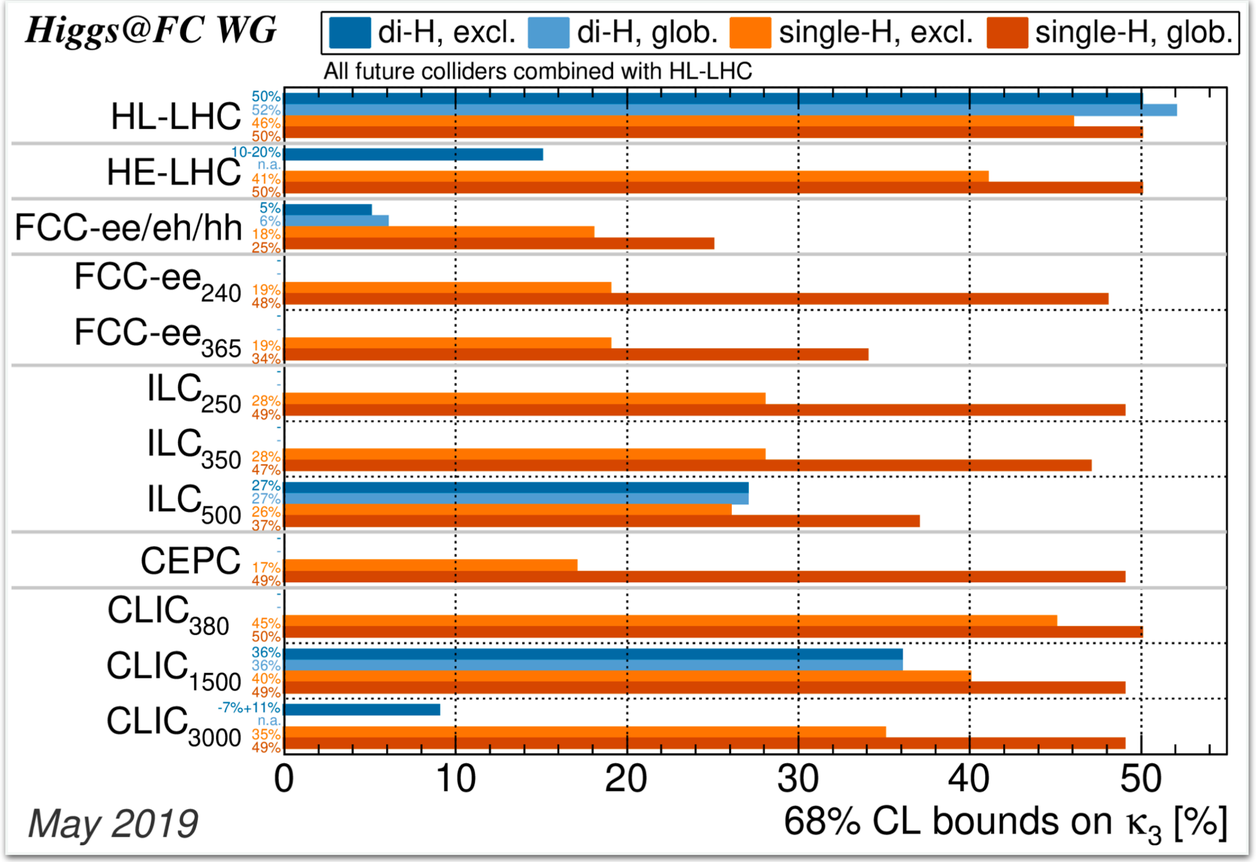


more details on the motivations in the talk by G. Servant

- Approximation around the v.e.v:

$$V(\Phi)\approx\underbrace{\lambda v^2 h^2}_{\text{mass term}}+\underbrace{\lambda v h^3+\frac{1}{4}\lambda h^4}_{\text{self-coupling terms}}$$

- λ known from v.e.v and Higgs mass: $\lambda=\frac{m_H^2}{2\cdot v^2}\approx 0.13$
- BSM effects could change $\lambda \Rightarrow$ define deviation of tri-linear term: $\kappa_\lambda=\kappa_3=\frac{\lambda_{HHH}}{\lambda_{HHH}^{SM}}$
  - no quartic terms considered here

