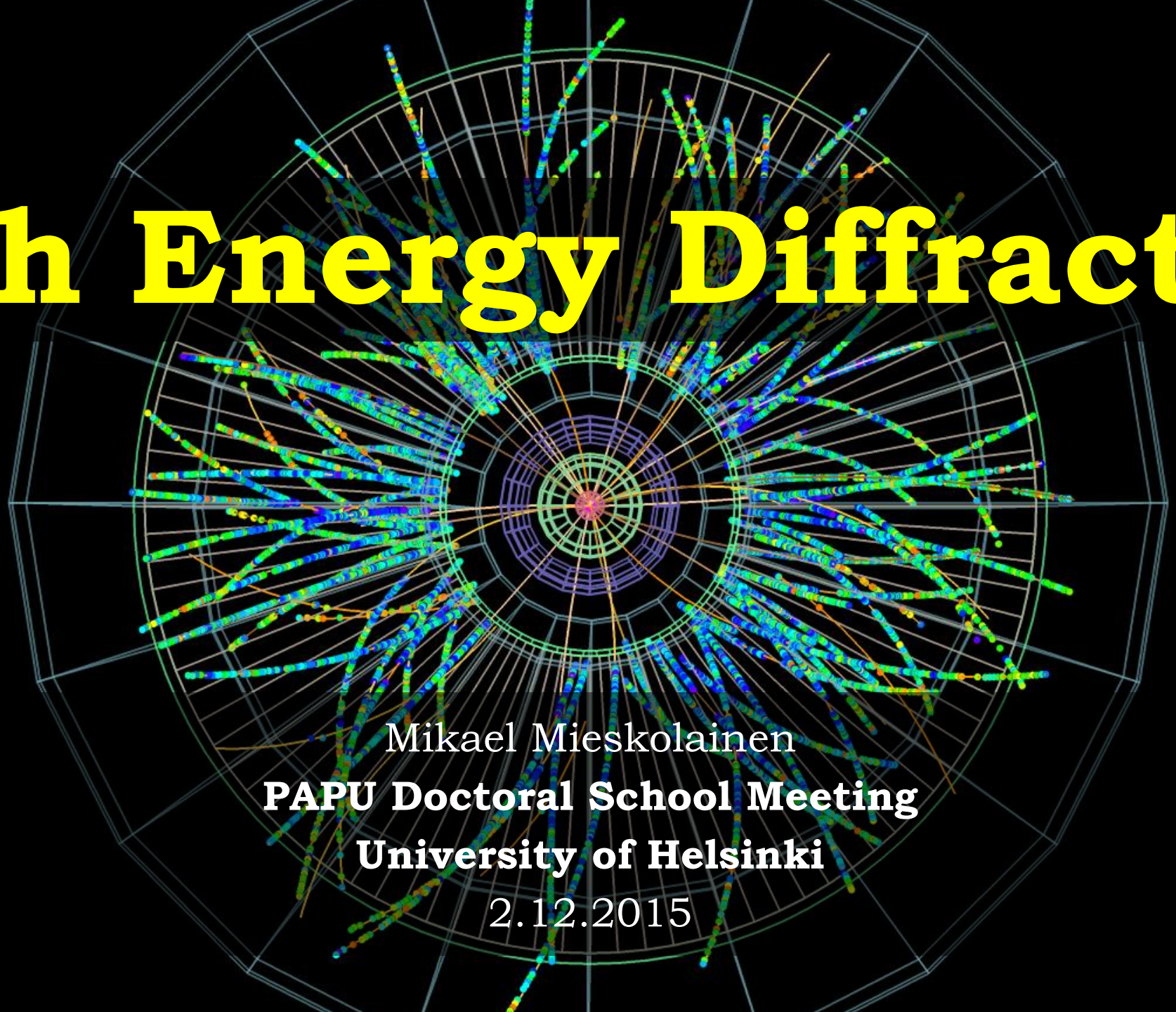
High Energy Diffraction



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PAPU Doctoral School Meeting

