The Upgraded Argonne Wakefield Accelerator Facility (AWA): a Test-Bed for the Development of High Gradient Accelerating Structures and Wakefield Measurements

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The AWA Approach: a Realistic Path to a Future HEP Machine

Use short RF pulses

It is well established that shorter RF pulses are less likely to cause breakdown. The energy efficiency and structure bandwidth can be made appropriately high.

Use advanced structures (e.g. dielectrics)

Dielectric materials are likely to withstand higher electric fields than metals, without arcing.

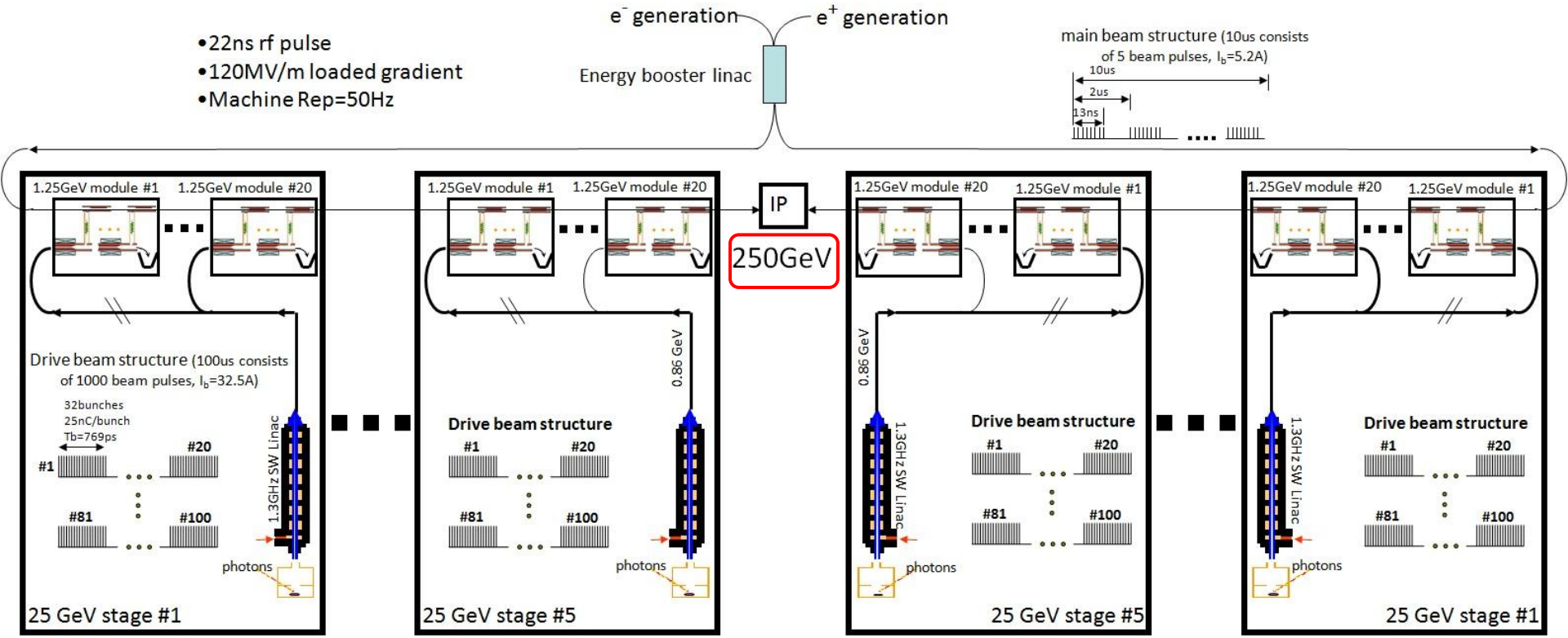
Use structures that can accelerate electrons and also positrons

Since colliders are assumed to need electron beams and positron beams, it is sensible to develop accelerating structures that can operate with either.

Use schemes that allow for staging

The phase of the RF pulses generated needs to be precisely defined and controlled, allowing the use of multiple stages.

ANL Flexible Linear Collider



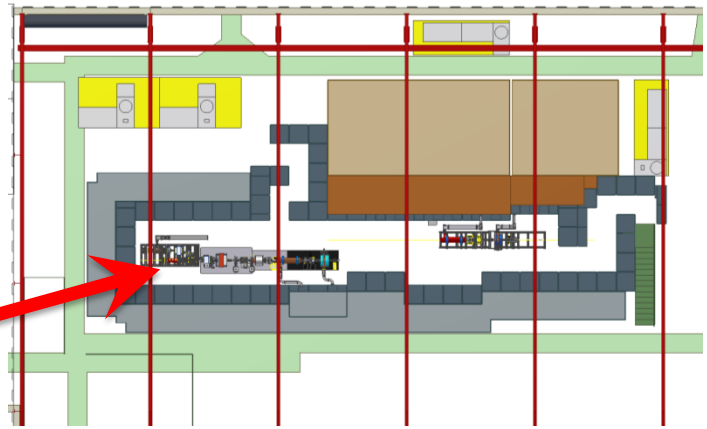
Core of Concept:

1. Short rf pulse: tens of nanosecond
2. Modular TBA scheme: energy scalable easily
3. Flexible drive beam structure

AWA Facility Upgrade

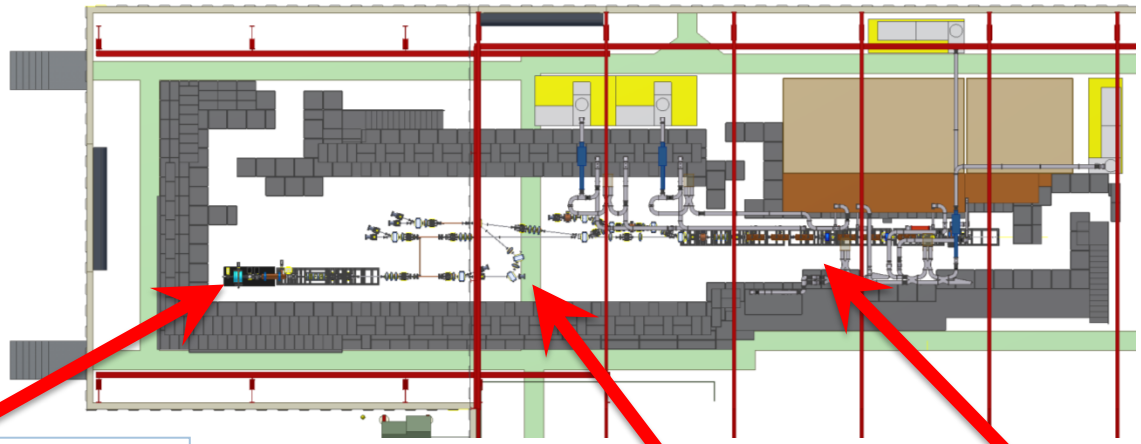
Before…

15 MeV drive beam: 100 nC as a single bunch or split into bunch train



Generates:
tens of MV/m
tens of MW

After…



15 MeV witness beam

new beamline switchyard (collinear, TBA, phase space)

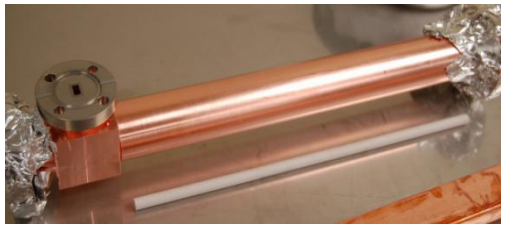
75 MeV drive beam: train with 100 nC per bunch

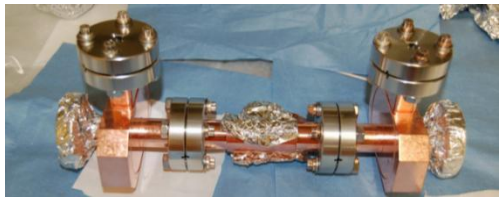
Generates:
hundreds of MV/m
hundreds of MW

Planned Main Experiments at AWA within 2~3 years (mostly relevant to LC development)

Experiment Group	Experiment List	Experimental Goal
High Power High Frequency rf generation	1) High charge bunch train generation and characterization	Demonstrate the high current drive beam in the new AWA drive beamline
	2) 26GHz dielectric wakefield power extractor w/ BBU control	Demonstrate multi-hundreds MW short pulse rf generation
	3) 11.7GHz metallic wakefield power extractor	Demonstrate multi-hundreds MW short pulse rf generation
Two Beam Acceleration	4) 26GHz TBA experiment	Demonstrate short pulse high gradient TBA scheme
Collinear wakefield acceleration	5) Ring beam and coaxial two channel structure 2nd run	Demonstrate high transformer ratio
	6) Shaped bunch generation	Demonstrate the triangular bunch using EEX technique
	7) High transformer ratio w/ shaped bunch	Demonstrate high transformer ratio w/ a shaped bunch
Beam diagnostics	8) Emittance measurement	New diagnostic method
Wakefield	9) Wakefield measurement of CLIC choke mode structure	Characterize a new CLIC wakefield damping structure

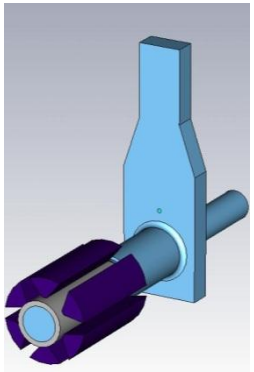
Objectives to be Achieved with Upgrades

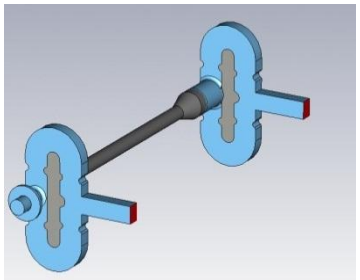




- Higher gradient excitation: **~ 0.5 GV/m** in long structures.
- Acceleration of witness beam: **~ 100 MeV**
- Higher RF power extraction: **~ GW level**

Example of 26 GHz dielectric loaded structures for two-beam-acceleration experiment:





Decelerating structure	**Accelerating structure**
ID / OD / length (mm) 7.0 / 9.068 / 300	ID / OD / length (mm) 3.0 / 5.025 / 300
Dielectric constant 6.64	Dielectric constant 9.70
Group velocity 0.254 c	Group velocity 0.111 c
R/Q 9.79 kΩ/m	R/Q 21.98 kΩ/m
RF power (50 nC) 1.33 GW	Shunt impedance 50.44 MΩ/m
Peak gradient 167 MV/m	E_{acc} (1.26 GW) 316 MV/m
Energy loss 20.5 MeV	E_{loaded} (1.26 GW) **267 MV/m**

Longer Term Goal: Staging