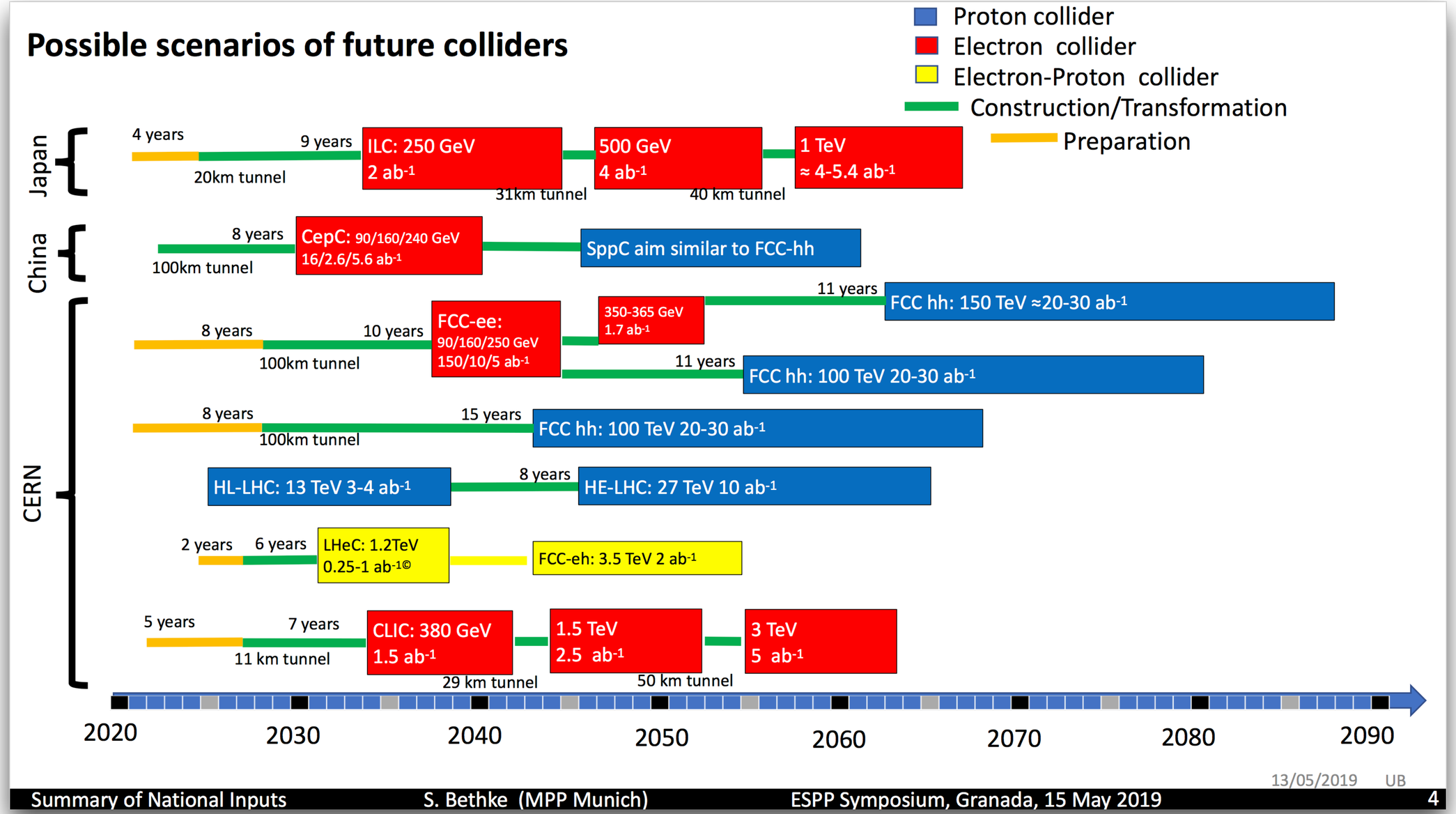


The Big Questions (BQs)

- **The four big questions for BSM (@colliders):**
  - **To what extent can we tell whether the Higgs is fundamental or composite?**
  - **Are there new interactions or new particles around or above the electroweak scale?**
  - **What cases of thermal relic WIMPs are still unprobed and can be fully covered by future collider searches?**
  - **To what extent can current or future accelerators probe feebly interacting sectors?**

[Gian Giudice and Paris Sphicas]

Timeline


Possible scenarios of future colliders
Proton collider
Electron collider
Electron-Proton collider
Construction/Transformation
Preparation
Japan
4 years
9 years
20km tunnel
ILC: 250 GeV
2 ab-1
31km tunnel
500 GeV
4 ab-1
40 km tunnel
1 TeV
≈ 4-5.4 ab-1
China
8 years
100km tunnel
CepC: 90/160/240 GeV
16/2.6/5.6 ab-1
SppC aim similar to FCC-hh
CERN
11 years
FCC hh: 150 TeV ≈20-30 ab-1
8 years
10 years
100km tunnel
FCC-ee:
90/160/250 GeV
150/10/5 ab-1
350-365 GeV
1.7 ab-1
11 years
FCC hh: 100 TeV 20-30 ab-1
8 years
15 years
100km tunnel
FCC hh: 100 TeV 20-30 ab-1
HL-LHC: 13 TeV 3-4 ab-1
8 years
HE-LHC: 27 TeV 10 ab-1
2 years
6 years
LHeC: 1.2TeV
0.25-1 ab-1©
FCC-eh: 3.5 TeV 2 ab-1
5 years
7 years
11 km tunnel
CLIC: 380 GeV
1.5 ab-1
29 km tunnel
1.5 TeV
2.5 ab-1
50 km tunnel
3 TeV
5 ab-1
2020
2030
2040
2050
2060
2070
2080
2090
13/05/2019 UB
Summary of National Inputs S. Bethke (MPP Munich) ESPP Symposium, Granada, 15 May 2019 4