University of Helsinki

2.12.2015

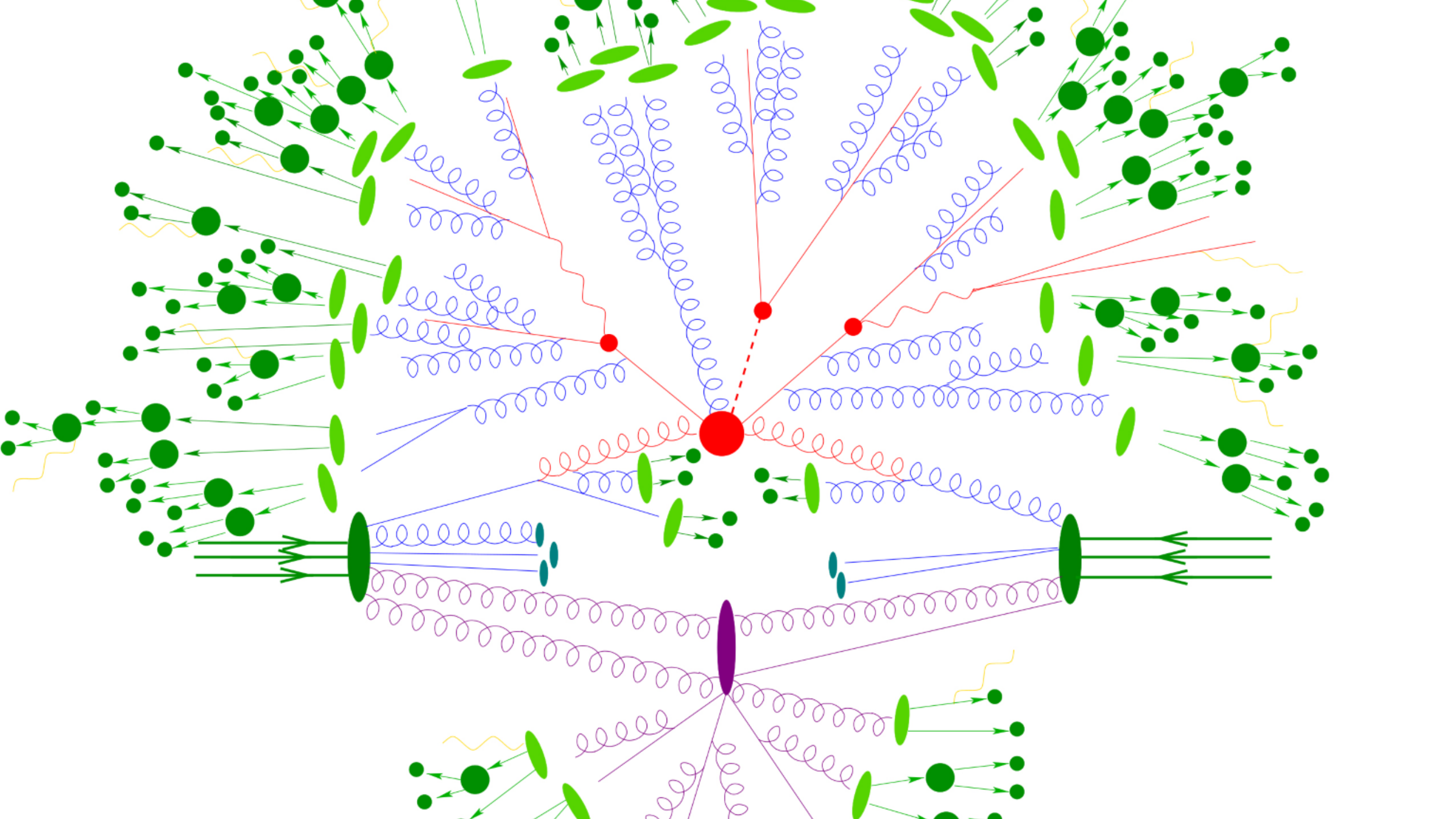
High Energy Hadronic Diffraction?

A simple, non-technical* description: Quantum Mechanical ***coherence*** during the relativistic space-time evolution of high energy proton-proton collision → ”multiple” long wavelength (=soft*) **QCD** partons are ”truly aware” of each other via color charge.

Exact ***scattering amplitudes*** for soft QCD diffraction are unknown!

Classic subject with high technicality, already puzzled Feynman, Bjorken, Gribov… Started with the S-matrix theory of strong interactions, **Regge** poles appeared → early strings were born, **parton image** appeared, QCD was invented, perturbative techniques evolved, some insight from pQCD side to diffraction (BFKL Pomeron etc.) but big mysteries remained.

