1. Cyclotron facility at CYRIC

- K110 MeV Cyclotron
- Two cyclotrons are used for research and education in:
  - Nuclear Physics
  - Nuclear chemistry
  - Nuclear engineering
  - Nuclear medicine
- A dock of university hospital for PET patients
- Officially open to internal users of university

2. Location of CYRIC and Earthquake

- Sendai city is located 70 km from Sendai.
- The earthquake happened 70 km from Sendai. It was Level 9.0, including 7.1 of Land 4 as of June 8th, 2011. (5.0 - 8.2 MHz, 502560)
- Fukushima nuclear power plant is 100 km away from Sendai city.
- Japan is below the global average (2.4 m/year)

3. Damage of cyclotron pillars

- The K110 MeV cyclotron is produced in ArcelorMittal (PMC) facility, whose dimensions are 1.7(W) x 0.8(D) x 4(H) m.
- Upper portions of the pillars were partly damaged.
- A task force of Tohoku University for the accident was estabished on CYRIC.

4. Damage around the cyclotron

- The cyclotron should be leveled to within 200 µm.
- No fatal damages for the cyclotron were found.
- Pipes for cooling water were damaged.
- 10 electromagnets were broken.
- No electromagnetic fields were severely limited for 3 weeks.
- Many aftershocks happened including 170 Level 4 as of June 8th, 2011.

5. Damage of shielding doors

- Shielding door was fully moved to outside.
- Officially open to internal users.
- Damage: 28 buildings (4.7%) were damaged.
- Damage to buildings: Dangerous - 28 buildings (4.7%)
- Damage to cooling water: approx. 1.2 million-dollar
- Damage to electricity: approx. 1.2 million-dollar
- Total: approx. 9.1 million-dollar

6. Other damage in cyclotron facility

- Buildings of CYRIC: Many cracks were observed, but not serious damage.
- HM12 cyclotron: 1. Piping parts were broken.
 2. Piping for cooling water was dropped and damaged.
 3. Cooling water was poured inside the steel sheets.

7. Summary of damage

- Costs for repair of cyclotron accelerator facility: approx. 0.6 million-dollar
- HM12 cyclotron: approx. 2.0 million-dollar
- Beams line: approx. 3.5 million-dollar
- Safety for radiation people: approx. 1.4 million-dollar
- Total: approx. 7.1 million-dollar
- Damage of buildings was estimated on April 13.
- Damage to buildings: Dangerous - 28 buildings (4.7%)
- Damage to facilities: approx. 440 million-dollar
- Damage to radiation people: approx. 560 million-dollar
- Damage to facilities: approx. 1.4 million-dollar
- Safety for radiation people: approx. 1.4 million-dollar
- Total damage: approx. 526 million-dollar

8. Road to recovery

- Repair of shielding doors was assigned the highest priority.
- Repair of K110 cyclotron was started after shielding doors were completed.
- Repair of K110 cyclotron was started after shielding doors were completed.
- Cyclotron was slightly jacked up with 4 hydraulic jacks.
- Cyclotron was slightly jacked up with 4 hydraulic jacks.

9. Repair of shielding doors

- Shielding door was fully moved to outside.
- 20 electromagnets were broken.
- 20 electromagnets were broken.
- Air-conditioning duct was fallen down.
- Cable was fallen down.
- Air-conditioning duct was fallen down.
- Cable was fallen down.

10. Repair of cyclotron pillars

- Pillars were surrounded by steel sheets.
- Support for puller of pillars were installed.
- Upper yoke is lifted up and supported with 4 threaded rods.
- No communications due to the electric outage.

11. Realignment of cyclotron

- Cyclotron was slightly jacked up with 4 hydraulic jacks.
- Cyclotron was slightly jacked up with 4 hydraulic jacks.
- Damage to buildings: Dangerous - 28 buildings (4.7%)
- Damage to cooling water: approx. 1.2 million-dollar
- Damage to electricity: approx. 1.2 million-dollar
- Total: approx. 9.1 million-dollar

12. Acceleration test

- July 3, 2012
- Equipment such as RF system were removed.
- Acceleration chamber was removed.
- Cyclotron was positioned with an accuracy of ±2 µm.
- 480 million-dollar
- 560 million-dollar
- Partially resumed on Mar. 31.
- Subway was partially resumed on Mar. 14.

13. In progress and to do

- Before the great earthquake:
  - Rods for tracks, power supplies, tools, etc., are fixed on the wall.
- After the great earthquake:
  - Brackets of yokes (145 µm) were installed.
  - Upper yoke is lifted up and supported with 4 threaded rods.
  - Brackets of yokes (145 µm) were installed.
- Beam line was restored in late October.
- Beams line was restored in late October.

14. Countermeasures to the earthquake

- Brackets of yokes (145 µm) were installed.
- Upper yoke is lifted up and supported with 4 threaded rods.
- Brackets of yokes (145 µm) were installed.
- Before the great earthquake:
  - Beams line was restored in late October.