LHC Luminosity Upgrades

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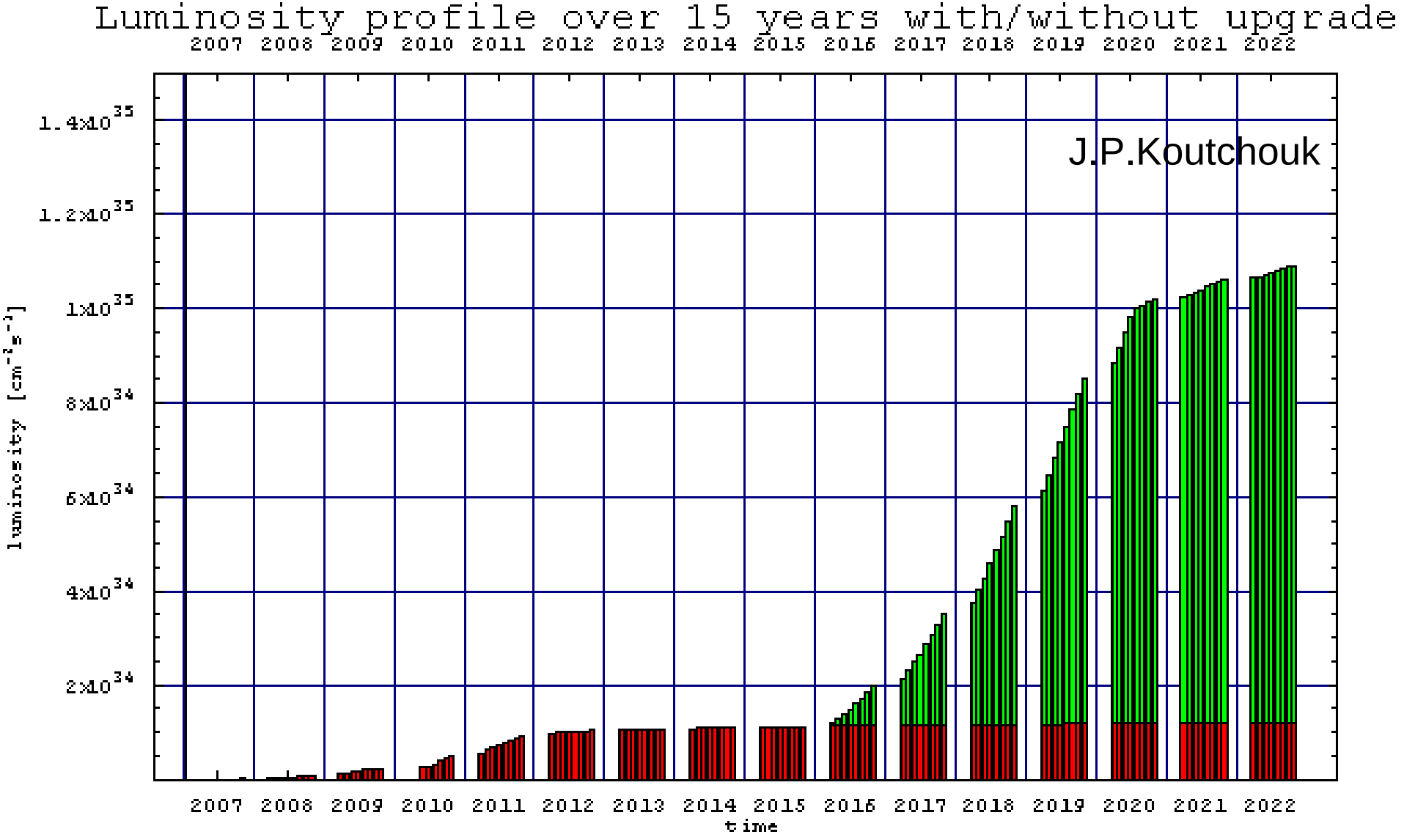
“Desired” LHC Luminosity Evolution