*More technical folklore: ”at Born level 2-gluon system / Pomeron driven processes with no net charge transfer”, ”t-channel vacuum exchange”, ”processes with large rapidity gaps”…
*Q^2 is the 4-momentum transfer squared (”soft” ~ a few GeV^2)

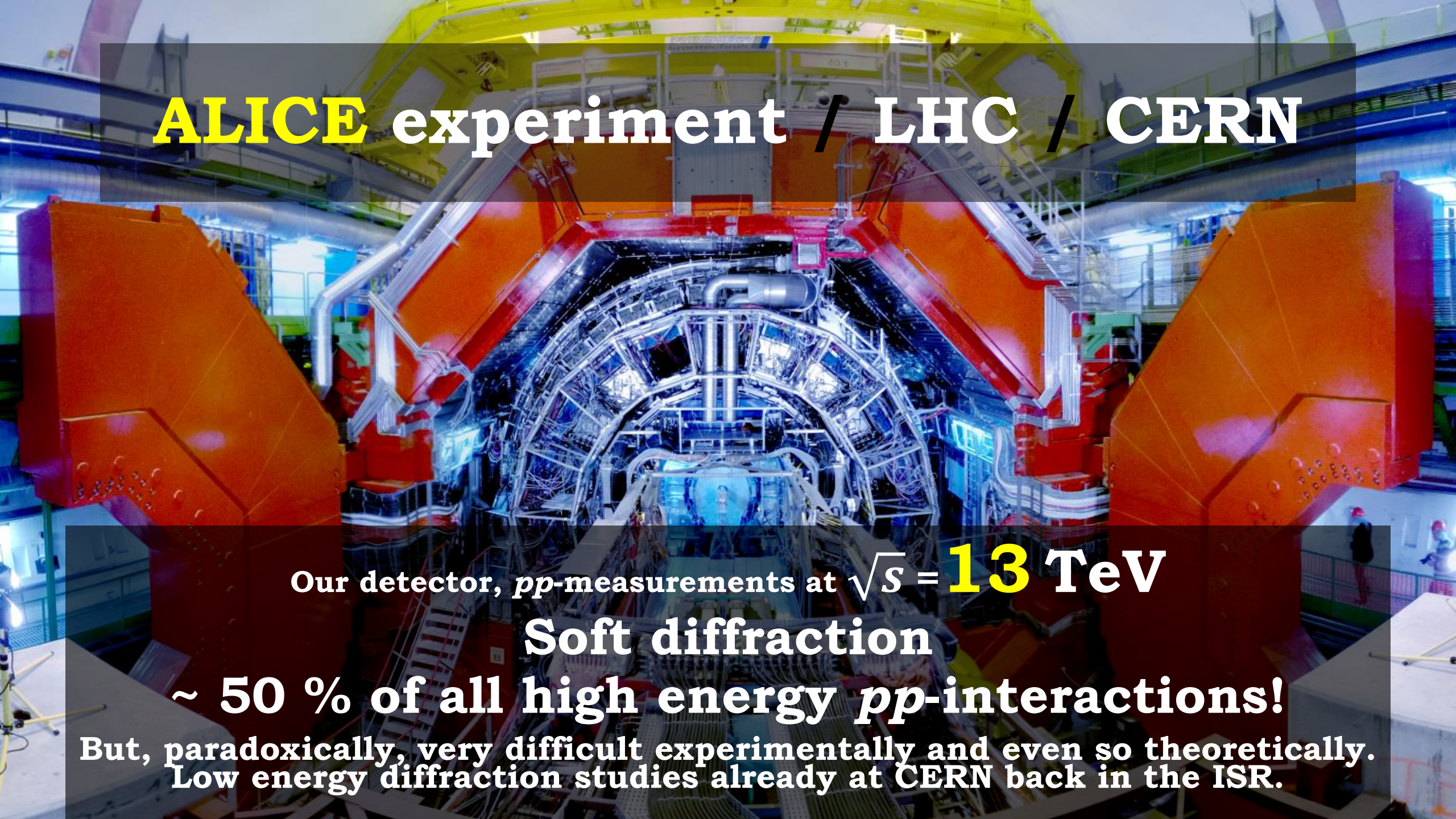


QCD *pp*-event at the LHC in a nutshell

Cookbook Recipe for a hard event:

Pick a hard parton pair ***incoherently*** from protons according to the parton densities in (x,Q^2) evolved to the event hard momentum scale Q^2 and then evaluate the fixed order (maybe NLO) hard QCD Matrix Element squared, dress with initial state and final state parton showering. Finally hadronization and hadron decays. Add underlying event and QED radition, you got an event. Plus some spices. Remember to conserve energy-momentum!

With low-Q^2 **soft diffraction**, this image is not adequate at all. Things are not perturbative, partonic degrees of freedom questionable and things do not factorize in a same way. Things are ***coherent***.



