# FCC challenges: Centre of mass Energy Calibration

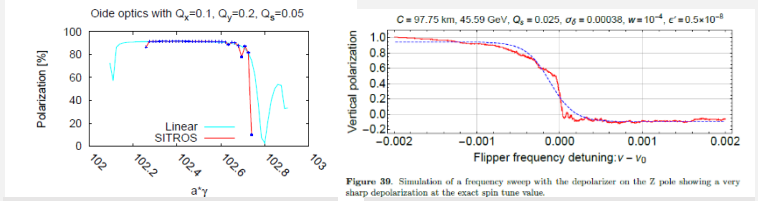
**Context:** FCC technical and financial feasibility study approved as CERN 'plan A'. First stage: 'tunnel and e+e- H/ EW factory'.

**Motivation:** precision measurement of $m_Z$, $\Gamma_Z$ , $A_{FB}(m_Z)$, $m_W$ allow exploring existence of more particles with SM Couplings

**Opportunities:** Huge lumi. → tiny stat. err. 4 keV on $m_Z$, $\Gamma_Z$
Resonant depolarization → 100keV (LEP,Z) or 6keV (VEPP4,J/ψ)
monochromatization *maybe* feasible for e+e- → H ($\Gamma_H$=4MeV)

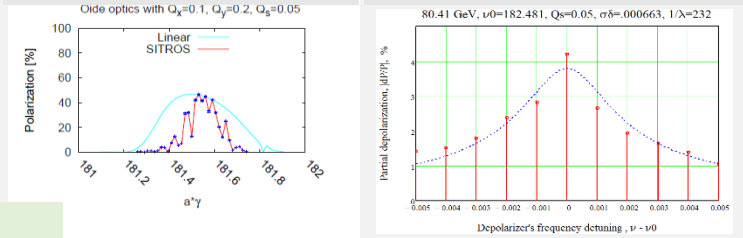
**Challenges: can systematics match achievable statistics?**

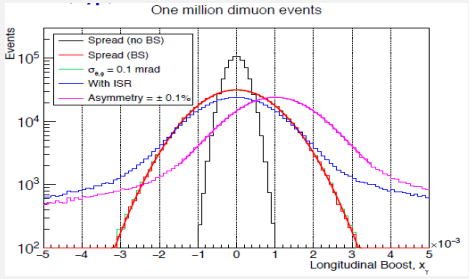
## Beam Energy measurement by RDP



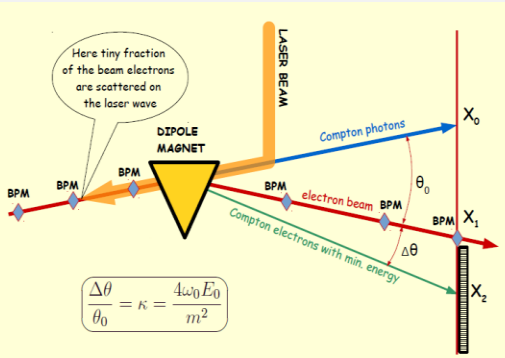

Sufficient degree of polarization at Z and W

resonant depolarization at Z (sweep) and W (steps)



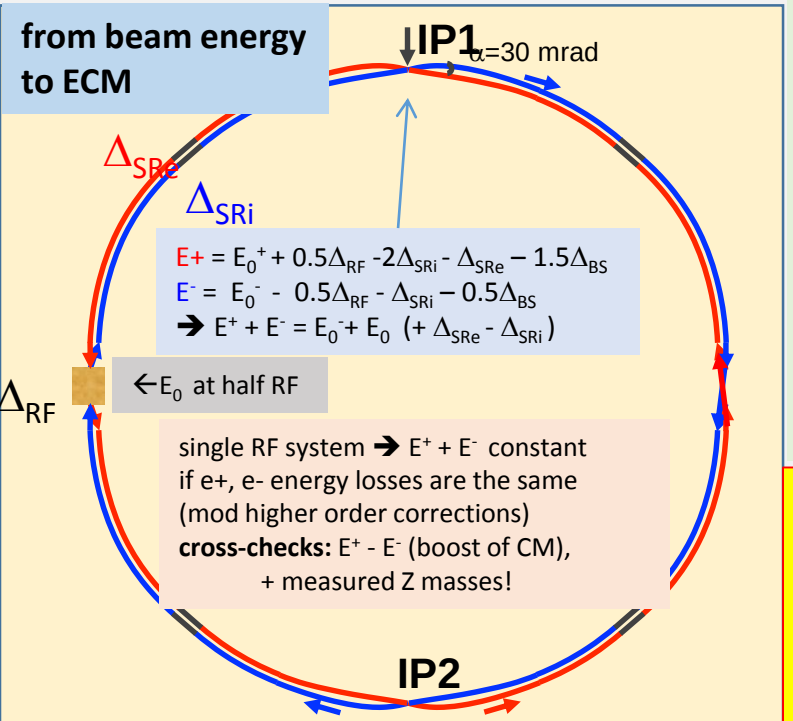




Muon pairs can be used to measure CM energy spread and average boost of CM




Compton Polarimeter uses scattered e & γ
e→ $P_yP_Z$ &Eb γ → $P_yP_x$

### from beam energy to ECM




**Plan to measure Energy by RDP on non-colliding pilot bunches. (1/10min)**

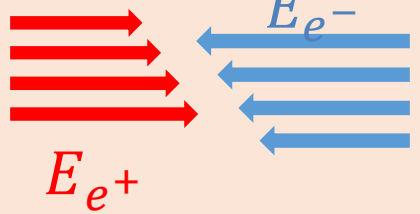
**Average energies $E_0$ around the ring** are determined by the magnetic fields
→ same for colliding or non-colliding beams
-- measured by resonant depolarization
-- can be different for $e^+$ and $e^-$

at the Z :
$\Delta_{SR} = 2\Delta_{SRi} + 2\Delta_{SRe}$ =36 MeV
$\Delta_{SRe} - \Delta_{SRi} \approx \alpha/2\pi\ \Delta_{SR}$ = 0.17 MeV
$\Delta_{BS}$ = 0 up to 0.62 MeV
Beamstrahlung E loss compensated by RF.

### A few big challenges

-- large ground motion! ±90MeV
-- $E_b$ vs $f_{RDP}$ in imperfect ring
-- interference with s,x,y motions
-- parasitic IP dispersions IP offsets
-- how well can we measure nul polarization?
-- how do we operate it all ?

**Issue from collision offset x parasitic opposite sign IP dispersion**
→ vernier scans and $D_{x,y}$ measurements
Radiative Bhabha monitor to measure beam-beam kick of colliding particles




FCC EPOL group:
arxiv 1909.12245

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