Things that are known to be a problem

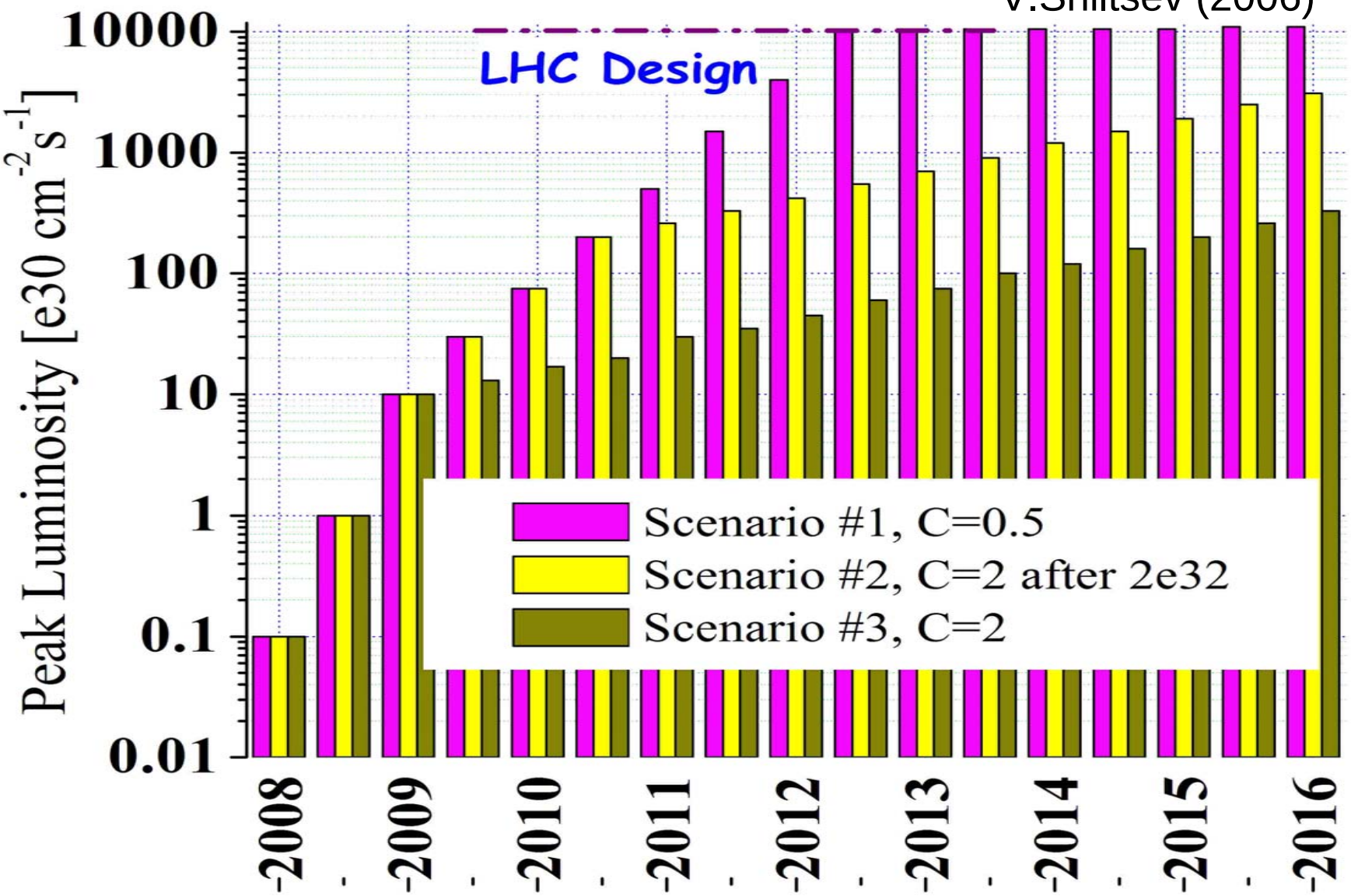
1. Unrealiable injector chain (SPS, PS, Booster, Linac)
2. >100 units of chromaticity snap-back on the ramp
3. Electron cloud
4. Inefficiency of Phase I collimation system
5. Impedance of the machine (coherent instabilities
6. Beam-beam effects

Things that may be a problem

1. Orbit jitter due to GM, PSs, beam screen -> emm blowup
2. Cautious QPS does not allow to run
3. Detector background, abort gap beam at 450 GeV
4. Emittance blowup at injection and ramp
5. Slower than expected turn around time
6. Fewer days of operations than expected
7. Longitudinal instabilities, losses
8. Energy deposition in IR magnets
9. 1001 other reasons (failures, RF trips, kickers, power, cryo)

“Realistic” LHC Luminosity Scenarios

V.Shiltsev (2006)



Ways to improve luminosity - I

- Reduce beta* from 55cm to:
  - NbTi magnets beta*=25 cm (Phase I)
  - Nb3Sn magnets beta*=25 to 8.7cm (Phase II)
- Reduce 0.4 mrad crossing angle to ~0
  - D0 Nb3Sn slim magnets in the detectors to separate beams early
  - Crab cavities
- Increase beam current or bunch intensity
  - Compensate long-range beam-beam by wires
  - Compensate head-on beam-beam by electron lenses
  - Reduce collimator impedance

Ways to improve luminosity - II

- Handle IR energy deposition and beam losses in rings
  - "Phase II Collimators" to handle design current (RC, crystals)
  - IR magnets aperture and shielding
- Smaller emittances
  - From new injectors
  - Shorter bunchlength by higher RF voltage
- All together:
  - Factor 3-10 possible in peak luminosity
  - 70% to factor of 3 in integral

LARP : IR Upgrade Vision

S.Peggs

Item	Total Cost $M	Technical Risk	Lumi Gain	LARP R&D
MAGNETS	**100**			
IR triplet Nb3Sn quads	90	Low	High	Ongoing
Slim magnets in detectors	10	Low	Moderate	FY08+
Magnetized TAS absorbers	-	Moderate	Moderate	
BEAM-BEAM COMPENSATORS	**4**			
Electron lenses for head-on	3	High	High	FY08+
Wires for long range	1	Low	Moderate	Ongoing
Small angle crab cavities	-	High	Moderate	Prelim.

Notes:

- Triplet quads: "low risk" assumes LARP R&D success in 2009.
- Slim magnets: ongoing discussion of scenarios at CERN.
- Electron lenses: R&D with beam at Tev & RHIC to lower risk.
- Crab cavities: back up plan for worst case beam-beam scenario.