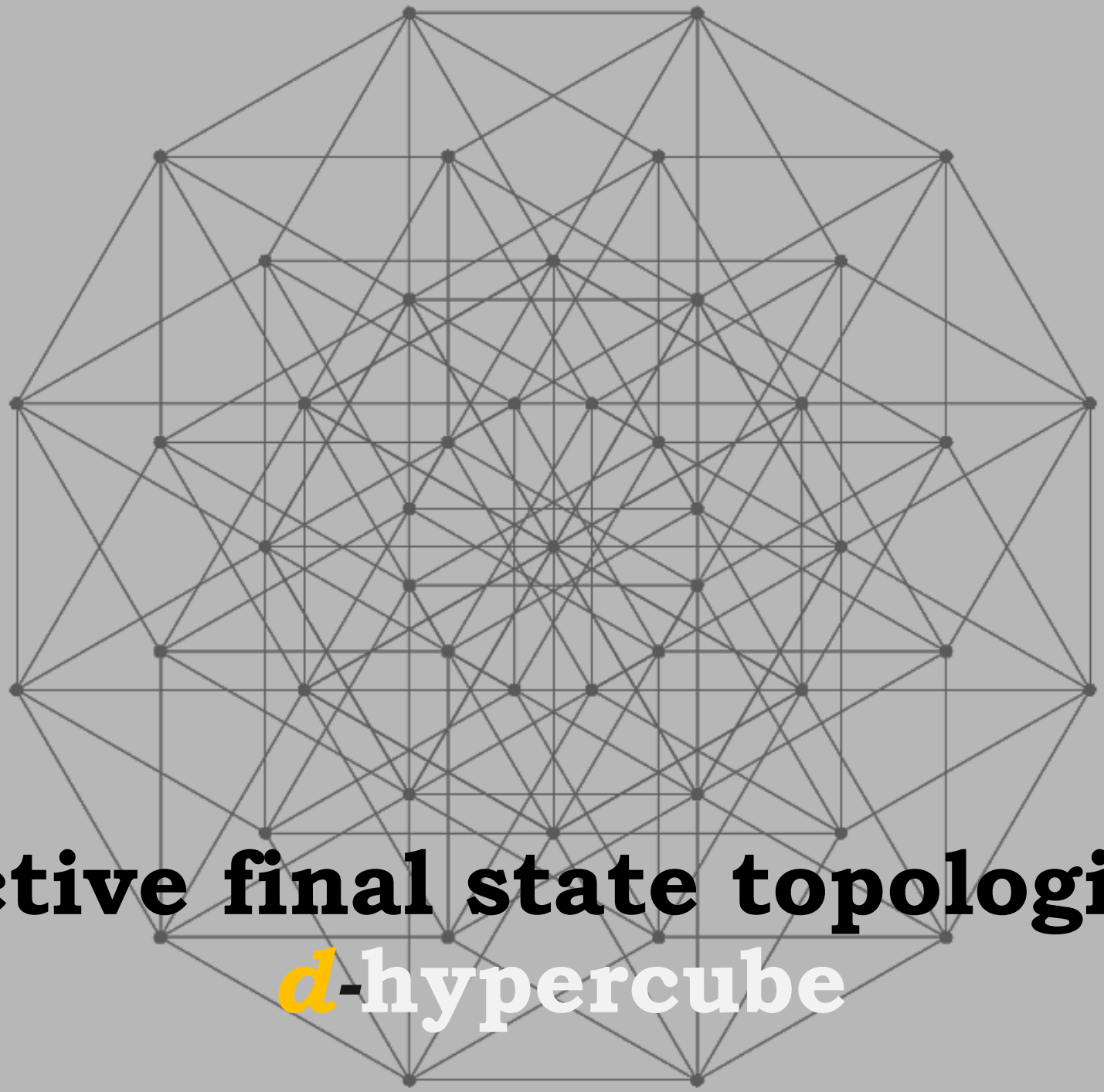
ALICE experiment / LHC / CERN

Our detector, *pp*-measurements at $\sqrt{s}$ = 13 TeV

Soft diffraction

~ 50 % of all high energy *pp*-interactions!

But, paradoxically, very difficult experimentally and even so theoretically.
Low energy diffraction studies already at CERN back in the ISR.



