

# **WG2 (Collider Design) summary for Thu morning discussion**

**Daniel Schulte and Andrei Seryi**



**29 March 2018**

# ALEGRO 2018





## Why try for 10x versus 10%?

- When you shoot for 10x improvement you approach the problem in a radically different fashion.
- When you attack a problem as though it were solvable, even if you don't know how to solve it, you'll be shocked with what you come up with.
- 10x vs 10% improvement is 100 times more worth it...but, it's never 100 times harder.
- Finally, having a moonshot focuses and motivates your team, attracts the best talent in the world, and critically, allows you to solve interim problems and create interim products/services along the way.

*How to Disrupt Yourself With Moonshot Thinking...*  
Peter H. Diamandis, SingularityHub



- ***“Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world and all there ever will be to know and understand” – Einstein***



- **Motivations**
  - Long term, mid term, near term
- **Status of technologies**
- **Structure of WG for future ALEGRO**
  - Mechanisms for encouraging common efforts of design work



- **Long term**
  - **30 TeV e+e- or gg collider**
- **Mid term**
  - **Stand-alone advanced collider**
  - **Upgrade of ILC or CLIC**
- **Near term**
  - **Plasma Electron Proton Ion Collider**



- **30 TeV  $e^+e^-$  or  $gg$  collider**

From these examples, the goal would be to do **systematic searches for resonances and thresholds** in the 10 - 50 TeV energy region.

They give guidance that a narrow CM energy spectrum may not be needed. We can measure the resonance or threshold energies from calorimetry on the final state.

On the other hand, **CM energy, luminosity, and beam polarization** are crucial.

M. E. Peskin  
March 2018

**Can advanced acceleration technologies provide this?**



# Motivations – mid-term

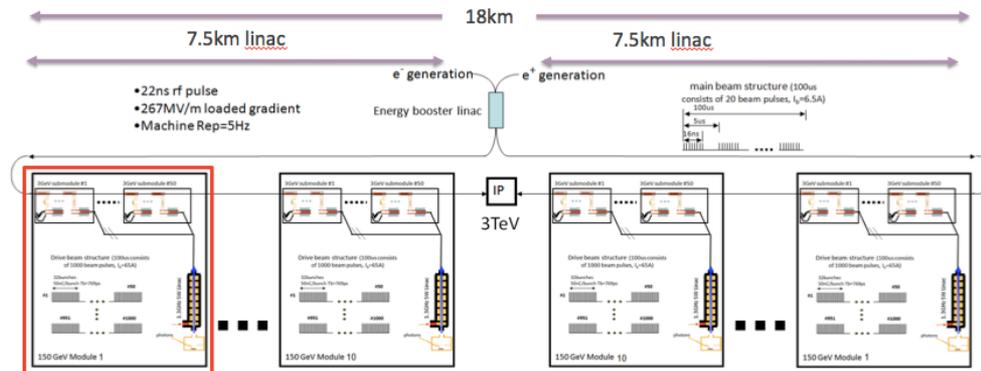
## • Stand-alone advanced collider – example

Andrei Seryi's megatable

Parameter	Concept dielectric TBA
Colliding species & $\sqrt{s_{e^+e^-}}$	e+e-
Upgrade or stand-alone	stand-alone
Final E CM, TeV & 1.0	3
Luminosity, $10^{34} \text{cm}^{-2} \text{s}^{-1}$	6.34E+34
Effective $L^* \text{m}$	
Detector forward exclusion angle, mrad	
Total length, km	18
Length of beam delivery, km	3
Repetition rate, Hz	5
Total wall plug power, MW	400/286/245
Colliding beam power, MW	31
IP beam sizes, X/Y, nm	
IP beam length, Z, mm	0.044
IP beam n-emittance, X/Y, nm	660/20
IP beam E-spread, %	
Colliding bunch population, $10^{10}$	
Initial E of colliding bunches, GeV	1500
Driver type & laser & e-bunch & p-bunch	e-bunch
Adv. acc. media & plasma & diel	structure
Driver E/bunch, J	50nC/bunch
Adv. acc. transformer ratio	6
Length of single adv. acc stage, m	750
Number of adv. acc stages	10
Effective gradient of adv. acc media	200

