NEXT in Flavour:
a Flavour Physics experiment at the HL-LHC

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WhatNext Mid-Term meeting

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Motivation and Impact

- The WN question: where do we go if no new physics in 2017 ?
  - Idea born in first WN meeting
- No clear path, large energy gap from Fermi to Planck scale
  - Aka “SM desert...”
  - Struggle to motivate the next step in energy
- Idea: send a “unmanned probe” to the highest possible energy
  - hope to find a hint in high-precision measurements
- Flavor measurements are such probe, but need extreme precision/extreme intensity program, well beyond present
- Opportunity: enormous production of HF at HL-LHC “for free”
  - Means 10^{14} bottom/10^{15} charm quarks per year in acceptance.
- Current/foreseen experiments only use a fraction of it
  - Compare LHCb upgrade: O(100x)
- A *major undertaking* (still much easier than a 1 PeV accelerator...)

Mid-term assessment

- Contributors: R. Barbieri, C. Bozzi, N. Cartiglia, G. D'Ambrosio, F. De Fazio, S. Malvezzi, U. Marconi, N. Neri, F. Palla, D. Pedrini, G. Punzi, L. Silvestrini, C. Tarantino, V. Vagnoni
- Several Meetings/workshops
- Points discussed:
    - Specific physics targets
    - Theory uncertainties
    - Detector issues
    - Data acquisition
    - Data handling/analysis model
    - Timing/cost
    - R&D
- It is a new idea, and little previous background existed
- Status: I believe we have a first idea of where we stand.
    - Most people think it is a good idea - and might even be doable...
- 15 pages of report written in the WP from CSN1

Physics Targets

- Big initial concern : theoretical uncertainties

- However, it seems now clear that a list of useful measurements exists that are not theory-dominated and within reach, and that is a sufficient motivation.
    - UT angles 0.1°, Bd/Bs->μμ ~3%, $\tau \rightarrow \mu\mu\mu$ ~10^{-11}
    - Surprisingly: rare K decays, sterile neutrinos

- Many believe that by the time we get there, theory will have improved to the point that many other opportunities will be available, in precision beauty and charm (CPV 10^{-5}) - plus many things we just can't guess from where we stand now (a 10^3 - 10^4 gap)

- Lots of interesting topics to study

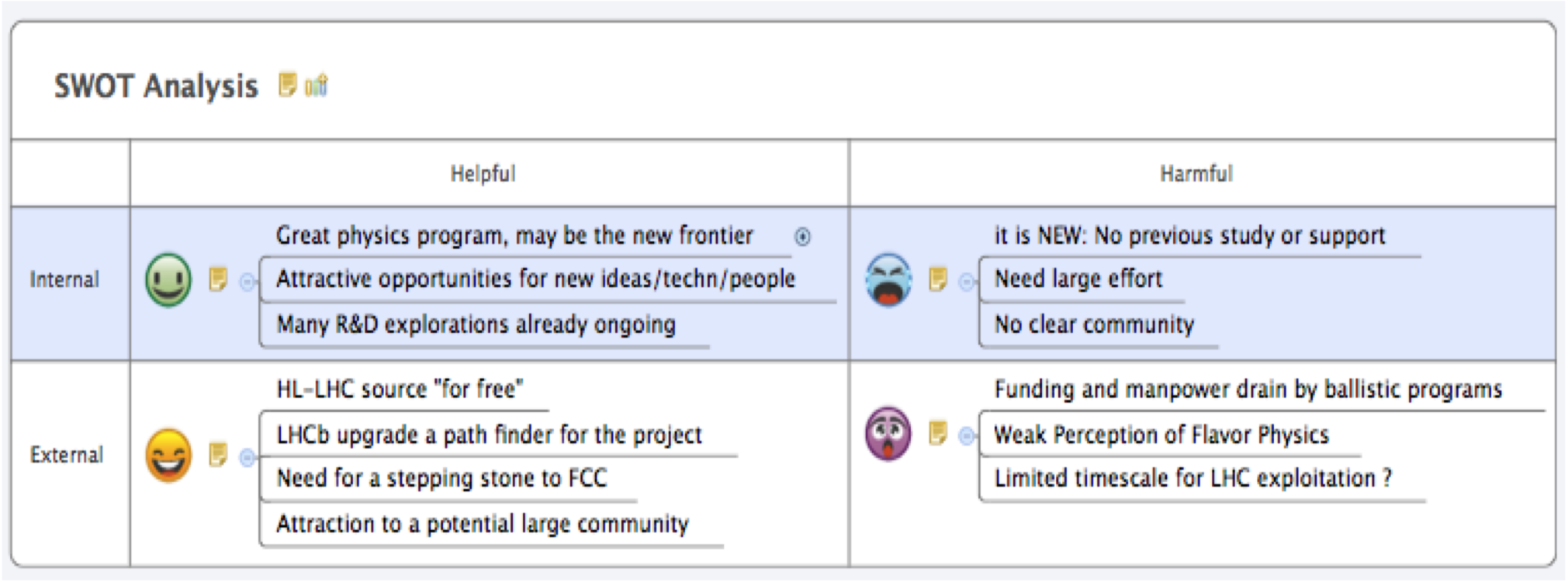
Technology needs of an "Extreme Flavor" detector

1. Detector with strong tracking capability at high-lum
   - Technologically within reach. Radiation is an issue (but ATLAS/CMS need it as well)
   - Hadron PID desirable (but hard !). Not a show stopper if we can have muons.
2. Detector readout at 40MHz
   - High-speed optical readout - enabled by progress of commercial telecom technology (e.g. LHCb upgrade)
3. Real-time, complex event reconstruction at 40MHz
   - Get tracks and other complex primitives (complete decay trees ?) straight out of the detector. Requires continuing R&D in real-time (embedded) digital system
   - Pattern recognition would benefit from time-tagged detectors ("4D reconstruction")
4. Offline-grade reconstruction and calibration in real-time.
   - Exploit progress in CPU processing power. But lot of effort needed on *algorithms*.
5. *Physics analysis* "in real time".
   - Offline processing and re-processing seems out of question. Need ability to do precision measurements from reduced-size stored sample, and special systematic-control methods
   - Again LHCb will be a testing ground

Experimental scenario

- Needs techniques and technologies not fully available today – but not far from reach
- R&D already in progress for ATLAS/CMS phase2 or U-LHCb
- Significant synergy with R&D for FCC-era detectors
  - At the FCC all SM physics is “high-intensity, low-pt”
  - Indeed, good “stepping stone” for any future accelerator detectors
- Timing must be phase2 to phase3 → exploitation of HL-LHC
- Cost and human effort typical of a large detector
- Efforts must begin *today*

SWOT



From SWOT to a Strategy*:*

- Grow a wide community
  - International Study Group
- Establish solid physics projections
- Immediately start focused R&D on critical items
- Build on synergies with farther future R&D programs like FCC