Diffractive final state topologies as a *d*-hypercube

PhD studies so far, supervisor prof. Orava

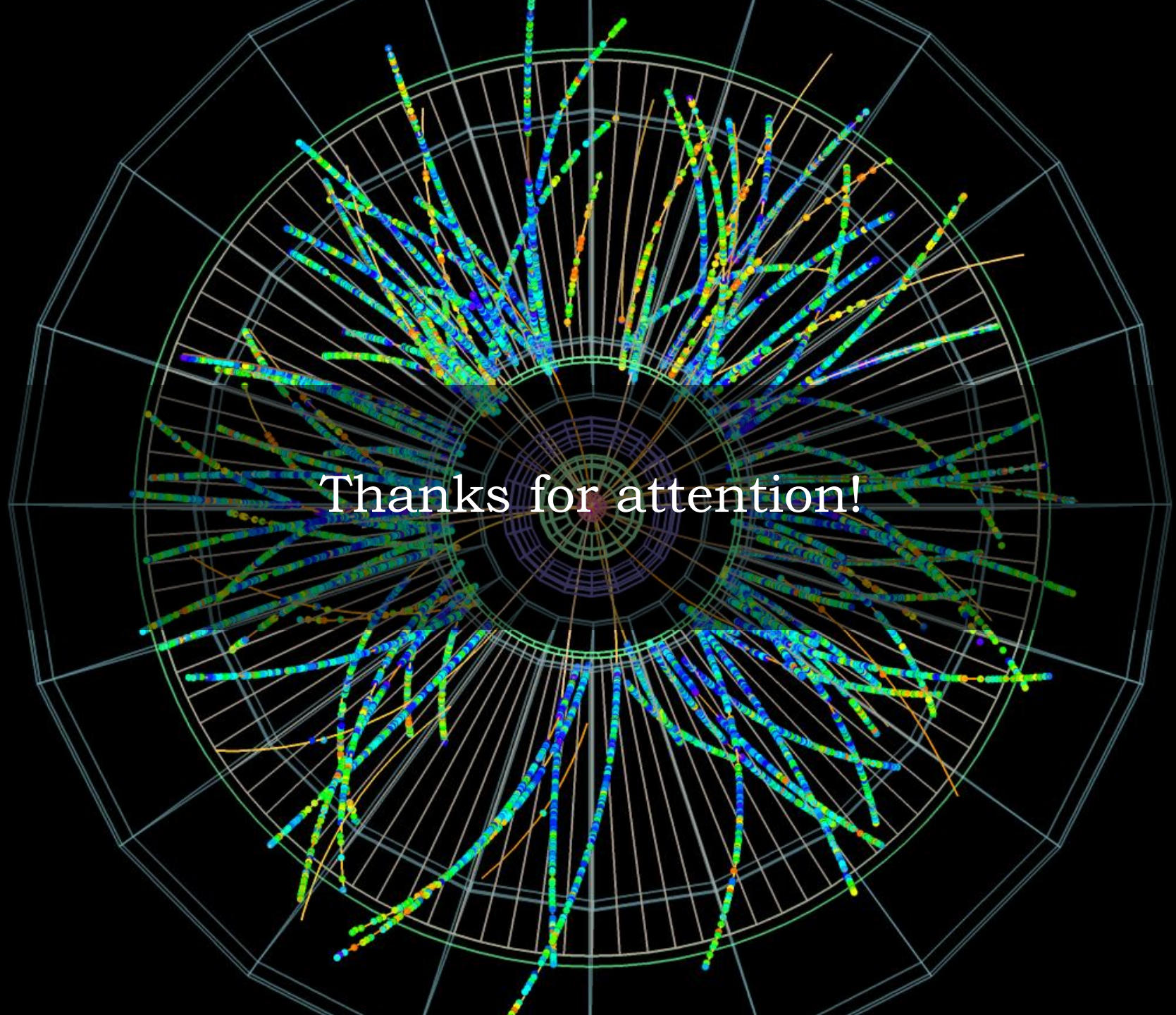
♥ A mathematical, probabilistic formalism for the unification of theoretical definitions of soft diffraction and measurements. The main theme.

♦ ALICE Physics Analysis of soft *inclusive* and soft *exclusive* (definite final state) production. In exclusive production glueball candidates! Supervision of HIP summer students at CERN.

♣ Special Monte Carlo (MC) event generator implementations. Extensive studies of the existing Soft QCD / Diffraction MC models. Spin dependent decay and production for the exclusive case.

♠ Regge theory/phenomenology studies about Regge factorization and unitarization and the experimental probes for that. Several deep unknowns.

Underlying theme: a complete overhaul of the *definition* of soft diffraction.


Thanks for attention!