### SWFA Concept: Two-Beam Acceleration based on Cylindrical Dielectric Structures

#### 3TeV 30MW Beam Argonne Flexible Linear Collider

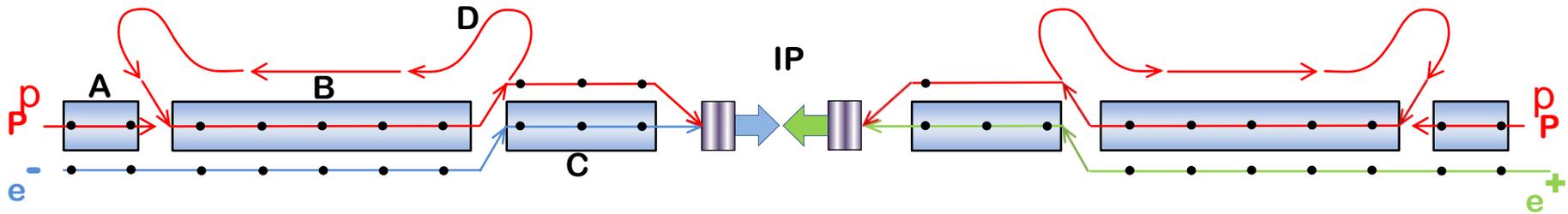


Based on scientifically mature and low cost Dielectric TBA technologies

- Short rf pulse (20ns) for high gradient ( $e^+ e^- 200 \text{MeV/m}$  of effective gradient)
- Modular design  $\rightarrow$  easily staged
- Wall plug efficiency (~10%)

John Power, ANL

- Upgrade of ILC or CLIC
  - Example – upgrade of ILC to ~TeV CM



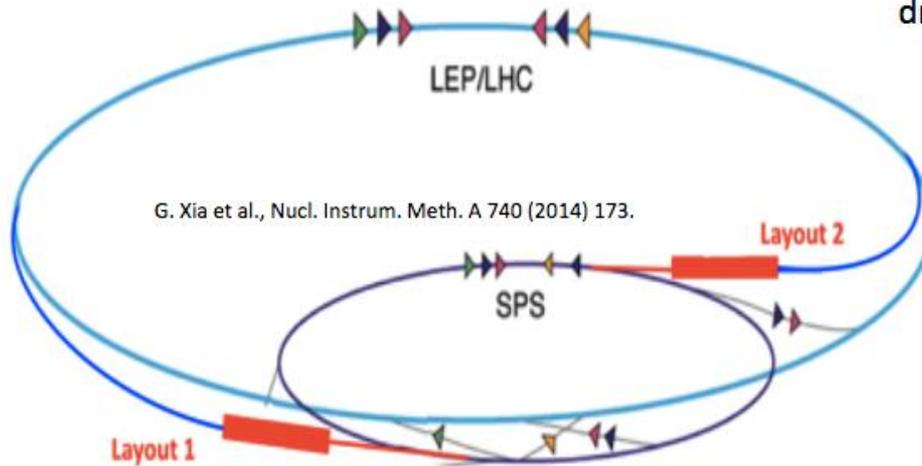
Concept of ILC 250 GeV CM Higgs Factory upgrade to ~2 TeV CM using plasma acceleration driven by proton beam

## • Plasma Electron Proton Ion Collider

### Physics with an Electron-Proton or Electron-Ion Collider

PEPIC: Plasma Electron Proton/Ion Collider:

Create ~50 GeV electron beam within 50–100 m of plasma driven by SPS protons, But luminosity  $< 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$ .



- What is the electron energy, e.g.  $E_e \sim 100\text{--}150$  GeV in 200m?
- Which luminosity can we reach?
- What is the physics programme, e.g focus on QCD and low-x physics?

- **Focus on QCD:** Large cross sections  $\rightarrow$  low luminosity enough (HERA level)
- Many open physics questions !
  - $\rightarrow$  High energy ep collider:  $E_e$  up to  $O(50 \text{ GeV})$ , colliding with LHC proton;
  - $\rightarrow$  e.g.  $E_e = 10 \text{ GeV}$ ,  $E_p = 7 \text{ TeV}$ ,  $\sqrt{s} = 530 \text{ GeV}$  already exceeds HERA cm energy.

Edda  
Gschwendtner,  
CERN



- **Gradient established for plasmas**
- ...
- **Beam quality, efficiency, project integration => ...**



- **WGs should be structured according to systems of collider (for near term future)**
  - **WG Physics Case**
  - **WG Acceleration (plasma, swfa, etc)**
  - **WG Power Sources (drive beam, laser, etc)**
  - **WG Luminosity Delivery (beam sources, beam cooling, tolerances, stabilization, focusing)**
    - **May need to be split to several groups eventually**
  - **WG Detector (Machine Detector Interface)**